

July 6, 1943.

C. L. WECKESSER

2,323,581

METHOD AND APPARATUS FOR CAPSULATING LIQUIDS

Filed Aug. 12, 1940

4 Sheets-Sheet 1

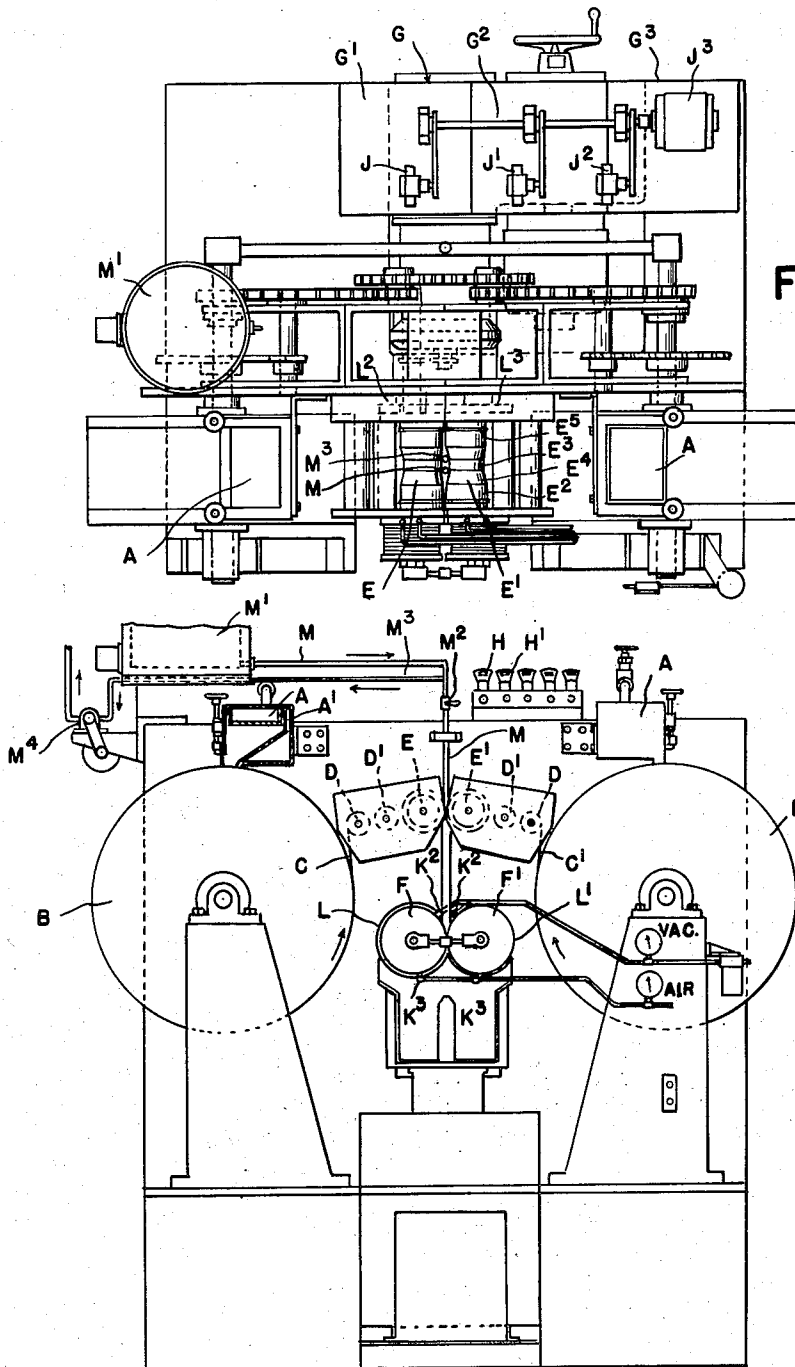


FIG. 2.

FIG. 1.

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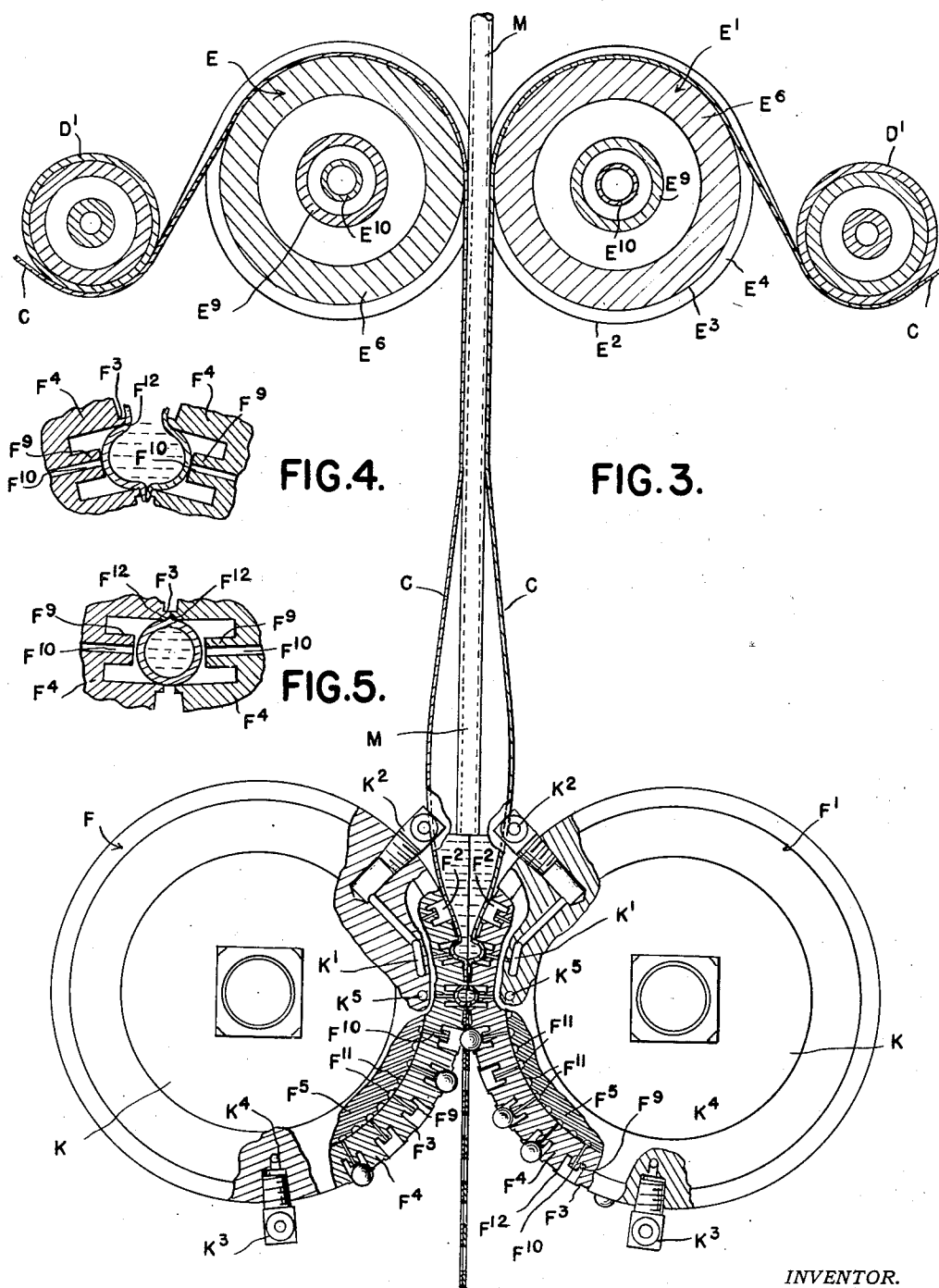
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4 Sheets-Sheet 3

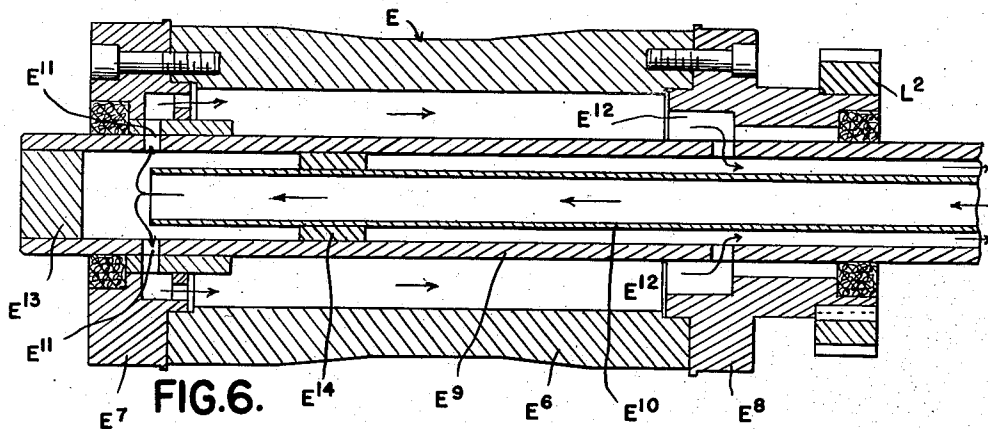


FIG. 6.

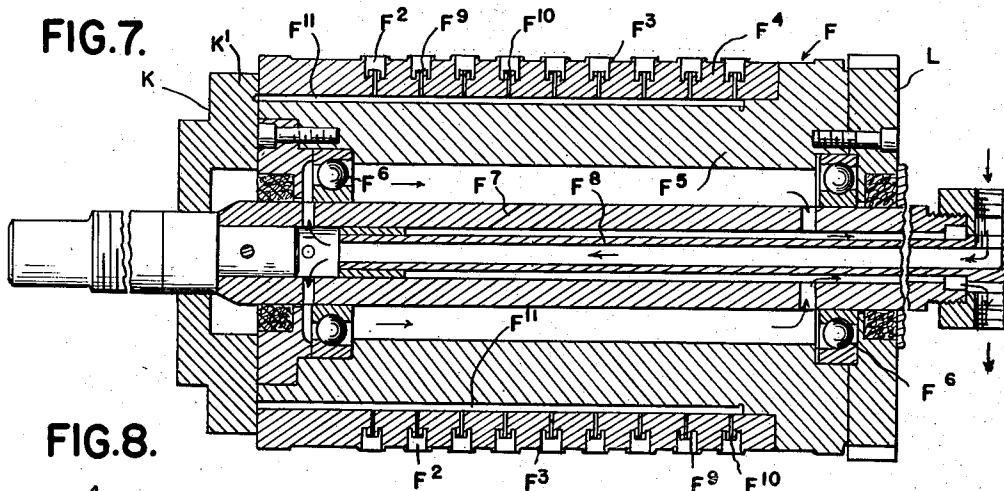


FIG. 7.

FIG. 8.

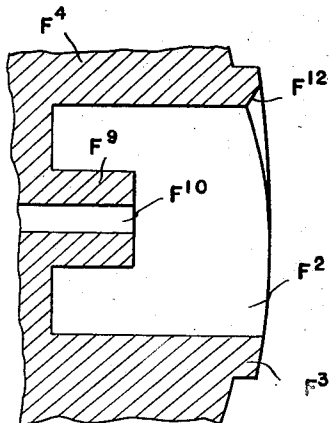
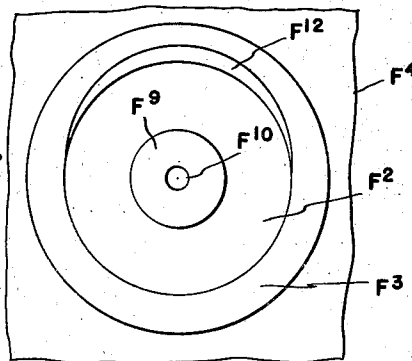


FIG. 9.



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4 Sheets-Sheet 4

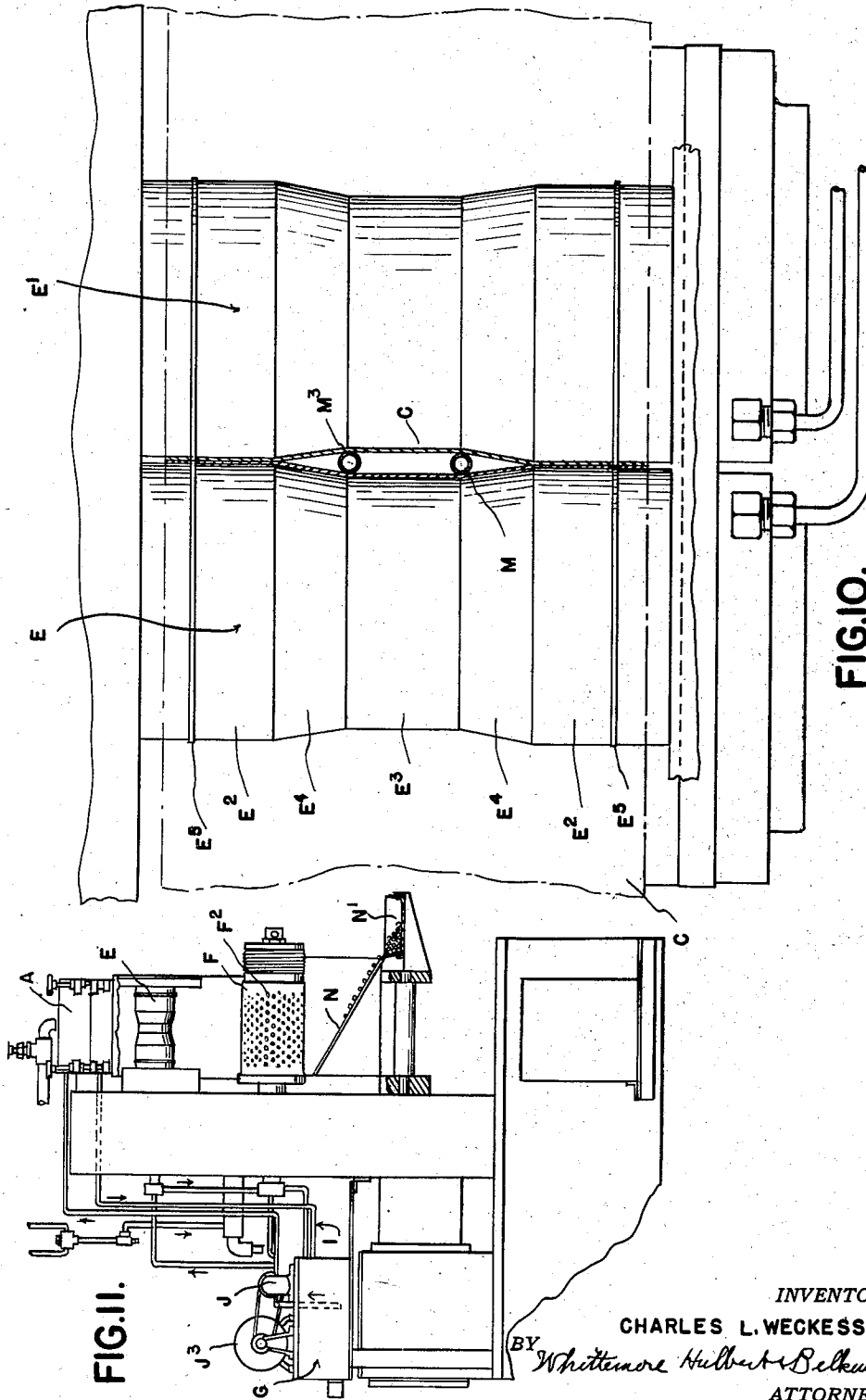


FIG.II.

FIG.IO.

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UNITED STATES PATENT OFFICE

2,323,581

METHOD AND APPARATUS FOR CAPSULATING LIQUIDS

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Application August 12, 1940, Serial No. 352,319

12 Claims. (Cl. 18—21)

The invention relates to the manufacture of liquid medicament filled gelatin capsules and forms a continuation in part of my pending application for patent Serial No. 191,793, filed February 21, 1938. The invention consists in certain novel features in the method and the apparatus, as hereinafter set forth.

In the drawings:

Figure 1 is a front elevation of the machine;

Figure 2 is a plan view thereof;

Figure 3 is an enlarged vertical longitudinal section partly in elevation through the holder forming and capsule forming rolls;

Figures 4 and 5 are sections similar to Figure 3 showing successive positions in the forming of a capsule;

Figure 6 is an axial section through one of the holder forming rolls;

Figure 7 is a similar view through one of the capsule forming rolls;

Figure 8 is an enlarged section through a portion of the capsule forming roll, showing one of the capsule forming pockets;

Figure 9 is a front elevation of Figure 8;

Figure 10 is a plan view of the pair of holder forming rolls;

Figure 11 is an end elevation of the machine with some of the parts broken away.

In the present state of the art of forming medicament liquid filled gelatin capsules, registering half capsules are formed in a pair of opposed gelatin strips having the medicament liquid therebetween, said strips being then pressed together to exclude the surplus liquid and to weld the capsule sections to each other. In the carrying out of such a method it is very essential that the gelatin strips should be in the proper condition of plasticity, both for the forming of the pockets therein and for effecting a sealing weld therebetween. It is, therefore, one of the features of my improvement to provide means for insuring such proper conditioning of the gelatin strips at the time when these operations are performed thereon. Another feature of my improvement is the means for introducing and holding the liquid between the strips during the capsule forming operations. Other features of my improvement relate to the construction of various portions of the apparatus, as hereinafter set forth.

The gelatin strips may be formed in the usual way by depositing the liquid gelatin upon a traveling surface maintained at proper temperature to cause solidification. As shown, the liquid gelatin in a receptacle A is deposited on the periphery

of a revolving drum B, and while traveling therewith is solidified to form the strip C. This strip is passed over rolls D and D', which oil the opposite surfaces thereof prior to delivery to the capsule forming mechanism. A similar strip forming mechanism simultaneously delivers a second strip to the capsule forming mechanism.

Capsule forming mechanism

This mechanism comprises a pair of rolls E and E' for forming a liquid holder and a pair of capsule forming die rolls F and F' arranged therebeneath. The holder forming rolls have cylindrical portions E² at opposite ends thereof with a central portion E³ of smaller diameter and tapering portions E⁴ connecting the portions E² and E³. There is also a rib E⁵ on each of the portions E² which serves to seal the margins of the strips to each other so as to temporarily form thereof a holder. The peripheries of the portions E³ of the two rolls are sufficiently spaced to leave an opening for the insertion of a conduit through which the liquid medicament is introduced.

The rolls F and F' are directly beneath the rolls E and E' and serve to close the bottom of the holder portion of the strips so as to retain the liquid content. In addition to this function, the rolls F and F' are provided with registering pockets F² in which the individual capsules are formed, said pockets being arranged in circumferential and transverse series so as to cover the greater part of the periphery. Each pocket is surrounded by an annular flange F³, which in cooperation with the registering flange of the other roll progressively welds the liquid filled capsule portions to each other and severs the same from the surrounding portions of the strips. There is sufficient space between the flanges of adjacent pockets to leave a continuous web or net which will be fed downward by the rotation of the rolls into a suitable receptacle. On the other hand, the capsules will be retained in one or the other of the registering pockets from which they may later be expelled as hereinafter described.

As above stated, the successful performance of the successive steps in forming the capsule is dependent upon maintaining the proper condition in the gelatin strips which is accomplished as follows. All of the rolls E, E', F and F' have their peripheral portions maintained at a predetermined temperature so that the temperature of the gelatin strips in contact therewith will be exactly controlled. I have found that the holder forming rolls should be maintained at a tempera-

ture between 90° F. and 100° F., preferably 95° F. If the temperature is too low a very ragged and imperfect seal is made between the marginal portions of the strip, while on the other hand, if the temperature is too high the gelatin will stick to the rolls and will be so weakened as not to satisfactorily hold the medicament. The die rolls should be kept at a temperature between 80° F. and 90° F., while the medicament liquid which is to be filled into the capsules should be between the limits of 80° F. and 100° F. Such temperatures are maintained by forming the rolls hollow and circulating therethrough a heating liquid. As shown in Figures 1 and 2, the liquid circulating medium, preferably a hydrocarbon oil, is held in a tank G which is divided into several compartments G', G² and G³. Heating means is provided for each of these compartments, preferably electrical heaters, which are automatically controlled by thermostatic means. As shown, H, H', etc., are the individual heating, controlling and indicating devices for the several tanks, which are mounted on a panel where they may be observed by the attendant and adjusted when necessary. As the detailed construction of these devices forms no part of the instant invention, it is not completely illustrated. The compartments G', G² and G³ are connected by circulating conduits I with the different parts of the apparatus in which the temperature is to be controlled. There are also individual pumps J, J' and J² for propelling the fluid from each compartment, said pumps being simultaneously operated, preferably by an electric motor J³. The fluid from the compartment G' is circulated through a jacket A' surrounding the liquid gelatin receptacle A, so as to maintain this receptacle at the proper temperature. The fluid from the compartment G² is circulated through the capsule forming rolls and the fluid from the compartment G³ is circulated through the holder forming rolls. To insure uniform temperature in all of the gelatin contacting portions of each of these rolls they are preferably constructed as follows. The rolls E and E' are formed with an outer shell E⁶ having heads E⁷ and E⁸ at opposite ends thereof. E⁹ is a tubular shaft extending axially through the heads E⁷ and E⁸ and E¹⁰ is an inner tube extending part way through the tubular shaft E⁹. The liquid propelled by the pump enters through the tube E¹⁰ which conducts it to the head E⁷. Here it passes into the tube E⁹ and through ports E¹¹ in said tube and the head E⁷ into the annular chamber between the shaft E⁹ and shell E⁶. The tubular shaft E⁹ forms the outlet for the fluid which passes from the annular chamber through ports E¹² in the head E⁸ into the interior of said tubular shaft. A plug E¹³ closes the outer end of the tubular shaft E⁹ and a bushing E¹⁴ between the tubes E¹⁰ and E⁹ prevents any short-circuiting of the fluid. Thus, the heated fluid is compelled to traverse the whole length of the annular chamber within the shell E⁶, thereby heating said shell to the desired temperature for contact with the gelatin strips.

The rolls F and F' are heated in a similar manner by passing the heating fluid through a chamber within the outer shell of the roll. These rolls are, however, more complex in their construction to enable them to perform a number of distinct functions, the construction being as follows.

The primary function of the rolls F and F' is to form in the gelatin strips the registering half capsule portions, which are filled with the medicament and then sealed to each other. The gela-

tin is expanded into the pocket F³ by suction combined with the hydrostatic pressure of the liquid content in the holder. It is, therefore, necessary to apply suction to the pockets at a predetermined point in the revolution of the roll to cut off this suction when the gelatin is expanded to the desired amount, and finally after the sealing of the complementary capsule sections to each other, to eject the capsule from the pocket by super-atmospheric pressure. For convenience in manufacture, I preferably form the rolls F and F' of an outer shell portion F⁴, having its outer peripheral surface machined to form therein the pockets F² and the surrounding annular flanges F³. This outer shell is mounted on an inner annular member F⁵ which latter is revolubly mounted, preferably by ball bearings F⁶, on an inner non-revoluble hollow shaft member F⁷. The shaft F⁷ together with an inner tube F⁸ forms a means of circulating the heating fluid through the roll in the same manner as with the rolls E and E'.

The pockets F² are arranged in axially extending rows which alternately are in staggered relation so as to cover the greater part of the peripheral area. Each pocket forms a substantially cylindrical recess having a central post F⁹ extending outward from the bottom, and a passage F¹⁰ in this post extending completely through the shell F⁴. The member F⁵ is formed with a series of axially extending grooves F¹¹ in its peripheral surface each of which registers with all of the passages F¹⁰ in a single axially extending row of pockets. The grooves F¹¹ extend through one end of the row but terminate short of the other end. A non-revoluble head K mounted on the shaft F⁷ forms sealing contact with one end of the members F⁴ and F⁵. This head has a segmental groove K' in its contacting surface located to communicate successively with the grooves F¹¹ during the rotation of the roll. The groove K' is connected by passages within the head K to a hollow post K² connected by conduits to a source of suction (not shown). A second hollow post K³ is connected with a source of compressed air, and a passage leading from this post through the head is connected with a port K⁴ with which the grooves F¹¹ are successively registered. The grooves K' are so located that suction will be communicated with each row of pockets in the descending portion of the periphery of the rolls a short distance above the horizontal plane of the axes of said rolls. Thus the gelatin strip will be expanded into each pocket of the row until it contacts with the post F⁹ at which time the passage F¹⁰ will be sealed to prevent further exhaustion of the air within the pocket. This gauges the size and capacity of the capsule section, while still permitting a slight expansion incident to the closing and welding of the two complementary sections to each other. The exact location of the port K⁴ is not so important as its function is merely to dislodge the complete capsule from the pocket. I have shown the port slightly before the lower dead center of the roll.

The function of the flanges F³ is two-fold, first, they progressively press the capsule sections together and into welding contact; and second they sever the completed capsule from the surrounding web or net. While these two functions might be performed by an annular flange surrounding the pocket of one roll cooperating with an unflanged surface surrounding a complementary pocket in the other roll, I find

it preferable to form such flanges on both rolls. It is also important that these flanges should be accurately fashioned. The outer surface of each flange must be concentric with the axis of the roll and in cooperation with the corresponding flange of the complementary roll will progressively squeeze out the gelatin therebetween. The forward side of the flange in the direction of travel of the rolls will squeeze the gelatin toward the pocket so as to form a wall of full thickness in the capsule. There is, however, danger that on the trailing side the capsule may be severed from the strip without forming a wall of full thickness or even without forming a complete closure. This is for the reason that the approaching surfaces on the trailing side are at such an angle to each other as to force the gelatin therebetween away from the pocket, whereas the approaching surfaces on the forward side are at an angle to force the gelatin toward the pocket. I have avoided this difficulty by chamfering or cutting away the flange on the trailing side of the pocket, so as to form oblique surfaces that will force the squeezed out gelatin toward the pocket instead of away from it. Thus, as shown in Figures 8 and 9, the chamfer 12 is greatest at the center of the trailing edge of the pocket and progressively narrows to die out at the opposite side of the pocket. Such construction I have found will form a capsule with full thickness of wall on its trailing side.

The rolls E, E' and F, F' are driven at substantially the same peripheral speed by any suitable construction of transmission mechanism. This includes the intermeshing gear wheels L and L' on the rolls F and F', which hold these rolls in proper registration, and the intermeshing gear wheels L² and L³ for the rolls E and E'.

Operation

In carrying out my improved process with the mechanism as above described, the gelatin strips C and C' formed respectively on the drums B and B' are led over and under the oiling rolls D and D' to the holder forming rolls E and E', thence downward between the rolls F and F'. After the machine is in full operation these strips will be formed into a holder while passing around the rolls E and E', their marginal edges being welded to each other by the ribs E⁵ so as to form a liquid-tight seal. Also, the portion of the strips passing between the rolls F and F' are pressed together to form a bottom seal. Consequently, the medicament liquid may be fed into the holder through a conduit M and maintained at a predetermined level therein. The conduit M extends to a tank M' in which the liquid medicament is stored and maintained at the desired temperature. Suitable means, such as a valve M² in the conduit M, will regulate the flow. Thus, the hydrostatic pressure of the liquid in the holder will bend the strips forming the opposite sides thereof into conformity to the surface of the rolls F and F', while the suction applied to the pockets will expand the portions of the strip covering the same until suction is cut off by sealing contact with the post F⁶. Liquid within the holder will fill the capsule sections as they are formed so that when in their downward travel they are pressed in welding contact with each other a measured quantity of liquid will be enclosed, the surplus liquid being forced out-

ward and upward in the holder. However, after the closing of the orifice at the trailing end of the pocket, there will still be a slight movement of the capsule sections toward each other without any opportunity to eject any portion of the liquid content. As the liquid is incompressible it must be provided with some place to go which with my construction is the portion of the pocket surrounding the post F⁶. In the further advancement of the rolls F and F' the channels F¹¹ are registered with exhaust ports K⁵, through the heads K which restores atmospheric pressure in the pockets F². Subsequently, these channels are registered with the passages K⁴ admitting air at more than atmospheric pressure, which will eject the capsules from the pockets. As frictional resistance is not exactly balanced in the complementary pockets, some of the capsules will remain in the pockets of one roll while others will remain in the pockets of the other roll. This is immaterial as both rolls are provided with capsule ejecting means. The ejected capsules will drop on an inclined chute N which will direct them into a suitable receptacle N'.

While the medicament may be supplied to the holder through the single conduit M, as above described, I find it preferable to provide a circulatory system through which the medicament in the storage tank M' is continuously fed into the holder and back again into the tank. Thus, as shown, a second conduit M³ extends downward into the holder with its lower end placed at a predetermined height. This conduit withdraws the medicament through the operation of a circulating pump M⁴ and returns it to the tank M'. Such construction has the advantage, first, it can be used to accurately control the level of liquid in the holder and, consequently, the hydrostatic pressure which is exerted against the gelatin while the capsule is being formed; second, it keeps the reserve liquid in the holder at a more constant temperature because it provides for a continuous change of the liquid; and third, it provides for circulation of the liquid which helps to keep any suspended matter uniformly distributed.

What I claim as my invention is:

1. In a process of forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between pocketed die rolls, heating the strips above said rolls to an exactly predetermined temperature, separating the central portions of said heated strips from each other, and pressing the marginal portions thereof together while above said rolls to temporarily form thereof a liquid holder, feeding liquid into said holder to a predetermined level, and expanding the walls of said holder into the pockets of said die rolls to form complementary liquid filled registering capsule portions which are sealed together when passed between said rolls.

2. In a process of forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between pocketed die rolls, heating said strips above said die rolls to an exactly predetermined temperature, pressing the margins of said heated strips together while still above said rolls and maintaining the central portions thereof spaced to temporarily form a liquid holder, feeding liquid into said holder to a predetermined level, expanding the walls of said holder into the pockets of said rolls to form registering liquid filled capsule portions which are sealed together while passing between said rolls, and maintaining said strips while pass-

ing between said die rolls at a predetermined temperature slightly less than that of the strips above said rolls.

3. An apparatus for forming liquid filled gelatin capsules comprising a pair of rolls between which a pair of gelatin strips are fed, said rolls having registering pockets and annular portions surrounding said pockets in rolling contact with each other, each of said annular portions being flush with the inner surface of the wall of the pocket on the leading side thereof with respect to the direction of rotation of said rolls and being chamfered on the trailing side.

4. An apparatus for forming liquid filled gelatin capsules comprising a pair of rolls between which a pair of gelatin strips are fed, said rolls having series of registering pockets, annular portions surrounding said pockets in rolling contact with each other and portions between said annular portions providing clearance for the thickness of said strips, the inner surface of the wall of each pocket being normal to the rolling surface of said annular portion at the point of intersection therewith on the leading side thereof with respect to the direction of rotation of said rolls and the inner surface on the trailing side at the point of intersection with the rolling surface being at an oblique angle to force the displaced gelatin toward said pocket.

5. In a process of forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between die rolls having registering pockets therein, sealing together the marginal portions of said strips above said rolls to temporarily form thereof a liquid holder, feeding into said holder the liquid medicament from a source of supply maintained at a predetermined temperature, withdrawing a portion of the liquid from said holder and returning the same to the source of supply whereby said liquid is constantly circulated and held at a predetermined level within the holder, expanding the portions of said strips in contact with the liquid into the pockets of said rolls to form registering liquid filled capsule portions, closing together said capsule portions and severing the same from said strips.

6. In an apparatus for forming liquid filled gelatin capsules, a pair of die rolls having series of registering pockets therein, means for feeding a pair of gelatin strips downward between said rolls, means for pressing together and sealing the margins of the portions of said strips above said rolls to form thereof a liquid holder, a container for liquid medicament, a conduit for feeding the liquid medicament from said container into said holder, a second conduit extending from said container into said holder, and means for withdrawing a portion of the liquid through said second conduit and returning the same to said container whereby the liquid in said holder is circulated to maintain the same at a constant temperature and also to maintain a constant hydrostatic level.

7. In a process of forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between relatively movable dies having complementary registering pockets therein, sealing together marginal portions of said strips above said dies to temporarily form thereof a liquid holder, introducing liquid into said holder to form a pool, expanding into said pockets the portions of said strips in registration therewith to form liquid filled complementary capsule portions, and closing said complementary dies to seal

together said complementary capsule portions and to sever the same from said strips.

8. In a process of forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between rotary die rolls having registering pockets therein, sealing together the marginal portions of said strips above said die rolls to temporarily form thereof a liquid holder, introducing liquid into said holder to form a pool therein and to spread said strips over pockets in said rolls by hydrostatic pressure, expanding into said pockets the portions of said strips covering the same to form liquid filled complementary capsule portions, and closing together said complementary capsule portions and severing the same from said strips by the continued rotation of said die rolls.

9. In a process for forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between rotary die rolls having registering pockets therein, sealing together the marginal portions of said strips above said rolls to temporarily form thereof a liquid holder, introducing liquid into said holder to form a pool therein and maintaining said pool at a constant level to spread said strips over the pockets in said rolls by a predetermined hydrostatic pressure, expanding into said pockets the portions of said strips covering the same to form liquid filled complementary capsule portions, and closing together said complementary capsule portions and severing the same from said strips by the continued rotation of said die rolls.

10. In a process of forming liquid filled gelatin capsules, the steps of feeding a pair of gelatin strips downward between rotary die rolls having registering pockets therein, sealing together the marginal portions of said strips above said die rolls to temporarily form thereof a liquid holder, introducing liquid at a predetermined temperature into said holder to form a pool therein and maintaining a substantially constant temperature in the liquid in said pool to condition the portions of gelatin strips in contact therewith, expanding into said pockets the portions of said strips covering the same to form liquid filled complementary capsule portions, and closing together said complementary capsule portions and severing the same from said strips by the continued rotation of said rolls.

11. In an apparatus for forming liquid filled gelatin capsules, a pair of rotary die rolls having complementary series of registering pockets therein, means for directing a pair of gelatin strips downward between said die rolls, means for sealing together the margins of said strips above said die rolls to temporarily form thereof a liquid holder, means for introducing liquid into said holder to form a pool therein and to spread said strips over the pockets in said rolls by hydrostatic pressure, and means for applying suction to said pockets to expand the portions of said strips covering the same and to form complementary liquid filled capsule sections adapted to be sealed together and severed from said strips during the continued rotation of said die rolls.

12. In an apparatus for forming liquid filled gelatin capsules, a pair of rotary die rolls having complementary series of pockets therein, a pair of rolls above said die rolls, over and between portions of which a pair of gelatin strips are fed and thence downward between said die rolls, means for sealing together the margins of said strips above said die rolls to

temporarily form thereof a liquid holder, means for introducing liquid into said holder to form a pool therein and to spread said strips over the pockets in said rolls by hydrostatic pressure, means for applying suction to said pockets to expand the portions of said strips covering the same and to form complementary liquid filled capsule sections adapted to be sealed together

and severed from said strips during the continued rotation of said die rolls, means for maintaining the upper rolls at a predetermined temperature to condition the strips passing thereover, and means for maintaining the die rolls at a slightly lower temperature.

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