(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 235 413 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.10.2017 Bulletin 2017/43

(51) Int Cl.:
A47L 9/16 *(2006.01)*

(21) Application number: **16166389.3**

(22) Date of filing: **21.04.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Senur Elektrik Motorlari San. Ve Tic. A.S.**
34310 Istanbul (TR)

(72) Inventors:
- **ULUKAN, Yasemin**
  34310 Istanbul (TR)
- **GÜZELTEPE, Fahrettin**
  34310 Istanbul (TR)
- **TURAN, Arif Ozan**
  34310 Istanbul (TR)

(74) Representative: **Sevinç, Erkan**
Istanbul Patent A.S.
Plaza-33, Büyükdere Cad. No: 33/16
Sisli
34381 Istanbul (TR)

(54) CYCLONIC SEPARATOR

(57) The present invention proposes a mainly cylindrical cyclone (1) for household vacuum cleaners, having a mainly rectangular inlet with a width (b) to height (a) ratio (b/a) at a value between 0.4 and 0.65; the cyclone further comprises a main axis (A1) and a mainly prismatic flow path (11) on a first plane (P1) orthogonal to the main axis (A1), wherein the flow path (11) comprises an inlet length (c) of at least 20 millimeters along a mainly linear flow axis (A2). The present invention further proposes a household vacuum cleaner comprising such cyclone.

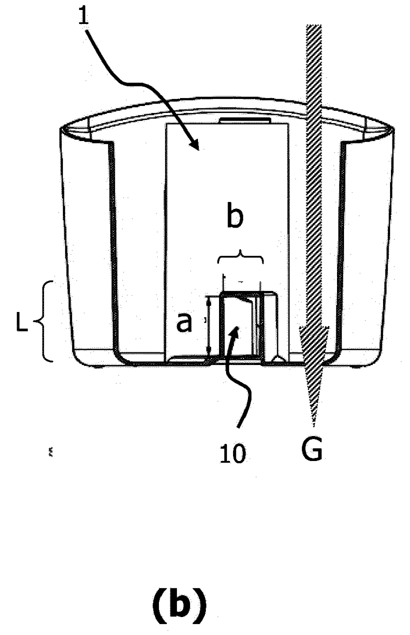


FIGURE 1

EP 3 235 413 A1

Description

Technical Field of the Invention

[0001] The present invention relates to a cyclonic separator, and more specifically to an improved cyclonic separator for vacuum cleaners.

Background of the Invention

[0002] For solid-gas separation (e.g. dust separation), various cyclonic separator designs are employed in different industries, as well as in household vacuum cleaners. US 2015/216 384 discloses an upright vacuum cleaner with a cyclonic separator, and EP 2 820 990 discloses a horizontal vacuum cleaner with an inclined cyclonic separator. Horizontal vacuum cleaners may comprise cyclonic separators with an inclined main axis (A1), or typical upright cyclonic separators designed to perform in a reversed manner (i.e. reversed cyclonic separators). At reversed cyclonic separators, the effects of forces acting during vortex formation differ from those at typical upright cyclonic separators. Therefore a specific design is required to obtain high performance in reversed cyclonic separators.

[0003] Single stage cyclonic separators in the market have a limited efficiency in separation of fine solid (dust) particles (i.e. particles with a diameter of about 0.4 micrometers or smaller) from coarse ones (i.e. particles with a diameter of 4.2 micrometers or larger), therefore such separators require further improvement. Especially low extent of separation of coarse solid particles with higher diameter values causes clogging of fine dust filters which are employed with the aim of filtering fine solid particles. In such case, fine dust filters are at least partly occupied by coarse particles, thus end up by being used ineffectively. Fine dust filters are generally known to be more expensive, therefore this problem can be solved either by frequent replacement of a fine dust filter, or by employing a coarse dust filter upstream with respect to a fine dust filter. Both solutions are problematic by being economically non-feasible; and in the latter case by necessitating a higher volume dedicated for such system of multiple filters.

[0004] Furthermore, structural designs of the common cyclonic separators result in improperly balanced accumulation of particles in a respective dust tank (100). Therefore, base of a tank (100) operated with such cyclonic separator gets disproportionally covered with particles. In such case the tank (100) necessitates shaking during operation for obtaining a proper distribution of particles on its base, or requires emptying and cleaning before being completely filled with particles, thus results in intermittences of operation. Additionally, several positioning restrictions apply to known cyclonic separators to be employed in vacuum cleaners for obtaining acceptable separation results; which restrictions negatively affect the flexibility of industrial designers at designing such vacuum cleaners. These issues require a thorough rearrangement of several design parameters concerning cyclonic separators.

Objects of the Invention

[0005] Primary object of the present invention is to overcome the abovementioned shortcomings of the prior art.

[0006] Another object of the present invention is obtainment of a cyclonic separator for increased retention of solid particles.

[0007] A further object of the present invention is obtainment of a cyclonic separator providing higher design flexibility.

[0008] A further object of the present invention is provision of an economically advantageous cyclonic vacuum cleaner with improved efficiency in particles retention.

Summary of the Invention

[0009] The present invention proposes a mainly cylindrical cyclone for household vacuum cleaners, having a mainly rectangular inlet with a width (b) to height (a) ratio (b/a) at a value between 0.4 and 0.65; the cyclone further comprising a main axis (A1) and a mainly prismatic flow path (11) on a first plane (P1) orthogonal to the main axis (A1), wherein the flow path (11) comprises an inlet length (c) of at least 20 millimeters along a mainly linear flow axis (A2). The present invention further proposes a household vacuum cleaner comprising such cyclone.

Brief Description of the Figures

[0010] The figures, whose brief explanation are herewith provided, are solely intended for providing a better understanding of the present invention and are as such not intended to define the scope of protection or the context in which said scope is to be interpreted in the absence of the description.

Figure 1 shows (a) a side view of an assembly of a tank (100) and a cyclone according to the present invention, and (b) a section view thereof.

Figure 2 shows (a) a side view of an assembly of a tank (100) and a cyclone according to the present invention, and (b) a section view thereof.

Figure 3 shows (a) a section view, and (b) a side view of an assembly of a tank (100) and a cyclone according to the present invention.

Figure 4 shows (a) a front view of an assembly of a tank (100) and a cyclone according to the present invention, and (b) a section view thereof.

Figure 5 shows (a) a section view of a filter designed for the cyclone according to the present invention, and (b) a top view thereof.

Figure 6 shows (a) a section view of an assembly of a cyclone according to the present invention and a tank (100), wherein the filter shown in Fig.5 is adapted thereto, and (b) a perspective view of an assembly of a cyclone according to the present invention and a tank (100).

Figure 7, 8 and 9 show comparative results of modular tests where the cyclone according to the present invention is compared with cyclones of three different brands on the market, respectively.

Figure 8 shows comparative results of integral tests where the cyclone according to the present invention assembled with complementary parts forming a household vacuum cleaner is compared with the comparative cyclone of Fig.9 assembled with complementary parts forming a household vacuum cleaner available on the market.

Detailed Description of the Invention

[0011] Referring now the figures outlined before, the present invention proposes a cyclonic separator, and more specifically a cyclonic separator for vacuum cleaners.

[0012] The cyclonic separator (which is hereinafter also called 'cyclone') according to the present invention is intended to be employed in gas-solid separation systems such as horizontal vacuum cleaners. For the best performance in operation, the cyclone according to the present invention is to be positioned mainly upright. This means the cyclone has a longitudinal main axis (A1) which is, in operation, to be aligned mainly parallel to a gravity vector. The cyclone according to the present invention is preferably mainly cylindrical and its diameter is called cyclone diameter (e) hereinafter. The cyclone diameter (e) preferably has a value between 80 mm and 100 mm, more preferably between 85 mm and 95 mm, even more preferably about 90 mm, especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner.

[0013] The cyclone (1) has an inlet (10) in a lower portion (L) thereof; wherein the lower portion is a distal portion which is to be, in operation, positioned closer to the ground when compared with an upper portion of the cyclone. The inlet has a mainly rectangular geometry, wherein the ratio (b/a) of an inlet width (b) to an inlet height (a) has a value between 0.4 and 0.65, more preferably between 0.55 and about 0.62, even more preferably 0.6. Herein, the term 'height' refers to a distance which, in operation, is in a direction mainly parallel to the gravity vector (G); whereas the term 'width' refers to a distance mainly orthogonal to the height. The inlet width (b) and inlet height (a) define the inlet as an opening where fluids (gases) to be separated from solid particles enter to the cyclone.

[0014] The cyclone comprises a mainly prismatic flow path (11) on an imaginary first plane (P1) orthogonal to the main axis (A1) of the cyclone. The flow path (11) connects the inlet to an initial deflection zone (12) having a common wall with an inner surface (i.e. inner wall) of the cyclone. Thus, starting from the inlet, the cyclone communicates with a flow path (11) which connects tangential to the initial deflection zone (12) of an inner surface of the cyclone, which inner surface in operation starts deflecting a fluid stream (S) coming from the inlet, helically around the main axis (A1) of the cyclone.

[0015] The flow path (11) is a duct having an inlet length (c) of at least 20 millimeters between the inlet and the initial deflection zone (12) along a mainly linear flow axis (A2). The inlet length (c) has preferably a length of about 55 mm or larger, even more preferably about 60 mm, especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner.

[0016] At the initial deflection zone (12), the lower portion of the cyclone comprises a ramp (13) with an elevation angle ($\beta 1$) of 25 degrees to 35 degrees, more preferably of 28 degrees to 32 degrees (i.e. about 30 degrees) from the first plane (P1). Thus, upon connecting to the inner surface of the cyclone at the initial deflection zone (12), the flow path (11) is further deflected such that, in operation, a fluid stream coming from the inlet in a mainly horizontal direction, is deflected (and deviated) against the gravity, in addition to being deflected helically around the main axis (A1) of the cyclone as disclosed above. The resultant of said both deflections simultaneously and effectively slow down the solid particles being dragged along with the fluid flow, by absorbing their momentum. This effect is valid for all solid particles dragged along with the fluid flow, but mostly the solid particles with higher mass (whereby basically, the mass of a mainly global particle is proportional to the third power of its diameter).

[0017] The ramp (13) is a helical duct conducting the initial deflection zone (12) to a release zone (14). Preferably, starting from the initial deflection zone (12) towards the release zone (14), the elevation angle of the ramp (13) gradually decreases to a value (β2) between 0 to 5 degrees, preferably to 0 to 2 degrees, more preferably to 0 to 1 degree, even more preferably about 0 degree with respect to an imaginary second plane (P2) mainly parallel to the first plane (P1). Thereby in operation, direction of the fluid flow is changed to the second plane (P2) mainly parallel to the first plane (P1), and this deviation results in further absorption of the momentum (thus decreasing the velocities) of the solid particles. In operation, a sudden expansion occurs at the release zone (14), where linear velocities of solid particles in the fluid suddenly further drop. In the release zone (14), the fluid mainly rotates around the main axis (A1) of the cyclone, and the stream gets released from the cyclone at an upper portion thereof, into a tank (100) (100) communicating with the cyclone, being pushed by further fluid coming from an upstream direction (i.e. from the inlet (10) and through the ramp (13)). Having lost the momentum keeping them in the fluid stream, solid particles get mainly collected in the tank (100). The stream mainly returns into the upper portion of the cyclone, upon being separated from its solid particle content by leaving most of the particles into the tank (100). The projection of the distance between the first plane (P1) and the second plane (P2) onto the main axis (A1) of the cyclone corresponds to a ramp elevation (h1).

[0018] The ramp elevation (h1) is preferably between 35 mm and 65 mm, more preferably between 45 mm and 55 mm, even more preferably about 50 mm, especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner.

[0019] The cyclone coaxially comprises a longitudinal outlet duct (15) having a diameter narrower than that of the cyclone itself, and preferably at least partly sharing the main axis (A1) of the cyclone. The outlet duct (15) conducts the fluid stream from the upper portion of the cyclone (i.e. a distal portion of the cyclone with respect to the inlet, along a direction parallel to the main axis (A1)) towards an outlet, through which, in operation, the fluid stream is sucked out of the cyclonic separator and gets eventually released from the gas-solid separation system where the cyclone is employed. The projection of the minimum distance between the second plane (P2) and the entrance of the outlet duct (15) opening to the upper portion of the cyclone, onto the main axis (A1) of the cyclone corresponds to a height between ramp and outlet duct (f).

[0020] Throughout the ramp elevation (hi), the outlet duct is surrounded by the ramp (13). Upon leaving the ramp (13), the fluid continues flowing helically upwards around the outlet duct (15), being guided by outer wall thereof along a second elevation (h2). The second elevation (h2) corresponds to a projection of the minimum distance between the second plane (P2) and a third plane (P3) where the entrance of the outlet duct resides parallel to the second plane (P2), onto the main axis of the cyclone. The second elevation (h2) and the height between ramp and outlet duct (f) can be considered as corresponding to each other, as applied in the design variable values used in the examples below. The second elevation (h2) is preferably between 35 mm and 65 mm, more preferably between 45 mm and 55 mm, even more preferably about 50 mm, especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner. In other words, the cyclone preferably comprises a second elevation (h2) having a value between 35 mm and 65 mm, the second elevation (h2) corresponding to the projection onto the main axis (A1), of the distance between the second plane (P2) and a third plane (P3) where the entrance of the outlet duct resides, the third plane (P3) being parallel to the second plane (P2).

[0021] The ratio (f/e) of the height between ramp and outlet duct (f) to the cyclone diameter (e) is preferably between 0.35 and 0.65, more preferably between 0.45 and 0.55, even more preferably of about 0.50, especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner.

[0022] The cyclone has a cyclone height (g) which corresponds to the longest distance between distal ends of the cyclone along the main axis (A1) thereof.

[0023] An outer diameter of the outlet duct (15) is considered as a vortex diameter (d). The ratio (d/e) of the vortex diameter (d) to the cyclone diameter (e) has preferably a value between 0.40 and 0.60, more preferably between 0.45 and 0.50, even more preferably between 0.43 and 0.47, especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner. This provides negligible increase in drag forces acting on fluid stream at favorable dust retention performances.

[0024] The ratio (g/f) of the cyclone height (g) to the height between ramp and outlet duct (f) has preferably a value between 3.5 and 4.5, more preferably between 3.75 and 4.25, even more preferably about 4 especially in case where the cyclone according to the present invention is to be employed in a household vacuum cleaner.

[0025] An exemplary series of experiments are performed in order to design a cyclonic separator suitable for achieving the goals of the invention, which is to be employing in a household vacuum cleaner. By giving the below details about said examples, it is solely intended to provide a better understanding of the present invention and is as such not intended to limit the scope of the appended claims.

EXAM PLES

[0026] Several cyclone designs having various dimensional design variables were manufactured and tested. Preferred design variables are used to obtain a cyclone with a most preferred set of design variables (Cyclone 1). Comparative tests were performed to compare the separation performance of Cyclone 1 with that of various cyclones employed in household vacuum cleaners (Known Cyclones) on the market. The tests were performed according to IEC TC 59 SC 59F (which corresponds to Turkish Standard TS EN 60312-1 : 3013-12 approved by CENELEC).

[0027] A first series of comparative tests (modular tests) were performed as follows: Cyclone 1 and one of Known Cyclones were adapted to corresponding (same) type of vacuum cleaners. A second series of comparative tests (integral tests) were performed by using Cyclone 1 with vacuum cleaner used in modular tests, and known cyclones with their original vacuum cleaners (obtained from the market).

Table 1. Dimensional design variables of the Cyclone 1

Design Variable	*Preferred value range*	*More preferred value range*	*Even more preferred value range*	*Value in Cyclone 1*
b/a	0.4-0.65	0.55-0.62	0.6	0.6
c	min. 20 mm	min. 55 mm	About 60 mm	60 mm
$\beta 1$	25 to 35 deg	28 to 32 deg	About 30 deg	30 deg
$\beta 2$	0 to 5 deg	0 to 2 deg	0 to 1 deg	0 deg
h1	35 to 65 mm	45 to 55 mm	About 50 mm	50 mm
h2 (here, also f)	35 to 65 mm	45 to 55 mm	About 50 mm	50 mm
f/e	0.35 to 0.65	0.45 to 0.55	About 0.50	0.50
e	80 to 100 mm	85 to 95 mm	About 90 mm	90 mm
d/e	0.40 to 0.60	0.45 to 0.50	0.43 to 0.47	0.45
g/f	3.5 to 4.5	3.75 to 4.25	About 4	4

[0028] The above (b/a) and (c) values provide a preferable flow regime to the fluid stream entering the cyclone. The value of (f/e) ratio being 0.50 provides the highest available retention for dust particles of any dimension used in the tests. By using these values in design, pressure drop at the release zone (14), and volumetric flow rate of the fluid stream subjected to separation, were easily increased with minimum energy consumption; which corresponds to minimized entropy generation at the flow through the cyclone. The set of the preferred ranges in design values provides highly satisfactory results in achieving the objects of the present invention.

[0029] Even though the tests were performed without using any filter, also a filter has been designed for further adapting to the entrance of the outlet duct (15). The filter is preferably mainly a frusto-conical hollow body having a closed upper base, and a fine dust filter (preferably HEPA) on its side surface. Maximum inner diameter of the filter is taken as filter diameter (j), and the height of the frustum of the cone is taken as filter height (i). The filter diameter (j) has a value of about that of the vortex diameter (d). This provides negligible increase in drag forces acting on fluid stream at favorable dust retention performances. The test results given in Figs. 7-10 are obtained without using such filter.

[0030] The preferred cyclone height (g), elevation angle and gradual decrease thereof provide favorable transfer of particles under tangential forces up to the release zone (14), and finally into the tank (100). Test results showed that the obtained particle separation ratios are above 50% as defined in IEC 60312-1 standard.

Modular Tests:

[0031] Figures 7, 8 and 9 show comparative results where performances of vacuum cleaner cyclones of several brands available in the market is compared with that of the cyclone according to the present invention, wherein all of the remaining features and factors kept the same for each cyclone. The remaining features and factors include solid particles sample mixture, energy supply and complementary parts for constituting a vacuum cleaner with each cyclone subjected to the tests. The comparative cyclones were codenamed as Cyclone X, Cyclone Y and Cyclone Z, respectively; and the respective vacuum cleaners obtained from the market, comprising said cyclones are identified in the following table:

Table2. Comparative cyclones and vacuum cleaners (VC) with such cyclones

Codes of Comparative cyclones	*Corresponding commercial VC model ID's (in Turkish Market)*	*Results shown in:*
Cyclone X	Fakir Veyron Oko	Fig.7
Cyclone Y	Samsung SC 8690	Fig.8
Cyclone Z	Philips Marathon Ultimate	Fig.9, Fig.10

[0032] In each graph given in Figs 7, 8, 9 and 10, the values on the axis of abscissae correspond to various solid particle sizes in the dust mixture, and the values on the axis of ordinates correspond to separation performance (efficiency, E[%]) for solid particles of various particle sizes.

[0033] The efficiency E[%] here is defined as the ratio of 'total weight of solid particles of a certain size collected in the tank at the end of a test run where a sample is completely subjected to cyclone separation (dCnup-dCndown)' to 'total weight of solid particles of that certain size in the sample before the test run (dCnup)'. X50, X80 and X95 correspond to particle sizes for which minimum efficiency values of 50%, 80% and 95% are observed, respectively. 'Ret.' and 'Ret. (0.4 μm)' correspond to retention (%) of solid particles of all sizes and of solid particles having particle sizes up to 0.4 μm, respectively. Here, 'retention' is considered as analogous to 'efficiency'.

[0034] Figs.7, 8 and 9 show comparative modular test results of the Cyclone 1 according to the present invention (dashed) compared with Cyclones X, Y and Z (all solid), respectively.

[0035] Modular test performance of Cyclone 1 is clearly higher than those of each comparative cyclone at lower particler sizes (up to 2 μm), and clearly higher than those of Cyclone X and Y at higher particle sizes (2 μm and higher).

Table 3. Comparative modular test results (cf. Figs.7 to 9)

Value	*Cyclone 1*	*Cyclone X*	*Cyclone Y*	*Cyclone Z*
X50	0.55 μm	0.89 μm	0.88 μm	0.65 μm
X80	1.60 μm	4.22 μm	3.45 μm	1.77 μm
X95	4.27 μm	-	-	4.30 μm
Ret. (%)	57.26781	38.65980	37.37969	48.76522
Ret (%) (0.4 μm)	36.32140	15.43870	12.68821	22.15520

Integral Tests:

[0036] Figure 10 shows exemplary integral test results comparing a vacuum cleaner comprising the Cyclone 1 according to the present invention with a commercially available vacuum cleaner comprising the comparative Cyclone Z which showed the closest performance to the Cyclone 1 in the modular tests. The legends symbolizing the efficiencies of commercially available vacuum cleaner comprising the Cyclone X and the vacuum cleaner comprising the Cyclone 1 according to the present invention are more distant than those in Fig.9. This is considered as an experimental proof showing the superiority of the cyclone according to the present invention and its performance being even more improved when employed in a household vacuum cleaner.

Table 4. Comparative integral test results (cf. Fig.10)

Value	*Cyclone 1 (in vacuum cleaner)*	*Cyclone Z (in vacuum cleaner)*
X50	0.38 μm	0.50 μm
X80	1.36 μm	1.69 μm
X95	3.82 μm	4.40 μm
Ret. (%)	66.47538	58.97169
Ret (%) (for 0.4 μm)	53.19752	42.01539

[0037] In all experiments, solid particles amounts deposited in the parts of experimental setups (including commercial vacuum cleaners) except in their respective tanks are omitted.

[0038] Thus the following objects are achieved by the present invention:

- overcoming the abovementioned shortcomings of the prior art,
- provision of:
  - a cyclonic separator for increased retention of solid particles,
  - a cyclonic separator providing higher design flexibility,
  - an economically advantageous cyclonic vacuum cleaner with improved efficiency in particles retention.

Claims

1. A mainly cylindrical cyclone (1) with a cyclone diameter (e) for household vacuum cleaners, having a mainly rectangular inlet with a width (b) to height (a) ratio (b/a) at a value between 0.4 and 0.65; the cyclone further comprising a main axis (A1) and a mainly prismatic flow path (11) on a first plane (P1) orthogonal to the main axis (A1), wherein the flow path (11) comprises an inlet length (c) of at least 20 millimeters along a mainly linear flow axis (A2).

2. Cyclone according to the claim 1, wherein the inlet length (c) has a value of at least 55 millimeters.

3. Cyclone according to any of the claims 1 or 2, wherein the width to height ratio (b/a) has a value between 0.55 and about 0.62.

4. Cyclone according to any of the claims 1 to 3, wherein the flow path (11) connects the inlet to an initial deflection zone (12), where the cyclone comprises a ramp (13) with an elevation angle ($\beta 1$) between 25 degrees and 35 degrees from the first plane (P1); and the elevation angle gradually decreases along the ramp (13) towards a release zone (14) at a second plane (P2) mainly parallel to the first plane (P1), to a value ($\beta 2$) between 0 degrees to 5 degrees.

5. Cyclone according to claim 4, wherein the projection of the distance between the first plane (P1) and the second plane (P2) onto the main axis (A1) of the cyclone corresponds to a ramp elevation (h1) having a value between 35 mm and 65 mm.

6. Cyclone according to any of the claims 4 or 5, comprising a second elevation (h2) having a value between 35 mm and 65 mm, the second elevation (h2) corresponding to the projection onto the main axis (A1), of the distance between the second plane (P2) and a third plane (P3) where the entrance of the outlet duct resides, the third plane (P3) being parallel to the second plane (P2).

7. Cyclone according to any of the claims 4 to 6, comprising a longitudinal outlet duct (15) having a diameter narrower than that of the cyclone itself, and preferably at least partly sharing the main axis (A1) of the cyclone; the projection of the minimum distance between the second plane (P2) and the entrance of the outlet duct (15) opening to the upper portion of the cyclone, onto the main axis (A1) of the cyclone corresponding to a height between ramp and outlet duct (f); wherein the ratio (f/e) of the height between ramp and outlet duct (f) to the cyclone diameter (e) is between 0.35 and 0.65.

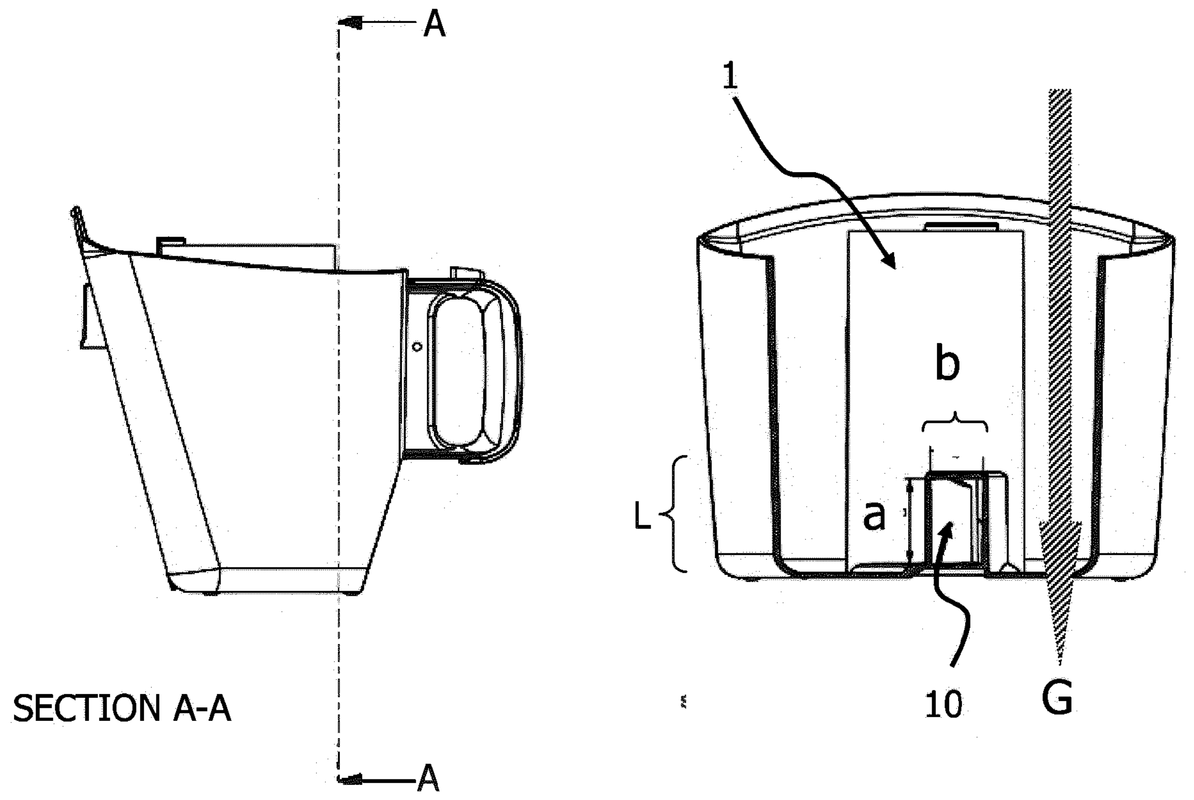
8. Cyclone according to the Claim 7, having a cyclone height (g) corresponding to the longest distance between distal ends of the cyclone along the main axis (A1) thereof, wherein the ratio (g/f) of the cyclone height (g) to the height between ramp and outlet duct (f) has preferably a value between 3.5 and 4.5.

9. Cyclone according to any of the claims 7 or 8, wherein an outer diameter of the outlet duct (15) corresponds to a vortex diameter (d) and the ratio (d/e) of the vortex diameter (d) to the cyclone diameter (e) has a value between 0.40 and 0.60.

10. Cyclone according to any of the claims 1 to 9, wherein the cyclone diameter (e) has a value between 80 mm and 100 mm.

11. A household vacuum cleaner comprising a cyclone according to any of the claims 1 to 10.

12. Use of a cyclone according to any of the claims 1 to 10 in a household vacuum cleaner.



(a) (b)

FIGURE 1

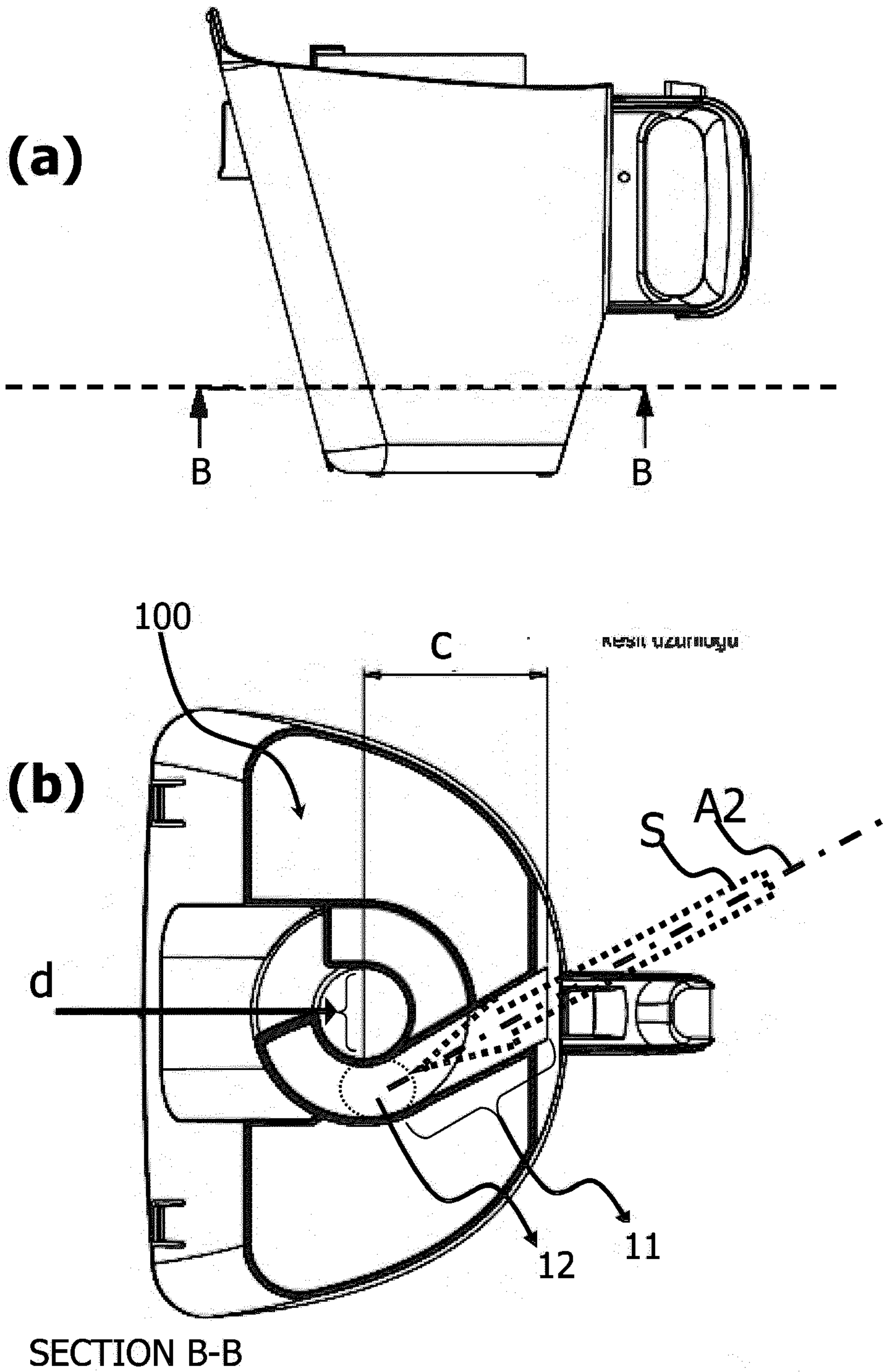


FIGURE 2

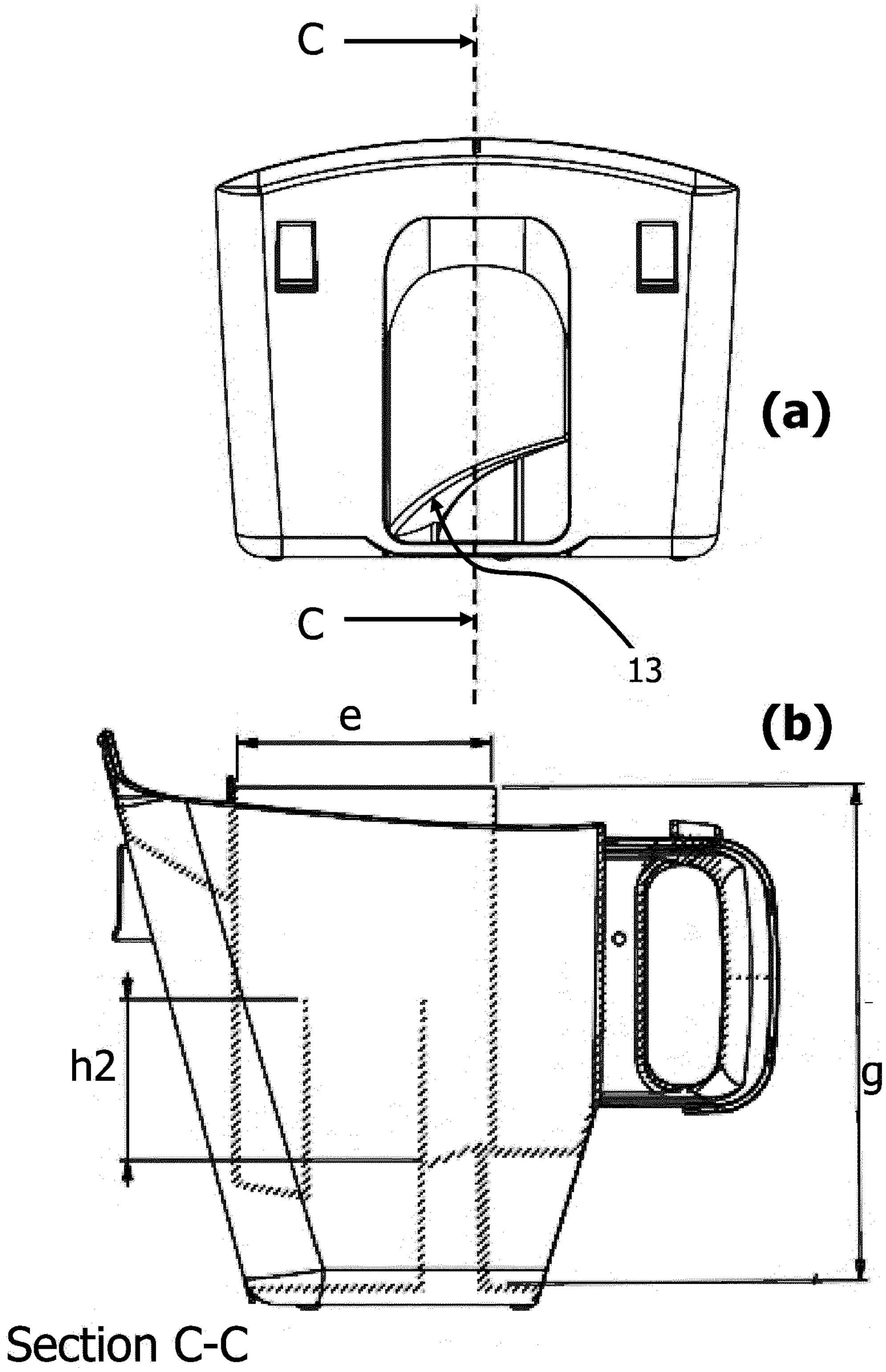
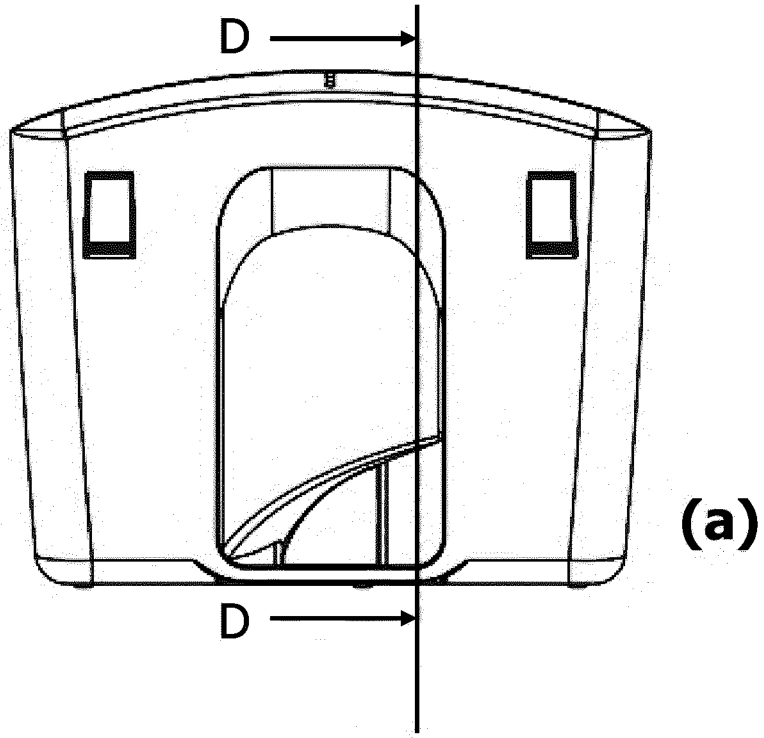


FIGURE 3



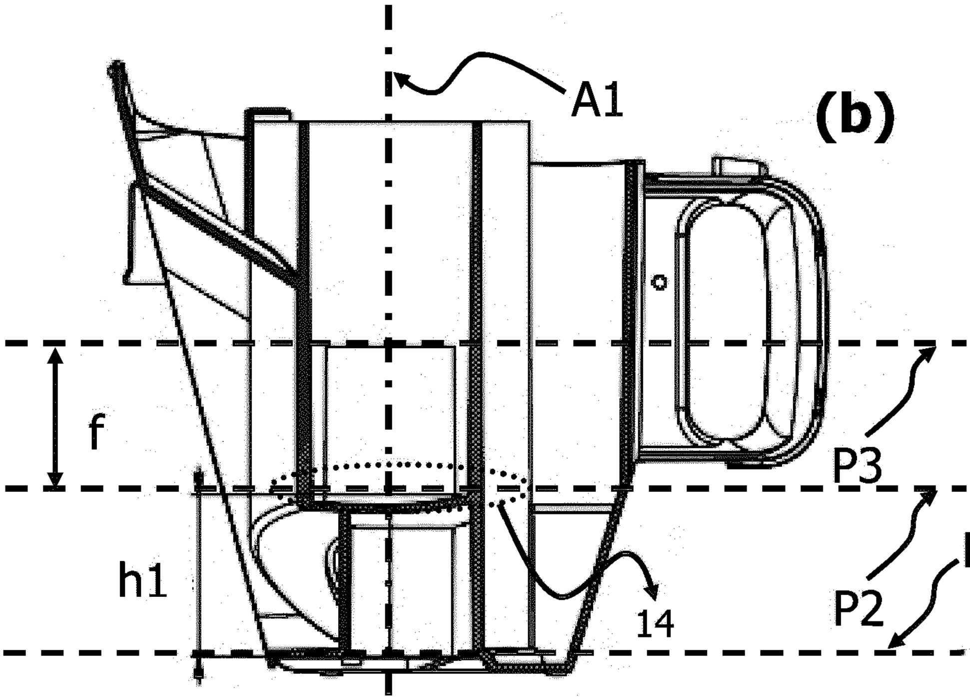


FIGURE 4

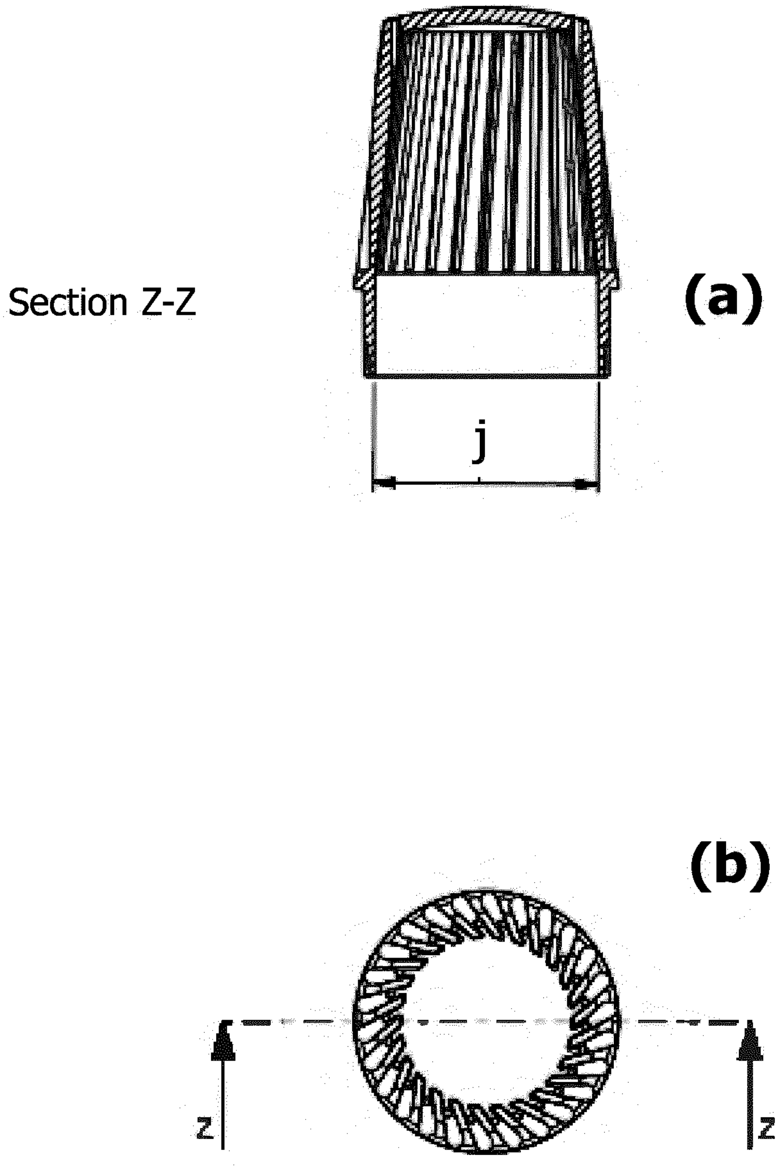


FIGURE 5

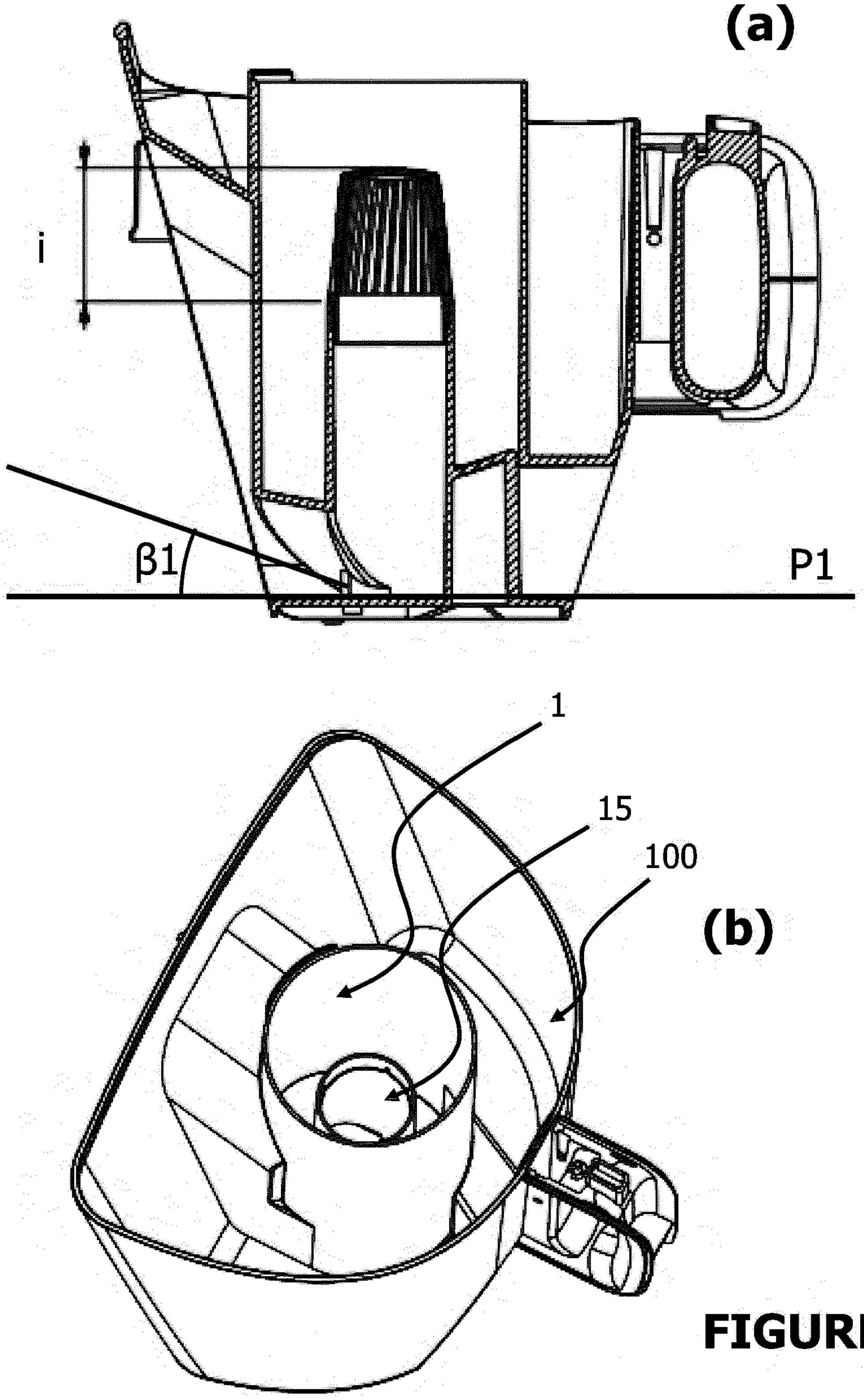


FIGURE 6

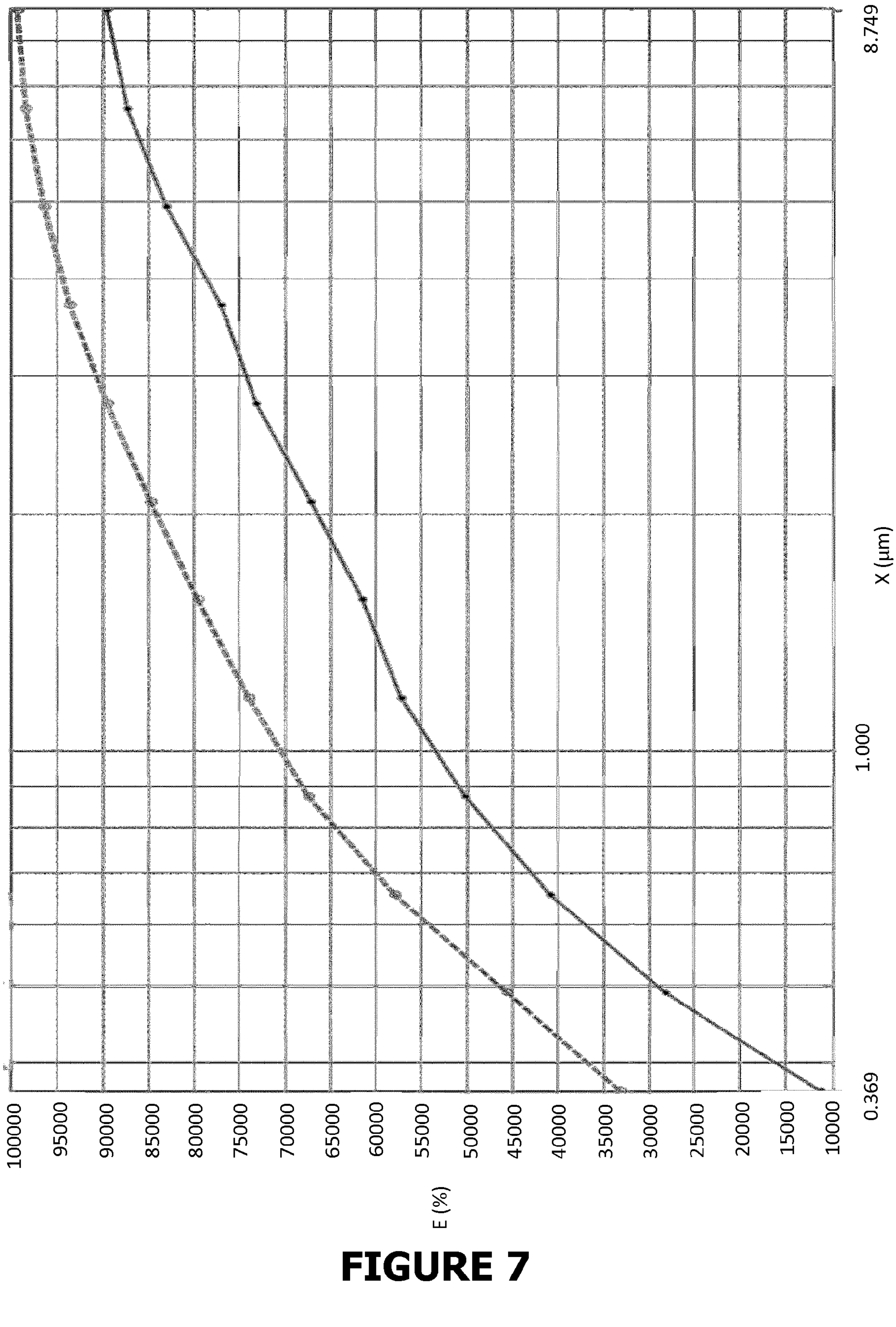

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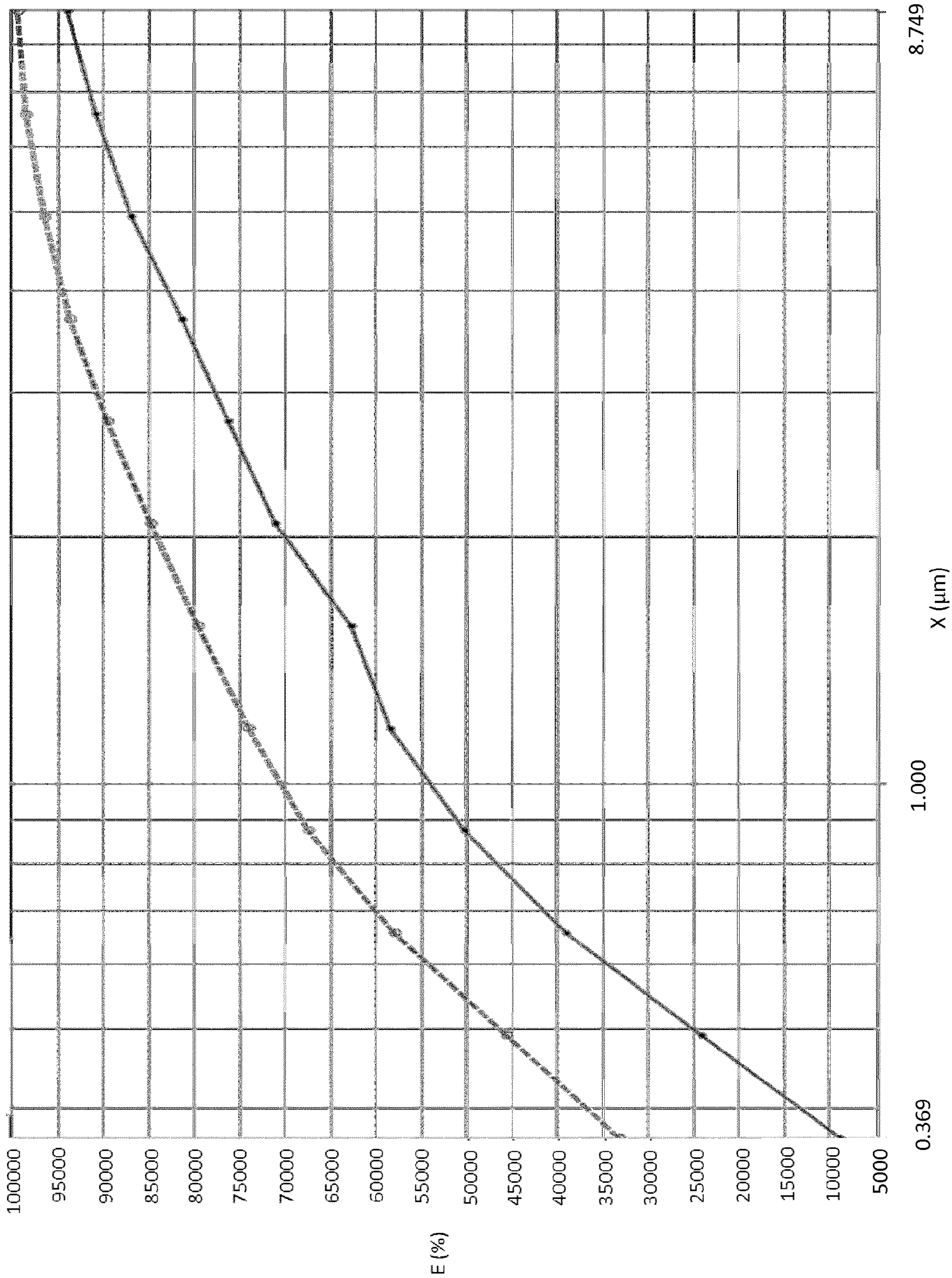
FIGURE 7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25000
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15000
10000
5000
E (%)
0.369
1.000
8.749
X (µm)

FIGURE 8

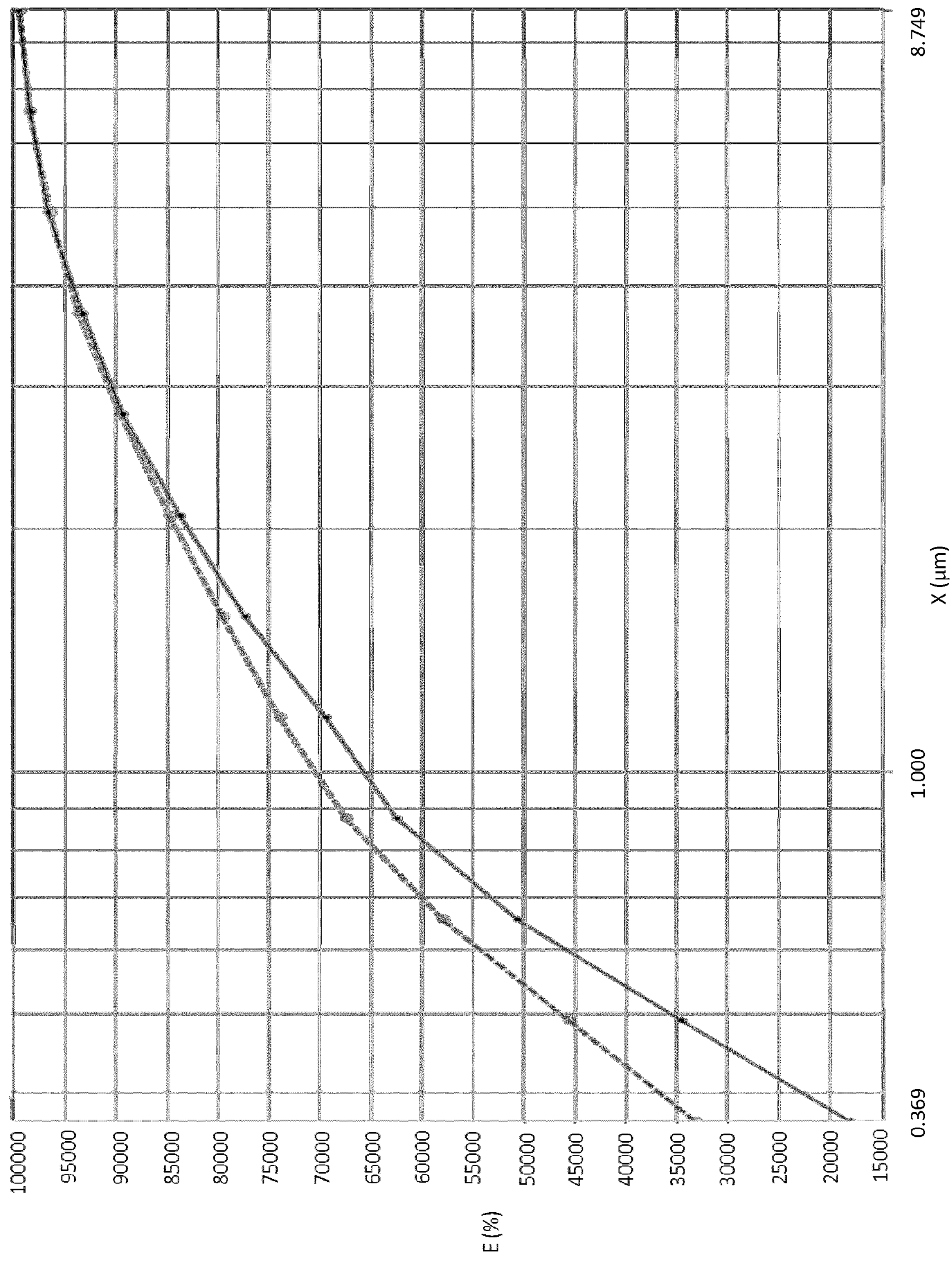
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
E (%)
0.369
1.000
8.749
X (µm)

FIGURE 9

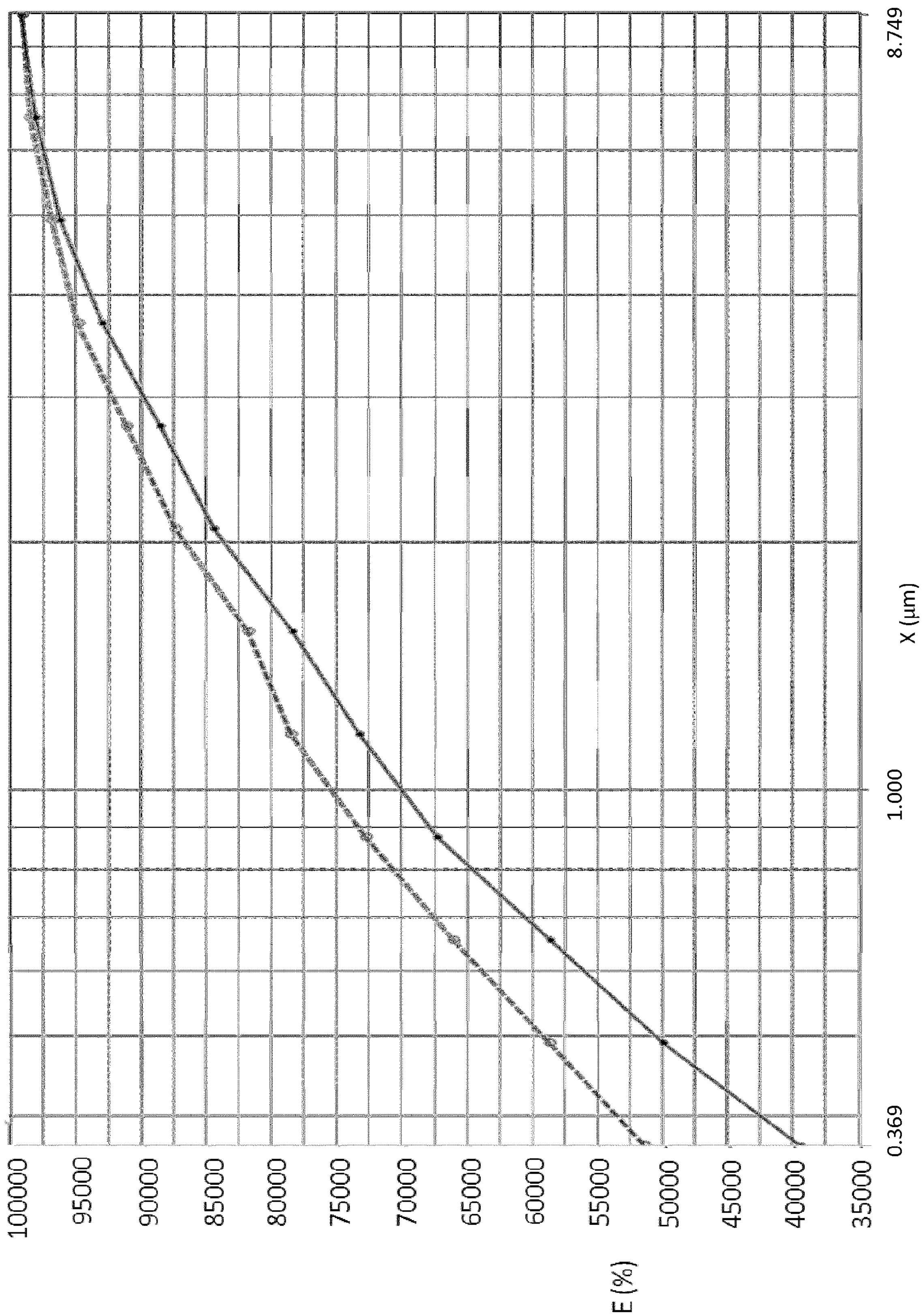
8.749
X (µm)
1.000
0.369
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
E (%)

FIGURE 10

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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 6389

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Place of search	Date of completion of the search	Examiner
Munich	22 September 2016	Lopez Vega, Javier

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