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(54) **METHOD AND APPARATUS FOR STRAIGHTENING ONE OR MORE WIRES**

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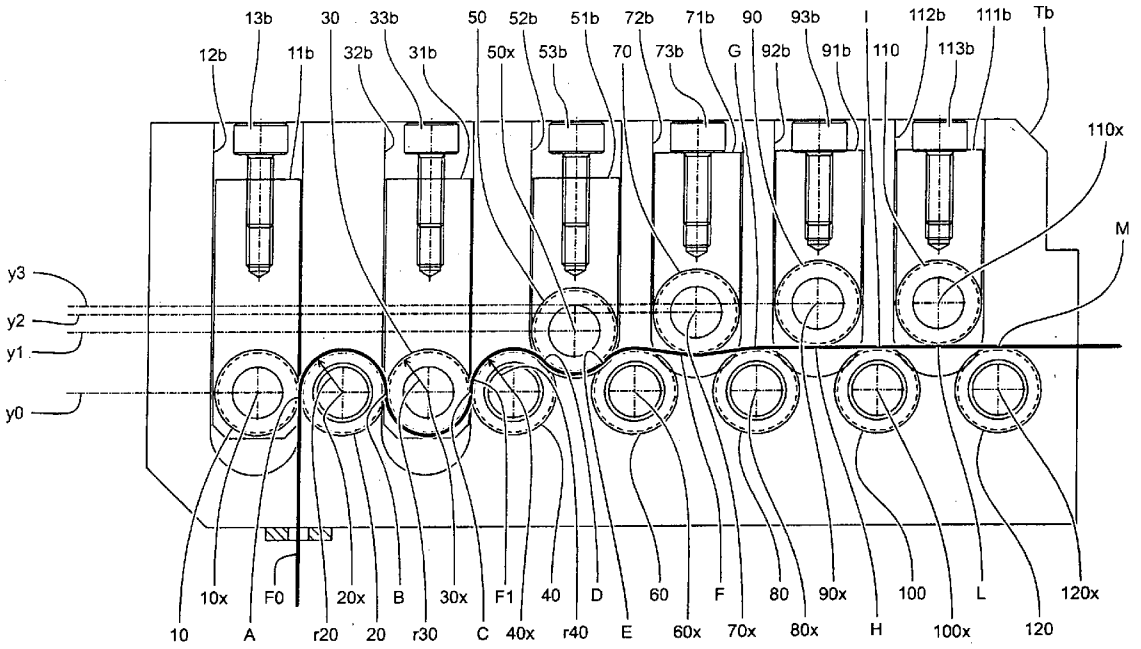
(57) **ABSTRACT**

A method for straightening at least one original wire (**F0**), by means of a travel path (AM), comprises a first bending-curving segment (AC) intended to bend and curve the original wire (**F0**) in order to obtain downstream (C) of said first bending-curving segment (AC) a flow of bent and curved intermediate wire (**F1**) having a given radius of curvature, and a second straightening segment (CM) arranged consecutively after said first bending/curving segment (AC) and intended to straighten the said flow of intermediate wire (**F1**). —An apparatus for implementing said method, comprising a first series of bending/curving rollers (**10, 20, 30, 40**) and a second series of straightening rollers (**50, 60, 70, 80, 90, 100, 110**).



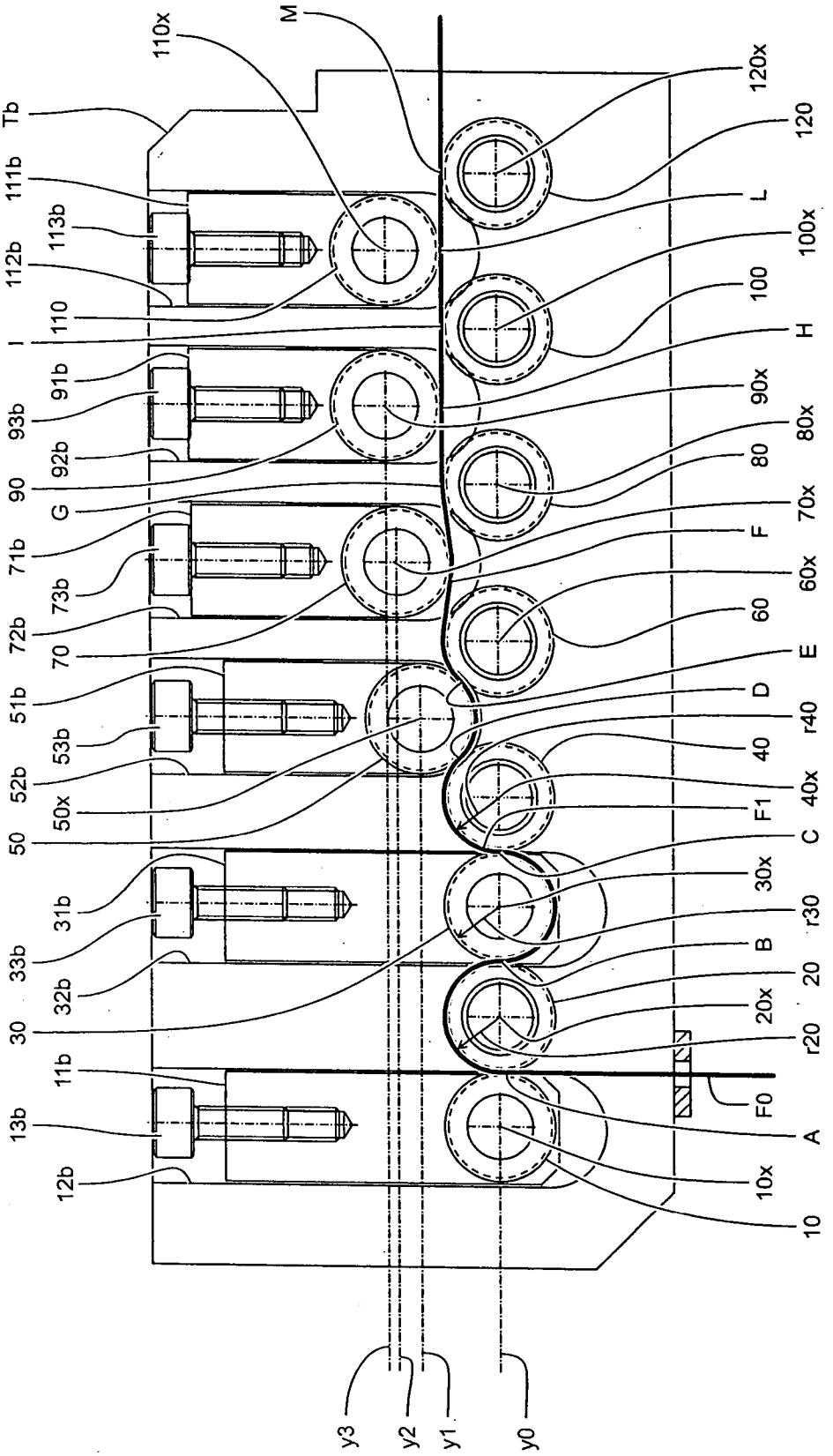
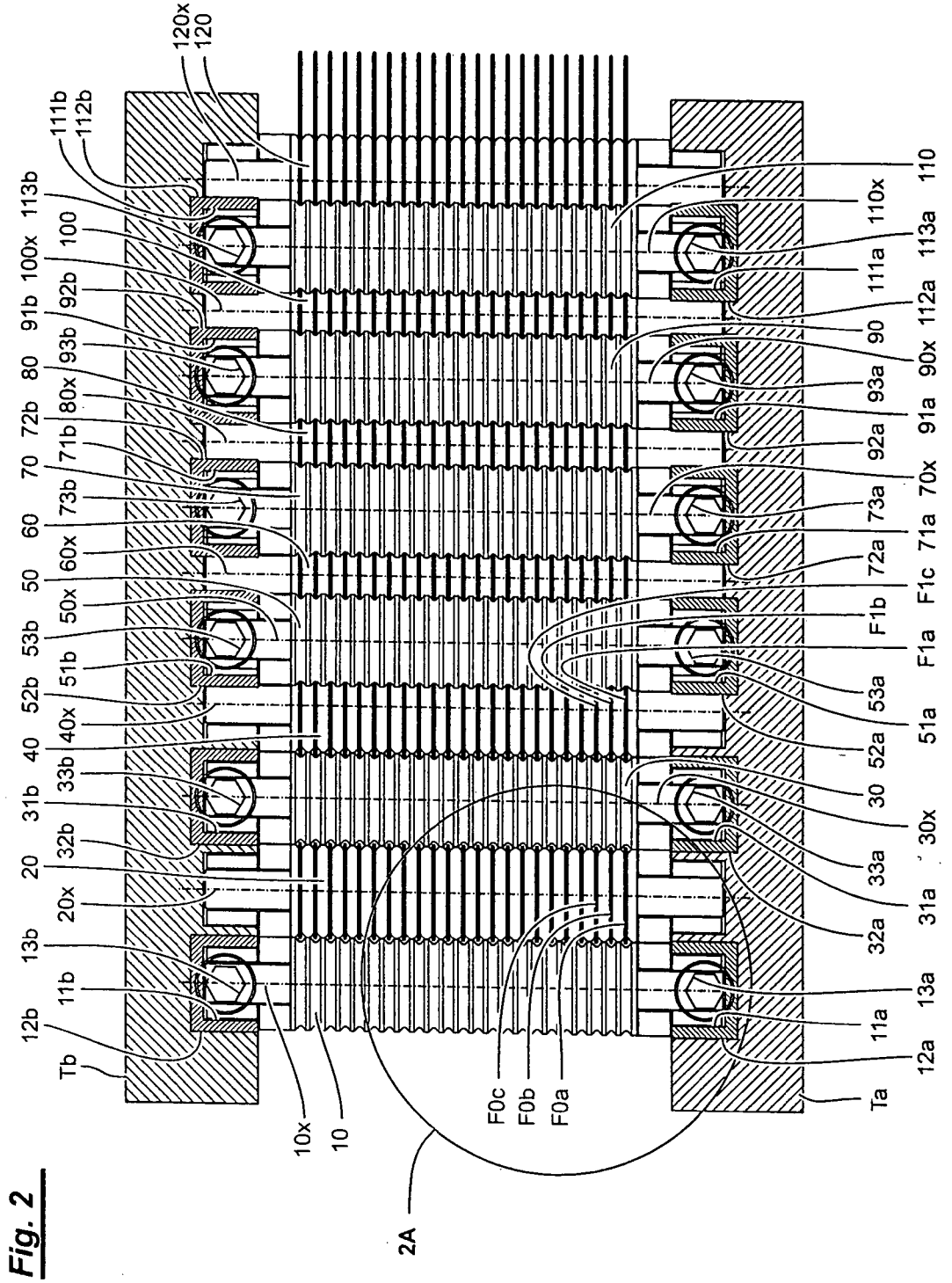

M
110x
120x
Tb
111b
113b
112b
110
I
91b
93b
92b
90
G
71b
73b
72b
70
51b
53b
52b
50x
50
31b
33b
32b
30
11b
13b
12b
y3
y2
y1
y0
120
L
100x
100
H
90x
80x
80
F
70x
60x
60
E
D
r40
40
40x
F1
C
30x
r30
B
20
20x
r20
F0
A
10x
10

Fig. 1


120x
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111b
112b
113b
100
100x
92b
91b
93b
80
80x
72b
71b
70
73b
60
60x
50
50x
53b
51b
52b
40x
40
33b
31b
32b
20
20x
13b
11b
12b
Tb
10x
10
2A
F0c
F0b
F0a
Ta
12a
11a
13a
31a
32a
33a
30x
30
52a
51a
53a
F1a
F1b
F1c
72a
71a
73a
70x
92a
91a
93a
90x
90
112a
111a
113a
110x
110

Fig. 2

Fig. 2C

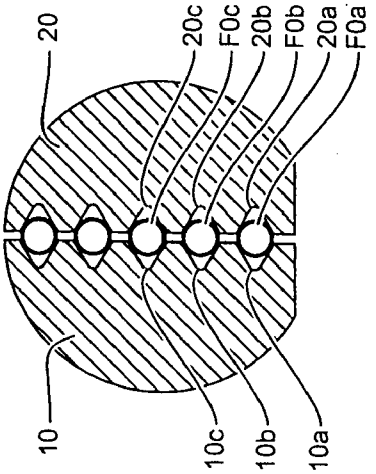


Fig. 2B

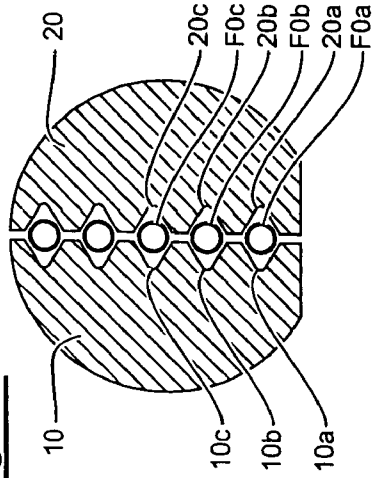
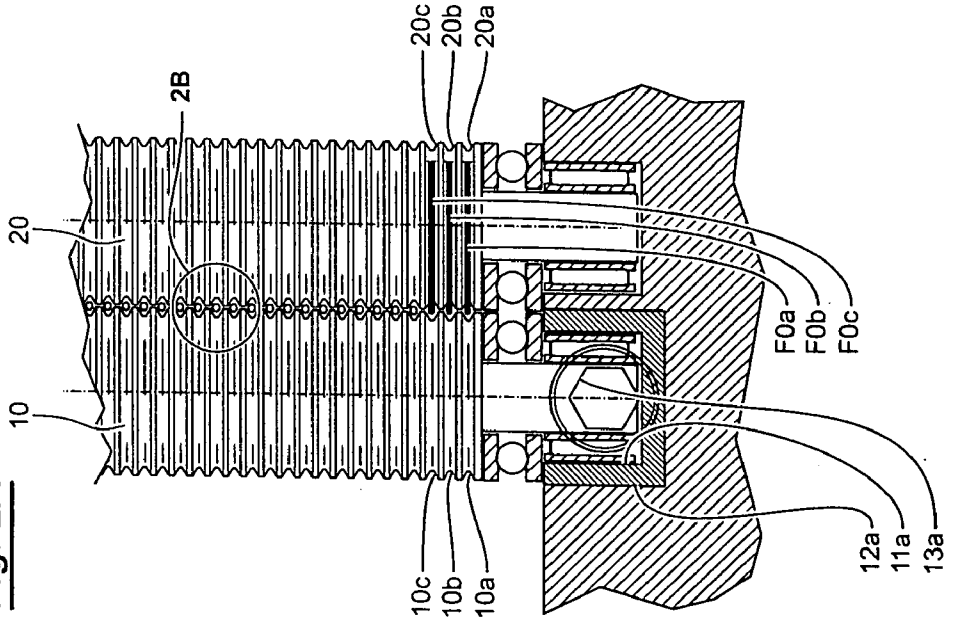


Fig. 2A



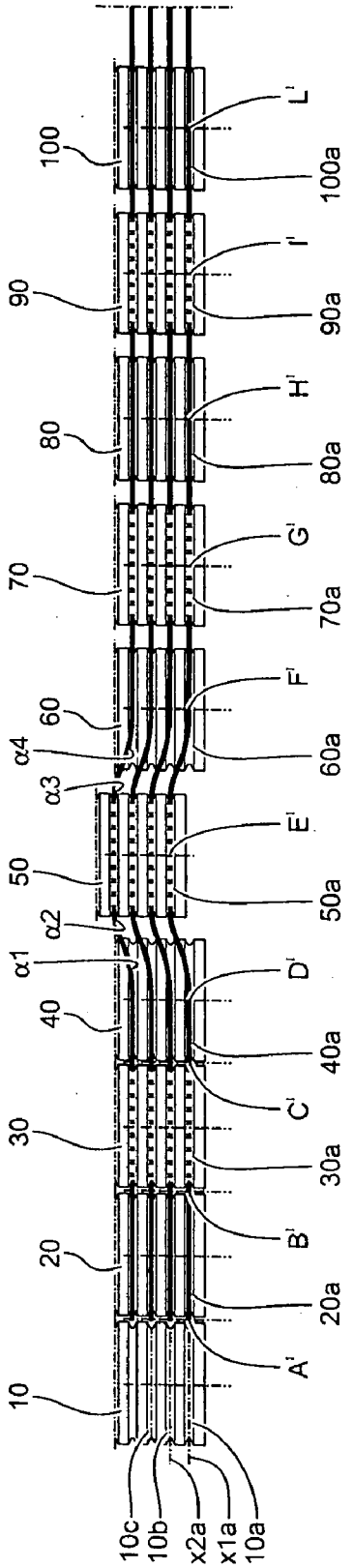

10
20
30
40
50
60
70
80
90
100
α1
α2
α3
α4
A'
B'
C'
D'
E'
F'
G'
H'
I'
L'
20a
30a
40a
50a
60a
70a
80a
90a
100a
10a
x1a
x2a
10b
10c

Fig. 3A

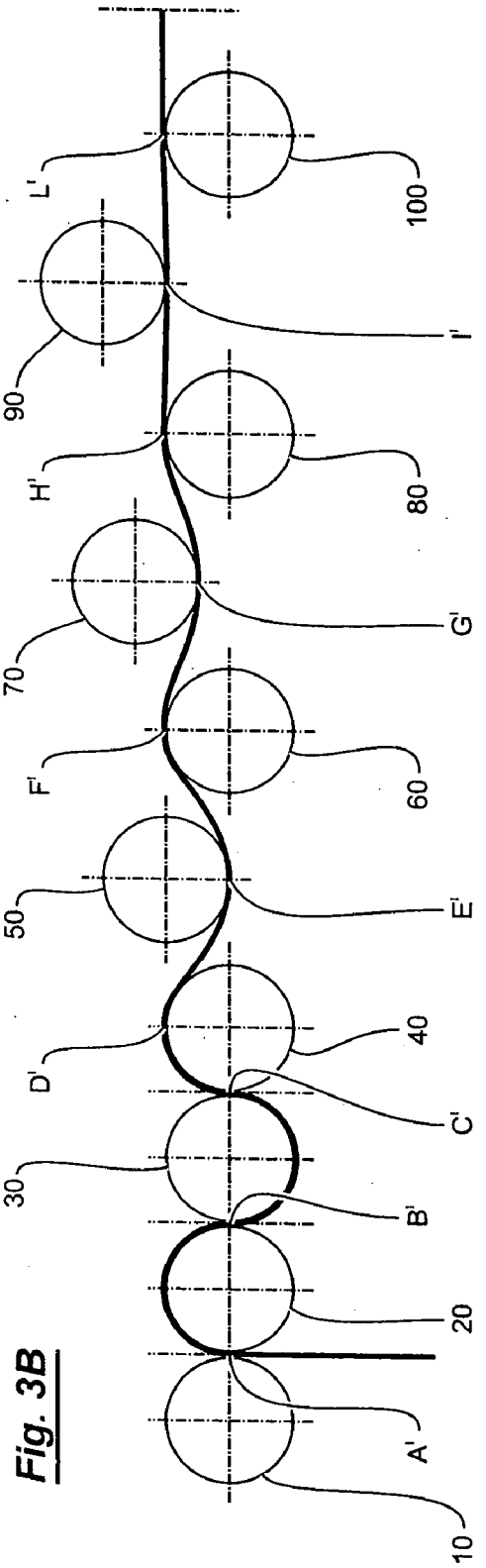

10
20
30
40
50
60
70
80
90
100
A'
B'
C'
D'
E'
F'
G'
H'
I'
L'

Fig. 3B

METHOD AND APPARATUS FOR STRAIGHTENING ONE OR MORE WIRES

FIELD OF THE INVENTION

[0001] The present invention concerns a method and an apparatus for straightening at least one or more wires which are not straight and, more particularly, for straightening at least one metal wire having a circular cross-section and/or other shape, such as for example a metal wire unwound from a storage reel, said wire being substantially curved and/or contorted (twisted) relative to its longitudinal axis, with a consequent curved and/or helical and/or non-rectilinear progression when arranged in the free state.

[0002] The present invention also concerns a method and an apparatus for straightening simultaneously a plurality of wires.

BACKGROUND ART

[0003] At present, the methods for straightening a wire which is not straight comprise unwinding of the wire and therefore substantial longitudinal travel thereof along a travel path in order to apply forces intended to straighten the curvature possessed by the original wire and, more particularly, apply forces intended to act on the extrados of the original arc of curvature so as to straighten it.

[0004] At present also, the apparatus for implementing the aforementioned known methods envisage, essentially, a first series of rollers arranged staggered in two parallel rows, i.e. arranged for example with vertical rotation axes, intended to form between said two rows a first path segment for straightening the travelling unwound wire by means of forces acting in a horizontal plane on the extrados of the curves of the wire and, after said first series of rollers, a second series of rollers, arranged staggered in two parallel rows, with horizontal axes of rotation, intended to form between said two rows a second path segment for straightening the travelling wire by means of forces acting in a vertical plane on the extrados of the curves of the wire, said wire being made to travel along said two rectilinear straightening paths by means of driving devices arranged downstream of the said apparatus.

[0005] This method and this apparatus have a series of drawbacks.

[0006] A first drawback is due to the fact that said method and said apparatus do not manage to straighten metal wire having particular metallurgical/mechanical properties such as, for example, hard drawn wire with a high carbon content, which, owing to the particular form-drawing operation and/or owing to the reeling operation and/or for other reasons, has twists and/or internal curvatures with a consequent configuration having a helical progression when arranged in the free state.

[0007] A second drawback is due to the fact that said apparatus, owing to the double series of straightening rollers, is complex and costly to manufacture.

[0008] A third drawback is due to the fact that said method and said apparatus require the adjustment and/or the replacement of so-called "made-to-measure" parts, depending on the curvature characteristics of the original wire to be straightened, as well as depending on the size of its cross-section.

[0009] A fourth drawback is due to the fact that said method and said apparatus do not allow simultaneous straightening of a plurality of wires.

[0010] A fifth drawback is due to the fact that said method and said apparatus do not allow correct and simultaneous straightening of a plurality of wires having original radii of curvature which differ from each other.

OBJECT OF THE INVENTION

[0011] The object of the present invention is to solve the abovementioned drawbacks.

[0012] The invention, which is characterized by the claims, solves the problem of creating a method for straightening at least one original wire, by means of a travel path along which said original wire is made to travel longitudinally from upstream to downstream, said method being characterized in that said travel path comprises: —a first bending-curving segment intended to bend and curve the original wire, in order to obtain downstream of said first bending-curving segment a flow of bent and curved intermediate wire having a given radius of curvature; —a second straightening segment arranged consecutively after said first bending/curving segment and intended to straighten the said flow of intermediate wire on the basis of the bending/curving previously performed by means of the first bending/curving segment.

[0013] The invention, which is characterized by the claims, also solves the problem of creating an apparatus for implementing the abovementioned method, said apparatus being characterized in that it comprises: —bending-curving means intended to configure a first bending-curving segment for the travel path of the wire along which the original wire is bent and curved until, downstream of said first bending-curving segment, a flow of bent and curved intermediate wire having a given radius of curvature is obtained; straightening means arranged downstream of said bending-curving means and intended to configure a second straightening segment for the travel path of the wire along which the said flow of intermediate wire is straightened on the basis of the bending and curving previously performed by means of the first bending-curving segment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Further characteristic features and advantages of the present invention will emerge more clearly from the description which follows of some preferred practical embodiments thereof provided here purely by way of a non-limiting example, with reference to the figures of the accompanying drawings in which:

[0015] **FIG. 1** is a schematic side view of a first embodiment of the method and apparatus according to the present invention;

[0016] **FIG. 2** is a schematic top plan view of a first embodiment of the method and apparatus according to the present invention intended to straighten a plurality of wires;

[0017] **FIG. 2A** is a view of the detail **2**A according to **FIG. 2**;

[0018] **FIG. 2B** is a view of the detail **2**B according to **FIG. 2A**;

[0019] **FIG. 2C** is a view similar to that of **FIG. 2B** according to a different embodiment of the operating method;

[0020] **FIG. 3A** is a schematic top plan view of a second embodiment of the method and apparatus according to the present invention;

[0021] **FIG. 3B** is a schematic side view of **FIG. 3A**.

DESCRIPTION OF THE FIRST EMBODIMENT

[0022] With reference to **FIGS. 1 and 2**, the apparatus according to the present invention comprises a frame with two side walls, Ta and Tb, extending longitudinally and vertically and intended to support, from upstream to downstream, in succession: >—two first slides, **11***a* and **11***b*, which are movable in a vertically guided manner and are preferably slidable inside respective vertical seats **12***a* and **12***b* formed in the walls Ta and Tb, movable, adjustable and able to be fixed in the vertical position by means of adjusting members, such as for example screws **13***a* and **13***b*, said first two slides **11***a* and **11***b* being intended to support the opposite ends of a first roller **10** having an axis of rotation **10***x* and therefore movable and adjustable vertically; >—the opposite ends of a second roller **20** having an axis of rotation **20***x*; >—two second slides, **31***a* and **31***b*, similar to the preceding slides, **11***a* and **11***b*, and therefore comprising vertical seats **32***a* and **32***b* and adjusting screws **33***a* and **33***b*, intended to support the opposite ends of a third roller **30** having an axis of rotation **30***x* and therefore being movable and adjustable vertically; >—the opposite ends of a fourth roller **40** having an axis of rotation **40***x*; >—two third slides, **51***a* and **51***b*, similar to the preceding slides and therefore comprising vertical seats **52***a* and **52***b* and adjusting screws **53***a* and **53***b*, intended to support the opposite ends of a fifth roller **50** having an axis of rotation **50***x* and therefore being movable and adjustable vertically; >—the opposite ends of a sixth roller **60** having an axis of rotation **60***x*; >—two fourth slides, **71***a* and **71***b*, similar to the preceding slides and therefore comprising vertical seats **72***a* and **72***b* and adjusting screws **73***a* and **73***b*, intended to support the opposite ends of a seventh roller **70** having an axis of rotation **70***x* and therefore being movable and adjustable vertically; >—the opposite ends of an eighth roller **80** having an axis of rotation **80***x*; >—two fifth slides, **91***a* and **91***b*, similar to the preceding slides and therefore comprising vertical seats **92***a* and **92***b* and adjusting screws **93***a* and **93***b*, intended to support the opposite ends of a ninth roller **90** having an axis of rotation **90***x* and therefore being movable and adjustable vertically; >—the opposite ends of a tenth roller **100** having an axis of rotation **100***x*; >—two sixth slides, **111***a* and **111***b*, similar to the preceding slides and therefore comprising vertical seats **112***a* and **112***b* and adjusting screws **113***a* and **113***b*, intended to support the opposite ends of an eleventh roller **110** having an axis of rotation **110***x* and therefore being movable adjustable vertically; >—the opposite ends of a twelfth roller **120** having an axis of rotation **120***x*.

[0023] With reference also to **FIGS. 2A and 2B**, all the said rollers, see for example the rollers **10** and **20**, have on their casing one or more circumferential grooves, **10***a*, **10***b*, **10***c*, etc. and **20***a*, **20***b*, **20***c*, etc., which are axially spaced, have the shape of a "V" with the vertex directed towards the axis of rotation **10***x* and **20***x* and are intended to seat respective individual wires F**0***a*, F**0***b*, F**0***c*, etc., the grooves of each roller being aligned and facing the grooves of the rollers arranged alongside so as to define in the vicinity of the point of possible tangency between two rollers a plurality of channels, **1***a*-**20***a*, **10***b*-**20***b*, etc., in the manner of a lozenge formed by two "V" and intended to contain and/or retain and/or guide a respective original wire F**0***a*, F**0***b*, F**0***c*, etc., as can be understood more clearly below.

[0024] In this context, it is obvious that the form of the circumferential grooves **10***a*, **10***b*, **10***c*, etc., and **20***a*, **20***b*, **20***c*, etc., may assume different dimensions and/or configurations which are selected depending on the size and/or the form of the cross-section of the wires to be straightened.

[0025] With reference to the first four rollers **10**, **20**, **30** and **40**, they are arranged close, tangential or not tangential with each other, with respective axes of rotation, **10***x*, **20***x*, **30***x*, **40***x*, arranged lying in succession in a same plane, defined here as bottom level **Y0**.

[0026] With reference to the following rollers, **50**, **60**, **70**, **80**, **90**, **100**, **110**, **120**, they are preferably arranged as follows: >—the roller **50** is supported alongside and close (tangential or not tangential) to the roller **40** and on a first level **Y1** situated higher than the bottom level **Y0**; >—the roller **60** is supported spaced from and alongside the roller **40** and on the bottom level **Y0**; >—the roller **70** is supported spaced from and alongside the roller **50** and on a second level **Y2** situated higher than the first level **Y1**; >—the roller **80** is supported spaced from and alongside the roller **60** and on the bottom level **Y0**; >—the roller **90** is supported spaced from and alongside the roller **70** and on a third level **Y3** situated higher than the second level **Y2**; >—the roller **100** is supported spaced from and alongside the roller **80** and on the bottom level **Y0**; >—the roller **110** is supported spaced from and alongside the roller **70** and on the level **Y3**; >the roller **120** is supported spaced from and alongside the roller **100** and on the bottom level **Y0**.

[0027] With this arrangement (see **FIG. 1** again) each original wire F**0** is provided with a particular travel path defined by the points A, B, C, D, E, F, G, H, I, L, M, said path having a plurality of sub-segments, AB, BC, CD, DE, EF, FG, GH, IL, LM, intended to implement a method comprising: >—a first bending-curving segment AC intended to bend and curve the original wire F**0** until, downstream C of said first bending-curving segment AC, a flow of bent and curved intermediate wire F**1** with a given radius of curvature is obtained; >—a second straightening segment CM arranged consecutively after said first bending/curving segment AC and intended to straighten the said flow of intermediate wire F**1** on the basis of the bending and curving previously performed by means of the first bending-curving segment AC, i.e. intended to straighten an intermediate wire F**1**, of which the mechanical properties, the radius of curvature and the yield point are known, as can be understood more clearly below.

[0028] Still with reference to **FIG. 1**, it is necessary to point out that said first bending-curving segment AC comprises: >—a first sub-segment, AB, where the original wire F**0** is bent and curved along a first arc, AB, preferably equal to about 180°, with a radius of curvature r**20**, having a first bending-curving direction; >—a second sub-segment, BC, along which the original wire F**0** is bent and curved along a second arc, BC, preferably equal to about 180°, with a radius

of curvature r**30**, having a second bending-curving direction contrary and/or opposite to the first bending/curving direction of the first arc AB.

[**0029**] This first bending-curving segment, AC, is therefore intended to obtain in the vicinity of its outgoing end, C, a flow of bent and curved intermediate wire, F**1**, having a constant and uniform radius of curvature irrespective of the curvature of the original wire F**0** entering at A and, moreover, again exiting from the point C, a flow of bent and curved intermediate wire F**1** which has a given projection-orientation.

[**0030**] In this context, therefore, by varying the angular amplitudes by means of vertical displacement of the rollers **10** and **30** with respect to the fixed rollers **20** and **40**, or by varying the radii of curvature r**20** and r**30** for the bending-curving arcs AB and BC or varying the operating travel speeds of the wire F**0**, it is possible to set a desired and optimum bending-curving process for the original wire F**0** during its travel along the first bending-curving segment AC, in order to obtain, in the vicinity of the outgoing point C, a flow of bent and curved intermediate wire, F**1**, with desired mechanical properties, such as for example a desired yield point based on the bending performed and a given curvature, so as to set, optimize and standardize and select the subsequent straightening operations.

[**0031**] With reference to the rollers **10**, **20**, **30** and **40**, and in particular the two bending-curving arcs AB and BC, it is preferable to set a radius of curvature r**20** and/or r**20** preferably equal to or less than the minimum radius of curvature of the original wire F**0** when arranged in the free state.

[**0032**] In this context, moreover, if desirable, it is also possible to envisage a first bending-curving segment AC comprising three or more sub-segments AB or BC intended to bend and curve several times the original wire F**0**.

[**0033**] With reference to the second segment for straightening the intermediate wire F**1** exiting at the point C, comprising the sub-segments CD, DE, EF, FG, GH, IL, LM, said second segment CM may assume different embodiments chosen in relation to the type of original wire F**0** to be straightened, the mechanical properties of the intermediate wire F**1**, the operative linear speed of travel of the wire, the quality of straightening required for the straightened final wire, and the mechanical properties which the same straightened final wire must have.

[**0034**] With reference to the first embodiment, shown in **FIG. 1**, said second segment CM comprises preferably a third bending-curving sub-segment, CD, arranged upstream, the intermediate wire F**1** being bent and curved along a third arc CD, preferably equal to about 135°, with a radius of curvature r**40** having a bending-curving direction contrary to the bending-curving direction of the second arc BC.

[**0035**] Again according to said first embodiment (**FIG. 1**), said second straightening segment CM envisages a plurality of sub-segments CD, DE, EF, FH, HG which are arranged consecutively in succession and are intended to define a path for the intermediate wire F**1** in the manner of a dampened sinusoid terminating in a rectilinear manner.

SECOND EMBODIMENT

[**0036**] With reference to the second embodiment, shown in **FIGS. 3A and 3B**, it comprises: a first bending-curving segment A'C', substantially identical to the segment AC of the preceding embodiment; a second straightening segment C'L' which differs from the segment CM of the preceding embodiments since it comprises: —a first lateral folding segment, D'E', arranged in a horizontal plane and intended to fold laterally, first to the left, at an angle "α**1**", and then to the right, at an angle "α**2**", the intermediate wire F**1**; and —a second lateral folding segment, E'F', arranged in a horizontal plane and intended to fold laterally, first to the right, at an angle "α**3**", and then to the left, at an angle "α**4**", the intermediate wire F**1**.

[**0037**] With reference to the apparatus described above, this particular second embodiment may be easily obtained by axially displacing the roller **50**, in order to keep the circumferential grooves, **10***a*, **20***a*, **30***a*, **40***a* in a plane X**1***a*, arrange the groove **50***a* in a second plane X**2***a*, and keep the grooves **60***a*, **70***a*, **80***a*, etc. in the plane X**1***a*.

[**0038**] Plurality of Wires

[**0039**] The method and the apparatus according to the present invention are also particularly suitable for straightening simultaneously, a plurality of original wires, which may also have original radii of curvature different from each other, such as, for example, original wires unwound from reels having different winding diameters and/or original wires supplied from different drawing operations, using a common apparatus which is reliable and small in size.

[**0040**] With reference to **FIGS. 1 and 2**, a plurality of original wires also having different radii of curvature, such as, for example, wires F**0***a*, F**0***b*, F**0***c*, etc., are seated in respective circumferential grooves, **10***a*, **10***b*, **10***c*, etc., **20***a*, **20***b*, **20***c*, etc., etc., of the various rollers **10**, **20**, **30**, etc., and are therefore made to travel along a plurality of identical travel paths AM arranged alongside and parallel, extending in respective parallel vertical/longitudinal planes, each intended to contain a respective original wire F**0***a*, F**0***b*, etc. to be straightened.

[**0041**] Said plurality of identical travel paths, AM, from upstream to downstream, comprise a plurality of first bending-curving segments, AC, identical to each other and intended to bend and curve uniformly the plurality of original wires F**0***a*, F**0***b*, etc., until, downstream of said first bending/curving segments AC, a plurality of intermediate wires F**1***a*, F**1***b*, etc., having a mutually uniform radius of curvature, is obtained; and a plurality of second straightening segments, CM, arranged consecutively after said first bending/curving segments, AC, and intended to straighten the said intermediate wires F**1***a*, F**1***b*, etc., on the basis of the uniform radius of curvature existing between them and obtained by means of the first bending/curving segments AC.

[**0042**] In this context, if the original wires F**0***a*, F**0***b*, F**0***c*, etc., have original radii of curvature different from each other, it is preferable to adopt for the arcs of curvature AB and BC of the first bending-curving segments AC, a radius of curvature r**20** and r**30** for the rollers **20** and **30** which is equal to, or less than, the smaller of the radii of curvature of the original wires, in order to obtain a plurality of intermediate wires, F**1***a*, F**1***b*, F**1***c*, etc., all having the same uniform and unidirectional curvature, irrespective of the original curvature, in order to then proceed with straightening of said plurality of intermediate wires, F**1***a*, F**1***b*, F**1***c*, etc., rendered uniform with respect to each other, in the optimum manner as described above.

[0043] With reference to the circumferential grooves, **10***a*, **10***b*, **10***c*, etc., **20***a*, **20***b*, **20***c*, etc., etc., and the adjustable position for the rollers **10**, **30**, **50**, **70**, **90**, **110**, which can be obtained by means of the respective adjusting screws, **13***a*, **33***a*, **53***a*, **73***a*, **93***a*, **113***a*, it is obvious that, with the apparatus described above, it is possible to change rapidly the vertical position of the movable rollers **10**, **30**, **50**, **70**, **60**, **100** with respect to the fixed rollers **20**, **40**, **60** in order to change the amplitude of the bending-curving arcs of the wire travel path and, therefore, optimize the operating method(s) described above in relation to the types of original wires used.

[0044] Moreover, by modifying the adjustable position of the rollers **10**, **30**, **50**, **70**, **90**, **110**, it is also possible to increase or reduce the distance between the circumferences of the rollers arranged in succession in the vicinity of their point of possible tangency, such as, for example, between the rollers **10** and **20** shown in **FIGS. 2A, 2B**, 2C, in order to increase or reduce the width of the channels **10***a*-**20***a*, **10***b*-**20***b*, etc., and therefore contain wires having a greater or smaller cross-section.

[0045] Also, in this context, moreover, by modifying the adjustable position of the rollers **10**, **30**, **50**, with respect to the fixed rollers 2Q, **40**, **60**, in order to move the associated circumferences further away and/or closer together, and/or by modifying the size of the circumferential grooves **10***a*, **10***b*, **10***c*, etc., **20***a*, **20***b*, **20***c*, etc., etc., it is possible to implement the abovementioned operating methods with the original wire F**0** and/or the original wires F**0***a*, F**0***b*, etc., see **FIG. 2C**, gripped-clamped inside the lozenges **10***a*-**20***a*, **20***a*-**30***a*, **30***a*-**40***a*, etc., therefore avoiding a possible axial rotation of the wires during their travel, or, alternatively, see **FIG. 2B**, implement the same operating methods with the original wire and/or the original wires not gripped/clamped inside the said lozenges, allowing axial rotation thereof.

[0046] With reference to the description relating to the method and the apparatus for straightening a plurality of wires mentioned above with reference to **FIGS. 1 and 2**, it is obvious that it is also possible to use the method and the apparatus according to the second embodiment shown in **FIGS. 3A and 3B**. In this case, the plurality of original wires will be made to travel along a plurality of identical travel paths A'L' arranged alongside each other and parallel.

[0047] The description of the method and the apparatus mentioned above are provided purely by way of a non-limiting example and, therefore, it is obvious that said method and said apparatus may be subject to all those modifications and/or variations suggested by practice and their use or employment, and in any case within the scope of the following claims, which form an integral part of the description provided above.

1)- Method for straightening at least one original wire by means of a travel path along which said original wire is made to travel longitudinally from upstream to downstream, characterized in that the travel path (AM; A'L') comprises:

- a first bending-curving segment (AC; A'C') intended to bend and curve the original wire (F**0**), in order to obtain downstream (C; C') of said first bending-curving segment (AC; A'C') a flow of bent and curved intermediate wire (F**1**), having a given radius of curvature;
- a second straightening segment (CM; C'L') arranged consecutively after said first bending-curving segment (AC; A'C') and intended to straighten the said flow of intermediate wire (F**1**) on the basis of the bending-curving previously performed by means of the first bending-curving segment (AC; A'C').

2)- Method according to claim **1**, characterized in that said first bending-curving segment (AC; A'C') comprises at least:

- a first sub-segment (AB; A'B') along which the original wire (F**0**) is bent and curved by causing it to travel along a first bending-curving arc (AB; A'B') having a first bending-curving direction, and
- a second sub-segment (BC; B'C') along which the original wire is bent and curved by causing it to travel along a second bending-curving arc (BC; B'C') having a second bending-curving direction contrary to the first bending-curving direction of the first arc (AB; A'B').

03)- Method according to claim **2**, characterized in that said first bending-curving arc (AB; A'B') has a radius of curvature (r**20**) which is preferably equal to or less than the minimum radius of curvature of the original wire (F**0**).

04)- Method according to claim **2**, characterized in that said first bending-curving arc (AB; A'B') has an amplitude preferably equal to about 1800.

05)- Method according to one of claim **2**, characterized in that said second bending-curving arc (BC; B'C') has a radius of curvature (r**30**) preferably equal to or less than the minimum radius of curvature of the original wire (F**0**).

06)- Method according to one of claim **2**, characterized in that said second bending-curving arc (BC; B'C') has an amplitude preferably equal to about 180°.

07)- Method according to claim **1**, characterized in that said second straightening segment (CM; C'L') comprises a third bending-curving sub-segment (CD; C'D') which is arranged upstream and along which the intermediate wire (F**1**) is bent and curved along a third bending-curving arc (CD; C'D') having a bending-curving direction contrary to the bending-curving direction of the second arc (BC) and in that said third bending/curving arc (CD; C'D') has an amplitude equal to about 135°.

8)- Method according to claim **7**, characterized in that said second straightening segment (CM; C'L') envisages a plurality of sub-segments (CD, DE, EF, FG, GH, HI, IL, LM; C'D', E'F', F'G', G'H', H'I', I'L') arranged in succession and intended to define a path for the intermediate wire (F**1**) in the manner of a dampened sinusoid terminating in a rectilinear manner.

09)- Method according to claim **1** (**FIGS. 3A-3B**), characterized in that said second straightening segment comprises at least one lateral bending sub-segment (D'E') intended to bend the intermediate wire (F**1**) in a direction inclined transversely with respect to the direction of bending-curving occurring along the first bending-curving segment (A'C').

10)- Method according to claim **1** for straightening a plurality of wires, characterized in that it envisages a plurality of identical travel paths (AM; A'L') arranged alongside and parallel, each intended to contain a respective original wire (F**0***a*, F**0***b*, etc.) and comprising:

- a plurality of first bending-curving segments (AC; A'C') identical to each other and intended to bend and curve each wire of the plurality of original wires (F**0***a*, F**0***b*, etc.) until, downstream (C) of said first bending-curv-

ing segments (AC), a flow of a plurality of corresponding bent and curved intermediate wires (F1*a*, F1*b*, etc.) having a same given radius of curvature is obtained;

a plurality of second straightening segments (CM; C'L') arranged consecutively after said plurality of first bending-curving segments (AC) and intended to straighten the said plurality of intermediate wires (F1*a*, F1*b*, etc.,) on the basis of the bending and curving performed by means of the plurality of first bending-curving segments (AC).

11)- Method according to claim **1**, characterized in that axial rotation (**FIG. 2C**) of the original wire (F**0**) during its travel along the first bending-curving segment (AC) is prevented.

12)- Method according to claim **1**, characterized in that the axial rotation (**FIG. 2B**) of the original wire (F**0**) during its travel along the first bending-curving segment (AC) is allowed.

13)- Apparatus for straightening at least one original wire (F**0**) by means of a travel path along which said wire is made to travel longitudinally from upstream to downstream, characterized in that it comprises:

bending-curving means (**10**, **20**, **30**, **40**) intended to configure a first bending-curving segment (AC; A'C') for the travel path of the wire, along which the original wire (F**0**) is bent and curved until, downstream (C) of said first bending-curving segment (AC), a flow of bent and curved intermediate wire (F**1**) having a given radius of curvature is obtained;

straightening means (**50**, **60**, **70**, **80**, **80**, **100**, **110**) arranged downstream of said bending-curving means (**10**, **20**, **30**, **40**) and intended to configure a second straightening segment (CM; C'L') for the travel path of the wire along which the said intermediate wire (F**1**) is straightened on the basis of the bending and curving previously performed by means of the first bending-curving segment (AC; A'C').

14)- Apparatus for straightening a plurality of original wires (F**0***a*, F**0***b*, F**0***c*, etc.) according to claim **13**, characterized in that said bending-curving means (**10**, **20**, **30**, **40**) are intended to configure a plurality of first bending-curving segments (AC; A'C') identical to each other and intended to bend and curve each wire of the plurality of original wires (F**0***a*, F**0***b*, etc.) until, downstream (C) of said first bending-curving segments (AC), a flow of a plurality of corresponding bent and curved intermediate wires (F1*a*, F1*b*, etc.) having a given radius of curvature is obtained and in that said straightening means (**50**, **60**, **70**, **80**, **80**, **100**, **110**) are intended to configure a plurality of second straightening segments (CM; C'L') arranged consecutively after said plurality of first bending/curving segments (AC) and intended to straighten the said plurality of intermediate wires (F1*a*, F1*b*, etc.) on the basis of the bending and curving performed by means of the plurality of first bending/curving segments (AC).

15)- Apparatus according to claim **13**, characterized in that said first bending-curving means (**10**, **20**, **30**, **40**) comprise a first series of bending-curving rollers (**10**, **20**, **30**, **40**) arranged in succession and intended to configure one or more first bending-curving segments (AC; A'C').

16)- Apparatus according to one of claim **13**, characterized in that said second straightening means (**50**, **60**, **70**, **80**, **80**, **100**, **110**) comprise a second series of straightening rollers (**50**, **60**, **70**, **80**, **80**, **100**, **110**) arranged in succession and intended to configure one or more second straightening segments (CM; C'L') arranged consecutively after said one or more first bending/curving segments (AC; A'C').

17)- Apparatus according to claim **15**, characterized in that said rollers (**10**, **20**, **30**, **40**, etc.) have on their casing one or more circumferential grooves (**10***a*, **10***b*, etc.; **20***a*, **20***b*, etc.; etc.) which are axially spaced and each intended to seat a respective wire (F**0***a*, F**0***b*, etc.).

18)- Apparatus according to claim **15**, characterized in that at least some of said rollers (**10**, **30**, **50**, **70**, **90**, **110**) are movable and able to be adjustably positioned with respect to the other rollers (**20**, **40**, **60**, **80**, **100**, **120**).

19)- Apparatus according to claim **15**, characterized in that said first series of bending-curving rollers comprises four rollers (**10**, **20**, **30**, **40**) arranged in succession and alongside close to each other and in that the circumferential grooves (**10***a*, **10***b*, etc.; **20***a*, **20***b*, etc.,; etc.) of each roller (**10**, **20**, **30**, **40**) are situated facing each other and aligned with respect to the grooves of the rollers alongside (**10***a*, **20***a*, **30***a*, **40***a*; **10***b*, **20***b*, **30***b*, **40***b*, etc.).

20)- Apparatus according to claim **15**, characterized in that said first series of rollers (**10**, **20**, **30**, **40**) have their circumferences arranged close so that the respective circumferential grooves (**10***a*, **10***b*; **20***a*, **20***b*, etc.) in the vicinity of the point of possible tangency between adjacent rollers define one or more channels (**10***a*, **20***a*; **10***b*, **20***b*; etc.) intended to contain the original wires (F**0***a*, F**0***b*, etc.).

21)- Apparatus according to claim **20**, characterized in that said one or more channels (**10***a*, **20***a*; **10***b*, **20***b*, etc.) each have a width such as to clamp-grip the respective original wire (F**0***a*, F**0***b*, etc.).

22)- Apparatus according to claim **20**, characterized in that said one or more channels (**10***a*, **20***a*; **10***b*, **20***b*, etc.) each have a width such as not to clamp-grip the respective original wire (F**0***a*, F**0***b*).

23)- Apparatus according to claim **15**, characterized in that said first series of bending-curving rollers (**10**, **20**, **30**, **40**) comprises:

a frame comprising two side walls (Ta and Tb) extending longitudinally and vertically and intended to support, from upstream to downstream, in succession:

two first slides (**11***a*, **11***b*) movable vertically and guided (**12***a*, **12***b*) on a respective wall (Ta, Tb) and able to be adjusted vertically by means of respective adjusting members (**13***a*, **13***b*), said first slides (**11***a*, **11***b*) being intended to support the opposite ends of a first roller (**10**) having a first axis of rotation (10×);

the opposite ends of a second roller (**20**) having an axis of rotation (20×) arranged parallel with respect to the first axis (10×);

two second slides (**31***a*, **31***b*) movable vertically and guided (**32***a*, **32***b*) on a respective wall (Ta, Tb) and able to be adjusted vertically by means of adjusting members (**33***a*, **33***b*), said second slides (**31***a*, **31***b*) being intended to support the opposite ends of a third roller (**30**) having an axis of rotation (30×);

the opposite ends of a fourth roller (**40**) having an axis of rotation (40×) arranged parallel with respect to the first axis (10×).

24)- Apparatus according to claim **23**, characterized in that said second series of straightening rollers (**50**, **60**, **70**, **80**, **80**, **100**, **110**) comprises:

two third slides (**51***a*, **51***b*) movable vertically and guided (**52***a*, **52***b*) on a respective wall (Ta, Tb) and able to be adjusted vertically by means of respective adjusting members (**53***a*, **53***b*), said third slides (**51***a*, **51***b*) being intended to support the opposite ends of a fifth roller (**50**) having a fifth axis of rotation (50×) arranged parallel with respect to the first axis (10×);

the opposite ends of a sixth roller (**60**) having an axis of rotation (60×) arranged parallel with respect to the first axis (10×);

two fourth slides (**71***a*, **71***b*) movable vertically and guided (**72***a*, **72***b*) on a respective wall (Ta, Tb) and able to be adjusted vertically by means of adjusting members (**73***a*, **73***b*), said fourth slides (**71***a*, **71***b*) being intended to support the opposite ends of a seventh roller (**70**) having an axis of rotation (70×) arranged parallel with respect to the first axis (10×);

the opposite ends of an eighth roller (**80**) having an axis of rotation (80×) arranged parallel with respect to the first axis (10×).

25)- Apparatus according to claim **15**, characterized in that said first series of bending/curving rollers (**10**, **20**, **30**, **40**) comprises a second roller (**20**) and/or a third bending-curving roller (**30**) having a radius preferably equal to or less than the minimum radius of curvature of the original wire (Fa).

26)- Apparatus according to claim **15** (**FIGS. 3A and 3B**), characterized in that a roller (**40**) has the circumferential grooves (**40***a*, etc.) arranged in one plane (X1*a*, etc.) and the following roller (**50**) has the circumferential grooves (**50***a*, etc.) arranged in a second plane (X2*a*, etc.) arranged spaced transversely with respect to the first plane (X1*a*, etc.) in order to configure between said two rollers (**40**, **50**) a travel path for the wires comprising a fourth sub-segment (D'E') for lateral bending and oriented skew alongside the first plane (X1*a*).

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