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(72) Inventors:
• **TRAVINI, Vittorio**
27020 Borgo San Siro (Pavia) (IT)
• **BOSONI, Riccardo**
27020 Borgo San Siro (Pavia) (IT)

(74) Representative: **Petruzzello, Aldo**
Racheli S.r.l.
Viale San Michele del Carso, 4
20144 Milano (IT)

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(71) Applicant: **Olimpia 80 SRL**
27020 Borgo San Siro (PV) (IT)

(54) **FINISHING STATION OF A MACHINE FOR PRODUCING SQUARE PIPES**

(57) Finishing station (10) of a machine for continuously producing square pipes, apt to reduce the aperture of a square pipe (100) being formed, coming out from a forming section, comprising a lower cylindrical roller (1) with horizontal axis which acts as support for the lower side (101) of the square pipe being formed; two lateral conical rollers (2, 3) with vertical axes, placed at the respective sides (102, 103) of the square pipe being formed, with the conical shells in contact with these sides,

and two upper conical or cylindrical rollers (4, 5) placed above the square pipe being formed, with the axes parallel to respective portions (104, 105) of the upper open side of the square pipe being formed, all five rollers (1, 2, 3, 4, 5) being placed in the same transverse section of the production line, each roller being movable in a direction parallel to the section of a surface of revolution of an adjacent roller in order to adapt to the dimensions of the pipe to be produced.

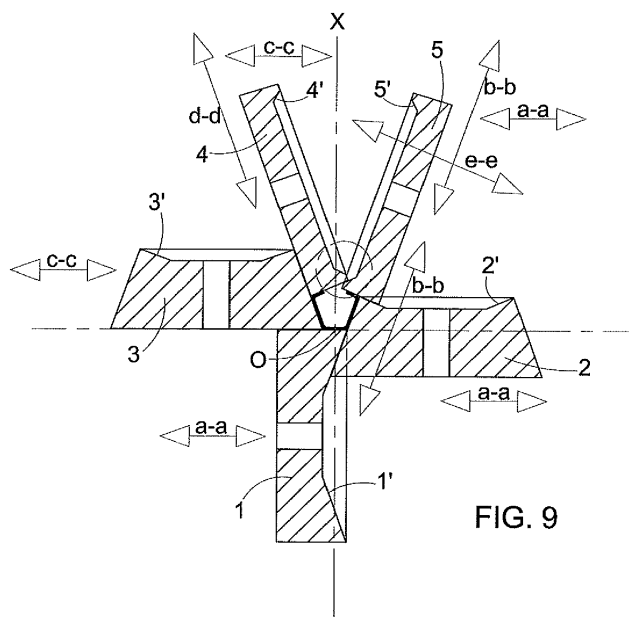


FIG. 9

Description

[0001] The object of the present invention is a finishing station of a machine for continuously producing square pipes, i.e. with square or rectangular section.

[0002] A machine for the continuous forming of square pipes comprises a plurality of forming stations which progressively bend a strip of sheet metal, followed by a finishing section comprising at least one station which brings further together, in view of final welding, the edges of the sheet metal strip bent by the forming stations, and at least one station for the final welding of the square pipe.

[0003] Machines for forming square pipes by means of continuous bending of strips of sheet metal are well known in the art and comprise, in series one with the other, a plurality of stations wherein the strip of sheet metal is progressively deformed by pairs of joined rollers, i.e. having grooves with complementary profiles.

[0004] These known machines have the disadvantage of making necessary the replacement of the pairs of rollers when the sizes of the pipe produced have to be changed, which entails machine down times of varying length which reduce the productivity of the line.

[0005] The need for maximum production flexibility linked to the reduction in production batches has led to the need for machines for the production of the pipe with very short size change times.

[0006] These machines have some special features which distinguish them from others: in particular they do not need a tool change in the change from production of one size to another in the production range of the same machine.

[0007] JP 2004 283844 A describes a machine for the production of square pipes comprising stations made up of a lower cylindrical roller with horizontal axis on which the square pipe rests, two lateral conical rollers with variable axes and two upper conical rollers with horizontal axis and with variable conicity.

[0008] A machine, defined as machine with variable linear geometry, is described in the European patent application, published as EP 2279807, in the name of the same Applicant OLIMPIA 80 S.R.L., and provides a variable number of so-called "pipe forming" steps wherein the originally flat sheet metal is deformed, creating the lower and upper edges of a square or rectangular profile by means of adjustable rollers, and therefore adaptable to several sizes of pipes to be produced, which press on the sheet metal both from the outside and from the inside of the profile of the pipe being formed until the latter is sufficiently open. The pipe forming section is followed by a "pipe finishing" section wherein, it no longer being possible to act with rollers inside the profile of the pipe, rollers are provided which act from the outside to confer the final profile of the pipe before welding.

[0009] According to the aforementioned European patent application the finishing section comprises a plurality of stations, each of which comprises a lower roller placed under the square pipe being formed, a pair of rollers with

vertical axis, adjustable horizontally, placed at the sides of the square pipe being formed, and a pair of rollers with horizontal axes, distanced longitudinally and adjustable vertically, placed above the square pipe being formed.

[0010] The lateral rollers with vertical axes are conical rollers in order to adapt to the lateral profile of the square pipe being formed and are placed in line with the lower roller.

[0011] The upper rollers are instead biconical rollers, again in order to adapt to the upper profile of the square pipe being formed and, as mentioned, are staggered longitudinally in order not to interfere with the lateral conical rollers.

[0012] The Applicant has noted that this arrangement of the rollers in the stations of the finishing section created problems which the present invention aims to solve at least in part.

[0013] The longitudinally staggered arrangement of the upper biconical rollers, imposed by the presence of the lateral conical rollers in line with the lower roller, generates a torque on the pipe being formed, determining an undulation of the same, with possible displacements and imperfect finishing.

[0014] Additionally the longitudinal staggering of the upper biconical rollers with respect to the lateral rollers and to the lower roller causes an elongation of the production line in the case where the finishing section contains numerous stations.

The object of the invention is that of eliminating the disadvantages mentioned above. More particularly an object of the invention is that of providing a finishing station with an arrangement of the rollers such as to avoid any displacement or twisting or undulation of the square pipe being formed.

[0015] Another object of the invention is that of providing an arrangement and configuration of the rollers such as to make the corresponding finishing station compact.

[0016] Yet another object of the invention is that of providing a finishing station which allows containing of the longitudinal extension of a finishing section with several stations.

[0017] These and other objects are achieved by the finishing station according to the invention which has the features of the annexed independent claim 1.

[0018] Advantageous embodiments of the invention are disclosed by the dependent claims.

Substantially a finishing station according to the invention, apt to reduce the aperture of a square pipe during its formation, coming out from a forming section, comprises a lower cylindrical roller with horizontal axis which acts as support for the lower side of the square pipe being formed; two lateral conical rollers with vertical axes, placed at the respective sides of the square pipe being formed, with the conical shells in contact with these sides, and two upper conical or cylindrical rollers placed above the square pipe being formed, with the shells parallel to respective portions of the upper open side of the square pipe being formed, the axes of all five rollers being placed

in the same transverse section of the production line of the machine, each roller being movable in a direction parallel to the section of a surface of revolution of an adjacent roller, with the lower roller movable horizontally, in order to adapt to the dimensions of the pipe to be produced.

[0019] Further features of the invention will be made clearer by the following detailed description, referred to a purely non-limiting example thereof, illustrated in the accompanying drawings in which:

Figure 1 is an axonometric view of a finishing station according to the invention, showing the arrangement of rollers and the pipe being formed, advancing in the direction indicated by the arrow;

Figures 2a and 2b are a front view and a median cross section view of the finishing station of Figure 1; Figures 3a and 3b are a side view and a view from above;

Figures 4a to 4d are median cross section views showing the positioning of the rollers with various pipe dimensions;

Figures 5 to 9 show in succession the movements of the various rollers of a forming station in order to adapt to the different dimensions of a pipe being formed;

Figure 9a is an enlargement of the detail denoted by K in Figure 9.

[0020] The accompanying drawings only show the rollers of a finishing station, denoted overall by reference numeral 10, and the pipe being formed, denoted by reference numeral 100, the devices designed to support and to move the rollers being known in the art.

[0021] The finishing station 10 comprises a lower cylindrical roller 1 with horizontal axis, two conical lateral rollers 2, 3 with vertical axes, and two upper rollers 4, 5, with appropriately slanted axes, which in the embodiment shown are slightly conical, but which could also be perfectly cylindrical. All the rollers are placed with the respective axes in the same cross section of the production line or of the pipe being formed, that is, in the same vertical transverse plane of the machine, and are provided with the movements which are to be described here below, in order to adapt to the range of pipes to be produced.

[0022] The arrangement of all five rollers with the respective axes on the same vertical plane makes the machine compact and eliminates the problems previously disclosed.

[0023] In order to adapt the station to different dimensions of pipes being formed it is necessary to shape appropriately the various rollers so as to exploit for the set-up an onset of relative movement of each roller in a direction parallel to the section or profile of a surface of revolution of an adjacent roller, with the lower roller 1 movable horizontally.

[0024] In particular, in the embodiment illustrated, all the rollers have a perfectly flat side or base, and the other

appropriately grooved, with a conical perimeter profile which is tangent, short of a minimum offset, to the shell of an adjacent roller. The providing of grooved sides on all five rollers has been done for a reason of symmetry, so that optionally the rollers can be placed symmetrically with respect to the vertical axis X, i.e. with an overturning of Figures 2-9 around this axis. From the description that is to follow it will be seen however that in the arrangement shown the rollers 3 and 4 would not need to have grooved sides.

[0025] Here below the terms left, right, upper, lower and the like are referred to the positions occupied in the drawings.

[0026] In order to facilitate the description, in the accompanying drawings the sides of the pipe being formed have been denoted as follows: 101 lower side; 102 right side; 103 left side; 104 and 105 left and right portions of the open upper side.

[0027] With the upper rollers 4, 5 with conical profile, the angle formed by the left 104 and right 105 portions of the open upper side with the corresponding left 103 and right 102 sides of the pipe is slightly obtuse, while it would be perfectly straight if the upper rollers 4, 5 were cylindrical.

[0028] Naturally the conicity of the lateral rollers 2, 3 and the slant of the upper rollers 4, 5 will vary on the basis of the position of the finishing station 100 in the production line, i.e. on the basis of the degree of closure of the pipe being formed, it being understood that such a station cannot be used in the final stages of closure of the pipe due to the impossibility of being able to physically arrange the upper rollers 4, 5.

[0029] Figure 5 shows schematically the movement of the lower roller 1. Since the centre O of the lower side of the pipe does not vary as the size being produced varies, the lower roller accomplishes a horizontal movement a-a only, so that the upper right apex A of the section of the roller is always located at the lower right apex of the pipe.

[0030] Figure 6 shows the movement of the right lateral roller 2. The roller accomplishes a relative oblique movement b-b with respect to the roller 1 so that the upper left apex B of the section of the roller is always located at the upper right apex of the pipe. At the same time the roller 2 moves horizontally together with the roller 1 to avoid interference with the latter, therefore the absolute movement comes from the combination of a-a and b-b. To allow the movement b-b for the roller 2, the roller 1 has the right side grooved with a conical inner perimeter surface 1' which matches the conicity of the conical roller 2 corresponding to the slant of the right side 102 of the pipe 100. The roller 2 has the upper base or side grooved with a conical inner perimeter surface 2' for the reasons to be given here below.

[0031] Figure 7 shows the movement of the lateral left roller 3. The roller accomplishes a horizontal movement c-c so that the lower right apex C of the section of the roller is always located at the lower left apex of the pipe. The conicity of the roller 3 corresponds to the slant of the

left side 103 of the pipe 100, which is identical to that of the right side 102. Therefore the roller 103 has the same configuration of the roller 102, including a grooved upper base with a conical inner perimeter surface 3' like the corresponding grooved upper base of the roller 2, for the reasons of symmetry disclosed previously. However in the illustrated arrangement of rollers, the upper base of the roller 3 could be perfectly flat.

[0032] Figure 8 shows the movement of the upper left roller 4. The roller accomplishes a relative oblique movement d-d with respect to roller 3, parallel to the conical shell thereof, so that the lower right apex D of the section of the roller is always located at the upper left apex of the pipe. At the same time the roller 4 moves horizontally together with the roller 3 to avoid interference with the latter, therefore the absolute movement comes from the combination of d-d and c-c. The roller 4 has such a slant that its shell is arranged parallel to the left portion 104 of the upper side of the pipe.

[0033] Figure 9 shows the movement of the upper right roller 5, as well as the movement of all the other rollers. The roller 5 accomplishes a relative oblique movement e-e with respect to the roller 2 with its shell (placed parallel to the right portion 105 of the upper side of the pipe) which runs tangentially to the inner conical surface 2' of the roller 2. At the same time the roller 5 moves together with the roller 2 to avoid interference with the latter, therefore the absolute movement of the roller 5 comes from the combination of e-e, b-b, a-a. The roller 5 also has the left side grooved with a conical inner perimeter surface 5' apt to house the shell of the roller 4, avoiding the interference with the same. The situation is illustrated in greater detail in the enlarged section of Figure 9' where the lower right edge E of the roller 4 is shown parallel and at a very short distance from the conical surface 5'. Again for the reasons of symmetry disclosed previously, the roller 4 also has the right side grooved with a conical inner perimeter surface 4' which, in the arrangement shown, does not have any function.

[0034] All the rollers 1, 2, 3, 4, 5 of the finishing station 10 are normally mounted idle around their relevant axes.

[0035] As mentioned previously, in a finishing section of a line for the production of square pipes several finishing stations can be provided with the rollers shaped and placed in such a way that their shells work on the respective sides of the pipe being formed, on the basis of the degree of closure of the pipe itself.

[0036] Naturally the invention is not limited to the particular embodiment previously described and illustrated in the accompanying drawings, but numerous detailed changes may be made thereto, within the reach of the person skilled in the art, without thereby departing from the scope of the invention itself as defined by the appended claims.

Claims

1. Finishing station (10) of a machine for continuously producing square pipes, apt to reduce the aperture of a square pipe (100) during its forming, comprising a lower cylindrical roller (1) with horizontal axis which acts as support for the lower side (101) of the square pipe; two conical lateral rollers (2, 3) with vertical axes, placed at the respective sides (102, 103) of the square pipe, with the conical shells in contact with these sides, and two upper conical or cylindrical rollers (4, 5), placed above the square pipe, with the shells in contact with respective portions (104, 105) of the open upper side of the square pipe, the axes of all five rollers (1, 2, 3, 4, 5) being placed on a same vertical transverse plane of the machine, wherein said lower cylindrical roller (1), at least one of said lateral conical rollers (2, 3) and at least one of said upper conical or cylindrical rollers (4, 5) have a grooved base or side with a respective conical inner perimeter surface (1', 2', 3', 4', 5') apt to house the shell of an adjacent roller in order to adapt to the dimensions of the pipe to be produced.
2. Finishing station according to claim 1, **characterised in that** all the rollers have a grooved flank or base, the two side rollers (2, 3) and the upper rollers (4, 5) being identical one to the other.
3. Finishing station according to any one of the preceding claims, **characterised in that**, in order to adapt to the dimensions of the pipe to be produced, said lower roller (1) accomplishes a horizontal movement a-a only, so that an upper apex of the section of the roller, the right apex (A), is always located at the lower right apex of the pipe.
4. Finishing station according to claim 3, **characterised in that** said lateral right roller (2) accomplishes a relative oblique movement b-b parallel to the corresponding side (102) of the pipe being formed, so that the upper left apex (B) of the section of the roller is always located at the upper right apex of the pipe, and a horizontal movement a-a together with the roller (1) in order to avoid interference with the latter, such that the absolute movement is the combination of a-a and b-b.
5. Finishing station according to claim 4, **characterised in that** said lateral left roller (3) accomplishes a horizontal movement c-c so that the lower right apex (C) of the section of the roller is always located at the lower left apex of the pipe.
6. Finishing station according to claim 5, **characterised in that** said upper left roller (4) accomplishes a relative oblique movement d-d with respect to the roller (3), parallel to the conical shell thereof, so that

the lower right apex (D) of the section of the roller (4) is always located at the upper left apex of the pipe, and a horizontal movement together with roller (3) in order to avoid interference with the latter, such that the absolute movement comes from the combination of d-d and c-c. 5

7. Finishing station according to claim 6, **characterised in that** said upper right roller (5) accomplishes a relative oblique movement e-e parallel to the inner conical surface (2') of the lateral right roller (2) and moves together with the roller (2) to avoid interference with the latter, such that the absolute movement of the roller (5) comes from the combination of e-e, b-b, a-a. 10 15
8. Finishing station according to claim 7, wherein the conical inner perimeter surface (5') of the roller (5) houses the shell of the roller (4), avoiding the interference with this roller. 20
9. Machine for continuously forming square pipes comprising, in series one with the other, a forming section suitable for progressively bending a sheet metal strip, a finishing section suitable for bringing further together the upper edges of the bent sheet metal strip and a section for welding the formed square pipe, **characterised in that** said finishing section comprises at least one finishing station (10) according to any one of the preceding claims. 25 30
10. Method to reduce the aperture of a square pipe (100) during its formation using at least one finishing station (10) according to any one of claims 1 to 8. 35

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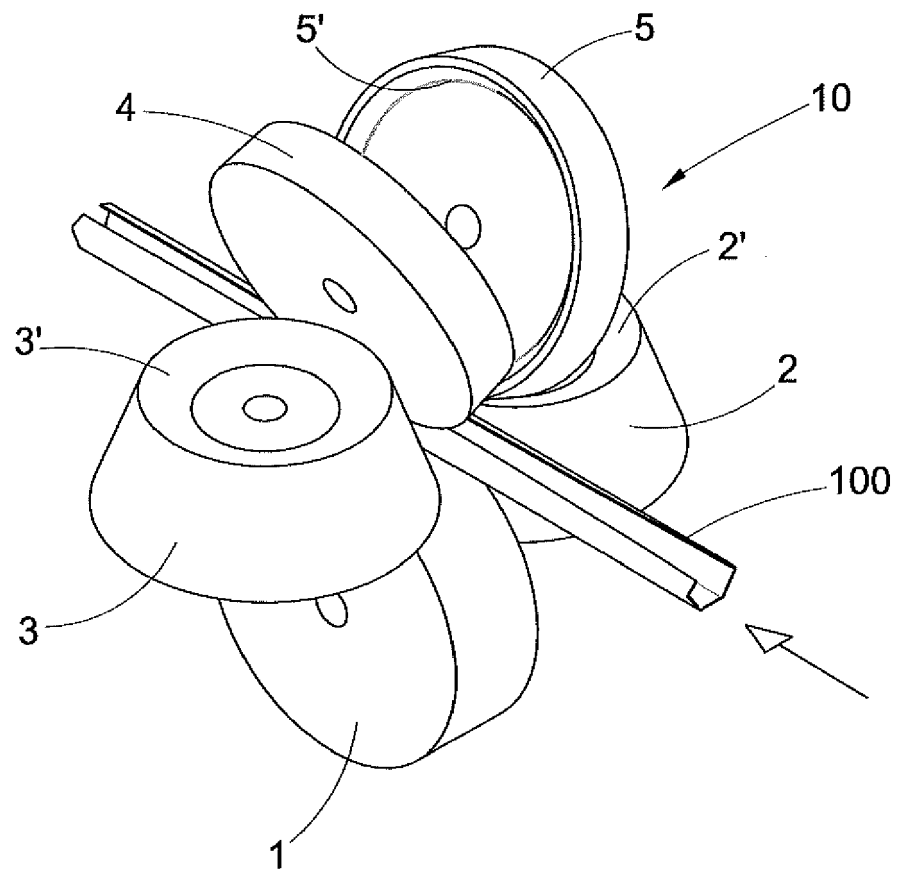
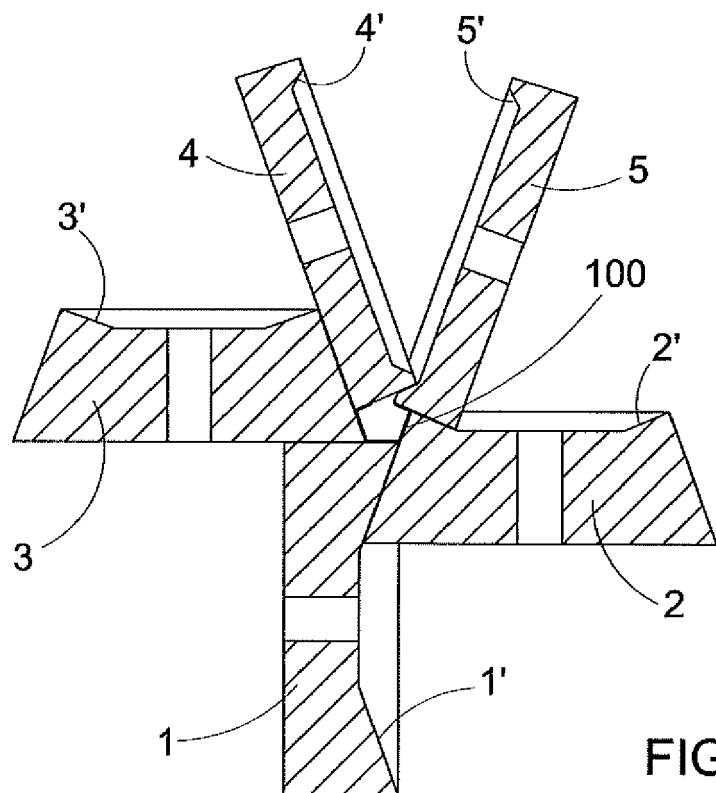
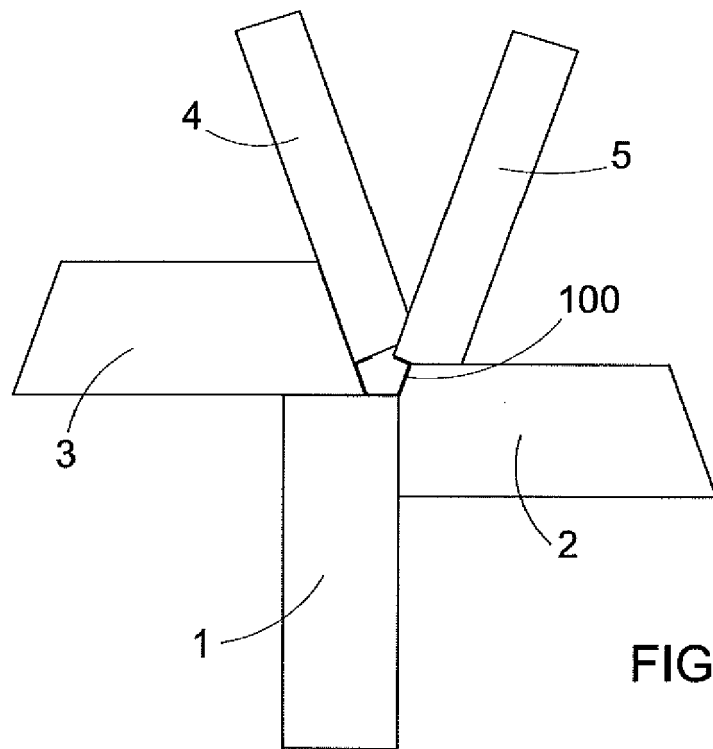


FIG. 1



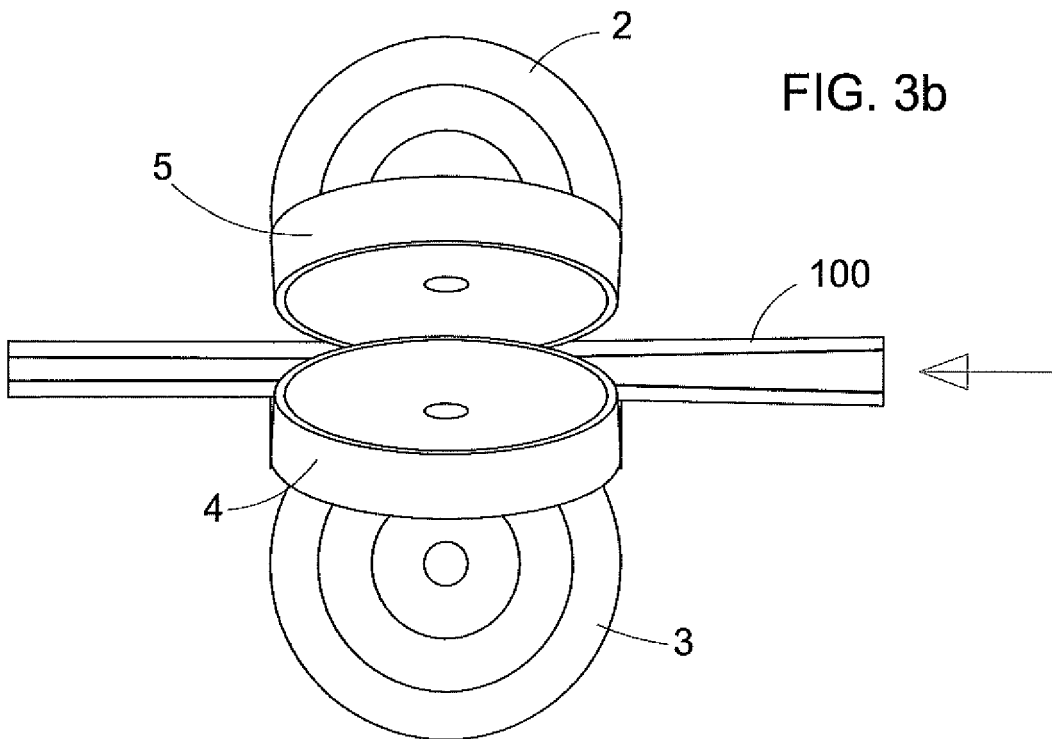
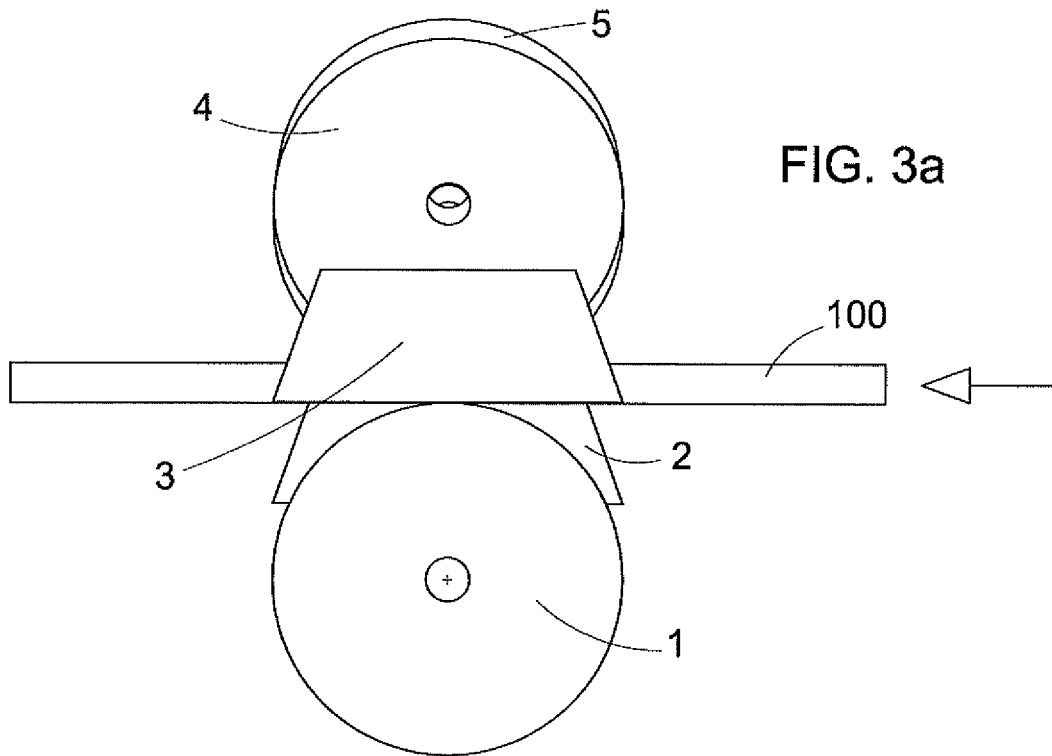


FIG. 4a

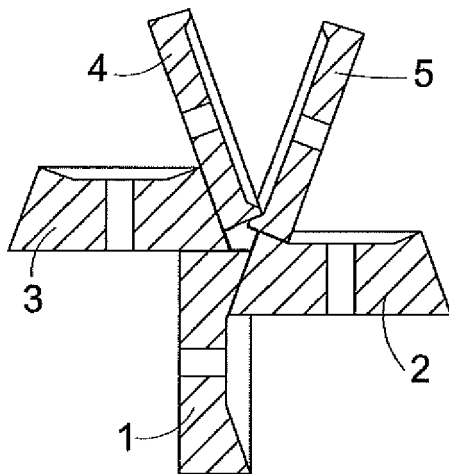


FIG. 4b

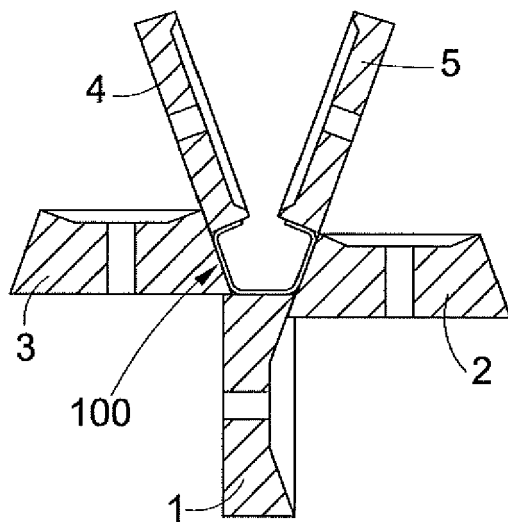
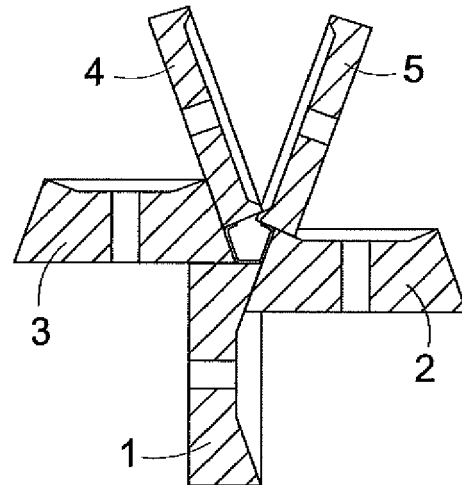


FIG. 4c

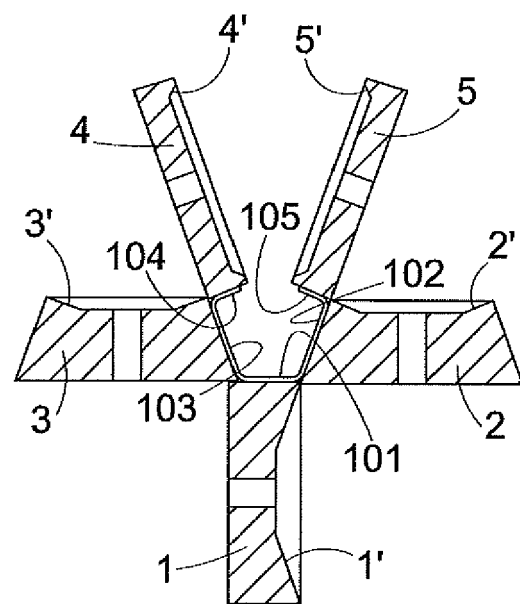


FIG. 4d

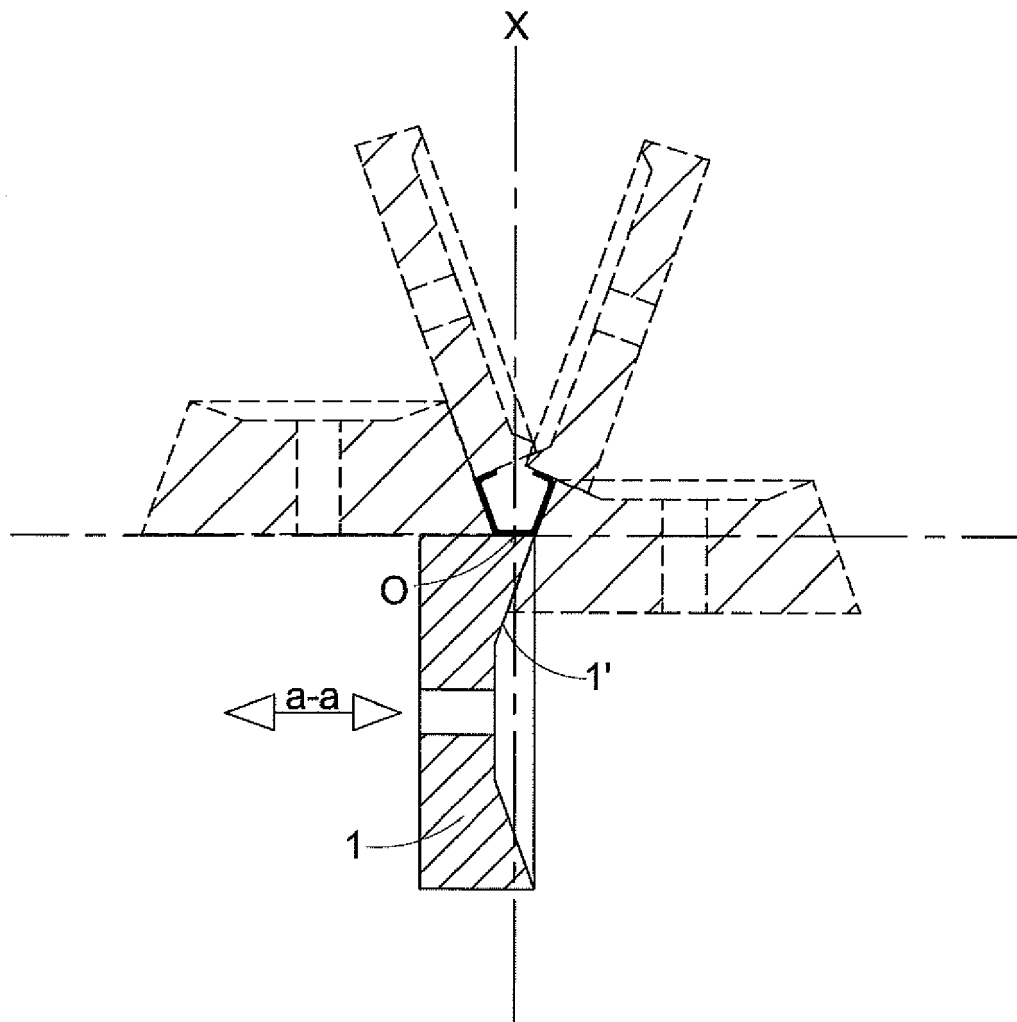


FIG. 5

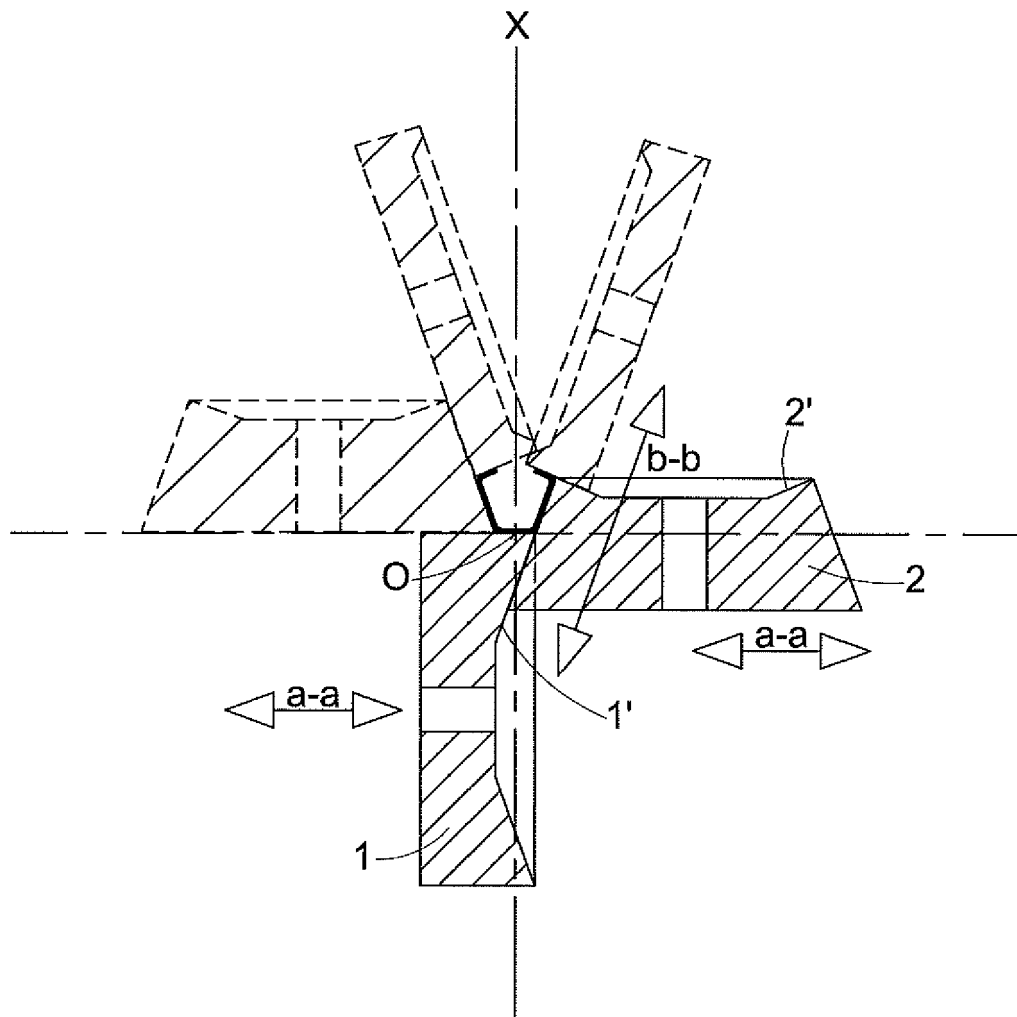


FIG. 6

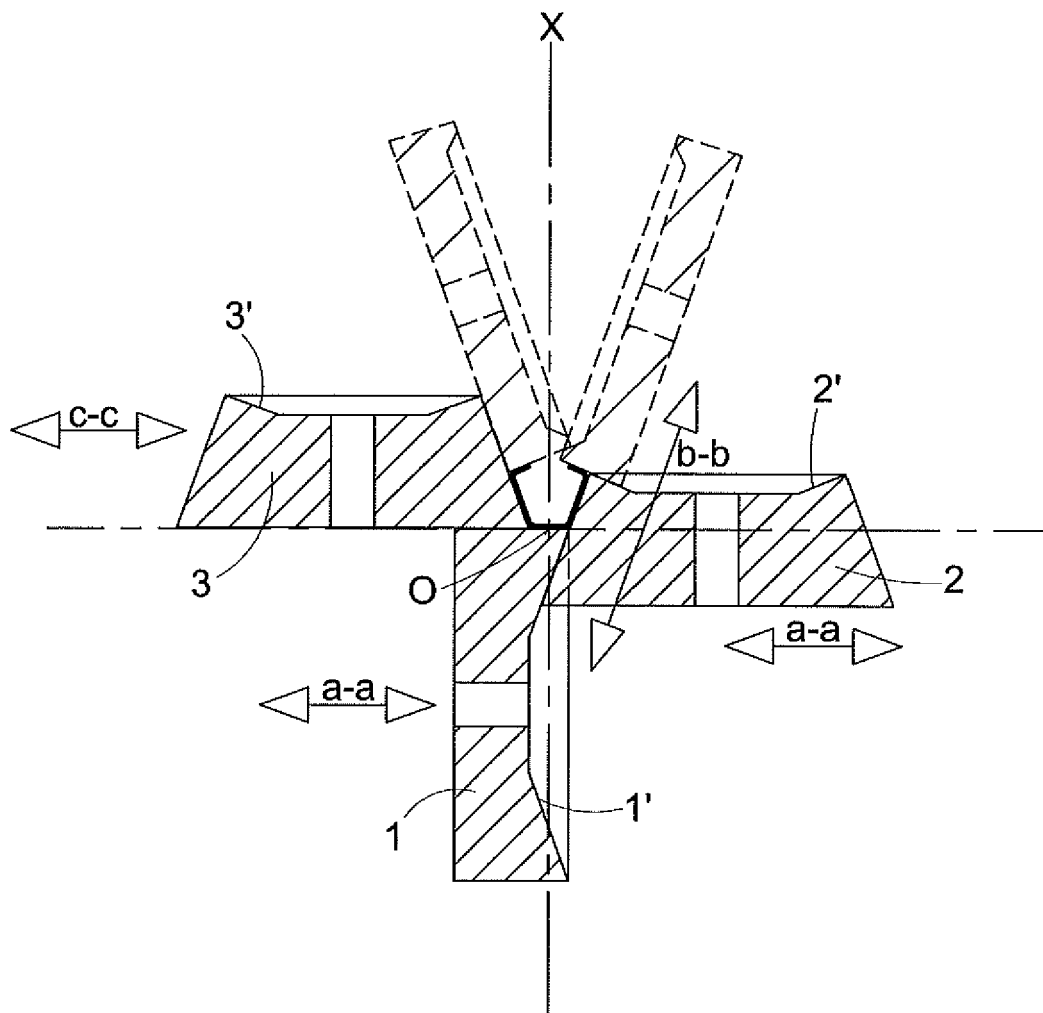


FIG. 7

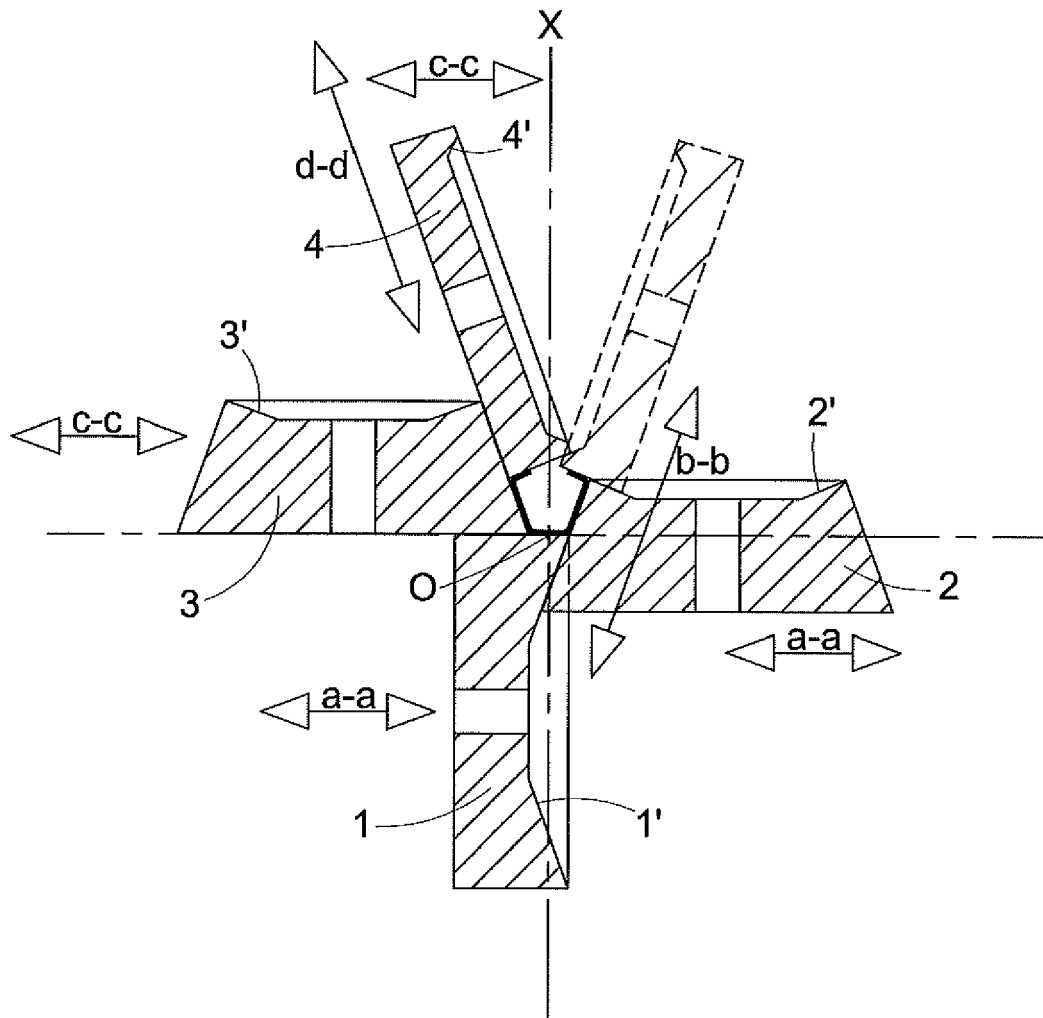


FIG. 8

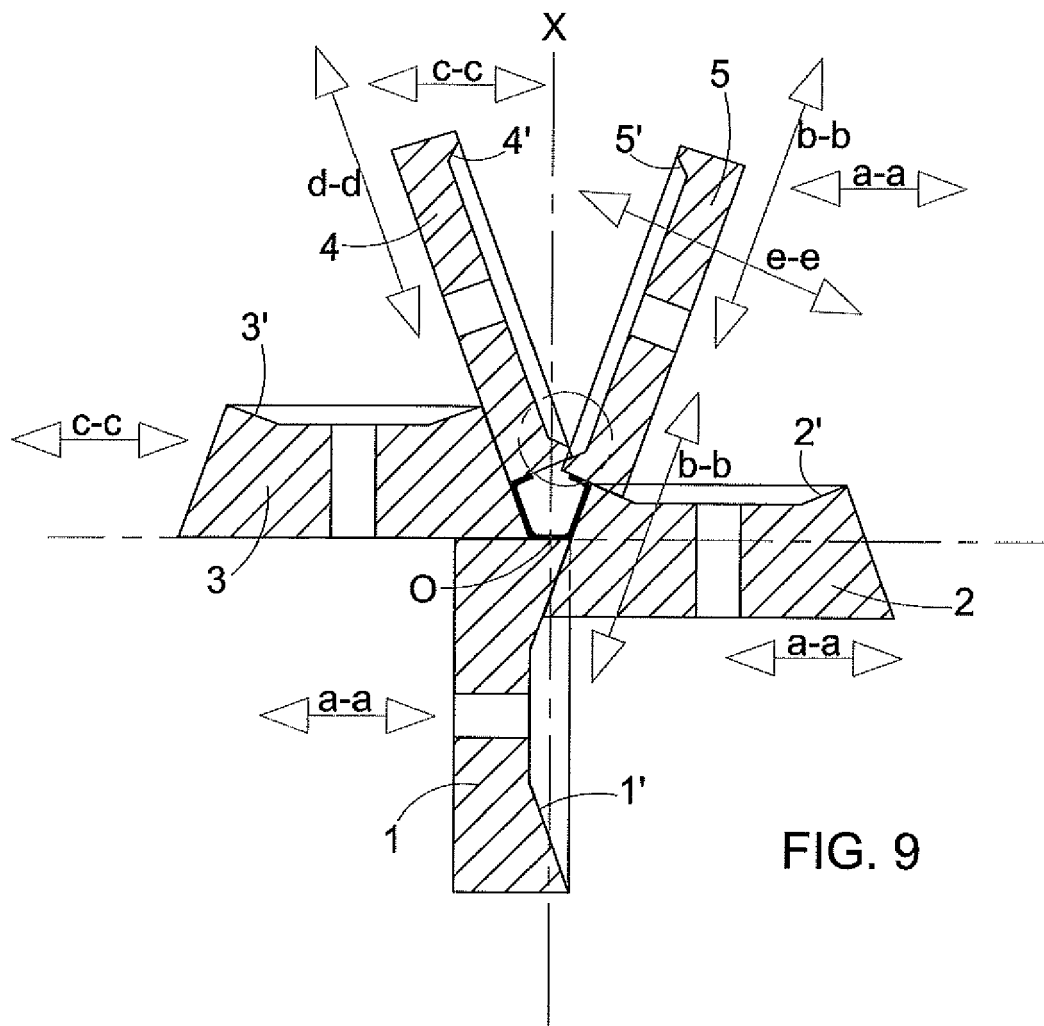
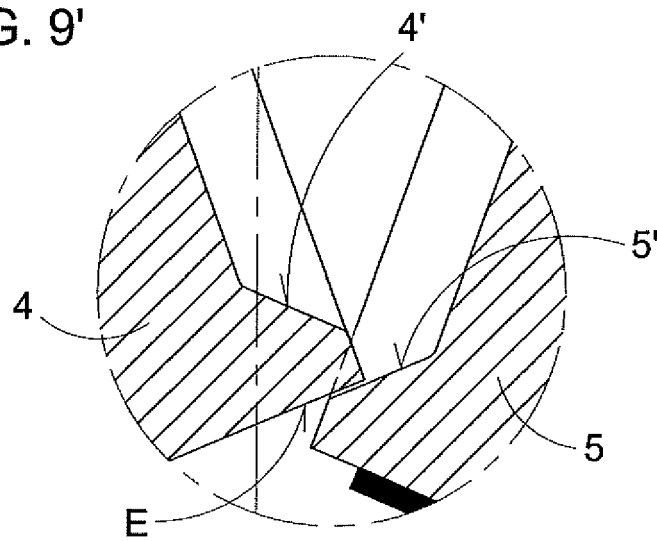


FIG. 9

FIG. 9'





EUROPEAN SEARCH REPORT

Application Number
EP 16 20 5511

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A	EP 2 279 807 A1 (OLIMPIA 80 SRL [IT]) 2 February 2011 (2011-02-02) * paragraph [0006] * * paragraph [0039] - paragraph [0040]; claim 1; figures *	1,9,10	
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			TECHNICAL FIELDS SEARCHED (IPC)
			B21D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 April 2017	Examiner Pieracci, Andrea
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EPO FORM 1503 03/02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 16 20 5511

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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