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(54) **Method and rolling mill for rolling tubes by means of a mandrel**

(57) The following invention relates to a method for rolling tubes on mandrels (2), wherein the final finish of the tube (10) is operated with a pair of stands (8, 9) provided with four rollers (8a, 8b, 8c, 8d; 9a, 9b, 9c, 9d) with

a perpendicular arrangement inside each one. High rolling quality is thus obtained, at the same time reducing the stocks of mandrels stored, as the four-roller finishing stands are able to operate on vaster ranges of tube wall thicknesses.

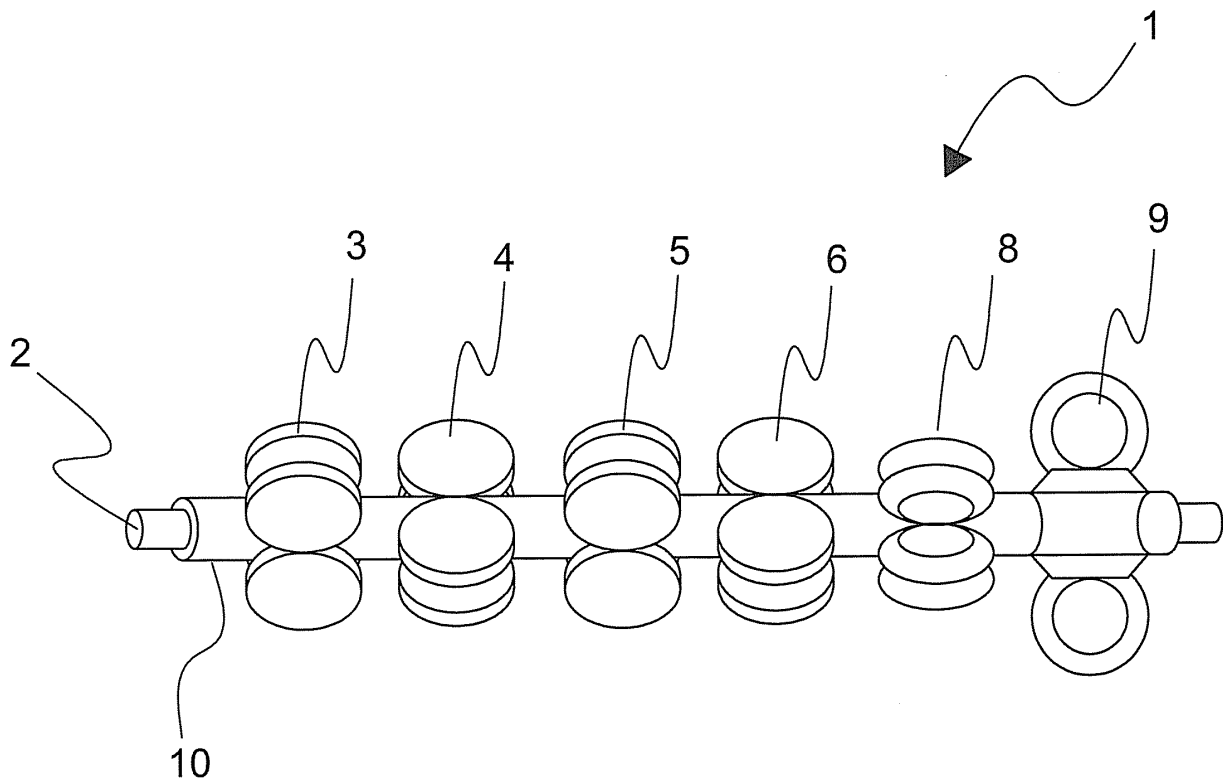


Fig. 1

Description

[0001] The following invention relates in general to the rolling of tubes, particularly, seamless tube rolling operated by means of a mandrel.

[0002] It is currently known for this type of rolling to use essentially two different types of rolling mills: the first is constituted by an alignment of roughing and finishing stands, both having rollers with orientation of the rollers staggered by 90° between one stand and another, whereas the second type of rolling mill is formed only by three-roller stands that are also staggered, but with angles of 60°.

[0003] An example of the first type of rolling mill can be found in US patent no. 4416134; this has the advantage of being constructively quite simple, as the pairs of rollers of each stand have parallel axes and this facilitates the driving thereof with a sole motor and a splitter reducer.

[0004] However, it is known to those skilled in the art that the rolling quality that can be obtained in two-roller stands is not very good, because the action thereof on the tube tends to deform the outer surface in an oval way and furthermore is the cause of scratches on the surface.

[0005] Moreover, the range of tube thicknesses that can be rolled in two-roller finishing stands using a single mandrel diameter is somewhat limited and therefore it becomes necessary to have a store with a high number of different diameter mandrels, if one wants to machine tubes of various dimensions; this has evident drawbacks given the costs of mandrels.

[0006] In order to overcome this drawback the above-mentioned rolling mills have been engineered with three-roller stands, an example of which is described in US patent no 5331835.

[0007] This latter rolling mill is compact and makes it possible to obtain a better rolling quality, but it has a considerable structural complexity and it requires a powerful control system; more in general, one can say that with the increase in the number of rollers the structural and functional complexity of the rolling mills increases.

[0008] Lastly, from US patent No. 5657659 a tube rolling technology is also known that can be considered intermediate between the two previous ones; in fact, for the actuation thereof a rolling mill is envisaged wherein the first and the last stand have four rollers, whereas between them simple two-roller stands are arranged.

[0009] This solution is in practice a hybrid that does not overcome the drawbacks of the prior art because the presence of two-roller finishing stands is cause of the drawbacks mentioned previously, which the first and the last four-roller stands are not able to compensate.

[0010] The aim of the present invention is to overcome this state of the art; to this end it envisages a rolling method wherein the final tube finishing stage is operated by a pair of stands provided with four perpendicular rollers in each one.

[0011] Preferably, the arrangement of such rollers is staggered by 45° between one finishing stand and the

other, and upstream thereof the tube is machined by a plurality of two-roller roughing stands, with orientation staggered by 90°.

[0012] These characteristics of the method according to the invention make it possible to obtain high level tube finishing with a short structure rolling mill; in fact the four-roller solution makes it possible to use only two finishing stands (instead of the three of US patent 5657659).

[0013] Furthermore, as the finishing stands must support rolling strains lower (at equal conditions) than those of the roughing stands, the four-roller stands can be made with compact dimensions, thus limiting the structural and functional complexity thereof.

[0014] The invention also comprises a rolling mill for the implementation of the method wherein there is a plurality of two-roller stands with orientation staggered by 90°, downstream of which two four-roller finishing stands are arranged with orientation staggered by 45°.

[0015] Further characteristics and advantages of the invention will become apparent in view of the detailed description of a preferred, though not exclusive, embodiment illustrated with the aid of the appended drawings wherein:

fig. 1 illustrates a side view of a rolling mill according to the invention;

figs. 2a, 2b, 2c, 2d, 2e and 2f illustrate the respective arrangements of the rollers inside the stands of the rolling mill of fig. 1.

[0016] With reference to such drawings, 1 is used to indicate a rolling mill according to the invention, destined for rolling with a mandrel 2.

[0017] The rolling mill 1 comprises (in the embodiment) four roughing stands 3, 4, 5 and 6, provided with pairs of rollers 3a-3b; 4a-4b; 5a-5b; 6a-6b with axes staggered by 90° as schematically illustrated in the sequence of figures 2a-2d; preferably all the pairs of roughing stands rollers are controlled with a motor and a splitter-reducer, not shown in the drawings because in themselves known.

[0018] Downstream of the roughing stands, there is a pair of finishing stands 8 and 9; the latter are of the four-roller type 8a, 8b, 8c, 8d; 9a, 9b, 9c, 9d, arranged perpendicularly in each one and having an orientation staggered 45° to one another; all the rollers of the finishing stands 8, 9 are also identical to one another and controlled as per the state of the art.

[0019] In rolling mill 1 the orientation of one of the pairs of rollers of the first finishing stand 8, in this case the pair 8c-8d, is identical to that of the rollers 6a-6b of the last roughing stand 6: this arrangement makes it possible to load each roller of the finishing stand 8 in a symmetrical way, because the orientation thereof matches that of the previous roughing stands and therefore the pairs of rollers 8a-8b and 8c-8d work on the non-uniformities of thickness of a tube 10 formed upstream.

[0020] The subsequent finishing stand 9 corrects the slight residual non-uniformities originating in stand 8; with

this roller arrangement high rolling quality is obtained using just two roughing stands, thus reducing the range of mandrels stored.

[0021] In order to better understand this aspect, one must consider the maximum additional tolerance parameter (T_{am}), defined by the relationship $(S_{max} - S_{min}) / S_{mean} \times 100$ where:

- i) S_{max} and S_{min} are respectively the maximum and minimum thickness of the wall of the tube roughed on the mandrel (at the outlet of the tube from stand 9).
- ii) S_{mean} is the mean thickness of said wall in a transverse section.

Those skilled in the art know that the T_{am} parameter gives an indication (as a percentage) of the dimensional error of the tube thickness, for a given roller work condition.

[0022] Therefore, if in the conditions of maximum opening and maximum closure of the rollers the T_{am} remains below the preset value, it means that it is possible to use the same mandrel for tube wall thicknesses included between the foregoing positions of maximum opening and closure.

[0023] Thus, for example, it is possible to produce tubes with external diameters equal to 200 mm and wall thicknesses (on the radius) comprised between 4 mm and 37 mm, using a number of different diameter mandrels, which, in the case of four-roller finishing stands according to the invention is half, at equal T_{am} , that of the two-roller finishing stands of the known art.

[0024] More in general, one might say that with the rolling method according to the invention, using two four-roller finishing stands the number of mandrels necessary to produce the tubes is halved, with evident economic advantages.

[0025] This is achieved with a rolling mill composed of two-roller roughing stands, therefore structurally simple, and two final finishing stands 8 and 9 that having to support reduced rolling stresses, have far smaller dimensions than those that they would need were they arranged upstream in the rolling mill.

Claims

1. Method for rolling tubes on mandrels (2) actuated by means of a plurality of roughing (3-6) and finishing stands (8, 9), **characterised in that** it comprises a final tube finishing phase (10) operated with a pair of stands (8, 9) provided with four rollers (8a, 8b, 8c, 8d; 9a, 9b, 9c, 9d) with a perpendicular arrangement in each one.
2. Method according to claim 1, wherein the arrangement of the rollers (8a, 8b, 8c, 8d) of the first finishing stand (8) is staggered by 45° with respect to the arrangement of the rollers (9a, 9b, 9c, 9d) of the second

finishing stand (9).

3. Method according to claim 2, wherein upstream of the finishing stands (8,9) the tube (10) is rolled by a plurality of roughing stands (3-6) provided with two rollers (3a-3b; 4a-4b; 5a-5b; 6a-6b), with orientation staggered by 90°.
4. Method according to claim 3, wherein a pair (8c-8d) of rollers of the first finishing stand (8) has the same orientation as those (6a, 6b) of the last roughing stand (6).
5. Method according to the previous claims, wherein the rollers (3a-3b; 4a-4b; 5a-5b; 6a-6b) of the roughing stands (3-6) and the rollers (8a, 8b, 8c, 8d; 9a, 9b, 9c, 9d) of the finishing stands (8-9) are controlled.
6. Rolling mill for the actuation of the method according to claims from 1 to 5, comprising a pair of finishing stands (8, 9) provided with four rollers (8a, 8b, 8c, 8d; 9a, 9b, 9c, 9d) with a perpendicular arrangement inside each one.
7. Rolling mill according to claim 6, wherein the arrangement of the rollers (8a, 8b, 8c, 8d) of the first finishing stand (8) is staggered by 45° with respect to the rollers (9a, 9b, 9c, 9d) of the second finishing stand (9).
8. Rolling mill according to claim 7, wherein upstream of the finishing stands (8,9) a plurality of roughing stands (3-6) is present, provided with two rollers (3a-3b; 4a-4b; 5a-5b; 6a-6b) with an orientation staggered by 90°.
9. Rolling mill according to claim 8, wherein a pair (8c, 8d) of rollers of the first finishing stand (8) has the same orientation as those (6a-6b) of the last roughing stand (6).
10. Rolling mill according to claim 9, wherein the rollers (3a-3b; 4a-4b; 5a-5b; 6a-6b) of the roughing stands (3-6) and the rollers (8a, 8b, 8c, 8d; 9a, 9b, 9c, 9d) of the finishing stands (8-9) are controlled.

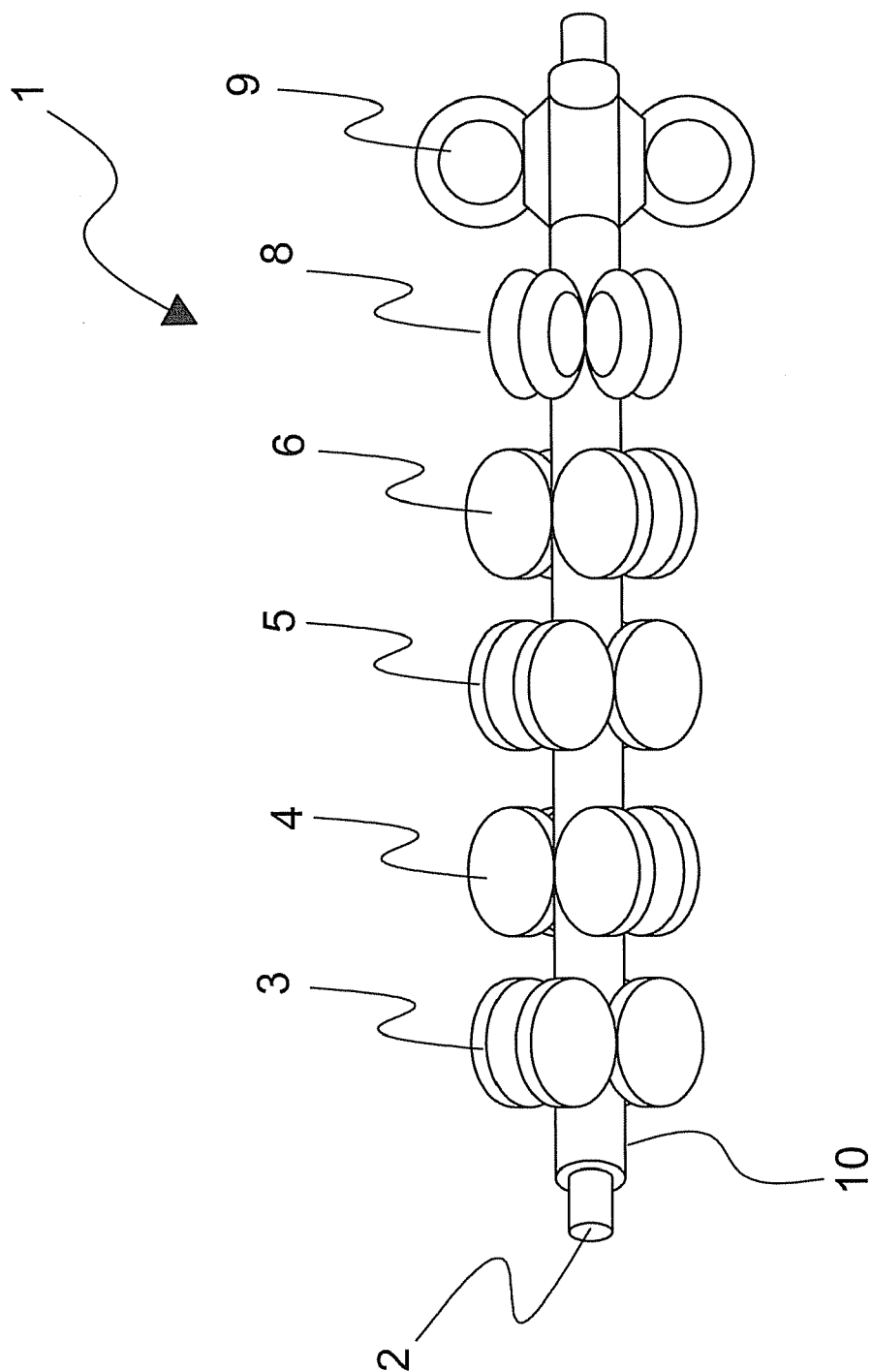
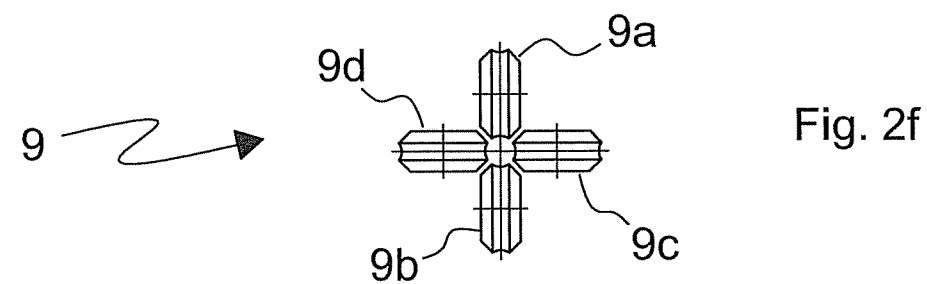
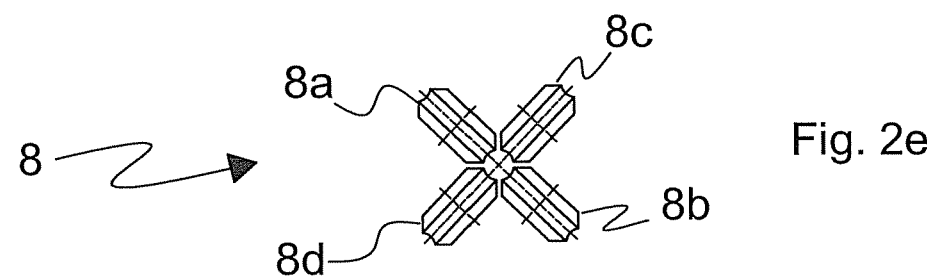
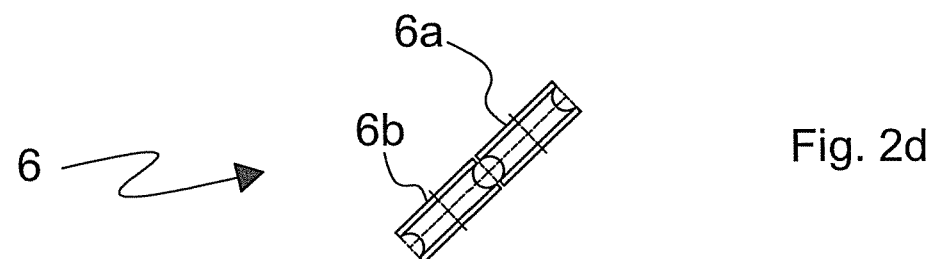
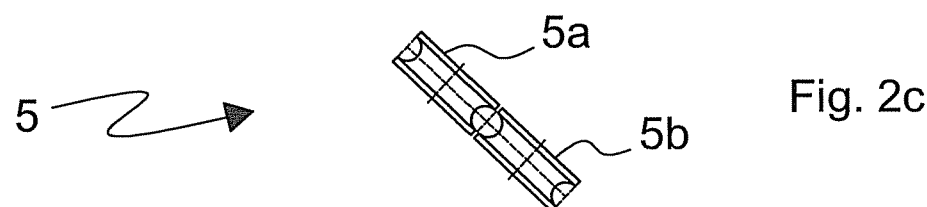
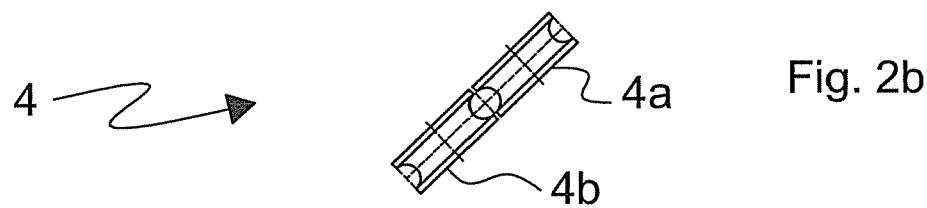
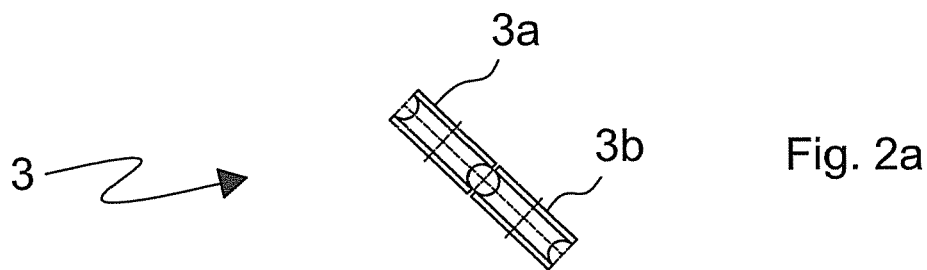


Fig. 1





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 10 0559

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Y	* page 5, line 10 - line 26; figures 1,3a,3b4-7 *	3,8	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 April 2006	Examiner Forciniti, M
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
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EP 06 10 0559

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