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[Continued on next page]

(54) Title: A SORTING APPARATUS

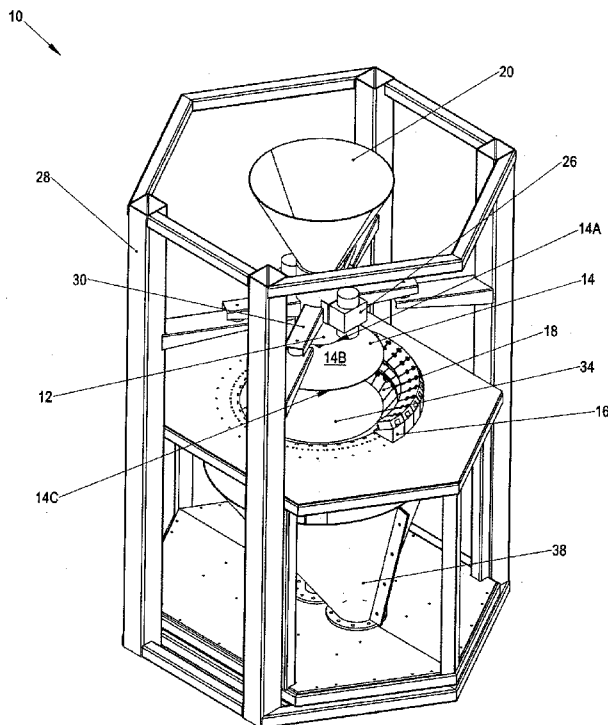


Figure 1

(57) Abstract: This invention relates to a sorting apparatus (10). More specifically, the invention relates to a high throughput sorting apparatus (10), particularly suited for diamond sorting. The sorting apparatus (10) includes a dispenser (12) for dispensing a material, a diffuser (14), at least one sensor (16) and at least one deflector (18). The diffuser (14) in use comprises a receiving region (14A) for receiving material from the dispenser (12), a downwardly sloping surface (14B) radiating from and about the receiving region (14A) for diffusing material as it travels along the diffuser (14) and a continuous rim (14C) over which the material is discharged from the diffuser (14). In use, where the sensor (16) senses that a property of the material discharged from the diffuser (14) matches a predefined property, the deflector (18) is triggered to deflect the material into a collection bin.



Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

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

5

A SORTING APPARATUS

10

BACKGROUND OF THE INVENTION

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THIS invention relates to a sorting apparatus. More specifically, the invention relates to a high throughput sorting apparatus, particularly suited for diamond sorting.

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Sorting devices are well known in the industry. However, the large majority of these devices comprise of a slide or rotating belt of a fixed dimension, giving rise to low material throughputs, material build up and masking.

25

Masking takes place where two or more particles travelling on the slide or rotating belt of a sorting device lie over one another. In so doing the top particle "masks" the bottom particle from being detected by sensors, causing the masked particle to be discarded. In this way, massive losses can be suffered where the masked particle happens to be very valuable, for example, a diamond.

30

It is an object of the invention to address the disadvantages of the prior art by reducing the risk of masking while at the same time producing a cost effective, high throughput sorting apparatus with a footprint similar to those of existing sorting devices.

SUMMARY OF THE INVENTION

According to the invention there is provided a sorting apparatus including:

5 a dispenser for dispensing a material;

a diffuser having in use:

10 a receiving region for receiving material from the dispenser;

a downwardly sloping surface radiating from and about the receiving region for diffusing material as it travels along the diffuser; and

15 a continuous rim over which the material is discharged from the diffuser;

at least one sensor for in use sensing a property of the material discharged from the diffuser; and

20 at least one deflector for in use deflecting material where the property of the material matches a predefined property.

25 Generally, the sorting apparatus includes a primary means of agitation for in use agitating the dispenser and/or the material therein thereby assisting the dispensation of material from dispenser. The sorting apparatus may also include a secondary means of agitation for in use agitating the diffuser thereby assisting the diffusion of material travelling along the diffuser.

30 Preferably, the primary and secondary agitation means is one or more vibrators mounted on the dispenser, the diffuser in use being mounted beneath the dispenser on a connecting arm, and further wherein the vibrations produced by the vibrators are transmittable to the diffuser via the connecting arm.

The material in use is preferably dispensed from the dispenser and travels along the diffuser under the force of gravity, assisted by the agitation means. Typically, the downwardly sloping surface of the diffuser comprises a downward gradient of between about 0.15 and 0.27.

5

The diffuser may be conical, domed or pyramidal in shape. Alternatively, the diffuser may be frusto-conical, frusto-domed or frusto-pyramidal in shape.

10

In use and when viewed in plan, the ratio of the area defined by the continuous rim of the diffuser to the area defined by a dispensing mouth of the dispenser is preferably at least 9:1.

15

The ratio of the area defined by the dispensing mouth of the dispenser to the cross-section area as measured at the maximum diameter of the material passing through the sorting apparatus is typically at least 7:1.

20

The sorting apparatus preferably includes at least one emitter for in use exposing the material discharged from the diffuser to one or more waves, wherein predefined post-exposure variations in the waves and/or in material reaction sensed in use by the sensors identifies material having the required predefined property.

25

The waves are typically electromagnetic waves. Furthermore, the emitter may be covered by a wave disperser to disperse the waves emitting from the emitter.

30

Preferably, and specifically for the application of diamond sorting applications, the waves are X-rays causing in use diamonds in the material to fluoresce. Alternatively, the diamonds are identifiable by measuring their atomic density post-exposure to the X-rays.

In use, the material having the predefined property is deflected by the deflectors into a collection area. The remaining material is directed to waste and discarded.

5 In use and when viewed in plan, the continuous rim of the diffuser defines an inner area and an outer area. The inner is typically the area falling within the footprint of the diffuser, whereas the outer area is typically the area falling outside of the footprint of the diffuser.

10 In one embodiment, the sensors and the emitters may be in use positioned in the outer area and beneath the continuous rim of the diffuser. In an alternative embodiment, the sensors and the emitters may be in use positioned in the inner area and beneath the continuous rim of the diffuser.

15 In yet another embodiment, the sensors and the emitters may be in use positioned in the outer area and the inner area respectively, or vice versa, the sensors and the emitters in use being positioned beneath the continuous rim of the diffuser.

20 Preferably, the downwardly sloping surface radiates from and 360 degrees about the receiving region such that the discharging material in use forms a continuous curtain of discharge material. Typically, the sensors and emitters are in use configured in a 360 degree orientation, thereby providing the sorting apparatus with high throughput capability.

25 Generally, the components making up the sorting apparatus are assembled onto a mounting structure.

30 The deflectors may be mechanically deflectors capable of directly striking the material when required. Alternatively, the deflectors are fluid deflectors. Where the deflectors are fluid deflectors, the fluid may be liquid or gaseous.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

5

Figure 1 is a perspective view of a sorting apparatus in accordance with the present invention;

10

Figure 2 is a plan view of the sorting apparatus of figure 1; and

Figure 3 is a cross-sectional side view of the sorting apparatus, cross-sectioned along line A-A in figure 2.

15

DETAILED DESCRIPTION OF THE DRAWINGS

20

A sorting apparatus according to a preferred embodiment of the invention is designated generally with reference numeral 10 in figure 1, figure 2 and figure 3. The sorting apparatus 10 includes a dispenser 12, a diffuser 14, at least one sensor 16 and at least one deflector 18.

25

The dispenser 12 is fed with material directly, or through a feed hopper 20, via a first upper opening 22. The dispenser 12 defines a dispensing mouth 24 through which the material in the dispenser 12 is dispensable onto the diffuser 14.

30

Although the dispenser 12 may be of any shape and size, it is preferable that it be circular in cross-section. More preferably, the ratio of the area defined by the dispensing mouth of the dispenser to the cross-section area as measured at the maximum diameter of the material passing through the sorting apparatus is typically at least 7:1.

Although the material is dispensable from the dispenser 12 under the force of gravity, agitation means in the form of one or more vibrators 26 assist the

dispenser 12 in dispensing material. The dispenser 12 is mounted to a mounting structure 28 through a plurality of mountings 30.

5 The diffuser 14 comprises a receiving region 14A for receiving material dispensed in use from the dispenser 12. The diffuser further includes a downwardly sloping surface 14B radiating from and about the receiving region 14A for diffusing material as it travels in use along the diffuser towards a continuous rim 14C over which the material is discharged.

10 It will be appreciated that the diffuser is appropriately sized and shaped to provide the material travelling in use down the diffuser 14 to diffuse evenly thereover. Even distribution of the material over the diffuser 14 is further enhances by vibrating the diffuser. Although it is possible to fit the diffuser 14 with independent vibrators, it is preferably that the vibration generated
15 by the vibrators 26 mounted to the dispenser 12 are transmitted to the diffuser 14 via a connecting arm 32 connecting the diffuser 14 to the underside of the dispenser 12.

20 The diffuser 14 may take any form, but preferably is domed or convex in shape. It has been determined that a downwardly sloping surface 14B of the diffuser 14 having a downward gradient of between 0.15 and 0.27 promotes even distribution of the material over the diffuser 14. Further, it has also been determined that even distribution is further promoted by
25 keeping the ratio of the area defined by the continuous rim 14C of the diffuser 14 to the area defined by a dispensing mouth 24 of the dispenser 12 (when in use and viewed in plan) to at least 9:1.

30 The sensor 16 is in use adapted to sense a property of the material discharged from the diffuser 14. To enhance sensing capabilities, the sorting apparatus 10 includes at least one emitter 34 positioned in use beneath and within the footprint of the diffuser 14. The emitter 34 in use emits waves 360 degrees radially outwardly, thereby exposing the discharge material to waves. It will be appreciated that the waves are typically electromagnetic waves. It will be appreciated further that for the

application of identifying diamonds, the waves are X-rays causing diamonds within the discharge material to fluoresce. It is also possible to identify diamonds using X-rays and measuring their atomic density.

5 Predefined post-exposure variations in the waves and/or in material reaction sensed in use by the sensors 16 is then used to identify material having the required predefined property. On finding a match, the deflectors 18 are triggered in use to deflect material having the predefined property thereby to separate this material from the material that does not possess
10 the predefined property.

In the preferred embodiment illustrated in the figures, a single emitter 34 is used together with a plurality of sensors 16 and deflectors 18. The emitter 34 is positioned beneath the diffuser 14 and within an inner area defined by
15 the footprint thereof. The plurality of sensors 16 and deflectors 18 are positioned in a 360 degree configuration beneath the diffuser and outside of the area defined by the footprint thereof. It is believed that this configuration offers the most cost effective manner of manufacturing the sorting apparatus 10.

20 It will of course be appreciated that many other configurations may be used, for example, having the plurality of sensors within the inner area defined by the footprint of the diffuser 14 and a plurality of emitters outside of the area defined by the diffuser. Alternatively, the plurality of sensors and
25 emitters may all be located in the inner area defined by the footprint of the diffuser 14 or an outer area defined thereby.

It will be appreciated that the 360 degree configuration of the downwardly sloping surfaces 14B of the diffuser 14, the continuous rim 14C, the
30 plurality of sensors 16 and deflectors 18, and the ability of the emitter to emit waves 360 degrees radially provides a sorting apparatus 10 which is cost effective and has high throughput capabilities.

In use, and with specific reference to the application of sorting diamonds, material to be sorted is fed into the dispenser 12 and dispensed therefrom onto a diffuser 14. The vibrators 26, together with the dimensional relationship of the dispenser 12, the diffuser 14 and the material being processed enables a monolayer stream of material to discharge over the continuous rim 14C of the diffuser 14, thereby reducing the possibility of masking.

The emitter 34 emits X-ray waves 360 degrees radially outwardly. Exposure of diamonds in the discharge material to X-rays causes the diamonds to fluoresce. The sensors 16, configured 360 degrees about the discharging material and facing the emitters 34 senses the fluorescents (or atomic density as previously explained) of the diamond, triggering the deflectors 18 to deflect the diamond into a collection area or collection bin 36. The material not reacting to the X-ray waves falls into a waste area or a waste bin 38 to be discarded.

Although the invention has been described above with reference to preferred embodiments, it will be appreciated that many modifications or variations of the invention are possible without departing from the spirit or scope of the invention. For example, a cover (illustrated as a conical cover in the figures) may cover the emitter so as to disperse the waves emitting from the emitter.

CLAIMS

1. A sorting apparatus including:

5 a dispenser for dispensing a material;

a diffuser having in use:

10 a receiving region for receiving material from the dispenser;

a downwardly sloping surface radiating from and about the receiving region for diffusing material as it travels along the diffuser; and

15 a continuous rim over which the material is discharged from the diffuser;

at least one sensor for in use sensing a property of the material discharged from the diffuser; and

20 at least one deflector for in use deflecting material where the property of the material matches a predefined property.

25 2. A sorting apparatus according to claim 1, including a primary means of agitation for in use agitating the dispenser and/or the material therein thereby assisting the dispensation of material from dispenser.

30 3. A sorting apparatus according to claim 1 or claim 2, including a secondary means of agitation for in use agitating the diffuser thereby assisting the diffusion of material travelling along the diffuser.

4. A sorting apparatus according to claim 2, wherein the primary and secondary agitation means is one or more vibrators mounted on the dispenser, the diffuser in use being mounted beneath the dispenser on

a connecting arm, and further wherein the vibrations produced by the vibrators are transmittable to the diffuser via the connecting arm.

- 5
5. A sorting apparatus according to claim 4, wherein the material in use is dispensed from the dispenser and travels along the diffuser under the force of gravity, assisted by the agitation means.
- 10
6. A sorting apparatus according to claim 6, wherein the downwardly sloping surface of the diffuser comprises a downward gradient of between about 0.15 and 0.27.
- 15
7. A sorting apparatus according to claim 7, wherein the diffuser is conical, domed or pyramidal in shape.
- 20
8. A sorting apparatus according to claim 7, wherein the diffuser is frusto-conical, frusto-domed or frusto-pyramidal in shape.
- 25
9. A sorting apparatus according to claim 8, wherein in use and viewed in plan, the ratio of the area defined by the continuous rim of the diffuser to the area defined by a dispensing mouth of the dispenser is at least 9:1.
- 30
10. A sorting apparatus according to claim 9, wherein the ratio of the area defined by the dispensing mouth of the dispenser to the cross-section area as measured at the maximum diameter of the material passing through the sorting apparatus is typically at least 7:1.
- 35
11. A sorting apparatus according to claim 9 or claim 10, including at least one emitter for in use exposing the material discharged from the diffuser to one or more waves, wherein predefined post-exposure variations in the waves and/or in material reaction sensed in use by the sensors identifies material having the required predefined property.
12. A sorting apparatus according to claim 11, wherein the waves are electromagnetic waves.

13. A sorting apparatus according to claim 11 or claim 12, wherein the waves are X-rays causing in use diamonds in the material discharged from the diffuser to fluoresce.
- 5 14. A sorting apparatus according to claim 11 or claim 12, wherein the diamonds are identifiable by measuring their atomic density post-exposure to the X-rays.
- 10 15. A sorting apparatus according to any one of claims 11 to 14, , wherein the material having the predefined property is in use deflected by the deflectors into a collection area, the remaining material in use being directed to waste.
- 15 16. A sorting apparatus according to claim 15, wherein in use and viewed in plan, the continuous rim of the diffuser defines an inner area, being that area falling within the footprint of the diffuser, and an outer area, being that area falling outside of the footprint of the diffuser.
- 20 17. A sorting apparatus according to claim 16, wherein the sensors and the emitters are in use positioned in the outer area and beneath the continuous rim of the diffuser.
- 25 18. A sorting apparatus according to claim 16, wherein the sensors and the emitters are in use positioned in the inner area and beneath the continuous rim of the diffuser.
- 30 19. A sorting apparatus according to claim 16, wherein the sensors and the emitters are in use positioned in the outer area and the inner area respectively, or vice versa, and further wherein the sensors and the emitters are in use positioned beneath the continuous rim of the diffuser.
- 35 20. A sorting apparatus according to any one of claims 17 to 19, wherein the downwardly sloping surface radiates from and 360 degrees about the receiving region such that the discharging material in use forms a

continuous curtain of discharge material, the sensors and emitters being similarly configured in a 360 degree orientation.

- 5 21. A sorting apparatus according to any one of claims 11 to 20, wherein the emitter is covered by a wave disperser to disperse the waves emitting from the emitter.
- 10 22. A sorting apparatus according to any one of the preceding claims wherein the components making up the sorting apparatus are assembled onto a mounting structure.
23. A sorting apparatus according to any one of the previous claims, wherein the deflectors are mechanically deflectors or fluid deflectors.
- 15 24. A sorting apparatus according to claim 23, wherein the fluid used in the fluid deflectors is liquid or gaseous.
25. A sorting apparatus as herein described and illustrated.

1/2

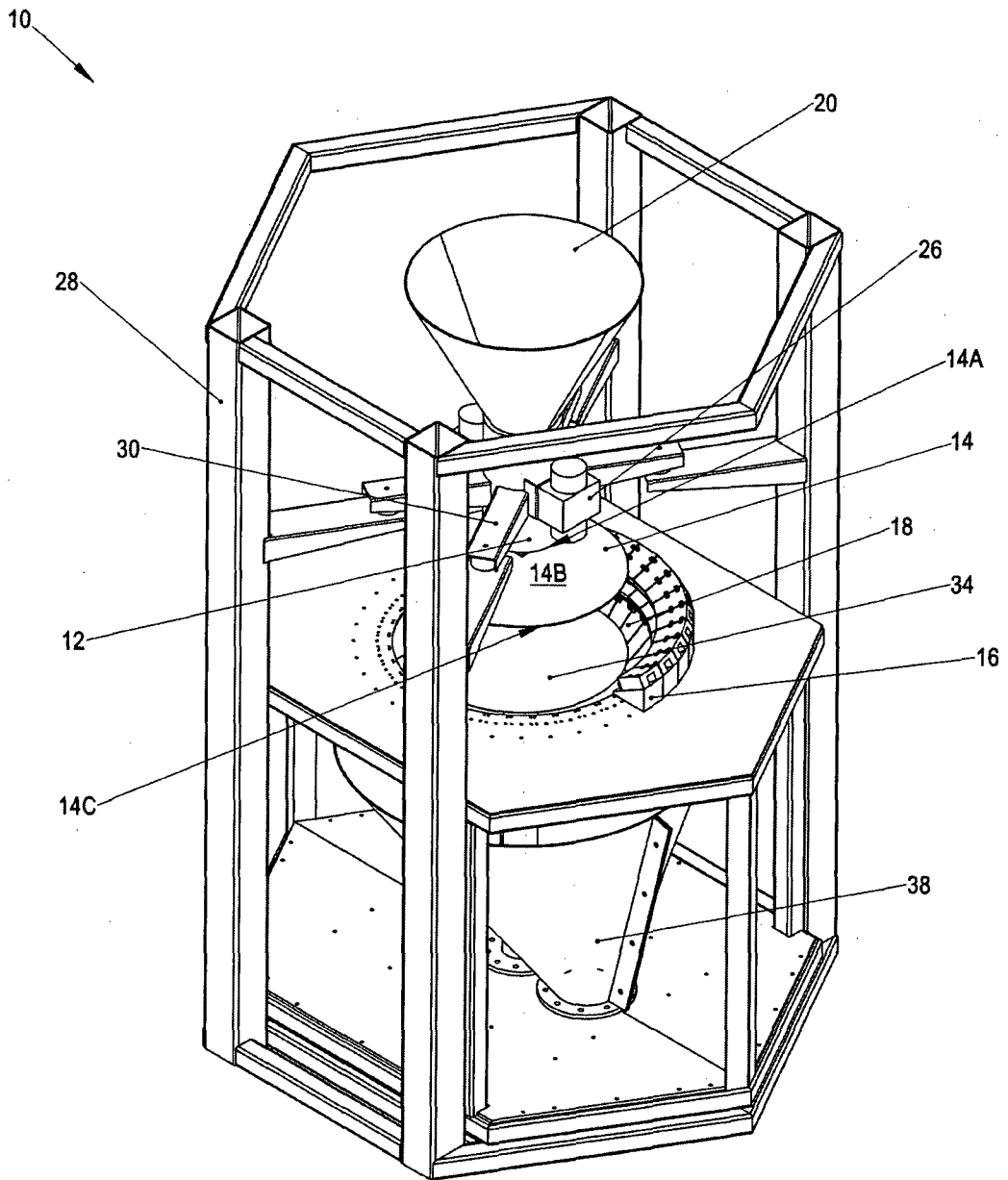


Figure 1

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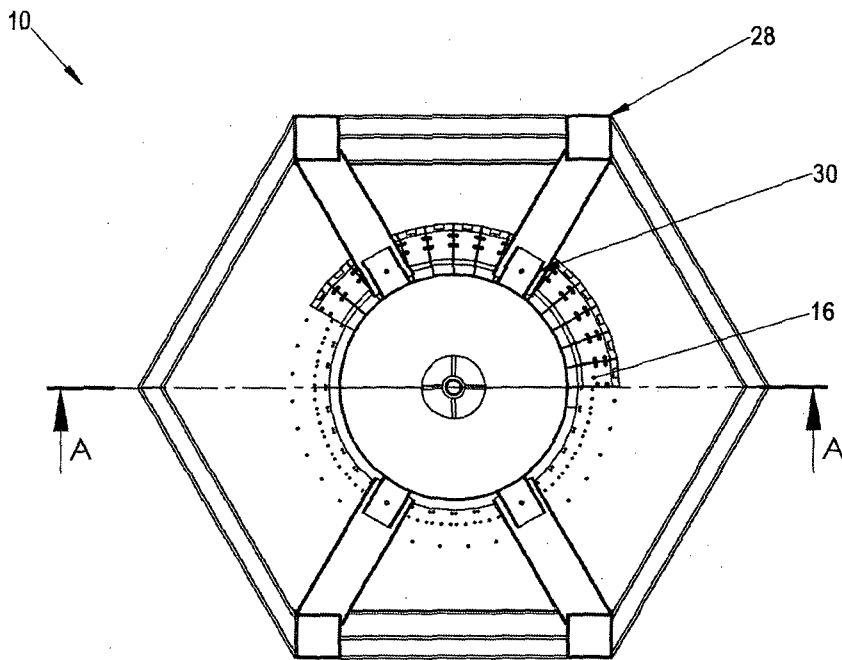


Figure 2

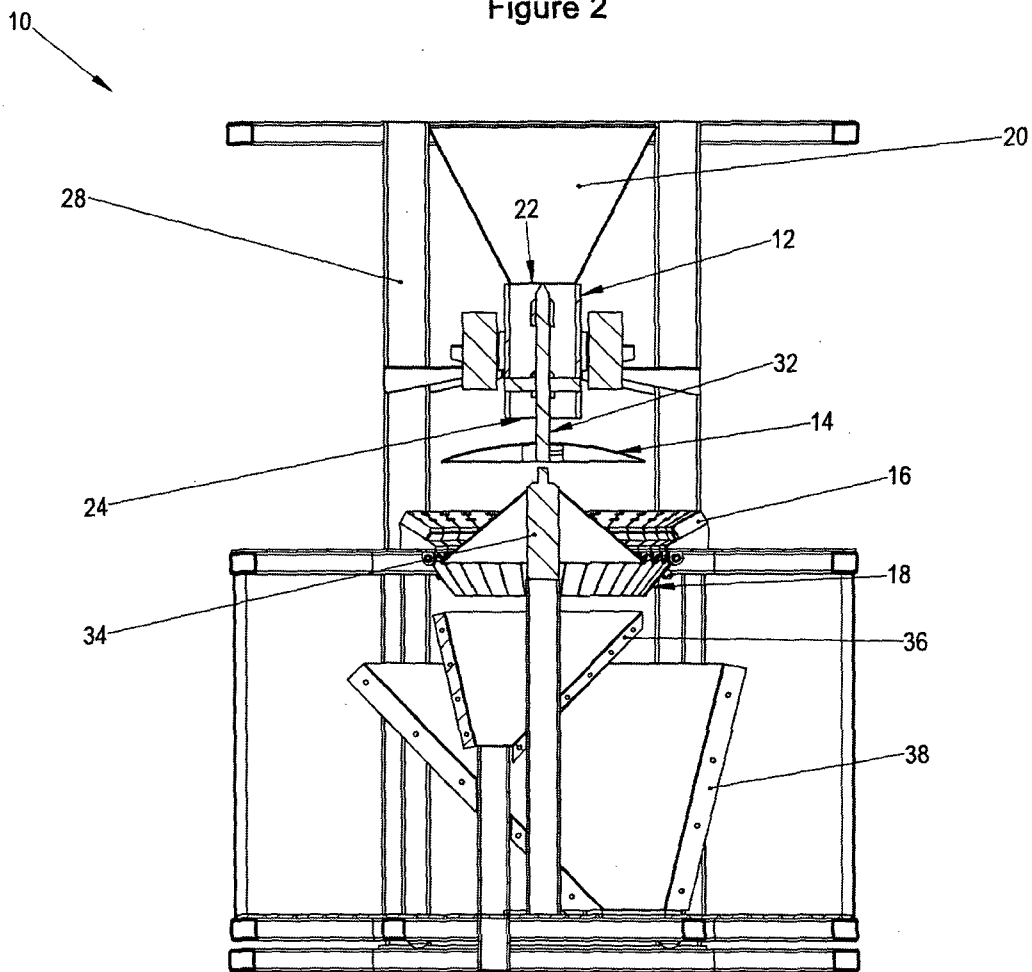


Figure 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT / ZA 2013/000069

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC: B07C 5/36 (2006.01); B07C 5/342 (2006.01); B07C 5/346 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC</p>		
<p>B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B07C Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched</p>		
<p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC, WPI</p>		
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4858771 A (HAWKINS, ALBERT P et al.) 22 August 1989 (22.08.1989) Figs. 1, 3, 4; abstract; column 2, line 23 - column 3, line 48	1 - 24
X	WO 2005018835 A1 (AUSTRALIAN INSPECTION TECHNOLOGIES) 03 March 2005 (03.03.2005) abstract; Fig. 3; page 9, lines 22 - 33; claims 2 - 5	1 - 24
<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.</p>		
<p>* Special categories of cited documents:</p> <p>“A” document defining the general state of the art which is not considered to be of particular relevance</p> <p>“E” earlier application or patent but published on or after the international filing date</p> <p>“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>“O” document referring to an oral disclosure, use, exhibition or other means</p> <p>“P” document published prior to the international filing date but later than the priority date claimed</p> <p>“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>“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</p> <p>“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</p> <p>“&” document member of the same patent family</p>		
Date of the actual completion of the international search 08 April 2014 (08.04.2014)		Date of mailing of the international search report 14 April 2014 (14.04.2014)
Name and mailing address of the ISA/AT Austrian Patent Office Dresdner Straße 87, A-1200 Vienna Facsimile No. +43 / 1 / 534 24-535		Authorized officer ENGLISCH M. Telephone No. +43 / 1 / 534 24-565

INTERNATIONAL SEARCH REPORT

International application No.

PCT / ZA 2013/000069

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: 25
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claim 25 claims the sorting apparatus "as herein described and illustrated.", which does not comply with PCT Rule 6.2 (a), which defines that claims shall not rely on such references as: "as described in part ... of the description," or "as illustrated in figure ... of the drawings."

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT / ZA 2013/000069

Patent document cited in search report			Patent family member(s)			Publication date
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