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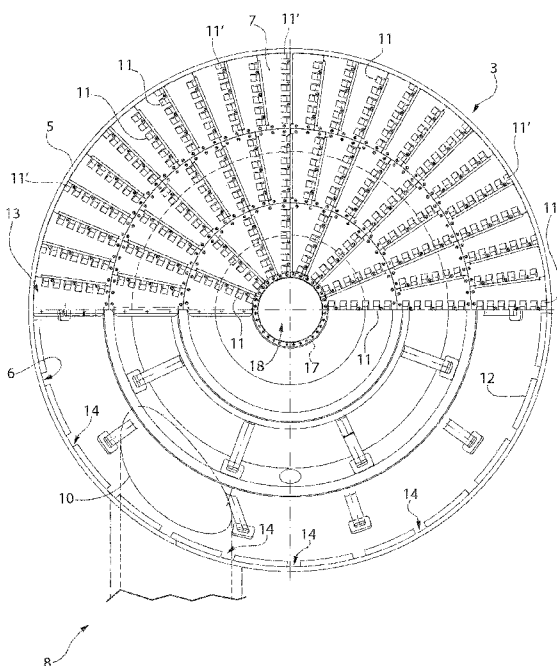


FIG. 2

(57) Abstract: A fluidized-bed reactor for the gas-phase polymerization of olefins; the fluidized-bed reactor (1) having an inner chamber (2), which, in turn, has at least one lower portion (3) and at least one upper portion (4); the fluidized-bed reactor (1) comprising: a gas distribution grid (7), which is located inside the inner chamber (2) and which at least partially separates the lower portion (3) from the upper portion (4); and a recycle line (8), which is configured to feed a fluidizing gas to the lower portion (3) and has a first end (9) connected to the inner chamber (2) at the upper portion (4); the gas distribution grid (7) comprise a plurality of openings, that are configured to allow the passage of the fluidizing and comprise a plurality of openings (11') located at less than 30 mm from the inner surface (6) of the lateral wall (5).



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TITLE: "FLUIDIZED-BED REACTOR FOR THE GAS-PHASE POLYMERIZATION OF OLEFINS"

DESCRIPTION

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TECHNICAL FIELD

The present invention relates to a fluidized-bed reactor for the gas-phase polymerization of olefins and a process of preparing an olefin polymer.

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BACKGROUND OF THE INVENTION

Gas-phase polymerization processes are economical processes for the preparation of polyolefins such as homopolymers of ethylene or propylene or copolymers of ethylene or propylene with other olefins. Fluidized-bed reactors for carrying out such processes have been known for a long time. These reactors contain a bed of polymer particles which is maintained in a fluidized state by an upward flow of a fluidizing gas. Customary reactors comprise, *inter alia*, a reactor space in the form of an inner chamber of a vertical cylinder. These reactors have a recycle gas line, in which coolers for removing the heat of polymerization, a recycle gas compressor and, if desired, further elements such as a cyclone for removing fine polymer dust are installed. Monomers consumed by the polymerization reaction are normally replaced by adding make-up gas to the recycle gas stream.

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To achieve a homogeneous distribution of the fluidizing gas in the bed of growing polymer particles, some reactors are equipped with a gas distribution grid, sometimes also called gas fluidization grid or distribution plate. Such a gas distribution grid is a device provided with openings which dispense into the bed a gas stream introduced under the grid itself. The grid also acts as support for the bed when the supply of gas is cut off.

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The gas distribution grid can be configured as a perforated or porous plate, sometimes in combination with an upstream flow divider. It is possible to arrange roof-shaped deflector plates above the openings in the distributor plate, as for example disclosed in EP 0 697 421 A1, or to cover the openings with a cap as described in EP 0 600 414 A1. The geometry of the gas distribution grid may also deviate from a plate. EP 0 088 638 A2 discloses a gas distributor for a fluidized-bed reactor which has a double cone-body. WO 2008/074632 A1 describes a gas distribution grid which has the form of an inverted cone. Due to the high amount of circulated fluidization gas and the consequently large size of the gas inlet nozzle, a relatively large volume is required below the gas distribution grid.

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Over time, the fines present in the fluidizing gas can accumulate in the space under the reactor grid. These reactive fines in stagnant conditions can then develop polymer agglomerates which can eventually obstruct the grid openings and thus jeopardize the operability and reliability of the reactor system.

There is accordingly a need to provide a fluidized-bed reactor which allows fine polymer particles carried over by the fluidizing gas to be easily transported back into the fluidized bed of polymer particles.

The object of the present invention is to provide a fluidized-bed reactor and a process of preparing an olefin polymer that allow the drawbacks of the known art to be at least partially overcome, and which are, at the same time, simple and inexpensive to implement.

#### SUMMARY

According to the invention there is provided a fluidized-bed reactor and a process of preparing an olefin polymer according to the appended independent claims and, preferably, according to any one of the claims directly or indirectly depending on the independent claims.

#### BRIEF DESCRIPTION OF THE FIGURES

The invention is hereinafter described with reference to the accompanying drawings, which depict a non-limiting embodiment thereof, wherein:

- figure 1 is schematic and side view of a fluidized-bed reactor in accordance with the invention;
- figure 2 is a plan view of the part of figure 1 with some details removed for clarity;
- figure 3 is a lateral cross-section of a part of the fluidized-bed reactor of figure 1;
- figure 4 is a front cross-section of a detail of figure 3;
- figure 5 is a lateral cross-section of the detail of figure 4.

#### DETAILED DESCRIPTION

In figure 1, the numeral 1 indicates as a whole a fluidized-bed reactor for the gas-phase polymerization of olefins. The fluidized-bed reactor 1 has an inner chamber 2, which, in turn, has at least one lower portion 3 and at least one upper portion 4. The fluidized-bed reactor 1 comprises: at least one lateral wall 5, which has an inner surface 6 delimiting the inner chamber 2 laterally (at least partially); a gas distribution grid 7, which is located inside the inner chamber 2 and which (at least

partially) separates the lower portion 3 from the upper portion 4; and a gas recycle line 8, which has a first end 9 connected to the inner chamber 2 at the upper portion 4 and a second end 10 connected to the inner chamber 2 at the lower portion 3.

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In particular, olefins which may be polymerized in the fluidized-bed reactor of the present disclosure are especially 1-olefins, i.e. hydrocarbons having terminal double bonds, without being restricted thereto. Preference is given to nonpolar olefinic compounds. Particularly preferred 1-olefins are linear or branched C<sub>2</sub>-C<sub>12</sub> -1-alkenes, in particular linear C<sub>2</sub>-C<sub>10</sub> -1-alkenes such as ethylene, propylene, 1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-decene or branched C<sub>2</sub>-C<sub>10</sub>-1-alkenes such as 4-methyl-1-pentene, conjugated and nonconjugated dienes such as 1,3-butadiene, 1,4-hexadiene or 1,7-octadiene. It is also possible to polymerize mixtures of various 1-olefins. Suitable olefins also include those in which the double bond is part of a cyclic structure which can have one or more ring systems. Examples are cyclopentene, norbornene, tetracyclododecene or methylnorbornene or dienes such as 5-ethylidene-2-norbornene, norbornadiene or ethylnorbornadiene. It is also possible to polymerize mixtures of two or more olefins.

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In this text, "C<sub>x</sub>-C<sub>y</sub>" refers to a group and/or a compound which is intended as having x to y carbon atoms.

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The fluidized-bed reactor 1 is in particular suitable for the homopolymerization or copolymerization of ethylene or propylene and is especially preferred for the homopolymerization or copolymerization of ethylene. Preferred comonomers in propylene polymerization are up to 40 wt.% of ethylene, 1-butene and/or 1-hexene, preferably from 0.5 wt.% to 35 wt.% of ethylene, 1-butene and/or 1-hexene. As comonomers in ethylene polymerization, preference is given to using up to 20 wt.%, more preferably from 0.01 wt.% to 15 wt.% and especially from 0.05 wt.% to 12 wt.% of C<sub>3</sub>-C<sub>8</sub>-1-alkenes, in particular 1-butene, 1-pentene, 1-hexene and/or 1-octene. Particular preference is given to polymerizations in which ethylene is copolymerized with from 0.1 wt.% to 12 wt.% of 1-hexene and/or 1-butene.

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In an advantageous but non-limiting embodiment of the present disclosure, the polymerization is carried out in the presence of an inert gas such as nitrogen or an alkane having from 1 to 10 carbon atoms such as methane, ethane, propane, n-butane, isobutane, n-pentane, isopentane or n-hexane or mixtures thereof. The use of nitrogen or propane as inert gas, if appropriate in combination with further

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alkanes, is advantageous. In especially advantageous embodiments of the present disclosure, the polymerization is carried out in the presence of a C<sub>3</sub>-C<sub>5</sub> alkane as polymerization diluent and most preferably in the presence of propane, especially in the case of homopolymerization or copolymerization of ethylene.

5 The reaction gas mixtures within the reactor additionally comprise the olefins to be polymerized, i.e. a main monomer and one or more optional comonomers. In an advantageous embodiment of the present disclosure, the reaction gas mixture has a content of inert components from 30 to 99 vol.%, in particular from 40 to 95 vol.%, and especially from 45 to 85 vol.%. In another advantageous embodiment

10 of the present disclosure, especially if the main monomer is propylene, no or only minor amounts of inert diluent are added. The reaction gas mixture may further comprise additional components such as antistatic agents or molecular weight regulators like hydrogen. The components of the reaction gas mixture may be fed into the gas-phase polymerization reactor or into the recycle gas line in gaseous

15 form or as liquid which then vaporizes within the reactor or the recycle gas line.

According to some non-limiting embodiments, the polymerization of olefins is carried out using all customary olefin polymerization catalysts. That means that, for example, the polymerization can be carried out using Phillips catalysts based

20 on chromium oxide, using Ziegler or Ziegler-Natta-catalysts, or using single-site catalysts. For the purposes of the present disclosure, single-site catalysts are catalysts based on chemically uniform transition metal coordination compounds. Furthermore, it is also possible to use mixtures of two or more of these catalysts for the polymerization of olefins. Such mixed catalysts are often designated as

25 hybrid catalysts. The preparation and use of these catalysts for olefin polymerization are generally known.

Advantageous examples of catalysts of the Ziegler type comprise a compound of titanium or vanadium, a compound of magnesium and optionally an electron

30 donor compound and/or a particulate inorganic oxide as a support material.

Catalysts of the Ziegler type are usually used in the presence of a cocatalyst. Examples of cocatalysts are organometallic compounds of metals of Groups 1 ,

35 2, 12, 13 or 14 of the Periodic Table of Elements, in particular organometallic compounds of metals of Group 13 and especially organoaluminum compounds. Preferred cocatalysts are for example organometallic alkyls, organometallic alkoxides, or organometallic halides.

Advantageous examples of organometallic compounds comprise lithium alkyls,

40 magnesium or zinc alkyls, magnesium alkyl halides, aluminum alkyls, silicon

alkyls, silicon alkoxides and silicon alkyl halides. More advantageously, the organometallic compounds comprise aluminum alkyls and magnesium alkyls. Even more advantageously, the organometallic compounds comprise aluminum alkyls, most advantageously trialkylaluminum compounds or compounds of this type in which an alkyl group is replaced by a halogen atom, for example by chlorine or bromine. Examples of such aluminum alkyls are trimethylaluminum, triethylaluminum, tri-isobutylaluminum, tri-n-hexylaluminum or diethylaluminum chloride or mixtures thereof.

According to some non-limiting embodiments, the fluidized-bed reactor of the present disclosure is operated at pressures of from 0.5 MPa to 10 MPa, advantageously from 1.0 MPa to 8 MPa and in particular from 1.5 MPa to 4 MPa. The polymerization is advantageously but not necessarily carried out at temperatures of from 30 °C to 60 °C, particularly advantageously from 65 °C to 125 °C, with temperatures in the upper part of this range being preferred for preparing ethylene copolymers of relatively high density and temperatures in the lower part of this range being preferred for preparing ethylene copolymers of lower density.

According to some non-limiting embodiments, the polymerization in the fluidized-bed reactor is also carried out in a condensing or super-condensing mode, in which part of the circulating reaction gas mixture is cooled to below the dew point and returned to the reactor either separately as a liquid and a gas-phase or together as a two-phase mixture in order to make additional use of the enthalpy of vaporization for cooling the reaction gas.

With particular reference to figure 1, the gas recycle line 8 is configured to feed a fluidizing gas, which comprises a recycled part (taken from the inner chamber 2) and fresh olefins monomers (added along the gas recycle line 8), to the lower portion 3 of the inner chamber 2.

With particular reference to figure 2, the gas distribution grid 7 comprises a plurality of openings, that are configured to allow the passage of the fluidizing gas from the lower portion 3 to the upper portion 4 of the inner chamber 2 and comprise a plurality of first openings 11 located at more than 30 mm (in particular, at more than 40 mm; more in particular, at more than 80 mm) from the inner surface 6 of the lateral wall 5 and second openings 11' located at less than 30 mm (in particular, at less than 20 mm; more in particular, less than 5 mm) from the inner surface 6 of the lateral wall 5.

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In this way, it has been experimentally seen that, surprisingly, there is a reduced development of polymer agglomerates inside the lower portion 3 (in particular, in the area between a peripheral edge of the grid 7 and the lateral wall 5).

5 Advantageously but not necessarily, the fluidized-bed reactor 1 comprises a lateral support 12, which extends (in a loop) along the inner surface 6 in contact with the inner surface 6 (and – at least partially – supports the gas distribution grid 7). The gas distribution grid 7 has a peripheral edge 13, which is positioned (at least) partially on (in particular, rests on) and in contact with the lateral support  
10 12. The lateral support 12 has apertures 14, each of which is positioned at under a corresponding second opening 11' and is configured to allow the passage of the fluidizing gas from the lower portion 3 to the upper portion 4 of the inner chamber 2 through the corresponding second opening 11'. This ensures, at the same time, sufficient mechanical stability for the grid 7 without, at the same time,  
15 hindering the passage through the openings.

According to some non-limiting embodiments, the lateral support 12 has a width (measured from the inner surface 6 towards the center of the inner chamber 2) of at least 2 cm (in particular, at least 3 cm). More precisely but not necessarily,  
20 such a width (measured from the inner surface 6 towards the center of the inner chamber 2) is up to 6 cm (in particular, up to 4 cm).

Please note that in figure 2, only a part (about one half) of the grid 7 is depicted so as to better show the structure of the lateral support 12.  
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According to some non-limiting embodiments, the apertures 14 are at least as big as the openings. In particular, the apertures 14, have a length of at least 40 mm (in particular, at least 50 mm; more in particular at least 70 mm; in particular up to 200 mm; more in particular up to 150 mm; even more in particular up to 100  
30 mm).

Advantageously but not necessarily, the apertures 14 are complete interruptions (gaps) of the lateral support 12. In other words, the apertures 14 are open – not delimited – towards the center of the inner chamber 2. More precisely but not  
35 necessarily, the lateral support 12 is completely absent – not even partially present at the apertures 14 (a first stretch of the lateral support 12 ends just upstream from – before – an aperture 14 and a second stretch thereof starts just downstream from – after – such an aperture 14).



According to some non-limiting embodiments, the openings are formed in such a way that the flow of the fluidizing gas after having passed the openings is substantially parallel to a plane of the gas distribution grid 7 (in particular, tangential to the gas distribution grid 7; more in particular, substantially horizontal).

Advantageously but not necessarily, the openings are slots. According to some non-limiting embodiments, the width of the slots (openings) is more than their height (in particular, more than the double of their height).

In particular, the openings are at least 3 mm wide (in particular, the width is in the direction from the inner surface 6 towards the center of the inner chamber 2). In addition or alternatively the openings are at most 10 cm wide (in particular, at most 5 cm wide).

More precisely but not in a limiting way, the openings are made as disclosed in patent application WO2008074632 of the same applicant.

Advantageously but not necessarily, the openings are at least ten (in particular, at least one hundred).

In some non-limiting cases, the openings comprise groups of openings aligned one with respect of the others (in particular, radially with respect to an axis of the inner chamber 2). In other words, the openings of one group are aligned one with respect of the others (radially with respect to an axis of the inner chamber 2).

In some embodiments, which are not limiting, the fluidized-bed reactor 1 comprises an upper wall 15, which delimits a top of the inner chamber 2 and is connected to the lateral wall 5; and a lower wall 16, which delimits a bottom of the inner chamber 2 and is connected to the lateral wall 5.

According to some non-limiting (and not depicted) embodiments, the gas recycle line 8 is configured to convey the recycled part of the fluidizing gas from the upper portion 4 of the inner chamber 2 through the upper wall 15 and the fluidizing gas through the lateral wall 5 to the lower portion 4.

According to some non-limiting embodiments, the fluidized-bed reactor 1 further comprises a polymer discharge pipe 17, which comprises an upper opening 18 integrated into the gas distribution grid 7. In particular, the upper opening 18 of the polymer discharge pipe 17 is arranged in the center of the gas distribution

grid 7. More in particular, the polymer discharge pipe 17 is configured to discharge the polymer produced inside the upper portion 4.

5 According to some non-limiting embodiments, the discharge pipe 17 comprises regulation means 21, such as a discharge valve, configured to adjust the mass flow rate of polymer discharged from the reactor 1. The opening of the regulation means 21 are continuously adjusted, so as to keep constant the height of the fluidized polymer bed inside the reactor.

10 The discharge pipe 17 may be made of a uniform diameter, but preferably comprises more sections having decreasing diameters in the downward direction. The regulation means 21 are preferably placed in the area of (at) a restriction between a section of higher diameter and a section of lower diameter as shown in Fig. 1.

15 As an alternative the discharge system is as disclosed in patent application WO2007071527A1 of the same applicant.

20 In specific and non-limiting cases, the gas recycle line 8 is provided with (a compressor 19 and) a heat exchanger 20, which is configured to reduce the heat of the recycled part.

25 Advantageously but not necessarily, the recycle line 8 is provided with a topping up line 22 for feeding (in particular, to a main pipe 23 of the recycle line 8) the fresh olefins monomers, molecular weight regulators and, optionally inert gases (and antistatic agents, mileage improvers, etc.). More precisely but not necessarily, the topping up line 22 is configured to feed the fresh olefins monomers, molecular weight regulators and, optionally inert gases (and antistatic agents, mileage improvers, etc.) upstream from the heat exchanger 20 (in particular, between the upper portion 4 and the compressor 19; more in particular, upstream from the compressor 19).

35 According to some embodiments, which are not limiting, the gas distribution grid 7 has substantially the form of a lateral surface of a truncated (and inverted) cone.

More details about fluidized-bed reactor 1 and about how it works are provided in patent application WO2008074632 of the same applicant.

40 In accordance with a further aspect of the present invention it is also hereby provided a process for preparing an olefin polymer comprising homopolymerizing

an olefin or copolymerizing an olefin and one or more other olefins (in particular, at temperatures of from 20 to 200 °C; in particular, at a pressures of from 0.5 to 10 MPa) in the presence of a polymerization catalyst, wherein the polymerization is carried out in the fluidized-bed reactor 1 as above disclosed.

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According to some non-limiting embodiments, the fluidized-bed reactor 1 comprises a polymer discharge pipe 17, through which the polymer is continuously discharged.

10

According to some non-limiting embodiments, the polymerization conditions are those conventionally adopted in gas-phase reactors for the olefin polymerization, that is to say a temperature ranging from 60 to 120°C and a pressure ranging from 5 to 40 bar. The gas-phase polymerization process can be combined with conventional technologies operated in slurry, in bulk, or in a gas-phase, to carry out a sequential multistage polymerization process. Therefore, upstream or downstream the polymerization reactor of this disclosure, one or more polymerization stages operating in a loop reactor, or in a conventional fluidized bed reactor, or in a stirred bed reactor, can be provided. In particular, gas-phase polymerization reactors having interconnected polymerization zones as described in EP 782 587 and EP 1012195 can be advantageously arranged upstream or downstream the apparatus of the present invention.

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The gas-phase polymerization process allows the preparation of a large number of olefin powders having an optimal particle size distribution with a low content of fines. The [alpha]-olefins advantageously polymerized by the process of the invention have formula  $\text{CH}_2=\text{CHR}$ , where R is hydrogen or a hydrocarbon radical having 1-12 carbon atoms. Examples of polymers that can be obtained are:

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high-density poly ethylenes (HDPEs having relative densities higher than 0.940) including ethylene homopolymers and ethylene copolymers with [alpha]-olefins having 3 to 12 carbon atoms;

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linear polyethylenes of low density (LLDPEs having relative densities lower than 0.940) and of very low density and ultra low density (VLDPEs and ULDPEs having relative densities lower than 0.920 down to 0.880) consisting of ethylene copolymers with one or more [alpha]-olefins having 3 to 12 carbon atoms; elastomeric terpolymers of ethylene and propylene with minor proportions of diene or elastomeric copolymers of ethylene and propylene with a content of units derived from ethylene of between about 30 and 70% by weight;

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isotactic polypropylene and crystalline copolymers of propylene and ethylene and/or other [alpha]-olefins having a content of units derived from propylene of more than 85% by weight;

isotactic copolymers of propylene and [alpha]-olefins, such as 1-butene, with an [alpha] -olefin content of up to 30% by weight; impact-resistant propylene polymers obtained by sequential polymerisation of propylene and mixtures of propylene with ethylene containing up to 30% by weight of ethylene;

5 atactic polypropylene and amorphous copolymers of propylene and ethylene and/or other [alpha]-olefins containing more than 70% by weight of units derived from propylene.

10 The gas-phase polymerization process herewith described is not restricted to the use of any particular family of polymerization catalysts. The process can be implemented in any exothermic polymerization reaction employing any catalyst, whether it is supported or unsupported, and regardless of whether it is in pre-polymerized form.

15 The polymerization reaction can be carried out in the presence of highly active catalytic systems, such as Ziegler-Natta catalysts, single site catalysts, chromium-based catalysts, vanadium-based catalysts.

20 Unless expressly indicated to the contrary, the content of the references (articles, books, patent applications etc.) cited in this text is recalled in full herein. In particular, the above-mentioned references are incorporated herein by reference.

## CLAIMS

- 5 1. A fluidized-bed reactor for the gas-phase polymerization of olefins; the fluidized-bed reactor (1) having an inner chamber (2), which, in turn, has at least one lower portion (3) and at least one upper portion (4); the fluidized-bed reactor (1) comprising: at least one lateral wall (5), which has an inner surface (6) delimiting the inner chamber (2) laterally at least partially; a gas distribution grid (7), which is located inside the inner chamber (2) and which at least partially separates the lower portion (3) from the upper portion (4); and a recycle line (8), which has a first end (9) connected to the inner chamber (2) at the upper portion (4) of the inner chamber (2) and a second end (10) connected to the inner chamber (2) at the lower portion (3) of the inner chamber (2);
- 10 15 the recycle line (8) being configured to feed a fluidizing gas, which comprises recycled unreacted and/or partially reacted olefin monomers and fresh olefin monomers, to the lower portion (3) of the inner chamber (2);
- the gas distribution grid (7) comprising a plurality of openings that are configured to allow the passage of the fluidizing gas from the lower portion (3) to the upper portion (4) of the inner chamber (2);
- 20 said openings comprise a plurality of first openings (11) located at more than 30 mm from the inner surface (6) of the lateral wall (5) and a plurality of second openings (11') located at less than 30 mm from the inner surface (6) of the lateral wall (5).
- 25
2. The fluidized-bed reactor according to Claim 1, wherein said second openings (11') are at less than 20 mm from the lateral wall (5).
3. The fluidized-bed reactor according to Claim 1, wherein said second openings (11') are at less than 5 mm from the lateral wall (5).
- 30
4. The fluidized-bed reactor according to any one of the previous Claims, and comprising a lateral support (12), which extends along the inner surface (6) and in contact with the inner surface (6);
- 35 the gas distribution grid (7) having a peripheral edge (13), which is positioned at least partially in contact with the lateral support (12); the lateral support (12) having apertures (14), each of which is positioned at a corresponding second opening (11') and is configured to allow the passage of the fluidizing gas from

the lower portion (3) to the upper portion (4) of the inner chamber (2) through the corresponding second opening (11').

- 5 5. The fluidized-bed reactor according to Claim 4, wherein said apertures (14) are complete interruptions of the lateral support (12) and, in particular, have a length of at least 40 mm.
- 10 6. The fluidized-bed reactor according to any one of the previous Claims, wherein the openings are formed in such a way that the flow of the fluidizing gas after having passed the openings is substantially parallel to a plane of the gas distribution grid (7).
- 15 7. The fluidized-bed reactor according to any one of the previous Claims, wherein said openings are slots and are at least 3 mm wide.
- 20 8. The fluidized-bed reactor according to any one of the previous Claims, wherein said openings are at most 10 cm wide and are at least ten (in particular, at least one hundred).
- 25 9. The fluidized-bed reactor according to any one of the previous Claims, and comprising an upper wall (15), which delimits a top of the inner chamber (2) and is connected to the lateral wall (5); and a lower wall (16), which delimits a bottom of the inner chamber (2) and is connected to the lateral wall (5); the recycle line (8) being configured to convey the recycled part of the fluidizing gas from the upper portion (4) of the inner chamber (2) through the upper wall (15) and the fluidizing gas to the lower portion (3).
- 30 10. The fluidized-bed reactor according to any one of the previous Claims, and further comprising a polymer discharge pipe (17), which comprises an upper opening (18) integrated into the gas distribution grid (7).
- 35 11. The fluidized-bed reactor according to any one of the previous Claims, wherein the recycle line (8) is provided with a heat exchanger (20), which is configured to reduce the heat of the recycled part.
12. The fluidized-bed reactor according to any one of the previous Claims, wherein the gas distribution grid (7) has substantially the shape of a lateral surface of a truncated cone.

13. A process of preparing an olefin polymer comprising homopolymerizing an olefin or copolymerizing an olefin and one or more other olefins in the presence of a polymerization catalyst, wherein the polymerization is carried out in the fluidized-bed reactor (1) according to any one of claims 1 to 12.

5

14. The process of claim 13, wherein the fluidized-bed reactor (1) comprises a polymer discharge pipe (17), through which the polymer is continuously discharged.

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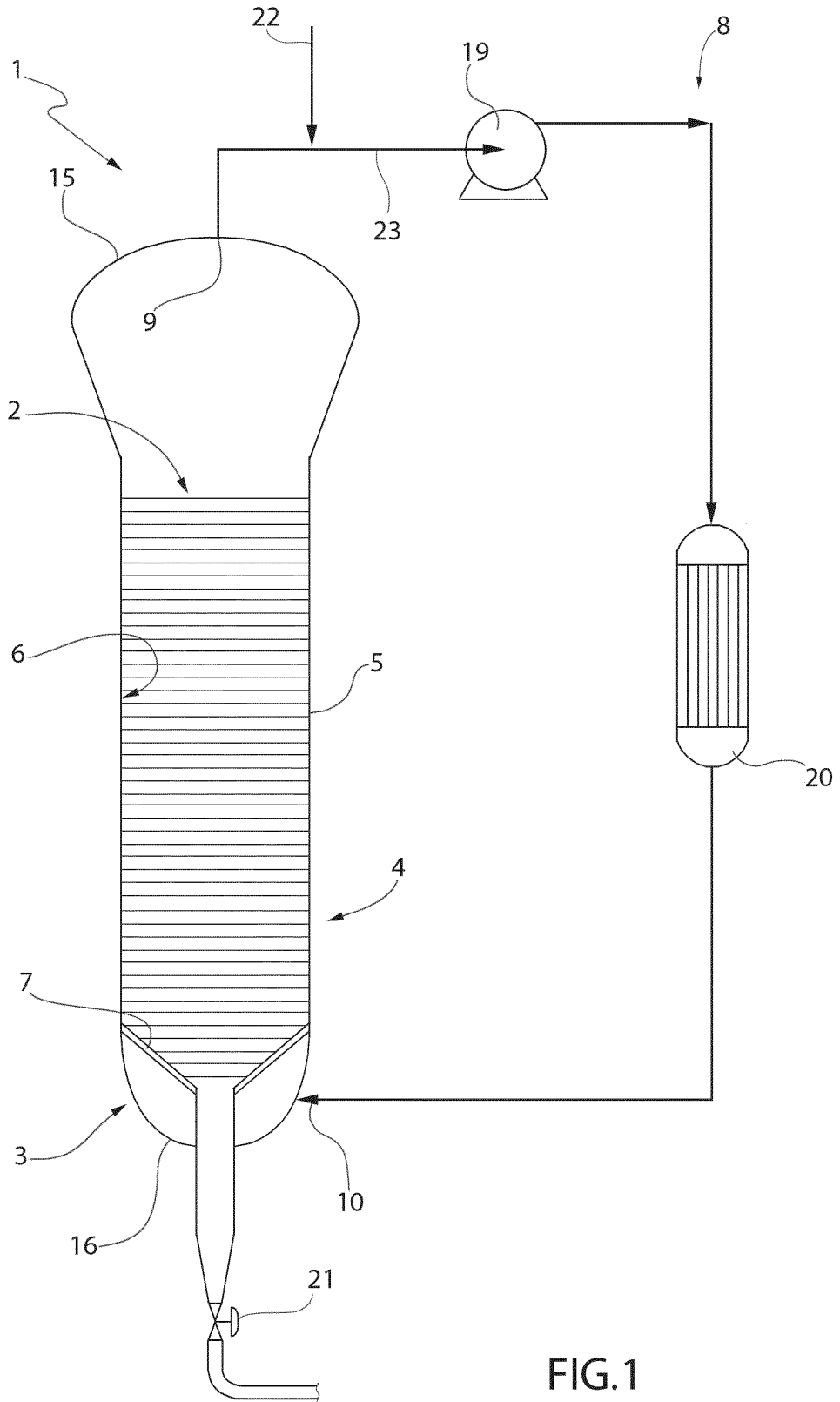


FIG.1



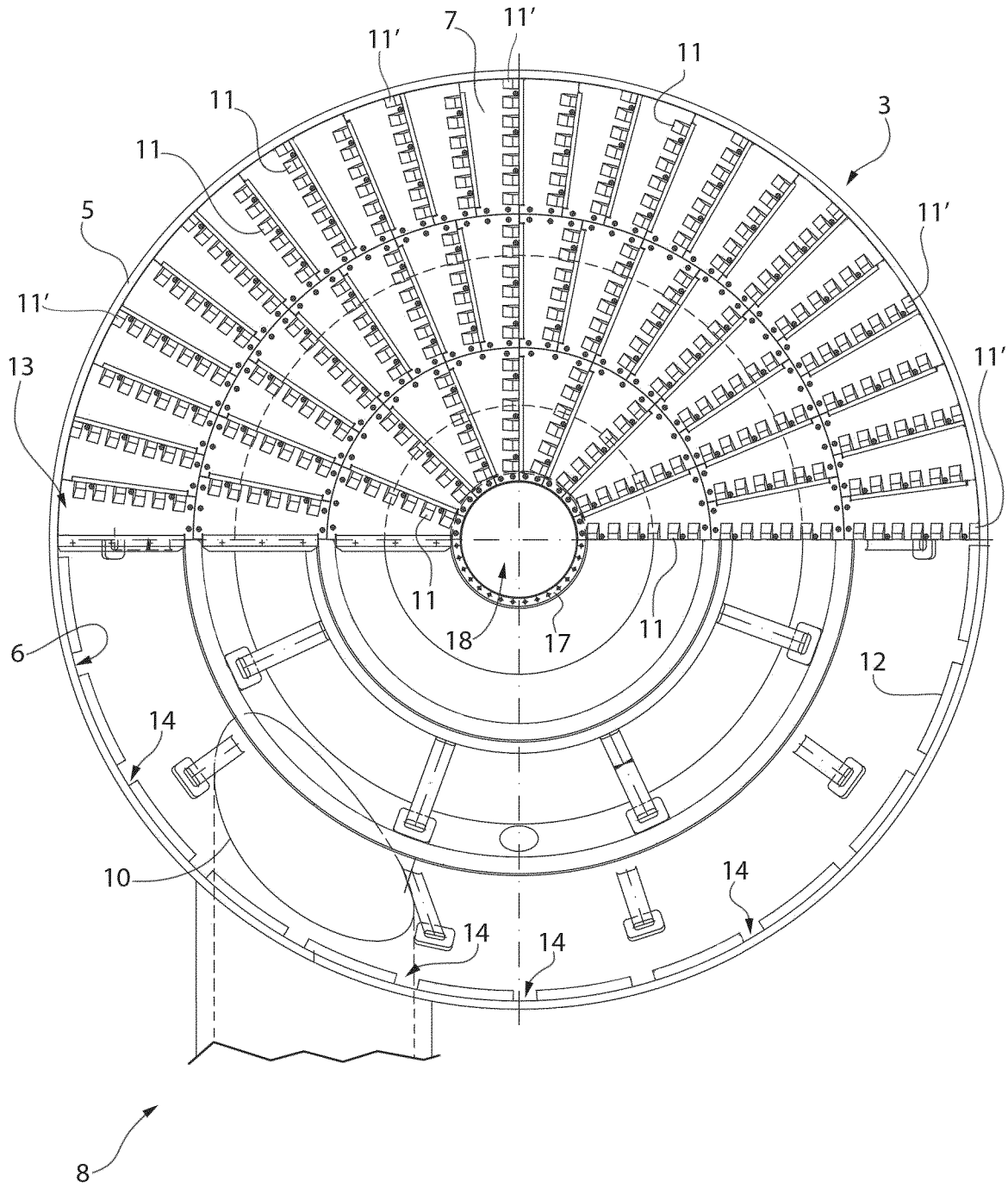


FIG.2

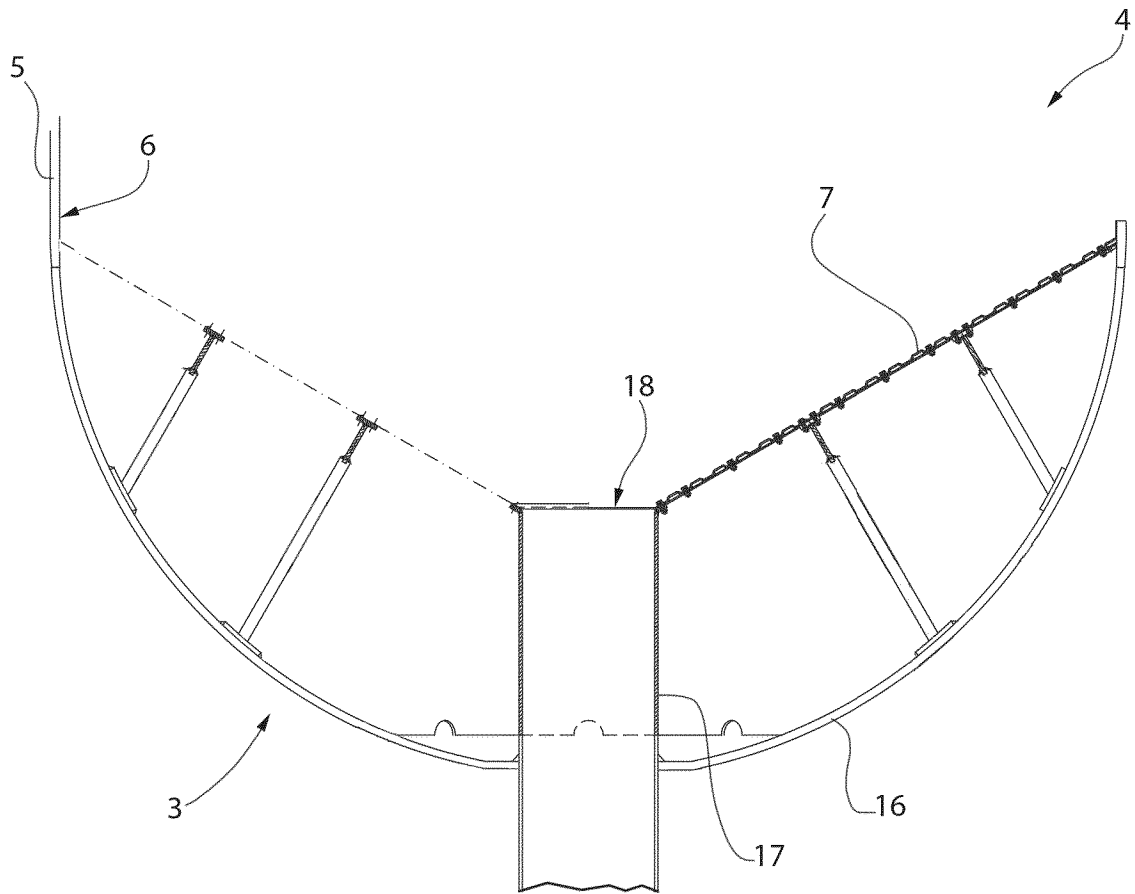


FIG.3

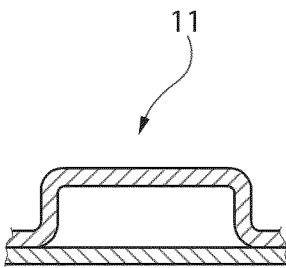


FIG. 4

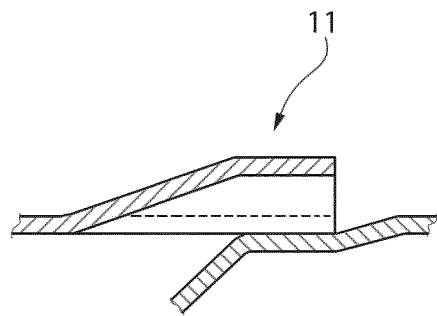


FIG. 5

# INTERNATIONAL SEARCH REPORT

International application No  
**PCT/EP2023/074719**

**A. CLASSIFICATION OF SUBJECT MATTER**  
**INV. B01J8/44 B01J8/18 B01J4/00 C08F2/01 C08F2/34**  
**ADD.**

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)  
**B01J C08F**

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.
<b>X</b>	<b>EP 0 721 798 A2 (MITSUI PETROCHEMICAL IND [JP]) 17 July 1996 (1996-07-17)</b>	<b>1-3, 6-9, 11, 13, 14</b>
<b>Y</b>	<b>page 3, lines 21-37; figures 1, 2, 3</b>	<b>10, 12</b>
<b>A</b>	<b>page 5, lines 1-35</b>	<b>4, 5</b>
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<b>Y</b>	<b>WO 2008/074632 A1 (BASELL POLIOLEFINE SRL [IT]) 26 June 2008 (2008-06-26)</b> <b>cited in the application</b> <b>figure 2a</b>	<b>10, 12</b>
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Further documents are listed in the continuation of Box C.       See patent family annex.

\* Special categories of cited documents :

<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>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search  <b>10 November 2023</b>	Date of mailing of the international search report  <b>21/11/2023</b>
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  <b>Borello, Ettore</b>
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

**PCT/EP2023/074719**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date			
<b>EP 0721798</b>	<b>A2</b>	<b>17-07-1996</b>	<b>CA 2166171 A1</b>	<b>29-06-1996</b>		
			<b>CN 1144713 A</b>	<b>12-03-1997</b>		
			<b>DE 69525729 T2</b>	<b>08-08-2002</b>		
			<b>DE 69531374 T2</b>	<b>15-04-2004</b>		
			<b>EP 0721798 A2</b>	<b>17-07-1996</b>		
			<b>EP 1160008 A1</b>	<b>05-12-2001</b>		
			<b>JP 3497029 B2</b>	<b>16-02-2004</b>		
			<b>JP H08245709 A</b>	<b>24-09-1996</b>		
			<b>KR 960022582 A</b>	<b>18-07-1996</b>		
			<b>MY 115388 A</b>	<b>31-05-2003</b>		
			<b>SG 41968 A1</b>	<b>15-08-1997</b>		
			<b>TW 304892 B</b>	<b>11-05-1997</b>		
			<b>US 5753191 A</b>	<b>19-05-1998</b>		
			-----			
<b>WO 2008074632</b>	<b>A1</b>	<b>26-06-2008</b>	<b>AR 064443 A1</b>	<b>01-04-2009</b>		
			<b>BR PI0720690 A2</b>	<b>25-02-2014</b>		
			<b>CL 2007003670 A1</b>	<b>25-07-2008</b>		
			<b>CN 101578134 A</b>	<b>11-11-2009</b>		
			<b>EP 2125190 A1</b>	<b>02-12-2009</b>		
			<b>JP 2010513622 A</b>	<b>30-04-2010</b>		
			<b>KR 20090101186 A</b>	<b>24-09-2009</b>		
			<b>RU 2009127726 A</b>	<b>27-01-2011</b>		
			<b>SG 177890 A1</b>	<b>28-02-2012</b>		
			<b>TW 200836837 A</b>	<b>16-09-2008</b>		
			<b>WO 2008074632 A1</b>	<b>26-06-2008</b>		
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