July 3, 1945. C. E. MABBS 2,379,817

PROCESS AND APPARATUS FOR MAKING A CAPSULE

Filed Oct. 30, 1940 3 Sheets-Sheet 1

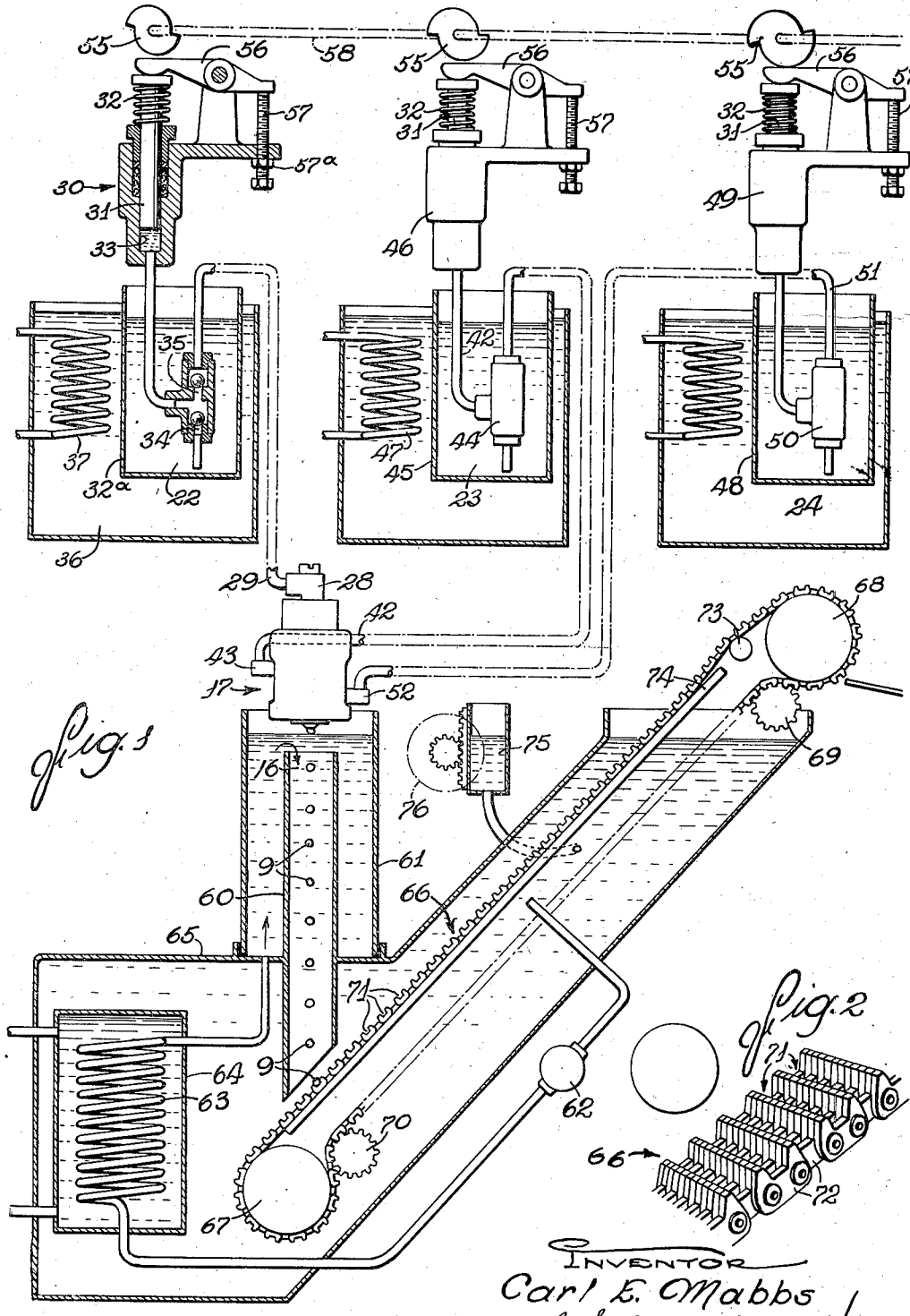


Fig. 1

Fig. 2

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Fig. 3

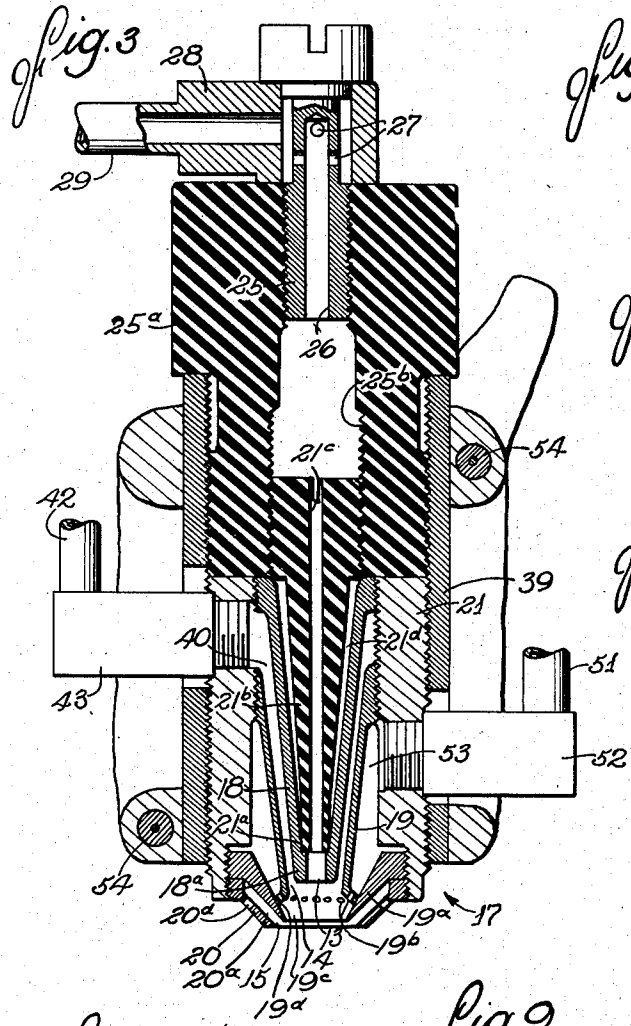


Fig. 4

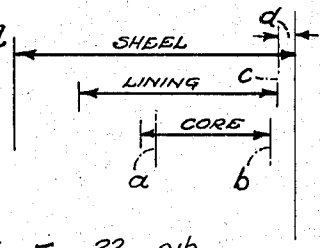


Fig. 5

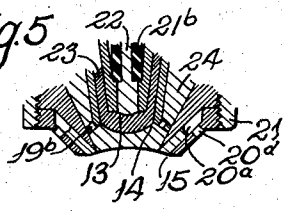


Fig. 6

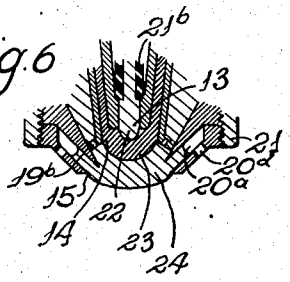


Fig. 7

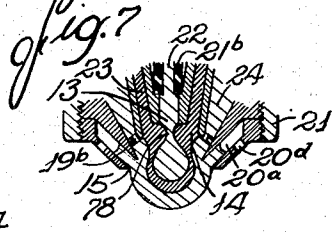


Fig. 8

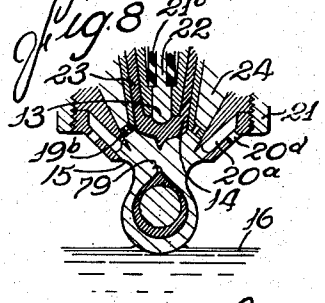


Fig. 9

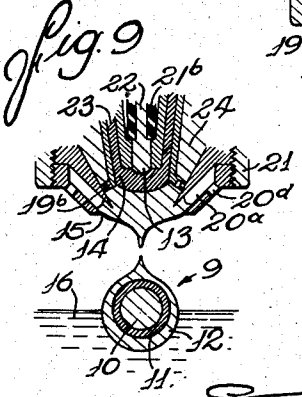


Fig. 10



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Fig. 11.

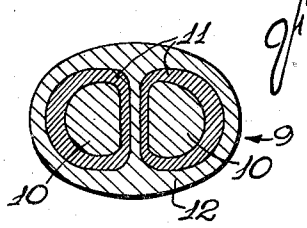
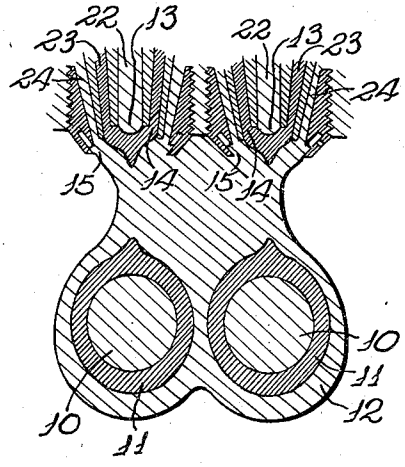


Fig. 12.



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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR MAKING CAPSULES

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Application October 30, 1940, Serial No. 363,483

24 Claims. (Cl. 18—5)

This invention relates to the capsulation of liquid or plastic core materials in a shell of congealable material. Gelatin is commonly used to form capsule shells. Because of its affinity for water and because it becomes insoluble or precipitated when exposed to certain other carriers for ingredients to be capsulated, capsulation heretofore has been limited to oils and oil solvents.

The primary object is to capsulate aqueous or other core materials which, when in contact with gelatin or other available shell material, will change the physical or chemical condition or properties of the shell material and render the capsule useless.

A more detailed object is to provide a capsule comprising a core, an outer shell of gelatin or the like and a partition or inner shell permanently separating the core material from the outer shell.

A further object is to provide a capsule of the above character having a separating or partition film which is substantially solid at ordinary temperatures but capable of liberating the core material at body temperature.

Another object is to produce capsules of the above character having seamless shells and linings.

Still another object is to produce capsules of the above character by natural drop formation.

The invention also resides in the novel construction and arrangement of the drop forming orifices.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a schematic view of an apparatus for practicing the novel method.

Fig. 2 is a fragmentary perspective view of a portion of the retrieving mechanism.

Fig. 3 is a diametrical cross-sectional view of the drop forming nozzle.

Figs. 4 to 9 illustrate successive stages in the formation of a capsule.

Fig. 10 is a cross-sectional view of a completed capsule having a single core.

Fig. 11 is a similar view of a multi-cell capsule.

Fig. 12 is a view similar to Fig. 8 showing a final stage in the formation of the multi-cell capsule.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiments and methods of carrying out the invention. It is to be understood that I do not intend to limit the invention by such disclosure, but aim to cover all modifications, alternative constructions, methods and uses falling within the spirit and scope of the invention as expressed in the appended claims.

As shown in Figs. 10 and 11 capsules designated generally at 9 and constituting the present invention are generally spheroidal in shape and comprise one or more cores 10 in the form of a generally spherical globule composed of or containing the material to be capsulated completely encased in a seamless and thin substantially solid film 11 of substantially uniform thickness constituting a partition or lining for maintaining the core material separated from a seamless outer casing or solidified shell 12, usually gelatin, which congeals from a liquid state on cooling to a temperature, preferably below ninety degrees. In the case of the multi-cell capsules (Fig. 11), each core is enclosed by partitions 11 which separate the cores from each other in a single globule of shell material.

Ordinarily the core consists of the medicinal or other material to be capsulated, dissolved or dispersed in water, glycerin or other liquid, which reacts with the shell material.

The partition layer 11 must possess well-defined properties. First, it must be immiscible in or unaffected by the materials, either of the core 10 or of the outer shell 12. For capsules to be taken internally, for medicinal or dietary purposes, it should be a solid at ordinary room temperatures, but physiologically inert and also unstable at body temperatures, so as to free the core materials. Preferably, the lining material should not shrink or crack on standing after congealing. Finally, where, as in the present instance, the capsule is produced by natural drop formation, the lining should have a relatively sharp melting point, that is, be capable of solidifying rapidly and completely on cooling below its melting point. Vegetable and animal oils, greases, and certain waxes or various mixtures of these may be used. Paraffin having a melting point slightly above body temperature has proved very satisfactory for use with aqueous core materials.

To produce the capsules by natural drop formation, measured quantities of the core, lining, and shell materials are subjected to the natural forces of gravity, capillarity, and surface tension while the materials are maintained in the proper positional relation and at the correct temperatures. To this end, globules of the liquid core material

are discharged intermittently from the end of an orifice 13 which preferably is circular. The lining and shell materials in the liquid state are discharged in properly timed relation from successively larger annular orifices 14 and 15 surrounding the core orifice and, for purposes to appear later, preferably spaced progressively increasing distances below the core orifice. The three orifices face downwardly and are positioned so that the composite drop, as it forms below and hangs downwardly from the orifice 15 in the final stage, contacts a column 16 of cooled receiving liquid, the density of which is correlated with that of the composite drop.

In the apparatus illustrated, the three orifices are positioned at the lower end of a nozzle 17 defined by the lower ends of tapering relatively thin walled tubes 18, 19, 20. Herein, the upper end of the tube 18 is threaded into a metal sleeve 21 threading into a metal tube 39 by which it is held in abutment with a block 25a of insulating material. The tube 18 is formed short of the orifice 13 with shoulders 21a against which abuts the end of a tube 21b threading at its upper end into the central bore 25b of the block 25a and having a bore 21c through which the cold core liquid 22 flows to the orifice 13. The tube 21b is composed of insulating material and preferably is separated from the tube 18 by a dead air space 21d which further insures insulation of the core liquid from the heated lining and shell liquids 23 and 24 to a point adjacent the orifice 13. A screw 25 threaded into the upper end of the block 25a has a bore 26 communicating through openings 27 with a fitting 28 at the end of a conduit 29 through which the core liquid is forced by a metering pump 30. On the quick upstroke of the pump piston 31 produced by a spring 32, core liquid from a storage tank 32a is drawn into the pump cylinder 33 through a check valve 34. On the down stroke the valve 34 is closed and a metered amount of the liquid is discharged through a check valve 35 into the conduit 29. By immersing the tank 32a in a water bath 36 cooled by a coil 37, the core liquid is maintained at the desired temperature, preferably about 35 degrees Fahrenheit below the melting point of the lining material.

The tube 19 is threaded into a portion of the sleeve 21 spaced below the tube 18 and cooperates with the latter to define a passage 40 for flow of the lining material to the orifice 14. The upper end of this passage communicates with a supply conduit 42 through a fitting 43 threading into a side bore in the sleeve 21 and an opening in the tube 39. Through a valve 44, lining material 23 is drawn from a tank 45 by a pump 46 whose discharge is timed accurately with that of the other pumps. A heating coil 47 maintains the tank at the proper temperature, preferably about 140 degrees Fahrenheit, when paraffin is employed.

In a similar way, the gelatin solution 24 having a specific gravity of between 1.25 and 1.45 and heated to approximately 150 degrees Fahrenheit in a tank 48 is discharged intermittently by a cam driven pump 49 through a similar control valve 50 into a conduit 51 and a fitting 52. The latter communicates with a downwardly tapering annular chamber 53 around the tube 19 and within a tube 19a threaded into a counter bore in the sleeve 21 and tapering to an orifice 19c. At its lower end, the tube 19 is flared outwardly to form a flange 19d which fits against the inner downwardly converging wall of the tube 19a. Holes 19b in the flange permit the flow of the shell liquid to the orifice 15 with a slight Venturi effect which contributes to the proper positioning of the lining material and the formation of lining and gelatin layers of uniform thickness throughout.

To assist in holding the excess material in the nozzle passages following falling of a drop and also to increase the effective area of the tip from which the drop falls, the tubes 19a and 20 are spaced apart to form a capillary ring 20a around the orifice 19c. Preferably, orifice 15 is larger than and spaced slightly below the orifice 19c. The capillary ring opens to atmosphere at its upper end through holes 20d.

The nozzle 17 is preferably heated by an electric heater 54 not only to facilitate initiating and maintaining proper operation of the apparatus but also to effect final heating of the lining and shell liquids so as to insure an accurately controllable final temperature at the nozzle orifices. The heat is conducted through the sleeves 39 and 21 and the metal tubes 18, 19, 20 and 19a. In the present instance, the capacity of the heater is such that the lining and shell materials are discharged from their orifices at about 160 degrees Fahrenheit.

The relative sizes and spacing of the nozzle orifices are approximately as shown in the drawings. This relation and the dimensions of the individual orifices will, of course, vary with the materials used, the size of capsule to be produced, the character of the receiving liquid, etc.

The pumps 30, 46 and 49 are of the same construction, each having a piston 31 raised by a spring 32 and projected downwardly with an accelerated motion by a cam 55 acting on a follower 56. The cam is shaped to terminate the active stroke abruptly and permit the return movement of the piston to be initiated quickly. As a result of this, the pump pressure is released quickly and the liquids in the nozzle passages are permitted to take their natural positions. This, combined with the tapering of the passages 40 and 53 and the narrowness of the annular orifices 14 and 15 and the capillary ring 20a avoids dribble and causes the small amounts of surplus materials left at the orifices following breaking off of the composite drop to be held at the orifices in readiness for formation of the next drop. By adjusting a screw 57 and a clamp nut 57a, the pump stroke may be varied in length to correspondingly change the amount of material discharged from the orifices. Proper timing of the discharges is effected by driving the cams 55 from a common power driven shaft 58 and by proper shaping and spacing of their surfaces.

For purposes to appear later, the discharges of the core, lining and shell materials are of different lengths and start successively as shown by the time chart of Fig. 4. Preferably, the discharge of lining material overlaps both ends of the core discharge while the discharge of shell material is initiated substantially before the lining and continues for a brief time after the lining and core materials have been cut off. It has been found that this timing is obtainable by making the cams 55 of substantially the same lengths as shown and by properly positioning them angularly on the shaft 58. The variations in the deliveries as indicated in Fig. 4 are due to the pumpability characteristics of the different liquids. For example, a gelatin solution of the solids-concentration used is highly viscous and reacts slowly to pressure changes; consequently,

the pressure must be applied an appreciable length of time before emission of the solution begins. Also, the flow will continue for some time after the pump stroke has been completed. For the same reasons, the characteristics of the lining material determine the timing of the active stroke of the pump 46.

In the final stage of formation of the composite drop and while the drop is hanging on the lower end of the nozzle tip, it contacts and is partially supported by the receiving column 16. This is a liquid, such as vegetable or mineral oil, or a mixture thereof, which is free flowing at temperatures below the gel or melting points of the shell and lining materials, and has a density, for example 0.80, somewhat less than that of the compound drop so that each drop descends slowly and yet does not interfere with the formation of the succeeding drop. The descent is prolonged sufficiently to enable the lining 11 to solidify completely and the shell 12 to cool below its gel point and thereby congeal to a rubbery consistency. The receiving liquid should possess some dehydrating property and its interfacial surface relation to that of the gelatin solution is such as to accelerate the action of capillarity in causing the drop to take a generally spheroidal shape on leaving the nozzle.

The receiving column is defined by a tube 60 disposed within a larger tube 61 to the lower end of which the circulating receiving liquid is delivered by a motor driven pump 62 through a coil 63 immersed in a cooling tank 64 by which the liquid is maintained at the desired temperature, usually about 40 degrees Fahrenheit. The liquid flows upwardly between the tubes 60 and 61 and then downwardly through the tube 60 so that the drop initially contacts the coolest portion of the column. The lower end of the tube 60 is disposed within a tank 65 connected intermediate its ends to the inlet of the pump 62.

Provision is made for raising and lowering the level of the receiving liquid and adjustment of the spacing of the receiving liquid relative to the nozzle. This is accomplished herein by an auxiliary reservoir 75 communicating with the tank 65 and mounted for vertical movement as by turning a hand wheel 76.

The capsules descending through the liquid column 16 are delivered to a suitable retrieving mechanism. As shown, this comprises an inclined chain type conveyor 66 supported by pulleys 67 and 68 and sprockets 69 and 70 so that the upper run of the chain, which travels along flat guides 74, is positioned to receive the completed capsules and carry them out of the receiving liquid. To drive the chain, the sprocket 69 is motor driven. The recesses 71 in the individual links 72 constitute pockets for receiving the congealed capsules. At a point above the level of the receiving liquid, the chain passes over a cross rod 73 and is thereby lifted from the guides 74 to permit the excess oil to drain off. The rod also wipes along the underside of the chain and by capillary action removes any surplus oil from between the chain links. The capsules, quite freed of oil, fall from the chain as they pass over the head pulley 68.

The successive stages in the formation of a capsule with the apparatus above described are shown in Figs. 5 to 9. After the falling of one drop and during the return strokes of the pump plunger, the materials will be held in the nozzle passages as shown in Fig. 5, the shell material being drawn upwardly into the nozzle as shown by capillary action due to the ring 20a.

As shown in Fig. 4, the flows of shell, lining and core materials are initiated successively. When the pump pistons have advanced to *a*, the liquids will occupy approximately the positions shown in Fig. 6. As the flows progress, the composite globule hanging from the nozzle enlarges as shown in Fig. 7 which is about the time the liquid pump completes its active stroke, as indicated at *b*. By this time, the core globule hangs by a narrow contracted neck 78 which soon becomes pinched off whereupon the core globule assumes a spherical shape within the bodies of lining and shell materials still hanging from the orifices 19 and 20. As shown in Fig. 8, the lining material breaks off at the completion of the active stroke of the pump 46, which occurs at *c*, a characteristic curl 79 being formed at the time. Not until this stage does the downwardly hanging globule contact the receiving liquid and become supported thereby as shown in Fig. 8. A rather delicate balance is established between the gravity of the receiving liquid, the weight of the drop and the spacing of the receiving liquid below the nozzle. It is such that if the flow of shell material were interrupted simultaneously with that of the lining material, the globule would remain suspended as shown in Fig. 8. Thus, when the globule encounters the receiving liquid, its motion is interrupted momentarily for a purpose to appear later. By continuing the flow of shell material as indicated at *d*, sufficient weight is added to cause the drop to overcome the buoyant force exerted by the receiving liquid and break from the orifice 20 as shown in Fig. 9 whereupon the drop as a whole contracts into a sphere due to the interfacial action of capillarity and surface tension.

Momentary suspension of the globule by the receiving liquid in the final stage is an important factor in proper formation of the present type of capsule. This is because the relatively cold core material in leaving its orifice 13 causes the immediately adjacent lining material to congeal and thereby attach itself to the tip of the tube 18. If the downward movement of the composite drop were permitted to continue uninterruptedly, the congealed lining material thus attached to the core orifice tip would be torn away and broken permitting contact of the core and shell materials. However, by supporting the globule in the receiving liquid sufficient time is allowed for the lining material to become detached, the shell material acting as a receiving liquid for the globule of core and lining material which thereby takes the desired spherical form with the lining wall unbroken.

The foregoing action necessitates a rather close correlation between the physical properties of the core, lining and shell liquids on the one hand and of this group with the receiving liquid on the other hand. Also, the spacing of the lowermost nozzle orifice 15 above the receiving column is important. If this spacing is too great, fracture of the lining material at the orifice 13 is apt to occur. If it is too small, the buoyant force of the receiving liquid will not permit of complete separation of the core material from the orifice 13 before the complete drop breaks from the orifice 15.

The danger of the lining material congealing and adhering too firmly on the core orifice is eliminated in the present instance by providing the heated shield 18 around the advancing col-

umn of core liquid, which shield defines the core orifice 13. This body of heated metal indicated at 18a serves the dual purpose of keeping the lining material fully liquid clear to its area of contact with the core and of transmitting sufficient heat to the orifice 13 to remelt any of the lining material that may become congealed therein by the passage of the colder core material therethrough. This remelting occurs at the time when the shell liquid first encounters the receiving liquid and causes the interruption in the drop movement during which the lining material becomes released as above described from the core orifice. Also, this interruption allows for the transfer of heat between the lower part of the lining material and the receiving liquid through the shell material and a consequent congealing of this part of the lining. As a result of this, the heavier core material cannot displace the semi-solidified lining material under the action of gravity and thus move out of place in the composite drop.

From the foregoing, it will be observed that during the progress of drop formation, the core and shell materials are at all times maintained properly separated by the lining material which congeals rapidly owing to its sharp melting point and becomes completely solid before the drop has descended far into the column 16. During the descent of the composite drop, the gelatin congeals gradually and by the time it reaches the retrieving mechanism, it will have set sufficiently to be handled without danger of changing the shape of the drop.

The size of the finished capsule is, of course, determined by the quantity of core material to be capsulated and this in turn determines the amount of the lining and shell materials required. These quantities and the physical properties of the various materials forming the drop will determine the size of the orifices under the established drop weight and liquid column stability laws.

To form the multi-cell capsules shown in Figs. 11 and 12, the same general arrangement of nozzle orifices above described is employed. In addition, the nozzles are multiplied according to the number of cells to be formed in each capsule and disposed adjacent each other as shown in Fig. 12 so that the globules of shell liquid discharged from the orifices 15 will contact each other about the time that the two composite globules encounter the receiving liquid as shown. As a result, all of the globules break from the respective nozzles approximately simultaneously whereupon the natural forces act to shape the several globules into a composite ovate drop in which the lining and core drops remain separated in the combined globule of shell material.

I claim as my invention:

1. Capsulating apparatus having, in combination, a projection defining a downwardly facing orifice, means for discharging measured quantities of a liquid to be capsulated from said orifice to form a drop, an annular orifice surrounding said first mentioned orifice, a third orifice surrounding said annular orifice, and mechanism for discharging congealable lining and shell materials from said annular and third orifices to enclose said drops and cause the formation of a compound drop by drop formation and having the core and shell separated by said lining material.

2. Capsulating apparatus having, in combination, a projection defining a downwardly facing orifice, means for discharging measured quantities of a liquid to be capsulated from said orifice to form a drop, an annular orifice surrounding said first mentioned orifice, mechanism for discharging liquid solidifiable material from said annular orifice to enclose each drop of said liquid, a third orifice surrounding said annular orifice, mechanism for discharging liquid solidifiable shell material from said third orifice to enclose the material from said annular orifice and cause a compound drop to fall therefrom under drop formation, and a column of liquid immiscible with said shell material to receive the compound drop before it leaves said third orifice and cool the same below the solidification points of said shell material and the material from the annular orifice.

3. Capsulating apparatus comprising means defining a downwardly facing orifice, means providing a second larger orifice surrounding said first orifice and axially spaced therebelow, means providing a third larger orifice surrounding said second orifice and axially spaced therebelow, a column of liquid disposed immediately below said orifices to contact the materials discharged therefrom, mechanism for discharging from said second and third orifices quantities of immiscible liquids congealable at the temperature of said column, and mechanism for discharging from said first orifice a quantity of a core material which is immiscible in the liquid discharged through said second orifice, said mechanism being timed to cause the formation of a compound drop by drop formation in which the core and shell materials are separated by the material discharged from said second orifice.

4. Capsulating apparatus comprising means defining a downwardly facing orifice, means providing a second larger orifice surrounding said first orifice, means providing a third larger orifice surrounding said second orifice, a column of liquid disposed immediately below said orifices to contact the materials discharged therefrom, mechanism for effecting timed discharges from said second and third orifices of quantities of immiscible liquids congealable at the temperature of said column, and mechanism for timing the discharge from said first orifice of a quantity of a core material which is immiscible in the liquid discharged through said second orifice.

5. Capsulating apparatus comprising three substantially concentric orifices facing downwardly and mechanism for discharging quantities of three different liquids from the respective orifices in timed relation to form a composite drop having liquid in the center separated from congealed outer liquid by congealed intermediate liquid.

6. Capsulating apparatus having, in combination, an orifice communicating with a supply of liquid core material, a second orifice surrounding the first orifice and communicating with a supply of molten lining material, a third orifice surrounding said second orifice and communicating with a supply of gelatin, mechanism operable intermittently to discharge measured quantities of said materials from their respective orifices to form composite drops by drop formation each having the core and shell separated by said lining material.

7. Capsulating apparatus having, in combination, first, second and third orifices respectively arranged one within the other, means for discharging shell, lining and core materials from the respective orifices to form a compound drop, said orifices being arranged to cause the core,

lining and shell materials to break from their orifices successively by drop formation.

8. The method of forming compound drops of first and second reactable liquids and a third liquid immiscible therewith, which includes the steps of intermittently discharging a globule of said first liquid from a downwardly facing orifice, correlatively discharging a quantity of said third liquid from a lower surrounding orifice, and correlatively discharging a quantity of said second liquid from an orifice surrounding said second orifice and spaced therebelow, the amounts of said second and third liquids being such as to cause the compound drop to fall from said third orifice by drop formation.

9. The process of capsulation which includes successively initiating the flow of shell, lining and core materials from concentric orifices of progressively decreasing sizes to form a compound drop globule, successively terminating the flow of the core, lining, and shell materials respectively, and supporting the globule in a cooled receiving liquid after termination of the core material discharge.

10. The process of capsulation which includes successively initiating the flow of shell, lining and core materials from concentric orifices of progressively decreasing sizes to form a compound drop, the lining material being immiscible with both the core and shell materials, and supporting the globule of said materials in a cooled receiving liquid during the final stage of drop formation.

11. The process of capsulation which includes successively initiating the flow of shell, lining and core materials from concentric orifices to form a compound drop globule, successively terminating the flow of the core and shell materials respectively, so that the discharges of the core, lining and shell materials are of different lengths, and supporting the globule in a cooled receiving liquid during the final discharge of the shell material.

12. The method of forming compound drops of first and second reactable liquids and a third liquid immiscible therewith, which includes the steps of intermittently discharging a globule of said first liquid from a downwardly facing orifice, simultaneously discharging a quantity of said third liquid from a surrounding orifice, and simultaneously discharging a quantity of said second liquid from an orifice surrounding said second orifice.

13. In capsulating apparatus, the combination of a pair of concentric spaced tubes defining a passage there-between for the flow of a melted congealable shell material therethrough, a flange on one of said tubes closing said passage and having annularly spaced holes through which the shell material is extruded, the central one of said tubes defining a passage for the flow of a material within the extruded shell material.

14. The method of forming compound drops of first and second reactable liquids and a third liquid immiscible therewith, which includes the steps of intermittently discharging quantities of said first, third, and second liquids from concentric orifices of successively increasing size.

15. The process of capsulation which includes the steps of intermittently dropping globules of liquid core material from an orifice, correlatively discharging an immiscible congealable liquid around each drop to enclose the latter, and correlatively discharging a congealable liquid around said second liquid to enclose the latter and form a composite drop in which the core and shell are separated by said second liquid.

16. The method of forming compound drops of first and second reactable liquids and a third liquid immiscible therewith, which includes the steps of assembling measured quantities of said liquids into a composite drop with the first and second liquids separated by the third liquid, and partially supporting said drop during its formation and descent in a liquid of a density less than that of the drop.

17. The process of capsulation which includes the step of subjecting quantities of first and second miscible liquids and a third liquid immiscible with the first and second liquids to natural forces of gravity capillarity and surface tension to combine the same into a composite drop having said first liquid enclosed by said third liquid and the third liquid enclosed by the second liquid.

18. The process of capsulation which includes the steps of correlatively discharging separated quantities of core liquid and heated shell liquid from orifices disposed one within the other, and correlatively discharging a measured quantity of a congealable liquid from an intermediate orifice whereby to separate the core and shell materials, said liquids being subjected to natural forces of gravity, capillarity and surface tension.

19. In the process of forming a composite capsule by natural drop formation, the step which includes successively initiating the flow of shell, lining and core liquids from concentric orifices progressively spaced in the direction of flow, said liquids being subjected to natural forces of gravity, capillarity and surface tension.

20. The process of capsulation which includes the steps of discharging a quantity of a congealable lining material into a body of congealable gelatin, simultaneously discharging a liquid core material into the body of lining material, subjecting the materials to natural forces of gravity, capillarity and surface tension to form a composite drop, and cooling the drop to congeal said lining material and gelatin, the lining material separating the core material from the gelatin.

21. Apparatus of the character described having, in combination, three concentric orifices, means for discharging heated shell and lining materials and cooler core material from the outer, intermediate and inner orifices respectively to form a composite drop that falls from the outer orifice, the discharge of shell material being prolonged beyond the interruption of lining and core material, and a body of cooled liquid of lower gravity than the composite drop positioned beneath said orifices to contact the drop only after substantially complete discharge of said lining and core materials and during the final discharge of the shell material.

22. Capsulating apparatus comprising a nozzle having a plurality of spaced metal tubes nested together to provide three concentric orifices in spaced apart relation, a tube of insulation disposed within the inner metal tube and having a longitudinal opening, the latter metal tube extending beyond the end of the insulation tube and having a longitudinal opening forming the inner orifice and being a continuation of the opening in the insulation tube through which two openings cooled core liquid passes, the space between the inner metal tube and the next outwardly spaced metal tube forming a passage for lining material, and the space between the last mentioned metal tube and the next outwardly spaced metal tube forming a passage for shell

material, a common metal support for said metal tubes, said support surrounding the nozzle, and means for heating the support to cause conduction of heat along said metal tubes to said orifices to prevent premature congealing of the shell and lining materials at their respective nozzle orifices.

23. In capsulating apparatus, the combination of an insulating tube having a longitudinal bore, a metal tube enclosing the insulating tube and having an end portion extending beyond the end of the insulating tube and having a bore in alinement with the bore in the insulating tube, the bore in said end portion forming an inner orifice for receiving and discharging cooled core material from the bore of the insulating tube, a second metal tube spaced from the first mentioned metal tube, and forming therewith a lining material orifice, a third metal tube defining a passage around the second metal tube and forming a shell material orifice, and means for heating said metal tubes to prevent premature congealing of the shell and lining materials at their respective orifices.

24. In capsulating apparatus of the character described, a nozzle comprising three tubes nested together to form three concentric orifices in spaced apart relation for discharging core, lining and shell liquids, and a ring outside of the outside metal tube and spaced therefrom to form a capillary chamber.

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