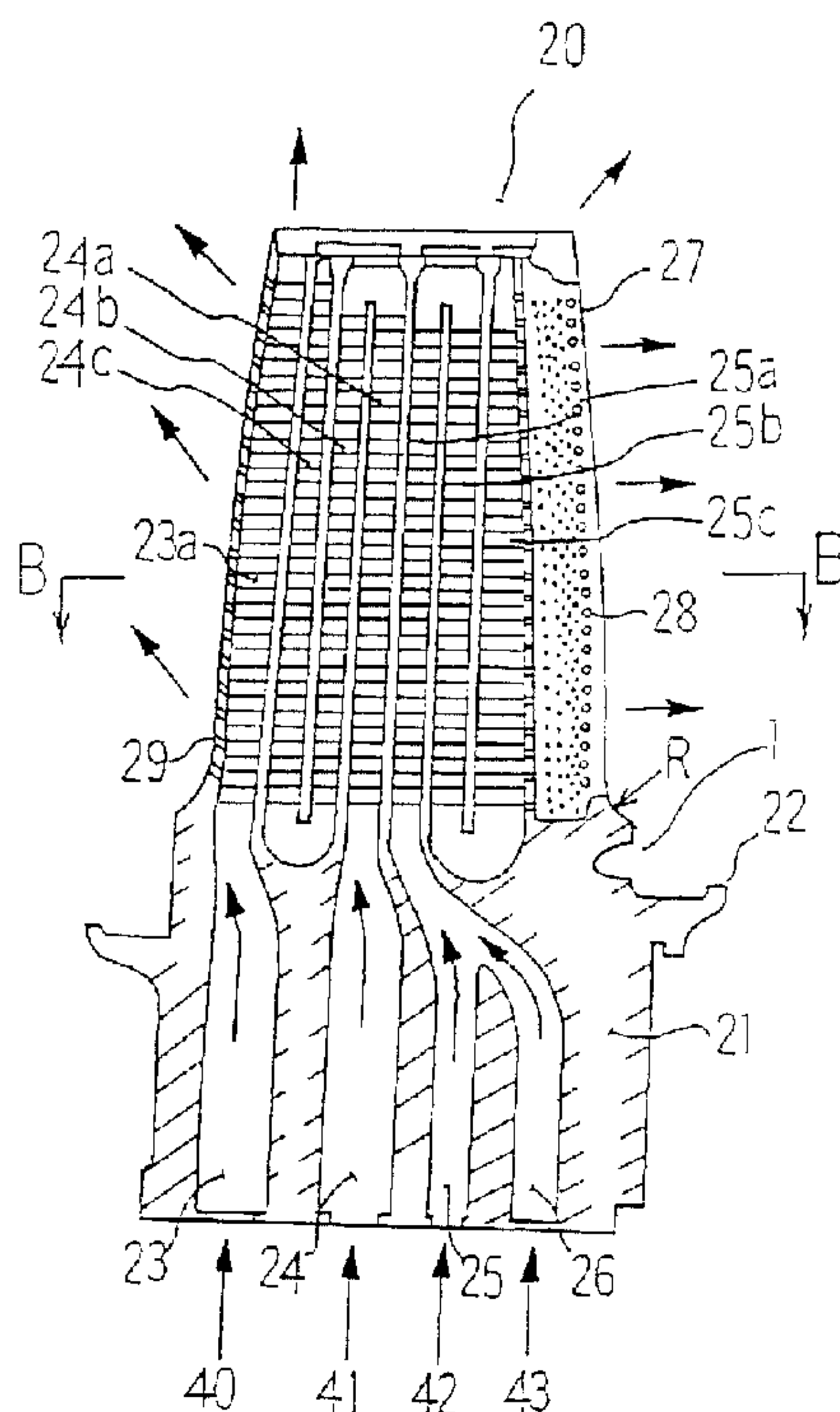




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(57) Abrégé/Abstract:

Gas turbine moving blade is improved so as to prevent occurrence of cracks caused by thermal stresses due to temperature differences between blade and platform when gas turbine is stopped. In steady operation time of moving blade (20), cooling air (40 to 43) enters cooling passages (23 to 26) to flow through cooling passages (23a, 24a to 24c, 25a to 25c) for cooling the blade (20) to then flow out of the blade (20). Recessed portion (1) having smooth curved surface is provided in platform (22) near blade fitting portion on blade trailing edge side. Fillet (R) of the blade fitting portion on the blade trailing edge side is formed with curved surface having curvature larger than conventional case. Hub slot below the fillet (R) for blowing air is formed having slot cross sectional area larger than other slots of blade trailing edge. TBC is applied to blade (20) surface. By these improvements, thermal stresses due to temperature differences between the blade (20) and the platform (22) in gas turbine stop time are made smaller and occurrence of cracks is prevented.

## Abstract of the Disclosure

Gas turbine moving blade is improved so as to prevent occurrence of cracks caused by thermal stresses due to temperature differences between blade and platform when gas turbine is stopped. In steady operation time of moving blade (20), cooling air (40 to 43) enters cooling passages (23 to 26) to flow through cooling passages (23a, 24a to 24c, 25a to 25c) for cooling the blade (20) to then flow out of the blade (20). Recessed portion (1) having smooth curved surface is provided in platform (22) near blade fitting portion on blade trailing edge side. Fillet (R) of the blade fitting portion on the blade trailing edge side is formed with curved surface having curvature larger than conventional case. Hub slot below the fillet (R) for blowing air is formed having slot cross sectional area larger than other slots of blade trailing edge. TBC is applied to blade (20) surface. By these improvements, thermal stresses due to temperature differences between the blade (20) and the platform (22) in gas turbine stop time are made smaller and occurrence of cracks is prevented.

## GAS TURBINE MOVING BLADE

## BACKGROUND OF THE INVENTION

## Field of the Invention

5           The present invention relates generally to a gas turbine moving blade and more particularly to a gas turbine moving blade which is improved in a cooling structure of blade and platform so as to prevent occurrence of cracks due to thermal stresses caused by temperature changes in gas turbine starts and stops or in high  
10           temperature combustion gas.

## Description of the Prior Art

          In Fig. 14, which is a cross sectional view of a representative first stage moving blade of a prior art gas turbine, numeral 20 designates the moving blade, numeral 21 designates a  
15           blade root portion and numeral 22 designates a platform. In the blade root portion 21, there are provided cooling passages 23, 24, 25, 26, which are independent of each other. The cooling passage 23 is a passage on a blade leading edge side to communicate with a  
20           cooling passage 23a provided in a blade leading edge portion. Cooling air 40 flows into the cooling passage 23 from a turbine rotor side to flow through the cooling passage 23a and to flow out of a blade tip portion for cooling the blade leading edge portion and, at the same time, to flow out of cooling holes 29 for effecting  
25           a shower head film cooling of the blade leading edge portion. Cooling air 41 flows into the cooling passage 24 to flow through a cooling passage 24a provided in the blade and then turns at the

blade tip portion to flow through a cooling passage 24b and turns again at a blade base portion to flow through a cooling passage 24c and to flow out of the blade tip portion. In this process of the flow, the cooling air 41 cools a blade interior and, at the same time, flows out of cooling holes, to be described later with respect to Fig. 15, onto a blade surface for effecting a film cooling thereof.

Cooling air 42 entering the cooling passage 25 and cooling air 43 entering the cooling passage 26 join together to flow through a cooling passage 25a and then turn at the blade tip portion to flow through a cooling passage 25b and turn again at the blade base portion to flow through a cooling passage 25c. In this process of the flow, the cooling air 42, 43 cools the blade interior and, at the same time, flows out of cooling holes, to be described later with respect to Fig. 15, onto the blade surface for effecting the film cooling thereof and a portion still remaining of the cooling air 42, 43 flows out of cooling holes 28 of a blade trailing edge 27 for effecting a pin fin cooling of a blade trailing edge portion.

In Fig. 15, which is a cross sectional view taken on line B-B of Fig. 14, a portion of the cooling air flowing through the cooling passage 23a in the blade leading edge portion flows out of the blade through the cooling holes 29 for effecting the shower head film cooling of the blade leading edge portion. Also, a portion of the cooling air flowing through the cooling passage 24c flows outside obliquely through cooling holes 30 for effecting the film cooling of the blade surface. Likewise, a portion of the cooling air flowing through the cooling passage 25c flows outside obliquely

through cooling holes 31 for effecting the film cooling of the blade trailing edge portion. It is to be noted that although the cooling holes 29, 30, 31 only are illustrated, there are actually provided a multiplicity of cooling holes other than the mentioned  
5 three kinds of the cooling holes 29, 30, 31.

In Fig. 16, which is an explanatory plan view of a cooling structure of the platform 22, Fig. 16(a) shows an example to cool a front portion, or a blade leading edge side portion, of the platform 22 as well as to cool both side portions, or blade ventral  
10 and dorsal side portions, of the platform 22 and Fig. 16(b) shows another example to cool upper surface portions of both of the side portions of the platform 22 in addition to the cooled portions of Fig. 16(a). In Fig. 16(a), there are bored cooling passages 50a, 50b in the front portion and both of the side end portions of the  
15 platform 22 so as to communicate with the cooling passage 23 of the leading edge portion of the moving blade 20. Cooling air 72a, 72b flows through the cooling passages 50b, 50a, respectively, for cooling the front portion and both of the side portions of the platform 22 and flows out through a rear portion, or a blade  
20 trailing edge side portion, of the platform 22 as air 72c, 72d.

In Fig. 16(b), in addition to the cooling passages 50a, 50b of Fig. 16(a), there are provided a plurality of cooling holes 51a, 51b, respectively, in both of the side portions of the platform 22 so as to open at an upper surface of the platform 22. These  
25 cooling holes 51a, 51b communicate with one or more of the cooling passages leading to the interior of the moving blade 20, so that cooling air flows through the cooling holes 51a, 51b to flow out

onto the upper surface of the platform 22 and cools both of the side portions of the platform 22. Thus, in the gas turbine moving blade, the moving blade 20 as well as the platform 22 are cooled as described with respect to Figs. 14 to 16, so that thermal influences given by the high temperature combustion gas are mitigated.

In Fig. 17, which shows an example of a second stage moving blade in the prior art, Fig. 17(a) is a cross sectional view thereof, Fig. 17(b) is a cross sectional view taken on line F-F of Fig. 17(a) and Fig. 17(c) is a cross sectional view taken on line G-G of Fig. 17(a). In Figs. 17(a) and (b), numeral 180 designates the second stage moving blade, numeral 181 designates a blade root portion and numeral 182 designates a platform. In the blade root portion 181, there are provided cooling passages 183, 184, 185, which are independent of each other. The cooling passage 183 is a passage on a blade leading edge side to communicate with a cooling passage 183a provided in a blade leading edge portion. Cooling air 190 flows into the cooling passage 183 from a turbine rotor side to flow through the cooling passage 183a for cooling the blade leading edge portion and to flow outside through a blade tip portion. Cooling air 191 flows into the cooling passage 184 to flow through a cooling passage 184a provided in the blade and then turns at the blade tip portion to flow through a cooling passage 184b and turns again toward inside at a blade base portion. In the blade base portion, the cooling air 191 and cooling air 192 flowing through the cooling passage 185 join together and flow into a cooling passage 184c. In the cooling passage 184c, the cooling air 191, 192 flows between pin fins 185 for enhancing the cooling effect and flows

outside through slots 186 provided in a blade trailing edge as well as through a hole of the blade tip portion. In this process of the cooling air flow, the blade is cooled.

In Fig. 17(c), there is provided a blade tip thinned portion 187 along each of blade tip edge portions of the moving blade 180 so as to function as a seal of air leaking toward blade rear stages from the blade tip. Numeral 188 designates a plug, which plugs up openings provided for working purposes when the moving blade 180 is being manufactured. In the second stage moving blade 180 as so constructed also, the cooling air is led into the interior of the blade, so that thermal influences given by the high temperature combustion gas are mitigated.

As mentioned above, in the gas turbine moving blade, the blade and the platform are cooled by flowing the cooling air and elevation of metal temperature due to the high temperature combustion gas is suppressed. While there is a large difference in the mass between the platform and a blade profile portion of the gas turbine moving blade, the platform and the blade profile portion are cooled by the cooling air during a gas turbine steady operation time and there occurs no large temperature difference between them, so that thermal stress influences caused by the temperature difference are also small. However, in an unsteady time to stop the gas turbine, while the blade profile portion, which is of a thin shape, is cooled earlier, the platform, which is of a larger mass, is cooled slowly and this causes a large temperature difference between them, which results in causing large thermal stresses.

If large thermal stresses occur between the blade profile

portion and the platform, as mentioned above, cracks may arise easily, especially at a portion where there is the severest thermal influence, that is, at blade hub portions where the blade and the platform join together on the blade leading edge and trailing edge sides and also cracks are likely to arise at other portions where there are thermal stress influences, that is, at the cooling holes of the blade trailing edge, the blade tip thinned portion and the like.

The cracks of the mentioned portions are caused by combination of creep ruptures caused by high temperature and high stress repeated by long time operations and fatigue failures caused by repeated stresses due to operation starts and stops and, in order to avoid such cracks, it is necessary to reduce the temperature and thermal stresses as much as possible at portions where stress concentrations are caused (blade and platform fitting portions of the blade leading edge and trailing edge portions).

#### SUMMARY OF THE INVENTION

In view of the problems in the prior art, therefore, it is an object of the present invention to provide a gas turbine moving blade which is improved in structural portions of blade and platform which are prone to be influenced by thermal stresses, especially blade and platform fitting portions and blade trailing edge cooling holes, as well as improved in cooling structures of a blade tip portion and platform front and rear both end portions so that cracks caused by thermal stresses due to temperature differences may be suppressed and life and reliability of the blade may be enhanced.

In order to achieve the mentioned object, the present invention provides means of the following (1) to (11):

(1) A gas turbine moving blade comprising a platform and a blade fitting portion where the blade is fitted to the platform as well as comprising a blade cooling passage provided in the blade, a platform cooling passage provided in the platform and cooling air blow holes provided in and around the blade so that the blade may be cooled by cooling air flowing through the blade cooling passage, flowing through the platform cooling passage and flowing out of the blade through the cooling air blow holes, characterized in that there is provided a recessed portion, having a smooth curved surface and extending in a direction orthogonal to a turbine axial direction, in an end face portion of a rear side portion of the platform near the blade fitting portion on a blade trailing edge side; the blade fitting portion is formed having a fillet exterior with a curved surface; and the cooling air blow holes provided in a blade trailing edge includes a hole provided in a blade hub portion positioned at a lowermost end of the cooling air blow holes provided in the blade trailing edge, the hole having a hole cross sectional area larger than that of each of the cooling air blow holes provided in the blade trailing edge above the hole.

(2) A gas turbine moving blade as mentioned in (1) above, characterized in that there is applied a coating of a heat resistant material to the blade and platform so that the blade fitting portions of blade leading edge and trailing edge portions may be applied to with the coating thicker than other portions of the blade and portions of the platform near and around the blade

leading edge and trailing edge portions may be applied to with the coating thinner than other portions of the platform.

(3) A gas turbine moving blade as mentioned in (1) above, characterized in that the curved surface of the fillet exterior of the blade fitting portion is formed to an elliptical curve.

(4) A gas turbine moving blade as mentioned in (1) above, characterized in that the platform cooling passage is connected with a platform cooling air supply system and there are provided in the platform cooling air supply system an opening/closing valve for opening and closing the platform cooling air supply system and a control unit for controlling the opening/closing valve so as to be closed while a gas turbine is operated and to be opened for a predetermined time when the gas turbine is stopped.

(5) A gas turbine moving blade as mentioned in (1) above, characterized in comprising a shank portion for fixing the platform, the shank portion being formed in an elongated shape having a height (H) of the shank portion in a turbine radial direction larger than a width (W) of the shank portion in a turbine rotational direction ( $H > W$ ).

(6) A gas turbine moving blade comprising a platform and a blade fitting portion where the blade is fitted to the platform as well as comprising a blade serpentine cooling passage provided in the blade, a platform cooling passage provided in each of blade ventral and dorsal side end portions of the platform and cooling air blow holes provided in and around the blade so that the blade may be cooled by cooling air flowing through the blade serpentine cooling passage, flowing through the platform cooling passage and

flowing out of the blade through the cooling air blow holes, characterized in that the blade serpentine cooling passage comprises two flow paths constructed such that cooling air entering a central portion of a blade root portion flows toward blade leading edge and trailing edge sides; the blade fitting portion is formed having an exterior with a curved surface; there is provided a recessed portion, extending in a direction orthogonal to a turbine axial direction, in an end face portion of each of front side and rear side portions of the platform near the blade fitting portions on the blade leading edge and trailing edge sides; and the cooling air blow holes include a plurality of cooling holes provided in the platform, the cooling holes being arranged along the platform cooling passage on the blade dorsal side and each having one end communicating with the platform cooling passage on the blade dorsal side and the other end opening at an end face on the blade dorsal side of the platform.

(7) A gas turbine moving blade as mentioned in (6) above, characterized in that the curved surface of the exterior of each of the blade fitting portions on the blade leading edge and trailing edge sides comprises a combination of a linear portion and a curved portion.

(8) A gas turbine moving blade as mentioned in (6) above, characterized in comprising a blade tip thinned portion provided only at a blade tip edge portion on the blade dorsal side and a plug of a circular shape provided in a blade tip portion.

(9) A gas turbine moving blade as mentioned in any one of (6) to (8) above, characterized in comprising a shank portion for

fixing the platform, the shank portion being formed in an elongated shape having a height (H) of the shank portion in a turbine radial direction larger than a width (W) of the shank portion in a turbine rotational direction ( $H > W$ ).

5           (10) A gas turbine moving blade comprising a platform and a blade fitting portion where the blade is fitted to the platform as well as comprising a blade serpentine cooling passage provided in the blade, a platform cooling passage provided in each of blade ventral and dorsal side end portions of the platform and cooling air  
10 blow holes provided in and around the blade so that the blade may be cooled by cooling air flowing through the blade serpentine cooling passage, flowing through the platform cooling passage and flowing out of the blade through the cooling air blow holes, characterized in that the blade serpentine cooling passage  
15 comprises a flow path constructed such that cooling air entering a central portion of a blade root portion flows toward a blade trailing edge side; the blade fitting portion is formed having an exterior with a curved surface; there is provided a recessed portion, extending in a direction orthogonal to a turbine axial  
20 direction, in an end face portion of a rear side portion of the platform near the blade fitting portion on the blade trailing edge side; and the cooling air blow holes include a plurality of cooling holes provided in the platform, the cooling holes being arranged along the platform cooling passage on the blade dorsal side and each having one end communicating with the platform cooling passage  
25 on the blade dorsal side and the other end opening at an end face on the blade dorsal side of the platform.

(11) A gas turbine moving blade as mentioned in (10) above, characterized in comprising a blade tip thinned portion provided only at a blade tip edge portion on the blade dorsal side.

In the invention (1), there is provided the recessed portion, or cut-out portion, having the smooth curved surface, in the rear end face portion of the platform near the blade fitting portion on the blade trailing edge side and a thick portion of the platform near this blade fitting portion is thinned by the recessed portion. Thus, there is eliminated a sharp thickness change between the thin blade portion and the thick platform portion and also the mass of the platform right under the thin blade portion is reduced by the recessed portion to make the thermal capacity there smaller and thus the thermal capacity difference also can be made smaller. Thereby, the temperature difference caused by the difference in the cooling velocity at the time of gas turbine stop or the like becomes also smaller and occurrence of the cracks as have been caused by the thermal stresses at the blade fitting portion can be prevented. Further, the fillet of the blade fitting portion is made in the curved surface which has partially the linear portion, so that the fillet R is made larger than the conventional case in the curvature and the rigidity of this portion is strengthened. Moreover, the lowermost hole of the cooling air blow holes provided in the blade trailing edge is made to have a hole cross sectional area larger than that of the other cooling air blow holes provided in the blade trailing edge and thereby the cooling effect of this portion is enhanced, the temperature difference in the blade fitting portion becomes smaller to suppress occurrence of the

thermal stresses and occurrence of the cracks can be avoided securely.

In the invention (2), the thermal barrier coating (TBC) of the heat resistant material is applied to the blade, so that temperature lowering of the blade after the stop of the gas turbine becomes slower and thereby the temperature difference between the blade fitting portion and the platform becomes smaller and the thermal stresses are made smaller. Also, temperature lowering of the blade portion where the thicker TBC is applied becomes further slower and the temperature difference between the blade and the platform becomes further smaller. Moreover, by the platform portion where the thinner TBC is applied, temperature lowering of the platform at and around this portion is comparatively fast, so that the temperature difference between the blade fitting portion and the platform becomes further smaller and thus the thermal stresses caused there are made further smaller. Also, in the invention (3), the fillet exterior of the blade fitting portion is formed to the elliptical curve so that the curvature there becomes large and the stress concentration in this portion can be mitigated.

In the invention (4), when the gas turbine is stopped, the control unit opens the opening/closing valve for the predetermined time so that cooling air from the platform cooling air supply system may be led actively into the cooling passage of the platform and the platform is cooled even in the stop of the gas turbine. Hence, cooling of the platform which is slower in the temperature lowering than the thin moving blade is accelerated, the temperature difference between the blade and the platform is made smaller to

suppress occurrence of the thermal stresses and occurrence of the cracks is prevented.

In the invention (5), the shank portion which fixes the platform is elongated in the height as compared with the conventional one, so that deformation caused by the thermal stresses at the connection portion of the blade and the platform is absorbed by the damping effect which is given by the elongation of the shank portion to mitigate the influences of the thermal stresses and thereby occurrence of the cracks is prevented.

In the invention (6), which is applied to the first stage moving blade, there are two flow paths of the serpentine cooling passage in which the cooling air flows toward the blade leading edge side and toward the blade trailing edge side, so that the blade interior is cooled effectively. At the same time, there are provided the recessed portions, or cut-out portions, in the platform front and rear end faces near the blade fitting portions on the blade leading edge and trailing edge sides, so that the thick portions right under the mentioned blade fitting portions are thinned by the recessed portions. Thus, there is eliminated a sharp thickness change between the thin blade and the thick platform and also the mass of the platform in the mentioned portions is reduced to lower the thermal capacity there and to thereby make the thermal capacity difference smaller. Thereby, the temperature difference caused by the difference in the cooling velocity becomes also smaller and occurrence of the cracks due to the thermal stresses as have been so far caused at the connection portion of the blade and the platform is prevented. Moreover, the

platform is cooled by the cooling air flowing through the cooling passages of both side end portions, or the blade ventral and dorsal side end portions, of the platform as well as flowing out of the platform side end face through the cooling holes provided along the cooling passage on the blade dorsal side end portion of the platform and thereby the blade dorsal side end portion of the platform which is exposed to the high temperature combustion gas to be in the thermally severe state is cooled effectively.

In the invention (7), the exterior of the two fillets on the blade leading edge and trailing edge sides is formed by the curved surface having the combination of the linear portion and the curved portion, for example, the linear portion on the upper side of the fillet and the curved portion on the lower side near the blade fitting portion, so that the mentioned curved surface is approached to a linear surface to have the curvature of the fillet R larger than that of the fillets on the blade ventral and dorsal sides and thereby the rigidity of this portion is enhanced, occurrence of the thermal stresses is suppressed and occurrence of the cracks is prevented.

In the invention (8), the blade tip thinned portion on the blade ventral side tip edge portion is eliminated as compared with the conventional case and the blade tip thinned portion only on the blade dorsal side tip edge portion, which receives especially high thermal influences, is provided and while the blade tip sealing performance is at least maintained by the blade tip thinned portion on the blade dorsal side tip edge portion, damage of the blade tip thinned portion due to the high temperature can be lessened. Also,

the plug is made in the circular shape and thereby fitting of the plug becomes facilitated and damage thereof due to the high temperature is also lessened.

5 In the invention (9), the shank portion which fixes the platform is elongated in the height as compared with the conventional one, so that deformation caused by the thermal stresses at the connection portion of the blade and the platform is absorbed by the damping effect which is given by the elongation of the shank portion to mitigate the influences of the thermal stresses  
10 and thereby occurrence of the cracks is prevented.

In the invention (10), which is applied to the second stage moving blade, the serpentine cooling passage comprises the flow path in which the cooling air entering the central portion flows toward the blade trailing edge side, so that the blade interior is cooled  
15 effectively. At the same time, there is provided the recessed portion, or cut-out portion, in the platform rear end face near the blade fitting portion on the blade trailing edge side, so that the thick portion right under the mentioned blade fitting portion is thinned by the recessed portion. Thus, there is eliminated a sharp  
20 thickness change between the thin blade and the thick platform and also the mass of the platform in the mentioned portion is reduced to lower the thermal capacity there and to thereby make the thermal capacity difference smaller. Thereby, the temperature difference caused by the difference in the cooling velocity becomes also  
25 smaller and occurrence of the cracks due to the thermal stresses as have been so far caused at the connection portion of the blade and the platform is prevented. Moreover, the platform is cooled by the

cooling air flowing through the cooling passages of both side end portions, or the blade ventral and dorsal side end portions, of the platform as well as flowing out of the platform side end face through the cooling holes provided along the cooling passage on the blade dorsal side end portion of the platform and thereby the blade dorsal side end portion of the platform which is exposed to the high temperature combustion gas to be in the thermally severe state is cooled effectively.

In the invention (11), the blade tip thinned portion on the blade ventral side tip edge portion is eliminated as compared with the conventional case and the blade tip thinned portion only on the blade dorsal side tip edge portion, which receives especially high thermal influences, is provided and while the blade tip sealing performance is at least maintained by the blade tip thinned portion on the blade dorsal side tip edge portion, damage of the blade tip thinned portion due to the high temperature can be lessened.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view of a gas turbine moving blade of a first embodiment according to the present invention.

Fig. 2 shows a blade fitting portion of the first embodiment of Fig. 1, wherein Fig. 2(a) is a side view of the blade fitting portion, Fig. 2(b) is a rear view seen from line A-A of Fig. 2(a) and Fig. 2(c) is a view showing a fillet R of Fig. 2(a).

Fig. 3 is a rear view of a blade trailing edge showing a modified form of a hub slot of Fig. 2(b).

Fig. 4 is a perspective view of a gas turbine moving blade

including a shank portion thereof, wherein Fig. 4(a) shows a prior art one and Fig. 4(b) shows a second embodiment according to the present invention.

Fig. 5 is a cooling system diagram of a gas turbine moving blade of a third embodiment according to the present invention.

Fig. 6 is a plan view of a platform of the third embodiment according to the present invention, including a cooling system diagram thereof.

Fig. 7 is a cross sectional view of a gas turbine first stage moving blade of a fourth embodiment according to the present invention.

Fig. 8 is a cross sectional view taken on line A-A of Fig. 7.

Fig. 9 is a cross sectional view taken on line B-B of Fig. 7.

Fig. 10 shows a structure of a blade tip thinned portion, wherein Fig. 10(a) is a cross sectional view of a prior art one, Fig. 10(b) is a plan view of the prior art one of Fig. 10(a), Fig. 10(c) is a cross sectional view taken on line C-C of the blade tip thinned portion of the fourth embodiment of Fig. 7 and Fig. 10(d) is a plan view of the blade tip thinned portion of Fig. 10(c).

Fig. 11 is a view showing a shape of a fillet R of the fourth embodiment of Fig. 7 in comparison with a conventional case.

Fig. 12 is a perspective view of a gas turbine moving blade including a shank portion thereof, wherein Fig. 12(a) shows a prior art one and Fig. 12(b) shows a fifth embodiment according to the present invention.

Fig. 13 shows a gas turbine second stage moving blade of a sixth embodiment according to the present invention, wherein Fig.

13(a) is a cross sectional view thereof and Fig. 13(b) is a cross sectional view taken on line D-D of Fig. 13(a).

Fig. 14 is a cross sectional view of a representative first stage moving blade of a prior art gas turbine.

5 Fig. 15 is a cross sectional view taken on line B-B of Fig. 14.

Fig. 16 is an explanatory plan view of a cooling structure of a platform of the prior art moving blade of Fig. 14, wherein Fig. 16(a) shows an example to cool a front portion and both side portions of the platform and Fig. 16(b) shows an example to cool upper face portions of the platform in addition to the cooled portions of Fig. 16(a).

10 Fig. 17 shows an example of a second stage moving blade of a prior art gas turbine, wherein Fig. 17(a) is a cross sectional view thereof, Fig. 17(b) is a cross sectional view taken on line F-F of Fig. 17(a) and Fig. 17(c) is a cross sectional view taken on line G-G of Fig. 17(a).

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

20 Herebelow, embodiments according to the present invention will be described concretely with reference to figures.

In Fig. 1, which is a cross sectional view of a gas turbine moving blade of a first embodiment according to the present invention, there is provided a recessed groove or cut-out portion 1, which is grooved in or cut out of a thick portion and has a rounded smooth curved surface, at a blade fitting portion where a moving blade 20 and a platform 22 join together to be fitted to each other

on a blade trailing edge side. The recessed groove 1 is provided in an end face portion of a rear portion, or a blade trailing edge side portion, of the platform 22, extending in a direction orthogonal to a turbine rotor axial direction and having such a groove depth as not affecting lines of load force of the blade.

In Fig. 2 showing the blade fitting portion of the first embodiment of Fig. 1, Fig. 2(a) is a side view thereof, Fig. 2(b) is a rear view seen from line A-A of Fig. 2(a) and Fig. 2(c) is a view showing a fillet R of Fig. 2(a). As shown by the shape of the fillet R of Fig. 2(c) provided at the blade fitting portion on the blade trailing edge side, while fillets of other portions than the blade trailing edge side portion have a smaller curvature, 6 mm for example, in the present first embodiment, the fillet R is made to an elliptical curve of 20 mm x 40 mm. By so making the fillet R larger, the stress concentration can be suppressed.

Also, in Fig. 2, while there are provided cooling holes 28 in a blade trailing edge portion and slots 33 in a blade trailing edge, one slot 2 nearest to the platform 22 of the slots 33 (that is, the slot of the lowermost end, which is near a blade hub portion and is called a hub slot) is made to have a slot cross sectional area larger than that of other slots 33. For example, the hub slot 2 is of a 1.6 mm diameter while other slots 33 are of a 1 mm diameter. Thus, the construction is made so as to enhance the cooling effect of this portion.

In Fig. 3, which is a rear view of the blade trailing edge showing a modified form of the hub slot of Fig. 2(b), while the slots 33 are formed by pedestals 34 provided between each of the

slots 33, one pedestal 34a nearest to the platform 22 of the pedestals 34 is cut off so as to connect two slots to each other to thereby form a hub slot 3. Thus, the hub slot 3 which is nearest to the platform 22 is made to have a slot cross sectional area larger than that of other slots 33. Other structures of the moving blade 20 and the platform 22 are same as those shown in Figs. 1 and 2 and description thereon will be omitted.

By the construction of the slots as described above, heat transfer area in the slot portions of the blade fitting portion on the blade trailing edge side is increased and cooling air flowing therethrough is increased in volume and temperature of the portion where the stress concentration occurs easily in operation can be reduced. Thus, the thermal stress influences in this portion are mitigated and occurrence of cracks can be prevented.

Further, in the moving blade 20 of the present embodiment, a TBC (thermal barrier coating) is applied to the entire surface of the moving blade 20 including the recessed groove 1 and the hub slot 2, 3. Moreover, in so applying the TBC, (1) the blade fitting portions to the platform 22 on the blade leading edge and trailing edge sides are applied to with a thicker TBC as compared with other portions of the blade 20 and also (2) the platform 22 on the blade leading edge and trailing edge sides is applied to with a thinner TBC as compared with other portions of the platform 22.

By the TBC so applied, when the gas turbine is stopped, cooling velocity of the blade is lowered as a whole, so that the temperature is lowered slowly, the temperature difference between the blade fitting portion and the platform becomes smaller and the

thermal stress caused in this portion is reduced. Also, according to (1) above, in the portions of the blade where the TBC is applied thicker, the temperature lowering becomes slower and the temperature difference between those portions of the blade and the platform becomes further smaller. Hence, the thermal stress caused in this portion is further reduced. Furthermore, according to (2) above, in other portions than the portion of the platform where the TBC is applied thinner, the temperature lowering becomes slower and the temperature difference between those portions of the platform becomes further smaller. Hence, the thermal stress caused in the platform is further reduced.

According to the gas turbine moving blade of the first embodiment as described above, cooling air flows in the same way as in the conventional case of Figs. 14 to 16, that is, the cooling air 40 to 43 enters the interior of the moving blade 20 from inside of the platform 22 for cooling the moving blade 20 to then flow out into the gas path through the blade tip portion on the blade leading edge side and through the cooling holes 29 to 31 and the blade trailing edge portion and, at the same time, enters the cooling passages 50a, 50b on both side end portions, or blade ventral and dorsal side end portions, of the platform 22 for cooling the platform 22 to then flow out toward the rear portion, or the blade trailing edge side portion, of the platform 22. In this cooling process as well as at the time of gas turbine stop, while, in the conventional case, the temperature difference between the blade profile portion and the platform 22 becomes large due to mass difference between them to thereby cause thermal stresses, in the

present invention, there is provided the recessed groove or the cut-out portion 1 in the rear portion, or the blade trailing edge side portion, of the platform 22 and thereby the following effect can be obtained.

5           That is, by the recessed groove 1, there is eliminated a sharp thickness change between a thin portion of the blade fitting portion of the moving blade 20 and a thick portion of the platform 22 as well as a thickness right under the thin portion of the blade fitting portion is recessed, so that thermal capacity there is  
10 reduced and also thermal capacity difference therearound is made smaller. Thus, the cracks as have been so far caused by thermal stresses at the fitting portion of the moving blade 20 and the platform 22 can be prevented. Also, the fillet R at the blade fitting portion is made larger than in the conventional case so that  
15 rigidity at this curved surface portion is increased and occurrence of cracks at this portion can be suppressed.

Moreover, there is provided the hub slot 2, 3 at the portion of the fillet R and the hub slot 2, 3 has a slot cross sectional area larger than that of the other slots 33. Hence, heat transfer  
20 area in the thickness changing portion of the blade fitting portion is increased and also the cooling air is increased in volume so as to enhance the cooling effect. Thereby, in addition to the effect to reduce the thermal capacity by the recessed groove 1 right under the hub slot 2, 3, a large temperature difference therearound is  
25 suppressed synergically and occurrence of cracks can be prevented. Also, there is applied the TBC and yet it is applied thicker to the blade fitting portion and thinner to the platform 22 of that

portion, so that, by this coating also, the thermal influences can be made smaller.

In Fig. 4, which is a perspective view of a gas turbine moving blade comprising a shank portion thereof, Fig. 4(a) shows a prior art one and Fig. 4(b) shows a second embodiment according to the present invention comprising the recessed groove of the first embodiment of Fig. 1 and an improvement in the shank portion. In the shank portion of the present second embodiment, the shank portion to support fixedly the platform 22 is elongated in the height and thinned in the width. That is, as compared with a conventional shank portion 40a, having a height  $H_0$  and a width  $W_0$ , of a moving blade 20 shown in Fig. 4(a), a shank portion 40b shown in Fig. 4(b) has a height  $H$  and a width  $W$ , wherein  $H$  is larger than  $H_0$  ( $H > H_0$ ) and  $W$  is smaller than  $W_0$  ( $W < W_0$ ), and  $H$  is larger than  $W$  as a whole. By so making the shank portion 40b longer and thinner, the shank portion 40b is given a flexibility against thermal stress changes and because of a damping effect thereof, the thermal stresses are dispersed and absorbed. Thereby, occurrence of cracks due to the thermal stresses can be suppressed.

In Fig. 5, which is a cooling system diagram of a gas turbine moving blade of a third embodiment according to the present invention, cooling air is led into a moving blade 20 for cooling thereof from a cooling air supply system 80 and then flows out through a blade trailing edge portion and, at the same time, a portion of the cooling air is led into a platform 22 for cooling thereof and then flows out through a rear portion, or a blade trailing edge side portion, of the platform 22. This cooling system

is same as that of the conventional system described with respect to Figs. 14 to 16.

In the present third embodiment, in addition to the cooling system mentioned above, there is provided a platform cooling air supply system 81, so that cooling air is led therefrom into cooling passages provided in the platform 22 via an opening/closing valve 11 and pipings 14a, 14b. Numeral 10 designates a control unit, and when the gas turbine is stopped, the control unit 10 is inputted with a gas turbine stop signal S to thereby control the opening/closing valve 11 so that cooling air may be supplied into the cooling passages of the platform 22 for a predetermined time after the stop of the gas turbine.

Fig. 6 is a plan view of the platform 22 of the third embodiment, including a cooling system diagram thereof. Like in the prior art case, there are provided the cooling passages 50a, 50b in a front portion, or a blade leading edge side portion as well as in both side end portions, or blade ventral and dorsal side end portions, of the platform 22 so that cooling air flows therein for cooling the front portion and both of the side portions of the platform 22 and flows out through a rear portion of the platform 22. Further, in the front portion of the platform 22, there are provided passages 13a, 13b so as to communicate with the cooling passages 50a, 50b, respectively, of both of the side end portions of the platform 22. On the other hand, the passages 13a, 13b are connected with the pipings 14a, 14b, respectively, and the pipings 14a, 14b are connected to the platform cooling air supply system 81 via the opening/closing valve 11, as mentioned above.

In the cooling system of the third embodiment constructed as described above, the opening/closing valve 11 is closed in the ordinary operation time of the gas turbine so that the ordinary cooling, as mentioned above, may be carried out. When the gas turbine is stopped, the gas turbine stop signal S is inputted into the control unit 10 and the control unit 10 controls to open the opening/closing valve 11 for the predetermined time. Thereby, cooling air from the platform cooling air supply system 81 is led into the cooling passages 50a, 50b of the platform 22, that is, even after the stop of the gas turbine, the cooling air is supplied into the platform 22 so that the platform 22 only may be cooled actively for the predetermined time, and when the platform 22 is so cooled for the predetermined time, the opening/closing valve 11 is closed by the control unit 10.

In the conventional case, when the gas turbine is stopped, the platform 22, which has a mass larger than the moving blade 20, is slow in the temperature lowering to cause a large temperature difference between the thin blade 20 and the thick platform 22 and this causes large thermal stresses. But in the cooling system of the present invention, the platform 22 is cooled actively even after the stop of the gas turbine to accelerate the temperature lowering of the platform 22, so that no large temperature difference occurs between the moving blade 20 and the platform 22 and thereby occurrence of the thermal stresses is prevented and occurrence of the cracks can be suppressed.

It is to be noted that, while the cooling system of the mentioned third embodiment has been described on the example where

it is applied to a gas turbine moving blade in the prior art, this cooling system may be naturally applied to a gas turbine moving blade having constructions of the first and second embodiments and then the effect to prevent the occurrence of the cracks can be  
5 obtained further securely.

Fig. 7 is a cross sectional view of a gas turbine first stage moving blade of a fourth embodiment according to the present invention. In Fig. 7, numeral 101 designates the first stage moving blade and numeral 102 designates a platform. There are  
10 provided a cut-out portion 103a formed in a recessed groove on a front portion, or a blade leading edge side portion, of the platform 102 and another cut-out portion 103b formed with a smooth curved surface on a rear portion, or a blade trailing edge side portion, of the same. Numerals 104a and 104b designate fillets R  
15 provided on the blade leading edge and trailing edge sides, respectively. Both of the fillets R are formed having a curvature larger than that of fillets on blade ventral and dorsal sides.

Numeral 117 designates a blade root portion. Within the blade root portion 117, there are provided cooling passages 105, 106,  
20 107, which are independent of each other. The cooling passage 105 is a passage on the blade leading edge side to communicate with a cooling passage 105a provided in a blade leading edge portion. Cooling air 181 flows into the cooling passage 105 from a turbine rotor side to flow through the cooling passage 105a for cooling the  
25 blade leading edge portion and to flow out of a hole 110a of a blade tip portion and, at the same time, to flow out through film cooling holes 109 onto a blade surface for effecting a shower head

film cooling of the blade leading edge portion. Cooling air 182 flows into the cooling passage 106 to flow through a cooling passage 106a provided in a blade interior and then turns at the blade tip portion to flow through a cooling passage 106b and turns again at a blade base portion to flow through a cooling passage 106c and to flow out of a hole 110b of the blade tip portion for cooling the blade interior and, at the same time, to flow out through film cooling holes 108 onto the blade surface for effecting a film cooling of the blade surface, as described later with respect to Fig. 8.

Cooling air 183 entering the cooling passage 107 flows through a cooling passage 107a provided in the blade interior and turns at the blade tip portion to flow through a cooling passage 107b and turns again at the blade base portion to flow through a cooling passage 107c and to flow out of a hole 110e of the blade tip portion. In this process of the flow, the cooling air 183 cools the blade interior and, at the same time, flows out through film cooling holes 111 onto the blade surface for effecting the film cooling of the blade surface as well as flows out through slots 112 provided in the blade trailing edge for cooling the blade trailing edge portion. Numerals 113a and 113b designate knife edge portions, which form sharp edges of the blade trailing edge and leading edge portions, respectively, to position closely to a seal portion with adjacent stationary blades so as to maintain a good sealing ability there.

Fig. 8 is a cross sectional view taken on line A-A of Fig. 7. As shown in Fig. 8, while omitted in Fig. 7, there are provided

turbulators on both blade inner walls in each of the cooling passages 106a to 106c and 107a to 107c. In the cooling passage 105a on the blade leading edge side, there are provided a multiplicity of the film cooling holes 109 up and down along the blade leading edge portion so that the cooling air may be blown therethrough for effecting the film cooling of the blade surface. Also, up and down on the blade dorsal side of the cooling passage 106c, there are provided a multiplicity of the film cooling holes 108 so that the cooling air may be blown therethrough for effecting the film cooling of the blade surface on the blade dorsal side. Further, up and down on the blade ventral side of the cooling passage 107b, there are provided a multiplicity of the film cooling holes 111 so that the cooling air may be blown therethrough for effecting the film cooling of the blade rear side surface on the blade ventral side. Furthermore, there are provided a multiplicity of the slots 112 in the blade trailing edge and the cooling air is blown therethrough.

In the present fourth embodiment as described above, the cooling air enters an interior of the blade root portion 117 to flow through the cooling passages 105a and 106a to 106c for cooling the blade leading edge side and through the cooling passages 107a to 107c for cooling the blade trailing edge side. That is, the cooling air flows through two flow paths of a serpentine passage having an elongated cooling path in the blade so that the cooling effect may be enhanced. Further, there are provided the film cooling holes 109 on the blade leading edge side and the film cooling holes 108 on the blade dorsal side as well as the film cooling holes 111 on the blade ventral side of the blade trailing

edge portion, respectively, for effecting the film cooling of the blade surfaces so that the cooling effect may be also enhanced.

Fig. 9 is a cross sectional view taken on line B-B of Fig. 7, wherein the right hand side of Fig. 9 is the front side, or the blade leading edge side, of the platform 102 and the left hand side of the same is the rear side, or the blade trailing edge side, of the platform 102. In Fig. 9, as described in the conventional case of Fig. 16, there are provided cooling passages 150a, 150b on both side end portions, or blade ventral and dorsal side end portions, of the platform 102 so that cooling air 172a, 172b may be led thereinto from the front portion of the platform 102 to flow out, as air 172c, 172d, through the rear portion of the platform 102 for cooling the front portion and both of the side portions of the platform 102. In the present fourth embodiment, there are further provided a plurality of cooling holes 114 arranged along the cooling passage 150b on the blade dorsal side end portion of the platform 102 so as to communicate with the cooling passage 150b and to open at a platform side end face on the blade dorsal side and thereby the cooling air 172a is blown out onto the platform side end face of the blade dorsal side portion of the platform 102 and the cooling effect in this portion is enhanced.

According to the platform of the fourth embodiment, as mentioned above, in addition to the cooling passages 150a, 150b provided on the blade ventral and dorsal side end portions of the platform 102, the cooling holes 114 are provided on the blade dorsal side end portion of the platform 102 and thereby the cooling effect is enhanced. Also, as described with respect to Fig. 7, the

recessed grooves 103a, 103b are provided on the blade leading edge and trailing edge side portions, respectively, of the platform 102, so that the blade fitting portions on the blade leading edge and trailing edge sides, where there is the severest thermal influence, are made to have a less thermal capacity so as to be balanced with the blade and thereby the thermal stresses in this portion are made even and the thermal stress influences can be made smaller.

Fig. 10 shows a structure of a blade tip thinned portion, wherein Fig. 10(a) is a cross sectional view of a prior art one and Fig. 10(b) is a plan view of the same as well as Fig. 10(c) is a cross sectional view taken on line C-C of the fourth embodiment of Fig. 7 and Fig. 10(d) is a plan view of the same. In the structure of a conventional blade 160, a blade tip thinned portion 173 is provided to rise from and along blade ventral and dorsal side tip edge portions and a plug 174 of a rectangular shape for plugging up a rectangular opening provided in the course of the blade manufacturing is fitted into a central portion of a blade tip portion. In the blade 101 of the present invention, a blade tip thinned portion 115 is provided to rise from and along the blade dorsal side tip edge portion only with no blade tip thinned portion being provided on the blade ventral side and yet sealing ability at the blade tip portion is maintained. Further, the opening provided in the course of the blade manufacturing is made in a circular shape, so that a plug 116 is also made in a circular shape and is fitted to the central portion of the blade tip portion by welding carried out from above. Thereby, the structure of the present invention is made so that assembling thereof may be done easily.

According to the blade tip portion of the present fourth embodiment as mentioned above, the blade tip thinned portion on the blade ventral side is eliminated and only the blade tip thinned portion 115 is provided on the blade dorsal side and thereby, while  
5 lowering of the sealing performance there is suppressed to the minimum, the structure is made simple so as to avoid damage due to the high temperature there. Moreover, the opening at the blade tip portion is made smaller to have a circular shape and the plug 116 is also made in a circular shape and is welded to thereby improve  
10 the workability.

Fig. 11 is a view showing a shape of the fillet R of the fourth embodiment of Fig. 7 in comparison with a conventional case. As to the shape of the fillet R at the blade and platform fitting portions on the blade leading edge and trailing edge sides, in the  
15 conventional case shown by a dotted curve  $Y_1$  and a solid curve  $Y_2$ , the fillet is made to a combined smooth curve of  $Y_1$  and  $Y_2$  connecting a point of about 14 mm distance in the horizontal axis and a point of about 13 mm blade height in the vertical axis. On the contrary, in the present invention, the fillet R is made to a  
20 combined line of an inclined straight line X and the curve  $Y_2$ , wherein the straight line X connects a point of about 20 mm blade height in the vertical axis and a point P on the curve  $Y_2$  taken at a distance of about 5 mm in the horizontal axis and the straight line X and the curve  $Y_2$  join with each other smoothly at the point P.  
25 The fillet R, so made larger than the conventional one to have generally a curved portion partially including a straight line portion, is formed at and around two places on the blade leading

edge and trailing edge sides and other fillets of the blade fitting portions on the blade ventral and dorsal sides are made in the same shape as the conventional one.

By so making the fillet R larger on the blade leading edge and trailing edge sides, fillet thickness of this portion is increased and bending strength of this portion is enhanced so that the stress concentration may be avoided. Also, there is added the effect of the mentioned recessed grooves 103a, 103b and thereby a flexibility against the thermal stress is enhanced in the blade leading edge and trailing edge portions and occurrence of the cracks can be suppressed.

According to the fourth embodiment as described above, the moving blade cooling structure is made such that the two serpentine flow paths, that is, the cooling passages 106a to 106c having two turns toward the blade leading edge side and the cooling passages 107a to 107c having two turns toward the blade trailing edge side, are provided in the blade interior, so that the length of the flow paths is elongated and, moreover, the film cooling holes 109 of the blade leading edge, the film cooling holes 108 of the blade dorsal side leading edge portion and the film cooling holes 111 of the blade ventral side rear portion are provided for cooling the blade 101. Also, the platform cooling structure is made such that cooling air is blown outside toward the blade dorsal side direction of the platform through the cooling holes 114 connected to the cooling passage 150b.

Further, the fillets R of the blade fitting portions on the blade leading edge and trailing edge sides are made larger than the

conventional ones as well as larger than the fillets of the blade ventral and dorsal sides, the recessed grooves 103a, 103b are provided in the platform 102 right under the fillets R and the blade tip thinned portion 115 is provided only on the blade dorsal side with no blade tip thinned portion being provided on the blade ventral side.

By employing the mentioned cooling structures, the cooling effect of the entire blade 101 is enhanced and the thermal stresses at the blade fitting portions are lowered as well as the averaged stress at the fillet R is lowered, the bending strength is enhanced, the sealing performance at the blade tip is maintained and damage of the blade tip thinned portion due to the high temperature can be avoided.

In Fig. 12, which is a perspective view of a gas turbine moving blade comprising a shank portion thereof, Fig. 12(a) shows a prior art one and Fig. 12(b) shows a fifth embodiment according to the present invention comprising the recessed grooves of the fourth embodiment of Fig. 7 and an improvement in the shank portion. In the shank portion of the present fifth embodiment, the shank portion to support fixedly the platform 102 is elongated in the height and thinned in the width. That is, as compared with a conventional shank portion 195, having a height  $H_0$  and a width  $W_0$ , of a moving blade 160 shown in Fig. 12(a), a shank portion 118 shown in Fig. 12(b) has a height  $H$  and a width  $W$ , wherein  $H$  is larger than  $H_0$  ( $H > H_0$ ) and  $W$  is smaller than  $W_0$  ( $W < W_0$ ), and  $H$  is larger than  $W$  as a whole. By so making the shank portion 118 longer and thinner, the shank portion 118 is given a flexibility against thermal stress

changes and because of a damping effect thereof, the thermal stresses are dispersed and absorbed. Thereby, occurrence of the cracks due to the thermal stresses can be suppressed. Constructions of other portions of the fifth embodiment are same as those of the fourth embodiment and the effect of the fourth embodiment is further enhanced by the fifth embodiment.

In Fig. 13, which shows a gas turbine second stage moving blade of a sixth embodiment according to the present invention, Fig. 13(a) is a cross sectional view thereof and Fig. 13(b) is a cross sectional view taken on line D-D of Fig. 13(a). In Fig. 13(a), numeral 121 designates the second stage moving blade and numeral 122 designates a platform. Cooling passages 123, 124, 125 are provided in a blade root portion 120. Cooling air 150 enters the cooling passage 123 to flow through a cooling passage 123a provided in the blade 121 for cooling a blade leading edge portion and flows out through a blade tip portion.

Cooling air 151 enters the cooling passage 124 to flow through a cooling passage 124a provided in the blade 121 and turns at the blade tip portion to flow through a cooling passage 124b and turns again at a blade base portion. At this time, the cooling air 151 and cooling air 152 entering the cooling passage 125 join together to flow through a cooling passage 124c and to flow out through the blade tip portion and, at the same time, to flow out through slots provided in a blade trailing edge. In this process of the flow, a portion of the cooling air 124 flows out through the blade tip portion above the cooling passages 124a and 124b. Numeral 126 designates a recessed groove or cut-out portion, which is provided

to have a smooth curved surface in an end face portion of a rear portion, or a blade trailing edge side portion, of the platform 122. Also, fillets R 128 of blade fitting portions of blade leading edge and trailing edge portions are made to have a curvature larger than that of fillets of other blade fitting portions. The shape of the fillet R is same as that described with respect to Fig. 10(c) and description thereon will be omitted.

In the gas turbine moving blade of the above-described structure, in addition to the cooling effect of the cooling passage 123a and the serpentine flow path of the cooling passages 124a to 124c, there is obtained a further effect by the recessed groove 126 on the rear portion of the platform 122 and the fillets R of the blade leading edge and trailing edge portions to reduce thermal stresses therearound and to enhance a strength of the fillets R against thermal stresses and occurrence of the cracks can be prevented, in the same way as described with respect to the fourth embodiment. Also, cooling of the platform 122 is carried out by the same cooling structure as described with respect to the fourth embodiment shown in Fig. 9 and description thereon will be omitted.

In Fig. 13(b), a blade tip thinned portion 129 is provided to rise from and along a blade tip edge portion only on the blade dorsal side with no blade tip thinned portion being provided on the blade ventral side. Also, a plug 130 is made in a structure to be fitted by welding carried out from above, so that manufacture and assembly thereof are facilitated. By so providing the blade tip thinned portion 129 only on the blade dorsal side, sealing performance at the blade tip portion is maintained and yet damage of

the blade thinned portion due to the high temperature can be suppressed.

5 According to the present sixth embodiment as described above, a sufficient cooling effect of the blade is obtained by the cooling passage 123a and the serpentine flow path of the cooling passages 124a to 124c and, in addition thereto, the strength against thermal stresses of the blade fitting portions on the blade leading edge and trailing edge portions is enhanced by the fillets R and the recessed groove 126 and damage of the blade tip thinned portion can be prevented as well. Further, as a cooling structure of the platform 122, the platform cooling structure of the fourth 10 embodiment may be applied as it is.

15 While the preferred forms of the present invention have been described, it is to be understood that the invention is not limited to the particular constructions and arrangements herein illustrated and described but embraces such modified forms thereof as come within the scope of the appended claims.

## WHAT IS CLAIMED IS:

1           1. A gas turbine moving blade comprising a platform (22) and  
2 a blade fitting portion where the blade (20) is fitted to said  
3 platform as well as comprising a blade cooling passage (24a to 24c,  
4 25a to 25c) provided in the blade, a platform cooling passage (50a,  
5 50b) provided in said platform and cooling air blow holes (28, 29,  
6 33) provided in and around the blade so that the blade may be cooled  
7 by cooling air (40 to 43) flowing through said blade cooling  
8 passage, flowing through said platform cooling passage and flowing  
9 out of the blade through said cooling air blow holes, characterized  
10 in that there is provided a recessed portion (1), having a smooth  
11 curved surface and extending in a direction orthogonal to a turbine  
12 axial direction, in an end face portion of a rear side portion of  
13 said platform (22) near said blade fitting portion on a blade  
14 trailing edge side; said blade fitting portion is formed having a  
15 fillet (R) exterior with a curved surface; and said cooling air blow  
16 holes (33) provided in a blade trailing edge includes a hole (2, 3)  
17 provided in a blade hub portion positioned at a lowermost end of  
18 said cooling air blow holes (33) provided in the blade trailing  
19 edge, said hole (2, 3) having a hole cross sectional area larger  
20 than that of each of said cooling air blow holes (33) provided in  
21 the blade trailing edge above said hole (2, 3).

1           2. A gas turbine moving blade as claimed in Claim 1,  
2 characterized in that there is applied a coating of a heat resistant  
3 material to said blade (20) and platform (22) so that said blade  
4 fitting portions of blade leading edge and trailing edge portions

5 may be applied to with said coating thicker than other portions of  
6 said blade and portions of said platform near and around the blade  
7 leading edge and trailing edge portions may be applied to with said  
8 coating thinner than other portions of said platform.

1 3. A gas turbine moving blade as claimed in Claim 1,  
2 characterized in that said curved surface of the fillet (R) exterior  
3 of said blade fitting portion is formed to an elliptical curve.

1 4. A gas turbine moving blade as claimed in Claim 1,  
2 characterized in that said platform cooling passage (50a, 50b) is  
3 connected with a platform cooling air supply system (81) and there  
4 are provided in said platform cooling air supply system an  
5 opening/closing valve (11) for opening and closing said platform  
6 cooling air supply system and a control unit (10) for controlling  
7 said opening/closing valve so as to be closed while a gas turbine  
8 is operated and to be opened for a predetermined time when the gas  
9 turbine is stopped.

1 5. A gas turbine moving blade as claimed in Claim 1,  
2 characterized in comprising a shank portion (40b) for fixing said  
3 platform (22), said shank portion being formed in an elongated  
4 shape having a height (H) of said shank portion in a turbine radial  
5 direction larger than a width (W) of said shank portion in a  
6 turbine rotational direction ( $H > W$ ).

1 6. A gas turbine moving blade comprising a platform (102) and  
2 a blade fitting portion where the blade (101) is fitted to said  
3 platform as well as comprising a blade serpentine cooling passage  
4 (106a to 106c, 107a to 107c) provided in the blade, a platform  
5 cooling passage (150a, 150b) provided in each of blade ventral and

6 dorsal side end portions of said platform and cooling air blow  
7 holes (108, 109, 110a to 110c, 111, 112) provided in and around the  
8 blade so that the blade may be cooled by cooling air (181 to 183)  
9 flowing through said blade serpentine cooling passage, flowing  
10 through said platform cooling passage and flowing out of the blade  
11 through said cooling air blow holes, characterized in that said  
12 blade serpentine cooling passage comprises two flow paths (106, 107)  
13 constructed such that cooling air (182, 183) entering a central  
14 portion of a blade root portion (117) flows toward blade leading  
15 edge and trailing edge sides; said blade fitting portion is formed  
16 having an exterior (104a, 104b) with a curved surface; there is  
17 provided a recessed portion (103a, 103b), extending in a  
18 direction orthogonal to a turbine axial direction, in an end face  
19 portion of each of front side and rear side portions of said  
20 platform near said blade fitting portions on the blade leading edge  
21 and trailing edge sides; and said cooling air blow holes include a  
22 plurality of cooling holes (114) provided in said platform, said  
23 cooling holes being arranged along said platform cooling passage  
24 (150b) on the blade dorsal side and each having one end  
25 communicating with said platform cooling passage on the blade  
26 dorsal side and the other end opening at an end face on the blade  
27 dorsal side of said platform.

1 7. A gas turbine moving blade as claimed in Claim 6,  
2 characterized in that said curved surface of the exterior (104a,  
3 104b) of each of said blade fitting portions on the blade leading  
4 edge and trailing edge sides comprises a combination of a linear  
5 portion (X) and a curved portion (Y<sub>2</sub>).

1           8. A gas turbine moving blade as claimed in Claim 6,  
2 characterized in comprising a blade tip thinned portion (115)  
3 provided only at a blade tip edge portion on the blade dorsal side  
4 and a plug (116) of a circular shape provided in a blade tip  
5 portion.

1           9. A gas turbine moving blade as claimed in any one of Claims  
2 6 to 8, characterized in comprising a shank portion (118) for  
3 fixing said platform, said shank portion being formed in an  
4 elongated shape having a height (H) of said shank portion in a  
5 turbine radial direction larger than a width (W) of said shank  
6 portion in a turbine rotational direction ( $H > W$ ).

1           10. A gas turbine moving blade comprising a platform (122)  
2 and a blade fitting portion where the blade (121) is fitted to said  
3 platform as well as comprising a blade serpentine cooling passage  
4 (124a to 124c) provided in the blade, a platform cooling passage  
5 (150a, 150b) provided in each of blade ventral and dorsal side end  
6 portions of said platform and cooling air blow holes provided in and  
7 around the blade so that the blade may be cooled by cooling air  
8 (150 to 152) flowing through said blade serpentine cooling  
9 passage, flowing through said platform cooling passage and flowing  
10 out of the blade through said cooling air blow holes, characterized  
11 in that said blade serpentine cooling passage comprises a flow path  
12 (124) constructed such that cooling air (151) entering a central  
13 portion of a blade root portion (120) flows toward a blade trailing  
14 edge side; said blade fitting portion is formed having an exterior  
15 (128) with a curved surface; there is provided a recessed portion  
16 (126), extending in a direction orthogonal to a turbine axial

17 direction, in an end face portion of a rear side portion of said  
18 platform near said blade fitting portion on the blade trailing edge  
19 side; and said cooling air blow holes include a plurality of cooling  
20 holes (114) provided in said platform, said cooling holes being  
21 arranged along said platform cooling passage (150b) on the blade  
22 dorsal side and each having one end communicating with said platform  
23 cooling passage on the blade dorsal side and the other end opening  
24 at an end face on the blade dorsal side of said platform.

1 11. A gas turbine moving blade as claimed in Claim 10,  
2 characterized in comprising a blade tip thinned portion (129)  
3 provided only at a blade tip edge portion on the blade dorsal side.

Fig. 1

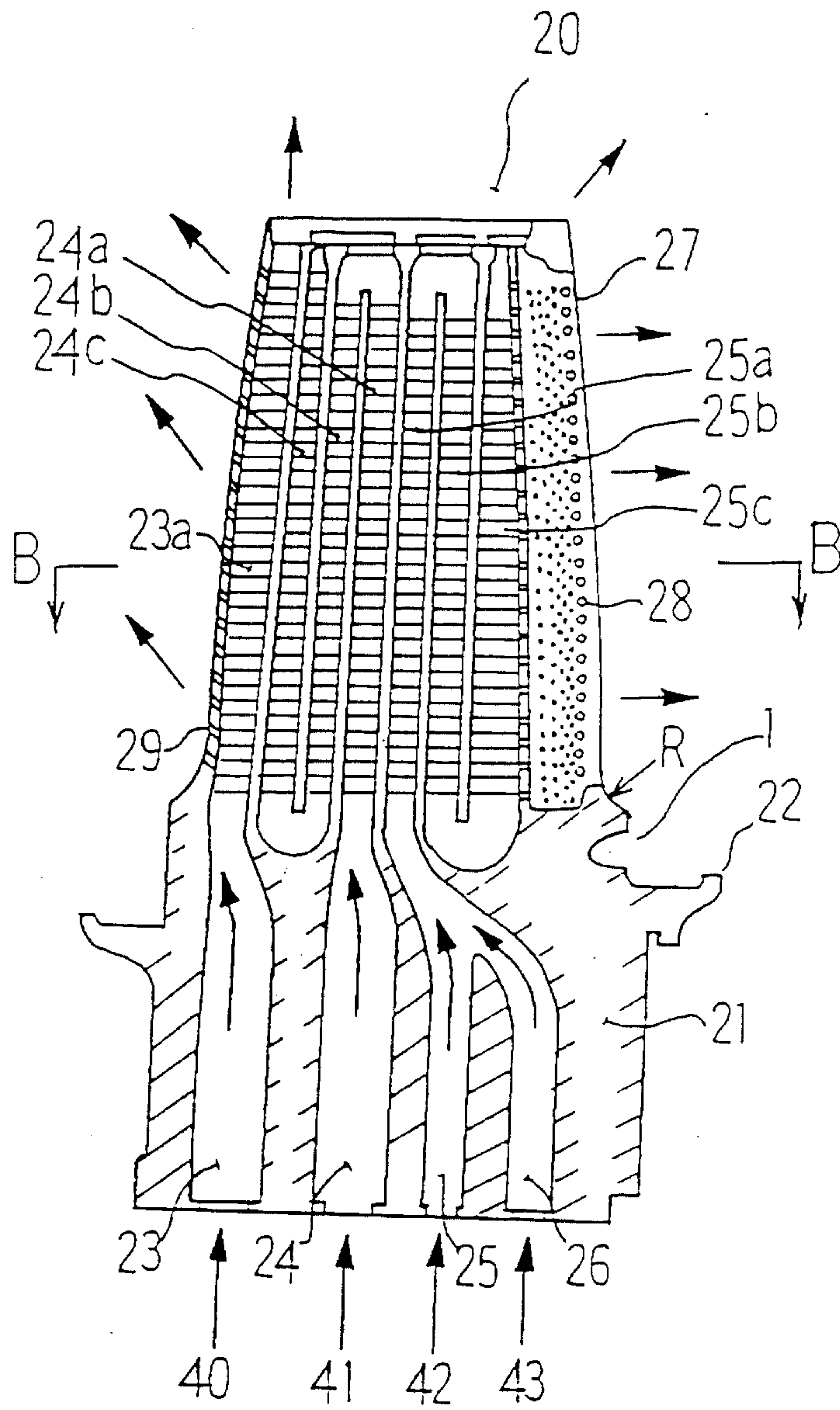


Fig. 2(a)

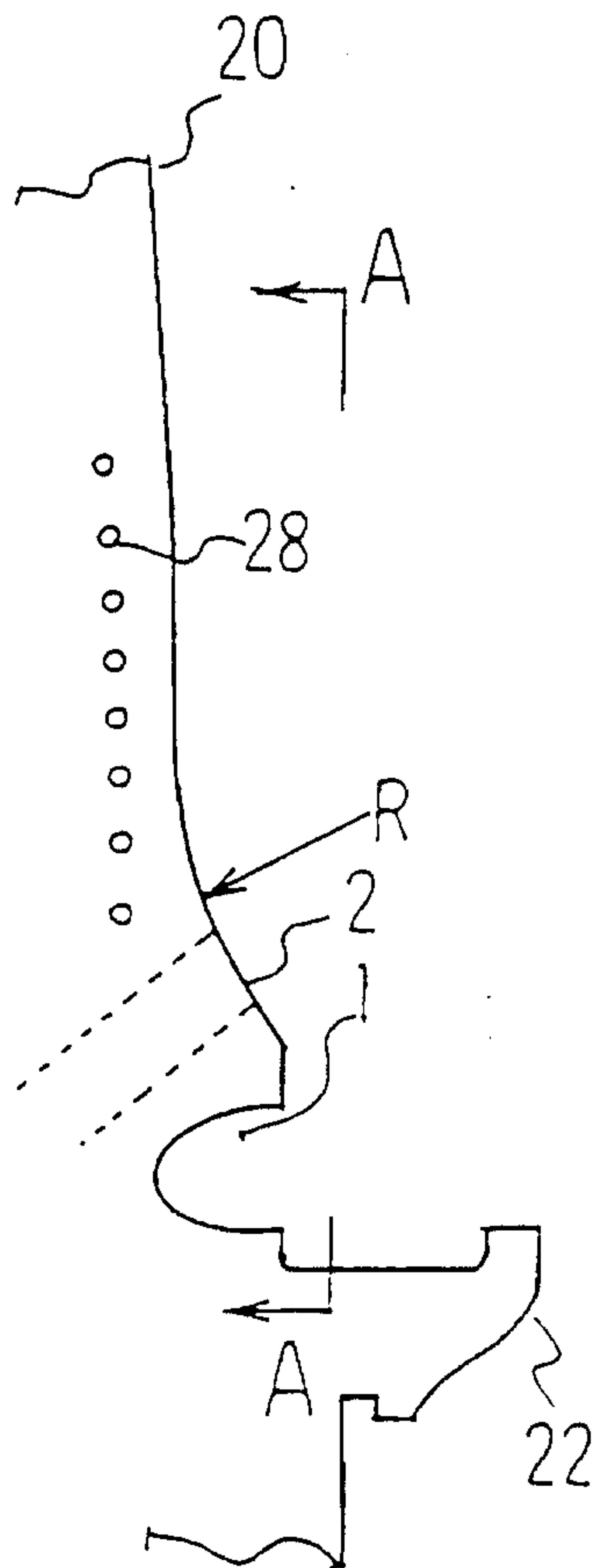


Fig. 2(b)

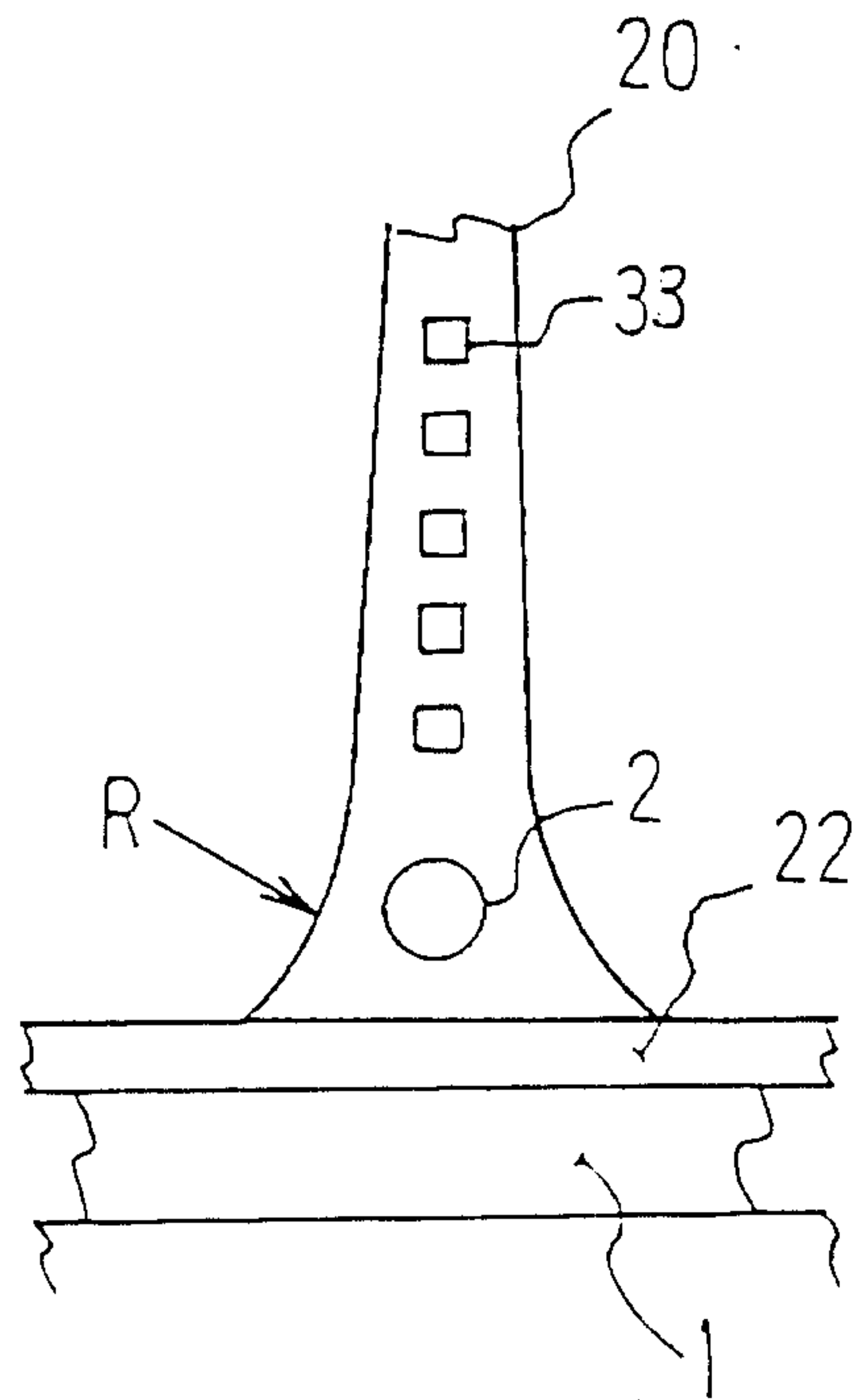


Fig. 2(c)

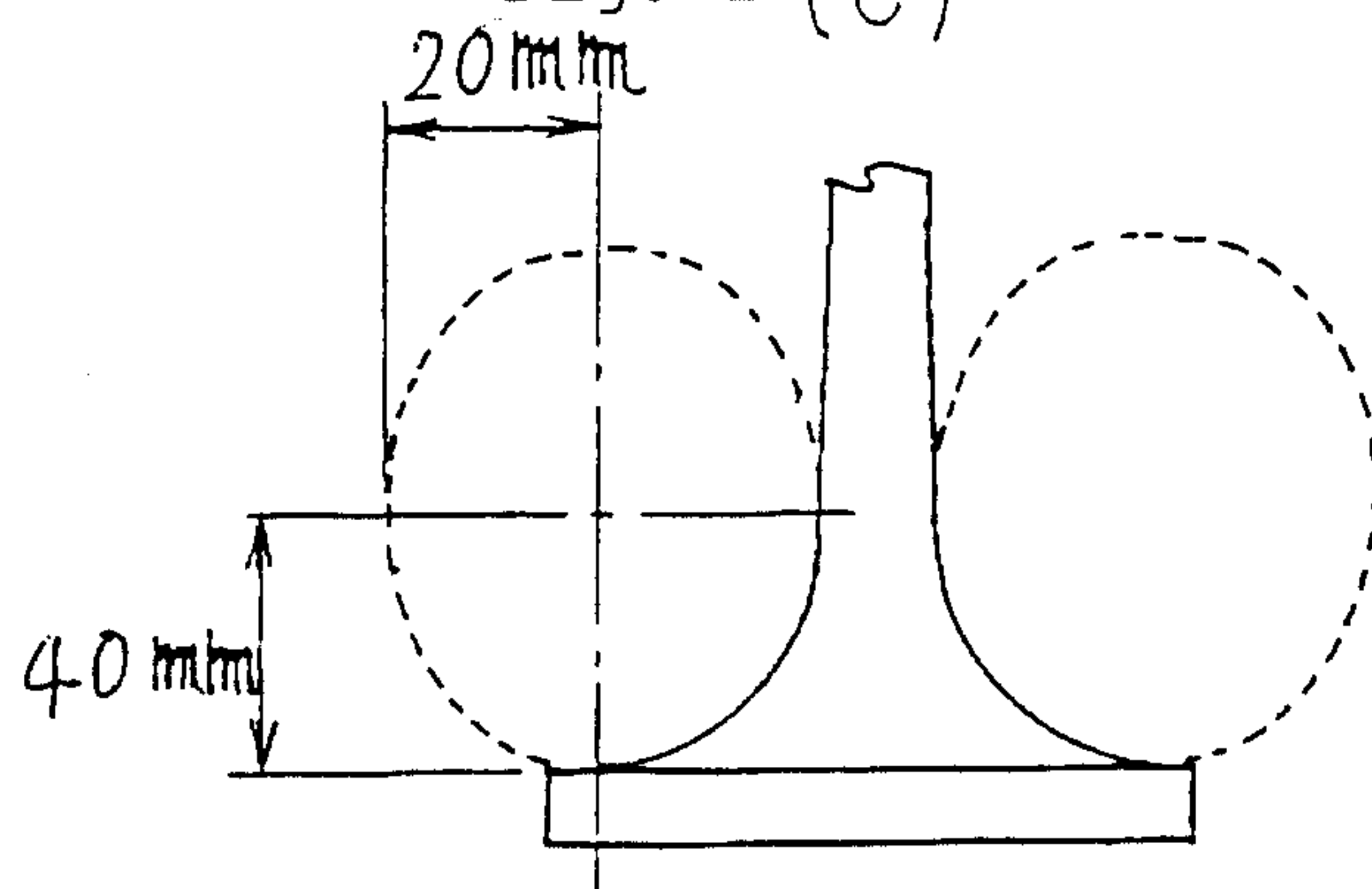


Fig. 3

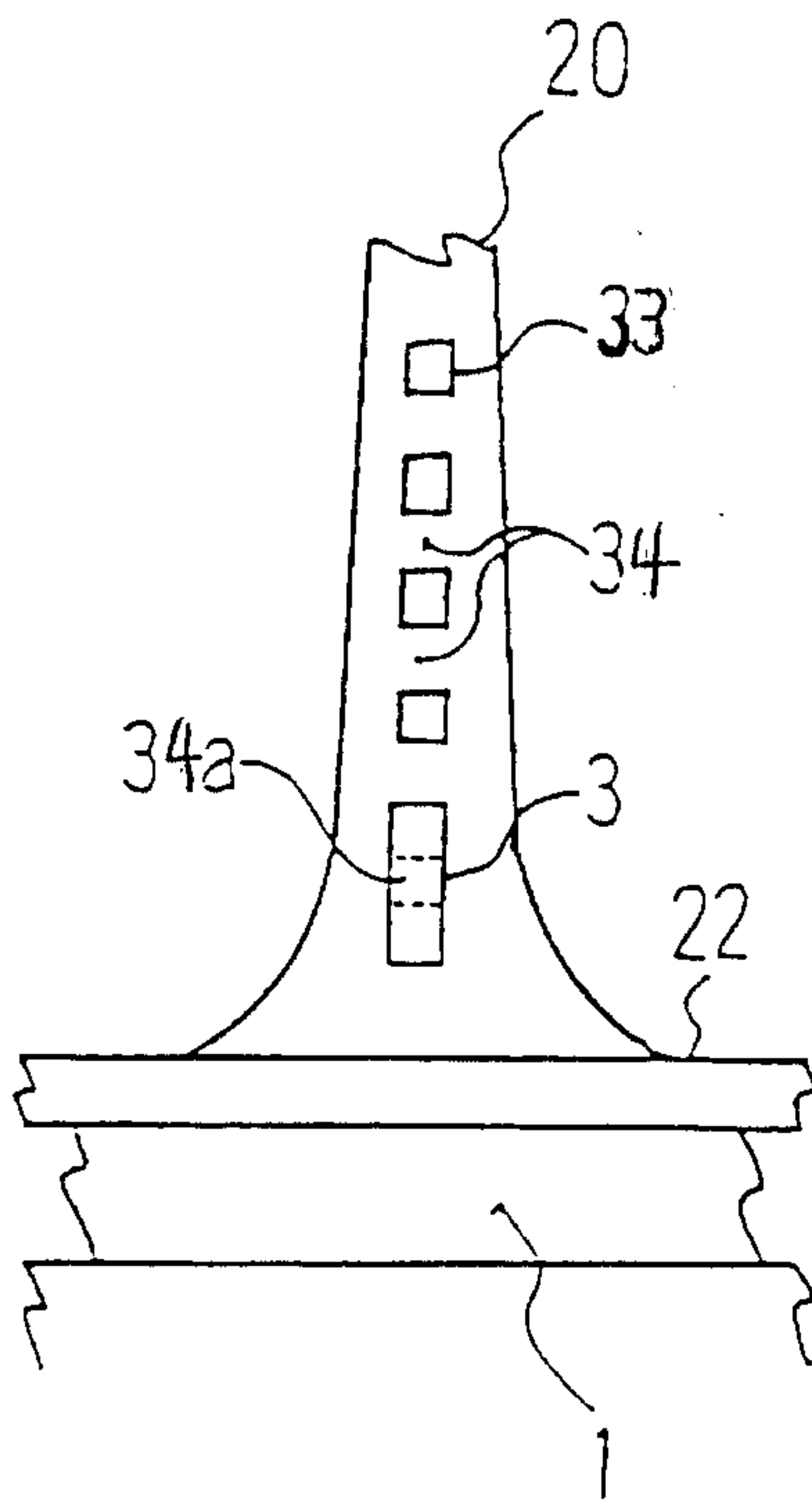


Fig. 4 (b)

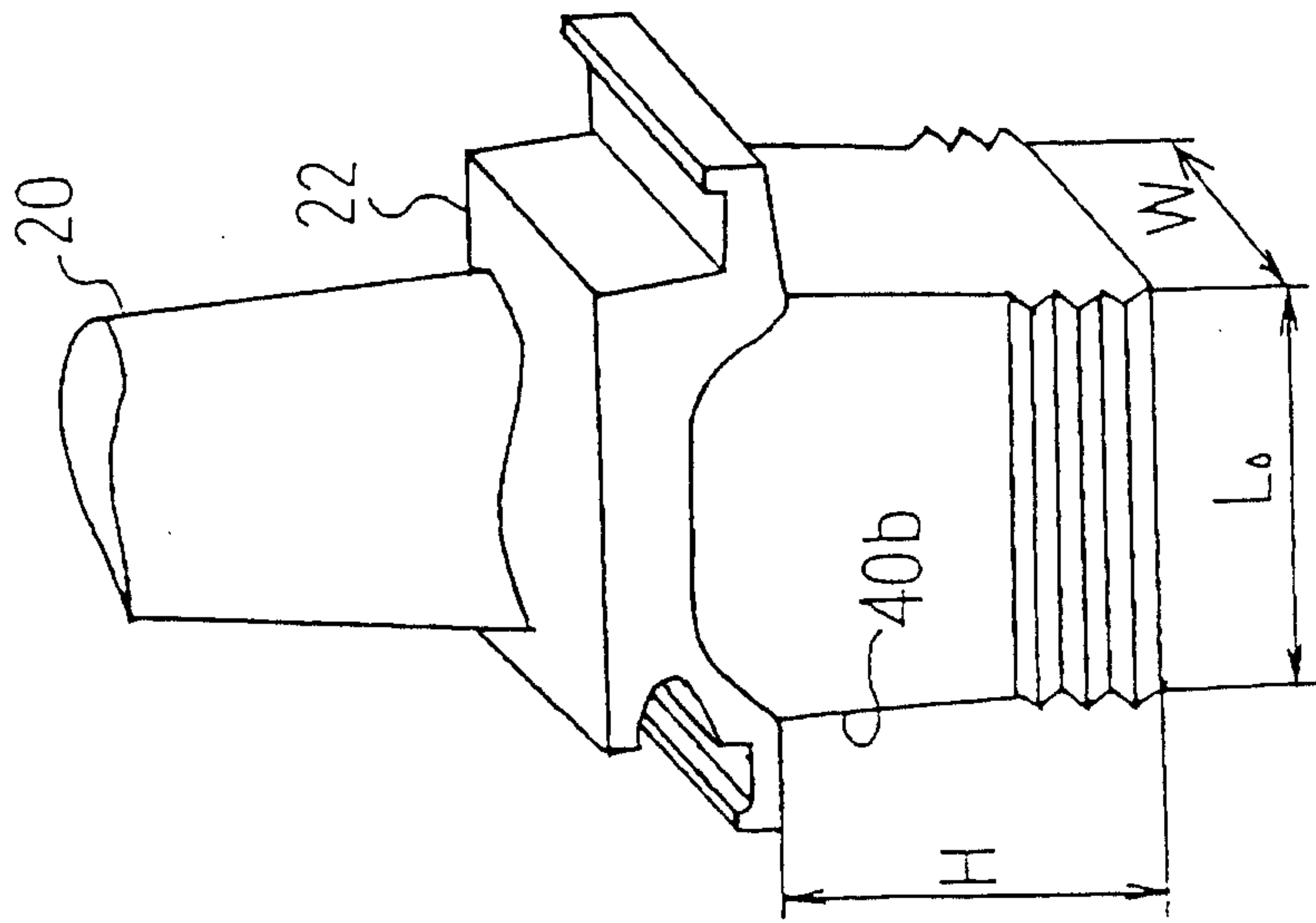


Fig. 4 (a)

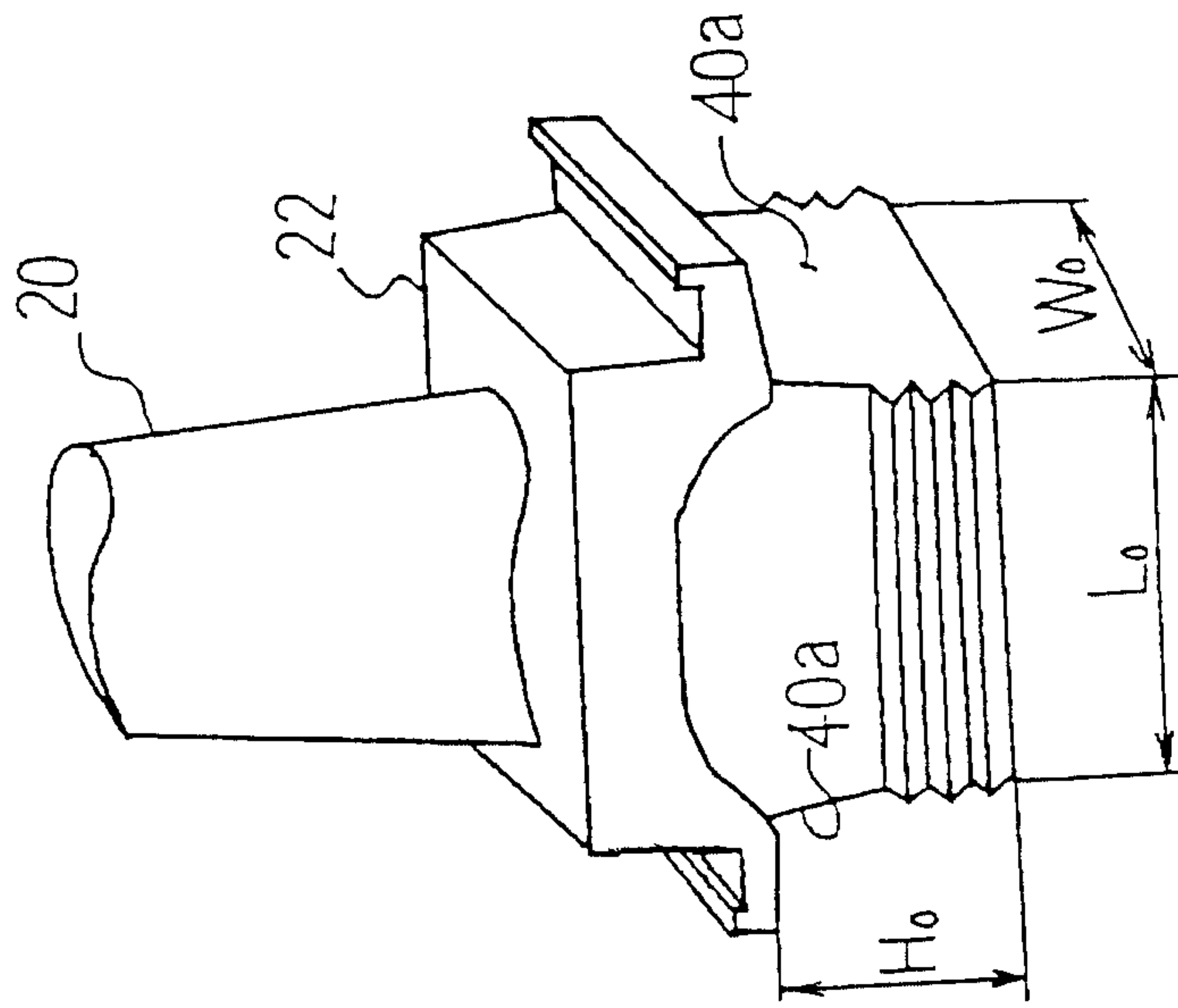


Fig. 5

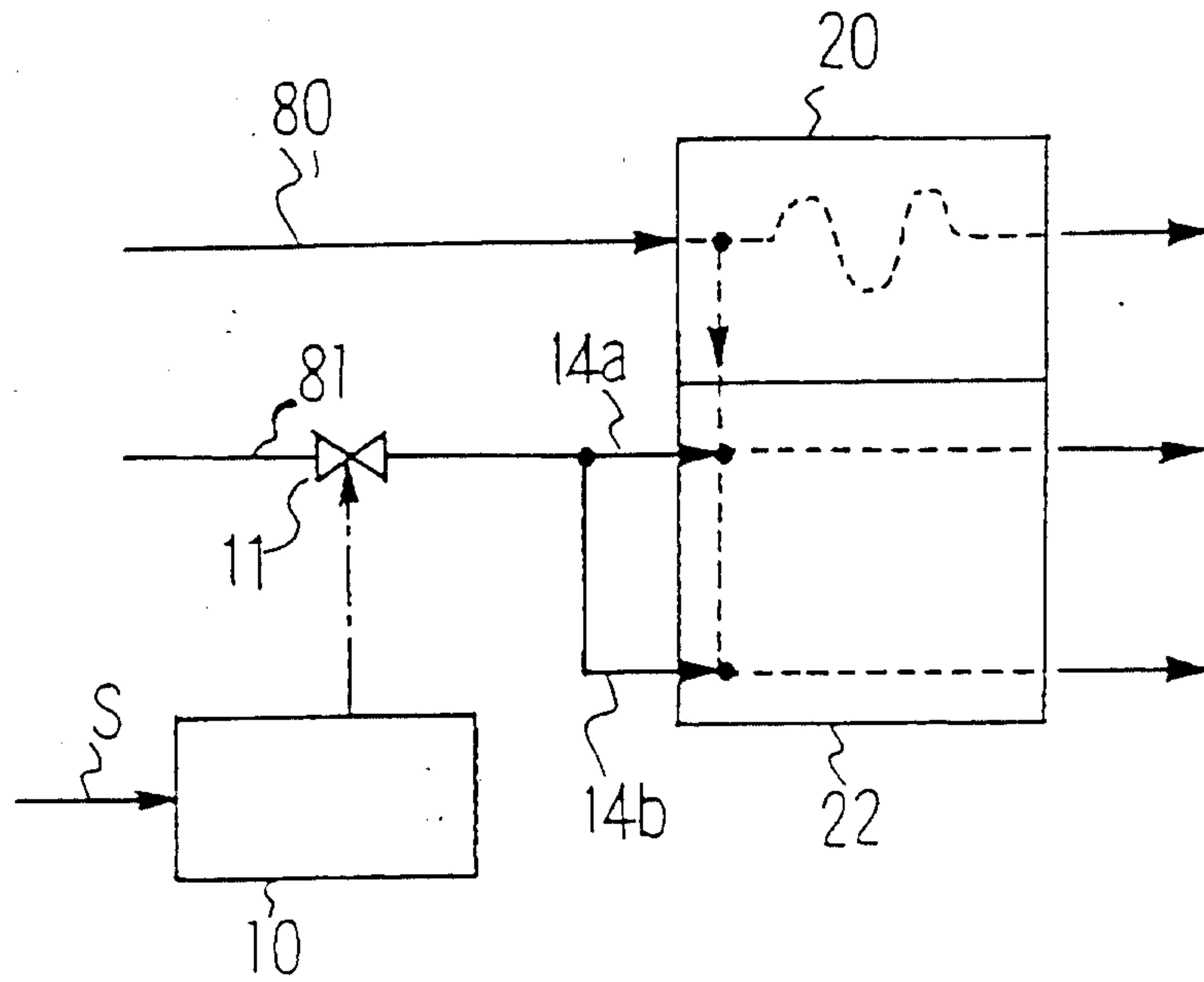


Fig. 6

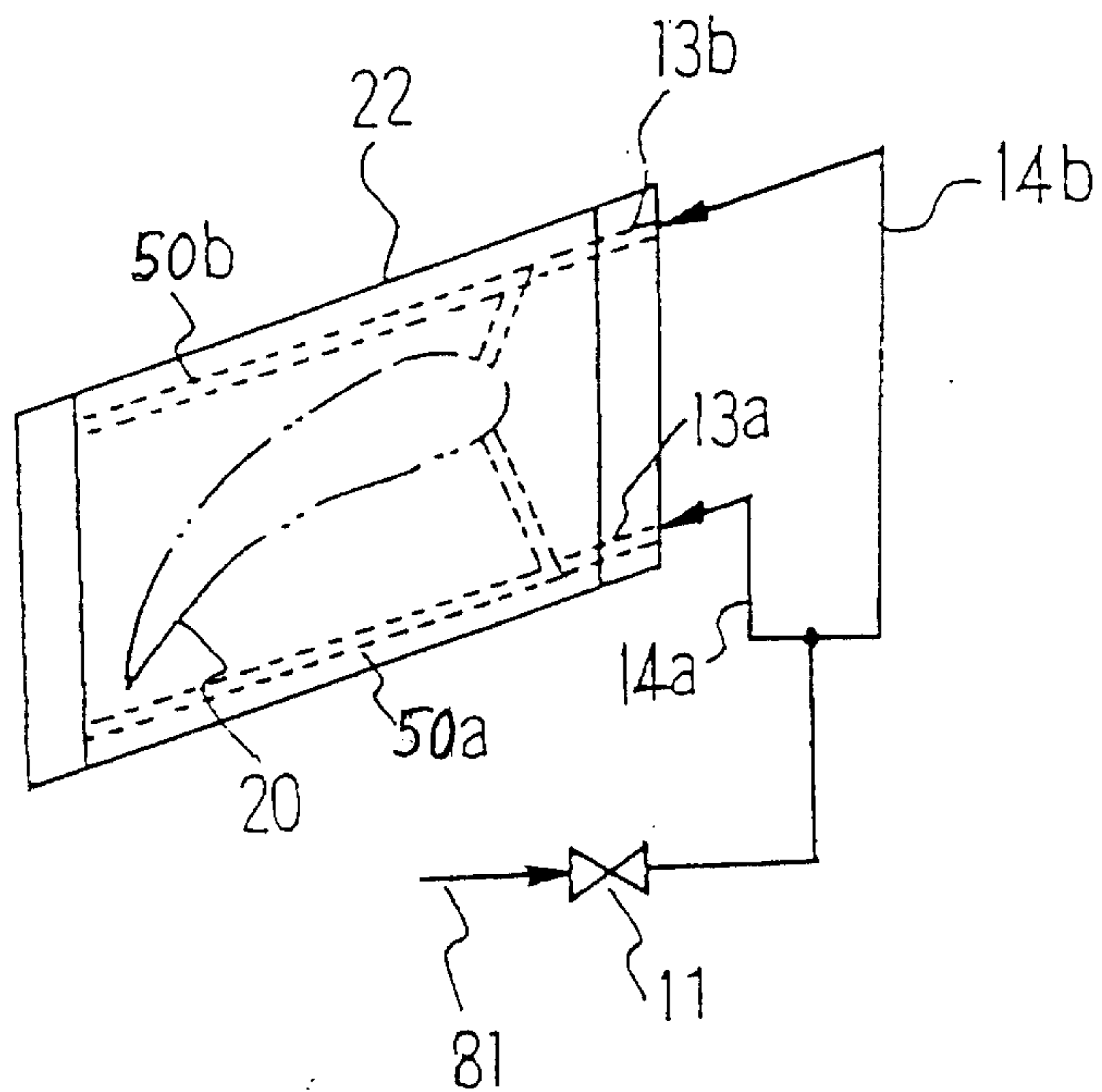


Fig. 7

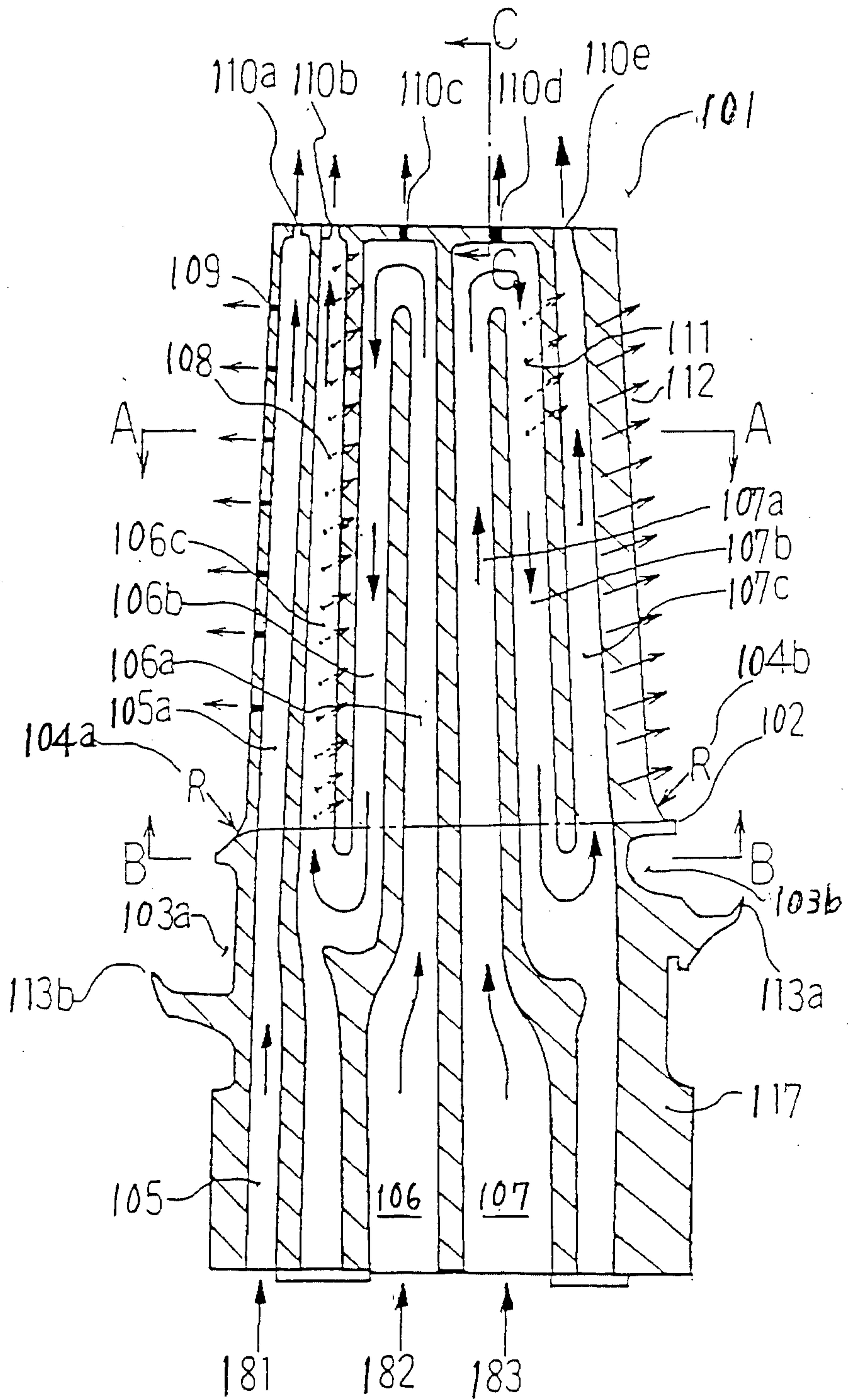


Fig. 8

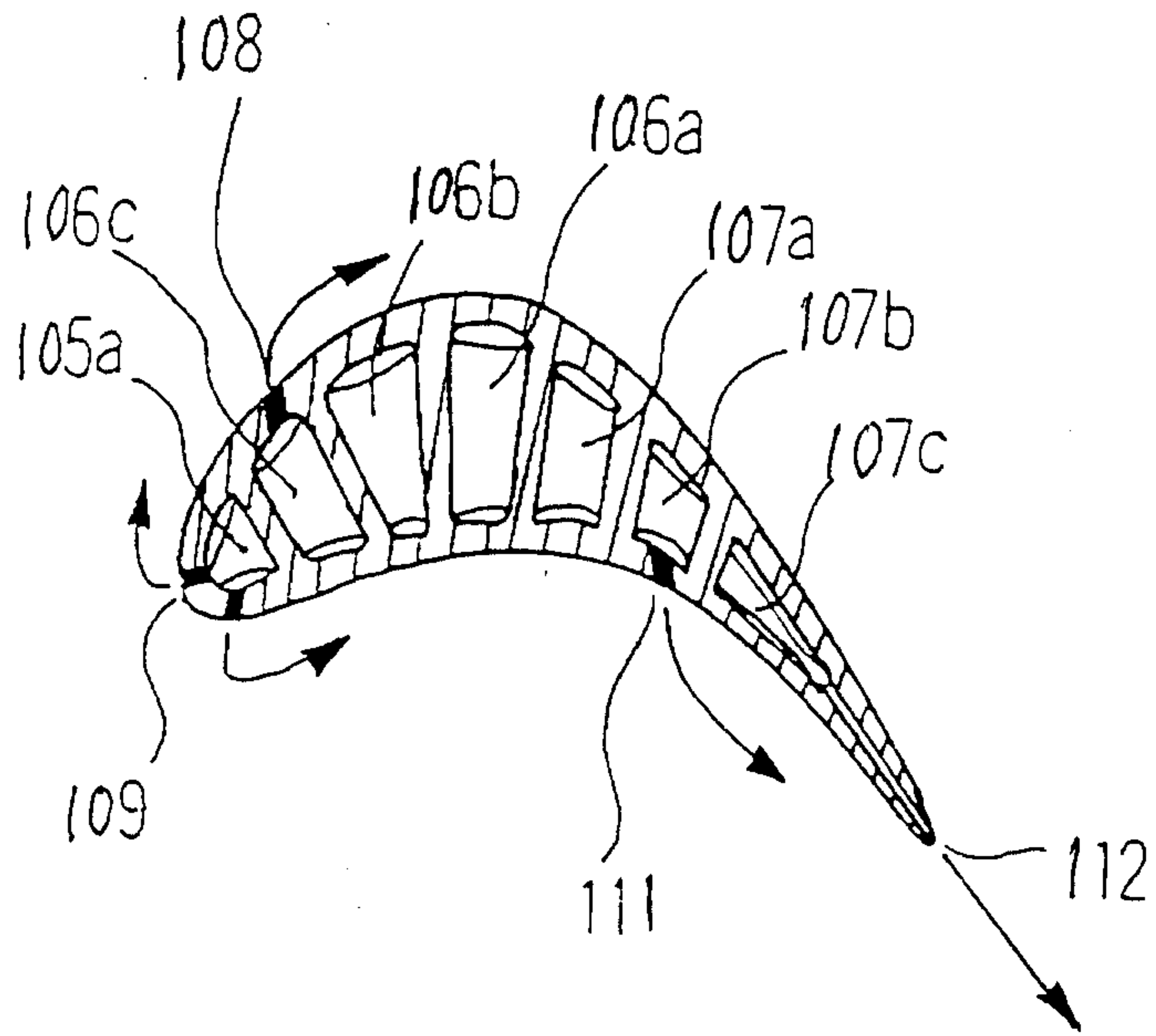


Fig. 9

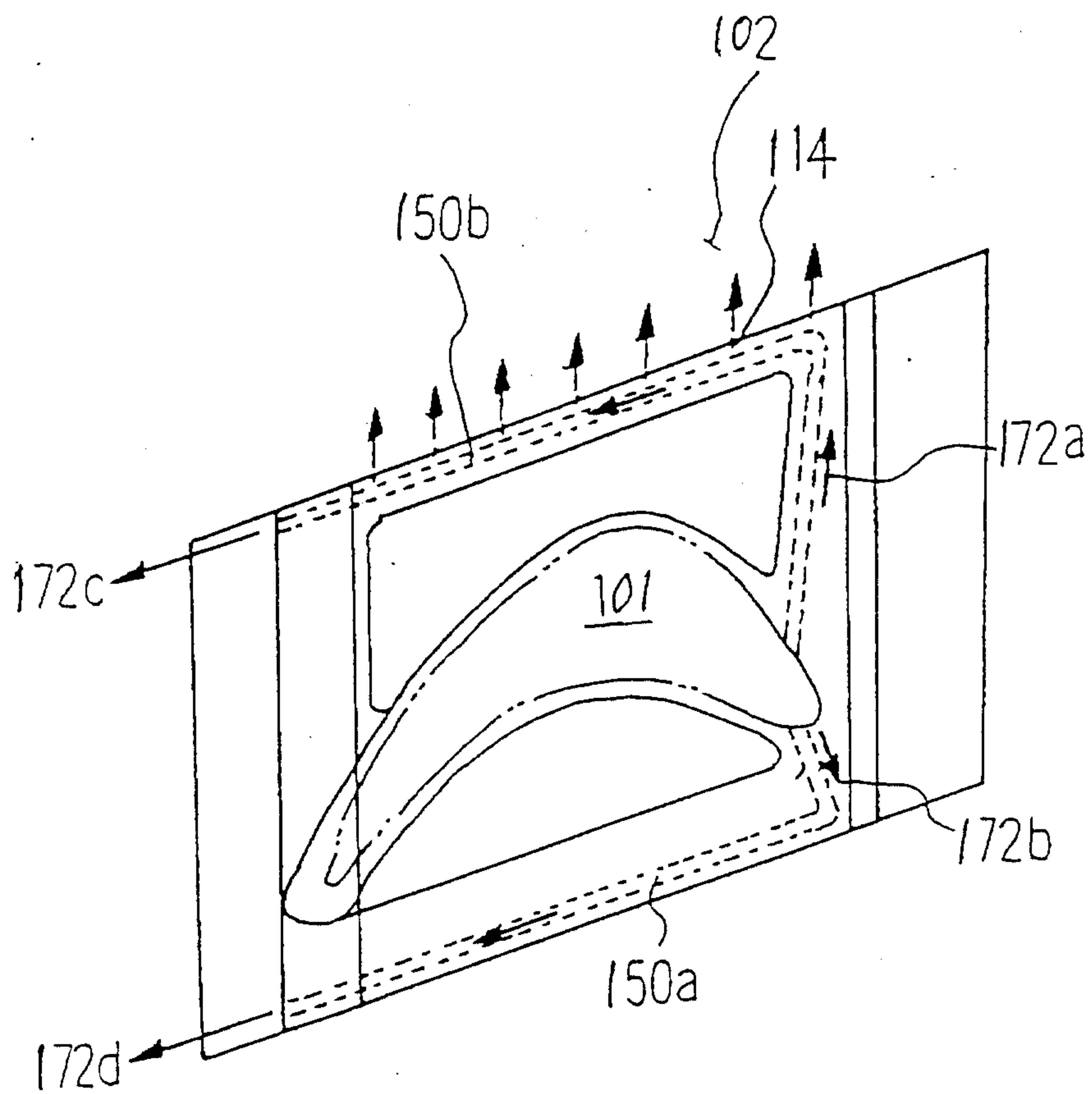


Fig. 10(b)

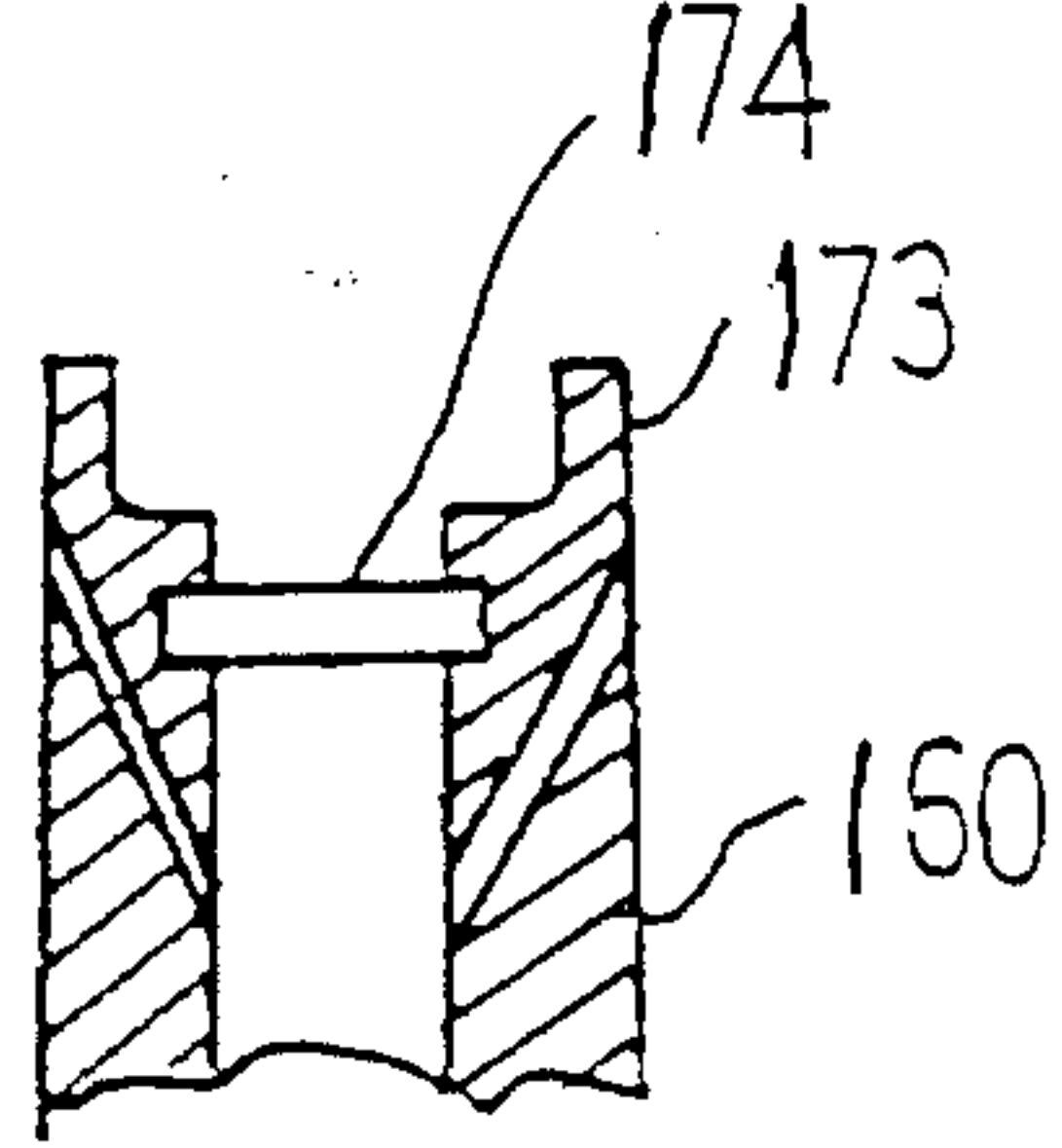
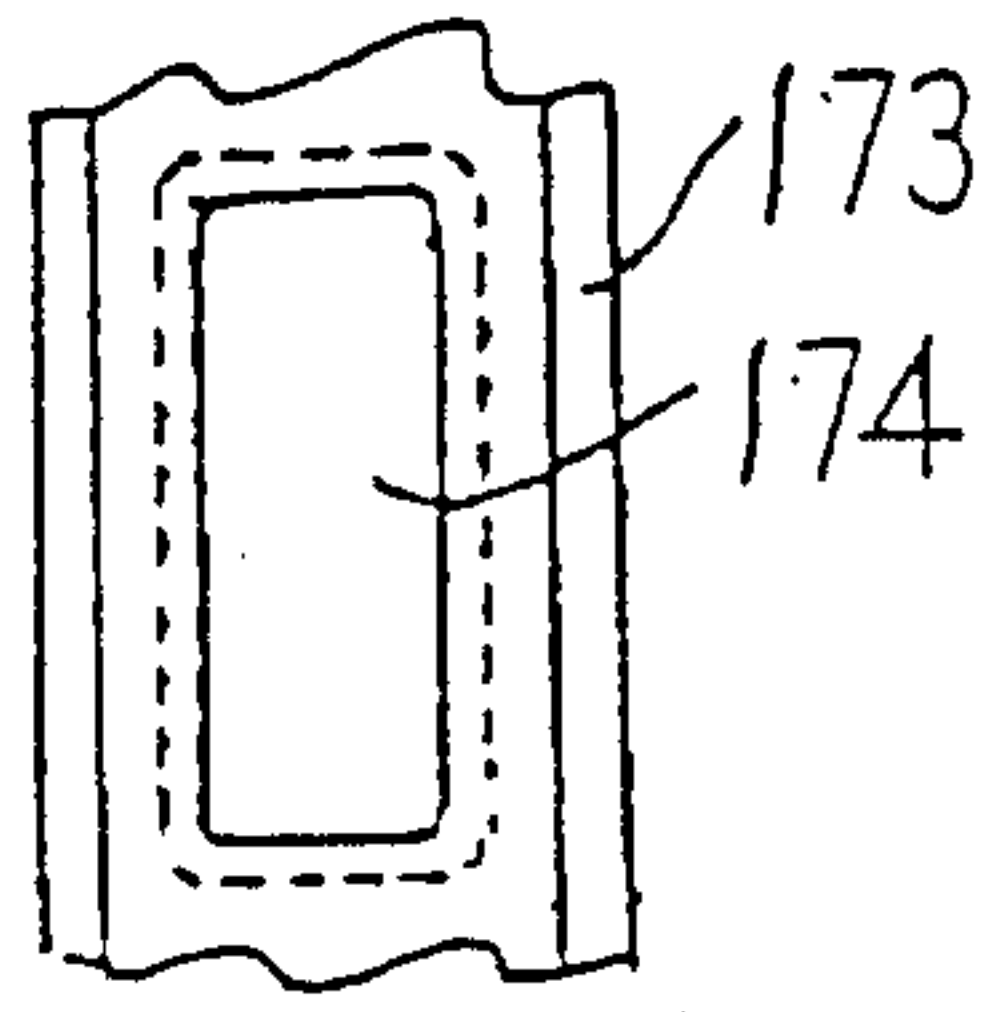


Fig. 10 (a)

Fig. 10 (d)

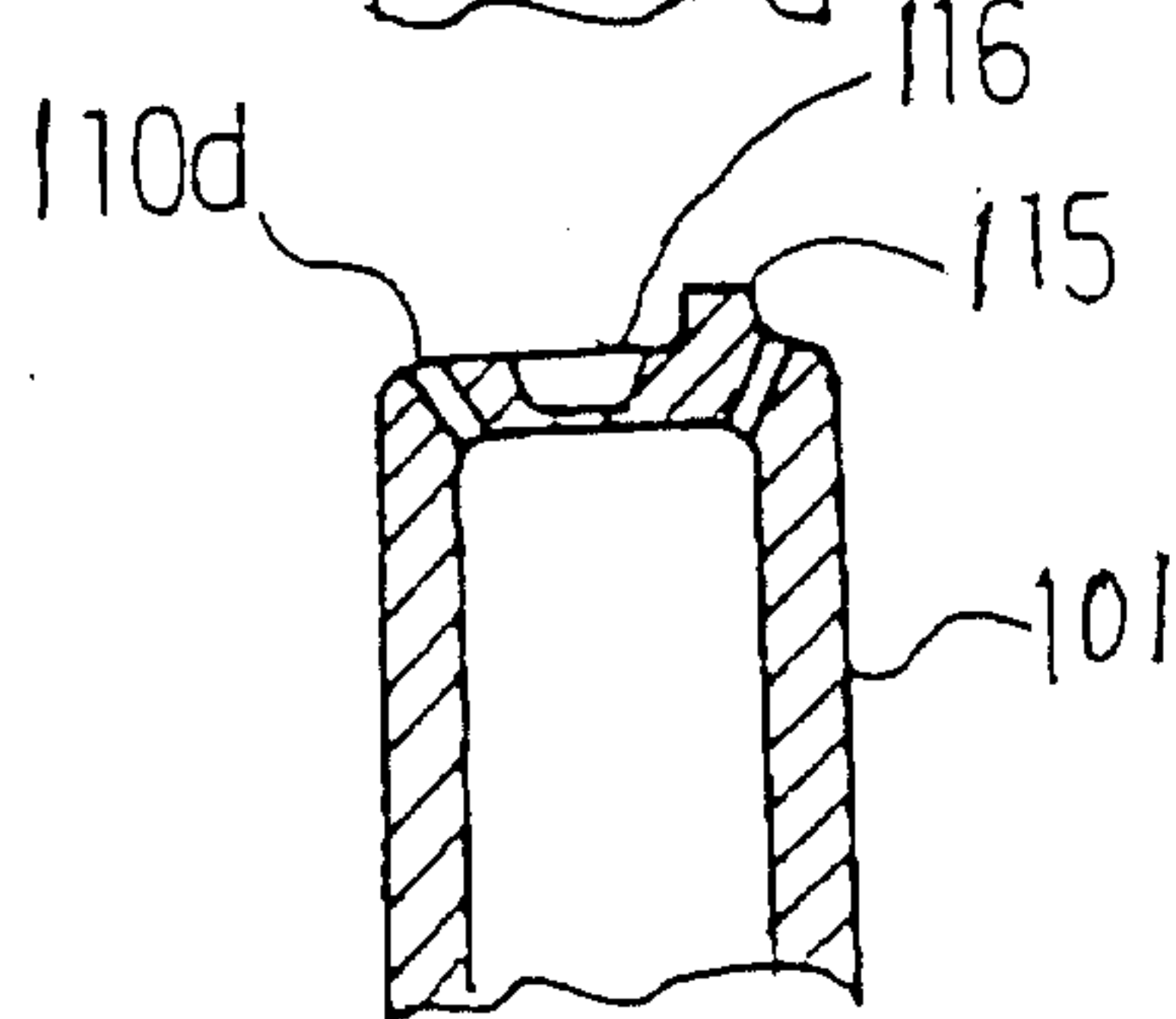
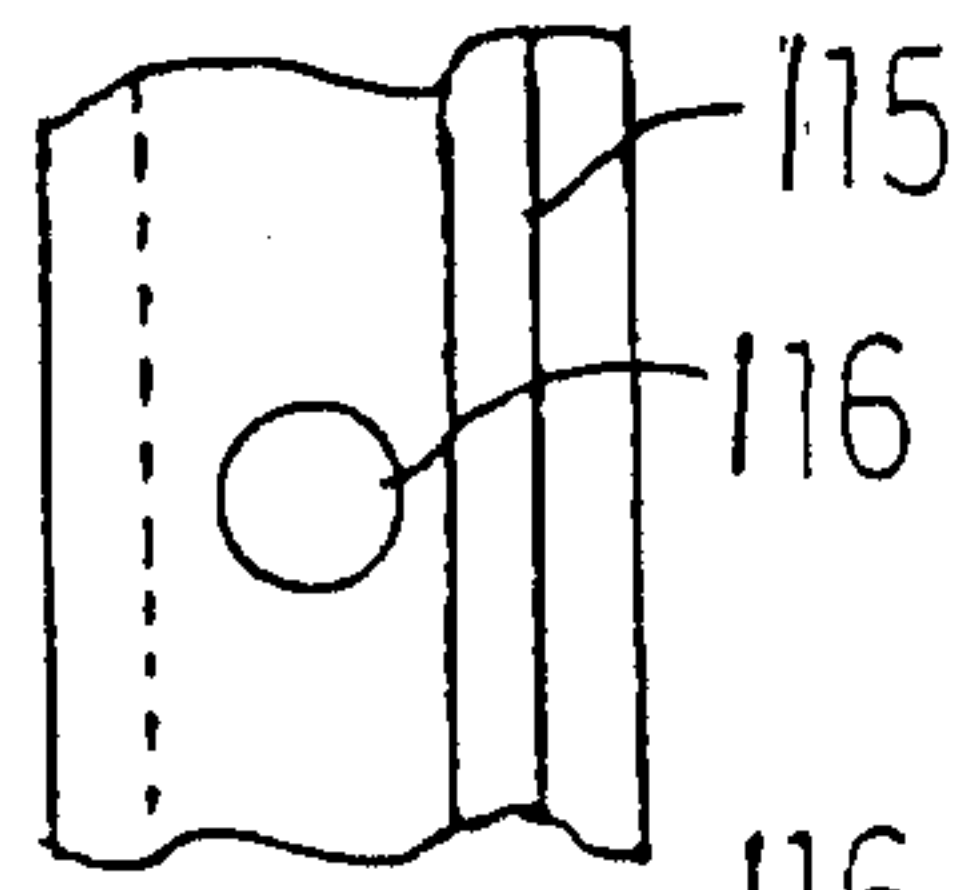


Fig. 10 (c)

Fig. 11

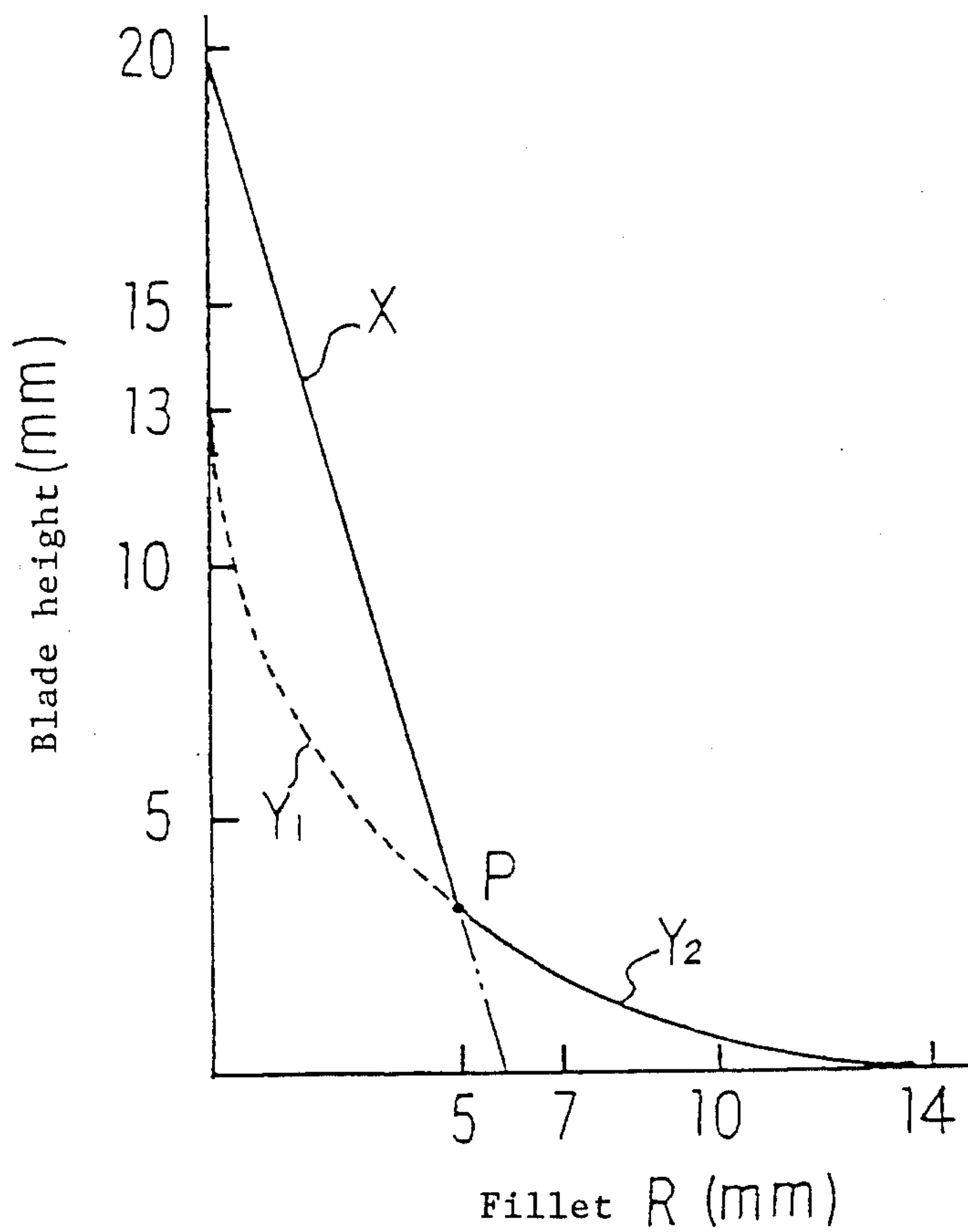


Fig. 12 (b)

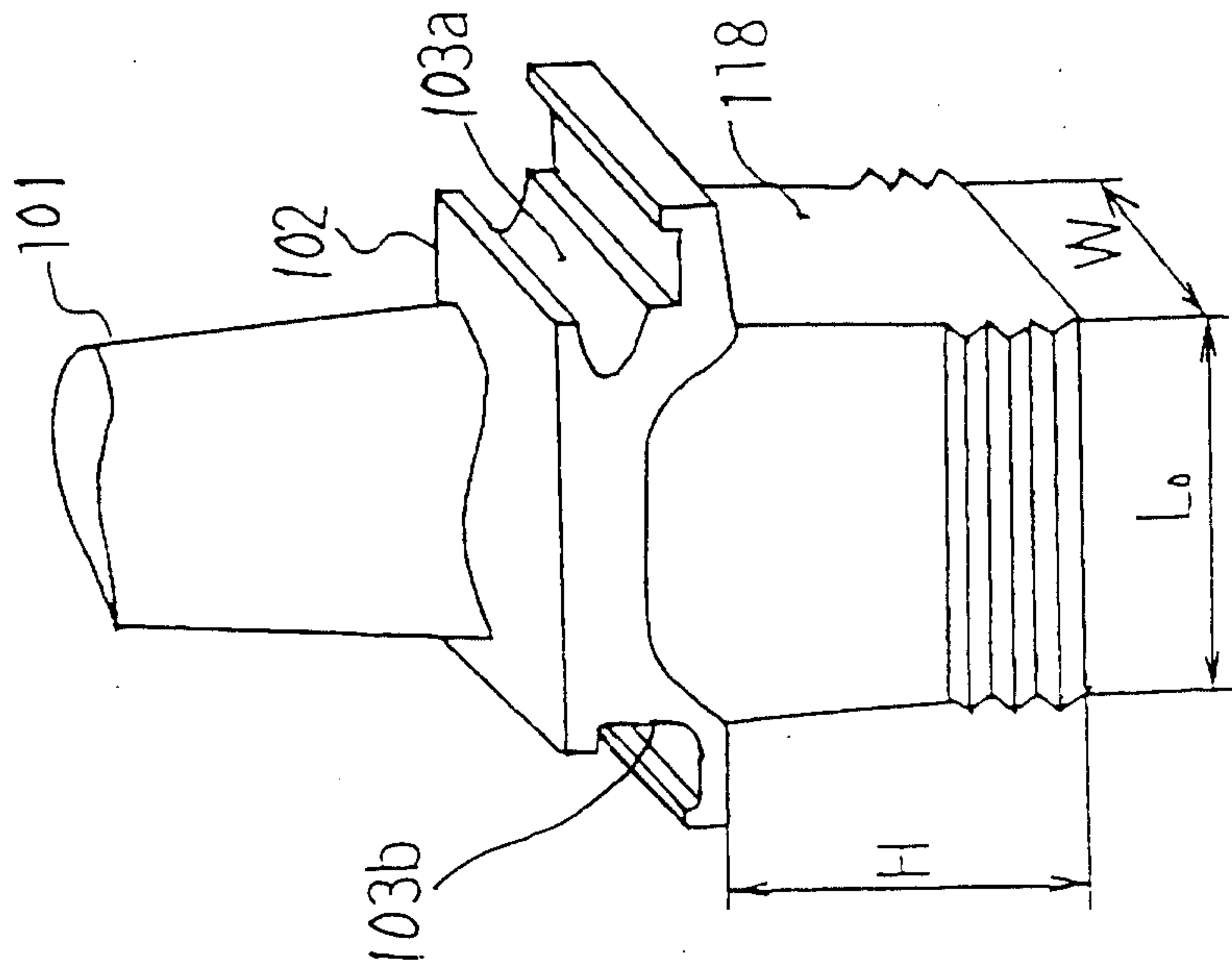


Fig. 12 (a)

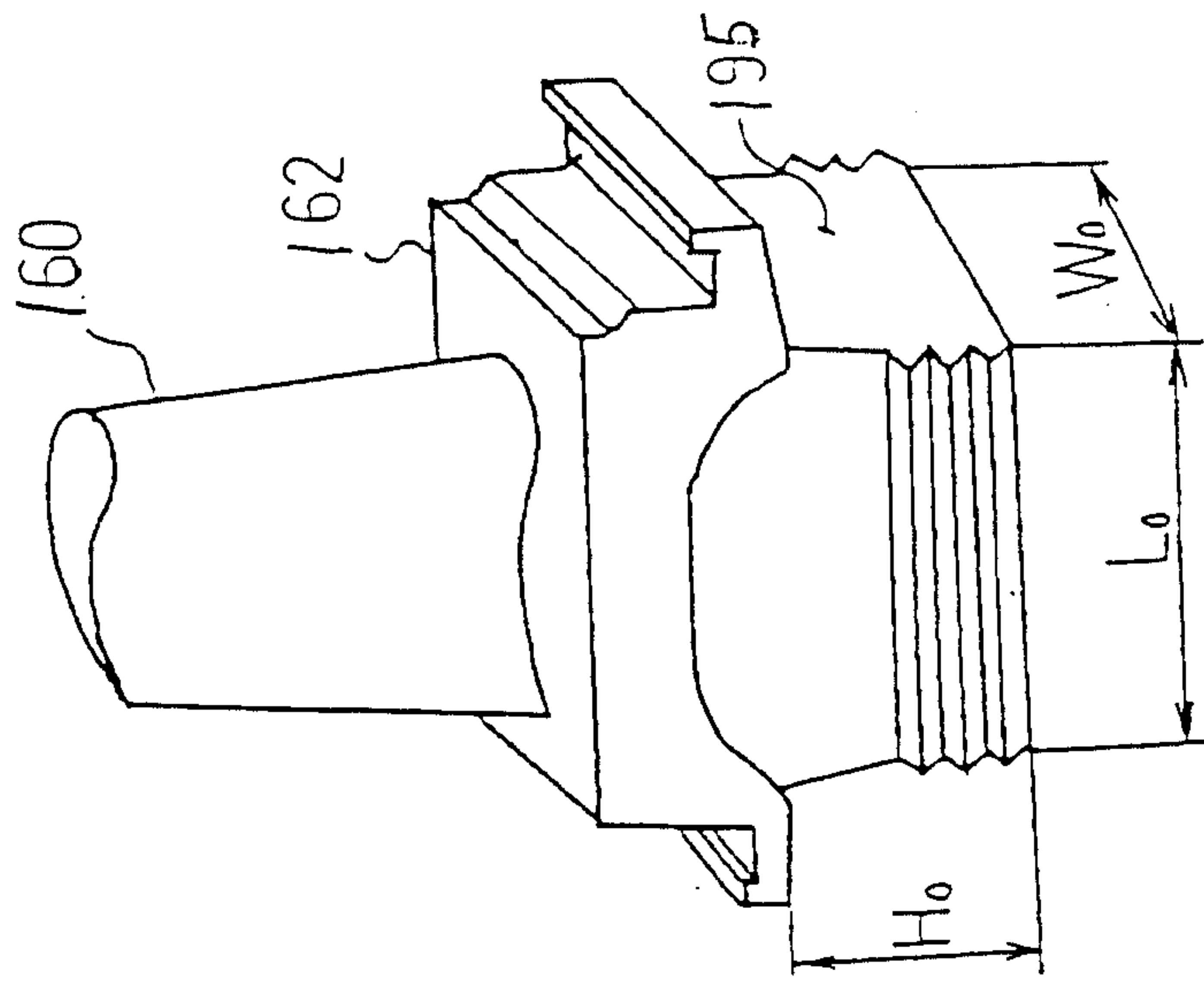


Fig. 13(a)

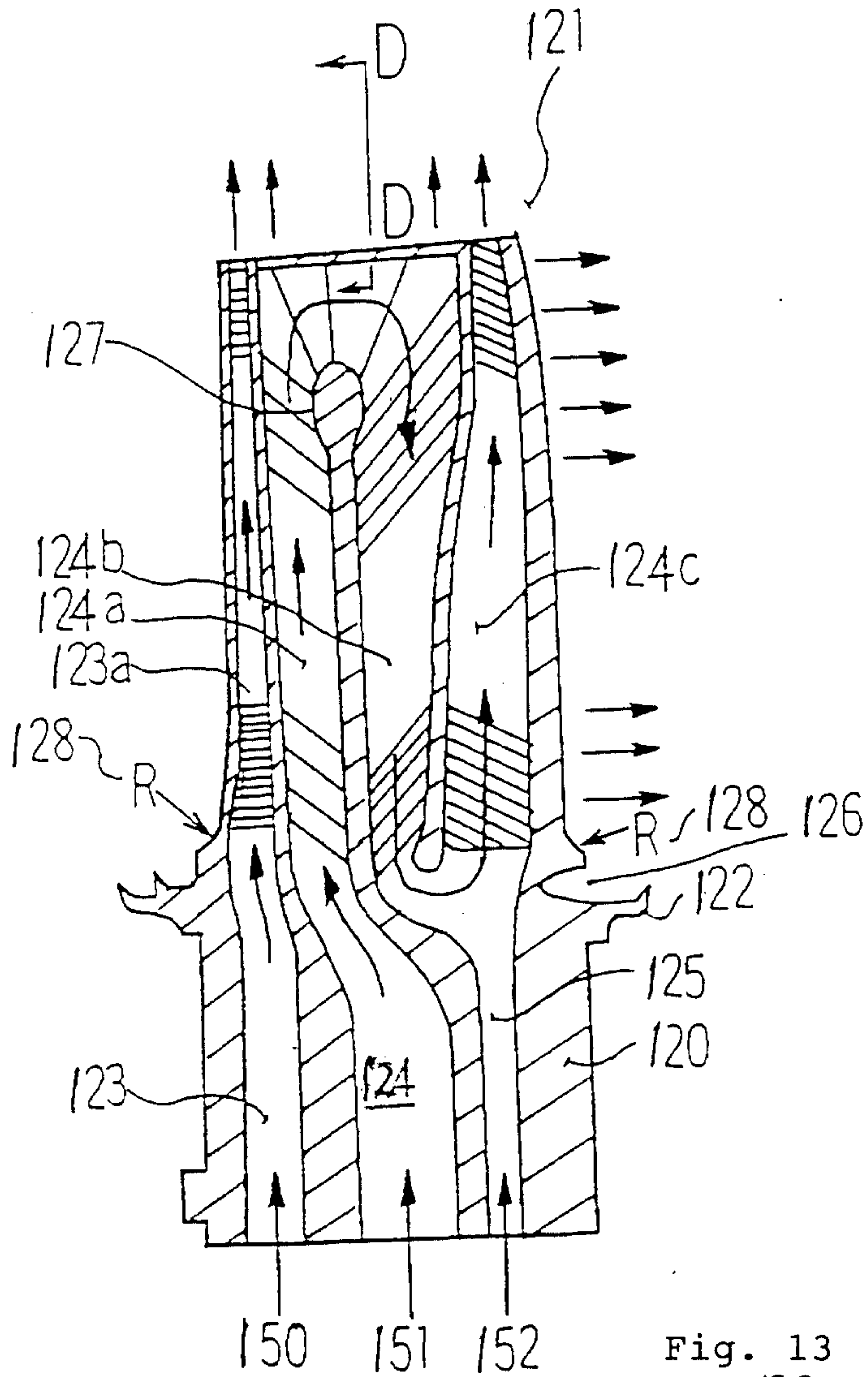


Fig. 13 (b)

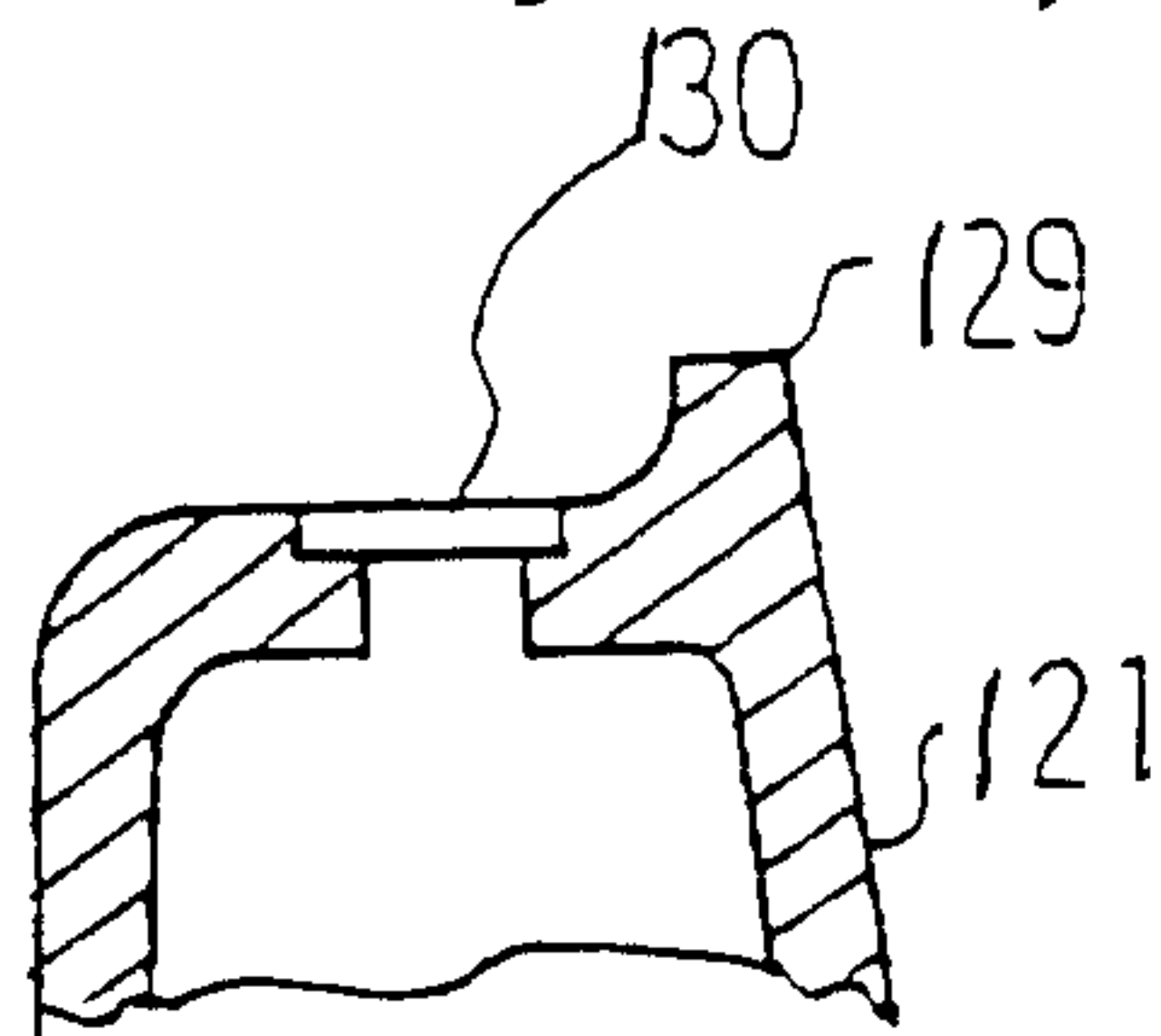


Fig. 14 (Prior Art)

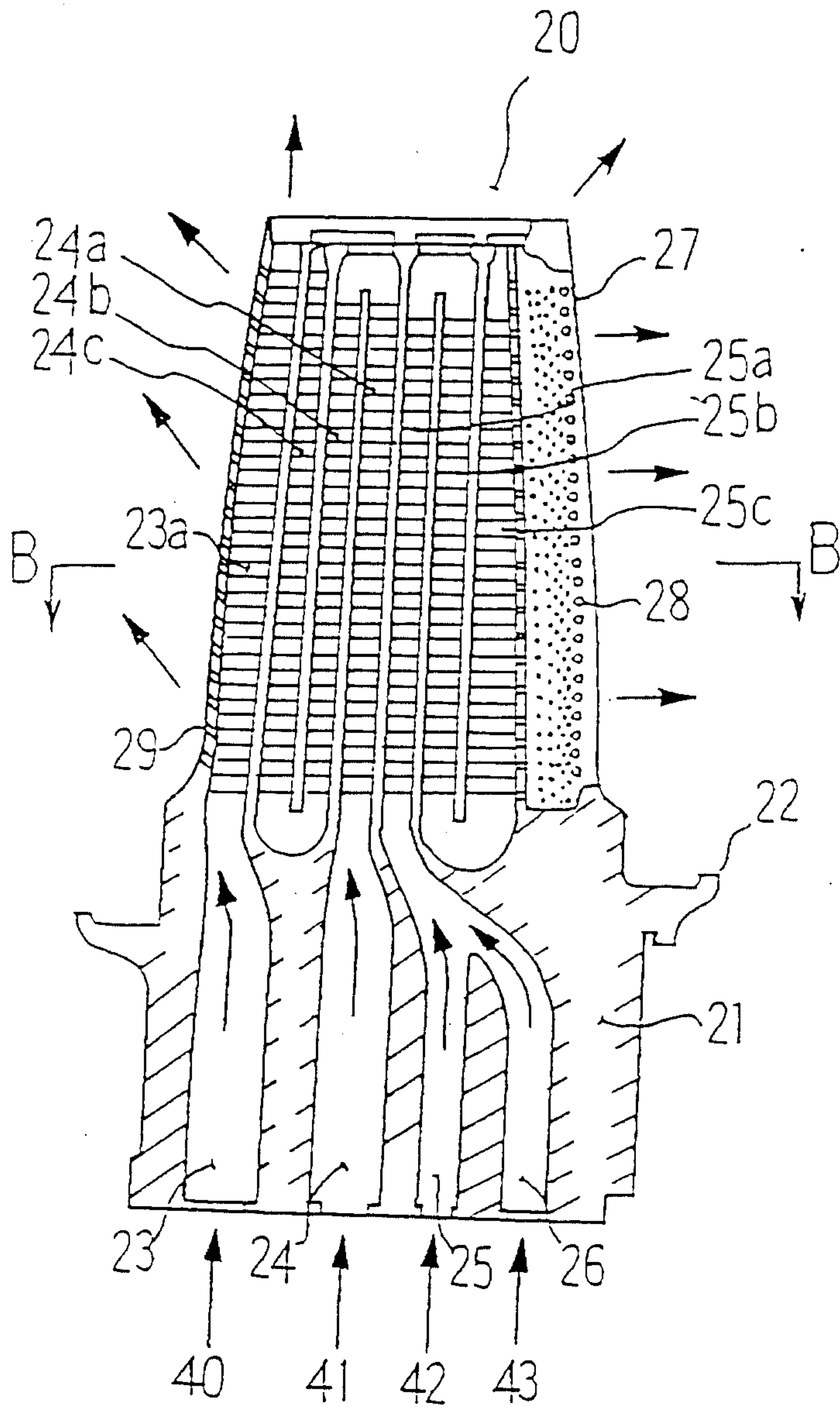


Fig. 15 (Prior Art)

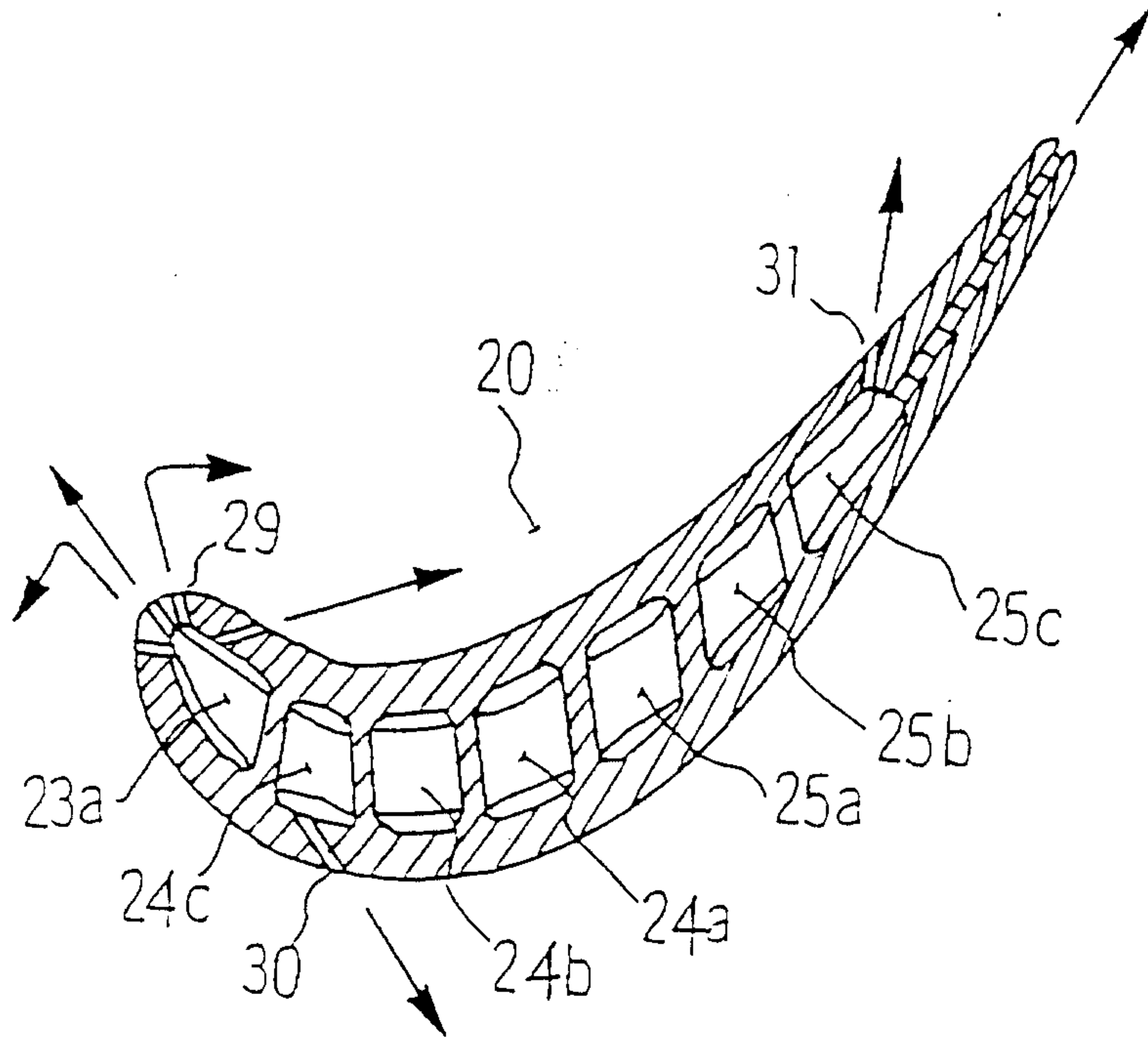


Fig. 16 (a) (Prior Art)

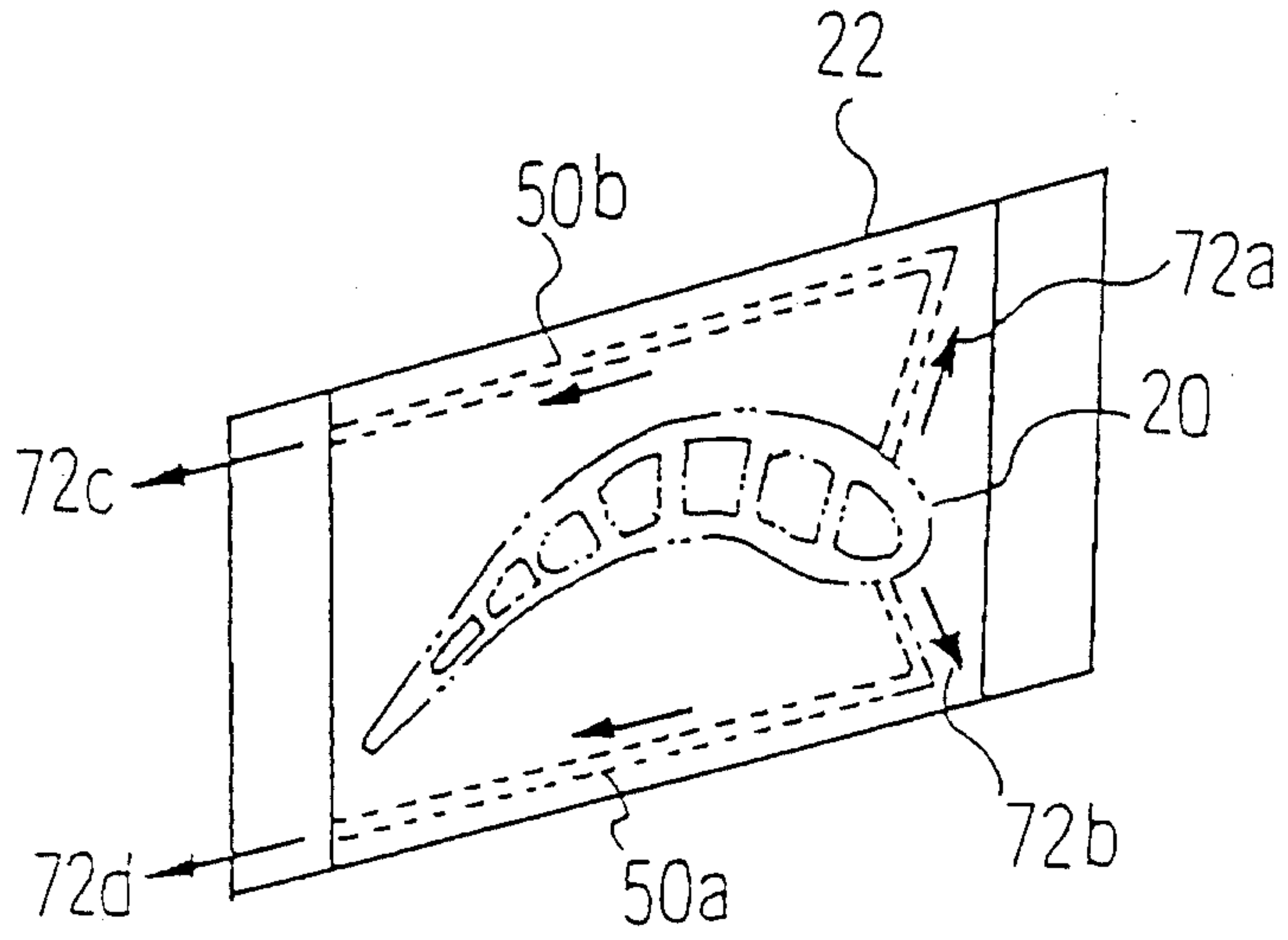


Fig. 16 (b) (Prior Art)

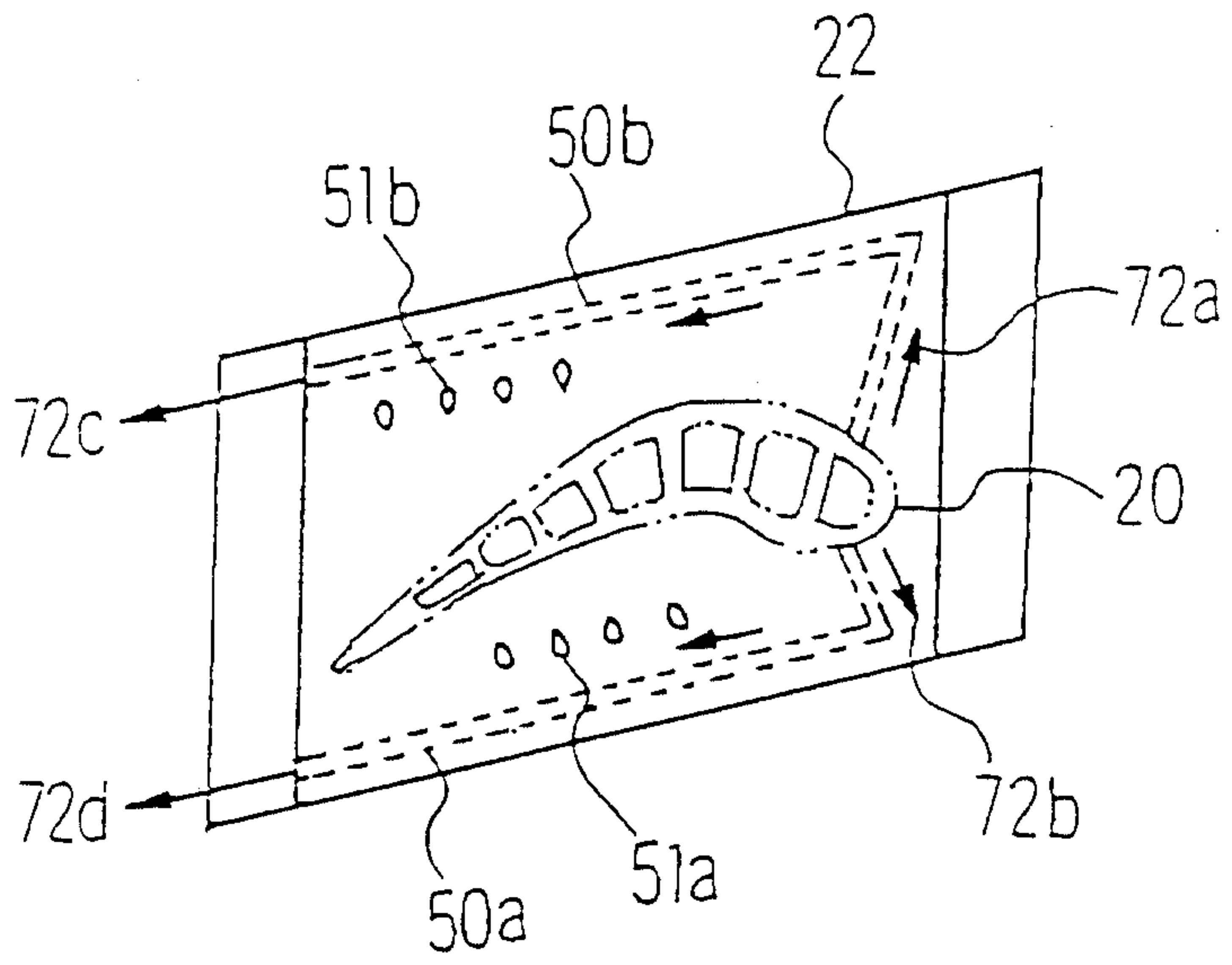


Fig. 17 (a) (Prior Art)

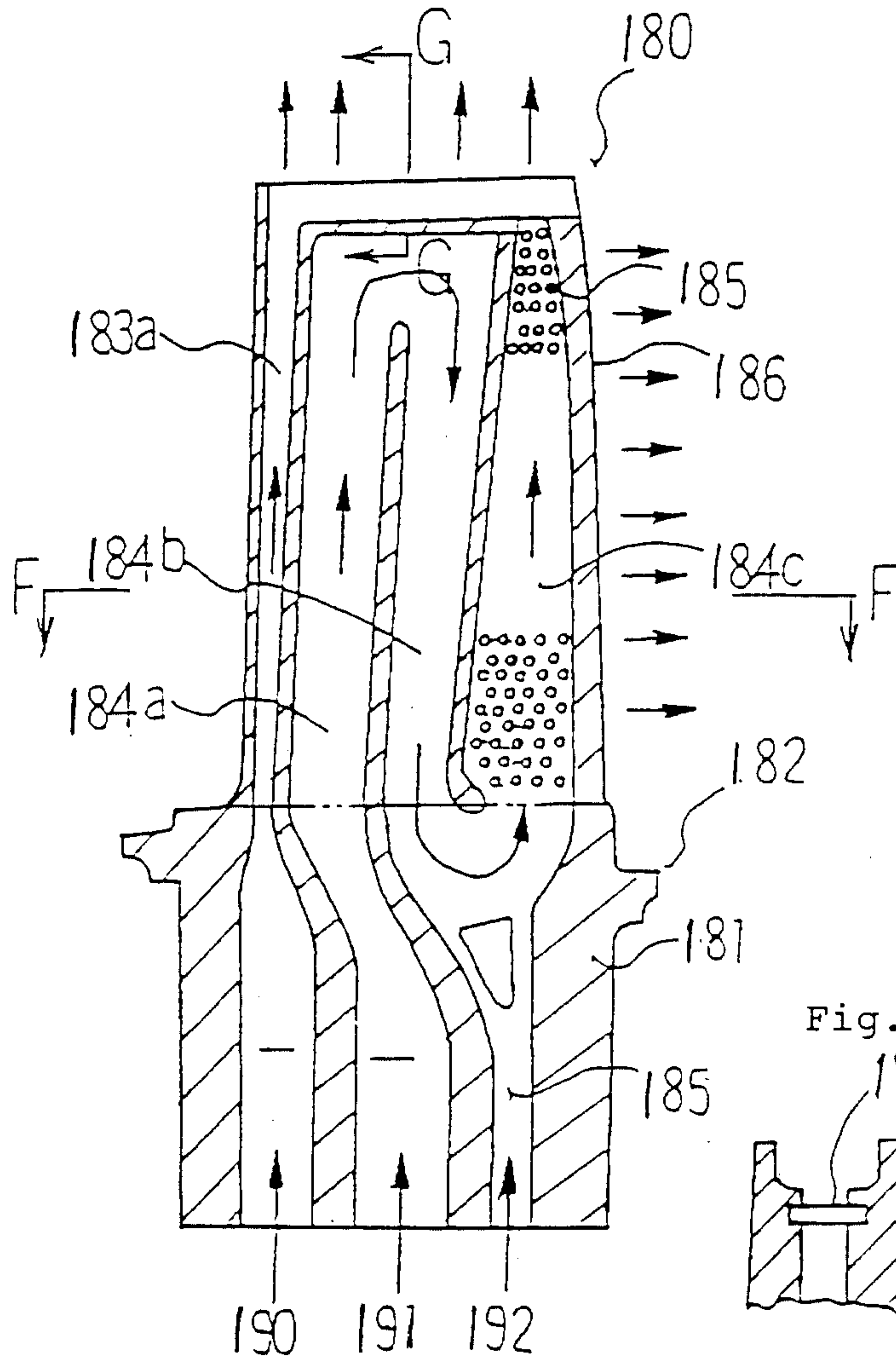


Fig. 17 (C) (Prior Art)

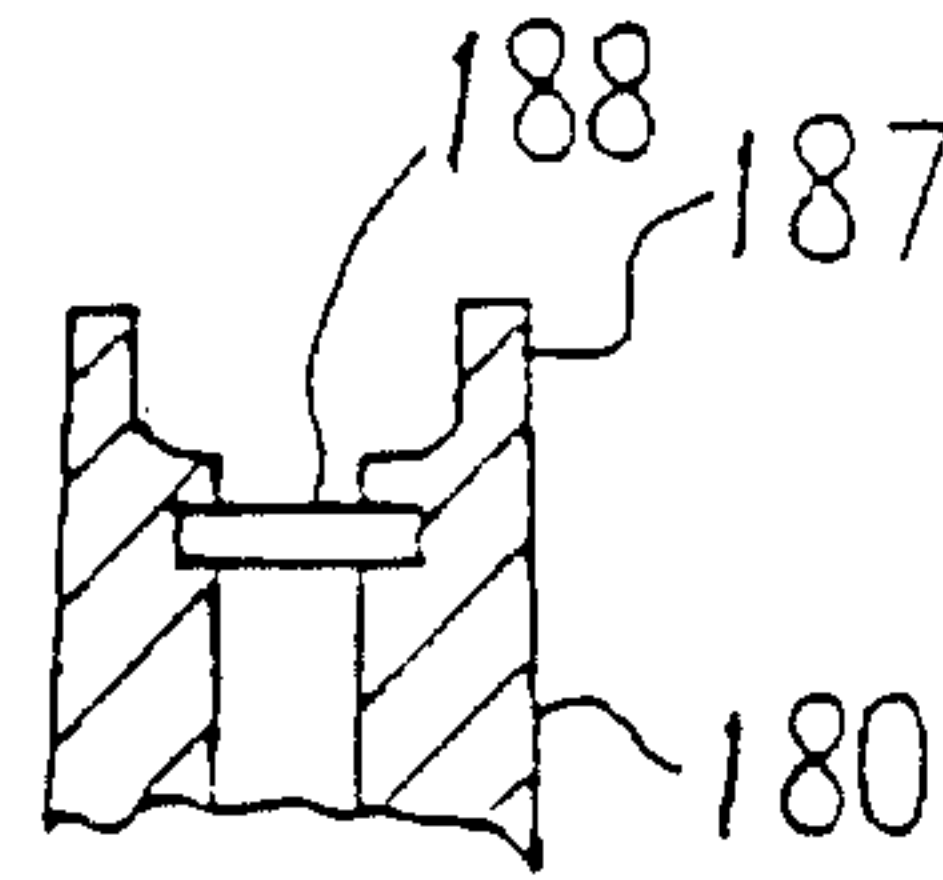


Fig. 17 (b) (Prior Art)

