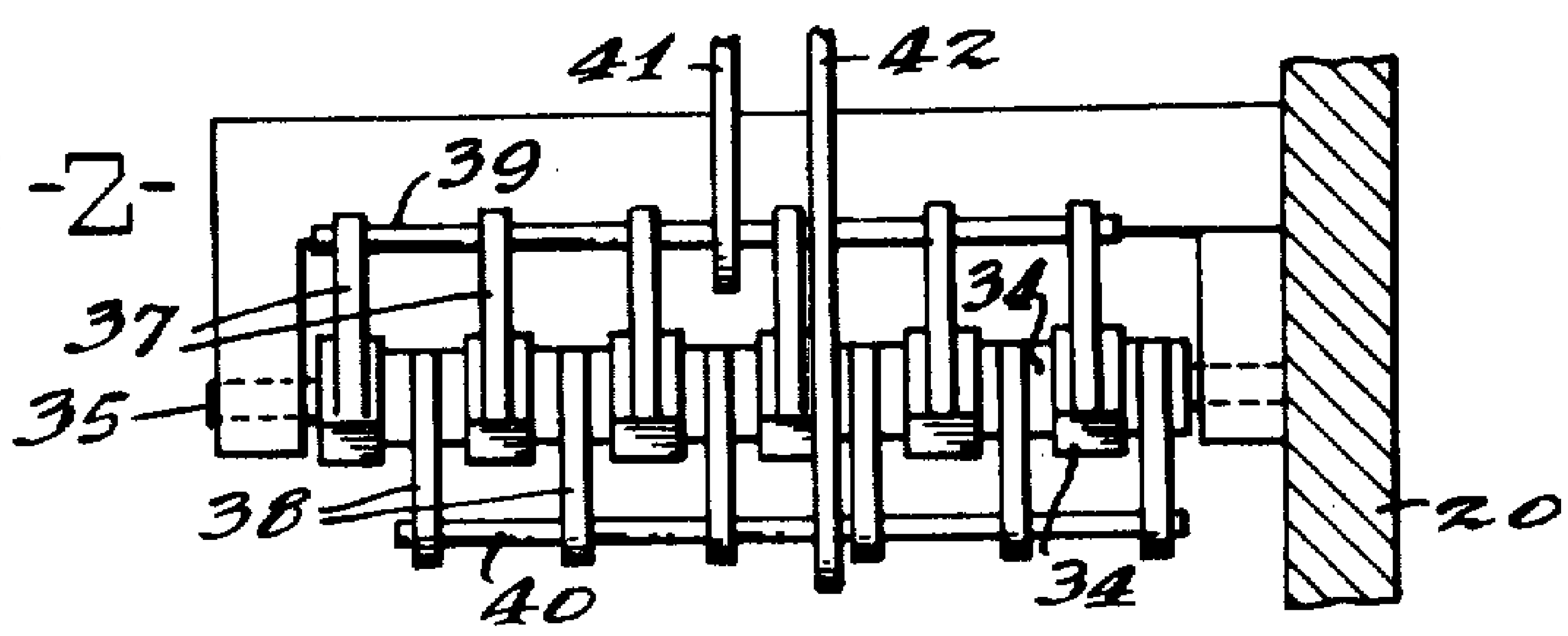
Jan. 6, 1953 A. M. DONOFRIO 2,624,164

METHOD OF AND APPARATUS FOR ENCAPSULATING LIQUID AND SEMILIQUID SUBSTANCES AND THE LIKE

Filed Nov. 16, 1950 3 Sheets-Sheet 1

FIG-2-



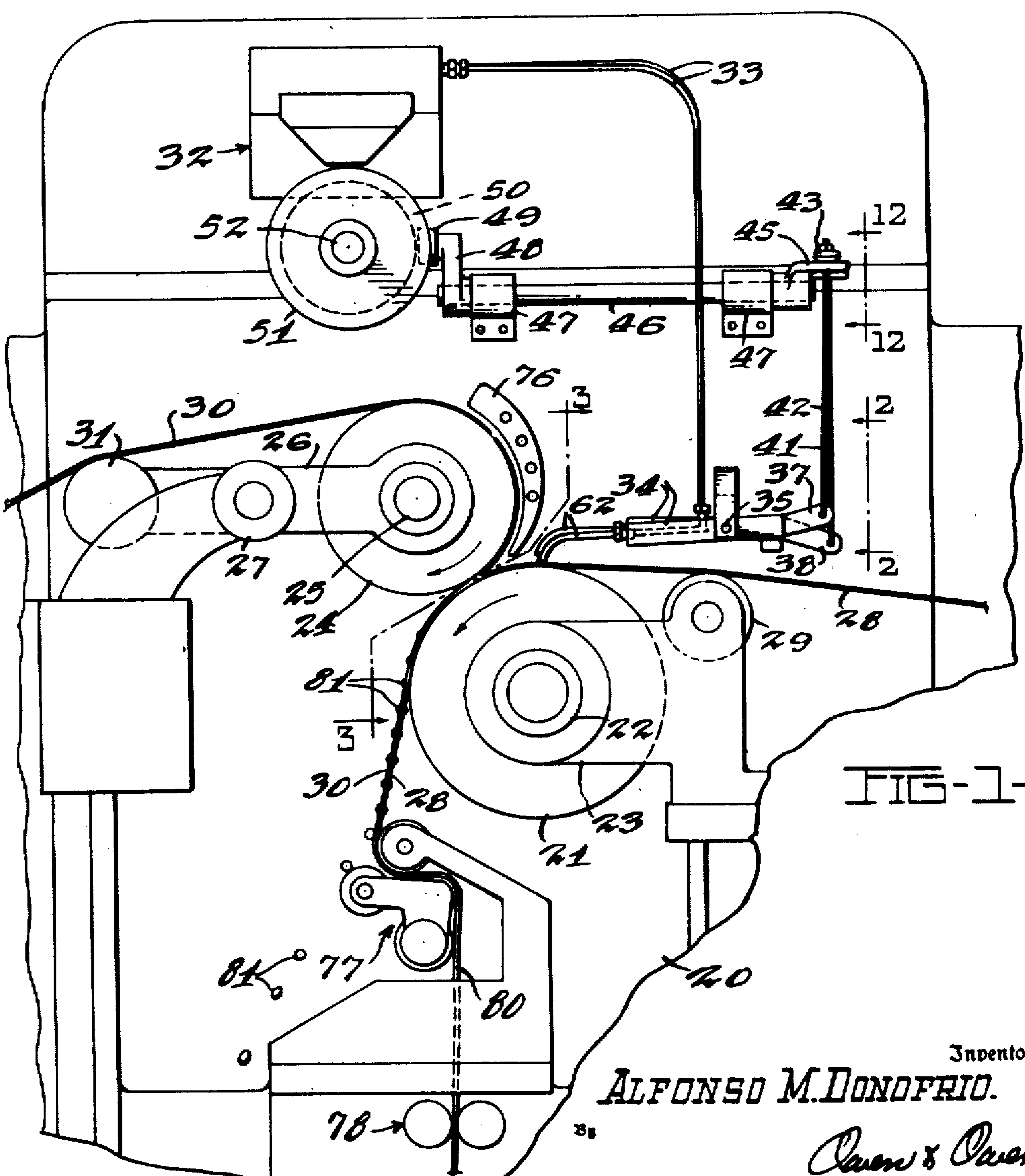


FIG-1-

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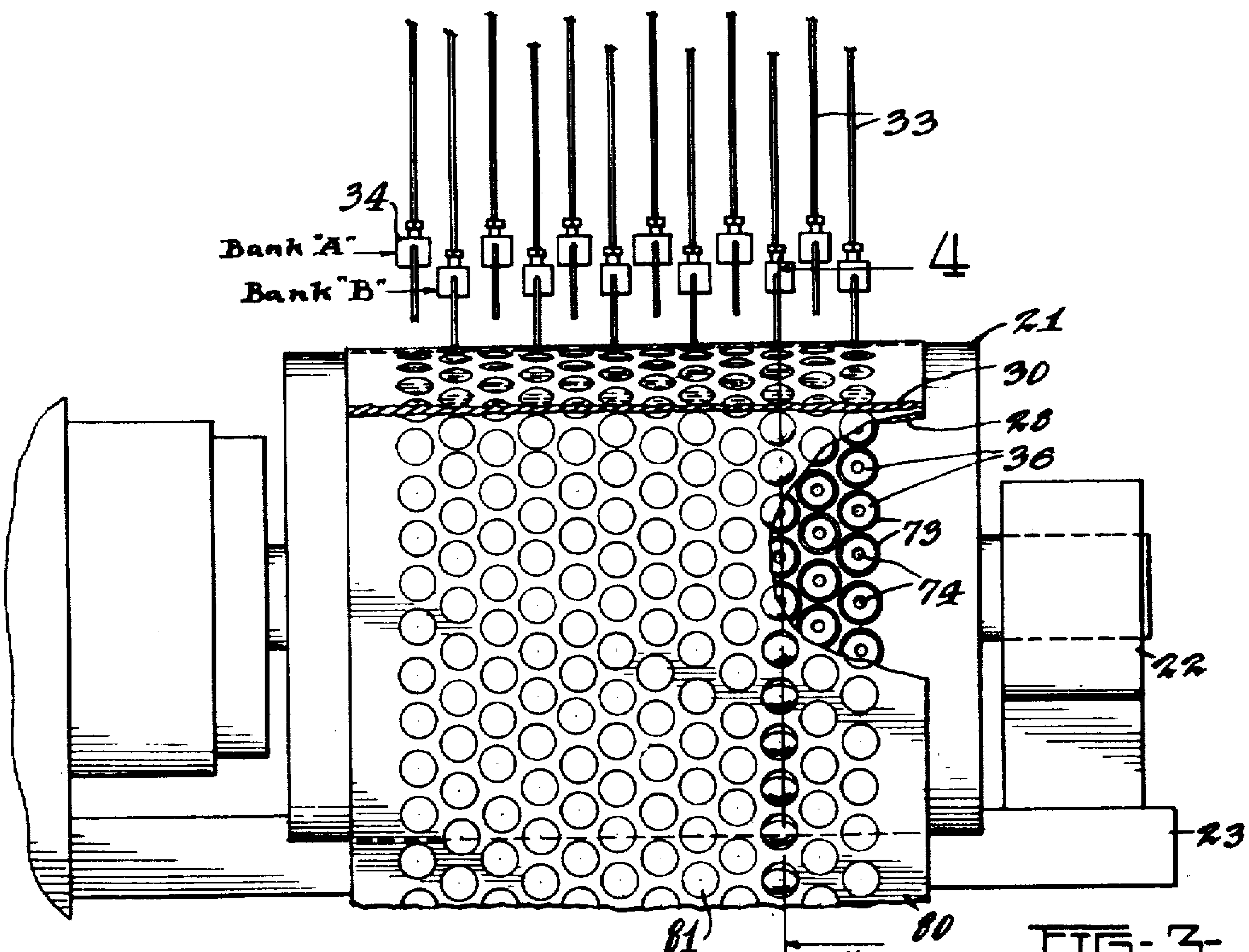

FIG-3-

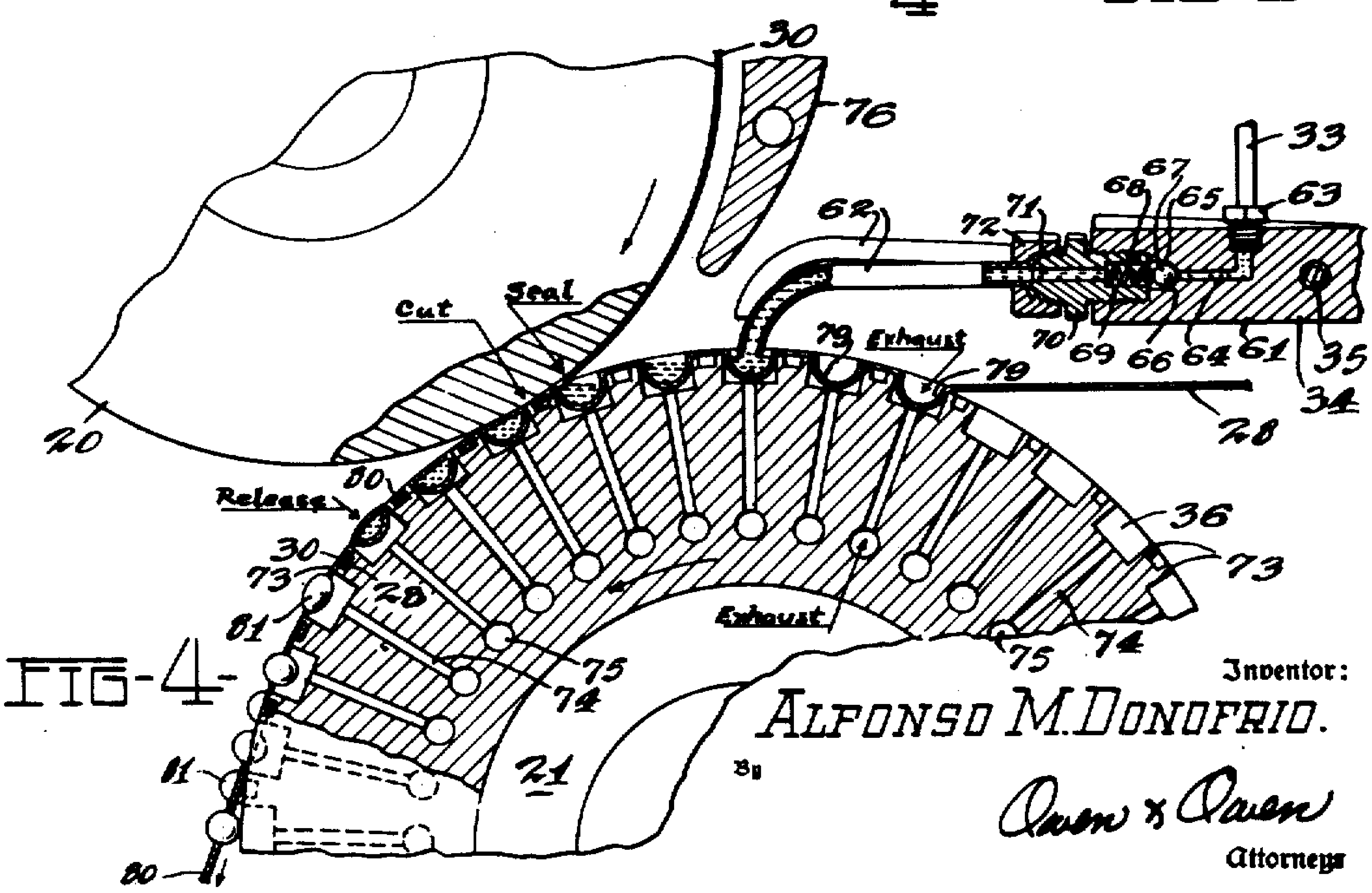

FIG-4-

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Filed Nov. 16, 1950 3 Sheets-Sheet 3

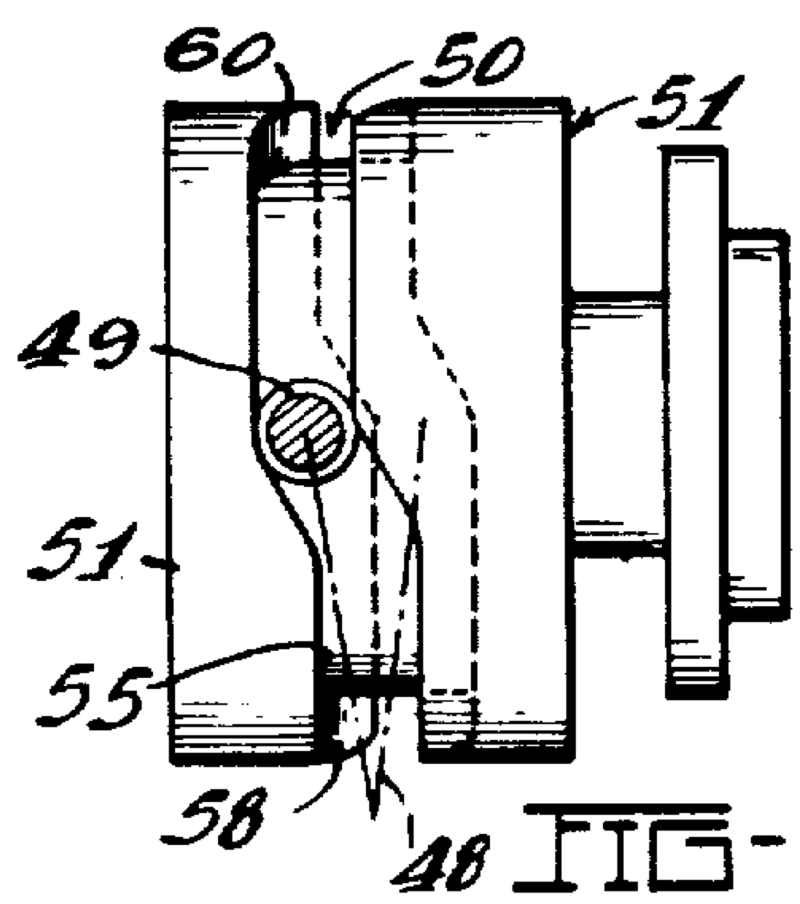

FIG-5-

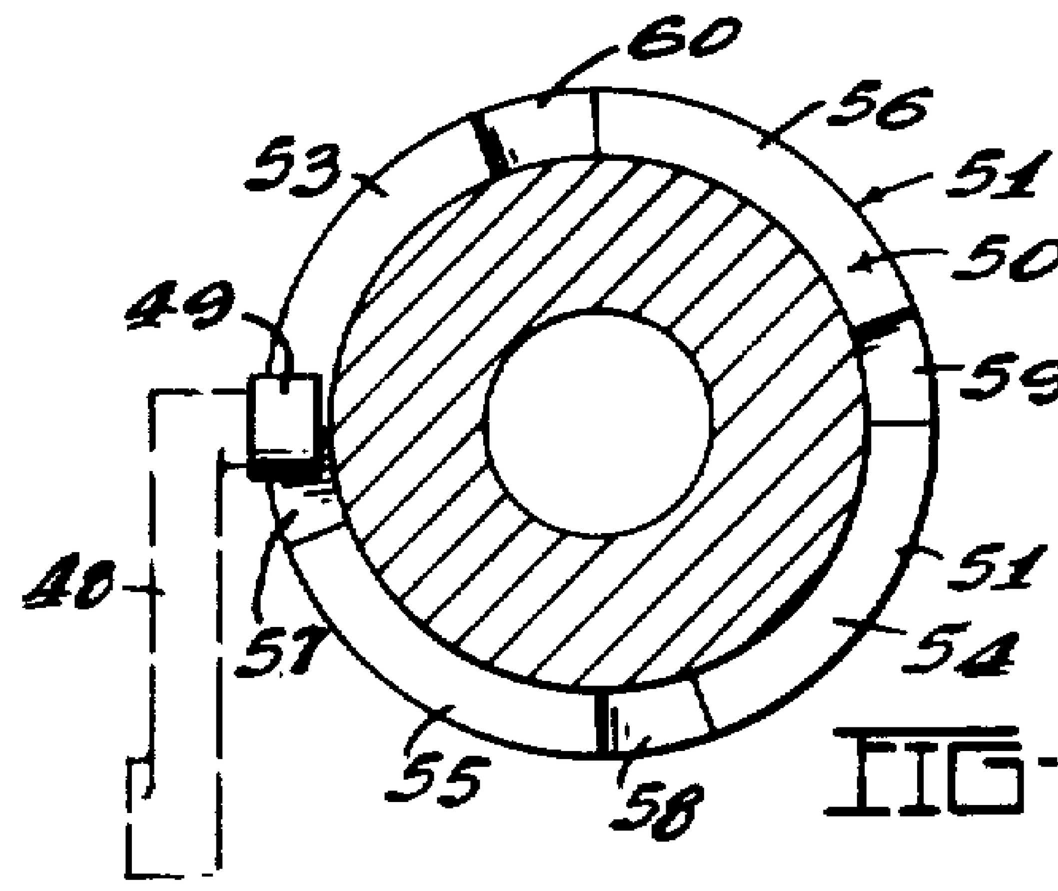

FIG-6

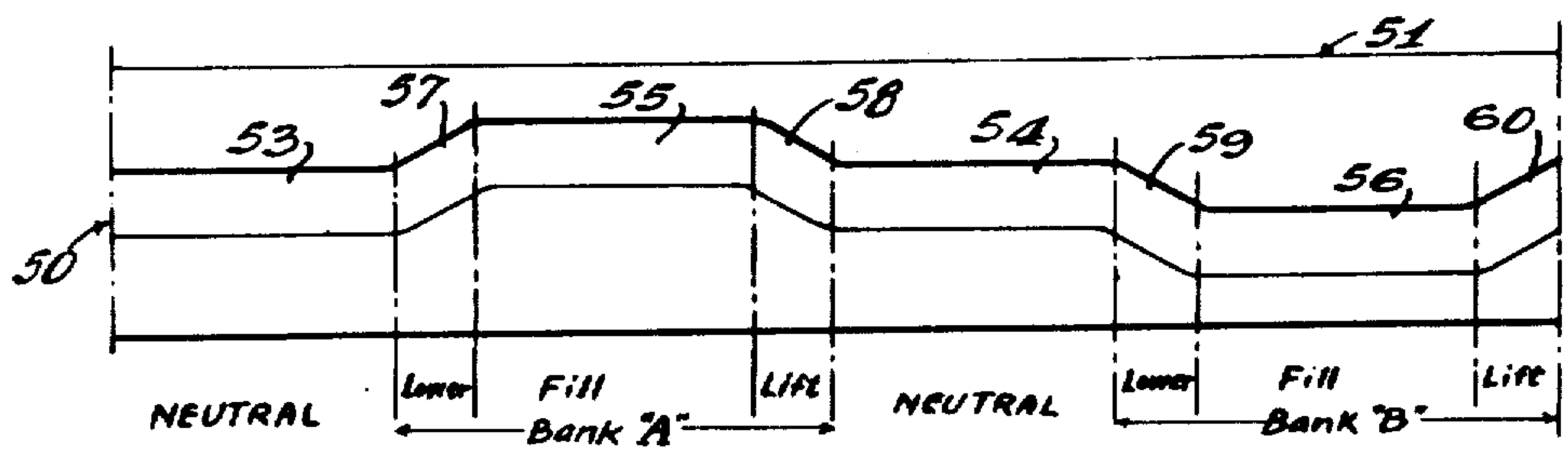

FIG-7-

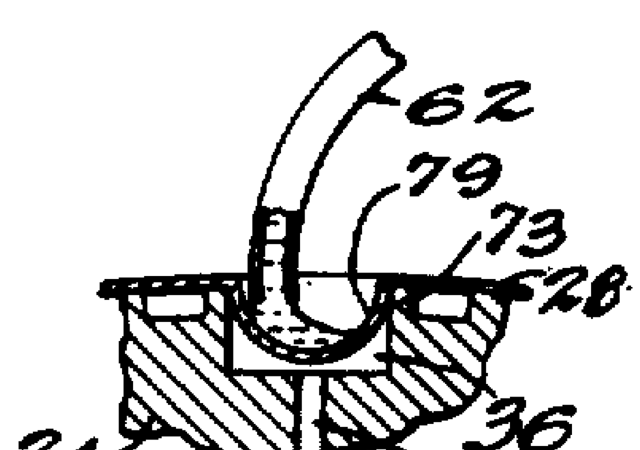

FIG-8-

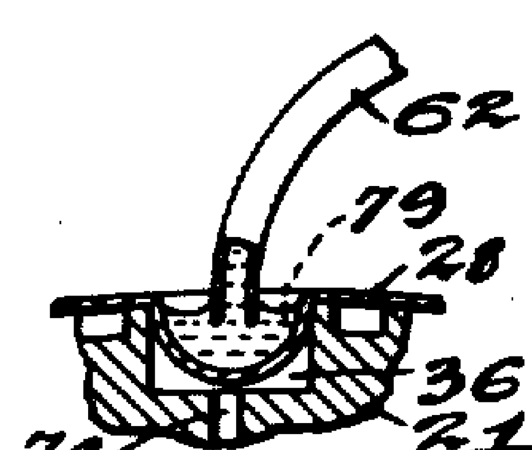

FIG-9-

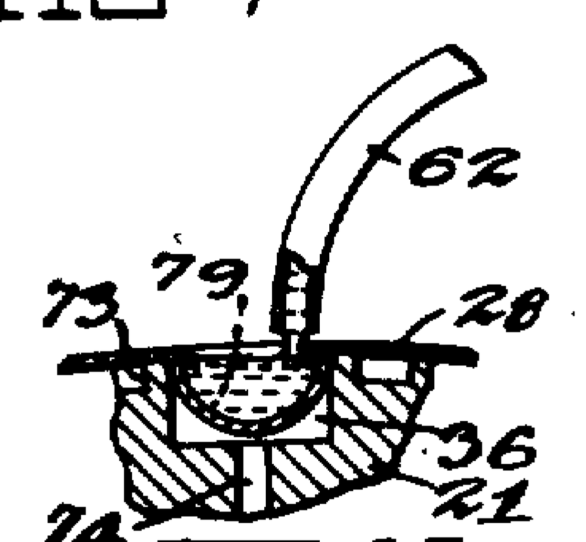

FIG-10-

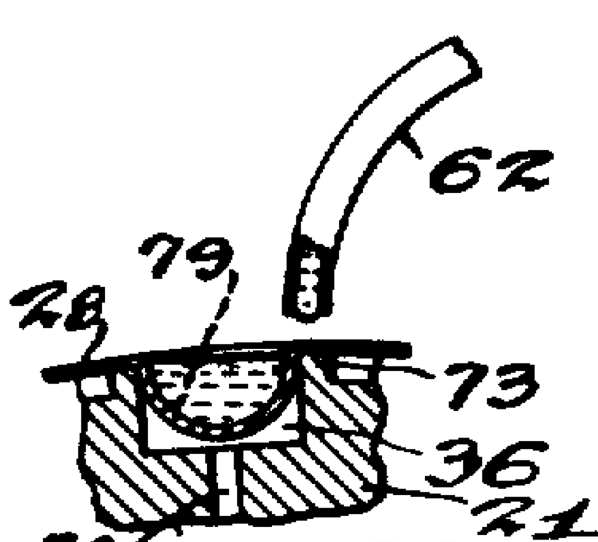

FIG-11-

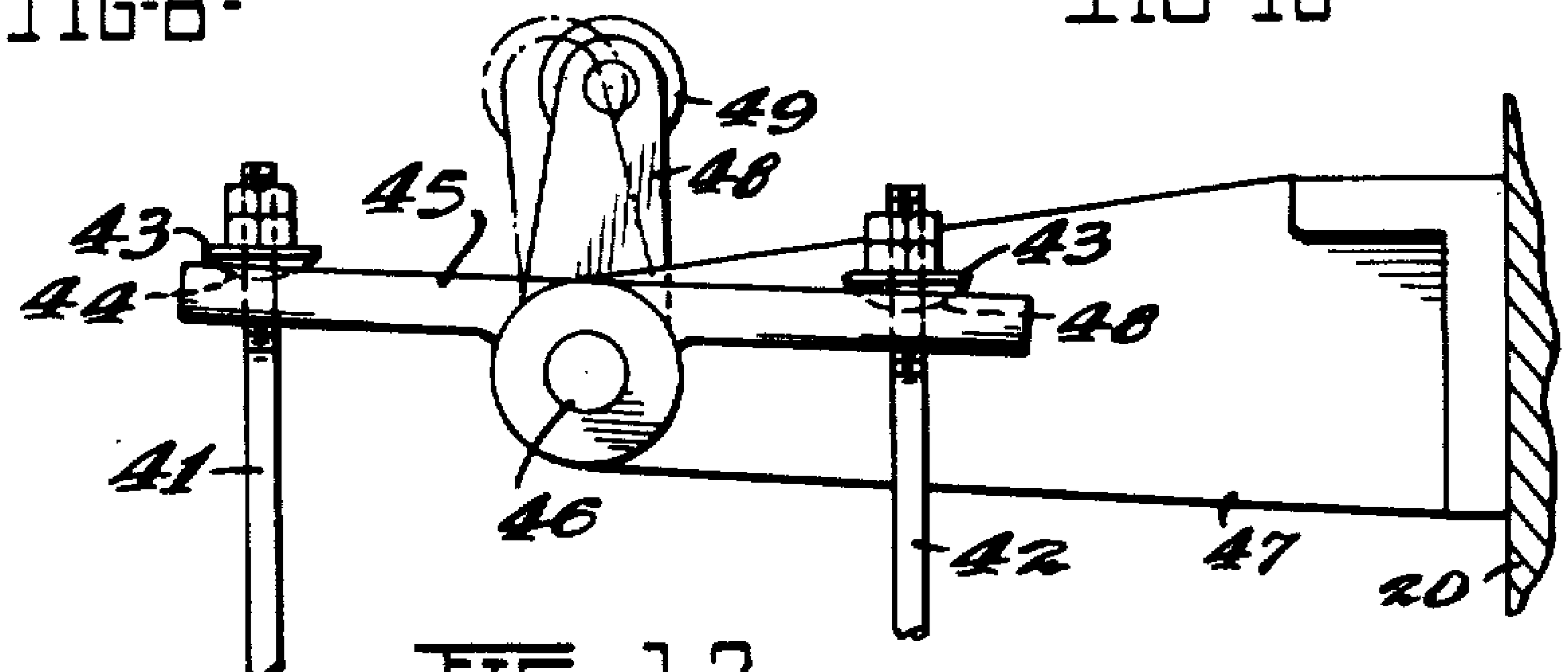

FIG-12-

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Patented Jan. 6, 1953

2,624,164

UNITED STATES PATENT OFFICE

2,624,164

METHOD OF AND APPARATUS FOR ENCAPSULATING LIQUID AND SEMILIQUID SUBSTANCES AND THE LIKE

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Application November 16, 1950, Serial No. 195,967

15 Claims. (Cl. 53—9)

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This invention relates to the art of encapsulating liquid, semi-liquid and paste substances in soft capsules formed from edible gelatins or similar thin elastic sheet materials and, in particular, is most useful in the manufacture of edible gelatin capsules for the administration of medicines, drugs, vitamins and the like.

This application is a continuation-in-part of my copending application Serial No. 126,026 filed November 7, 1949, which is a division of my earlier filed application that matured into United States Patent 2,513,852.

In my copending application and in the mentioned patent, I have disclosed and claimed a method for the fabrication of soft gelatin capsules which consists in forming semi-ellipsoidal pockets in a sheet of elastic capsulating material, filling the half-capsule-like pockets with a substance to be encapsulated which is capable of transmitting hydrostatic forces, covering the filled half-capsules with another sheet of elastic capsulating material, sealing the two sheets together around the margins of the pockets and severing the half-capsules thus formed from the two sheets of capsulating material whereby the tendency of the pocketed sheet to restore to its original shape creates forces which are transmitted through the content material and cause the originally flat sheet to be bulged; the tendency of the first sheet to contract being eventually balanced by the resistance to expansion of the second sheet whereby the resultant capsules are symmetrical and the lines of contact of the two sheets of material forming their halves lie along median planes of the capsules.

The present invention consists in an improvement on the method disclosed in Patent No. 2,513,852 as well as including an improvement on the apparatus disclosed in my copending application Serial No. 126,026, which apparatus is particularly designed for the performing of the process also disclosed herein in the commercial production of soft gelatin capsules containing various liquid, paste, and semi-liquid substances or powders and fine granules which transmit hydrostatic force.

In prior art encapsulating machines and processes, perhaps the most difficult operation to accomplish has been the filling step. Numerous methods have been proposed and numerous structures developed in which great pains have been expended to prevent the entrapment of air in the finished capsules. The reason for this great effort lies in the fact that the presence of

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bubbles in the finished capsules is undesirable from an appearance standpoint and, particularly in the case of certain expensive vitamin concentrates, air has a deleterious effect upon the medicaments themselves. Because of requirements of the Pure Food and Drug Laws, as well as the high cost of the content materials, it is also very important that the quantity of material in each capsule is held to close tolerances and that all the capsules in a batch be substantially identical.

It is, therefore, the principal object of this invention to provide a novel method and apparatus for the filling of preformed pockets of precise volume with charges of precise volume of liquid or semi-liquid materials capable of transmitting hydrostatic force and subsequent completion of symmetrical, generally ellipsoidal capsules of definite content.

In this application the terms "liquid" and "semi-liquid" are used to denominate any substances capable of transmitting hydrostatic force. Such substances include liquids of high and low viscosity, oleaginous substances, pastes, powders, fine granular material, etc., excepting only solid objects which transmit purely mechanical force. The words "generally ellipsoidal" are used herein to mean shapes formed by revolving symmetrical curves on their axes and include, without limitation, the shapes resulting from the revolution of semi-circles on their diameters, ellipses on either their longer or shorter axes, parabolas on either axis and other similar modified curves revolved either on shorter or longer axes to produce solid forms "generally ellipsoidal" in shape and generally symmetrical on opposite sides of generally median planes. As is explained in my Patent No. 2,513,852 the precise shapes of resulting capsules can be controlled by the control of the relative tensions and strains introduced into the two sheets of capsulating material by their mechanical, chemical and thermal histories and by the selection of the original shape of the unfilled half-capsules.

A machine embodying the instant invention and diagrams illustrating the performance of the process embodying the instant invention are both disclosed in the drawings, in which:

Fig. 1 is a fragmentary view in elevation of the principal components of a machine consisting of apparatus embodying the invention, shown on a relatively small scale and in somewhat simplified form.

Fig. 2 is an enlarged fragmentary view in elevation taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary enlarged view, parts being broken away, taken substantially along the line 3—3 of Fig. 1.

Fig. 4 is a vertical sectional view taken substantially on the line 4—4 of Fig. 3 and illustrating the formation of generally ellipsoidal, symmetrical capsules from "half-capsule" pockets of substantially hemispherical shape.

Fig. 5 is a detailed enlarged view in elevation of a rotary cam designed to control in carefully timed relationship the operation of other elements of the apparatus disclosed in Fig. 1.

Fig. 6 is a detailed view, partly in elevation and partly in cross section, showing the appearance of one face of the cam shown in Fig. 5.

Fig. 7 is a projection of the outline of the cam track of the cam shown in Figs. 5 and 6 and diagrammatically illustrating the operation of the elements controlled by the cam.

Figs. 8, 9, 10 and 11 are greatly enlarged fragmentary views illustrating the progression of the filling of a single "half-capsule" depression with the substance to be encapsulated.

Fig. 12 is a fragmentary detailed view taken substantially from the position indicated by the line 12—12 in Fig. 1.

A machine embodying the invention and designed for the fabrication of capsules in the practice of the process embodying the invention comprises among other parts a main frame 20 on which a die roll 21 is rotatably mounted by means of bearings 22 in a bracket 23. A pressure roll 24 is mounted in bearings 25 in the end of a pair of arms 26 pivoting around pivot bearings 27 to adjust the position of the pressure roll 24 toward and away from the die roll 21. The peripheries of the die roll 21 and pressure roll 24 are placed in contact (see also Fig. 4) during the operation of the machine.

A first sheet of encapsulating material 28 which usually is formed from edible gelatin by a mechanism not shown, is led up over an idler roller 29 and around the periphery of the die roll 21 between the pressure roll 24 and the die roll 21. A second sheet of similar material 30 similarly formed is led over an idler roller 31 and over the top and around the pressure roll 24 converging with the sheet 28 between the pressure roll 24 and the die roll 21.

The machine is equipped with a pump 32 driven in synchronism with the rotation of the die roll 21 and the feeding of the sheets of capsulating material 28 and 30. The pump 32 is provided with a bank of pump pistons (not shown) and with valve means (not shown) for directing charges of the substance to be encapsulated to selected ones of a plurality of feeder lines 33. Each of the feeder lines 33 is connected to one of a plurality of charging nozzles 34 (see also Fig. 4) which are pivotally mounted by a pin 35 and extend into the converging space between the two sheets of gelatin 28 and 30. The nozzles 34 are arranged in two banks "A" and "B," alternate nozzles being associated in each bank as shown in Fig. 3.

Each of the nozzles 34 is associated with a circumferentially extending row of die pockets 36. The die pockets 36 are arranged in a plurality of circumferentially extending rows and spaced circumferentially in two series of axially aligned pockets corresponding to banks "A" and "B" of the nozzles 34. As can be seen in Fig. 3, alternate circumferential rows of pockets 36 comprise each of the groups of rows associated with each bank of nozzles. In Fig. 3 counting from the left, rows 1, 3, 5, 7, 9 and 11 are associated with the nozzles in bank "A" and rows 2, 4, 6, 8, 10 and 12 are associated with those in bank "B." It also can be seen in Fig. 3 that the pockets in the rows associated with bank "A" are all aligned axially and thus all pass beneath the ends of the nozzles 34 in bank "A" at the same time during the rotation of the die roll 21. Similarly, the pockets in the rows associated with the bank "B" simultaneously pass beneath the ends of the nozzles 34 in that bank.

Each of the nozzles 34 has a rearwardly extending tongue 37 or 38, as the case may be, which are connected, again in banks, by connecting pins 39 and 40 to the corresponding ones of a pair of pull rods 41 and 42. The upper ends of the pull rods 41 and 42 (see also Fig. 12) are provided with spherical surface washers 43 which are engaged in loose sockets 44 in opposite arms of a "walking beam" 45. The "walking beam" 45 is pinned or otherwise secured on the end of a horizontal rocker shaft 46 mounted by bearing brackets 47 on the main frame 20. At the other end of the rocker shaft 46 there is secured a crank 48 on the end of which is mounted a cam engaging roller 49. The cam engaging roller 49 is engaged in a cam track 50 formed in the surface of a rotary cam 51. The cam 51 is secured on the end of a shaft 52 which is driven by the same mechanism that drives the pump 32, in synchronism with the rotation of the die roll 21, the operation of the pump pistons and the pump valving mechanism.

The cam track 50, as can be most easily seen in the projected view in Fig. 7, has two neutral levels 53 and 54, two filling levels 55 corresponding to bank "A" of the nozzles, and 56 corresponding to bank "B" of nozzles, and sharply inclined "lower" and "lift" surfaces 57, 58, 59, and 60 extending between and connecting the neutral surfaces and the filling surfaces of the cam.

As the cam 51 rotates in synchronism with the other members of the machine, the cam roller 49 travels along the track 50 and swings, as shown by the broken line 48 in Figs. 5 and 12, in response thereto. This oscillates the shaft 46 swinging the "walking beam" 45 as shown in Fig. 12 and lifting and lowering the pull rods 41 and 42 and the banks of nozzles 34.

Each of the nozzles 34 (see Fig. 4) consists in an elongated body 61 at the rear of which is attached the associated tongue 37 or 38 and to the front of which there is connected a nozzle tube 62. The associated one of the feeder lines 33 is secured by a plug 63 in a threaded hole communicating with an interior passageway 64 in the interior of the nozzle body 61. The passage 64 is in communication with a valve socket 65 having a conical seat 66 against which a ball 67 is urged by a spring 68. This forms a ball check valve which permits movement of material out of the passage 64 but not back into the passage 64. A socket for the spring 68 is formed by an opening 69 in a plug 70 which is threaded in the end of the nozzle body 61. The plug 70 also has a cone end 71 against which the end of the nozzle tube 62 is flared and sealed by a sealing nut 72. The far end of the nozzle tube 62 is turned over and downwardly having an open end.

Each of the die pockets 36 in the die roll 21 (see Figs. 4 and 8 through 11) is generally cylindrical in shape and is surrounded by an annular lip 73 raised above the general level of the periphery of the die roll 21 and surrounding its pockets 36. Each of the pockets 36 is connected by a center passageway 74 to manifolding 75 drilled through the die roll 21. In Fig. 4 where one of the peripheral rows of die pockets 36 is shown in section, it can be seen that the passageways 74 in any one of the axially extending rows of die pockets 36 are all connected to a single manifold 75. By means not shown which are associated with a source of vacuum and air pressure, air can be exhausted simultaneously from all of the pockets in each of the axial rows of pockets 36 or can be injected into the pockets in each of the axial rows.

In addition to the structural elements already described the machine as a whole is provided with other elements and assemblies, for example, an arcuate heater 76 (Figs. 1 and 4) may extend near the surface of the pressure roll 74 to heat the sheet of gelatin 30 just prior to engagement of the surface of the pressure roll 24 and die roll 21 to render the material tacky and thus assist in sealing. The machine also may be equipped with a capsule ejection assembly 77 (Fig. 1) and with gelatin web feeding rollers 78 for pulling away the waste web of gelatin from which the formed capsules are severed.

Operation

As has been generally explained, the rotation and operation of the pump pistons, pump valving, cam 51 and die roll 21 are all interconnected under closely timed control. As the die roll 21 rotates in the direction of the arrow in Fig. 1, successive axial rows of pockets 36 alternating between banks "A" and "B" reach the position indicated as "exhaust" in Fig. 4. At this point the sheet of gelatin 28 is drawn into each of the pockets 36 in the axial row thus being depressed into a plurality of "half-capsule" pockets 79 for the subsequent reception of material to be encapsulated. As the die roll continues to rotate the row of formed pockets 79 moves up until it approaches the space beneath the ends of the nozzle tubes 62. As soon as the leading edge of a pocket 79 passes beneath the end of the nozzle tube 62, the cam roller 49 which has been in the neutral level 54 of the cam 51, strikes the rise 59 in the cam and the crank 48 is oscillated, rotating the shaft 46, oscillating the "walking beam" 45, pulling upwardly on the rod 41 and tipping the nozzle units 34 of bank "B" to the position indicated in Fig. 4. Fig. 8 shows one of the nozzle tubes 62 just after it has moved downwardly into one of the formed pockets 79 in the gelatin 28. At this point the cam roller 49 reaches the portion 56 of the cam track and at the same time the pump pistons start their pumping stroke, the pump valving means having moved over so that the pistons are discharged into the feeder lines 33 corresponding to bank "B" of the nozzles 34.

As the material is pumped down one of the feeder lines 33, the pressure in the material created by the pump piston displaces the ball 67 from its seat 66 allowing a measured quantity of material to be ejected from the feeder tube 62. The flow from the feeder tube continues as long as the pump piston discharges which is during the time when the cam roller is engaged in the "filling" surface of the cam and thus the tube 62 is down in a pocket.

As the pump continues to discharge and as long as the material being pumped by the associated piston has a pressure greater than that exerted on the ball 67 by its spring 68, material continues to flow into the pocket 79 in the gelatin sheet 28. It should be noted that the lower end of the feeder tube 62 is inserted into the pocket 79 to an extent such that, as shown in Fig. 9, the level of the substance being filled into the pocket 79 is substantially above the lower end of the feeder tube 62 before the feeder tube 62 is withdrawn.

At this point the cam roller 49 strikes the return surface 60 of the cam 51 which returns the crank 48, shaft 46, "walking beam" 45 and the pull rod 41 to neutral position. This drops the rear end of each of the nozzle members 34 in bank "B" sharply lifting the front ends of the feeder tube 62 from beneath the surface of the charges of material which have just been pumped into the pockets 36 in the axial row just filled. At the same instance that the cam roller strikes the beginning of the surface 60 in the cam 51 and each of the feeder tubes 62 starts to withdraw from its associated pocket, the pump pistons reach the ends of their pumping stroke and the pump valve mechanism starts to move away from bank "B" position toward neutral position. As the nozzle tube 62 is removed from beneath the surface of material that has just been pumped into the pocket 79, as shown in Fig. 10, surface tension in the material causes the material to be pulled into an hour-glass shape.

Immediately thereafter the feeder tube 62 is lifted a sufficient distance so that the hour-glass shaped stringer of substance to be encapsulated breaks away from the lower portion, allowing the lower portion to return to the mass in the pocket and the upper portion, by the action of surface tension in the material, forming a meniscus drop on the end of the feeder tube 62.

At this point the roller 49 has reached the beginning of the neutral level 53 of the cam, the pump pistons have begun their cylinder filling stroke to pull substance to be encapsulated from a supply source into the pump cylinders and no rows of pockets are in line beneath the ends of any of the feeder tubes 62.

Immediately thereafter there simultaneously occurs: (1) the engagement of the roller 49 with the cam surface 57, (2) the approach of an axial row of pockets 79 to the position of the feeder tubes 62 of bank "A" of the nozzles 34 and (3) the commencement of movement of the pump valving mechanism from the position in which the substance flows from the source into the valve cylinders to the position in which the pump cylinders are in communication with those feeder lines 33 that are connected to the nozzles 34 in the bank "A." During the subsequent elapse of time the cam roller 49 travels up the inclined surface 57 and the corresponding feeder tubes 62 of bank "A" are lowered into the associated axial row of pockets 79 in the die pockets 36 preparatory to the next filling step in the cycle.

The function of the ball check valve comprising the ball 67, its conical seat 66 and its spring 68 is two-fold. By affording resistance to the passage of the substance to be encapsulated through the tubing, it maintains any entrapped air in the column of substance in the feeder line under a certain pressure so that when a pump piston discharges into the feeder line, the same quantity of material discharged into one end of the feeder line by the pump piston passes the ball check valve at the other end of the feeder line and the same quantity is discharged from the corresponding feeder tube 62. Furthermore, the ball check valve, in its return movement, after the pump piston has stopped its discharge stroke and no pressure exists in the column of substance in the feeder line 33, creates a very small suction on the column of substance between it and the end of the feeder tube 62 which assists in sharply breaking off the hour-glass string of material shown in Fig. 10 and leaving the meniscus droplet shown in Fig. 11. It has been found that this operation controls the precise quantity of substance discharged into each of the pockets with great accuracy.

As the die roll 21 continues to rotate, the filled half-capsule pockets 79 in each of the axial rows of pockets approach the converging second sheet of gelatin 30 at the point of engagement between the die roll 21 and the pressure roll 24. Continued rotation of the two rolls 21 and 24 progressively seals the two sheets of gelatin 28 and 30 together between the surface of the pressure roll 24 and the peripheral surfaces of the lips 73 as shown in Fig. 4 at the position indicated as "seal." Further rotation of the two rolls 21 and 24 brings the actual smooth surface of the pressure roll 24 into engagement with the lips 73 and the sealed "half-capsules" are severed from the web 80 (formed by the two sheets of gelatin 28 and 30) at the point indicated as "cut" in Fig. 4. Inasmuch as the exhaust line is still connected to the respective manifold 75, suction is retained in the row of pockets 36, maintaining the "half-capsules" in their originally formed semi-ellipsoidal shape until continued rotation of the die roll moves each axial row of filled sealed half-capsules to the position indicated as "release" in Fig. 4.

At this point the manifold 75 is opened to atmosphere and the stored force in the pocketed sheet of gelatin 28 acts through the encapsulated content material against the originally flat sheet of gelatin 30 starting to bulge the gelatin as shown in Fig. 4 at the "release" point. As the die roll continues to rotate the balancing of the strain in the sheet 28 against the relatively unstrained sheet 30, gradually shapes each sealed "half-capsule" into a symmetrical, generally ellipsoidal form as shown at 81 at the lower left side of Fig. 4.

The capsules 81 are retained in the web 80 as the web leaves the periphery of the die roll 21 and passes downwardly between the rollers in the assembly 77. The rollers in the assembly 77 bend the web 80 in opposite directions ejecting the capsules 81 which tumble down into a receptacle (not shown). The web 80 passes downwardly from the assembly 77 between a pair of oppositely driven rough surface web feeding rollers 78, which are driven at a linear speed faster than that of the web thus stretching the web and assist in ejecting the capsules 81 while passing through the assembly 77.

The process of filling capsules according to the method of this invention consists in the improvement in the substance depositing step which comprises the insertion of a nozzle beneath the level of the top of a depression, discharging from the nozzle a quantity of substance such that it reaches a level above the bottom edge of the nozzle and thus so that the bottom edge of the nozzle is immersed in the liquid and then the rapid withdrawal of the nozzle from beneath the surface of the liquid at the same instance that the feeding of the liquid is stopped. It is this action of rapid withdrawal at the instance of cessation of feeding that causes the substance just fed through the nozzle to be pulled into the hour-glass shape shown in Fig. 10 and, upon further withdrawal of the nozzle causes the substance to be severed at a precisely controlled point leaving a droplet of the substance of precise volume at the end of the feeding nozzle or tube. Precise control over the volume of substance discharged into each of the depressions is maintained by controlling the volume of such substance drawn into a pump cylinder; by then pumping a measured charge of the substance from the pump cylinder into the piping leading from the pump cylinder to the feeding nozzle; by interposing resistance to the flow of the substance through the feeder line and the nozzle so as to prevent the build up of air pockets in the column of substance and the accurately controlled withdrawal of the end of the feeding tube itself from beneath the surface of the substance just fed therefrom.

In the practice of this process of filling open topped depressions with measured charges of material, the timing of the operations is all important and the function of all of the necessary devices for the performing of this process must be timed and controlled with a high degree of accuracy. It is essential, therefore, that the interconnection between the elements of any machine designed to perform the process shall be rendered as "backlash" free as possible.

Reduced to its essentials, the process consists in filling open topped depressions or pockets with a measured charge of a liquid or semi-liquid substance or the like, by carrying out the steps of inserting a charging nozzle into the open topped pocket to a point below the horizontal level of the top edge of the depression, discharging a measured charge of substance into the depression to a level above the bottom edge of the nozzle and in a volume exactly equal to the volume of the depression, and withdrawing the nozzle from beneath the surface of the semi-liquid or liquid substance at the precise moment that the discharge from the nozzle stops whereby the combined action of cessation of discharging and withdrawal of the end of the nozzle from beneath the surface of the substance just discharged results in the nozzle pulling up from the surface of the substance, a "string" of the substance which, upon further removal of the nozzle, severs at a precisely controlled point allowing a desired quantity of the substance pulled upwardly from the surface by the withdrawing movement of the nozzle, to fall back into the mass in the pocket and leaving a controlled meniscus of substance projecting convexly from the end of the nozzle.

There is no loss of substance in this process of filling successive pockets being moved beneath a vertical reciprocal nozzle because the meniscus of substance left over from a previous filling step in the first substance discharged into a successive pocket. The "string" of material resulting from the shutting off of a nozzle alone or from the pulling of a nozzle out of the substance without shutting off the flow, would stretch over the edge of each filled pocket and across the web to a successive pocket. Any such string of material leading between pockets not only is wasted (and such waste is expensive) but its presence at the edges of the pockets interferes with the sealing of the two sheets of gelatin around the edges of the pockets.

Having described my invention, I claim:

1. In a machine for producing symmetrical generally ellipsoidal capsules each containing a measured volume of substance enclosed between opposed sheets of elastic capsulating material sealed around said substance along a generally median plane, the improvement comprising, in combination, means for periodically discharging a predetermined volume of substance; feeder means, to receive and conduct said volume to a pocket, connected to said discharge means and having an open nozzle-like end; means for feeding a pair of sheets of capsulating material along converging paths; means for deforming a defined area of one of said sheets to form an upwardly open pocket of definite volume; means operating in timed relationship with said discharging means for inserting the open end of said feeder means into said pocket beneath the level of the upper edge thereof at the beginning of a discharge, holding the end therein during such discharge and until the level of substance discharged rises above and around the end of said feeder means and withdrawing the feeder means upwardly out of said substance at the end of such discharge; and means for sealing said sheets of capsulating material together around the edge of said pocket to form a closed capsule and for severing said closed capsule from the web of said sheets.

2. Apparatus for forming symmetrical generally ellipsoidal capsules, each containing a definite volume of substance enclosed between opposed, mated, substantially equally deformed sheets of elastic capsulating material sealed around such substance, comprising, in combination, a pump having a timed cycle of discharge strokes; a feeder tube connected to said pump and having an open nozzle end; a die roll having a horizontal axis and a row of circumferentially spaced die pockets; means to rotate said die roll; means for feeding a sheet of elastic capsulating material over the upper surface of said die roll, means for deforming said material into said die pockets to form pockets therein equal in volume to the volume of the substance discharged in a single discharge stroke of said pump; said nozzle being mounted above said die roll; means operated in timed relationship to the discharge strokes of said pump and to the rotation of said die roll for inserting the end of said nozzle into a pocket at the beginning of a discharge stroke of said pump to a point beneath the level of the upper edge of said pocket, for holding said nozzle therein during the discharge stroke and for upwardly removing said nozzle from said pocket at the end of said discharge stroke; and means for laying a generally flat sheet of elastic capsulating material over the top of a filled pocket in the first said sheet of material, sealing the said sheets together around the margin of said pocket and severing the sealed sheets from the remaining web of said sheets.

3. Apparatus for forming, filling and sealing capsules, comprising, in combination, means for feeding a pair of sheets of capsulating material along converging paths, one of said sheets lying generally horizontally along a part of its path, means for deforming a defined area of said sheet while horizontal to form an open topped pocket therein having a definite volume, a discharge nozzle mounted above said sheet and movable to be inserted into and removed from said pocket, means operated in timed relation to said deforming means and to the movement of said nozzle for causing the discharge of a quantity of substance to be encapsulated equal in volume to the volume of said pocket from said nozzle with the discharge thereof starting when said nozzle is inserted into said pocket, continuing until said pocket is filled to a level above the end of said nozzle and ending when said nozzle is withdrawn therefrom, and means for laying the second sheet of said capsulating material over the top of the filled pocket and for sealing said sheets together around the edge of said pocket and severing the filled sealed capsule from the sheets of capsulating material.

4. Apparatus for forming, filling and sealing capsules, comprising, in combination, means for feeding a pair of sheets of capsulating material along converging paths, one of said sheets lying generally horizontally along a part of its path, means for successively deforming defined areas of said sheet to form a row of spaced open topped pockets of definite volume therein, a pivotably mounted discharge nozzle having a downwardly turned end mounted above said sheet of capsulating material with said end in line with said row of pockets, a pump for delivering a measured charge of substance equal in volume to the volume of one of said pockets at each stroke and being connected to said discharge nozzle, means actuated by said pump in timed relation to the formation of said pockets for pivoting said nozzle to insert said end into a pocket beneath the upper edge thereof at the start of a discharge, retaining said end therein until the level of substance is above said end and withdrawing said end at the end of a discharge and means for laying the second sheet of said capsulating material over the top of the filled pocket and for sealing said sheets together around the edge of said pocket and severing the filled sealed capsule from the sheets of capsulating material.

5. A machine for encapsulating liquid, semi-liquid and the like substances in elastic gelatin that comprises, in combination, a rotatable, horizontal axis die roll having a plurality of half-capsule shaped die pockets in its periphery, and raised annular lips around each of said die pockets, a smooth surface pressure roll rotating in contact with said lips on said die roll, means for feeding a first sheet of elastic gelatin over the surface thereof and between said die roll and said pressure roll, means for drawing the gelatin into said die pockets as each die pocket approaches the top of said die roll to form pockets of definite volume in said gelatin, a filling nozzle for depositing substance in each of said pockets as such pocket reaches the top of said die roll, means timed in sequence with the rotation of said die roll for dipping said nozzle into the pocket to be filled below the rim thereof, pump means for discharging a measured charge of substance equal in volume to the charge of substance desired in the finished capsule into said pocket while said nozzle is dipped therein and thus to a level above the end of said nozzle, means also timed in sequence with said die roll for rapidly removing said nozzle out of the substance just discharged at the cessation of discharge, means interconnecting said die roll, said pump means, said nozzle dipping means and said nozzle removing means in timed synchronous operation and means for feeding a second sheet of gelatin over said pressure roll and between said die roll and said pressure roll in a converging path with the first sheet and into contact therewith between said die roll and said pressure roll.

6. Apparatus for producing generally symmetrical capsules consisting in two opposed, mated, bulged, sheets of soft elastic gelatin, meeting along a generally median plane and closely containing a measured charge of a liquid, semi-liquid or the like substance, that comprises, in combination, a power source and power transmission, a generally cylindrical, horizontal axis, die roll, said die roll having a plurality of die pockets in its surface, each of said die pockets having a radially extending rim raised above the surrounding surface of said die roll and circumscribing said die pocket, a cylindrical, smooth periphery pressure roll running in contact with the peripheral surfaces of said raised lips, means for feeding a first sheet of elastic gelatin over the periphery of said die roll and a second sheet of elastic gelatin over the periphery of said pressure roll in converging paths between said die roll and said pressure roll, said die roll being driven by said transmission to move said gelatin sheets toward each other; means for depressing said gelatin into said die pockets as said die pockets approach the upper surface of said die roll and thus forming pockets of definite volume in said gelatin; a discharge nozzle mounted above said sheet and movable to be inserted into and removed from each of said pockets, means operated in timed relation to the rotation of said die roll and to the movement of said nozzle for causing the discharge of a quantity of substance to be encapsulated equal in volume to the volume of said pocket from said nozzle with the discharge thereof starting when said nozzle is inserted into said pocket, continuing until said pocket is filled to a level above the end of said nozzle and ending when said nozzle is withdrawn therefrom; and means for feeding a second sheet of gelatin over said pressure roll and into juxtaposition with said first sheet therebetween.

7. Apparatus for depositing a measured charge of a substance to be encapsulated in an open topped pocket having a volume equal to the volume of the charge comprising, in combination, a pump for delivering such charge, feeder means connected to the output of said pump, a nozzle pivotally mounted above said pocket and connected to said pump by said feeder means, means operable in timed relation to the operation of said pump for pivoting said nozzle to insert said nozzle into said pocket at the beginning of a discharge, to hold said nozzle in such position until the level of the substance discharged rises above the end of said nozzle and for quickly removing said nozzle from said pocket at the cessation of discharge therefrom, whereby the movement of said nozzle out of such substance cleanly breaks the flow of substance therefrom as said discharge ceases.

8. In an apparatus according to claim 7, the improvement that consists in a one way check valve in said feeder operable at a pressure less than that at which the pump delivers the charge of substance therethrough.

9. A method of forming a symmetrical, generally ellipsoidal capsule that comprises deforming a defined area in a sheet of elastic capsulating material to create a pocket having a definite volume, inserting the end of a nozzle into said pocket and beneath the level of the upper edge thereof, discharging through said nozzle a measured charge of substance to be encapsulated equal in volume to the volume of said pocket, thus filling the pocket to a level above the end of said nozzle, withdrawing said nozzle at the instant of

cessation of discharge of substance therefrom, placing a second sheet of capsulating material over the filled pocket, sealing the two sheets of material together around the margin of the pocket and severing the sealed capsule thus formed from the sheets of material.

10. Apparatus for forming, filling and sealing capsules comprising in combination means for feeding a pair of sheets of capsulating material along converging paths, one of said sheets lying generally horizontally along a part of its path, means for successively deforming defined areas of said sheet to form a plurality of rows of spaced open topped pockets of definite volume therein, a movably mounted discharge nozzle having a downwardly extending end above each of the rows of pockets, pump means for delivering a measured charge of substance equal in volume to the charge of substance desired in the finished capsule to each of said discharge nozzles, means actuated in timed relation to the passing of said pockets beneath each nozzle to insert said end into a pocket beneath the upper edge thereof, and retain said end therein until the level of the substance is above said end, and withdraw said end after the completion of discharge, and means for laying the second sheet of said capsulating material over the top of the filled pockets and for sealing said sheets together around the edge of said pockets and severing the filled sealed capsules from the sheets of capsulating material.

11. An apparatus according to claim 10 in which the plurality of rows of pockets are arranged in staggered relationship.

12. An apparatus according to claim 11 in which the discharge nozzles for the staggered rows of pockets are arranged to operate in alternating timed relationship.

13. A method of forming symmetrical, generally ellipsoidal capsules which comprises deforming a plurality of defined areas in a sheet of elastic capsulating material to create a plurality of rows of pockets each having a definite volume, inserting the end of a nozzle into each of said pockets and beneath the level of the upper edge thereof, discharging through said nozzle into each of said cavities a measured charge of substance to be encapsulated equal in volume to the charge of substance desired in the finished capsule, thus filling the pockets to a level above the end of said nozzle, withdrawing said nozzle after the cessation of discharge of substance therefrom, placing a second sheet of capsulating material over the filled pockets, sealing the two sheets of material together around the margin of the pockets, and severing the thus formed sealed capsules from the sheets of material.

14. The method of claim 13 in which the plurality of pockets are formed in staggered rows.

15. The method of claim 14 in which nozzles are inserted into said staggered rows of pockets in alternating timed relationship.

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Certificate of Correction

Patent No. 2,624,164 January 6, 1953

ALFONSO M. DONOFRIO

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 8, line 64, for "in the" read *is the*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of May, A. D. 1953.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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