(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 121 252**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **84103535.5**

(51) Int. Cl.³: **B 21 C 37/20**

(22) Date of filing: **30.03.84**

(30) Priority: **31.03.83 PL 241324**

(43) Date of publication of application:
10.10.84 Bulletin 84/41

(84) Designated Contracting States:
DE FR GB IT NL SE

(71) Applicant: **Zakłady Urzadzen Chemicznych METALCHEM**

47-225 Kedzierzyn-Kozle(PL)

(72) Inventor: **Przybyla, Janusz**
ul Sosnowa 1
PL-42-520 Zabkowice Bedzinskie(PL)

(72) Inventor: **Gozdziewicz, Zygmunt**
ul. Harcerska 3/6
PL-47-220 Kedzierzyn-Kozle(PL)

(72) Inventor: **Szal, Andrzej**
ul. Niemcewicza 3a/3
PL-47-220 Kedzierzyn-Kozle(PL)

(72) Inventor: **Zub, Ryszard**
ul. Leszka Bialego 4/F/4
PL-47-220 Kedzierzyn-Kozle(PL)

(72) Inventor: **Maczynski, Andrzej**
ul. Andromedy 4/6
PL-44-100 Gliwice(PL)

(74) Representative: **Füchsle, Klaus, Dipl.-Ing. et al,**
Hoffmann . Eitle & Partner Patentanwälte
Arabellastrasse 4
D-8000 München 81(DE)

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

(57) A method of rolling transverse ribbed tubes consists in that the rib (11) after forming is deflected in the direction of rolling parabolically, the external tube (4) is pressed down to the core tube (5), and deflecting the rib (11) and pressing down the external tube (4) to the core tube (5) is carried out during one revolution of the tube, and afterwards the rib is straightened.

A set of tools for rolling transverse ribbed tubes has three tools provided with roll-formed disks (6, 7, 8, 9), supporting and straightening, whereby the second – in the direction of rolling – part of the profile of supporting disks is concave, preferably parabolically, and the last – in the direction of rolling – tool is provided with a supporting disk of the outer diameter bigger by from 0.1 to 0.8 mm from the outer diameter of the other supporting disks.

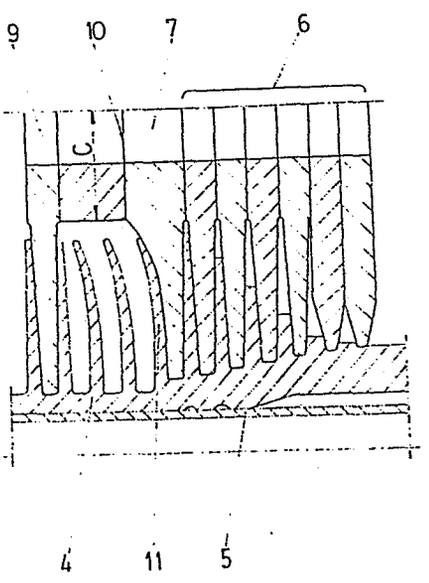

Fig. 2

EP 0 121 252 A2

40 044

Zaklady Urzadzen Chemicznych METALCHEM

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

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 the application in heat exchangers.

Rolling the ribs on tubes consists in pressing down rotationally driven multi-disk tools to 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 additionally the external ribbed tube is pressed down to 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 to the internal tube in the last stage of forming the shape of ribs. In this method described for example in the USSR patent specification no. 217344 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 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 tearing off the material of the external tube from the internal tube end, 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 Polish patent specification no. 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 the height thereof. The thinning process creates the tendency to increase the perimeter of the rib, what at limiting the radial flow of metal in the region adjacent to the tops of initial disks leads to the formation of the draw-in directly under the rib. The set of unsymmetrical disks performs the work causing that the previously formed draw-in is 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 to the internal tube by means of several unsymmetrical disks causes in the 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 Polish patent specification no. 113419 the ribs are rolled by introducing after initial 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 big average thickness not smaller then 0.45 mm and an average slenderness ratio of up to 1 : 40. At further thinning the rib a significant influence on the formation of the rib is gained 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.

The essence of the method according to the invention of rolling transverse ribbed bimetallic tubes with rotational tools with roll-formed disks, in which the external tube is initially chased, the rib is drawn and the shape thereof is formed, and immediately after forming the rib the external tube is pressed down to the core tube and - in the final stage of rolling - the rib is straightened, consists in that the rib after forming is deflected in

the direction of rolling non-linearly, preferably parabolically, and then the external tube is pressed down to the core tube, whereby deflection of the rib and pressing down the external tube to the core tube is carried out during one revolution of the tube and afterwards the rib is straightened.

In the presented method of rolling the rib is deflected unilaterally non-linearly - parabolically, due to what deflection of the rib at the base thereof is negligible, what protects it against destruction even in the case of local cracks of the rib caused by defects of the surface of the tube being rolled. Moreover, pressing down the external tube to the core tube - internal tube realized immediately after deflecting the rib during one revolution of the tube eliminates the necessity of conducting the rib through subsequent stages of the treatment thereof, reducing the number of contraflexures harmful to very thin ribs. By this method it is possible to roll industrially for example on aluminium tubes the 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 composed of three tools, whereof each one comprises roll-formed disks forming the section of chasing the tube, the section of drawing the rib and the section of forming the shape of the rib, and a supporting disk and a straightening disk, has supporting disks with the profile of the first - in the direction of rolling - part corresponding to the profile of the last forming disk, and the second part of a concave profile. The outer diameter of the last - in the direction

of rolling - supporting disk is bigger by from 0.1 to 0.8 mm from the outer diameter of the other supporting disks. 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 big rigidity and is simple in design. By increasing the outer diameter of the last supporting disk - this disk the least loeaded with forces along the axis performs the additional work of pressing down the external tube to the core tube. It has appeared that such pressing down with one supporting disk after previous deflecting the rib enables obtaining bimetallic tubes practically without the 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 be now presented in more detail in drawings, in 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^{o} round the external tube 4, inside which a core tube 5 is placed. Tools are composed of known roll-formed disks 6 forming sections of chasing the tube, of drawing the rib and of forming the shape thereof, supporting disks 7 and 8 and straightening disks 9. Supporting disks 7 and 8 have the profile in the first - in the direction of rolling - part corresponding to the profile of the last forming disk, and in the second part - 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 $B \geqslant 0$. The selection of quantities A and B depends on the geometry of ribs and the diameter of the charge tube - the external tube 4. The external tube 4 together with the core tube 5 after passing through the zone of the action of roll-formed disks 6 displaces with rotary-translatory motion (helically) to the zone of the action of supporting disks 7 and 8. Supporting disks 7 situated in the first - in the direction of rolling - tools 1 and 2 deflect parabolically the rib 11. The supporting disk 8 situated on the third, the last tool 3 has the outer diameter bigger by from 0.1 to 0.8 mm from the outer diameter of the first supporting disks 7. Increasing the diameter causes pressing down the external tube 4 to the core tube 5. The rib 11 is straightened in the last stage of rolling by the straightening disk 9.

PATENT CLAIMS

1. A method of rolling transverse ribbed bimetallic tubes with rotary tools with roll-formed disks, in which the external tube is initially chased, the rib is drawn and its shape is formed, and immediately after forming the rib the external tube is pressed down to the core tube and in the final stage of rolling the rib is straightened, characterized in that after forming the rib is deflected in the direction of rolling parabolically and then the external tube is pressed down to the core tube, and thereafter deflecting the rib and pressing down the external tube to the core tube is carried out during one revolution of the tube, and thereafter the rib is straightened.

2. A set of tools for rolling rransverse ribbed bi-metallic tubes, composed of three tools whereof each one comprises roll-formed disks (6) forming the section of chasing the tube (4), the section of drawing the rib (11) and the section of forming the shape of the rib (11), and a supporting disk (7, 8) and a straightening disk (9), characterized in that supporting disks (7, 8) have profiles in the first - in the direction of rolling - part corresponding to the profile of the last forming disk, and in the second part of the concave profile, and in that the outer diamter of the last - in the direction of rolling - supporting disk is bigger by from 0.1 to 0.8 mm from the outer diameter of the other supporting disks.

3. A set of tools for rolling laterally ribbed bimetallic tubes according to claim 2, characterized in that the profile of the second part of supporting disks (9) 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.

0121252

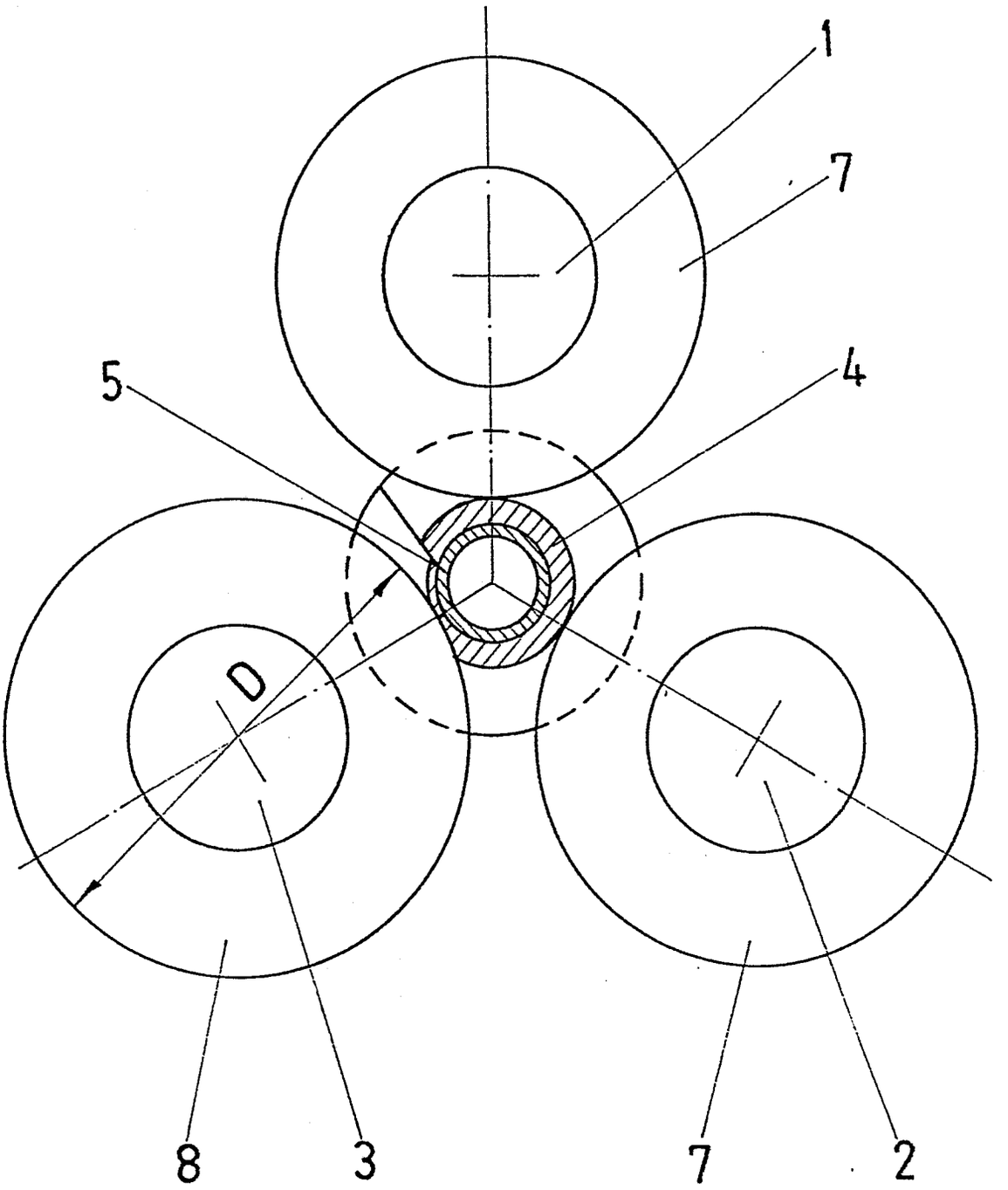

Fig. 1

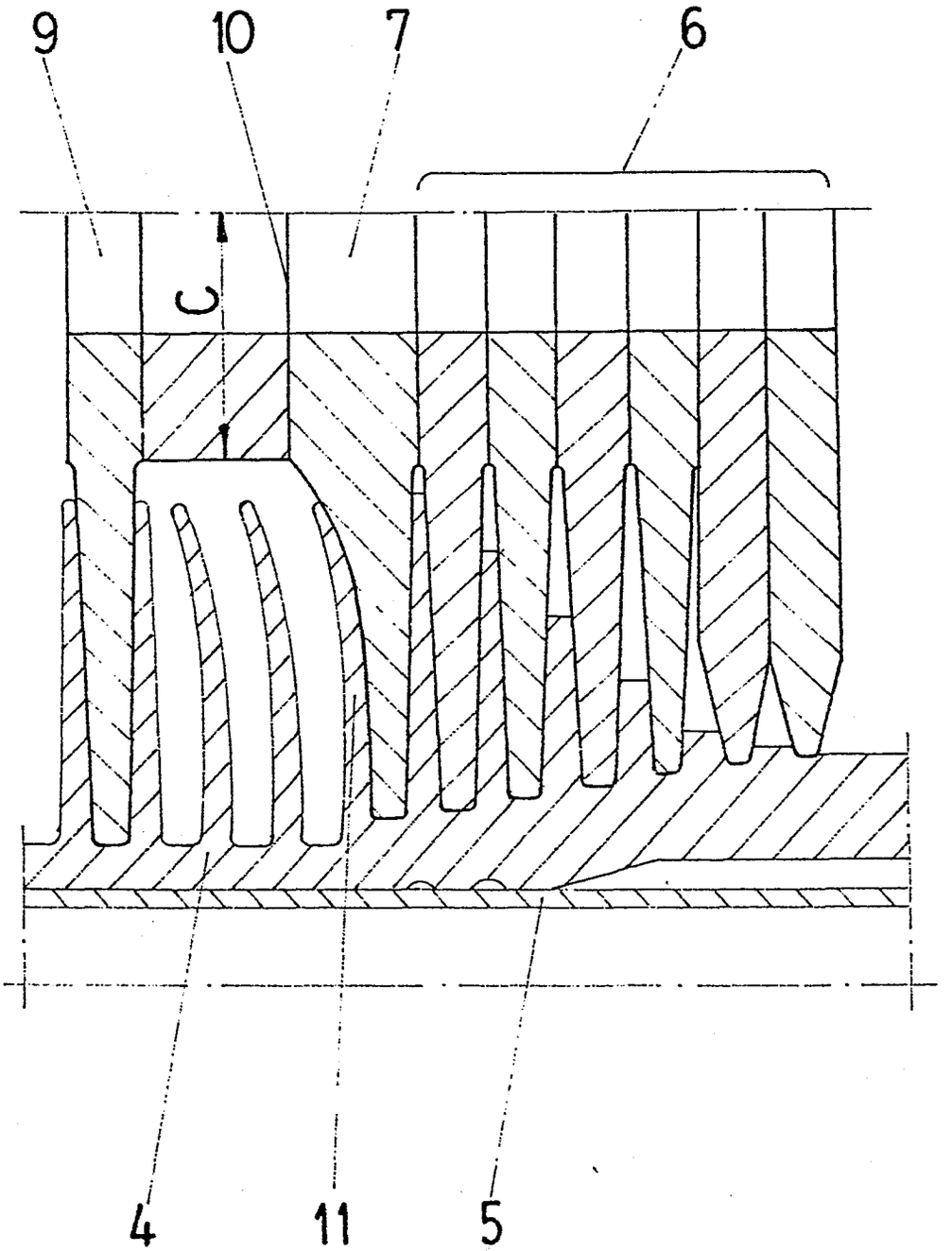

Fig. 2

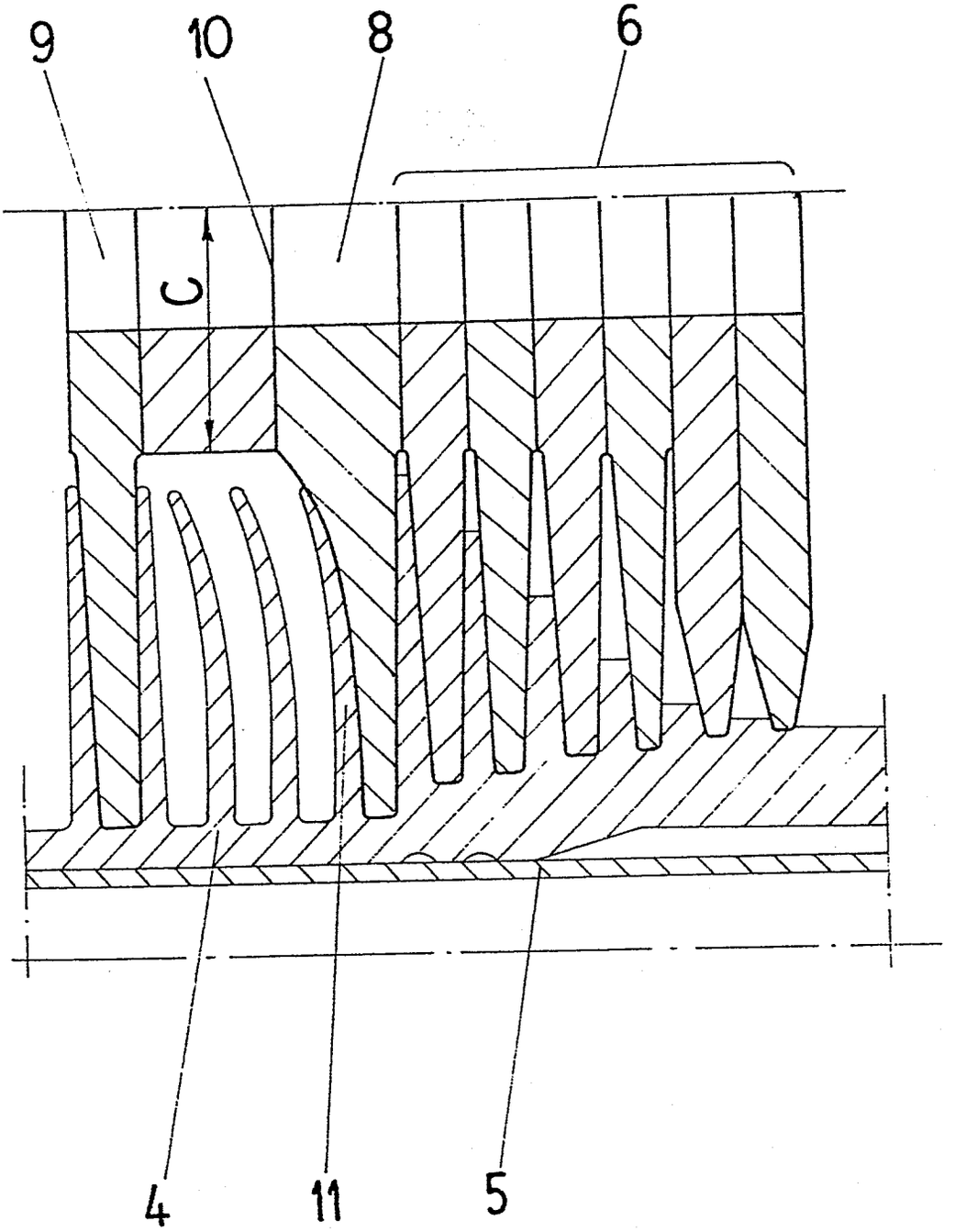

Fig. 3

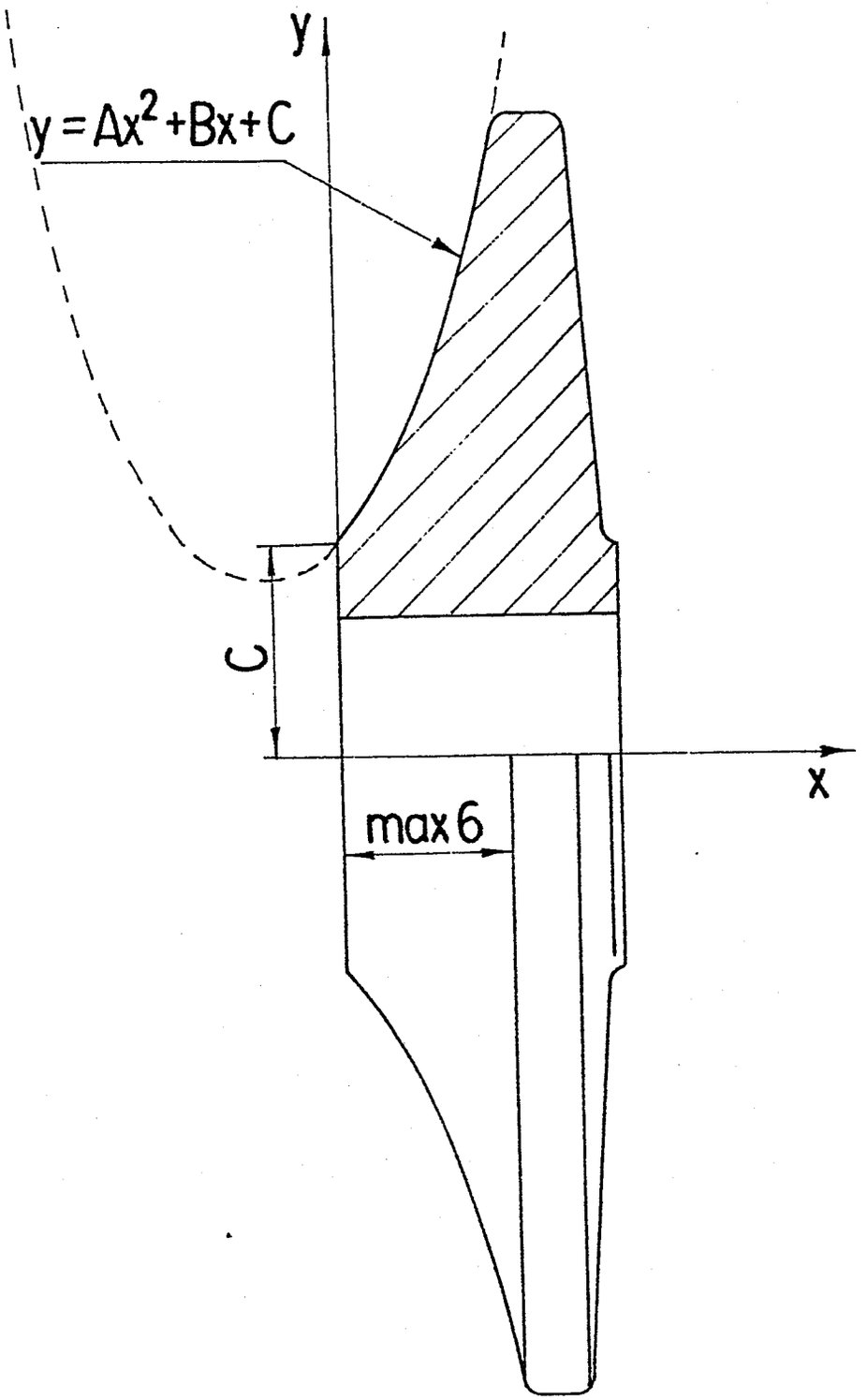

Fig. 4