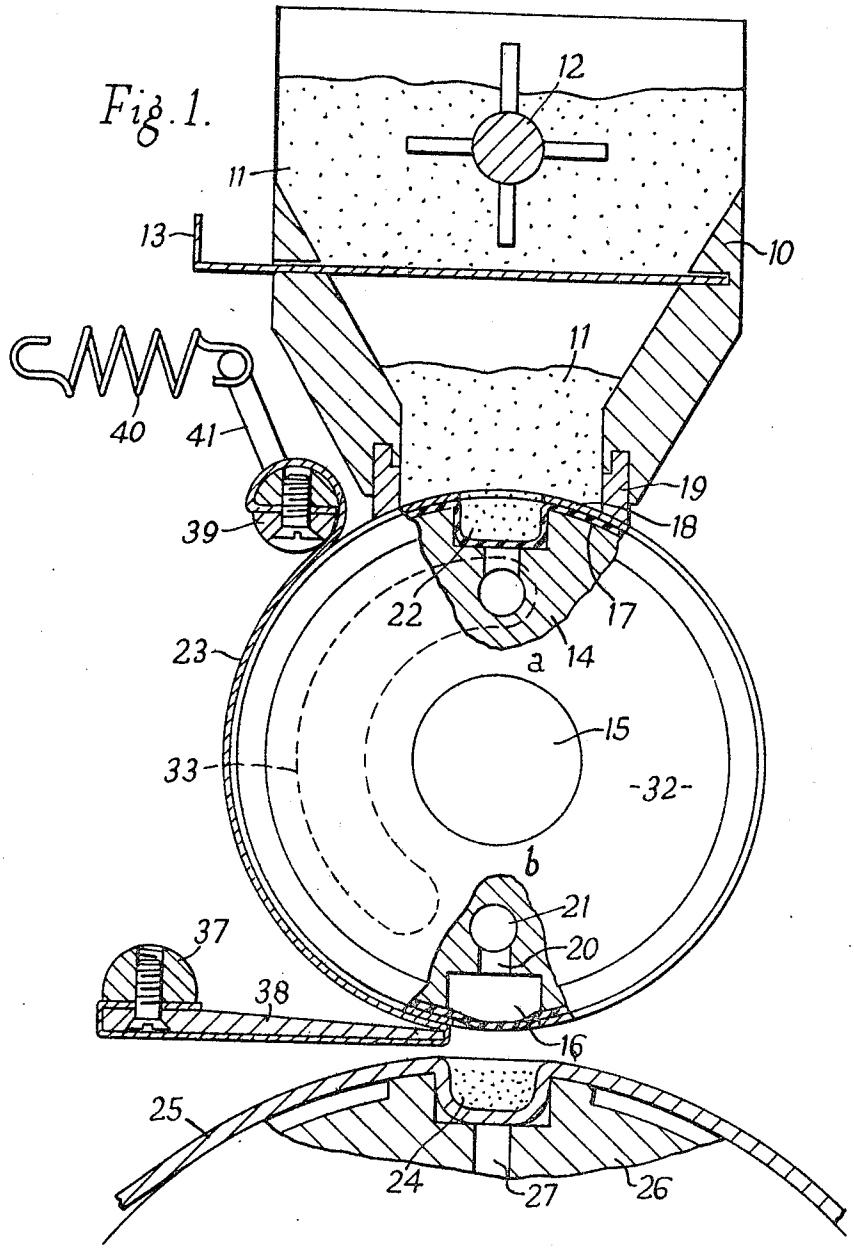
May 27, 1969 M. K. MEHTA 3,446,404

ENCAPSULATION OF POWDERS

Filed Jan. 15, 1968 Sheet 1 of 7

Fig. 1.



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Sheet 2 of 7

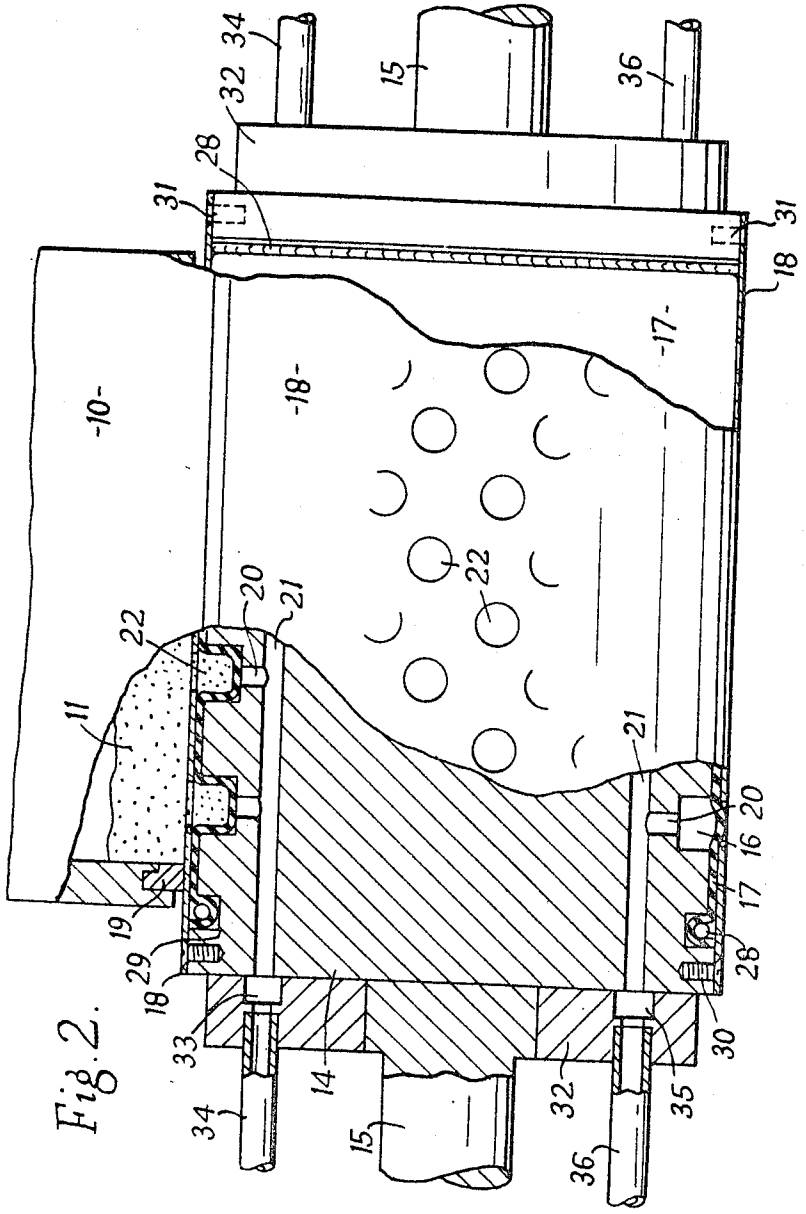

Fig. 2.

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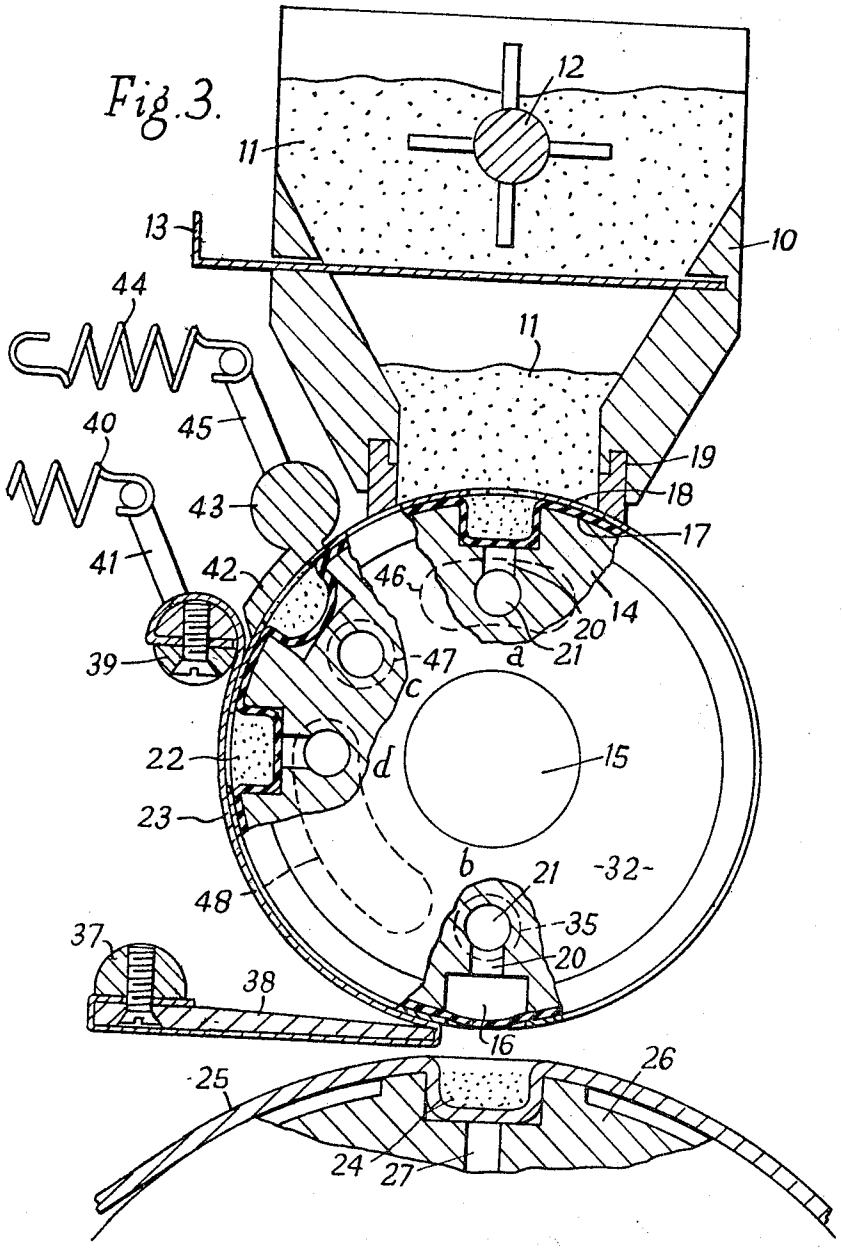
ENCAPSULATION OF POWDERS

Filed Jan. 15, 1968

Sheet 3 of 7

Fig. 3.



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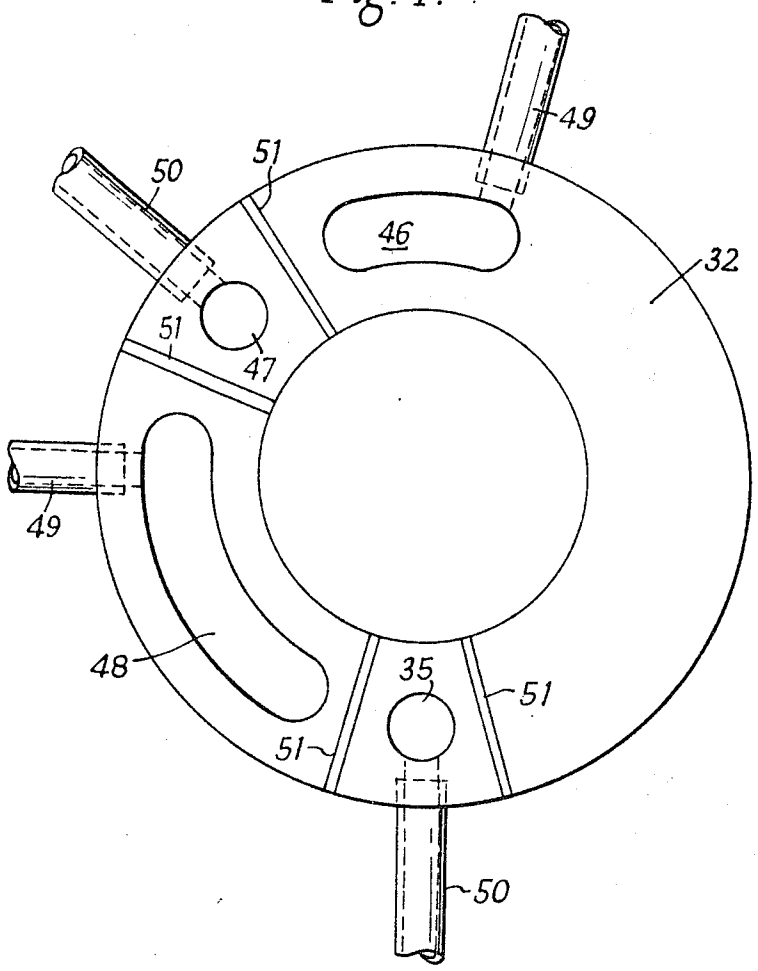
ENCAPSULATION OF POWDERS

Filed Jan. 15, 1968 Sheet 4 of 7

Fig. 4.



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ENCAPSULATION OF POWDERS

Filed Jan. 15, 1968

Sheet 5 of 7

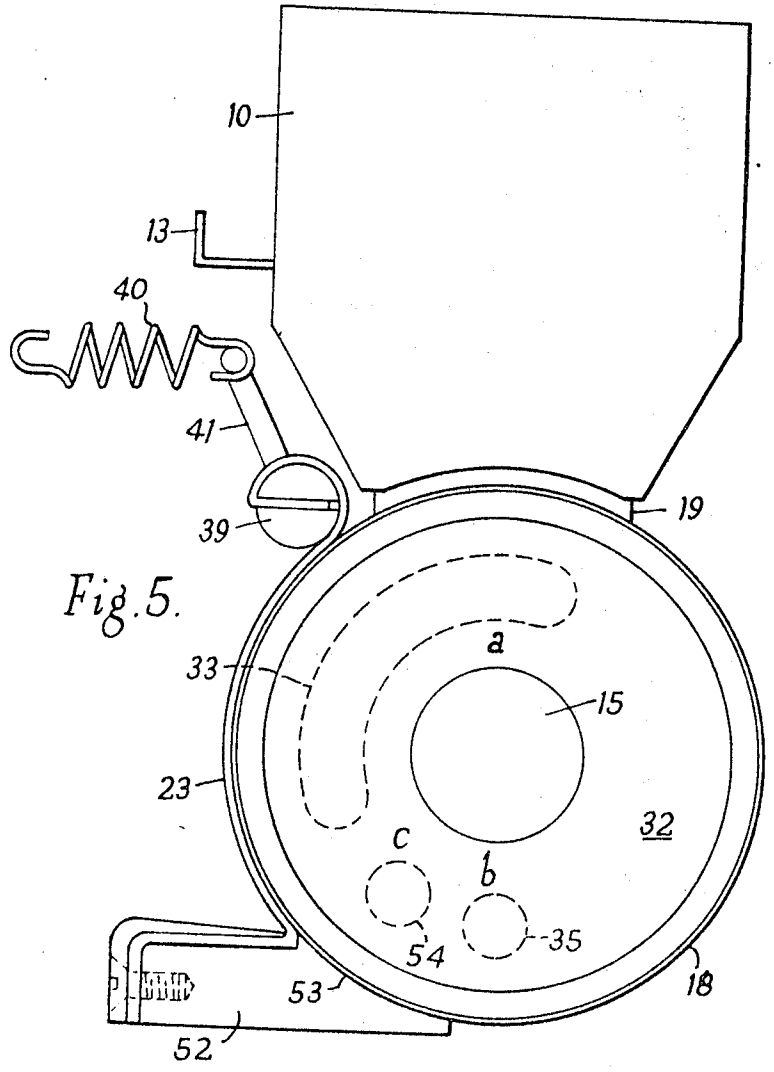

Fig. 5.

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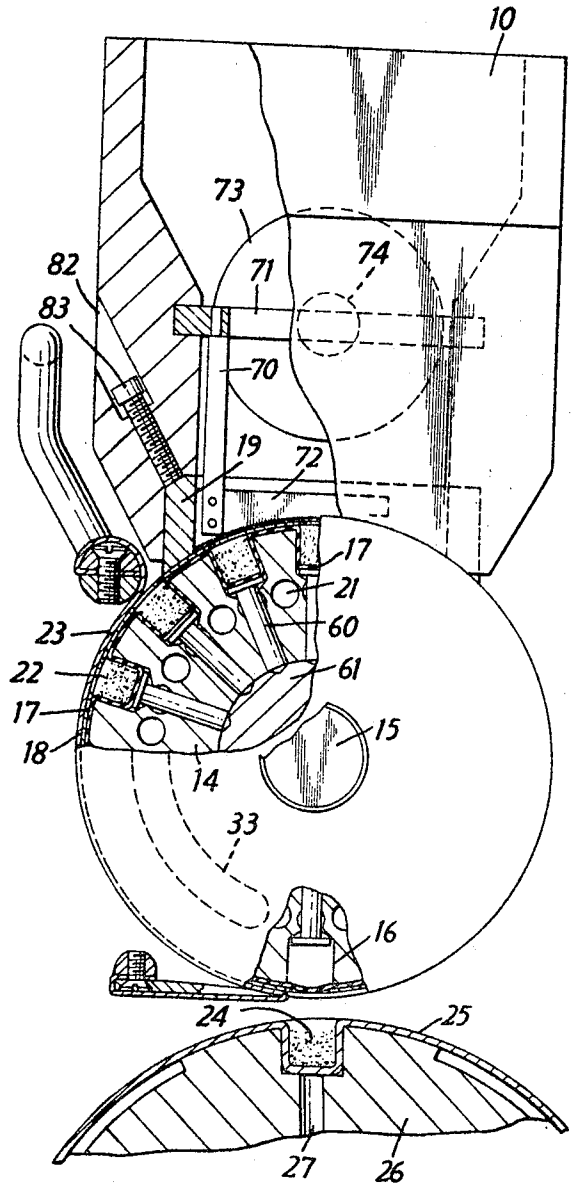
May 27, 1969 M. K. MEHTA 3,446,404

ENCAPSULATION OF POWDERS

Filed Jan. 15, 1968

Sheet 6 of 7

Fig. 6.



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Sheet 7 of 7

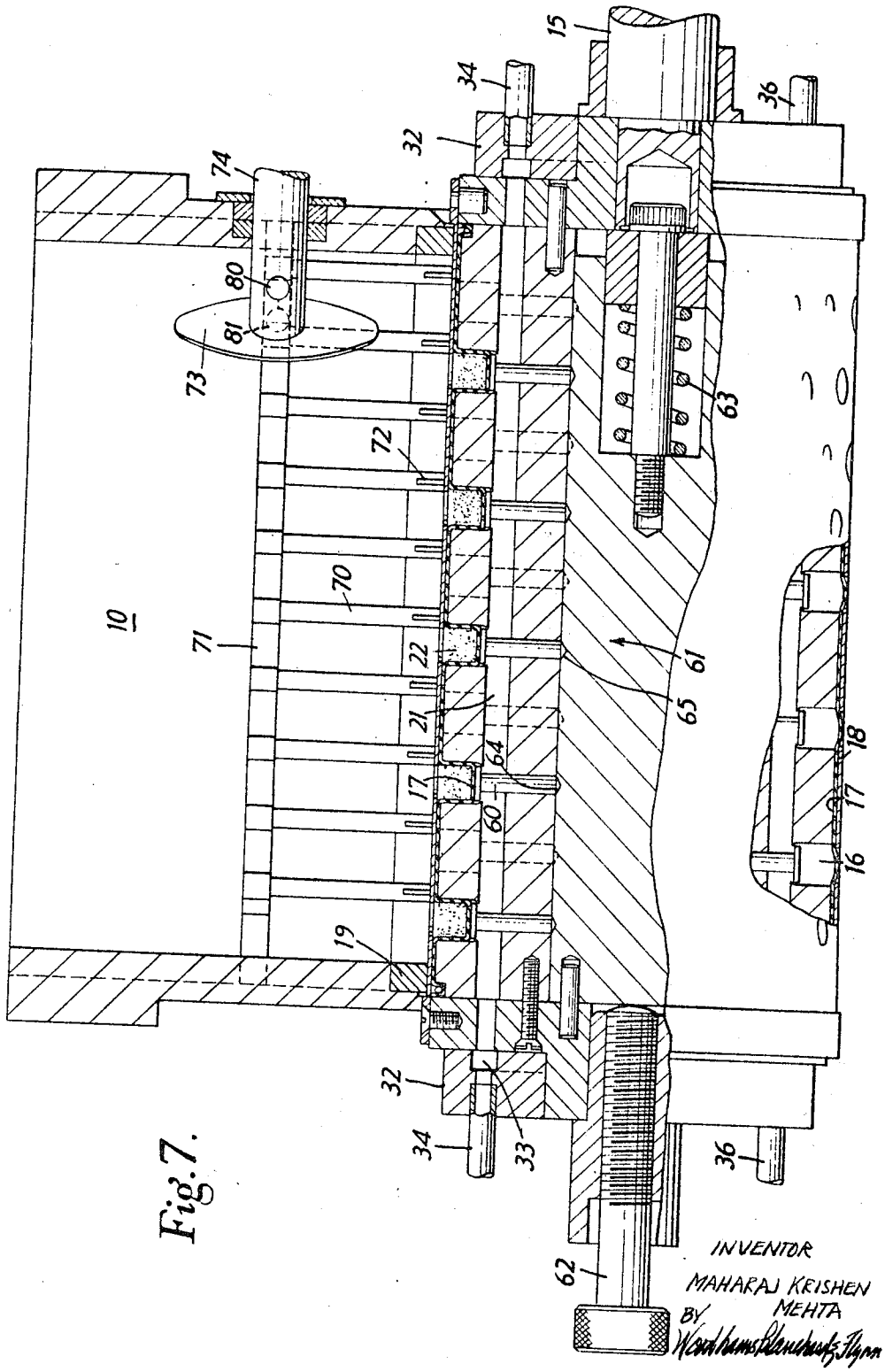

Fig. 7.

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United States Patent Office

3,446,404

Patented May 27, 1969

3,446,404

ENCAPSULATION OF POWDERS

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Continuation-in-part of application Ser. No. 614,323, Feb. 6, 1967. This application Jan. 15, 1968, Ser. No. 697,949

Claims priority, application Great Britain, June 20, 1967, 28,469/67

Int. Cl. G01f *11/24, 15/00*

U.S. Cl. 222—225

12 Claims

ABSTRACT OF THE DISCLOSURE

A rotary feed roll for filling gelatine capsules with powder from a hopper, the roll being covered with a rubber sleeve which is drawn by suction into openings in the surface of the roll to form charge chambers for the reception of the powder, the rubber sleeve being covered with an apertured metal sleeve to protect the rubber sleeve against damage and facilitate rotation of the roll across the mouth of the hopper. Upon release of the suction the charges are ejected by the resilience of the rubber sheet. This resilience, aided by air pressure in place of the suction, may be used to compress the charges against a backing plate covering the mouths of the charge chambers. The size of the charge chambers may be varied by variation of the degree of suction, or by providing an element within each opening to limit the penetration of the elastic sheet.

This application is a continuation-in-part of my copending application Ser. No. 614,323, filed Feb. 6, 1967, now abandoned.

The invention relates to dispensing apparatus for powdered or granular materials which comprises a hopper and a rotary feed roll closing the mouth of the hopper and having openings in its periphery to receive material from the hopper and convey it to a discharge position.

Apparatus of this kind is used particularly for filling gelatine capsules with pharmaceuticals. For example, British patent specification No. 881,022 describes apparatus in which capsules are formed by bringing together two capsule-halves formed in two strips of gelatine or the like which pass round two revolving die rolls having matching die pockets in their surface to which suction is applied to form the capsule-halves. The capsule-halves formed on each die roll are filled with the aid of a feed roll mounted directly above the die roll and having charge chambers in its periphery which are filled with powder from a hopper and from which the powder is ejected into the formed capsule-halves.

In that specification each of the charge chambers contains a cam-operated plunger for ejection of the charge at the discharge position. This plunger forms the base of the charge chamber and must fit closely to prevent entry of powder between the plunger and the walls of the chamber. The accurate construction and fitting of these plungers in each of a large number of individual charge chambers increases the difficulty and cost of manufacture and maintenance of the apparatus.

It is an object of the present invention to provide improved dispensing apparatus which does not require accurately constructed and fitted plungers.

British patent specification No. 394,489 describes another form of dispensing apparatus for moulding substances such as confectionery. This form of apparatus has a sheet of elastic material covering a roll having moulds in its periphery. The moulds are adapted to be raised out of the roll up to the mouth of the hopper when they are to be filled. Suction is applied to the moulds in order to draw the sheet of elastic material into them. This apparatus has the disadvantage that it is slow due to the necessity for raising the moulds out of the feed roll for filling, which requires the feed roll to be rotated discontinuously. In addition the sheet of elastic material suffers great deformation when the moulds are raised up to the mouth of the hopper, and thus must be relatively thick to withstand the repeated deformation. However, the thicker the sheet of elastic material is, the less accurate will be the volume of material dispensed by the apparatus. Thus this form of apparatus is not used for accurate measurement such as is required in pharmaceutical applications.

It is an object of this invention to provide a feed roll which can employ a thin sheet of material so that the volume of material dispensed is sufficiently accurate for pharmaceutical purposes, and which can be operated quickly and continuously.

The present invention exploits the use of a feed roll having a sheet of elastic material covering openings in the periphery of the feed roll. A sleeve fits closely over the sheet of elastic material and has apertures registering with the openings in the feed roll. The apparatus applies suction to the openings to draw in the sheet of elastic material and thereby form charge chambers to receive charges of material from the hopper, and releases the suction to cause ejection of the charges at the discharge position.

In this way the walls of each charge chamber are formed by the elastic sheet and thus present a continuous barrier to the passage of powder into the interior of the feed roll. The elastic sheet is easily fitted to the feed roll and a single sheet can cover all the openings in the feed roll. The elasticity of the sheet effects ejection of the charges when the suction is released.

The apertured sleeve serves to protect the elastic sheet against damage and to enable a close fit to be maintained with the mouth of the hopper while allowing the feed roll to rotate smoothly. The apertures in the sleeve define the mouths of the individual charge chambers.

The mouths of the charge chambers can be covered in known manner during their passage from the hopper to the discharge position either by a stationary plate or by a flexible charge retention sheet stretches around the periphery of the feed roll or by a combination of these elements. If the suction is released while the mouth of the charge chamber is covered by a stationary backing plate the elasticity of the sheet will tend to compact the powder into a slug. This may be assisted by the application of pneumatic pressure in place of the suction. Such pressure may also be used to assist the ejection of the charge.

Controlled application of suction to form the charge chamber while the opening in the feed roll is under the mouth of the hopper will assist in drawing the powdered or granular material into the charge chamber and ensuring complete filling of the charge chamber, thereby enabling accurately-measured quantities to be dispensed. The size of the charge chamber can be varied at will by changing the degree of suction applied.

However, when using this method of varying the volume of the charge chambers, it is found that it is not possible to control the volume of the charge sufficiently accurately for some applications, for example for use with certain pharmaceutical products. Also it is difficult to handle materials which are not free-flowing, as the suction created between the elastic sheet and material resting on the feed roll is not sufficient to fill the charge chamber.

When using the apparatus to dispense such materials, it is sometimes found convenient to employ a modified form of the apparatus which includes an element within each opening in the feed roll which is movable within the opening to limit the depth of penetration of the elas-

tic sheet into the opening on the application of suction.

The feed roll may have an axially movable core, and the said elements so engaging with the core that axial movement of the core causes movement of the elements in a generally radial direction in the feed roll to control the positions of the elements.

The invention will now be described in more detail with the aid of examples illustrated in the accompanying drawings, in which:

FIGURE 1 is a front view, partly in section transverse to the axis of the feed roll, of dispensing apparatus in accordance with the invention forming part of a machine for manufacturing filled gelatine capsules,

FIGURE 2 is a side view, partly in section, of part of the apparatus shown in FIGURE 1,

FIGURE 3 is a view similar to FIGURE 1 showing a modified form of apparatus,

FIGURE 4 is a detail of the valve plate used in the apparatus of FIGURE 3,

FIGURE 5 is a front view of a further modification,

FIGURE 6 is a view similar to FIGURE 1 showing another modified form of apparatus, and

FIGURE 7 is a side view, partly in section, of part of the apparatus shown in FIGURE 6.

The apparatus of FIGURES 1 and 2 has a hopper **10** in which the powdered or granular material **11** is held and maintained in a free-flowing condition by an agitator **12**. A sliding closure plate **13** enables the bottom of the hopper to be closed when the machine is taken out of operation. A feed roll **14** is mounted on a shaft **15** for rotation about a horizontal axis below the mouth of the hopper **10**. A number of openings or cavities **16** are formed in the periphery of the roll **14**. The surface of the feed roll is covered by an elastic sheet **17** in the form of a cylindrical sleeve fitting over the roll and covering the openings **16**. Over the elastic sheet **17** is a thin metal sleeve **18** having apertures registering with the openings **16** in the feed roll. At the mouth of the hopper **10** a seal **19** engages the surface of the sleeve **18** to prevent escape of powder from the hopper while allowing the feed roll **14** to rotate, carrying with it the sleeve **18**.

The openings **16** in the periphery of the roll **14** are arranged in rows parallel to the axis of rotation of the feed roll, as shown in FIGURE 2, and the openings in each row are staggered relative to those in adjacent rows. The openings of each row communicate through radial holes **20** with a common axial passage **21** to which suction can be applied to draw the elastic sheet **17** into the openings **16** and thereby form charge chambers **22** lined by the elastic sheet, which receive charges of powder from the hopper **10**. The roll **14** rotates in an anti-clockwise direction (as seen in FIG. 1) to carry the powder which enters the charge chamber **22** at its topmost position *a* to the lowermost or discharge position *b*. A charge retention sheet **23** prevents the loss of powder from the charge chambers until they reach the discharge position. Here the charge is delivered into a preformed capsule-half **24** shaped from a gelatine sheet **25** on a die roll **26** by the application of suction through a passage **27**.

The elastic sheet **17** is a sleeve of latex rubber and has a thickness of about .010 inch. It is held in place at each end by a retaining ring **28** disposed in a groove **29** (FIGURE 2). The sleeve **18** is a thin stainless steel sleeve which is secured to the feed roll **14** by screws **30** at one end of the roll and locating dowels **31** at the other end.

The application of suction to the passages **21** is controlled by stationary valve plates **32** at each end of the feed roll **14**. Each valve plate **32** has an arcuate vacuum groove **33** extending from the filling position *a* round to a position before the discharge position *b*. The vacuum groove **33** is connected by a conduit **34** to a vacuum line and while the ends of each passage **21** are in register with the vacuum groove **33** suction is applied to the individual openings **16** to draw the elastic sheet **17** inwards and thus form the charge chambers **22**. At the discharge

position *b* the ends of the passages **21** come into register with ejection pressure holes **35** in the valve plates **32** which communicate through conduits **36** with a pressure source. The pressure thus applied to the openings **16** assists the elasticity of the sheet **17** in ejecting the charge from the charge chamber into the capsule-half **24**.

As shown in FIGURE 1 the charge retention sheet **23** is secured at its lower edge to a bar **37** on which is mounted a plate **38**. The edge of the plate **38** defines the discharge position, the sheet **23** passing round this edge on to the surface of the feed roll and being attached at its upper edge to a rotatable bar **39**. The bar **37** is hinged to allow the plate **38** to swing and the bar **39** is biased by a spring **40** acting on an arm **41** to maintain the sheet **23** in tension against the periphery of the feed roll. The charge retention sheet **23** can be a single or double layer of woven material, for example two layers of cotton fabric or a layer of cotton fabric backed by fine wire mesh.

FIGURE 3 shows a modification of the apparatus of FIGURES 1 and 2. Corresponding parts in the three figures have been given the same reference numerals and it will not be necessary to describe again those parts of the apparatus of FIGURE 3 which are the same as that of FIGURES 1 and 2. In FIGURE 3 the charge retention sheet **23** extends over a smaller area of the surface of the feed roll **14** and is preceded by a backing plate **42** attached to a rotatable rod **43** and biased against the sleeve **18** forming the surface of the feed roll by a spring **44** acting on an arm **45**. The valve plate **32** has a short suction groove **46** in the region of the mouth of the hopper **10**, a compression pressure hole **47** at the position *c* where the mouths of the charge chambers are closed by the backing plate **42**, and a longer arcuate suction groove **48** extending from the point *d* where the charge chambers pass under the charge retention sheet **23**. By the application of air pressure through the hole **47** the charge of powder in the charge chamber is compressed between the backing plate **42** and the elastic sheet **17**. The elasticity of the rubber sheet will effect some compression when the suction is released but preferably this compression is increased by the application of air pressure to the extent necessary to form the powder into a slug which will be coherent when ejected into the formed capsule-half **24** but sufficiently fragile to break up when the capsule takes its final shape.

The slug ejected at the discharge position falls into the preformed capsule half **24**. The filled capsule half is brought into register with a similarly-filled complementary capsule half on a second die roll and the two capsule halves are united as described in British patent specifications Nos. 881,022 and 957,840. The two slugs in each capsule break up under the pressure exerted by the walls of the capsule during its formation and during subsequent tumbling of the capsule. The compaction of the powdered material nevertheless facilitates filling of the capsules and enables a greater weight of material to be enclosed in a given size of capsule. The shape of the slug may be changed by altering the transverse cross-section of the charge chamber so that the slugs are suitable for encapsulation in round, oval or oblong capsules.

FIGURE 4 shows the details of the construction of the valve plate **32** for the embodiment of FIGURE 3. The grooves **46** and **48** are connected by conduits **49** to the vacuum source while the holes **35** and **47** are connected by conduits **50** to the pressure source. To avoid any leakage of compressed air across the valve plate into the vacuum grooves, radial channels **51** are formed in the valve plate which communicate at each end with the atmosphere.

FIGURE 5 shows in outline a further modification in which the compression of the charges is effected immediately before their ejection from the charge chambers. As in FIGURE 1 the charge chambers after leaving the hopper **10** pass directly under the charge retention sheet

23 and suction is maintained by the groove 33. The lower edge of the charge retention sheet 23 is attached to a block 52 which presents a backing surface 53 engaging the periphery of the feed roll in the position *c*. Here a pressure hole 54 is provided in the valve plate 32 and pressure is applied to compress the charge. On reaching the position *b* pressure is again applied through the hole 35 to eject the compressed charge.

The apparatus shown in FIGURES 6 and 7 is a modified form of the apparatus described with reference to FIGURES 1 and 2. Corresponding parts have been given the same reference numerals and it will not be necessary to describe again those parts of the apparatus of FIGURES 6 and 7 which are the same as that of FIGURES 1 and 2.

The apparatus illustrated in FIGURES 6 and 7 has improved means for adjusting the volume of the charge chambers 22, to permit more accurate and hence economical dispensation of the powder or granulated material 11. The extent to which the elastic sheet 17 can be drawn into the openings 16 when suction is applied is controlled by flat-headed pins 60, which are movable with the openings 16 to limit the depth of penetration of the elastic sheet 17.

As is illustrated in FIGURE 7, the feed roll 14 has a close-fitting shaft or core 61 which is adjustable axially within a small range by means of a knurled bolt 62. A spring 63 tends to push the core up against the inner end of the bolt 62. Rotation of the bolt 62 causes the core 61 to move axially to left or right as seen in FIG. 7.

The flat-headed pins 60 have cone-shaped inner ends 64 which engage in cone-shaped depressions or holes 65 in the core. As shown, the inner ends 64 of the pins fit fully into the depressions 65. If the core 61 is moved axially to the right by means of the bolt 62, the pins 60 will be caused to rise out of the depressions 65, and thus to decrease the volume of the charge chambers 22. Thus it can be seen that the volume of the charge chambers is continuously adjustable over a limited range.

The openings 16 are circular in cross-section, although other shapes, for example, oval and oblong, may be used. The pins 60 fit inside the openings 16 with a small clearance between the pins and the sides of the openings to allow the vacuum applied to the passage 21 to reach the elastic sheet 17.

The apparatus illustrated in FIGURES 6 and 7 also has improved means for agitating the material in the hopper.

The hopper 10 contains a number of scrapers or wiper arms 70. These are supported from a frame 71 and carry wiper shoes or blades 72. The frame is reciprocated from left to right (as seen in FIGURE 7) by means of a cam 73 on a shaft 74 which may conveniently be connected to the shaft 15, preferably through gearing, for rotation by a common motor. The cam 73, which is a skew-mounted disc, runs between two pins 80 and 81 on the frame 71 to effect movement thereof. The movement of the frame causes the wiper shoes to reciprocate transversely across the surface of the feed roll, and thus to sweep material into the charge chambers 22. It also serves to agitate the material in the hopper, which additionally assists in proper filling of the charge chambers and thus helps to maintain consistency of the volume of the charge. The use of the wiper shoes makes it possible to handle powders which are substantially not free-flowing.

The hopper side walls contain screws 83 for adjusting the pressure on the seal 19 on the feed roll independently of the position of the hopper. The screws are threaded into holes 82 in the walls of the hopper 10.

While the specific embodiments have been described as forming part of a particular known form of encapsulating machine it will be apparent that the dispensing apparatus in accordance with the invention may be used in other forms of encapsulation machine whether for filling capsules in process of formation or preformed capsules. Moreover the apparatus can be applied to the filling of bottles, ampoules, packets and other containers.

The specific embodiments show two valve plates, one at each end of the roll, to ensure uniformity of pressure in the charge chambers in each row. With shorter feed rolls a single valve plate will suffice.

The means employed for retaining the charges in the charge chamber up to the discharge or delivery position may be of any known type and may, for example, consist of a rigid housing surrounding the periphery of the roll.

I claim:

1. Dispensing apparatus for continuously dispensing powdered or granular materials, comprising:

a hopper, a rotary feed roll having a portion of its periphery closing the mouth of said hopper, said feed roll having openings in its periphery to receive material from said hopper and convey it to a discharge position, a sheet of elastic material covering said openings and normally positioned adjacent the periphery of the roll, a sleeve fitting closely over said sheet of elastic material and having apertures registering with said openings, conduits within said feed roll each connected to one or more of said openings inside of said sheet of elastic material, and connecting means for sequentially connecting a vacuum source to said conduits so that when the openings are in registry with the hopper the sheet of elastic material is drawn into the openings to form charge chambers for receiving material from the hopper, the conduits being disconnected from the vacuum source at the discharge position to permit the contents of the charge chambers to be discharged at least in part by the resilience of the sheet of elastic material.

2. Apparatus as claimed in claim 1 wherein said openings are arranged in rows parallel to the axis of rotation of said feed roll, and each conduit connects the openings in one row.

3. Apparatus as claimed in claim 2 wherein said connecting means comprises a valve plate engaging one end of said feed roll and having means for placing each of said conduits in communication with said vacuum source when the corresponding row of openings is under the mouth of the hopper.

4. Apparatus as claimed in claim 1, further comprising a backing plate engaging the surface of said feed roll at a position between said hopper and said discharge position.

5. Apparatus as claimed in claim 4, wherein said connecting means comprises means for releasing the suction while said openings are covered by said backing plate.

6. Apparatus as claimed in claim 5, further comprising a pressure source, said connecting means having means for connecting said pressure source sequentially to said conduits to compress the charge between said elastic sheet and said backing plate.

7. Apparatus as claimed in claim 4, wherein said backing plate is adjacent said discharge position, and further comprising a flexible charge retention sheet positioned preceding said backing plate and attached by one edge to said backing plate.

8. Apparatus as claimed in claim 1, further comprising an element movable within each of said openings to limit the depth of penetration of said elastic sheet.

9. Apparatus as claimed in claim 8, wherein said feed roll includes an axially movable core, and said elements so engage with said core that axial movement of said core causes movement of said elements in a generally radial direction within said feed roll.

10. Apparatus as claimed in claim 9, wherein each element includes a generally radially-extending rod having a cone-shaped end which engages in cone-shaped holes in said core.

11. Apparatus as claimed in claim 1 further comprising a wiper system within said hopper for wiping said sleeve to sweep material into said openings.

12. Apparatus as claimed in claim 11, wherein said wiper system comprises a plurality of wiper arms, and means for reciprocating said wiper arms transversely across said sleeve.

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U.S. Cl. X.R.

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