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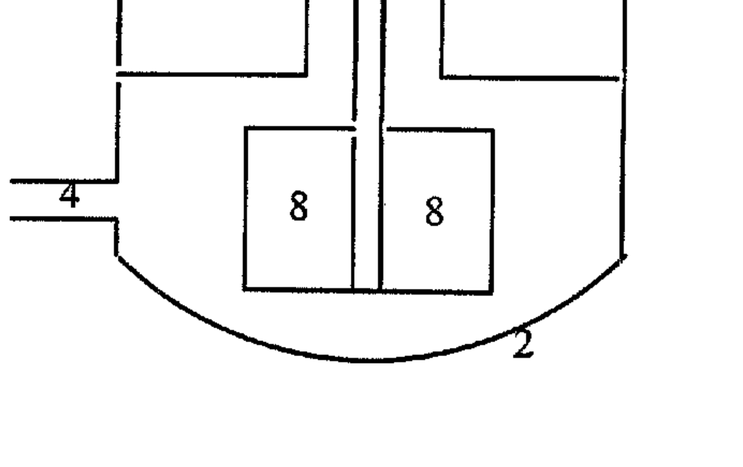
(54) Titre : AGITATEUR DE REACTEUR SUSPENDU
(54) Title: SUSPENDED REACTOR STIRRER



(57) Abrégé/Abstract:
A reactor agitator may be suspended from a drive shaft inside a closed pressurized reactor using a flexible joint. This agitator may be stabilized by hydrodynamic stabilization or by connecting to a foot bearing at the end of the shaft distant from the universal joint. The presence of the joint reduces bending torque on the agitator and also the stress on the seal through which the drive shaft enters the reactor.

SUSPENDED REACTOR STIRRER

ABSTRACT OF THE DISCLOSURE

A reactor agitator may be suspended from a drive shaft inside a closed pressurized reactor using a flexible joint. This agitator may be stabilized by hydrodynamic stabilization or by connecting to a foot bearing at the end of the shaft distant from the universal joint. The presence of the joint reduces bending torque on the agitator and also the stress on the seal through which the drive shaft enters the reactor.

FIELD OF THE INVENTION

The present invention relates to stirred tank reactors. More particularly the present invention relates to pressurized stirred tank reactors. In conventional pressured stirred tank reactors the agitator or stirrer shaft is a single shaft passing through a seal typically at the top of the reactor. As the reactor size increases the bending moment on the shaft increases which places a stress on the seal and may ultimately cause seal wear and premature seal failure.

BACKGROUND OF THE INVENTION

Continuous stirred tank reactors (CSTR's) are well known in the chemical industry.

Universal joints have been known for a number of years and have been extensively used in the automotive industry. The universal joint permits power to be transferred to a part or shaft which need not be directly aligned with the power shaft or drive shaft.

To the best of Applicant's knowledge universal joints have not been used inside a pressurized CSTR.

The closest art Applicant has been able to locate is U.S. patent 5,690,541 issued Nov. 25, 1997 to General Electric Company. The reference relates to a device for polishing seal surfaces in a nuclear reactor. The polishing device has a universal joint on or proximate the polishing head. The reference does not disclose a Continuous stirred tank reactor nor does it disclose the use of a universal joint on an agitator or stirrer shaft.

SUMMARY OF THE INVENTION

The present invention provides a stirred tank reactor comprising a reactor having an upper and lower end and one or more side walls, at least one inlet port and at least one outlet port, a seal and bearing in the upper end of the reactor, a drive shaft passing through said seal and bearing, an agitator shaft, at least one mixing element said shaft having a length less than the height of said one or more side walls, and a universal joint connecting said drive shaft and said agitator shaft. The agitator shaft may be stabilized in the desired position in the reactor either hydrodynamically or by a foot bearing.

The present invention also provides an agitator shaft for use in a stirred tank reactor characterized in that the shaft has a universal joint therein.

DETAILED DESCRIPTION

Figure 1 is a schematic sectional view of a stirred tank reactor according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Figure 1 is a schematic sectional view of a continuous stirred tank reactor according to the present invention. In figure 1 the reactor has a top 1, a bottom 2 and at least one sidewall 3. In the figure the reactor is cylindrical in shape. However, the reactor could also be spherical or it could have a number of side walls (e.g. octagonal but care would be taken to determine the effect of multiple side walls on mixing the reactor contents. There is at least one inlet 4 and at least one outlet 5 to the reactor. Typically the reactor is filled with a fluid, preferably liquid, to a

level at least to the outlet. On the internal surface of the reactor wall (s) are one or more baffles 6 Inside the reactor is an agitator or stirrer comprising a shaft 7 and mixing elements 8. In the embodiment shown in the figure the mixing elements 8 are agitator or turbine blades at the bottom of the shaft Baffles 6 are positioned above the blades (i.e. outside the agitator blades or elements). As a practical matter there may be any relative position of the agitator blades and the baffles provided they do not contact teach other. For example the shaft could support a number of blades and there could be a number of baffles projecting towards the shaft between the turbine blades. However the agitator elements need not be turbine blades. They could have other shapes such as an "anchor" or screw or auger (e.g. an inclined plane device such as Archimedes screw) or a helix. For some configurations the baffles may be suspended from the internal top surface of the reactor and inside the agitator elements (e.g. anchor or helix). Also the baffles could be positioned close to the agitator devise but not overlapping with its arc of rotation (outside or inside the agitator elements).

The reactor has a seal and bearing 9 on the top of the reactor. A drive shaft 10 passes through the seal. The drive shaft is attached to a drive device such as an electric motor, hydraulic motor or a hydrocarbon powered motor (e.g. gasoline or diesel motor) or some other suitable power source. The power source is not shown in the drawing. The drive shaft passes through the seal and terminates within the reactor. The end of the drive shaft 10 is attached to a universal joint 11. The upper end of the agitator shaft 7 is also attached to the universal joint (e.g. the agitator

is suspended from the universal joint). Typically the universal joint is in the top quarter of the reactor, preferably proximate the seal (top 1/4 to 1/10 of the reactor). On the agitator shaft the universal joint is distant from the location of the attachment of the mixing or stirring elements to the shaft.

The universal joint may be a simple universal joint (Hooke's joint or Cardan's joint) comprising two yokes ("u" shaped brackets) attached to the respective ends of their shafts and attached to a simple spider. The universal joint may be a yoke and spider universal joint. The universal joint may be a constant velocity joint universal joint (e.g. a Carl Weiss joint).

The shaft of the agitator is suspended from the universal joint. In this type of embodiment the agitator elements and the baffles may be arranged to hydrodynamically stabilize or position the agitator in the center of the reactor or in any desired position. For example the agitator may be designed so that it interacts with the baffles or with the reactor wall in such a way that the shaft is pushed toward the reactor centre. Any excursion of the shaft out of the reactor centre will unbalance the forces and the shaft will be driven back to the reactor centre. Other means of hydrodynamically fixing the shaft position may be used. Such means would be well known to those skilled in fluid dynamics and /or reactor design. In an alternative embodiment there may be a rotary foot bearing mounted on the internal bottom surface of the reactor aligned with the seal. The end of the agitator shaft distant from the universal joint may be mounted in the rotary bearing. This will also help to keep the shaft in line. The bearing may touch the shaft in which case a suitable low wear and friction material would be used

as one part of the bearing. Alternately the bearing may be designed so that the fluid in the reactor is forced between the shaft and the stationary part of the bearing thus providing a non – contact bearing.

While the present invention may be applied to any continuous stirred tank reactor, in a preferred embodiment the reactor is pressurized. The reactor may be pressurized to a pressure from 100 psi to 10,000 psi (689.5 kPa to 689475.7 kPa), typically from about 2,000 to 8,000 psi (13,789 kPa to 55,185 kPa) preferably from 3,000 to 5,000 psi (20,684 kPa to 34,474 kPa).

The reactor of the present invention may be used in a number of processes including solution polymerization, including the solution polymerization of ethylene homopolymers and copolymers of ethylene and C_{3-10} preferably C_{4-8} alpha olefins. These types of processes are disclosed in a number of patents in the names of NOVA Chemicals International S.A. and The Dow Chemical Company.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A stirred tank reactor comprising a reactor having an upper and lower end and one or more side walls, at least one inlet port and at least one outlet port, a seal and a bearing in the upper end of the reactor, a drive shaft passing through said seal and bearing at least one mixing element said shaft having a length less than the height of said one or more side walls, and a universal joint connecting said drive shaft and said agitator shaft.

2. The stirred tank reactor according to claim 1, wherein the seal is a pressure seal capable of withstanding pressures up to 10,000 psi.

3. The stirred tank reactor according to claim 1, wherein the universal joint is located in the upper 1/4 of the reactor

4. The stirred tank reactor according to claim 3, wherein the said agitator shaft is suspended from said universal joint.

5. The stirred tank reactor according to claim 4, wherein the universal joint is proximate to the said seal.

6 The stirred tank reactor according to claim 1, where baffles are attached to the reactor inside surface.

7 The stirred tank reactor according to claim 6, where the baffles are designed to hydrodynamically stabilize the agitator in the center of the reactor.

8 The stirred tank reactor according to claim 7, where the baffles are outside the agitator elements.

9. The stirred tank reactor according to claim 7, where the baffles are between the agitator elements and the agitator shaft.

10. The stirred tank reactor according to claim 7, where there is no bearing at the bottom end of the agitator shaft.

11. The stirred tank reactor according to claim 5, wherein said at least one mixing element is selected from the group consisting of agitator blades and an auger blade or a combination thereof.

12. The stirred tank reactor according to claim 11, wherein the universal joint is a simple universal joint.

13. The stirred tank reactor according to claim 12, wherein the end of the agitator shaft distant from said universal joint is mounted in a rotary bearing attached to the internal surface of the bottom of the reactor positioned substantially in line with the drive shaft.

14. The stirred tank reactor according to claim 13 wherein said rotary bearing attached to the internal surface of the bottom of the reactor is a non-contact bearing.

15. The stirred tank reactor according to claim 11, wherein the universal joint is a yoke and spider joint.

16. The stirred tank reactor according to claim 15, wherein the end of the agitator shaft distant from said universal joint is mounted in a rotary bearing attached to the internal surface of the bottom of the reactor positioned substantially in line with the drive shaft.

17. The stirred tank reactor according to claim 16 wherein said rotary bearing attached to the internal surface of the bottom of the reactor is a non-contact bearing.

18. The stirred tank reactor according to claim 11, wherein the universal joint is a constant velocity universal joint.

19. The stirred tank reactor according to claim 18, wherein the end of the agitator shaft distant from said universal joint is mounted in a rotary bearing attached to the internal surface of the bottom of the reactor positioned substantially in line with the drive shaft.

20. The stirred tank reactor according to claim 19 wherein said rotary bearing attached to the internal surface of the bottom of the reactor is a non-contact bearing.

21. An agitator shaft for use in a stirred tank reactor characterized in that the shaft has a universal joint therein.

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22. The agitator shaft according to claim 21, wherein the universal joint is distant from the point of attachment of the agitator elements to the shaft.

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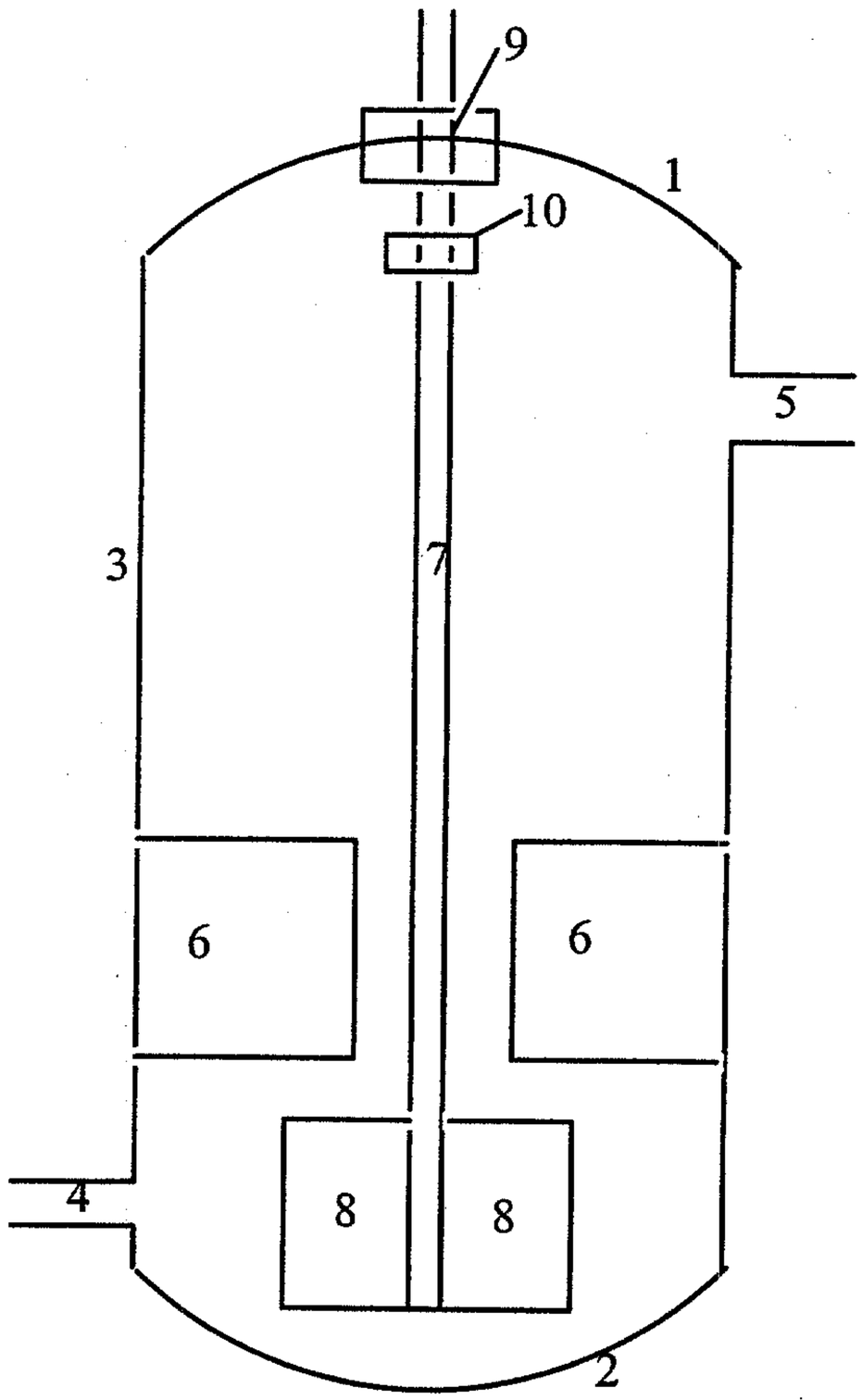
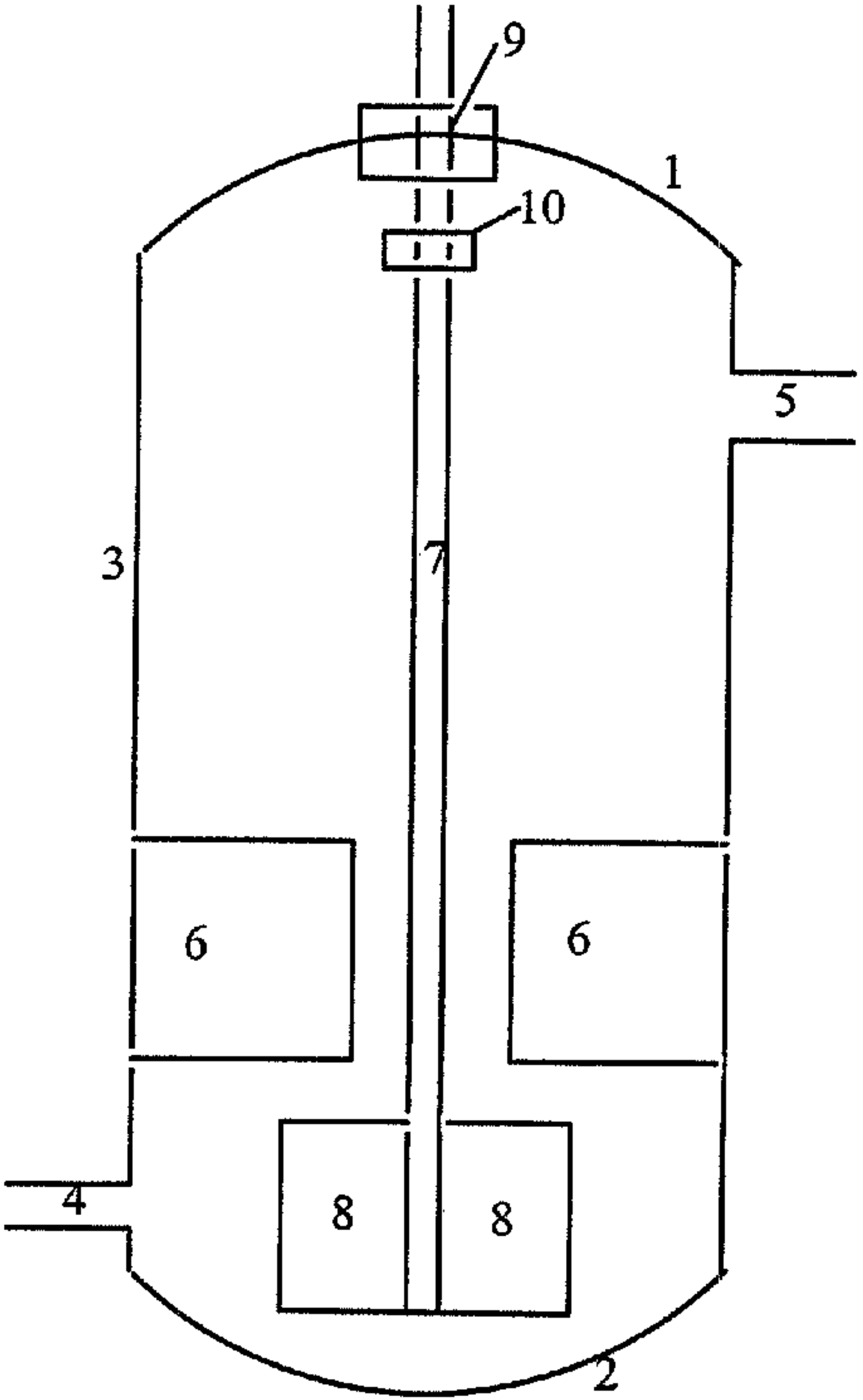
Figure 1

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