

Nov. 28, 1950

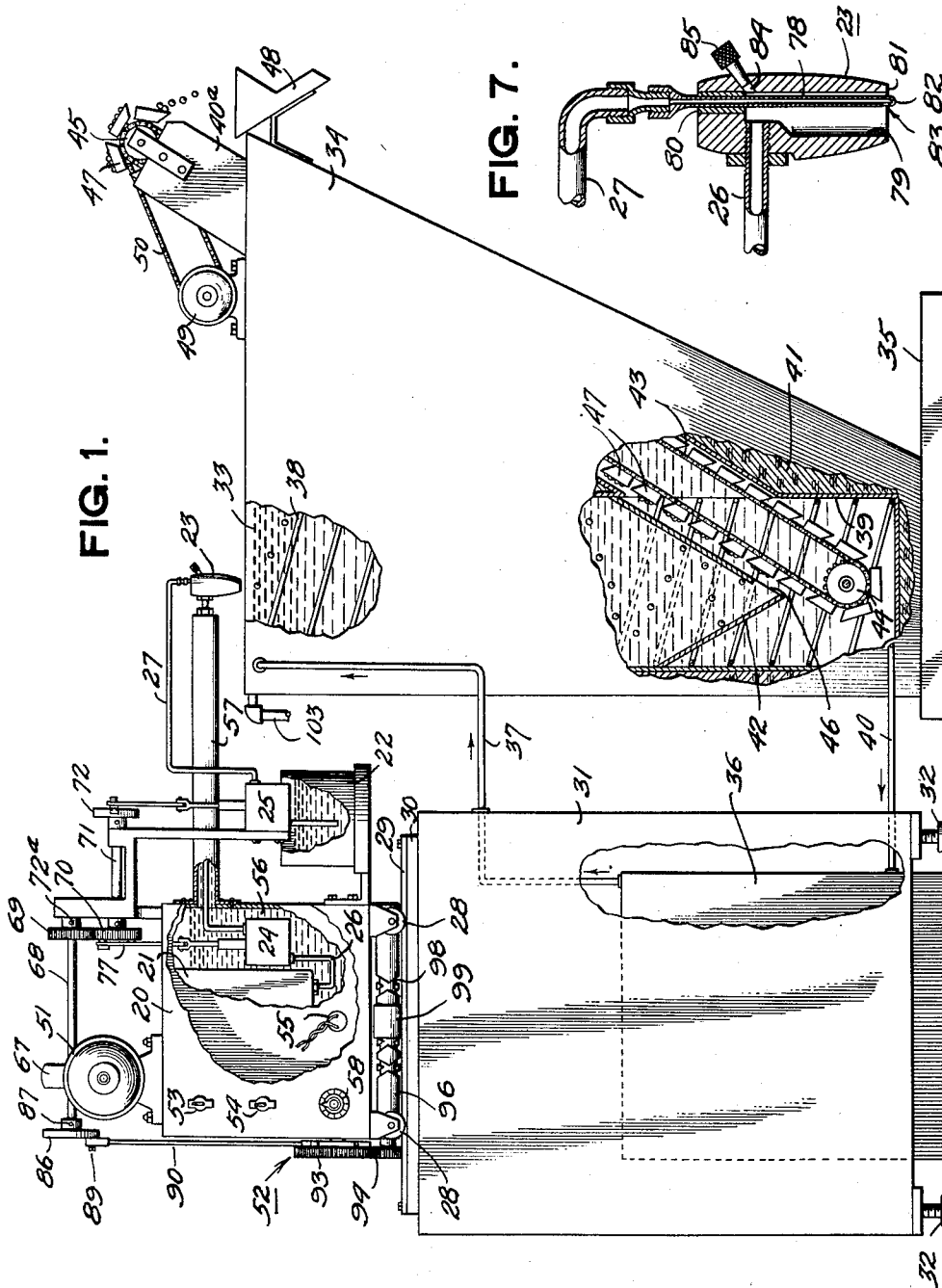
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2,531,986

PROCESS AND APPARATUS FOR PRODUCING CAPSULES

Filed Nov. 17, 1947

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

FIG. 2.

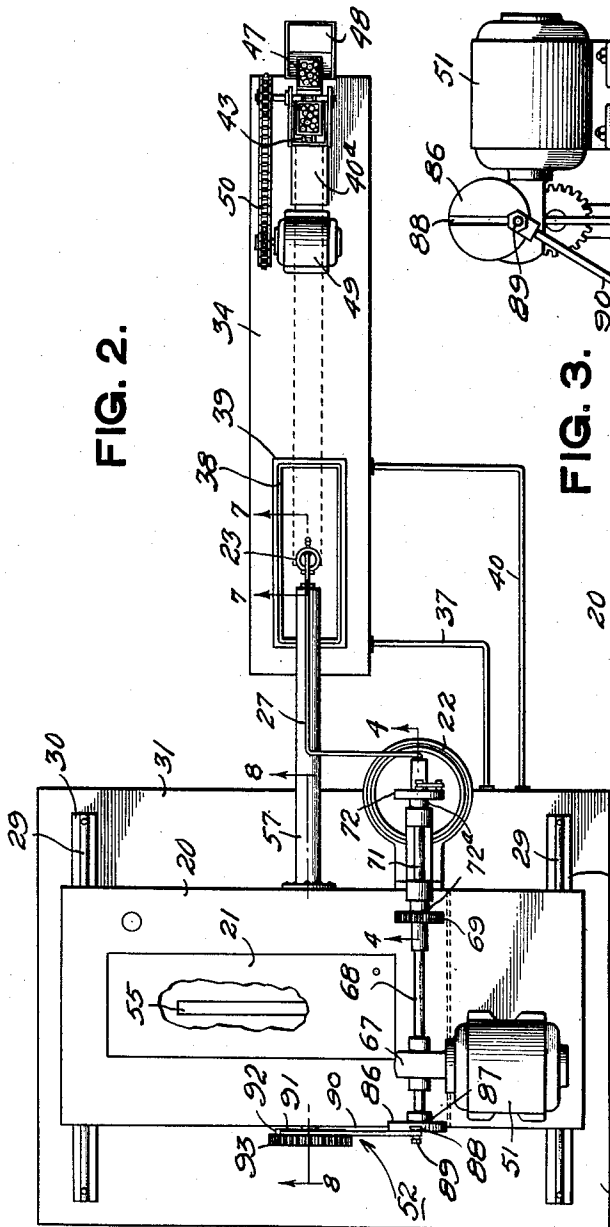


FIG. 3.

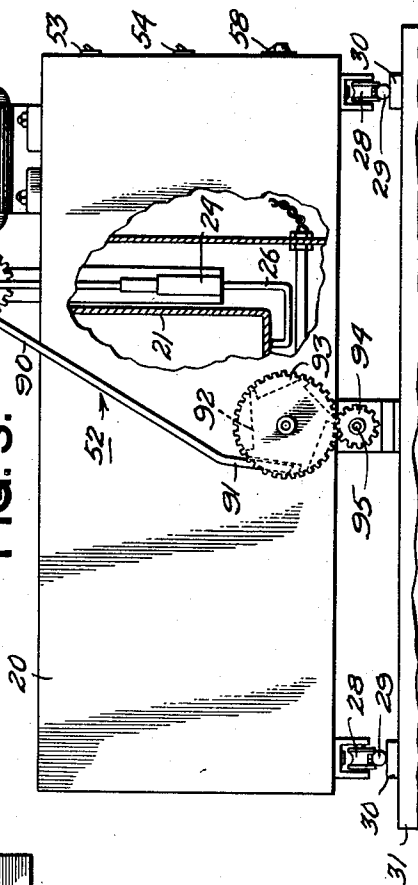
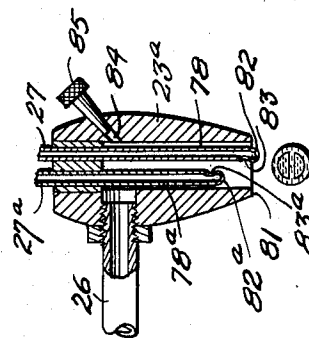


FIG. 7A.



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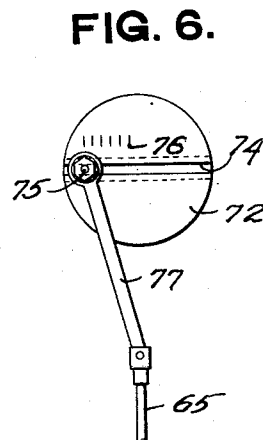
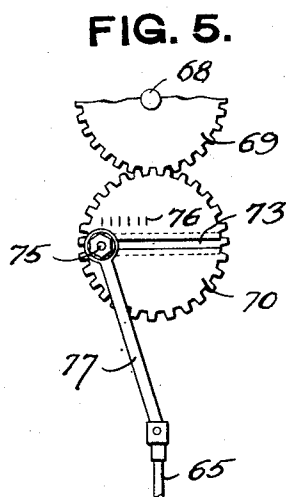
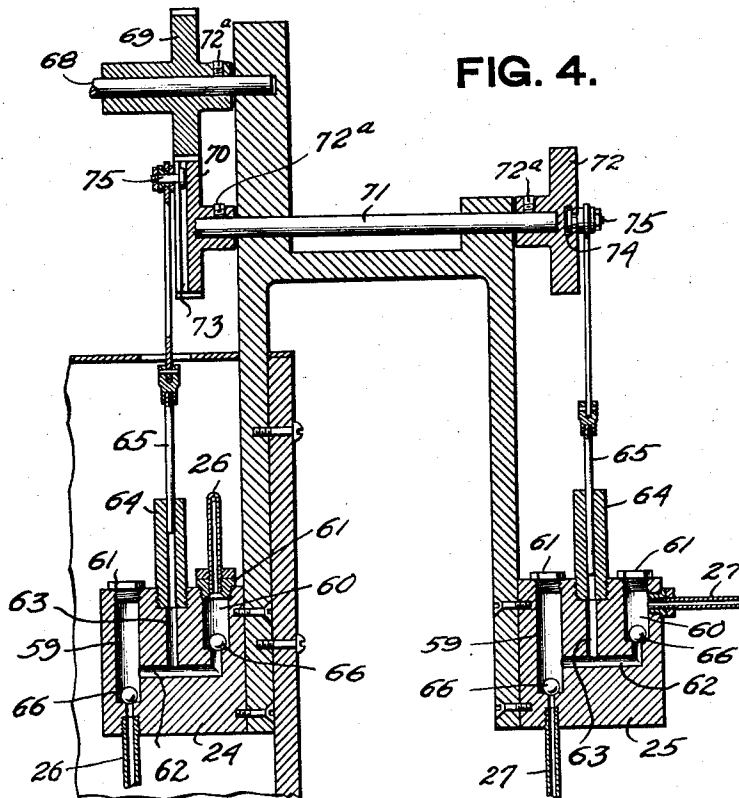
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PROCESS AND APPARATUS FOR PRODUCING CAPSULES

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4 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,531,986

PROCESS AND APPARATUS FOR PRODUCING CAPSULES

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Application November 17, 1947, Serial No. 786,354

10 Claims. (Cl. 18—5)

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This invention relates to an improved process and apparatus for producing seamless capsules containing ingredients in a fluid or semi-fluid state, particularly for medicinals.

Great numbers of capsules filled with medicaments are used in the pharmaceutical and drug industries, and there is a great need for a machine and process for the economical manufacture of capsules of uniform size and shape at high speeds, while at the same time assuring the preservation of sanitary conditions.

The primary object of our invention is to provide apparatus and a process for the manufacture of uniform spherical thin walled seamless capsules containing ingredients such as fluids and semi-fluids which will melt or dissolve when heated or placed in warm water or taken internally and yet be sufficiently strong to withstand ordinary handling.

Another object of the invention is to provide an improved form of nozzle for producing such filled capsules, whereby the amount of contents of the capsule may be determined with greater precision, insuring a higher degree of uniformity as to the amount of such contents in the capsules as they are successively produced from the nozzle.

Another object of the invention is to provide in the machine, a variable control of the amount of ingredients and the overall size of the capsule, resulting in uniform capsules of the desired size.

Another object of the invention is to provide improved operating means for forming and filling the capsule so that such operating means for supplying the ingredients and capsule material to the nozzle may be adjusted with respect to each other and so as to produce a more uniform and higher quality finished product.

Another object of the invention is to provide in a machine for producing such capsules, means for moving the nozzle in regular advanced stages between productions of capsule articles, so that when the capsules fall from the nozzle successively they will be deposited therefrom in regularly advanced, separately spaced positions with respect to the surface of a cooling and solidifying fluid medium, during pauses between movements of the capsule forming nozzle and so that none of the newly formed capsules will contact each other as they are released from the nozzle.

Another object of the invention is to regulate the densities of the various fluids, capsule material fluid or semi-fluid ingredients and cooling fluid, as well as the spacing of the nozzle above the cooling fluid for production of improved capsules, as will hereinafter be set forth in detail.

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Further objects, details and advantages of our improved process and apparatus will appear in the following detailed description of a highly satisfactory embodiment of our machine for producing such capsules, in accordance with our invention, supplemented by the accompanying drawings, forming a part of the specification.

In the drawings:

Fig. 1 is a side elevation, partly broken away and parts in section, of a capsule machine made in accordance with our invention.

Fig. 2 is a plan view thereof, with a portion broken away to disclose preferred construction.

Fig. 3 is an end elevation of a portion of the machine, with a part of the casing broken away and parts shown in section.

Fig. 4 is a vertical sectional detail view, on an enlarged scale, taken on line 4—4 of Fig. 2.

Fig. 5 is a fragmental end elevation of parts shown at the upper left side of Fig. 4.

Fig. 6 is a similar fragmental end elevation of parts at the upper right side of Fig. 4.

Fig. 7 is a vertical sectional view taken on line 7—7 of Fig. 2 of the improved capsule forming nozzle.

Fig. 7A is a similar vertical sectional view of a modified type of capsule forming nozzle.

Fig. 8 is a detail vertical sectional view on an enlarged scale taken on line 8—8 of Fig. 2.

Fig. 9 is a vertical cross-sectional view taken on line 9—9 of Fig. 8.

Fig. 10 is a diagrammatic sectional view for illustrating the supplying of materials to the nozzle, and

Figs. 11, 12, 13, 14 and 15 are fragmental vertical sectional views of the lower end of the capsule producing nozzle illustrating successive stages of the formation of a capsule.

Referring to Figs. 1, 2 and 3, the capsule producing machine in general, comprises a movable housing 20 providing a water jacket tank and containing a temperature controlled capsule material tank 21, and carrying a container 22 for capsule filling ingredients. Communicating with tank 21 and container 22 is a capsule producing nozzle 23. Pumps 24 and 25 in conducting pipes 26 and 27 supply the capsule forming material and filling ingredients, from tank 21 and container 22 respectively, to nozzle 23.

Water jacket tank or housing 20 is supported on rollers 28 which engage tracks 29 on base members 30 mounted on the top of a cabinet 31, which has adjustable supporting mounts 32, so that the height of nozzle 23 and other supporting structure may be adjustably varied as desired,

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for varying the height of the nozzle above capsule cooling and hardening fluid 33 in a receiving container 34 which is mounted on a base 35 closely adjacent to cabinet 31.

Cabinet 31 houses a conventional form of refrigerating unit 36 which as indicated by arrows preferably supplies cooled refrigerant upwardly through pipe 37 to the upper end of refrigerating coil 38 since most of the heat of the capsules is dissipated in the upper portion of the receiving solution. The refrigerant circulates downwardly therethrough adjacent the walls of receiving tank 39 and thence the refrigerant is returned by pipe 40 to refrigerating unit 36. In operation of the machine, however, the temperature near the top of the receiving solution 33 is somewhat higher than at the bottom because of the above mentioned heat dissipation.

An upwardly and outwardly inclined channel 40^a extends from the lower portion of receiving tank 39 and this tank and channel are surrounded with insulating material 41 within receiving container 34. Tank 39 has baffles or a funnel arrangement therein, adjacent to channel 40^a, and an endless conveyor 43 is mounted on conveyor supporting wheels 44 and 45 so as to extend in channel 40^a from a point below the opening 46 of the funnel 42 to above the top of channel 40^a. Buckets 47, carried by conveyor 43, carry finished capsules which fall therein to the top and dump them into a delivery chute 48, carried by the upper portion of receiving container 34. A motor 49 mounted on container 34 is provided with a chain or other form of belt drive 50 for operating conveyor 43.

An electric motor 51 is mounted on top of water jacket housing 20 for operating pumps 24 and 25 and the housing moving apparatus 52 as will be set forth in detail. A switch 53 on housing 20 controls the operation of said motor and a similar switch 54 controls the supply of current to a heating element 55 in the heating fluid 56 in water jacket housing 20 surrounding capsule material tank 21, and entering a tube 57 extending outwardly from housing 20 to nozzle 23, through which tube capsule material tube 26 extends and is kept hot by the heated fluid. The temperature of heating fluid 56 is controlled by an adjustable thermostat 58 on housing 20 adjacent to switches 53 and 54. It is to be pointed out that these switches, the heating element and thermostat as well as various other elements employed in connection with our capsule machine are of conventional construction and need little if any detailed description or illustration; like the motors and conveyor, by way of further examples, they are conventionally illustrated.

Highly satisfactory types of pumps 24 and 25 are illustrated on an enlarged scale in Fig. 4. Each of these pumps includes an inlet and outlet bored chamber 59 and 60 respectively communicating with the conductor pipes 26 and 27 and having their upper ends closed by plugs 61 which may be opened for eliminating air entrapped in the pumps. These bores or cylinders have communicating passageways 62 with intermediate bores 63 communicating with piston cylinders 64 in which are reciprocable rod piston elements 65. The pistons and cylinders are closely fitted to operate similar to a hypodermic syringe. Ball check valves 66 in inlet and outlet chambers 59 and 60 effectively prevent any back flow of fluid being pumped by actuation of piston elements 65, the amount of fluid being pumped being controlled by the reciprocating movements of

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the piston elements and with a high degree of precision as to the amount for equal successive displacement movements of the pistons. Ball check valves 66 preferably are a fourth of an inch in diameter and made of Monel metal. The valve seats are machined to a right angle edge. The seat is formed by placing a hardened steel ball on the seat and giving it a slight hammer blow which does not change the seat from the apparent sharp edge but it of course does form a very thin area of contact for the ball valves.

In order to operate these pumps 24 and 25 at the required speed, driving motor 51 has reduction gearing in a gear case 67 for driving a shaft 68. This shaft carries, at one end, a drive gear 69, meshing with a gear 70 on a shaft 71, which in turn carries at its other end a crank member 72. Preferably both the gears 69 and 70, and the crank member 72 are fastened on their shafts by means of set screws 72^a so that their time may be varied as desired. As shown in Figs. 4, 5 and 6 gear 70 has a diametrical channel 73 and crank 72 has a similar channel 74; in Fig. 4 they are represented as at right angles with respect to each other, which angular relationship may be varied by loosening the corresponding set screw or screws 72^a. Channels 73 and 74 each carry a bolt type of pivot bearing 75 which may be set in any desired longitudinally adjusted position in its corresponding channel. A calibrated scale 76 for each, indicates the setting for a given measured amount of fluid displacement by the piston rods 65 which are operated by these crank pivot members 75 thru connecting rods 77. Thus by changing the position of the bolt pivot 75 in its slot 73 or 74 the volume delivered by each stroke of the pump may be changed, and by changing the angular relationship of gear 70 and crank 72 with respect to each other the timing of one pump may be advanced with respect to the other and also with respect to movements of the housing 20 and nozzle 23 as will be referred to hereinafter.

As best shown in Fig. 7, nozzle 23, which is supplied with capsule forming material and filling ingredients by means of pumps 24 and 25 and pipes 26 and 27 respectively, is of an improved type.

Heretofore the nozzles have been made with a concentric jet for downward delivery of filling ingredients. In accordance with our improvement the filling ingredient tube 78, connected with pipe 27, is preferably eccentrically mounted in the bore 79 of nozzle 23 extending through a packing bushing 80 in the top of the nozzle and downwardly along one side of bore 79 ending substantially at the bottom end 81 of the nozzle. The end 82 of this tube 78 is closed but it is provided with a side jet opening 83 for ejecting the filling ingredients radially laterally into the capsule forming material. An aperture 84 adjacent to the top of nozzle 23 provides an air bleed opening which is normally sealed by means of a set screw or plug 85.

A nozzle 23^a illustrated in Fig. 7A, is of the same construction as nozzle 23 except that provision is made for forming a capsule with two filling ingredients which are partitioned from each other in the capsule. One ingredient is supplied through pipe 27 and the tubing to side jet opening 83 the same as in nozzle 23 and the only change in the nozzle is to provide a duplicate tube 78^a on the other side of nozzle 23^a from tube 78 which is supplied with a second

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ingredient from a separable filling ingredient container and pump (not illustrated) through pipe 27^a to tube 78^a, the lower end 82^a of which terminates slightly above end 82 of tube 78 and this tube has a side jet opening 83^a above opening 83 in tube 78. A spherical capsule is produced but the filling ingredients are partitioned therein from each other by a wall formed of the capsule material. The proportions of the ingredients may be the same or the separate pumps may be adjusted so that the amounts of each may be different.

In operation motor 51 may be run at a speed so that as many as fifty capsules or more a minute may be formed from nozzle 23. In order that succeeding capsules will not fall on one which is still on the surface of the refrigerant fluid 33 the housing moving apparatus 52 is arranged to advance the housing 20 and nozzle 23 during each interval following the dropping of a capsule from the jet.

This housing moving apparatus includes a crank element 86 mounted on the end of motor driven shaft 68 opposite from gear 69 for driving the pumps. As in the case of the other gears and crank member 72, this crank element 86 is secured on the shaft by means of a set screw 87 so that the timing thereof may be varied with respect to the operation of pumps 24 and 25. As best shown in Fig. 3, crank element 86 has a slot 88 similar to slots 73 and 74 and a bolt bearing pivot member 89 is carried thereby for reciprocating a pawl rod 90 having a pawl end 91 which engages a ratchet wheel 92 and turns it advancing it one notch for each revolution of crank 86.

As shown in Fig. 8 ratchet wheel 92 has a driving gear 93 secured thereto, which meshes with a pinion 94 for driving a shaft 95 to which it is secured. The ends of this shaft extend from a worm drum 96 and bearings 97 secured to the bottom of housing 20 maintain these members in position with respect to the housing.

Worm drum 96 has a double thread worm 98, one thread cut right handed and the other cut left handed forming one continuous thread. On this worm is a sleeve 99 attached to a pivot 100 which is a bearing for a dog 101 which engages in the continuous threads of the worm. This sleeve 99 with dog 101 are pivoted in a bearing 102 mounted in the top of cabinet 35 as a base member for spindle pivot 100. The drum 96 is intermittently driven by motor 51 through the speed reduction gears, crank 86, pawl rod 90, ratchet 92, gear 93, and pinion 94 so that it is actuated once for each pumping cycle, the gear and pinion ratio being such that a complete cycle of operation for a back and forth movement of the housing 20 and nozzle 23 is completed by ten intermittent steps and the points of pause are spaced so that they are not the same for the left and right movements of the housing and nozzle.

In operation it is obvious that with each revolution of drive shaft 68 of motor 51 the pistons 65 of both pumps 24 and 25 make a complete cycle (down and up) and that the housing tank 20 with the attached parts moves a certain distance on the rails 29. The ratchet 92 and pitch of the worm threads 98 is such as to move the mechanism one inch, by way of example, for each revolution of drive shaft of motor 1. The travel in each direction is five rest positions. The mesh of gear 93 with pinion 94 is such that the rest positions after travel is reversed, is midway between the five preceding positions. This

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provides a total of ten rest positions before coinciding positions are repeated. The timing of ratchet 92 by pawl 91 is adjusted by shifting the lead of gear 86 on the drive shaft 68 with respect to the timing of the pump cycles.

The movement of the tank mechanism is made on the upstroke of the piston of the capsule ingredient pump 24. Conversely, the down stroke of this piston is made while the tank mechanism is at rest. The piston of the filling ingredient pump 25 leads the piston of the capsule material pump 24 by about 90 degrees. This timing relationship between the pistons is not extremely critical; there is a latitude of about 15 degrees and about one-half of the work stroke of the piston of the filling ingredient pump 25 occurs while tank housing 20 is in motion. This is necessary because the piston of the filling ingredient pump 25 should lead the piston of the capsule material pump 24 by approximately one half of the work stroke, in order that the material from the inner nozzle is forced into the outer nozzle well before the piston of the capsule material pump 24 forces the combination of the core and shell material out of the outer nozzle. The tank 20 is at rest during the entire down stroke of the piston of the capsule material pump 24. Thus heating tank housing 20 and nozzle 23 move only while the piston of the capsule material pump 24 is on the up stroke, because crank 86 driving ratchet 92 through rod 90 and pawl 91, is secured in position which is in direct phase opposition to gear 70. Movement of nozzle 23 does not aid in disengaging the drop from the nozzle.

The gelatin solution, which is the shell material, is contained in tank 21. The solution may consist of gelatin, glycerin and water. A satisfactory mixture for example has been found to be in the proportion of 100 grams of flake gelatin, 25 cubic centimeters of glycerin and 225 cubic centimeters of water. Varying amounts of glycerin may be used depending upon the shell consistency desired for storage purposes. Glycerin prevents the gelatin from drying to the point that cracking occurs. This mixture has a specific gravity of about 1.085 at 165 degrees Fahrenheit. It has been found that the best results are obtained when the temperature of the shell material is between 160 and 170 degrees Fahrenheit. The solution is quite fluid at this temperature and, as will be discussed later, it is necessary to make use of the density change in the gelatin, due to temperature change as it cools in the receiving solution. The density of the shell material must be near that of the core material, and is therefore determined in some degree by the density of the core material.

The material to be capsulated, that is, the filling ingredient material in container 22, is usually an oil or some other liquid immiscible in a gelatin solution. This liquid is the medicament or the vehicle for the medicament. The medicament may be soluble in the oil or it may be in the form of solids finely powdered so that the oil will hold them in suspension. As an example, the liquid may be cod liver oil and the solid material, cornstarch. The specific gravity of most oils, if not all, is less than 1.0 usually around .90. Cornstarch is added to the cod liver oil to increase the specific gravity of the mixture to approximately 1.080, or slightly less than the specific gravity of the shell material. Should it be desired to capsule an oil for example, such inert solids as cornstarch may be added to obtain the necessary

balance between the core and the shell material. Cornstarch is commonly used for example in tablets, in which instance the function is that of a binding material for the active ingredients. The limit to which solids can be added is determined by the surface tension of the mixture. If the amount of solids added is such that the property of surface tension is not sufficient to cause the core material to form a spheroidal shape, then the capsule will not form properly.

The receiving solution 33 in tank 39 is preferably composed of liquid petrolatum (mineral oil) and carbontetrachloride. By the use of carbontetrachloride the density of the mixture can be adjusted to that desired. The proportions are near 3 parts mineral oil to 1 part carbontetrachloride by volume. The solution is refrigerated to a temperature of 35 to 40 degrees Fahrenheit. The specific gravity of the receiving solution used to produce capsules in test runs was 1.085.

Now referring to schematic Fig. 10 the hot liquid gelatin shell material, or capsule forming material, is supplied to the outer nozzle 23. The plug 85 is removed to vent the air that is trapped at the end of the nozzle, until it is filled with gelatin. After the air is removed and the plug replaced the nozzle remains filled and any material forced out is due to the displacement of the piston of pump 24. Likewise tube or nozzle 78 is filled with core material, the capsule filling ingredient, but due to its design a vent is unnecessary. Nozzle 78 having a laterally facing orifice 83, which feature is particularly important, provides a sharp cut-off of the core material avoiding small drops that otherwise are encased in the shell material of the capsule near the surface of the shell, as occur in capsules formed with a downwardly facing nozzle. The force of inertia of the core material, as it is forced out of the side facing nozzle, is in a horizontal plane and causes the gelatin solution to protrude from the lower end of nozzle 23. In a downward facing inner nozzle this force tends to break through the gelatin. The side facing nozzle also is conducive to greater speeds of production since this vertical force is eliminated. The cranks driving the pumps provide simple harmonic motion of the pistons which is better than an accelerated motion sharply retarded at the end of the stroke. The result is that the mass of shell and core material leave the nozzle as a drop, the size of which is determined by the displacement of the pump pistons. The size of the outer nozzle does not determine the size of the capsule. There is a limit to the diameter that will hold the gelatin solution when the nozzle is facing downward which is determined by the surface tension of the liquid. The distance from the orifice of nozzle 23 to the solution is about three-eighths of an inch, which may be regulated by changing the height of cabinet 31 and tank by the adjustable supporting means 32. It appears that the optimum distance is that which permits the mass of shell and nozzle material to break from the nozzle just as it touches the receiving liquid, as indicated in Figs. 13 and 14.

The various stages of formation and detachment of a capsule are indicated in Figs. 11 to 15 inclusive. In Fig. 11 the operation of the capsule filling ingredient pump 25 has started and the material is being ejected through orifice 83 into the capsule material in nozzle 23, and is continued in Fig. 12 at which time pump 24 has started to supply capsule material to the nozzle. The supply of the capsule material is continued

in Fig. 13 but the flow of the filling ingredient has stopped, pump 25 being on its reverse stroke, drawing more of the ingredient from supply container 22. Fig. 14 illustrates the instant later, when after the capsule neck has narrowed and the capsule has become detached therefrom, and Fig. 15 illustrates the capsule in its submerged or partially submerged position at the surface of the cooling solution. At this time pump 24 starts the up stroke of its piston and lateral movement of nozzle 23 by the mechanism 52 is effected and continued during the stage of formation of the next capsule as illustrated again by Fig. 11 in the repetition of the cycle.

The distance between the nozzle and the receiving solution should be as indicated, above, because the cutoff of the mass is not effected by the receiving solution. When the mass is not allowed to touch the solution until it starts to break from the nozzle, there appears to be better uniformity of size which variation occurs in shell material only. Then too, if the mass is allowed to touch the receiving solution before it breaks from the nozzle, air tends to enter the nozzle and the "prime" is lost, probably due to the fact that the nozzle holds material (due to the surface tension of the material), and when this material touches something, like the receiving solution, this force of surface tension is reduced to the extent that the nozzle will no longer hold the material. When the cross-section of the mass at the tip of the nozzle starts to narrow, then the size of the drop is determined and any touching of the lower part of the mass with the receiving solution does not affect the size of the mass or rather the quantity of shell material. While this phase of the operation is shown in Fig. 14, operation of the apparatus with more nozzle clearance—sufficient clearance that the drop has definitely broken before it touched the receiving solution—is found to be all right except that a greater speed may be obtained with the lesser clearance.

The nozzle is stationary when the drop, or capsule, separates from the nozzle. The gelatin solution is quite fluid and there is no need for the drop to be assisted in breaking from the nozzle by movement of the nozzle. The gelatin solution is about the same fluid consistency as SAE 20 motor oil.

As the maintaining of a constant level of the receiving cooling solution is so important any conventional type of fluid level maintaining means may be employed for supplying fluid to receiver tank 39 but as the process starts before capsules are removed the level rises, so the level retaining means is illustrated as an over flow pipe 103.

The capsule mass as it leaves the nozzle contains core material having a specific gravity of about 1.080, or rather it had that specific gravity at room temperature of 75 degrees Fahrenheit, and shell material having a density of about 1.085 at a temperature of 165 degrees Fahrenheit. The density of the core material probably changes somewhat due to the heat transfer from the hot shell material. Whatever the change in the specific gravity of the core material, the specific gravity of the mass is less than that of the receiving liquid. This is true because the capsule mass assumes the spheroidal shape and remains only partly submerged at the surface as indicated in Fig. 15 for three to five seconds before it starts to descend through the refrigerated receiving solution 33. It must be assumed that the mass

cools sufficiently in this position at the surface of the cooling solution to increase the density to a value greater than that of the cooling solution. It then descends slowly through the cooling solution and is completely gelled before reaching the conveyor. This pause of the capsule mass at the surface is quite important because it is at this point that the spheroidal shape is formed and it is not distorted as it would be if it was falling through the cooling solution while forming. While the mass is hot its shape can be changed by the slightest force. For example if the densities are such that the mass does not pause at the surface, the resistance between the mass and the receiving solution will produce a depression on the top of the capsule that looks similar to the depression in an orange where the stem attaches. Inasmuch as the pause in the reciprocating movements of the nozzle 23 is necessary, the mechanism 52 was arranged with the pawl 91 and ratchet 92 to move the nozzle, after each capsule is ejected. This feature provides speed in production, at the rate of 50 capsules per minute. It will be understood that a number of such nozzles may be added to operate simultaneously, the number of which is only limited by the size of the apparatus, though the rate of 50 per minute seems to be the maximum rate per nozzle.

By changing the adjustment of the bolt bearing pivots 75 in the crank channels 73 and 74 the capacities or displacements of both pumps 24 and 25 may be changed, thus amount of filling material and thickness of the capsule shell may be changed.

Capsules which fall to the bottom of the cooling fluid are caught in buckets 47 of endless conveyor 43 and are elevated and dumped into chute 48. They are then washed in an oil solvent such as carbontetrachloride and placed for drying in an atmosphere, at a temperature which should not exceed 75 degrees Fahrenheit for a period of from 8 to 12 hours.

We claim:

1. A machine for producing filled capsules comprising, a container for capsule forming material, a container for capsule filling ingredients, means for heating the capsule forming material, pumps for pumping the capsule forming material and the filling ingredient, a downwardly facing nozzle for receiving the capsule forming material, a jet within said nozzle through which the filling ingredients are projected laterally into the capsule material adjacent to the lower end of the nozzle, a receiver tank containing capsule cooling fluid therein for receiving capsules formed by the nozzle, and means for moving the capsule forming nozzle following the detachment of a completely formed capsule so that the next capsule formed by the nozzle will engage a different point on the surface of the receiving capsule cooling fluid.

2. A machine for producing filled capsules comprising, a cabinet, a refrigerating unit in said cabinet, a container for capsule forming material movably mounted on said cabinet, means for heating said container, a capsule filling ingredient container carried thereby, a capsule forming nozzle, pumps for pumping the capsule forming material and filling ingredients to said nozzle at intermittent cycles, a receiving container for cooling fluid for receiving capsules formed by the nozzle, means for reciprocally moving said capsule forming material container in step by step movements so that the capsule forming nozzle

will be in successively spaced positions over the surface of the cooling fluid in the receiving container, supports for said cabinet adjustable as to height of the nozzle over cooling fluid in the receiving container may be adjusted, cooling coils surrounding said receiving container supplied with refrigerant from said refrigerating unit, and an endless conveyor for raising capsules formed by the nozzle from the lower part of the container and discharging them therefrom.

3. A machine for producing filled capsules comprising, a cabinet, a refrigerating unit in said cabinet, a container for capsule forming material movably mounted on said cabinet, means for heating said container, a capsule filling ingredient container carried thereby, a capsule forming nozzle, pumps for pumping the capsule forming material and filling ingredients to said nozzle at intermittent cycles, a receiving container for cooling fluid for receiving capsules formed by the nozzle, means for reciprocally moving said capsule forming material container in step by step movements so that the capsule forming nozzle will be in successively spaced positions over the surface of the cooling fluid in the receiving container, a motor for operating said pumps and said container moving means, means for independently varying the timing of the pumps and the container moving means so that the movements of the container and nozzle will occur at a selected cyclic period with respect to the cyclic operating periods of the pumps and the cyclic operating period of the pumps may be varied with respect to each other, supports for said cabinet adjustable as to height of the nozzle over cooling fluid in the receiving container may be adjusted, cooling coils surrounding said receiving container supplied with refrigerant from said refrigerating unit, and an endless conveyor for raising capsules formed by the nozzle from the lower part of the container and discharging them therefrom.

4. A machine for producing filled capsules comprising, a cabinet, a refrigerating unit in said cabinet, a container for capsule forming material movably mounted on said cabinet, means for heating said container, a capsule filling ingredient container carried thereby, a capsule forming nozzle, pumps for pumping the capsule forming material and filling ingredients to said nozzle at intermittent cycles, a receiving container for cooling fluid for receiving capsules formed by the nozzle, means for reciprocally moving said capsule forming material container in step by step movements so that the capsule forming nozzle will be in successively spaced positions over the surface of the cooling fluid in the receiving container, a motor for operating said pumps and said container moving means, supports for said cabinet adjustable as to height of the nozzle over cooling fluid in the receiving container may be adjusted, cooling coils surrounding said receiving container supplied with refrigerant from said refrigerating unit, and an endless conveyor for raising capsules formed by the nozzle from the lower part of the container and discharging them therefrom.

5. In a capsule producing machine, a capsule forming nozzle, comprising a downwardly projecting tubular nozzle casing, a conduit leading into said casing for supplying capsule forming material thereto and a capsule filling ingredient tube extending into said casing downwardly eccentrically thereof and to a point adjacent to

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the lower end thereof, and having a side jet opening therein directed towards the axis of the nozzle casing for ejecting the filling ingredient material laterally into capsule forming material in the said nozzle casing.

6. In a capsule producing machine, a capsule forming nozzle, comprising a downwardly projecting tubular nozzle casing, a conduit leading into said casing for supplying capsule forming material thereto, a capsule filling ingredient tube extending into said casing downwardly eccentrically thereof and to a point adjacent to the lower end thereof, and having a side jet opening therein directed towards the axis of the nozzle casing for ejecting the filling ingredient material laterally into capsule forming material in the said nozzle casing, said nozzle casing having an air bleed port adjacent to its upper end, and a plug for sealing said port after filling the nozzle with capsule forming material and bleeding the air therefrom.

7. A process of forming filled capsules from a downwardly directed capsule forming nozzle which includes intermittently feeding quantities of liquid capsule forming material into said nozzle, intermittently feeding capsule filling ingredients into said nozzle in successive overlapping periods to the feed of said material and directing said ingredient laterally of said nozzle from a location within the nozzle and eccentric thereof toward the axis of the nozzle before ejection of said material therefrom to insert said ingredient into each of said quantities of said material.

8. In the process of forming filled capsules, the steps which consist of flowing a definite quantity of liquid capsule forming material through a downwardly directed nozzle and inserting a definite quantity of capsule filling ingredients into said material by directing said ingredients laterally of said nozzle, from a location within the nozzle and eccentric thereof toward the axis of the nozzle before ejection of said material therefrom.

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9. In the process of forming filled capsules, the steps which consist of flowing a quantity of capsule forming material from a nozzle into a cooling fluid at a first position over the same and inserting a quantity of capsule filling ingredients therein before dropping the same from the nozzle into the capsule cooling fluid, and repeating the steps forming a successive capsule with the nozzle moved to another position over the cooling fluid removed from the first position for dropping the succeeding capsule into the capsule cooling fluid so that the succeeding formed capsule will not engage the preceding capsule which may be sustained by the cooling fluid adjacent to the surface thereof for a limited period of time.

10. In the process of forming filled capsules, the steps which consist of flowing a quantity of capsule forming material from a downwardly directed nozzle and inserting therein laterally at different points of elevation with respect thereto quantities of different capsule filling ingredients before dropping the same from the nozzle into a capsule cooling fluid so that the different ingredients will occupy resulting separate compartments in the capsule.

BENJAMIN D. PILE.
ARCHIE H. McCALLUM.

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2,333,433	Mabbs	Nov. 2, 1943
2,339,114	Scherer	Jan. 11, 1944
2,379,817	Mabbs	July 3, 1945
2,389,084	Routh	Nov. 13, 1945