Oct. 29, 1940. P. S. PITTENGER 2,219,578

MANUFACTURE OF MEDICINAL CAPSULES

Filed Dec. 19, 1936 4 Sheets-Sheet 1

Fig. 1.

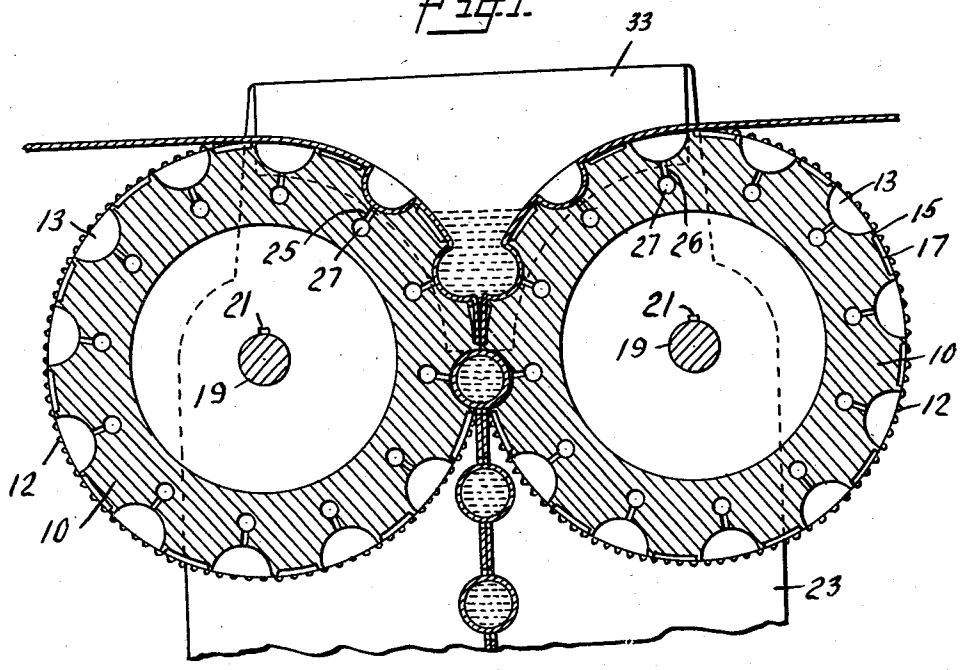
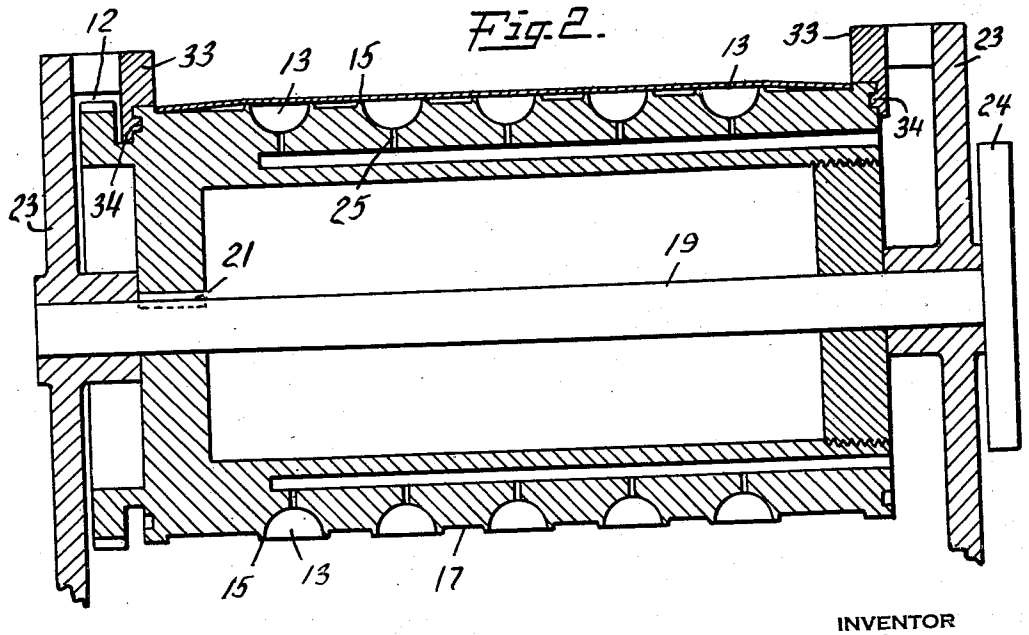


Fig. 2.



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Fig. 3.

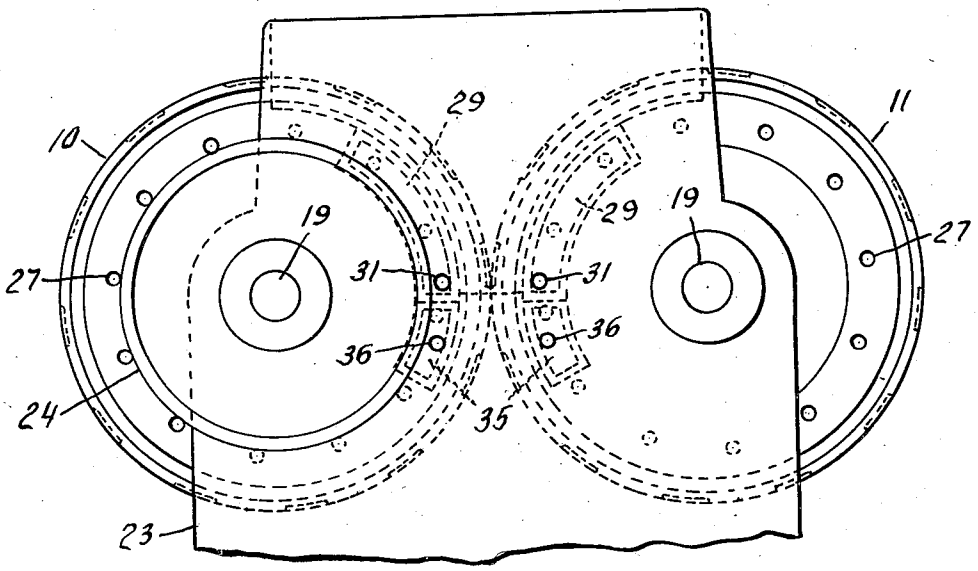
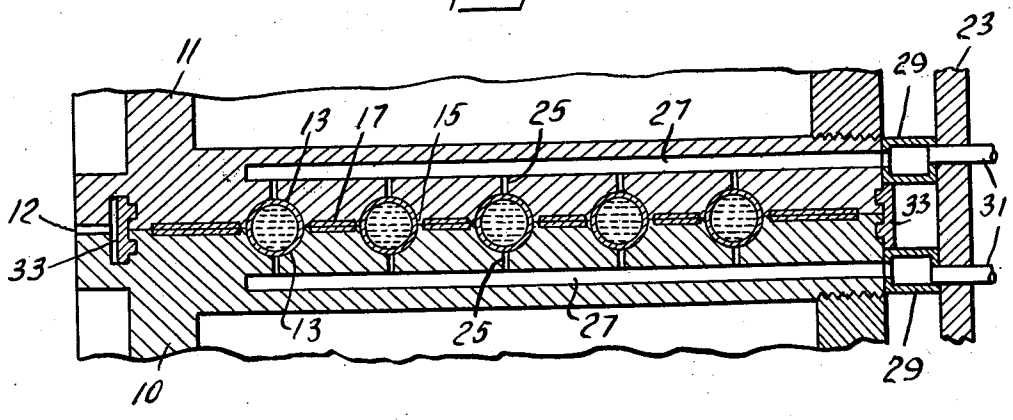


Fig. 4.



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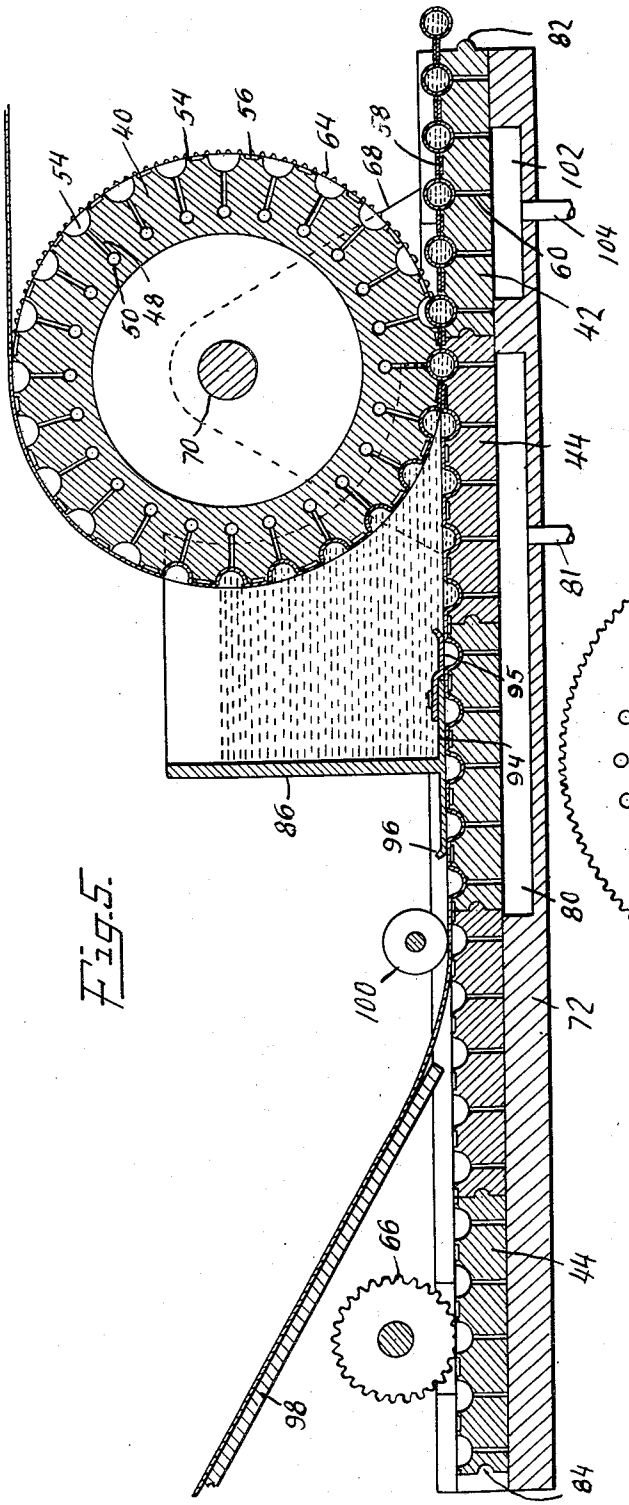


Fig. 5.

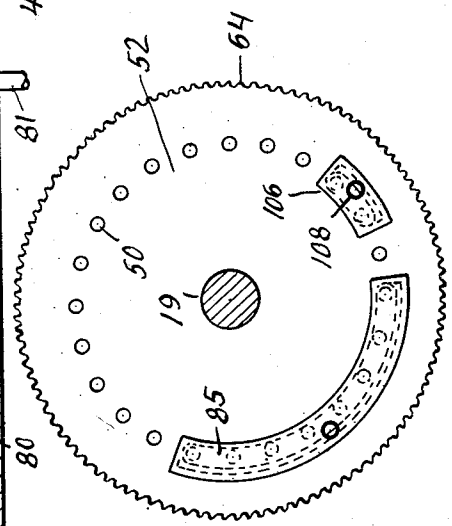


Fig. 6.

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Fig. 7.

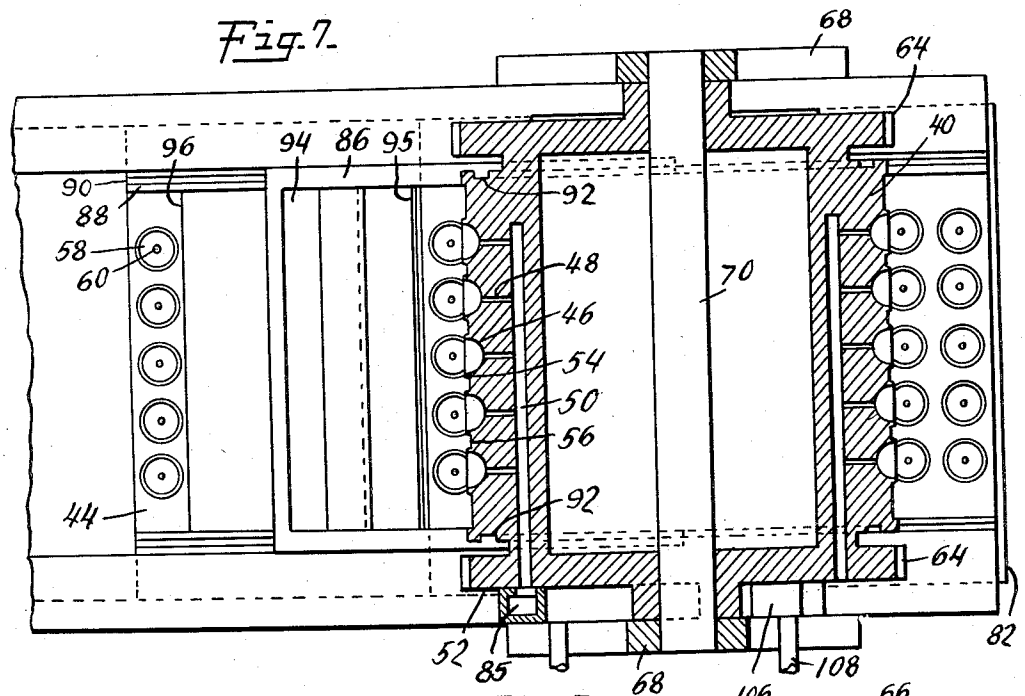


Fig. 8.

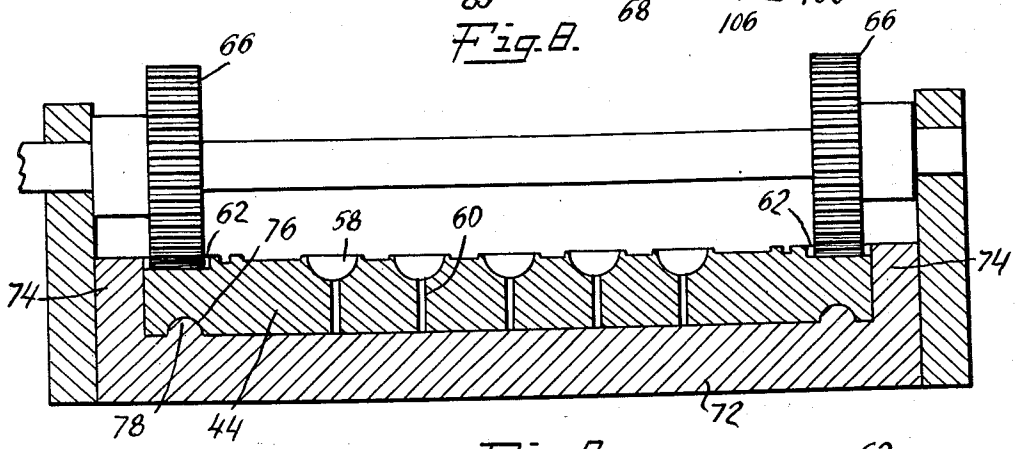
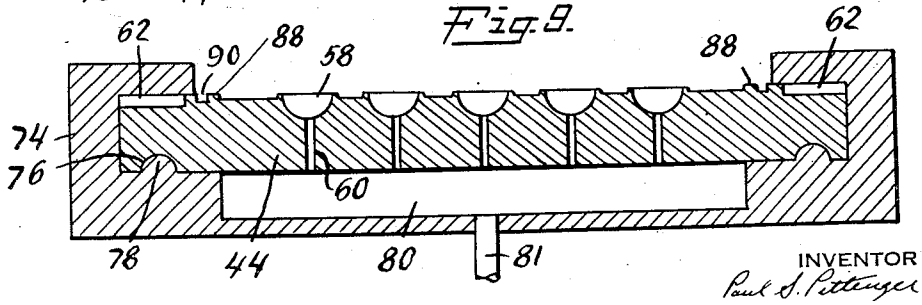


Fig. 9.



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UNITED STATES PATENT OFFICE

2,219,578

MANUFACTURE OF MEDICINAL CAPSULES

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Application December 19, 1936, Serial No. 116,690

4 Claims. (Cl. 18—21)

This invention relates to new and improved processes and apparatus for the continuous production of medicinal capsules having coatings of a tough, tenacious, soluble, elastic sheet material and containing accurately measured and predetermined amounts of a liquid medicinal substance hermetically sealed therein.

It is important, in producing medicinal capsules containing a liquid medicinal compound that the quantity of the medicinal compound be accurately determined and that the proper amount of the compound be introduced into each capsule. It is also important to be sure that the capsules are properly sealed, and that air be excluded from the capsules, so that they contain no air bubbles. The present invention provides a process and apparatus by which capsules meeting all these requirements may be continuously produced in an economical manner, with a minimum of waste and a minimum of improperly formed capsules which must be rejected and treated for the recovery of the material.

It has been customary for a long time, in the production of liquid-containing capsules, to use soluble sheet gelatin, to place a sheet of the gelatin on a female mold member having raised edges and having spaced openings therein, to pour the desired amount of liquid to be incapsulated on the sheet, then to place a second sheet over the liquid in a manner which eliminates all air bubbles, and with the edge of the top sheet overlapping the raised edges of the lower sheet, and then to place a similar mold member, having openings opposite those in the lower member, on top of the top sheet, and place the mold members in a hydraulic press, where pressure is applied. As the mold members are forced together, the liquid, not being able to escape, pushes the elastic gelatin in both directions into the openings, thus forming the upper and lower halves of the capsules, and the motion of the mold members finally results in the cutting of the gelatin and the forcing of the edges together, thus hermetically sealing the capsules. In such processes, it frequently happens that capsules produced near the center of the mold members have more liquid incapsulated in them than the capsules located near the periphery of the mold members, due to the fact that the gelatin when placed upon the lower mold member does not lie flat, and there is a tendency for a bulge to form between the two sheets of gelatin near the center. Also, where differences in thickness or tensile strength of the gelatin occur, there is a tendency to form lopsided capsules, with portions of the coating unduly stretched, which frequently must be discarded.

It has also been proposed to form liquid filled capsules by a continuous process in which two sheets of coating material, for example, gelatin, are fed in converging paths over rotatable mold members having a number of mold openings, similar to those previously used in the process above described, and, by a suitable ejecting device, which forces a measured amount of liquid on to the gelatin positioned over the mold openings, to form suitable half sections of capsules in corresponding positions in each of the converging sheets of gelatin, with subsequent uniting of these half sections and sealing of the edges thereof. Such a process depends largely upon proper control of the fluid ejected for control of the amount of liquid incapsulated.

According to the present invention, liquid filled capsules are produced continuously by preforming depressions or recesses in corresponding positions in each of two converging sheets of coating material, such as gelatin, by means of a vacuum, the size of the depressions or recesses being determined by the size and shape of the mold openings into which the coating material is drawn by the vacuum, and by proper control over the thickness of the sheets used. The preformed recesses or depressions in the sheets are filled with liquid to be incapsulated by passing the continuously moving sheets with the depressions or recesses formed therein through a body of liquid in a manner such that each recess or depression is completely filled with liquid, with complete elimination of air, and at the point of convergence of the two sheets, cutting and sealing the coating material around each of the capsules formed by the convergence of two corresponding recesses or depressions each filled with liquid.

In this way, capsules of various sizes and shapes may be readily produced, the size and shape of the capsule being determined by the size and shape of the mold opening into which the coating material is drawn by the vacuum, and by the thickness of the coating material. Thus great accuracy can be achieved in the predetermination of the amount of liquid to be incapsulated in each capsule, as the mold opening may be readily made of any desired shape or size, and as the thickness of the coating material may be readily controlled with a tolerance of 0.001 inch or less.

The sheet material which is employed in coating the capsules may advantageously be sheet gelatin, but other suitable coating materials, such as certain soluble gums or gum resins, which are

not attacked by the liquid incapsulated, may be used. Where it is desired to incapsulate an aqueous liquid, sheet gelatin of the type now available cannot be used, as it is dissolved by the aqueous liquid; but other sheet material having the necessary elasticity and plasticity may be used.

The coating material may be readily produced in sheets of the required thickness, and within closely assigned limits of tolerance, e. g. within tolerances of 0.001 inch, readily, by flowing the material in a liquid state on to a moving web or drum and under an accurately positioned doctor knife, and subsequently passing the web through a suitable conditioning chamber or internally cooling the drum to harden the material thereon to the desired degree of plasticity.

Various forms of apparatus may be used for the carrying out of the invention, but whatever form of apparatus may be used, it is important to provide means by which a suitable body of liquid may be maintained above the point of convergence of the two sheets of gelatin, the liquid being prevented from flowing past the point of convergence by properly controlling the depth of the depressions between the mold openings so that those portions of the sheets of gelatin between the capsules which are formed come into contact under pressure, forming a tight joint which prevents any considerable amount of the liquid from flowing past the point of convergence.

The invention will be further described in connection with the accompanying drawings, which illustrate, in a somewhat conventional and diagrammatic manner, apparatus which embodies the invention and is adapted for the practice of the process of the invention.

In the drawings:

Fig. 1 is a transverse sectional view of a portion of an apparatus which embodies the invention, showing two rotatable drums adapted to act as continuous molds;

Fig. 2 is a transverse sectional view of one of the drums illustrated in Fig. 1;

Fig. 3 is a side view in elevation showing the two rotatable drums of Fig. 1;

Fig. 4 is a sectional view of portions of the two rotatable drums at the point of contact where the two sheets of coating material are forced together and the capsules are cut out;

Fig. 5 is a transverse sectional view of a modified apparatus which embodies the invention in which one of the mold members is a rotatable drum and the other is flat and composed of sections;

Fig. 6 is a side view in elevation of the rotatable mold member of the apparatus illustrated in Fig. 5;

Fig. 7 is a plan view with portions in section of the apparatus illustrated in Fig. 5;

Fig. 8 is a sectional view of one of the flat mold sections with its support; and

Fig. 9 is another sectional view of one of the flat mold sections with its support, showing the means by which a vacuum is applied to the sheet of coating material.

In the apparatus illustrated in Figs. 1 through 4, there are provided two rotatable drum-like mold members 10 and 11, each provided with gear teeth 12 which mesh to insure that the two mold members rotate in synchronism.

Each of these mold members is provided with a series of female mold openings 13 corresponding in size and shape to the size of the capsules to be produced, each opening being provided with a raised cutting edge 15 and with depressed portions 17 between these openings. The depth of the depressions 17 is carefully regulated so that it is about the same as the thickness of the sheets of coating material, such as gelatin, which are to be used with the apparatus.

These rotatable mold members are supported on the shafts 19, to which they are keyed as at 21, which shafts in turn are supported by the frame 23. The mold members are rotated by means of a belt passing over the pulley 24, or in any other suitable way, the fact that each carries inter-meshing gears insuring their synchronous rotation.

Each of the mold openings 13 is of a size and shape to correspond to the exterior of one-half of the desired finished capsule, and may be hemispherical, as illustrated, or semi-ellipsoidal, or of other desired shape. From the bottom of each of the mold openings there is a small passageway 25, communicating with conduits 27, which extends from an open end at one side of the rotatable member to connect each of the depressions 13 in a given row, so that when a vacuum is applied at the open end of the conduit a vacuum is produced within each of the interconnected depressions or mold openings 13.

The passageways 25 are relatively small, so that when the sheet of coating material is drawn down into a mold opening 13 a smooth surfaced depression or recess is formed, and no part is drawn further into the passageway 25 with the production of a protuberance. On the other hand, the passageways 25 are sufficiently large so that a vacuum is readily produced in the mold openings 13, and so that the passageways are not readily clogged by a small particle of foreign matter. It will be evident that the size of these passageways must depend upon the thickness and hardness of the coating material used, being quite small if a thin sheet of relatively soft material is used, and larger if a thick sheet of relatively hard material is used. These passageways serve not only as a means of producing a vacuum to preform the depressions or recesses in the sheets of coating material, but also serve as conduits or passageways through which compressed air may be introduced into the mold openings to force the finished capsules out, to avoid any possibility of their sticking after they have been finished.

The end surface of the drums at which the conduits 27 open are machined, and have a smooth surface. An open box 29, with the open side in tight contact with the machined end of the drum, suitably connected by conduits 31 to vacuum, is provided on each drum, and is so located, as illustrated in Fig. 3, that a vacuum is produced within each of the openings 13 about one-sixth of a revolution before the convergence of the two drums, the vacuum box being of sufficient length so that the vacuum is continued to about the point of convergence.

There is also provided a dam 33 at each end of the apparatus, which dam serves to maintain a body of liquid above the point of convergence of the two rotatable drums. These dams are interlocked with the drums, as shown at 34, to minimize leakage, the liquid serving as a lubricant between the sliding surfaces of the dams and the rotatable drums.

In operation, a body of liquid is maintained above the point of convergence of the two drums, between the dams 33, and two sheets of coating material are fed continuously to the apparatus, one at the top of each of the rotatable mold mem-

bers, as illustrated. As the drums rotate, carrying with them the two sheets of coating material, each row of mold openings 13 comes successively into communication with the vacuum chambers 29, with the result that the coating material is drawn down into the mold openings with the formation of depressions or recesses therein. As these depressions or recesses are formed, and as they pass forward into and through the body of liquid maintained between the dams, they become filled with liquid, care being taken that the level of the liquid is maintained sufficiently high so that no air is entrapped in the recesses or depressions. The liquid level may be controlled by an automatic float (not shown) manually, or in any suitable way. As the mold openings progress forward, and the two sheets converge, the raised edges 15 around each of the mold openings serve to compress the coating material between them and to cut it around each of the capsules which are formed, thus hermetically sealing together the two halves of each capsule.

The depressions 17 between the mold openings are of such depth as to just accommodate the coating material, while compressing together the two sheets somewhat, so that no part of the liquid can flow down between the mold openings, thus preventing leakage.

There is also provided at the machined side of each of the drums a chamber 35, placed below the point of contact of the two drums, similar to the vacuum chambers 29, but smaller in size and connected by conduits 36 to a suitable course of compressed air, so that if any of the capsules have a tendency to stick in the mold openings they are forced out by the compressed air almost immediately after they have been formed.

The number of mold openings 13 which may be provided in each row along an element parallel to the axis of each rotatable drum may be varied almost at will, from one to any desired number, the practical limitation being fixed by the width of the strips of coating material which may be continuously formed with accurately predetermined thickness, the number illustrated being five. It will be apparent that by making the vacuum conduits 27 sufficiently large, it will be easily possible to produce the desired vacuum, which need only be of the order of a few inches of mercury, in an almost indefinite number of mold openings in a single row.

In the apparatus more particularly illustrated in Figs. 5 through 9, there are provided, instead of two rotatable mold members, one rotatable mold member 40, and one flat mold member 42, made up in sections 44. The construction of the rotatable mold member 40 is almost identical with that of the rotatable mold members illustrated in Fig. 1, it being provided with suitable mold openings 46 of the desired shape and size, suitably connected by passageways 48 to conduits 50, open at one end of the rotatable mold member, which end is provided with a machined surface 52, and closed at the other end. The mold openings are provided with raised cutting edges 54, and with depressed portions 56 between them, the depth of these depressions being regulated in accordance with the thickness of the sheets of coating material to be used.

The mold sections which constitute the flat mold member are also provided with mold openings 58, which correspond to the openings 46 in the rotatable mold member, and which are similar in shape and size, and are provided with corresponding raised cutting edges and depressed portions between them. Each of these openings 58 is connected by a passageway 60 leading from its bottom to the bottom of the mold sections, so that there is a free passageway from each of the openings 58 through to the bottom of the mold sections.

Each of the flat mold sections 44 is provided on each side with gear teeth 62 which mesh with the gear teeth 64 provided on the rotatable mold member and which insure that the forward movement of the flat mold sections and the rotational movement of the rotatable mold members are synchronized, such that as the successive rows of mold openings in the flat sections come under the axis of the rotatable molds, a corresponding row of openings of the rotatable mold member reaches the same point, and a capsule is formed between each pair of openings. The flat mold sections are moved forward by the gear wheel 66, suitably driven, and serve to drive the rotatable mold member.

The rotatable mold member is supported on the frame 68, and rotates on the axis 70 supported thereby. The flat mold sections are supported by the frame 72, fitting between the upright flanges 74. A groove 76 is provided at each side of each mold section, and a corresponding rib 78 is provided at each side of the flange 72 so that as the mold section moves forward over the vacuum chamber 80, the entrance of air along the points of contact of the mold section and the frame into the vacuum chamber is minimized. Each mold section is also provided at the front end with a rib 82, which fits into a corresponding groove 84 provided at the back of each mold section, so that tight joints between the mold sections are insured.

The vacuum chamber 80, which is provided in the frame or support 72, is connected by means of conduits 81 to a suitable vacuum device (not shown), and extends to a point about under the axis of the rotatable mold member. A vacuum chamber 85, similar to those provided on the rotatable mold members of the apparatus of Figs. 1 through 4, is provided at the side of the rotatable mold member which is provided with a machined surface, and at which the conduits 50 open. This vacuum chamber 85 extends from somewhat above a horizontal diameter of a rotatable mold member to a point about under its axis, serving to preform recesses or depressions in the gelatin from a point somewhat above the horizontal axis of the drum, and to maintain the recesses or depressions properly formed until the capsules are finally sealed.

There is also provided a dam 86, which extends down in tight sliding engagement with the surface 88 provided at each side of the flat mold sections, the dam being provided with a lip which fits into the groove 90 at each side of each flat mold section, to minimize leakage. The dam also is fitted in an interlocking manner, as shown at 92, to the sides of the rotatable mold member, to minimize leakage at the points of contact of the dam and the rotatable mold member. At the point of contact of the dam with the sheet of coating material which is carried forward along the flat mold member there is provided an apron 94, with the edge with which the coating material first comes into contact somewhat upraised as at 96 to prevent sticking, and with the other edge held in position by the spring shoe 95, which exerts a proper downward pressure to insure tight contact between the apron and the shoe. This apron, which is somewhat wider than the distance between three

rows of mold openings, serves to prevent leakage of the liquid along the upper surface of the strip. The height of the dam is such that a body of liquid can be maintained between the converging strips of coating material which is sufficient to insure that when the depressions or recesses are formed in the strip being carried forward by the rotatable mold member, no air can be entrapped, and care should be taken that the height of the liquid level is sufficient to prevent the entrapping of air. The liquid level may be maintained either by means of an automatic float, or other automatic means, or it may be maintained manually.

A continuous sheet of coating material is fed to the flat mold member along the runway 98, passing under the roller 100 so that it lies flat on top of the mold member before passing under the apron 94 and before coming above the vacuum chamber. If it is found that the coating material has a tendency to stick to the apron 94, the roller 100, instead of being a simple roller to insure that the coating material is flat on the mold member, may be an oiling roller, supplying lubricant to the coating material to lubricate its passage under the apron. If this roller is used as an oiling roller, care should be taken that the lubricant which is supplied thereby is of a nature which is compatible with the liquid which is being incapsulated, and which, when present in minute amounts in the finished capsule, has no deleterious effect. In many cases, it will be found desirable to use as a lubricant the same material which is being incapsulated, or a related material. As the mold member, and the coating material, move forward over the vacuum chamber, a vacuum is produced within each row of hemispherical molds, each connected with a passageway 60 leading to the bottom of the mold member, so that the air is withdrawn from the molds and the coating material is drawn down into the molds forming a number of depressions or recesses corresponding in shape and size to the mold openings. As the thickness of the coating material is carefully controlled, the volume of the liquid which passes into the recesses or depressions may be accurately predetermined and controlled. As the depressions or recesses move forward with the mold member, they pass under the body of liquid which is maintained by the dam and the depressions or recesses become full of the liquid.

Another continuous sheet of the coating material is fed to the rotatable drum at about the top and is carried forward along with it as it rotates toward the flat mold member. As the rotatable mold member rotates, the mold openings 46 come into successive communication with the vacuum chamber 85, with the result that a depression or recess is formed corresponding to each mold opening, and as the sheet of coating material passes down through the body of liquid which is maintained, the depressions or recesses become full of liquid. As the drum rotates, and the flat mold member moves forward, each row of recesses or depressions in the sheet being carried by the rotatable mold member comes over a corresponding row of depressions or recesses formed in the sheet on the flat mold member, and as the corresponding rows come under the axis of the rotatable mold member, the two sheets of coating material are forced together, forming the capsules, which are hermetically sealed and are cut from the sheets of coating material. As the depressions between the openings are carefully regulated as to depth to provide room only for the coating material, none of the liquid in the body can pass forward or leak past the point at which the capsules are formed and sealed.

A chamber 102, connected by conduit 104 to a suitable source of compressed air, is provided in the frame 72 which supports the flat mold member at a point subsequent to that at which the capsules are formed, and a similar chamber 106, connected by conduit 108 to a suitable source of compressed air, is provided to communicate with the conduits 50 of the rotatable member, subsequent to the point where the capsules are formed. These compressed air chambers are provided so that in the event that any of the capsules tend to stick in the mold openings after they are formed, they will be forced out by the compressed air.

After each section of the flat mold member passes the rotatable mold member, and the capsules are formed, it is removed from the suport 72, and returned to the other end of the apparatus; so that, in effect, the flat mold member is continuous.

It will thus be seen that by the present invention, I provide a method and apparatus by which medicinal capsules provided with a liquid center suitably coated with a coating of a tough, elastic, soluble material, such as sheet gelatin, and hermetically sealed therein, the coating having a substantially uniform thickness throughout, and the volume of the liquid within the capsule being accurately determined, may be produced in a continuous manner and with apparatus which requires a minimum of attention.

I claim:

1. The continuous process of producing liquid filled capsules which comprises feeding a pair of sheets of elastic coating material in converging paths, progressively and continuously subjecting each sheet to the action of a vacuum to perform depressions or recesses therein, each recess or depression in one sheet corresponding to one in the other, passing the sheets of coating material with the depressions or recesses formed therein against a body of liquid maintained adjacent the point of convergence of the sheets of coating material to fill each recess or depression with liquid and eliminate all air therefrom, and progressively and continuously cutting the sheets of material and applying pressure thereto to cause the edges of the cut portions to adhere to form capsules, and substantially preventing the liquid from flowing past the line of convergence of the sheets and from coming into contact with the exterior of the capsules.

2. Apparatus for continuously producing liquid filled capsules comprising a pair of continuously moving mold members, each provided with a plurality of mold recesses in corresponding positions, a raised cutting edge around each said recess, said mold members being adapted to carry two continuous sheets of coating material in converging paths, means for applying a vacuum within each mold recess at a position prior to the convergence of the two sheets of material to preform corresponding recesses or depressions in each sheet of coating material, damming means for maintaining a body of liquid to be encapsulated above and adjacent to the point of convergence of the two sheets of coating material and for substantially preventing the liquid from flowing past the line of convergence of the sheets and from coming into contact with the exterior of the capsules,

and means for synchronising the movement of the two mold members.

3. Apparatus as in claim 2, in which the mold openings are of a size and shape to correspond to one half of the desired exterior dimensions of the capsules.

4. Apparatus as in claim 2, in which the mold openings are provided with raised cutting edges with depressions therebetween, the depth of said depressions being substantially the same as the thickness of the coating material to be used.

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