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Arrangement for sealing off a transition between cooling passages of two components of a turbomachine

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Abstract of the Disclosure

The present invention relates to an arrangement for sealing off a transition between a first passage (1a) for a cooling medium in a first component (1) of a turbomachine, in particular gas turbine, and a second passage (2a) for the cooling medium in a second component (2) of the turbomachine. In this arrangement, the two components (1) and (2) are so designed and mutually arranged that, in a state of rest of the turbine, there is, at the transition between the two passages (1a) and (2a), a gap (3) which, at an operating temperature of the turbomachine, closes as a result of the different thermal expansion of the two components (1) and (2).

The present arrangement makes it possible to seal off the transition between the cooling passages of two components reliably by means of a minimum number of individual parts.

Figure 2

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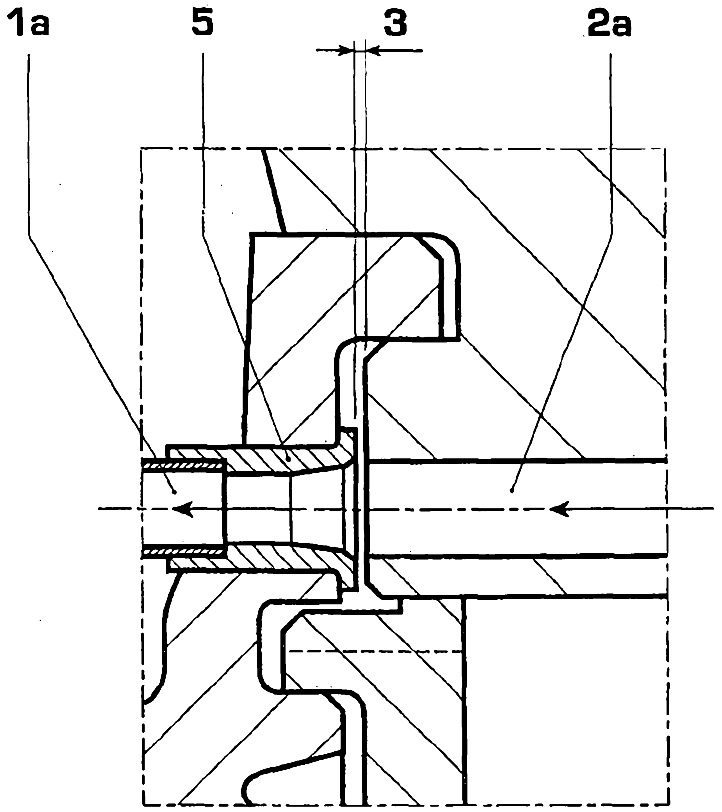

Fig. 2

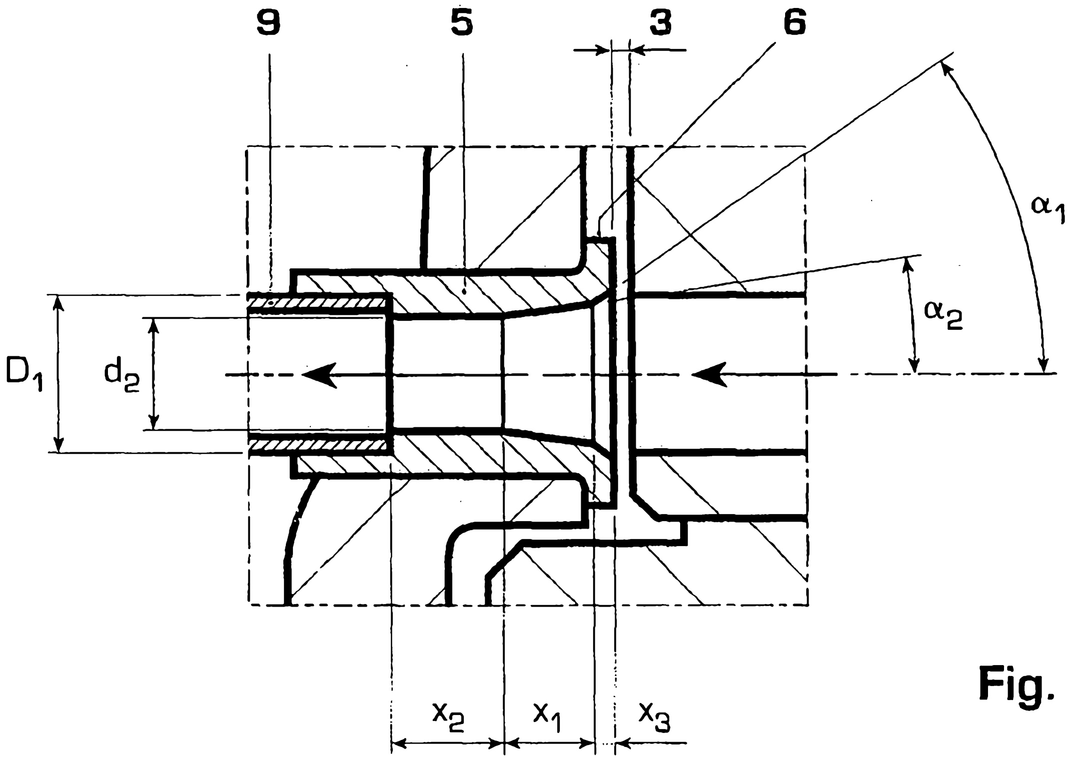

Fig. 3

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COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title:

Arrangement for sealing off a transition between cooling passages of two components of a turbomachine

The following statement is a full description of this invention including the best method of performing it known to us:-

Arrangement for sealing off a transition between cooling passages of two components of a turbomachine

Technical field

The present invention relates to an arrangement for sealing off a transition between a first passage for a cooling medium in a first component of a turbomachine and a second passage for the cooling medium in a second component of this turbomachine which may be, in particular, a gas turbine.

Prior art

When turbomachines, in particular gas turbines, are in operation, high temperatures occur which subject the individual component of the turbomachine to a severe load. With the development of gas turbines of ever higher performance, temperatures are reached which exceed even the melting point of the material of individual turbine components. To avoid damage to these components owing to the high operating temperatures, these have to be constantly cooled during operation. For this purpose, within the turbine components, cooling passages are provided, via which a cooling medium, as a rule sucked-in compressor air, is led past the locations to be cooled. In addition to convective cooling, in which cooling ducts run directly in the regions to be cooled, for example cooling ducts within a blade leaf, impact cooling, as it may be referred to, and film cooling are also adopted. In impact cooling, the cooling air impacts approximately perpendicularly onto the surface to be cooled, while, in film cooling, it brushes approximately tangentially over this surface and forms a thin cooling air film there. One example of components to be cooled is heat shield segments which protect the outer carrier structure of the gas turbine, for example the carrier for the turbine guide blades,

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from direct contact with hot gas.

For transporting the cooling medium within the turbine, sealed-off transitions for the passages of the cooling medium between the individual components of the turbine are required. However, different materials, from which the individual components are manufactured, and different temperatures, to which the components are exposed, lead to differences in the thermal expansion of these components. This makes it difficult to seal off a transition of the cooling passages between two adjacent components.

To solve this problem, it is known to employ, at the transition, flexible metallic seals, such as, for example, metallic bellows or sliding joints. Both types of seals can be prestressed via spring or pressure mechanisms. However, the usually very good sealing action of seal connections of this type require a relatively large number of small parts susceptible to fracture, of which these seal connections are composed. Precisely where turbine plants employed on a commercial scale are concerned, there is therefore a high risk of the destruction of a seal of this type, which may entail losses in the turbine power output and the risk of damage.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Presentation of the invention

According to the present invention, there is provided an arrangement for sealing off a transition between a first passage for a cooling medium in a first component of a turbomachine, in particular of a gas turbine, and a second passage for the cooling medium in a second component of the turbomachine, the two components being so designed and mutually arranged that, in a state of rest of the turbomachine, there is, at the transition between the two passages which, at operating temperatures of the turbine, closes as a result of the different thermal expansion of the two components comprising a through bush for making the connection from the first passage to the second passage wherein the through bush has a double-conical inner contour, in which an outer linear portion with a larger aperture angle follows an inner linear portion with a smaller aperture angle.

The present invention may advantageously provide an arrangement for sealing off a transition between the cooling passages of two adjacent components of the turbomachine, in particular a gas turbine, which, along with a smaller number of parts, makes it possible to seal off reliably during the operation of the turbomachine and avoid pressure losses even where the cooling passages are not exactly superposed.

The present arrangement for sealing off a transition between a first passage for a cooling medium in a first component of a turbomachine and a second passage for the cooling medium is a second component of the turbomachine, in particular a gas turbine, is distinguished in that the two components are so designed and mutually arranged or fixed that, in a state of rest of the turbomachine, there is, at the transition between the two passages, a gap which, at operating temperatures of the turbomachine, closes as a result of the different thermal expansion of the two components. Preferably, for this purpose, the first component consists of a material having a higher coefficient of thermal expansion than the second component.

Depending on the temperatures to which the two components are exposed, it is also possible, in this case, to produce both components from the same material, in which case the differences in thermal expansion are brought about by the different temperatures to which the two components are exposed when the machine is in operation. If, in the case of the same materials, this temperature difference is not sufficient for the intended sealing action, then the materials of the two components are selected, within the materials possible for the respective applications, so as to have a difference such that the desired sealing effect during operation occurs due to the different coefficients of thermal expansion of the materials. In the simplest embodiment, this seal therefore does not require any additional parts, since sealing off is achieved solely as a result of the different thermal expansion of the two components, owing to which the components are pressed against one another in the region of the transition.

The mutual arrangement of the two components is, of course, selected such that the two components can move with respect to one another in the region of the transition of the cooling passages as a result of the different thermal expansion. This is achieved, depending on the geometry of the two components, either by means of a common carrier, to which both components are fastened at a suitable location, or by means of a fastening of one component at a suitable location on the other component, as is illustrated in more detail further below with reference to an exemplary embodiment of the invention.

To compensate manufacturing tolerances in the production of the two components, there may also be provision for either the connection of the respective components to the carrier or the connection of one component to the other component to have some flexibility or elasticity. Similarly, one or both components may be shaped in such a way that they have, overall or in one or more portions, the required flexibility for compensating the manufacturing tolerances. This may be achieved, for example, by means of suitable curves in the shape of the components.

A further possibility for compensating manufacturing tolerances is to use a through bush at at least one exit or entrance of the two cooling passages. Preferably, a through bush of this type has a collar or rib which runs around between the two components and, when the two components are pressed against one another, is, where appropriate, deformed plastically between these and thereby reduces the occurrence of stresses in the components.

In a preferred refinement, this through bush has a double-conical inner contour with two linear conical regions adjoining one another. The outer conical region in this case has a larger aperture than the inner conical region and, in particular, also a larger maximum diameter than the exit or entry orifice of the cooling passage located opposite in each case. Pressure losses when the two cooling passages are not exactly superposed are thereby avoided.

The preferred use of the present arrangement relates to the transition between the cooling passage of a carrier of a gas turbine and the cooling passage of a heat shield segment fastened to it, that is also illustrated in the following exemplary embodiment.

Brief description of the drawings

The present arrangement is explained once again in more detail below with reference to an exemplary embodiment, in conjunction with the drawings in which:

fig. 1 shows an example of the sealing off of the transition between the cooling passages of a carrier structure of a gas turbine and a stator heat shield of the gas turbine;

fig. 2 shows an enlarged detail from the transition of fig. 1; and

fig. 3 shows an example of an embodiment of a through bush such as is used in the preceding figures.

Ways of implementing the invention

In fig. 1, an arrangement in a gas turbine can be seen, in which a stator heat shield 1 is fastened to a carrier structure 2. The fastening point is designated by the reference symbol 4 in this figure. The heat shield 1 serves for shielding the carrier 2 from the high temperatures occurring in the hot gas path of the gas turbine. The figure illustrated shows the tip of a blade leaf 7 of the turbine, said tip engaging in corresponding seals 8 on the heat shield 1. This region has to be cooled during operation, in order to reduce the high temperatures occurring at this location. For this purpose, cooling air, by means of which the tip of the turbine blade 7 and that region of the heat shield 1 which faces the latter are cooled, is delivered via corresponding passages 1a, 2a for the cooling medium.

For the reliable functioning of this cooling and to avoid major losses of cooling medium which may lead to a drop in the power output turbine, the transition between the two cooling passage 1a, 2a of the two components 1, 2 must be sealed off sufficiently effectively. In the present arrangement, this sealing off is achieved in that the fastening of the heat shield 1 to the carrier structure 2 and, where appropriate, the choice of the material of the heat shield 1 take place such that, taking into account the temperatures to which these two components are exposed during operation of the turbine, a higher thermal expansion of the heat shield 1 in the axial direction X is achieved than the axial expansion of the component 2 in this direction. A gap 3 between the two components 1, 2 in the region of the cooling passages 1a, 2a is thereby closed when the turbine is in operation.

This is made clear once again in the enlarged illustration of fig. 2 which indicates the gap 3 before the intended operating temperature of the turbine is reached. The shape of the heat shield 1 and the fastening point 4 are in this case selected such that, in the present example, the different thermal expansion acts precisely in this axial direction X in which the two cooling passages 1a, 2a have to be pressed against one another for sealing off.

For the compensation of manufacturing tolerances in the production of the components or of brief excess temperatures, it may be necessary to provide corresponding measures which avoid excessively high axial stresses in the two components 1 and 2 when the turbine is in operation. This may be carried out by means of an elastic fastening of the heat shield 1 to the component 2. The fastening at the fastening point 4 may in this case be designed, for example, as a spring connection. Furthermore, it is possible by a suitable configuration of the components, of the heat shield 1 in the present case, to achieve some elasticity of this heat shield. In the present example, this elasticity is achieved by means of the double curvature of the heat shield 1, which curvature is shown in cross section and can be seen in the left region of figure 1.

A further measure for the reduction of stresses is to use a through bush 5, such as that indicated in figures 1 and 2. This through bush 5 is soldered in at the entrance of the cooling passage 1a of the heat shield 1. Said through bush has an outer circumferential rib or collar 6 which, when the two components 1 and 2 are pressed against one another, lies between the two components in the region of the cooling passages 1a, 2a, as is evident in figure 2. If excessively high forces occur in the axial direction, this collar 6 is locally deformed plastically and thereby reduces the risk of excessively high axial stresses in the two components.

Fig. 3 shows an example of a more detailed embodiment of a through bush 5 of this type. This through bush has on its inner side, that is to say the side facing the cooling passage 1a of the component 1, a corresponding recess for receiving the cooling tube 9 running in the component 1. The outside diameter D1 of the cooling tube 9 in this case corresponds to the inside diameter of the corresponding recess. As can be seen in figure 3, a reduction in the inside diameter of the sleeve occurs in the axial direction of this through bush 5 and in the direction of the inlet of the cooling passage 2a of the component 2. A conical widening of the inner cross section occurs thereafter in a first region with a first aperture angle which is followed by a further conical widening with a second larger aperture angle. The two aperture angles are designated in the figure by $\alpha 2$ and $\alpha 1$ respectively. The axial length of the first linear conical region is designated by X1, that of the second conical region by X3 and that of the region of reduced cross section by X2. As can be seen from figure 3, the outermost diameter of the entrance to the through bush 5 is larger than the exit diameter of the cooling passage 2a of the adjacent component 2. As a result, and due to the conical design of the entry part of the through bush 5, pressure losses at the transition between the two components are reduced, should the two axes of the cooling passages not lie exactly one above the other in this region.

The through bush 5 may in this case be fastened mechanically to the heat shield 1 in different ways, for example by hard soldering, by welding, by means of an adhesive bond or by means of another suitable mechanical connection, for example a screw connection. Those dimensions of the individual regions which can be seen in figure 3 are listed below:

Angle:	$\alpha 1 = 1° \ldots 89°$, $\alpha 2 = 0.5° \ldots 70°$
Diameter:	D2 = 0.1*D1 ... D1
Axial lengths:	X1 = 0.3*D1 ... 2*D1

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X2 = 0.1*D1 ... D1

X3 = 0.01*D1 ... 0.9*D1

List of reference symbols

1	Heat shield
1a	Cooling passage in the heat shield
2	Carrier structure
2a	Cooling passage in the carrier structure
3	Gap
4	Fastening location
5	Through bush
6	Collar
7	Blade leaf
8	Blade leaf seal
9	Cooling tube

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An arrangement for sealing off a transition between a first passage for a cooling medium in a first component of a turbomachine, in particular of a gas turbine, and a second passage for the cooling medium in a second component of the turbomachine, the two components being so designed and mutually arranged that, in a state of rest of the turbomachine, there is, at the transition between the two passages which, at operating temperatures of the turbine, closes as a result of the different thermal expansion of the two components, comprising a through bush for making the connection from the first passage to the second passage wherein the through bush has a double-conical inner contour, in which an outer linear portion with a larger aperture angle follows an inner linear portion with a smaller aperture angle.

2. The arrangement as claimed in claim 1 wherein the first component consists of a material with a higher coefficient of the thermal expansion than the second component.

3. The arrangement as claimed in claim 1, wherein the first component is fixed to the second component.

4. The arrangement as claimed in claim 3, wherein the first component is fixed to the second component via a flexible or elastic connection.

5. The arrangement as claimed in claim 1, wherein the first component and/or the second component are/is shaped in such a way as to have flexible or elastic properties.

6. The arrangement as claimed in any preceding claim, wherein the through bush has a collar, via which the connection is sealed off.

7. The arrangement as claimed in one of claims 1 to 6, wherein the first component is a heat shield and the second component is a carrier structure of a gas turbine.

8. An arrangement for sealing off a transition between a first passage and a second passage substantially as hereinbefore described with reference to the accompanying drawings.

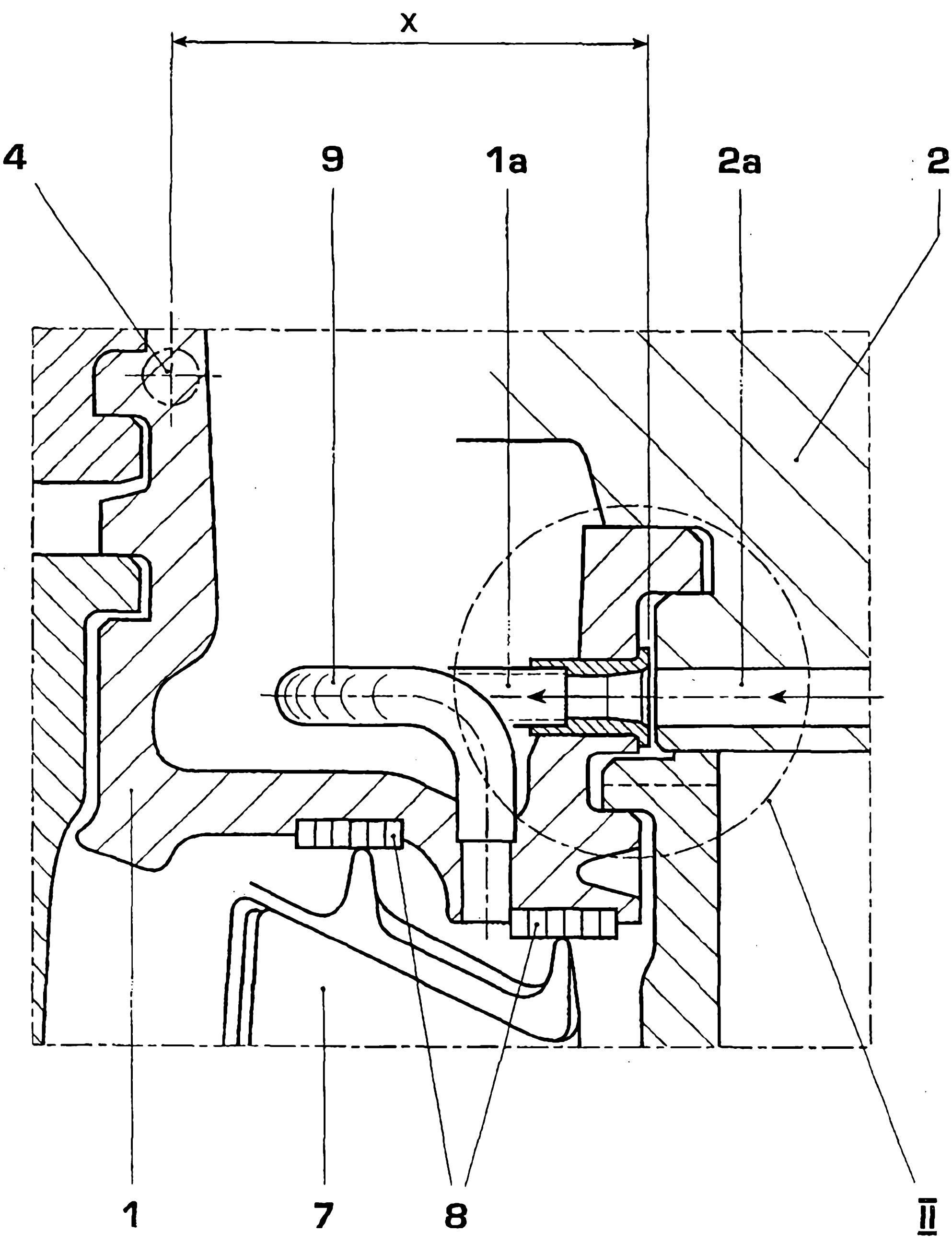

Fig. 1

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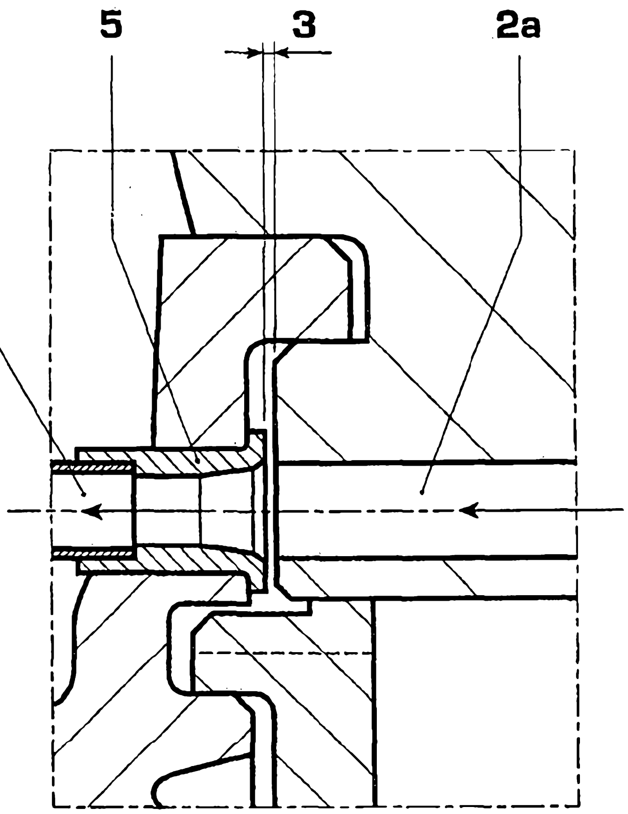

Fig. 2

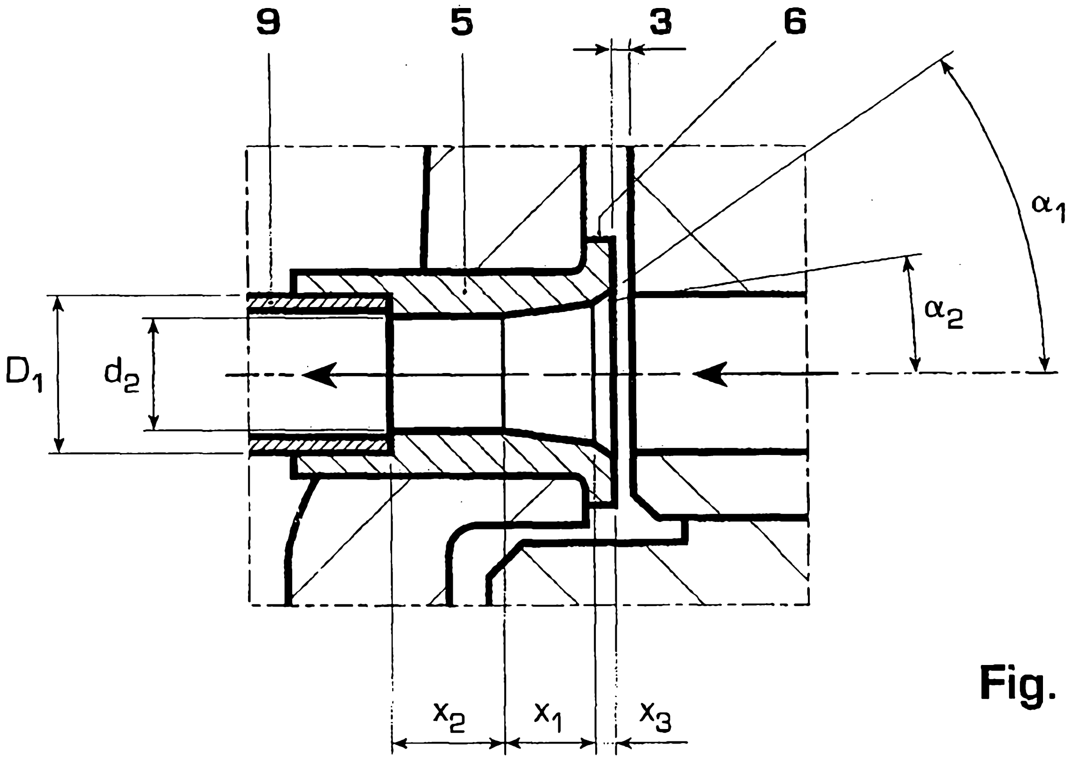

Fig. 3