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(54) **Method and apparatus for bending sections and the like according to programmable radii of curvature**

(57) The method for bending sections and the like according to programmable radii of curvature is applied in an apparatus that includes a bending assembly (1) provided with a central abutment tool (3) and with an eccentric section bending post (4). The method entails actuating the discontinuous advancement of the section (2) to be bent in abutment with the central tool (3) in step

with alternating angular strokes of the eccentric bending post (4), so as to make the section (2) follow the envelope of a virtual mandrel (5) whose radius of curvature can be programmed by virtue of an electronic processing means that is suitable to control or indicate the advancement of the section (2) to be bent and the angular strokes of the eccentric bending post (4).

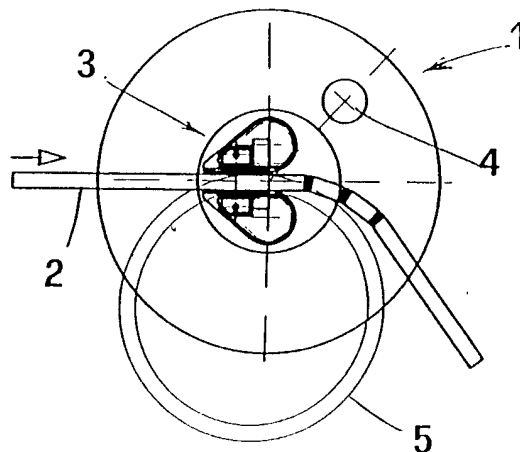


FIG.11

Description

[0001] The present invention relates to a method for bending sections and the like, particularly iron rods for reinforced concrete, according to programmable radii of curvature that are not limited by the dimensions of the tools used, and to an apparatus for performing the method.

[0002] It is known that shaped rods, used for example to provide reinforced-concrete frames, are generally obtained by means of an apparatus that subjects the iron rod, in coils or bars, to a plurality of bending operations. More particularly, bending machines are currently known which allow to provide a large number of different products, such as open or closed stirrups, polygonal bent shapes, and the like.

[0003] That type of apparatus usually has at least one bending assembly with a bending head provided with a central bending tool and with an eccentric bending post.

[0004] According to a prior art system, illustrated in Figure 1, the central bending tool, generally designated by the reference numeral 3, is constituted by two bending forms 6 that also act as abutments during the bending step performed by the eccentric post 4.

[0005] In a second prior art system, shown in Figure 2, the central bending tool 3 is constituted by a conventional cylindrical central mandrel that cooperates with a separate abutment 7 and with the eccentric bending post 4.

[0006] A specific problem, that occurs in the field being considered, is constituted by the need to bend the iron rods according to different radii of curvature depending on the use for which they are meant. For some applications, the statutory provisions currently in force require bending the rods according to relatively wide radii of curvature, in order to provide better grip with the concrete. Recent studies in this field have in fact found a problem of excessive specific pressure in the concrete which entails, in particular conditions, the collapse of the material in the regions below the curves of the rods.

[0007] Presumably, new statutory provisions will impose even greater radii of curvature than the ones that are currently required, which are often currently not complied with for practical reasons. One can also expect the requirement of different radii of curvature on the same part, which cannot be provided with conventional apparatuses.

[0008] In any case, the diameter of the central bending tool is related to the diameter of the rod to be bent, and therefore the radius of curvature to be provided increases as the diameter of the rod increases.

[0009] This entails the need to have an adequate number of bending forms or interchangeable mandrels having different diameters, to be mounted alternatively on the machine depending on the type of work required, i.e., depending on the diameter of the rods to be bent and on the radii of curvature to be provided. It should in fact be noted that current bending methods allow to ob-

tain an internal radius of curvature that is substantially identical to the radius of the central tool, minus spring-back, as shown by way of example in Figures 3 and 4, illustrating the bending of a rod 2.

[0010] In addition to having high costs for both purchase and storage of the bending tools, the above methods entail stopping production in order to replace the tools. Moreover, this replacement is often difficult and requires a relatively long time.

[0011] In particular, the provision of wide radii of curvature requires, according to current statutory provisions, tools having a correspondingly large diameter, which are heavy and difficult to handle. Moreover, the bending arms required have dimensions that make them very expensive and scarcely ergonomic, if they can be produced at all.

[0012] The aim of the present invention is to solve the cited problem, by providing a method that allows to rapidly and simply bend sections and the like, according to radii of curvature that can be programmed in the desired manner.

[0013] Within the scope of this aim, an object of the present invention is to provide an apparatus that provides the automatic bending of sections and the like with a structure that is simple and functional, reliable in operation, and highly flexible in use.

[0014] This aim and this object are achieved, according to the invention, by a method and by an apparatus for bending sections and the like as claimed in the appended claims.

[0015] More details of the invention will become better apparent from the detailed description of a preferred embodiment of the apparatus for bending sections and the like according to programmable radii of curvature, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figures 1 and 2 are schematic front views of section bending assemblies according to the prior art;

Figures 3 and 4 are similar schematic front views of the bending assemblies according to the prior art, shown during the bending of a section;

Figures 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 are schematic front views of a section bending assembly during successive working steps of the method according to the invention;

Figure 16 is a similar front view of the bending assembly during the bending of a section according to a different radius of curvature;

Figure 17 is a schematic view of a section bent according to the method of the invention;

Figures 18 and 19 are respectively a plan view and a transverse sectional view of a central bending and abutment tool used in the apparatus according to the invention.

[0016] With particular reference to the above figures, the numeral 1 generally designates a bending assembly

applied in a machine for bending sections 2, for example iron rods for reinforced concrete and the like, hereinafter termed rods for the sake of simplicity, although the method according to the invention can also be applied to pipes and sections of any size and shape.

[0017] The bending assembly 1 has, in a per se known manner, a central bending and abutment tool 3 and an eccentric bending post 4. In the case shown in the figures from Figure 5 onward, the tool 3 is conveniently constituted by a pair of bending and abutment forms 6 with a central channel, that are interchangeable and optionally adjustable according to the diameter of the rods 2 to be bent.

[0018] As shown in detail in Figures 18 and 19, it is possible to associate with the pair of bending forms 6 of the central tool 3 a corresponding pair of spacer strips 8 having a modular thickness, so as to adjust the width of the central channel according to the diameter of the sections to be bent. The spacer strips 8 are mounted adjacent to the mutually opposite faces of the bending forms 6 that form the central channel and are retained by appropriately provided engagement members 9.

[0019] The method for bending the rods 2, according to programmable radii of curvature, entails actuating the discontinuous advancement of the section 2 to be bent in abutment against the central tool 3, for example between the bending forms 6, in step with alternating and differentiated angular strokes of the eccentric bending post 4, so as to make the section 2 follow the envelope of a virtual mandrel 5 whose radius of curvature is programmable and tangent to the line along which the section 2 is fed.

[0020] The advancement strokes of the section 2 to be bent and the angular strokes of the eccentric bending post 4 are controlled or indicated by means of a suitable program managed by an electronic processing means, depending on the desired radius of curvature.

[0021] More particularly, at the beginning of the bending cycle of the rod 2, the advancement of a preset portion of the rod 2 between the bending and abutment forms 6 of the central tool 3 is actuated, as shown in Figure 5.

[0022] When the rod 2 stops, a first angular stroke of the eccentric bending post 4 is actuated through an arc whose breadth determines a first bending of the rod 2 (Figure 6).

[0023] Once the eccentric post 4 has been returned to the inactive position, a further advancement of the preset portion of rod 2 is actuated (Figure 7), followed by a second stroke of the post 4 (Figure 8), which causes a second bending of the rod 2. The return of the post 4 is of course meant to allow the advancement of the rod 2.

[0024] By continuing in a similar manner, the rod 2 is bent in successive steps and correspondingly advances discontinuously between the bending forms of the central tool 3, as shown in Figures 9 to 15.

[0025] These successive bending steps make the rod

2 follow the envelope of the virtual mandrel 5.

[0026] It should be noted that the angular strokes of the eccentric bending post 4 do not have a constant breadth but are modulated so as to approximate the envelope in an optimum manner. More particularly, the angular strokes of the post 4 increase in breadth at least in an initial part of the bending cycle.

[0027] This is due to the fact that the first bend is performed on a straight bar, while the successive bends are provided on an already-bent portion (see for example Figures 4, 6 and 8), so that if one wishes to maintain a constant angle between the successive segments of the bar it is necessary to make the eccentric post 4 travel through a wider angle.

[0028] This increase is provided until the first straight portion exits from the point of contact with the post 4 (Figure 12).

[0029] Figure 17 illustrates in greater detail a portion of a rod 2 bent according to the radius of curvature defined by the virtual mandrel. In such figure, dark areas 12 represent, for the sake of clarity, the bending regions provided sequentially by the action of the eccentric bending post 4.

[0030] In order to better approximate the circumference of the virtual mandrel 5, it is of course possible to increase the number of segments of the curve, at the cost of speed of execution.

[0031] The above cited electronic processing means controls or indicates, by means of a suitable program, the discontinuous advancement of the rod 2 to be bent in step with the alternating and variable angular strokes of the eccentric post 4, according to the intended radius of curvature.

[0032] In practice, by setting the diameter of the rod 2 to be bent and the desired radius of curvature, the sequence of the advancements of the rod is processed in combination with the corresponding angular strokes of the post 4, according to the radius of curvature formed by the virtual mandrel 5. More specifically, the variables to be considered are the characteristics of the central tool 3, the position of the eccentric post 4, the diameter of the section 2 being processed, the number of bends with which one wishes to approximate the desired theoretical radius of curvature, and the bending angle to be obtained on the section.

[0033] It should be noted that by varying the operating parameters, i.e., the advancement of the section and the angular strokes of the eccentric pivot 2, by means of a preset central tool 3, it is possible to bend the rod 2 according to any radius of curvature greater than that of the tool itself, as shown in Figure 16, which exemplifies the execution of the bend on a virtual mandrel 5' whose diameter is larger than that of the preceding figures.

[0034] The channel of the central tool 3 can conveniently be adjustable or interchangeable, so as to allow to process rods having different diameters, within a certain variation range, without replacing the tool.

[0035] The described method is of course also ap-

plied in machines that have a different configuration, for example in machines wherein the abutment and central mandrel functions are separate and are performed by two different members, as in the example of Figure 2.

[0036] The method according to the invention therefore achieves the aim of manually or automatically bending, in a simple and rapid manner, sections and the like according to programmable radii of curvature.

[0037] In particular, the described method allows to obtain sections with wide radii of curvature and sections with a curvature with portions having different radii.

[0038] A feature of the method according to the invention is that the programmable radii of curvature are not constrained by the physical dimensions of the central tool, be it constituted by a mandrel or by bending forms with a central channel, but can have any dimensions, so long as they are larger than those of the tool.

[0039] The method is also versatile in use and can be implemented in bending and shaping machines and in stirrup bending machines, regardless of whether they are automatic, semiautomatic or manual machines.

[0040] It should be noted that this result is achieved by means of an apparatus that is simple in concept, with a significant reduction of production costs.

[0041] In the practical embodiment of the invention, the materials used, as well as the shape and the dimensions, may be any according to requirements.

Claims

1. A method for bending sections and the like according to programmable radii of curvature, in an apparatus that comprises a bending assembly (1) provided with a central abutment tool (3) and with an eccentric post (4) for bending the sections (2), **characterized in that** it comprises discontinuously advancing the section (2) to be bent in abutment with said central tool (3) in step with alternating angular strokes of said eccentric bending post (4), so as to make said section (2) follow the envelope of a virtual mandrel (5) whose radius of curvature can be programmed by means of an electronic processing means that is suitable to control or indicate the advancement of the section (2) to be bent and said angular strokes of the eccentric bending post (4).
2. An apparatus for bending sections and the like according to programmable radii of curvature, of the type comprising a bending assembly (1) that is provided with a central abutment tool (3) and with an eccentric post (4) for bending the sections (2), **characterized in that** it comprises an electronic processing means adapted to control or indicate the discontinuous advancement of the section (2) to be bent in abutment with said central tool (3) in step with alternating angular strokes of said eccentric bending post (4), so as to make said section (2) fol-

low the envelope of a virtual mandrel (5) whose radius of curvature is programmable.

3. The apparatus according to claim 2, **characterized in that** said virtual mandrel (5) is tangent to the line along which said section (2) is fed.
4. The apparatus according to claim 2, **characterized in that** said angular strokes of said eccentric bending post (4) are modulated according to the advancement of said section (2) to be bent, with a breadth that increases at least during an initial part of the bending cycle.
5. The apparatus according to claim 2, **characterized in that** said central tool (3) is constituted by two abutment and bending forms (6) with a central channel, which are removable and adjustable according to the diameter of said sections (2) to be bent.
6. The apparatus according to claim 5, **characterized in that** a corresponding pair of spacer strips (8) having a modular thickness, is associable with said pair of bending forms (6) of said central tool (3), so as to adjust the breadth of said central channel depending on the diameter of said sections (2) to be bent.

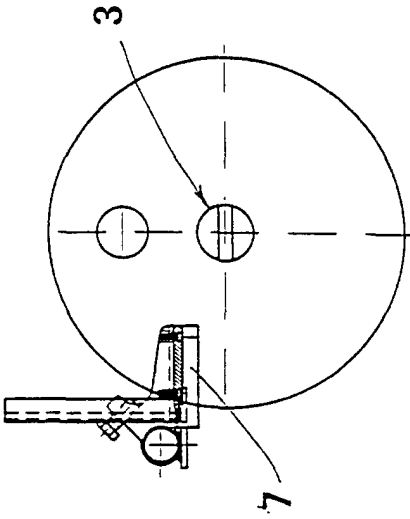


FIG.1 (PRIOR ART)

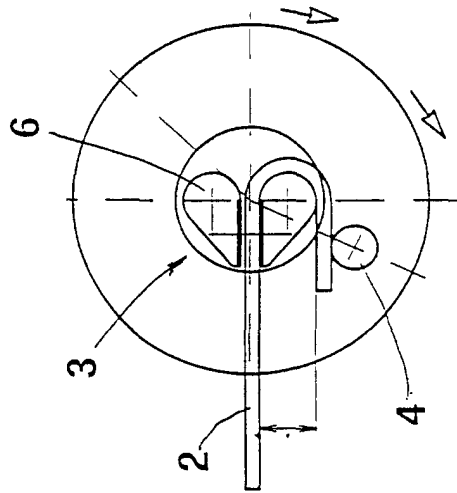


FIG.2 (PRIOR ART)

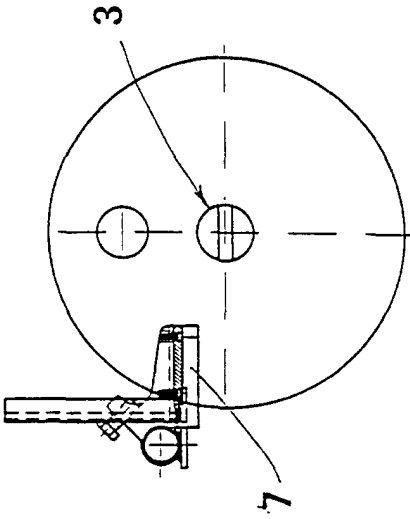


FIG.3 (PRIOR ART)

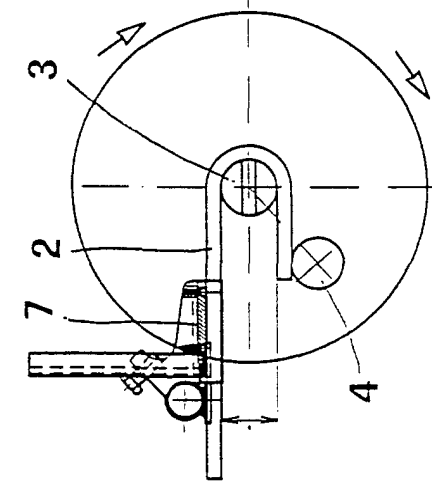


FIG.4 (PRIOR ART)

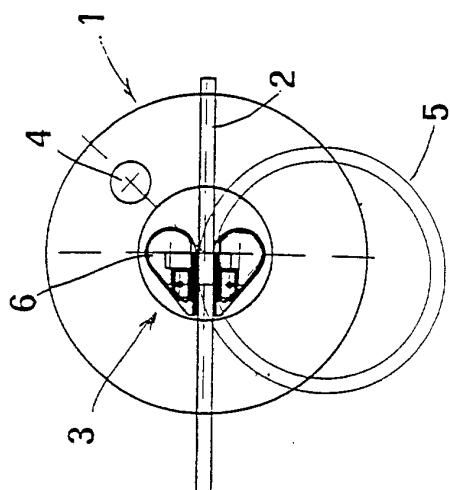


FIG. 5

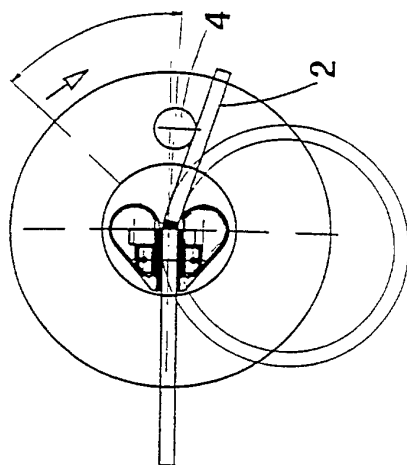


FIG. 6

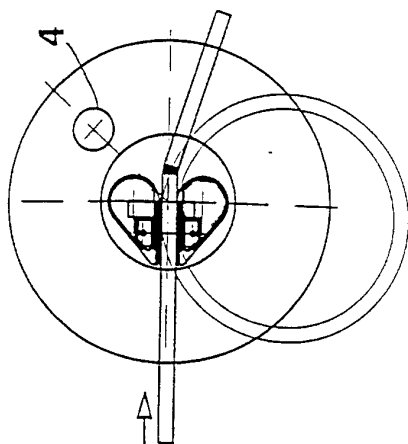


FIG. 7

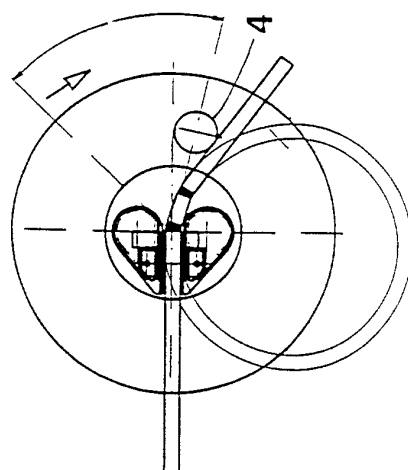


FIG. 8

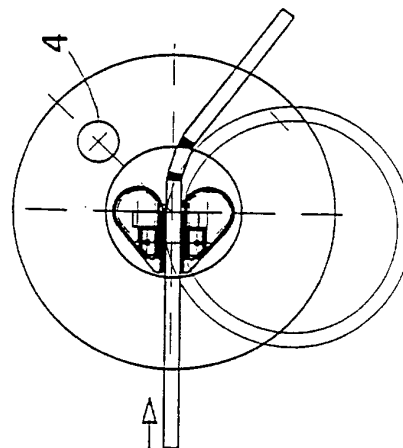


FIG. 9

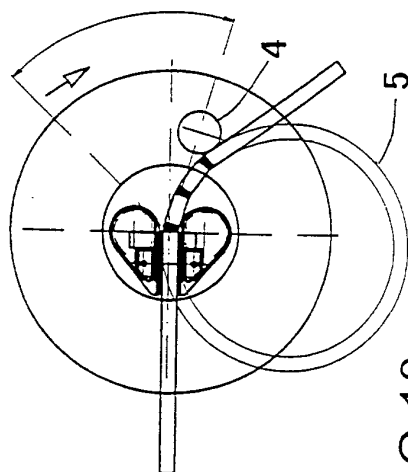


FIG. 10

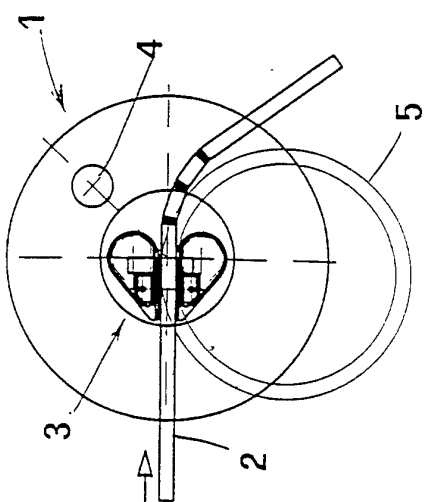


FIG. 11

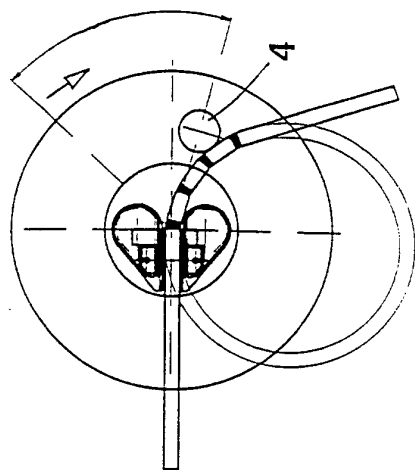


FIG. 12

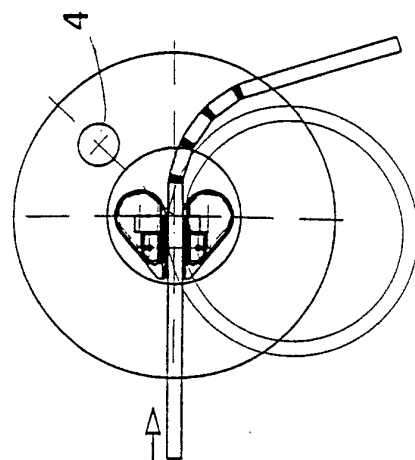


FIG. 13

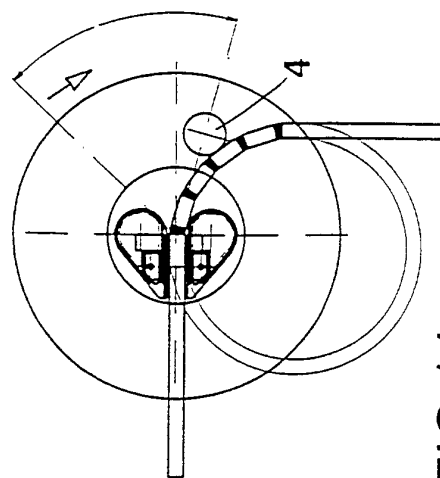


FIG. 14

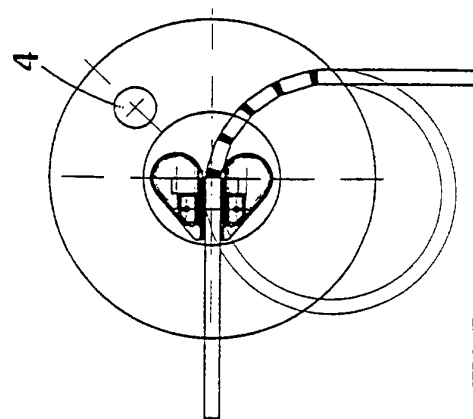


FIG. 15

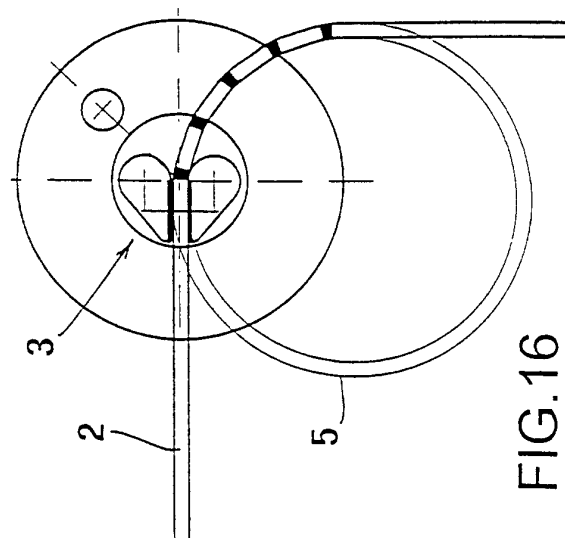


FIG. 16

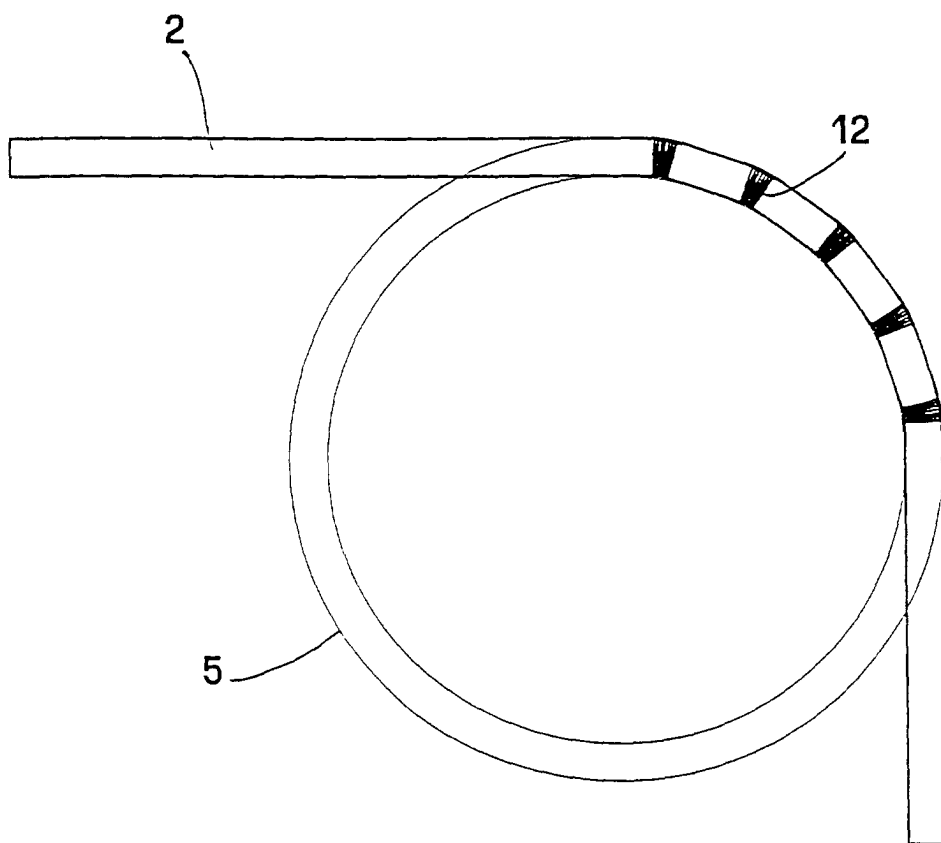


FIG.17

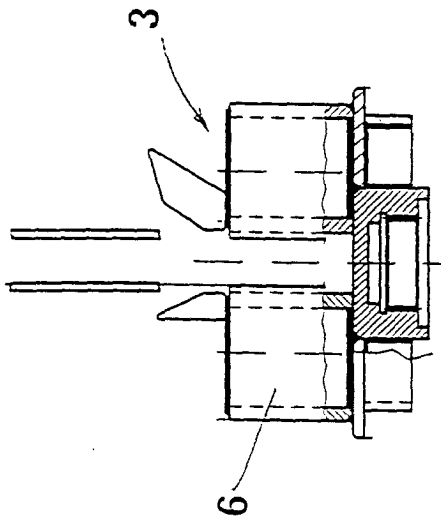


FIG.19

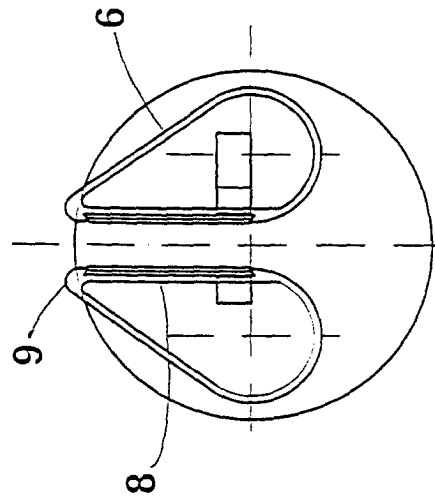


FIG.18



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 01 12 4568

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 334 353 A (ZAHLAUS HELMUT ;EBERT FRANK (DE)) 27 September 1989 (1989-09-27) * column 1, line 33 - column 2, line 21 * * column 4, line 37 - column 6, line 58; figure 1 *	1-3,5	B21D11/12 B21D7/022 B21D7/12
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B21D
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 28 January 2002	Examiner Vinci, V
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 12 4568

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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