(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 February 2014 (27.02.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/029753 A1

(51) International Patent Classification:
G01N 3/08 (2006.01) *G01N 35/04* (2006.01)

(21) International Application Number:
PCT/EP2013/067274

(22) International Filing Date:
20 August 2013 (20.08.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12181254.9 21 August 2012 (21.08.2012) EP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: APPARATUS AND METHOD FOR HANDLING LIQUID CONTAINING, SUBSTANTIALLY SPHERICAL OBJECTS

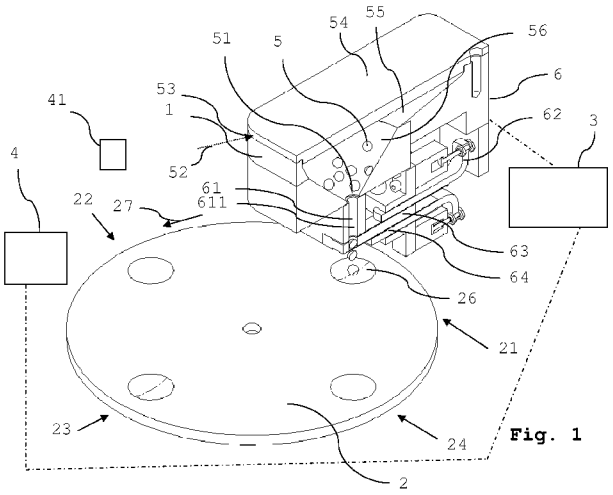


Fig. 1

(57) Abstract: The apparatus for handling liquid containing, substantially spherical objects comprises a reservoir for receiving a plurality of liquid containing, substantially spherical objects. The apparatus further comprises a sample plate for receiving a liquid containing, substantially spherical object from the reservoir. The sample plate comprises a seat adapted to receive a liquid containing, substantially spherical object, wherein the sample plate is adapted to be movable such that the seat for the liquid containing, substantially spherical object can be positioned in each of a loading position, an analysing position and an unloading position. A drive is provided for moving the seat for the liquid containing, substantially spherical object into a loading position, an analysing position and an unloading position. A control unit is provided for entering analysing parameters, and a communication port is provided for an interchange of the analysing parameters with an analysing unit.

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Apparatus and Method for Handling Liquid Containing, Substantially Spherical Objects

The present invention relates to an apparatus and method for the handling of liquid containing, substantially spherical objects.

Such liquid containing, substantially spherical objects are for example rupturable capsules with liquid content used in smoking article filters. Capsules for the use in smoking articles are known in the art. For example, European patent application EP-A-1906775 discloses a capsule with a certain crush strength prior and after use of the smoking article. For quality assurance purposes, the initial crush strength of the capsule is measured before smoking, by continuously applying a load vertically onto one particle until rupture. The force gauge is attached to a stand; the capsule is positioned in the middle of a plate that is moved up with a manual thread screw device. Pressure is then applied manually and the gauge records the maximum force applied at the very moment of the rupture of the capsule, (measured in Kg or in Lb). Rupture of the capsule results in the release of the core.

However, such a measurement of the crush force is slow, in particular in the light of high speed cigarette production where more than 10'000 cigarettes are produced per minute on a single machine.

It is thus desirable, to facilitate the quality assurance in the production of smoking articles with rupturable capsules. It is an objective of the present invention to provide an apparatus and method to facilitate the quality assurance in the production of smoking articles. It is a further objective to allow a high degree of repeatability of the quality assurance. It is a further objective of the invention to increase the analysing speed of a dynamometer used in the analysis of liquid containing, substantially spherical objects.

According to a first aspect of the present invention, there is provided an apparatus for handling liquid containing, substantially spherical objects, the apparatus comprising a reservoir for receiving a plurality of liquid containing, substantially spherical objects and a sample plate for receiving a liquid containing, substantially spherical object from the reservoir. The sample plate comprises a seat adapted to receive a liquid containing, substantially spherical object. The sample plate is adapted to be movable such that the seat adapted to receive the liquid containing, substantially

spherical object can be positioned in a loading position, an analysing position and an unloading position. According to the invention, the apparatus further comprises a drive for moving the seat adapted to receive the liquid containing, substantially spherical object into each of a loading position, an analysing position and an unloading position. Further, the apparatus comprises a control unit for entering analysing parameters and a communication port for an interchange of the analysing parameters with an analysing unit.

The apparatus according to the invention enables an increase in the automatisation of an analyzing process of liquid containing, substantially spherical objects, preferably of deformable liquid containing, substantially spherical objects such as capsules or beads. Further, random and manual errors may be avoided. Also analysing results are available faster than with a manually operated analysing process. By this, for example a batch of liquid containing, substantially spherical objects may be cleared more quickly for production. Alternatively, the number of liquid containing, substantially spherical objects to be analysed may be increased, for example to increase the robustness of the results of the analysing process.

By providing a reservoir, a plurality of liquid containing, substantially spherical objects that shall - all or only some - be analysed may be provided. The seat on the sample plate receives a liquid containing, substantially spherical object from the reservoir at a loading position and transports the substantially spherical object from the loading position to an analysing position. Such a transport is preferably performed by moving the sample plate. The loading of the liquid containing, substantially spherical object onto the sample plate takes place at a different location than the analysis of the deformable object, thus allowing a simultaneous loading and analysis of substantially spherical objects. This increases the velocity of a supply of liquid containing, substantially spherical object transferred to the sample plate and transported from the loading position to the analysing position. Therefore, the overall performance (throughput) of the analysing process may be increased. Preferably, the reservoir or at least an outlet opening of the reservoir is arranged above the sample plate, such that a liquid containing, substantially spherical object may fall by gravitational force into the seat in the sample plate arranged in the loading position. Preferably, an outlet opening of the reservoir is arranged directly above a seat such that the substantially spherical object may fall vertically into the seat. By this, lateral

forces acting on the liquid containing, substantially spherical object upon the loading process may be avoided and the risk of a substantially spherical object leaving the seat may be minimized.

Analysing parameters may be entered into a control unit before the analysing process is started. Such analysing parameters are for example a predetermined number of liquid containing, substantially spherical objects to be analysed. Such a number may be less than or equal to the plurality of substantially spherical objects provided in the reservoir. However, such an entered or selected number of substantially spherical objects to be analysed may also exceed a filling capacity of the reservoir. If this is the case, preferably an indicator is provided for indicating that a refilling of the reservoir is required. Further analysing parameters may depend on the nature of the analysis that is to be performed. If for example a breaking force or deformation behaviour of the liquid containing, substantially spherical object is to be analysed, an analysing parameter may be the maximum force or an increase in force per time unit the substantially spherical objects shall be subjected to. The analysing parameters are interchanged for example with a dynamometer by a communication port. After analysis of the liquid containing, substantially spherical object, preferably analysing results are communicable from the analysing unit via the communication port to the control unit. Such analysing results may be displayed or stored or both in the control unit. Thereby, the control unit also facilitates the compilation of analysing results, especially if a number of several tenths to a hundred of liquid containing, substantially spherical objects are analysed in one analysing process. Thus, the analysis of an entire batch of substantially spherical objects can be reduced to filling the substantially spherical objects into the reservoir and then introducing the analysing parameters once for the entire batch. Thus, a large amount of operator's time can be freed up, as a time consuming manual placement of the liquid containing, substantially spherical object into the analysing equipment becomes unnecessary.

The term "substantially spherical objects" as used in the present invention denotes objects that have a substantially spherical geometrical shape with well-defined boundaries, in contrast to liquids or gases. By way of example, liquid containing, substantially spherical objects include objects having a shell made of a solid substance enclosing a liquid or gaseous core, objects like gelatin capsules having well-defined boundaries and matrix materials that do not have a shell and core

structure but that have releasable substances within their matrix structure that can be released upon the application of pressure or heat. For the avoidance of doubt, the liquid containing, substantially spherical object according to the invention may be elastic, deformable and crushable if a sufficiently high force is applied. Preferably, the substantially liquid containing, spherical object has a diameter of between about 0.2 mm and about 6.5 mm; more preferably, the substantially spherical object has a diameter of between about 2.0 mm and about 4.5 mm. Preferably, the substantially spherical object is a capsule. Preferably, the capsule comprises a liquid. Preferably, the liquid is flavorant, for example, menthol. Preferably, the capsule is crushable, that is, the capsule can release its content when a sufficient crushing strength is applied that ruptures the capsule's shell. With like objects, it is particularly important to handle the objects carefully as not to release the liquid within the capsules unwantedly. Preferably, the liquid containing, substantially spherical objects are capsules for being introduced into smoking articles, such as cigarettes.

The term "dynamometer" is used in the present invention for an apparatus capable to exert a certain compression force upon a liquid containing, substantially spherical object. Preferably, a dynamometer is capable of measuring the force that is exerted upon the liquid containing, substantially spherical object. Preferably, the force exerted upon the substantially spherical object is reproducible for a plurality of substantially spherical objects. Preferably, the dynamometer is used to measure a breaking force or crushing force of the liquid containing, substantially spherical object or to determine a deformation behavior of the liquid containing, substantially spherical object. A dynamometer suitable for use in the analysing process of the present invention is the INSTRON 3365 available from ITW Test and Measurement S.r.l, Italy.

According to an aspect of the apparatus according to the invention, the sample plate comprises a seat adapted to receive the liquid containing, substantially spherical object. The substantially spherical object is kept in position on the sample plate, namely in the seat. The liquid containing, substantially spherical object is held in the seat while the object is being transported to an analysing position and also to further positions, such as for example an unloading position or a waiting position. Preferably, a seat for a liquid containing, substantially spherical object is a sample pit. The sample pit may be for example an indentation or a throughbore in the sample plate. Preferably, a sample pit is of a circular, spherical, conical, cylindrical or similar shape

such that the substantially spherical object is biased to stay in the sample pit and preferably in the center of the sample pit. This has the advantage that a substantially spherical object will self-center in the pit, thus facilitating the positioning of the substantially spherical object in relation to the analysing unit. A seat adapted to receive a substantially spherical object may also be an adhesive spot on the sample plate or any other means suitable for capturing a liquid containing, substantially spherical object on the sample plate and for securely holding the substantially spherical object on the sample plate during transfer between positions. When an adhesive spot is provided on the sample plate, a liquid containing, substantially spherical object is preferably removably adhered to the sample plate by means of the adhesive spot. This may for example be a low tack adhesive provided on the surface of the sample plate.

Preferably, a sample plate is provided with a plurality of seats adapted to receive liquid containing, substantially spherical objects and thus providing a plurality of positions on the sample plate where an object may be temporarily held in said position also when being transported from one location to another. Hence, upon movement of the sample plate, for example by rotation or by a linear movement of the sample plate, an empty seat follows a loaded seat. By providing a plurality of seats in the sample plate, several process steps may be performed simultaneously. For example a loading of the sample plate with a liquid containing, substantially spherical object may be performed, while another liquid containing, substantially spherical object is analysed in the analysing position and yet a further liquid containing, substantially spherical object - already analysed - is being discharged from the sample plate. Due to this possible parallel processing, required time of the analysing process can be advantageously further reduced.

According to another aspect of the apparatus according to the invention, the reservoir comprises a conical shape with diminishing dimensions in a direction of an outlet of the reservoir. At the same time, the open side of the funnel allows an easy refilling of the reservoir.

Advantageously, the gravitational force urges the liquid containing, substantially spherical objects contained in the reservoir into a downward direction to the outlet of the reservoir. The outlet is advantageously arranged in the bottom region of the reservoir, preferably in the bottom of the reservoir. A reservoir comprising a

conical shape gives the liquid containing, substantially spherical objects contained in the reservoir an additional continuous flow direction to the center of the conical shape of the reservoir.

The dimensions of the outlet of the reservoir are preferably adapted to dimensions of the liquid containing, substantially spherical object. The reservoir comprises a certain volume for receiving a plurality of liquid containing, substantially spherical objects but may comprise an outlet dimensioned for the passage of only few or only a single liquid containing, substantially spherical object. Preferably, the outlet of the reservoir has a dimension large enough for a single substantially spherical object to fit through the outlet of the reservoir but small enough such as to prevent two liquid containing, substantially spherical objects to pass through the outlet at the same time.

According to yet another aspect of the apparatus according to the invention, the apparatus further comprises a dosing unit arranged underneath an outlet of the reservoir for a transferring of a single liquid containing, substantially spherical object onto the sample plate.

A dosing unit arranged underneath the outlet of the reservoir may ensure that exactly one liquid containing, substantially spherical object is transferred from the reservoir onto a sample plate. The presence of more than one substantially spherical object on the sample plate in the loading position could falsify the results of a subsequent analysis of the substantially spherical object. It might also lead to the loss of a liquid containing, substantially spherical object, which could also alter an analysing process, possibly of a whole series of substantially spherical objects to be analysed.

According to some embodiments of the apparatus according to the invention, the dosing unit comprises a dosing chamber for receiving the single liquid containing, substantially spherical object, and comprises a first and a second valve, the first valve for closing and opening an inlet of the dosing chamber and the second valve for closing and opening an outlet of the dosing chamber.

With a first valve in an open position and a second valve in a closed position, a single liquid containing, substantially spherical object may enter the dosing chamber and is kept in the dosing chamber. By closing the first valve thereby closing the inlet of the dosing chamber, any subsequent liquid containing, substantially spherical object

provided by the reservoir is kept out of the dosing chamber, preferably back in the reservoir or in a connection channel between reservoir and dosing chamber. By opening the second valve and thereby opening the outlet of the dosing chamber, the single liquid containing, substantially spherical object is released from the dosing chamber. The single liquid containing, substantially spherical object may be transferred, preferably by gravitational force, onto the sample plate and preferably into a sample pit provided in the sample plate. A presence of a sample pit in the loading position and an opening of the outlet of the dosing chamber is preferably synchronized and controlled such that an opening of the outlet of the dosing chamber is not performed but when a sample pit or another seat for a liquid containing, substantially spherical object is in the loading position.

By such a clearly defined separation of one substantially spherical object from any subsequent substantially spherical objects also a shearing between substantially spherical objects during a transfer movement of the substantially spherical objects from the reservoir to the sample plate may be minimized or prevented. This is advantageous as otherwise a shearing between liquid containing, substantially spherical objects may lead to undesired damage of the substantially spherical objects.

According to a further aspect of the apparatus according to the invention, the reservoir further comprises a cover for covering an inlet of the reservoir. The cover for covering an inlet of the reservoir prevents liquid containing, substantially spherical objects from falling out of the reservoir and at the same time prevents unwanted objects from falling into the reservoir. Preferably, the reservoir further comprises an agitator for agitating the plurality of liquid containing, substantially spherical objects, such as capsules contained in the reservoir. An agitator may advantageously unblock a random jam in the reservoir and thus ensure a continuous supply of liquid containing, substantially spherical objects. An agitator may be a gas, preferably compressed air, which is blown into the reservoir through a gas inlet. The gas inlet may be arranged in the reservoir or in the cover, respectively. An agitator may also be a vibrator or shaker or any other kind of agitator suitable for the purpose of keeping the liquid containing, substantially spherical objects in the reservoir in motion. Depending on the kind of agitator used, a cover for covering the inlet of the reservoir may be omitted.

According to yet a further aspect of the apparatus according to the invention, the apparatus further comprises a safety sensor for detection of an undesirable occurrence during the analysing process of the liquid containing, substantially spherical object, and for interruption of the analysing process upon detection of such an undesirable occurrence.

According to a further aspect of the apparatus according to the invention, a gas nozzle for providing a gas jet is arranged in an unloading position for discharging the liquid containing, substantially spherical object from the sample plate when the liquid containing, substantially spherical object is in the unloading position. After analysing a liquid containing, substantially spherical object in the analysing position the substantially spherical object is then preferably transported to an unloading position different from the analysing position. A discharging of the liquid containing, substantially spherical object is advantageously performed by application of a gas jet, for example originating from a compressed air source. By this, the substantially spherical object is removed from the sample plate and - if provided – from the seat, for example out of a sample pit. In addition, the gas jet may be adapted to remove the previous content of a capsule that may have spilled out of the capsule during the measurement process. The so emptied and cleaned seat in the sample plate may then advantageously be moved into the loading position again for being loaded with a further liquid containing, substantially spherical object to be analysed. A discharging is preferable also performed in an automatised manner. A waste container may be provided for receiving any discharged deformable object or discharged parts of the liquid containing, substantially spherical object.

In a variation of this embodiment, a liquid nozzle is provided instead of or in combination with a gas nozzle. Using a liquid jet for discharging the liquid containing, substantially spherical object or parts of the liquid containing, substantially spherical object instead of the gas jet is favourable, especially since the substantially spherical object or parts of the substantially spherical object are of a liquid consistence or contain liquid or tacky components. A liquid nozzle and a corresponding liquid jet are preferably used for the discharge of capsules filled with a liquid that are crushed during an analysis that includes a measurement of the breaking force of the liquid containing, substantially spherical object.

Depending on the kind of analysis, a liquid containing, substantially spherical object is deformed or broken into pieces during analysis. The term "discharging the liquid containing, substantially spherical object" is therefore meant to include the discharge of a whole liquid containing, substantially spherical object but also of a broken liquid containing, substantially spherical object, of parts of a broken liquid containing, substantially spherical object, also including any content of the liquid containing, substantially spherical object that may have leaked from or have been forced out of the liquid containing, substantially spherical object upon the analysing procedure.

According to a further aspect of the apparatus according to the invention, the apparatus further comprises a protecting cover arranged in the unloading position for reducing contamination of the environment with the liquid containing, substantially spherical object when the liquid containing, substantially spherical object is discharged from the sample plate by the gas jet or liquid jet.

In order that a liquid containing, substantially spherical object - in the case of using a liquid jet for discharging, also the discharging liquid - is removed from the seat and the sample plate in a more controlled manner, a protecting cover is provided in the unloading position. The protecting cover preferably covers at least the seat for the liquid containing, substantially spherical object. The directions the liquid containing, substantially spherical object moves after having been pushed away by the gas jet or the liquid jet, respectively, are constrained by the protecting cover. The protecting cover may be arranged and designed such that discharged liquid containing, substantially spherical objects, parts of liquid containing, substantially spherical objects and possibly also a discharging liquid is guided inside the protection cover for example to a waste container.

For the safety of personnel and equipment, a safety sensor may be provided. Such a safety sensor is preferably arranged such as to detect any accidental interference with the handling apparatus or analysing unit, for example a dynamometer, especially to detect undesired elements entering an analysing region. Upon detection of an accidental interference the analysing process or only individual steps of the analysing process, such as the loading or the analysing, are interruptible. An exemplary safety sensor comprises a light barrier detecting a disturbance of the light barrier. Preferably,

the safety sensor initiates the interruption of any analysing process upon the detection of such a disturbance.

According to another aspect of the apparatus according to the invention, the apparatus further comprises a base, which comprises the reservoir, the sample plate and the control unit. Preferably, the base is demountably attachable to the dynamometer.

By providing the apparatus with a base, which can demountably be attached to the analysing unit, for example a dynamometer, an existing the analysing unit may be upgraded from a manual to an automatised process in a simple and convenient manner. This is advantageous not only for the acceleration of an analysing process but also of analysing process sequences. In addition, this enables to use non-automatised commercially available dynamometer in different modes. An automatisation may be carried out reversibly. In addition, the apparatus according to the invention may be used together with different analysing units enabling an automatisation of different analysing processes or of an analysing sequence. Exemplary dynamometers used in the present invention measure a breaking force or deformation behaviour of the liquid containing, substantially spherical object, such as a capsule or bead.

According to another aspect of the invention there is provided a method for the handling liquid containing, substantially spherical objects in an analysing process of liquid containing, substantially spherical objects, the method comprising the steps of: providing a plurality of liquid containing, substantially spherical objects in a reservoir; entering a selected number of liquid containing, substantially spherical objects to be analysed via a control unit, transferring a liquid containing, substantially spherical object to be analysed from the reservoir into a seat provided in a sample plate at a loading position of the sample plate and transporting the liquid containing, substantially spherical object to be analysed from the loading position to an analysing position by moving the sample plate. Further, according to the invention, the method comprises the step of analysing the liquid containing, substantially spherical object by the analysing unit in the analysing position and discharging the analysed liquid containing, substantially spherical object from the sample plate. According to the invention, the steps of providing, entering, transferring, transporting, analysing and

discharging are repeated for a number of liquid containing, substantially spherical objects of the plurality of liquid containing, substantially spherical objects.

According to an aspect of the method according to the invention, for performing the step of discharging the analysed liquid containing, substantially spherical object from the sample plate, the analysed liquid containing, substantially spherical object is transported from the analysing position to an unloading position by moving the sample plate.

According to another aspect of the method according to the invention, the method further comprises the steps of:

- providing a base comprising the reservoir, the sample plate and the control unit; and
- demountably attaching the base to the analysing unit for analysing the liquid containing, substantially spherical object.

The advantages of the method according to the invention have been described above with reference to the apparatus. Preferably, the method is performed until no liquid containing, substantially spherical objects are left in the reservoir or until a number of analysed liquid containing, substantially spherical objects corresponds to the selected number of liquid containing, substantially spherical objects to be analysed as entered into the control unit. Preferably, the method is performed in cycles, while the length of a cycle is typically defined by the length of the analysing step.

According to a further aspect of the method according to the invention, the step of providing a plurality of liquid containing, substantially spherical objects in a reservoir comprises:

- sampling the plurality of liquid containing, substantially spherical objects out of a stock of liquid containing, substantially spherical objects by inserting a sampling device into the stock of liquid containing, substantially spherical comprising an array of spherical object capturing locations, thereby filling the spherical object capturing locations of the array of spherical object capturing locations with liquid containing, substantially spherical objects from the stock of liquid containing, substantially spherical objects; and
- emptying the sampling device by transferring the liquid containing, substantially spherical objects from the spherical object capturing locations into the reservoir.

A sampling device comprising an array of spherical object capturing locations used for sampling a plurality of liquid containing, substantially spherical objects further

facilitates and speeds up the process of analysing liquid containing, substantially spherical objects. Upon the process of analysing a certain number of liquid containing, substantially spherical objects, for example a few tenths or a few hundred substantially spherical objects have to be selected from a stock of liquid containing, substantially spherical objects. A stock of substantially spherical objects is commonly available as bulk material. The selected liquid containing, substantially spherical objects have to be counted in order to get a predefined number of substantially spherical objects to be analysed. Having to count a number of substantially spherical objects to be analysed is time consuming and the handling of the substantially spherical objects is prone to mistakes or may damage the substantially spherical objects.

Preferably, the array of spherical object capturing locations in the sampling device comprises a predefined number of spherical object capturing locations. If the array or also only part of the array of spherical object capturing locations of the sampling device is filled after the insertion and removal of the sampling device into and out of the stock of liquid containing, substantially spherical objects, a counting of substantially spherical objects and a touching of individual substantially spherical objects may be omitted.

Advantageously, an array of spherical object capturing locations is a regular arrangement of throughbores or indentations in a plate, for example in a metallic or plastic sheet. The shape of the capturing locations may for example be circular, spherical, conical, cylindrical or have any other shape suitable for temporarily capturing a liquid containing, substantially spherical object in the sampling device. Preferably, the sizes of the spherical object capturing locations are such as to capture exactly one liquid containing, substantially spherical object in one capturing location. For example, the array may comprise a 10 times 10 matrix of bores in the sheet material to swiftly capture exactly 100 objects, for example capsules from the bulk of material. Liquid containing, substantially spherical objects captured in the spherical object capturing locations are preferably released from the capturing location upon tilting or turning the sampling device upside down. The liquid containing, substantially spherical objects from the sampling device may be filled into the reservoir of the apparatus according to the present invention for analysing purposes.

According to another aspect of the method according to the invention, the step of analysing the liquid containing, substantially spherical object in a dynamometer comprises a measurement of a breaking force of the liquid containing, substantially spherical object or a determination of deformation behaviour of the liquid containing, substantially spherical object.

Further advantageous aspects of the invention are described in more detail with reference to the following drawings, in which

Fig. 1 shows a cut-open side view of an embodiment of the apparatus according to the invention;

Fig. 2 shows a sample plate provided with a protecting cover in the discharging position, and

Fig. 3 shows an enlarged cut of the object releases system.

Fig. 1 shows a reservoir 1, a sample plate 2, a control unit 3 and a dynamometer 4. A plurality of liquid containing, substantially spherical objects such as liquid containing, substantially spherical capsules 5 are provided in the reservoir 1. The substantially spherical objects pass through the outlet 51 of the reservoir 1 and into a dosing unit 6. From the dosing unit 6 one capsule 5 is transferred into a first sample pit 26 provided in the sample plate 2 at a loading position 21. The dosing unit 6 is arranged directly above sample pit 26 such that the capsule falls vertically into sample pit 26. The convex form of the sample pit 26 thereby supports the capturing, alignment and holding of the capsule in the sample pit 26. The sample plate 2 is then rotated by 90 degrees in the rotation direction indicated by arrow 27. Thereby the first sample pit 26 is arranged at a waiting position 22 and a second sample pit is arranged in the loading position 21 to be filled with a next capsule 5 transferred from the dosing unit 6 into the second sample pit. Upon a further rotation of the sample plate 2 by 90 degrees the capsule in the first sample pit 26 is transported into an analysing position 23 and a third sample pit is arranged at the loading position 21 to be filled with a capsule. In the analysing position 23 the capsule 5 in the first sample pit 26 is analysed by the dynamometer 4. Generally, a breaking force of the capsule is measured. The strength of a force acting on the capsule or other measurement parameters may initially be entered into the control unit 3 and communicated to the dynamometer 4 via a corresponding communication port (schematically indicated with dash-dotted lines). The analysing results from the dynamometer 4 are preferably also

communicated via the communication port to the control unit 3, where the results may be displayed and stored. Upon a further rotation of the sample plate 2 by 90 degrees the first sample pit 26 with the now analysed and generally broken capsule is transported into the discharging position 24. In the discharging position 24, the capsule is removed from the first sample pit 26 and from the sample plate 2. A removal may be done manually but is preferably also done in an automated manner, for example by a brush-like device or preferably by a gas jet or a liquid jet provided by an appropriate gas nozzle or liquid nozzle (not shown).

After a further rotation about 90 degrees of the sample plate 2, the now emptied first sample pit 26 has performed a 360 degree rotation and is arranged in the loading position 21 again. The first sample pit 26 may be loaded anew with a further capsule to be analysed. Such a loading of sample pits and performing analysis on the capsules may be repeated as long as a number of analysed capsules is smaller or equal to a number of capsules to be analysed. The number of capsules to be analysed is initially entered into the control unit 3 and is communicated to the dynamometer 4 and preferably also to the dosing unit 6.

The dosing unit 6 is arranged below the reservoir 1 and comprises an aligning channel 61, an upper sliding system 62, a dosing chamber 63 and a lower sliding system 64. The aligning channel 61 is arranged below the outlet 51 of the reservoir. The aligning channel is formed by two walls forming a gap 611 in between the two walls. The size of the gap 611 essentially corresponds to the size of a capsule 5 such that a capsule neatly fits through the aligning channel 61. Preferably, the diameter of the outlet 51 of the reservoir 1 corresponds to the size of the gap 611. A single file of capsules 5 may form in the aligning channel 61. The lowermost capsule in the aligning channel enters the dosing chamber 63 if the upper sliding system 62 is in its open position. The dosing chamber 63 is formed by a throughhole in a plate and encloses a space dimensioned such as to receive one single capsule.

The dosing chamber 63 is fixed with the dosing aligning chamber 61. As can be seen in **Fig. 3**, opening the upper sliding system 62 requires displacing a thin plate 622 towards the side of the aligning chamber 61 by a predetermined distance that allows free passage of the liquid containing, substantially spherical object into the dosing chamber 63. Assisted by gravity a capsule 5 falls inside the dosing chamber 63 from the aligning chamber 61. Subsequently, the thin plate 622 moves back to its

initial position, thus closing the passageway between the aligning chamber 61 and the dosing chamber 63. The speed of the closing movement of the thin plate 622 is adapted to prevent the unintended rupture of a capsule 5 that may be positioned on top of the capsule 5 that has entered the dosing chamber 63. Any following capsules are securely held back in the aligning channel 61. After that, the lower sliding system 64 is activated. The thin plate 644 moves to the side of the dosing chamber 63 by a predetermined distance that allows free passage of the liquid containing, substantially spherical object out of the dosing chamber 63 and into the seat arranged at the desired position on plate 2. Finally, the thin plate 644 of the lower sliding system 64 returns into its initial, closed position. As there is not any longer an object present in the dosing chamber, the speed of the lower sliding plate 644 is less critical as for the upper sliding plate 622. Upper and lower sliding system 62, 64 are essentially formed as L-shaped elements that are preferably actuated automatically, for example by means of electromotors that receive their commands from the control unit 3.

The closing of an inlet of the dosing chamber 63 after having been charged with a capsule ensures that only one capsule is transferred to the sample plate 2.

The lower sliding system 64 is preferably only open when a capsule is in the dosing chamber and when a sample pit – or any other seat - is in the loading position 21. The upper sliding system 62 may then be actuated to open the inlet of the dosing chamber again to allow a next capsule to enter the dosing chamber. This procedure is repeated until a last capsule to be analysed has entered the dosing chamber 6 and has been transferred to the sample plate 2.

In order to facilitate an aligning of capsules in the reservoir 1, the reservoir 1 comprises a conical shape 56. The lower end of the conical shape 56 forms the outlet 51 of the reservoir 1. In order to avoid blockage in the reservoir 1 and to further facilitate the aligning of the capsules in the reservoir, the reservoir 1 is provided with a gas inlet 53 for leading a gas stream 52 into the reservoir (indicated by a dashed line). A gas for a gas stream is preferably provided by a compressed air source. The gas stream 52 led into the reservoir keeps the capsules agitated such that a blocking of capsules in the reservoir or in the outlet 51 may be prevented. Such a gas stream may also support an alignment of capsules if the capsules are not of a spherical but for example of an elongated shape. The reservoir 1 also comprises a cover 54 for covering the inlet 55 of the reservoir. Such a cover 54 prevents agitated capsules from

falling out of the reservoir 1 and prevents unwanted objects from falling into the reservoir.

For safety reasons a safety sensor 41, for example a light barrier, is arranged next to the dynamometer 4. A safety sensor 41 is preferably coupled to the control unit 3 in order to interrupt the analysing process or at least the analysing step in the dynamometer 4, should an unexpected object enter the analysing region.

In **Fig. 2** for reasons of simplicity, control unit 3, reservoir 1 and dynamometer 4 are not shown. The sample plate 2 is mounted on a base 8 and a protecting cover 9 is provided in the unloading position 24.

The protecting cover covers a sample pit in the unloading position 24 and the capsule or parts of the capsule if the capsule had been broken during the analysing step. Sidewalls 91 of the protection cover are preferably arranged such as to neatly close off a region around the sample pit in the unloading position 24, especially such as to prevent any liquid spilled from the capsule upon analysis to contaminate the environment upon discharging of the capsule

One of the sidewalls 91 is provided with a drawer-like container 92 serving as a waste box. In the drawer-like container 92 discharged capsules including spilled liquid content of the capsules and possibly also discharging liquid from a liquid jet used for discharging the capsules may be collected. The drawer-like container 92 may be removed for emptying and cleaning and may be inserted back into the protection cover 9 for refilling.

Any discharging device, such as a gas nozzle or liquid nozzle is preferably arranged under the protecting cover 9. If a compressed air source or other gas source is used for providing a gas stream into the reservoir for agitating the capsules in the reservoir, this air source may also be used to provide a gas jet for the discharge of capsules.

The base 8 may be attached to the dynamometer 4, preferably in a detachable manner, for example with screws.

It goes without saying that a different number of sample pits or other seats for liquid containing, substantially spherical objects may be provided in the sample plate 2 and that also further or less process positions may be provided. For example, further waiting positions 22 may be present also after an analysing position 23 or unloading position 24. On the other hand, a waiting position 22 or an unloading position 24 may

be omitted. If no separate unloading position 24 is foreseen, a capsule having been analysed may be discharged in the analysing position 23, such that for example a so emptied sample pit may directly proceed to the loading position 21. A cleaning step of the sample pit may then also be used for or combined with a cleaning of the dynamometer or a dynamometer probe, respectively.

Also the sample plate is not limited to a rotatable disc but may for example also be designed in the form of a conveyor. A sample plate is preferably designed and arranged such that an emptied seat in the sample plate is transferable to a loading position to be loaded again.

With an automatisation of the analysing process according to the invention the velocity and reliability of the analysing process of capsules may be noticeably enhanced. An analysis of an identical amount of capsules may be performed in less than half the time than with a manually performed analysis.

Claims

1. Apparatus for handling liquid containing, substantially spherical objects, the apparatus comprising:
- a reservoir for receiving a plurality of liquid containing, substantially spherical objects;
- a sample plate for receiving a liquid containing, substantially spherical object from the reservoir, the sample plate comprising a seat adapted to receive a liquid containing, substantially spherical object, wherein the sample plate is adapted to be movable such that the seat adapted to receive the liquid containing, substantially spherical object can be positioned in each of a loading position, an analysing position and an unloading position;
- a drive for moving the seat adapted to receive a liquid containing, substantially spherical object into a loading position, an analysing position and an unloading position;
- a control unit for entering analysing parameters; and
- a communication port for an interchange of the analysing parameters with an analysing unit.

2. Apparatus according to claim 1, wherein the reservoir comprises a conical shape with diminishing dimensions in a direction of an outlet of the reservoir.

3. Apparatus according to any one of the preceding claims, further comprising a dosing unit arranged underneath an outlet of the reservoir for a transferring of a single liquid containing, substantially spherical object onto the sample plate.

4. Apparatus according to claim 3, wherein the dosing unit comprises a dosing chamber for receiving the single liquid containing, substantially spherical object, and comprises a first valve and a second valve, the first valve for closing and opening an inlet of the dosing chamber and the second valve for closing and opening an outlet of the dosing chamber.

5. Apparatus according to any one of the preceding claims, wherein the reservoir further comprises a cover for covering an inlet of the reservoir, and wherein the

reservoir further comprises an agitator for agitating the plurality of liquid containing, substantially spherical objects contained in the reservoir.

6. Apparatus according to any one of the preceding claims, wherein a gas nozzle for providing a gas jet is arranged in an unloading position for discharging the liquid containing, substantially spherical object from the sample plate when the liquid containing, substantially spherical object is in the unloading position.

7. Apparatus according to claim 6, further comprising a protecting cover arranged in the unloading position.

8. Apparatus according to any one of the preceding claims, further comprising a safety sensor for detection of an undesirable occurrence during the analysing process of the liquid containing, substantially spherical object, and for interruption of the analysing process upon detection of such an undesirable occurrence.

9. Apparatus according to any one of the preceding claims, further comprising a base, which comprises the reservoir, the sample plate and the control unit, the base being demountably attachable to the analysing unit.

10. Apparatus according to any one of the preceding claims, wherein the analysing unit is a dynamometer.

11. Method for the handling of liquid containing, substantially spherical objects in an analysing process of liquid containing, substantially spherical objects, the method comprising the steps of:

a) providing a plurality of liquid containing, substantially spherical objects in a reservoir;

b) entering a selected number of liquid containing, substantially spherical objects to be analysed via a control unit;

c) transferring a liquid containing, substantially spherical object to be analysed from the reservoir into a seat provided in a sample plate at a loading position of the sample plate;

d) transporting the liquid containing, substantially spherical object to be analysed in the seat from the loading position to an analysing position by moving the sample

plate;

e) analysing the liquid containing, substantially spherical object by the analysing unit in the analysing position;

f) discharging the analysed liquid containing, substantially spherical object from the sample plate;

g) repeating steps c) to f) for a number of liquid containing, substantially spherical objects of the plurality of liquid containing, substantially spherical objects.

12. Method according to claim 11, wherein for performing the step of discharging the analysed liquid containing, substantially spherical object from the sample plate, the analysed liquid containing, substantially spherical object is transported from the analysing position to an unloading position by moving the sample plate.

13. Method according to claim 11 or 12, further comprising the steps of:
- providing a base comprising the reservoir, the sample plate and the control unit; and
- demountably attaching the base to the analysing unit for analysing the liquid containing, substantially spherical object.

14. Method according to any one of claims 11 to 13, wherein the step of providing a plurality of liquid containing, substantially spherical objects in a reservoir comprises:
- sampling the plurality of liquid containing, substantially spherical objects out of a stock of liquid containing, substantially spherical objects by inserting a sampling device into the stock of liquid containing, substantially spherical objects, the sampling device comprising an array of spherical object capturing locations, thereby filling the spherical object capturing locations of the array of spherical object capturing locations with liquid containing, substantially spherical objects from the stock of liquid containing, substantially spherical objects; and
- emptying the sampling device by transferring the liquid containing, substantially spherical objects from the spherical object capturing locations into the reservoir.

15. Method according to any one of claims 11 to 14, wherein the step of analysing the liquid containing, substantially spherical object comprises a measurement of a breaking force of the liquid containing, substantially spherical object or a

determination of deformation behaviour of the liquid containing, substantially spherical object.

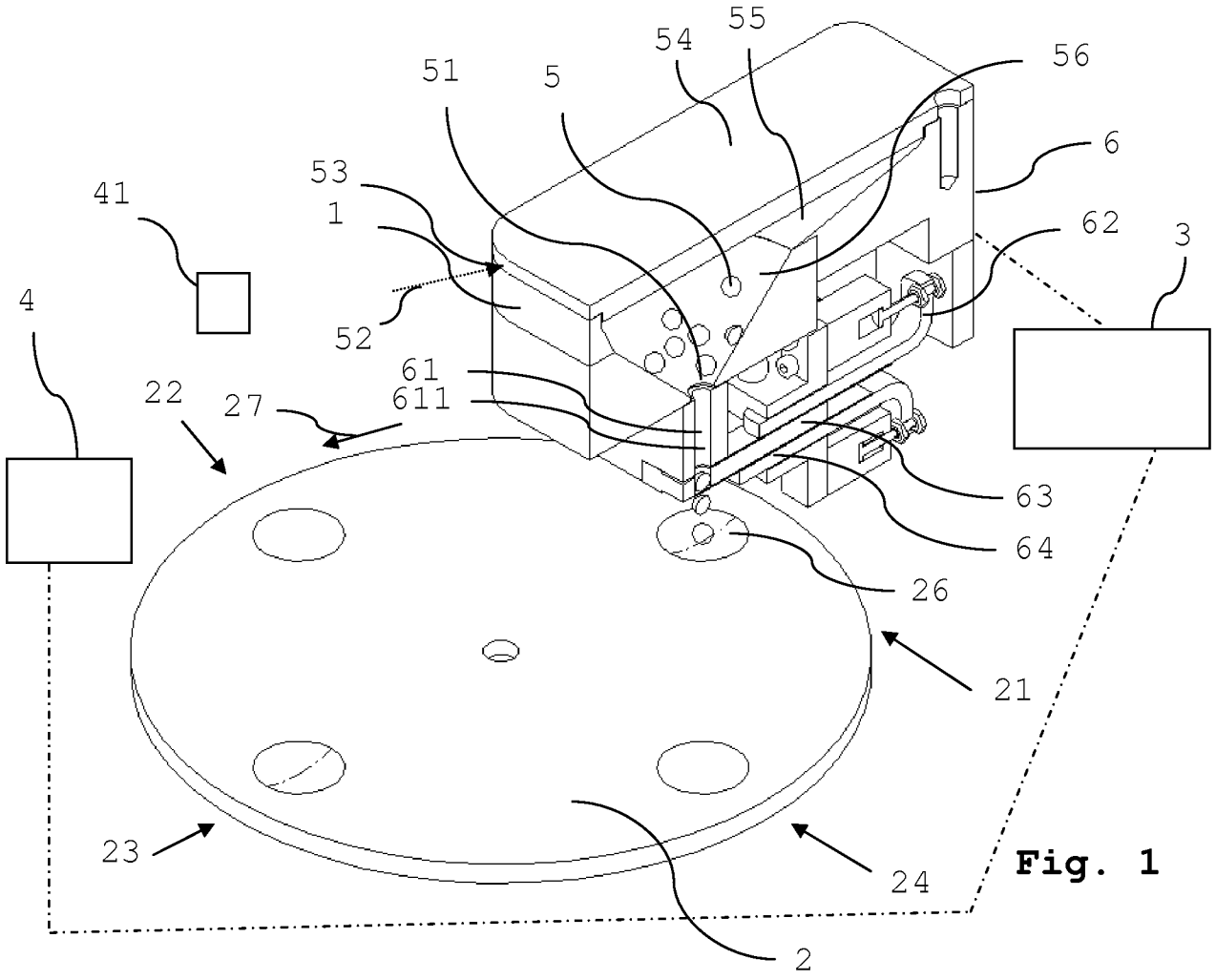

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Fig. 1

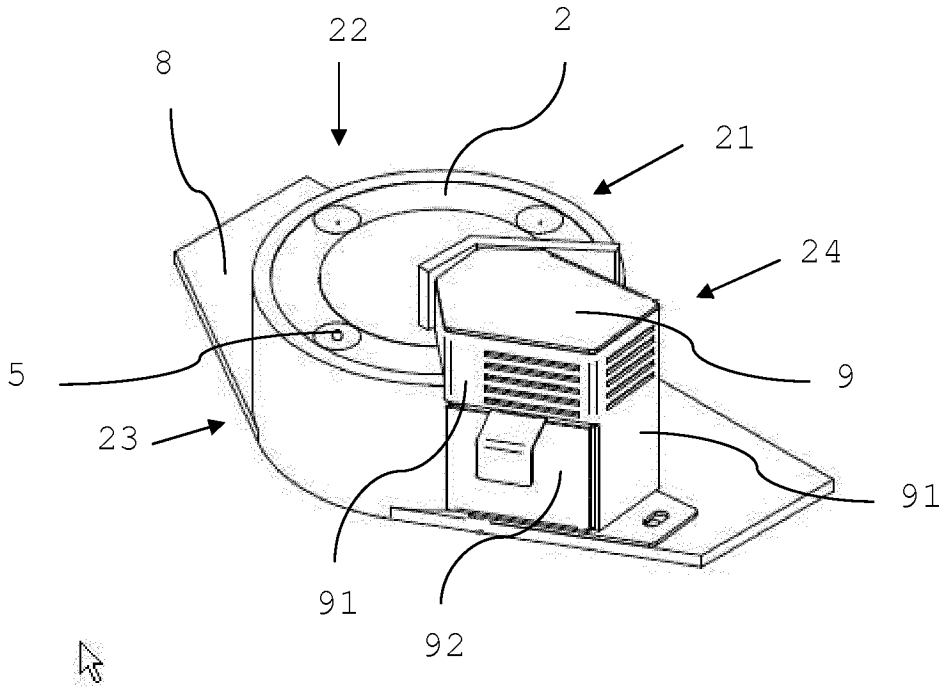

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Fig. 2

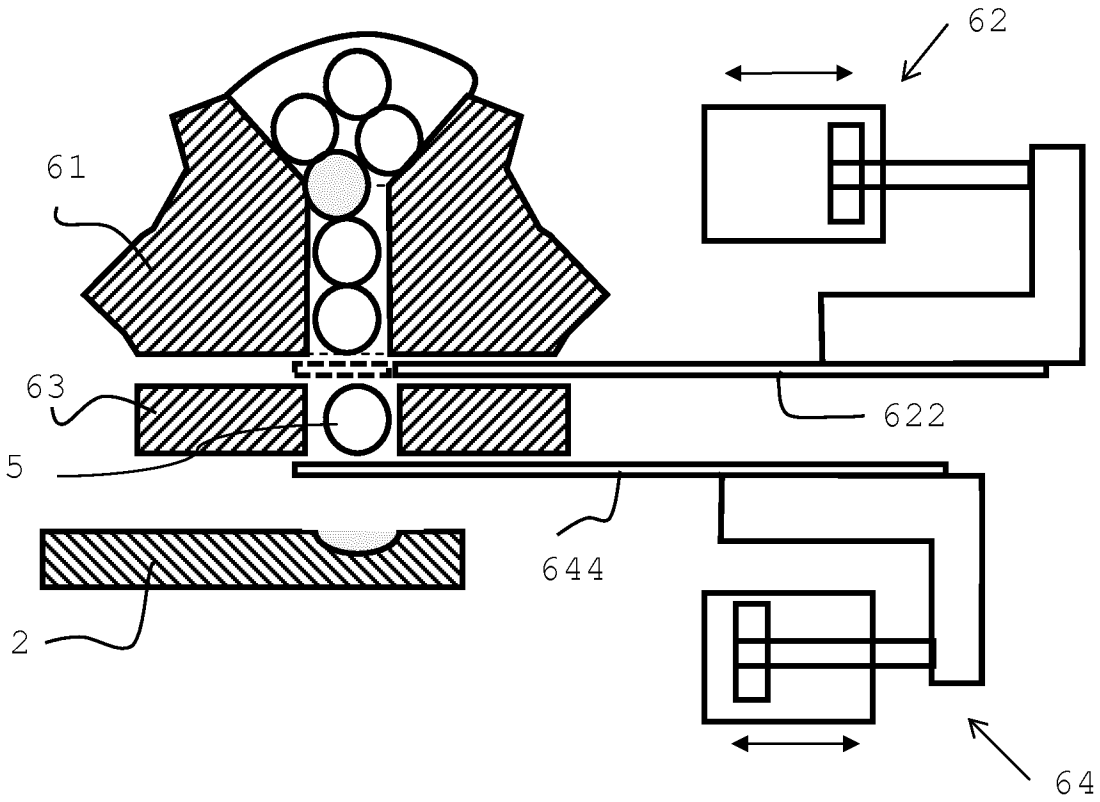


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/067274

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N3/08
ADD. G01N35/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	GB 2 017 305 A (THOMAE GMBH DR K) 3 October 1979 (1979-10-03) figures 1-2 page 2, line 50 - line 52 page 3, line 38 - line 40 page 3, line 66 - line 69 page 3, line 83 - line 88	1-3,5-15 4
X	WO 87/00621 A1 (MICROSPAN PROCESS CONTROLS [GB]) 29 January 1987 (1987-01-29) page 3, line 14 - line 21; figure 1	1-15
A	DE 20 2011 003680 U1 (HOEFLIGER HARRO VERPACKUNG [DE]) 9 June 2011 (2011-06-09) figure 3	1-15
Y	US 5 397 025 A (LEE CHARLES H [US]) 14 March 1995 (1995-03-14) figures 3a-6b	4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2013	27/09/2013

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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