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(54) Title: CYCLONE SEPARATOR APPARATUS

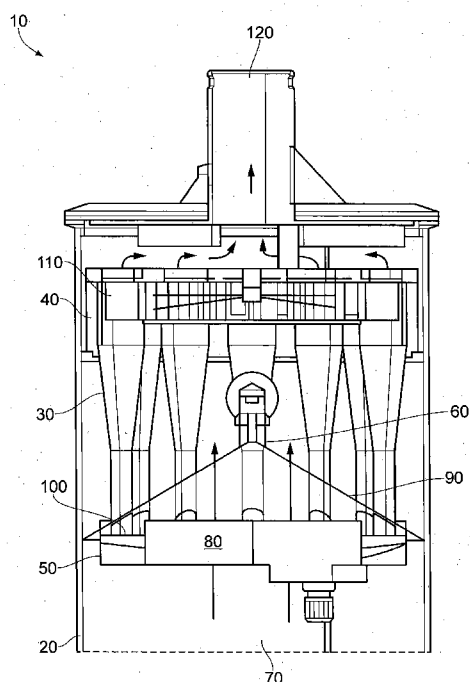


FIG. 1

(57) Abstract: Apparatus for a cyclone separator are disclosed. A collection tray (50) for an abatement apparatus cyclone separator (10) operable to separate particles from a processing tool effluent stream, the collection tray comprising: sidewalls; and an inclined floor positionable to receive the particles from a plurality of cyclone separators (30) locatable above the collection tray and to convey the particles to a drain aperture. In this way, the accumulation of particles in the vicinity of the cyclone separators is reduced which helps to prevent the operation of the cyclone separators from being impaired.

**Published:**

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

## CYCLONE SEPARATOR APPARATUS

### FIELD OF THE INVENTION

The field of the invention relates to apparatus for a cyclone separator.

5

### BACKGROUND

Abatement apparatus cyclone separators are known. Such cyclone separators are used for removing particulate matter from an effluent stream being processed by an abatement apparatus. Such abatement apparatus are typically used for  
10 treating an effluent gas stream from a manufacturing process tool used in, for example, the semiconductor or flat panel display manufacturing industry. During such manufacturing, residual perfluorinated compounds (PFCs) and other compounds exist in the effluent gas stream pumped from the process tool. PFCs are difficult to remove from the effluent gas and their release into the environment  
15 is undesirable because they are known to have relatively high greenhouse activity. Known abatement apparatus use combustion to remove the PFCs and other compounds from the effluent gas stream. Typically, the effluent gas stream is a nitrogen stream containing PFCs and other compounds. A fuel gas is mixed with the effluent gas stream and that gas stream mixture is conveyed into a  
20 combustion chamber that is laterally surrounded by the exit surface of a foraminous gas burner. Fuel gas and air are simultaneously supplied to the foraminous burner to affect flameless combustion at the exit surface, with the amount of air passing through the foraminous burner being sufficient to consume not only the fuel gas supplied to the burner, but also all the combustibles in the  
25 gas stream mixture injected into the combustion chamber.

Although such abatement apparatus cyclone separators help to separate the particles from the effluent stream, their use can have unexpected consequences. Accordingly, it is desired to provide an improved abatement apparatus cyclone  
30 separator.

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## SUMMARY

According to a first aspect, there is provided a collection tray for an abatement apparatus cyclone separator operable to separate particles from a processing tool effluent stream, the collection tray comprising: sidewalls; and an inclined floor  
5 positionable to receive the particles from a plurality of cyclone separators locatable above the collection tray and to convey the particles to a drain aperture.

The first aspect recognizes that a problem with existing abatement apparatus cyclone separators is that particles separated from the effluent stream and exiting  
10 an outlet of a cyclone separator can accumulate near the outlet and eventually block or impair the outlet which affects the operation of the cyclone separators. Accordingly, a collection tray may be provided. The collection tray may be an abatement apparatus cyclone separator collection tray. The collection tray may comprise side walls. The collection tray may comprise a sloped or inclined floor  
15 which may be positioned to receive or accept particles exiting from cyclone separators located or positioned with the collection tray. The inclined floor may convey or transport the particles to a drain for removal from the collection tray. In this way, the accumulation of particles in the vicinity of the cyclone separators is reduced which helps to prevent the operation of the cyclone separators from  
20 being impaired.

In one embodiment, a height of the inclined floor for adjacent cyclone separators differs. Accordingly, the inclined floor may slope along its length so that the height difference between the floor and a cyclone separator varies between the  
25 cyclone separators.

In one embodiment, the height varies one of linearly and non-linearly. Accordingly, the height may vary constantly or the floor may curve.

30 In one embodiment, a surface of the inclined floor is one of planar and non-planar. Accordingly, the floor may be flat or ridged.

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In one embodiment, the drain aperture is located where the height is lowest. Accordingly, the drain apertures may be positioned at a low point of the floor.

5 In one embodiment, the tray is annular. The tray may be annular to match the positioning of the separator cyclones.

In one embodiment, the sidewalls comprise an inner cylinder separated from a concentric outer cylinder by the inclined floor.

10 In one embodiment, the inclined floor is inclined between the inner cylinder and the outer cylinder. Accordingly, the floor may be inclined radially as well as or instead of being inclined circumferentially.

15 In one embodiment, the collection tray comprises a plurality of the drains, each positioned circumferentially around the inclined floor.

In one embodiment, the collection tray comprises a lid having sealable apertures for receiving a corresponding one of the plurality of cyclone separators. Providing a lid helps to prevent interaction between the space within the collector  
20 tray and other fluids flowing within the abatement apparatus cyclone separator.

According to a second aspect, there is provided a cleaner for an abatement apparatus cyclone separator operable to separate particles from a processing tool effluent stream, the cleaner comprising: a mechanism activatable to interact  
25 with fluid flow within the cyclone separator to dislodge gathered particles within the cyclone separator.

The second aspect recognizes that particle accumulation may occur at other locations within the cyclone separator which may impair its operation.  
30 Accordingly, an abatement apparatus cyclone separator cleaner may be provided. The cleaner may comprise a mechanism or assembly which may interact with or vary fluid flow within the cyclone separator. This interaction may

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dislodge or displace particles accumulating within the cyclone separator. In this way, the accumulation of particles within the cyclone separator is reduced which helps to prevent the operation of the cyclone separators from being impaired.

5 In one embodiment, the mechanism comprises a nozzle operable to spray fluid into an inlet of the cyclone separator. Accordingly, the nozzle may spray or inject fluid into the inlet of the cyclone separator. Injecting the fluid into the inlet of the cyclone separator enables the fluid to flow within the cyclone separator to help wash out accumulating particles.

10

In one embodiment, the abatement apparatus cyclone separator comprises a plurality of cyclone separators and the nozzle comprises plurality of outlets, each operable to spray a fluid into an inlet of one of the plurality of cyclone separators. Accordingly, a number of outlets may be provided in the nozzle in order to inject  
15 fluid into each inlet of an associated cyclone separator. This enables multiple cyclone separators to be washed using a common nozzle.

20

In one embodiment, the nozzle is operable to spray the fluid into the inlets one of consecutively and simultaneously. Accordingly, each cyclone separator may be washed individually or together.

25

In one embodiment, the plurality of cyclone separators are arranged circumferentially and the nozzle is rotatable to spray the fluid into each of the inlets consecutively. Accordingly, the nozzle may rotate in order to deliver the fluid to each cyclone separator in turn.

30

In one embodiment, the mechanism comprises a restrictor operable to restrict fluid flow from an outlet of the cyclone separator. Accordingly, a restrictor or baffle may be provided which restricts or impairs fluid flow from the cyclone separator. Such a restriction in fluid flow helps to create a pressure pulse within the cyclone separator which helps to remove accumulating particles.

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In one embodiment, the restrictor comprises a member and an actuator configured to translate the member between positions which cover and uncover the outlet. Accordingly, the member may be moved to different positions to block and unblock the outlet in order to generate the pressure pulse within the  
5 separator cyclones.

In one embodiment, the actuator is configured to translate the member to transiently cover the outlet.

10 In one embodiment, the abatement apparatus cyclone separator comprises a plurality of cyclone separators and the actuator is configured to translate the member between positions which cover and uncover each outlet of the cyclone separators.

15 In one embodiment, the plurality of cyclone separators are arranged circumferentially and the actuator is rotatable to convey the member across each outlet of the cyclone separators.

In one embodiment, the actuator is configured to translate a plurality of the  
20 members between positions which cover and uncover the outlet of a corresponding cyclone separator.

In one embodiment, the actuator is operable to cover and uncover the outlets one of consecutively and simultaneously.

25 According to a third aspect, there is provided an abatement apparatus cyclone separator comprising the collection tray of the first aspect and its embodiments and/or the cleaner of the second aspect and its embodiments.

30 Further particular and preferred aspects are set out in the accompanying independent and dependent claims. Features of the dependent claims may be

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combined with features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

Where an apparatus feature is described as being operable to provide a function,  
5 it will be appreciated that this includes an apparatus feature which provides that function or which is adapted or configured to provide that function.

### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described further, with  
10 reference to the accompanying drawings, in which:  
Figure 1 illustrates an abatement apparatus cyclone separator according to one embodiment;  
Figure 2 illustrates a collector tray in more detail;  
Figure 3 illustrates the collector tray with a lid removed;  
15 Figure 4 illustrates a nozzle mechanism 40 in more detail; and  
Figure 5 is a cross-sectional view through the nozzle mechanism.

### DESCRIPTION OF THE EMBODIMENTS

#### Overview

20 Before discussing the embodiments in any more detail, first an overview will be provided. Some cyclone separators suffer from blockages when separating gases from heavy or high particulate processes. For example, the particles themselves may have a tendency to clump together or be ejected into an environment where another fluid can cause the particles to build up in the vicinity  
25 of the outlet of the separator cyclones. Also, the particles can gather within the cyclone. Accordingly, a mechanism is provided which helps to prevent the build-up and/or dislodge accumulated particles within the cyclone separator and/or at its outlet. In one approach, the mechanism involves a receiving tray which is located at the outlet of the separator cyclones. The outlet tray is shaped to  
30 discourage the build-up of particles ejected from the outlets and convey the particles to a drain for removal. Typically, the tray is provided with inclines which facilitate movement of the particles away from the outlets towards the drain.

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Furthermore, the tray is typically enclosed in order to prevent other fluids being used to pre-treat the effluent stream to be separated by the cyclone separators from entering the tray or interacting with the outlets of the cyclone separators.

The mechanism may also or instead interact with or alter the fluid flow within the cyclone separators to dislodge any accumulating particles. For example, a fluid may be provided at an inlet of the cyclone separators which helps to wash out particles accumulating within the cyclone separators. Likewise, an outlet of the cyclone separators may be rapidly covered and/or uncovered in order to create a transient pressure pulse within the cyclone separators, again to dislodge

accumulating particles.

### Cyclone

Figure 1 illustrates an abatement apparatus cyclone separator 10 according to one embodiment. Positioned within a casing 20 are a plurality of separator cyclones 30. Located at one end of the separator cyclones 30 is a nozzle mechanism 40. Located at another end of the separator cyclones 30 is a collector tray 50. Positioned at the centre of the circumferentially-distributed separator cyclones 30 is a water quench 60.

In operation, an effluent gas stream enters the casing 20 through an inlet 70 and passes through a central aperture 80 provided in the collector tray 50. The effluent stream passes through a water curtain 90 provided by the water quench 60 and is conveyed by the nozzle mechanism 40 to inlets of the separator cyclones 30. Particles within the effluent stream are discharged through particle outlets 100 of the separator cyclones 30 and the cleaned effluent gas exits the separator cyclones 30 through a gas outlet 110. The cleaned effluent stream then exits the abatement apparatus cyclone separator 10 through an outlet 120.

### Collector Tray

Figure 2 illustrates the collector tray 50 in more detail. As can be seen, the collector tray 50 forms an annular ring. The annular ring has an inner sidewall 130, a concentrically located outer sidewall 140, a lid 150 and a floor 160. The lid

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150 is provided with sealable apertures 170 which are shaped to receive at least a portion of the separator cyclones 30 which define the particle outlets 100.

Locating the separator cyclones 30 within the sealable apertures 170 seals the internal cavity of the collector tray 50 from the effects of the water curtain 90 and any transiting fluid stream through the central aperture 80.

The floor 160 is provided with a pair of drains 180. As can be seen in Figure 3, in which the lid 140 has been removed to more clearly show the floor 160, the floor 160 is inclined or slopes such that the height of the floor 160 within the collector tray 50 varies. In particular, the height of the floor is at its lowest in the vicinity of the drains 180 and at its highest midway between the drains 180. Although in this example, the floor 160 has a constant gradient, it will be appreciated that a variable gradient may be provided, depending on the nature of the particles exiting the separator cyclones 30 in order to encourage them towards the drains 180. Also, although the surface of the floor 160 is planar and level in the radial direction, it will be appreciated that the surface may be non-planar and/or may be sloped in the radial direction, again dependent on the nature of the particles in order to encourage them towards the drains 180.

In operation, particles exiting the gas outlets 110 land onto the floor 160 and are conveyed by the slope of the floor 160 to the drains 180. The presence of the lid 150 helps prevent ingress of the water curtain 90 and prevents any back pressure caused by the flow of the effluent stream through the central aperture 80.

#### Nozzle Mechanism

Figure 4 is a perspective view showing the nozzle mechanism 40 in more detail. As can be seen, the nozzle mechanism 40 receives the gas outlets 110. In one arrangement, a paddle 190 is provided which rotates about a central axis 200 when required. The paddle 190 is dimensioned to close the particle outlets 100 when rotated. The paddle 190 need not fully seal the gas outlets 110, but merely needs to impair the flow of gas out of the gas outlets 110. As the paddle 190

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blocks the outlet 110, a pressure pulse is created within the separator cyclones 30 which helps to dislodge any accumulating particles. Although a rotating paddle arrangement is shown, it will be appreciated that other shutter mechanisms may be provided which obscure the gas outlets 110 either  
5 individually or together.

Figure 5 is a cross-sectional view through the nozzle mechanism 40. As can be seen, a set of radially extending conduits 210 couple with an effluent inlet 220 of each of the separator cyclones 30. The effluent inlets 220 receive the effluent  
10 stream containing particles to be separated by the separator cyclones 30. A spray nozzle 230 is located at a centre of the radially extending conduits 210.

In operation, the spray nozzle 230 ejects a fluid stream (typically water) out of spray apertures (not shown) radially aligned with the conduits 210 and effluent  
15 inlets 220. This causes the fluid to enter the effluent inlets 220 together with the effluent stream and helps to dislodge particles within the separator cyclones 30. Although in this arrangement fluid enters each effluent inlet 220 simultaneously, it will be appreciated that the fluid may be provided to each separator cyclone 30 individually and, typically, consecutively. Furthermore, a rotating nozzle may be  
20 provided to reduce the number of orifices required. The fluid exiting the outlets 120 help to convey the particles on the floor 160 towards the drains 180.

Although in this embodiment both a paddle 190 and spray nozzle 230 are provided, it will be appreciated that this need not be the case and just one of  
25 these may be provided to dislodge particles within the separator cyclones 30.

As mentioned above, an air cyclone is designed to extract heavy particulate and moisture from a gas stream in a negative or positive atmosphere. Existing cyclones used for heavy/high particulate processes have failed due to the  
30 particulate clogging the outlets meaning the water starting oscillating in the cyclones. The amount of particulate can be unexpectedly high, and the type of particulate can be a dense, 'mud-like', powder. Failure was also attributed to the

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fact the cyclones outlets were sat within a high flow area with only a baffle below to prevent back-flow of gas up into the cyclone outlets. Active water injection is used to prevent particulate build-up and allow active flushing of this particulate out of the system. In one embodiment, spray jet nozzles are used for washing of cyclones. A jet is sprayed into the inlet of each cyclone. In one embodiment, the pump and spray nozzle are controlled via software. The duration of the cyclone spray and pump operation is selectable at between 1 and 120 seconds. The operation of both the cyclone and pump is selectable to be either concurrent or sequential. A startup sequence is provided to enable longer pre-flushing on startup (to fill the tray). In one embodiment, the cyclone outlets are within a sealed environment to stop backflow and to ensure draining. The bottom water tray is sloped towards outlets to help with draining. Dual outlets are provided on the underside of the water tray to help reduce restrictions through a single outlet. Accordingly, the cyclone outlets have been redesigned and backflow prevented by sealing the outlets in a ring to protect from the gas flows/pressures of the environment. Sealing the cyclone outlets in their own environment, enabled the use of a water flushing system. As part of this water flushing system design, it needs to handle the removal of particulates, this is implemented by providing two outlets from the sealed environment, which can go to an area for removal, that doesn't impact the pressure or flow to the cyclone outlets. It can also be actively pumped to ensure the particulate is removed, or can be passive, using the head of water collected to drain the sealed environment.

Accordingly, it can be seen that one embodiment provides sealed cyclone outlets – outlets of the cyclones are sealed within the 'ring' which means no interference from positive or high flow/pressure environments. This means the cyclone can be used within different types of atmosphere and if the cyclone has enough flow velocity through the inlet. It also allows the captured particulate to be contained and actively or passively managed e.g. flushing/pumping particulate. One embodiment provides a curved/sloped tray design. The design allows the particulate to flow/fall naturally towards the outlets of the tray and then passively or actively managed out of the tray. One embodiment provides active flushing.

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The tray may be optionally flushed with fluid to assist in the removal of the particulate. One embodiment provides active pumping of the sealed cyclone outlets. A pump may be optionally attached to the tray outlet ports, to actively pump the particulate out for disposal. This pump can be used permanently or  
5 intermittently in conjunction with or alone from active flushing.

Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the invention is not limited to the precise embodiment and that various changes and  
10 modifications can be effected therein by one skilled in the art without departing from the scope of the invention as defined by the appended claims and their equivalents.

REFERENCE SIGNS

|    |                                          |
|----|------------------------------------------|
|    | abatement apparatus cyclone separator 10 |
|    | casing 20                                |
| 5  | separator cyclones 30                    |
|    | nozzle mechanism 40                      |
|    | collector tray 50                        |
|    | water quench 60                          |
|    | inlet 70                                 |
| 10 | central aperture 80                      |
|    | water curtain 90                         |
|    | particle outlets 100                     |
|    | gas outlets 110                          |
|    | outlet 120                               |
| 15 | inner wall 130                           |
|    | outer wall 140                           |
|    | lid 150                                  |
|    | floor 160                                |
|    | apertures 170                            |
| 20 | drains 180                               |
|    | paddle 190                               |
|    | central axis 200                         |
|    | conduits 210                             |
|    | effluent inlet 220                       |
| 25 | spray nozzle 230                         |

CLAIMS

1. A collection tray for an abatement apparatus cyclone separator operable to separate particles from a processing tool effluent stream, said collection tray  
5 comprising:  
    sidewalls; and  
    an inclined floor positionable to receive said particles from a plurality of cyclone separators locatable above said collection tray and to convey said particles to a drain aperture.
- 10 2. The collection tray of claim 1, wherein a height of said inclined floor for adjacent cyclone separators differs.
3. The collection tray of claim 2, wherein said height varies one of linearly  
15 and non-linearly.
4. The collection tray of Claim 1, wherein said sidewalls comprise an inner cylinder separated from a concentric outer cylinder by said inclined floor and said inclined floor is inclined between said inner cylinder and said outer cylinder.
- 20 5. The collection tray of Claim 1, comprising a lid having sealable apertures for receiving a corresponding one of said plurality of cyclone separators.
6. A cleaner for an abatement apparatus cyclone separator operable to  
25 separate particles from a processing tool effluent stream, said cleaner comprising:  
    a mechanism activatable to interact with fluid flow within said cyclone separator to dislodge gathered particles within said cyclone separator.
- 30 7. The cleaner of claim 6, wherein said mechanism comprises a nozzle operable to spray fluid into an inlet of said cyclone separator.

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8. The cleaner of claim 7, wherein said abatement apparatus cyclone separator comprises a plurality of cyclone separators and said nozzle comprises plurality of outlets, each operable to spray a fluid into an inlet of one of said plurality of cyclone separators.

5

9. The cleaner of claim 8, wherein said nozzle is operable to spray said fluid into said inlets one of consecutively and simultaneously.

10. The cleaner of claim 8, wherein said plurality of cyclone separators are arranged circumferentially and said nozzle is rotatable to spray said fluid into each of said inlets consecutively.

10

11. The cleaner of Claim 6, wherein said mechanism comprises a restrictor operable to restrict fluid flow from an outlet of said cyclone separator.

15

12. The cleaner of claim 11, wherein said restrictor comprises a member and an actuator configured to translate said member between positions which cover and uncover said outlet.

13. The cleaner of claim 12, wherein said abatement apparatus cyclone separator comprises a plurality of cyclone separators and said actuator is configured to translate said member between positions which cover and uncover each outlet of said cyclone separators.

20

14. The cleaner of claim 13, wherein said actuator is configured to translate a plurality of said members between positions which cover and uncover said outlet of a corresponding cyclone separator.

25

15. An abatement apparatus cyclone separator comprising at least one of the collection tray of claim 1 and the cleaner of claim 6.

30

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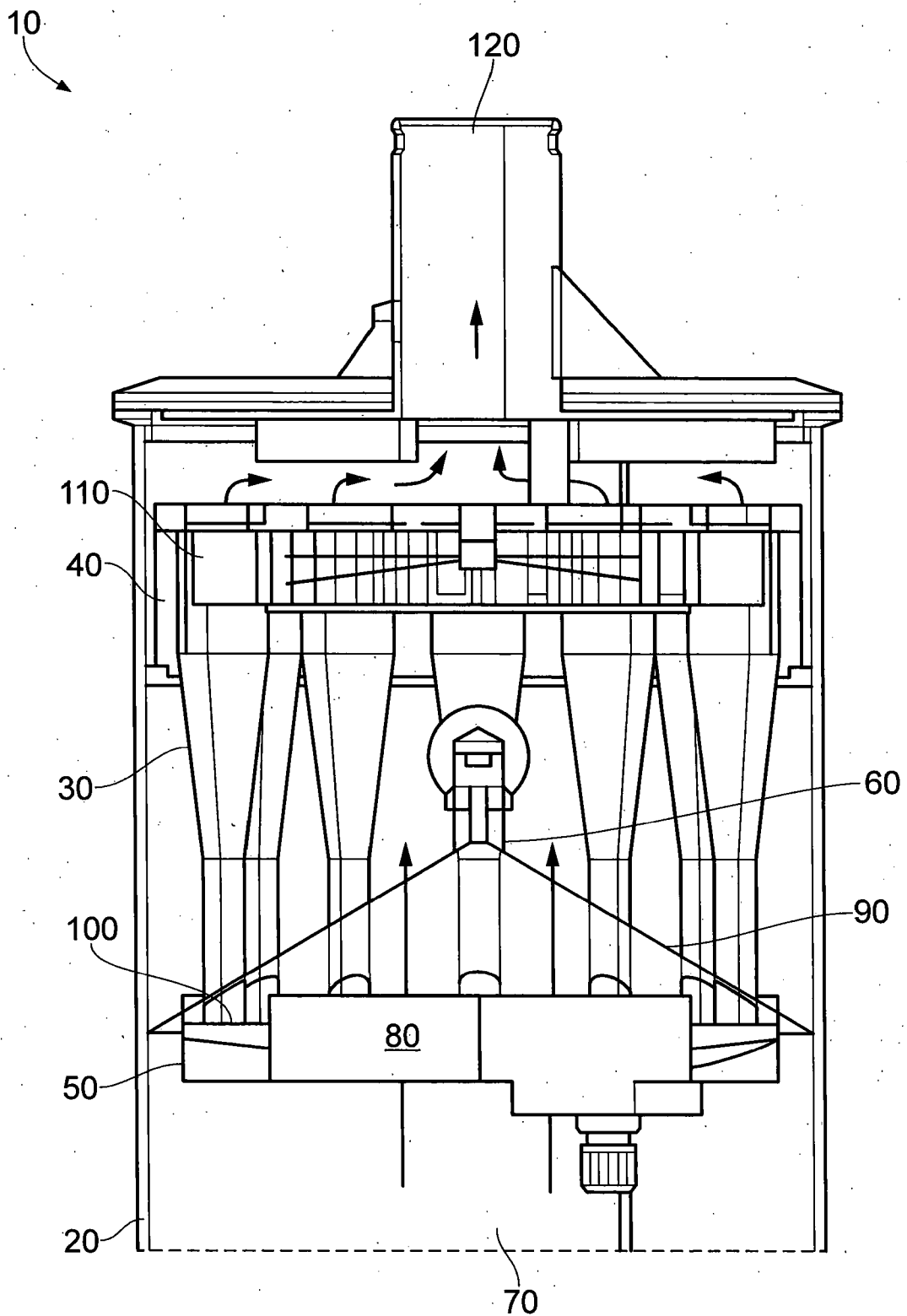


FIG. 1

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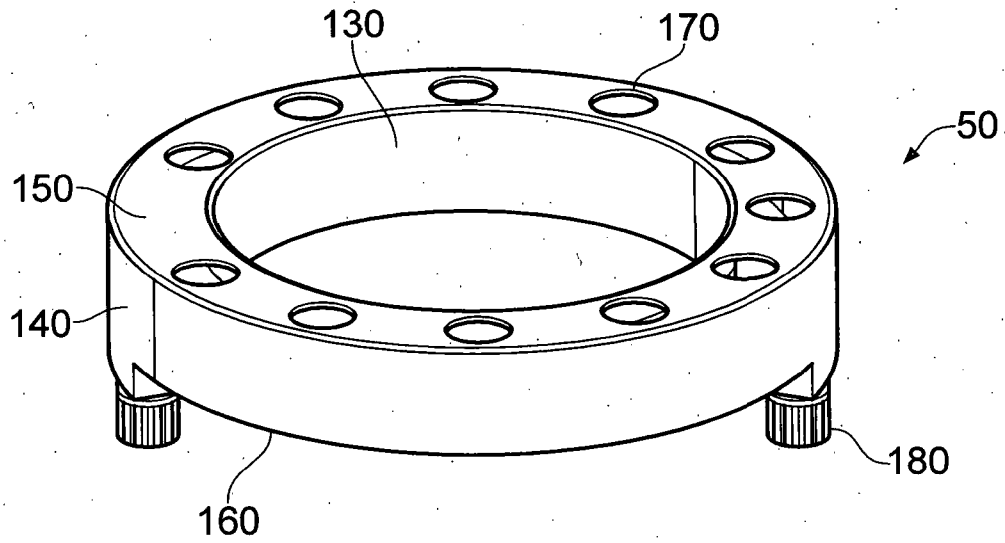


FIG. 2

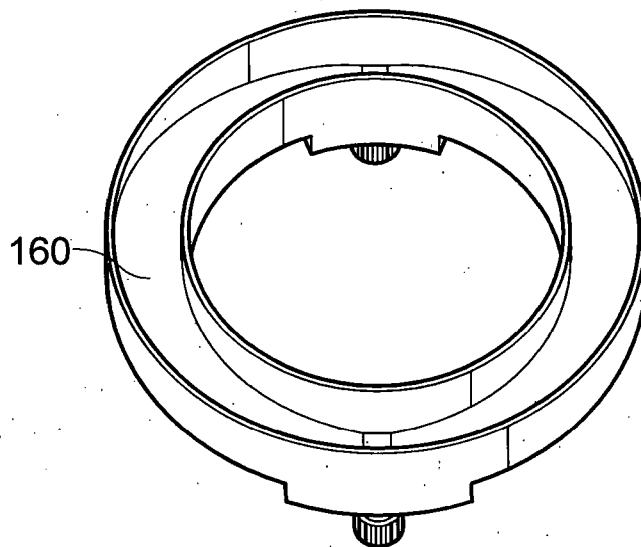


FIG. 3

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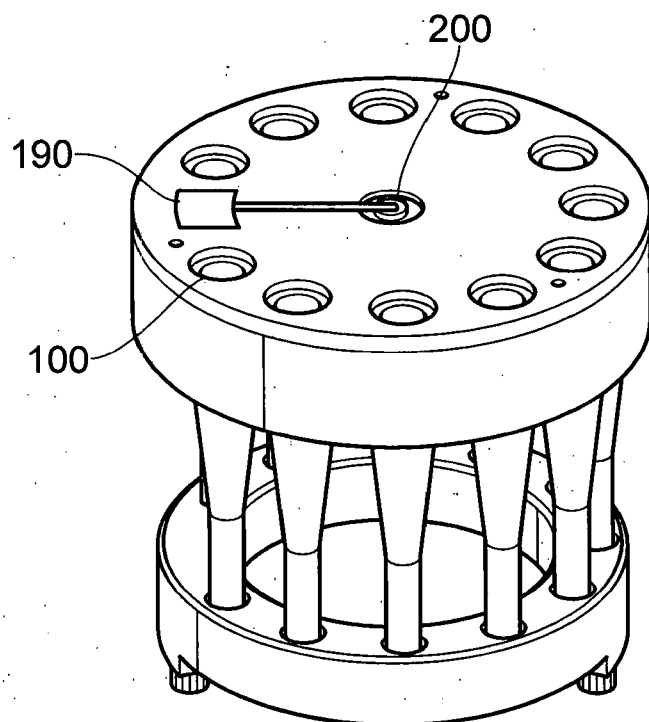


FIG. 4

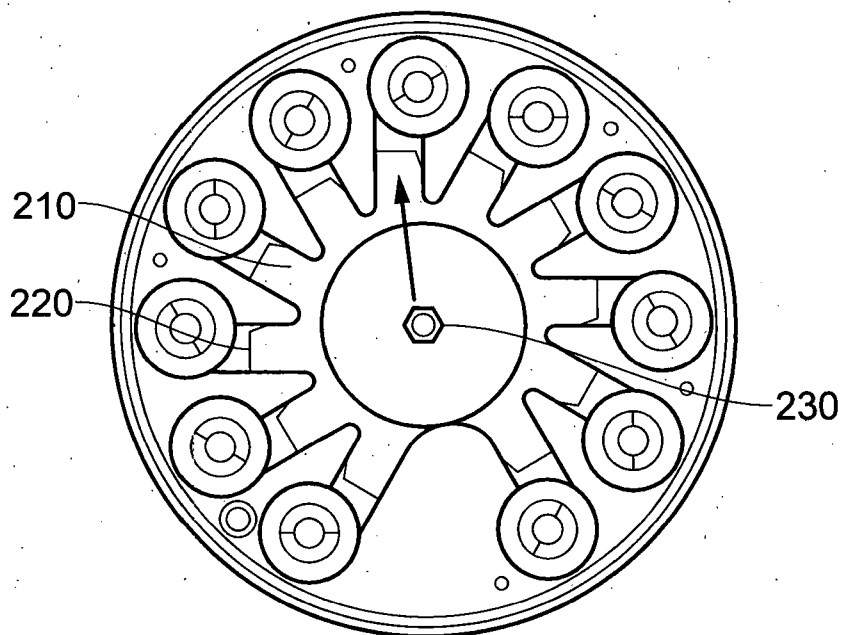


FIG. 5

# INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2020/050294

## A. CLASSIFICATION OF SUBJECT MATTER

INV. B04C5/185 B04C5/28  
ADD. B04C9/00

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)  
B04C

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         | CN 108 212 564 A (CHINA ENFI ENG CORP)<br>29 June 2018 (2018-06-29)<br>figures 2,4,5               | 1-5,15                |
| X         | JP 2017 047368 A (IHI CORP; WURTH PAUL IHI<br>CO LTD) 9 March 2017 (2017-03-09)<br>figures 2,4,6,8 | 1-5,15                |



Further documents are listed in the continuation of Box C.



See patent family annex.

### \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"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

"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

23 April 2020

Date of mailing of the international search report

29/06/2020

Name and mailing address of the ISA/

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Authorized officer

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/GB2020/050294

### 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.:  
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:
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:

see additional sheet

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 an 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.:

1-5(completely); 15(partially)

#### 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.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5(completely); 15(partially)

collection tray  
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2. claims: 6-14(completely); 15(partially)

cleaner  
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2020/050294

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---|---------------------|----------------------------|---------------------|
| CN 108212564                              | A | 29-06-2018          | NONE                       |                     |
| -----                                     |   |                     |                            |                     |
| JP 2017047368                             | A | 09-03-2017          | NONE                       |                     |
| -----                                     |   |                     |                            |                     |