Sept. 15, 1942. T. F. BANIGAN ET AL 2,295,823

ARTIFICIAL STRUCTURE

Filed June 5, 1940 2 Sheets-Sheet 1

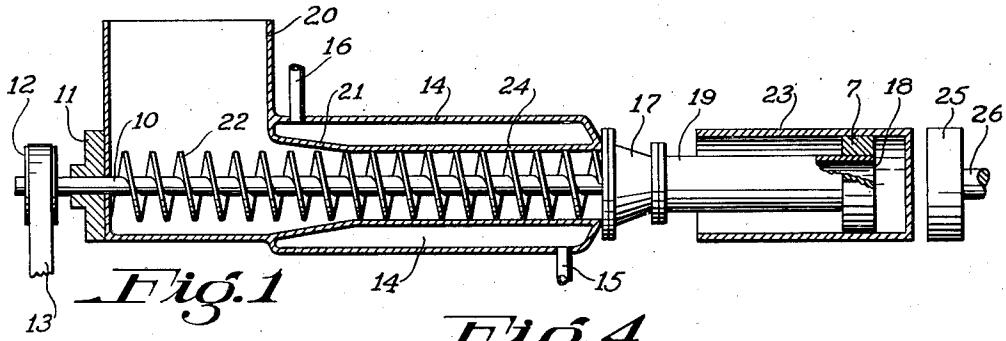


Fig. 1

Fig. 4

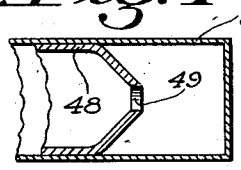


Fig. 2

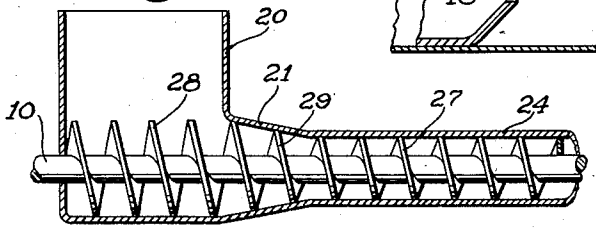


Fig. 6

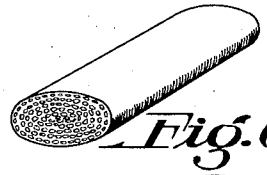


Fig. 7



Fig. 5

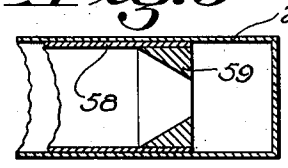


Fig. 8



Fig. 3

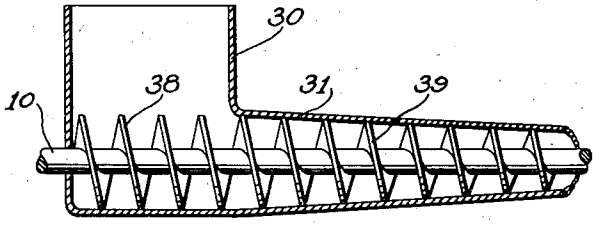
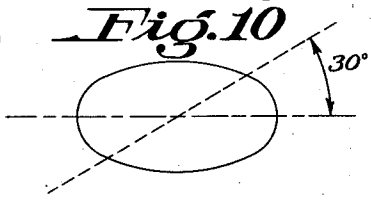


Fig. 9



Fig. 10



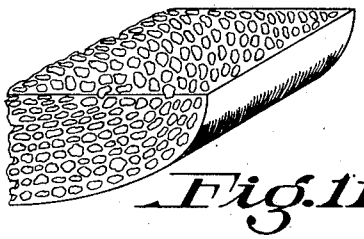


Fig. 11

Thomas F. Banigan
INVENTORS
Omar E. Snyder
BY
ATTORNEY

Sept. 15, 1942. T. F. BANIGAN ET AL 2,295,823

ARTIFICIAL STRUCTURE

Filed June 5, 1940 2 Sheets-Sheet 2

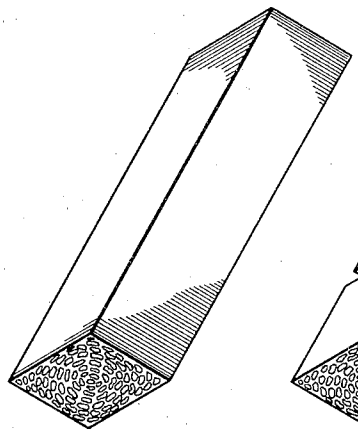


Fig. 12

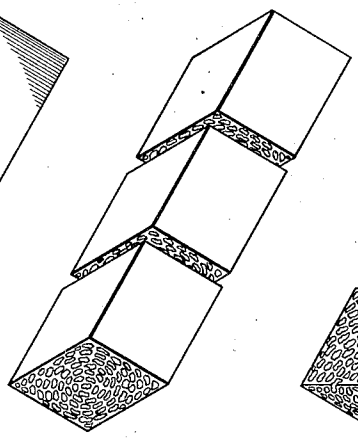


Fig. 13

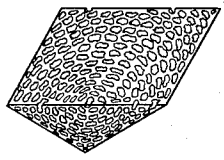


Fig. 14

Fig. 15



Fig. 16



Fig. 17

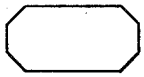


Fig. 18

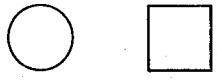


Fig. 19

Fig. 15A

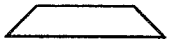


Fig. 16A

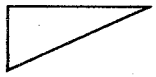


Fig. 17A

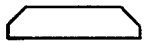
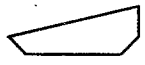


Fig. 18A



Fig. 17B



Thomas F. Banigan
Oman E. Snyder
INVENTORS
BY Paul Adler
ATTORNEY

Patented Sept. 15, 1942 2,295,823

UNITED STATES PATENT OFFICE

2,295,823

ARTIFICIAL STRUCTURE

Thomas F. Banigan, Kenmore, and Omar E. Snyder, Buffalo, N. Y., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application June 5, 1940, Serial No. 338,850

4 Claims. (Cl. 15—244)

This invention relates to artificial sponges, especially the production of cellulosic sponge from cellulosic solutions or dispersions, for example, viscose.

The development of the artificial sponge art has been greatly hindered by the inability of the workers therein to make wide use of machinery. The mechanical difficulties are inordinate in the filling of molds with coagulable sponge material. For example, when the molds are filled by means of extrusion presses the resulting sponges are anisotropic, particularly in strength characteristics. If the press is of the screw conveyor type, additional effort is necessary to get the sponge mass to feed evenly from the receiving hopper to the conveying screw.

In our earlier U. S. A. Patent 2,280,022, we have shown how molds can be satisfactorily filled by means of extrusion presses. Various features in the filling of molds with a screw-conveyor extrusion press are critical as pointed out hereinafter.

It has been recognized for some time that sponge masses produced by known processes are extremely non-uniform, and that the small individual sponge units cut from the molded block have very pronounced lines or planes of weakness. This effect is found not only in sponge material produced by discontinuous molding processes, but also in the material produced by continuous molding (extrusion). With the extruded products the orientation is very noticeable because the sponge material is much stronger in the lengthwise direction (the direction of extrusion, that is, along the "grain") than it is in the transverse direction (across the "grain"). As a result, the sponges heretofore produced have been incapable of giving long and efficient service because of the ease with which they were broken or torn.

It is an object of this invention to produce artificial sponge structures which do not possess an objectionable orientation of constituents, and/or in which the direction of orientation is controlled so that maximum durability and working strength are obtained. Other objects are to extrude sponge masses from which the resulting sponges will not possess an objectionable orientation of constituents, to uniformly produce sponges of regenerated cellulose which possess useful tensile strength along all their main axes, to extrude cellulosic sponge masses which upon coagulation and/or regeneration will give sponges which tend to have substantially uniform tensile strength in all directions, to manufacture sponge of high durability and freedom from the orientation called "grain," to provide an improved extrusion apparatus for filling sponge molds in one operation, to provide an improved screw extrusion apparatus for filling sponge molds, to provide extrusion nozzles which will function to obliterate surfaces of separation in a sponge mass in which fibers and crystals have become oriented along definite lines, planes or surfaces, and to fill molds with sponge masses having controlled fiber and pore-forming substance alignments. Still another object is to avoid air pockets, surfaces of separation, and weakening lines of solid material orientation in molded sponge masses. A general advance in the art, and other objects which will appear hereinafter, are also contemplated.

From the following description and specific examples, in which are disclosed certain embodiments of the invention as well as details of what is believed to be the best mode for carrying out the invention, it will be apparent how the foregoing objects and related ends are accomplished. The written description is amplified by the accompanying drawings, in which:

Figure 1 is an elevation view partly in section of a screw-conveyor type extrusion press and the molding apparatus;

Figure 2 is a sectional elevation view showing particularly another form of screw;

Figure 3 is a sectional elevation view illustrating still another form of screw;

Figure 4 is a sectional elevation view showing another form of nozzle outlet;

Figure 5 is a sectional elevation view showing still another form of nozzle outlet;

Figure 6 is an isometric view of a finished sponge cylinder having an elliptical cross-section made according to this invention;

Figure 7 is an isometric view of the sponge of Figure 6 cut partway in a lengthwise direction to illustrate one step in the cutting of the sponge cylinder;

Figure 8 is an isometric view of one of the parts of the sponge of Figure 6 resulting from the completion of the cut indicated in Figure 7;

Figure 9 is an isometric view of the pieces of sponge resulting from the secondary cutting (or slicing) of the sponge piece of Figure 8;

Figure 10 is an outline showing the limiting angle within which the cutting of the sponge should take place; and

Figure 11 is a view related to Figure 9 but greatly enlarged to more clearly show the orientation of the sponge parts.

Figure 12 corresponds to Figure 6. It shows a molded sponge block ready to be cut into individual sponges.

Figure 13 shows the slicing of the sponge block of Figure 12.

Figure 14 shows an individual sponge which has been formed by slitting one of the sponge slices of Figure 13.

Figure 15 illustrates a sponge block of hexagonal cross-section;

Figure 15—*a* shows the preferred cross-section of a sponge piece slit from the sponge cylinder of Figure 15;

Figure 16 illustrates a sponge block of rectangular (tetragonal) cross-section;

Figure 16—*a* shows the preferred cross-section of a sponge piece slit from the sponge cylinder of Figure 16;

Fig. 17 illustrates a sponge block of octagonal cross-section;

Figure 17—*a* shows a preferred cross-section of a sponge piece slit from the sponge cylinder of Figure 17;

Figure 17—*b* shows another preferred cross-section of a sponge piece slit from the sponge cylinder of Figure 17;

Figure 18 illustrates a circular cross-section sponge cylinder;

Figure 18—*a* shows the preferred cross-section of a sponge piece slit from the sponge cylinder of Figure 18;

Figure 19 illustrates a square cross-section sponge cylinder; and

Figure 19—*a* shows the preferred cross-section of a sponge piece slit from the sponge cylinder of Figure 19.

In the practice of the invention there is first produced a pasty mass by mixing together viscose (cellulose xanthate solution), crystals of pore-forming substance and strength-giving fibers. The preferred viscose solution used contains between 5% and 10% of cellulose. The concentration of the viscose solution in the viscose sponge mixtures may be varied to meet the desires of the person operating the process.

Crystals of sodium sulfate decahydrate, preferably having one axis considerably longer than the other two, of the appropriate size or range of sizes to give the desired pore structure, are usually employed as the pore-forming material. An amount of pore-forming substance sufficient to form between 50% and 90% by weight of the total sponge mixture, is preferred. In sponges for ordinary uses the sodium sulfate decahydrate crystals should all pass through a screen having openings 0.5 inch in diameter. At least 50% of the crystals should pass an opening of 0.3 inch in diameter and stay at an opening 0.1 inch in diameter. Where it is desired to produce sponges of very fine porosity fine crystals only are employed and a portion of this pore-forming substance may be in the form of an anhydrous powder.

Preferably the fibers used may consist of fibers of jute, hemp, nylon, and the like. Other fibrous materials may be used if desired. One or more of these types of fiber may be used in the same mix. The best results have been obtained with fibers 0.2 to 2.0 inches in length. An amount of vegetable fiber between 0.5% and 3% of the total sponge mixture is preferred.

The components of the sponge mixture may be mixed with each other in any desired order and manner. The mixture, after being stirred and kneaded to form a uniform consistency, is transferred to the receiver (hopper) of a mold-filling extrusion press.

Referring now to the drawings, a complete extrusion and molding apparatus is illustrated in Figure 1. The aforementioned hopper is designated by the numeral 20. The sponge mixture is forced from the hopper under pressure through the delivery end of the press, comprising a conical section 21 and a cylindrical barrel portion 24, by a screw conveyor 22. The screw 22 is of uniform diameter throughout its length. Its shaft 10 extends through the hopper wall and a bearing 11. On its projecting end a pulley 12 is fixed. A belt 13 drives this pulley, supplying power to the screw. The tapered section 21, which facilitates the withdrawal of the sponge mixture from the hopper, and the tubular part 24, are surrounded by the hollow jacket 14 for controlling or maintaining the temperature of the sponge mixture. By means of an inlet 15 and an outlet 16, the temperature regulating fluid, for example water, can be circulated in the jacket to secure the desired temperature.

The mold in which the sponge mixture is coagulated is designated by the numeral 23. A nozzle 19 is provided for guiding the sponge mixture into the mold. Connecting the delivery end of the press and the extrusion nozzle is a tapered (or conical) conduit section 17 which constricts the sponge mixture coming from the barrel 24, causing a merging of the separate helices of sponge mixture formed by the screw.

The nozzle 19 and/or its orifice 18 are preferably circular in cross-section, but either may be of any other shape and need not necessarily conform to the cross-section of the mold. The mold is open at one end and closed at the other, as indicated. It is tubular and may be of circular, oval, square or any other desired cross-section.

The mold to be filled is slipped over the flange 7, being positioned telescopically on the nozzle 19 so that the bottom of the mold rests at the orifice 18. In order to apply the desired amount of pressure on the sponge mixture in the mold, a supporting member 25, mounted on the piston 26, is brought to bear on the bottom of the mold before the filling operation starts. The piston may be mounted in any desired manner, so long as the pressure which it applies to the bottom of the mold can be regulated. In one satisfactory form of apparatus the piston extends into a cylinder containing a gas or liquid. As the mold is filled, it is forced back against the member 25, which in turn forces the piston 26 into the aforementioned cylinder. The gas or liquid is allowed to escape from the cylinder through a release valve under a controlled pressure. The cylinder can be refilled at an appropriate time, causing the piston shaft to be moved against an empty mold. Ordinarily a pressure between 5 and 200 pounds per square inch is sufficient to produce the desired compactness of the mass in the nozzle and mold.

The thickness of the flange 7 depends upon the amount of bearing surface desired for the mold. It may even be coextensive with the nozzle 19.

The pressure applied by the screw 22 forcing the sponge mixture through the tubular parts 21, 24, and 17 and the nozzle 19 into the mold 23 against the member 25, will cause the expulsion of most of the entrapped air in the mass. When the sponge completely fills the mold the latter is removed from the press and is im-

mersed in a hot salt solution, or any other environment that will cause the viscose solution to coagulate or set. When the coagulation process is sufficiently advanced, the pore forming material is removed by washing and the sponge material removed from the mold. It is then washed dried and/or subjected to other finishing treatments, after which it is cut or sliced into units of desired size and shape. Purification operations may be carried out in the mold.

In Figure 2 a modified form of screw conveyor is illustrated. In this figure the screw conveyor has a small uniform diameter part 27, a large uniform diameter part 28, and a tapered part 29 which operates in the tapered portion 21 of the delivery end of the press.

In Figure 3 still another form of screw conveyor and a press delivery end conforming thereto, are illustrated. In this figure, 38 indicates the large uniform diameter portion of the screw, and 39 the tapered portion. In this form the tapered portion extends from the hopper and is conterminous with the delivery end of the press. The conforming tubular jacket for the tapered screw is indicated at 31, and the receiving hopper is designated by the numeral 30.

In Figure 4 a modification of the extrusion nozzle, in which the mold 23 conforms to and slides telescopically on the outside of the cylindrical nozzle 48, is illustrated. This extrusion tube is constricted at its exit to provide an orifice 49. The sponge mass traveling through the nozzle is first caused to contract and is then allowed to expand sharply just beyond the orifice. This contraction (or constriction) and expansion serves very effectively to break up undesirable orientation of fibers and salt crystals.

A somewhat similar device is illustrated in Figure 5. In this case the constriction at the orifice is obtained by locating a cone-shaped ring 59 in the end of the thin walled delivery nozzle. This arrangement provides the greatest amount of bearing surface for the mold while it is upon the nozzle.

In one specific example of the invention viscose containing 10% cellulose was mixed with one-half its weight of jute fibers and eight and one-half times its weight of crystals of sodium sulfate decahydrate, in the order named. The resulting mixture was pressed into a circular mold 5 inches in diameter under 25 pounds per square inch pressure. The diameter of the nozzle on the extrusion press which loaded the mold was approximately one-quarter that of the mold. The mixture in the mold was kept confined during the filling, and the mold which, when empty, was over the nozzle of the extrusion press, was retracted as filled at such a rate that the pressure on the sponge mixture in the mold was substantially constant, with the result that the sponge mass did not move along the sides of the mold. The sponge mixture was then treated in the usual manner to regenerate the cellulose. The sponge material obtained was very uniform in all directions.

In another example of the invention a quantity of viscose had added thereto Glauber's salt crystals and vegetable (jute) fibers in proportions to give a pasty mass such as is well known in the art for use in the production of artificial cellulose sponges. The mass was thoroughly mixed in a suitable mixing machine, and the resultant Glauber's salt-viscose-jute mixture charged into the cylinder of an hydraulic press. A tubular mold of 5 inches inside diameter, closed at one end, was then forced over the flanged end of the discharge pipe of the extrusion press so that the flanged end extended to the bottom of the mold and was conterminous therewith. The mold was then filled under such conditions that a pressure of 20 pounds per square inch was necessary to cause relative movement of the discharge pipe and mold, as the mold was filled.

When the mold had been filled (and retracted from the nozzle), it was removed and placed in a tank containing 15% sodium sulfate solution at 95° C. The filled mold was kept immersed in the hot sodium sulfate solution for 6 hours. During this treatment viscose was coagulated, and the pore-forming crystals melted and dissolved. At the end of this operation the mold was removed from the coagulating tank and allowed to drain free from excess dissolved sodium sulfate solution.

The sponge blocks were then washed while in the mold, after which they were removed and subjected to additional washing, bleaching and purifying procedures. The blocks were then dried for 24 hours at 90° C., after which they were cut into slices of the desired thickness. The product obtained by this process was found to have a more uniform tensile strength in all directions, and to exhibit no appreciable predisposition to tear in one direction over any other direction; neither were any specific planes of weakness apparent.

In still another embodiment of the invention a screw extrusion device of the type illustrated in Figure 1, the extrusion chamber discharge end of which had an interior diameter of 6 inches, was provided. The interior diameter of the discharge nozzle was 4 inches, and the interior diameter of the mold was 6 inches. The taper of the feed end of the extrusion chamber was such that the diameter began at 7 inches and tapered down to a constant bore of 6 inches in 9 inches lengthwise dimension. The constant bore section of the discharge chamber was 24 inches long.

A sponge mixture as herein described was charged into the hopper with the extrusion screw in motion. The entrained air was worked out as the mixture was compressed in moving through the tapered section. As the mixture continued to move through the chamber, a uniform helical orientation of the hemp fibers and of the pore-forming crystals was set up. The helical orientation was attenuated and somewhat compacted as the mixture moved through the discharge end of the extrusion chamber into the extrusion nozzle through the tapered section. The mass leaving the nozzle moved into the comparatively large mold with the change in its direction of movement which will be apparent from the description and drawings. There was a corresponding development of radial orientation with this change in movement direction. The combination of a tapered reducer and a discharge nozzle of appreciable length (several times its diameter) has the object of kneading and drawing the mixture delivered by the feed screw so as to attenuate and essentially obliterate the lines of separation between the adjacent sides of the helical ribbon of the mixture delivered by the screw. This makes for greatly improved tenacity and cohesiveness, even though the helical block structure caused by the screw (and which is desirable) still remains.

The filled mold was kept immersed in a hot sodium sulfate solution for 6 hours, with the result that the viscose was coagulated, and the

pore-forming crystals melted and substantially dissolved. At the end of this treatment the mold was removed from the coagulating tank and washed free from excess of dissolved sodium sulfate solution. The sponge blocks were then withdrawn from the molds, washed, bleached, purified, and glycerinated. They were then dried for 24 hours at 90° C., after which they were cut into slices of the desired thickness at right angles to the main (lengthwise) axis. The structure of the resulting sponge was found to have a controlled, uniform and useful helical orientation. The orientation of the structure of the sponge was such as to successfully resist tearing across any main axis thereof.

The slicing and slitting schemes of the two series of Figures 6—7—8—9 and 12—13—14 are interchangeable and either may be used with sponge block cylinders of other cross-sections. Individual sponges cut by these schemes from oval cross-section cylinders have curved backs which fit the hand and have a broad, flat working surface. The smooth skin on the back (the original molded surface) has an attractive appearance, and feel and makes the sponge easier to hold. The tapered ends make it easy to use in close quarters and give it flexibility that allows it to follow the contours of an irregular surface. The large, flat working surface (which may be grooved as a means of eliminating any tendency, as a result of suction, of the water-saturated sponge to stick to a surface being cleaned) covers a large area at each stroke without the necessity of applying considerable pressure to bring it in contact with the surface. The oblong cross-sections are preferred for the preparation of individual sponges by the methods described in connection with Figures 6–14, inclusive.

Variations in the cross-section of the sponge cylinder (blocks) are illustrated on page 2 of the drawings in Figures 15, 16, 17, 18 and 19. Other useful cross-sections will be apparent to those skilled in the art.

The sponge blocks should be slit on or within 30° to 40° of a major axis as indicated in Figure 10. The preferred cross-sections for the individual sponges are shown in Figures 7, 14, 15—*a*, 16—*a*, 17—*a*, 17—*b*, 18—*a* and 19—*a*.

If the sponge mixture contains materials capable of orientation during the molding operation, the process of this invention can be advantageously employed. Many types of sponge mixtures of this character are known to the art, and the applicability of the present invention thereto will be obvious to those skilled in this field. Any mixture employing solid pore-forming material gives better results when molded by the methods described above.

By forcing the sponge mixture against the bottom of the mold under pressure, a further merging of the helices, resulting from the screw conveyor, is obtained. A complete random orientation of the fibrous material can be produced by suitable choice of mold sizes, nozzle sizes, extruding pressures and the like, but a controlled orientation or alignment of fibers and crystals is preferred. The orientation of the semi-elliptical sponge of Figure 10 is parabolic with the curve of the parabola away from the extrusion nozzle. The same orientation is shown in the diamond or rhombus-shaped sponge cylinder of Figures 12, 13 and 14.

The combination of a tapered reducer, such as that shown at 17 in Figure 1, and a discharge nozzle having a constricted orifice like that illustrated at 58 and 59 in Figure 5, accentuates the effect of controlling the orientation of the sponge mixture ingredients.

The flange 7 may be equipped with an expansible skirt which will further insure against leakage of the sponge mass between the flange and the mold. Ordinarily this is not necessary because the flange fits snugly against the inside of the concentrically disposed mold. Absence of the expansible skirt permits the hydraulic or other pressure applying member 25 to force the mold on to the nozzle until the flange touches the bottom of the mold.

Although a jacket for controlling the temperature of the extrusion chamber is preferred, this is not critical.

A constant pitch screw for the press is preferred.

Although a threaded shaft can be used to regulate the pressure applied to the bottom of the mold during filling, the piston type fluid press is preferred, because the speed of retraction is more easily correlated with the force and speed of filling the mold.

The apparatus of Figure 3, in which the screw tapers down to a bore substantially the same as the diameter of the delivery end of the press, enables a more gradual compacting of the sponge mass to be obtained.

In the preferred embodiment of the invention the extrusion chamber (parts 21 and 24) is not less than twice as long as the internal diameter of the constant bore section (part 24), unless an arrangement whereby forced feed is employed in the hopper is used.

The sponges produced in accordance with this invention are very appreciably better than those produced according to the prior art, even when a screw extrusion press was used. The sponges of the prior art have definite planes of weakness which give rise to tears across the main axis. Sponges of the present invention are characterized by having very long service life, principally because there is no plane of weakness across any main axis, and because of their high tensile strength in all directions. It is difficult to tear it cleanly across the sponge in any direction, and it is difficult for the sponge to come apart in use. The uniform distribution of the reenforcing fibers and the controlled orientation thereof gives a high tensile strength in all directions, which causes the sponge to wear evenly. Some of the improved strength is also due to the removal of entrapped air in the pasty mass as it passes through the tapered section of the extrusion press. Sponges produced according to prior art methods tear and break readily when put to hard usage, thus making them unsuitable for operations like scrubbing.

The sponges of the present invention are also characterized by an improved wet softness as compared with the sponges heretofore known, and sponges produced by prior art methods. The reason for this improvement is not known, but the advantages thereof are substantial. Any gain in softness is immediately reflected in better public acceptance, since one of the previous difficulties in the sale of artificial sponges has been the fact that they do not feel like natural sponges when in the wet condition.

One of the most important advantages which accrue to the sponges when made in accordance with this invention is their notable uniformity from piece to piece (particularly in small sponges made from very large sponge blocks by several

parallel cuts in each of the slitting directions), an objective which has long been sought in this field.

The molding process, too, has many advantages. It makes possible the ready production of sponge blocks with a minimum of labor and cutting waste. In a simple embodiment of the invention the process consists merely in the molding of the sponge block, the coagulation, the purification and the drying of it, and the slicing of the resulting block into saleable sponges by cutting across the main axis. When the individual sponge has some of the original molded surface, the said sponge may be used to remove drops of water from washed surfaces, like chamois.

From the above it is believed apparent that the sponges of this invention are characterized by controlled, uniform and useful orientation of the strength giving fiber and of the pores resulting from the removal of the pore-forming material, and in résumé, it may now be pointed out that it has now been found that a durable, artificial sponge whose physical properties in the various directions are practically uniform can be produced by extruding the plastic or pasty sponge mass along a screw conveyor through a tapered reducing outlet and a discharge nozzle or conduit into a mold which is larger in diameter than the discharge conduit, which fits telescopically over such conduit and which retracts as filled so that the sponge mass does not travel along the sides of the mold.

In sponge cylinders of the type shown in Figure 6 the main orientation is to be found in the form of a spiral perpendicular to the axis of the cylinder. There is a second orientation present formed during the extrusion due to the fact that the center of the sponge mass being extruded into the mold moves faster than the outside, due to friction with the sides of the nozzle.

The "skin" which is formed when the pasty mass is coagulated in contact with the mold surface is quite smooth, and gives individual sponges of the type illustrated in Figure 9 a satisfactory "feel." The sponges of this invention, because of their uniformity of texture, are especially adapted for use in general cleaning and as absorbent media. Like other regenerated cellulose, they may be bleached and dyed. Suitably impregnated with various materials, the sponge also has a wide range of usefulness such as polishing silver, brass and other metal-ware. It may be impregnated with abrasive material and serve as a wet sanding tool, grinding, buffing and polishing wheels, etc. A sponge sheet or chamois may be coated with an artificial leather composition and used as a bookbinder or covering, or for other similar application.

In addition to the foregoing uses, mention may be made of sweat boats molded to fit highball glasses, washable dress shields, mats for sun bathers, baby crib pads, filters (in nozzles on kitchen sink water taps), high chair tray pads, pump packing, dust seals (gear cases and other lubricated machine parts), dust seals (for hydraulic brake systems), lubricant applicators, packing for journal boxes (railroad and mine car), and race-horse hoofs, sedimentation pads (in oil reservoirs of gear boxes, power transmission equipment, etc.), insulating pads (under soldering iron plates, etc.), non-sweating coverings (for pipes in buildings and homes to avoid dripping), menstrual pads (both exterior and interior types), exercising pads (for arthritis in ankle joints), wet dressings, abrasive pads on the back of horses' legs near the hoof, billiard cue tips, shot shell wadding, dice board pads, hot plate pads, table pads, hospital bed pads, table coasters, clothes pressing equipment pads, seat pads, stuffing for mattresses and pillows, refrigerator door gaskets, stuffing for blankets and quilts, thermal and sound insulating material, bumpers (to protect boat sides), bottle cap gaskets, bottle and flask stoppers, shot gun recoil pads, cushions (for protecting the ankles of race horses), windshield cleaners (impregnated with liquid for preventing ice formation), lithographic equipment dampening rolls, grips (for squash and tennis rackets), wicks on wet bulb hygrometers, football helmet pads, absorbents in hats, sub-surface mats (to conserve moisture in seed flats), beehives, blotters, means for absorbing excess grease from fried foods, moistening pads (for counting money, wetting stamps, envelopes and the like, etc.), radiator humidity pads, wiping pads (in industrial rolls and industrial conveyors), reservoirs (impregnated) for insect fumigants, absorbent or filling media for liquids or gases, dry mulch (for winter garden protection), and mushroom spawn beds.

Pieces of the sponge material of various configurations may be very satisfactorily employed in applying wax (to linoleum floors, furniture and automobiles), cleaning and polishing (kitchen stoves and ranges), cleaning (statues, art objects, Venetian blinds, etc.), crumbing tables, removing spots (from cloth and clothing), washing and cleaning (ice boxes and refrigerators), washing floors, applying oil to leather, removing oils, fats, etc., from dry cleaning solvents, removing oils from boiler feed water, removing oils from gas streams, lubricating pneumatic hoists and tools (air stream takes up oil in passing over sponge), massaging gums, cleaning and washing engines, cleaning and wiping soft plastics, cleaning auto distributor heads, cleaning auto steering wheels, cleaning batteries, cleaning dye vats, cleaning show cases, cleaning spark plugs, cleaning tire tubes and casings (in making repairs), cleaning tools (with kerosene or other solvents), applying gasoline or other cleaning fluids to lathes and machine tools, washing and renovating railroad passenger cars, washing infants and children, washing animals and vehicles, washing off cashiers' counters, washing out metal lockers, wiping off butchers' blocks, removing face creams and organic tissue protective compositions, cleaning aluminum (during the manufacture of utensils, wire, etc.), cleaning accurately machined or ground parts (in manufacture), finishing metal (rubbing down preliminary coats of paint), processing in photographic and X-ray work, cleaning plate-glass during manufacture, and cleaning silverware during manufacture.

This material also has a use in filtration in the manufacture of wines, in brewery filtration, in the general filtration of liquids, in the general filtration of gases, in the filtration of meat sauces and condiment sauces, in the filtration of milk and dairy products, in the filtration of viscose coagulating baths, in emergency equipment for ambulances and first-aid kits, in medical work for casts (impregnated with a stiffening medium), in post mortem work, in fish bait (impregnated with decayed fish or other lure), in grout removal (in water proofing of brick buildings), in hat (felt and straw) manufacturing processes, in lithograph plate etching and pre-

paring, in pottery and ceramic manufacture, in florist shop uses, and in laundry and dry cleaning uses.

The product may also be used as an absorbing medium in cold inhalers, as a base material for hydroponic growth of plants, as an absorbing medium in acetylene cylinders, as a base material for impregnation with ferric oxide for removal of sulfur from air and gas, as a base material for impregnation with metallic salts to lend color to fireplace fires, as a resilient filling and stuffing medium, as table pads, coasters, hospital bed pads and the like when two laminae of sponge material are joined with a latex lamina, as a textile applicator or wiper, as a structural material (impregnated sponge material stiffened for use in aircraft), and as a soap dripping catcher in soap racks.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that this invention is not limited to the specific embodiments thereof except as defined in the appended claims.

We claim:

1. A hand size regenerated cellulosic sponge bounded essentially by a rectangular surface of sponge-like porosity, a relatively smooth curved surface intersecting said rectangular surface at opposite boundaries thereof, and two plane surfaces perpendicular to said rectangular and curved surfaces, said sponge structure being characterized by essentially paraboloid-like areas of somewhat reduced strength disposed about an axis centrally located in the said rectangular face and parallel to its boundaries of intersection with the arcuate surface, and with great resistance to tearing normal to said paraboloid areas.

2. A hand size regenerated cellulosic sponge having a regular internal structural arrangement comprising strengthening fiber and whose outer surface consists substantially of a flat working face, two flat ends and a cylindrical surface back, said ends being oval segments, the subtending chords of which constitute edges of the working face, said sponge having a controlled internal structural orientation comprising substantially nested hemi-paraboloid-like strengthening fiber alignments, the direction of nesting being substantially parallel to an element of the cylindrical surface back, said sponge having great resistance to tearing normal to said paraboloid areas.

3. A hand size regenerated cellulosic sponge having reenforcing fibers and good wet softness, and being adapted for cleaning automobiles, said sponge having a tetragonal working face, a cylindrical surface back comprising the smooth molded-surface skin arching between opposite edges of the working face, and semi-oval ends whose subtending chords form the other two edges of the working face, said sponge having a controlled reenforcing fiber orientation in which the main orientation is in the form of a helix and nested hemi-paraboloids whose axis is perpendicular to the said semi-oval ends.

4. A cleaning device comprising a regenerated cellulosic sponge whose outer surface consists of a tetragonal plane working face, two substantially semi-oval segment ends whose subtending chords constitute two edges of the working face, said ends being substantially perpendicular to said face and a cylindrical surface back therebetween, the said subtending chords being the longest chords of the said ovals, and the said sponge having an internal orientation of strengthening fiber similar to a nest of hemi-paraboloids, the segmenting plane of which paraboloids is in the working face of said sponge.

THOMAS F. BANIGAN.
OMAR E. SNYDER.