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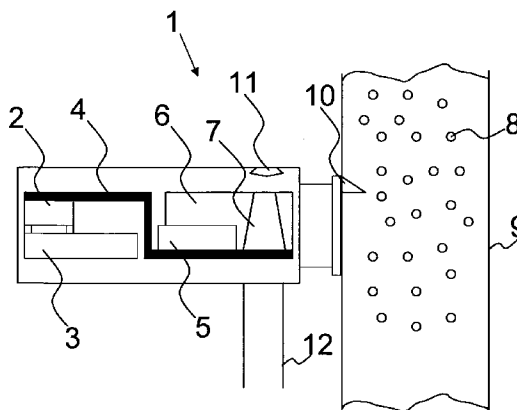


Fig. 1

(57) Abstract: The present invention concerns an apparatus and a method for sampling from a product flow, where the sampling is performed continuously and where the product is collected in a cup for determining physical conditions, for example weight in relation to volume, and where the cup is emptied after ending the sampling. The apparatus according to the invention is provided with at least one sampling cup, where the cup is provided with a filling opening with a cross-sectional area and with an emptying opening with a different cross-sectional area, respectively. It is thus a sampling cup where the product is not emptied through the same opening as the one through which it is filled. An apparatus according to the invention may therefore be designed in a simple and reliable way as it is not necessary to perform a turning movement of the sampling cup in order to empty it. Preferably, the sampling cup is emptied by opening the bottom and subsequently cleaning the cup with open bottom. Emptying of the cup is advantageously effected in the product flow, but may also occur in a separate duct for the purpose.



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Sampling Apparatus and Method for Sampling

Field of the Invention

5 The present invention concerns an apparatus and a method for sampling from a product flow, where the sampling is performed continuously and where the product is collected in a cup for determining physical conditions, for example weight in relation to volume, and where the cup is emptied after ending the sampling.

10 Description of Prior Art

It is common knowledge to perform sampling, e.g. measuring density of products, such as e.g. expanded and heat treated products, but also of other products where the products appear with a certain porosity during the manufacturing process, and where the product is desired to be continuously weighed in order
15 thereby to regulate the processes controlling the expansion and thereby the porosity of the weighed product.

Density measurement is presently performed in various ways. Systems based on a specifically defined volume which is filled with products and weighed subsequently
20 is the most widely used technique. This technique is frequently used at a purely manual level, where a process operator manually fills a tared container with a known volume with products. The container is often a traditional household measuring glass with closed bottom which is overfilled with product and subsequently levelled at the top such that the defined volume is completely filled
25 with products. Subsequently, the container is weighed and the weight of the product in the defined volume may thereby be determined. This method of determining the density of a given product is used in production processes within many different industries, such as e.g. processes for making food for animals, breakfast cereals, snacks, metal powder, fertiliser, wood and plastic.

30 During the making of these different products, which often occurs under high temperature by means of a compacting or extruding machine, the process parameters can be changed such that the texture of the given product is changed, entailing a change of the density of the product as well. A given product will
35 frequently have a specific volume which is intended. This may e.g. be in connection with filling of bags of a given product where a given density of a product is wanted in order thereby to fill a ready packing optimally. By changing the addition of energy, moisture or similar process parameters for making a given product, the characteristic of the product can be changed and thereby also the

density of the product. A process operator will therefore continuously check the density in order thereby to regulate the process if the density deviates from the specified value.

5 The problem of manual sampling or density measurement is that the repeatability is not great enough and that the weighing result therefore only can be used as an indication and not as a completely true value. This is due to the fact that a process operator is not able to fill a given sampling container in a uniform way. On this background, it has previously been attempted to construct automatic
10 systems which may perform a continuous uniform sampling and weighing of the products. These systems are satisfactory for specific products and sizes of products; however, in industries as e.g. for the making of snacks, breakfast products and feed for animals, the products are often relatively large as well as they are sticky as a result of the heating process by which the product is formed.

15 The best known prior art for density weighing is based on a sampling cup with a closed bottom. The sampling cup is mounted on an arm which may be displaced horizontally and which is mounted on a weighing cell. The sampling cup is moved into a give product flow whereby the cup is (over)filled with product. When the
20 cup is retracted to the weighing area, the sampling cup is scraped clean at the top in order to provide a defined volume of the product to be weighed. When the sample has been weighed, the cup is turned such that the product is emptied from the sampling cup. The prior art, however, has certain drawbacks that frequently entail that the weighing result is so inaccurate, comparable to a manual weighing,
25 that it can only be used as an approximate result. The drawbacks are the following:

1. The sampling cup with closed bottom. Density measurement of hot pellets, which the product is often, though not limited to, is a result of the heating process
30 by which the temperature of the product immediately before density measurement will often be about the boiling point of water. The density in the manufacturing process is flexible and easily influenced. By collecting a given sample for measurement, a condensation of vapour will start during collecting in the cup. The product as well as dust and crumbs will stick to the cup at the
35 emptying. After some time, deposits will appear in the sampling cup which will cause that the presumed volume in the sampling cup used for collecting the product will be reduced, and the weighing result is thereby not accurate any more.

Attempts of cleaning the sampling cup, either with compressed air or rotating brushes, have not appeared to be sufficiently effective.

5 2. Scraping the sampling cup is an essential part of the system. The more homogenous scraping of the sampling cup is, the more precise weighing. As the prior art has a closed bottom, it is required with a large diameter in order to achieve a reasonable volume for the product, at the same time generating a large scraping area and thereby fluctuating measuring results. In general, the best weighing result is achieved by the largest possible volume and the smallest
10 scraping area in the sampling cup. Since the products are often hot and sticky, scraping of the sampling cup can imply that large lumps are entrained, causing large deviations in the weighing result.

15 3. Hygiene is essential in manufacturing processes for products forming part of the food chain. Since cleaning cannot be done efficiently by the prior art, either by the product flow or in other mechanical ways, a hygiene problem arises whereby bacteria cultures as e.g. salmonella can appear.

20 4. The installation height of a given density measuring apparatus is very critical as many processing plants have very little spacing between two processing machines available. The prior art is very space consuming due to the technical embodiment, where compensation is made for the design of the sampling cup with closed bottom by increasing the diameter and the height, respectively, and large changes in the processing plant are therefore required, if possible at all.

25 From DE 199 09 437 is known an apparatus for taking a sample in a product flow where the sample is taken by a sampling cup with an upper and a lower plate that close and open the filling and emptying openings, respectively. This sampling cup is cleaned by compressed air which partly may provide for the cleaning of the
30 sampling cup. However, there is the disadvantage that possible accumulation of residues of a sticky product cannot entirely be avoided, entailing that it is required with a regular manual cleaning of the sampling cup.

35 It is thus the purpose of the invention to provide a solution that is secure, precise and takes into account the above mentioned disadvantages.

Description of the Invention

As mentioned in the introduction, the invention concerns an apparatus and a method for sampling from a product flow, where the sampling is performed

continuously and where the product is collected in a cup for determining physical conditions, for example weight in relation to volume, and where the cup is emptied after ending the sampling.

5 The apparatus according to the invention is provided with at least one sampling cup, where the cup is provided with a filling opening with a cross-sectional area and with an emptying opening with a different cross-sectional area, respectively. It is thus a sampling cup where the product is not emptied by the same opening through which it is filled. An apparatus according to the invention may therefore
10 designed in a simple and reliable way as it is not necessary to perform a turning movement of the sampling cup in order to empty it.

A method for sampling according to the invention includes at least steps where a sampling cup is introduced in a product flow whereby the cup is filled, where the
15 sampling cup is withdrawn, scraped in level and weighed, where the sampling cup is emptied by opening the bottom and subsequently cleaned with open bottom, after which the bottom is closed and the system is ready for the next weighing. Emptying of the cup is preferably effected in the product flow, but may also occur in a separate duct intended therefor.

20 In a preferred embodiment of an apparatus according to the invention, the apparatus includes at least one cup, where the cup is provided with an opening bottom, preferably a sliding bottom. By using an opening bottom, the weighed product may easily be emptied in the product flow, and by a sliding bottom is
25 achieved a particularly advantageous solution where possible deposits of the product on the bottom are scraped off by sliding the bottom.

A further embodiment of an apparatus for sampling according to the invention is in a preferred form provided with a filling opening of the cup that has a cross-sectional area which is less than the cross-sectional area of the emptying opening.
30 Thus is achieved a cup with a given volume with relatively small surface area. The small or minimal surface area causes that the levelling taking place when the cup is drawn out of the product flow becomes much more exact than if there were a larger surface area. At the same time, the desired volume is maintained whereby
35 a great and sufficient measuring accuracy can be achieved.

In one variant of the invention, the apparatus may be provided with a compressed air device for cleaning the interior of the cup. Possible residues in the form of dust or crumbs of the product may thus be removed from the sampling cup.

The method for sampling from a product flow according to the invention may advantageously be with a step wherein the sampling cup is cleaned by compressed air, but is preferably provided with a step where cleaning is effected by means of the product flowing through the open cup. The cleaning is thus effected by products scraping against the surface in the cup with the open bottom.

It is a characteristic of all heat treatment processes that control of density is essential for the physical as well as nutritional quality of the product. The problem of achieving a uniform continuous density measurement by the ability of the prior art technologies that have sufficient flexibility for handling many different product characteristics and providing such great repeatability that the value can be used for documentation is commonly known.

In order to solve this problem, by the new invention it has been found that by means of several process independent technical solutions there may be provided an accurate and continuous measurement of the density of the product. It has been found that by making a bottomless sampling cup it may be avoided that products and dust particles accumulate at the bottom of the sampling cup. By having a bottomless sampling cup, the product flow may thereby be used as cleaning medium for the cup during emptying. By supporting the bottomless sampling cup during emptying, one may still measure a product weight in a controlled volume without risk of accumulating foreign bodies that reduce the weighing result. Also, it has been found that by making a bottomless sampling cup, the design of the cup can be made such that a minimal scraping area occurs. By e.g. making a smaller diameter at the top than at the bottom, a very small scraping area is attained, considerably improving the weighing accuracy and the repeatability.

By means of the new invention, a such exact weighing result may be achieved that it is immediately usable for regulating the process parameters used in the process for making the weighed products, e.g. for regulating a heat treatment process. The producer of a given product may thereby ensure that the declaration of contents is followed exactly with regard to density. Also, the hygiene of the process for density measurement will be substantially improved as the system is self-cleaning, since the product flow will prevent local areas at which the product can accumulate and bacteria cultures be formed. Due to the bottomless sampling cup, a large volume is attained at a small height, simultaneously improving the possibilities of installing the system between the product processes.

An apparatus and a method for sampling in a product flow may furthermore include determination of the density of a "stamped" product, after which the compression index of the product can be determined. Determining the stamped
5 density of a product is traditionally determined by taking a product sample manually in a measuring glass with a given volume. The density may then be determined by manual weighing, or the density is alternatively determined via a sampling cup with a well-defined volume which is introduced in the product flow and weighed afterwards. The sample is then vibrated, and the product compacted
10 or "stamped" hereby, and finally the density of the stamped product may be determined by manual reading of the stamped volume which now may be put in relation to the weight of the sample. This process is manual and resource-demanding and may advantageously be substituted by a new automatic process.

15 This new process is in principle independent of the design of the automatic sampling equipment itself and therefore not limited to sampling cups with e.g. conical sides, but may be used for all thinkable embodiments of sampling cups, when only these can take out a sample with a constant and well-defined volume.

20 This may be done with an apparatus according to the invention where a sample is taken with an apparatus as mentioned above and which furthermore is equipped with means for compacting or stamping of the contents in the filled sampling cup. These means may e.g. impart a mechanical action on the sampling cup and possibly constituted by a known type of vibrator/oscillator which is mounted in
25 connection with the sampling cup. After ending the stamping, the volume of the sample can be determined by camera reading of e.g. a scale on the sampling cup. Alternatively, the volume can be determined via telemeter which is used for determining how far the product has sunk into the sampling cup.

30 By knowing these data, the density of the product as well as the stamped density may be determined rapidly without using staff to perform a protracted manual measurement.

35 Stamping may, as mentioned, advantageously be effected by providing the apparatus according to the invention with a vibrator/oscillator of suitable type. The vibrator may advantageously be arranged such that at least the sampling cup is vibrated. This vibration may in principle be initiated at the same moment as the sampling cup is withdrawn from the product flow or when a lid is put on the filling opening in the sampling cup.

The frequency by which "stamping" is performed may be adapted individually to various products, and similarly the time of "stamping" may be regulated such that a desired result is achieved.

5

A further advantage of an apparatus according to the invention which may perform a density determination of a "loose" product sample as well as of a "stamped" product sample is that the results of the performed measurements may immediately be used as regulating parameters for the preceding process or processes as well as for one or more succeeding processes. A much better and not the least more rapid regulation of respective parameters may hereby be achieved in that regulation can be performed immediately after ending density determination, without having to do a manual process before regulation. Moreover, there is the obvious advantage that regulation can be performed much more often, as in principle density determination can be performed continually - one after another - and the results may instantaneously be introduced to a continuous regulation. By such a continuous regulation is achieved a much better result while at the same time the risk of regulation errors is greatly minimised since there is no need for human data processing before a regulating action. The measured values for the densities may e.g. be expressed as analogous signals of 4-20 mA which immediately can be used as input in various process regulating systems.

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A further advantage of measuring the "stamped" density in connection with a sampling cup is that simultaneously a water measurement of the sample can be done. Such a measurement is typically performed with microwave equipment and the measuring accuracy is much more exact in a stamped sample than in a loose sample. Also, the more exact measurement of the water content in a sample may be used for regulating preceding and/or subsequent processes. Again, the great advantage that rapid regulation can be effected is achieved, and thereby greater certainty that the process is running as expected and that the quality of the product maintains the desired quality. Processes where the measured data can be used for regulation may e.g. be drying and/or cooling, but other processes may be controlled and regulated as well on the background of the measured densities and the water content of the product.

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Short Description of the Drawing

Embodiments of the invention are described in the following with reference to the drawing, wherein:

- Fig. 1 shows a sectional view of a sampling apparatus from the side and mounted on a channel section with a product flow.
- Fig. 2 shows the apparatus in various positions.
- 5 Fig. 3 shows examples of different designs of sampling cups.

Detailed Description of the Invention

As previously mentioned, the invention concerns a system which can be mounted at any place in a manufacturing process for diverse products where e.g. a density determination may be of interest. The density measurement according to the invention is developed with regard to a more optimal design which will facilitate cleaning of the sampling cup and while at the same time the scraping off of the product may be substantially reduced in order thereby to improve the weighing result. Furthermore, other measurements may be performed in the sample taken by the sampling cup, whereby a plurality of physical conditions of the product may be determined and used as regulating parameter.

In Fig. 1 is seen the system 1 which consists of a weighing cell 2 mounted on a first actuator 3 which is displaceable back and forth in horizontal direction. On the weighing cell 2, an arm 4 is mounted on which a further actuator 5 is fitted. In connection with the actuator 5, a sampling cup 6 is mounted in the form of a piston in which is provided a hole 7 for filling the product 8.

In Fig. 1, the system 1 furthermore appears mounted on a channel section 9 into which a flow of product fall. By horizontal displacement of the first actuator 3, the sampling cup 6 is moved into the product flow 8 whereby the product 8 fills the cup 6. The sampling cup 6 is made without a bottom and consists of a cylindric, conical or other geometrically designed hole 7 without a bottom. By supporting the sampling cup 6 by the arm 1, whereby the latter acts as bottom for the sampling cup 6, the cup 6 is filled without the product 8 falling out of the bottom. After a given period of time within the product flow 8, the first actuator 3 is horizontally displaced to its initial position, and excess material filled in the cup 6 is scraped off by scraper 10. Immediately after withdrawal of the sampling cup 6, a weighing via the weighing cell 2 is performed. When the actual weighing result is defined, the sampling cup 6 is displaced horizontally again by means of the first actuator 3. When the sampling cup 6 is placed again in the product flow 8, the second actuator 5 is activated such that the sampling cup 6 is displaced again in relation to the arm 4. The bottom in the sampling cup 6 is thereby opened and the weighed product 8 flows out. The product flow 8 falling by the force of gravity

will simultaneously clean the cup 6 from above. This is only effected in that the surface in the hole 7 is touched by the product flow 8. After a given period of time, the sampling cup is horizontally displaced via the first actuator 3 again while the second actuator 5 is still in the extended position. The sampling cup 6 is thus still horizontally displaced from the arm 4 and therefore with open bottom and free passage through the hole 7. After a given period of time, a compressed air nozzle 11 is activated, whereby compressed air blows possible particles out of the sampling cup 6. Possible dust particles are discharged through discharge pipe 12 under the system 1. After a given period of time, the second actuator 5 is horizontally displaced whereby the sampling cup 6 is again supported by the arm 4. Before a new sampling is performed, the weighing result is reset.

In Fig. 2 appears a description of a sequence where the sampling apparatus 1 is seen in three different positions in cross-sectional views. The apparatus is shown schematically why various elements, as e.g. the actuators 3, 5, are not shown.

In Fig. 2.1, the sampling cup 6 is shown in extended position into the channel 9, which is here shown as a channel section with flanges 13 for bolt mounting in a channel, where the hole 7 is made with conical geometry and with an opening upwards and which is therefore filled with the product 8 flowing in the channel 9.

In Fig. 2.2, the sampling cup 6 is withdrawn into the apparatus 1 for determining physical conditions of the product, e.g. determining weight by means of a not shown weighing cell 2 in relation to the specific volume in the sampling cup 6. Other conditions at the product 8, e.g. water content, may also be determined in the apparatus 1, e.g. by photocells, microwave technique or other methods.

Finally, in Fig. 2.3 is seen how the sampling cup 6 is displaced into the channel 9 and where the part itself of the sampling cup 6 with the hole 7 are displaced in relation to the arm 4 that otherwise forms the bottom in the sampling cup 6. In this position, emptying of the product 8 which has just been examined occurs, and subsequently a flowing through the hole 7 of the flowing products 8 occurs in the channel 9. Hereby, the sides of the hole 7 is cleaned from possible deposits from the just emptied product 8. This cleaning process may in principle be compared with a "shot blasting" of an item, where the "shot" is here constituted by the product flow 8.

In a controlled experiment on a process line for making dog feed it has been found that the design of the cup with regard to the scraping area has much

influence on the weighing result. In Fig. 3 is shown four different cup designs which have been tested in a production of dog feed:

Fig. 3.1 Conical design with $\varnothing 60$ mm top and $\varnothing 120$ mm bottom

5 Fig. 3.2 Conical design with $\varnothing 100$ mm top and $\varnothing 120$ mm bottom

Fig. 3.3 Cylindrical hole with $\varnothing 120$ mm top and $\varnothing 120$ mm bottom

Fig. 3.4 Prior art with closed bottom

Data for experiment

10 Type of feed: Extruded dog feed

Diameter of feed: $\varnothing 18.2$ mm

Thickness of feed: 10.4 mm

Specified density: 385 g/l

Humidity: 26% water

15 Temperature of feed: 80-85 °C

The volumes of the various cups used in the experiment were identical as shown on the table below:

Cup design	Dimension	Volume of cup	Scraping area	Drawing
Cone	$\varnothing 60$ - $\varnothing 120$ mm	1000 ml	2.826 mm ²	Fig.3.1
Cone	$\varnothing 100$ - $\varnothing 120$ mm	1000 ml	7.850 mm ²	Fig 3.2
Cylindric	$\varnothing 120$ - $\varnothing 120$ mm	1000 ml	11.304 mm ²	Fig 3.3
Closed cup	$\varnothing 120$ mm	1000 ml	11.304 mm ²	Fig 3.4

20

Experiment

25 By controlled experiments it could be demonstrated that by having a reduced scraping area, very accurate weighing results can be produced as compared with prior art.

Measurement no.:	Fig. 3.1	Fig. 3.2	Fig. 3.3	Fig. 3.4
1	382	380	378	371
2	381	380	376	382
3	383	378	384	397
4	384	384	386	385
5	380	385	389	374
6	385	386	379	391
7	381	380	385	381
8	379	382	393	370
9	382	377	384	373
10	384	376	388	400
11	382	379	379	389
12	379	378	386	377
13	382	381	377	398
14	383	383	381	373
15	384	386	377	379
16	382	384	391	395
17	382	383	384	378
18	379	379	391	389
19	384	376	393	397
20	385	386	381	378
Max. deviation	±3 g/l	±5 g/l	±8 g/l	±15 g/l

- 5 It appears from the above table that the smallest deviations are achieved by the three variants using a sampling cup with opening bottom. Moreover, a clearly smaller deviation appears by the two sampling cups that have a conical shape and with smaller filling opening than discharge opening. The deviation is particularly small by the sampling cup shown in Fig. 3.1.

CLAIMS

1. An apparatus for sampling from a product flow, where the sampling is performed continuously and where the product is collected in a cup for determining physical conditions, for example weight in relation to volume, and where the cup is emptied after ending the sampling, **characterised in that** the apparatus is provided with at least one sampling cup, that the cup is provided with a filling opening with a cross-sectional area and with an emptying opening with a different cross-sectional area, respectively.
2. Sampling apparatus according to claim 1, **characterised in that** the apparatus at least includes one cup, where the cup is provided with an opening bottom, preferably a sliding bottom.
3. Sampling apparatus according to any of claims 1-2, **characterised in that** the filling opening of the cup has a cross-sectional area which is less than the cross-sectional area of the emptying opening.
4. Sampling apparatus according to any of claims 1-3, **characterised in that** the apparatus is provided with a compressed air device for cleaning the interior of the cup.
5. Sampling apparatus according to any of claims 1-4, **characterised in that** the apparatus is further provided with vibrating means for stamping the removed sample.
6. Sampling apparatus according to claim 5, **characterised in that** the apparatus includes reading means for determining product volume in the sampling cup after stamping, where the reading means preferably is constituted by a camera or a telemeter.
7. Sampling apparatus according to claim 6, **characterised in that** the reading means is directly or indirectly connected with one or more control units in connection with preceding or succeeding processes in the production facility in which the apparatus is arranged.
8. A method for sampling from a product flow, where the sampling is performed continuously by an apparatus according to any of claims 1-7, **characterised in that** the method includes at least the following steps:

- a sampling cup is introduced in a product flow whereby the cup is filled;
- the sampling cup is withdrawn, scraped in level and weighed;
- the sampling cup is emptied by opening the bottom;
- the sampling cup is cleaned with open bottom;
- 5 - the bottom is closed and the system is ready for the next weighing.

9. Method for sampling from a product flow according to claim 8, **characterised in that** the sampling cup is cleaned with compressed air.

- 10 10. Method for sampling from a product flow according to claim 8, **characterised in that** the sampling cup is cleaned by means of the product flowing through the open cup.

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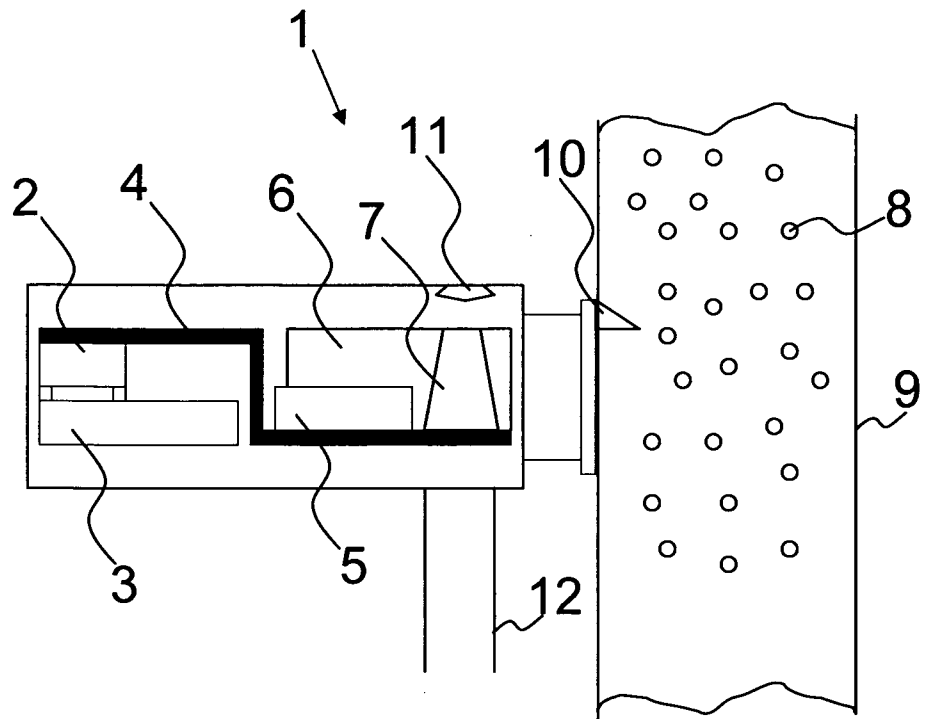


Fig. 1

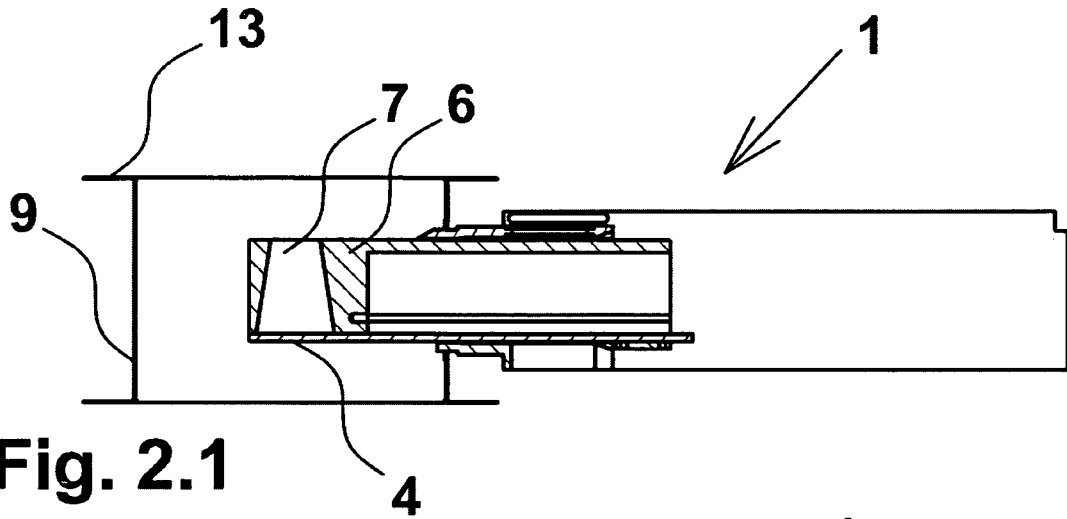


Fig. 2.1

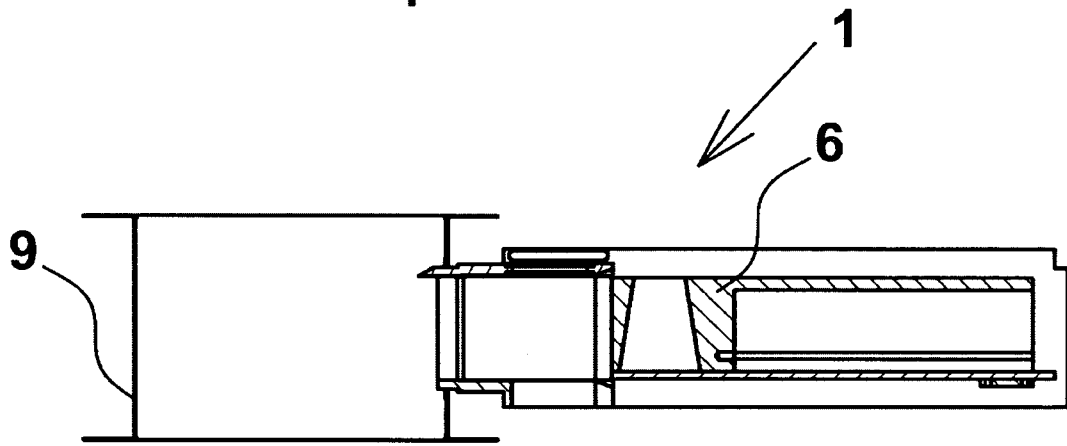


Fig. 2.2

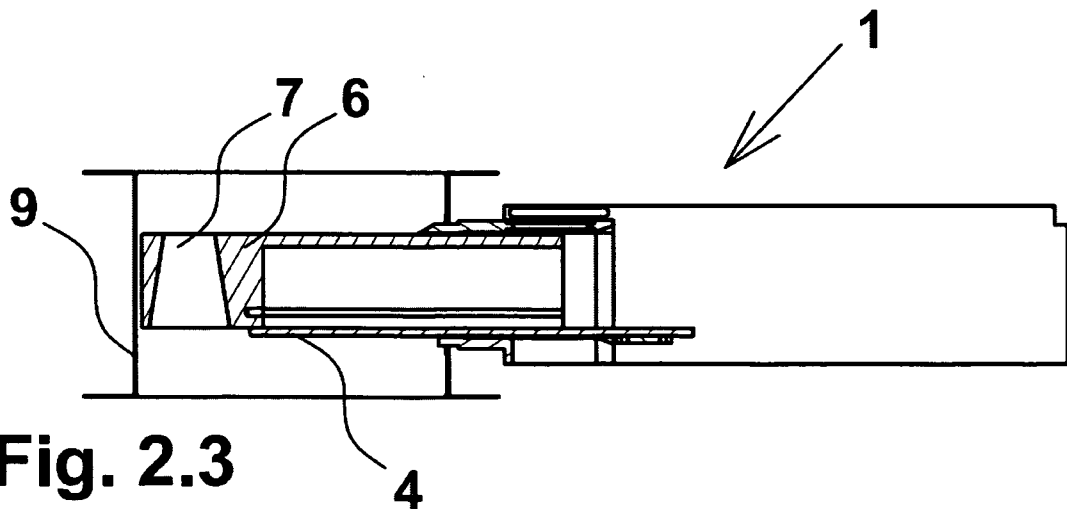


Fig. 2.3

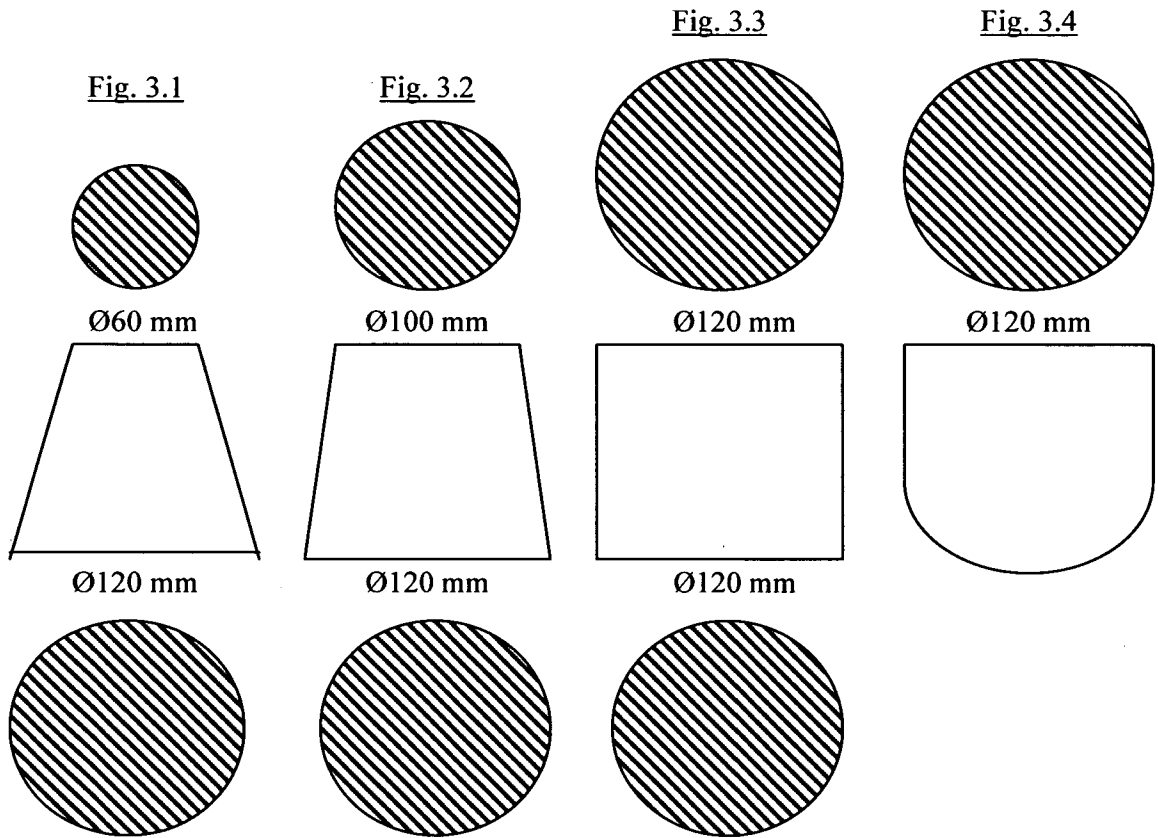


Fig. 3