

METHOD FOR MANUFACTURING METAL FIBERS, MORE PARTICULARLY STEEL FIBERS

[0001] The invention relates to a method for manufacturing metal fibers, in particular tempered or untempered steel fibers, from strip-shaped flat material, wherein the metal fibers have a substantially rectangular cross-section, and at least one of the wider fiber lateral surfaces, preferably both of the wider fiber lateral surfaces, is provided with at least one V-shaped anchor notch extending in the fiber longitudinal direction, wherein, in order to form the metal fibers, a metal strip is preferably provided with fracture notches on both metal strip surfaces in the longitudinal direction, as a result of which separating webs are formed at the notch base thereof, which separating webs, optionally also after a rolling process deforming the separating webs by bending, form a burr-free and fracture-free separating surfaces.

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[0002] The invention also relates to a device for carrying out this method, and to a metal fiber, in particular steel fiber, manufactured according to the method.

[0003] Metal fibers of this type have already been described, in particular in DE 20 2017006 298 A1. Such metal fibers serve as admixture in concrete with the aim of compensating for the cracks occurring in concrete components and causing a reduction of the tensile load, that is to say, in turn to absorb the tensile load, and to stitch up the crack in this way, figuratively speaking. In order to achieve this, the greatest possible number of metal fibers must be distributed as uniformly as possible in the component. For this purpose, the metal fiber should be thin, so that a high number of parts per weight unit, and thereby statistically a high homogeneity, is achieved. It is important here that the metal fibers should have no or no large projections projecting beyond their surface, such as hooks at the fiber ends and the like, which could cause "clumping" of the metal fibers in the concrete, and thus "hedgehog formation", which would lead to uneven distribution. On the other hand, for the effect of the metal fiber under tensile load

to be achieved, the anchorages together with the strength of the material used are specifically decisive for the tensile load capacity.

5 [0004] In order to meet the performance specifications required in the construction industry, coordination is required with regard to the design of the metal fiber, on the one hand, and the fiber material to be used in terms of strength and strain on the other hand. In the context of the object of the invention, it is also particularly important to be able to use the simplest possible, most cost-effective manufacturing technology possible.

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[0005] According to the invention, this task is solved from a process point of view in that a material is first used as the metal strip which is adapted to the strength required for the metal fiber in subsequent use, the metal strip being fed in a first production line in the form of a coil from a driven and controlled
15 uncoiler (1) to a straightening and transport unit (3), which is provided with an overrunning clutch enabling freewheeling and has a downstream crop shear (4), which forms at least the start of the strip, whereupon the metal strip is fed to a profiling roll (6), which consists of an upper roll and a lower roll and is in the form of a rolling tool, for introducing both anchor notches, which are
20 arranged axially offset from one another on the upper and lower sides, and the fracture notches, wherein the two rolls may be provided with interruptions for forming anchor surfaces and/or anchors in the anchor notches or the fracture notches, respectively, which form anchor lines on the metal strip, for which purpose the rolls can be precisely adjusted in their synchronization properties
25 for exact positioning of the anchor lines with respect to the upper and lower rolls and are additionally equipped with stable and adjustable axial guidance of the two rolls with respect to one another, and in that the metal strip then passes, if required, through a combined scoring and straightening unit (7) for deeper notching, scoring or leveling of the anchors in the fracture notches with
30 one or more scoring roller pairs, and is finally wound up again as a coil by a coiling device (8) or is conveyed further in the corresponding production line.

[0006] The progress achieved by the invention consists, among other things, in that an adapted material can be provided for the forming process of the metal fibers, i.e., in particular the profile rolling, as a result of which smaller rolls can be used due to the lower bending forming force for the anchor notches and thus a lower rolling force. The metal strip can be selected to be relatively thin, so that the webs of the fracture notches between the metal fiber strands can be designed to be very small and thus simplify the subsequent separation. The arrangement of the anchor notches on the upper and lower side of the metal strip, in which the inner anchors are provided, makes it possible to keep the axial forces within more easily controllable limits due to their mutual offset by means of a guide function, which significantly reduces the mechanical effort. Finally, the manufacturing process of notching, tempering, and separating described above allows for a very space-saving storage of the metal fiber strips, since the separation into metal fibers can be carried out as needed a later point in time, while metal fibers filled in a container, such as a big bag, take up significantly more space and their subsequent separation for admixture in concrete is complex and usually requires specially equipped devices for this purpose.

[0007] Within the scope of the invention, it is also possible, in particular, for the metal strip to optionally pass through a plurality of rolling stations in the optional scoring and straightening unit downstream of the scoring roller pairs, after which an optical detection of the anchors present in the anchor notches and arranged on anchor lines perpendicular to the direction of travel of the metal strip takes place, and herewith a control of a longitudinal dividing shear takes place, which, if necessary, carries out a pre-separation of the metal fiber strands of the anchors in the region of the fracture notch, whereupon a longitudinal dividing roll separates the pre-separated fibers from the metal strip substantially in the anchor region, whereby the profiled metal strip is drawn through the separating roll by a downstream drawing roll, but the latter also requires a supporting, controlled drive of its own, wherein, upstream of the coiling device, a straightening unit having a crop shear and a further

straightening unit for pre-bending the profiled metal strip are optionally provided before the coiling. Instead of coiling, however, the fibers can also be manufactured immediately, especially if no tempering is planned. Due to the relatively thin separating webs, even after a carried out tempering process of the metal strip, a particularly simple and low-interference slitting is possible by means of a dragged separating roll, which may optionally be provided with a supporting drive.

[0008] Following these process steps, depending on the starting material used or the properties of the desired end product, the profiled metal strip can then be subjected to a common and usual heat treatment process, which will therefore not be described in detail here.

[0009] Furthermore, the invention provides that in an alternative second production line, after the optional scoring unit and the pre-separation, the profiled and, if necessary, tempered metal strip is uncoiled from a driven and controlled uncoiler and fed into a straightening unit, which is in turn equipped with an overrunning clutch, for straightening and drawing in the beginning of the strip, the beginning of the strip being provided with a clean, flat section by a downstream crop shear, whereupon, after passing through a flat, narrow strip guide, an optical detection of the anchors present in the anchor notches and arranged on anchor lines perpendicular to the direction of travel of the metal strip takes place, which serves the subsequent control of a transverse dividing shear, and, after passing through a further flat, narrow strip guide, the complete separation of the metal fibers from one another takes place in dragged longitudinal dividing rolls or longitudinal dividing rolls provided with a supporting drive, for which purpose the separated metal fibers are drawn through a narrow guide with a high tensile load of a drawing roll, and, still longitudinally separated, are pushed closely guided into a transverse dividing shear and finally cut to length are fed into a collecting container for the separated metal fibers.

[0010] For carrying out the above-described process in terms of devices, in which metal fibers, in particular steel fibers, are manufactured from strip-shaped flat material, the metal fibers having a substantially rectangular cross-section and at least one, preferably both, of the respectively wider fiber side faces being provided with at least one V-shaped anchor notch extending in the longitudinal direction of the fibers and, for forming the metal fibers, a metal strip being provided with fracture notches in the longitudinal direction, preferably on both metal strip faces, whereby separating webs are formed at the notch base thereof, which form low-burr and fracture-rough separating surfaces during subsequent separation, optionally also after a rolling process deforming the separating webs by bending, the invention proposes that a driven and controlled uncoiler for the metal strip in the form of a coil is provided in a first production line, furthermore a straightening and transport unit for the metal strip, which is provided with an overrunning clutch enabling a freewheel, furthermore a downstream crop shear for forming at least the beginning of the strip, furthermore a profiling roller consisting of an upper roller and a lower roller and designed as a rolling unit for introducing the anchor notches and the fracture notches into the metal strip, the synchronization properties of the two rollers and their axial guidance relative to one another being precisely adjustable, further optionally with a combined scoring and straightening unit with one or more pairs of scoring rollers for notching, scoring or also, if desired, for leveling the anchors in the fracture notches in the metal strip, and finally with a coiling device for rewinding the metal strip as a coil.

[0011] In this case, it is advantageous and therefore preferred within the scope of the invention that a plurality of rolling stations for the metal strip are provided downstream of the scoring roller pairs, if necessary, that further an optical detection unit is provided for the anchors present in the anchor notches and arranged on anchor lines perpendicularly to the direction of travel of the metal strip, by means of which a control of a longitudinal dividing roll is effected, which enables a pre-separation of the anchors of the metal fiber strands in the region of the fracture notch, wherein a downstream drawing roll is provided for

advancing the profiled metal strip, and that, upstream of the coiling device, a straightening unit having a crop shear for pre-bending the profiled metal strip is optionally arranged prior to the coiling, wherein, instead of coiling, the units required for longitudinal and transverse dividing can also be provided in
5 accordance with a second production line.

[0012] For carrying out the second production line, it is advantageous if, for unwinding the now profiled and/or optionally tempered metal strip, a driven and controlled uncoiler is again provided, as well as a straightening unit, again
10 equipped with an overrunning clutch, for straightening and drawing in the beginning of the strip, furthermore a crop shear for applying a clean, flat section to the beginning of the strip, furthermore an optical detection device for determining the anchors present in the anchor and fracture notches and arranged on anchor lines perpendicular to the direction of travel of the metal
15 strip, wherein for guiding the metal strip in front of and behind the optical detection device, flat, narrow strip guides are provided for the metal fibers, which are partially separated from one another, in that furthermore dragged or optionally drive-supported longitudinal dividing rolls are provided for complete separation of the metal fiber strands from one another, as well as a drawing
20 roll, wherein for the longitudinally separated metal fiber strands a narrow guide is to be provided to the transverse dividing shears, which are controlled by the optical detection device and cuts the metal fiber strands to length. The fibers are fed into a collecting container.

25 [0013] In this case, it has proven to be advantageous if the scoring and straightening unit is provided with a plurality of, preferably two, scoring roller pairs.

[0014] Finally, the invention relates to a metal fiber, in particular a steel fiber, which is formed from strip-shaped flat material, the metal fiber having a
30 substantially rectangular cross-section and at least one, preferably both, of the respective wider fiber side faces being provided with at least one V-shaped anchor notch extending in the longitudinal direction of the fiber, the metal fiber

being formed from a metal strip which is provided in the longitudinal direction, preferably on both metal strip surfaces, with fracture notches, the notch bases of which form separating webs which, on subsequent separation, optionally also after a rolling process deforming the separating webs by bending, form low-burr and fracture-rough separating surfaces, wherein the metal strip used consists of a material which is adapted with respect to the strength required for the metal fiber in subsequent use, wherein furthermore the anchor notches arranged axially offset relative to one another on the upper and lower sides as well as the fracture notches are introduced by a profiling roller, which consists of an upper roll and a lower roll and is in the form of a rolling tool, the two rolls of which, which have exactly synchronous running properties, can be provided with undercuts for the formation of anchor surfaces and/or anchors in the anchor notches and the fracture notches, respectively, whereby the fracture notches can be notched or scored more deeply by the scoring roller pairs of a scoring and straightening unit, or the anchors in the fracture notches may be leveled.

[0015] The invention is explained in more detail below with reference to an exemplary embodiment in the form of a device, in which:

Fig. 1 shows a schematic representation of a production line according to the invention from cold strip to the profiled metal strip in a first embodiment, Fig. 2 shows a representation corresponding to Fig. 1 of an alternative embodiment in plan view a) and section b), wherein also all of the structural units provided only optionally are shown, Fig. 3 shows a detail of the notched metal strip with the anchor lines and the non-separated web region (web rest), Fig. 4 shows the production line adjoining the subject matter according to Fig. 1 or 2 from the profiled metal strip to the profiled metal fiber in a side view, Fig. 5 shows a metal fiber in section.

[0016] The arrangement shown in the drawing is provided for carrying out a method which serves to produce metal fibers, in particular steel fibers, from strip-shaped flat material. These metal fibers, shown by way of example in Fig.

5 in section, have a substantially rectangular cross-section, wherein at least one, but preferably both of the respectively wider fiber side surfaces are provided with at least one V-shaped anchor notch extending in the longitudinal direction of the fiber. In order to form the metal fibers, a metal strip is provided
5 with fracture notches in the longitudinal direction, preferably on both metal strip surfaces, whereby separating webs are formed at their notch bases. These separating webs, during subsequent separation, optionally only after a rolling process deforming the separating webs by bending, form low-burr and fracture-rough separating surfaces.

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[0017] The metal strip used here is usually a material initially adapted to the strength required for the metal fiber in its subsequent use. According to Fig. 1, the metal strip is fed in a first production line at 1 in the form of a coil by a driven and controlled uncoiler to a straightening and transport unit 3, which is
15 provided with an overrunning clutch enabling freewheeling. It also has a downstream crop shear 4 forming at least the beginning of the strip.

[0018] The metal strip is then fed to a profiling roll 6, which consists of an upper roll and a lower roll and is in the form of a rolling tool unit, which is used to
20 introduce both the anchor notches arranged axially offset from one another on the upper and lower sides and the fracture notches whose undercuts form the anchor lines. The profiling roll 6 has precisely adjustable synchronization of both rolls to achieve exact positioning of the anchor lines on the upper roll to the lower roll. Furthermore, it is equipped with a likewise stable and adjustable
25 axial guidance of the two rolls with respect to one another. Subsequently, if required, the metal strip passes through a combined scoring and straightening unit 7 for scoring the anchors in the fracture notches with one or more scoring roller pairs, whereby two scoring roller pairs have preferably proved effective. Finally, the metal strip is rewound as a coil by a coiling device 8. When
30 arranging the individual components just described, care must be taken to ensure that there is sufficient clearance 2 and 5 behind both the uncoiler 1 and

the crop shear 4 for winding and threading on the coil start and for preparing the ring start.

5 [0019] In an alternative process sequence according to Fig. 2, in which the same reference signs are used for positions 1 to 7, the metal strip optionally passes through several rolling stations in the scoring and straightening unit 7 after the scoring roller pairs, whereupon an optical detection 9.1 takes place in the anchors present in the notches and arranged on anchor lines perpendicular to the direction of travel of the metal strip. This makes it possible to control a longitudinal dividing roll 9.2, which performs a pre-separation of the metal fiber strands in the anchor area of the fracture notches, with the profiled metal strip being pulled through the longitudinal dividing roll by a downstream drawing roll 10. As a result, the longitudinal dividing roll requires no or only a supporting drive of its own. Upstream of the coiling device 13, a straightening unit 11 having a crop shear and a further straightening unit 12 for pre-bending the profiled metal strip prior to coiling can optionally be provided. For metal fibers without tempering, the machine units according to items 11 - 13 are to be replaced with the machine units 25 - 33 according to Fig. 4.

20 [0020] Fig. 3 shows a side view and a plan view of the metal fiber strip, in which the regions in which the webs are separated or respectively not separated are visible. The anchor lines are also visible, as is the section line A on which the fibers are cut to length.

25 [0021] The profiled metal strip can then optionally be subjected to a common and usual tempering process in a subsequent method step in a manner not shown in detail.

30 [0022] In a second production line, shown schematically in Fig. 4, the profiled and tempered metal strip is uncoiled from a driven and controlled uncoiler 21 and fed into a straightening unit 22, again equipped with an overrunning clutch, for straightening and drawing in the beginning of the strip. In this case, the

beginning of the strip is provided with a clean, flat section by a downstream crop shear 23. Here again, provision must be made for sufficient clearance 24 behind the crop shear 23 for processing or threading the beginning of the strip.

- 5 [0023] After passing through a flat, narrow strip guide 25, an optical detection of the anchors present in the anchor notches and arranged on anchor lines perpendicular to the direction of travel of the metal strip takes place at 26, which serves the subsequent control of a transverse dividing shear. After passing through another flat, narrow strip guide 27, the complete separation of
- 10 the metal fibers from one another takes place in dragged longitudinal dividing rolls 28 or longitudinal dividing rolls 28 provided with supporting drive, for which purpose the separated metal fibers are fed through a narrow guide 29 with a high tensile load to a drawing roll 30.
- 15 [0024] After continued narrow plate guidance 31, the longitudinally divided metal fiber strands are pushed into a transverse dividing shear 32 and cut to length, and finally fed into a collecting container 33 for the separated metal fibers.

Claims:

1. The method for manufacturing metal fibers, in particular tempered or untempered steel fibers, from strip-shaped flat material, wherein the metal
5 fibers have a substantially rectangular cross-section and at least one, preferably both, of the respective wider fiber side faces is/are provided with at least one V-shaped anchor notch extending in the longitudinal direction of the fibers, wherein, to form the metal fibers, a metal strip is provided in the longitudinal direction, preferably on both metal strip surfaces, with fracture
10 notches, as a result of which separating webs are formed at the notch base thereof, which form low-burr and fracture-rough separating surfaces during subsequent separation, optionally also after a rolling process which deforms the separating webs by bending, characterized in in that a material adapted to the strength required for the metal fiber in subsequent use is initially used as
15 the metal strip, the metal strip being fed in a first production line in the form of a coil from a driven and controlled uncoiler (1) to a straightening and transport unit (3) which is provided with an overrunning clutch enabling freewheeling, and a downstream crop shear (4) forming at least the beginning of the strip, whereupon the metal strip is fed to a profiling roll (6), which consists of an
20 upper roll and a lower roll and is in the form of a rolling tool, for introducing both the anchor notches, which are arranged axially offset from one another on the upper and lower sides, as well as the fracture notches, wherein the two rolls can be provided with undercuts for forming anchor surfaces and/or anchors in the anchor notches and the fracture notches, respectively, which
25 form anchor lines on the metal strip, for which purpose the rolls can be precisely adjusted in their synchronization properties for exact positioning of the anchor lines with respect to the upper and lower rolls and are additionally equipped with stable and adjustable axial guidance of the two rolls with respect to one another, and in that the metal strip then passes, if required, through a
30 combined scoring and straightening unit (7) for deeper notching, scoring or leveling of the anchors in the fracture notches with one or more scoring roller

pairs and is finally wound up again as a coil by a coiling device (8) or is continued in the corresponding production line.

2. The method according to claim 1, characterized in that the metal strip
5 optionally passes through several rolling stations in the optional scoring and
straightening unit (7) after the scoring roller pairs, and thereafter an optical
detection (9.1) of the anchors present in the notches and arranged on anchor
lines perpendicularly to the direction of travel of the metal strip is effected, and
therewith a control of a longitudinal dividing roll (9.2), which carries out a pre-
10 separation of the metal fiber strands in the anchor region of the fracture
notches, wherein the profiled metal strip is drawn through the longitudinal
dividing roll (9.2) by a downstream drawing roll (10) such that the longitudinal
dividing roll (9.2) requires no drive or only a supporting drive of its own, wherein
a straightening unit (11) having a crop shear and a further straightening unit
15 (12) for pre-bending the profiled metal strip prior to coiling are optionally
provided upstream of the coiling device (13).

3. The method according to claim 1 or 2, characterized in that the profiled
metal strip is optionally subjected to a common and usual tempering process
20 in a subsequent process step.

4. The method according to claims 1 to 3, characterized in that in a second
production line the profiled and/or tempered metal strip is uncoiled from a
driven and controlled uncoiler (21) and fed to a straightening unit (22), again
25 equipped with an overrunning clutch, for straightening and drawing in the
beginning of the strip, the beginning of the strip being provided with a clean,
flat section by a downstream crop shear (23), whereupon, after passing
through a flat, narrow strip guide (25), an optical detection (26) of the anchors
present in the anchor notches and arranged on anchor lines perpendicular to
30 the direction of travel of the metal strip is carried out, which serves for the
subsequent control of a transverse dividing shear (12), and after passing
through a further flat, narrow strip guide (27), the complete separation of the

metal fibers from one another takes place in dragged longitudinal dividing rolls (28) or longitudinal dividing rolls (28) provided with a supporting drive, wherein for this purpose the separated metal fibers are drawn through a narrow guide (29) with a high tensile load of a drawing roll (30) and are further narrowly
5 guided (31) into a transverse dividing shear (32) and cut to length and finally fed to a collecting container (33) for the separated metal fibers.

5. A device for carrying out the method according to claims 1 to 4, in which metal fibers, in particular steel fibers, are produced from strip-shaped flat
10 material, the metal fibers having a substantially rectangular cross-section and at least one, preferably both, of the respectively wider fiber side faces being provided with at least one V-shaped anchor notch extending in the longitudinal direction of the fibers and, to form the metal fibers, a metal strip is provided with fracture notches in the longitudinal direction, preferably on both metal strip
15 faces, whereby separating webs are formed at the notch base thereof, which form low-burr and fracture-rough separating surfaces during subsequent separation, optionally also after a rolling process which deforms the separating webs by bending, characterized in that a driven and controlled uncoiler (1) for the metal strip in the form of a coil is provided in a first production line, further
20 a straightening and transport unit (3) for the metal strip, which is provided with an overrunning clutch enabling freewheeling, further a downstream crop shear (4) for forming at least the beginning of the strip, further a profiling roll (6), which consists of an upper roll and a lower roll and is in the form of a rolling tool unit, for introducing the anchor notches and the breaking notches into the
25 metal strip, the synchronization properties of the two rolls and their axial guidance relative to one another being precisely adjustable, further comprising a combined scoring and straightening unit (7) having one or more scoring roller pairs for deeper notching, scoring, or also, if desired, for leveling the anchors in the fracture notches in the metal strip, and finally comprising a coiling device
30 (8) for rewinding the metal strip as a coil.

6. The device according to claim 5, characterized in that, if required, a plurality of rolling stations for the metal strip are provided downstream of the scoring roller pairs, in that further an optical detection unit (9.1) is provided for the anchors present in the anchor notches and arranged on anchor lines
5 perpendicular to the direction of travel of the metal strip, by means of which a control of a longitudinal dividing roll (9.2) is carried out, which enables a pre-separation of the metal fiber strands of the anchors in the region of the fracture notches, wherein a downstream drawing roll (10) is provided for driving the profiled metal strip, and in that a straightening unit (11) having a crop shear for
10 the pre-bending of the profiled metal strip prior to the coiling is optionally arranged upstream of the coiling device (13).

7. The device according to claims 5 and 6 for carrying out a second production line, characterized in that for unwinding the now profiled and
15 tempered metal strip, there is again provided a driven and controlled uncoiler (21) and a straightening device (22), again equipped with an overrunning clutch, for straightening and drawing in the beginning of the strip, further a crop shear (23) for applying a clean, flat section to the beginning of the strip, further an optical detection device (26) for detecting the anchors present in the anchor
20 and fracture notches and arranged on anchor lines perpendicular to the direction of travel of the metal strip, wherein, for guiding the metal strip in front of and behind the optical detection device (26), flat, narrow strip guides 25 or 27 are provided for the metal fibers which have been partially separated from one another, in that dragged longitudinal dividing rolls (28) or optionally drive-
25 supported longitudinal dividing rolls (28) are provided for completely separating the metal fiber strands from one another, as well as a drawing roll (30), wherein the metal fiber strands are pushed by the drawing roll (30) through a narrow guide (29) of a transverse dividing shear (32) controlled by the optical position detection device (26) for cutting to length, and the fibers
30 are fed into a collecting container (33).

8. The device according to claims 5 to 7, characterized in that the scoring and straightening unit (7) is provided with a plurality of, preferably two, scoring roller pairs.

- 5 9. A metal fiber, in particular steel fiber, according to claims 1 to 6, formed from strip-shaped flat material, wherein the metal fiber has a substantially rectangular cross-section and at least one, preferably both, of the respective wider fiber side faces is/are provided with at least one V-shaped anchor notch extending in the longitudinal direction of the fiber, the metal fiber being formed
- 10 from a metal strip which is provided in the longitudinal direction, preferably on both metal strip surfaces, with fracture notches, the notch bases of which form separating webs which, during subsequent separation, optionally also after a rolling process which deforms the separating webs by bending, form low-burr and fracture-rough separating surfaces, characterized in that the metal strip
- 15 used consists of a material which is adapted with respect to the strength required for the metal fiber in subsequent use, wherein the anchor notches arranged axially offset from one another on the upper and lower sides as well as the fracture notches are introduced by a profiling roll (6), which consists of an upper roll and a lower roll and is in the form of a rolling tool, the two rollers
- 20 of which, which have exactly synchronous running properties, can be provided with undercuts for forming anchor surfaces and/or anchors in the anchor notches or the fracture notches, wherein the fracture notches may be notched deeper, scored deeper or the anchors in the fracture notches may be leveled by the scoring roller pairs of a scoring and straightening unit (7).