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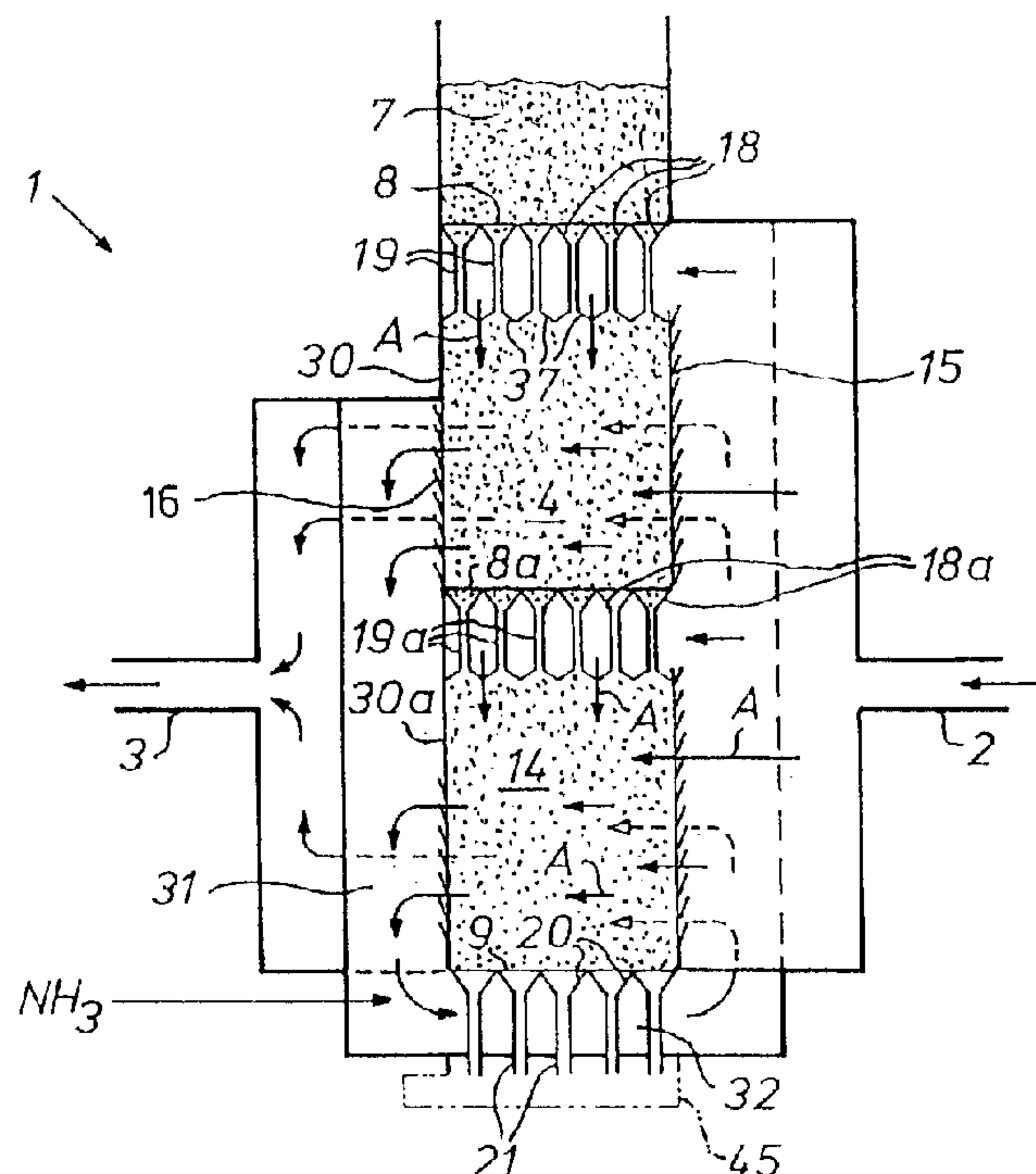
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(57) Abrégé/Abstract:

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Abstract

Apparatus for Removing Undesired Components from
a Fluid

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(Fig. 1)

The invention relates to an apparatus for removing undesired components from a fluid, particularly an exhaust gas, with a reactor which defines at least one reaction space which has supply means at its top and hopper-shaped outlet means at its bottom for supplying and for discharging, respectively, a pourable, particulate or granular adsorption agent.

10 DE-A 2626939 shows an apparatus of the above type in which the fluid is guided within the reaction space through two layers moving parallel to one another and the adsorption agent in the downstream layer is moved at a higher speed and is loaded to a lesser extent than in the layer on the upstream side. As complete as possible a cleaning of the exhaust gas is supposed to be effected with this known apparatus since sufficient fresh adsorbent is available to the exhaust gas on the downstream side. On the other hand, adsorbent, which is
20 utilised only to a very limited extent, must be continuously withdrawn in a relatively thick layer on the downstream side and regenerated. The reaction chamber is divided by vertical partition walls. The individual sections are supplied from a central filling opening with adsorption agent and have outlet openings or hoppers associated with the individual layers.

It is known from DE-C 3427905 to make the adsorbent particle flow uniform over the cross-section of the
30 moving bed by means of installations.

In known adsorption apparatus, substantial portions, particularly of the loose material cone in the top region and of the outlet cone in the bottom region of the

reactor can not be reached, or only unsatisfactorily, by the transversely flowing fluid. The consequence is hot spots (thermal concentrations) up to furnace temperatures in the top region and the accumulation of condensate in conjunction with the agglomeration of particles in the bottom region of the reactor.

10 The degree of efficiency of the gas cleaning in such moving bed reactors, which operate continuously or quasi-continuously, also depends on the unimpeded and uniform replacement of the charged adsorption agent particles by fresh and reactive particles. Fresh solid particles are introduced from above into the reactor in the amount in which charged loose material particles are discharged at the bottom out of the delivery openings after passing through the reactor and reacting with the fluid to be cleaned. The discharge by means of rotating dosing apparatus has not proved to be satisfactory due to the aggressiveness of the discharged materials and the non-20 uniform particle size and shape of the adsorption agent.

It is the object of the invention to ensure that the fluid to be treated flows better through the adsorption agent bed and to prevent operational disruptions, particularly in the critical top and discharge regions of the adsorber.

30 In order to solve this object the apparatus in accordance with the invention is characterised in that the supply means are constituted by a grid of a plurality of supply hoppers arranged adjacent and behind one another and the outlet means are constituted by a further grid of outlet hoppers with delivery openings and arranged adjacent and behind one another; that fluid openings are provided not

only on at least one side but also in the top region of the reaction space; that arranged beneath the delivery openings there is a substantially horizontal intermediate storage plate with discharge openings situated laterally adjacent the delivery openings; and that a discharge rake, whose blades engage in the space between the delivery openings and the intermediate storage plate, is swingably suspended on at least one support axis such that adsorption agent piled up beneath the delivery openings is slidable transverse to the pouring direction into the lateral discharge openings.

By dividing the supply and discharge regions of the adsorption agent into a plurality of conical sub regions, the pockets of material in the top and bottom regions of the reactor which are difficult to be reached by the fluid flow are minimised. Furthermore, the particle flow and loose material mechanics within the reaction space are improved, not only in the supply but also in the discharge of the adsorption agent, by the division into component flows. Although the main flow of the fluid is directed transverse to the adsorption agent column, fresh adsorber in the top region of the reactor is caused to participate in the reaction to an enhanced extent by the fluid introduced there into the reaction space or discharged out of the reaction space.

A further substantial advantage of the invention resides in that the discharge rake manages without linear guides which are at risk of clogging. The oscillating bearings can be arranged substantially above the delivery openings remote from the regions which are particularly at risk from dust and granulate and on the other hand can be so encapsulated that penetration of dust or abraded

particles is substantially prevented. The horizontal movements of the oscillating or swinging suspended rake are sufficiently large in order to move the loose material cone piled up under each delivery opening to one or other side into the discharge openings on each movement back and forth of the rake. The vertical movements of the operational blades, which are of small stroke by comparison, loosen the loose material cone and reduce the pushing forces necessary to transport the loose material in comparison to purely horizontal linear movements. Sliding contact between the discharge rake or its blades and the fixed components of the discharge occurs - if at all - only to a small extent and indirectly via the solid particles to be discharged.

A particularly precise horizontal guiding of the discharge rake without the guide components engaging in one another may be achieved in a further embodiment of the invention if the discharge rake is suspended on an oscillating parallelogram, all the pivotal axes lying in a common horizontal plane which is preferably arranged spaced above the discharge openings. With this type of oscillating suspension, the blade angles remain constant in each phase of movement and can accordingly be preset to the optimum degree of blade efficiency during both the forward and the backward movement.

In the adsorption apparatus in accordance with the invention the delivery openings are arranged in the manner of a grid or matrix in columns and rows. A discharge rake can be associated with a plurality of delivery openings arranged in a plane and behind one another in at least one row. This reduces the expense for the associated actuator or actuators.

A plurality of rectangular intermediate plate sections and delivery openings are preferably arranged behind one another in the direction of movement of the rake. After movement of the blades within the gap the loose material piles up again beneath each delivery opening and is discharged during the rearward movement into the discharge opening situated on the other side of the intermediate storage plate section.

- 10 In the preferred embodiment the discharge rake comprises a frame into which walls acting as plates are inserted.

The drive for the discharge rake is derived in the preferred embodiment of the invention from at least one crank mechanism. The crank mechanism enables the precise adjustment of a horizontal movement stroke without impairment by (small) vertical movements superimposed on it. A plurality of discharge rakes can be actuable in different movement cycles and/or in offset phases. A
20 plurality of adjacent reaction chambers or chamber regions can thus be operated with different bed movement speeds or different exchange volumes in order to adapt the loose material discharge to the reaction conditions in all the reactor regions as optimally as possible.

The carrier components and their mounting can vary with the respective conditions of use. Thus the discharge rake can be suspended, for instance, on the discharge plate or on an independent frame.

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Further details of the invention will be apparent from the following description of exemplary embodiments which are schematically illustrated in the drawings. Sub-combinations of the features of the claims are also

disclosed as being of importance to the invention.

In the drawings:

Fig. 1 is a vertical sectional view through an adsorption device in accordance with the invention without a discharge device;

10 Fig. 2 is a side view of the lower portion of Fig. 1 with an exemplary embodiment of the new discharge device, seen transverse to the direction of movement of the moved parts of the discharge device;

Fig. 3 is a vertical view at right-angles to Fig. 2;

Fig. 4 is a scrap view in which an alternative suspension of the discharge rake to that of the embodiment of Fig. 3 is shown.

20 The adsorber 1 illustrated in vertical section in Fig. 1 has a crude gas inlet 2 and a clean gas outlet 3. Between the inlet and outlet the fluid flows through a first reaction stage 4 and a second reaction stage which is divided into two reaction chambers which are connected in parallel and situated in front of and behind the plane of the drawing. The reaction stage 4 has a reaction chamber 14 of rectangular cross-section which is filled in operation with a bed of loose material of particulate or granular adsorption agent. The chamber 14 is bounded on the inlet side by a shutter 15 extending over the entire height of the chamber and on the outlet side by a shutter 16 which extends only up to a limited height. The supply of the adsorption agent is effected from a supply container 7 positioned on the chamber 14 via a distributor plate 8 at the top. The distributor plate comprises a uniform grid in the illustrated exemplary embodiment of square supply hoppers 18 which are arranged adjacent one another and behind one another in rows and

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columns and connected to which are supply tubes 19 opening out into the chamber 14.

10 An intermediate plate 8a is installed approximately half way up the chamber 14. It serves principally to relieve the pressure in high adsorption beds and in the illustrated exemplary embodiment has the same construction and arrangement (grid of supply hoppers 18a and supply tubes 19a and blocking section 30a) as the distributor plate 8. The guiding of the fluid through the loose material core below the intermediate plate 8a also corresponds to that in the top region. The incorporation of one or more intermediate plates 8a into the reaction chamber is not necessary but frequently convenient.

20 An outlet plate 9 is composed similarly to the distributor plate 8 of a grid of outlet hoppers 20 arranged adjacent one another and behind one another. Connected to the outlet hoppers 20 are outlet tubes 21.

30 The crude gas inlet 2 broadens out to the dimension of the entire height of the reaction chamber 14, that is to say to the region of the supply hoppers 18 and supply tubes 19. The fluid can thus flow into the adsorption agent bed not only from the side through the shutter 15 but also from above between the supply tubes 19 through the loose material cones 37, as is shown by the solid line arrows A in Fig. 1. The fluid can thus reach all the zones of the loose material bed, not only with a shifting bed but also with a stationary bed. Thus practically all the particles take part in the reaction in the same manner.

Provided on the outlet side between the uppermost layer (loose material cones 37) and the upper end of the downstream shutter 16 is a blocking section in the form of a closed wall 30 which prevents a short circuit of the fluid from above directly into the outlet channel 31.

10 The outlet passage 31 merges into a horizontal passage section 32 which extends beneath the outlet plate 9. The precleaned fluid leaving the reaction chamber 14 through the outlet passage 31 flows around the outlet hoppers 20 and the outlet tubes 21 in the passage section 32 and thus heats the adsorption agent situated within these elements to the extent that condensation is reliably prevented. The fluid is deflected upwardly out of the passage section 32 into the two chambers of the second reaction stage. The fluid distribution in the two chambers essentially corresponds to the fluid distribution described above at the shutter 15 on the inlet side and the loose material cones 37 at the top of
20 the first reaction stage 4. Supply and outlet hoppers are also arranged in the manner of grids in the two chambers in order to ensure as uniform as possible participation of the adsorption agent in the entire interior of the chambers.

As may be seen in Fig. 1, the reducing agent NH_3 is injected in at the deflection point between the outlet passage 31 and the horizontal passage section 32. Other supply points or preloading of the mineral coal activated
30 coke in the chambers of the second reaction zone are of course also possible.

As regards the shapes and dimensions of the individual hoppers 18 and 20, the invention is not subject to any

special exceptional conditions. A square or optionally rectangular cross-sectional shape ensures a particularly large area utilisation of the cross-sectional surface in the loose material distribution and favourable loose material mechanics. Other shapes are, however, possible essentially with the same advantages of the invention.

10 The crude gas inlet 2 can, however, also extend to below the outlet plate 9, whereby suitable openings to the interior of the reaction chamber 14 are then formed in the outlet hoppers 20, through which openings the crude gas can flow in but no granular adsorption agent can flow out into the fluid inlet distributor. Such incident flow plates are known, for instance, from DE-G 8706839.8. When constructing the outlet plate 9 as an incident flow plate a blocking section corresponding to the wall 30 must also be provided at the rear wall directly above the plate 9 in order to prevent fluid short circuits to the outlet passage.

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In the view of Figs. 2 and 3 15 outlet hoppers 20 are arranged in the discharge plate 9 in a matrix of five columns in three rows. Each outlet hopper 20 opens out into the associated vertically extending outlet tube 21. All the outlet tubes have delivery openings 33 arranged in a common horizontal plane.

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Arranged spaced below the delivery openings is an intermediate storage plate 34 which has a plurality of rectangular sections 35 lying in a common horizontal plane. Provided on both sides of each section 35 of the intermediate storage plate 34 are discharge openings 36 which open out into a discharge hopper 37 extending over the entire reactor base.

The discharge device described below may be used with essentially the same advantages on counterflow, transverse flow and even co-flow reactors and on all apparatus in which pourable solid materials are to be discharged in a dosed manner from a reaction space or other storage space.

10 Schematically illustrated in Fig. 2 below the delivery openings 33 are loose material cones 38 which, in operation, are heaped up above each section 35 of the intermediate storage plate 34 before they are discharged. The discharge device has a discharge rake 39 which comprises a rectangular frame 40 and blades 41 arranged in it in the manner of cross bars. The rake is so dimensioned that it can be moved with the blades 41 in the transversely extending frame sides without contact in the gap between the intermediate storage plate 34 and the lower edges of the outlet tubes 21 surrounding the delivery openings 33. The loose material cones 38 can be
20 limited by the blades 41 and the transversely extending sides of the frame 40. The rake 39 is suspended on pivotal arms 42 constituting an oscillating parallelogram such that its frame 40 extends parallel in every pivotal position of the oscillating parallelogram. The pivotal arms 42 have stationary bearing points at the upper end whose axes 43 lie parallel to one another in a common horizontal plane. In the exemplary embodiment illustrated in Figs. 2 and 3, the bearing points are arranged below the outlet plate 9 on reactor support
30 constructions 45. Alternatively, the pivotal arms 42 can also be arranged on individual support bridges 46 (Fig. 4).

The motor 47 in combination with a crank assembly 48

10 serves as the actuator for the discharge device. The crank assembly 48 has a connecting rod 49 which is pivotally connected to one side of the discharge rake 39 and actuates the discharge rake 39 in the direction of the double headed arrow A in Fig. 2. A gentle vertical movement is superimposed on the movement in the horizontal principal direction A due to the oscillatory support of the rake 39, but this is small in comparison to the horizontal transport movement in the direction of the arrow A. The greater the distance between the pivot points 43 and 50 of the pivotal arms 42 the smaller it is. The slight vertical movement is however definitely operationally desirable; thus whilst sweeping over the sections 35 it imparts an additional rotation or rolling movement to the particulate, pulverulent or granular loose material due to the blades 41 of the discharge rake 39 and thus breaks up lumps. Intensified breaking up of agglomerated loose material may be achieved by means of rods, tines, bevelled projections, ribs, noses or the like 41a which are arranged in front of the active blade surfaces of the discharge rake 39 and break up the loose material in the manner of a rake or ploughshare. The movement stroke in the direction of the double headed arrow A is selected to be so large that each loose material cone is discharged at least during one movement stroke in one direction into one of the adjacent discharge openings 36. Preferably, however, the arrangement of the blades 41 and of the transversely extending sides of the frame 40 is such that transport of a loose material cone 38 into one of the two adjacent discharge openings 36 and removal through the discharge hoppers 37 occurs in each direction of movement.

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As stated above, it is of no significance to the

kinematics and the transfer capacity of the discharge device illustrated in Figs. 2 and 3 at which horizontal positions the bearing points 43 are arranged. Of importance are the horizontal oscillatory amplitude and the arrangement or the layout grid of the blades 41 and/or the frame sides. This layout grid is so selected in the exemplary embodiment shown in Fig. 2 that in the right hand end position (Fig. 2) of the rake 39 the right hand most blade 41 has dumped the loose material cone 38 piled up below the first discharge passage into the discharge opening 36 furthest to the right; in the opposite swinging movement of the rake 39 or the pivotal arms 42 to the furthestmost position on the left, the same blade 41 has pushed the loose material cone which has in the meantime built up below the right hand most delivery opening 33 above the right hand section 35 into the region of the left hand discharge opening 36 and pushes it into this discharge opening 36. The blade 41 has thus reached its lowest vertical position in that pivotal position of the rake 39 in which it is disposed axially below the delivery opening 33. The blades 41 and the transversely extending sides of the frame 40 (Fig. 2, left and right) can also be used to limit and adjust the cone of loose material 38. For this purpose the distances between adjacent blades 41 must be smaller than the breadth in the direction A of each intermediate storage plate section 35. Furthermore, the rake must be halted after each discharge stroke in a suitable position in which the blades are centred in pairs on the axes of the delivery openings 33 so that sintered loose material cones 38 can form.

The entire matrix of outlet tubes 21 and delivery openings 33 arranged in rows and columns is made use of

in the described exemplary embodiment of a rectangular discharge rake 39. The blades 41, inserted in the manner of cross bars, are rigidly coupled from row to row, i.e. in the direction of the gaps, by transverse elements 51. These transverse couplers 51 can however be omitted and the rakes 39 which are then produced and service the individual rows can be actuated with a phase difference and/or even with different speeds. Also suitable for this purpose is a crank arrangement whose connecting rods are pivotally connected to a common crank disc, optionally with different spacings and/or at different angular spacings.

The oscillating suspension of the discharge rake 39 described above is useable practically universally. The delivery openings 33 certainly do not need to lie at a common horizontal level, as in the exemplary embodiment illustrated in the drawings; each blade 41 acting between a delivery opening 33 and section 35 of the intermediate storage plate can be moved on a different level of movement corresponding to the position, size and construction of the associated loose material cone and at a completely different angle of incidence from blade to blade. There are also absolutely no limitations as regards the number and/or the position of the delivery openings 33 and intermediate storage plate sections 35 to be serviced by a discharge rake 39. Parameters of this type may be freely selected in the invention by the constructor from case to case. By suitably choosing the length of the pivotal arms 42 the ratio of the horizontal to the vertical stroke can also be adjusted. As may be seen, only simple pivotal bearings 43, 50 are necessary to retain and guide the moved components of the discharge device which are insensitive to the heavy dust and

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granulate loading at the place of use.

CLAIMS

1. Apparatus for removing undesired components from a fluid, with a reactor (4) which defines at least one reaction space (14) which has supply means at its top and hopper-shaped outlet means at its bottom for supplying and for discharging, respectively, a pourable, particulate or granular adsorption agent, characterised in that the supply means are constituted by a grid of a plurality of supply
10 hoppers (18) arranged adjacent and behind one another and the outlet means are constituted by a grid of outlet hoppers (20) with delivery openings (33) and arranged adjacent and behind one another; that fluid openings are provided not only on at least one side but also in the top region of the reaction space (14); that arranged beneath the delivery openings (33) there is a substantially horizontal intermediate storage plate (34) with discharge openings (36) situated laterally adjacent the delivery openings (33); and that a discharge rake (39), whose blades
20 (41) engage in the space between the delivery openings (33) and the intermediate storage plate (34), is swingably suspended on at least one support axis such that adsorption agent piled up beneath the delivery openings (33) is slidable transverse to the pouring direction into the lateral discharge openings (36).

2. Apparatus as claimed in claim 1, characterised in that the discharge rake (39) is suspended on an oscillating parallelogram (42) having pivotal axes (43), all the pivotal axes (43) being arranged in a common horizontal
30 plane.

3. Apparatus as claimed in claim 2, characterised in that the discharge rake (39) is associated with a plurality of delivery openings (33) arranged behind one another in one plane and at least one row.

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4. Apparatus as claimed in claim 3, characterised in that rectangular intermediate storage plate sections (35) and the discharge openings (36) are arranged behind one another in the direction of movement (A) of the discharge rake (39).

5. Apparatus as claimed in one of claims 1 to 4, characterised in that the discharge rake (39) comprises a frame (40) in which walls (41) acting as blades are inserted in the manner of cross bars.

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6. Apparatus as claimed in one of claims 1 to 5, characterised in that the discharge rake (39) is driven by a crank mechanism (47...49).

7. Apparatus as claimed in one of claims 3 to 6, characterised in that a plurality of discharge rakes (39) for serving a plurality of rows of delivery openings (33) situated adjacent one another are arranged so as to be movable parallel to one another.

8. Apparatus as claimed in claim 7, characterised in that the discharge rakes (39) are actuatable in different movement cycles and/or in offset phases.

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9. Apparatus as claimed in one of claims 1 to 8, characterised in that the discharge rake (39) is suspended on an outlet plate (9).

10. Apparatus as claimed in one of claims 1 to 8, characterised in that the discharge rake (39) is

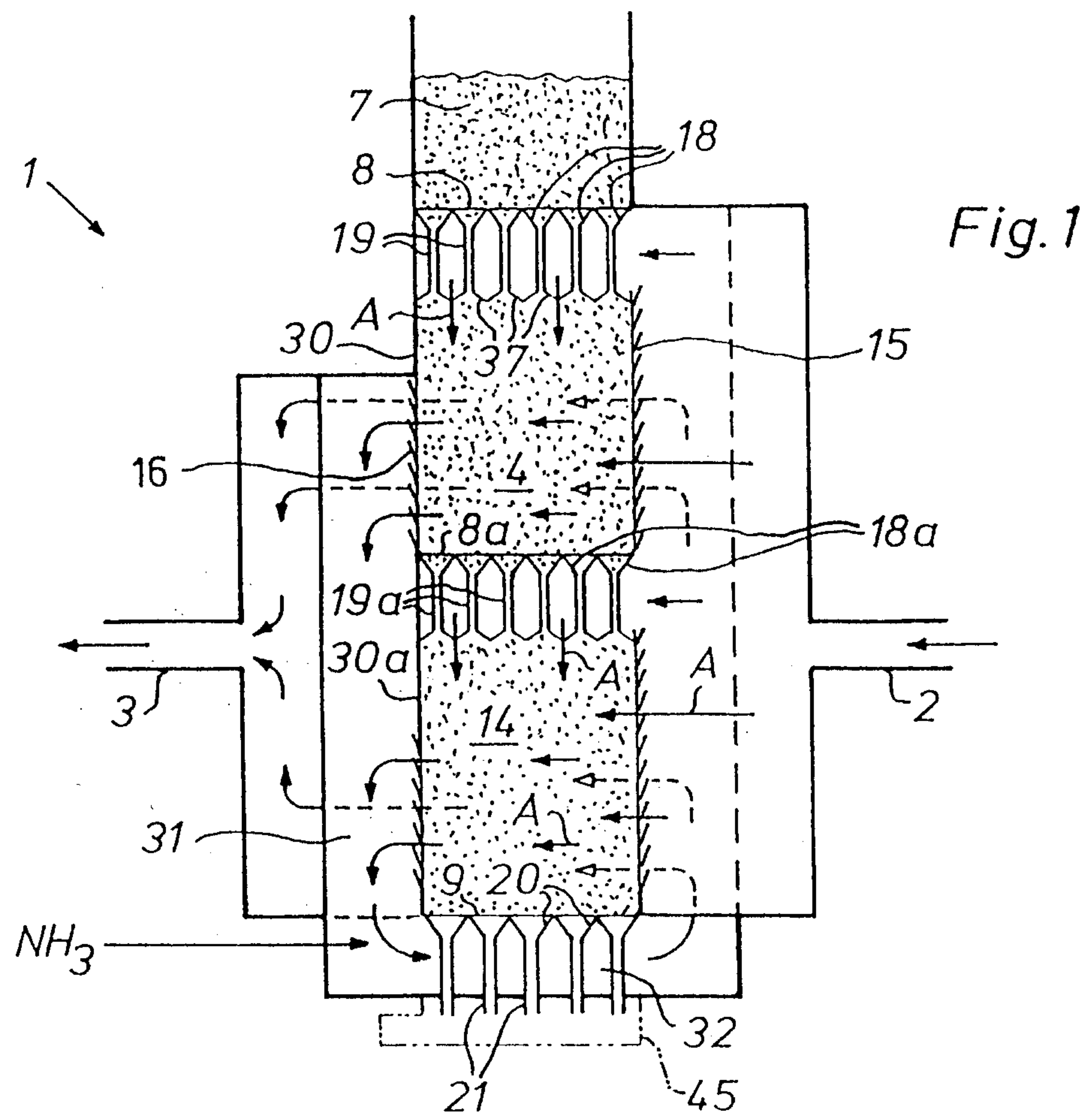
suspended on an individual support construction.

11. Apparatus as claimed in claim 10, characterised in that the support construction has at least two bridge beams (46) arranged parallel to one another.

12. Apparatus as claimed in one of claims 5 to 11, comprising means (41a) for breaking up loose material cone (38), arranged on the discharged rake (39).

13. Apparatus as claimed in claim 12, characterised in that the breaking up means are constructed as cutting edges, rods (41a), tines or point or nose-shaped projections which precede the operational blade surfaces in the discharge movement direction (A).

B



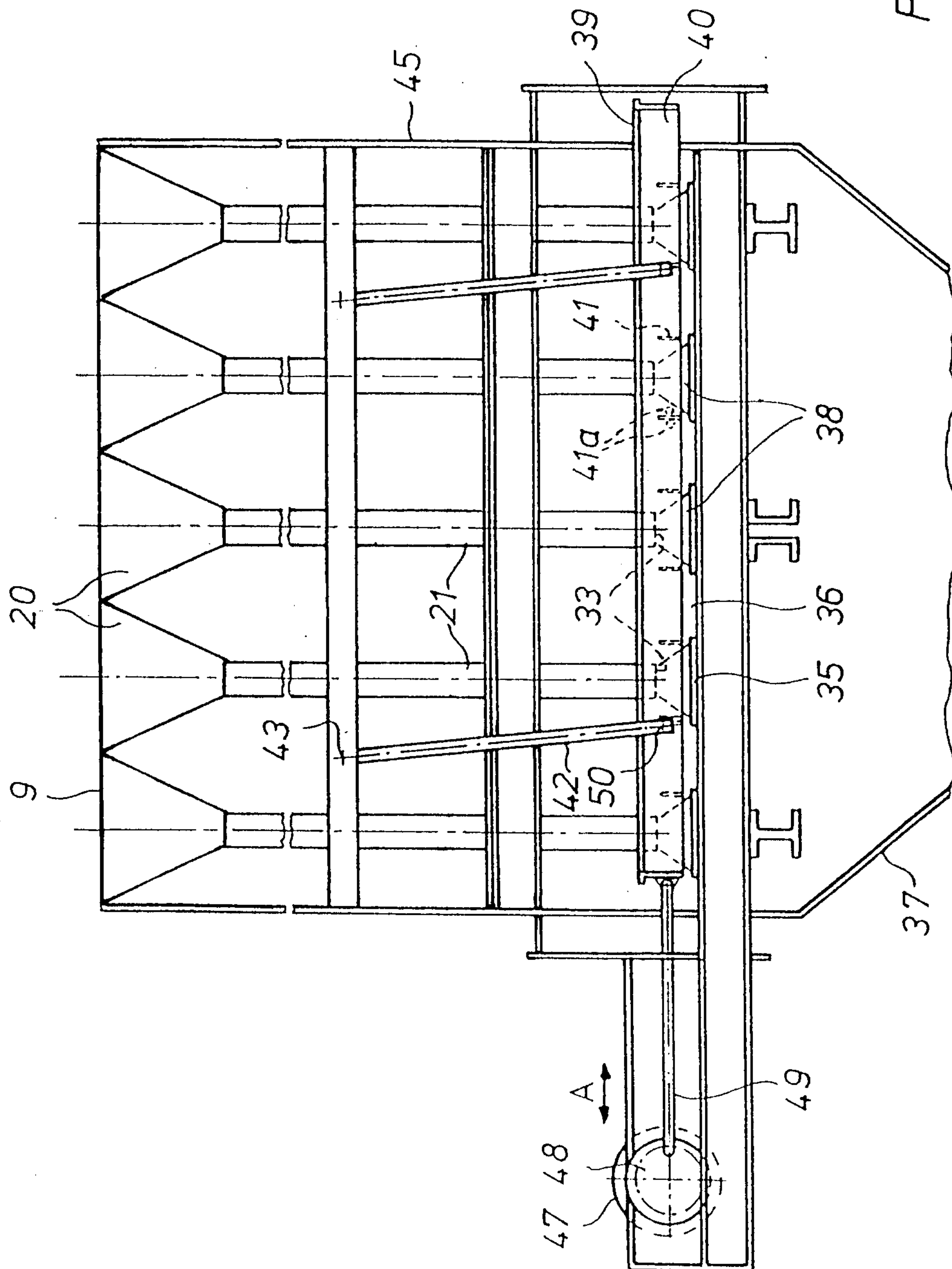


Fig. 3

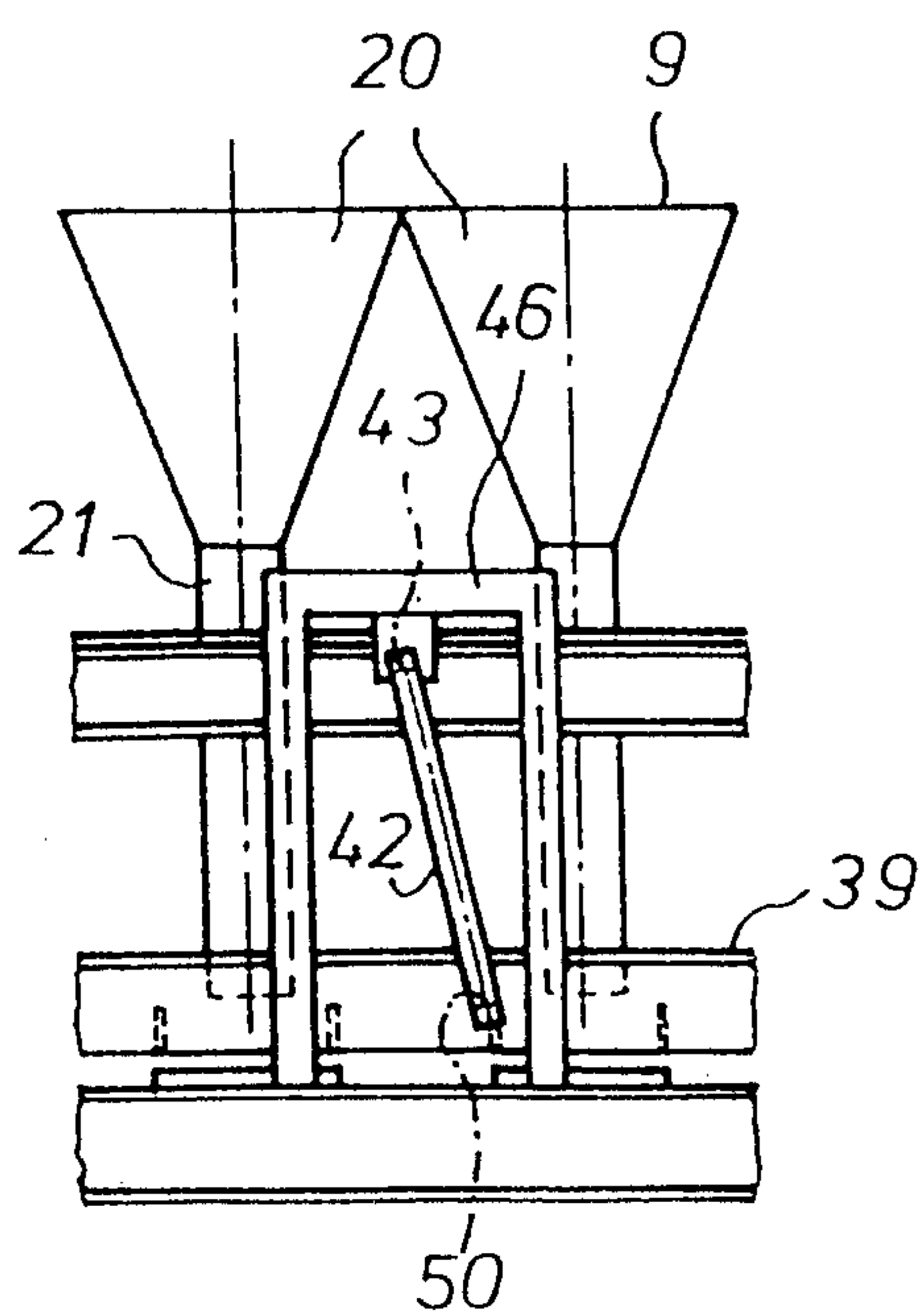
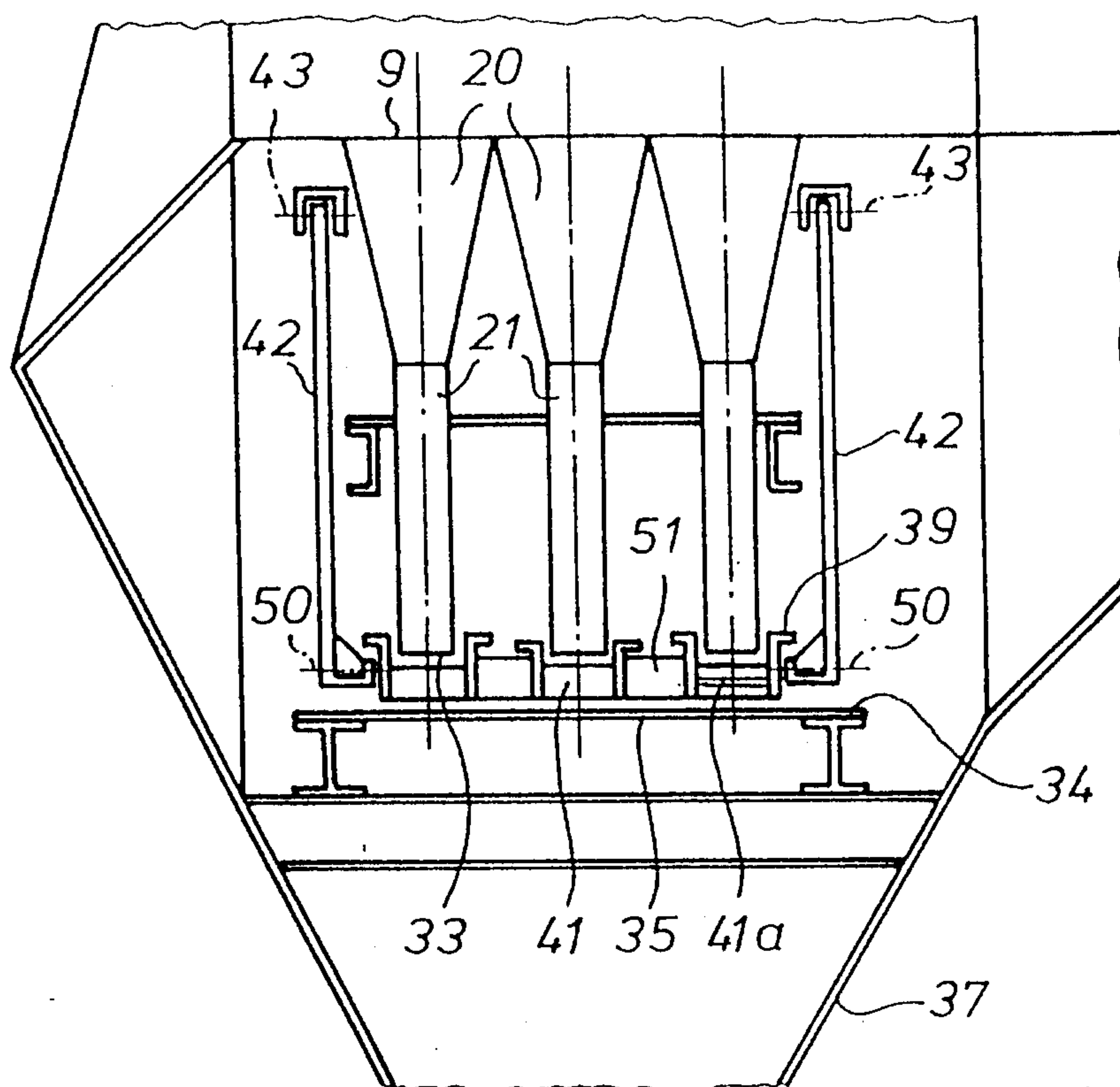


Fig. 4

