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(71) Applicant: OFFICINE MACCAFERRI S.P.A. [IT/IT];
Via Kennedy, 10, 40069 Zola Predosa (BO) (IT).

(72) Inventor: FERRAIOLO, Francesco; Via Gandolfi, 58,
40050 Ca' de' Fabbri (BO) (IT).

(74) Agent: PROVVISIONATO, Paolo; c/o Provvisionato &
Co S.r.l., Piazza di Porta Mascarella, 7, 40126 Bologna (IT).

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(54) Title: MACHINE AND METHOD FOR MANUFACTURING A REINFORCED NET AND REINFORCED NET

(57) Abstract: A machine for manufacturing a reinforced net (1, 10), which has hexagonal meshes comprising a plurality of permanently deformable wires (2, 2', 3, 3') and at least one reinforcing element (5), comprises a mechanism for the reciprocal coiling of first wires (2, 2') and second wires (3, 3') in twos, which mechanism is provided with passages for the reinforcing elements (5), and a feed system for the first wires (2, 2'), fed in from a plurality of containers (90, 90') that are mounted on board the machine and provided internally with a predetermined length of said first wires (2, 2'), for part of the second wires (3), fed in alternately with the first wires, so as to be interwoven therewith in twos in the coiling mechanism, and for the reinforcing elements (5), fed into the machine, wherein, for all the reinforcing elements (5), a wire receptacle (202) is provided for one of said second wires (3'), the wire receptacle being rotatable around the reinforcing element. The invention also relates to a multiple-twist net with hexagonal meshes and a method for producing such a net.

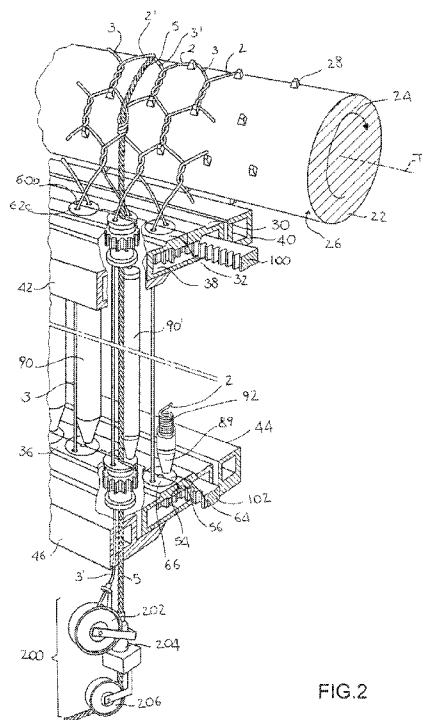


FIG. 2



MACHINE AND METHOD FOR MANUFACTURING A REINFORCED NET AND
REINFORCED NET

The present invention relates to a machine and to a method for manufacturing a reinforced hexagonal net, and also to a reinforced hexagonal net.

The invention has been developed with particular regard, but not restrictively, to a machine for manufacturing a hexagonal-mesh net provided with at least one longitudinal reinforcing element, woven through the whole net and positioned so as to bisect the meshes through which it passes.

Over forty years ago (IT1050936), the present developed a machine for manufacturing a hexagonal net that provided at least one longitudinal reinforcing wire. The machine (Fig. 1) has proven to be very effective but is designed to be used with reinforcing wires 1 having the same thickness and strength as the wires 27 and 34 used for manufacturing the whole net. It is not, however, possible to use either high-strength wires, which are more rigid, or cables, which are more rigid and also thicker. In the machine, to allow the net to be woven with three wires into a twisted portion, a wire 34 is housed inside a cylindrical container 33 that can be wound around the other wires during weaving, as is common in the field. A device is provided for the reinforcing wire and the wire 27, which device allows the wire 27 to be rotated around a reel 85 over which the reinforcing wire 1 is wound. For this purpose, the reel 85 has compact dimensions and the wire 27 winds around it with a specially designed system. Clearly, a similar solution works perfectly with reinforcing wires 1 of a similar rigidity to the wires 27 and 34, but cannot be used with cables or high-strength wires, since it

is impossible to wind them around a reel with such a small diameter. A spool of a suitable diameter for a cable or a high-strength wire would not, however, be compatible with this solution.

The applicant has also patented two hexagonal-mesh nets in which a wire is replaced by a cable. In these nets, each twisted portion comprises just two elements: either two wires or a wire and a cable. Consequently there is no provision for a device allowing a third wire/cable to be coiled together.

The object of the present invention is to solve the problems of the prior art and in particular to provide a machine for producing a hexagonal-mesh net having additional longitudinal reinforcing elements, wherein said reinforcing elements are high-strength wires or cables or ropes. A further object is that of producing an economic, safe piece of machinery that is reliable to use.

In order to achieve the above-mentioned objects, the present invention relates to a machine and to a net as in the attached claims.

Further features and advantages will become evident from the following detailed description of a preferred embodiment of the invention, with reference to the attached drawings, provided purely by way of non-restrictive example, in which:

- Fig. 1 illustrates the machine according to the prior art,
- Fig. 2 shows a portion of a machine according to the invention,
- Fig. 3 shows a net produced by the machine in Fig. 2,
- Fig. 4 shows another net produced by the machine in Fig. 2,

- Fig. 5 is a detailed view of an upper bar 30 of the machine in Fig. 2,
- Fig. 6 is a detailed view of an upper bar 32 of the machine in Fig. 2,
- Fig. 7 shows the pair of upper bars 30 and 32 in a first position,
- Fig. 8 shows the pair of upper bars 30 and 32 in a second position, and
- Fig. 9 shows the pair of upper bars 30 and 32 in a third position.

In Fig. 2-9, the same elements are indicated by the same reference numeral; the numbering is independent from that in Fig. 1, which is the prior art.

The portion of net 1 in Fig. 3 is a double-twist net comprising hexagonal meshes and reinforcing cables. It comprises a plurality of wires 2, 3, 2', 3' coiled around one another in twisted portions 7, 7', to form hexagonal meshes 4, and at least one reinforcing cable 5 inserted longitudinally through selected twisted portions 7'. Between two successive twisted portions 7' in the longitudinal direction, the reinforcing cable forms two trapezoidal meshes 6 placed side by side. Here and below, the term "cable" will be used for conciseness; it is, however, understood that any reinforcing element having a strength greater than the strength of the wires making up the net can be used. For example, it can be a metal cable made up of several strands, a rope having a textile core or else a high-strength metal wire, and can be galvanised or plastics-coated if appropriate.

The wires and cables making up the net are all arranged in the same direction, which will be denoted below as being

longitudinal. Each wire 2, 3 is coiled alternately with the preceding wire 3, 2 and the subsequent wire 3, 2, as known in a double-twist net, to form the twisted portions 7.

Furthermore, for all cables 5, a wire 2' is coiled alternately with the single preceding wire 3, forming a twisted portion 7, and with a subsequent wire 3' together with the reinforcing cable 5, forming a twisted portion 7' having three elements.

Similarly, the wire 3' is coiled alternately with the preceding wire 2', together with the reinforcing cable 5, forming a twisted portion 7' having three elements, and with the single subsequent wire 2, forming a twisted portion 7 having just two elements.

Twisting follows the same twist direction in each twisted portion 7, 7': clockwise or anticlockwise but constant in each twisted portion. In Fig. 3 the twisted portions 7, 7' have the wires 2, 3 coiled in directions that alternate from one row to the next: if in one row the wires 2 and 3 are coiled together in a clockwise direction, in the row below and the one above the wires 2 and 3 are coiled in an anticlockwise direction. A variant wherein all the twisted portions 7, 7' have the same direction of weaving should not, however, be ruled out.

In the variant in Fig. 4, the net 10 further comprises at least one transverse cable 11. The cable 11 is positioned perpendicularly to the cables 5, which intersect at intersections 12, and is inserted into twisted portions 7" formed by two single longitudinal wires 2, 3, 2', 3'.

It should be noted that the portions of net depicted in Fig. 3 and 4 show a single longitudinal cable 5 and a single transverse cable 11 because the portion depicted is small, so as to be able to consider it in detail. Nonetheless, a plurality of longitudinal and transverse cables are normally provided. A net having these characteristics has extremely high resistance to puncture and traction, given by the reinforcing cables that directly bear most of the stress; in traditional double-twist nets it is, however, the wires that have to bear the stress.

Preferably, the cables 5, 11 are less than a metre away from each other both transversely (for both embodiments) and longitudinally (for the embodiment in Fig. 4), so as to ensure adequate strength. It should be noted, for example, that regulations for puncture tests provide for the use of a square punch with a 1m side; hence the presence of cables at a distance of less than one metre ensures that at least one longitudinal cable and one transverse one (if present) are in line with the punch.

The function of the wires in the net in question is to hold the small material and above all to keep all the cables in a fixed position, which cables are directly interwoven in the twisted portions, and to hold fast the intersection points 12 between cables 5, 11.

The machine according to the invention, intended for producing a net having the features described above, is in part similar to a known machine for the assembly of traditional double-twist nets, developed many years ago by the same applicant. In the following description, which while relating to the whole machine, will focus mostly here on the

new and original elements that make it possible to produce a net having the reinforcing cables 5 and, preferably, 11.

As can be seen in Fig. 2, the machine 20 comprises a drum 22, mounted with means (not illustrated) in the fixed framework of the machine so that it can rotate at a constant speed in the direction of the arrow 24 about its axis T. Radial protuberances or pegs 28 project outwards from the curved face 26 of the drum. These pegs are arranged in rows that extend in a direction parallel to the axis T and are arranged at equal angular intervals. The pegs 28 are positioned at a constant spacing within each row and two successive rows are out of phase with each other by a half-pitch in the axial direction.

These pegs serve to form the hexagonal-mesh net and to hold a portion of the net already formed in the outlet direction of the machine.

Below the drum 22, two pairs of bars 30, 32 and 34, 36 are provided, which are parallel to the axis T and support semi-cylindrical rotatable bodies 60, 62, 64 and 66; the function of the semi-cylindrical bodies is to coil the wires together in pairs, to produce the net.

The bars have a U-shaped cross section. They are positioned in pairs with the respective open edges of the U facing one another and lying in a vertical plane of symmetry that is tangent to the periphery of the drum 22; the bars 30 and 32 form an upper pair and the bars 34 and 36 form a lower pair. Naturally, upper and lower indicate the position in which the bars are arranged in the embodiment in the figures. Positioning them in a different way, for example with the wires running horizontally, is by no means ruled out,

however. More generally, an "upper" bar is downstream in the working direction compared with a corresponding "lower" bar, irrespective of the height at which it is placed.

The bars are supported by elements 40, 42, 44, 46, which form part of the fixed framework of the machine. They can also move in a direction parallel to that of the axis T.

Fig. 5 and 6 depict in greater detail the bars 30 and 32, which are exactly the same as the bars 34 and 36 of the lower pair of bars. A plurality of through-seatings 48 are made in the edges 50, 52, 54, 56 of each of the bars 30, 32, 34, 36 of all the pairs facing the respective edges 52, 50, 56, 54 of the paired bar. The through-seatings 48 are semi-cylindrical, having axes perpendicular to the axis T and lying in the above-mentioned plane of symmetry; the distance between each seating and the adjacent seating in the same bar is equal to the distance between the pegs 28. Each of said seatings 48 faces a similar seating 48 made in the edges of the other bar of the same pair.

A semi-cylindrical rotatable body 62, 66 is mounted in each of the seatings 48 in the bars 32, 36. The rotatable bodies 62 of the upper bar 32 are aligned with the rotatable bodies 66 of the lower bar 36 and have through-holes 72, 76 having axes parallel to the axes of the semi-cylindrical rotatable bodies which are aligned with each other within the superimposed semi-cylindrical bodies 62, 66. Wires 3, 3' pass through these holes and are fed into the net being formed, as described more clearly below.

The semi-cylindrical bodies 62, 66 have diametrical plane faces 82, 86, which normally lie in the above-mentioned plane of symmetry. These plane faces 82, 86 are juxtaposed with

corresponding plane faces 80, 84 of corresponding semi-cylindrical bodies 60, 64 housed in the seatings 48 made in the bars 30, 34.

Each semi-cylindrical body 60 carried by the bar 30 has an eccentric axial pivot 78 protruding downwards and on which a plate 88 engages, which plate is preferably discoid and coaxial with the pivot 78. The pivot 78 and the plate 88 are aligned with a corresponding conical element 89 placed eccentrically on the corresponding semi-cylindrical body 64, protruding upwards. Each pair formed by a plate 88 and a conical element 89 allows a cylindrical container 90, 90' containing a predetermined length of wire 2, wound in a coil 92, 92', to be mounted. The wires 2, 2' emerge upwards from the containers 90, 90', pass through the through-holes 70 and are fed into the machine for forming the net, together with the wires 3, 3'. In use, the cylindrical containers 90, 90' rotate around the wires 3, 3', so as to prevent the twisting of the wires 2 and 3 above the semi-cylindrical bodies 60, 62 from creating an equal and opposite twist therebelow.

It should be noted that, for all the cables 5, two cylindrical containers 92' are provided, which are narrower than the other containers 92. During operation, these two containers are in turn actually located close to the cable 5 and if kept at normal dimensions would press too much against the cable 5. For the same reason, the two containers 92' are mounted on plates 88', which are also narrower; furthermore, one of these has a bevel 87 to prevent the reinforcing element 5 from pressing against a sharp edge while the net is being woven.

The pairs of bars 30, 32 and 34, 36 are connected by rack s to positioning mechanisms that allow the two superimposed

bars 32, 36 and the two superimposed 30, 34 to be moved simultaneously in a direction parallel to the axis T of the drum, but in opposite directions. The positioning mechanisms are configured such that each semi-cylindrical body carried by a bar can be moved from one position, in which it faces a first semi-cylindrical body of the paired bar, into a second position, in which it faces a second semi-cylindrical body that is adjacent to the first semi-cylindrical body. Furthermore, the semi-cylindrical rotatable bodies are connected, by racks like those 100, 102 visible in Fig. 2, to rotation mechanisms that set them in rotation in pairs, in order to interweave a wire 2 and a wire 3 and create a twisted portion and, thus, the net.

In the known machines for producing simple double-twist nets, with no reinforcing elements, all the semi-cylindrical bodies 62, 66 and 60, 64 are identical to one another. In the machine according to the present invention, however, some groups of semi-cylindrical bodies have small but significant structural differences. In particular, for each cable 5 there are provided three pairs of modified semi-cylindrical bodies 60a and 62a, 60b and 62b, 60c and 62c housed in the upper bars 30 and 32 and an equal number of modified semi-cylindrical bodies 64a and 66a, 64b and 66b, 64c and 66c housed in the lower bars 34 and 36.

The cable 5 must in fact also be fed into the machine, but does not need to be moved laterally while the net is being woven, since it always maintains a straight course. Consequently, it is fed in a fixed position, corresponding to the common axis of rotation of two semi-cylindrical bodies 62a, 60a and 66a, 64a in the first operating position of Fig. 7.

To allow the cable 5 to stay still while the semi-cylindrical bodies 62a, 60a and 66a, 64a are moved as described above, into the positions depicted in Fig. 8 and 9, the semi-cylindrical bodies 62a, 60a and 66a, 64a each have a groove 112, 110 and 116, 114, respectively. Each groove 112, 110, 116, 114 in the semi-cylindrical bodies 62a, 60a, 66a, 64a continues over the edge 52, 50, 56, 54, respectively, of each of the bars 32, 30, 36, 34 in a groove 122, 120, 126, 124. The grooves in the semi-cylindrical bodies and in the edges of the bars have the same depth, slightly greater than the radius of the cable 5, so that two grooves facing one another can comfortably house the cable 5 without compressing it. Widthways, each groove in the semi-cylindrical body is equal to at least the radius of the semi-cylindrical body plus the radius of the cable 5. Each groove created by the combination of the groove in the semi-cylindrical body and the groove on the edge of the bars is at least as wide as the pitch between two pegs 28, plus the diameter of the cable 5.

Thanks to these grooves, when the semi-cylindrical bodies 62a, 60a, 66a, 64a are moved to the positions depicted in Fig. 8 and 9, the cable 5 runs within the grooves facing one another, staying substantially still.

Furthermore, to prevent the cable 5 from rubbing excessively against the cylindrical containers 92', the semi-cylindrical bodies 62a, 60a, 66a, 64a have a slanting channel, visible in the figures only for the semi-cylindrical body 60a, where it is indicated with the numeral 61. The channel 61 (and the corresponding channel provided in the body 62a, slanting in the same direction) allows the cable 5 to have a slightly slanted arrangement when the semi-cylindrical bodies are in the position in Fig. 7, so as to reduce pressure and rubbing against the cylindrical container 92' and the plate 88'. The

semi-cylindrical bodies 66a, 64a also have a similar slanting channel, slanted in the opposite direction to that of the semi-cylindrical bodies 62a, 60a, for the same reason.

To keep the cable still when the semi-cylindrical bodies 60a and 62a, 64a and 66a are facing, protrusions 600 and 602 are provided on each semi-cylindrical body 60a, 62a, 64a and 66a. These protrusions project from the upper and lower faces of each semi-cylindrical body. Furthermore, the protrusions 600 have a face that is coplanar with the groove 110, 112, 114, 116. The protrusions 602, on the other hand, project from the diametral plane face 80, 82, 84, 86 so that they abut against the protrusions 600 when the semi-cylindrical bodies 60a and 62a, 64a and 66a are facing each other. In this way, when the semi-cylindrical bodies 60a and 62a, 64a and 66a are facing each other, the cable 5 remains embraced between the protrusions 602. Furthermore, the two semi-cylindrical bodies facing one another always remain completely coupled, being in contact with each other by means of the protrusions 600 and 602 along their whole diameter, with the sole exception of the passage for the cable 5.

During manufacture, the semi-cylindrical body 60a is in turn facing the body 62a in a first position (Fig. 7) and the body 62b in a second position (Fig. 9). Similarly, the semi-cylindrical body 62a is in turn facing the body 60a in the first position (Fig. 7) and the body 60b in the second position (Fig. 9). The bodies 60a and 62a have a channel 604 in the diametral plane face 80, 82, of the same depth as the groove 110, 112. On the other hand, a protuberance 606 of the same depth and height is provided on the diametral plane face 80, 82 of the bodies 60b, 62b. This protuberance 606 is therefore in contact with the groove 110, 112 and the channel 604, when the semi-cylindrical bodies are in the second

position in Fig. 9. In this way, in the second position, the semi-cylindrical bodies of the pairs 60a and 62b, 60b and 62a are in contact with each other along their whole diameter, for stable coupling.

Finally, the semi-cylindrical bodies 60c and 62c have a channel 608, having the same depth and height as the protuberance 606 and a width equal to the whole width of the semi-cylindrical body. This channel 608 allows the semi-cylindrical bodies 60b, 62b to be coupled to the semi-cylindrical bodies 62c and 60c, respectively, in the first position in Fig. 7.

Naturally, the same system of protuberances and channels is also present in the semi-cylindrical bodies 64a, 64b, 64c and 66a, 66b, 66c, corresponding to the description given above of the semi-cylindrical bodies 60a, 60b, 60c and 62a, 62b, 62c.

With reference now, in greater detail, to Fig. 7-9, it should be noted that in these drawings the protrusions 600 and 602 are not depicted because they would hinder understanding of the operation illustrated in the figures.

In use, the upper bars 30, 32 are first positioned so that the semi-cylindrical bodies 60, 60a, 60b, 60c are directly facing the semi-cylindrical bodies 62, 62a, 62b, 62c, respectively (Fig. 7). Wires 2 and 2' are inserted into the holes 70, wires 3 and 3' are inserted into the holes 72 and a cable 5 is housed between the grooves 110 and 112 in the two semi-cylindrical bodies 60a and 62a.

In this position, two rotations of the pairs of semi-cylindrical bodies determine the formation of the twisted

portions 7; the rotation of the semi-cylindrical bodies 60a and 62a determines the formation of the twisted portion 7', which comprises both two wires 2' and 3', and the cable 5. It should be noted that all the movements of the upper bars 30, 32 and the semi-cylindrical bodies positioned therein are also carried out in an identical fashion by the lower bars 34, 36 and by the semi-cylindrical bodies positioned therein, both in this and in all phases of production.

Once the two twists are completed, the two bars 30, 32 are moved in the direction of the arrows 130, 131, passing through the position in Fig. 8 and reaching the position in Fig. 9. In this position, the semi-cylindrical body 60a is facing a semi-cylindrical body 62b and the semi-cylindrical body 62a is facing a semi-cylindrical body 60b. In this position, two rotations of the semi-cylindrical bodies, preferably in the opposite direction to that taken in the phase in Fig. 7 (in other words, if the twists in Fig. 7 took place clockwise, in Fig. 9 they take place anticlockwise and vice versa), determine the formation solely of twisted portions 7, which comprise just two wires 2 or 2' and 3 or 3'. The cable 5, on the other hand, is housed between the two grooves 120 and 122 provided in the two bars 30, 32 and is therefore not involved in the twisting but is located between two adjacent twists 7.

Finally, the two bars 30, 32 are again moved in the directions of the arrows 132 and 133, which are respectively opposite the directions 130, 131 taken in the previous movement. The position in Fig. 7 is thus returned to and weaving of the net continues.

In a machine for manufacturing a hexagonal-mesh net of a traditional type, the wires 3 are fed into the semi-

cylindrical bodies 66 from spools, reels or the like, positioned on the rear of the machine; the moveable containers 90, 90' rotating around the wires 3.

In the machine according to the present invention, to allow the insertion of cables 5, a device for feeding in a wire 3', given the overall numeral 200, is provided for each cable 5. The device comprises a reel 202 around which the wire 3' is wound, which reel is rotatable about both its axis, in order to reel out the wire, and around a support 204 (fastened directly to the framework of the machine). The cable 5 runs through the support 204, so that the reel 202 can rotate around the support 204 and therefore around the cable 5 while the net is being woven. After the cable 5 is diverted through a snub pulley 206, it can therefore be fed directly from a spool or in some other way if desired, without any constraint.

Thanks to the feeding device 200 it is possible to use a cable having any desired diameter, which could not be housed in a reel like that of the prior art. Similarly, it is possible to use a high-strength reinforcing wire which, being more rigid than the wires 2, 3 (normally made of mild steel), could not be housed in the known reel unless a device for straightening the wire were also provided, although this would have provided a mediocre result.

In particular, the applicant has found that with wires, cables or ropes having a strength greater than approximately 500 or 600 kg/mm², it is impossible to use the known machine and therefore the machine forming the subject matter of the present invention is particularly beneficial. It is stressed that the new machine may nonetheless also be used with reinforcing wires 1 of a lesser strength, even identical to

the wires 2 and 3 that make up the hexagonal meshes, to produce a reinforced net of a known type.

Preferably, the reinforcing elements 1 have a diameter of between 4 and 10 mm and even more preferably between 5 and 8 mm. The wires 2, 3, 2', 3', on the other hand, have a diameter of between 1.8 and 3.9 mm and can also be galvanised or plastics-coated. The hexagonal meshes 4 of the net preferably have the dimensions 5x7, 6x8, 8x10, 10x12 or 12x14 mm.

For simplicity, the portion of the machine depicted and described provides for the use of a single cable 5, but it should be noted that it is possible and even recommended to insert more cables 5 into the same net. For each cable 5, all the contrivances described above can be provided: a pair of cylindrical containers 90' having a reduced diameter, modified semi-cylindrical bodies 60a, 60b, 60c, 62a, 62b, 62c, 64a, 64b, 64c, 66a, 66b and 66c, as well as, and in particular, a feed device 200.

The preferred distance between two adjacent cables 5 is between 25 cm and 100 cm. The overall lateral dimension of the net is preferably between 2 and 5 m.

The machine described above can also be used for producing a net that also has transverse cables 11 like that described above with reference to Fig. 4. It is in fact enough, during the weaving of the net, to insert cables 11 periodically, immediately above the semi-cylindrical bodies 60, 62 during weaving. For greater success, it is advisable to insert the cables 11 into different twisted portions 7" from the twisted portions 7' formed by two wires 2, 3 and a cable 5. The cable 11 should therefore preferably be inserted when the semi-

cylindrical bodies 60, 62 are in the position depicted in Fig. 9, after they have completed a first rotation and before they complete the second one.

The preferred distance between two adjacent transverse cables 11 is between 25 cm and 100 cm.

Naturally, without prejudice to the principle of the invention, the embodiments and the implementation details can vary greatly from what is described and illustrated, while remaining within the scope of the invention.

CLAIMS

1. Machine for manufacturing a reinforced net (1, 10) that has hexagonal meshes comprising a plurality of permanently deformable wires (2, 2', 3, 3') and at least one reinforcing element (5), the machine comprising a mechanism for the reciprocal coiling of first wires (2, 2') and second wires (3, 3') in twos, which mechanism is provided with passages for the reinforcing elements (5), and a feed system for:

- the first wires (2, 2'), fed in from a plurality of containers (90, 90') that are mounted on board the machine and provided internally with a predetermined length of said first wires (2, 2'),
 - part of the second wires (3), fed in alternately with the first wires so as to be interwoven therewith in twos in the coiling mechanism, and
 - the reinforcing elements (5), fed into the machine,
- wherein, for all the reinforcing elements (5), a wire receptacle (202) is provided for one of said second wires (3'), the wire receptacle being rotatable around the reinforcing element.

2. Machine according to claim 1, wherein the wire receptacle (202) is a reel.

3. Machine according to either claim 1 or claim 2, wherein, for all the reinforcing elements (5), two (90') of the containers (90) for feeding in the first wires (2, 2') are narrower than the others.

4. Machine according to any one of the preceding claims, wherein the reciprocal coiling mechanism comprises:

- an upper pair of supports (30, 32) for rotatable semi-cylindrical bodies (60, 62, 60a, 62a), the rotatable semi-

cylindrical bodies each being provided with a through-hole (70, 72) through which a first or a second wire (2, 3, 2', 3') passes and being capable of being coupled in twos and rotatable in pairs, so as to form twisted portions (7, 7') of the net, at least one pair (60a, 62a) of said rotatable semi-cylindrical bodies further being provided with a groove (110, 112) to accommodate the reinforcing element (5) while the wires (2, 2', 3, 3') are being coiled together or around said reinforcing element,

- a lower pair of supports (34, 36) for rotatable semi-cylindrical bodies (64, 66, 64a, 66a), the lower pair of supports and the semi-cylindrical bodies being in direct correspondence with the upper pair of supports and the related semi-cylindrical bodies and being moveable synchronously therewith, at least one pair (64a, 66a) of said rotatable semi-cylindrical bodies furthermore being provided with a groove (114, 116) to accommodate the reinforcing element (5),

and wherein a plurality of wires (3, 3') are slidable between the semi-cylindrical bodies (66, 66a) of one support (36) of the lower pair of supports and the corresponding semi-cylindrical bodies (62, 62a) of the corresponding support (32) of the upper pair of supports.

5. Machine according to claim 4, wherein the supports (30, 32, 34, 36) for the semi-cylindrical bodies (60, 62, 64, 66, 60a, 62a, 64a, 66a) are bars that have a U-shaped cross-section and are positioned in pairs with the respective open edges (50, 52, 54, 56) of the U that face one another, lie in a vertical plane of symmetry and are moveable in the direction of their length, a plurality of through-seatings (48) being made in the edges (50, 52, 54, 56) of each of the bars (30, 32, 34, 36) of each pair facing the respective edges (52, 50, 56, 54) of the paired bar, each through-

seating facing a similar seating (48) made in the edges of the other bar of the same pair for the semi-cylindrical bodies, wherein each groove (112, 110, 116, 114) in the semi-cylindrical bodies (62a, 60a, 66a, 64a) continues respectively over the edge (52, 50, 56, 54) of each of the bars (32, 30, 36, 34) into another groove (122, 120, 126, 124) and wherein the grooves (112, 110, 116, 114) in the semi-cylindrical bodies and the grooves (122, 120, 126, 124) in the edges of the bars have a depth slightly greater than the radius of the reinforcing element (5) and an overall width that is equal to the width of a mesh of the net, plus the diameter of the reinforcing element (5).

6. Multiple-twist net (1, 10) that has hexagonal meshes comprising a plurality of wires (2, 3, 2', 3') and at least one reinforcing element (5), the wires being coiled together in twos as primary twisted portions (7, 7''), wherein the two wires are coiled together, and secondary twisted portions (7'), wherein the wires are coiled together and around the reinforcing element, wherein said reinforcing element has a greater strength than the strength of the wires.

7. Net according to the preceding claim, wherein the reinforcing element is a cable, rope or high-strength steel wire.

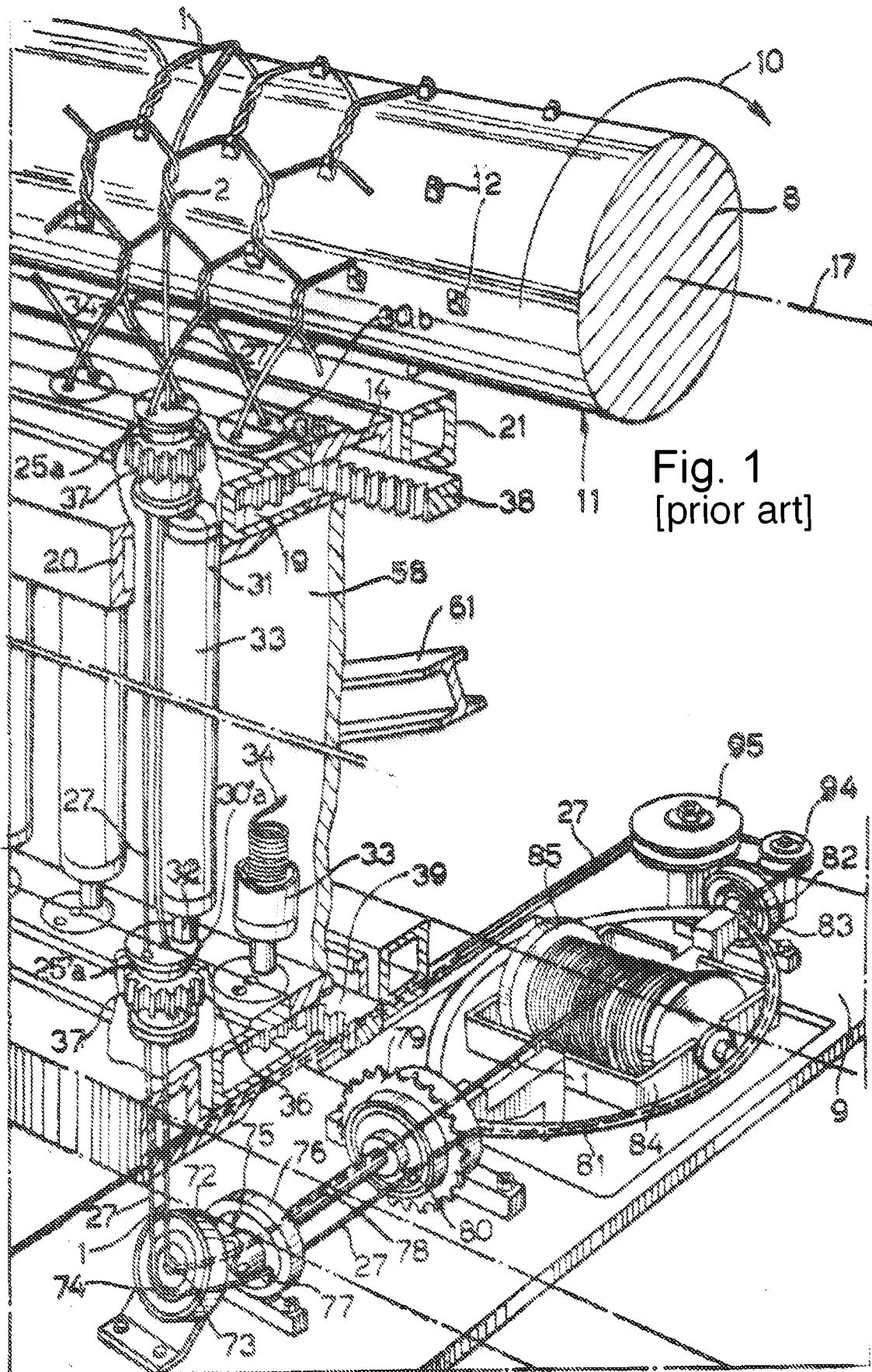
8. Net according to the preceding claim, wherein the reinforcing element (5) is a metal cable composed of several strands and having an overall diameter at least twice that of the permanently deformable wires making up the rest of the net.

9. Net according to claim 6, wherein the reinforcing element is a high-strength wire having a strength of at least approximately 500 kg/mm².

10. Net according to any one of claims 6 to 8, further comprising at least one transverse reinforcing element (11) that is positioned perpendicularly to the direction of the reinforcing elements and inserted into the primary twisted portions (7").

11. Method for producing a net according to any one of claims 6 to 10, comprising the steps of:

- providing a plurality of wires (2, 2', 3, 3'),
- providing at least one reinforcing element (5) having a strength greater than the strength of the wires,
- coiling adjacent wires (2, 2', 3, 3') into primary twisted portions (7, 7"), wherein only two wires are coiled together, and secondary twisted portions (7'), wherein two wires are coiled together and around the reinforcing element.



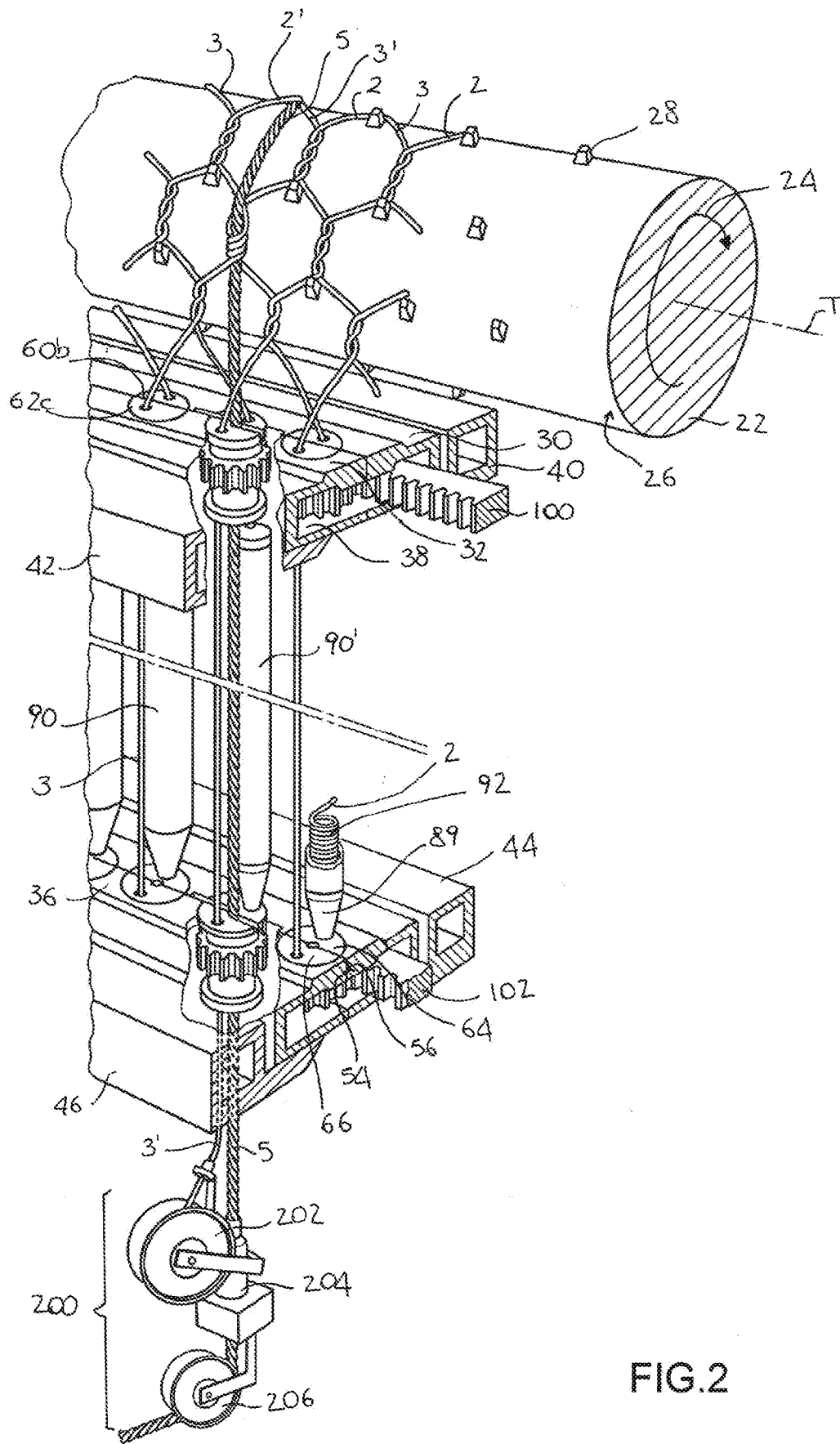


FIG.2

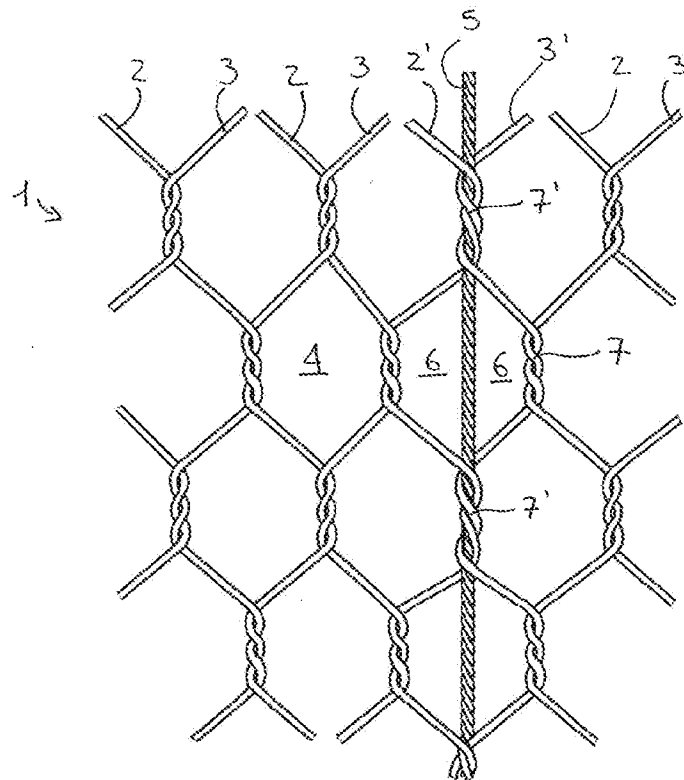


Fig 3

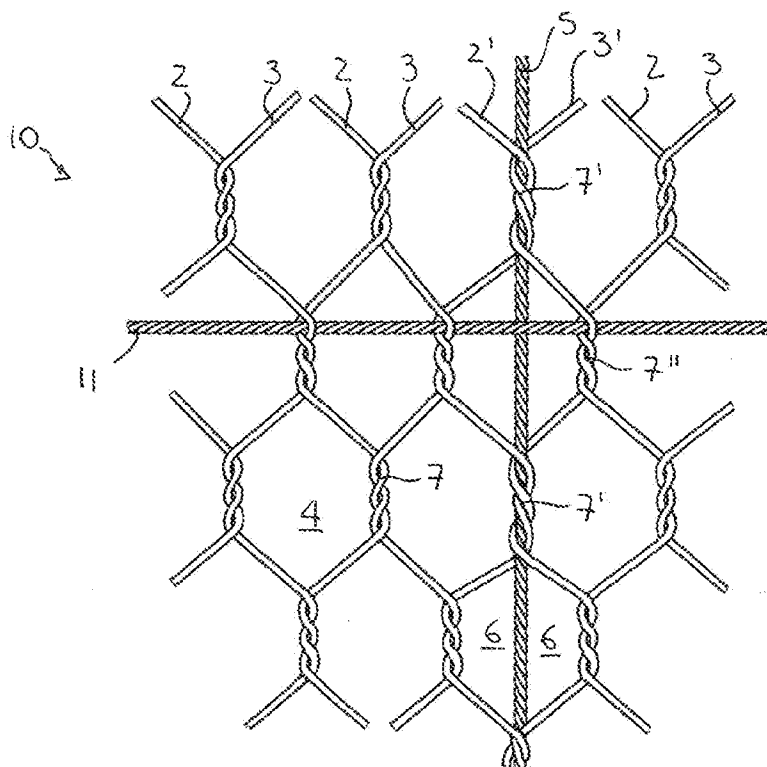


Fig 4

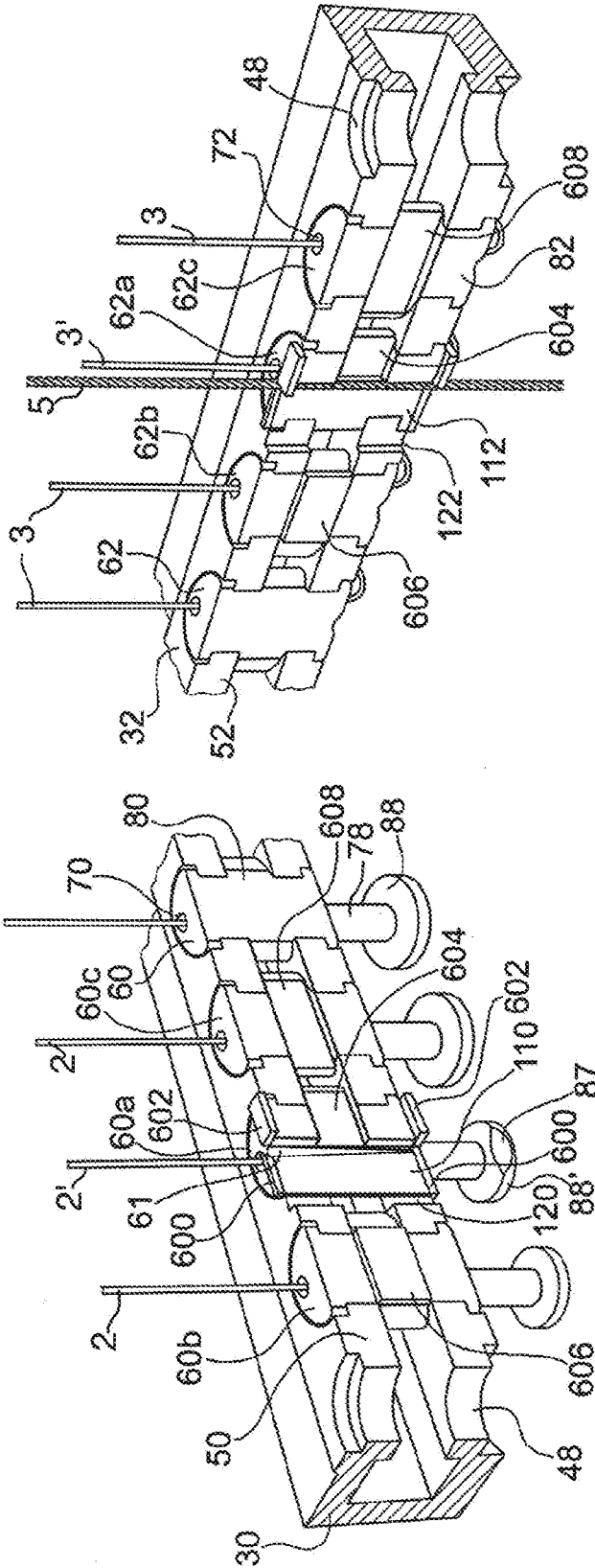


FIG.5

FIG.6

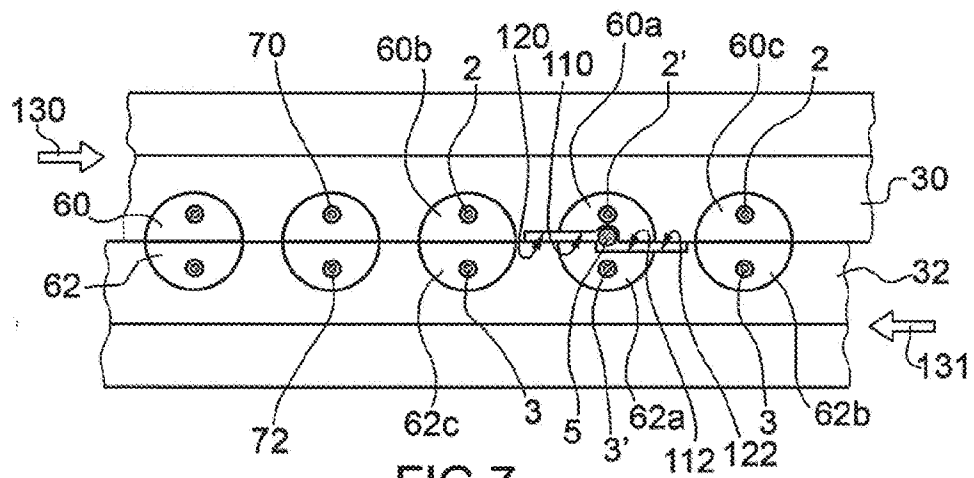


FIG. 7

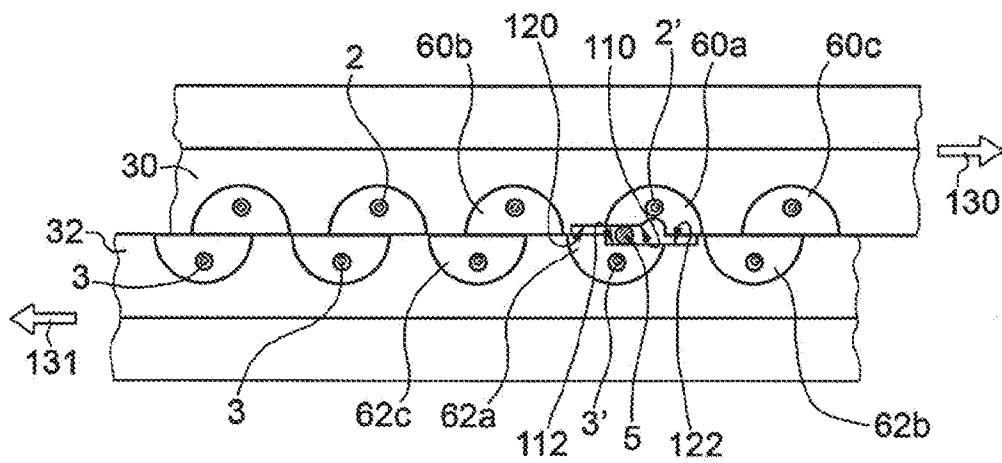


FIG. 8

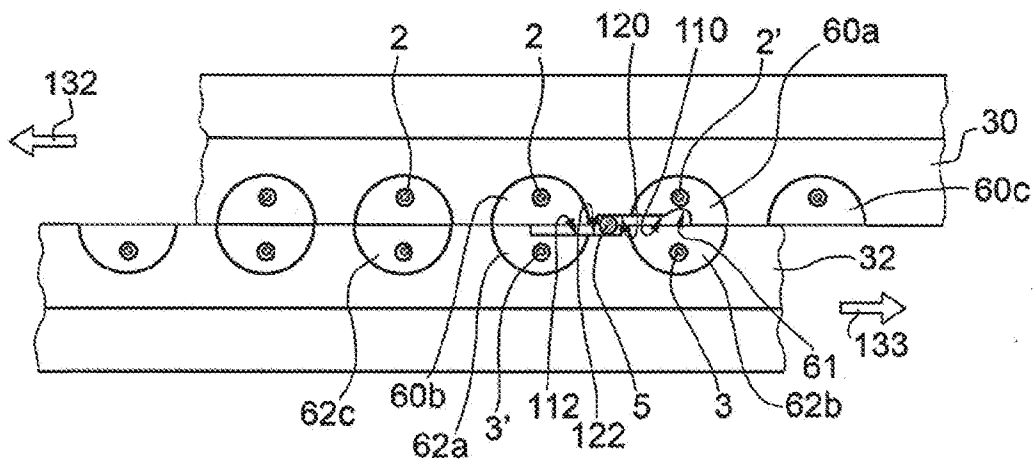


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/050700

A. CLASSIFICATION OF SUBJECT MATTER
INV. B21F27/06 E04C5/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B21F E04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 433 633 A (B. SCARLES) 5 August 1890 (1890-08-05)	1,3-5
A	page 1, line 10 - line 16 page 1, line 31 - line 77 page 2, line 4 - line 122; figures 1-12 -----	6,11
Y	US 768 102 A (WHITTINGTON GEORGE W [US]) 23 August 1904 (1904-08-23) page 1, line 9 - line 13 page 1, line 55 - page 2, line 9 page 3, line 77 - page 4, line 38; figures 1,5-8,13-17 -----	1,2
Y	IT 1 050 936 B (MACCAFERRI SPA OFF [IT]) 20 March 1981 (1981-03-20) cited in the application figure 3 ----- -/--	1,2



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 November 2017

Date of mailing of the international search report

16/11/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Ritter, Florian

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/050700

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 113 968 A (FRANCISCO RIVIERE E HIJOS [ES]) 17 April 1919 (1919-04-17)	6-9,11
Y	page 1, line 5 - line 14	10
A	page 2, line 4 - line 11; figures 1-4 -----	1
Y	DE 339 688 C (ALPENLAENDISCHE DRAHTINDUSTRIE) 2 August 1921 (1921-08-02) page 1, line 19 - line 23; figure 1 -----	10
A	US 483 969 A (B. SCARLES) 4 October 1892 (1892-10-04) page 1, line 10 - line 14 page 2, line 70 - page 3, line 43; figures 3,4,8-15 -----	1,6,11
A	GB 05977 A A.D. 1912 (HARNISCHMACHER FRITZ [DE]) 25 July 1912 (1912-07-25) the whole document -----	1,6,11
A	GB 280 542 A (ROSA ROS CASABLANCAS) 22 December 1927 (1927-12-22) page 1, line 8 - line 75 page 2, line 70 - page 3, line 42; figures 2-6,10-13 -----	1,6,11
A	US 1 195 688 A (W.A. KILMER) 22 August 1916 (1916-08-22) page 1, line 19 - line 24 page 2, line 89 - page 3, line 19; figures 1-12 -----	1,6,11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/050700

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 433633	A	05-08-1890	NONE	
US 768102	A	23-08-1904	NONE	
IT 1050936	B	20-03-1981	NONE	
GB 113968	A	17-04-1919	NONE	
DE 339688	C	02-08-1921	NONE	
US 483969	A	04-10-1892	NONE	
GB 191205977	A	25-07-1912	NONE	
GB 280542	A	22-12-1927	NONE	
US 1195688	A	22-08-1916	NONE	

PCT REQUEST

Print Out (Original in Electronic Form)

0	For receiving Office use only	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form PCT/RO/101 PCT Request	
0-4-1	Prepared Using	ePCT-Filing Version 3.3.017 MT/FOP 20151028/0.20.5.24
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	International Bureau of the World Intellectual Property Organization (RO/IB)
0-7	Applicant's or agent's file reference	PE1685
I	Title of Invention	MACCHINA E PROCEDIMENTO PER LA FABBRI-CAZIONE DI UNA RETE RINFORZATA E RETE RINFORZATA
II	Applicant	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States
II-4	Name	OFFICINE MACCAFERRI S.P.A.
II-5	Address	Via Kennedy, 10 40069 Zola Predosa (BO) Italy
II-6	State of nationality	IT
II-7	State of residence	IT
II-10	e-mail	info@provvisionato.com
II-10(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications

PCT REQUEST

Print Out (Original in Electronic Form)

III-1	Applicant and/or inventor	
III-1-1	This person is	Inventor only
III-1-3	Inventor for	All designated States
III-1-4	Name (LAST, First)	FERRAILOLO, Francesco
III-1-5	Address	Via Gandolfi, 58 40050 Ca' de' Fabbri (BO) Italy
IV-1	Agent or common representative; or address for correspondence	
	The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent
IV-1-1	Name (LAST, First)	PROVVISIONATO, Paolo
IV-1-2	Address	c/o Provvisionato & Co S.r.l. Piazza di Porta Mascarella, 7 40126 Bologna Italy
IV-1-3	Telephone No.	+39-051-6390251
IV-1-4	Facsimile No.	+39-051-6390252
IV-1-5	e-mail	info@provvisionato.com
IV-1-5(a))	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications
V	DESIGNATIONS	
V-1	The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.	
VI-1	Priority Claim	NONE
VII-1	International Searching Authority Chosen	European Patent Office (EPO) (ISA/EP)

PCT REQUEST

Print Out (Original in Electronic Form)

VIII	Declarations	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	Check list	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	4	✓
IX-2	Description	15	✓
IX-3	Claims	4	✓
IX-4	Abstract	1	✓
IX-5	Drawings	5	✓
IX-7	TOTAL	29	
	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	-	✓
IX-20	Figure of the drawings which should accompany the abstract	2	
IX-21	Language of filing of the international application	Italian	
X-1	Signature of applicant, agent or common representative	/Paolo Provvisionato/	
X-1-1	Name (LAST, First)	PROVVISIONATO, Paolo	
X-1-3	Capacity (if such capacity is not obvious from reading the request)	Agent	

PCT REQUEST

Print Out (Original in Electronic Form)

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/EP
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
------	--	--

PATENT COOPERATION TREATY

RECEIVED
RICEVUTO

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

27 MAG. 2019

To:

PROVVISIONATO, Paolo
PROVVISIONATO & CO S.r.l.
Piazza di Porta Mascarella, 7
I-40126 Bologna
ITALIE

PCTPROVVISIONATO

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(PCT Rule 71.1)

Date of mailing

(day/month/year)

22.05.2019

Applicant's or agent's file reference

PE1685

IMPORTANT NOTIFICATION

International application No.

PCT/IB2017/050700

International filing date (day/month/year)

09.02.2017

Priority date (day/month/year)

Applicant

OFFICINE MACCAFERRI S.p.A.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international
preliminary examining authority:



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0
Fax: +49 89 2399 - 4465

Authorized Officer

Faux, Paul

Tel. +49 89 2399-8269



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PE1685	FOR FURTHER ACTION		See Form PCT/IPEA/416
International application No. PCT/IB2017/050700	International filing date (<i>day/month/year</i>) 09.02.2017	Priority date (<i>day/month/year</i>)	
International Patent Classification (IPC) or national classification and IPC INV. B21F27/06			
Applicant OFFICINE MACCAFERRI S.p.A.			
1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36. 2. This REPORT consists of a total of <u>7</u> sheets, including this cover sheet. 3. This report is also accompanied by ANNEXES, comprising: a. ☒ (<i>sent to the applicant and to the International Bureau</i>) a total of <u>25</u> sheets, as follows: ☒ sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions). ☐ sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2). ☐ superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)). b. ☐ (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in the form of an Annex C/ST.25 text file, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3ter of Annex C of the Administrative Instructions).			
4. This report contains indications relating to the following items: ☒ Box No. I Basis of the report ☐ Box No. II Priority ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability ☐ Box No. IV Lack of unity of invention ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement ☐ Box No. VI Certain documents cited ☒ Box No. VII Certain defects in the international application ☒ Box No. VIII Certain observations on the international application			
Date of submission of the demand 07.12.2018	Date of completion of this report 22.05.2019		
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	Authorized officer Ritter, Florian Telephone No. +49 89 2399-2387 		

Box No. I Basis of the report

1. With regard to the **language**, this report is based on
- ☐ the international application in the language in which it was filed
 - ☒ a translation of the international application into English, which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3(a) and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4(a))
 - ☒ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-16 filed with the letter of 07-12-2018

Claims, Numbers

1-10 filed with the letter of 15-03-2019

Drawings, Sheets

1/5-5/5 as originally filed

- ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
5. ☐ This report has been established:
- ☐ taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
 - ☐ without taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/IB2017/050700

6. ☒ With regard to top-up searches (Rules 66.1 *ter* and 70.2(f)):
- ☒ A top-up search was carried out by this Authority on 08.05.2019 (all discovered documents are listed in the Supplemental Box Relating to Top-up Search).
 - ☐ Additional relevant documents have been discovered during the top-up search.
 - ☐ No top-up search was carried out by this Authority because it would serve no useful purpose.
7. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

* If item 4 applies, some or all of those sheets may be marked "superseded".

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>1-10</u>
	No: Claims	
Inventive step (IS)	Yes: Claims	<u>1-10</u>
	No: Claims	
Industrial applicability (IA)	Yes: Claims	<u>1-10</u>
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

- D1 US 433 633 A (B. SCARLES) 5 August 1890 (1890-08-05)
- D2 US 768 102 A (WHITTINGTON GEORGE W [US]) 23 August 1904 (1904-08-23)
- D3 IT 1 050 936 B (MACCAFERRI SPA OFF [IT]) 20 March 1981 (1981-03-20) cited in the application
- D4 GB 113 968 A (FRANCISCO RIVIERE E HIJOS [ES]) 17 April 1919 (1919-04-17)

2 Independent claim 1:

Document D3, which is considered as being the closest prior art, discloses:

Machine for manufacturing a reinforced net that has hexagonal meshes comprising a plurality of permanently deformable wires (27, 34) and at least one reinforcing element (1), the machine comprising a mechanism for the reciprocal coiling of first wires and second wires in twos, which mechanism is provided with passages for the reinforcing elements (figure 3), and a feed system for:

- the first wires (34), fed in from a plurality of containers (33) that are mounted on board the machine and provided internally with a predetermined length of said first wires,
- part of the second wires (27), fed in alternately with the first wires (34) so as to be interwoven therewith in twos in the coiling mechanism, and
- the reinforcing elements (1), fed into the machine.

The subject-matter of claim 1 differs from D3 in that

for each reinforcing element, a reel is provided for feeding one of the remaining said second wires, the reel being rotatable around the reinforcing element.

The technical problem thereby solved consists in how to adapt the machine in order to be able to use reinforcing elements of higher strength. Since the reel of the remaining second wires is rotatable around the reinforcing element, the reinforcing element can be fed from any source outside the machine. In D3 the reinforcing element has to be provided on a reel of limited diameter, which also limits the use of high strength reinforcing elements.

No prior art document suggests the provision of a reel for the second wires which is rotatable around the reinforcing element in order to solve above mentioned technical problem.

In D1 containers are provided for the first and the second wires. The provision of two containers has the inconvenience of limiting the quantity of wire provided on the machine. In the machine of claim 1 the container for the first wires can be increased in size in comparison to D1 while still leaving enough space for the reinforcing element.

In D2 all wires are provided on spools.

The subject-matter of claim 1 is new and inventive (Article 33(2) and 33(3) PCT).

3 Dependent claims 2-4:

Claims 2-4 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

4 Independent claim 5:

Claim 5 contains subject-matter which extends beyond the content of the application as filed. According to the original disclosure the reinforcing element has a greater strength than the strength of the wires. This feature is now missing in claim 5.

The following analysis is therefore based on the assumption that this objection has been overcome by reintroduction of this feature.

Document 3, which is considered as being the closest prior art, discloses in figure 1:

Multiple-twist net that has hexagonal meshes comprising a plurality of wires and at least one reinforcing element (1), the wires being coiled together in twos in primary twisted portions (2), wherein the two wires are coiled together

in the same twist direction, and secondary twisted portions, wherein the wires are coiled together and around the reinforcing element.

The subject-matter of claim 5 differs from D3 in that said reinforcing element *has a greater strength than the strength of the wires and* has a strength greater than approximately 500 kg/mm².

The technical problem thereby solved consists in how to increase the strength of the net.

No prior art document suggest the use of reinforcing element of a strength being superior to 500 kg/mm². It appears that the use of such reinforcing elements was not considered since the machines were not able to process them.

The subject-matter of claim 5 is therefore new and inventive (Article 33(2) and 33(3) PCT).

5 Dependent claims 6-9:

Claims 6-9 are dependent on claim 5 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

6 Independent claim 10:

Claim 10 also contains subject-matter which extends beyond the content of the application as filed. According to the original disclosure the reinforcing element has a greater strength than the strength of the wires. This feature is now missing in claim 10.

The following analysis is therefore based on the assumption that this objection has been overcome by reintroduction of this feature.

Claim 10 defines the corresponding method of manufacturing a net comprising reinforcing elements having *a greater strength than the strength of the wires and* having a strength greater than approximately 500 kg/mm².

The subject-matter of claim 10 is new and inventive for the reasons mentioned above for claim 5 (Article 33(2) and 33(3) PCT).

Re Item VII

Certain defects in the international application

Independent claims 1 and 5 are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art D3 being placed in the preamble (Rule 6.3(b)(i) PCT) and the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

Re Item VIII

Certain observations on the international application

See Item V, sections 4 and 6.

Claim 8 stands in contradiction to claim 5. In claim 5 it is defined that the reinforcing element has a strength greater than approximately 500 kg/mm^2 , i.e. the value of 500 kg/mm^2 is excluded, while in claim 8 it is defined that it has a strength of at least approximately 500 kg/mm^2 , i.e. the value of 500 kg/mm^2 is included.

Furthermore, the expression "approximately" in each of claims 5, 8 and 10 renders the subject-matter of these claims unclear (Article 6 PCT).

International Preliminary Examining Authority
EUROPEAN PATENT OFFICE
Postal Address:
D-80298 München
GERMANY

- web-form filing -

Bologna, 15 March 2019
Our ref.: PE1685

INTERNATIONAL - patent application no. PCT/IB2017/050700 dated 09.02.2017
"Machine and method for manufacturing a reinforced net and reinforced net"
in the name of: OFFICINE MACCAFERRI S.p.A.

Dear Sirs,

Reference is made to the second Written Opinion issued by the ISA in connection with the present patent application.

1. Objections

In the Written Opinion the Examiner objected to independent claims 6 and 10 as being not inventive over D3 (IT1050936). Claim 6 had been renumbered as claim 5, so the following is based on the assumption that claim 5 and not 6 was objected to.

2. Amendments

In order to overcome the objections raised by the Examiner, please find enclosed replacement pages of the claims, to be substituted for all the pages of the claims in the application as presently on file. Claim 5 and 10 have both been amended adding thereto technical features taken from the description as originally filed, page 15, third paragraph.

It is deemed that the amendments do not add new subject matter beyond the content of the application as filed and, therefore, meet requirements of Art. 123(2) EPC.

3. Inventive step

Claim 5 was considered not inventive with respect to D3. As also stated by the Examiner, a difference between claim 5 and D3 is in the stronger reinforcing elements. Claim 5 as newly amended further specifies that the "*reinforcing element has a strength greater than approximately 500 kg/mm²*". As already discussed in the previous reply, using stronger reinforcing wires, and more specifically wires having a strength greater than approximately 500 kg/mm² is far from obvious. A man skilled in the art would know in fact that the making of such a net is more problematic because of the increased stiffness and thickness of the wires.

In particular, wires with a strength greater than approximately 500 kg/mm² cannot be used in the machine of D3. This is also discussed in the application. Therefore even if a man skilled in the art wanted to use reinforcing elements with a higher strength in the net of D3, he would not know how to do it. Claim 5 is therefore inventive.

It is to be noted that there is no need to refer to claim 1 in claim 5. The net itself is new and inventive, because at the time of the invention there did not exist a machine capable of manufacturing it. Moreover, the machine that produces it is also an invention, as claimed in claim 1.

The same reasoning applies to claim 10 as well.

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* * *

Reconsideration of the present application is kindly requested. Should the Examiner feel that any remaining issues are left open to discussion and that they might be quickly resolved with a telephone conversation, the Examiner is kindly requested to contact the undersigned Representative.

Yours faithfully,
The Representative



PROVVISIONATO, Paolo
PROVVISIONATO & CO

Enclosures:

- amended claims with underlined amendments
- amended claims, clean copy

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CLAIMS

1. Machine for manufacturing a reinforced net (1, 10) that has hexagonal meshes comprising a plurality of permanently deformable wires (2, 2', 3, 3') and at least one reinforcing element (5), the machine comprising a mechanism for the reciprocal coiling of first wires (2, 2') and second wires (3, 3') in twos, which mechanism is provided with passages for the reinforcing elements (5), and a feed system for:

- the first wires (2, 2'), fed in from a plurality of containers (90, 90') that are mounted on board the machine and provided internally with a predetermined length of said first wires (2, 2'),
 - part of the second wires (3), fed in alternately with the first wires so as to be interwoven therewith in twos in the coiling mechanism, and
 - the reinforcing elements (5), fed into the machine,
- wherein, for each reinforcing element (5), a reel (202) is provided for feeding one of the remaining said second wires (3'), the reel being rotatable around the reinforcing element.

2. Machine according to claim 1, wherein, for each reinforcing element (5), the two containers (90') for feeding in the first wires (2, 2') that are closer, in use, to the reinforcing element (5) are narrower than the others.

3. Machine according to any one of the preceding claims, wherein the reciprocal coiling mechanism comprises:

- an upper pair of supports (30, 32) for rotatable semi-cylindrical bodies (60, 62, 60a, 62a), the rotatable semi-cylindrical bodies each being provided with a through-hole (70, 72) through which a first or a second wire (2, 3, 2', 3') passes and being capable of being coupled in twos and

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rotatable in pairs, so as to form twisted portions (7, 7') of the net, at least one pair (60a, 62a) of said rotatable semi-cylindrical bodies further being provided with a groove (110; 112) to accommodate the reinforcing element (5) while the wires (2, 2', 3, 3') are being coiled together or around said reinforcing element,

- a lower pair of supports (34, 36) for rotatable semi-cylindrical bodies (64, 66, 64a, 66a), the lower pair of supports and the semi-cylindrical bodies being in direct correspondence with the upper pair of supports and the related semi-cylindrical bodies and being moveable synchronously therewith, at least one pair (64a, 66a) of said rotatable semi-cylindrical bodies furthermore being provided with a groove (114, 116) to accommodate the reinforcing element (5),

and wherein a plurality of wires (3, 3') are slidable between the semi-cylindrical bodies (66, 66a) of one support (36) of the lower pair of supports and the corresponding semi-cylindrical bodies (62, 62a) of the corresponding support (32) of the upper pair of supports.

4. Machine according to claim 3, wherein the supports (30, 32, 34, 36) for the semi-cylindrical bodies (60, 62, 64, 66, 60a, 62a, 64a, 66a) are bars that have a U-shaped cross-section and are positioned in pairs with the respective open edges (50, 52, 54, 56) of the U that face one another, lie in a vertical plane of symmetry and are moveable in the direction of their length, a plurality of through-seatings (48) being made in the edges (50, 52, 54, 56) of each of the bars (30, 32, 34, 36) of each pair facing the respective edges (52, 50, 56, 54) of the paired bar, each through-seating facing a similar seating (48) made in the edges of the other bar of the same pair for the semi-cylindrical bodies, wherein each groove (112, 110, 116, 114) in the semi-

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cylindrical bodies (62a, 60a, 66a, 64a) continues respectively over the edge (52, 50, 56, 54) of each of the bars (32, 30, 36, 34) into another groove (122, 120, 126, 124) and wherein the grooves (112, 110, 116, 114) in the semi-cylindrical bodies and the grooves (122, 120, 126, 124) in the edges of the bars have a depth slightly greater than the radius of the reinforcing element (5) and an overall width that is equal to the width of a mesh of the net, plus the diameter of the reinforcing element (5).

5. Multiple-twist net (1, 10) that has hexagonal meshes comprising a plurality of wires (2, 3, 2', 3') and at least one reinforcing element (5), the wires being coiled together in twos in primary twisted portions (7, 7''), wherein the two wires are coiled together in the same twist direction, and secondary twisted portions (7'), wherein the wires are coiled together and around the reinforcing element, wherein said reinforcing element has a strength greater than approximately 500 kg/mm².

6. Net according to the preceding claim, wherein the reinforcing element is a cable, rope or high-strength steel wire.

7. Net according to the preceding claim, wherein the reinforcing element (5) is a metal cable composed of several strands and having an overall diameter at least twice that of the permanently deformable wires making up the rest of the net.

8. Net according to claim 5, wherein the reinforcing element is a high-strength wire having a strength of at least approximately 500 kg/mm².

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9. Net according to any one of claims 5 to 8, further comprising at least one transverse reinforcing element (11) that is positioned perpendicularly to the direction of the reinforcing elements and inserted into the primary twisted portions (7").

10. Method for producing a net according to any one of claims 5 to 9, comprising the steps of:

- providing a plurality of wires (2, 2', 3, 3'),
- providing at least one reinforcing element (5) having a strength greater than approximately 500 kg/mm²,
- coiling adjacent wires (2, 2', 3, 3') in the same twist direction into primary twisted portions (7, 7"), wherein only two wires are coiled together, and secondary twisted portions (7'), wherein two wires are coiled together and around the reinforcing element.

WIPO INTERNATIONAL BUREAU
34, Chemin des Colombettes
1211 GENEVA 20
SWITZERLAND

- ePCT -

Bologna, 7 December 2018
Our ref.: PE1685

INTERNATIONAL - patent application no. PCT/IB2017/050700 dated 09.02.2017
"Machine and method for manufacturing a reinforced net and reinforced net"
in the name of: OFFICINE MACCAFERRI S.p.A.

Dear Sirs,

Reference is made herewith to the Written Opinion issued by the ISA in connection with the present patent application.

1. Objections

In the Written Opinion the Examiner objected to claim 1 as being not new over D1 (US433633). Independent claim 6 was objected to as being obvious over D4 (GB113968). All other claims were considered not new or not inventive.

2. Amendments

With a view to overcoming the objections raised by the Primary Examiner, please find herewith enclosed replacement pages of the claims to be substituted for all the pages of the claims in the application as presently on file. Claim 1 has been amended adding thereto technical features defined in claims 2 as originally filed. All the claims have been renumbered accordingly and amended to preserve the correct dependency from the preceding claims. It is now also clarified that it is one of the "remaining second wires" (i.e. other than the "*part of the second wires*" referred to previously) that is provided in the reel. Basis is, for example, in the drawings.

Claim 2 has been amended too, specifying which containers are narrower. Basis for the amendment is on page 8, second paragraph.

Claim 6 (now 5) has been amended adding that the wires are coiled together "*in the same twist direction*", as described on page 4, third paragraph, of the application as filed. The same feature was added in the method claim 11 (now 10).

Moreover a better translation of the original Italian "*per ogni elemento di rinforzo*" has been provided: "*for each ~~all the~~ reinforcing elements*" in claim 1, 2 and on page 8 of the description.

Finally, D1 and D4 have been briefly discussed in the description, as requested by the Examiner. Kindly find enclosed replacement pages of the description.

It is deemed that the amendments effected do not add new subject matter beyond the content of the application as filed and, therefore, meet requirements of Art. 123(2) EPC.

3. Novelty

Amended claim comprises a reel, that is not disclosed in D1, as also stated by the Examiner. Claim 1 is therefore new.

4. Inventive step

Claim 1 refers to a machine for manufacturing a net with reinforcing elements. If we consider D1 to be the closest prior art, a difference between the invention and the prior art lies in the reel. In D1 all the wires are housed in tubes and semi-tubes on board of the machine. This results in a low productivity. A technical problem to be solved is therefore that of providing a machine for manufacturing a net with reinforcing elements having a higher productivity.

According to amended claim 1, in order to accommodate each reinforcing element, the present invention provides only a first wire in a container mounted on the machine. The second wire meant to form a twisting region with the reinforcing element is provided on a reel that turns around the cable. The difference is not a mere preference: having only one container mounted on the machine allows it to be bigger, still leaving enough space for the reinforcing element. For example, the reinforcing element does not need to be perfectly straight between the bars 30 32 and 34 36, but can bend slightly on one side, accommodating a larger container 90°. A larger container has a longer wire inside, therefore needs to be changed less frequently; reducing the frequency of stops required increases the overall productivity of the machine. Moreover, since the reel can be placed in a less tight space, it can be much bigger than any on board container could be. This also improves the productivity.

Starting from D1, a man skilled in the art wishing to increase the productivity may have thought about making the semi-tubes taller, to compensate for the loss in thickness. However this solution, which is different from the claimed one, would result in a more complex and larger machine. Nothing in D1 points to the fact that, when accommodating reinforcing elements, for increasing the productivity one would have to change how some of the wires are supplied.

D2 shows a different machine for making a diamond mesh net with reinforcing wires. Wires 5 that form the diamonds are supplied on spools 4 and straight reinforcing wires 1 are supplied on spools 2. All the wires are therefore supplied in the same way. While this configuration works well for making a small fencing net, it is not suitable for making large and more resistant nets such as those of the invention, therefore a man skilled in the art would not have considered this document in order to solve the problem of D1. But even if he did, there is no indication in D2 that supplying only a few wires in a different way than the others may have any impact on the machine's productivity, nor gives any indication on which ones.

D3 does not give any indication to that end either. Instead, it provides the reinforcing element on a reel.

None of the other documents provides any additional insight that could point to the solution of claim 1, which is therefore inventive.

Claim 5 (former claim 6) was considered not inventive with respect to D4. D4 refers to a net where two (or three) wires are twisted together both in a clockwise direction and in an anti-clockwise direction in a same twisted portion. Amended claim 5 now specifies that the wires are coiled together *"in the same twist direction"*.

Such a difference is far from trivial. The resulting net of D4 can be opened by simply pulling at it, causing the unraveling of the twisted portions. Therefore such a net is normally used where there is no need for particular strength, for example as a poultry netting. On the other hand, the net of D4 is much easier to manufacture because there is no need to have wire receptacles turning one around the other.

D4 can hardly be considered the closest prior art for the newly amended claim 5, because of the structural major difference between the two nets. Any of the nets of D1 or D3 seems more

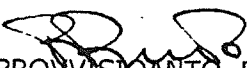
suitable for that role. The objective technical problem is therefore that of providing a stronger net. Using stronger reinforcing wires is not an obvious choice, because a man skilled in the art would know that the making of such a net is significantly more challenging: as discussed in the introduction of the present invention, strong reinforcing wires are significantly stiffer and usually also much thicker. Therefore none of the known machines allows to make such a net. Therefore even if a man skilled in the art wanted to use reinforcing elements with a higher strength in the net of D1 or D3, he would not know how to do it.

For the reasons stated above it is deemed that new amended claim 5 is inventive.

* * *

Reconsideration of the present application is kindly requested. Should the Examiner feel that any remaining issues are left open to discussion and that they might be quickly resolved with a telephone conversation, the Examiner is kindly requested to contact the undersigned Representative.

Yours faithfully,
The Representative



PROVVISIONATO, Paolo
PROVVISIONATO & CO

Enclosures:

- amended claims with underlined amendments
- amended claims, clean copy
- amended description with underlined amendments
- amended description, clean copy

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MACHINE AND METHOD FOR MANUFACTURING A REINFORCED NET AND
REINFORCED NET

The present invention relates to a machine and to a method for manufacturing a reinforced hexagonal net, and also to a reinforced hexagonal net.

The invention has been developed with particular regard, but not restrictively, to a machine for manufacturing a hexagonal-mesh net provided with at least one longitudinal reinforcing element, woven through the whole net and positioned so as to bisect the meshes through which it passes.

Over forty years ago (IT1050936), the present developed a machine for manufacturing a hexagonal net that provided at least one longitudinal reinforcing wire. The machine (Fig. 1) has proven to be very effective but is designed to be used with reinforcing wires 1 having the same thickness and strength as the wires 27 and 34 used for manufacturing the whole net. It is not, however, possible to use either high-strength wires, which are more rigid, or cables, which are more rigid and also thicker. In the machine, to allow the net to be woven with three wires into a twisted portion, a wire 34 is housed inside a cylindrical container 33 that can be wound around the other wires during weaving, as is common in the field. A device is provided for the reinforcing wire and the wire 27, which device allows the wire 27 to be rotated around a reel 85 over which the reinforcing wire 1 is wound. For this purpose, the reel 85 has compact dimensions and the wire 27 winds around it with a specially designed system. Clearly, a similar solution works perfectly with reinforcing wires 1 of a similar rigidity to the wires 27 and 34, but cannot be used with cables or high-strength wires, since it

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is impossible to wind them around a reel with such a small diameter. A spool of a suitable diameter for a cable or a high-strength wire would not, however, be compatible with this solution.

The applicant has also patented two hexagonal-mesh nets in which a wire is replaced by a cable. In these nets, each twisted portion comprises just two elements: either two wires or a wire and a cable. Consequently there is no provision for a device allowing a third wire/cable to be coiled together. US433633 describes a machine for producing a double twist net with reinforcing wires identical to the the other wires of the net.

GB113968 describes a hexagonal meshes net with reinforcing wires identical to the the other wires of the net, wherein the wires are twisted together both clockwise and anticlockwise in a same twisting region.

The object of the present invention is to solve the problems of the prior art and in particular to provide a machine for producing a hexagonal-mesh net having additional longitudinal reinforcing elements, wherein said reinforcing elements are high-strength wires or cables or ropes. A further object is that of producing an economic, safe piece of machinery that is reliable to use.

In order to achieve the above-mentioned objects, the present invention relates to a machine and to a net as in the attached claims.

Further features and advantages will become evident from the following detailed description of a preferred embodiment of

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the invention, with reference to the attached drawings, provided purely by way of non-restrictive example, in which:

- Fig. 1 illustrates the machine according to the prior art,
- Fig. 2 shows a portion of a machine according to the invention,
- Fig. 3 shows a net produced by the machine in Fig. 2,
- Fig. 4 shows another net produced by the machine in Fig. 2,
- Fig. 5 is a detailed view of an upper bar 30 of the machine in Fig. 2,
- Fig. 6 is a detailed view of an upper bar 32 of the machine in Fig. 2,
- Fig. 7 shows the pair of upper bars 30 and 32 in a first position,
- Fig. 8 shows the pair of upper bars 30 and 32 in a second position, and
- Fig. 9 shows the pair of upper bars 30 and 32 in a third position.

In Fig. 2-9, the same elements are indicated by the same reference numeral; the numbering is independent from that in Fig. 1, which is the prior art.

The portion of net 1 in Fig. 3 is a double-twist net comprising hexagonal meshes and reinforcing cables. It comprises a plurality of wires 2, 3, 2', 3' coiled around one another in twisted portions 7, 7', to form hexagonal meshes 4, and at least one reinforcing cable 5 inserted longitudinally through selected twisted portions 7'. Between two successive twisted portions 7' in the longitudinal direction, the reinforcing cable forms two trapezoidal meshes 6 placed side by side. Here and below, the term "cable" will be used for conciseness; it is, however, understood that any

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reinforcing element having a strength greater than the strength of the wires making up the net can be used. For example, it can be a metal cable made up of several strands, a rope having a textile core or else a high-strength metal wire, and can be galvanised or plastics-coated if appropriate.

The wires and cables making up the net are all arranged in the same direction, which will be denoted below as being longitudinal. Each wire 2, 3 is coiled alternately with the preceding wire 3, 2 and the subsequent wire 3, 2, as known in a double-twist net, to form the twisted portions 7.

Furthermore, for all cables 5, a wire 2' is coiled alternately with the single preceding wire 3, forming a twisted portion 7, and with a subsequent wire 3' together with the reinforcing cable 5, forming a twisted portion 7' having three elements.

Similarly, the wire 3' is coiled alternately with the preceding wire 2', together with the reinforcing cable 5, forming a twisted portion 7' having three elements, and with the single subsequent wire 2, forming a twisted portion 7 having just two elements.

Twisting follows the same twist direction in each twisted portion 7, 7': clockwise or anticlockwise but constant in each twisted portion. In Fig. 3 the twisted portions 7, 7' have the wires 2, 3 coiled in directions that alternate from one row to the next: if in one row the wires 2 and 3 are coiled together in a clockwise direction, in the row below and the one above the wires 2 and 3 are coiled in an anticlockwise direction. A variant wherein all the twisted

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portions 7, 7' have the same direction of weaving should not, however, be ruled out.

In the variant in Fig. 4, the net 10 further comprises at least one transverse cable 11. The cable 11 is positioned perpendicularly to the cables 5, which intersect at intersections 12, and is inserted into twisted portions 7'' formed by two single longitudinal wires 2, 3, 2', 3'.

It should be noted that the portions of net depicted in Fig. 3 and 4 show a single longitudinal cable 5 and a single transverse cable 11 because the portion depicted is small, so as to be able to consider it in detail. Nonetheless, a plurality of longitudinal and transverse cables are normally provided. A net having these characteristics has extremely high resistance to puncture and traction, given by the reinforcing cables that directly bear most of the stress; in traditional double-twist nets it is, however, the wires that have to bear the stress.

Preferably, the cables 5, 11 are less than a metre away from each other both transversely (for both embodiments) and longitudinally (for the embodiment in Fig. 4), so as to ensure adequate strength. It should be noted, for example, that regulations for puncture tests provide for the use of a square punch with a 1m side; hence the presence of cables at a distance of less than one metre ensures that at least one longitudinal cable and one transverse one (if present) are in line with the punch.

The function of the wires in the net in question is to hold the small material and above all to keep all the cables in a fixed position, which cables are directly interwoven in the

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twisted portions, and to hold fast the intersection points 12 between cables 5, 11.

The machine according to the invention, intended for producing a net having the features described above, is in part similar to a known machine for the assembly of traditional double-twist nets, developed many years ago by the same applicant. In the following description, which while relating to the whole machine, will focus mostly here on the new and original elements that make it possible to produce a net having the reinforcing cables 5 and, preferably, 11.

As can be seen in Fig. 2, the machine 20 comprises a drum 22, mounted with means (not illustrated) in the fixed framework of the machine so that it can rotate at a constant speed in the direction of the arrow 24 about its axis T. Radial protuberances or pegs 28 project outwards from the curved face 26 of the drum. These pegs are arranged in rows that extend in a direction parallel to the axis T and are arranged at equal angular intervals. The pegs 28 are positioned at a constant spacing within each row and two successive rows are out of phase with each other by a half-pitch in the axial direction.

These pegs serve to form the hexagonal-mesh net and to hold a portion of the net already formed in the outlet direction of the machine.

Below the drum 22, two pairs of bars 30, 32 and 34, 36 are provided, which are parallel to the axis T and support semi-cylindrical rotatable bodies 60, 62, 64 and 66; the function of the semi-cylindrical bodies is to coil the wires together in pairs, to produce the net.

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The bars have a U-shaped cross section. They are positioned in pairs with the respective open edges of the U facing one another and lying in a vertical plane of symmetry that is tangent to the periphery of the drum 22; the bars 30 and 32 form an upper pair and the bars 34 and 36 form a lower pair. Naturally, upper and lower indicate the position in which the bars are arranged in the embodiment in the figures. Positioning them in a different way, for example with the wires running horizontally, is by no means ruled out, however. More generally, an "upper" bar is downstream in the working direction compared with a corresponding "lower" bar, irrespective of the height at which it is placed.

The bars are supported by elements 40, 42, 44, 46, which form part of the fixed framework of the machine. They can also move in a direction parallel to that of the axis T.

Fig. 5 and 6 depict in greater detail the bars 30 and 32, which are exactly the same as the bars 34 and 36 of the lower pair of bars. A plurality of through-seatings 48 are made in the edges 50, 52, 54, 56 of each of the bars 30, 32, 34, 36 of all the pairs facing the respective edges 52, 50, 56, 54 of the paired bar. The through-seatings 48 are semi-cylindrical, having axes perpendicular to the axis T and lying in the above-mentioned plane of symmetry; the distance between each seating and the adjacent seating in the same bar is equal to the distance between the pegs 28. Each of said seatings 48 faces a similar seating 48 made in the edges of the other bar of the same pair.

A semi-cylindrical rotatable body 62, 66 is mounted in each of the seatings 48 in the bars 32, 36. The rotatable bodies 62 of the upper bar 32 are aligned with the rotatable bodies 66 of the lower bar 36 and have through-holes 72, 76 having

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axes parallel to the axes of the semi-cylindrical rotatable bodies which are aligned with each other within the superimposed semi-cylindrical bodies 62, 66. Wires 3, 3' pass through these holes and are fed into the net being formed, as described more clearly below.

The semi-cylindrical bodies 62, 66 have diametrical plane faces 82, 86, which normally lie in the above-mentioned plane of symmetry. These plane faces 82, 86 are juxtaposed with corresponding plane faces 80, 84 of corresponding semi-cylindrical bodies 60, 64 housed in the seatings 48 made in the bars 30, 34.

Each semi-cylindrical body 60 carried by the bar 30 has an eccentric axial pivot 78 protruding downwards and on which a plate 88 engages, which plate is preferably discoid and coaxial with the pivot 78. The pivot 78 and the plate 88 are aligned with a corresponding conical element 89 placed eccentrically on the corresponding semi-cylindrical body 64, protruding upwards. Each pair formed by a plate 88 and a conical element 89 allows a cylindrical container 90, 90' containing a predetermined length of wire 2, wound in a coil 92, 92', to be mounted. The wires 2, 2' emerge upwards from the containers 90, 90', pass through the through-holes 70 and are fed into the machine for forming the net, together with the wires 3, 3'. In use, the cylindrical containers 90, 90' rotate around the wires 3, 3', so as to prevent the twisting of the wires 2 and 3 above the semi-cylindrical bodies 60, 62 from creating an equal and opposite twist therebelow.

It should be noted that, for each cable 5, two cylindrical containers 92' are provided, which are narrower than the other containers 92. During operation, these two containers are in turn actually located close to the cable 5 and if kept

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at normal dimensions would press too much against the cable 5. For the same reason, the two containers 92' are mounted on plates 88', which are also narrower; furthermore, one of these has a bevel 87 to prevent the reinforcing element 5 from pressing against a sharp edge while the net is being woven.

The pairs of bars 30, 32 and 34, 36 are connected by racks s to positioning mechanisms that allow the two superimposed bars 32, 36 and the two superimposed 30, 34 to be moved simultaneously in a direction parallel to the axis T of the drum, but in opposite directions. The positioning mechanisms are configured such that each semi-cylindrical body carried by a bar can be moved from one position, in which it faces a first semi-cylindrical body of the paired bar, into a second position, in which it faces a second semi-cylindrical body that is adjacent to the first semi-cylindrical body. Furthermore, the semi-cylindrical rotatable bodies are connected, by racks like those 100, 102 visible in Fig. 2, to rotation mechanisms that set them in rotation in pairs, in order to interweave a wire 2 and a wire 3 and create a twisted portion and, thus, the net.

In the known machines for producing simple double-twist nets, with no reinforcing elements, all the semi-cylindrical bodies 62, 66 and 60, 64 are identical to one another. In the machine according to the present invention, however, some groups of semi-cylindrical bodies have small but significant structural differences. In particular, for each cable 5 there are provided three pairs of modified semi-cylindrical bodies 60a and 62a, 60b and 62b, 60c and 62c housed in the upper bars 30 and 32 and an equal number of modified semi-cylindrical bodies 64a and 66a, 64b and 66b, 64c and 66c housed in the lower bars 34 and 36.

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The cable 5 must in fact also be fed into the machine, but does not need to be moved laterally while the net is being woven, since it always maintains a straight course. Consequently, it is fed in a fixed position, corresponding to the common axis of rotation of two semi-cylindrical bodies 62a, 60a and 66a, 64a in the first operating position of Fig. 7.

To allow the cable 5 to stay still while the semi-cylindrical bodies 62a, 60a and 66a, 64a are moved as described above, into the positions depicted in Fig. 8 and 9, the semi-cylindrical bodies 62a, 60a and 66a, 64a each have a groove 112, 110 and 116, 114, respectively. Each groove 112, 110, 116, 114 in the semi-cylindrical bodies 62a, 60a, 66a, 64a continues over the edge 52, 50, 56, 54, respectively, of each of the bars 32, 30, 36, 34 in a groove 122, 120, 126, 124. The grooves in the semi-cylindrical bodies and in the edges of the bars have the same depth, slightly greater than the radius of the cable 5, so that two grooves facing one another can comfortably house the cable 5 without compressing it. Widthways, each groove in the semi-cylindrical body is equal to at least the radius of the semi-cylindrical body plus the radius of the cable 5. Each groove created by the combination of the groove in the semi-cylindrical body and the groove on the edge of the bars is at least as wide as the pitch between two pegs 28, plus the diameter of the cable 5.

Thanks to these grooves, when the semi-cylindrical bodies 62a, 60a, 66a, 64a are moved to the positions depicted in Fig. 8 and 9, the cable 5 runs within the grooves facing one another, staying substantially still.

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Furthermore, to prevent the cable 5 from rubbing excessively against the cylindrical containers 92', the semi-cylindrical bodies 62a, 60a, 66a, 64a have a slanting channel, visible in the figures only for the semi-cylindrical body 60a, where it is indicated with the numeral 61. The channel 61 (and the corresponding channel provided in the body 62a, slanting in the same direction) allows the cable 5 to have a slightly slanted arrangement when the semi-cylindrical bodies are in the position in Fig. 7, so as to reduce pressure and rubbing against the cylindrical container 92' and the plate 88'. The semi-cylindrical bodies 66a, 64a also have a similar slanting channel, slanted in the opposite direction to that of the semi-cylindrical bodies 62a, 60a, for the same reason.

To keep the cable still when the semi-cylindrical bodies 60a and 62a, 64a and 66a are facing, protrusions 600 and 602 are provided on each semi-cylindrical body 60a, 62a, 64a and 66a. These protrusions project from the upper and lower faces of each semi-cylindrical body. Furthermore, the protrusions 600 have a face that is coplanar with the groove 110, 112, 114, 116. The protrusions 602, on the other hand, project from the diametral plane face 80, 82, 84, 86 so that they abut against the protrusions 600 when the semi-cylindrical bodies 60a and 62a, 64a and 66a are facing each other. In this way, when the semi-cylindrical bodies 60a and 62a, 64a and 66a are facing each other, the cable 5 remains embraced between the protrusions 602. Furthermore, the two semi-cylindrical bodies facing one another always remain completely coupled, being in contact with each other by means of the protrusions 600 and 602 along their whole diameter, with the sole exception of the passage for the cable 5.

During manufacture, the semi-cylindrical body 60a is in turn facing the body 62a in a first position (Fig. 7) and the body

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62b in a second position (Fig. 9). Similarly, the semi-cylindrical body 62a is in turn facing the body 60a in the first position (Fig. 7) and the body 60b in the second position (Fig. 9). The bodies 60a and 62a have a channel 604 in the diametral plane face 80, 82, of the same depth as the groove 110, 112. On the other hand, a protuberance 606 of the same depth and height is provided on the diametral plane face 80, 82 of the bodies 60b, 62b. This protuberance 606 is therefore in contact with the groove 110, 112 and the channel 604, when the semi-cylindrical bodies are in the second position in Fig. 9. In this way, in the second position, the semi-cylindrical bodies of the pairs 60a and 62b, 60b and 62a are in contact with each other along their whole diameter, for stable coupling.

Finally, the semi-cylindrical bodies 60c and 62c have a channel 608, having the same depth and height as the protuberance 606 and a width equal to the whole width of the semi-cylindrical body. This channel 608 allows the semi-cylindrical bodies 60b, 62b to be coupled to the semi-cylindrical bodies 62c and 60c, respectively, in the first position in Fig. 7.

Naturally, the same system of protuberances and channels is also present in the semi-cylindrical bodies 64a, 64b, 64c and 66a, 66b, 66c, corresponding to the description given above of the semi-cylindrical bodies 60a, 60b, 60c and 62a, 62b, 62c.

With reference now, in greater detail, to Fig. 7-9, it should be noted that in these drawings the protrusions 600 and 602 are not depicted because they would hinder understanding of the operation illustrated in the figures.

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In use, the upper bars 30, 32 are first positioned so that the semi-cylindrical bodies 60, 60a, 60b, 60c are directly facing the semi-cylindrical bodies 62, 62a, 62b, 62c, respectively (Fig. 7). Wires 2 and 2' are inserted into the holes 70, wires 3 and 3' are inserted into the holes 72 and a cable 5 is housed between the grooves 110 and 112 in the two semi-cylindrical bodies 60a and 62a.

In this position, two rotations of the pairs of semi-cylindrical bodies determine the formation of the twisted portions 7; the rotation of the semi-cylindrical bodies 60a and 62a determines the formation of the twisted portion 7', which comprises both two wires 2' and 3', and the cable 5. It should be noted that all the movements of the upper bars 30, 32 and the semi-cylindrical bodies positioned therein are also carried out in an identical fashion by the lower bars 34, 36 and by the semi-cylindrical bodies positioned therein, both in this and in all phases of production.

Once the two twists are completed, the two bars 30, 32 are moved in the direction of the arrows 130, 131, passing through the position in Fig. 8 and reaching the position in Fig. 9. In this position, the semi-cylindrical body 60a is facing a semi-cylindrical body 62b and the semi-cylindrical body 62a is facing a semi-cylindrical body 60b. In this position, two rotations of the semi-cylindrical bodies, preferably in the opposite direction to that taken in the phase in Fig. 7 (in other words, if the twists in Fig. 7 took place clockwise, in Fig. 9 they take place anticlockwise and vice versa), determine the formation solely of twisted portions 7, which comprise just two wires 2 or 2' and 3 or 3'. The cable 5, on the other hand, is housed between the two grooves 120 and 122 provided in the two bars 30, 32 and is

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therefore not involved in the twisting but is located between two adjacent twists 7.

Finally, the two bars 30, 32 are again moved in the directions of the arrows 132 and 133, which are respectively opposite the directions 130, 131 taken in the previous movement. The position in Fig. 7 is thus returned to and weaving of the net continues.

In a machine for manufacturing a hexagonal-mesh net of a traditional type, the wires 3 are fed into the semi-cylindrical bodies 66 from spools, reels or the like, positioned on the rear of the machine; the moveable containers 90, 90' rotating around the wires 3.

In the machine according to the present invention, to allow the insertion of cables 5, a device for feeding in a wire 3', given the overall numeral 200, is provided for each cable 5. The device comprises a reel 202 around which the wire 3' is wound, which reel is rotatable about both its axis, in order to reel out the wire, and around a support 204 (fastened directly to the framework of the machine). The cable 5 runs through the support 204, so that the reel 202 can rotate around the support 204 and therefore around the cable 5 while the net is being woven. After the cable 5 is diverted through a snub pulley 206, it can therefore be fed directly from a spool or in some other way if desired, without any constraint.

Thanks to the feeding device 200 it is possible to use a cable having any desired diameter, which could not be housed in a reel like that of the prior art. Similarly, it is possible to use a high-strength reinforcing wire which, being more rigid than the wires 2, 3 (normally made of mild steel),

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could not be housed in the known reel unless a device for straightening the wire were also provided, although this would have provided a mediocre result.

In particular, the applicant has found that with wires, cables or ropes having a strength greater than approximately 500 or 600 kg/mm², it is impossible to use the known machine and therefore the machine forming the subject matter of the present invention is particularly beneficial. It is stressed that the new machine may nonetheless also be used with reinforcing wires 1 of a lesser strength, even identical to the wires 2 and 3 that make up the hexagonal meshes, to produce a reinforced net of a known type.

Preferably, the reinforcing elements 1 have a diameter of between 4 and 10 mm and even more preferably between 5 and 8 mm. The wires 2, 3, 2', 3', on the other hand, have a diameter of between 1.8 and 3.9 mm and can also be galvanised or plastics-coated. The hexagonal meshes 4 of the net preferably have the dimensions 5x7, 6x8, 8x10, 10x12 or 12x14 mm.

For simplicity, the portion of the machine depicted and described provides for the use of a single cable 5, but it should be noted that it is possible and even recommended to insert more cables 5 into the same net. For each cable 5, all the contrivances described above can be provided: a pair of cylindrical containers 90' having a reduced diameter, modified semi-cylindrical bodies 60a, 60b, 60c, 62a, 62b, 62c, 64a, 64b, 64c, 66a, 66b and 66c, as well as, and in particular, a feed device 200.

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The preferred distance between two adjacent cables 5 is between 25 cm and 100 cm. The overall lateral dimension of the net is preferably between 2 and 5 m.

The machine described above can also be used for producing a net that also has transverse cables 11 like that described above with reference to Fig. 4. It is in fact enough, during the weaving of the net, to insert cables 11 periodically, immediately above the semi-cylindrical bodies 60, 62 during weaving. For greater success, it is advisable to insert the cables 11 into different twisted portions 7" from the twisted portions 7' formed by two wires 2, 3 and a cable 5. The cable 11 should therefore preferably be inserted when the semi-cylindrical bodies 60, 62 are in the position depicted in Fig. 9, after they have completed a first rotation and before they complete the second one.

The preferred distance between two adjacent transverse cables 11 is between 25 cm and 100 cm.

Naturally, without prejudice to the principle of the invention, the embodiments and the implementation details can vary greatly from what is described and illustrated, while remaining within the scope of the invention.

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