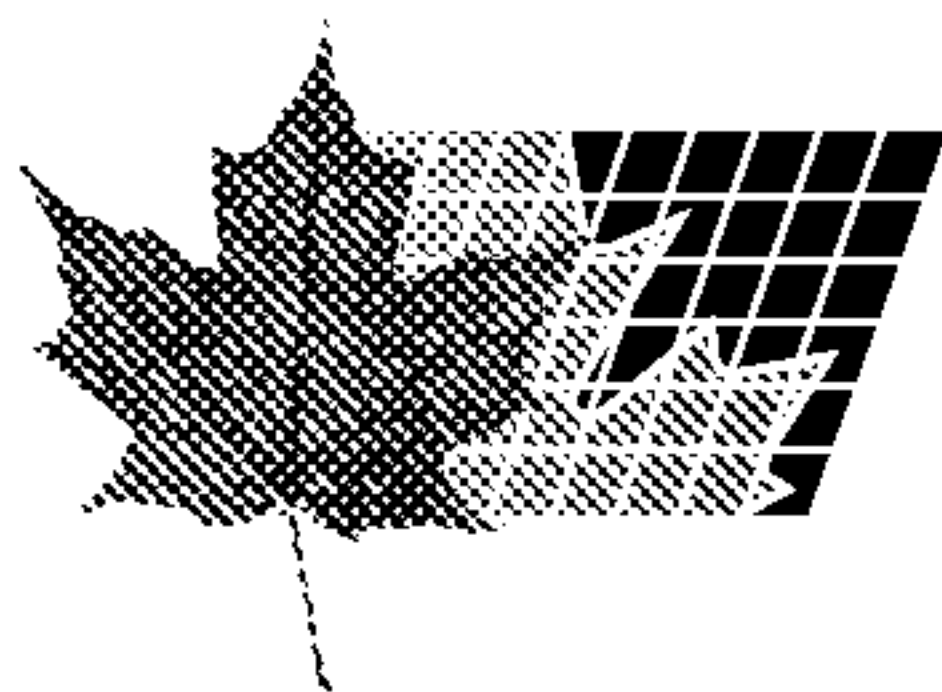




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(72) Christensen, Jorgen S., DK

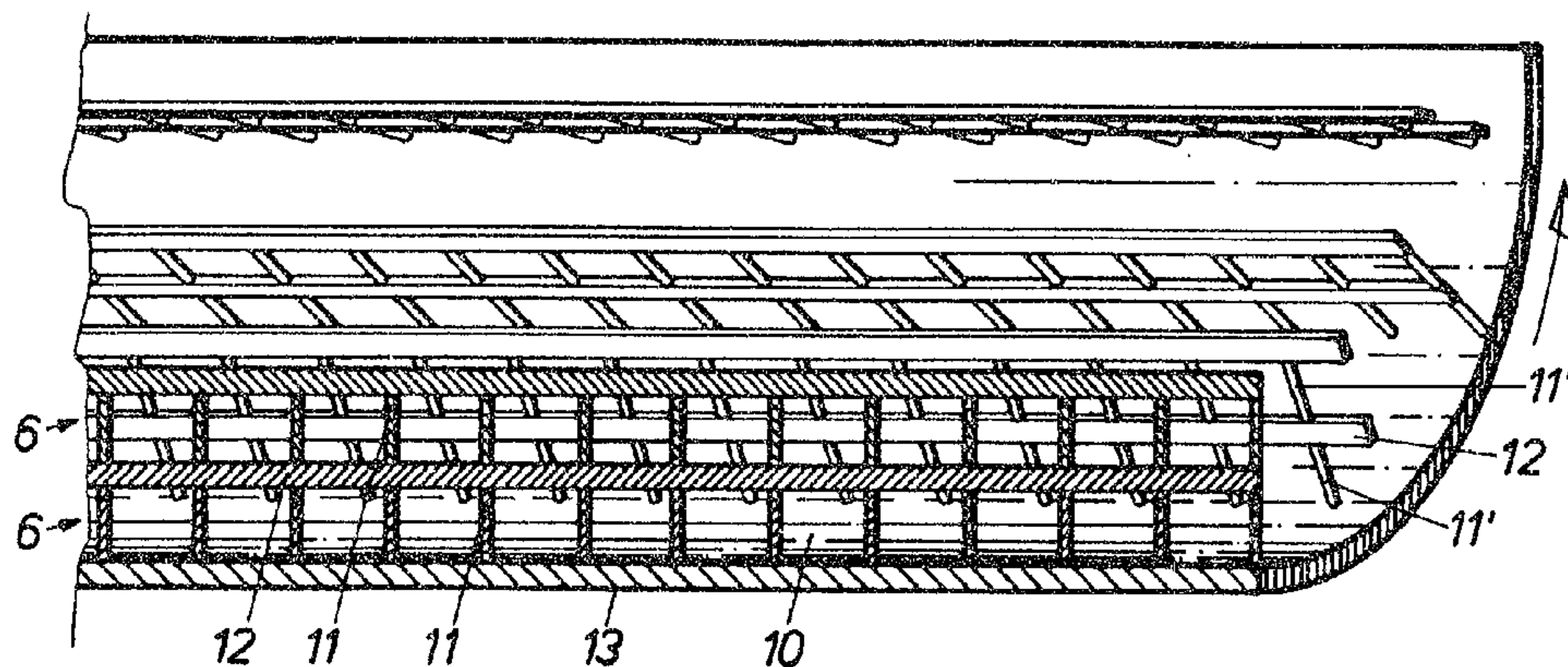
(73) Atlas Industries A/S, DK

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(54) **SECHOIR ROTATIF ET INSTALLATION CORRESPONDANTE**

(54) **ROTARY DRYER AND ASSOCIATED DRYING PLANT**



(57) A rotary dryer (1) for the drying of, for example, biological sludge, comprises a rotatable drum having rake elements (6) with openings for the passage of sludge disposed on the inner side of the drum casing. A drying plant with such a dryer further comprises a hot-gas plant (3) and one or more co-rotating drying zones (4,5).

A B S T R A C T

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biological sludge, comprises a rotatable drum having
5 rake elements (6) with openings for the passage of
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A drying plant with such a dryer further comprises
a hot-gas plant (3) and one or more co-rotating
10 drying zones (4,5).

ROTARY DRYER AND ASSOCIATED DRYING PLANT

The invention relates to a rotary dryer for the drying of hydrous masses, and as disclosed in the preamble to claim 1.

Such rotary dryers are used for the drying of many different kinds of hydrous masses, e.g. biological sludge or comminuted masses of organic or biological materials, the water contents of which must be removed by drying off.

In order to reduce the consumption of energy in the drying of hydrous masses, there is often first carried out a mechanical drying, for example with the use of a press, before the thermal drying is established. With the mechanical drying of e.g. biological sludge, the water content can only be reduced to around 65-85%, so that there is still a very high content of water to be dried off.

By drying the sludge down to a completely dry granulate, a stable and odourless, biological inactive material is obtained which can be used as fertilizer or soil improvement agent.

If, for example, the biological sludge is dried down to a water content of less than 10%, preferably around 5%, the dried sludge is combustible with a calorific value of approx. 2500-3500 kcal/kg, and can thus be used as fuel, for example in connection with the generation of thermal energy for the drying process.

From USA patent no. 3,950,861 there is known a rotary dryer for the drying of e.g. biological sludge by means of a rotating drying drum which is equipped with lifting vanes which bring the sludge into better contact with the hot drying gas. In the configuration of the lifting vanes, special regard is paid to preventing the sludge from packing tightly on or around said vanes.

10 However, biological sludge from cleaning plants, which is more or less dried mechanically, has the very unfortunate characteristic that an apparently firm press-cake becomes deliquescent and sticky (tixotropic) when worked mechanically and will, 15 for example in a plant such as disclosed in USA patent 3,950,861, be kneaded into large clumps which are unsuitable for a rational drying. In order to avoid this, material which has already been dried is mixed back in, so that from the start the sludge 20 is not tixotropic but substantially fluid, otherwise one must introduce mechanical breaking elements which separate the large clumps to form smaller clumps, for example such as disclosed in USA patent no. 3,720,004.

25 The known methods thus have a number of disadvantages, in that the mixing-back results in reduced capacity, increased energy consumption, complicated control etc., and in that the introduction of mechanical breaking elements results, among other things, 30 in a complicated and expensive construction with high energy consumption and high maintenance costs.

The object of the invention is to provide a rotary

dryer into which hydrous masses can be introduced and dried, e.g. biological sludge, and in which said sludge can be dried down to a granulate with the desired water content without the above-mentioned disadvantages inherent in such plants.

This is achieved by configuring the dryer according to the invention as disclosed and characterized in claim 1. The openings in the vane elements constantly separate the sticky, tixotropic mass into smaller clumps which are dried by the hot, through-flowing drying gas, and the size of the openings determines the maximum size of the individual clumps which can be formed, hereby achieving a well-defined clump formation during the initial drying.

The result is a very efficient breaking down of the sludge into smaller clumps which are lifted up inside the drying drum and flushed by the drying gas. The rake elements thus simultaneously comprise the stirring elements, lifting elements and breaking elements, and it should be noted that this is achieved without the use of independent mechanical moving parts, in that the passive rake elements are secured on the inner wall of the drum casing and follow this around during the rotation of the drum.

The dryer according to the invention is preferably configured as disclosed and characterized in claim 2, whereby a very simple mechanical construction is achieved which is both inexpensive to produce and inexpensive to mount inside the drum.

By configuring the dryer as disclosed and characterized in claim 3, there is a reduced risk of the sticky material being able to pack firmly around the ribs and hereby block the openings in the vane elements.

By configuring the dryer according to the invention as disclosed and characterized in claims 4 or 5, the material to be dried is broken down into smaller clumps than that which corresponds to the openings in the rake elements. A clump which is just able to pass through an opening in a rake element will, for reasons of the drum's rotation, meet a rib at the next rake element, and the clump will be instantly divided or crushed. With a rotary dryer of this kind, the material to be dried is broken down into a granulate.

The rotary dryer according to the invention can have the vane elements configured in many different ways, as disclosed in more detail and characterized in claims 6-8, all depending on the kind of hydrous material to be dried, its water content and depending on the desired degree of granulate comminution.

The invention also relates to a drying plant which uses a rotary dryer with vane elements as described above. The drying plant is preferably configured as disclosed and characterized in claim 9, in that the plant thus achieved is one for the continuous drying of hydrous masses, arranged in such a manner that it is normally never necessary to stop the drying plant as a consequence of an over-accumulation or clumping together of the material to be dried. With such a

drying plant, a sludge which has been pre-dried mechanically with, for example, 20% drystuff content, can be dried down to a granulate with a drystuff content of 95% and substantially energy neutral, in that the
5 dried granulate in comminuted condition contains sufficient thermal energy upon combustion to provide the amount of hot gas or air necessary to dry the sludge.

10 By configuring the drying plant according to the invention as disclosed and characterized in claim 10, the drying plant becomes automatic and self-regulating without the use of setting elements, such that the drying plant can continuously dry materials,
15 for example biological sludge, down to around 5% water content, i.e. around 95% drystuff.

The invention will now be described in more detail with reference to the drawing, which shows a preferred
20 embodiment and alternative embodiments, in that

fig. 1 is a sketch of a drying plant according to the invention with a rotary dryer, partly in
section,

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fig. 2 shows a plane, radial section II-II of the dryer in fig. 1,

fig. 3 shows a plane, radial section III-III in the
30 intermediate drying zone of the drying plant in fig. 1.

fig. 4a and b show a plane, radial section IV-IV in two different embodiments of the accumula-

tion zone in the drying plant in fig. 1.

fig. 5 shows a section of a dryer with rake elements in accordance with a first embodiment.

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fig. 6a and b show the same as fig. 5, but in a second embodiment,

10 fig. 7a and b show the same as fig. 5, but in a third embodiment, and

fig. 8 shows a system diagram of a complete drying plant for the drying of drained sludge.

15 In fig. 1, which is a sketch showing the principle of the drying plant according to the invention, the reference figure 1 indicates a rotary drum dryer, also according to the invention, and 2 indicates the inlet end of the dryer with inclined feeding vanes
20 so that the press-cake introduced does not accumulate here, but is immediately conveyed into the interior of the dryer. In front of the dryer there is provided a drying gas plant 3, e.g. an oven for the combustion of dry, pulverized sludge or other
25 waste, and with blower elements so that the hot drying gas or air is fed to the rotary dryer 1. Alternatively, fuels such as oil or natural gas may be used. The oven 3 will normally be non-rotating and can be of any known kind. In the direction of flow
30 after the rotary dryer 1 there are two co-rotating zones 4,5, zone 4 being an intermediate zone and zone 5 being an accumulation zone in which the final drying is effected before the granulated material leaves the plant.

The driving elements, rollers, motors etc. for the rotating parts of the drying plant are not shown in fig. 1 of the drawing, and can moreover be executed in accordance with any known principles and methods.

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In the interior of the dryer 1, a number of vane elements 6 are provided on the inner side of the casing; said vane elements provide the desired effect and are therefore described in more detail with reference to fig. 2 and figs. 5-7.

In figs 2 and 5 it will be seen that the vane elements 6, which are welded to the inner side of the drum casing 13, are configured as one or more "rakes" or rake elements 6, built up of ribs 11, the free ends of which are connected to bridge-like connecting elements 12. The ribs 11 can be formed from round rods or tubes, for example with a diameter of 10 mm, and the connecting elements 12 can be made of 10 x 20 mm flat bars as shown, and thus the connecting elements 12 form a kind of lifting vane with the ribs 11, but with a number of intermediate openings 10, in one or more rows.

As shown in fig. 5, the rake elements 6, which are arranged successively in the direction of rotation, are offset from one another in such a manner that the ribs 11 are for example disposed opposite the centre of the openings 10 in the adjacent rake elements seen in the direction of rotation.

The individual rake elements can be disposed on the cylinder casing at regular intervals, and the tooth depth of each rake element 6 can be around 60 mm,

while the distance between the ribs 11 can be around 100 mm. Whether there should be more than one rake element disposed in the radial direction, as shown in fig. 5, will depend on the diameter of the drum, the desired degree of filling and on the material to be dried. The extent of the rake elements in the axial direction from the inlet through the dryer must be so long that the material to be dried is no longer sticky exteriorly, but has at least a thin dry shell surface when it leaves this zone and moves over into the intermediate zone 4.

In figs. 6a and 6b, a third row of rake elements 6' is shown with stippled lines, in that the most central rake element 6' is shown in this manner, while the two rows at the casing are shown with solid lines. For other applications, it will be sufficient for each lifting vane to comprise only one rake element 6.

Figs. 7a and 7b show another embodiment of the rake elements 6, in that these are augmented with lifting vanes 15 which can be disposed either at the drum casing or on the part facing inwards towards the axis of rotation.

It will be obvious to those familiar with the art that the rake elements 6, 6', 15 can be configured in many different ways, and that these different configurations can be combined without deviating from the basic idea of the invention, in that the more detailed configuration of the rake elements will be determined by the length and diameter of the dryer, the kind of material to be dried and on its

degree of hydrousness. Normally, the total area of the openings in the vane elements must be around 60-90% of the total area of the vane elements.

5 Figs. 3 and 4 show sections in those zones of the drying plant which lie after the rotary dryer 1. Usually, the intermediate zone 4 will be provided with normal, longitudinal lifting vanes 7 (fig. 3), and corresponding lifting vanes 7, see fig. 4a, or
10 backwards-leading lifting vanes 8, see fig. 4b, can be provided in the final drying zone 5, depending on how high a degree of accumulation of the materials there is need for in this zone. The final zone 5 can also be provided with auxiliary elements 9,
15 see fig. 4a, in the form of longitudinal cross members, which increase the fall time of the now flowable, substantially dry sludge, so that the time for which it is in contact with the drying air is increased.

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In fig. 8 is seen a system diagram of the drying process for the drying of drained, biological sludge. Mechanically-drained sludge with a drystuff content of around 15-35% is fed into a drying plant 16 by
25 means of a conveyor 14, in that the drying plant is of the kind shown in fig. 1. The dried product is conveyed to a cyclone 19, where the drying gases are separated from the dried product. From here, the dried product is conveyed to a silo 20, from which
30 it can be transported away 24 or carried via a conveyor 26 to a cyclone burner 17, which for start-up or alternative operation can be provided with an oil or a gas burner 18. The hot drying gas from the cyclone 19 is fed as required through a pipe 27,

either to an oven 17 or direct to the drying plant 16. The residual thermal energy in the drying gas is hereby reused. Surplus drying gas is condensed and cleaned in a condenser 21 and a scrubber 22, which
5 is provided with water via a pipe 28, and from where the waste water 25 is carried to a waste-water plant. Instead of the water scrubber, a biological filter of known kind can be used, e.g. a so-called compost filter, in that the need for water is hereby consider-
10 ably reduced. The cleaned air is led to the chimney 23. If the drained sludge which is supplied to the drying plant 16 has a reasonable calorific value, which for example is the case with dried sludge, such a drying process using a drying plant 16 with a rot-
15 ary dryer according to the invention without feed-back of the materials will function in a substantially energy-neutral manner, in that energy in the form of oil or gas needs only to be supplied during start-up of the plant.

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CLAIMS:

1. Rotary dryer (1) for the drying of hydrous masses comprising an elongated, rotatable drum having a drum casing (13), and a plurality of vane elements (6) extending into the interior of the drum, characterized in that at least one of the vane elements (6) is configured with at least one opening (10) for the passage of sludge, and comprises a rake element (6) disposed on an inner surface of the drum casing and formed by a plurality of ribs (11) that extend in the radial direction of the drum and at least one bridge-like connecting element (12) which connect the free ends of the ribs.
2. Rotary dryer according to claim 1, characterized in that the rake element/elements (6) are disposed radially and substantially with the connecting elements (12) parallel to the axis of the drum.
3. Rotary dryer according to claim 1 or 2, characterized in that the ribs (11) have a round cross-sectional profile, while the connecting elements (12) are configured with lifting surfaces.
4. Rotary dryer according to claim 1, characterized in that the openings (10) in adjacent vane elements (6) are offset from one another in the direction of rotation.
5. Rotary dryer according to claim 4, characterized in that the offsets arise from the ribs (11, 11') in adjacent vane elements (6) being offset from one another.
6. Rotary dryer according to any one of claims 1-5, characterized in that the vane elements (6) are configured with substantially plane lifting surfaces (15).

7. Rotary dryer according to any one of claims 1-6, characterized in that each vane element is composed of more than one rake element (6) (fig. 5) in the radial direction.
8. Rotary dryer according to any one of claims 1-8, characterized in that the total area of the openings in the vane elements constitute 60-90% of the total area of the vane elements seen in the direction of rotation.
9. Drying plant for drying of hydrous masses, comprising:
a rotary dryer (1) according to any one of claims 1-8, characterized in that said drying plant further comprises:
 - a) a hot-gas plant (3) arranged in front of the dryer,
 - b) one or more co-rotating post-drying zones (4, 5) arranged after the dryer, and in which there are disposed lifting vanes (7, 8) to increase the fall time of the dried sludge.
10. Drying plant according to claim 9, characterized in that the first post-drying zone (4) comprises longitudinal lifting vanes (7) parallel to the axis of rotation, and in that the last drying zone (5) comprises lifting vanes (8) configured as back-feeding vanes.

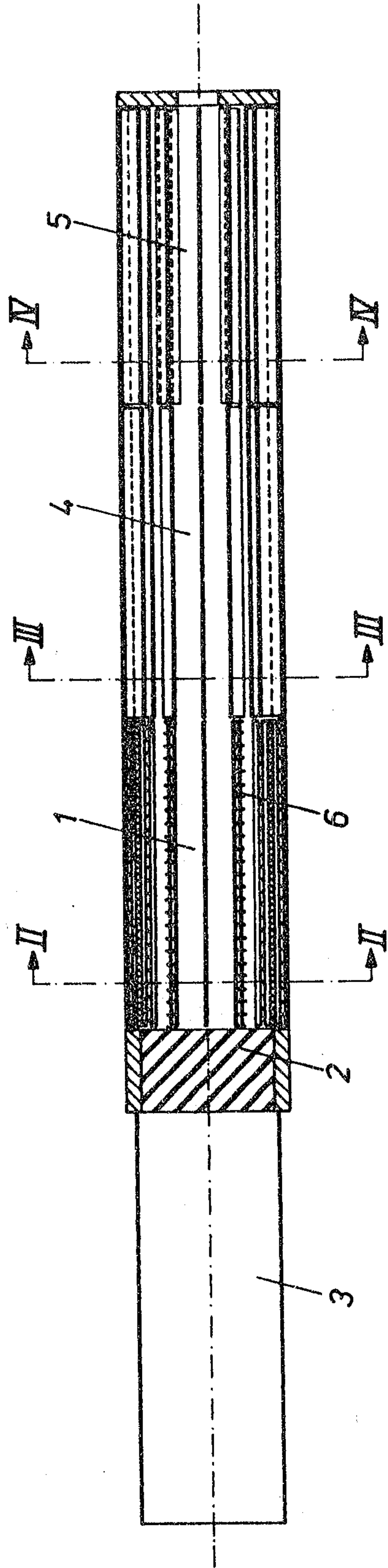


Fig. 1

by: Rogers, Bereskin + Pann

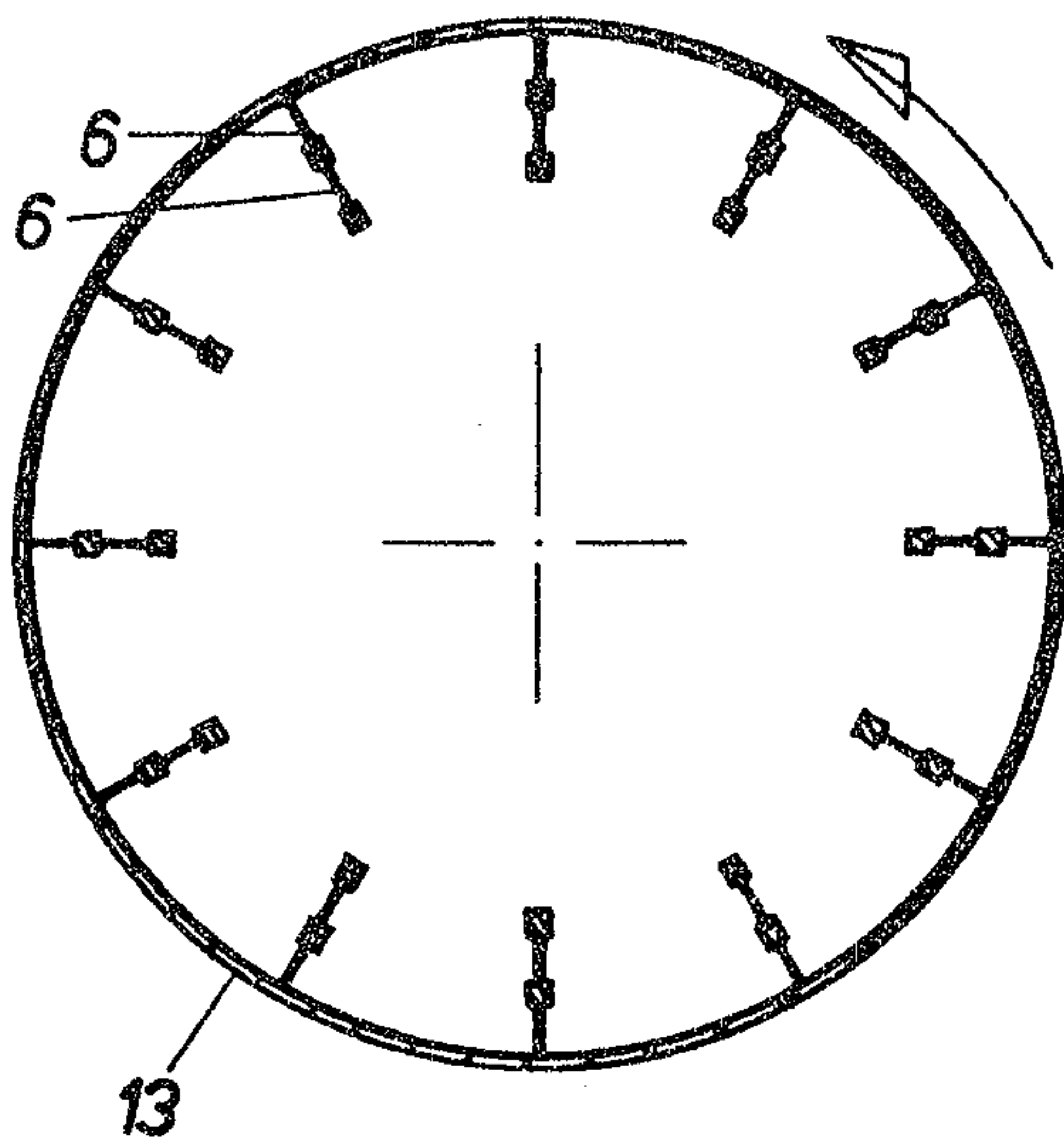


Fig. 2

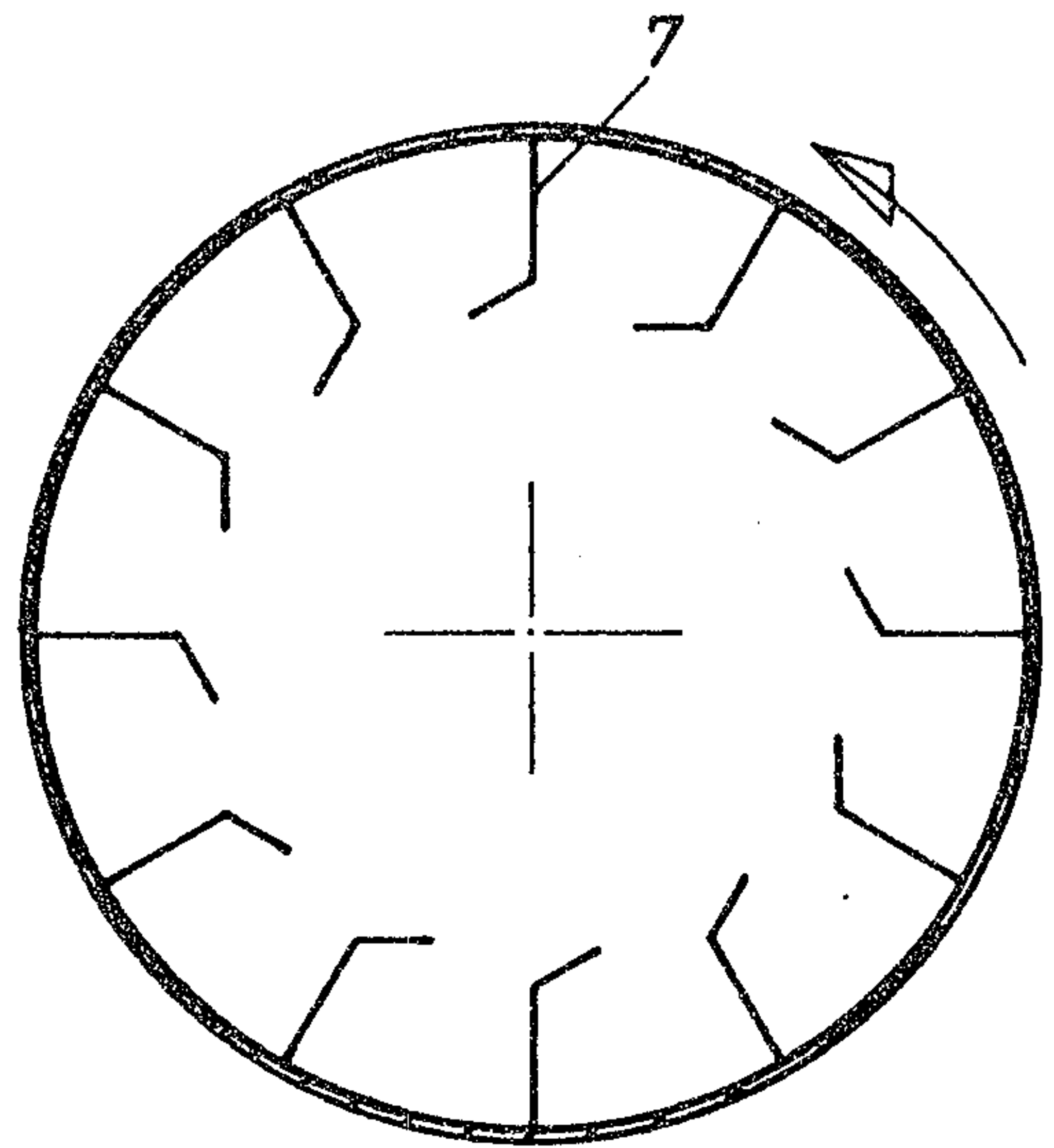


Fig. 3

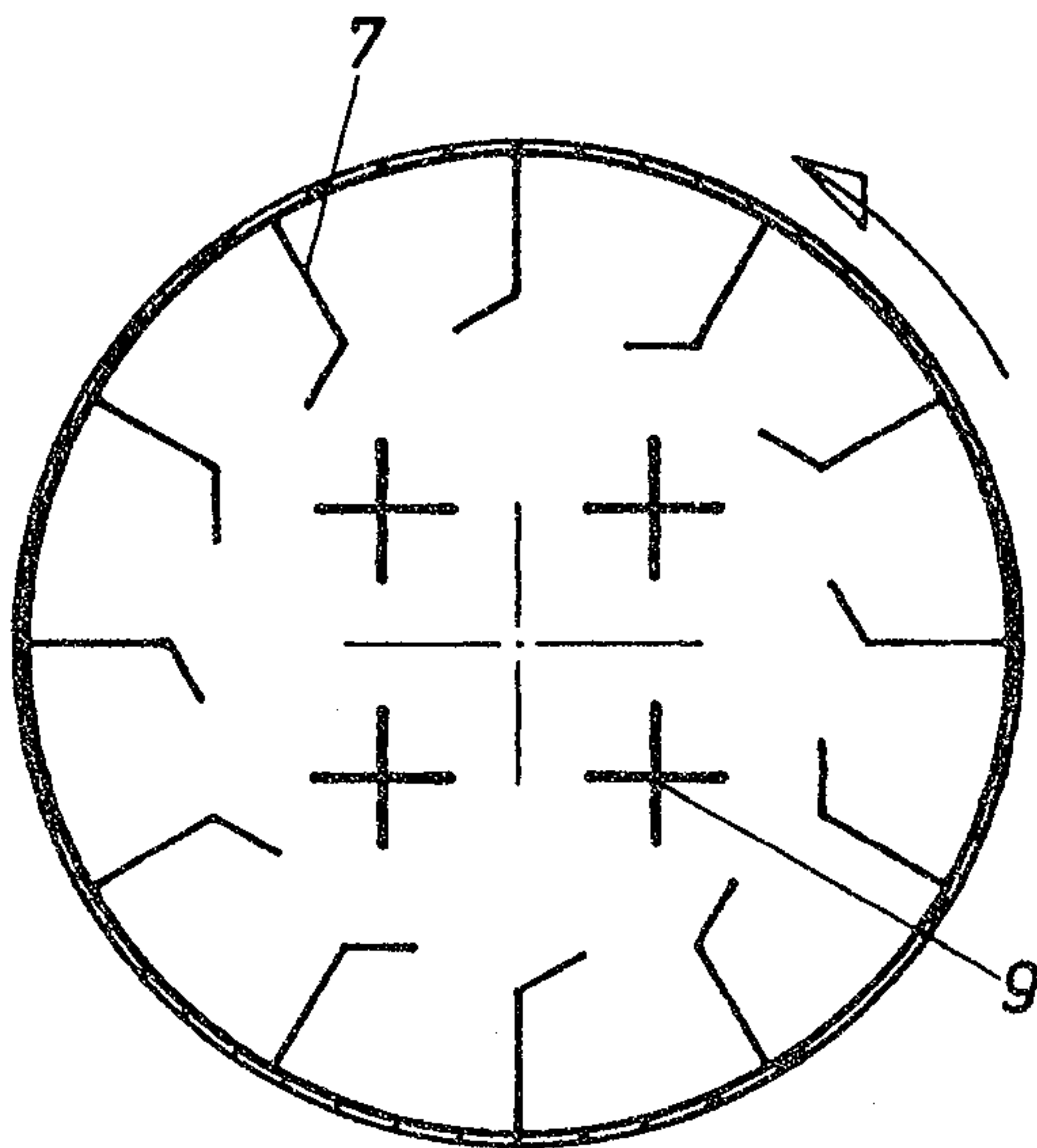


Fig. 4a

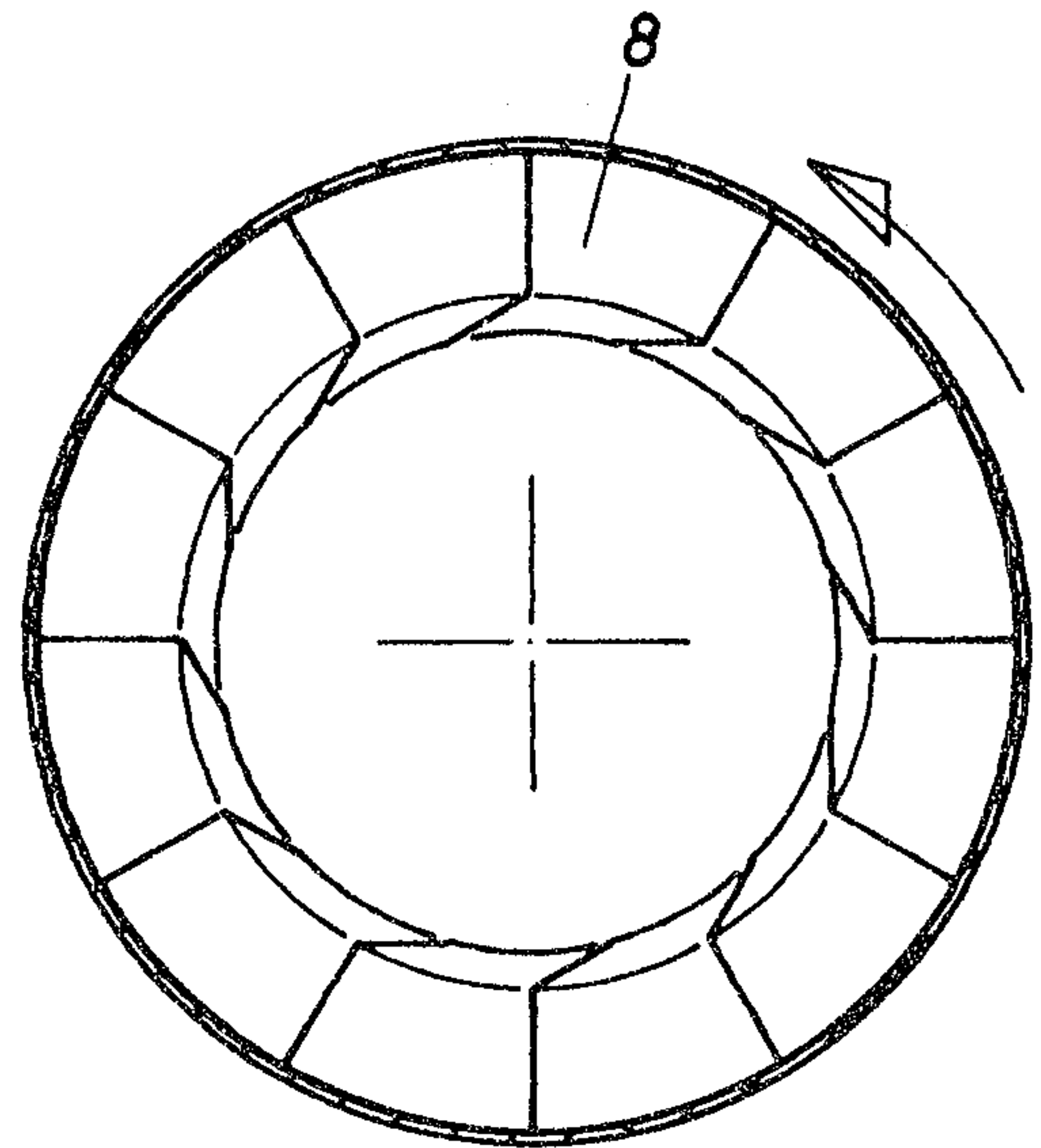
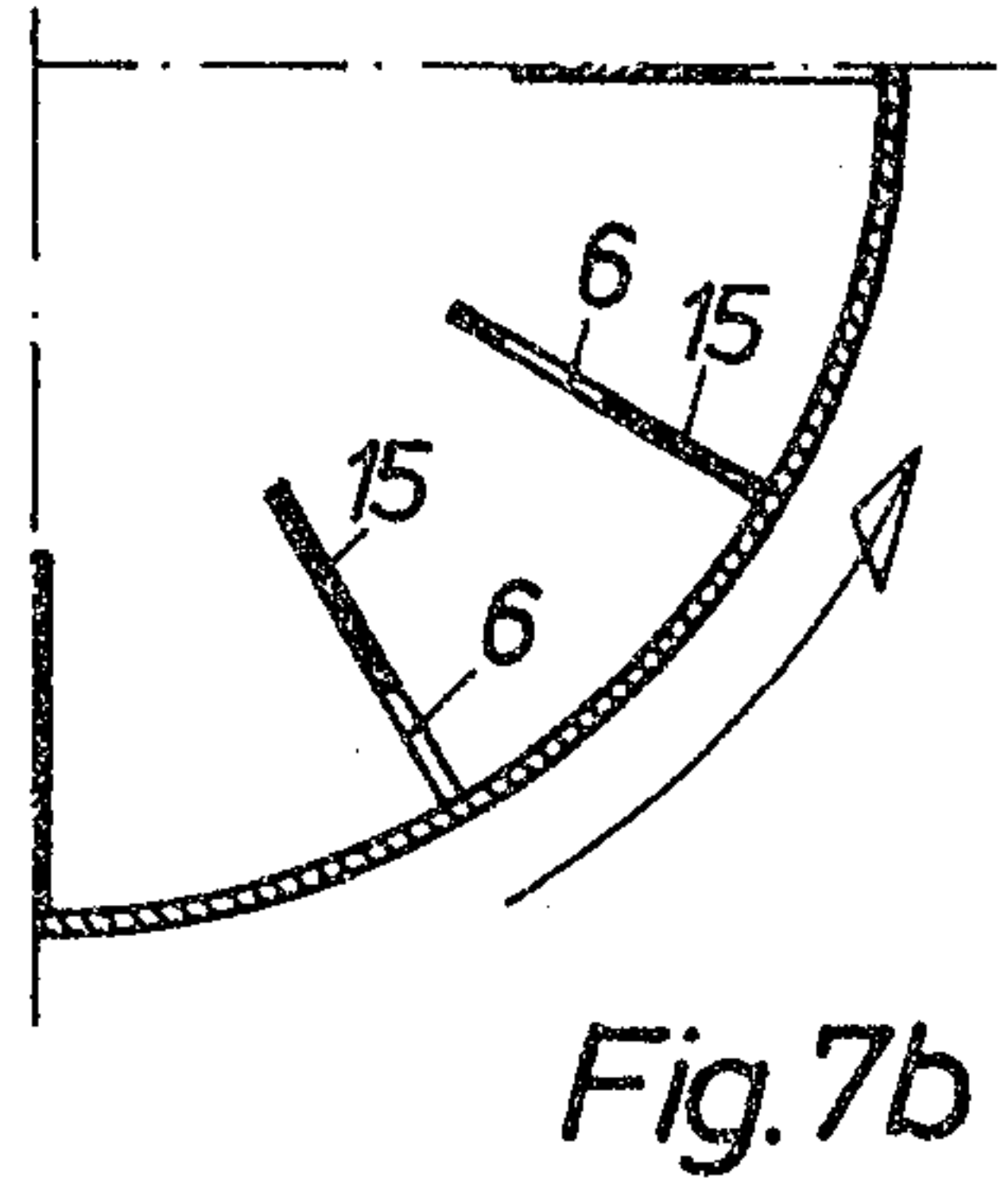
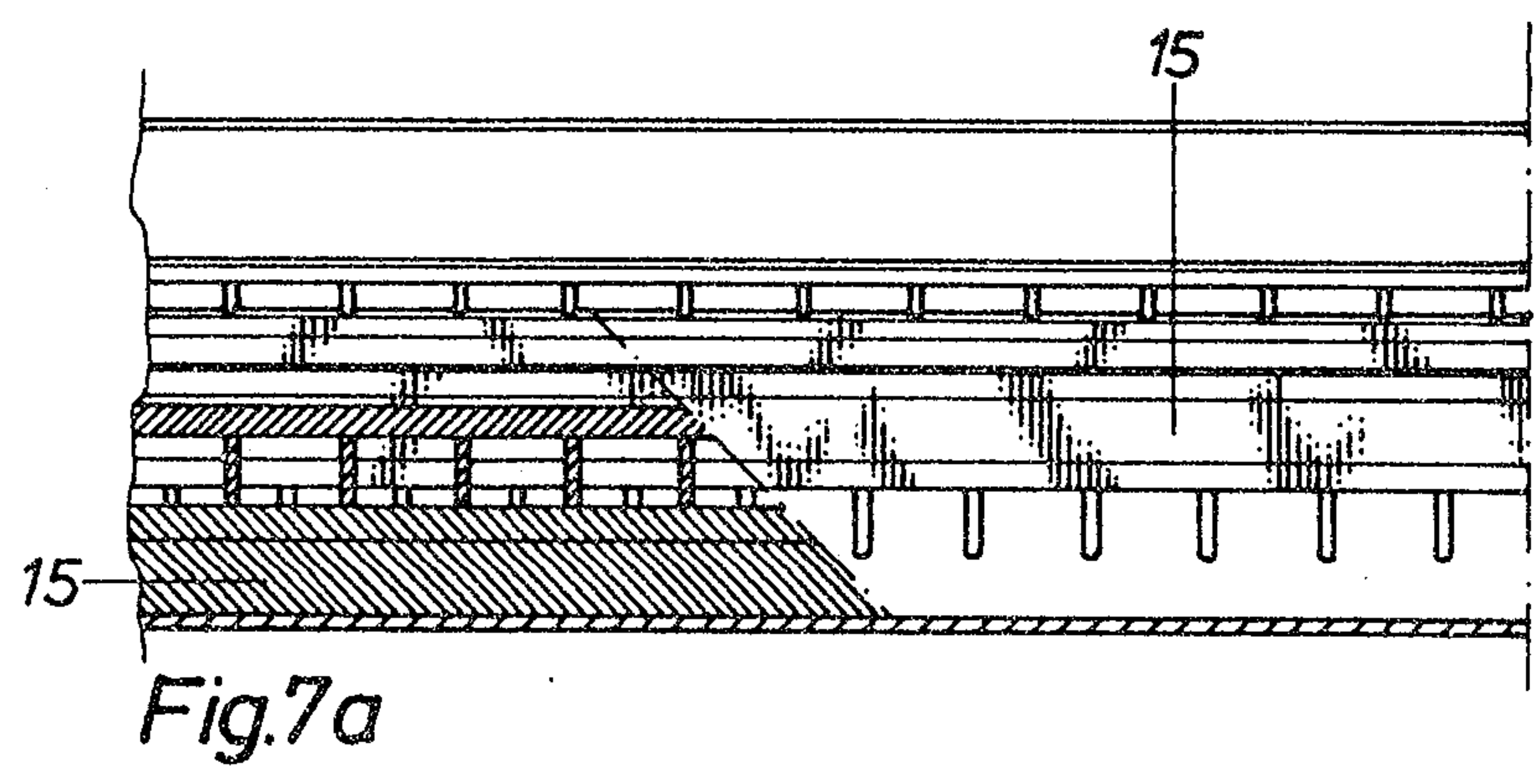
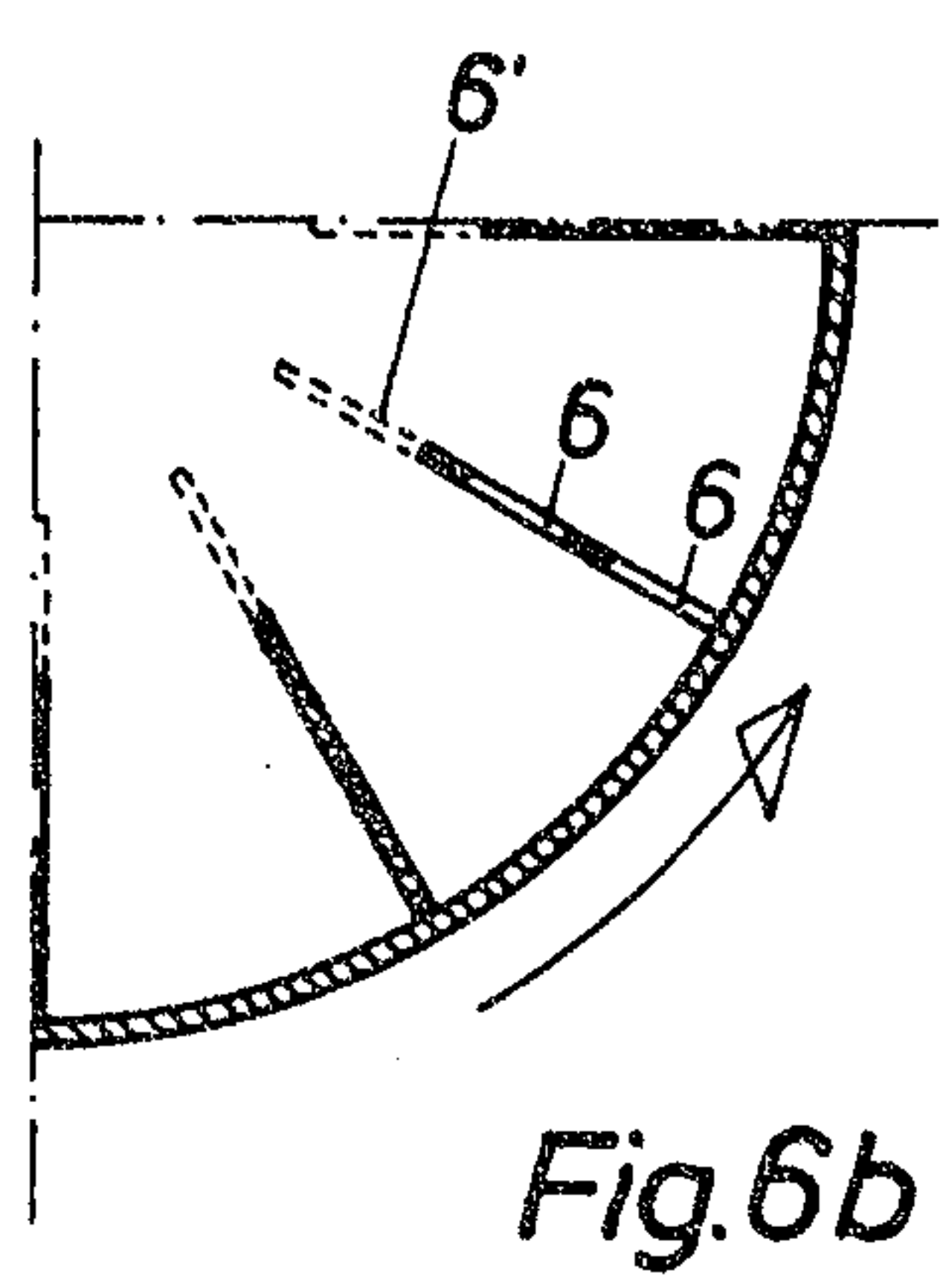
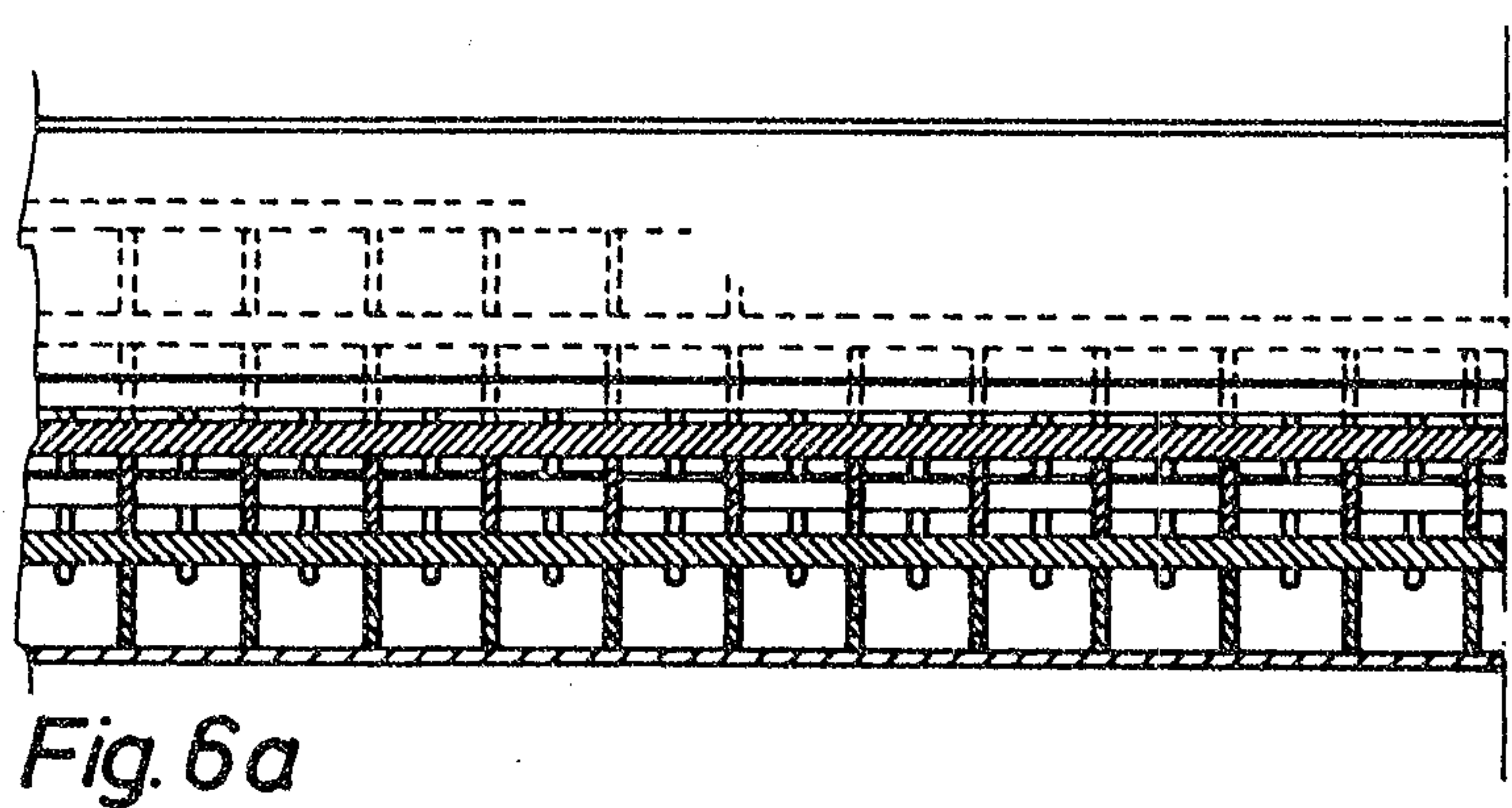
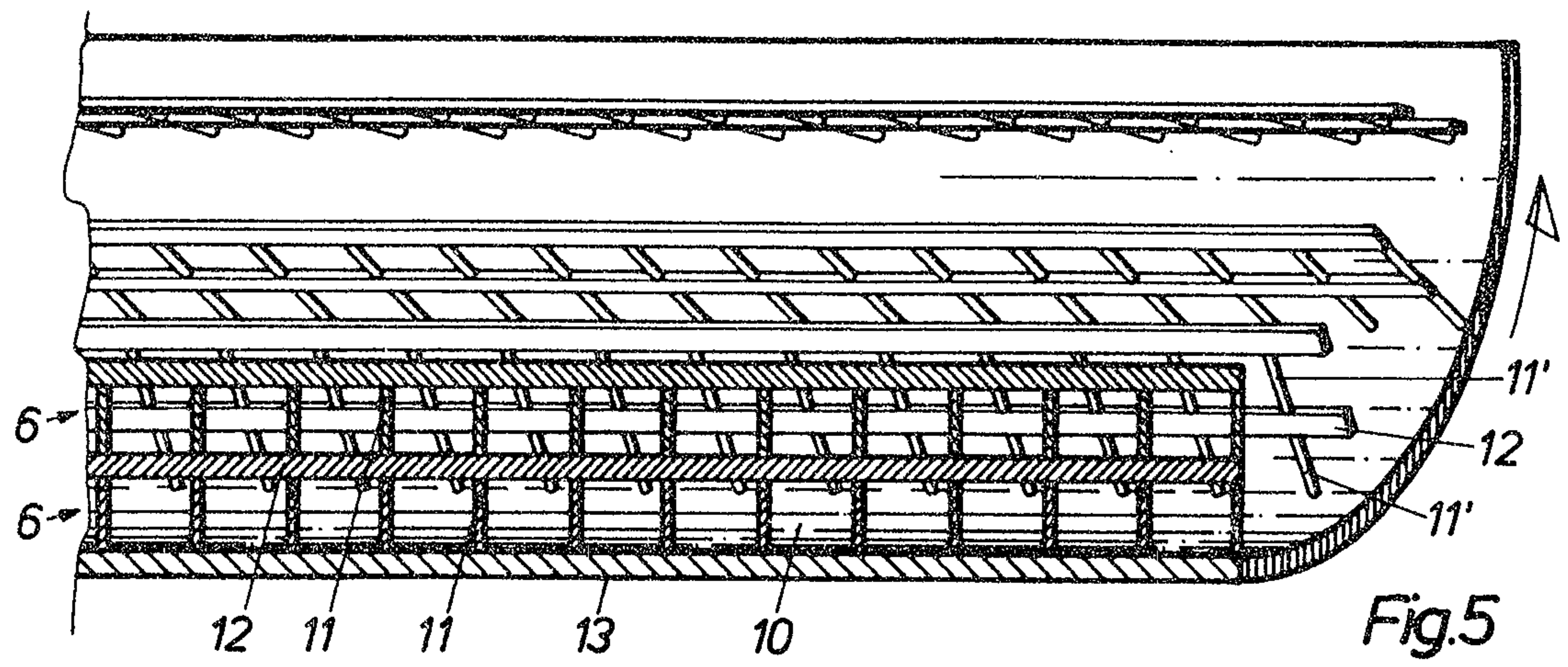


Fig. 4b

by: Rogus, Bueskin + Parr



by: Rogers, Bluskin + Parr

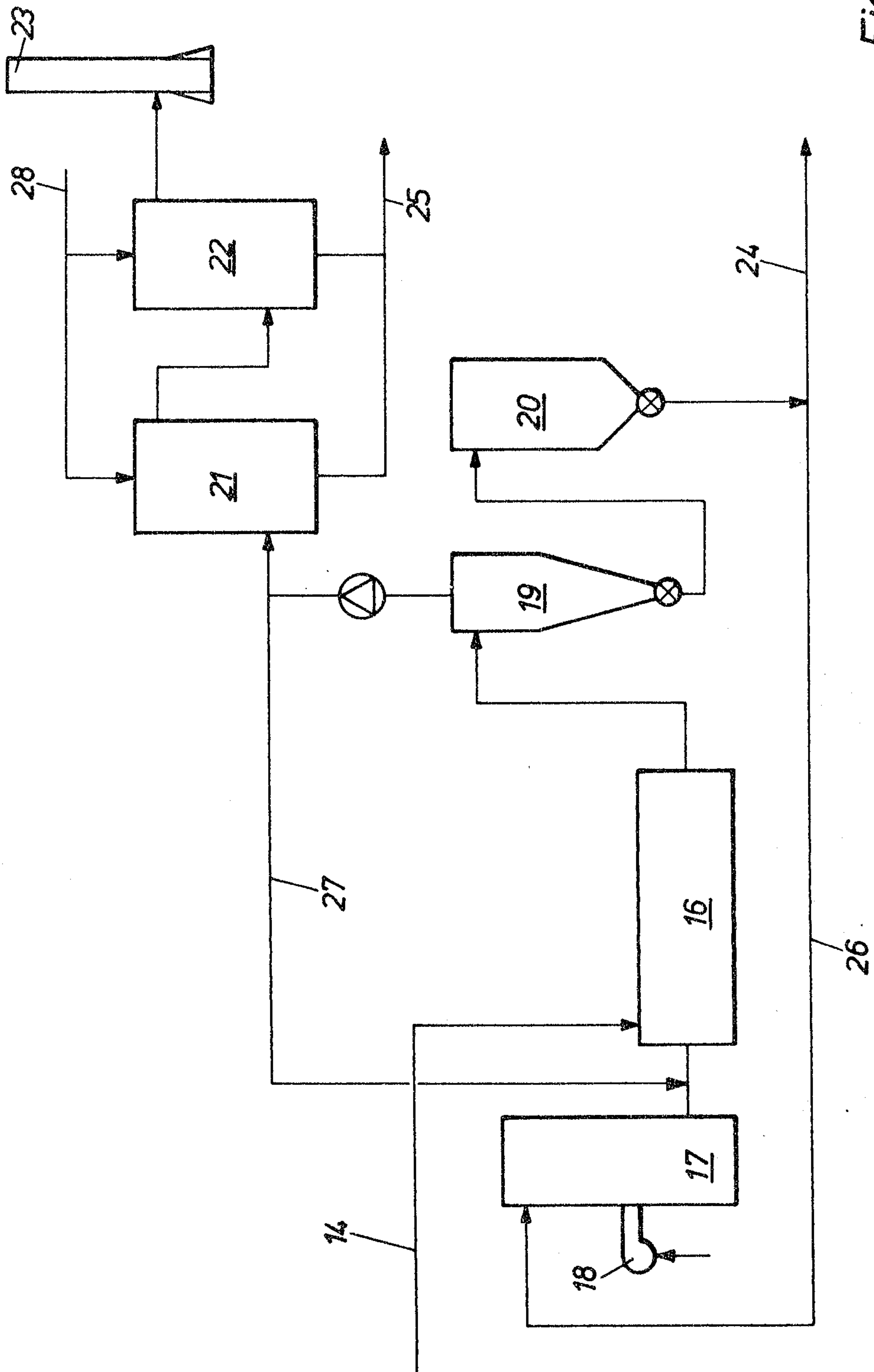


Fig. 8

by: ROGERS, BRESKIN + PAUL

