(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 228 400 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.10.2017 Bulletin 2017/41

(21) Application number: **16164437.2**

(22) Date of filing: **08.04.2016**

(51) Int Cl.:
B21D 43/00 *(2006.01)* ***B21F 23/00*** *(2006.01)*
B65G 47/00 *(2006.01)* ***B65G 47/14*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(54) **METHOD AND AN APPARATUS FOR DIVIDING A GROUP OF METAL BARS INTO A FIRST AND A SECOND SUBGROUP**

(57) For feeding machines for rebars, a group of metal bars are collected in a single layer, for example on an electromagnet, counted by a scanner, and the group is divided into a first and second subgroup. This is accomplished by moving a separation edge (14) to an adjacent position near a space between the two subgroups and separating the first subgroup (2a) from a second subgroup (2b) by providing only the first subgroup of bars (2a) on the first side of the separation edge (14) and the second subgroup (2b) only on the second side of the separation edge (14). For example, the first subgroup (2a) falls onto a separation arm (13) that is located only on the first side of the separation edge (14) and the second subgroup (2b) passes the second side of the separation edge (14) for discharge back into the store (3).

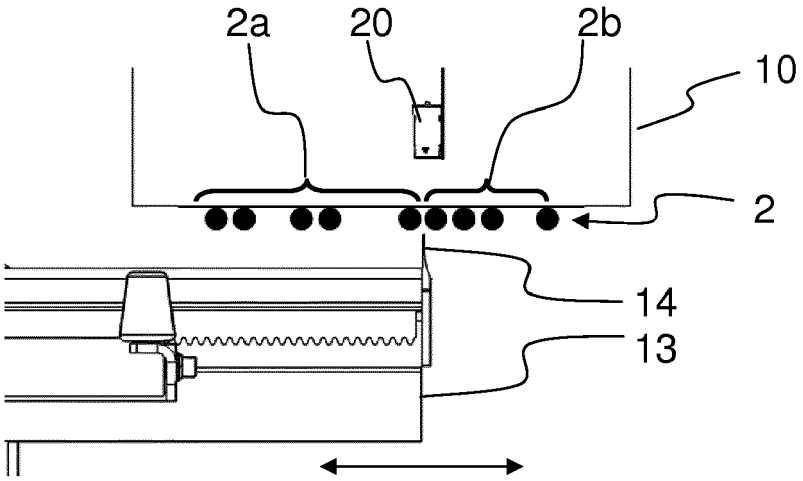

FIG. 4

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method and an apparatus for the automatic dividing a group of metal bars into a first and a second subgroup, in particular steel bars in the form of rods for reinforced concrete, in connection with working such metal bars.

BACKGROUND OF THE INVENTION

[0002] When large numbers of reinforcing bars, also called rebars, for concrete are to be cropped into specific lengths, optionally bent, and collected in containers for shipment to the location of use, it is customary to use automated machines.

[0003] European patent application EP1356875 discloses a machine and method for feeding automatically metal profiles in bar form. It entails gripping a group of the metal profiles from a magazine for collecting the profiles and transferring the group of metal profiles or their end to a raised position. The raised metal profiles are arranged on a movable transfer device provided with a screw feeder for separating the metal profiles, at which the initial portion of a preset number of metal profiles to be fed to the machine at each work cycle is conveyed transversely and counted. The metal profiles are transferred, in the counted number, at receiving elements of the machine, while the excess metal profiles are unloaded inside the collection magazine.

[0004] For such processing of rebars, there is a continuous aim towards simplification and reduction of operations time. Although, EP1356875 provided an improvement by automatic counting with an automated screw feeder, the operation time is relatively long, as it is explained in EP1934000 from the same applicant. As further improvement, EP1934000 proposes providing a tracked tool for collecting the rebars from a magazine and releasing a first, desired number of bars onto shuttles for further working and subsequently releasing those bars that exceed the desired number back into the magazine. However, the tracked tool in EP1943000 for the counting and separation of bars is complex as the teeth have to be adjusted for various thickness of the bars, and also, the teeth have to be movable in order for only releasing the desired number of bars onto the shuttles for further working. All in all, the system of EP1934000, although an improvement to a certain extent relatively to EP1356875, is relatively complicated and therefore expensive to produce. Furthermore, the bars are dropped from the counter onto the shuttles one by one, which increases the risk for entanglement. This is believed to be the reason for the system of EP1934000 also implementing a grabber that fixes the bars at the central position during outward transport of the shuttles. However, the grabber is making the system additionally complicated.

[0005] Safe counting of bars during working and transfer despite apparent simplicity is a challenging task, as it has to be reliable and robust.

[0006] It would be desirable to provide an improvement in the art towards further simplification and further reduced operation time.

DESCRIPTION / SUMMARY OF THE INVENTION

[0007] It is therefore an objective of the invention to provide an improvement in the art. It is a further objective to provide a method and system that is simplified relatively to the prior art and which reduces operation time. A further objective is cost reduction for production of the system. An even further objective is to provide a safe automated counting method for metal bars in connection with working and transfer, as well as method of automated separation of a prefixed number of bars from groups of bars. One or more of these objectives are obtained by a method and apparatus as described in the following and in the claims.

[0008] The objective is obtained by an automated method, as explained in the following, for dividing a group of metal bars, in particular of the type used for reinforcing concrete, into a first and a second subgroup, the first subgroup having a prefixed number of bars.

[0009] Such division is relevant in a number of automated working processes of metal bars. For example, a group of bars is collected from a store of such bars, and only the first subgroup is transferred to a magazine, for example an entrance magazine of a cropping machine for cropping the length of the bars of the first subgroup or in bending machines. The second subgroup is then potentially transferred as a second portion to the same magazine, or transferred to a further magazine for different working, or merely returned to the store for a potential different collection process.

[0010] In coarse terms, a group of metal bars are collected in a single layer, for example on an electromagnet, counted by a scanner, and the group is divided into a first and second subgroup. This is accomplished by moving a separation edge to an adjacent position near a space between the two subgroups and separating the first subgroup from a second subgroup by providing, for example simultaneously, only the first subgroup of bars on the first side of the separation edge and the second subgroup only on the second side of the separation edge.

[0011] In more detail, the method comprises the following steps. A group of metal bars, typically parallel or approximately parallel metal bars, is collected in a single layer, for example planar layer, although a slight curving layer is also possible to be used. Typically, the single layer has an angle with a vertical plane of less than 45 degrees. For example the single layer is horizontal or substantially horizontal.

[0012] A counter is provided with a surface scanner configured for providing topological data representing scanned surface profiles of objects, and a computer sys-

tem is functionally connected to the scanner. By the scanner, the surface of the group of metal bars is scanned while moving the surface scanner along a line, typically straight line, optionally horizontal line, across the group of metal bars, for example using an actuator. The scanner can be provided on either side of the bars, however, in order to minimize dirt and debris falling onto the scanner, a position above the bars is preferred. Relative position coordinates of the scanner are repeatedly determined during the moving, and the scanning data signals as well as the relative position coordinates are provided to the computer system.

[0013] The term computer system includes relative simple programmable systems, such as PLC (Programmable Logic Controller) systems, which are widely used in machine control.

[0014] Once, the computer system has received the data, the scanning signals are automatically related to the relative position coordinates, and a surface profile of the group of the metal bars is calculated in the computer system. From the surface profile, the relative positions of the metal bars and of the spaces between the metal bars are determined, and the metal bars are counted. For example, the computer system is programmed to find the highest points of the metal bars in the surface profile and from these data determine the number of metal bars. For example, the highest points, as measured from a plane in which the bars are provided, are used in combination with indications of spaces, which are represented by lowest points. Optionally, the scanning signals are filtered by a low pass filter for eliminating high frequency signal noise oscillations due to roughness on the bars.

[0015] Advantageously, the distance scanner comprises a laser triangulation system configured for scanning the distance between the laser triangulation system and the surface of a scanned point on the group of bars. Such triangulation distance scanner systems are commercially available, for example as disclosed on the internet page http://www.mtiinstruments.com/products/lasertriangulation.aspx.

[0016] The group of metal bars is then divided into a first subgroup of the prefixed number of bars and a second subgroup of bars. The spaces between the bars are counted and, as a result of the counting, a particular space and its position is determined that is located between the first subgroup and the second subgroup of bars. For the separation into the subgroups, a separation edge is moved to the particular space, the separation edge having a first side and a second opposite side relatively to a vertical plane, and the first subgroup is separated from the second subgroup by providing the first subgroup of bars only on the first side of the separation edge and the second subgroup only on the second side of the separation edge, for example simultaneously. Thus, typically, the bars are provided to opposite sides of a vertical plane. However, the edge itself need not necessarily be arranged vertically but can have opposite sides that are inclined relatively to a vertical plane.

[0017] In some embodiments, the separating comprises moving the separation edge into the particular space. In case of a horizontal single layer of bars, the separation edge is driving along a direction which has an upwards or downwards vertical component, for example along a vertical or substantially vertical direction, dependent on whether the separation edge is provided above or below the bars. Optionally, when the separation edge has been driven into the particular space or while the separation edge is driving into the particular space, the separation edge is used to drive the two subgroups apart. For example, the direction of motion of the edge is not entirely vertical but along a direction that is inclined relatively to a vertical direction, or the edge has sides that are inclined relatively to the direction of movement, for example vertical movement. In some embodiments, the separation edge is formed as a wedge.

[0018] Alternatively, the first subgroup is moved to the first side of the separation edge and the second subgroup to the second side of the separation edge, while the separation edge is stationary. For example, the movement has a vertical component, optionally is along a vertical or substantially vertical direction, especially if the single layer is horizontal or substantially horizontal.

[0019] A combination of driving the separation edge and moving the bars is also possible. Important is the relative movement between the bars and the separation edge for providing the first subgroup of bars only on the first side of the separation edge and the second subgroup only on the second side of the separation edge, for example simultaneously.

[0020] For example, the bars are brought to a lifted condition with a free space underneath the bars, and the separation edge is moved underneath the bars to the particular space. Subsequently, the bars are dropped from the lifted position and, during dropping, the first and the second subgroup are separated by dropping the first subgroup of bars only pass the first side of the separation edge and dropping the second subgroup only pass the second side of the separation edge. For example, the first subgroup and the second subgroup are dropping pass the edge simultaneously.

[0021] As an alternative to the simultaneous dropping, the first or the second or both subgroups are dropped in portions. This is especially relevant if the bars are heavy, and the dropping of the entire group of lifted bars would imply a risk of creating damage due to the accumulated weight.

[0022] For example, the separation of the metal bars is achieved by dropping only the first subgroup of bars onto a separation arm that is located only on the first side of the separation edge and dropping the second subgroup pass the second side of the separation edge, for example simultaneously with the dropping of the first subgroup or a portion of the first subgroup. In some embodiment, the separation edge is attached to or integral with one end of the separation arm, and the locating of the separation edge underneath the particular space com-

prises moving or extending the separation arm until its end with the separation edge is located under the particular space.

[0023] Optionally, a free-fall space is provided on the second side of the separation edge for free fall drop of the second subgroup of bars, to the store or further magazine, for example from an electromagnet when the electromagnet is located vertically above the store or the further magazine.

[0024] Specific examples of such procedures and related apparatus are explained in greater detail in the following, where the apparatus comprises a store for storing metal bars, in particular of the type used for reinforcing concrete, and the bars are collected from such store and brought into a single layer and divided into subgroups.

[0025] For example, the apparatus is configured for transfer of bars from the store to a magazine. The term magazine is used in a broad sense and can be a magazine for storage prior to the next working step or prior to transport but can equally well be a magazine which directly leads to working, for example the entrance magazine of a cropping machine or a bending machine.

[0026] In some embodiments, this apparatus comprises a support beam that is arranged on rails for moving the support beam laterally to a longitudinal direction of the store, the longitudinal direction coinciding with the longitudinal direction of the bars in the store. Typically, there are a number of stores provided side by side, and the support beam would move on the rails to that particular store from which bars have to be provided for transfer to a magazine. The bars may have various diameters and lengths in the various stores.

[0027] An electromagnet is provided for collecting a group of metal bars from the store in a lifted position, the group being attached in a single layer to a lower side of the electromagnet. The particular store for collection of bars is optionally a selected one among a plurality of stores. During attachment, the bars are in a parallel or approximately parallel configuration. Once, the current to the electromagnet is switched off, the magnetic force vanished and the bars from the electromagnet are released, for example simultaneously, although a portionwise release from the magnet is also possible, dependent on the layout of the magnet, for example in case that the electromagnet is built of independently powered sections.

[0028] In some embodiments, a lifting mechanism, for example a hydraulic or pneumatic piston or a gripper, is used to lift the bars up to the electromagnet. In other embodiments, the electromagnet is provided on an actuator and arranged for moving, typically along a vertical line, for lifting a group of metal bars free from the store. In the latter case, the electromagnet is configured for being lowered into the store and for electromagnetically attaching the group of bars only in a single layer to a lower side of the electromagnet. This is achieved by proper adjustment of the magnetic strength and the layout of the magnet, including the geometry of the magnet. The movement into the store is stopped when contact with the bars is made, for example using a contact sensor.

[0029] The counter is used for counting the number of metal bars while in the lifted position. Also, the relative positions of the bars and of the spaces between the bars are determined. The counter comprises a surface scanner and a computer system as described above, and the bars and spaces between bars are counted and their position determined. The particular space is determined, and the edge is positioned underneath this particular space. The scanner and computer system are configured for the method steps as described above.

[0030] The apparatus can be used for transferring an initial prefixed number of metal bars from the store to the magazine. However, this number may be smaller or larger than the number of bars picked up with the electromagnet in a single pick up action. If the prefixed number is larger than the number of bars that are picked up by the magnet, the picked-up number of bars are transferred, and the procedure has to be repeated, until the total number of transferred bars matches the prefixed number. However, if the prefixed number is less than the number of metal bars on the magnet a division procedure as described above has to be applied, as only a portion of the picked-up bar is needed for transfer.

[0031] In more detail, in case that the number of metal bars on the electromagnet is less than or equal to the initial prefixed number, the bars are released from the electromagnet and thereby dropped onto a separation arm and transferred from there to the magazine. This procedure is repeated, until the number of bars on the electromagnet in a subsequent cycle is higher than the number of bars still needed to be transferred to the magazine. In practice, the initial prefixed number is adjusted in each cycle to a new adjusted prefixed number by subtracting the already transferred number of bars. The lifting and counting operation is repeated cyclic as long as the adjusted prefixed number is larger than zero, which means that the already transferred number of bars has not yet reached the prefixed number.

[0032] In case that the number of metal bars on the electromagnet is higher than the initial or adjusted prefixed number, for example after some cycles, the metal bars are separated into a first subgroup of a first number of bars, the first number being equal to the initial or adjusted prefixed number, and a second subgroup of remaining bars. The first subgroup only is transferred to the magazine. The second subgroup is discharged, typically back into the store, or alternatively discharged into a further store or magazine. This separation, transfer and discharge procedure is explained in greater detail in the following.

[0033] The separation procedure of the metal bars into the first subgroup that is to be transferred to the magazine and the second subgroup that is to be discharged into the store comprises a determination of the position of spaces between the metal bars. From this information, a particular of the spaces is found wherein the first sub-

group and the second subgroup are on opposite sides of the particular space. A movable separation edge is then moved in a direction laterally across the bars until the separation edge is located underneath the particular space that divides the bars into the first subgroup and the second subgroup.

[0034] For example, the apparatus comprises a support beam as mentioned above, and the separation edge is moved in a direction laterally to the support beam. In such case, the separation edge has a first side towards the support beam and a second opposite side facing away from the support beam.

[0035] The bars are then released from the electromagnet, and the first and the second subgroup are separated by the separation edge during dropping from the electromagnet. The first subgroup of bars drops onto a separation arm that is located only on the first side of the separation edge, while the second subgroup passes the second side of the separation edge for discharge into the store. For example, the second subgroup is dropped simultaneously with the drop of the first subgroup or simultaneously with portions of the first subgroup.

[0036] For example, the separation edge is attached to or integral with one end of the separation arm. In this case, locating of the separation edge underneath the particular space comprises moving or extending the separation arm until its end with the separation edge is located under the particular space.

[0037] Optionally, once on the separation arm, the number of bars in the first subgroup of bars is counted with the counter for verification of the correct number.

[0038] In some embodiments, shuttles are used for lifting the bars free and disentangle them. In this case, all of the bars from the separation arm are transferred onto at least two shuttles, for example by changing a level of the separation arm relatively to the shuttles in a rectilinear vertical motion of the separation arm or the shuttles or both. In this way, the shuttles lift the bars from the separation arm. While the bars are supported by the shuttles, the shuttles are moved in opposite directions along a straight path in a longitudinal direction of the bars for disentangling the bars and for lifting them fully off the store. For example, the bars are supported by the shuttles while the shuttles move without the bars being fixed at their central position. As no grabber is provided for fixing the bars at their central position, the apparatus differs also in this point from the system in the aforementioned publication EP19340000.

[0039] A plurality of support arms are provided underneath the straight path of the shuttles. As the shuttles move beyond the ends of the bars, the bars are dropped onto the support arms. Once, on the support arm, the bars are moved by the support arms to the magazine, typically in a direction transverse to the longitudinal direction of the bars, although also other directions are possible, for example directions along the longitudinal direction of the bars, for example for direct feeding into the receiving magazine of a cropping machine. For example, the support arms are attached to a support beam, as described above, and the support arms are moved by the movement of the support beam.

[0040] From the support arms, the bars are discharged into the magazine, for example by dropping the bars from the support arms directly into the magazine. In some embodiments, the discharging of the bars from the support arms into the magazine is accomplished by pushing the bars pass an end of the support arms in a horizontal movement of the bars, or alternatively by withdrawing the support arms underneath the bars, for example in a horizontal movement, thereby freeing the bars from the support arm for dropping the bars into the magazine.

[0041] A number of advantageous are achieved with the method and the apparatus as described. It has a relatively high speed, a high quality of bar counting and isolation, the count is fast and flexible without requirements for adjustment, and the isolation procedure is fast and flexible for isolating the desired number of bars. Furthermore, the scanner and computer system can be used for quality control purposes with respect to diameter and number of isolated bars before they are entered into secondary processes, for example working, such as cropping.

[0042] For the method above the apparatus as described in complex form in the following is useful.

[0043] The apparatus comprises a store of metal bars, for example of the type used for reinforcing concrete. An electromagnet is provided and arranged for collecting a group of metal bars from the store in a lifted position at a lifting level, the electromagnet being configured for electromagnetically attaching the group in a single layer to a lower side of the electromagnet and for releasing the entire group of bars either simultaneously or in portions, depending on the layout of the electromagnet. For example, the electromagnet is arranged for lifting a group of metal bars free from the store to an upper lifting level. A counter as described above is provided for counting the number of metal bars in the lifted group of metal bars in the lifted group and for determining the relative position of the bars and of the spaces between the bars and for determining the particular space.

[0044] The counter comprises a surface scanner configured for providing topological data representing scanned surface profiles of objects, and a computer system functionally connected to the scanner; the scanner being configured for scanning the surface of the group of metal bars by the scanner while moving the surface scanner along a line across the group of metal bars, determining relative position coordinates of the scanner repeatedly during the moving, and providing the scanning data signals as well as the relative position coordinates to the computer system. The computer system is programmed for automatically

- relating the scanning signals to position coordinates and calculating a surface profile of the group of the metal bars in the computer system along the line;

- in the surface profile determining the relative positions of the metal bars and of the spaces between the metal bars, and counting the metal bars;
- dividing the group of metal bars into a first subgroup of the prefixed number of bars and a second subgroup of remaining bars,
- counting the spaces between the bars and as a result of the counting determining a particular space that is located between the first subgroup and the second subgroup of bars and determining the position of the particular space.

[0045] A movable separation edge is located at a level underneath the upper lifting level. The separation edge has a first side and a second opposite side relatively to a vertical plane. The separation edge is configured for moving laterally to the bars to a position underneath any one selected particular of the spaces between the bars, thereby dividing the bars into a first subgroup on the first side of the separation edge and a second subgroup on the second side of the separation edge.

[0046] The apparatus is configured for releasing the bars from the electromagnet, either simultaneously or in portions, and thereby dropping the first subgroup of bars from the electromagnet on the first side of the separation edge but not the second subgroup of bars, and dropping the second subgroup of bars from the electromagnet on the second side of the separation edge.

[0047] Optionally, a free-fall space is provided on the second side of the separation edge for free fall drop of the second subgroup of bars from the electromagnet to the store.

[0048] In some embodiments, the apparatus comprises a movable separation arm configured for moving laterally to the group of bars on the electromagnet, wherein the separation edge is attached to or integral with one end of the separation arm, the separation arm being configured for receiving the first subgroup of bars that drop from the electromagnet on the first side of the separation edge but not the second subgroup of bars.

[0049] For example, the apparatus comprises a support beam that is arranged on rails for moving the support beam laterally to the store. Typically, plural stores are provided for storing different types of bars, for example with different diameters. If the electromagnet is provided with an actuator, it is advantageously attached to the support beam. Optionally, the movable separation arm is attached to the support beam and configured for moving laterally to the support beam. At least two shuttles are arranged movable on the support beam in opposite directions in a straight path along the support beam and configured for receiving the bars from the separation arm and for disentangling the bars and lifting the bars fully off the store during moving. In addition, a plurality of support arms are attached to the support beam underneath the straight path and configured for receiving the bars by dropping the bars from the shuttles when the shuttles are moved beyond the ends of the bars. The support arms are arranged for moving together with the support beam to a magazine and configured for releasing the bars into the magazine.

[0050] Optionally, the counter is configured for counting the number of bars in the first subgroup of bars while the first subgroup of bars is on the separation arm.

[0051] Optionally, the computer system is configured for filtering the scanning signals by a low pass filter and for eliminating high frequency signal noise oscillations due to roughness on the bars.

[0052] As an alternative to the optical scanner, a tactile sensor can be used that touches the surface of the bars or a camera system. Such sensor would also be functionally connected to the computer system.

[0053] The term "substantially horizontal" , "substantially vertical" or "substantially parallel" are used to indicate small variations, for example deviations of less than 10 degrees or less than 5 degrees.

SHORT DESCRIPTION OF THE DRAWINGS

[0054] The invention will be explained in more detail with reference to the drawing, where

FIG. 1 to 14 illustrate the apparatus in various operation steps;
FIG. 15 a and b illustrate processing of the signal from the laser counter;
FIG. 16 a-c illustrates an apparatus with longitudinal extraction;
FIG. 17 discloses an example of a prior art laser triangulation surface scanner.

DETAILED DESCRIPTION / PREFERRED EMBODIMENT

[0055] FIG. 1 illustrates an apparatus 1 for the automatic feeding of metal bars 2 from a store 3 to a further location, for example a cropping station or a different type of magazine arranged for further handling of the bars 2, for example a pallet for transport of bars 2 to another location. In the following, the further location is called magazine without loss of generalization. As explained in the following, the apparatus is configured for separating the bars 2, if entangled, and for counting the bars 2 during a transfer process between the store 3 and the magazine.

[0056] The store 3 comprises a U-formed channel 4 from which the bars 2 can be removed for the counting and separation. In the current shown embodiment, the channel 4 is provided as a plurality of spaced trestle stands 5 arranged in series. Above the store 3, there is provided an assembly 6 for collecting the bars 2, supported by a support beam 7 placed as a bridge parallel with the channel 4 and at a higher level than the channel 4.

[0057] The term parallel refer to the direction of the channel 4 as well as the approximate longitudinal direction of the bars 2, and in this particular case also the

direction of the support beam 7. The term transverse refers to a horizontal direction perpendicular to the channel 4.

[0058] The support beam 7 is supported at opposite ends by a couple of columns 8 that are movable on rails 9. This way, the assembly 6 can be moved horizontally, transversely to the store 3 at a level above the channel 4. Once the bars 2 are collected from the store 3, they can be moved transversely to a magazine and be unloaded there.

[0059] In addition or alternatively, it is also possible that the apparatus comprises a parallel-transporter such that the bars can be lifted from the store 3, moved transversely, lifted or lowered, and then moved in a parallel direction, which is the direction along the longitudinal direction of the bars and in the direction parallel with the support beam 7.

[0060] The collecting assembly 6 is provided with an electromagnet 10 for lifting a group of bars 2 from the channel 4. In order to collect the bars 2 and lift them, the electromagnet 10 is arranged vertically movable by an actuator 11, for example a hydraulic, pneumatic, or gear-driven or belt-driven actuator. The electromagnet 10 is shown as a single magnet but can be substituted by a plurality of spaced and cooperating electromagnets. The magnetic strength and the layout, including the geometry, are provided so that only one layer of bars 2 can be lifted by the electromagnet 10.

[0061] For collecting the bars 2 from the channel 4, the electromagnet 10 is lowered into the channel 4 until contact with the bars 2 is made, after which the electromagnet 10 is switched on and the bars 2 are by magnetic force held in a single layer to the surface of the electromagnet 10 and in an upwards movement by the electromagnet 10 lifted free from the channel 4. Typically, a contact sensor is used for stopping the downwards movement of the electromagnet 10 into the store 3.

[0062] As illustrated in the exemplified collection situation of FIG. 2, the electromagnet 10 has collected nine bars, five bars are for sake of illustration in the following regarded as the desired first subgroup 2a for separation. For the consecutive process, these five bars are to be collected for further processing, whereas the remaining four bars as a second subgroup 2b should return to the channel 4.

[0063] In order to accomplish the correct separation of the desired bars 2a from the remaining bars 2b, the bars 2 are counted by a counter 12.

[0064] For example, the counter 12 comprises a laser scanner 20 with a laser beam and laser detector in which the distance between the detector and the laser-reflecting surface is measured during transvers scanning of the bars 2. Optionally, the counter 12 comprises a laser beam scanner 20 working by laser triangulation principles. Laser triangulation distance scanner systems are commercially available, for example as illustrated in FIG. 17, which is a reproduction of a system as disclosed on the internet page http://www.mtiinstruments.com/products/lasertriangulation.aspx. A laser beam from a laser diode is projected onto the bars 2 and a portion of the beam is reflected off the surface of the bars 2 and through a focusing lens onto an optical position sensitive detector, for example a CCD (charge coupled device), arranged at a non-zero reflection angle. The distance between the laser diode and the surface determines the angle by which the reflected laser beam is transmitted to the detector. A varying angle during scanning due to varying distance to the surface is translated into a varying position on the detector. Accordingly, the position variation on the detector during scanning reveals the surface topology when related to the abscissa. The detector has a spatial and depth resolution matching or better than the desired resolution.

[0065] Accordingly, the optical scanner 20 of the counter 12 is arranged transversely movable. For counting, the scanner 20 is moved, for example in a horizontal plane, transversely above and across the 2 bars relatively to the electromagnet 10, as illustrated by double arrow 29 in FIG. 3, for example by a motorized chain drive or cam-belt drive, and the distance between the bars 2 and the surface of the group of bars 2 is scanned during the transverse movement of the counter 12. This scanning is evaluated in a correspondingly programmed computer system to yield topography data of the group of bars 2 on the electromagnet 10. Optionally, the measurement is performed in both directions in order to minimize risk for errors.

[0066] For example, while the scanner 20 of the counter 12 is moved across the bars 2, the actual position of the scanner 20 above the bars 2 is related to a variable (x), which used by the computer software as an abscissa for the topology profile. In a continuous or cyclic manner, the distance (y) between the laser beam emitter/sensor and the bars 2 is measured and related to the abscissa x. An (x,y) diagram reveals the topology of the group of bars on the electromagnet 10 with a ridge and two valleys for each bar. The ridges and valleys of the topography are interpreted by the computer software program as bars and spaces between bars, respectively. In the computer system recorded topography, the number of ridges reveals the numbers of bars, and the corresponding abscissa their position, while the abscissa related to the valleys reveal the spaces that can be used for separation of a selected number of bars 2a from the total group of bars on the magnet 10.

[0067] FIG. 15a illustrates a possible example of a data curve from the scanner and computer system. There are shown three upwards convex partial curves 25, each one corresponding to measurement data of one bar 2. The computer system is programmed to find the highest point 21 on each of the three partial curves 25. This highest point 21 is not necessarily aligned with the center of the corresponding bar 2, as the bars typically have ribs around the bar 2. This highest point is used by the computer system as offset for a trigger curve 22. The trigger curve 22 toggles between a single upper value and a

single lower value, which in the shown example are 10 and 0. At the edge 23 of the trigger curve, the start of the space 24 between bars is defined. Once, the spaces are defined, they can be counted and used for separation of the bars 2. FIG. 15b shows the same data, however, with the addition of a differential curve 26, the differential curve 26 illustrating the rise and fall of the partial curves 25. The differential curve 26 can be used alternatively or in addition to the trigger curve for safeguarding proper automatic identification of the spaces 24 between the bars 2.

[0068] Alternatively, a tactile sensor can be used to sense the topography of the bars 2 on the electromagnet by direct contact with the surface of the bars. For example, a flexible finger is moved across the bars and vertically adjusted to follow the surface profile of the bars 2, revealing the topology.

[0069] In order to minimize the risk for faults in counting, the computer software is provide with various control functions and filters taking into account surface roughness, surface structure and minimum diameters of the bars. For example, the surface roughness is filtered by a low pass filter, eliminating high frequency signal oscillations from the scanning due to surface roughness.

[0070] With reference to the principle sketch of FIG. 4, on the basis of the computer-recorded number of bars 2 and their position on the electromagnet 10, a separation arm 13 that is equipped at one end with a separation edge 14 is moved transversely underneath the bars 2, as indicated by the double arrow, until the separation edge 14 coincides with the space between two bars 2 of which one bar has been identified as belonging to the first subgroup 2a for further handling and the adjacent bar has been identified as belonging to the second subgroup 2b that is to be returned to the channel 4.

[0071] By switching off the electromagnet, the bars 2 fall on either side of the separation edge 14, which is illustrated in FIG. 5. Those bars that have been selected as the first subgroup 2b that are to be returned to the channel 4 fall behind the separation edge 14 and drop into the channel 4. The other five bars 2a that have been selected in the second subgroup 2b for further handling drop on the opposite side of the separation edge 4 onto the separation arm 13, as illustrated in FIG. 6.

[0072] It is noted that the separation edge 14 need not be part of the separation arm 13 and could be moved separately from the separation arm 13.

[0073] As an optional further step, the number of bars selected as the first subgroup 2a on the separation arm 13 is counted by the optical counter 12 with the scanner 20 in order to verify the counted number and minimize the risk for errors.

[0074] As illustrated in FIG. 7, the separation arm 13 has been retracted transversely and a shuttle 17 on either side of the assembly 6 has been moved upwards to lift the selected bars 2a from the separation arm 13. Alternatively, the separation arm 13 could be lowered for the transfer of the first subgroup 2a of bars from the separation arm 13 to the shuttles 17. The shuttles 17 comprise a carriages 15 with freely rotating horizontal rollers 16 by which the selected bars 2b are supported. The shuttles 17 are carried by the support beam 7 in translational manner, for example by a chain drive or cam-belt drive, and configured for moving in opposite directions away from the center of the support beam 7 and parallel with the support beam 7, thereby lifting the selected bars 2a entirely free from the channel 4 and also disentangling the bars 2a. In the illustrated embodiment of FIG. 8, a second 17 is moving in an opposing direction. It is possible to provide more than two shuttles 17 moving along the support beam 7 during this disentangling and lifting action.

[0075] As illustrated in FIG. 8 and 9, while the shuttles 17 move towards the end of the support beam 7, a plurality of support arms 18 along the support beam 7 are provided underneath the selected bars 2a, such that the selected bars 2a are discharged onto these support arms 18, once the shuttles 17 have been moved along the support beam 7 to an end position, which is beyond the ends of the selected bars 2b. The latter situation is illustrated in FIG. 10.

[0076] As illustrated in FIG. 11 the support arms 18 are partly retracted, although this is a requirement but depends on the configuration. As illustrated in FIG. 12 and 13, the support beam 7 is moved transversely for transport of the selected bars 2b from the location above the store 3 to a further location for further handling of the bars 2, for example an intermediate magazine 19, as illustrated in FIG. 14. Once, the bars 2a are located at the further location, they are discharged from the support arms 18, for example by being pushed down from the support arms 18 into the intermediate magazine 19.

[0077] Alternatively, the selected bars 2a are removed from the supports arms 18 by grippers or are inserted into a transport unit where the selected bars 2a are moved parallel to the support beam 7 away from the support arms 18, for example into a magazine of a cropping machine for cropping the bars into the desired length.

[0078] An example of an apparatus in which the bars are removed in a longitudinal direction is illustrated in FIG. 16a to 16c. Also in such a system, a counter 12 as described above is useful. The bars 2 are supported in a store 3 with a U-formed channel 4, which is elevated relatively to the ground. 26. At one end, the bars 2 are bending down towards the ground. For collection of a predetermined number of bars, the bent end of the bars 2 is lifted up with a piston lifter 30, for example electrical, hydraulic or pneumatic lifter 30, towards an electromagnet 10. A gripper could be used as an alternative to the piston lifter. This system differs from the system in FIG. 1-14 in that the electromagnet 10 is not lowered into the store 3, but the bars 2 lifted up to the electromagnet 10. The electromagnet 10 is mounted rotational in order to adjust to the angle of the bars 2. Once, the bars 2 in contact with the electromagnet 10, a single layer of bars 2 remains attached to the electromagnet 10, while the remaining bars are lowered towards the floor again by

lowering of the hydraulic lifter 30. While the bars 2 are on the electromagnet 10, a similar procedure with a counter 12 and separation edge 14 as disclosed above and illustrated in FIG. 4 is used to select only a first subgroup for further handling. For example, the first subgroup 2a is drawn into the jaws 27 of a cropping machine 28 along the longitudinal direction of the channel 4. Accordingly, this system also differs from the system in FIG. 1-14 in that the transfer procedure is not lateral to the longitudinal direction of the channel 4 and of the bars 2 but in a longitudinal direction of the bars 2. Typically, the store 3 comprises a plurality of channels 4 and is laterally movable in order to align the desired channel among the plurality of channels 4 with the piston lifter 26 and the cropping machine 27.

[0079] As it is readily recognized for the system as described herein in relation to the aforementioned EP1934000, there is no tracked tool (having number 20 in EP1934000) for handling the bars for transfer from the magnet to the separation arm, and there is no clamp with jaws for fixing the bars at the central position ((having numbers 15-17 in EP1934000). The system and method of operation as explained herein is simpler and it operation faster, requiring fewer operation steps. In addition, because bars are not clamped in jaws or have to fit into a special track, in contrast to EP1934000, it is also more versatile and procedure-wise more robust when dealing with a broad range of varying diameters of the bars. Furthermore, due to the simpler setup, the system implies lower production costs than for the system in EP1934000.

Reference numbers

[0080]

1 apparatus for the automatic feeding of metal bars 2
2 metal bars
2a selected bars
2b de-selected bars
3 store of bars
4 U-formed channel
5 trestle stand
6 collection assembly
7 support beam
8 columns supporting the support beam 7
9 rails for the columns 8
10 electromagnet
11 actuator for vertical movement of the electromagnet 10
12 counter
13 separation arm
14 separation edge
15 carriage of shuttle 17
16 horizontal rollers of carriage 15
17 shuttle
18 support arms
19 magazine for selected bars 2b
20 scanner
21 highest point
22 trigger curve
23 edge at space 24
24 space
25 partial curve
26 differential curve
27 jaws of cropping machine 28
28 cropping machine
29 double arrow illustrating movement of counter 12
30 hydraulic lifter

Claims

1. Method of dividing a group of metal bars into a first and a second subgroup, the first subgroup having a prefixed number of bars; the method, comprising

- collecting a group of metal bars (2) in a single layer, the number of metal bars (2) in the group being higher than the prefixed number;
- providing a counter (12), the counter (12) comprising a surface scanner (20) configured for providing topological data representing scanned surface profiles of objects, and a computer system functionally connected to the scanner (12);
- scanning the surface of the group of metal bars (2) by the scanner (20) while moving the scanner (20) along a line across the group of metal bars (2), determining relative position coordinates of the scanner (20) repeatedly during the moving, and providing the scanning data signals as well as the relative position coordinates to the computer system; by the computer system automatically
- relating the scanning signals to position coordinates and calculating a surface profile of the group of the metal bars (2) in the computer system;
- in the surface profile determining the relative positions of the metal bars and of the spaces (24) between the metal bars, and counting the metal bars;
- dividing the group of metal bars (2) into a first subgroup (2a) of the prefixed number of bars and a second, subgroup (2b) of remaining bars,
- counting the spaces (24) between the bars (2) and as a result of the counting determining a particular space that is located between the first subgroup (2a) and the second subgroup (2b) of bars and determining the position of the particular space;
- locating a separation edge (14) at the particular space; the separation edge (14) having a first side and a second opposite side relatively to a vertical plane;

- separating the first subgroup (2a) from the second subgroup (2b) by providing only the first subgroup of bars (2a) on the first side of the separation edge (14) and the second subgroup (2b) only on the second side of the separation edge (14).

2. Method according to claim 1, wherein the separating comprises

a) moving the separation edge (14) into the particular space along a vertical or substantially vertical direction
or
b) moving the first subgroup to the first side of the separation edge and the second subgroup to the second side of the separation edge along a vertical or substantially vertical direction;

or a combination of a) and b).

3. Method according to claim 1 or 2, wherein the separating comprises providing the first subgroup to the first side of the separation edge and the second subgroup to the second side of the separation edge, simultaneously.

4. Method according to claim 1, wherein the separating comprises providing the first or the second subgroup or both subgroups to the first and second side of the separation edge in portions.

5. Method according to any preceding claim, wherein the method comprises providing the bars (2) in lifted condition with a free space underneath the bars, locating the separation edge (14) underneath the particular space; and dropping the bars (2) from the lifted position and during dropping, separating the first subgroup (2a) and the second subgroup (2b) by dropping the first subgroup of bars (2a) only pass the first side of the separation edge (14) and dropping the second subgroup (2b) only pass the second side of the separation edge (14).

6. Method according to claim 5, comprising

- providing a store (3) of metal bars (2);
- by an electromagnet (10) collecting a group of metal bars (2) from the store (3) in a lifted position, the group being attached in a single layer to a lower side of the electromagnet (10);
- while in a lifted position counting the number of metal bars (2) on the electromagnet (10) with the counter (12);

wherein the separation of the metal bars (2) of the first subgroup (2a) from the second subgroup (2b) comprises releasing the bars (2) from the electromagnet (12) and separating the first and the second subgroup during dropping from the electromagnet by dropping only the first subgroup of bars (2a) onto a separation arm (13) that is located only on the first side of the separation edge (14) and dropping the second subgroup (2b) pass the second side of the separation edge (14).

7. Method according to claims 6, wherein the separation edge (14) is attached to or integral with one end of the separation arm (13), and wherein the locating of the separation edge (14) underneath the particular space comprises moving or extending the separation arm (13) until its end with the separation edge (14) is located under the particular space.

8. Method for according to claim 6 or 7, comprising

- providing an initial prefixed number, which is the number of the metal bars to be transferred from the store (3) to a magazine (19) for working or transport;
- in case that the number of metal bars (2) on the electromagnet is less than or equal to the initial prefixed number, releasing the bars (2) from the electromagnet (12) and thereby dropping the bars (2) onto a separation arm (13), and transferring the number of metal bars (2) from the separation arm (14) to the magazine (19), adjusting the initial prefixed number to a new adjusted prefixed number by subtracting the already transferred number of bars; repeating the lifting and counting operation as long as the adjusted prefixed number is larger than zero;
- in case that the number of metal bars (2) on the electromagnet is higher than the initial or adjusted prefixed number, separating the metal bars (2) into a first subgroup (2a) of a first number of bars, the first number being equal to the initial or adjusted prefixed number, and a second subgroup (2b) of remaining bars, transferring the first subgroup (2a) to the magazine (19) and discharging the second subgroup (2b) back into the store (3).

9. Method according to claim 8, wherein the transfer of the bars (2, 2b) from the separation arm (13) to the magazine (19) comprises

- transferring all of the bars (2, 2b) from the separation arm (13) onto at least two shuttles (17) and moving the at least two shuttles (17) in opposite directions along a straight path in a longitudinal direction of the bars (2) for disentangling the bars (2) and for lifting them fully off the store (3);
- providing a plurality of support arms (18) underneath the straight path and dropping the bars

(2, 2b) from the shuttles (17) onto the support arms (18) by moving the shuttles (17) beyond the ends of the bars (2, 2b);
- while the bars (2, 2b) are on the support arm (18), moving the support arms (18) in a direction transverse to the longitudinal direction of the bars (2) to the magazine, and discharging the bars (2, 2b) from the support arms into the magazine (19);

10. Method according to claim 9, wherein the discharging of the bars (2, 2b) from the support arms (18) into the magazine (19) is accomplished by dropping the bars (2, 2b) from the support arms (18) directly into the magazine (19).

11. Method according to claim 9 or 10, wherein the transferring of the bars (2, 2b) from the separation arm (13) onto at least two shuttles (17) is accomplished by changing a level of the separation arm relatively to the shuttles (17) in a rectilinear vertical motion of the separation arm (13) or the shuttles (17) or both.

12. A method according to any one of the claims 9-11, wherein the bars during movement of the shuttles (17) are not fixed at a central position.

13. A method according to any preceding claim, wherein the distance scanner comprises a laser triangulation system configured for scanning the distance between the laser triangulation system and the surface of a scanned point on the group of bars.

14. Apparatus for a method according to any preceding claim, comprising

- a store (3) of metal bars (2);
- an electromagnet (10) arranged for collecting a group of metal bars (2) from the store (3) in a lifted position at a lifting level, the electromagnet being configured for electromagnetically attaching the group in a single layer to a lower side of the electromagnet (10) and for releasing the entire group of bars;
- a counter (12) for counting the number of metal bars (2) in the lifted group of metal bars and for determining the relative position of the bars and of the spaces between the bars; the counter comprising a surface scanner configured for providing topological data representing scanned surface profiles of objects, and a computer system functionally connected to the scanner; the scanner being configured for

  - scanning the surface of the group of metal bars by the scanner while moving the surface scanner along a line across the group of metal bars (2), determining relative position coordinates of the scanner repeatedly during the moving, and providing the scanning data signals as well as the relative position coordinates to the computer system;

  by the computer system automatically
  - relating the scanning signals to position coordinates and calculating a surface profile of the group of the metal bars in the computer system along the line;
  - in the surface profile determining the relative positions of the metal bars and of the spaces between the metal bars, and counting the metal bars;
  - dividing the group of metal bars (2) into a first subgroup (2a) of the prefixed number of bars and a second subgroup (2b) of remaining bars,
  - counting the spaces between the bars (2) and as a result of the counting determining a particular space that is located between the first subgroup (2a) and the second subgroup (2b) of bars and determining the position of the particular space;

  the apparatus comprising a movable separation edge (14) at a level underneath the upper lifting level; the separation edge (14) having a first side (7) and a second opposite side relatively to a vertical plane; the separation edge (14) being configured for moving laterally to the bars (2) to a position underneath any one selected particular of the spaces between the bars (2), thereby dividing the bars into a first subgroup (2a) on the first side of the separation edge (14) and a second subgroup (2b) on the second side of the separation edge (14);
  - the apparatus being configured for releasing the bars from the electromagnet (10) and thereby dropping the first subgroup (2a) of bars from the electromagnet (10) on the first side of the separation edge (14) but not the second subgroup of bars (2b), and dropping the second subgroup of bars (2b) from the electromagnet (10) on the second side of the separation edge (14).

15. An apparatus according to claim 14, further comprising a free-fall space on the second side of the separation edge (14) for free fall drop of the second subgroup of bars (2b) from the electromagnet (10) to the store (3).

16. Apparatus according to claim 14 or 15, further comprising a movable separation arm (13) configured for moving laterally to the group of bars on the electromagnet (10), wherein the separation edge (14) is attached to or integral with one end of the separation arm (13), the separation arm (13) being configured for receiving the first subgroup (2a) of bars that drop

from the electromagnet (10) on the first side of the separation edge (14) but not the second subgroup of bars (2b).

17. Apparatus according to claim 16, further comprising

- a support beam (7) arranged on rails (9) for moving the support beam (7) laterally to the store (3), wherein the actuator (11) of the electromagnet (10) is attached to the support beam (7);
- a movable separation arm (13) attached to the support beam (7) and configured for moving laterally to the support beam (7), wherein the separation edge (14) is attached to or integral with one end of the separation arm (13), the separation arm (13) being configured for receiving the first subgroup (2a) of bars that drop from the electromagnet (10) on the first side of the separation edge (14) but not the second subgroup of bars (2b);
- at least two shuttles (17) arranged movable on the support beam (7) in opposite directions in a straight path along the support beam (7) and configured for receiving the bars (2a) from the separation arm (13) and for disentangling the bars (2a) and lifting the bars fully off the store (3) during moving;
- a plurality of support arms (18) attached to the support beam (7) underneath the straight path and configured for receiving the bars by dropping the bars (2a) from the shuttles (17) when the shuttles (17) are moved beyond the ends of the bars (2a); the support arms (18) being arranged for moving together with the beam (7) to a magazine (19) and configured for releasing the bars (2a) into the magazine (19).

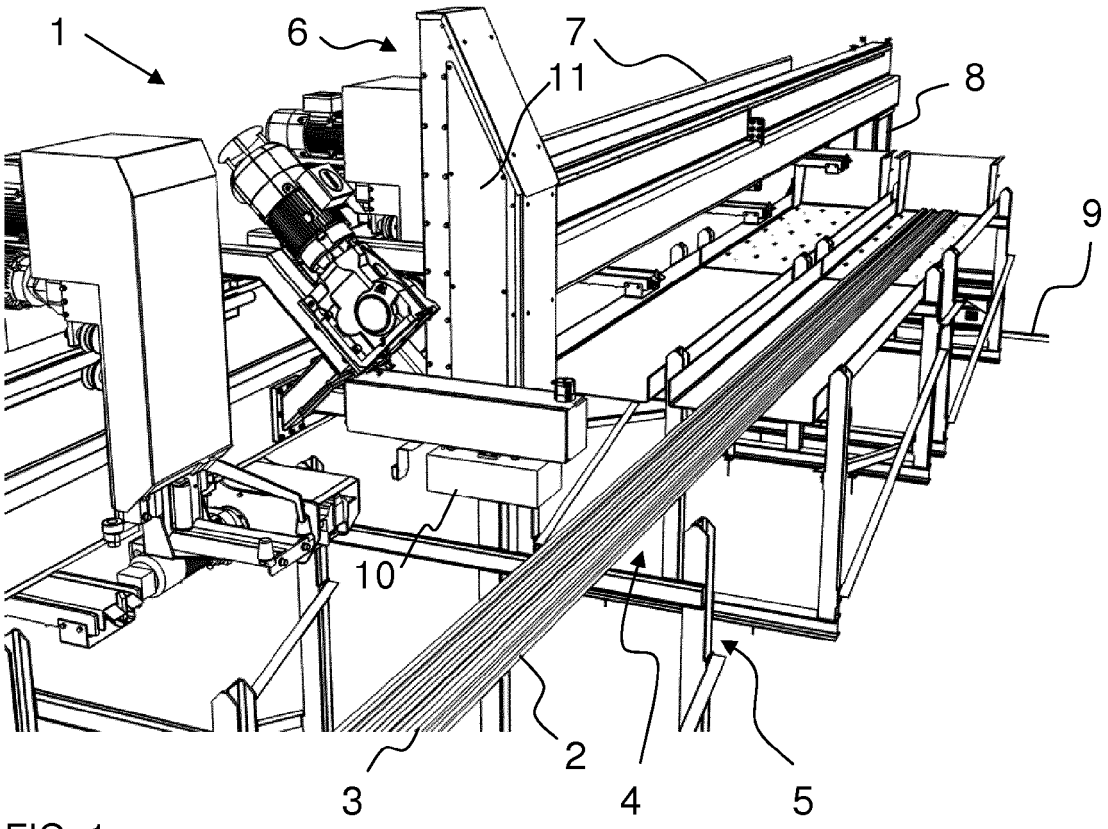

FIG. 1

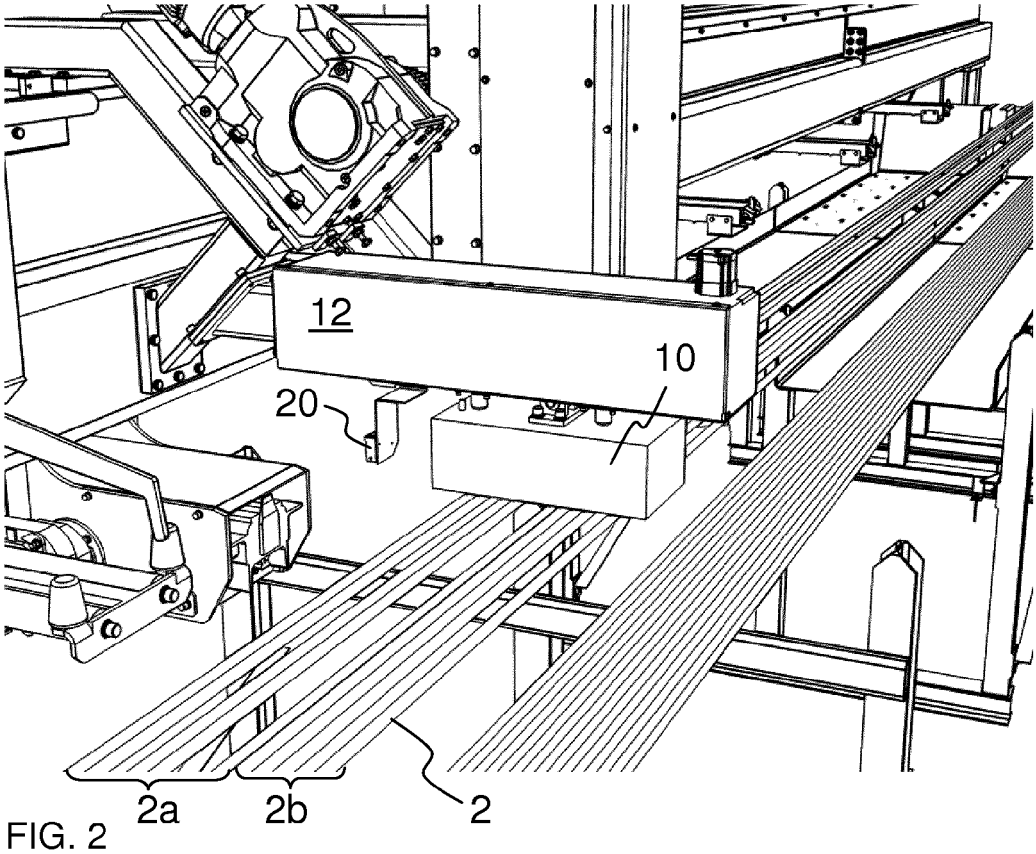

FIG. 2

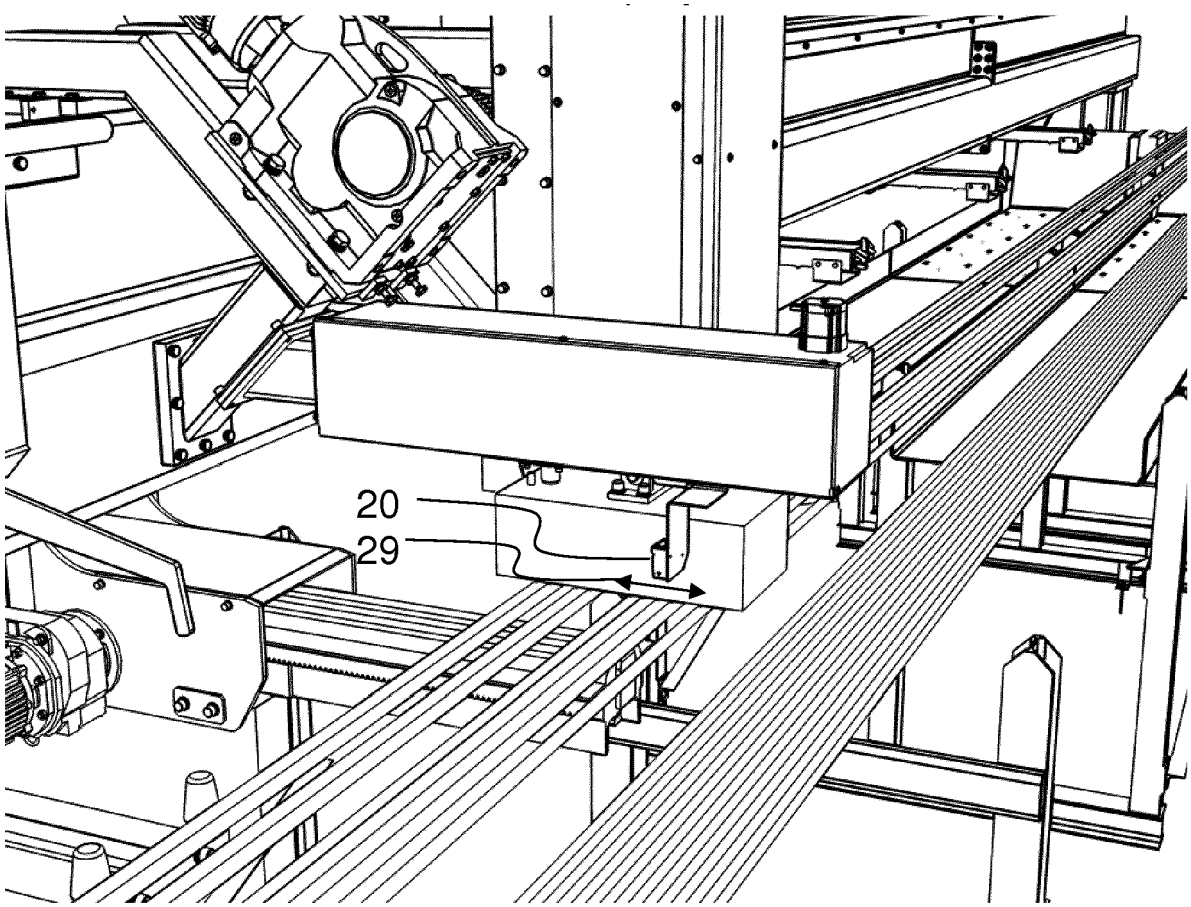

FIG. 3

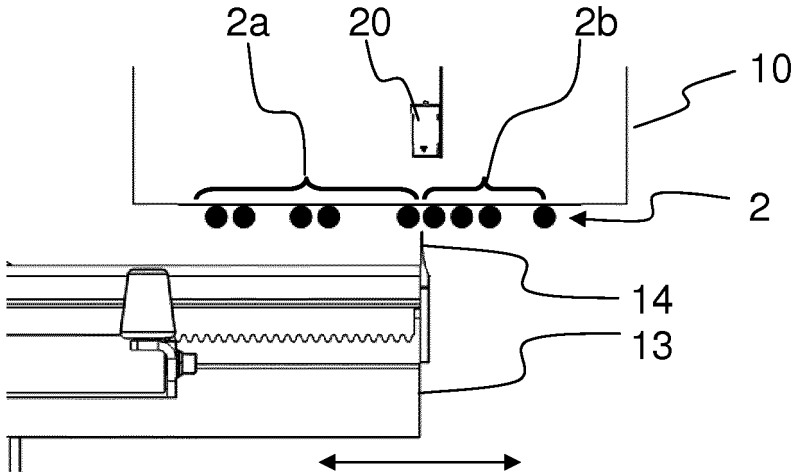

FIG. 4

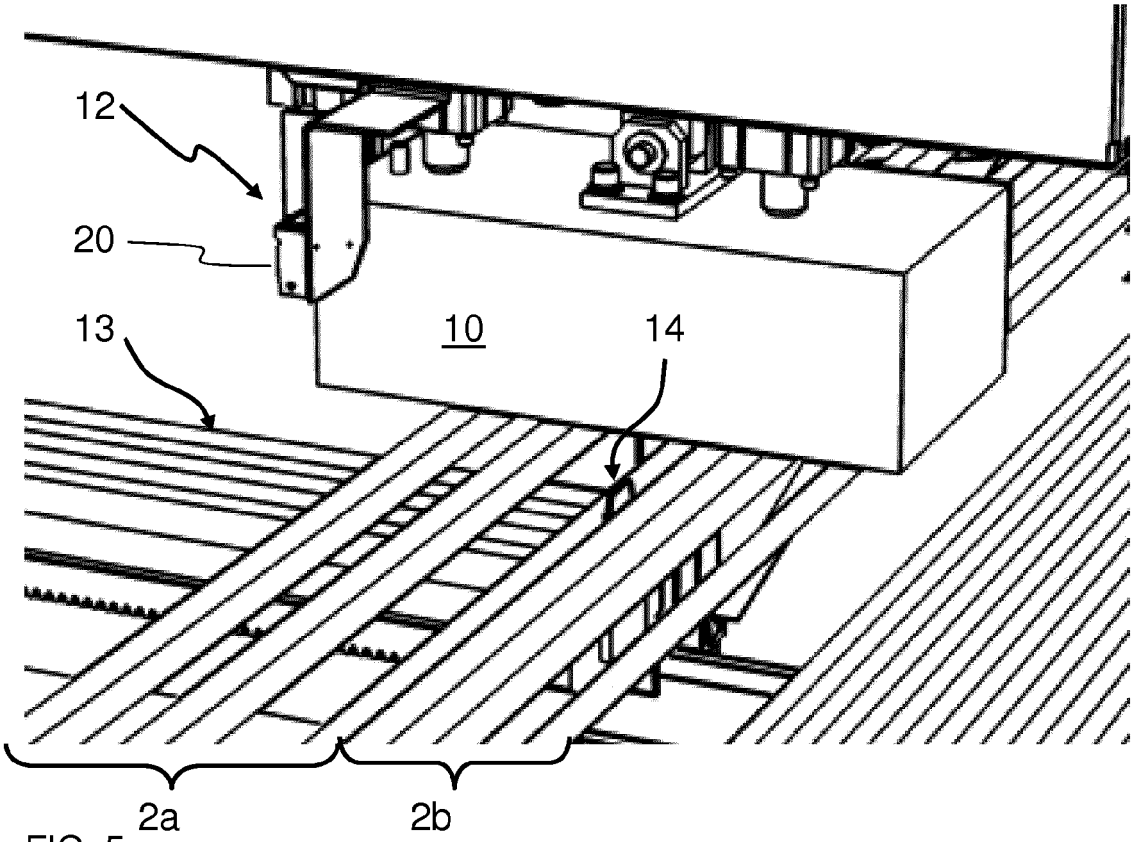

FIG. 5

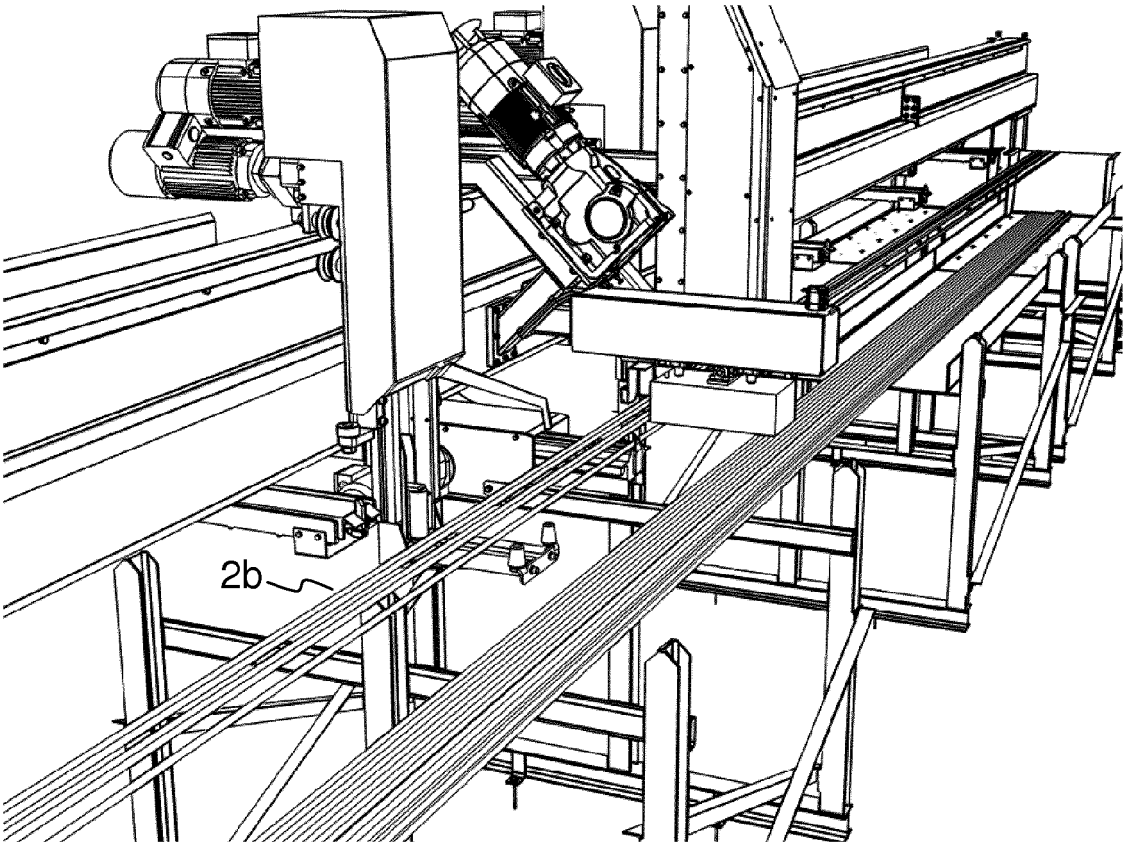

FIG. 6

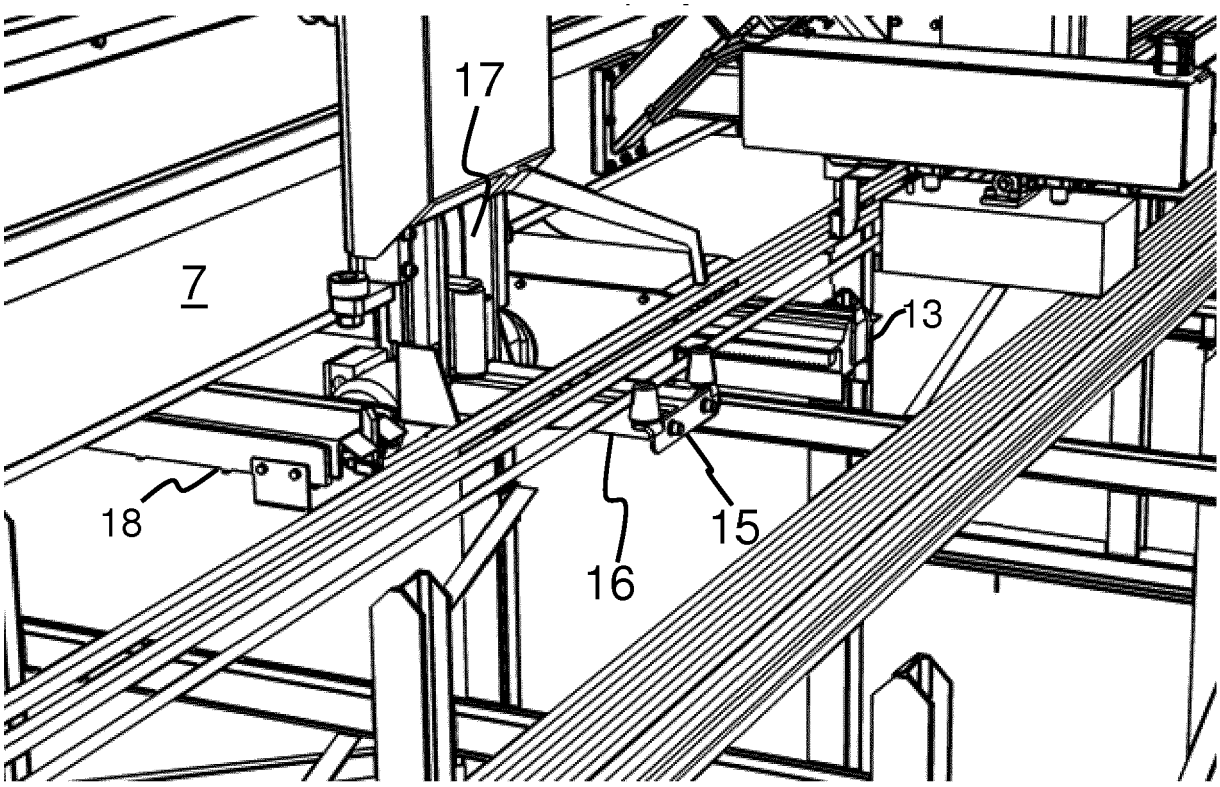

FIG. 7

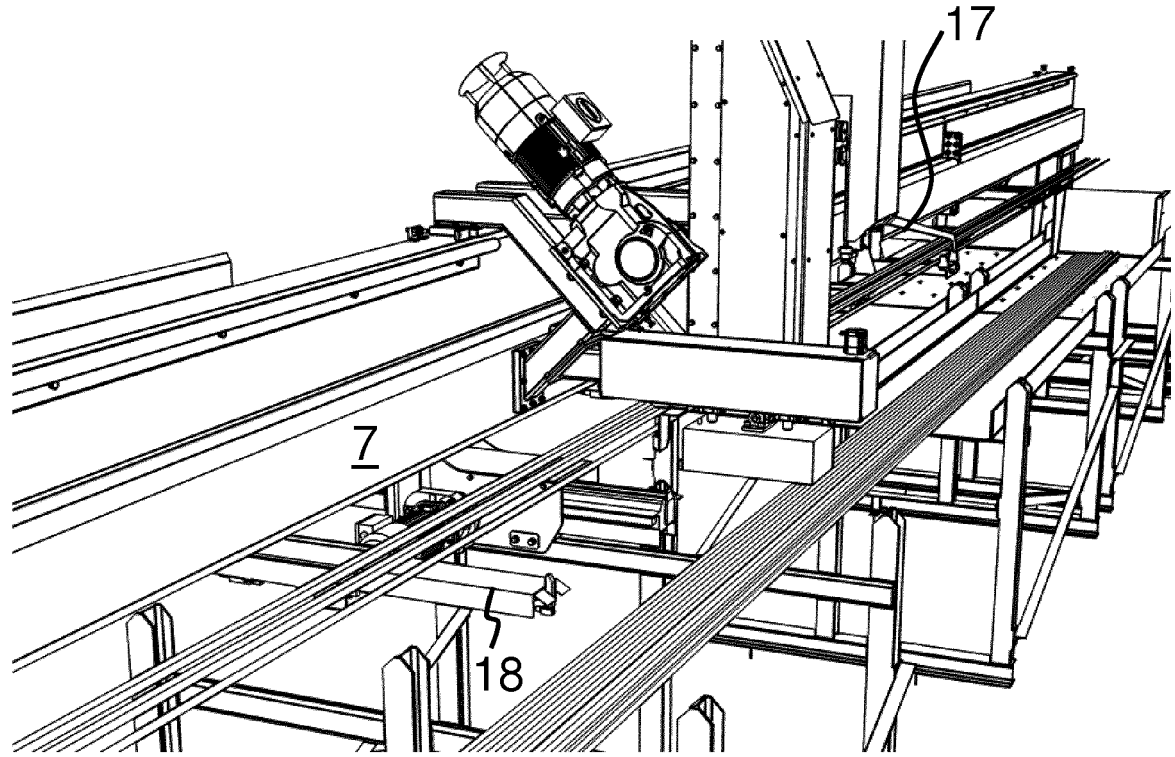

FIG. 8

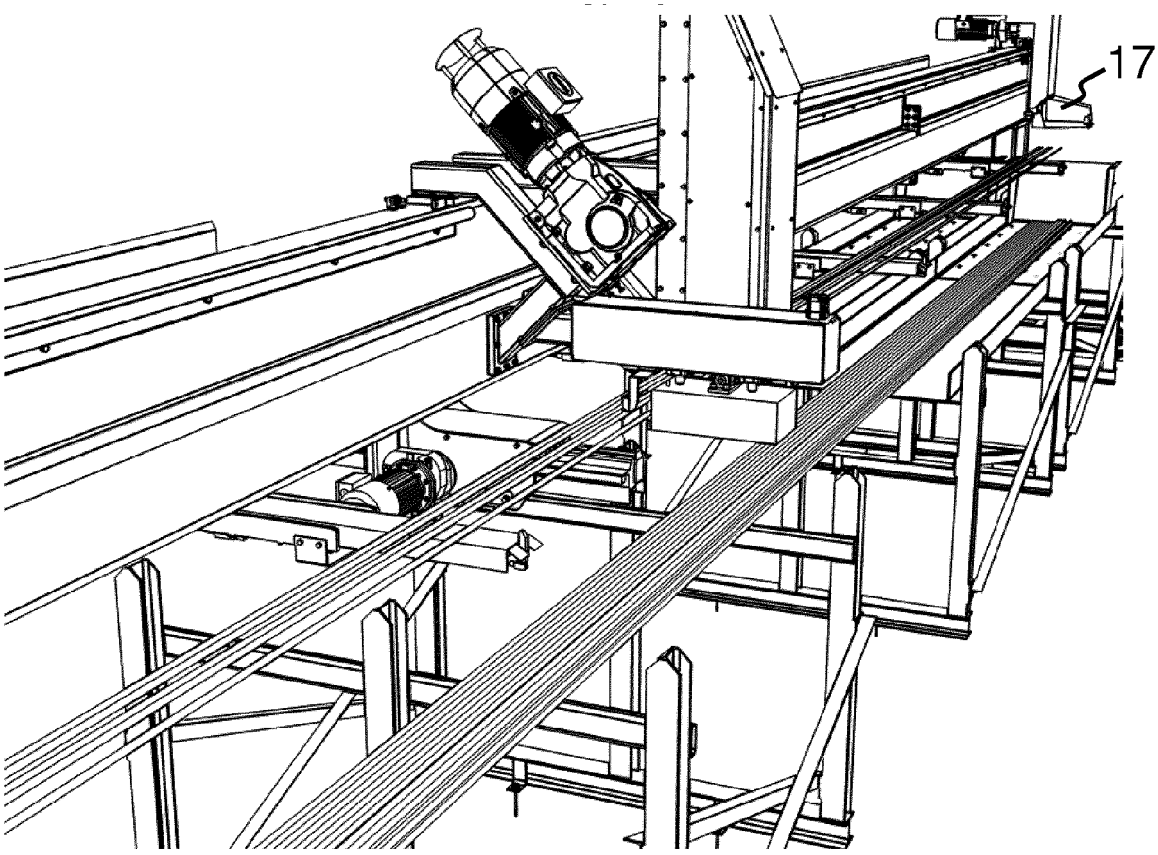

FIG. 9

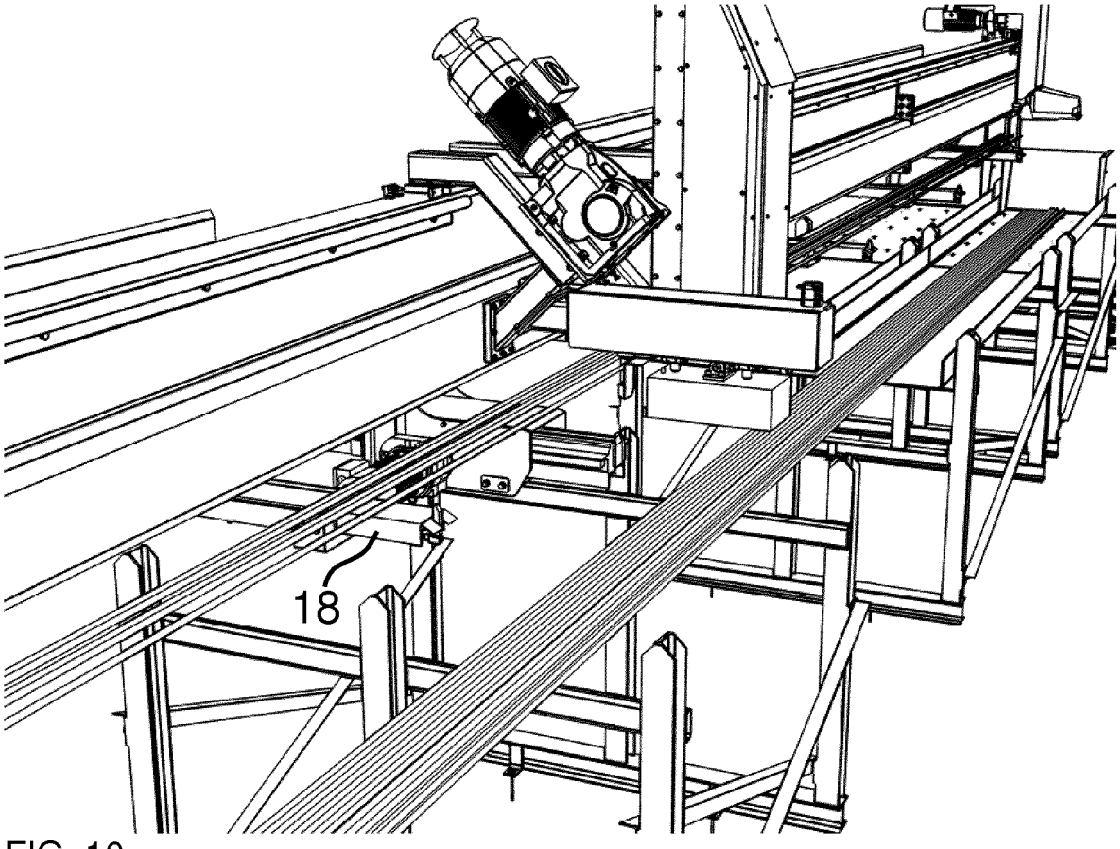

FIG. 10

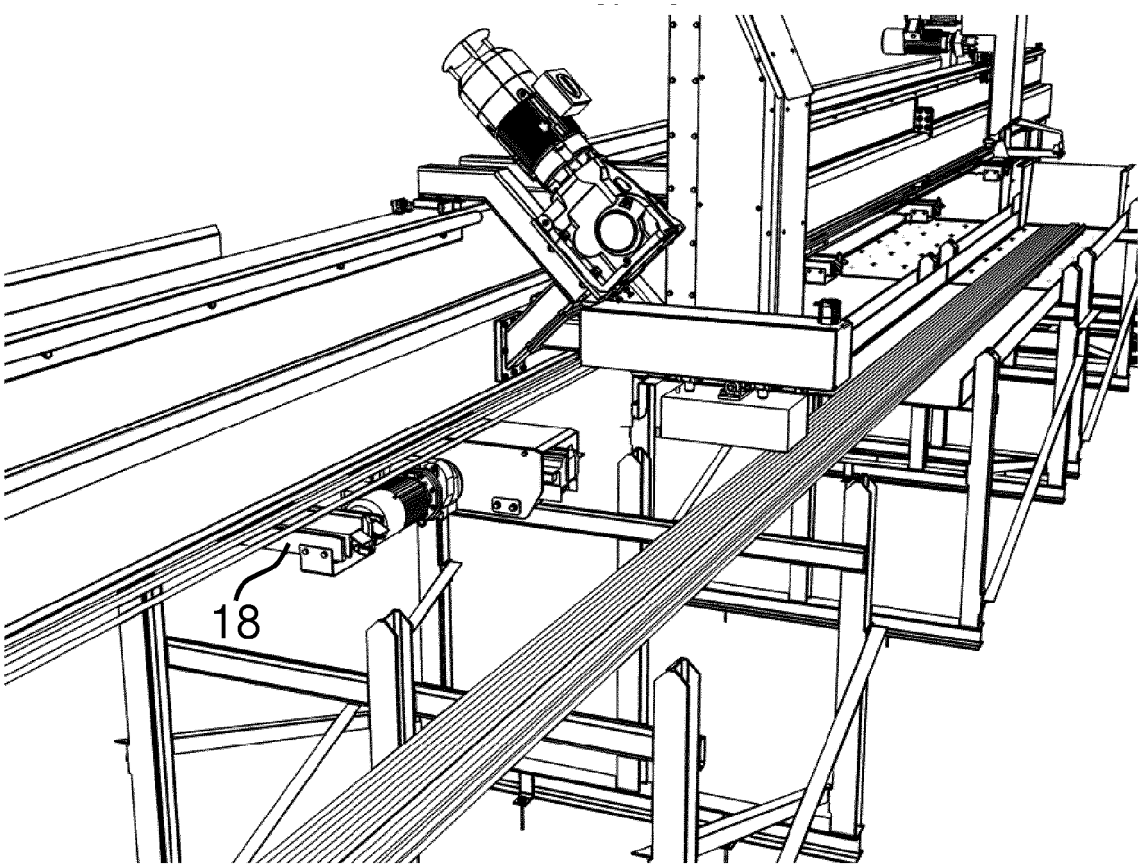

FIG. 11

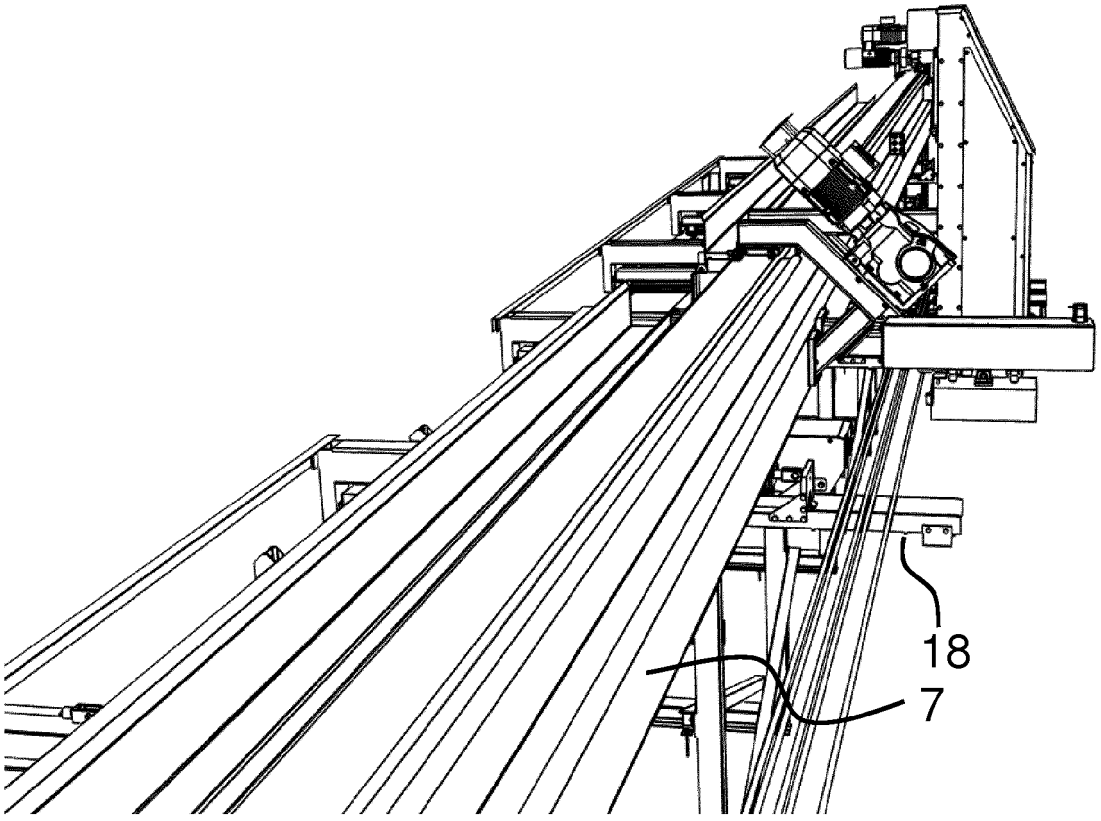

FIG. 12

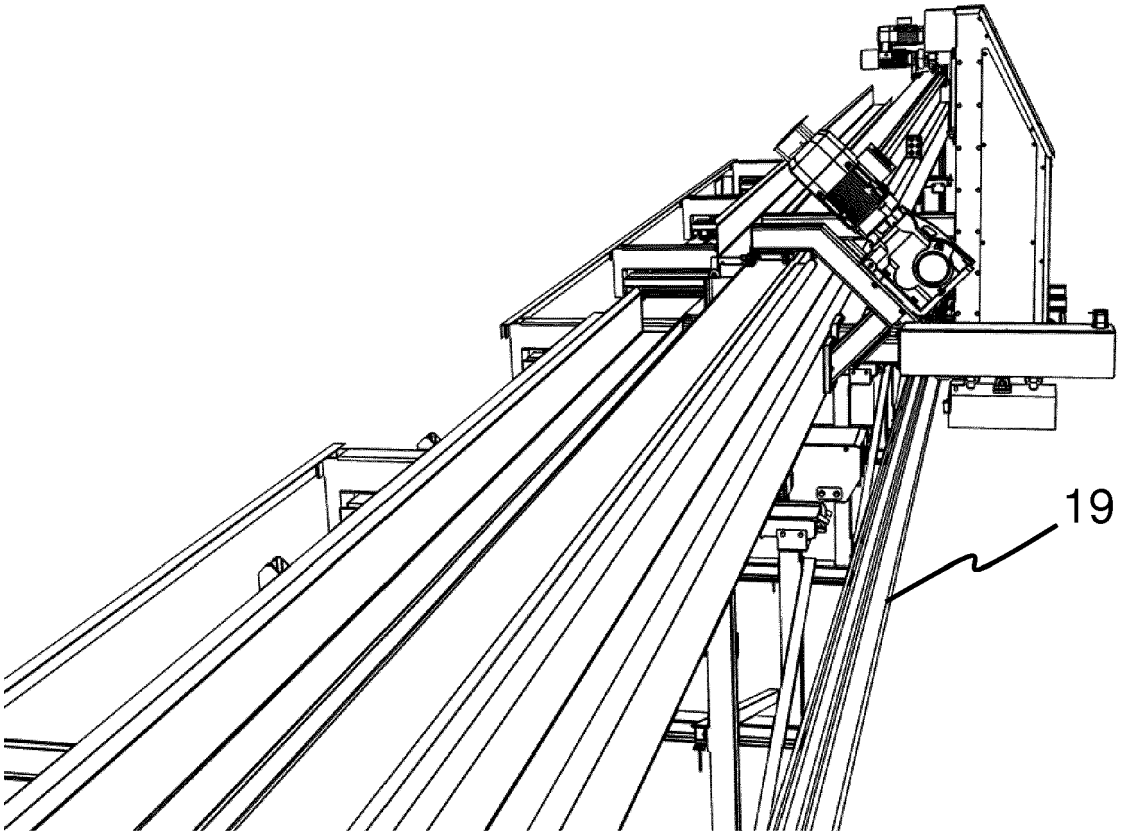

FIG. 13

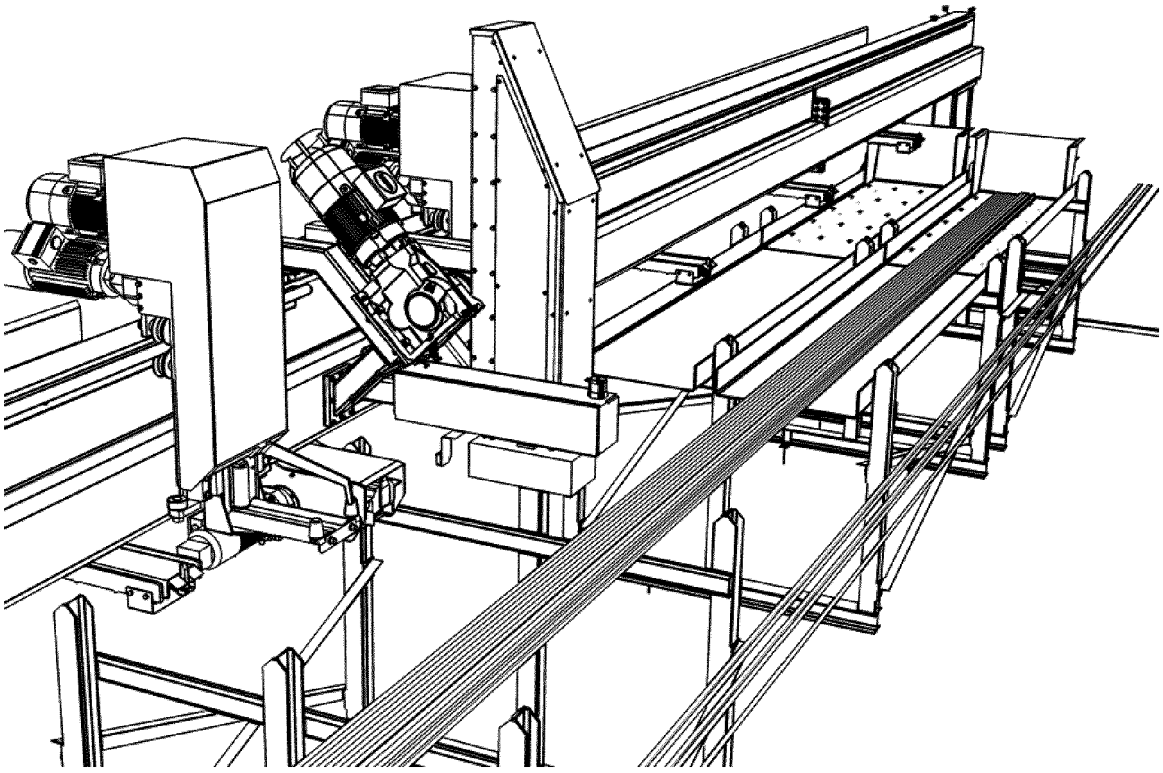

FIG. 14

FIG. 15a

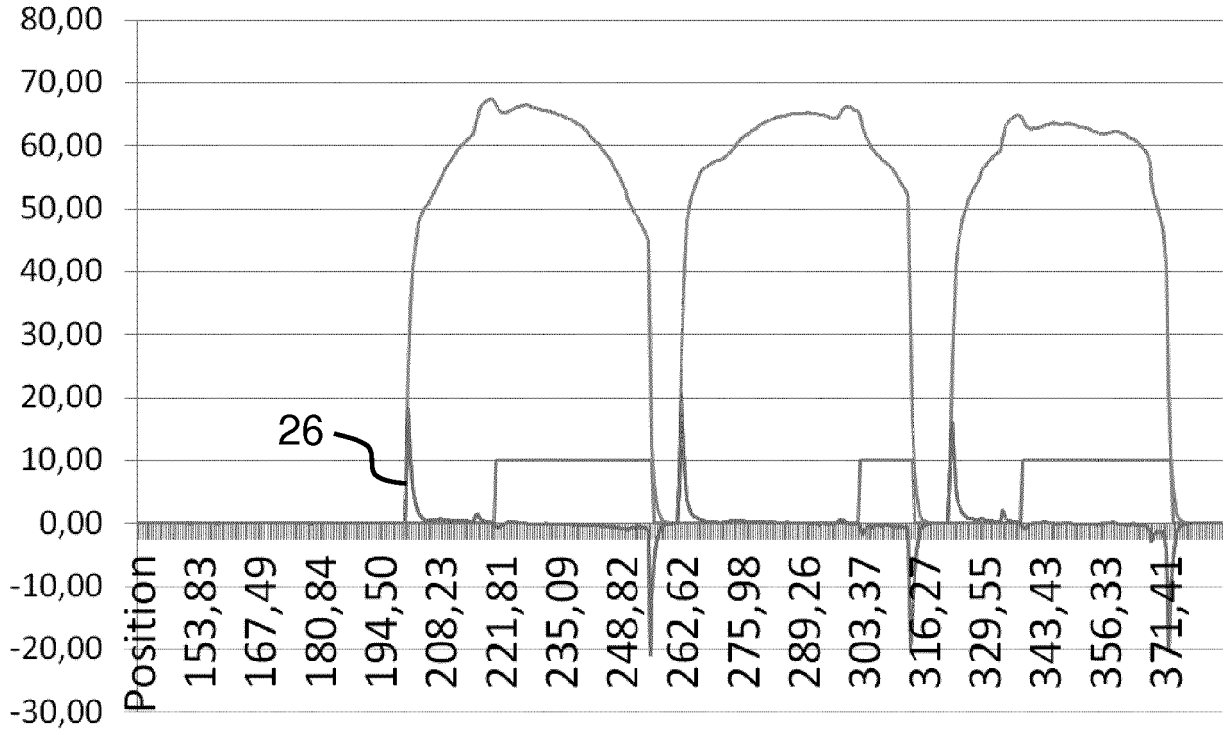

FIG. 15b

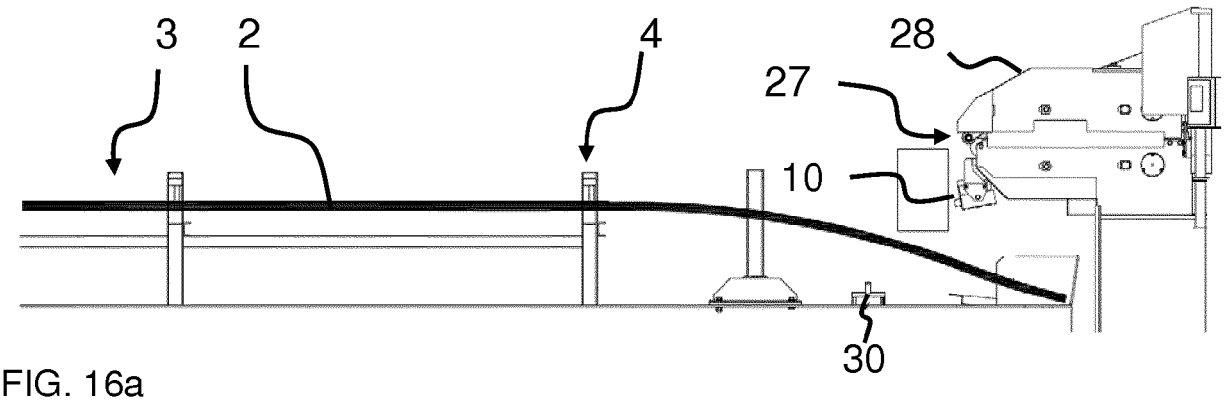

FIG. 16a

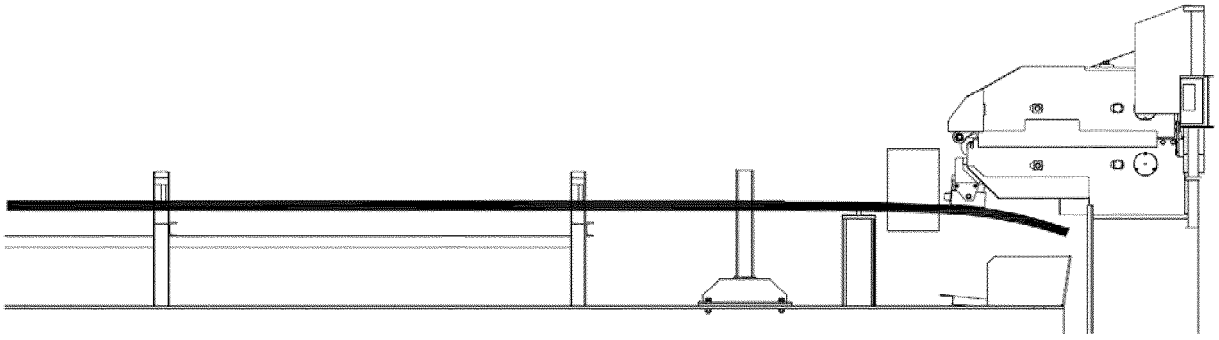

FIG. 16b

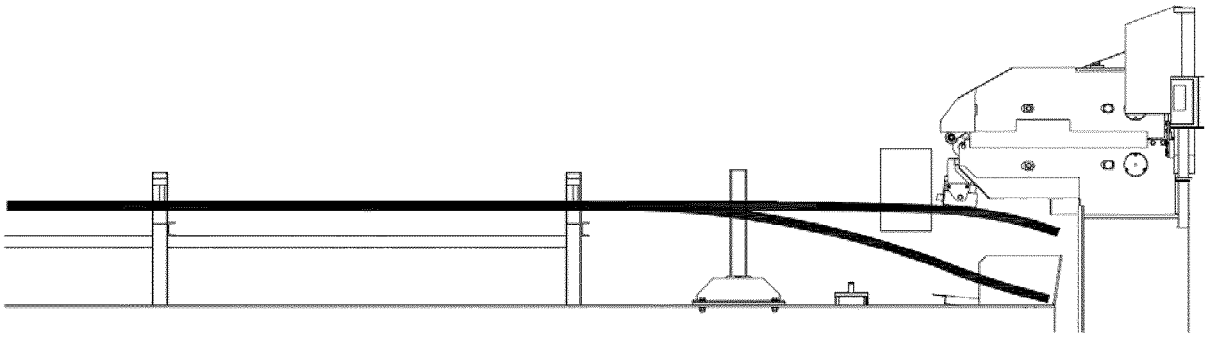

FIG. 16c

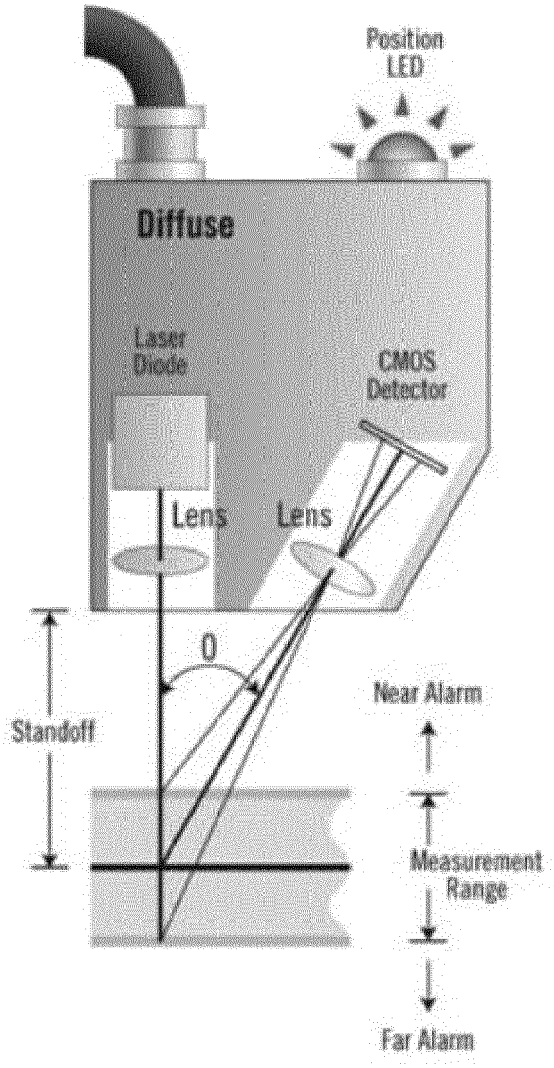

FIG. 17
(Prior art - http://www.mtiinstruments.com/products/lasertriangulation.aspx)

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 4437

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 356 876 A2 (SCHNELL SPA [IT]) 29 October 2003 (2003-10-29) * paragraphs [0023], [0042]; figures *	1-17	INV. B21D43/00 B21F23/00 B65G47/00
A	WO 2008/128541 A1 (STEMA ENGINEERING AS [DK]; KLOSTERHALFEN HARTWIG [DE]) 30 October 2008 (2008-10-30) * abstract; figures *	1-17	B65G47/14
A,D	EP 1 934 000 A1 (SCHNELL SPA [IT]) 25 June 2008 (2008-06-25) * the whole document *	1-17	
A,D	EP 1 356 875 A2 (SCHNELL SPA [IT]) 29 October 2003 (2003-10-29) * the whole document *	1-17	

TECHNICAL FIELDS SEARCHED (IPC)

B21D
B21F
B65G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 September 2016	Knecht, Frank

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 16 4437

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14-09-2016

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