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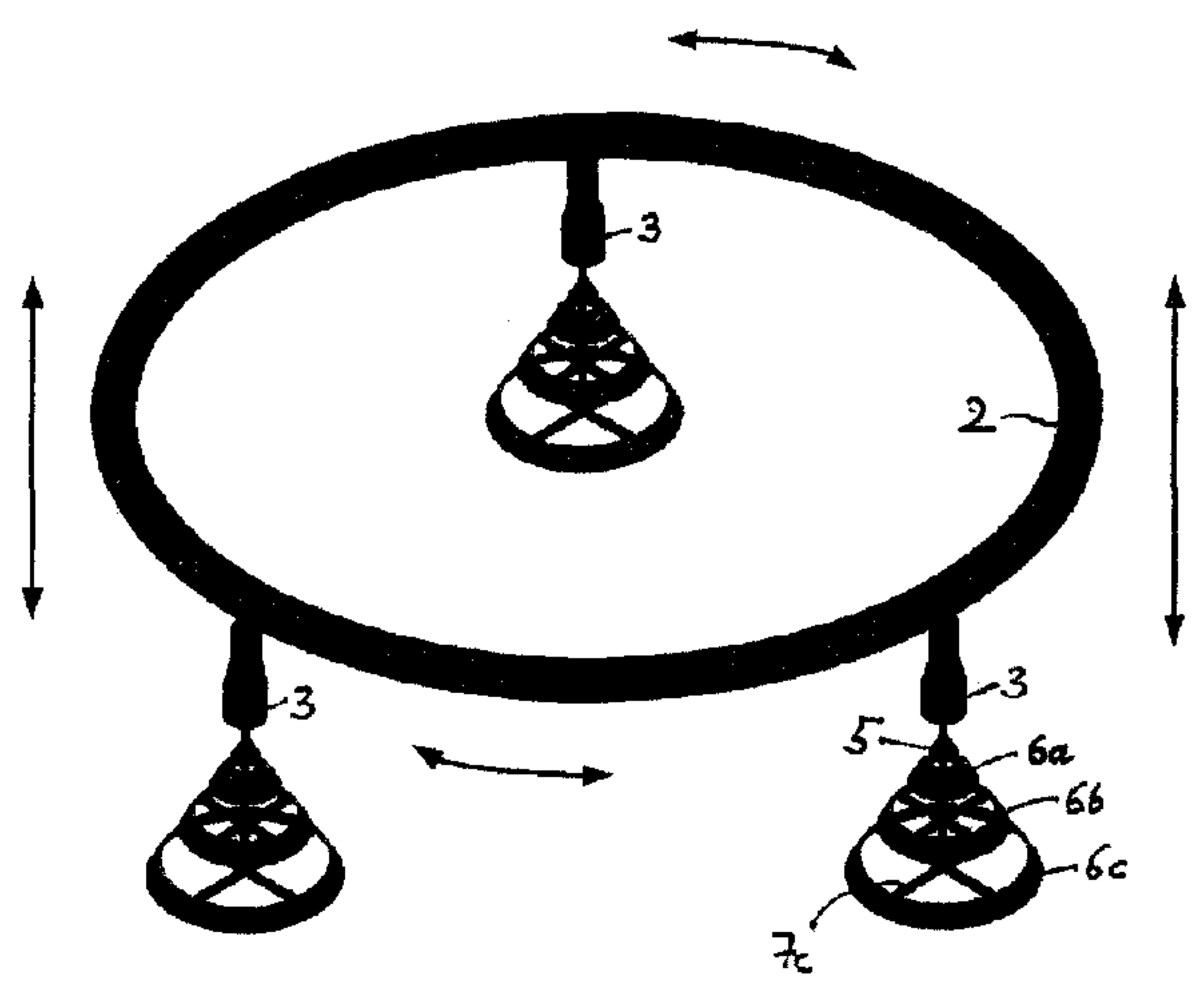

(57) Abrégé/Abstract:
The invention relates to a loading device having N loading heads offset by N/360°, wherein N is the number 3 or an integer multiple thereof, wherein each of the N loading heads has a connecting device for a hose arranged at the upper end, through which hose the catalyst material can be delivered from above, wherein each of the N loading heads has a deflecting cone with the tip pointing upwards beneath the connecting device and joined to the connecting device, a vertical holder is mounted on the underside of said deflecting cone, at least two circular deflector funnel elements are mounted on the vertical holder by means of horizontal braces, the deflector funnel elements open more narrowly at the top than at the bottom, gaps are provided between the deflector funnel elements and the lower deflector funnel elements have a larger diameter than the deflector funnel elements above them.

ABSTRACT

The invention relates to a loading device having N loading heads offset by N/360°, wherein N is the number 3 or an integer multiple thereof, wherein each of the N loading heads has a connecting device for a hose arranged at the upper end, through which hose the catalyst material can be delivered from above, wherein each of the N loading heads has a deflecting cone with the tip pointing upwards beneath the connecting device and joined to the connecting device, a vertical holder is mounted on the underside of said deflecting cone, at least two circular deflector funnel elements are mounted on the vertical holder by means of horizontal braces, the deflector funnel elements open more narrowly at the top than at the bottom, gaps are provided between the deflector funnel elements and the lower deflector funnel elements have a larger diameter than the deflector funnel elements above them.

LOADING DEVICE FOR CATALYSTS

FIELD

The present invention relates to a method for filling ammonia synthesis reactors and the filling devices that are used for this purpose.

BACKGROUND

Typically, for the production of ammonia in synthesis plants that operate in accordance with the Haber-Bosch process, use is made of ammonia reactors which, depending on the synthesis concept, contain up to three catalyst beds. The reactors consist of cylindrical pressure vessels and comparatively complicated internal constructions, the converter inserts, for receiving the catalyst beds and optionally heat exchangers. On account of the high pressure level of the synthesis of usually more than 200 bar, the diameters of the pressure vessels are kept as small as possible and the catalyst beds are arranged one beneath another along the container vessel axes. This arrangement has the consequence that the accessibility of the catalyst beds that are further away from the apparatus cover is highly restricted and filling with the catalyst material is rendered more difficult.

As a result of the different plant capacities and process engineering conditions, the catalyst beds have very different dimensions. On account of the efficiency with regard to the overall size and the pressure loss, the radial type of construction prevails nowadays, i.e. the catalyst beds are in the form of hollow cylinders and are flowed through in the radial direction.

In the case of continuous "hose loading", as it is known, in which the reactor beds are filled with catalyst via one or more hoses, only average bulk densities that are beneath the required value for the synthesis reaction are achieved. Therefore, the catalyst beds have hitherto been filled using the batchwise stratified loading method, that is to say catalyst layers of 250-300 mm are introduced using a hose and subsequently compacted, by means of concrete vibrators and other vibrators, to the required bulk density of at least 2.8 kg/l of oxidized catalyst, or 2.3 kg/l in the case of pre-reduced, that is to say specifically lighter catalysts. The vibration of a layer can take more than an hour depending on the bed geometry.

This procedure is acceptable when new plants are filled for the first time, since the operations take place during preparation for start-up and are not on the time-critical path, that is to say do not result in expensive production stoppages.

However, during a catalyst change, the catalyst-changing operations usually take place on the time-critical path and can be decisive for the length of the downtime. For conventional catalyst-containing vessels, it is conventional in such cases to use the "dense loading" method, as it is known, to effect the desired bulk density in a continuous loading method without an interposed compaction step, and in this case the catalyst can be introduced in a correspondingly quicker manner.

In terms of phenomena, the difference in the achievable bulk densities between hose loading and dense loading can be explained in that during hose loading a large number of particles drop onto a small area in a short period of time, wherein the particles obstruct one another in the event of arrangement in a dense packing structure, whereas in dense loading a large number of particles drop onto a larger area in a short period of time, with the result that the particles have enough space and time to be arranged in a denser packing structure.

A large number of systems and methods for dense loading are known from the prior art. For example, US 2010/0019952 A1 describes a system, in which a rotating distribution system is arranged in the top of a catalyst vessel, said system distributing the dropping catalyst particles uniformly over the cross section of the reactor area, wherein the distribution system is fixed at the top. EP 1 152 967 B1 describes a similar system in which the speed of rotation of the rotating distribution system is adapted such that, as the level of the bed increases, the particles can still be thrown into the outer region of the bed without, however, striking the vessel wall.

US 5,687,780 describes a system in which a rotating distribution system is likewise arranged in the top part of a catalyst vessel, said system distributing the dropping catalyst particles uniformly over the cross section of the reactor area, wherein the system can be displaced axially, however, thereby reducing the dropping height of the particles. EP 1 687 223 B1 describes such a system, which additionally operates with gas jets which drive the rotating distribution system and also influence the paths of the particles.

GB 2 287 016 A describes a system which is likewise arranged in the top of a catalyst vessel, said system distributing the dropping catalyst particles uniformly over the cross section of the reactor area, and in which the system can also be lowered and positioned in the reactor. The system is not rotatable and has vanes which project at different angles and which effect the uniform distribution of the particles.

These mentioned dense loading systems and also all further dense loading systems that are known from the prior art are not usable in ammonia synthesis reactors which are flowed through radially, since there is no top-side access and neither are the reactors which are flowed through radially able to be filled at all centrally along their axis of symmetry, since they are bounded on both sides in the radial direction by grid structures. Design details further constrict the clearances within the beds and thus impede accessibility for the loading systems. At the same time, specifically in reactors which are flowed through radially, it is particularly important for the particles not to be able to slip down during operation, since otherwise short-circuit currents would arise in the upper region of the radial bed.

SUMMARY

Therefore, the invention is based on the object of providing a structurally simple device in which the above-described disadvantages do not occur, and with which the method of catalyst dense loading can be carried out in as short a time as possible in a reactor having one or more catalyst beds which are flowed through radially.

The object is achieved by a loading device,

- having N loading heads that are offset through N/360°, wherein N is the number 3 or an integral multiple thereof,
- wherein each of the N loading heads has a connection device, arranged at the upper end, for a hose via which catalyst material can be conveyed from above,
- wherein each of the N loading heads has, beneath the connection device, a deflecting cone of which the tip is directed upward and which is connected to the connection device,
- a vertical holding device is fastened to the underside of this deflecting cone,
- at least 2 circular deflecting funnel elements are fastened to the vertical holding device by means of horizontal struts,
- the deflecting funnel elements open more narrowly at the top than at the bottom,

- gaps are provided between the deflecting funnel elements,
- and the lower deflecting funnel elements have a larger diameter than the deflecting funnel elements located thereabove.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained in more detail in the following text with reference to two drawings, in which:

Figure 1 shows a side view of a loading head and

Figure 2 shows an oblique view of a loading ring having three loading heads.

DETAILED DESCRIPTION

In a preferred embodiment of the invention, the deflecting cone and deflecting funnel elements are arranged such that they are in contact with an envelope surface which has a circular cone with an opening angle of 45° to 90°, particularly preferably 60°.

In a further configuration of the invention, in each case exactly three deflecting funnel elements are arranged one beneath another.

In a further configuration of the invention, three loading heads are fixed to a loading ring in a manner offset through 120°. Said loading ring is preferably arranged so as to be rotatable about the reactor axis. In a preferred configuration, this loading ring is vertically displaceable and has a releasable locking mechanism in the reactor, said locking mechanism making it possible to leave said loading ring in the reactor during operation.

The object of the invention is also achieved by a loading method, wherein the loading heads are pivoted tangentially back and forth sectionally on a circular path, as seen from above, during loading.

In one configuration of the method, provision is made for the loading heads to be lowered to a level just above the catalyst bed and then moved axially upward in accordance with the filling level.

In one configuration of the method, provision is made for the tangential pivoting movements and the axial upward movement to be controlled and carried out by the movement of the loading ring.

Figure 1 shows a hose 1, in which the catalyst material is conveyed, wherein pneumatic conveying or gravity conveying are possible. The hose 1 is fastened to the connection device 3, which is also connected to the loading ring 2. Also fastened to the connection device 3 is the holding device 4, which carries the deflecting cone 5 and also the three deflecting funnel elements 6a, 6b and 6c by means of the holding bars 7a, 7b and 7c. The deflecting cone and deflecting funnel elements have an opening angle α (alpha). The arrows at the deflecting funnel indicate the direction of flow of the catalyst particles, and the arrows at the loading ring 2 indicate the directions of movement.

Figure 2 shows an oblique illustration with the loading ring 2 and three loading heads, the reference numerals of which correspond to those in figure 1.

The following list of reference numerals is provided to assist in the understanding of the figures:

1	Hose,
2	Loading ring,
3	Connection device,
4	Holding device,
5	Deflecting cone,
6a, b, c	Deflecting funnel elements,
7a, b, c	Holding bars, and
α	Opening angle.

CLAIMS:

1. A loading device, having N loading heads that are offset through N/360°, wherein N is the number 3 or an integral multiple thereof,

- wherein each of the N loading heads has a connection device, arranged at the upper end, for a hose via which catalyst material is conveyed from above,
- wherein each of the N loading heads has, beneath the connection device, a deflecting cone of which the tip is directed upward and which is connected to the connection device,
- a vertical holding device is fastened to the underside of this deflecting cone,
- at least two circular deflecting funnel elements are fastened to the vertical holding device by means of horizontal struts,
- the deflecting funnel elements open more narrowly at the top than at the bottom,
- gaps are provided between the deflecting funnel elements,
- wherein each deflecting funnel element located lower than another deflecting funnel element has a larger diameter than the deflecting funnel element located thereabove.

2. The loading device as claimed in claim 1, wherein the deflecting cone and deflecting funnel elements are arranged such that they are in contact with an envelope surface which has a circular cone with an opening angle of 45° to 90.

3. The loading device as claimed in claim 2, wherein the circular cone has an opening angle of 60°.

4. The loading device as claimed in any one of claims 1 to 3, wherein in each case exactly three deflecting funnel elements are arranged one beneath another.

5. The loading device as claimed in any one of claims 1 to 4, wherein three loading heads are fixed to a loading ring in a manner offset through 120°.

6. The loading device as claimed in claim 5, wherein the loading ring is arranged so as to be rotatable about the axis of a reactor to be loaded.

7. The loading device as claimed in claim 5, wherein the loading ring is vertically displaceable.

8. The loading device as claimed in claim 5, wherein the loading ring has a releasable locking mechanism in a reactor to be loaded, said locking mechanism making it possible to leave said loading ring in the reactor, during operation.

9. A loading method using a loading device as claimed in any one of claims 1 to 4, wherein the loading heads are pivoted tangentially back and forth sectionally on a circular path, as seen from above, during loading.

10. The loading method as claimed in claim 9, wherein the loading heads are lowered to a level just above a catalyst bed

to be filled, and then moved axially upward in accordance with the filling level.

11. A loading method using a loading device as claimed in one of claims 5 to 8, wherein the loading heads are pivoted tangentially back and forth sectionally on a circular path, as seen from above, during loading.

12. The loading method as claimed in claim 11, wherein the loading heads are lowered to a level just above a catalyst bed to be filled, and then moved axially upward in accordance with the filling level.

13. The loading method as claimed in claim 11 or claim 12, wherein the tangential pivoting movements are controlled and carried out by the movement of the loading ring.

14. The loading method as claimed in claim 12, wherein the axial upward movement is controlled and carried out by the movement of the loading ring.

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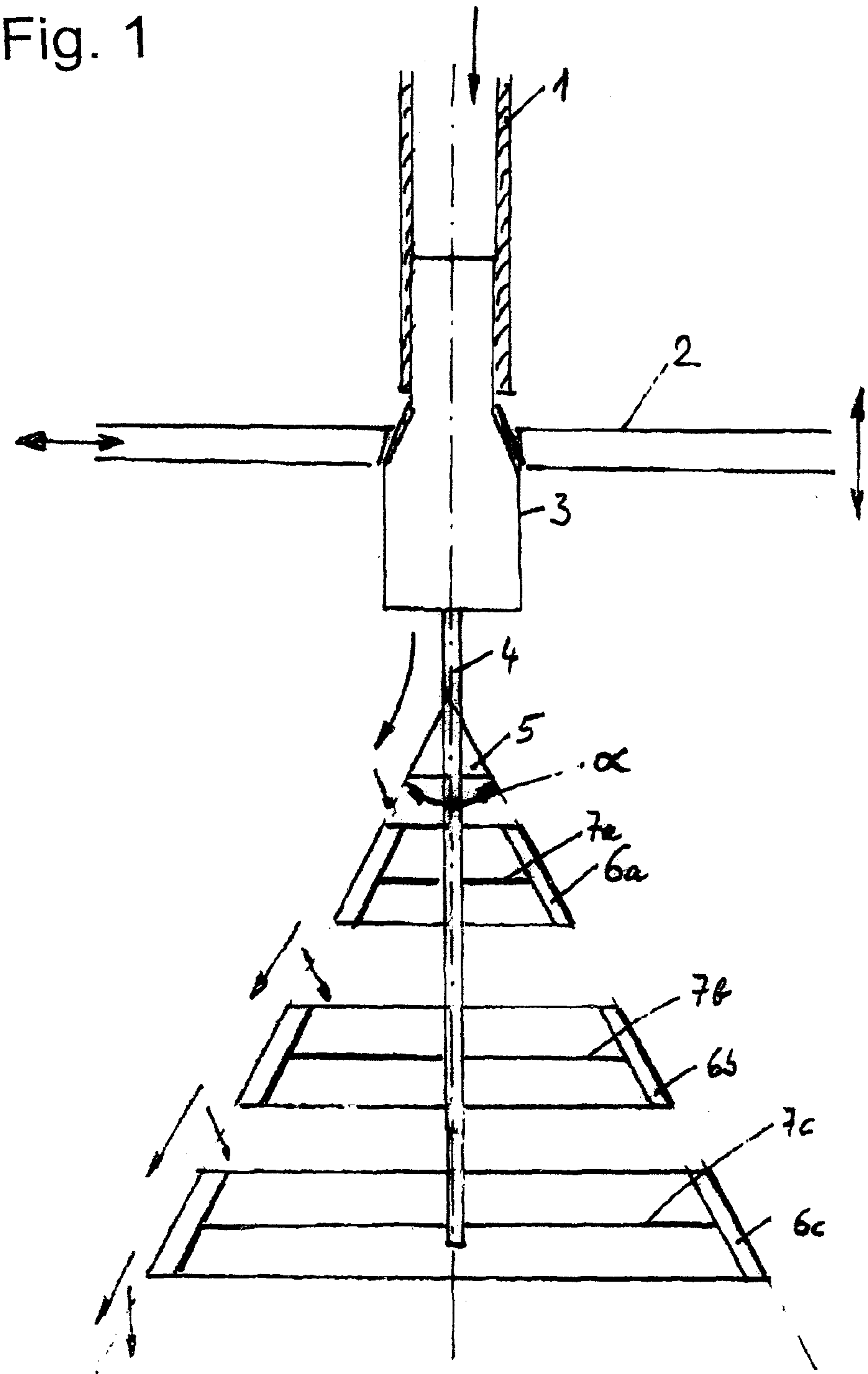
Fig. 1



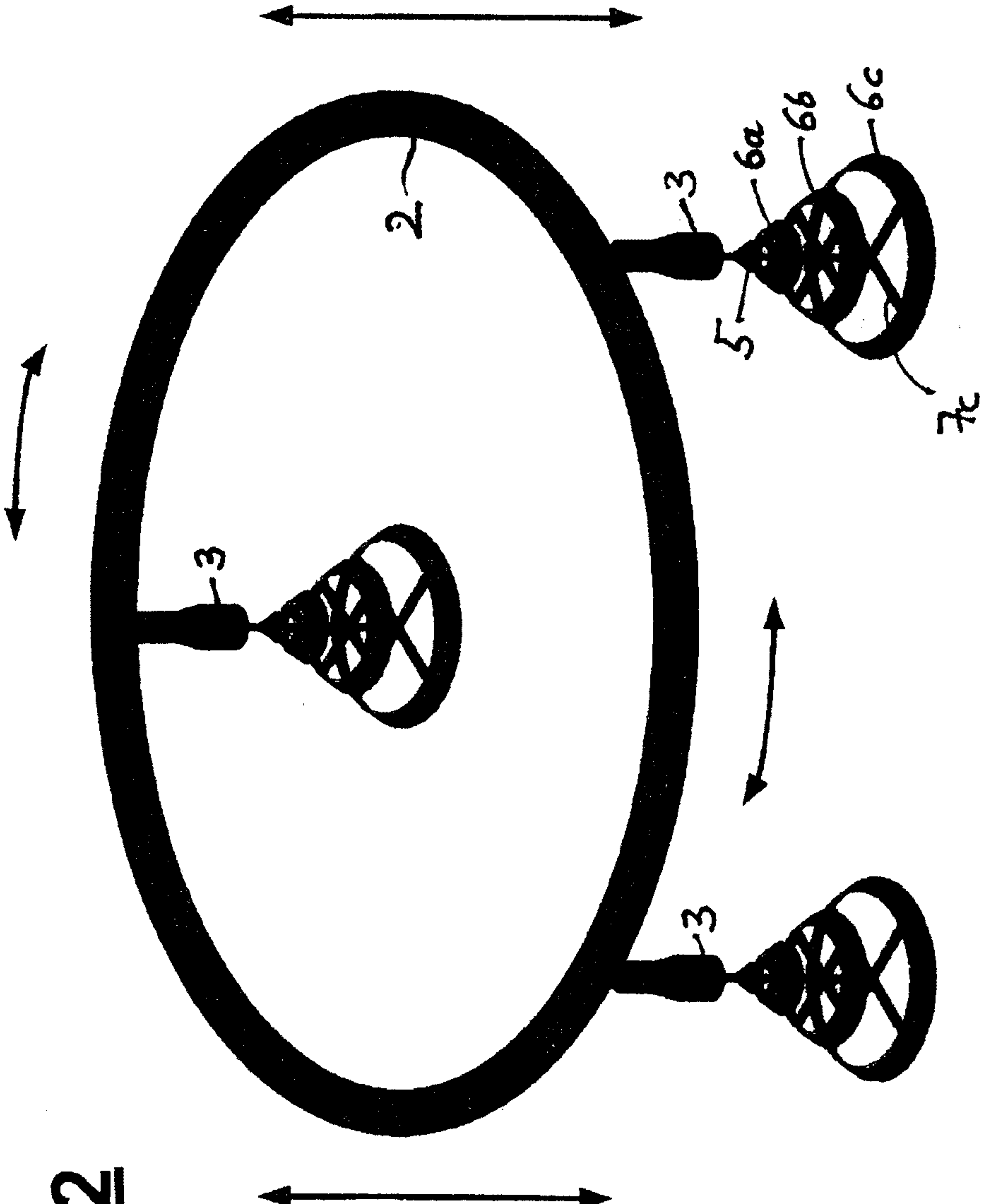
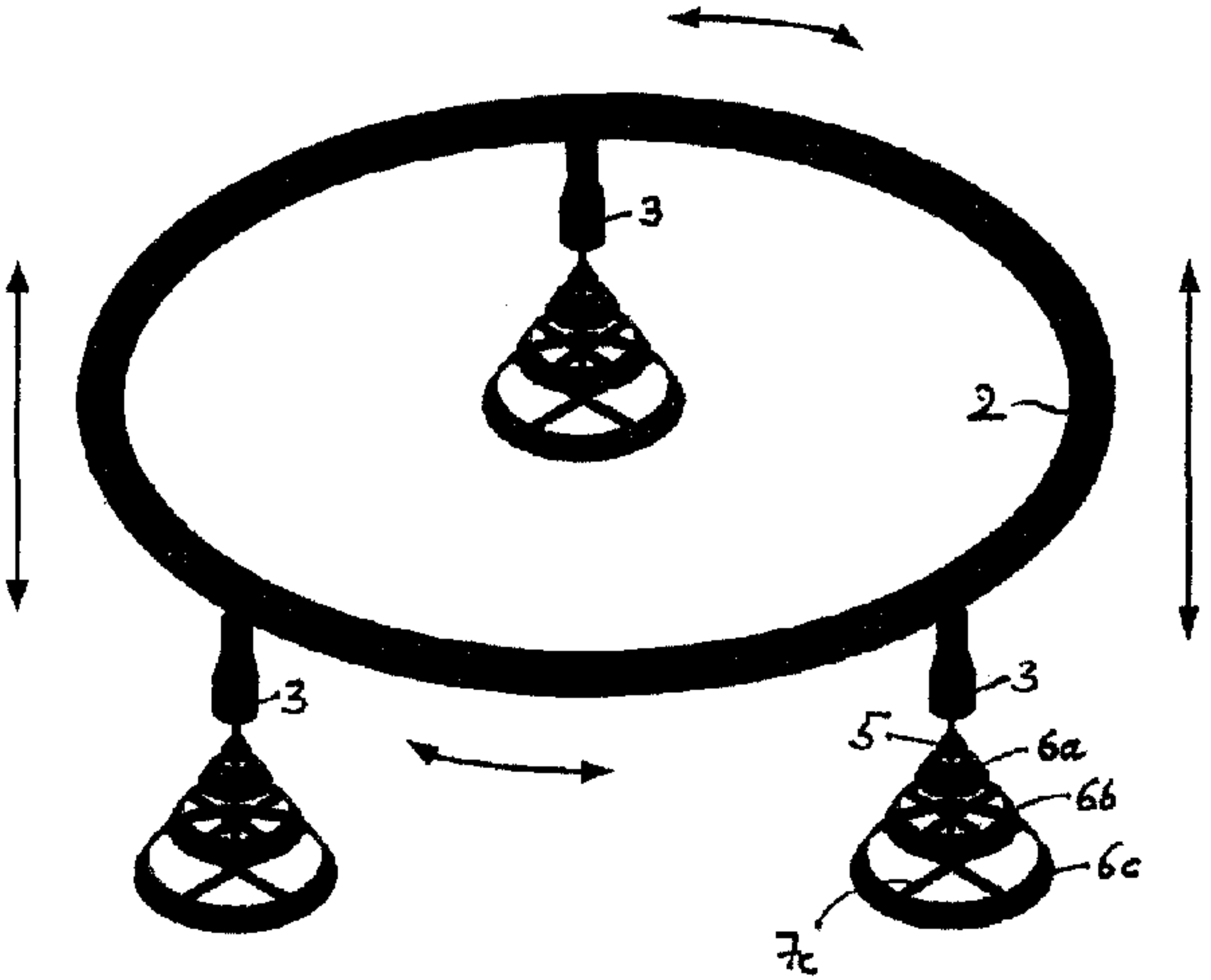


Fig. 2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3
3
5
6a
6b
6c
7c