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W. L. WEBB ET AL
METHOD AND APPARATUS FOR THE PRODUCTION
OF HOLLOW BODIES
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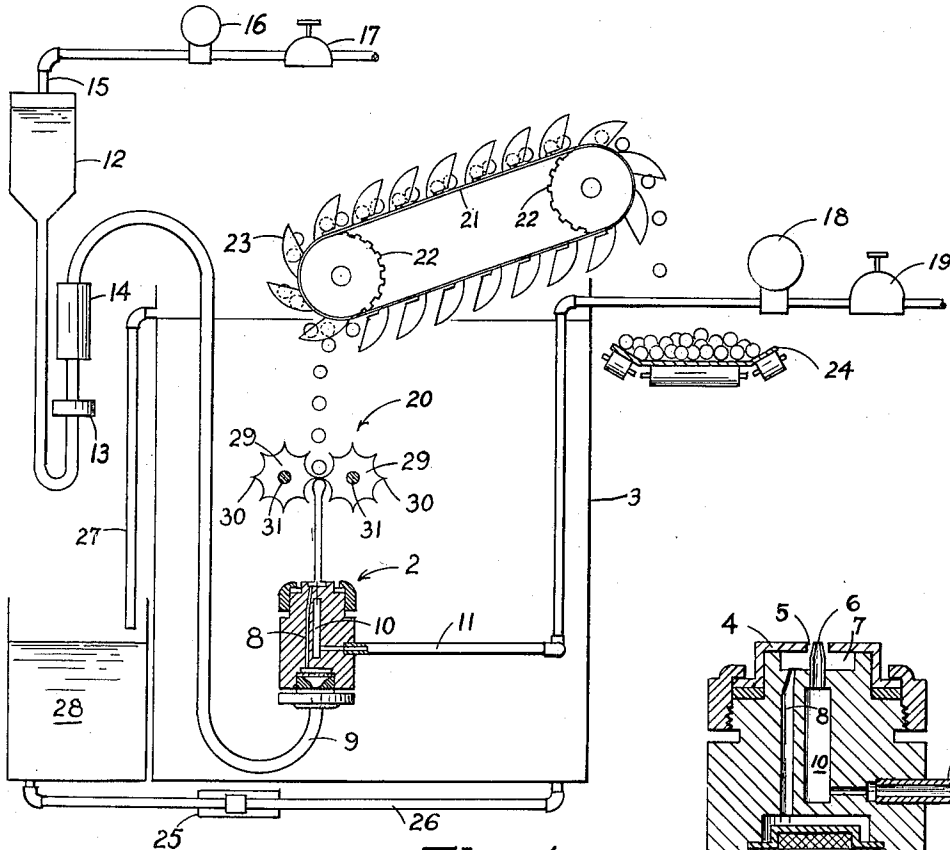


Fig. 1

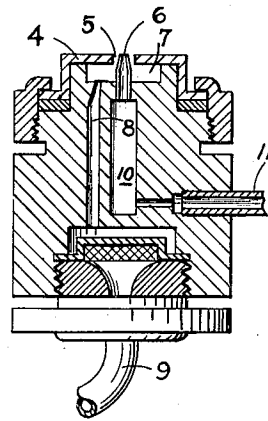


Fig. 2

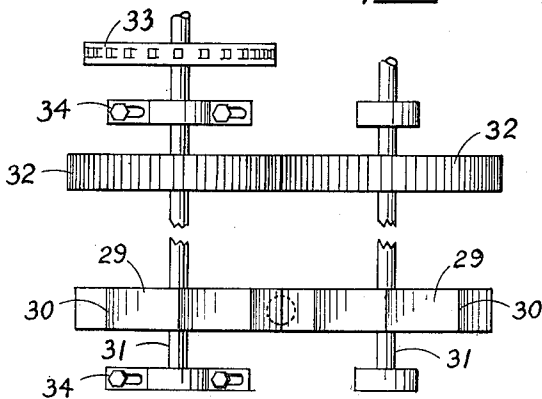


Fig. 3

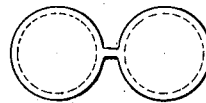


Fig. 4



Fig. 5

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METHOD AND APPARATUS FOR THE PRODUCTION OF HOLLOW BODIES

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12 Claims. (Cl. 18—14)

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This invention relates to the production of artificial masses in the form of hollow globules of more or less ovoid or spherical shape, or a plurality of such globules arranged in a manner so that they resemble a string of beads.

It has heretofore been suggested to produce hollow bodies by continuously extruding a relatively thick filament or slender rod-like stream of a film-forming or filament-forming material and intermittently injecting a bubble of air or other gas to form a string of spaced hollow globules having the appearance of a string of beads. This process requires special equipment to assure proper control of the air-supply. It is difficult to obtain uniform results because intermittent flow of the air must be provided.

It is an object of this invention to avoid these difficulties by providing a process and arrangement whereby a continuous stream of air is utilized in the production of the hollow globules. A further object of the invention is to provide a process and arrangement whereby a tubular mass of the globule-forming material is continuously extruded and the gas therein is caused to expand the tubular mass along a portion of its length, after which the expanded portion may be sealed off from the rest of the tubular mass or severed entirely therefrom, such expansion and sealing or severing being repeated indefinitely. Further objects and advantages will be apparent from the drawing and its description hereinafter.

In the drawing, illustrative of the invention—
Figure 1 shows somewhat diagrammatically one arrangement, in elevation and partially in cross-section, of the invention;

Figure 2 is a detail view of the extrusion device of Figure 1;

Figure 3 is a plan view of the cutter device of Figure 1;

Figure 4 shows one form of product obtainable in accordance with this invention; and

Figure 5 shows another form of product obtainable in accordance with this invention.

Referring to Figure 1, an extrusion device 2 (which may be one of a plurality thereof) is arranged in the container 3 (which may take the form of a trough with its length extending at right angles to the plane of the drawing where a plurality of devices 2 are used). The device 2 is preferably arranged to extrude the material

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to be formed in a substantially vertical direction within the coagulating or setting bath in the container 3 and, as better shown in Figure 2, comprises in its simplest form a spinneret 4 having an orifice 5 through which a hollow needle 6 extends. An annular space 7 is in communication with the orifice and surrounds the needle 6. The annular space 7 is connected to a supply of material to be formed by means of the passage 8 and the line 9. The needle 6 is connected to a supply of air or other gas under pressure by means of the passage 10 and line 11.

The material to be formed may be provided in a supply vessel 12, an adjustable measuring pump 13 and a filter 14 being disposed in the line 9 connecting the supply vessel 12 with the extrusion device 2. If desired, the upper region of the vessel 12 may be connected to a source of compressed air by line 15, and this line may be provided with a gage 16 and a pressure-regulating valve 17.

Line 11 may be provided with a gage 18 and an adjustable pressure regulator valve 19 to facilitate control of the gas or air flow there-through.

A hollow tube of the material to be formed is formed by the extrusion device and extends upwardly therefrom in the form of a column. A cutting device 20 is arranged at a suitable distance above the device 2 and intermittently cuts the column of material.

The distance of the device 20 above the extrusion device 2 may vary widely. Preferably it is sufficiently large so that the external surface of the formed material becomes coagulated and is substantially free of stickiness, though the material is still in a plastic condition. Under such conditions, no special treatment of the cutting or pressing portions of the cutter members is needed to prevent fouling thereof by adhesion of the material being cut, and yet the interior of the tube of material, not having had direct contact with the coagulating medium, is still sufficiently adhesive to be effectively sealed by the pressing involved in the cutting action. When, however, cutting is effected at a position of the column where there is a tendency of the material to adhere to the cutter members, the operative portions of these members may be coated with an oil or grease or any other sub-

stance which does not tend to adhere to the particular material being cut.

As one globule is cut from the column, the latter is sealed at its top and another globule begins to form immediately below the point of sealing as a result of the fact that the lowest external liquid pressure exists along this portion of the column. The more or less spherical globules thus cut off rise to the surface of the coagulating bath from which they may be removed by any suitable device. For this purpose there is shown a pair of endless chains 21 driven continuously about the sprockets 22. The chains carry a plurality of ropes 23 having curved prongs and are arranged to dump the globules onto a belt 24, which may run along one side of the trough 3 and convey the globules to a drying device or to a station where they may be subjected to further treatment preparatory to conveyance to a drying device or to other stations for additional treatment.

A pump 25 may be arranged to circulate fresh coagulating medium at any desired rate into the vessel 3 through the pipe 26. An overflow pipe 27 directs the surplus medium into the reservoir 28. If desired, an arrangement may be provided in advance of the reservoir 28 for restoring the composition of the overflow to correspond to the composition of the coagulating medium as initially supplied to the vessel 3.

As shown more particularly in Figure 3, the cutter may comprise a pair of co-operating fluted cutter members 29 having sharp peaks 30 arranged to effect intermittent cutting as the members are rotated. Preferably, the speed of rotation is so adjusted as to impart a peripheral speed at the peaks 30 substantially equal to, or larger than the speed of upward ascent of the tubular column extruded. The members 29 are mounted for rotation on shafts 31 (which may extend the length of the vessel 3) which carry driving gears 32 at one end thereof. Motion may be imparted to one of the shafts 31 by a sprocket 33 or equivalent means. One or both of the shafts may be supported in adjustable bearings 34 having slotted bases. By adjusting the spacing between the opposed peaks or blades 30 of the cutters, it is possible to sever the globules completely or to seal the neck between them by pressing or pinching action, thereby forming a product like that shown in Figure 5. Another form of product of "dumbbell" or "peanut" shape may be obtained by making alternate peaks 30 of the cutter members higher than those between to effect alternate cutting and sealing between adjacent globules. If desired, two or more sealing peaks may be disposed between the cutting peaks. Or, again, the cutter members may be constructed to produce a mixture of single globules, "dumbbells," and/or three or four-celled strings. If desired, recesses of any shape may be formed in the periphery of a pair of discs or rolls which may then serve as dies to mold the shape of the globules as well as to sever them. Such die rolls may take the form shown in Patent No. 2,323,582.

The process may be adapted to the production of hollow articles from any film or filament-forming material, solution, or composition which is settable or coagulatable by a liquid bath. Examples of such materials are solutions of: vinyl resins, such as polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, copolymers of vinyl chloride and vinyl acetate or acrylonitrile and such polymers and copolymers as have been after-chlorinated; also other resins such as polystyrene, 75

acrylic acid polymers, methyl and ethyl acrylate and methacrylate polymers, polyisobutylenes, polymers of chloroprene or butadienes or copolymers thereof with styrene or acrylonitrile; cellulose ethers and esters, such as cellulose acetate, cellulose acetate propionate, cellulose acetate butyrate, ethyl cellulose, benzyl cellulose; also viscose, cuprammonium cellulose; caseins, soya-protein, zein, and gelatine.

These materials are extruded into a suitable coagulating bath of conventional constitution, the particular bath depending upon the particular material to be coagulated. For example, a viscose solution may be coagulated in a dilute sulfuric acid bath containing a certain amount of sodium salts. A solution of cellulose acetate in acetone may be extruded into water containing a small proportion of acetone or of any other solvent or swelling agent for the cellulose acetate. A solution of a copolymer of vinyl acetate and vinyl chloride in acetone may be extruded into a water bath in which the acetone is not allowed to accumulate to a concentration of over about 10 to 15%.

The thickness of the wall of the cells or globules may be controlled by varying the rate of extrusion and the rate of supply of compressed air or other gas. Where exceptionally thick walls are desired, it may be desirable to incorporate a plasticizer in the solution of the material to be formed. However, a plasticizer may also be included in any of the materials regardless of wall thickness, where it is desired to obtain more pliability and rubbery elasticity.

Any gas may be used, such as air, nitrogen, carbon dioxide, hydrogen, helium, and the like.

The gas-filled cell products of this invention may be used as a filling material for cushions, especially where elasticity and lightness of weight are desired. Thus, they may be used as flotation material in life preservers either of the jacket, belt, or cushion type, and for this purpose it is preferable to employ such products as are made of hydrophobic materials, especially of resins, such as polyvinyl chloride and the copolymers thereof. The products are useful as a heat insulation filling material, for which purpose they are especially adaptable for filling the insulating walls of cold storage rooms or refrigerators.

It is to be understood that changes and variations may be made without departing from the spirit of the invention as defined by the following claims.

We claim:

1. In a method of producing hollow bodies, the steps of extruding a solution in a liquid of the material to be formed upwardly through an annular orifice into a coagulating liquid medium to form a continuous tube, maintaining a continuous column of gas under pressure within the tube of material being extruded, and intermittently pressing the wall of the tube together while the material is still plastic and the internal surface thereof is still in an adhesive condition to seal said gas column as the material passes a predetermined portion of its path above the point of extrusion, whereby the portions of the material immediately below the points of sealing are caused to expand by the gas pressure within.

2. In a method of producing hollow bodies, the steps of extruding a solution in a liquid of the material to be formed upwardly through an annular orifice into a coagulating liquid medium to form a continuous tube, maintaining a con-

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tinuous column of gas under pressure within the tube of material being extruded, and pressing the wall of the tube together while the material is still plastic and the internal surface thereof is still in an adhesive condition to seal said gas column as the material passes a predetermined portion of its path above the point of extrusion within the medium, whereby the portion of the material immediately below the point of sealing is caused to expand by the gas pressure within.

3. In a method of producing hollow bodies, the steps of extruding a solution in a liquid of the material to be formed upwardly through an annular orifice into a coagulating liquid medium to form a continuous tube, maintaining a continuous column of gas under pressure within the tube of material being extruded, and cutting through the tube and simultaneously pressing the wall of the tube together while the material is still plastic and the internal surface thereof is still in an adhesive condition to seal said gas column as the material passes a predetermined portion of its path above the point of extrusion, whereby the portion of the material immediately below the point of cutting and sealing is caused to expand by the gas pressure within.

4. In a method of producing hollow bodies, the steps of extruding a solution in a liquid of the material to be formed upwardly through an annular orifice into a coagulating liquid medium to form a continuous tube, maintaining a continuous column of gas under pressure within the tube material being extruded, pressing the wall of the tube together while the material is still plastic and the internal surface thereof is still in an adhesive condition to seal said gas column as the material passes a predetermined portion of its path above the point of extrusion, whereby the portion of the material immediately below the point of sealing is caused to expand by the gas pressure within, and shaping at least some of the portions as they are expanded.

5. In a method of producing hollow bodies, the steps of extruding a solution in a liquid of the material to be formed upwardly through an annular orifice into a coagulating liquid medium to form a continuous tube, maintaining a continuous column of gas under pressure within the tube of material being extruded, pressing the wall of the tube together while the material is still plastic and the internal surface thereof is still in an adhesive condition to seal said gas column as the material passes a predetermined portion of its path above the point of extrusion, whereby the portion of the material immediately below the point of sealing is caused to expand by the gas pressure within, and cutting the material at selected points of sealing.

6. In a method of producing hollow bodies, the steps of extruding a solution in a liquid of the material to be formed vertically upwardly through an annular orifice into a coagulating liquid medium to form a continuous tube, maintaining a continuous column of gas under pressure within the tube of material being extruded, pressing the wall of the tube together while the material is still plastic and the internal surface thereof is still in an adhesive condition to seal said gas column as the material passes a predetermined portion of its path above the point of extrusion within the medium, whereby the portion of the material immediately below the point of sealing is caused to expand by the gas pressure within, and cutting the material at certain points of sealing.

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7. Apparatus for producing hollow bodies comprising means for extruding a material as a continuous article having a continuous hollow channel therein, means for continuously maintaining a fluid under pressure in the channel as extrusion proceeds, a vessel containing a liquid bath for coagulating the material, said extruding means being arranged in the vessel to direct the material upwardly in the liquid, means for continuously maintaining a gas under pressure in the material as it is extruded, and means disposed in the vessel above the extrusion means for sealing the material at spaced points of its length.

8. Apparatus for producing hollow bodies comprising means for extruding a material as a continuous article having a continuous hollow channel therein, means for continuously maintaining a fluid under pressure in the channel as extrusion proceeds, a vessel containing a liquid bath for coagulating the material, said extruding means being arranged in the vessel to direct the material upwardly in the liquid, and means disposed in the vessel above the extrusion means for cutting the material at spaced points of its length.

9. Apparatus for producing hollow bodies comprising means for extruding a material as a continuous article having a continuous hollow channel therein, means for continuously maintaining a fluid under pressure in the channel as extrusion proceeds, a vessel containing a liquid bath for coagulating the material, said extruding means being arranged in the vessel to direct the material upwardly in the liquid, means disposed above the extrusion means for sealing the material at spaced points of its length, means for cutting the material at selected points of sealing, and means for withdrawing the cut material from the vessel.

10. Apparatus for producing hollow bodies comprising means for extruding a material as a continuous article having a continuous hollow channel therein, means for continuously maintaining a fluid under pressure in the channel as extrusion proceeds, a vessel containing a liquid bath for coagulating the material, said extruding means being arranged in the vessel to direct the material upwardly in the liquid, means disposed above the extrusion means for sealing the material at spaced points of its length, and means for shaping the material between the points of sealing.

11. Apparatus for producing hollow bodies comprising means for extruding a material as a continuous article having a continuous hollow channel therein, means for continuously maintaining a fluid under pressure in the channel as extrusion proceeds, a vessel containing a liquid bath for coagulating the material, said extruding means being arranged in the vessel to direct the material upwardly in the liquid, and means disposed above the extrusion means for both sealing and cutting the material at each of a plurality of spaced points of its length.

12. Apparatus for producing hollow bodies comprising means for extruding a material to be formed as a continuous article having a continuous hollow channel therein, means for continuously maintaining a fluid under pressure in the channel as extrusion proceeds, a vessel containing a liquid bath for coagulating the material, said extruding means being arranged in the vessel to direct the material upwardly in the liquid, means disposed above the extrusion means

for both sealing and cutting the material at each of a plurality of spaced points of its length, and means for shaping the material between the points of sealing.

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