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(71) Applicant (for all designated States except US):
SCHNELL S.P.A. [IT/IT]; Via Borghetto, 2, I-61030
Montemaggiore al Metauro (PU) (IT).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **MIGLIORANZA,
Aronne** [IT/IT]; c/o SCHNELL S.P.A., Via Borghetto, 2,
I-61030 Montemaggiore al Metauro (PU) (IT).

(74) Agent: **MANZELLA & ASSOCIATI**; Via Nosadella, 9,
I-40123 Bologna (IT).

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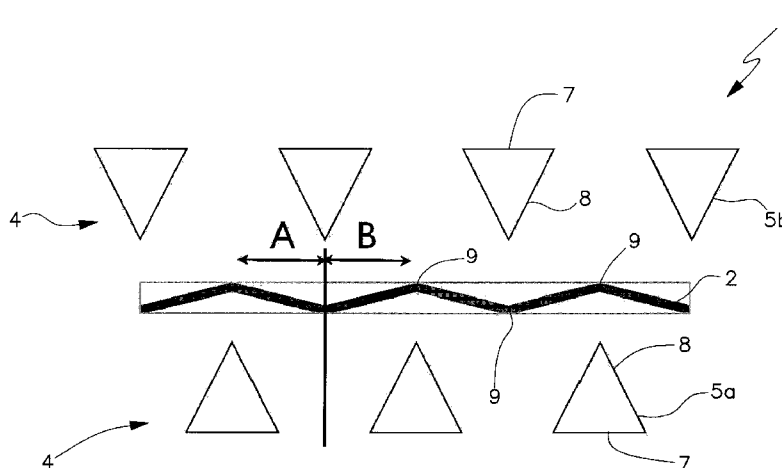


Fig. 1

(57) Abstract: The method for straightening iron rods and the like provides for subjecting the rod (2) to be straightened to the action of folder means (4) suitable to act in a discrete manner at a plurality of transverse sections (9), suitably spaced along a longitudinal axis (23) of the rod (2), from opposite parts with respect to such longitudinal axis (23), so as to realize on the same rod (2) a corresponding plurality of folds with curvature in opposite direction with respect to the longitudinal axis (23), such as to determine an undulated expansion with bights (21) having a substantially rectilinear effect.

DescriptionMETHOD AND APPARATUS FOR STRAIGHTENING IRON RODS AND THE
LIKETechnical Field

- [01] The present invention regards a method and an apparatus for straightening iron rods and the like, as well as the product thus obtained.

Background Art

- [02] It has been known that iron rods, used in particular for manufacturing reinforcements for reinforced concrete, are often obtained from rods prearranged in coil and unwound from respective reels to be worked in suitable operating machines. Such machines generally comprise apparatuses provided with suitable straightening members. The straightening members usually consist of operating members suitable to act on the iron rod being fed before it reaches the successive working stations, for example the cutting station and sometimes successively the folding station. Practically, such apparatuses are suitable to cancel both the lack of rectilinearity of the rod, and the curvature caused by the coil winding. To this aim, the straightener members subject the rod to suitable flexion actions of such an intensity to exceed the elastic limit of the material, so as to substantially cancel such curvature and make the straightening effect permanent.
- [03] Nowadays there are known various typologies of apparatuses for straightening iron rods. According to a widely known typology, illustrated for example in documents EP 0459869 and EP 0947256, the straightening apparatus comprises one or more straightening units consisting of couples

of counter-rotating wheels, sometimes also grooved, opposite with respect to the axis of the rod, to suitably engage the rod fed in advancement between them. The counter-rotating wheels are arranged in sequence and with parallel axis. For example, such apparatuses of known type can be equipped with a first straightening unit and a second straightening unit, suitable to prevalently correct corresponding components of the curvature of the iron rod, in particular on perpendicular planes, for example on a horizontal plane and a vertical plane. The counter-rotating wheels gradually correct the curvature of the rod, acting on opposite sides with respect to the rod being fed, so as to constraint this latter to have a substantially damped sinusoid profile, which has at last a rectilinear trend.

[04] Nevertheless, apparatuses with counter-rotating wheels do not allow to obtain a very precise straightening of the iron rods, but in compensation have the advantage of minimizing the alterations of the surface of the rod which, in the case of the iron rod for reinforced concrete, is purposely prearranged to match determined characteristics valued on the basis of a parameter defined "adherence index". This type of straightener is commonly named "roller straightener".

[05] In a different typology of straightening apparatuses, said with rotors, the straightener members are inserted inside a rotating member or rotor, suitable to be driven in rotation about an axis substantially coinciding with the feed direction of the rod. According to a known solution, illustrated for example in documents EP 0880415 and EP 1952906, the straightener members used in such rotors are constituted by inserts or reeds radially distributed inside the rotor, so as to act through rotating flexion on the

crossing iron rod. Practically, each straightener member presses and drags on the rod by effect of the rotating motion of the rotor and of the feed motion of the rod, consequently correcting the curvature of the rod in all the lying planes. But such apparatuses have the drawback of requiring frequent substitutions of the straightener members, because of the high friction that develops in the relative motion between inserts or reeds and the rod to be straightened. Moreover the continuous dragging action between the straightener members and the iron rod runs the risk of damaging in an unacceptable way the ribbing suitably made on the surface of the rod, flattening them over a limit value of the cited adherence index imposed by the regulations of the sector.

- [06] The cited frictional action implies again a high energy dispersion, verifiable in the sensible and diffuse heating of the straightened piece.
- [07] It is then necessary to consider that in such a type of apparatuses the iron rod to be straightened is stressed by a rotating flexion action which derives from the application of loads distributed on the whole length and directly applied on the surface of the rod through the straightener members. This can locally trigger stress, yield or plastification states, which can alter the mechanical features of the straightened piece in an unacceptable manner.
- [08] In a further different known solution, illustrated for example in document EP 1952906, the straightener members located inside the rotor are constituted by rollers rotating about axis suitably inclined with respect to the longitudinal feed axis of the rod. In these rotors, also said hyperbolic, the straightener members roll on the external surface of the rod to be straightened, so as to considerably reduce the wear and tear effects

deriving from the friction.

- [09] The solution with hyperbolic rotors reduces the risk of surface damage of the rod typical of the cited apparatuses with inserts or reeds rotors, substituting to the friction and rotating flexion action exerted by these latter, corresponding rotating rolling actions. The obtained straightening further results to have a high precision, with particular reference to the geometrical tolerance requirements imposed by the regulations of the specific sector.
- [10] Nevertheless, also the solution with hyperbolic rotors has drawbacks, ascribable to the fact that the rod to be straightened is subjected to considerable stresses directly and diffusely exerted by the rotating rollers or bushings, which can alter the mechanical features of the straightened piece.
- [11] Finally, the apparatuses with rotors as well as with hyperbolic rotors have drawbacks in the use in combination with folder apparatuses. In fact the rotor units have a considerable inertia and therefore it results difficult to stop them in order to perform any fold operation. To remedy such a drawback, avoiding the necessity to stop the rotating components, the cut is often realized by means of so-called "flying" systems having a considerable complexity.

Disclosure

- [12] The task of the present invention is that of solving the aforementioned problem, devising a method able to perform in an efficient way the straightening of iron rods and the like, maintaining substantially unaltered the mechanical and surface features thereof and optimally enabling the successive working and application thereof.

- [13] Within such a task, a further scope of the present invention is that of devising an apparatus able to actuate in an optimal manner the above mentioned method.
- [14] Another scope of the present invention is that of providing a method and an apparatus which enable to reduce the energy consumption necessary for straightening the iron rods.
- [15] Another object of the present invention is that of providing an apparatus having a simple conception, as well as a securely reliable functioning and versatile use.
- [16] Not least object of the present invention is to provide a product obtained through the above mentioned method, in particular consisting of a straightened rod with a substantially rectilinear trend.
- [17] The aforementioned scopes are attained, according to the present invention, by the method for straightening iron rods and the like according to claim 1, as well as by the apparatus according to claim 6 and by the product according to claim 16.

Description of Drawings

- [18] Details of the invention shall be more apparent from the detailed description of a preferred embodiment of the apparatus for straightening iron rods and the like, illustrated for indicative purposes in the attached drawings, wherein:
- [19] figure 1 shows a schematic front view of the apparatus for straightening iron rods and the like according to the invention;
- [20] figures 2A, 2B, 2C and 2D show respective schematic lateral views of the apparatus in hand, according to different embodiments;

- [21] figures from 3 to 6 show respective front views of the apparatus in hand in successive operating steps;
- [22] figures 7, 7A and 8 respectively show a schematic front view of the apparatus for straightening iron rods according to further embodiments;
- [23] figure 9 schematically shows the product obtained by means of the apparatus according to the invention;
- [24] figures 10A, 10B and 10C respectively show a schematic front view of the apparatus in successive operating steps of a different embodiment of the method in hand.

Best Mode

- [25] With particular reference to such figures, the apparatus for straightening iron rods 2 according to the invention is indicated in its entirety with 1.
- [26] The apparatus 1 comprises means 3 for feeding the rod 2 according to a longitudinal feed axis 23 designed to coincide with the longitudinal axis of the straightened rod (figures 3 and 8), as better explained in the following. The feeding means 3 can be for example of known type with counter rotating rollers (figure 3).
- [27] According to the present invention, the apparatus 1 comprises folder means 4 arranged at opposite sides with respect to the longitudinal axis of the rod 2 to be straightened. As schematically represented in figure 1, the folder means 4 comprise respectively a first series of teeth 5a and a second series of teeth 5b suitable to stress at opposite parts the iron rod 2 to be straightened. The first series of teeth 5a is suitable to be supported by a first support 6a, while the second series of teeth 5b is suitable to be supported by a second support 6b. Between the first series of teeth 5a and

the second series of teeth 5b there is suitable to be interposed a portion of at least one rod 2 to be straightened, oriented according to the above mentioned longitudinal feed axis 23.

[28] The teeth 5a and 5b are arranged in a staggered way with respect to the longitudinal axis of the iron rod 2 interposed therebetween, so that the undulations imparted to the same rod reciprocally compensate each other. The teeth 5a, 5b are preferably distributed in a regular way, with substantially constant step, on the respective supports 6a, 6b, in such a way that the longitudinal offset A, B between each tooth of a series and the successive tooth of the other series repeats with a substantially unvaried pattern along the interposed rod tract (figure 1) to obtain the mentioned reciprocal compensation. In substance, as specified in the following, the compensation straight line of the broken line obtained after the action of the folder means is such as to approximate as close as possible the ideal axis of the rectilinear rod which is desired, the relative undulations being such as not to be over the acceptability limits of the specific product. Furthermore it is preferable that such longitudinal offsets A, B are substantially equal, so as to intercept equidistant sections of the aforementioned portion of rod 2 interposed and to produce, through the use of the folder means 4, a sequence of symmetric undulations of the intercepted tract of rod, as better explained in the following.

[29] Each tooth 5a, 5b provides a base 7 for connecting to the respective support 6a, 6b and an end portion 8, preferably having a pointed shape or anyway having a decreasing front section, suitable to intercept a respective transverse section 9 of the iron rod 2. Each series of suitably distanced

teeth 5a, 5b is therefore suitable to interact in a distanced, that is discretized, way on the interposed iron rod 2, acting only on the intercepted transverse section 9. In other words, the distanced configuration of the teeth 5a, 5b on the supports 6a, 6b allows to selectively stress the rod 2 in the straightening operation, that is, only at the intercepted transverse sections 9, and leaving instead the intermediate portions of rod 2 free from any stress.

- [30] The end portion 8 of each tooth 5a, 5b has preferably a fold transverse profile 10, shaped in a way as to act on a plurality of distanced points of the intercepted transverse section 9. According to a preferred embodiment represented in figure 2A, each fold profile 10 is defined by a couple of fold segments 11 converging and symmetric with respect to a median longitudinal plane. Each fold segment 11 is therefore suitable to intercept in use a corresponding surface portion 12 of the rod 2 ideally punctiform or anyway with very reduced expansion. Obviously different conformations of the profile 10 can be provided, for example with a polygonal broken line defined by a greater number of segments 11 or with another shape.
- [31] The conformation of the profile 10 of the teeth 5a, 5b determines the radial orientation of the stresses acting in discrete way on the rod 2 to be straightened in the contact points. More precisely, the orientation of the interactions operating at the single intercepted transverse sections 9 turns out to be substantially perpendicular to the tangency plane characterized by each one of the segments 11 gripping on the rod 2.
- [32] According to further embodiments represented respectively in figures 2B, 2C, 2D, teeth 5a, 5b can provide a plurality of profiles 10 arranged

transversally in sequence. Each profile 10 is thus suitable to receive a respective rod 2 in order to simultaneously perform the straightening thereof.

- [33] The apparatus 1 further comprises actuation means, already known and therefore not represented in the figures for sake of simplicity, suitable to drive in reciprocal motion the first series of teeth 5a and the second series of teeth 5b so as to subject the interposed iron rod 2 to corresponding folding opposite actions.
- [34] According to the embodiment represented in the figures from 3 to 6, the actuation means are suitable to actuate the first support 6a and the second support 6b in a relative motion of alternated shift, to actuate the reciprocal approach and separation. As an example the first support 6a can be arranged fixed, while the second support 6b can be shifted alternatively between an approached configuration (figures 3 and 5) and a spaced configuration (figures 4 and 6) according to the direction indicated by the arrow C of the figures from 3 to 6. In alternative it is possible to provide that one only support, for example the first support 6a, is mobile, while the second support 6b is fixed, or that both supports 6a, 6b are mobile.
- [35] In any case, at the approached configuration the interposed rod 2 is tightened with a predetermined force between the teeth 5a and 5b or, more precisely, is seized by the teeth 5a, 5b in the sole surface zones 12. Therefore following such a seizing or gripping, the rod 2 is stressed by localized flexion actions at the only intercepted transverse sections 9.
- [36] Thanks to the staggered and opposite placement, the teeth 5a, 5b are suitable to be reciprocally approached in direction transverse to the feed

axis 23 over the same feed axis 23 (figures 3, 5, 8), originating a kind of penetration between the teeth 5a, 5b, suitable to perform a predetermined and controlled longitudinal succession of folds on the rod 2. For each portion straightened according to the described method and apparatus, the rod 2 substantially turns out to be folded about the end portion 8 of each tooth 5a, 5b active in the aforesaid seizing. Such a localized folding action takes place in absence of reciprocal friction between the teeth 5a, 5b and the rod 2. In other words, the relative speed between the active portions of the teeth 5a, 5b and of the tightened transverse sections 9 is substantially of null value during the described actuation step.

- [37] On the whole, the intercepted and seized tract of rod 2 undergoes a particular deformation characterized by an undulated shape, the width 22 of which, determined at will on the basis of the dynamic and structural parameters of the folder means 4, repeats regularly at parts opposite to the longitudinal axis of the rod 2 (see figure 9). The width 22 of such an undulated shape has the further feature of having an algebraic sum for each couple of successive waves or bights 21 such as to reciprocally cancel with a compensative straightening effect. More precisely, if the longitudinal offset A, B between the teeth 5a, 5b is equal and constant, such an undulated shape results regular. As illustrated in figure 1, by effect of the substantially regular width 22 of the bights 21 the undulated conformation of the rod 2 obtained following the action of the folder means 4 can approximate a substantially rectilinear trend with good precision. It is therefore possible to obtain the wanted tolerance by varying suitably the step and the width of the undulation. In the spaced configuration of the

supports 6a, 6b the so shaped iron rod 2 is made free from the grip of the same teeth 5a, 5b and released from any localized compression action in order to enable the successive feed.

[38] The cited feed means 3, preferably located upstream of the folder means 4, provide to feed the rod 2 in suitable step relation with respect to the separation and approach motion of the supports 6a, 6b. In particular, the feed means 3 are suitable to perform the stepwise feed of the rod 2 being worked when this latter is free from the grip of the teeth 5a, 5b and the supports 6a, 6b are in the separated configuration (see figures 4 and 6).

[39] According to a preferred embodiment, particularly advantageous, represented in figure 7, the feed means 3 are integrated to the folder means and provide to feed and in the meantime to actuate the teeth 5a, 5b to continuously straighten the iron rod 2. More precisely the teeth 5a, 5b are fixed to flexible supports for example of the belt or chain type, so as to constitute respective girdle elements. It is therefore provided a first girdle 60a carrying the first series of teeth 5a and a second girdle 60b to which is fixed the second series of teeth 5b. The first girdle 60a and the second girdle 60b are respectively wound on feed and actuation means 13 consisting of couples of wheels 30. Such wheels 30 are suitable to be set in rotation in a continuous way. Each girdle wound on the wheels 30 defines an active branch 14a, 14b and an inactive branch 15a, 15b both substantially rectilinear. The respective active branches 14a, 14b of the first girdle 60a and of the second girdle 60b are arranged facing substantially parallel, so as to receive therebetween a rod 2 in the cited wave deformed configuration. More precisely the winding of the girdles 60a, 60b on the

wheels 30 is realized in such a way as to produce a determined offset, preferably constant and regular, between the teeth 5a and 5b. By virtue of such an offset the teeth 5a, 5b of the active branches 14a, 14b are arranged with the respective end portions 8 transversely protruding over the longitudinal feed axis 23, in a kind of reciprocal penetration suitable to determine the undulated deformation described in the preceding, through discrete folding actions. The continuous actuation of the wheels 30 is suitable to produce the progressive grip of the only transverse sections 9 of the rod 2, the progressive folding of corresponding portions of the rod 2 about the end portion 8 of each tooth 5a, 5b, as well as the progressive and continuous feed of the rod 2 by means of the feed of the grip portion.

[40] As in the embodiment illustrated in the figures from 3 to 6, also in this case, but by effect of a continuous feed motion instead of an alternative feed motion, each tooth 5a, 5b is subject to an alternated motion of reciprocal approach and separation, respectively in the tracts of the girdles 60a, 60b wound to the wheels 30 upstream and downstream of the active branches 14a, 14b, for gripping or seizing and releasing of corresponding transverse sections 9. In fact in the same way, the teeth 5a, 5b perform inflexions, that is folding, of alternatively opposite direction on the portion of rod 2 interposed along the active branches 14a, 14b, producing as an effect the controlled wave deformation which result in the straightening of the rod 2.

[41] In particular, it is to observe that the contact between the teeth 5a, 5b of the active branches 14a, 14b and the respective intercepted transverse sections 9 occurs, as in the previously described embodiment, without friction, so with a substantially relative speed of null value. Furthermore it is

important to note that the insertion in grip and the release of a tract of rod 2 between the active branches 14a, 14b occurs by effect of the continuous rotation of the wheels 30 which produces the approach and the separation of the teeth 5a, 5b in the branches of the girdles wound on the wheels. The intercepted transverse sections 9 are therefore seized by the folder means 4 and fed along the active branches 14a, 14b.

- [42] It is also important to note that the contact between the folder means 4 being fed and the inserted rod 2 is limited to the only intercepted transverse sections 9. Therefore in the ideal case wherein the contact occurs in a punctiform way on the surface of the rod 2, no substantial relative motion between said folder means 4 and the rod 2 occurs. In fact at the difference of a rolling motion, the contact of the folder means 4 driven in motion is discontinuous, that is designed to involve solely separated and discrete sections of the rod 2.
- [43] According to a not illustrated constructive variant, both branches 14a, 14b, or part thereof, could be not parallel or even not rectilinear to make the operations of insertion and straightening of the rod easier.
- [44] According to a further embodiment, it is possible to provide in a particularly advantageous way a plurality of couples of girdles 60a, 60b as described in the preceding, acting also on different planes of the rod 2 to be straightened. As an example a first couple of girdles can be suitable to act on a plane according to the described modality, while a second couple of girdles, inclined with respect to the previous one, is suitable to act on an inclined plane, preferably orthogonal, with respect to the previous one, for an optimal straightening of rod particularly difficult or having important

transverse dimensions. The effect of the folding action on multiple planes involves a further compensation of the undulated trend of the so obtained product, with a whole reduction of the width of the bights or waves and so a straightening geometrically more precise.

[45] Figure 7A shows a different embodiment of the apparatus, wherein the path of the said girdles 60a, 60b is diverted at the active branches 14a, 14b towards the detour 61a, 61b. The detours 61a, 61b are suitable to lengthen the said path of the girdles 60a, 60b of a tract corresponding to a half of the distance between the teeth 5a, 5b. As a consequence, after the detour 61a, 61b the teeth 5a, 5b reach the rod 2 at the transverse sections previously engaged by opposite teeth. Suitable counterfolds of the same transverse sections are therefore produced.

[46] According to a different embodiment represented in figure 8, the apparatus 1 can realize the straightening of rod 2 through the discretized grip and folding action performed by teeth carried by respective cogwheels 50a, 50b driven in continuous rotation. More precisely the apparatus comprises at least a first cogwheel 50a and a second cogwheel 50b, carrying teeth 5a, 5b of the type of the ones described in the preceding, opposite with respect to the interposed rod 2. The rod is fed thanks to the actuation in continuous rotation of the same wheels 50a, 50b. The first cogwheel 50a and the second cogwheel 50b are arranged with the teeth reciprocally staggered, so as to realize, as previously described, the straightening resulting from the alternated and compensated inflexion of successive tracts of the crossing rod. More precisely, in this case the resulting straightening effect is obtained by the localized and discontinuous seizing performed by the teeth

carried by respective facing portions of the cogwheels. Obviously it is possible to provide for a plurality of couples of cogwheels 50a, 50b acting in sequence on the rod 2, as represented.

- [47] It is also possible to prearrange the apparatus according to the invention as a combination of two or more of the described embodiments, suitably arranged in series. For example it is possible to provide for arranging in series first straightener members consisting of cogwheels 50a, 50b and second straightener members consisting of couples of girdles 60a, 60b as described in the preceding.
- [48] In any case, the product 20 obtained through the use of the apparatus according to one of the illustrated embodiments has an undulated shape with regular bights 21, with a width 22 reduced at will, that approximates and has the effects of a rod having a perfectly rectilinear expansion (fig. 9). In such an undulated shape the bights 21 are arranged in a repeated and regular way about a longitudinal symmetry axis 23 substantially rectilinear by the fact that the algebraic sum of the same bights 21 with respect to the aforementioned symmetry axis 23 is suitable to reciprocally cancel with a compensative straightening effect. In particular, the undulated shape with regular bights of the obtained product 20 also has the effects of a sufficiently rectilinear rod, in that it allows the easy and regular winding of the rod on any flat surface, so called "easy rotate", as in use in the empiric custom of the specific sector for the evaluation of the suitability for use of such products.
- [49] The method for straightening iron rods and the like according to the invention turns out to be easy to understand from the preceding description.

- [50] The iron rod 2 to be straightened is fed by the feed means, separated or integrated in the system, according to a longitudinal feed direction and inserted stepwise or continuously between the folder means 4.
- [51] Through the controlled activation of the actuation means, the teeth 5a, 5b opposite and offset are actuated in grip on corresponding transverse sections 9, triggering transverse folding stresses, discretized and at opposite sides along the longitudinal axis of the rod 2. Such controlled stresses are suitable to cancel the curvatures from the rod 2, producing an undulation the width 22 of which results controlled and transversely compensated, with an effect of substantial straightening of the same rod 2. The entity and the expansion of such undulation are in fact controllable on the basis of the constructive and regulation parameters of the folder means 4, for example on the basis of the entity of the imposed inflexion stress and of the conformation of the teeth 5a, 5b.
- [52] The successive actuation of the folder means 4, intermittent or continuous according to the embodiment, determines in any case the release of the so straightened tract of rod 2 and the insertion of a new tract of rod 2 to be straightened between the same folder means 4, respectively in an alternated or continuous way.
- [53] According to a preferred embodiment of the method in hand, useful in particular for straightening rod having important transverse dimensions or particularly twisted initial conditions, it is possible to provide for performing the feed of the rod 2 by a tract corresponding to a multiple of the step or by a fraction thereof between the teeth 5a, 5b, so as to subject the same transverse sections 9 to repeated flexion actions at alternatively opposite

parts, thus reinforcing the compensation effect of the residual tensions in the rod 2 being worked.

- [54] Practically, a first straightening step acts on a transverse section 9 through a tooth of the first series 5a of teeth, realizing a first fold operation of the rod 2; following the feed of the rod 2, the same transverse section 9 is subjected to the action of a tooth of the second series 5b of teeth, opposite to the first one.
- [55] In particular, advantageously operating a second folding staggered by half a step in longitudinal direction, as can be seen in figures 10A, 10B and 10C, it is possible to substantially cancel the residual undulation. This implies a considerable advantage in the cases wherein the residual undulation, although reduced, can trigger problems in any case.
- [56] In substance, this successive action has the scope of realizing a counterfold of the rod 2, that is a fold according to the flexion direction opposite to the direction of the fold performed in the same section 9 by the previous folder means, with the scope of cancelling in whole or in part the characteristic undulations of the system of discretized straightening described in the preceding. Practically, after having performed the first fold (figure 10A), the feed of the rod is operated for a tract equal to half a step, as indicated with broken line 2a in figure 10B; at such a point, operating a second folding or counterfolding at the same sections 9 (figure 10C), the substantial elimination of the residual undulation is obtained.
- [57] Obviously it is possible to provide that the aforesaid first fold and second fold or counterfold, staggered by half a step, are realized by folder means differently shaped, as previously said. In particular, it is possible to provide

that the first fold is realized by first straightener members consisting of couple of girdles 60a, 60b and the second fold or counterfold by second straightener members consisting of cogwheels 50a, 50b. Advantageously, in this case, the couples of girdles 60a, 60b also perform the function of feeding the rod. In substance the first straightener means and the second straightener means are distanced from each other in such a way that the bights imparted on the rod result staggered by half a step so that the undulations created to straighten the rod by the first straightener means are substantially cancelled by the second straightener means.

- [58] The method for straightening iron rods and the like according to the invention allows to operate in an efficient way the straightening of iron rods and the like, maintaining substantially unaltered the mechanical features thereof and allowing in an optimal way the successive working thereof. Such a scope is attained thanks to the discretized and controlled action of the folder means 4. In particular such folder means 4 are suitable to act in a controlled manner on discrete transverse sections 9, distanced from each other in a suitable way, so as to produce in the rod 2 an undulating deformation suitable to represent the straightening of the same rod 2. In fact the deformation resulting from the action of the folder means 4 is given by an undulation having a controlled width 22, that is small at will, in relation to the tolerances of the specific application sector, compensated in whole at each side of the rod being worked and the medium axis of which has a substantially rectilinear trend.
- [59] A characteristic of the invention is given by the fact that the action of folder means 4 is represented by concentrated transverse stresses, ideally

punctual or at least extended to surface zones 12 of reduced extension of the rod 2. This minimizes the dynamical actions exerted on the whole on the rod in the straightening step and so reduces the energetic consumption of such a working and implicitly also the possible alterations introduced in the straightening. In other words, at the difference of the known straightening methods, the action of the folder means 4 is not distributed along the entire rod 2, but involves only discretized sections of the rod 2.

[60] This implies a considerable reduction of the risk of deterioration of the mechanical features and of the surface quality of the same, overcoming an important drawback of traditional methods, wherein instead the rod to be straightened is subjected to continuous friction or rolling actions suitable in any case to involve every section of the rod. In particular the contact operated by the folder means 4 according to the invention is discretized and discontinuous along the longitudinal expansion of the rod 2.

[61] Again, the method according to the invention and the apparatus which actuates it, have the characteristic of subjecting only determined sections of the rod to be straightened to flexion actions, thus considerably reducing both the risk of damaging the same, and the energy necessary for the process. As a consequence also the surface state of the rod gets benefit therefrom, resulting substantially unaltered with respect to how it is realized in steelworks. On the other hand, known straightening methods and apparatuses have the common characteristic of subjecting without discrimination each section of the rod to be straightened to a dynamical alternated flexion action which subjects the material to a so-called "fatigue" stress. Such a "fatigue" stress, deriving from continuous folding and

counterfolding actions which deteriorate in a major measure the mechanical features of the material with respect to the maximum undergone stress, obviously weighs considerably upon the energy waste.

- [62] The innovative form of straightening object of the present invention, at the difference of the prior art, has the particular characteristic of subjecting only determined sections of the rod to be straightened to flexion actions, thus considerably reducing both the risk of damaging the same, and the energy necessary to the process. Moreover also the surface of the rod benefits considerably therefrom remaining substantially unaltered with respect to how it is produced in the steelworks.
- [63] It is also important to observe that the fold action operated by the apparatus according to the invention occurs in an operating condition wherein the relative speed between the teeth 5a, 5b and the corresponding intercepted transverse sections 9 is substantially of null value. The absence of any mechanical friction action further reduces the heat developed during the straightening and preserves the surface integrity of the rod 2, particularly the state of the surface ribbing, the dimensional characteristics of which, especially relating to the transverse protruding, must satisfy regulations in force.
- [64] It is to observe that the method for straightening iron rods according to the invention is very versatile. In facts it is possible to adapt the operating steps, as well as the involved dynamical and constructive parameters, to perform the optimal straightening of any type of rod. In particular, as previously described, it is possible to set up the actuation of the folder means 4 with the feed of the rod 2, so as to realize a counterfold of the rod

2 to straighten in optimal and repeatable way rods 2 particularly twisted or having particular dimensions.

[65] It is eventually to note that the product 20 obtained through the method according to the invention represents a result of very precise straightening. In particular, the rod straightened as described has an undulated trend, reproduced in sequence in a precise way, with regular waves of constant width reduced at will the widths of which compensate each other, therefore suitable to approximate a substantially rectilinear expansion of the median axis. Furthermore the products is free from deteriorations of the surface and mechanical features by virtue of the folding performed in a discontinuous way, that is discretized, according to the method object of the invention, to realize the aforesaid waves.

[66] In practice, the embodiment of the invention, the materials used, as well as the shape and dimensions, may vary depending on the requirements.

[67] Should the technical characteristics mentioned in each claim be followed by reference signs, such reference signs were included strictly with the aim of enhancing the understanding the claims and hence they shall not be deemed restrictive in any manner whatsoever on the scope of each element identified for exemplifying purposes by such reference signs.

Claims

1. Method for straightening iron rods and the like, **characterized in that** it subjects the rod (2) to be straightened to the action of folder means (4) suitable to act in discrete manner at a plurality of transverse sections (9), suitably spaced along a longitudinal axis (23) of said rod (2), from opposite parts with respect to said longitudinal axis (23), in a way as to realize on the same rod (2) a corresponding plurality of folds with a curvature in the opposite direction with respect to said longitudinal axis (23), such as to determine an undulating expansion with bights (21) having on the whole a substantially rectilinear trend.
2. Method according to claim 1, **characterized in that** it feeds said rod (2) for subjecting said transverse sections (9) of the same rod (2) to a further action of said folder means (4), such as to realize in said transverse sections (9) corresponding counterfolds, having a curvature in the opposite direction with respect to the direction of the folds previously made.
3. Method according to claim 2, **characterized in that** it provides for operating the feed of said rod (2) of a tract corresponding to half a step of said undulating expansion with bights (21) of the same rod (2), in a way as to substantially eliminate the residual undulation.
4. Method according to claim 1 or 2, **characterized in that** it comprises the following operating steps:
 - a. feeding at least one said rod (2) according to said longitudinal feed axis (23);
 - b. interposing a portion to be straightened of said rod (2) between said folder means (4) suitable to act in a discrete manner alternatively from

opposite sides at said transverse sections (9) longitudinally spaced of said portion of the rod (2);

c. handling in movement said folder means (4) from an inactive configuration separated from said transverse sections (9) to an active configuration approached in contact of said transverse sections (9), suitable to stress said transverse sections (9) until a condition of substantial reciprocal penetration of said folder means (4) in direction transverse to said longitudinal feed axis (23), in order to realize said undulating expansion with bights (21) of said interposed portion of the rod (2);

d. taking said folder means (4) back into said inactive configuration separated from said transverse sections of said rod (2).

5. Apparatus for straightening iron rods and the like, **characterized in that** it comprises means (3, 30) for feeding the rod (2) to be straightened along a longitudinal feed axis (23); folder means (4) suitable to act in a discrete manner at a plurality of transverse sections (9) of said rod (2), suitably spaced along said longitudinal feed axis (23) of said rod (2), arranged at opposite sides with respect to said longitudinal feed axis (23), and mobile between a separated inactive configuration and an active configuration approached in contact of said transverse sections (9); handling means suitable to handle in movement said folder means (4) alternatively between said separated configuration and said active configuration approached in contact of said transverse sections (9), in a way as to realize on the same rod (2) a corresponding plurality of folds with a curvature in the opposite direction with respect to said longitudinal axis (23), such as to determine an

undulating expansion with bights (21) having a substantially rectilinear trend.

6. Apparatus according to claim 5, **characterized in that** said folder means (4) comprise a first series of teeth (5a) and a second series of teeth (5b) carried by respective support means (6a, 6b), opposite in a discontinuous way and shifted with respect to said longitudinal axis (23) of said rod (2) to be straightened, said teeth (5a, 5b) comprising an end portion (8) suitable to intercept a respective transverse section (9) of the rod (2).
7. Apparatus according to claim 6, **characterized in that** said teeth (5a, 5b) have at said end portion (8) a fold transverse profile (10), shaped in a way as to act substantially on a plurality of distanced points of a said transverse section (9).
8. Apparatus according to claim 7, **characterized in that** said fold transverse profile (10) is defined by a couple of fold segments (11) converging and symmetric with respect to a medial longitudinal plane.
9. Apparatus according to claim 7, **characterized in that** said teeth (5a, 5b) comprise a plurality of profiles (10) arranged transversally in sequence, to receive a corresponding plurality of rods (2) to be straightened.
10. Apparatus according to claim 6, **characterized in that** said support means (6a, 6b) comprise flexible supports carrying said teeth (5a, 5b) in a way as to shape a respective first girdle element (60a) and a second girdle element (60b), wound on feed and handling means (13) in continuous, said first girdle element (60a) and said second girdle element (60b) being provided with respective active branches (14a, 14b), at which said teeth (5a, 5b) are facing, shifted and at least partially penetrated in direction transverse to

said longitudinal feed axis (23), to realize said undulating expansion with bights (21) of said rod (2).

11. Apparatus according to claim 10, **characterized in that** said active branches (14a, 14b) are arranged converging according to the rod (2) feed direction, in order to aid the operations of insertion and straightening thereof.
12. Apparatus according to claim 6, **characterized in that** said teeth (5a, 5b) are carried staggered by respective opposite cogwheels (50a, 50b) suitable to be handled in continuous rotation movement for straightening a said interposed rod (2).
13. Apparatus according to claim 6, **characterized in that** said handling means are suitable to handle said teeth (5a, 5b) carried by said first support (6a) and by said second support (6b) in a relative movement of alternated translation, of approaching until a sort of penetration in direction transverse to said longitudinal feed axis (23), and of reciprocal removing, in suitable phase relation to said feed means (3) suitable to be handled stepwise.
14. Apparatus according to claim 5, **characterized in that** it comprises first folder means suitable to realize a first fold at said plurality of transverse sections (9) of the rod (2) and second folder means arranged in series to said first folder means and suitable to subject the same transverse sections (9) of the rod (2) to a further action to realize corresponding counterfolds, having a curvature in opposite direction with respect to the direction of the folds previously made.
15. Apparatus according to claim 14, **characterized in that** said second folder means are arranged shifted with respect to said first folder means of a tract

corresponding to half a step of said undulating expansion with bights (21) of the rod (2), in a way as to substantially eliminate the residual undulation.

16. Apparatus according to claim 14 or 15, **characterized in that** said first and second folder means respectively comprise girdle elements (60a, 60b), provided with teeth (5a, 5b), and/or opposite cogwheels (50a, 50b).
17. Product obtained through the method for straightening iron rods and the like according to one of the claims from 1 to 4, **characterized in that** it has an undulating shape with regular bights (21), having a width (22) reduced at will, that approximates and has the effects of a rod having a perfectly rectilinear expansion, said bights (21) being arranged in a repeated manner around a longitudinal symmetry axis (23) substantially rectilinear by the fact that the algebraic sum of the same bights (21) with respect to said longitudinal symmetry axis (23) is suitable to reciprocally annul with a compensative straightening effect.

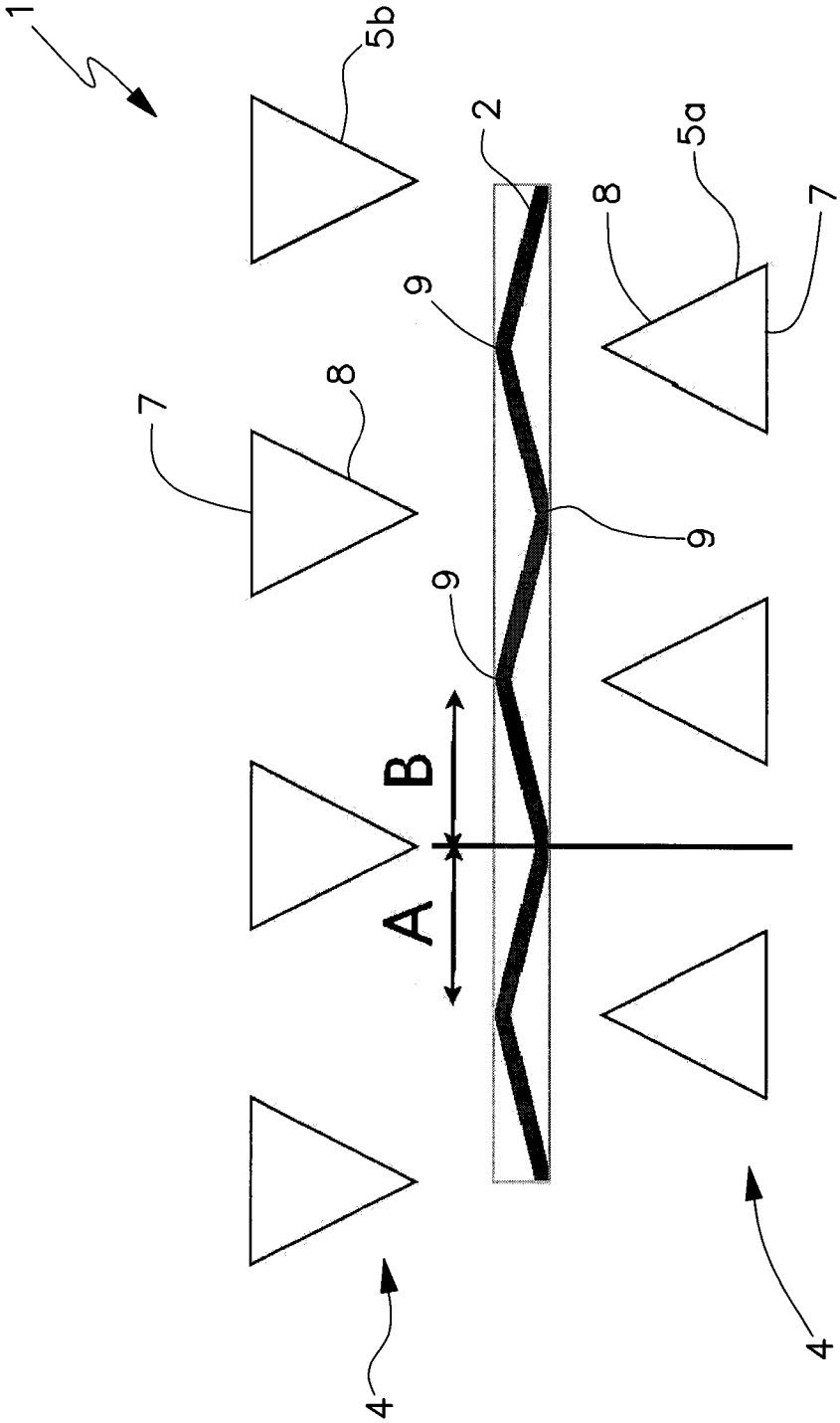
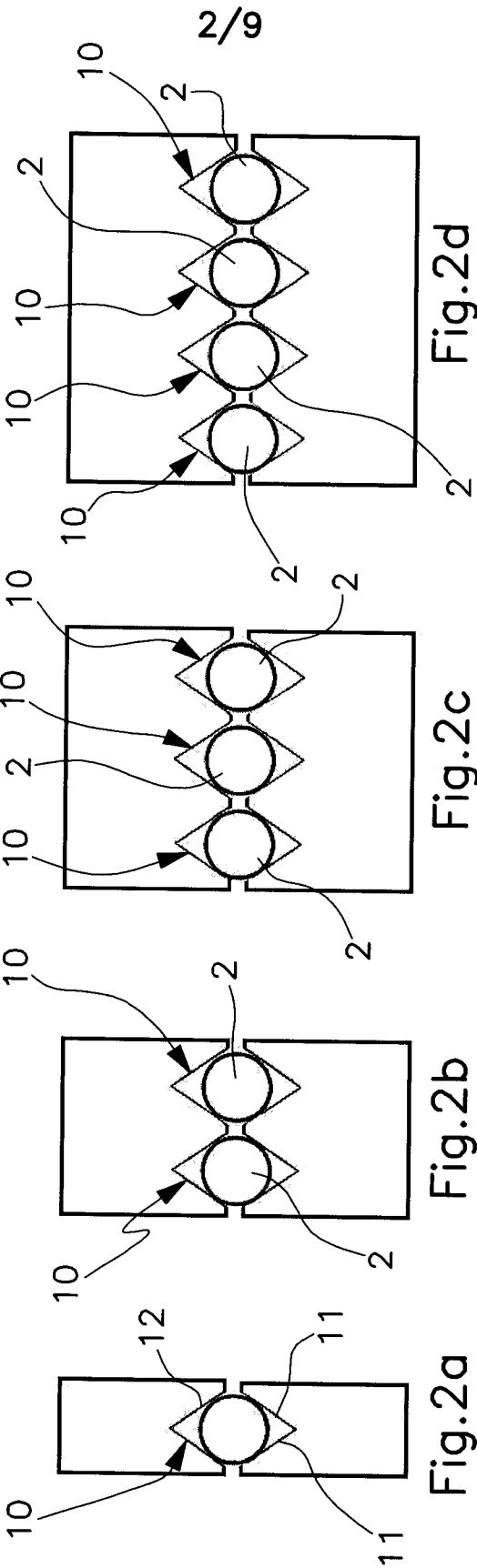
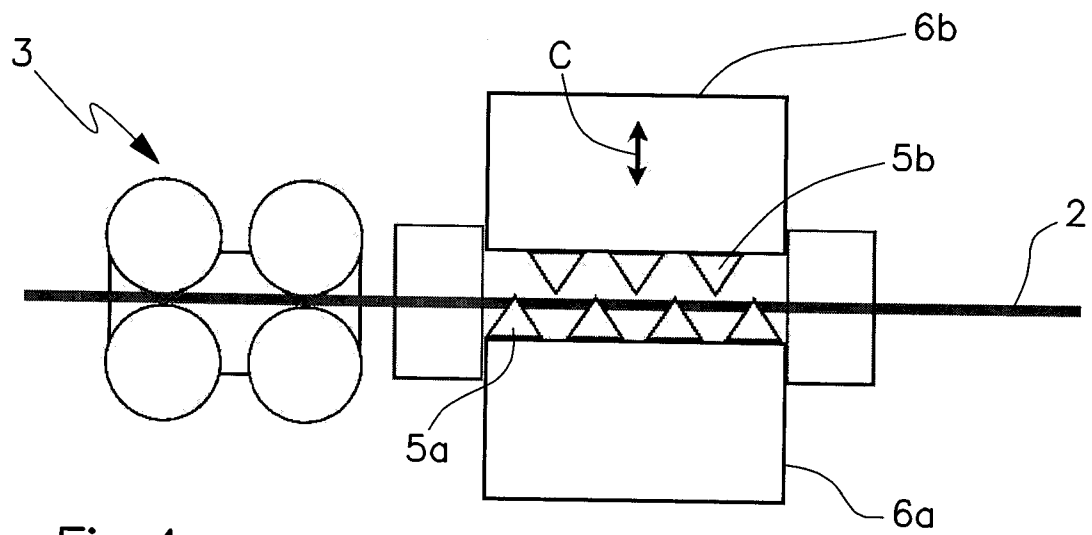
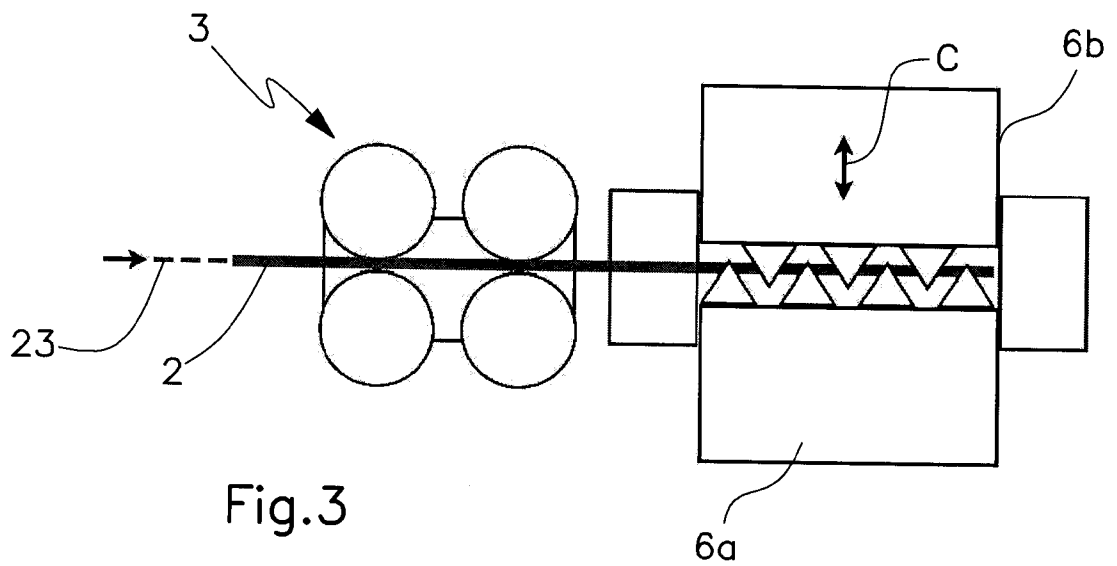


Fig.1



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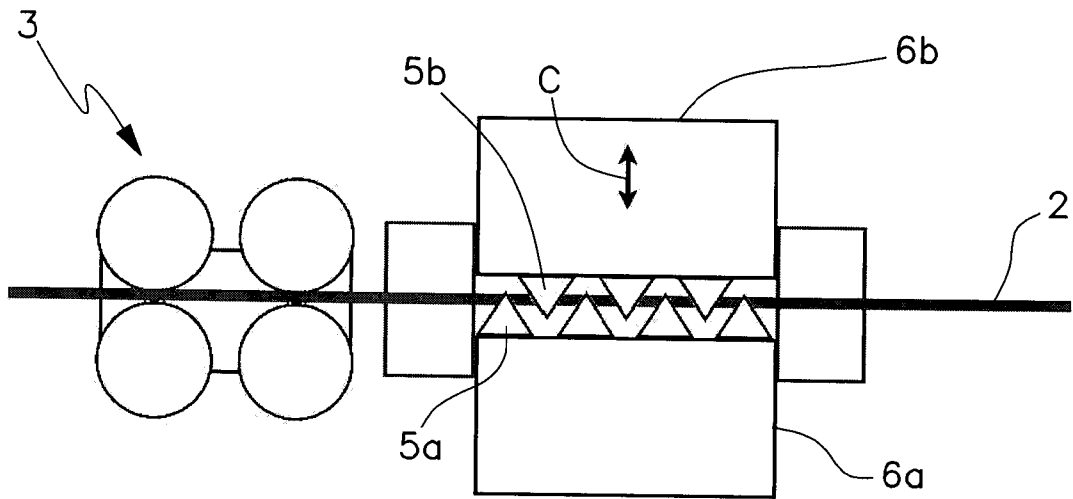


Fig.5

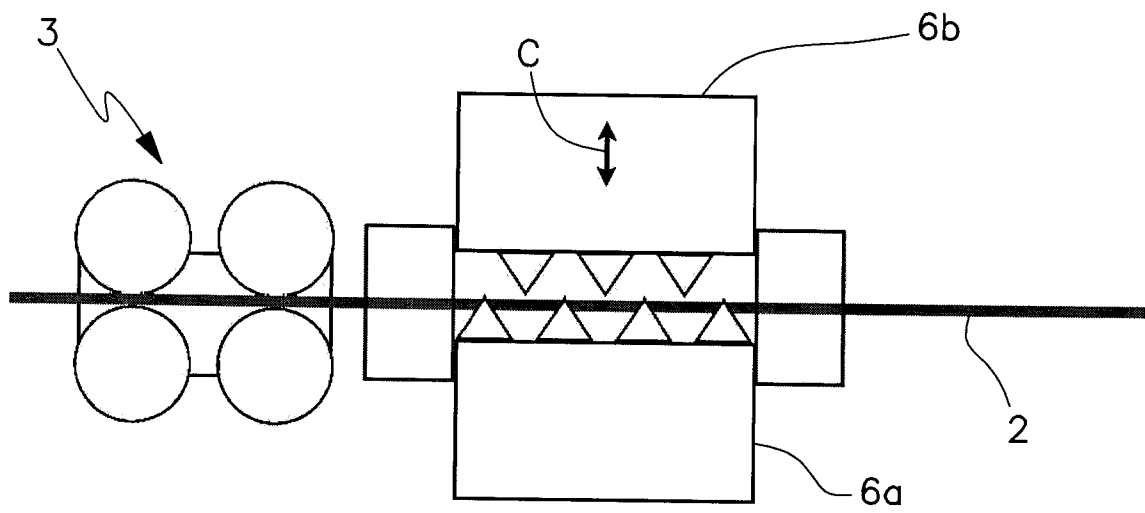


Fig.6

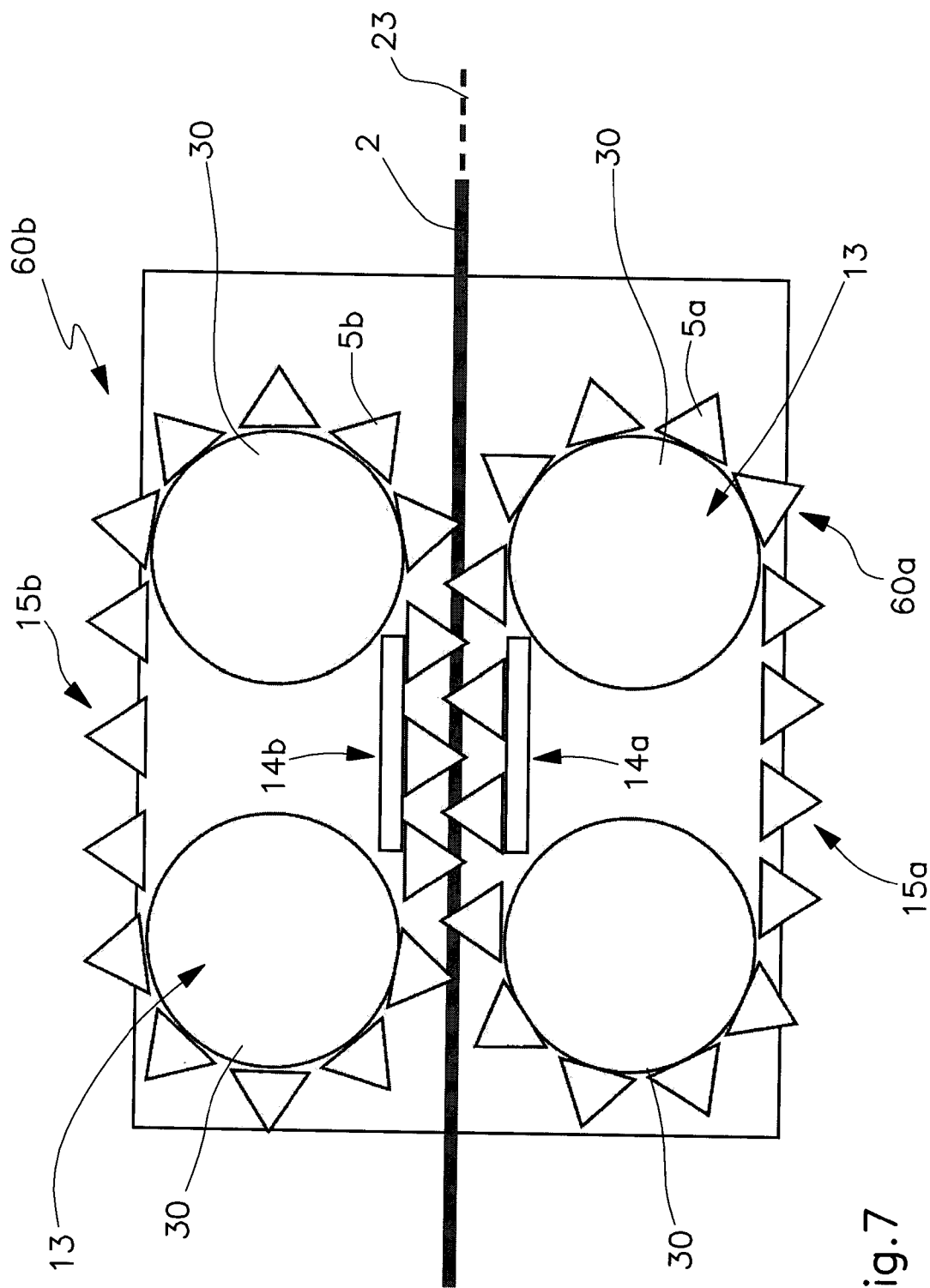


Fig.7

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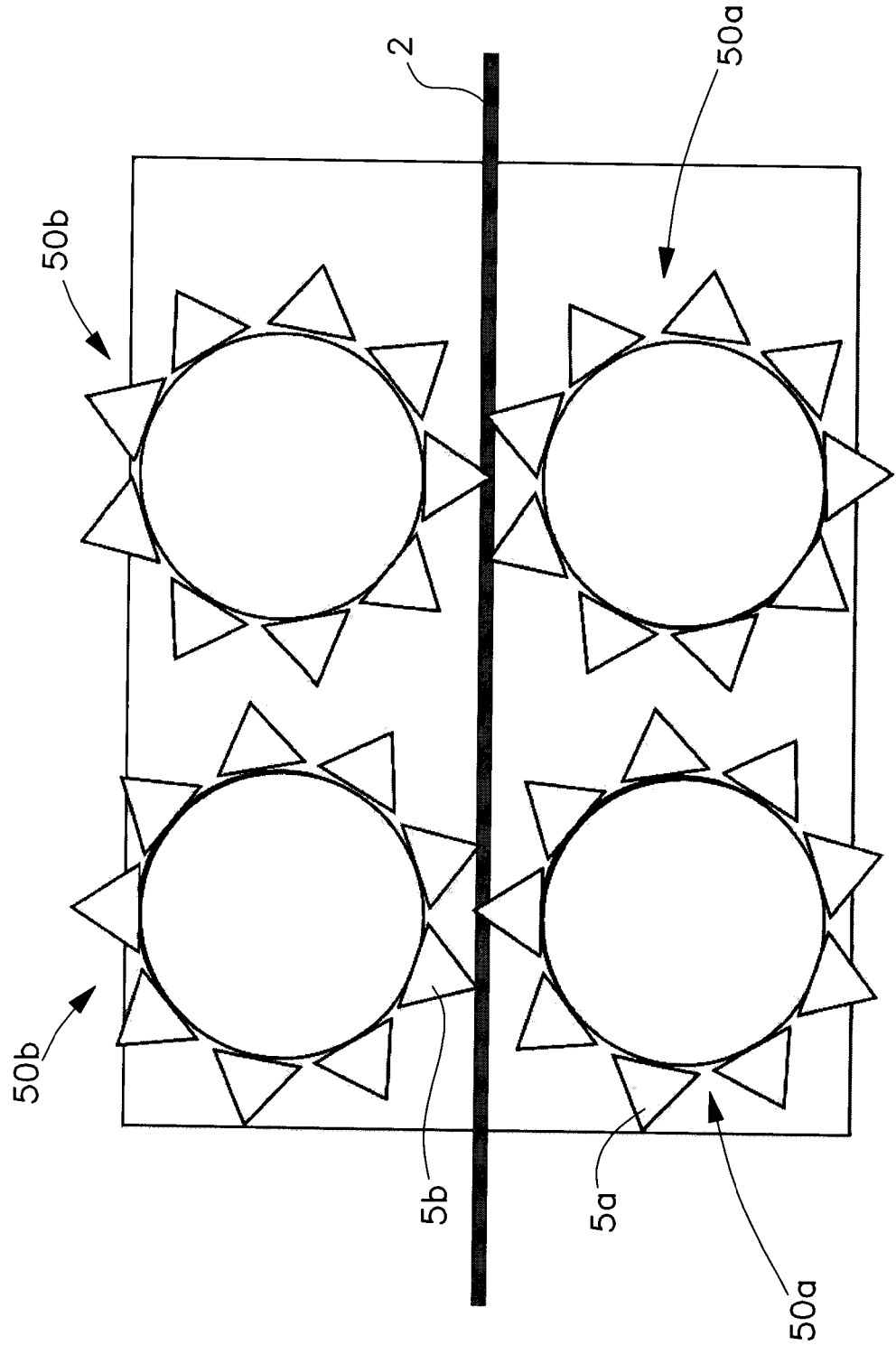


Fig. 8

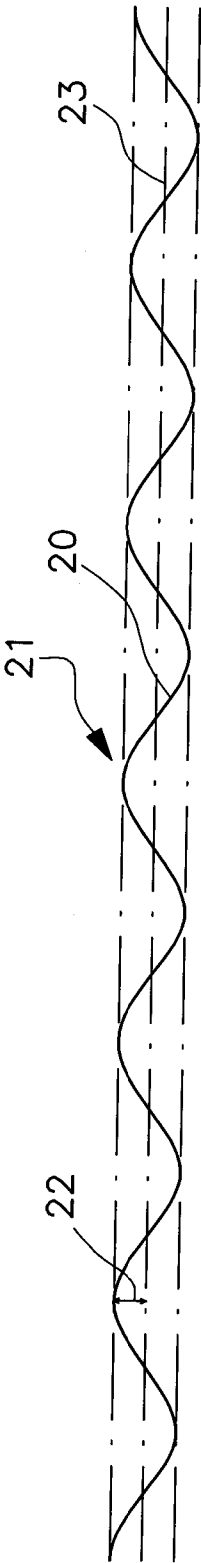
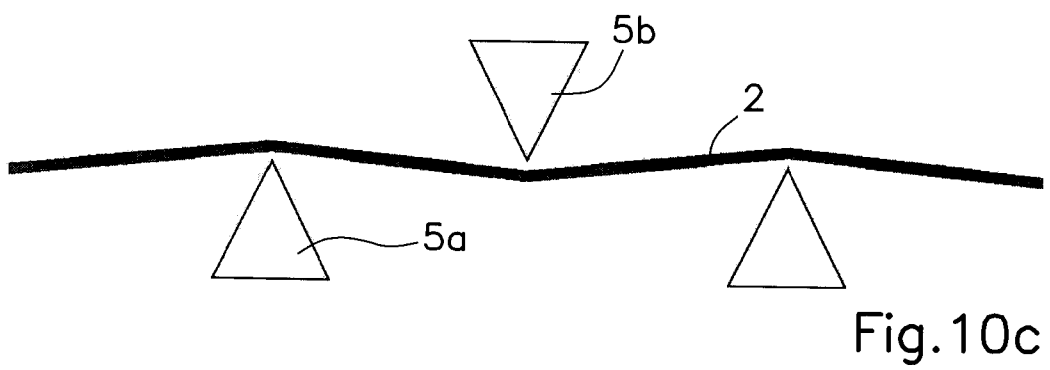
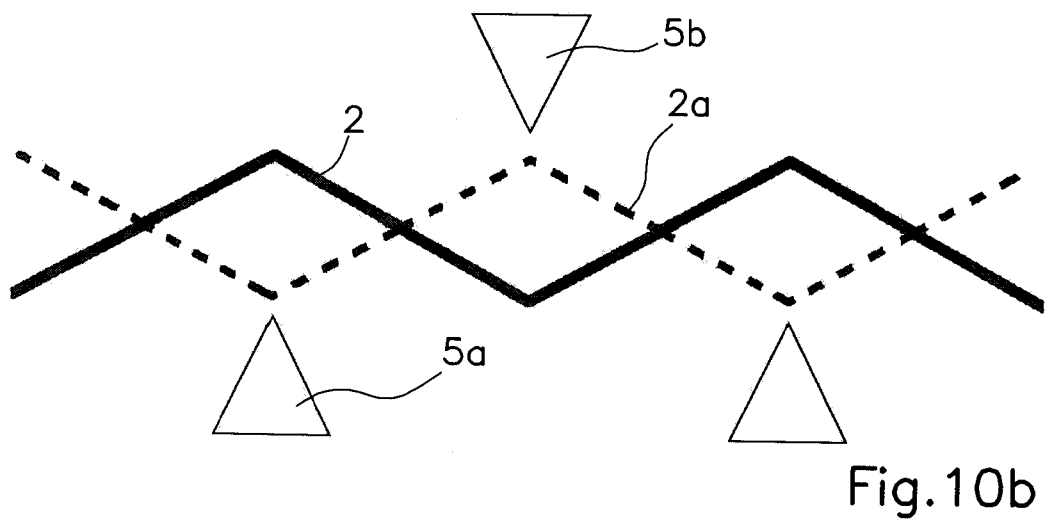
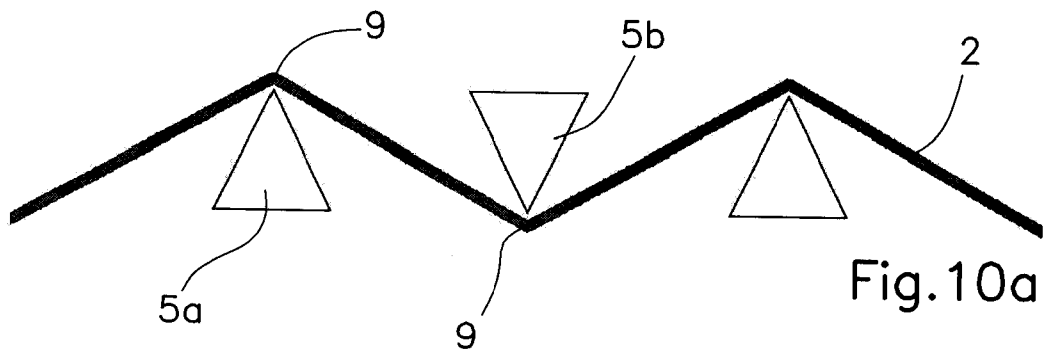


Fig.9

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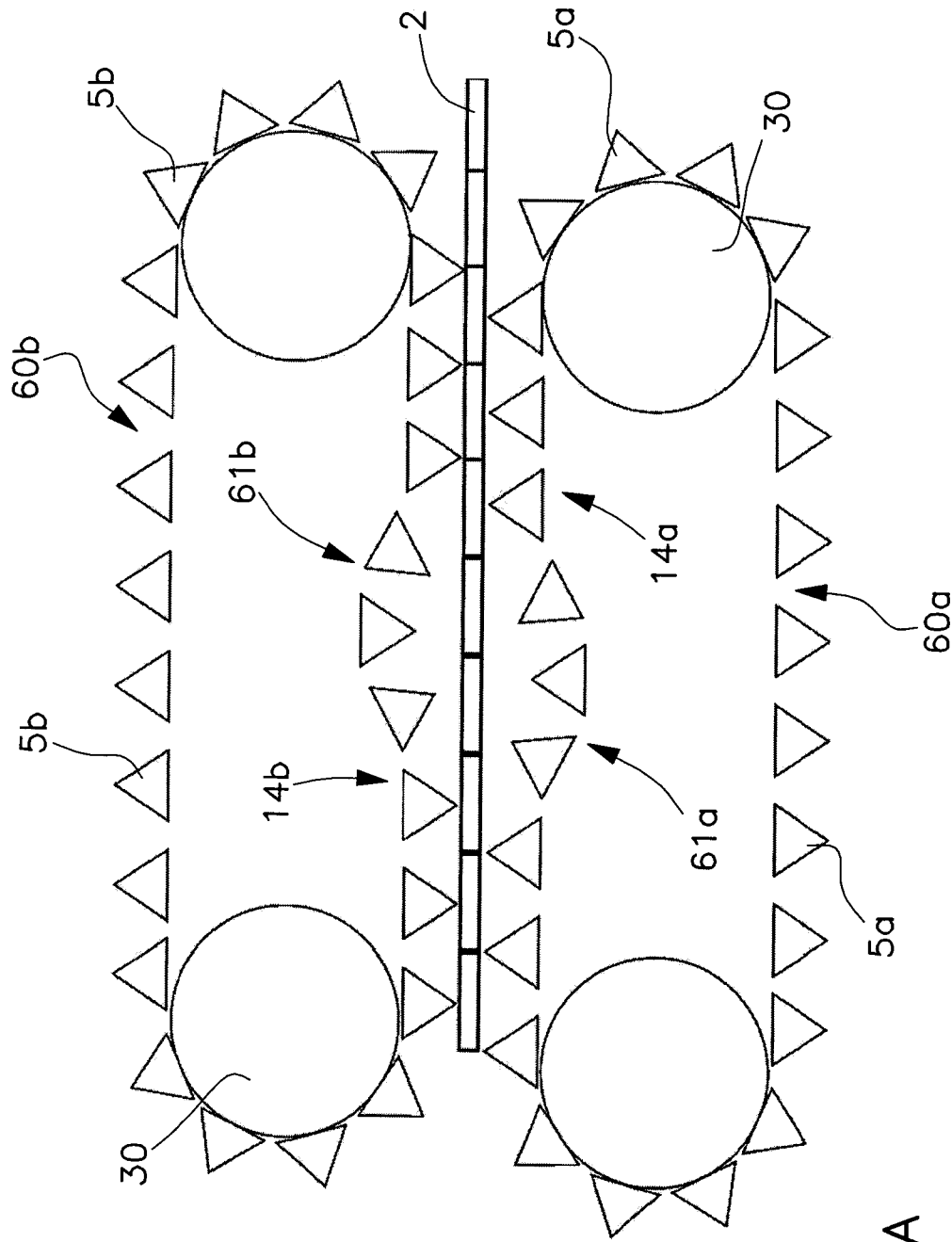


Fig. 7A