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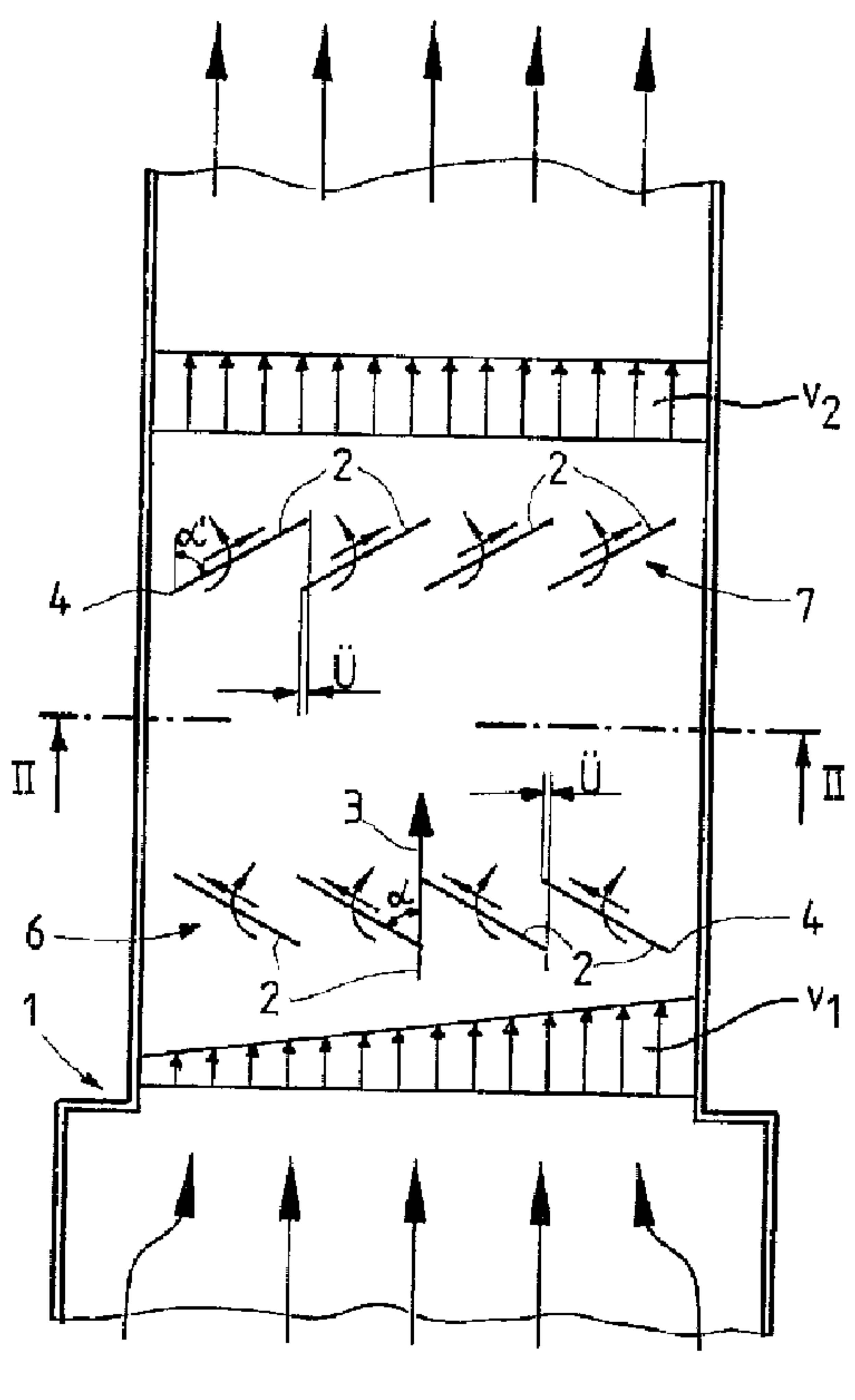
(54) Titre : MELANGEUR POUR GAZ ET AUTRES LIQUIDES NEWTONIENS
(54) Title: MIXER FOR MIXING GASES AND OTHER NEWTONIAN LIQUIDS



(57) Abrégé/Abstract:
What is proposed is a mixer for mixing gases and other Newtonian liquids, with a flow channel and arranged therein incorporated surfaces (2) that affect the flow. The incorporated surfaces are vortex-generating surfaces with leading edges (4) that are oriented against the flow and around which the flow can move freely; the shape of these leading edges has components that act in the direction of the main flow (3) of the gas, and components that act transversely thereto. In order to achieve rapid mixing in particularly short mixing sections, a plurality of identical incorporated surfaces (2) are arranged in a row (4) that is essentially transverse to the main direction of flow (3). Incorporated surfaces (2) that are adjacent overlap each other relative to the main direction of flow (3).

Abstract

What is proposed is a mixer for mixing gases and other Newtonian liquids, with a flow channel and arranged therein incorporated surfaces (2) that affect the flow. The incorporated surfaces are vortex-generating surfaces with leading edges (4) that are oriented against the flow and around which the flow can move freely; the shape of these leading edges has components that act in the direction of the main flow (3) of the gas, and components that act transversely thereto.

In order to achieve rapid mixing in particularly short mixing sections, a plurality of identical incorporated surfaces (2) are arranged in a row (4) that is essentially transverse to the main direction of flow (3). Incorporated surfaces (2) that are adjacent overlap each other relative to the main direction of flow (3).

(Figure 1)

Mixer for Mixing Gases and other Newtonian Liquids

The present invention relates to a mixer for mixing gases and other Newtonian liquids, with a flow channel and incorporated surfaces that affect the flow arranged therein, these incorporated surfaces being vortex generators that have front edges that are oriented against the flow and about which the flow can move freely, and whose shape has components that act in the main direction of flow of the gas as well as transversely thereto.

In order to mix flows of gas or liquids in pipe lines or channels, given a turbulent flow, one requires mixing lengths of 15 to 100-times the diameter of the channel. The length of this mixing section can be reduced significantly by using suitable static mixers in the form of incorporated bodies. However, in most of the systems that are usually used, a major loss of pressure has to be accepted if great demands are to be imposed with respect to homogeneity of the mixture that is produced. Many conventional mixing systems are also restricted to simple geometry, e.g., cylindrical pipes or rectangular channels, and cannot be used over great lengths and in complex mixing-chamber systems.

DE 29 11 873 C2 describes a static mixer in which the incorporated structures consist of delta-shaped surfaces, or surfaces that are shaped as circular disks, which the flow strikes at an angle, and on the front edges of which vortices are generated. The stationery and stable vortex systems that are so formed act far into the wake of the flow; the components that are to be mixed are rolled up in the form of layers, which results in very rapid mixing with very small pressure losses. These so-called incorporated vortex structures have proved themselves in practice because of the short mixing sections that they make possible.

In one aspect, there is provided a mixer for mixing gases and other Newton liquids, comprising: a flow channel; and built-in surfaces in the flow channel which influence a flow therein; said built-in surfaces having free surging leading edges directed against the flow for generating vortices within the flow, said free surging leading edges having one component running in a main flow direction of the gas and one component running transverse to the main flow direction; wherein several built-in surfaces are arranged in a first row basically transverse to the main flow direction, and wherein built-in surfaces next to one another partly overlap in relation to the main flow direction.

In a second aspect, there is provided a mixer for mixing gases and other Newton liquids, comprising: a flow channel; and built-in surfaces in the flow channel which influence a flow therein, comprising: a plurality of built-in surfaces arranged in a first row transverse to the main flow direction, wherein individual built-in surfaces forming the plurality are aligned side-by-side, wherein each individual built-in surface has a front surface, and wherein at least one of the individual built-in surfaces further comprises: a free surging leading edge overlapping the front surface of one of the adjacently disposed individual built-in surfaces, wherein the free surging leading edge is directed against the flow and has one component running in a main flow direction and one component running transverse to the main flow direction.

It is the task of the present invention to create a mixer for mixing gases and other Newtonian liquids, which provides for rapid mixing in even shorter mixing sections.

This objective has been achieved by a mixer with the features described in the introduction hereto, in that a plurality of similar incorporated surfaces are arranged in a row, essentially transversely to the direction of the flow; and in that, relative to the main direction of the flow, the incorporated surfaces are adjacent and partially overlap each other.

A mixer that is configured in this way permits particularly rapid mixing of the flow in very short mixing sections. The consequence of such mixing is that the profiles of the gas and/or liquid flow that passes through them are evened out, so that performance losses are avoided. Despite the formation of extended and stable vortices, the incorporated vortex structures according to the present invention generate a relatively small amount of resistance to the flow, since not all of their total surface acts as a baffle; rather, their leading edges generate static vortex fields that grow wider automatically in the direction of the flow, without the need for any additional incorporated surfaces or baffles being required to bring about this widening. What results, at least because of the incorporated vortex structures according to the present invention, which overlap each other relative to the direction of flow, is low-loss and effective mixing in a short mixing section.

A preferred development of the mixer is characterized by an additional row of incorporated surfaces that is arranged behind the first row, the angle at which the additional row is set up being opposite the angle at which the first row is set up. In addition to the mixing effect, such a configuration of the mixer makes it possible to even out the velocity profile across the cross section of the flow channel. It is preferred that the angle at which the incorporated surfaces are set up relative to the main direction of flow be between 40° and 80°, preferably 60°.

A further configuration of the mixer proposes that the flow channel be of an essentially rectangular cross section, the ratio of its width to its thickness, B/D, being ≥2, the row defined by the incorporated surfaces extending in the direction of the width of the flow channel.

One embodiment of the present invention is shown in the drawings appended hereto. These drawings show the following:

Figure 1: A longitudinal cross section through a flow channel, with the incorporated vortex structures being arranged in two rows therein;

Figure 2: A cross section through a flow channel, on the plane II-II in Figure 1.

Figure 1 is a cross section through a rectangular flow channel that is restricted at reference point 1. A non-homogenous mixture of gas or liquid flows through this flow channel. Within the context of this disclosure, gases and liquids are understood to be so-called "Newtonian liquids," i.e., those that include such fluids that behave in a manner similar to gases with respect to their flow behaviour.

Figure 2 shows the flow channel in cross section, and indicates its width B and its thickness D. It is preferred that the ratio of the width B to the thickness D, B/D, be ≥ 2.

Like Figure 1, Figure 2 shows that incorporated surfaces 2 are arranged in a row in the flow channel. In the embodiment shown, the row is made up of a total of four incorporated surfaces 2. The incorporated surfaces 2 in each row—which extends essentially transversely to the main direction of flow 3—are all configured identically, each being set at the angle α to the main direction of flow 3. The angle α that is subtended with the main direction of flow 3 is between 40° and 80°, and is preferably 60°.

The leading edges 4 of the incorporated surfaces 2, which are configured as circular disks in the embodiment, around which the medium can flow freely, and which are oriented against the flow, have components that act both in the main direction of the flow 3 and transversely thereto. Since, in addition, each incorporated surface 2 subtends an acute angle with the main direction of flow 3 in the flow channel, vortex fields are formed at each leading edge 4 of the incorporated surfaces 2, and these expand conically as they move downstream. When this happens, the individual vortices roll inwards, on the rear side of the incorporated surfaces 2. The vortices that are formed on the individual leading edges 4 are largely static and thus do not change position. Because of its rotation, each vortex field forms a flow component that is transverse to the main direction of the flow of gas, which results in good mixing of the gas mixture because of the associated pulse diffusion transversely to the main direction of flow. This mixing is enhanced even more by the particularly compact arrangement of the incorporated surfaces 2 in each row, in which adjacent incorporated surfaces 2 partially overlap each other relative to the main direction of flow 3. This overlapping is shown in Figure 2 at reference point 5, and is indicated by shading.

In Figure 1, v_1 indicates the velocity profile of the gas flow as it enters the mixing section. This velocity profile is uneven because of previous deflection of the gas flow. If a second row 7 of incorporated surfaces 2 is arranged after a first row 6 of incorporated surfaces, and if the angle α' of the incorporated surfaces of the second row 7 is opposite to the angle α of the first row 6, the velocity profile is evened out on exiting the mixing section, as is shown in Figure 1 by the velocity profile v_2.

In the embodiment shown, each of the incorporated surfaces 2 is in the form of a circular disk. In the same way, however, it is possible to use incorporated vortex structures in the form of disks of a delta-shaped or triangular basic shape, or in the form of elliptical or parabolic disks. Such disks also have symmetrical leading edges that are oblique to the middle plane, as are critical for the generation of leading-edge vortices.

Key to Reference Numbers

1 constriction

2 incorporated surface

3 main direction of flow

4 leading edge

5 overlap

6 row of incorporated surfaces

7 row of incorporated surfaces

B width of the flow channel

D thickness of the flow channel

V_1 velocity on entering

V_2 velocity on exiting

Ü Overlap

α angle of installation

α' angle of installation

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CLAIMS:

1. A mixer for mixing gases and other Newton liquids, comprising:

a flow channel; and

built-in surfaces in the flow channel which influence a flow therein;

said built-in surfaces having free surging leading edges directed against the flow for generating vortices within the flow, said free surging leading edges having one component running in a main flow direction of the gas and one component running transverse to the main flow direction;

wherein several built-in surfaces are arranged in a first row basically transverse to the main flow direction, and wherein built-in surfaces next to one another partly overlap in relation to the main flow direction.

2. The mixer of claim 1, further comprising a second row of built-in surfaces spaced from said first row, wherein an angle of incidence of the built-in surfaces in the second row is opposed to an angle of incidence of the built-in surfaces in the first row.

3. The mixer of claim 2, wherein the angle of incidence of the built-in surfaces is between 40° and 80°.

4. The mixer of claim 3, wherein the angle of incidence of the built-in surfaces is 60°.

5. The mixer of claim 2, wherein the flow channel has a rectangular cross section with a ratio of width (B) to thickness (D) of $B/D \geq 2$, whereby the first row and the second row extend in a direction of the width.

6. The mixer of claim 1, wherein an angle of incidence of the built-in surfaces is between 40° and 80°.

7. The mixer of claim 6, wherein the angle of incidence of the built-in surfaces is 60°.

8. The mixer of claim 1, wherein the built-in surfaces are round, elliptical or triangular in shape.

9. The mixer of claim 1, wherein the flow channel has a rectangular cross section with a ratio of width (B) to thickness (D) of B/D≥2, whereby the first row defined by the built-in surfaces extends in a direction of the width.

10. A mixer for mixing gases and other Newton liquids, comprising:

a flow channel; and

built-in surfaces in the flow channel which influence a flow therein, comprising:

a plurality of built-in surfaces arranged in a first row transverse to the main flow direction, wherein individual built-in surfaces forming the plurality are aligned side-by-side, wherein each individual built-in surface has a front surface, and wherein at least one of the individual built-in surfaces further comprises:

a free surging leading edge overlapping the front surface of one of the adjacently disposed individual built-in surfaces, wherein the free surging leading edge is directed against the flow and has one component running in a main flow direction and one component running transverse to the main flow direction.

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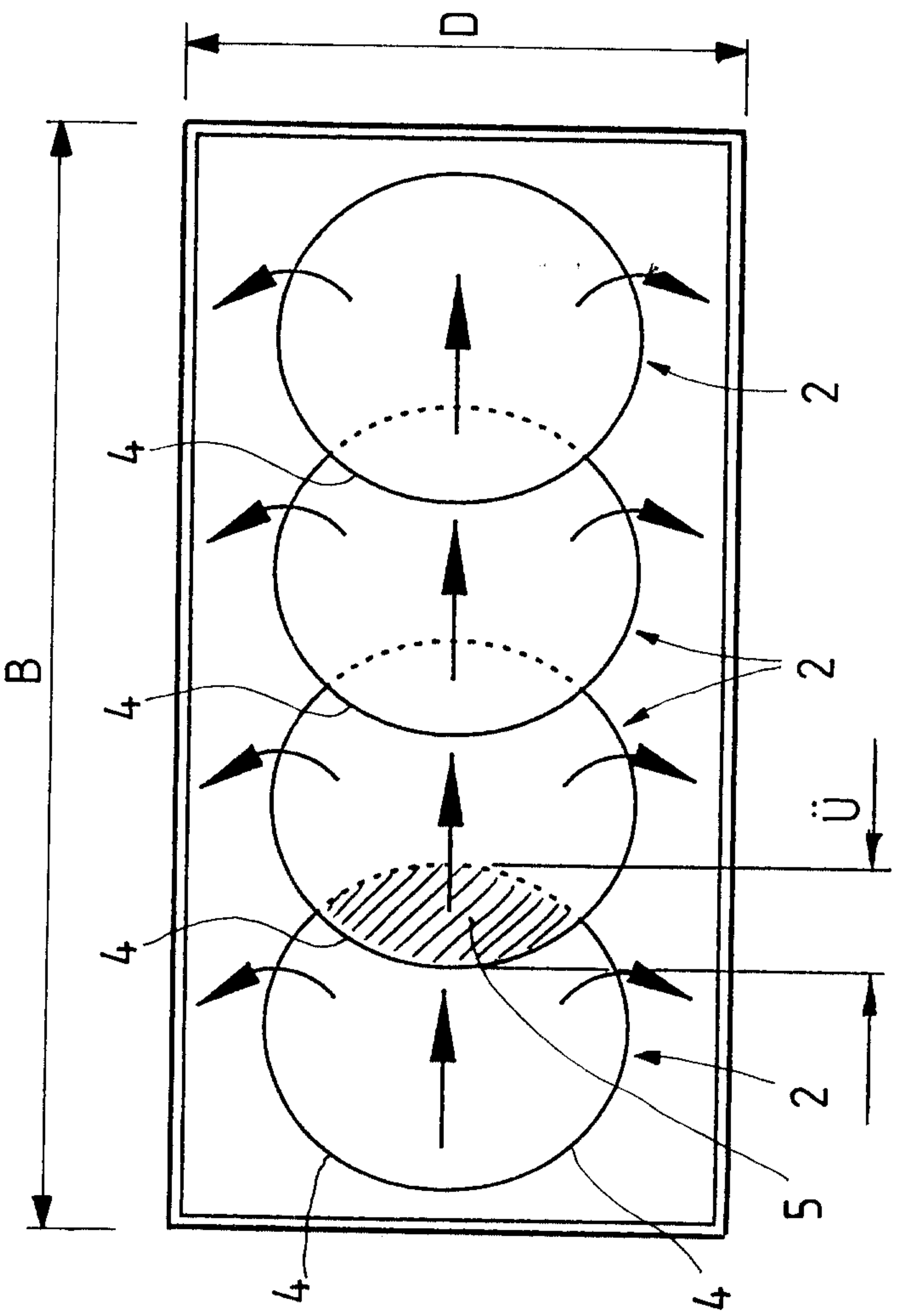


Fig.2

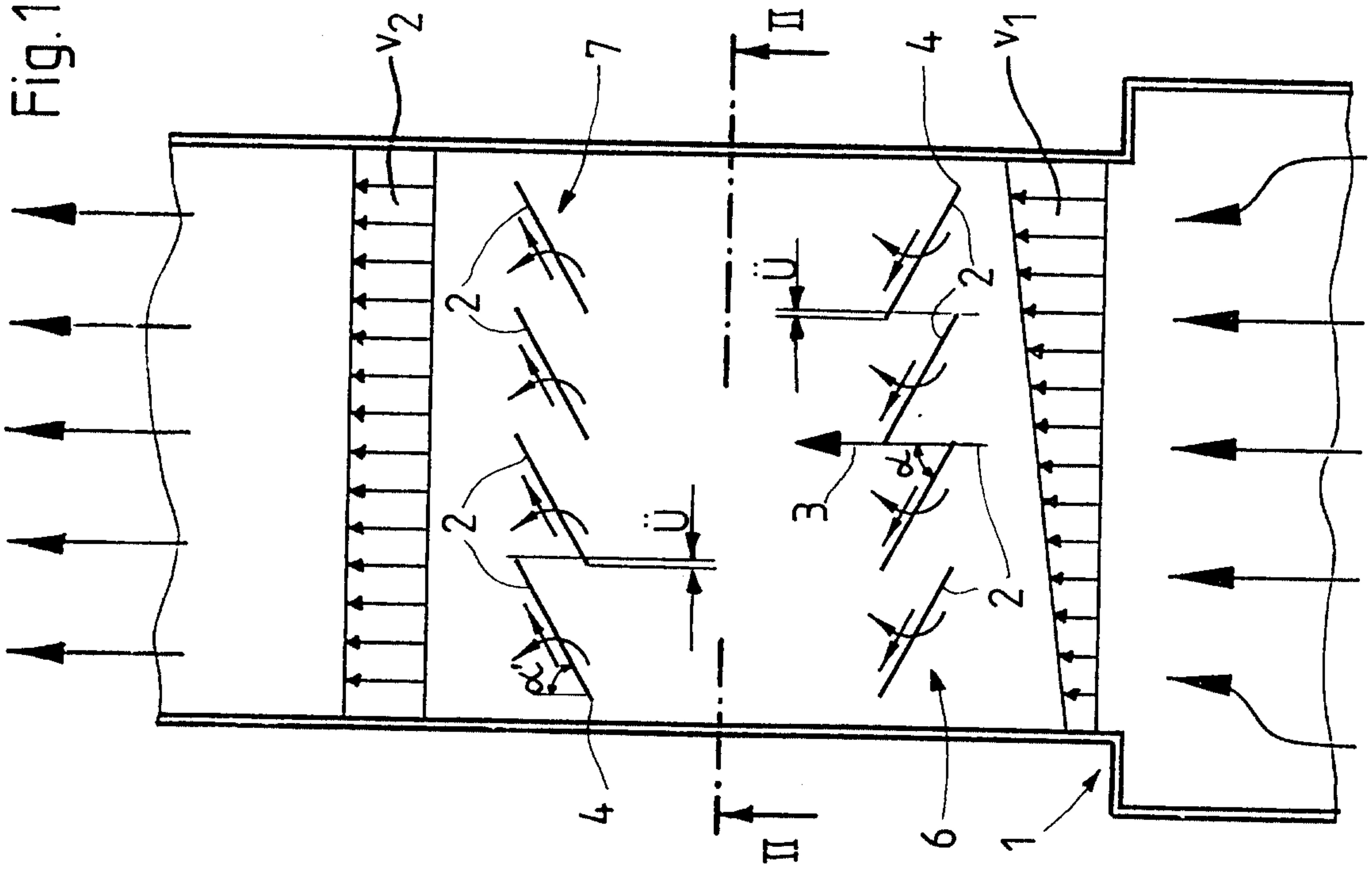
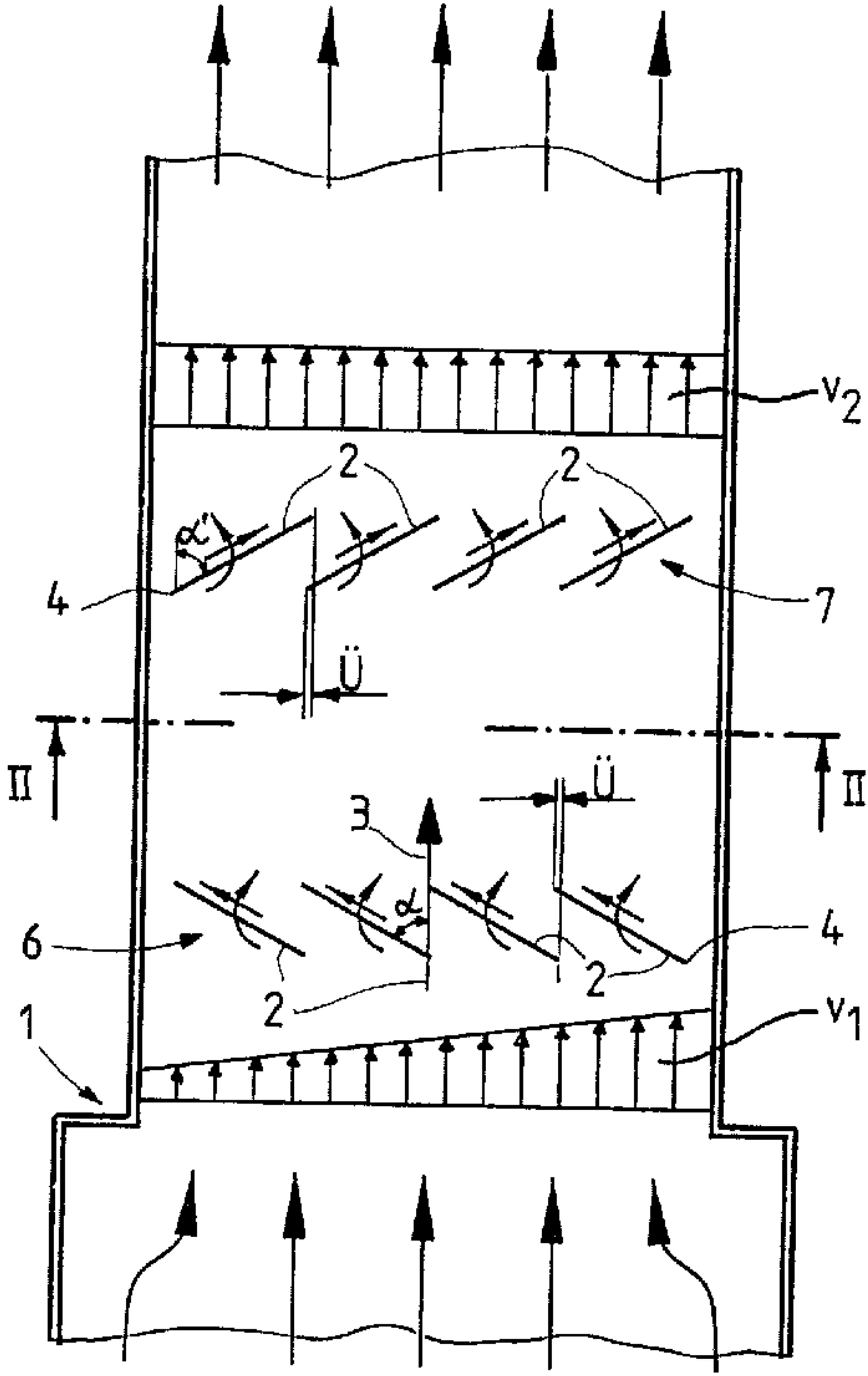


Fig.1



v2
2
2
α'
4
7
Ü
II
II
Ü
3
α
6
4
2
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2
1
v1