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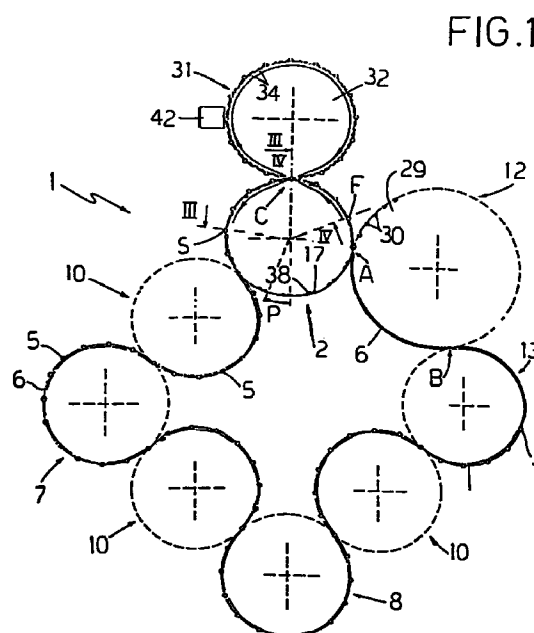
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(54) **Method and system for filling capsules with products, in particular pharmaceuticals products**

(57) The method includes a first step in which, at an orienting station (F), the capsules (3) are oriented vertically with the top shells (4) of the capsules (3) upwards; a second step in which the capsules (3) are fed successively to a detaching station (S) for detaching the top shells (4) from the bottom shells (5); a third step in which the bottom shells (5) are fed successively to a filling station (7, 8) to be filled with a predetermined quantity of at least one product; and an additional step, between the first step and the second step, in which the capsules (3), still closed, are fed successively to a checking station (31) for checking empty capsules (3).



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Description

The present invention relates to a method and system for filling capsules with products, in particular pharmaceutical products. More specifically, the present invention relates to a method and system for supplying, orienting and opening the empty capsules, filling the capsules with at least one pharmaceutical product, and then closing and expelling the capsules.

Modern pharmaceutical methods tend to reduce or eliminate the amount of excipient added to pharmaceutical products or mixtures, i.e. to the active drug in each dose, particularly those supplied in the form of capsules. As a result, the products must be metered in extremely accurate microdoses, which increases the risk of error in the amount of product metered into the capsule, due to variations in the weight of the empty capsules. Moreover, to prevent serious errors in the actual administration of drugs, it is essential to ensure each type of drug is metered into capsules of the prescribed colour. Finally, to reduce cost and product wastage, the empty capsules are best checked beforehand to ensure they are undamaged, i.e. with no dents or tears.

Various automatic capsule filling systems of the above type are known. In particular, US Patent N. 4.615.165 describes a method comprising a first step in which the system is supplied by a first machine with a number of closed capsules, each comprising a bottom shell and a removable top shell.

The above method also comprises a second step in which the capsules are first oriented vertically with the top shell upwards; the top shell is then detached from the bottom shell, which is deposited inside a seat on a conveyor travelling along the whole system; while the top shell is assigned to another conveyor.

The above method also comprises a third step in which each bottom shell is filled with a pharmaceutical product; and a fourth step in which the top shell of each capsule is deposited over and subsequently engages the corresponding bottom shell to close the capsule, which is then expelled onto a packing machine.

The above known method involves several drawbacks. In particular, as the supply and detachment steps are performed sequentially on the same machine, a check of the closed capsule, such as checking the condition and weight of the empty capsule, cannot be performed on or even downstream from the machine, by virtue of the capsule being fed off the machine already in two parts.

It is an object of the present invention to provide a highly straightforward, reliable capsule filling method and system, which provide for performing various checks of the closed empty capsule, and so eliminating the aforementioned drawbacks.

According to the present invention, there is provided a method of filling capsules with products, in particular pharmaceutical products, each capsule being

defined by a bottom shell and a removable top shell, and the method comprising a first step in which, at an orienting station, the capsules are oriented vertically with said top shell upwards; a second step in which the capsules are fed successively to a detaching station for detaching the top shells from the bottom shells; and a third step in which the bottom shells are fed successively to a filling station to be filled with a predetermined quantity of at least one product; characterized in that an additional step is performed between said first step and said second step, and in which the capsules, still closed, are fed successively to a checking station for checking empty capsules.

According to the present invention, there is also provided a system for filling capsules with products, in particular pharmaceutical products, each capsule being defined by a bottom shell and a removable top shell, the system comprising an orienting device for orienting the capsules vertically with said top shell upwards, and the capsules so oriented being fed to a detaching device for detaching said top shell; characterized by comprising at least one checking unit for checking empty capsules; and conveying means being provided for conveying said capsules, still closed, from said orienting device and through said checking unit to said detaching device.

A preferred non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a diagram of a system implementing the method according to the invention;

Figure 2 shows a block diagram of a capsule checking unit;

Figure 3 shows a larger-scale vertical section along line III-III in Figure 1;

Figure 4 shows a larger-scale partial section along line IV-IV in Figure 1 and in a different operating position;

Figure 5 shows a detail of the Figure 1 system;

Figure 6 shows the Figure 5 detail according to a variation of the invention.

Number 1 in Figure 1 indicates as a whole a system for filling capsules with pharmaceutical products and implementing the method according to the present invention. System 1 comprises a first machine 2 for supplying a number of capsules 3 (Figure 3), each defined by a top shell 4 and a bottom shell 5 detachable from each other. As explained in detail later on, machine 2 (Figure 1) also provides for orienting capsule 3 so that top shell 4 is upwards with respect to corresponding bottom shell 5, and also for opening capsule 3 by detaching top shell 4 from respective bottom shell 5.

System 1 comprises conveying means, in turn, comprising a conveyor defined by an endless belt 6, which is guided by a series of pulleys and conveys bottom shells 5 along a predetermined endless path in system 1 and indicated by the double continuous line in

Figure 1. System 1 also comprises a filling station where a second machine 7 meters at least a first pharmaceutical product into bottom shells 5 conveyed on belt 6; and at least a third machine 8 for possibly metering at least a second pharmaceutical product into the bottom shells. Each metering machine 7, 8 may also meter out mixtures of products in the form of powder or granules.

Each of machines 2, 7 and 8 is integral with a guide pulley of belt 6, of which Figures 3 and 4 show pulley 9 of machine 2. Two intermediate transmission units 10, each comprising a guide pulley of belt 6, are provided respectively between machines 2 and 7 and between machines 7 and 8; the pulleys of machines 2, 7 and 8 and of intermediate units 10 are integral with respective gears, of which Figure 3 shows gear 11 of machine 2, which rotates on a fixed base 15; and all the gears have the same diameter as the respective pulleys, and mesh with one another to ensure synchronous rotation of the guide pulleys of belt 6.

System 1 also comprises a further machine 12 for receiving top shells 4 from machine 2. Machine 12 also comprises a conveyor for conveying top shells 4 along another endless path, which is outwards of the path of belt 6 - the two paths being superimposed along a segment or portion A-B - and is tangent at a predetermined point to portion A-B, so that, as shown in detail later on, the conveyor of machine 12 aligns top shells 4 with the respective filled bottom shells 5 carried on belt 6.

System 1 also comprises a closing station where a further machine 13 replaces top shells 4 on bottom shells 5 to close capsules 3. Machine 13 also comprises a device (not shown) for expelling and supplying the closed capsules 3 to a packing machine. Finally, a third intermediate transmission unit 10 of belt 6 is provided between machines 8 and 13; and machines 12 and 13 and third intermediate unit 10 are integral with respective guide pulleys of belt 6 and with respective gears meshing with one another and with the gears of machines 2 and 8 to ensure synchronous rotation of the pulleys.

Machine 2 comprises a tub containing a given number of empty capsules 3 and having a number of vertical tubes 14 (Figure 3) spaced predetermined angular distances apart about a cylindrical surface coaxial with the tub; and the tub is integral with a distributor defined by a cylindrical body 16, rotating about a respective axis, and integral with pulley 9 and with gear 11. As the distributor rotates, vertical tubes 14 are moved axially back and forth to withdraw a given number of capsules 3 from the tub and transfer the capsules successively to machine 2 at an angular location F (Figure 1).

Cylindrical body 16 comprises a first number of seats 17, which are arranged with a spacing P, are even in number, e.g. sixteen, are aligned with vertical tubes 14 to receive empty capsules 3, and each have a hole 18 (Figure 3) connected to a suction circuit. Machine 2

also comprises an orienting device 19 for orienting capsules 3, and which operates at an orienting station at location F.

For each seat 17, device 19 comprises a number of blades, which, together with an appendix 20 of respective tube 14 and the suction along conduits 21, orient the capsule 3 to be fed into seat 17, as described in said US Patent N. 4.615.165, and so that top shell 4 faces upwards, i.e. over bottom shell 5.

Belt 6 comprises a number of parallel holes 22 perpendicular to the path of belt 6, and each having a bush 23 for housing a bottom shell 5; and machine 2 (see also Figure 1) also comprises a detaching device 24 (Figure 3) for detaching bottom shells 5 from top shells 4 at a detaching station \$ located between point C of a path portion C-A and the adjacent intermediate unit 10.

Device 24 comprises a disk 25 integral with body 16 and having a number of holes 26 with the same spacing as spacing P of seats 17; and disk 25 is located over a fixed annular conduit 27 having a suction outlet 28 connected to the suction circuit, so that, as will be seen later, the suction through outlet 28 detaches bottom shell 5 from top shell 4 as a bush 23 containing a capsule 3 passes over hole 26.

The conveyor of machine 12 for receiving top shells 4 comprises a further cylindrical body 29, which has a number of seats 30 for housing respective top shells 4, and is such as to align a given top shell 4 with the respective bottom shell 5 after a rotation of over 360°. In particular, the number of seats 30 differs by one unit with respect to the number or a multiple of the number of seats 17, e.g. with respect to twice the number of seats 17, so that seats 30 are odd in number (thirty-three in the example shown).

The spacing of seats 30 is half the spacing P of seats 17 of body 16, and the diameter of body 29 is such that the length of the path travelled by each top shell 4 in seat 30 equals the path travelled by the corresponding bottom shell 5 in bush 23 of belt 6, so that, as body 29 rotates clockwise, seat 30 with top shell 4 encounters no bush 23 at point B of portion A-B.

Conversely, as body 29 continues rotating clockwise, seat 30 of a given top shell 4, after one or more complete turns (one turn in the example shown), encounters at point B the bush 23 of belt 6 housing the corresponding bottom shell 5, so that machine 13 closes the already filled bottom shell 5 with the corresponding top shell 4, as described in said American patent.

According to an important aspect of the invention, system 1 comprises an additional station comprising an additional machine 31 for checking the closed empty capsules 3. Machine 31 comprises a check unit 42, described in detail later on; and a conveyor defined by a disk 32 (Figure 3) integral with a gear 33 rotating on a fixed base 40 and meshing with gear 11. The number of teeth of gear 33 differs by one with respect to the number or a multiple of the number of teeth of gear 11;

disk 32 comprises a number of seats 34, each for housing a still closed capsule 3; and each seat 34 has a conduit 35 communicating with a fixed annular channel 36 in turn having a suction outlet 37 connected to the suction circuit, so that the suction through outlet 35 retains capsules 3 in seats 34.

Disk 32 conveys capsules 3 along an endless path outwards of, and having a point C in contact with, the path of belt 6; the spacing of seats 34 equals a submultiple of spacing P of seats 17 of body 16; and disk 32 is of such a diameter as to contain a number of seats 34 differing by one with respect to a multiple of the number of seats 17. For example, in the example shown, body 16 has sixteen seats 17; the spacing of seats 34 is a quarter of spacing P of seats 17; and the multiple of seats 34 is also four, so that disk 32 is of such a diameter as to contain sixty-five seats 34, as shown schematically in Figure 5. In the Figure 6 variation, disk 32' is of such a diameter as to contain thirty-three seats 34 as opposed to sixty-five.

Cylindrical body 16 of machine 2 (Figure 1) also comprises a second number of seats 38 for empty capsules 3; and seats 38 are offset clockwise with respect to seats 17 by one spacing of seats 34, so that body 16 comprises a number of pairs of seats 17, 38. A disk 39 (Figure 3) is provided between cylindrical body 16 and pulley 9, and has a number of holes 41 corresponding with seats 38 in the second number, but not with seats 17. Seats 38 have no suction holes 18, and the diameter of holes 41 is such as to permit the passage of bottom shells 5 but not top shells 4.

System 1 operates as follows.

At location F, capsules 3, already oriented with top shells 4 upwards, are fed successively into seats 17 of body 16 and are arrested against disk 39 (Figure 3). As each seat 17 reaches point C, capsule 3 is transferred into the facing seat 34 of disk 32 by virtue of the suction along conduit 35, which is stronger than that of hole 18; and the empty capsule 3 is then conveyed clockwise along the circular path of seat 34 and past check unit 42.

After being checked by unit 42, capsule 3 continues along the same path back to point C, where it now encounters a seat 38 of the second number of seats of body 16; and the suction through suction outlet 28 (Figure 4), bush 23 and hole 41, which is stronger than along conduit 35 of seat 34, transfers capsule 3 from seat 34 of disk 32 into seat 38 of body 16. Disk 32 therefore provides for removing the closed capsules 3 off cylindrical body 16 at contact point C, feeding them through check unit 42 (Figure 1), and feeding them back onto body 16 at the same contact point.

As body 16 rotates, the checked capsule 3 is fed into hole 41 of disk 39; top shell 4, whose diameter prevents it from entering hole 41, remains inside seat 38; and, substantially at detachment point S (Figure 1) along the path of seat 38, the suction through hole 41 first detaches bottom shell 5 from top shell 4, and then

inserts bottom shell 5 inside bush 23 of belt 6 underneath.

Belt 6 feeds bottom shell 5 along the respective endless path through metering machines 7 and 8 up to point B. At the same time, the top shell is picked up by machine 12 and meets up with respective bottom shell 5 at point B for closure by machine 13.

System 1 therefore implements a method of filling capsules 3, which comprises a first step in which capsules 3 are oriented vertically at the orienting station at location F, so that top shells 4 are located over respective bottom shells 5; a second step in which capsules 3 are fed successively to detaching station S for detaching top shells 4 from bottom shells 5; a third step in which bottom shells 5 are fed successively through metering machines 7 and 8 and filled with a predetermined quantity of at least one product; and an additional step, between the first and second steps, in which capsules 3, still closed, are checked successively by machine 31 for checking empty capsules 3.

Control unit 42 comprises a number of checking devices 43-46 (Figure 2). Device 43, which is known, provides for checking the physical condition of closed capsules 3, to determine any defects such as tears, dents or similar, on the basis of form data stored in a memory 47, e.g. a read-only memory, controlled by a processing unit 48.

Device 44 provides for checking the colour of bottom shell 5 and top shell 4 on the basis of further data stored in memory 47. This is a very important check, in that each drug is normally assigned a particular pair of colours to prevent the wrong drug being administered to patients. If either one of the checks by devices 43 and 44 is negative, unit 48 activates a reject device 49 to expel the faulty or wrong capsule 3 from seat 34.

Device 45 provides for checking the weight of empty capsule 3, and is controlled by unit 48 to memorize the weight value in another, read-and-write, memory 51.

Finally, device 46, which is also known, provides for determining the presence of capsule 3 inside seat 34, and comprises a capacitive proximity sensor for supplying unit 48 with a no-capsule signal. On receiving a no-capsule signal, unit 48 enables a check routine whereby the sensor repeats the check a predetermined number of times, e.g. three, to confirm the no-capsule signal. And in the event the signal is confirmed, unit 48 activates a known purging device to clear the tube 14 (Figure 3) which should have supplied seat 17 corresponding to seat 34 without capsule 3.

The advantages, as compared with known technology, of the method and system according to the invention will be clear from the foregoing description. In particular, they provide for automatically making any check of empty capsules 3 with no time lost and with no possibility of error. Moreover, they prevent pharmaceutical products from being metered into faulty or wrong capsules 3, which would eventually have to be rejected.

And finally, the weight check of empty capsules 3 enables the pharmaceutical products or mixtures to be metered in precise microdoses, even in the event of no or only a small amount of excipient.

Clearly, changes may be made to the method and system as described herein without, however, departing from the scope of the accompanying Claims. For example, changes may be made to the number and type of stations or machines operating along the path of belt 6; distributor 16 and/or cylindrical body 29 may be defined by flexible belts as opposed to rigid bodies; and belt 6 may be replaced by a rigid disk.

Claims

1. A method of filling capsules with products, in particular pharmaceutical products, each capsule being defined by a bottom shell (5) and a removable top shell (4), and the method comprising a first step in which, at an orienting station (F), the capsules (3) are oriented vertically with said top shell (4) upwards; a second step in which said capsules (3) are fed successively to a detaching station (S) for detaching said top shells (4) from said bottom shells (5); and a third step in which said bottom shells (5) are fed successively to a filling station (7, 8) to be filled with a predetermined quantity of at least one product; characterized in that an additional step is performed between said first step and said second step, and in which said capsules (3), still closed, are checked successively at a checking station (31) for checking empty said capsules (3).
2. A method as claimed in Claim 1, characterized in that said additional step comprises an operation in which the oriented said capsules (3) are fed into a first number of seats (17) of a distributor (16); an operation in which said capsules (3) are transferred to a first conveyor (32) of said checking station (31); and an operation in which the checked said capsules (3) are fed back into a second number of seats (38) of said distributor (16).
3. A method as claimed in Claim 2, and comprising a step in which the filled said bottom shells (5) are fed successively to a closing station (13) for closing said bottom shells (5) with the corresponding said top shells (4); said bottom shells (5) being fed through said detaching, filling and closing stations (S, 7-8, 13) by a second conveyor (6) traveling along an endless path; characterized in that said first conveyor (32) travels along a corresponding endless path outwards of the path of said second conveyor (6); said paths having a point (C) of mutual contact.
4. A method as claimed in Claim 3, characterized in that said top shells (4) detached from said bottom shells (5) at said detaching step are transferred to a third conveyor (29) traveling along an endless third path also outwards of the path of said second conveyor (6); said third path having a portion (A-B) contacting the path of said second conveyor (6).
5. A method as claimed in one of the foregoing Claims, characterized in that said checking station (31) performs at least a condition check and/or a colour check of closed said capsules (3).
6. A method as claimed in Claim 5, characterized by comprising a reject operation for rejecting said capsules (3) on the basis of the outcome of said check, before the capsules are fed to said detaching station (S).
7. A method as claimed in Claim 5, characterized in that said checking station (31) also performs a check to determine the presence of said capsule (3); a purging operation for clearing supply of said capsules (3) being activated automatically in the event of repeated absence of a said capsule (3) in a given seat (34) of said first conveyor (32).
8. A method as claimed in Claim 6 or 7, characterized in that said checking station (31) also performs a weight check of said capsules (3).
9. A system for filling capsules with products, in particular pharmaceutical products, each capsule being defined by a bottom shell (5) and a removable top shell (4), the system comprising an orienting device (19) for orienting said capsules (3) vertically with said top shell (4) upwards, and said capsules (3) so oriented being fed to a detaching device (24) for detaching said top shell (4); characterized by comprising at least one checking unit (42) for checking empty said capsules (3); and conveying means (32, 6, 29) being provided for conveying said capsules (3), still closed, from said orienting device (19) and through said checking unit (42) to said detaching device (24).
10. A system as claimed in Claim 9, characterized in that said conveying means (32, 6, 29) comprise a first conveyor (32) for conveying said capsules (3) through said checking unit (42); a distributor (16) being provided with a first number of seats (17) for receiving and transferring said capsules (3) oriented by said orienting device (19) to said first conveyor (32); said distributor (16) having a second number of seats (38) for receiving and feeding the checked said capsules (3) from said first conveyor (32) to said detaching device (24).
11. A system as claimed in Claim 10, wherein said conveying means (32, 6, 29) also comprise a second

conveyor (6) travelling along an endless path to receive from said distributor (16) the bottom shells (5) detached by said detaching device (24), and to feed the bottom shells successively to at least one metering machine (7, 8) to be filled with a predetermined quantity of at least one product, and to a closing machine (13) for closing the filled bottom shells (5) with the respective top shells (4); characterized in that said first conveyor (32) travels along a corresponding endless path outwards of the path of said second conveyor (6); said distributor (16) feeding said first and second numbers of seats (17, 38) to a point of contact (C) of said two paths.

12. A system as claimed in Claim 11, characterized in that said distributor is defined by a cylindrical body (16) having an outer edge carrying said first and second numbers of seats (17, 38); said second conveyor being defined by a flexible member (6) guided by a number of pulleys (9) rotating synchronously with one another; one of said pulleys (9) being integral with said cylindrical body (16); the seats (17, 38) in each of said first and second numbers being spaced angularly with a predetermined spacing; and the seats in one number forming with the seats in the other number a number of pairs of seats (17, 38) offset by a fraction of said spacing.
13. A system as claimed in Claim 12, characterized in that said first conveyor is defined by a disk (32) rotating synchronously with said cylindrical body (16); gear means (11, 33) being provided between said cylindrical body (16) and said disk (32), and being such that, following a 360° rotation of said disk (32), a capsule (3) received from one seat (17) in each pair of seats (17, 38) is aligned with the other seat (38) in said pair.
14. A system as claimed in Claim 13, characterized in that said gear means comprise a pair of gears (11, 33) having parallel axes and respectively integral with said cylindrical body (16) and said disk (32); the gear (11) integral with said cylindrical body (16) having an even number of teeth; and the gear (33) integral with said disk (32) having a number of teeth differing by one with respect to the number or a multiple of the number of teeth of said gear (11) integral with said cylindrical body (16).
15. A system as claimed in one of the foregoing Claims from 9 to 14, characterized in that the top shells (4) detached from the bottom shells (5) by said detaching device (24) are transferred to a third conveyor (12) travelling along an endless third path also outwards of, and having a portion (A-B) contacting, the path of said second conveyor (6); said third path being of a length equal to the path of said second conveyor; said third conveyor (12) being defined by

a further cylindrical body (29) of such a diameter as to align a given top shell (4) with a corresponding bottom shell (5) following a rotation of over 360° of said further cylindrical body (29).

16. A system as claimed in one of the foregoing Claims from 9 to 15, characterized in that said checking unit (42) comprises at least one device (43) for checking the physical condition of the closed capsules (3), and/or a device (44) for checking the colour of the bottom shell (5) and the top shell (4) of each closed capsule (3).
17. A system as claimed in Claim 16, characterized by comprising a device for rejecting the capsules (3), on the basis of the outcome of the checks performed by said devices (43, 44), before the capsules are fed to said detaching device (24).
18. A system as claimed in Claim 16 or 17, characterized in that said checking unit (42) comprises a device (45) for checking the weight of said capsules (3).
19. A system as claimed in Claim 10 and one of the foregoing Claims from 16 to 18, characterized in that said checking unit (42) also comprises a device (46) for determining the presence of a capsule (3); and a purging device (52) for purging a number of supply elements (14) associated with the seats (34) of said first conveyor (32); said purging device (52) being controlled by a processing unit (48) for automatically determining the repeated absence of a capsule (3) in a given seat (34) of said first conveyor.

FIG.1

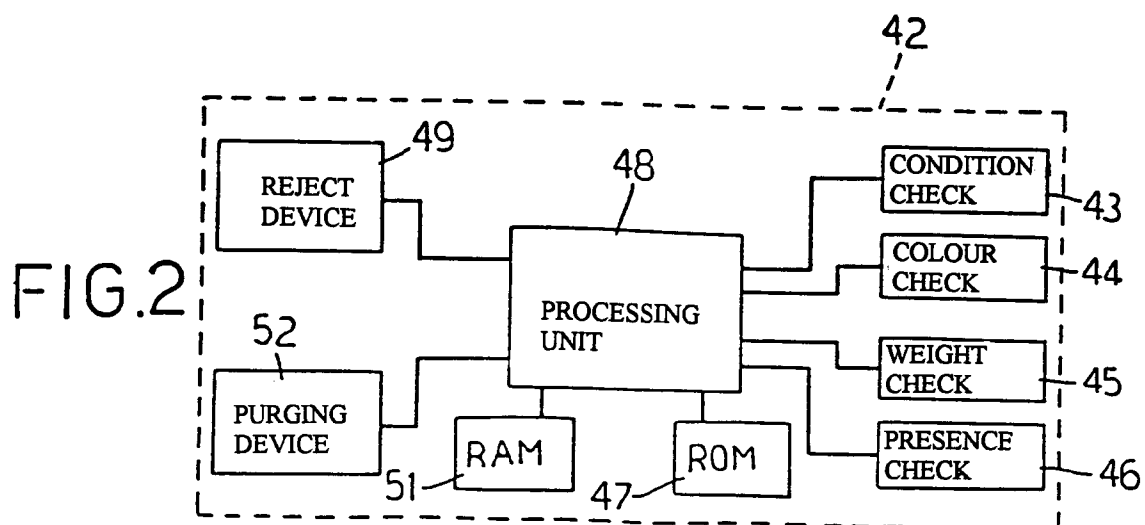
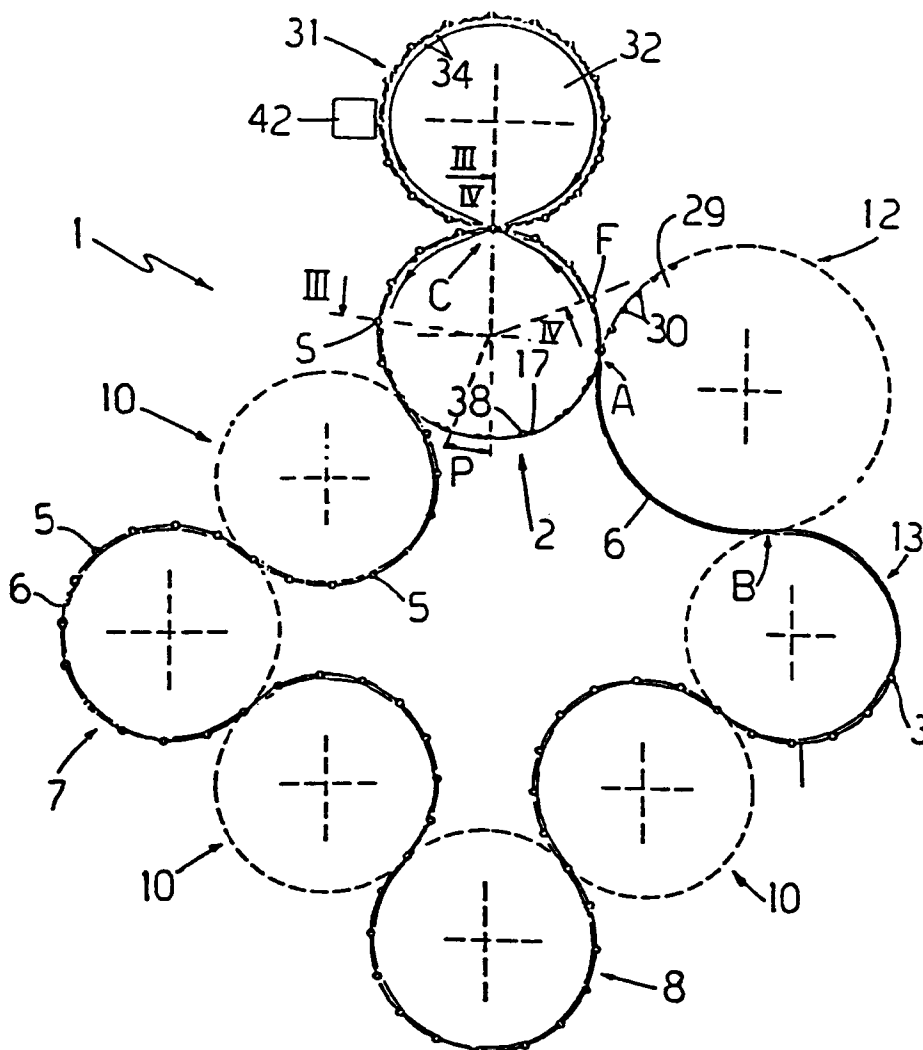


FIG.3

