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⑤④ **A method of rolling transverse ribbed tubes and a set of tools for rolling transverse ribbed tubes.**

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GB-A-1 084 142
PL-A- 79 817
US-A-3 683 656
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Description

The subject matter of the invention is a method of rolling transverse ribbed bimetallic tubes and a set of tools for rolling laterally ribbed bimetallic tubes, especially ribs having a small thickness, finding application in heat exchangers.

Rolling the ribs on tubes consists in pressing down rotationally driven multi-disk tools onto the surface of the tube. Usually a set of three tools is used, comprising sets of disks realizing several stages of producing the rib, which are chasing the tube, drawing the rib and forming the shape of the rib.

In the case of producing bimetallic tubes the external ribbed tube is additionally pressed down onto the internal core tube in order to provide for good adhesion of tubes and an improvement of thermal conduction.

In a known method of rolling the ribs the external tube is pressed down onto the internal tube in the last stage of forming the shape of the ribs. In this method described for example in the SU—A—217 344 (see corresponding document GB—A—1 084 142), all tools are provided with the last—in the direction of rolling—disks of an increased diameter, causing the formation of additional radial forces which cause pressing down the tubes. It has been observed, however, that by friction forces and the increase of the perimeter of the rib being thinned, radial forces of the opposite direction appear therein, which cause a tearing off of the material of the external tube from the internal tube and, in consequence, formation of a sub-rib draw-in, and thus a gap between the tubes.

Another tool for rolling ribs on bimetallic tubes is known from the PL—A—79817. In the said tool, in order to eliminate the inter-tube gap a set of unsymmetrical plano-convergent disks is additionally applied. Such a design of the tool enables in the first stage the formation of a low rib, and then intensive bilateral thinning thereof with simultaneous increasing of the height thereof. The thinning process creates the tendency to increase the diameter of the perimeter of the rib, while the radial flow of metal in the region adjacent to the tops of the initial disks leads to the formation of draw-in directly under the rib. The set of unsymmetrical disks performs the work of causing the previously formed draw-in to be shifted to the region of the direct action of the last burnishing disk.

Realization of the above presented method of pressing down the external tube onto the internal tube by means of several unsymmetrical disks causes in effect considerable loads along the axis of the tool, which hinder the practical utilization of the said solution in rolling ribbed tubes of very small pitches and small thicknesses of ribs.

In a method known from the PL—A—113 419 (see corresponding document US—A—4 153 982) the ribs are rolled by introducing after initially chasing the tube, drawing and forming the rib, additional operations consisting in annealing and

then several-times-repeated contraflexure of ribs in relation to the axis perpendicular to the direction of rolling, and pressing down the external tube of the core tube during contraflexure. The tool for realization of the said method comprises, apart from the known sections of initial disks, a supporting disk increasing the rigidity of the tool and initially deflecting the rib, a section of contraflexure disks at a certain distance from this disk, inside which there are burnishing disks, and also, as the last one, the disk straightening the rib. By the method and the tool according to the said invention it is possible to carry out industrial rolling of ribs of a relatively large average thickness not smaller than 0.45 mm and an average slenderness ratio of up to 1:40. By further thinning the rib a significant influence on the formation of the rib is brought about by certain, included in production standards for pipes, defects of the surface of smooth-charge tubes. These defects cause local cracks of the rib and in the result lead to destruction of the rib band in the stage of multiple contraflexure.

According to the present invention a method of rolling transverse ribbed bimetallic tubes comprising an external tube and a core tube by means of rotary tools composed of roll-shaped disks comprises:

- initially chasing the external tube to draw and form a rib;
- deflecting each formed rib non-linearly in the direction of rolling;
- then pressing down the external tube onto the core tube;
- the deflection of the rib and the pressing down of the external tube onto the core tube being carried out during one revolution of the tube; and
- thereafter straightening the rib.

In the presented method of rolling, the rib is deflected unilaterally non-linearly preferably parabolically. Because of this the deflection of the rib at its base is negligible and this protects it against destruction even in the case of local cracks in the rib caused by defects of the surface of the tube being rolled. Moreover, by pressing down the external tube onto the core tube (internal tube) immediately after deflecting the rib, both steps being performed during one revolution of the tube, eliminates the necessity of conducting the rib through subsequent stages of the treatment thereof, thereby reducing the number of contraflexures harmful to very thin ribs. By this method it is possible to roll industrially for example on aluminium tubes ribs of the average thickness of from 0.3 to 0.4 mm.

The essence of the set of tools for rolling transverse ribbed bimetallic tubes according to the invention consists in that the set is composed of three tools, whereof each one comprises roll-shaped disks forming the section for chasing the tube, the section for drawing the rib and the section for forming the shape of the rib, each followed by a supporting disk and a straightening disk, said disks being axially aligned whereby each of the supporting disks has a profile with a

first upstream lateral face corresponding to the profile of the last forming disk, and a second lateral face, the second lateral face having a non-linear profile. The outer diameter of the supporting disk furthest downstream is greater by from 0.1 to 0.8 mm than the outer diameter of the other supporting disks. The non-linear profile is preferably a concave parabolic profile. The concave profile of the second part of supporting disks is preferably a segment of a parabola, included within the quantity range x from 0 to 6 mm in the equation

$$y = Ax^2 + Bx + C,$$

where axis x is the axis of the tool, axis y lies in the plane of the base of the supporting disk, coefficient $A > 0$, coefficient $B \geq 0$, and coefficient C corresponds to the quantity of the radius of the base of the supporting disk.

The set of tools for rolling is characterized by great rigidity and is simple in design. By increasing the outer diameter of the last supporting disk, this disk being the least loaded with forces along the axis, it performs the additional work of pressing down the external tube onto the core tube. It has appeared that such pressing down with one supporting disk after previously deflecting the rib enables the obtaining of bimetallic tubes practically without inter-tube gap, of correct parameters of thermal conduction. The parabolic shape of supporting disks is close to the optimum shape of the section of the supporting disk of constant bending strength, said bending being caused by rolling forces along the axis.

The invention will now be presented in more detail in the accompanying drawings, which show:

Fig. 1 the section through the set of tools in the plane perpendicular to the axis of rolling,

Fig. 2 the axial section through one of the first—in the direction of rolling—tools,

Fig. 3 the axial section of the last—in the direction of rolling—tool, and

Fig. 4 the design of the supporting disk.

The set of tools consists of three tools 1, 2 and 3 situated every 120° round the external tube 4, inside which a core tube 5 is placed. The tools are composed of roll-shaped disks 6 forming sections for chasing the tube, for drawing the rib and for forming the shape thereof, supporting disks 7 and 8 and straightening disks 9. Supporting disk 7 and 8 have a profile with a first upstream lateral face corresponding to the profile of the last forming disk, and a second lateral face that is parabolic. The parabola satisfies the dependence

$$y = Ax^2 + Bx + C,$$

where x is the axial distance of points of the profile of the disk from the base 10 of the disk, C is the radius of the base 10 of the supporting disk, y is the radial distance of points of the profile of the supporting disk, and $A > 0$ and $B \geq 0$. The selection of quantities A and B depends on the geometry of

the ribs and the diameter of the charge tube, namely, the external tube 4. The external tube 4 together with the core tube 5 after passing through the zone of the action of the roll-shaped disks 6 moves with rotary-translatory motion (helically) to the zone of the action of supporting disks 7 and 8. Supporting disks 7 situated in the first tools 1 and 2 in relation to the direction of rolling deflect the rib 11 parabolically. The supporting disk 8 situated on the third, the furthest downstream tool 3, has an outer diameter larger by from 0.1 to 0.8 mm than the outer diameter of the first supporting disks 7. The increased diameter of the disk 8 causes the external tube 4 to be pressed down onto the core tube 5. The rib 11 is straightened in the last stage of rolling by the straightening disk 9.

Claims

1. A method of rolling transverse ribbed bimetallic tubes comprising an external tube (4) and a core tube (5) by means of rotary tools (1, 2, 3) composed of roll-shaped disks (6) said method comprising:

initially chasing the external tube (4) to draw and form a rib;

deflecting each formed rib non-linearly in the direction of rolling;

then pressing down the external tube onto the core tube;

the deflection of the rib and the pressing down of the external tube onto the core tube being carried out during one revolution of the tube; and thereafter straightening the rib.

2. A method as claimed in Claim 1 and wherein the non-linear deflection is parabolic.

3. A set of tools for rolling transverse ribbed bimetallic tubes, composed of three tools (1, 2, 3) whereof each one comprises roll-shaped disks (6) forming the section for chasing the tube (4), the section for drawing the rib (11) and the section for forming the shape of the rib (11), each followed by a supporting disk (7, 8) and a straightening disk (9), said disks (6, 7, 8, 9) being axially aligned whereby each of the supporting disks (7, 8) has a profile with a first upstream lateral face corresponding to the profile of the last forming disk and a second lateral face, characterized in that the second lateral face has a non-linear profile, and in that the outer diameter of the supporting disk (8) furthest downstream is greater by from 0.1 to 0.8 mm than the outer diameter of the other supporting disks (7).

4. A set of tools as claimed in Claim 3 and wherein the non-linear profile is a concave parabolic profile.

5. A set of tools as claimed in Claim 4 and wherein the profile of said second lateral face is a segment of a parabola of the equation

$$y = Ax^2 + Bx + C,$$

included within the quantity range x from 0 to 6 mm, where axis x is the axis of the tool, axis y lies

in the plane of the base of the supporting disk, coefficient $A > 0$, coefficient $B \geq 0$, and coefficient C corresponds to the quantity of the radius of the base of the supporting disk.

Patentansprüche

1. Verfahren zum Walzen von quergerippten, ein Außenrohr (4) und ein Kernrohr (5) umfassenden Bimetallrohren mittels sich drehender Werkzeuge (1, 2, 3), die sich aus walzenförmigen Scheiben (6) zusammensetzen, wobei das Verfahren umfaßt:

—anfängliches Drücken des Außenrohres (4) zum Ziehen und Formen einer Rippe;
—Abbiegen jeder geformten Rippe nichtlinear in Walzrichtung;
—dann Herunterdrücken des Außenrohres auf das Kernrohr;

—Durchführend des Abbiegens der Rippe und des Herunterdrückens des Außenrohres auf das Kernrohr während einer Umdrehung des Rohres;
—und danach Geraderichten der Rippe.

2. Verfahren nach Anspruch 1, gemäß dem das nichtlineare Abbiegen parabolisch erfolgt.

3. Satz von Werkzeugen zum Walzen quergegerippter Bimetallrohre, der sich aus drei Werkzeugen (1, 2, 3) zusammensetzt, von denen jedes walzenförmige Schreiben (6) umfaßt, die den Abschnitt zum Drücken des Rohres (4), den Abschnitt zum Ziehen der Rippe (11) und den Abschnitt zum Ausbilden der Form der Rippe (11) umfassen, wobei jede dieser Scheiben gefolgt ist von einer Stützscheibe (7, 8) zum Abbiegen der Rippe und einer Geraderichtscheibe (9), welche Scheiben (6, 7, 8, 9) axial ausgerichtet sind, wobei jede Stützscheibe (7, 8) ein Profil mit einer ersten stromaufliegenden Seitenfläche hat, die dem Profil der letzten Formscheibe entspricht und eine zweite Seitenfläche, dadurch gekennzeichnet, daß die zweite Seitenfläche ein nichtlineares Profil hat, und daß der Außendurchmesser der Stützscheibe (8) weiter stromab im Bereich von 0,1 bis 0,8 mm größer ist als der Außendurchmesser der anderen Stützscheibe (7).

4. Satz von Werkzeugen nach Anspruch 1, bei dem das nichtlineare Profil ein konkaves parabolisches Profil ist.

5. Satz von Werkzeugen nach Anspruch 4, bei dem das Profil der genannten zweiten Seitenfläche ein Segment einer Parabel der Gleichung

$$y = Ax^2 + Bx + C$$

ist, bei der x von 0 bis 6 mm beträgt, die x -Achse die Werkzeugachse ist, die y -Achse in der Ebene der Basis der Stützscheibe liegt, der Koeffizient $A > 0$, der Koeffizient $B \geq 0$ ist und der Koeffizient C

der Größe des Radius der Basis der Stützscheibe entspricht.

Revendications

1. Procédé de laminage de tubes bimétalliques à nervures transversales comportant un tube extérieur (4) et un tube intérieur (5), au moyen d'outils rotatifs (1, 2, 3) composés de disques (6) formant un rouleau, ledit procédé comportant les étapes consistant à:

commencer par repousser le tube extérieur (4) afin de l'étirer et de former une nervure;
courber de façon non linéaire, chaque nervure formée dans la direction de laminage;
ensuite pousser le tube extérieur contre le tube intérieur;

la courbure de la nervure et la poussée du tube extérieure contre le tube intérieur étant effectuées pendant une révolution du tube;
et ensuite redresser les nervures.

2. Procédé selon la revendication 1 dans lequel la courbure non linéaire est parabolique.

3. Outillage pour laminer des tubes bimétalliques à nervures transversales, composé de trois outils (1, 2, 3) dont chacun comporte des disques (6), formant un rouleau, constituant la section pour le repoussage du tube (4), la section pour l'étirage de la nervure (11) et la section pour le formage de la nervure (11), chacune suivie par un disque de support (7, 8) et un disque de maintien (9), lesdits disques (6, 7, 8, 9) étant alignés axialement et par lesquels chacun des disques de support (7, 8) comporte un profil avec une première face latérale amont correspondant au profil du dernier disque de formage et une seconde face latérale, caractérisé en ce que la seconde face latérale présente un profil non linéaire, et en ce que le diamètre extérieur du disque de support (8), le plus aval est supérieur de 0,1 à 0,8 mm au diamètre extérieur de l'autre disque de support (7).

4. Outillage selon la revendication 3, dans lequel le profil non linéaire est un profil parabolique concave.

5. Outillage selon la revendication 4, dans lequel le profil de ladite seconde face latérale est un segment de parabole d'équation

$$y = Ax^2 + Bx + C,$$

x étant une valeur dans la gamme de 0 à 6 mm, l'axe des x étant l'axe de l'outil, l'axe des y se trouvant dans le plan de la base du disque de support, le coefficient $A > 0$, le coefficient $B \geq 0$, et le coefficient C correspondant à la valeur du rayon de la base du disque de support.

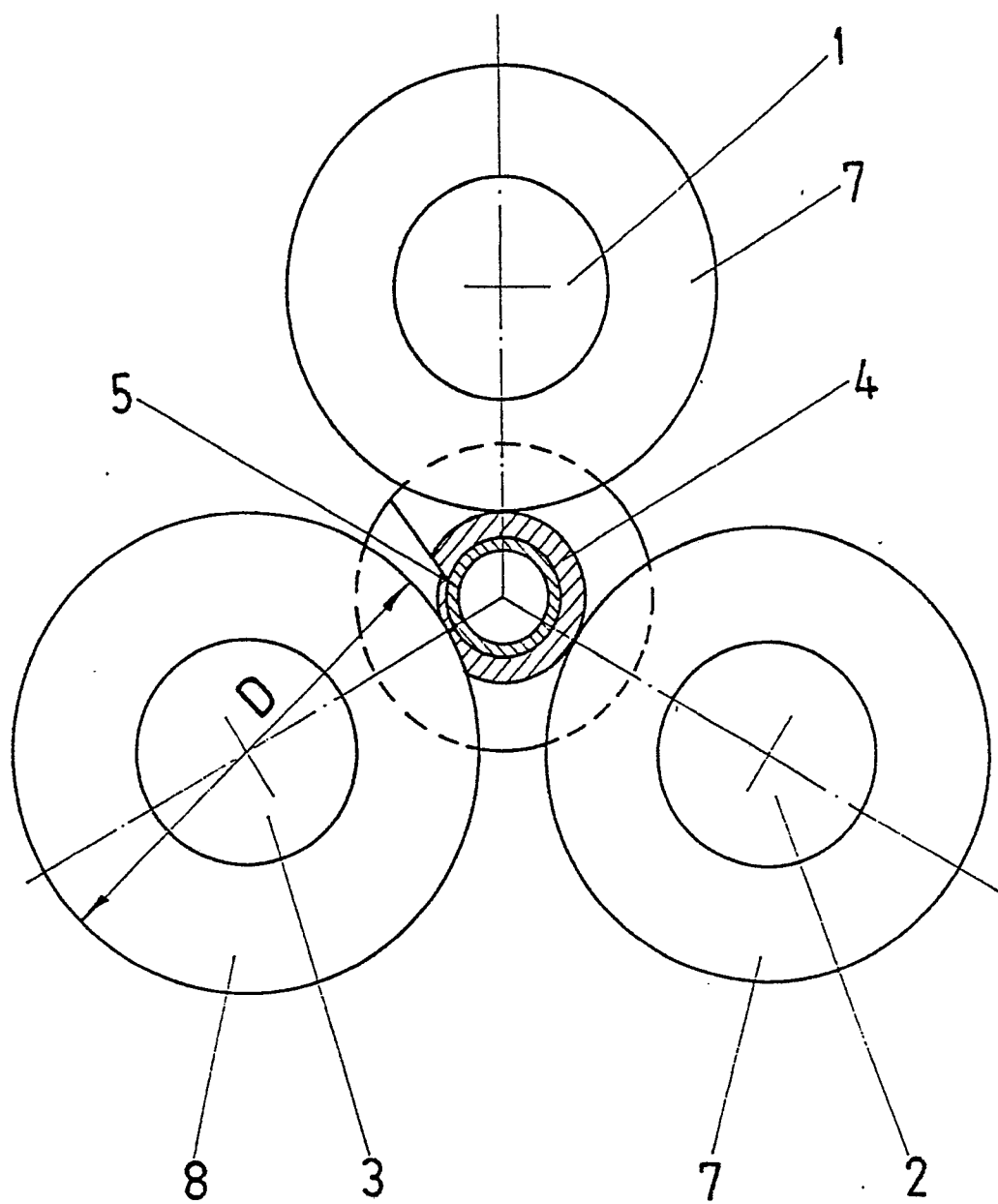


Fig. 1

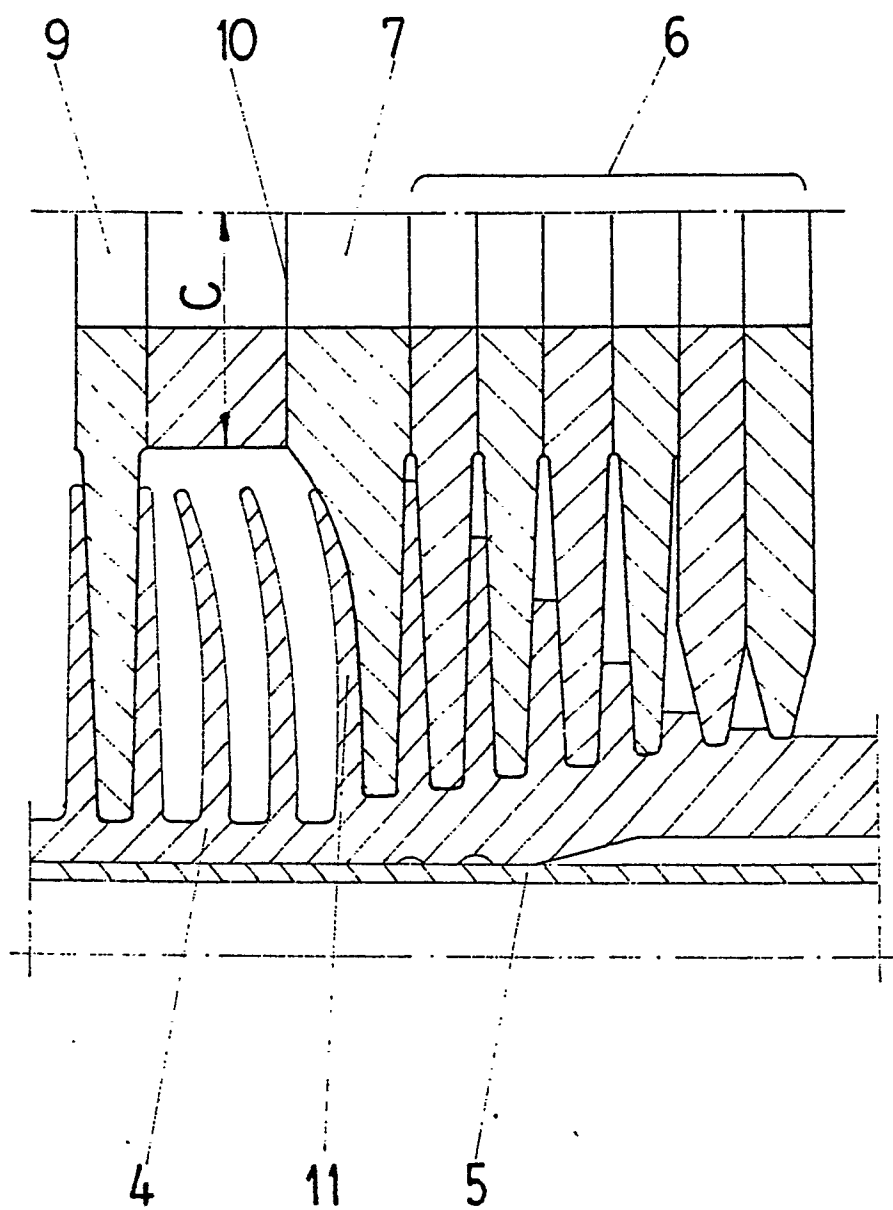


Fig. 2

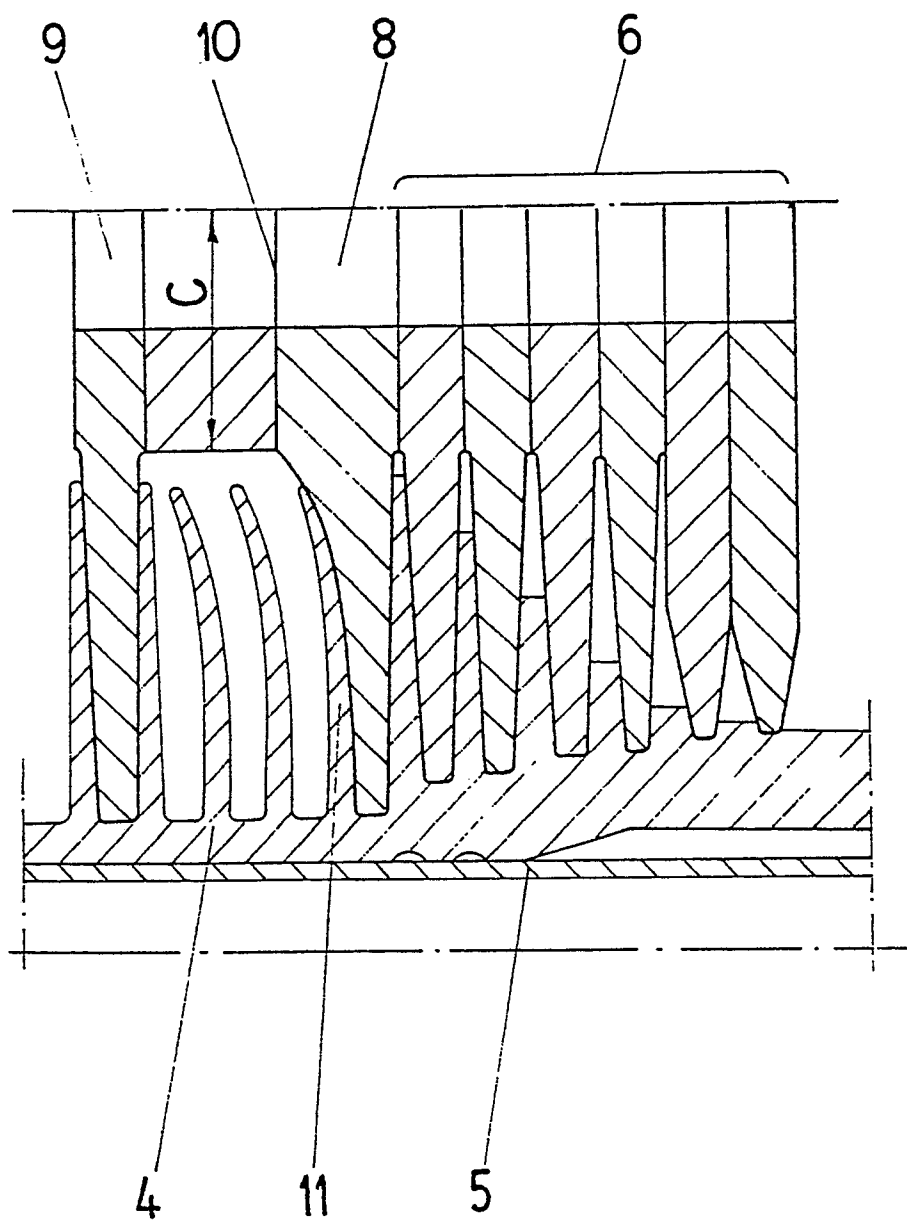


Fig. 3

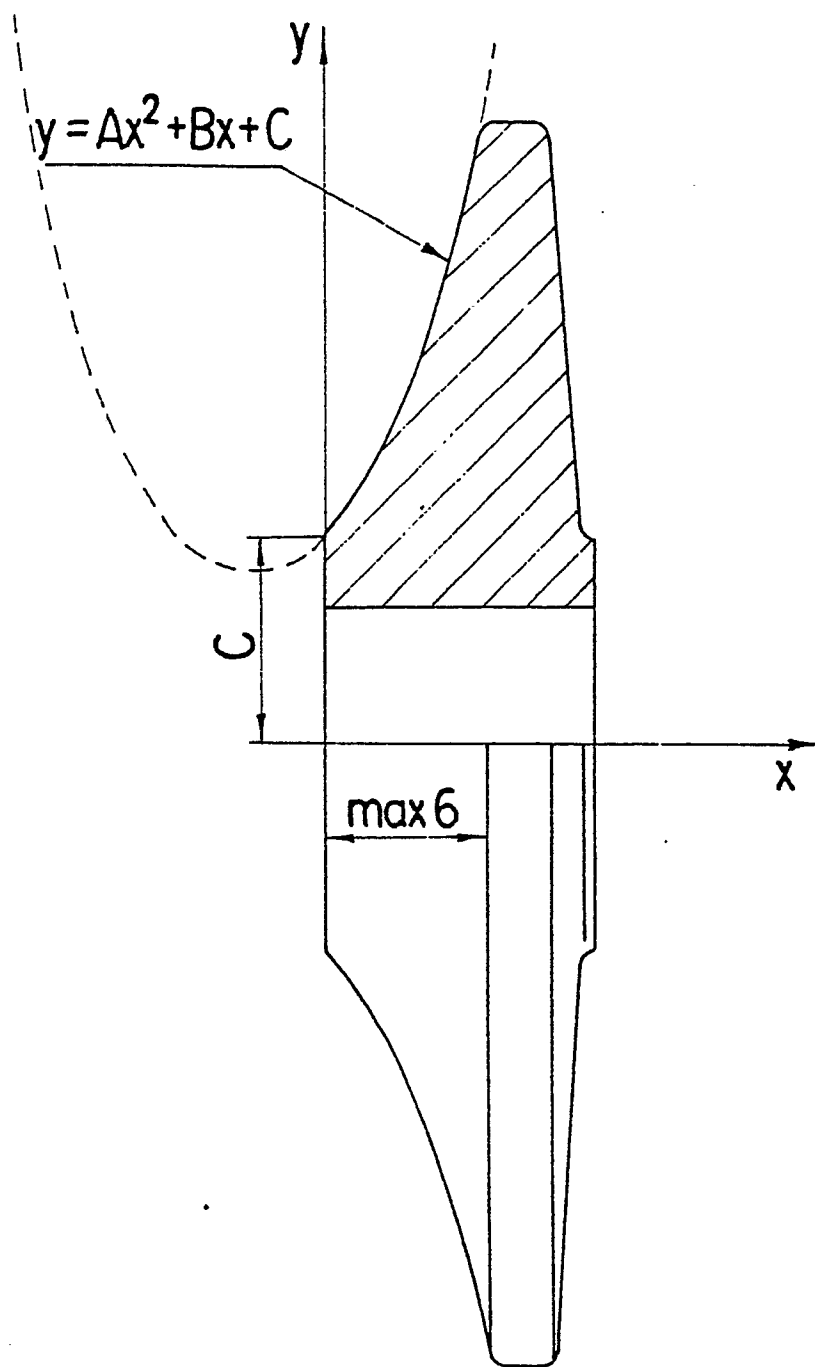


Fig. 4