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(71) Applicant: DRUGPACK MACHINES LIMITED
265 Strand
London WC2R 1AG(GB)

(72) Inventor: Summers, Ian
52 Westway
Holmes Chapel, Cheshire(GB)

(74) Representative: Main, Peter Stephen et al,
HYDE, HEIDE & O'DONNELL 2 Serjeants' Inn
London EC4Y 1LL(GB)

(54) **Apparatus and method for filling containers with discrete solids.**

(57) The specification describes a method and apparatus for vacuum filling containers, particularly small containers such as orally acceptable capsules, with powder. For filling a container (6) use is made of a material delivery passage (2) which is non-vertical. Discrete solid material from a supply (5) can descend freely into this passage but its spatial course and cross-sectional size are such that material remains supported in the passage until air is aspirated from the container (6) via an air exhaust passage (3). Flow of material through the delivery passage (2) ceases following restoration of normal atmospheric pressure at the exit end of such passage.

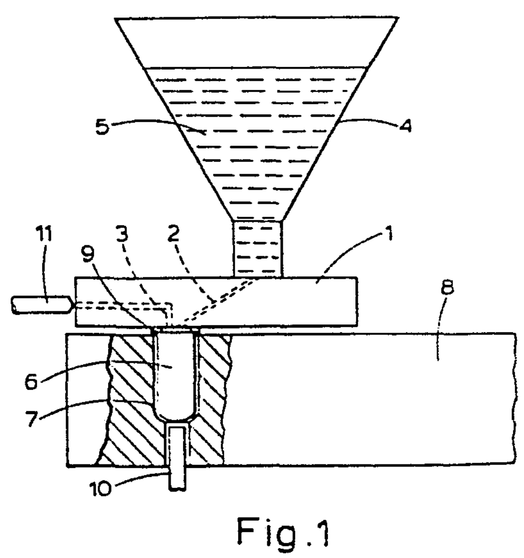

Fig.1

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Apparatus and Method for Filling Containers with Discrete Solids

Various filling machines are known for partially or completely filling containers with discrete solid material.

Some known machines allow the discrete material to fall into a container under gravity from a hopper or other reservoir via a delivery passage until the passage exit is closed, e.g. by a shutter or valve, or by contact with material in or overflowing from the container.

Machines are also known in which the material to be dispensed is drawn into the container from a reservoir via a vertical delivery tube by aspirating air from the container while its mouth is air-tightly sealed around such tube and the aspirating passage. The aspiration can be regulated for varying the amount of material which is dispensed. Filling machines operating such a vacuum-fill system are capable of high filling rates.

Problems are often encountered when using a vacuum-fill system in avoiding excess flow of the discrete material. United States specification 3 693 672 is concerned with this problem and describes a vacuum-fill type machine having a second vacuum system which operates after termination of the filling vacuum to inhibit further flow of discrete material to the filling nozzle. For this purpose the filling tube has an air permeable wall portion which is located above its nozzle and is surrounded by a vacuum chamber. Simultaneously with the operation of the second vacuum a blast of air is delivered into the container to pack the discrete material in the container. This air blast is possibly also intended to prevent particles of dispensed material from being aspirated back into the filling tube by the second vacuum.

The use of a second vacuum system is also proposed in United Kingdom Patent specification No. 1 510 634. In the filling machine described in that specification the second vacuum system is operated after completion of the vacuum fill and at a stage during movement of the filled container away from filling position. The purpose of the second vacuum is to purge residual material from within the filling head so that the amount of material dispensed in the next filling cycle is not affected by this residual material.

The provision of twin-vacuum systems operating as described in the prior patents must entail complication of the filling machines and add appreciably to their cost.

The known filling machines hereinbefore referred to are primarily if not exclusively intended for dispensing material in substantial unit quantities, e.g. for dispensing granular food materials and domestic powders, into cartons or jars. Machines operating as above described would not be suitable for cleanly dispensing discrete solid material in very small doses, for example doses of the sizes in which pharmaceutical powders are customarily contained in capsules of gelatin or other orally acceptable material. Even if the complication of a second vacuum system as described in the earlier patents above referred to were accepted, it would be difficult if not impossible to make the machine capable of dispensing the material in the required small doses with sufficient accuracy, and in a clean manner, i.e. without dropping of powder from the filling head. Excess material is liable to be released from the filling head of the known machines. The amount of such excess depends on the cohesiveness of the particulate material and any natural bridging effect in the delivery passage. Even when handling free-flowing material such excess amounts may be considered insignificant when filling ordinary domestic containers but they would be unacceptable when dispensing minute quantities of relatively expensive material or medicines requiring strict dosage control.

Vacuum-type filling machines are known for filling pharmaceutical capsules, which utilise an indirect filling system according to which a predetermined measured quantity of the pharmaceutical material is drawn into a measuring tube and subsequently released from that tube into a capsule. Direct vacuum filling would be simpler, but so far as is known, no direct vacuum filling machine is available which is capable of accurately and cleanly dispensing such very small quantities of material.

The principal object of the present invention is to provide a direct filling apparatus and method of vacuum-fill type in which discharge of material is controlled without resort to the use of a second vacuum system.

A secondary object of the invention, fulfilled by preferred embodiments of the invention, is to provide a vacuum-fill type apparatus and method which is capable of cleanly and accurately dispensing free-flowing discrete solid material in minute quantities directly into capsules or other small containers.

The vacuum-fill type apparatus according to the present invention is defined in claim 1 of this specification. The apparatus is characterised in that at least part of the length of the delivery passage is so orientated relative to the vertical that there is no vertical flow path through such passage.

This apparatus departs from the established convention of using a straight vertical delivery tube for conducting the discrete solid material from a hopper or other reservoir to the container to be filled. The material delivery passage of apparatus according to the invention has a course in space such that the passage can afford some degree of underlying support for particles in at least part of the length of the passage. A quantity of material of appropriate flow characteristics will remain in the passage awaiting the incidence of suction to initiate its flow, whereas if the passage were a vertical passage of the same size that same material would fall or be liable to fall under gravity. By employment of the invention, flow of material from the delivery passage into the container on termination of the filling vacuum and removal of the container from filling position is avoided or restricted in a very simple manner, without the use of valves or other moving parts and without the use of a second vacuum system.

The spatial course of the delivery passage is one factor which in practice determines the flow characteristics which a discrete material should have in order to be satisfactorily dispensed by the apparatus. Another factor is the size and particularly the cross-sectional dimensions of the delivery passage. For a passage of a given size, the more the spatial course of the passage departs from the vertical, the more versatile is the apparatus because the more freely-flowing can be the discrete material.

It will be apparent that for achieving the best advantages from the invention, and in particular for dispensing very free-flowing discrete material, the delivery passage should be at a substantial angle to the vertical over at least a part and preferably over at least the greater part of its length.

The spatial course of the delivery passage can easily be selected so that when handling discrete material of given flow characteristics none of the material or only a miniscule amount of the material will fall from the delivery passage when the container is moved away from filling position following a complete vacuum fill. Apparatus according to the invention and having its material delivery passage arranged in that manner, can be made to a size suitable for accurately dispensing small doses of discrete material, e.g. doses less than 1 gram in weight and even doses measured in milligrams. Such apparatus is very suitable for filling pharmaceutical capsules.

Preferably at least a lower end portion of the length of the delivery passage is downwardly inclined at an acute angle to the horizontal. This feature is advantageous for the purpose of avoiding fall of material from the exit end of the delivery channel under gravity.

In the most preferred embodiments of the invention, the delivery passage is downwardly inclined at a constant acute angle to the horizontal over its entire length.

The value of the aforesaid acute angle should be selected having regard to the flow characteristics of the material or materials intended to be dispensed by the apparatus. The more free-flowing is the material, the smaller should that angle be. Preferably the said acute angle is less than 40°.

Although the invention can be embodied in apparatus of any size specifications selected according to the unit quantities of material to be dispensed, the invention is in practice particularly beneficial when using a delivery passage of small size. Preferably the delivery passage has at all positions along its length a cross-sectional area of not more than .05 square inches (approximately 32 square millimetres) this being the approximate cross-sectional area of a circular bore $\frac{1}{4}$" (6.35mm) in diameter. Such a passage can easily be kept closed by fine grained solid material within the passage but without causing blockage of the material flow under the filling vacuum. Such closed condition of the delivery passage contributes to direct response of the discrete material to the aspirating force at the commencement of each filling operation, with continuous unidirectional flow of material towards the exit end of the passage over its entire cross-section. Preferably the length of the delivery passage is between $\frac{1}{4}$ inch and 2 inches. Passages of that length have been found to be most convenient and satisfactory in operation.

If the delivery passage is too long, blockage may occur. These preferred cross-sectional and length dimensions of the delivery passage are very appropriate in apparatus intended for dispensing very fine grained materials into small containers.

A delivery passage of very small sizes can be constituted very satisfactorily by a bore or channel within a solid body or combination of bodies e.g. within a solid plate or plate-like structure. In certain apparatus according to the invention the delivery passage is defined by solid material forming a cover for covering the mouth of a container to be filled, such passage extending between opposed faces of such cover.

Apparatus according to the invention can incorporate any form of container support. The support may in manner known per se be constructed to support a plurality of containers and be associated with mechanism for stepwise displacing such support to bring empty containers successively to a filling station. There may be means at such station for displacing the container or containers into sealing contact with the cover means preparatory to the creation of the filling vacuum.

When operating apparatus according to the invention it is important to avoid the condition that material in the delivery passage becomes pushed out of the passage by a static head of discrete solid material feeding to the delivery passage. At the same time of course there should be a smooth continuous flow of material into such passage. Preferably the entry end of the delivery passage communicates with a vertical feedway for discrete solid material. Preferably the area of the bottom end of such feedway is not more than four times the area of the entry end of said delivery passage.

Further features which can be incorporated in apparatus according to the invention with advantages which appear from the description of specific apparatus given later in this specification are defined in claims 8 to 12 hereof.

The present invention also includes a method of dispensing discrete solid material into a container by placing the container in sealed communication with a material delivery passage through which material can flow from a supply, and with an air exhaust passage, and aspirating air from the container via said exhaust passage to draw material into the container, characterised by the step of providing a said delivery passage into which material can freely descend from said supply but which follows such a spatial course and has such cross-sectional dimensions that following restoration of atmospheric pressure at the exit end of said delivery passage it remains filled over at least part of its length by discrete solid material which has entered said passage and which is held thereby in static condition ready to be sucked into another container.

A method according to the invention can be used for complete or partial filling of a container.

Complete filling means that filling continues until the mass of particles dispensed into the container reaches the exit end of the material delivery passage. In those circumstances the momentum of material flowing along the delivery passage under the influence of the aspirating force is destroyed by the material in the container.

Removal of the filled container causes the exit end of the delivery passage to be exposed to atmospheric pressure and the delivery passage therefore remains filled over at least part of its length by discrete material ready to be drawn into another container as above referred to. In preferred embodiments of the invention, performed for complete filling of a container the spatial course and cross-sectional dimensions of the delivery passage are such that on such removal of the filled container the delivery passage remained substantially entirely filled with material. None or substantially none of such retained material discharges under gravity.

When using a method according to the invention for partial filling, material in the delivery passage may have a slight residual momentum following termination of the aspirating force and consequent restoration of atmospheric pressure in the container. Therefore a further quantum of material may leave the delivery passage, depending on the flow characteristics of the material and the spatial course of such passage. Such further quantum can be allowed for in setting the strength and duration of the suction force.

In any given process, fall of material from the delivery passage solely under gravity can be avoided even when handling a very free-flowing material, by appropriate selection of the course and size of the passage as herein described.

Certain embodiments of the invention, selected by way of example only, will now be described with reference to the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of part of a dispensing apparatus according to the invention;

Figs. 2 and 3 show alternative forms of material delivery passage;

Fig. 4 is a plan view of part of a filling machine embodying the invention;

Fig. 5 is a sectional elevation of certain of the machine components shown in Fig. 4;

Fig. 6 is a part sectional elevation of the filling head of the machine and of part of an associated feed hopper;

Fig. 7 is a part-sectional elevation of the filling head taken at right angles to Fig. 6; and

Fig. 8 is an under-plan view of parts of the filling head.

The dispensing apparatus shown in Fig. 1 comprises a cover plate 1 for covering the mouth of a container to be filled. In this plate there is an inclined delivery passage 2 extending from the top to the bottom face of the plate. Within the plate there is also an air exhaust passage 3 comprising a short vertical section leading upwardly from the bottom face of the plate, and a horizontal section which extends to an edge face of the plate. The plate 1 is surmounted by a hopper 4 which is charged with discrete solid material 5.

The points at which the passages 2 and 3 open into the bottom of the plate 1 are sufficiently close together to come within the mouth area of a container 6. The container 6 is located in a recess 7 in a carrier 8 which is displaceable for carrying the container to the illustrated position and carrying it away from that position after a quantity of the discrete material has been dispensed into the container. The bottom surface of plate 1 has an annular sealing ring 9. After arrival of the container 6 at the filling station a pin 10 is lifted so that the pin pushes the mouth of the container against such sealing ring.

The discrete material in the hopper 4 has free access into the delivery passage 2 but given the cross-sectional size of the passage, its gradient is insufficient for the discrete material occupying the passage to slide down the passage under gravity. After positioning a container 6 in the illustrated position ready for receiving a predetermined quantum of the discrete material, air is aspirated from the interior of the container via the exhaust passage 3 and a vacuum pipe 11 which communicates with that passage and is connected to a vacuum pump or other sub-atmospheric pressure source. In consequence discrete material is sucked into the container.

The amount of material which enters the container depends on the strength and duration of the suction force propagated into the container. The vacuum system is adjusted to cause a predetermined quantity of material to be drawn into the container 6. The correct adjustment can be established on the basis of simple tests.

If the vacuum system is set so that the aspirated material completely fills the container and forms a small surface heap which touches the bottom end of the delivery passage 2, any momentum of the material in the delivery passage 2 is thereby destroyed. When the filled container is removed from the filling station the passage 2 remains full of discrete material. A negligible number (if any) of grains fall from the lower end of passage 2 as the filled container is removed. If on the other hand the vacuum system is set for only partially filling the container, there may be a slight discharge of material from delivery passage 2 after restoration of normal pressure in the upper part of the container 6 because of the residual momentum of material in the such passage but the amount of material thus discharged can be very small, particularly if the passage 2 has a shallow gradient and is of very small cross-section as hereinafter exemplified. Such discharge by residual momentum can be allowed for in the setting of the vacuum system, if necessary.

The termination of suction forces on material in the delivery passage 2 at a predetermined moment can be assisted by abruptly opening a short path of communication between the interior of the container and atmosphere. This can be achieved very conveniently by constructing the vacuum system so that the vacuum pipe 11 is unconnected with the cover plate 1 and moves out of registration with the air exhaust passage 3 at a predetermined moment so that the exhaust passage is instantly placed in communication with the ambient atmosphere.

The gradient of the delivery passage 2 is open to choice having regard to the minimum angle of friction between the material to be dispensed and the material supporting surface of the passage. It is preferable for the delivery passage to have a true and smooth surface. A very satisfactory form of passage is one constituted by a bore in a body of stainless steel.

The delivery passage 2 may be at a steeper angle than that shown, for example at 60° to the horizontal, particularly if the passage is of very small cross-section and the material to be dispensed has a slight natural cohesion. In any case the delivery passage is arranged so that there is no vertical flow path through the passage from its entry end to its exit end.

In preferred embodiments of the invention the apparatus incorporates a straight inclined delivery passage as shown in Fig. 1, the passage being inclined at less than 40° to the horizontal.

Figs. 2 and 3, in which parts identical with parts in Fig. 1 are designated by the same reference numerals, show alternative spatial configurations of the course of the material delivery passage. In Fig. 2 a delivery passage 12 is shown which has a downwardly inclined upper portion, a horizontal medial portion and a very short vertical portion adjacent its exit end. The horizontal portion of the delivery passage gives material in the passage a somewhat higher inertia resistance to flow under suction forces and also a slightly higher resistance to flow under residual momentum. However fall of grains from the bottom end portion of the passage under gravity may occur. With a very small bore any such gravity discharge will be slight.

A vacuum tube 13 is shown which is moveable out of registration with the air exhaust passage 3 for instantly placing that passage into communication with atmosphere to terminate filling. There is a slight clearance between the vacuum tube 13 and the plate 1 to avoid problems associated with relatively sliding surfaces.

The apparatus shown in Fig. 3 corresponds with that shown in Fig. 2 except that its material delivery passage 14, has a substantially vertical portion at its upper end and the remainder of the passage is downwardly inclined at an acute angle to the horizontal. The vertical orientation of the top portion of the passage can facilitate smooth entry of material into the passage from the superimposed hopper.

Reference will now be made to Figs. 4 to 8. These figures relate to a machine for automatically filling pharmaceutical capsules. The machine embodies dispensing apparatus according to the invention and utilises the new dispensing method herein claimed.

The capsule filling machine has capsule handling mechanism operative to open the capsules to be filled and to re-unite the capsule parts (the charge-receiving parts and the closure parts) in the same pairs after filling the charge-receiving parts with a pharmaceutical powder.

The capsule-handling mechanism will be described first, with reference to Figs. 4 and 5. This mechanism comprises a first rotatable carrier 15 in the form of a turntable having a plurality of groups of capsule-receiving apertures 16 arranged at intervals in the margin thereof. In the embodiments shown in the drawing there are four apertures in each group and there are twenty four groups but the number of groups and apertures in a group may be varied if desired. Each of the apertures extends through the carrier 15, the lower part 17 of each aperture being of reduced dimensions so as to form an annular shoulder 18.

The carrier 15 is disposed horizontally and is rotatable about a vertical axis 19.

A second rotatable carrier 20, also in the form of a turntable, is located adjacent and partly below the first carrier 15, the second carrier also being rotatable about a vertical axis 21 parallel with the axis 19. A series of circular openings 22, (six in the present embodiment), are provided in the carrier 20 at spaced intervals in the margin thereof and each opening 22 accommodates a disc 23 which is rotatable in its associated opening relative to the carrier 20.

Each disc has four apertures 24 formed therein, that is the same number of apertures as are provided in each group in carrier 15, and each of the apertures 24 is adapted to receive the lower half (the charge-receiving part) of a capsule.

A cam 25 is located below the carrier 20 but is not rotatable therewith. Cam followers 26 are provided on and below each disc, each cam follower having two oppositely disposed concave surfaces 27, 28 for co-operating with cam 25 and two oppositely disposed pins 29, 30 for co-operating with a cam 31 which is bolted to the cam 25.

A pillar 32 supports a cantilever arm 33. The free end of this arm supports a filling and vacuum head (to be described in detail with reference to Figs. 6 to 8) in a position for filling the charge-receiving parts of the capsules on their arrival at a filling station FS.

The capsule handling mechanism operates as follows:

The first and second carriers 15 and 20 are stepped clockwise in synchronism. Capsules are placed in the capsule-receiving apertures 16 of the first carrier by means known per se, at a station upstream of a capsule opening station OS (Fig. 4) where the groups of capsule-receiving apertures first arrive over carrier 20, in register with a group of apertures 24 in one of the discs 23. In the interval between the stepping movements of the carriers, vacuum means, known per se, are applied below the apertures 24 at station OS to draw the charge-receiving parts of the capsules at that station into the apertures 24 in the underlying disc 23. The upper halves (closure parts) of the capsules are retained in apertures 16 by virtue of the shoulders 18.

The two carriers are then moved clockwise through a further step so that the next group of capsules in carrier 15 moves over carrier 20 and into registration with the apertures in the next disc 23 in carrier 20, at station OS.

As can be seen from Fig. 4 two clockwise steps of the carrier will bring a group of charge-receiving capsule parts from the station OS where they are transferred to carrier 20, to the filling station FS. During movement of each disc 23, loaded with charge-receiving capsule parts, from station OS to the capsule filling station FS, such disc becomes turned about its axis through a certain angle relative to carrier 20. This turning is effected by co-operation between the cam 31 and the pins 29, 30 on the cam follower 26 which is associated with that disc. During the movement of the disc from station FS to a capsule closing station CS one of the concave surfaces 27, 28 of the cam follower 26 rides on an edge portion of cam 25 which is concentric with carrier 20 so that the orientation of the disc relative to the second carrier 20 remains unchanged during that movement. The arrival of a group of charged capsule parts at the capsule closing station CS coincides with the delivery of their closure parts at that station, by carrier 15. The purpose of the described turning movement of each disc 23 relative to carrier 20 is to ensure that when a group of charged capsule parts carried by the disc arrives at the capsule closing station CS each charged capsule part will be in register with the particular closure part from which it was separated at the capsule opening station. Moreover the two capsule parts will be in their original relative orientations about the capsule axis. The preservation of the capsule parts in their original pairs in the same relative orientation is of importance if there may be slight differences between the forms or dimensions of different capsules.

At the closing station CS, the two halves of each capsule are reunited by upward displacement of plungers (not shown) to cause the charged capsule parts to be pushed upwardly into mating relationship with their closure parts on the carrier 15.

Angular adjustment of the carriers 15 and 20 may be effected by pin and slot means 34, 35.

Further clockwise movement of the first carrier 15 brings the filled closed capsule to a station (not marked) where they are removed for packaging.

An inner series of groups of holes 36 may be provided in the carrier 15 at positions such that each such group moves into register with the apertures in a disc 23 after removal of the charged capsules therefrom so that such apertures can be cleaned by means of air-blasts or the like delivered via the said holes.

The loading of closed empty capsules onto the carrier 15 in correct orientation can be achieved automatically by loading mechanism known per se.

The capsule filling system will now be described with reference to Figs. 6 to 8.

An aperture 37 is present near the free end of the arm 33. This aperture accommodates the outlet end portion of a hopper 38 and a funnel block 39 in which there are four feedways 40 for the discrete material which descends from the hopper. The outlet end of the hopper is in threaded engagement with a surrounding plate 41 which is secured to the top face of the arm by bolts 42. The funnel block 39 is clamped between the outlet mouth of the hopper and a funnel supporting plate 43 which is secured to the bottom face of the arm by bolts 44. Sealing rings 45 are interposed between the plate 43 and the funnel block to form seals around the feedways in the block.

A bottom plate 46 is secured to plate 43 by screws 70 (Fig. 8). An end plate 47 is secured to one side edge face of the cantilever arm 33 by screws 48. The bottom plate locates sealing rings 49 for making sealing contact with the mouth of the charge-receiving parts of the capsules when they are raised at the capsule filling station FS (Fig. 4) as hereinbefore described. The sealing rings are secured e.g. glued, to a plate 50 (hereafter called the "intervening" plate) which is between the funnel supporting plate 43 and the bottom plate 46.

The plates 43 and 50 are made of stainless steel and they together define the delivery passages for the discrete solid material and associated air exhaust passages of the vacuum system. More specifically: the funnel supporting plate 43 has four parallel rectangular section grooves in its lower face and the mouths of the grooves are closed by the intervening plate 50 to form passages 51. These passages extend obliquely across the width of the cantilever arm 33 as appears from the under-plan view (Fig. 8). Four branch passageways 52, one to each of the passageways 51, extend vertically from those passageways 51 to the bottom face of the intervening plate 50 at locations within the areas surrounded by the sealing rings 49. Inclined delivery passages 53 extend through the two plates 43 and 50 for conducting discrete solid material from the feedways 40 in the funnel block 39 to positions also within the areas surrounded by the sealing rings 49.

The four delivery passages 53 are straight passages which are inclined at an acute angle to the horizontal. The vertical planes containing the longitudinal axes of the passages are at an angle to the planes of Figs. 6 and 7 and therefore neither of those figures represents their gradient which is shallower than appears in those figures.

The side edge face of cantilever arm 33 opposite the end plate 47 and the corresponding side edge faces of the plates 43 and 50 are shaped as shown in Fig. 7 to conform to the cylindrical surface of a vacuum head 54. This vacuum head is mounted for rotation about its horizontal axis. The vacuum head has a central blind bore 55. The end of the vacuum head through which the bore does not extend is connected to one end of a shaft 56 (Fig. 8) which is coupled to a rotary electric solenoid 57 which is also secured to the cantilever arm 33.

A vacuum pipe 58 from a vacuum source (not shown) projects through a bracket 59 on the cantilever arm 33. On a threaded end portion of this pipe 58 there is screwed a tubular end fitting 60 the bore of which is co-axial with the bore 55 in the vacuum head. The end fitting can be turned to adjust the size of an air gap between its free end and the adjacent end of the vacuum head and locked in position by a lock nut 61. The presence of the air gap avoids problems associated with relatively sliding surfaces.

There are four radial passages 62 in the vacuum head 54 which extend from the bore 55 to the peripheral surface of the head. The four passages 62 are located so that when the vacuum head occupies the position shown in Fig. 7 each of them registers with one of the air exhaust passages 51. The solenoid 57 operates periodically to oscillate the vacuum head 54 about its axis so that the vacuum passages 62 in the head move into and out of that position of registration with the passages 51. It will be noted that there is a small clearance between the vacuum head 54 on the one hand and the cantilever arm 33 and plates 43 and 50 on the other hand, which avoids sliding friction and surface wear.

The ends of the air exhaust passages 51 remote from the vacuum head communicate with holes 63 in the end plate 47. The holes 63 are accurately formed to obtain the correct aspirating force in the individual exhaust passages 51. But if desired such holes can be partially closed by tapered grub screws which can be turned to adjust such aspirating forces.

The energising circuit of the solenoid 57 contains a switching device actuation of which is synchronised by cams with the stepwise movements of the capsule carriers 15 and 20 so that the vacuum head 54 moves into the extreme position shown in Fig. 7 determined by a stop (not shown), immediately the charge-receiving capsule parts are in position against the sealing rings 49. The reverse movement of the vacuum head, which is anti-clockwise in the aspect of Fig. 7, takes place after an interval of time determined by an adjustable timer. The periphery of the vacuum head is shaped with a recess 64 so that this reverse movement of the vacuum head brings the exhaust passages 51 almost instantly into free communication with atmosphere. The said reverse movement is through about 25° and is terminated by a second stop (not shown). At the end of that movement the vacuum passages 62 in the vacuum head are still close to the arcuate side edge face of the cantilever arm 33 and there is only a very restricted communication between those passages 62 and atmosphere. The solenoid and associated components of the vacuum head control are of a conventional type and need no detailed description.

The following are examples of a dispensing method according to the invention, performed in a machine as described with reference to Figs. 4 to 8.

Example 1

The machine was used for filling gelatin capsules with a pharmaceutical powder 95% by weight of which passes through an 80 mesh per inch sieve. The powder had very free-flowing characteristics.

The inclined delivery passages 53 were cylindrical bores with a diameter of 1/16 inch and a length of ½ inch and they were inclined at 30° to the horizontal.

The machine was operated continuously over a period of 2 hours at a filling rate of 60 cycles per minute, corresponding with a filling rate of 240 capsules per minute.

The vacuum pipe 58 was connected to a vessel in which 2.5" water gauge vacuum was continuously maintained by means of a vacuum pump acting through a vacuum reservoir tank. The vacuum system was pre-set by trial and error to cause as nearly as possible 260 milligrams of the powder to be drawn into each capsule. The volume of such a dose of the powder is greater than the volume of one of the inclined delivery passages 53.

The powder was dispensed not only with a high degree of accuracy but also very cleanly. The amount of powder spilled at the filling station during the said period of operation of the machine was negligible.

The accuracy of filling over the two hour period (over 28000 capsules filled) was assessed by standard calculations known in the pharmaceutical industry and based on weight variation tests on periodic samples of filled capsules. The coefficient of variation was found to range from 2.142 to 0.932 and to average 1.354, which represents a very high dosage accuracy.

The same apparatus was also used for filling capsules at a similarly high rate with powder of 50 mesh 95% grain size. A coefficient of variation ranging from 1.46 to 0.85 and averaging 1.067 was achieved. This also represents a very high dosage accuracy.

Example 2

Example 1 was repeated with however the modification that the vacuum system was adjusted to cause a smaller quantity of the powder to be dispensed into capsules of the same size. In consequence the capsules were only partially filled. Following termination of the aspirating force and removal of each group of containers from the filling station the delivery passages 53 remained full of grains. The amount of material falling from the passages under gravity between filling operations was negligible.

1. Apparatus for use in dispensing discrete solid material into a container, comprising means for supporting an open-topped container, cover means adapted to make air-tight sealing contact with the mouth of such container, an air-exhaust passage and a material delivery passage extending through said cover means for communication with the interior of the container, and air-extraction means associated with said exhaust passage for establishing a reduced pressure in a said container, characterised in that at least part of the length of said delivery passage is so orientated relative to the vertical that there is no vertical flow path through such passage.

2. Apparatus according to claim 1, wherein at least a lower end portion of the length of said delivery passage is downwardly inclined at an acute angle to the horizontal.

3. Apparatus according to claim 2, wherein the said delivery passage is downwardly inclined at a constant acute angle to the horizontal over its entire length.

4. Apparatus according to claim 2 or 3, wherein said acute angle is less than 40°.

5. Apparatus according to any preceding claim, wherein said delivery passage has at all positions along its length a cross-sectional area of not more than .05 square inches.

6. Apparatus according to any preceding claim, wherein said delivery passage is between $\frac{1}{4}$" and 2" inches in length.

7. Apparatus according to any preceding claim, wherein said delivery passage is defined by solid material forming a cover for covering the mouth of a container to be filled, such passage extending between opposed faces of such cover.

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8. Apparatus according to claim 7, wherein a plurality of said material delivery passages and a plurality of associated air-exhaust passages extend through said cover at different regions thereof so that a plurality of containers can be simultaneously filled.

9. Apparatus according to claim 8, wherein two or more said air-exhaust passages are formed in part by a common channel in said cover and in part by branches from such channel.

10. Apparatus according to any preceding claim, wherein the air-extraction means include a suction head having at least one suction passage which is connectable to means for exerting suction forces, and wherein there is means for displacing said head through an operating cycle in which the or each said suction passage moves into and out of registration with the or a said air-exhaust passage extending through said cover means.

11. Apparatus according to claim 10, wherein said suction head is mounted for oscillatory movement about a fixed axis.

12. Apparatus according to claim 10 or 11, wherein there is a clearance between the said suction head and the adjacent end of the or each said air-exhaust passage.

13. A method of dispensing discrete solid material into a container by placing the container in sealed communication with a material delivery passage through which material can flow from a supply, and with an air exhaust passage, and aspirating air from the container via said exhaust passage to draw material into the container, characterised by the step of providing a said delivery passage into which material can freely descend from said supply but which follows such a spatial course and has such cross-sectional dimensions that following restoration of atmospheric pressure at the exit end of

said delivery passage it remains filled over at least part of its length by discrete solid material which has entered said passage and which is held thereby in static condition ready to be sucked into another container.

14. A method of dispensing discrete solid material into a container by placing the container in sealed communication with a material delivery passage through which material can flow from a supply, and with an air exhaust passage, and aspirating air from the container via said exhaust passage to draw material into the container, characterised in that use is made of a said delivery passage into which material can freely descend from said supply but which is non-vertical over at least part of its length, its spatial course and its cross-sectional dimensions being such that it remains filled or substantially filled with discrete material in static condition until said aspiration commences, and in that said aspiration of air is continued for a period of time sufficient to cause the material in the container to reach and close the exit end of said delivery passage, whereafter the container is removed thereby exposing the exit end of said passage to atmospheric pressure and leaving the passage filled or substantially filled with material all or substantially all of which the passage retains against discharge under gravity.

15. A method according to claim 13, wherein said aspiration of air takes place only for a period of time sufficient to cause partial filling of said container, the level of material in the container then being spaced below the exit end of said delivery passage.

16. A method according to any of claims 13 to 15, wherein the dispensed material is a pharmaceutical material and the container is a capsule.

17. A method according to any of claims 13 to 16, wherein the amount of material dispensed into the container is less than 1 gram.

18. A method according to any of claims 13 to 17, performed in apparatus according to any of claims 2 to 12.

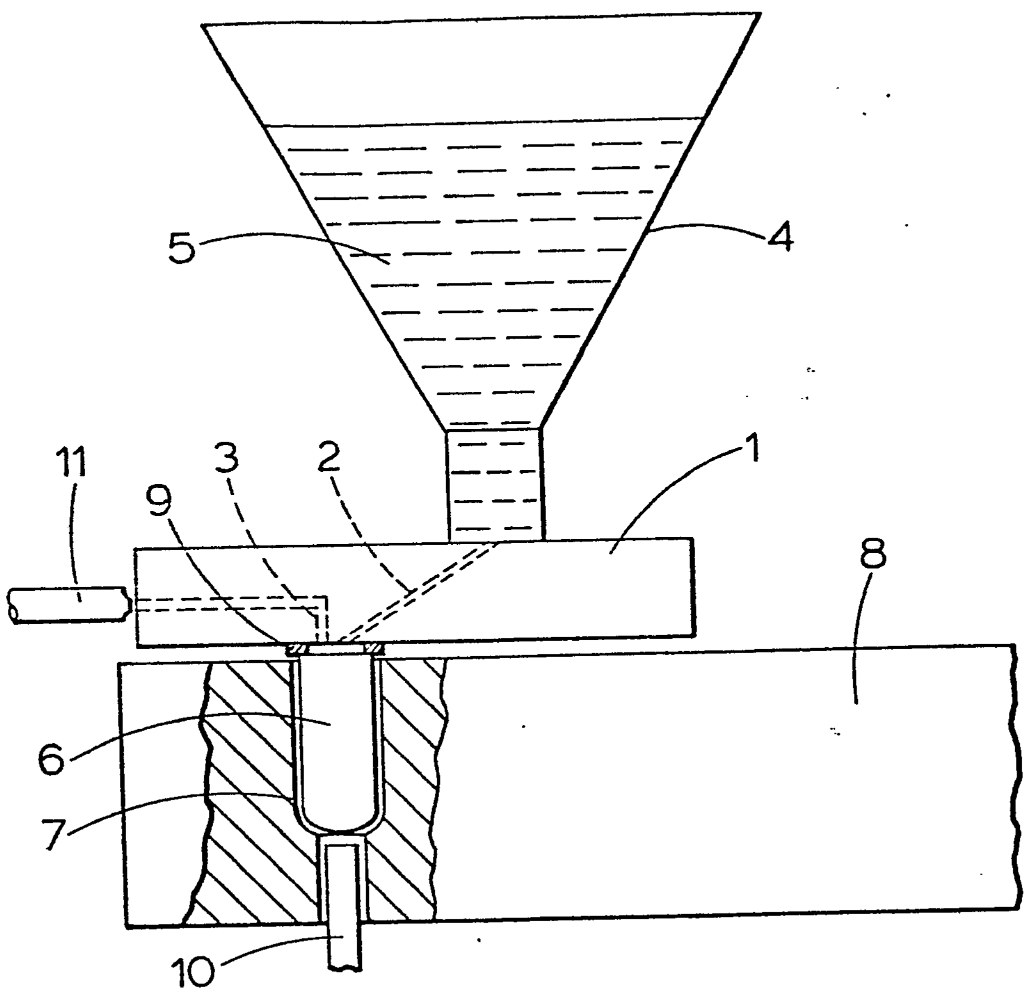

Fig.1

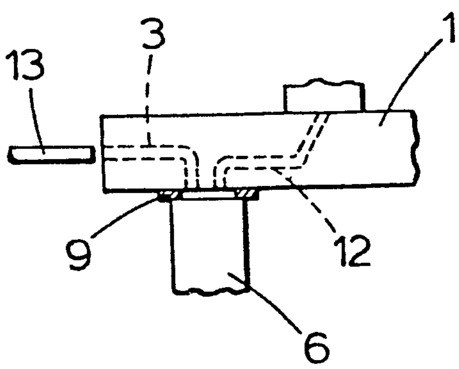

Fig.2

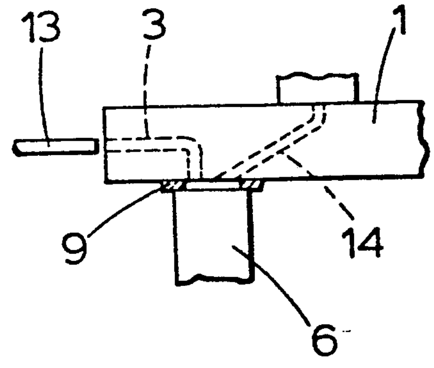

Fig.3

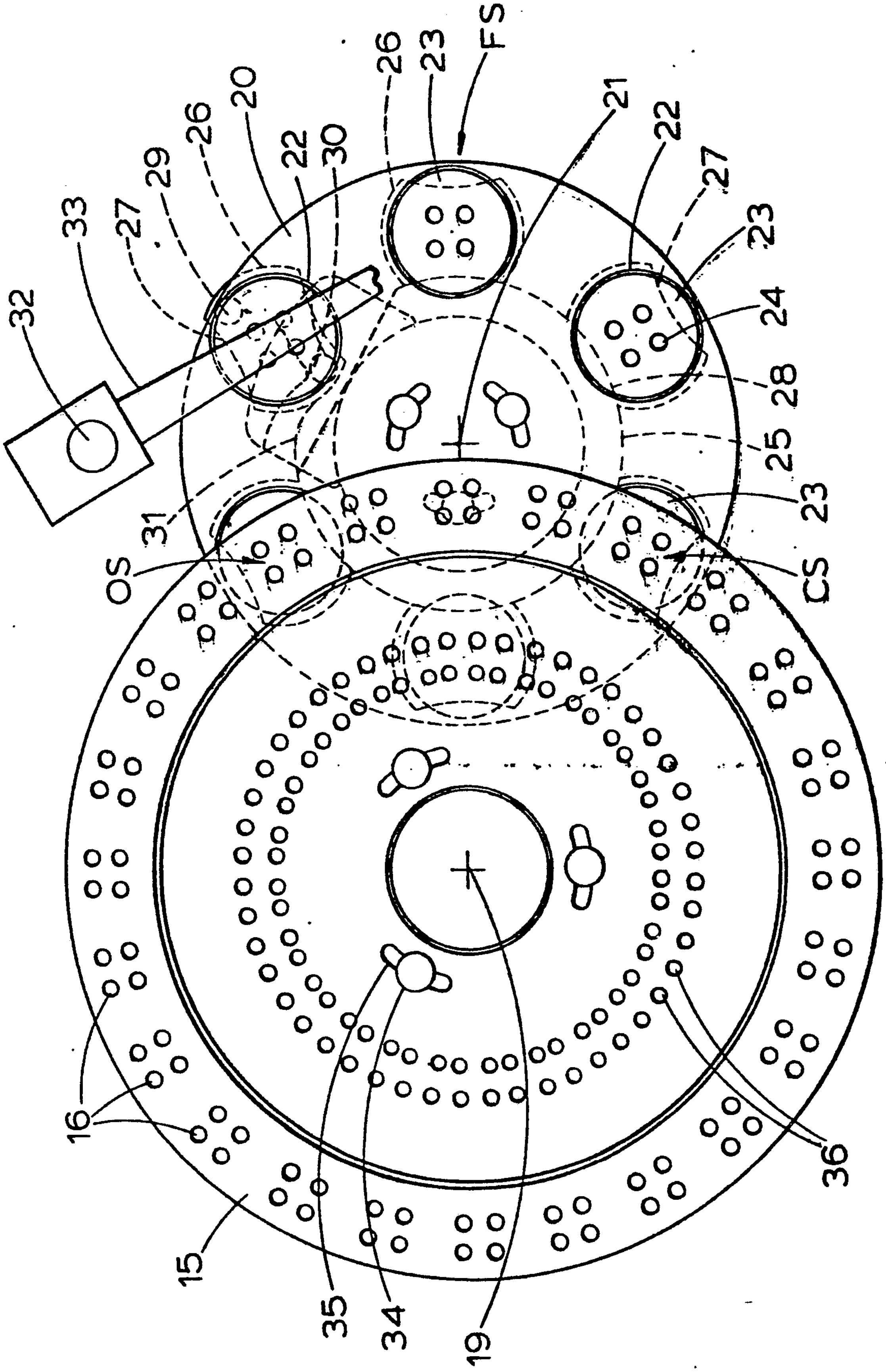
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Fig. 4

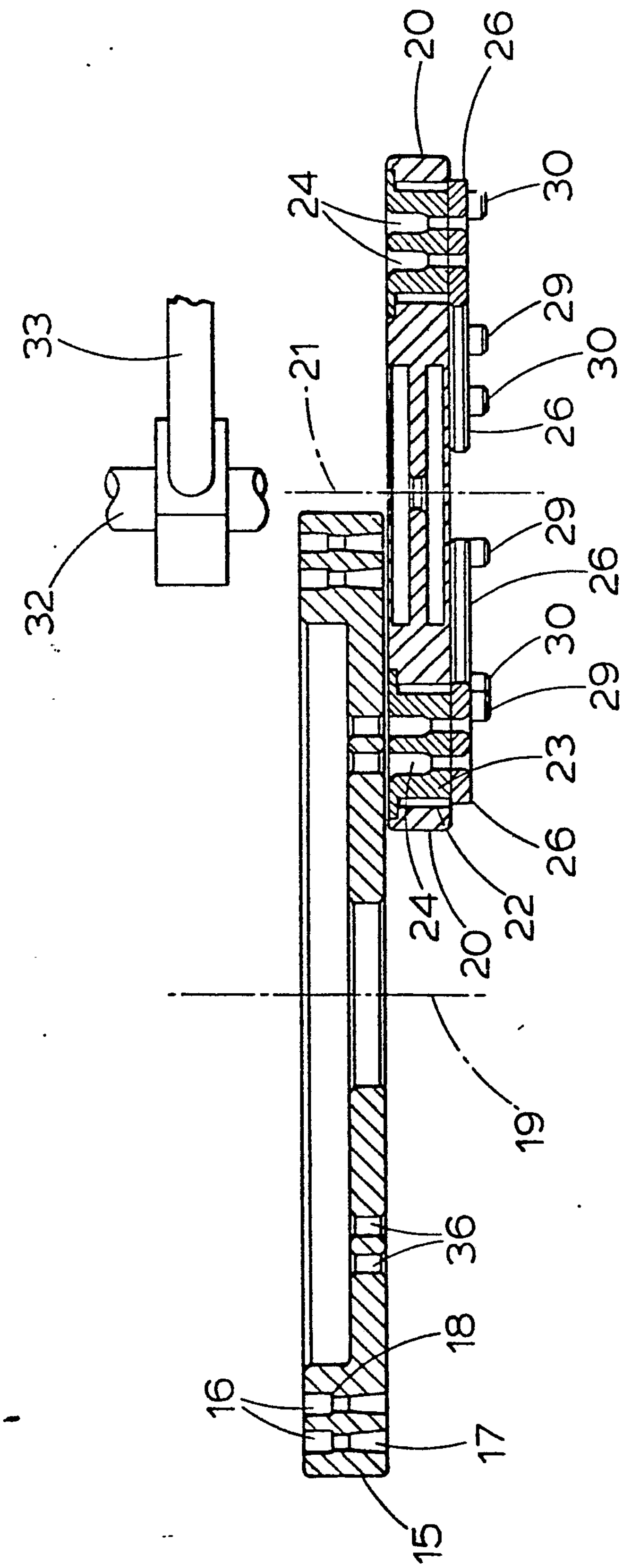

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Fig.5

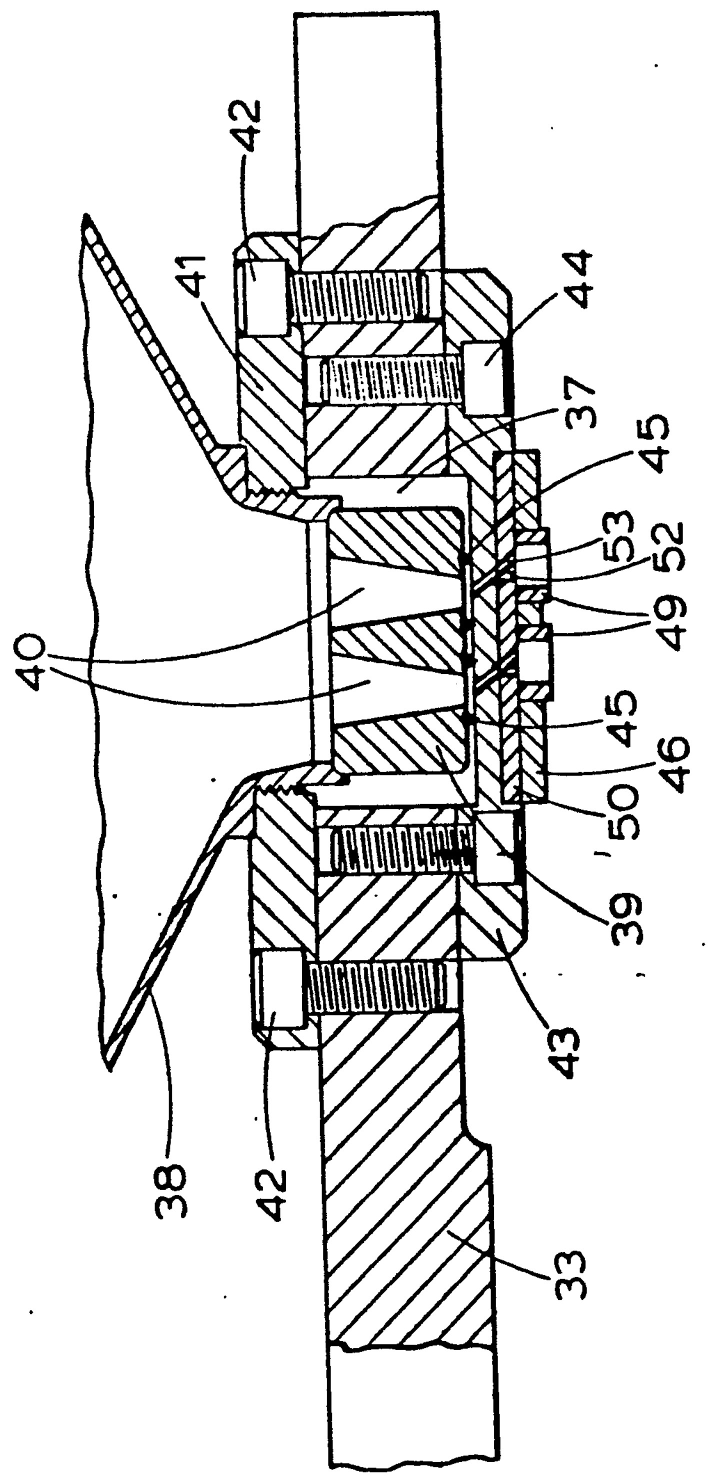

Fig.6

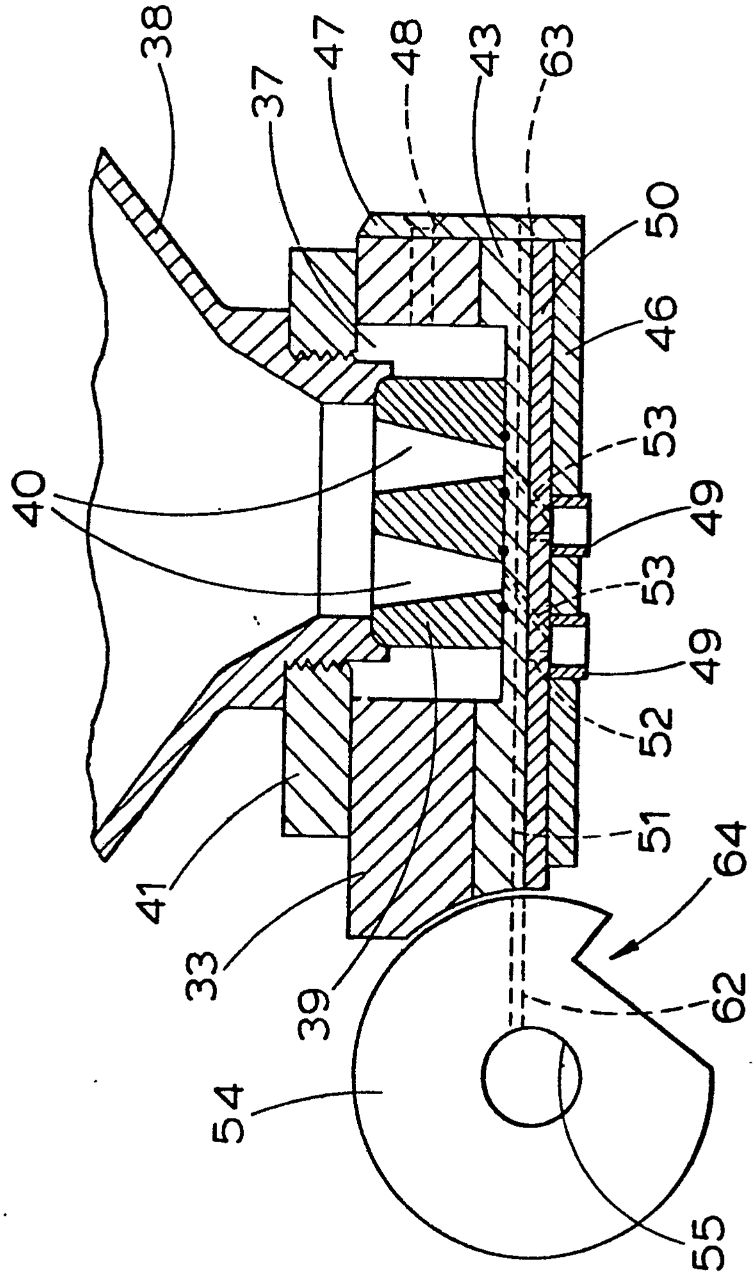

Fig. 7

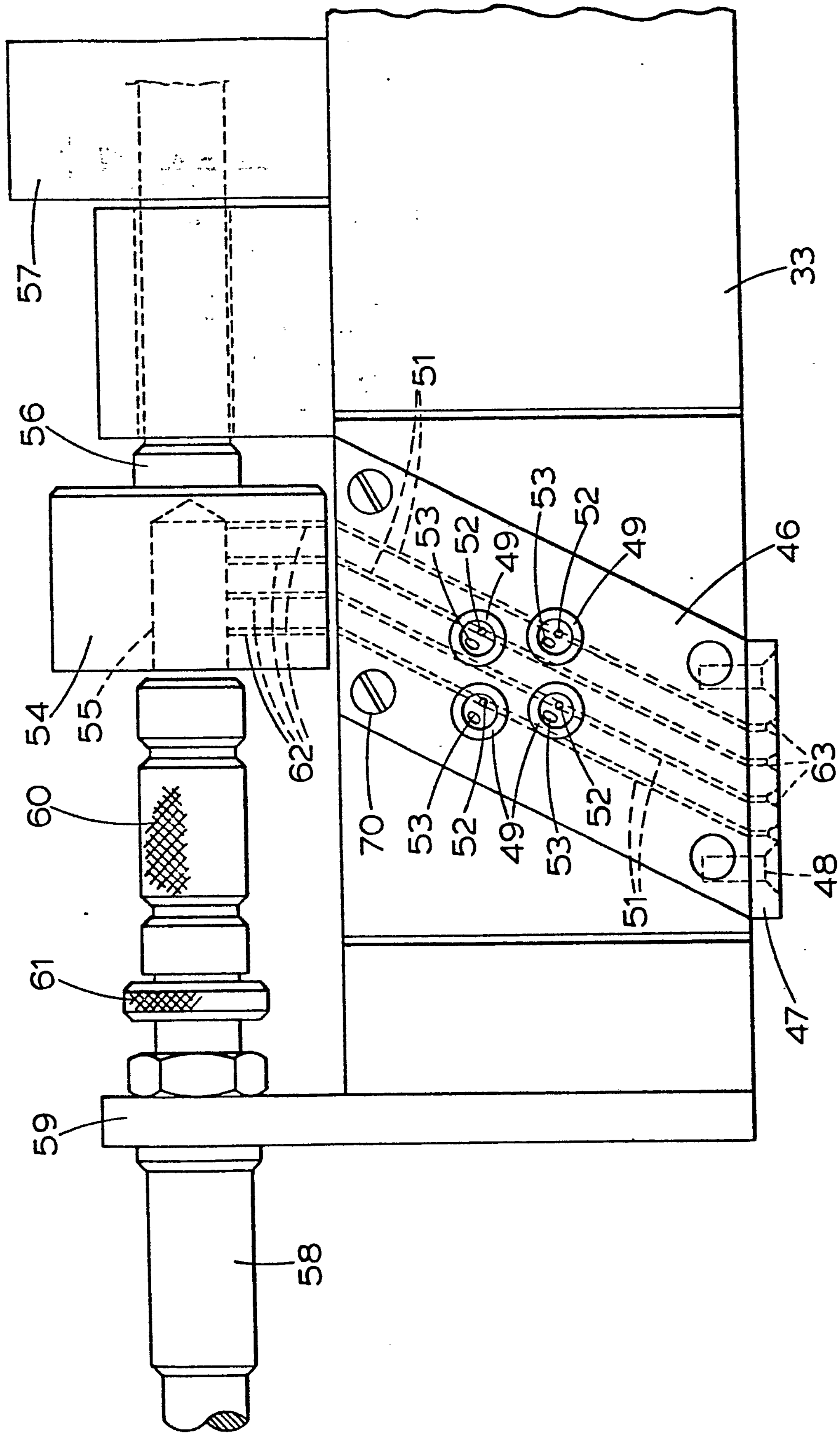

Fig. 8

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Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 79 30 2044

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
D,A	US - A - 3 693 672 (AVON PRODUCTS) * Column 2, line 5 - column 3, line 67; figures 1-3 * --	1
D,A	GB - A - 1 510 634 (ALBRO FILLERS) * Page 1, line 78 - page 3, line 62; figures 1-5 * ----	1

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

B 65 B 1/16
A 61 J 5/00

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

B 65 B
A 61 J
G 01 F

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11-01-1980	CLAEYS

EPO Form 1503.1 06.78