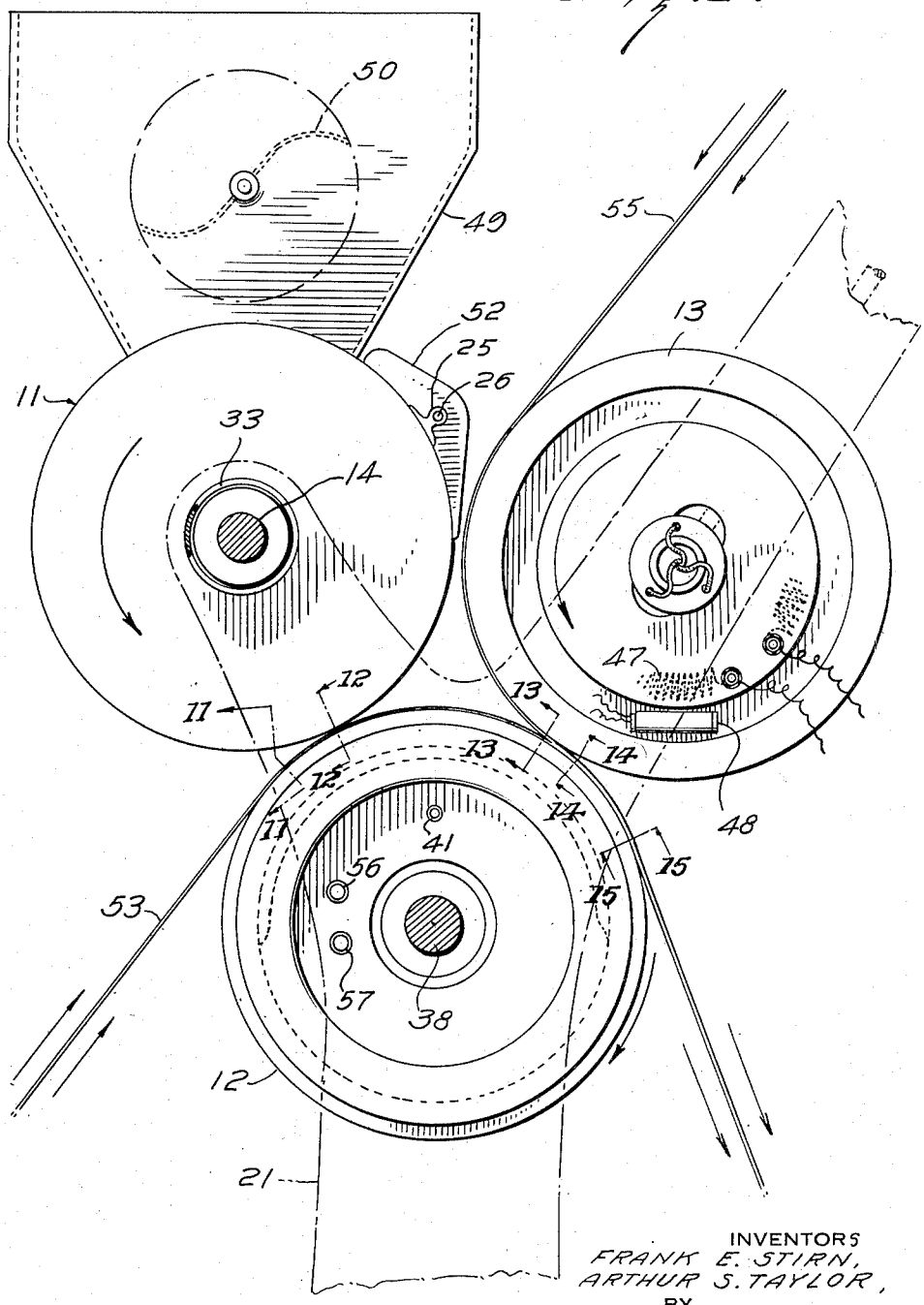
Dec. 25, 1956 F. E. STIRN ET AL 2,775,084

APPARATUS FOR FILLING POWDER IN CAPSULES

Filed Nov. 26, 1948 6 Sheets-Sheet 1

Fig. 1.



INVENTORS
FRANK E. STIRN,
ARTHUR S. TAYLOR,
BY
Samuel Brandt Walker
ATTORNEY

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APPARATUS FOR FILLING POWDER IN CAPSULES

Filed Nov. 26, 1948 6 Sheets-Sheet 2

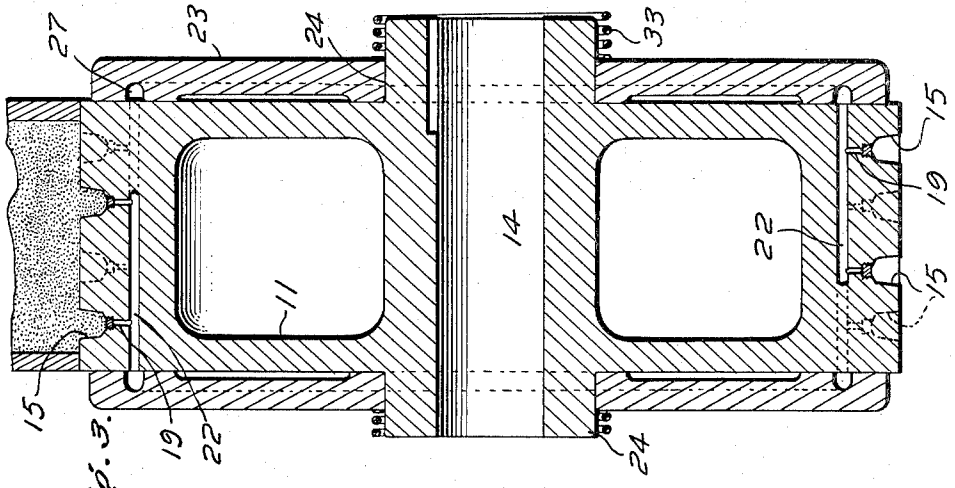

Fig. 3.

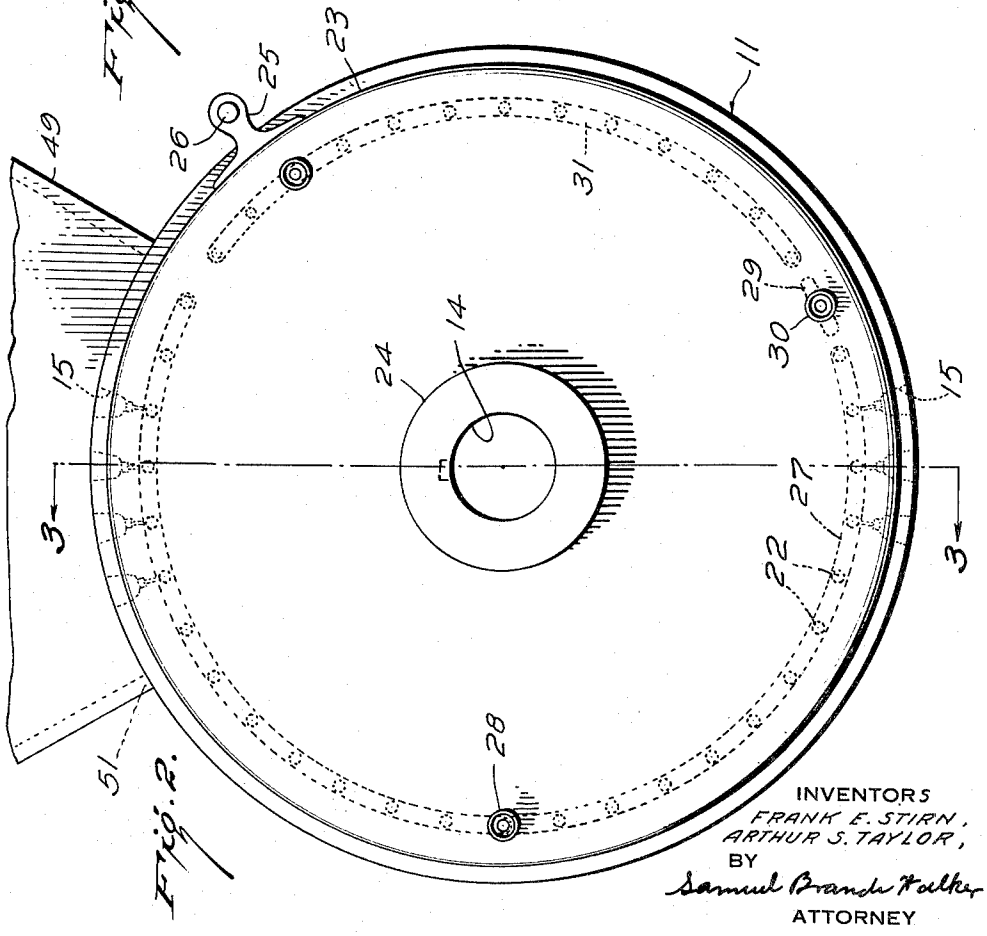

Fig. 2.

INVENTORS
FRANK E. STIRN,
ARTHUR S. TAYLOR,
BY
Samuel Brandt Walker
ATTORNEY

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Fig. 4.

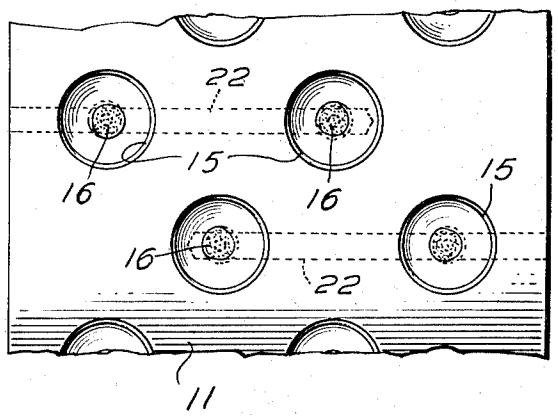


Fig. 5.

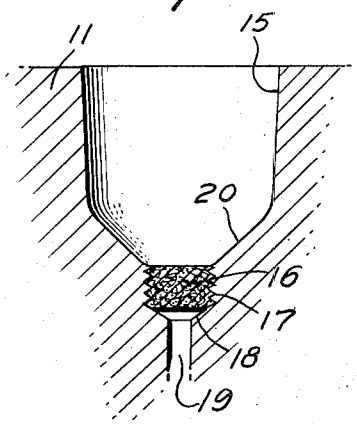
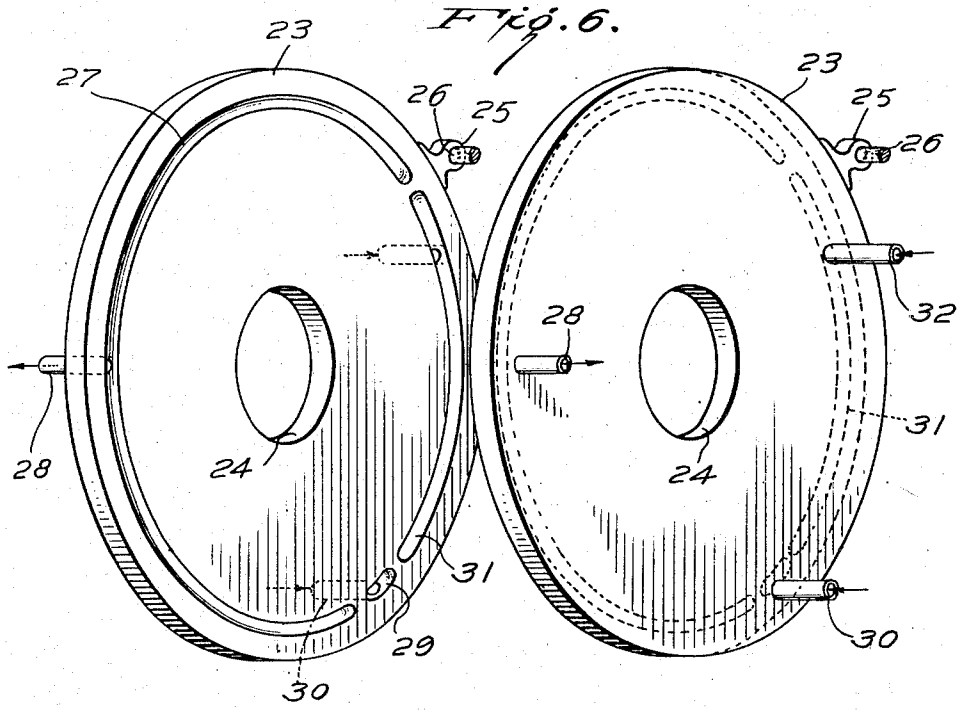


Fig. 6.



INVENTORS
FRANK E. STIRN,
ARTHUR S. TAYLOR,
BY
Samuel Branch Walker
ATTORNEY

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APPARATUS FOR FILLING POWDER IN CAPSULES

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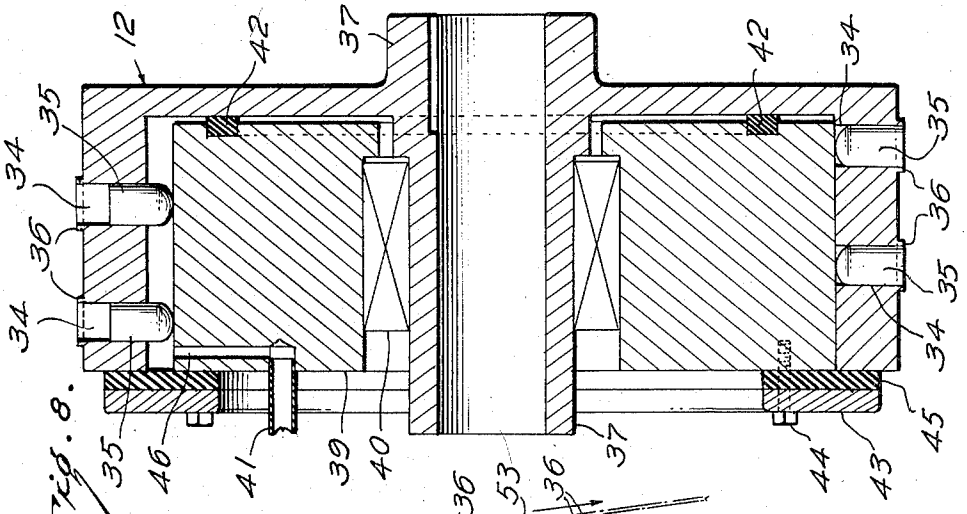

Fig. 8.

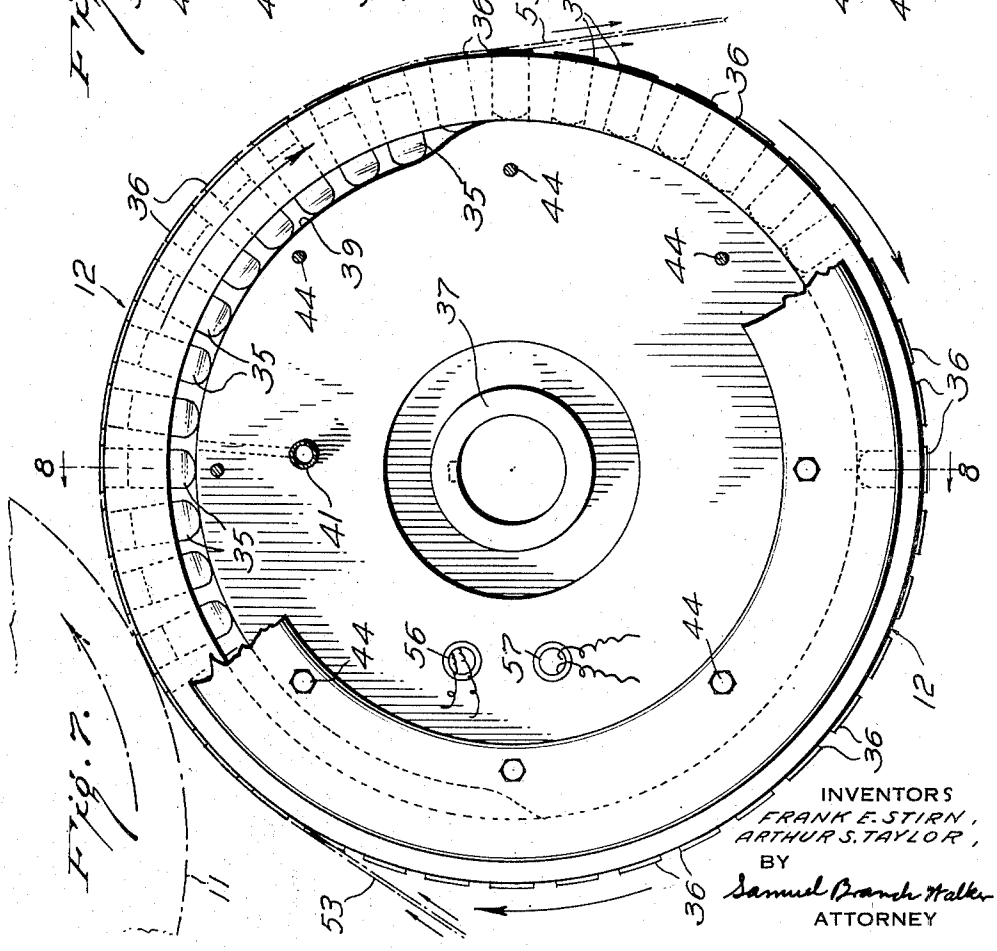

Fig. 7.

INVENTORS
FRANK E. STIRN,
ARTHUR S. TAYLOR,
BY
Samuel Branch Walker
ATTORNEY

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APPARATUS FOR FILLING POWDER IN CAPSULES

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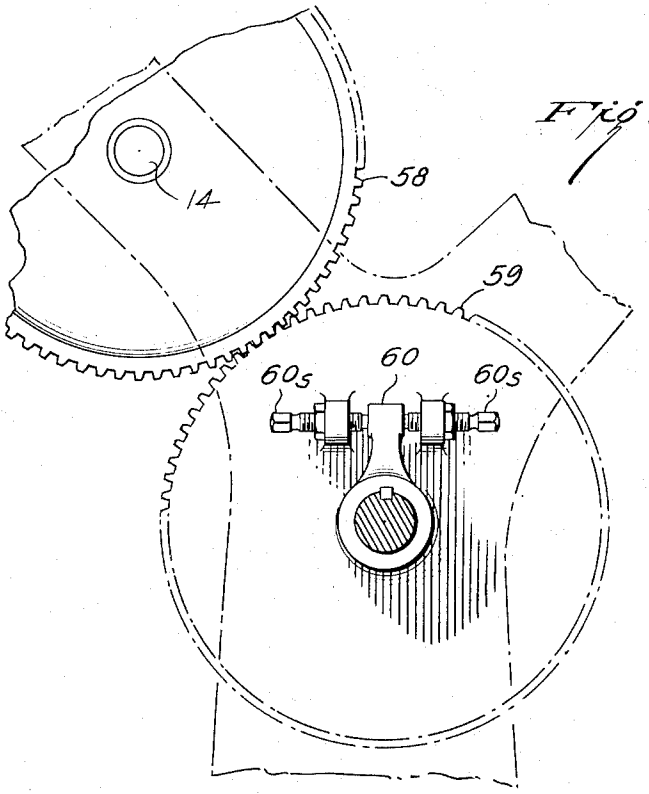

Fig. 9.

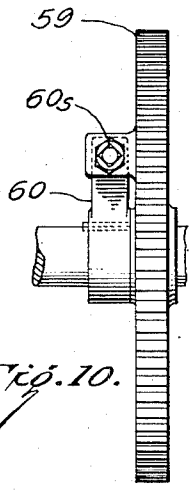

Fig. 10.

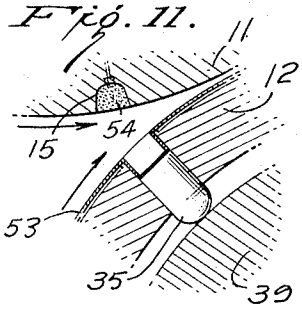

Fig. 11.

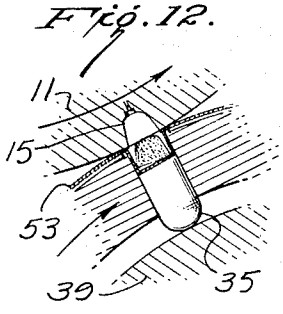

Fig. 12.

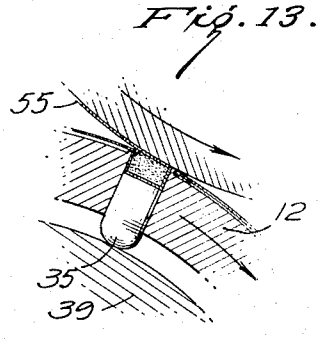

Fig. 13.

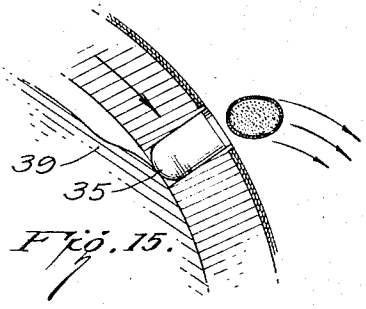

Fig. 15.

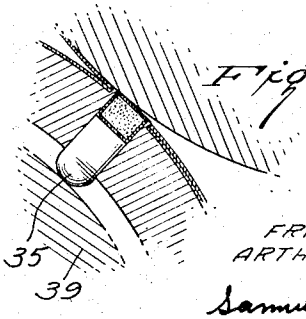

Fig. 14.

INVENTORS
FRANK E. STIRN,
ARTHUR S. TAYLOR,
BY
Samuel Brandt Walker
ATTORNEY

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APPARATUS FOR FILLING POWDER IN CAPSULES

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Fig. 16.

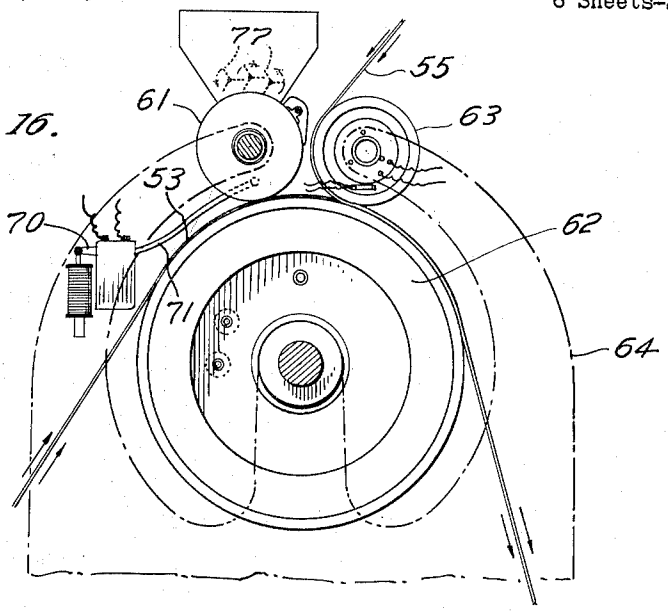


Fig. 19.

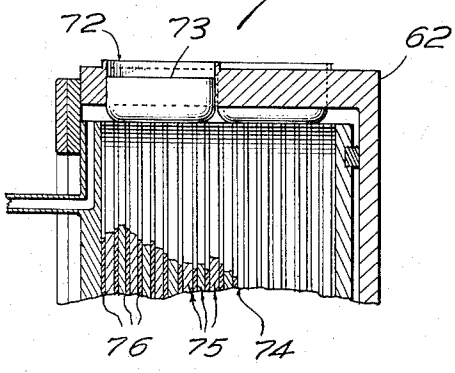


Fig. 17.

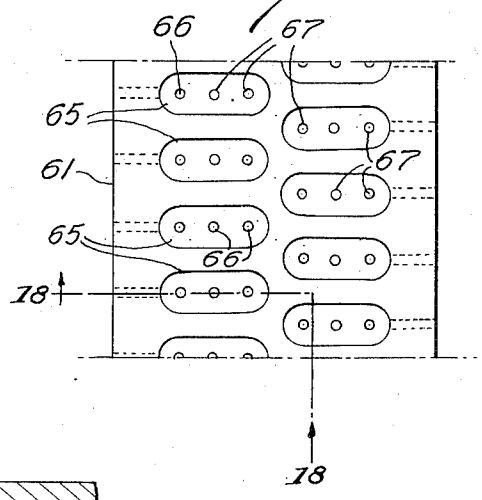
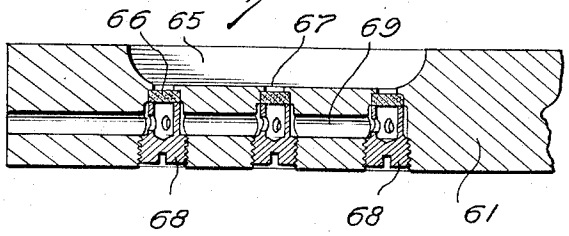


Fig. 18.



INVENTORS
FRANK E. STIRN,
ARTHUR S. TAYLOR,
BY
Samuel Branch Walker
ATTORNEY

United States Patent Office 2,775,084
Patented Dec. 25, 1956

2,775,084

APPARATUS FOR FILLING POWDER IN CAPSULES

Frank E. Stirn, Evans Park, and Arthur S. Taylor, Spring Valley, N. Y., assignors to American Cyanamid Company, New York, N. Y., a corporation of Maine

Application November 26, 1948, Serial No. 62,012

4 Claims. (Cl. 53—182)

Our invention relates to improvements in a mechanism for forming and filling capsules from deformable strip material such as soft gelatin, and relates particularly to a method of filling a comparatively dry powder into such capsules accurately, rapidly and efficiently.

This invention is a continuation-in-part of application Serial No. 16,554, filed March 23, 1948, Frank E. Stirn and Arthur S. Taylor, Method and Machine for Making Capsules, now U. S. Patent No. 2,663,128, and Serial No. 765,680, filed August 2, 1947, Frank E. Stirn and Arthur S. Taylor, Method and Apparatus for Measuring and Filling Powders Volumetrically, now U. S. Patent No. 2,540,059.

This invention relates to a method, and a machine for practicing the method, wherein a powder is filled into a charge chamber in a measuring roll, being compacted therein by the use of vacuum, and then transferred from such chamber into a lined cavity in a die roll, such die cavity being lined with a deformable, sealable material such as soft gelatin, the lined cavity containing the powder charge being then covered and sealed with a second strip of such deformable material, the two portions fastened together and joined by a pressure sealing of the two, which simultaneously cuts out suitable portions from each strip, thus forming the capsule and sealing it; and permitting the thus formed capsule to assume a desired shape. By means of this, our invention, it is possible to form and fill capsules with accurately measured doses of various types of powdered material.

Application Serial No. 16,554 describes in detail the methods of casting a gelatin strip, stripping it and preparing it for sealing as well as the methods of sealing two strips together and permitting them to assume the desired configuration in the production of the capsules.

This application pertains more particularly to a special method of filling the gelatin lined cavities in a die roll with a uniformly and accurately proportioned charge of a desired material whereby the capsules of a consistent charge size may be formed.

As an object of our invention is a method of measuring the powder charge for a capsule in a charge chamber and transferring such charge from the chamber to the die roll whereby accurate charges are measured, dependent solely upon the size of the charge chamber. It is a further object of our invention to measure charges for capsules which are determined and measured in portions of the apparatus which do not contact the gelatin strip and which are accordingly completely uninfluenced by variations in thickness and other variations of such gelatin strips or by their moisture or other properties.

This improved apparatus is designed to rapidly and efficiently encapsulate powdered materials, producing capsules of a consistent size. The capsules are particularly useful for therapeutic purposes and the specific examples will be drawn to this use, but it is to be understood that the medicinal powder may be for either man or animals, and the capsules may be adapted to contain any form of powdered material which it is desired to have formed into capsules. Such capsules may contain quantities of detergents, reagents, signal smokes or other material in the skill of the arts which it is desired to have in convenient sized, soluble containers. The size of the product capsule may be varied within wide limits. For many purposes, however, the minimum size will be governed by the necessary size of the dose, and the maximum size will be controlled by the size which may be readily swallowed.

The ease of filling with powders may vary. For best results in the present machine, it is desired that the powder to be filled have sufficient density and body that it will not blow too easily, be sufficiently fine that it may be readily handled, and sufficiently coarse that it will not pack unduly in the filters used, and be sufficiently tacky that it will pack to form a pellet which may be ejected. Fortunately a vast majority of pharmaceutical preparations which are solid either inherently fall within these limitations or by slight modifications, such as grinding, and bending, will come within these limitations. For vitamin preparations, for which the present invention is peculiarly suitable, it is generally desirable however to use a blend of several different products so that more than one vitamin may be administered at the same time, and at the same time it is usually desirable that an inert filler be used so that the finished capsule is not unduly small. It is found that cotton seed flour has peculiarly suitable characteristics in that it inherently contains many anti-oxidants which stabilize certain of the vitamins, and additionally, it is a good binder, causing the formed charges to cohere so that they may be easily and readily ejected from a charge measuring chamber into a capsule forming cavity.

Whereas the instant machine is peculiarly adapted to use soft gelatin mixtures, that is mixtures of commercial gelatin, glycerin and water, together with such flavoring and coloring materials as may be desirable for aesthetic appeal, the machines may be used with substitute materials such as certain of the cellulose derivatives and certain of the tacky resins. Slight modifications in spacing, temperatures, pressures and control conditions as may be necessary because of variations in the film strip or powder composition will naturally suggest themselves to those skilled in the art while using the machine.

Other objects, advantages and meritorious features will more fully appear in the following description and accompanying drawings which set forth by way of example certain embodiments of the invention covered by the appended claims.

Figure 1 is a side elevation of a particular form of an apparatus embodying the present invention.

Figure 2 is the side elevation, showing in more detail a charge measuring roll together with its associated manifolds and bearings.

Figure 3 is a sectional view along line 3—3 of Figure 2, showing certain details of the charge measuring roll and its associated manifolds and valve mechanisms.

Figure 4 is an enlarged view of the portion of the surface of this charge measuring roll showing in detail certain of the charge chambers together with gas passages associated therewith.

Figure 5 is a sectional view of a single charge measuring cavity together with its associated filter showing a taper in the cavity.

Figure 6 is an exploded view of the manifold plates showing more particularly the gas connections and pressure and vacuum chests.

Figure 7 is a front view of the die cavity roll showing more particularly a magnetic ejector.

Figure 8 is a sectional view along line 8—8 of Figure 7 showing sealing means wherein presusre control is maintained for drawing the gelatin strip into the cavity.

Figure 9 is a rear view of the charge measuring roll and the die cavity roll showing their drive gears.

Figure 10 is an elevation showing the mechanism for adjustment of timing of these rolls.

Figure 11 is a section view along the line **11—11** of Figure 1 showing the cooperation of the parts, showing an individual charge in its chamber approaching a cavity.

Figure 12 is a subsequent view along the line **12—12** of Figure 1 in which the charge is being transferred to the cavity.

Figure 13 is a subsequent view along the line **13—13** of Figure 1 showing the approach of the cavity sealing film, and the beginning of the cutout and seal.

Figure 14, along line **14—14**, shows the end of the cutout.

Figure 15, along line **15—15**, shows the ejection of the completed capsule, and the attainment of final shape.

Figure 16 is an alternative construction showing different roll sizes, a pulse ejector system, and three interlocked powder agitators; in general form similar to Figure 1.

Figure 17 is an alternative construction of the surface of the measuring roll for a type of capsule known as long ovals; being a modification of the construction shown in Figure 4.

Figure 18 is a sectional partial view, along line **18—18** of Figure 17, showing an alternative construction for the long oval shape and an alternative method of positioning the foraminous material, showing a modification of the construction shown in Figure 5.

Figure 19 is a sectional partial view showing an alternative construction of cavity die roll for the long oval shape in which the stator consists of laminated magnetized materials.

As shown in Figure 1, the present invention comprises three cooperating rolls, the measuring roll **11**, the cavity die roll **12**, and the sealing roll **13**, whereby charges are measured in the measuring roll, transferred to the individual cavities **34**, which are at that point lined with a continuous film of capsule forming material **53**, a covering strip **55**, applied thereto and the thus formed capsules sealed and cut out by pressure of the sealing roll, and after ejection permitted to assume the desired configuration.

The spacing, pressure and speed relationships between the measuring roll and the cavity die roll are critical and must be carefully coordinated to obtain satisfactory results. It is desirable that the gearing be adjustably attached to these rolls as shown in Figures 9 and 10, as later described in detail, in order that minute adjustments in timing may be made. The sealing roll **13**, is not necessarily power-driven although desirably so and may be of a different size than the other rolls, but should have the same surface speed so that capsules and gelatin films will not be subjected to a shearing stress at the point of seal.

CONSTRUCTION

The charge chamber roll, or measuring roll **11**, as shown in Figures 2 and 3, consists of a cylindrical roll suitably fastened onto a measuring roll shaft **14**, which in turn is journalled in the frame **21**. The frame is shown in dotted lines in Figure 1 because its exact shape and configuration is in no way critical, being used merely for support. It is desirable that the frame be cut out in such fashion that it is reasonably possible to look at and inspect the film and charge at the point of transfer of the charge to the cavity so that any adjusments necessary may be more readily made, and similarly it is desirable that it be possible to inspect the point of seal where the cover strip is sealed to the cavity containing strip.

The measuring roll **11**, has therein a series of charge chambers **15**. These charge chambers are spaced about the periphery of the measuring roll. Each cavity, as more clearly shown in Figure 5, may consist of a tapered chamber with rounded corners and conical bottom **20**, a portion of the bottom of which is made of a foraminous material **16**. A cylindrical chamber may be used but it is generally found that a slight taper, or draft, is more satisfactory so that once the charge is released it will drop free from the charge chamber without binding on the walls thereof. Additionally it is desirable but not always necessary that the bottom of the chamber be slightly conical at all portions other than that covered by the foraminous material **16**, so that it is not possible for a portion of the material to pack in a corner giving a non-uniform charge size. The exact angle at which the compacted charge will shear varies with the composition of the powders, but if the chamber is so shaped that at no portion is the slope less than 45° with its axis, under normal conditions it will be found that no packing of the charge into corners of the chamber will occur, and each and every charge will be completely uniform, with each chamber releasing its entire contents in every cycle.

The foraminous portion **16**, should be of such porosity that the application therethrough of a partial vacuum (or sub-atmospheric pressure) will suck powder into the chamber compacting the powder therein, and yet be sufficiently fine in texture that the particular powder being filled will not pack or bind into the interstices of the foraminous material thereby unduly obstructing the flow of gases through the foraminous material. For many pharmaceutical products, a good grade of fine felt, such as is used for wick oilers in electric motors is eminently satisfactory. As shown in Figure 5, the foraminous material is best fastened firmly into position at the bottom portion of the charge chamber. A short threaded portion **17**, with a retaining shoulder **18**, will serve to hold the felt firmly in place. The felt may be twisted and screwed thereinto permitting the felt to be readily removed and yet not permitting undue leaks around the edges. Knurled or grooved surfaces may be used with appropriate methods of inserting the felt, or a turned edge may be used to retain the felt. If desired, other retaining means such as multiple part chambers may be used, wherein the felt is placed under a detachable charge chamber so that only the working portion is exposed, or the foraminous material may consist of sintered metals, sintered glass, fine metallic screens, multiple finely spaced edges or other such material as will suggest itself, depending upon the porosity and type of powder which is to be filled. The suitability of pore size may be easily tested by inserting a test portion of the material placed over a vacuum orifice into the powder which is to be filled and then reversing the flow of gas to check and see that the material does not pack or block passages in the material and at the same time sufficient gas is permitted to flow therethrough to insure proper transfer and packing of the charged material.

The under-portion of the foraminous material opens on to a gas passage **19**, which, as shown in Figures 3 and 4, connects to the manifold passages **22**, which in turn lead to the respective faces of the measuring roll. Adjacent to each of the faces of the measuring roll is a stationary valve plate **23**. The valve plate may be positioned by a bearing surface **24**, riding on the hub surface of the measuring roll. The valve plate may be of Micarta or other material which in itself makes a suitable anti-friction material so that it is not necessary to insert other bearing material into the valve plate. As shown, the valve plates are prevented from rotating by a valve plate positioning block **25**, which in turn is positioned by a positioning rod **26**, which is adjustably connected to a suitable portion of the frame. The valve plates are shown in Figure 6 have therein a vacuum chest **27**, connected to a vacuum through the vacuum connection **28**; a discharge pressure chest **29**, connected to a suitable source of gas pressure by pressure connection **30**, and a cleaning pressure chest **31**, in turn connected to a cleaning pressure connection **32**. As shown in Figure 3, the measuring roll **11**, may be made hollow to reduce weight, or may be alternatively of built-up con-

struction, with arms or as otherwise would readily suggest itself to those skilled in machine construction. The valve plates may be held against the sides of the measuring roll by springs 33, which in turn bear against the frame or other portion of the mechanism.

Alternatively all of the passages 22, could lead to one side only of the measuring roll and but a single valve plate be used, although this would of course introduce unsymmetrical forces. Similarly the manifold passages could be arranged so as to terminate on a cylindrical surface of the measuring roll or elsewhere, with suitable valve arrangements as might under the circumstances be indicated. Various means may be used for positioning the valve plates, as well as various types of bearings where bearings are indicated. The valve plates themselves may be made of hard material with soft anti-friction inserts as seals, or may indeed be made of hard material, with no allowance for irregularities in the surfaces if suitably precise construction be used throughout. The discharge pressure may be admitted through the connection 30, by means of a suitable quick opening valve whereby the releasing pressure may be permitted to build up more rapidly than is the case with a slide valve such as shown, a timing device for admitting the discharge gas pressure in the proper timed relationship in the cycle, therein being mandatory.

The die roll 12 has cavities 34 formed in its surface. The cavities correspond in spacing to the charge chambers so that there is a cavity in spaced relationship to receive the charge from each charge chamber, and there is a charge chamber which positions a charge in each cavity each time that the cavity die roll passes under the measuring roll. A convenient though not essential means for accomplishing this is to have the measuring roll and die roll of the same size and rotating at the same speed. Multiple charges may be used for each cavity, with charges of the same or different materials, with the axes of the rolls even other than parallel, but such configurations are complex, require high precision of timing of the cooperating rolls, and are usually unnecessary.

In the modification shown in Figure 8, in section, the cavities are formed by cylindrical holes in the surface of the cavity die roll with the bottom formed by a magnetic insert 35. The cavity die roll itself, 12, may be formed from brass, aluminum or other non-magnetic material. Brass or bronze may be preferred because it is easily worked, readily takes a high finish and wears comparatively well; although for high speed, high production, long term runs, it may be found desirable to use a stainless steel or other highly resistant non-metallic material. Around each cavity there is formed a raised rim 36. The raised rim may be of built-up construction as a matter of convenience although it may be easily formed integral with the cavity die roll itself, 12. This raised rim should have a height above the surface of the cavity die roll of at least about the sum of the thicknesses of the film forming strips, to provide clearance at cut out as later described. The cavity die roll is hollow, its rim being supported entirely from one side on a cavity die roll hub, 37, which in turn is fastened on the cavity die roll shaft 38, as more particularly shown in Figure 7. Inside of the hollowed out cavity die roll is a magnetic stator 39, which may be formed from steel or other magnetic material, and which is journalled on the hub 37, a needle bearing 40 being a convenient low friction, accurate journal. The magnetic stator is free to rotate within the cavity die roll hub but is held in position, adjustably if desired, by a retaining pin 41, which may be held in the frame, or by suitable fastenings, not shown. As shown in Figures 1 and 7, the hollow retaining pin 41 may be used which serves the combined purposes of positioning the stator and serving as a lead for the vacuum line as later described. The magnetic inserts 35, which form the bottom of the cavities 34, are preferably made from a highly magnetic and magnetized material such as Alnico. When placed in the hole forming the cavity they are immediately attracted to the magnetic stator 39, and held in position there against by magnetic forces. Whereas mechanical means such as stops, cams or hydraulic or air lifts may be used to position inserts, such mechanical devices require positioning rings or pins or valves so that the inserts will rise or fall according to predetermined patterns. With the magnetic inserts it is possible to use a straight through cylinder, and it is not necessary that any other retaining force be used than magnetic attraction of the insert for the stator. The surface of the stator is cut as a cam surface so that the magnetic inserts will follow a predetermined path during their rotation. As shown in Figure 7, it is convenient to have the cavities formed by the magnetic inserts riding on the cam surface which is so positioned that the inserts drop to form a suitable size cavity during the transfer and sealing portions of the cycle, and that the inserts are approximately level with the surface of the cavity die roll during the ejection portion of the cycle when the formed capsules are ejected from the cavity die roll and while, if desired, the surface of the die is being brushed and oiled as later described. The stator has therein a seal ring 42, which may be of Micarta, or other soft material, as for example, a graphitic or other low friction composition, or leather, bearing against the inner portion of the die roll so that a comparatively vacuum tight seal is formed. On the outer surface of the stator and attached thereto is a retaining ring 43, and suitable fasteners 44, positioning an outer seal 45, which may be Micarta, or other material as mentioned above, adapted to bear on the outer surface of the cavity die roll. The outer seal and the inner seal together with the enclosed portions of the stator and cavity die roll form a closed vacuum chest in which a vacuum is maintained by a vacuum line attached to the hollow retaining pin 41, which is connected to the surface of the stator by a suitable duct 46.

In operation the stator may be retained in axial position by spring action, although normally the thrust maintained in the vacuum therein is sufficient to cause the stator to be firmly held against the surfaces of the cavity die roll, preventing the leaking of the vacuum. The magnetic inserts 35 should be a loose fit in the holes in the outer rim of the cavity die roll so that they will easily ride up and down and will not bind because of small particles of dirt, powder or gelatin. A clearance of a couple of thousandths of an inch is normally satisfactory. This clearance allows the vacuum acting through the hollow retaining pin 41, and in the vacuum chest to act upon the gelatin film forming the capsule and drawing it down into the cavity.

The stator may have inserted therein a heating element 56, and a thermostatic control 57, by which the temperature of the stator may be adjusted and kept constant and thereby the temperature of the surface of the cavity die roll maintained at such temperature as is found most desirable for a particular operating mix. With certain gelatin mixes, it is not necessary to supply heat to the cavity die roll as it may operate at the temperature which it assumes from room conditions. The thermostat and heating element may be of any desired form although electrical heating elements and electrical controls are particularly convenient.

The sealing roll 13 is so positioned that it bears against the surface of the raised rims of the cavity die roll. This may be achieved by having the axis parallel to the axis of the cavity die roll and the roll urged towards the cavity die roll by an adjustable spring system. Because of thermal expansion and mechanical inaccuracies, it is normally more convenient to use a spring loading on the axle rather than try to maintain a mechanically fixed relationship. The surface of the sealing roll may be smooth or may have vacuum cups therein, the better to retain the gelatin on its surface. To avoid sticking, it is frequently desirable that the surface of this roll be oiled. To assist in the sealing of the capsules and to give certain control over the location of the sealing line,

it is desirable and usually necessary that this roll be equipped with a heating element and a thermostat so that temperature control may be exercised over the covering gelatin film 55. We prefer to warm the covering film 55 to a slightly higher temperature than the lower film, so that it is more easily stretched. The exact degree of warming required is easily determined in operation, by adjusting the temperature until the seal line is in the desired location. This may be most conveniently obtained by means of an electric coil 47, and an electrical control thermostat 48, although other heating and controlling means may be used. Certain details of a roll which may be used for this purpose are more fully described and set forth in an application of which this application is a continuation-in-part, Serial Number 16,554.

OPERATION

In the operation of the device, a hopper 49, is positioned over the measuring roll 11, and may have therein an agitator 50 to prevent packing. A suitable filling material, such as vitamin preparation, in the form of a powder containing any desired group of vitamins at a desired concentration is fed through the hopper into the charge chambers 15. It is desirable that the powder be such as will uniformly pack into the cavities and form a charge which will be ejected without disintegration. It is found that the use of cottonseed flour frequently assists in forming a charge which is readily compacted to maintain its shape until the capsule is completely formed and additionally serves as an antioxidant to protect the vitamins from oxidation as well as increasing the bulk to the point where the desired therapeutic dose is contained in a convenient size capsule. The therapeutic powder is fed down through the hopper, and by the vacuum acting through the vacuum connection 28, and vacuum chest 27, manifold passage 22, gas passage 19, and the foraminous material 16, is compacted into the charge chamber 15, to a uniform density. As each individual charge chamber passes under the front edge of the hopper, the front edge serves as a doctor 51, to cut off the charge at the level of the surface of the measuring roll. The charge is retained in the cavity by the vacuum until it reaches a point in juxtaposition to the cavity die roll at which point the manifold passage passes from its connection to the vacuum chest 24 to the discharge pressure chest 29 through which the gas pressure acting through the pressure connection 30 builds up a gas pressure behind the individual charge and uniformly and effectively forces it out of the charge chamber and into the gelatin lined capsule cavity; the slight taper or draft in the charge chamber helps in insuring that the thus formed charge is uniformly transferred. Depending upon the coefficients of friction and the packing of the powder, it may be desired that the draft be from almost negligible to several degrees. The transfer occurs as shown in Figure 12. After discharging, the charge chambers pass on and are in turn connected to the cleaning pressure chest where a gas pressure is maintained to blow out any particles which might otherwise tend to remain in the filter preparatory to the receiving of their next charge. To prevent undue dusting, it is frequently desired to have a dust receiver 52 over the cavities at this point which is connected to a suitable discharge line so that any dust blown out is removed from the vicinity of the machine. Additionally it is sometimes desirable to have a brush and/or air jets to assist in the cleaning of the cavity. These are not illustrated because for normal operations these are not found to be necessary, particularly if the cavity is well polished, but there are adhesive powders, particularly hydroscopic powders, which require such drastic treatment to insure that no powder be permitted to collect or build up within the charge chamber and thus change its capacity.

A lower strip of gelatin 53 is supplied by a suitable casting means such as is described in our co-pending application Serial Number 16,554, or other suitable machine, the surface of which may be oiled or otherwise treated. The strip is fed on to the surface of the cavity die roll 12 as shown in Figure 1 so that it approaches the surface of the cavity die roll tangentially and rests upon the raised rims 36 of the cavities. The vacuum acting through the hollow retaining pin 41 acts upon the lower surface of this gelatin film, through the gap around the magnetic inserts, thus drawing the surface of the gelatin film down into the cavity 34 forming a gelatin lined cavity. This is shown in the operational view, Figure 11. The gelatin lined cavities pass adjacent to but do not come in contact with the measuring roll 11 in which there are the cooperating charge chambers, and as the rolls pass close to each other, a charge 54 is ejected as previously described; and by the force of the ejecting gas and the force of gravity falls into the gelatin lined cavity as shown at Figure 12. When properly operated, the charge 54 falls into the gelatin lined cavity without breaking or with but slight fracture and remains therein as the die roll passes on.

To assure a proper transfer, it is highly desirable that means be provided whereby the angular relationship of the charge measuring roll 11 and the cavity die roll 12 may be precisely adjusted. In Figure 9, these rolls are driven by drive gears 58 and 59, respectively, one of which, the cavity die roll gear, is rotatably mounted on the driven shaft, which has attached thereto a drive lug 60, locked between set screws 60_S whereby small angular adjustments may be made. These gears may be in turn driven from any suitable drive means.

The sealing film 55 is a similar strip of gelatin or other material which passes over the surface of the sealing roll 13 and into position against the surface of the lower strip 53. As the covered cavity passes between the cavity die roll and the sealing roll 13, the raised rim 36 of the cavity cuts through the adjacent gelatin films, causing them to unite to each other and be severed from the films, thus forming capsules. Figure 13 shows the approach to the bite, and Figure 14 shows the cut out sealed capsule in the cavity as it recedes from the point where the sealing occurs. As the cavity roll advances, the magnetic insert (35) rises on the cam surface of the stator 39, and forces out the sealed capsules. Normally the residual web is held against the cavity roll by tension. The ejected capsule then tends to round out to final form, as shown in Figure 15. The thus ejected capsule may be given such subsequent treatment as may be desired.

LONG OVAL MACHINE

Many modifications of the machine may readily be constructed. Figure 16 shows a particular modification in which a measuring roll 61 and a cavity die roll 62 of different diameters are used. It is necessary that the number of charge chambers in the measuring roll be coordinated with the cavities in the cavity die roll but in this particular modification, the measuring roll is made smaller as is the sealing roll 63. By making both the measuring roll and the sealing roll smaller, it is possible to place them proportionately closer together so that the direction of drop of the charge is more nearly vertical and there is less opportunity for the powder to spill out of the cavity before the sealing strip is placed thereon. In the modification of Figure 16 are shown three interlocking agitators 77, which are are driven by suitable means so that the center one rotates in an opposite direction to the other two. The agitator loops pass between each other, like gear teeth, but without contact. Multiple agitators give a more uniform stirring action, which is desirable for fine powders with a tendency to pack, cake or bridge. The frame 64 is shown as being of such a shape that inspection of the working portions of the rolls is not encumbered by parts of the frame.

In Figure 17 is shown the surface of a particular measuring roll 61, containing oval charge chambers 65.

The long narrow shape is desirable in certain large capsules because the minimum diameter of the capsule determines the ease with which it may be swallowed, and a long slender capsule is more readily administered to a patient than is a sperical capsule of equivalent volume. The proportions and exact shape obviously may be modified as desired. In each of these long oval charge chambers there are shown multiple foraminous areas, each of which comprises a foraminous material **66**, emplaced along the bottom of the charge chamber **65**. By having multiple foraminous areas it is possible to more easily fill an elongated chamber, and there is less danger of the foraminous material becoming loose under working conditions than if a single foraminous area of larger size were used. As shown in Figure 18, the foraminous areas may be emplaced from the inside of the cavity die roll. Therein is shown the foraminous material **66**, held against a small opening **67**, through which the foraminous area has its useful effect by a retaining screw **68** which has a hollow point, and lateral openings, to permit the foraminous area free access to gas passages **69**. The retaining screw permits the easy removal and replacement of the foraminous material as may be required. Small felt cutouts may be used and these are easily and quickly changed in this particular modification.

For ease of ejection it is highly desirable that with the long oval shape the ejection gases be admitted as a quick puff so that the pressure will build up rapidly and equally at all points along the charge chamber and eject the formed charge completely and quickly. If a slow blast is permitted, one of the areas may loosen one part of the charge and because of the entire gas pressure escaping through this one area, the pressure will not build up sufficiently on the remaining areas to give a completely satisfactory ejection with some types of powders. A slide valve such as shown in Figure 6 gives a comparatively slow build up of pressure, because of the so-called wire-drawing effect, it therefore is advantageous with this type of charge chamber to use a quick opening valve, as for example a solenoid or other type of quick opening valve, either electrically or mechanically operated by a suitable timing cam so that the quick acting valve **70** admits a sudden burst of air to the pressure connection **71**, at the desired instant of transfer, whereby a rapid build up of ejection pressure is obtained and the capsule charge is cleanly and quickly ejected into the gelatin lined cavity **72**.

Figure 19 shows a modification a cavity die roll **62** in which a long oval shape is used for the individual cavity. In the modification shown in Figure 19 magnetic inserts **73** are shown but the magnetic effect results from the magnetized stator **74**, which consists of several layers of magnetized materials of opposite surface polarities **75**, separated by non-magnetic materials **76**, which causes a magnetic flux to flow through the magnetic inserts **73**, which need not be magnetized, retaining them firmly in position.

As herein and elsewhere stated, obvious modifications of these constructions will suggest themselves to those skilled in the capsule forming arts.

By suitable adjustment of the temperature of the gelatin film or alternatively by the use of films of slightly different composition, as the portions of the film forming the capsule are released from the charge chambers by the relief of internal stress, they will stretch or shrink to form a desired configuration, which may be a spherical or long oval capsule, or other shape.

The formation of symmetrical capsules from asymmetrical dies, the effects of temperatures and stretching upon the final configuration of the capsules and the processes of finally treating and drying the capsules are the subjects of independent inventions more particularly described in application Serial Number 16,554.

Example 1

A gelatin mix was prepared by combining 48 parts of commercial gelatin, 18 parts of U. S. P. glycerin and 36 parts of water, which was held at approximately 40° F. overnight, then slowly warmed up to 136° F. Suitable coloring dyes and flavoring extracts were added to give a desired color, flavor, and odor and cast to form a gelatin film 0.030 plus or minus 0.005 inch thick. The film was held at a temperature of approximately 75° F. in a room at approximately the same temperature and a relative humidity of near 50% while the lower strip was being formed into cavities and the cavities being filled. The sealing film 53 was run over a compression roll which was held at a temperature of approximately 95° F. and the capsule formed by sealing the strips together. A good cut out, clearly edged, non-feathered, symmetrical capsule was formed. Under these conditions it was found that the seal line was approximately equatorially located. But slightly raising or lowering the temperature of the sealing roll, the location of the seal on the final capsule may be adjusted to the location desired. The capsules contained air.

Example 2

A vitamin-containing preparation was prepared using a finely ground cottonseed flour as a diluent and sufficient of each vitamin that a finished capsule measuring approximately ⅜ of an inch in diameter contained:

Vitamin A	U. S. P. units	5000
Vitamin D	do	500
Vitamin B_1	mg	3.0
Vitamin B_2	mg	2.0
Vitamin B_6	mg	0.2
Vitamin C	mg	75.0
Niacinamide	mg	20.0
Calcium pantothenate	mg	1.0
Folic acid	mg	1.0

This composition was selected purely on the basis of a therapeutically desirable dose and may be varied over wide limitations, depending upon the desired dose to be administered. Any dosage which is desirable medically may be incorporated into a suitably sized capsule.

The above mentioned blend with cottonseed flour was thoroughly mixed, and placed in the filling hopper while the machine was in continuous operation; the individual charges were transferred evenly and completely to the gelatin lined capsules, and when the gelatin conditions were as set forth in the preceding example, cut out as a well-sealed symmetrical capsule.

It will be understood that the composition of the film strips may be varied within wide limits depending upon the desired final product, and the sizes and shapes may be similarly varied to give an aesthetically pleasing product. Such products as may be desired can be capsulated. Such materials as laundry bluing, detergents, marking powders, etc. may be encapsulated to give a convenient clean means of handling an accurately measured quantity of the material.

Having described and set forth certain embodiments thereof, as our invention we claim:

1. In a machine for forming powder filled capsules, means to advance a pair of strips of capsule forming materials along converging paths into juxtaposition, said means including a single die roll having therein capsule forming cavities arranged circumferentially thereof, a raised rim around each cavity, and a cam surface inside said die roll, and ejection means comprising a magnetic insert held against said cam surface by magnetic attraction for each of said cavities; a powder measuring roll comprising a plurality of charge measuring chambers each of which has at least a portion of its surface of a foraminous material, means for drawing powder into said chambers, means for striking off the powder even with the surface of said measuring roll, thereby forming powder charges and means for transferring the charges into the capsule forming cavities, said means to advance compris-

ing also a second cylindrical roll in rolling contact with said raised rims whereby suitable portions of the gelatin strips are simultaneously sealed together and cut out at the line of rolling contact, thereby forming capsules.

2. In an apparatus for forming and filling soft gelatin capsules, a die roll comprising raised rim cavities containing magnetic inserts forming the bottom thereof, a magnetic cam surface against which said inserts ride whereby the cam surface raises and lowers said inserts in accordance with a desired sequence, said inserts being retained in position by magnetic forces.

3. In a machine for filling uniform powder charges into capsules, a rotatable measuring roll having therein a plurality of spaced tapered long oval charge chambers, the bottom of each of which has at least one foraminous area, each chamber having such draft that once a charge is released said charge drops free without binding, and having peripheral walls extending down to the foraminous area at the bottom thereof with a slope of less than 45° with respect to the axis of discharge, suction means, gas pressure means, and a manifold means whereby the suction means is connected to the back portion of the foraminous material during at least a portion of a filling step, and the gas pressure means is connected to the back portion of said foraminous means during at least a portion of a discharge step, a cavity die roll having therein a plurality of capsule forming cavities of such size and shape as to be, when lined with strip material, substantially filled by the contents of said charge chambers, means to supply capsule forming strip material to line said cavities, and means for operating said die roll in timed relationship with said measuring roll and in such a position relative thereto that the strip lined cavities receive the discharged powder from said charge chambers.

4. In a machine for filling soft gelatin capsules with powdered material, a rotatable measuring roll having therein a plurality of spaced tapered long oval charge chambers, the bottom of each of which has at least one foraminous area, each chamber having such draft that once a charge is released said charge drops free without binding, and having peripheral walls extending down to the foraminous area at the bottom thereof with a slope of less than 45° with respect to the axis of discharge, a powder hopper resting on said measuring roll, a doctor blade positioned to strike off evenly the filled material in each of said charge chambers during rotation, a source of suction and manifold means for applying the suction to the respective chambers through the foraminous material while in communication with said hopper, and a source of gas pressure and manifold connections arranged to apply the gas pressure to the respective chambers through the foraminous area at a discharge position, and in cooperation therewith a cavity die roll, means to supply a gelatin strip to the surface of said die roll, cavities of such size and shape as, when gelatin film lined, to receive and be substantially filled by, the contents of said charge chambers in said die roll, means to draw the gelatin film into said cavities, and means to maintain said cavities in timed relationship to receive the contents of the charge chambers at discharge.

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