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(54) **METHOD AND APPARATUS FOR FIXING METAL STRUCTURES**

VERFAHREN UND VORRICHTUNG ZUR BEFESTIGUNG VON METALLSTRUKTUREN

PROCEDE ET APPAREIL DE FIXATION DES STRUCTURES METALLIQUES

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(73) Proprietor: **Schnell S.p.A.**
61030 Montemaggiore Al Metauro PU (IT)

(72) Inventor: **MIGLIORANZA, Aronne**
I-31030 Padernello Di Paese (TV) (IT)

(74) Representative: **di Francia, Vincenzo**
Manzella & Associati
Via Nosadella 9,
40123 Bologna (IT)

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Description

Technical field

[0001] The present invention relates to a method according to the preamble of claim 1 and an apparatus according to the preamble of claim 5 for the completion of pre-cages through the fixing of longitudinal reinforcement bars to some of the stirrups at least, composing the pre-cage, in particular for the production of metal cages for reinforced concrete, an example of such a method and apparatus is disclosed by EP-A-1243358 (italian application UD 2001A000055).

Background art

[0002] It is well known that, for the production of reinforced concrete columns and beams, metal cages are commonly used, which are constituted by longitudinal reinforcement steel bars connected to transversal stirrups suitably spaced out. The stirrups usually define a closed pathway, for example with quadrilateral shape, having overlapped ends. The longitudinal bars are inserted inside the profile defined by the stirrups, at the design positions specified by the structural engineers, where they have to be suitably fixed, for example at the angles of such profile.

[0003] In order to improve the assembly accuracy and speed, are known automatic methods and apparatuses suited to realize a preliminary cage, usually called pre-cage or with similar words, constituted by the reinforcement stirrups and by disposable longitudinal auxiliary wires, not included in the structural design, which are usually welded externally in order to retain the stirrups of the cage to realize.

[0004] Only subsequently, or during the formation of the pre-cage, the longitudinal bars are inserted inside the pre-cage and fixed at the suitable design positions in order to obtain the desired structural geometry. The advantage of the use of the pre-cage consists in the fact that, for joining the reinforcement longitudinal bars, it is not necessary any more to fix all the bars at the crossings with all the stirrups to constitute a sufficiently rigid structure, but it is sufficient to hang the bars to the pre-cage, which is already itself a rigid structure. Consequently, thanks to this method, the fixing operations to effect are drastically reduced and the fixing accuracy is improved, thus increasing the total velocity with which the reinforcement cage is accomplished. Several patents are known, which illustrate how to produce such pre-cages, in particular the patent n° EP 0667195 B1 in the name of the Applicant and the patent EP 1101547 in the name of the company MEP S.p.A..

[0005] The Italian patent application UD2001A000055 (EP-A-1243358) in turn illustrates a device for the completion of reinforcement cages which enables to carry out the positioning of the longitudinal bars at the internal angles of the stirrups. This device comprises lifting ele-

ments which lift the pre-cage for overturning it partially and in succession on a supporting surface, so as to take each time a different angle to an operational position. However the cited device enables the positioning and the fixing of the longitudinal bars only at the angles of the stirrups and, moreover, does not carry out any automatic fixing of the bars.

[0006] Nevertheless, no matter the pre-cages are realized, even by using automatic apparatuses intended for their production, for completing the metal cages it is necessary to accomplish numerous manual operations, in particular for fixing the longitudinal bars to the stirrups at the design positions, even though at a reduced number of positions. In any case, such fixing operations, such as the binding, the welding, the glueing or any other jointing method, require considerable resources and always affect in a significant way the execution times, as they have to be effected manually or, at the most, with the aid of some tools.

[0007] In practice only the first part of the work has been successfully automated, that is the preparation of the pre-cage, while, on the contrary, the completion of the pre-cage with the longitudinal reinforcement bars has not been substantially automated yet.

[0008] In addition, a different technique is known for producing reinforcements for reinforced concrete, starting from electrowelded and suitably folded mesh, so as to constitute a pre-cage which, too, will have to be subsequently completed with longitudinal reinforcement bars, following the method previously described.

[0009] It is worth noting that one of the difficulties in the effort to automatically carry out the completion of the pre-cages through the fixing of the longitudinal reinforcement bars, is constituted by the fact that the elements in process are three-dimensional. Consequently it results very difficult to reach the fixing area through opposing operational tools, as, on the contrary, is the case, for example, while welding plane elements such as metal meshes and the like.

Disclosure of the invention

[0010] The aim of the present invention is to overcome the cited problems, by devising a method and an apparatus which enable to carry out the fixing of longitudinal reinforcement bars automatically, for the production of metal cages for reinforced concrete starting from a pre-cage.

[0011] Within this aim, it is a further scope of the present invention to provide for a method and an apparatus which make easier and speedier the fixing operations of the parts constituting the cited metal cages.

[0012] A further aim of the invention is to devise an apparatus for the completion of the pre-cages by the fixing of longitudinal reinforcement bars, which is of simple conception, reliable function and versatile use.

[0013] The cited aims are achieved according to the present invention by the method for the fixing metal struc-

tures, in particular metal cages of the type obtained starting from a metal pre-cage constituted by a series of stirrups suitably spaced out on substantially parallel planes, constrained to one longitudinal auxiliary wire at least, comprising the steps of:

[0014] (a). prearranging, along a fixing axis, contrasting means acting at selected fixing areas, suitably spaced out depending on the position of the selected stirrups to fix to longitudinal reinforcement bars in a position provided by the design and the relevant structural computation, for the completion of said cage;

[0015] (b). prearranging said metal pre-cage on a work surface, with at least one portion of the said stirrups to fix, positioned at said contrasting means;

[0016] (c). inserting inside said metal pre-cage a first longitudinal reinforcement bar at least, at said fixing axis, at the selected fixing areas where said contrasting means acts;

[0017] (d). tightening said first longitudinal reinforcement bar to said stirrups of the pre-cage in said design position through said contrasting means;

[0018] (e). carrying out the fixing of said first longitudinal reinforcement bar to said stirrups at said contrasting means through fixing means acting along a longitudinal axis at said work surface;

[0019] (f). translating said pre-cage transversally to the longitudinal axis on said work surface and / or rotating the same pre-cage in suitable phase relationship around an axis parallel to said longitudinal axis, for positioning said pre-cage in the position suitable for the fixing of further longitudinal reinforcement bars to said stirrups at a relevant further position provided by the design and the structural computation;

[0020] (g). inserting, in suitable phase relationship, the further longitudinal reinforcement bars provided by the design and the relevant structural computation inside said pre-cage;

[0021] (h). fixing all the longitudinal reinforcement bars to some of said stirrups at least, at said further positions provided by the design and the relevant structural computation, for completing the production of said cage.

Brief description of the drawings

[0022] Description details of the invention shall be further evident in the illustrations of a preferred embodiment of the apparatus for the completion of the pre-cages, by the fixing of the longitudinal reinforcement bars, illustrated in the guideline drawings attached, wherein:

[0023] fig. 1 illustrates a side view of the apparatus for fixing metal structures according to the invention;

[0024] fig. 2-12 respectively illustrate a detail view of the operational area of the claimed apparatus, at different operational steps;

[0025] fig. 13 illustrates a perspective exploded view of the fixing means intended for the use in the claimed apparatus;

[0026] fig. 14, 15, 16 and 17, 18, 19, 20 illustrate re-

spective front, side and perspective views of the same fixing means, at successive operational steps;

[0027] fig. 21, 22 and 23 respectively illustrate a perspective view, a front view and a side view of a different embodiment of said fixing means;

[0028] fig. 24, 25, 26 and 27, 28, 29 illustrate corresponding views of said fixing means at different operational steps,

[0029] fig. 30 illustrates a perspective view of the bench constituting the frame of the claimed apparatus.

Best mode for carrying out the invention

[0030] With reference to such figures, 1 refers to the apparatus for fixing metal structures according to the present invention. In particular the apparatus is suitable for carrying out the completion of pre-cages through the fixing, by welding, of longitudinal reinforcement bars for producing metal cages 2 for reinforced concrete (fig. 13). Obviously, it is also possible to use the apparatus 1 for carrying out the generic fixing of elements in structures of different material, size and use.

[0031] The metal cage 2 to produce is constituted by a series of longitudinal bars 4 usually positioned parallel and at prefixed distances from the longitudinal axis of the structure itself, internally fixed to a plurality of stirrups 3. The longitudinal reinforcement bars 4 are fixed to the stirrups 3 at respective design positions determined by the structural design.

[0032] In the figures, the stirrups 3 are represented closed for the sake of simplicity, but, actually, they commonly shape an open profile with overlapping ends. The apparatus 1 is suited to carry out the fixing of the longitudinal reinforcement bars 4, in some points at least, to a pre-cage 2a constituted by the stirrups 3 longitudinally spaced out and constrained to disposable longitudinal auxiliary wires 8.

[0033] The apparatus 1 is constituted by a work bench 6 suited to define a work surface 7 preferably horizontal, on which the pre-cage 2a is longitudinally prearranged, being the pre-cage 2a supported by respective sides of the stirrups 3. The work surface 7 can shape a front folding portion intended for facilitating the loading, unloading and handling operations of the pre-cage 2a. Moreover, the bench 6 preferably presents a series of recesses 60 suitably distributed along the edge, suited to enable an easy access of the operators for the execution of the manual operational steps (fig. 30).

[0034] The work bench 6 presents a longitudinal slit 9 along which suitably spaced fixing areas 10 are defined. At such fixing areas 10 are suited to act operational tools for the fixing to the stirrups 3 of the pre-cage 2a, of a reinforcement bar 4 prearranged in the suitable design position 5 of the cage 2, according to a fixing axis, as described in detail later on.

[0035] Such operational tools comprise a plurality of contrasting means 11 suitable for being positioned longitudinally along the slit 9, and mobile fixing means 12

suited to carry out, preferably in succession, the fixing operations required at the design positions 5.

[0036] The contrasting means 11 and the fixing means 12 are supported on the same side as to the pre-cage 2a, where the respective actuators are housed, too. In particular the contrasting means 11 is shaped so as to enter the volume of the pre-cage 2a, tighten the bar 4 against the stirrups 3 of the pre-cage 2a and, in case of need, disappear under the work surface 7, releasing the pre-cage 2a in order to avoid interference during the handling of the pre-cage 2a itself.

[0037] Once it is longitudinally positioned for a determined type of pre-cage, the contrasting means 11 remains in the selected positions. The contrasting means 11 is preferably constituted by couples of C-shaped contrasting elements aligned in longitudinal direction, so as to constitute a fork which defines a space suited to enable the interposition of a portion of the stirrup 3 to fix to the bar 4. The contrasting elements 11 present respective upper and lower end portions 13, 14 positioned orthogonally to respective intermediate portions 15 positioned in a substantial vertical way (fig. 13). The contrasting elements 11 are fixed to a vertical stem 16 sliding axially inside a short tube 17 sliding along a horizontal section bar 19 integral with the fixed framework 20 of the apparatus 1. The stem 16 is associated to drive means suited to operate its vertical sliding inside the short tube 17 for positioning the contrasting elements 11 at three positions:

a lowered position, inactive, at which the contrasting elements 11 are entirely below the work surface 7 (fig. 5), a lifted position, at which the respective upper end portions 13 project at a certain distance out of the work surface 7 (fig. 2), and an intermediate position, of contrasting, at which the said portions 13 project out of the work surface 7 by a distance substantially equal to the sum of the diameter of the iron rod constituting the stirrup 3 and the diameter of the longitudinal reinforcement bar 4 to fix (fig. 3). In practice, at the intermediate position, the contrasting elements 11 are suited to tighten the longitudinal reinforcement bar 4 between the portions 13 and the stirrups 3 leaning on the work surface 7.

[0038] The drive means of the contrasting elements 11 are preferably constituted by a linear actuator, not illustrated, suited to move a spar 18 having a longitudinal development substantially equal to that of the work surface 7, suited to contrast the stems 16 at a lower portion. In practice, the spar 18 is suited to contrast the lower end of the stems 16 in order to cause the lifting of all the contrasting elements 11 suitably distributed along the length of the apparatus. On the contrary, the lowering of the stems 16 is substantially produced by the gravity action acting on the contrasting elements 11 when the spar 18 is taken to the intermediate position and lowered.

[0039] The fixing means 12 are constituted by a first

and a second fixing element 22, 23 suited to cooperate with the contrasting elements 11 for the fixing of the longitudinal bar 4 to the stirrup 3 (fig. 13).

[0040] In the illustrated case, the first and second fixing element 22, 23 constitute a couple of overlapped electrodes suited to perform the desired junction through welding. The electrodes 22, which are conductive, preferably of a suitable copper alloy, are suitably connected to a power supplying device by means of suitable flexible conductors 24. The first electrode 22 shapes a flat upper face 25, through which it is suitable for intercepting the stirrup 3 by a lower portion during the welding phase. The second electrode 23 which is mounted below the first electrode 22, shapes a flat lower face 26 suited to contrast suitably the lower portions 14 of the contrasting elements 11 which, being operated by the electrode 23, transmit the polarity to the bar 4 and at the same time draw the bar 4 near the stirrup 3.

[0041] The electrodes 22, 23 are fitted mobile below the work surface 7. To be more precise, they are suited to be operated by respective linear actuators, not illustrated, in motion of translation according to opposite ways along the direction of the contact force. In this independent motion, the electrodes 22, 23 are suited to be guided by the guiding stems 27 provided at the upper portion of the second electrode 23 and inserted sliding axially in respective holes provided at a lower portion of the first electrode 22. To be more precise, the first electrode 22 is suited to be operated alternatively between a lowered configuration, inactive, at some distance from the stirrup 3 and a lifted configuration, active, whereat it is drawn near in contact with the stirrup 3 by the upper face 25. The second electrode 23 is suited to be operated in suitable phase relationship as to the first electrode 22, between a lifted configuration, inactive, and a lowered configuration, active, whereat the electrode contrasts by the lower face 26 the lower portions 14 of the contrasting elements 11 positioned, in turn, in the intermediate position for carrying out the welding of the stirrup 3 to the longitudinal bar 4.

[0042] The electrodes 22, 23, together with the operating actuators and the power supplying device, are fitted on a carriage 28 mobile in longitudinal direction. The carriage 28 is sliding through rolling means on guiding shanks 30 longitudinally extended as much as the apparatus 1 and integral with the fixed framework 20 beneath the work surface 7. The motion of the carriage 28 in longitudinal direction is controlled by operating means of known type through drive means, for example of flexible type through a chain wound around suitable gear wheels or through a wheel-rack coupling.

[0043] Near the electrodes 22, 23 are fitted sensors 40 (fig. 13), suited to detect, during the advance motion of the carriage 28, the reaching of the contrasting elements 11 positioned at the fixing areas 10. Such sensors 40 are suited to transmit suitable stop signals to the means operating the carriage 28. The sensors 40 provided are preferably two at least, on opposite sides of

the carriage 28 as to the direction of the motion, so as to signal usefully the reaching of the fixing area 10 in one way as well as in the opposite one.

[0044] The functioning of the apparatus for fixing metal structure according to the claimed method is described as follows.

[0045] Initially, the contrasting elements 11 have to be prearranged along a fixing longitudinal axis defined at the slit 9, being the contrasting elements 11 suitably spaced out depending on the position of the stirrups 3 to fix to the longitudinal reinforcement bars 4 in a position 5 provided by the design and the relevant structural computation, for the completion of the cage 2. To this aim the contrasting elements 11 are spaced each other by making the corresponding short tubes 17 slide along the section bar 19. At the work position, the contrasting elements 11 are suited to contrast the longitudinal reinforcement bars 4, by acting at the selected fixing areas 10.

[0046] Then the pre-cage 2a is prearranged on the work surface 7, leaning on respective horizontal sides of the stirrups 3, wherein the stirrups 3 are suitably positioned at respective contrasting elements 11 (fig. 1). To be more precise, the contrasting elements 11 are positioned so that the stirrups 3 of the pre-cage 2a to fix to the reinforcement bars 4 are substantially positioned in the middle of the fork defined by the contrasting elements 11 themselves.

[0047] Then a first longitudinal reinforcement bar 4 is inserted inside the stirrups 3, along the cited fixing axis. It is worth noting that, in order to easily insert such bar 4 inside the stirrups 3, the contrasting elements 11 are taken in this phase to the lifted position, suitably spaced from the work surface 7, while the pre-cage 2a is positioned at a position suitably advanced frontally to the contrasting elements 11, so as to be at some distance from the fixing area 10 (fig. 1).

[0048] After the insertion of the first longitudinal bar 4, the pre-cage 2a is pulled back so as to be positioned with the stirrups 3 close to the said bar 4 in the design position 5 (fig. 2). Advantageously, in order to make the work cycle easier, the first longitudinal bar 4 is fixed close to the inner lower corner of the vertical side turned to the gripping area of the hook-shaped contrasting elements 11, as illustrated. The cited moving back of the pre-cage 2a can be carried out manually or through suitable mechanical instruments.

[0049] So the prearranged pre-cage 2a lies with the first reinforcement bar 4 in the design position 5, aligned at respective fixing areas 10, and with the stirrups 3 to weld in the middle of each fork of the contrasting elements 11.

[0050] Then the contrasting elements 11 are lowered in the contrasting position so as to tighten suitably the longitudinal bar 4 to the stirrups 3 (fig. 3).

[0051] At this moment the fixing is carried out in sequence at the fixing positions 5.

[0052] The carriage 28 is operated in advance towards a first selected fixing area 10.. When the sensors 40 de-

tect the reaching of the corresponding contrasting elements 11, the carriage 28 stops for carrying out the desired fixing. The electrodes 22, 23, which are respectively in the inactive position, face the portions 13 and 14 of the contrasting elements 11 (fig. 14, 15 and 16). Subsequently the electrodes 22, 23 are operated in the active position and powered for transmitting the necessary fixing actions to the joint (fig. 17, 18, 19 and 20). In particular, to the joint are transmitted opposing contact forces and suitable amounts of current.

[0053] It is worth noting that no matter how the operational means is shaped and the diameter of the elements constituting the joint is, it is important that the fixing action is effected while substantially preserving the contact among the stirrups 3 of the pre-cage 2a and the work surface 7, that is while avoiding the lifting of the manufactured item and the production of undesired deformations, as well as the possible move of the bars 4 from the design positions 5. In particular the adopted solution reaches this aim thanks to the fact that the contrasting elements 11 push the joint against a reference surface constituted by the work surface 7 without requiring any external adjustment, setting or data input.

[0054] Once the junction is carried out according to the set execution parameters, the electrodes 22, 23 are taken back to the inactive position.

[0055] The carriage 28 is operated again in motion for reaching the second fixing area 10 aligned to the previous one in order to carry out the second fixing operation on the longitudinal bar 4.

[0056] The fixing operations are carried out in the same way at the remaining fixing areas 10 aligned along the longitudinal slit 9, in order to complete the fixing of the longitudinal bar 4 to the provided stirrups 3 of the pre-cage 2a.

[0057] It is worth noting that the pre-cage 2a and the bars 4 may have a longitudinal extension lower than the length of the work surface 7 or, anyway, the contrasting elements 11 actually used may be less than the ones provided on the apparatus 1. Therefore the device is usefully provided with suitable sensors able to recognize autonomously the end of the bar 4 in process, by detecting where the contrasting element 11 whereat the carriage 28 is positioned, in the event it does not contrast the bar 4, comes substantially in contact with the upper electrode under the gravity action, thus indicating the absence of the bar to weld without requiring any input relating to the length or the position of the bars themselves. Such recognition takes place even in case a stirrup 3 of the pre-cage 2a is actually in the contrasting element 11, but without any bar 4.

[0058] Once the welding of the first longitudinal bar 4 is completed, the contrasting elements 11 are operated to the lifted position in order to release the longitudinal bar 4 already fixed. So the pre-cage 2a can be translated on the work surface 7 transversally to its longitudinal axis and / or rotated in suitable phase relationship around an axis parallel to such longitudinal axis, in order to position

the stirrups 3 in the further positions 5 provided by the design and the structural computation, at the contrasting elements 11, and to fix the further longitudinal bars 4 to them.

[0059] For example, it is possible to translate the pre-cage 2a to an advanced position (fig. 5) so as to prearrange at the fixing axis the median stretch of the lower side of the stirrups 3 and to fix subsequently at such median stretch, according to the described way, a second longitudinal reinforcement bar 4 inserted inside the pre-cage 2a (fig. 6). To this aim, after releasing the first longitudinal bar 4, the contrasting elements 11 are shifted into the lowered position beneath the work surface 7 to avoid any interference with the auxiliary wires 8 of the pre-cage 2a (see fig. 5).

[0060] Subsequently the contrasting elements 11 are taken to the lifted position again in order to draw in to the new longitudinal bar 4 to fix, then lowered in the contrasting position to tighten the same bar 4.

[0061] In a similar way it is possible to insert and fix a third longitudinal bar 4 close to the lower inner corner of the vertical side opposite to the one carrying the first bar 4 (fig. 7 and 8).

[0062] It is to point out that the pre-cage 2a is advantageously translated forward to the gripping area of the contrasting elements 11, so as to enable the bar 4 just fixed to come out and move to the adjacent fixing position without interfering with the contrasting elements 11 themselves.

[0063] After fixing all longitudinal bars 4 belonging to the same side of the cage, the lower one in the illustrated case, the pre-cage 2a is rotated on the work surface 7 (fig. 9). It is to point out that, in order to carry out the capsizing of the pre-cage 2a, the previously fixed bar 4 advantageously acts as a pivot, being suitably retained by the contrasting elements 11 at the fixing axis.

[0064] The cage 2 is finally completed by proceeding with repeated cycles of handling the pre-cage 2a and fixing the longitudinal bars 4 provided by the structural computation (fig. 10, 11 and 12).

[0065] Once the cage 2 is finished, it is necessary to lift the contrasting elements 11, shift transversally the cage 2 for releasing the contrasting elements 11 from the bar 4 last fixed, take the contrasting elements 11 beneath the work surface 7 so as to prearrange a surface without obstacles and discharge the cage 2 by sliding it transversally on the surface 7.

[0066] So the claimed method and the apparatus which carries out the method reach the aim of fixing metal structure in a more automated way, in particular for the completion of metal cages for reinforced concrete, realized starting from a pre-cage.

[0067] Such result is achieved in particular thanks to the use of the mobile fixing means 12 which allows to operate the fixing of all longitudinal reinforcement bars 4 settled by the structural computation for a determined metal cage 2, by proceeding preferably in succession at the fixing positions 5. The fixing means 12 is preferably

mobile in longitudinal direction as to the work bench 6 as previously described. In particular, it is possible to provide for only one welding assembly which shifts in sequence at all the provided contrasting elements 11, carrying out the welding in a bidirectional way in order to optimize the execution times, or two or more welding assemblies which are mobile and coordinated each other.

[0068] Actually the claimed method and apparatus allow to carry out all the desired fixing operations in a very flexible way.

[0069] In the fig. 21, 22 and 23 a different embodiment for the fixing means 12 is illustrated, which provides for the use of two parallel electrodes 32, 33 moved by the same side, preferably upward. The first electrode 32 is suited to contrast the longitudinal reinforcement bar 4, while the second electrode 33 contrasts the stirrup 3. In this way, it is not necessary any more that the contrasting elements 11 are made of any expensive conductive material, thus gaining a considerable constructional economy.

[0070] According to a first embodiment the electrodes 32 and 33 are operated separately. In particular, at first both electrodes 32, 33 are moved upward till the first electrode 32 comes in contact with the reinforcement bar 4 (fig. 24, 25 and 26); in suitable phase relationship, only the second electrode 33 is operated till it comes in contact with the corresponding stirrup 3 of the junction (fig. 27, 28 and 29). Alternatively it is possible to provide for the simultaneous handling of both the electrodes 32 and 33, through a single actuator, by interposing one elastic element at least, in order to compensate for the different travel that the two electrodes must make. In the illustrated case the first electrode 32 is represented split in two prongs, but it is obviously possible to provide for an electrode shaped by only one element.

[0071] The claimed method and apparatus allow a notable reduction of the production costs for the metal cages, in particular thanks to the possibility of using only one fixing assembly or, anyway, a reduced number of fixing assemblies to join the reinforcement bars 4 to the stirrups 3.

[0072] A prerogative of the invention is constituted by the considerable speed in the execution of the fixing operations. In fact, the fixing means 12 is allowed to move forward at very high speed from a selected fixing area to the subsequent, thus reducing the idle times of the production cycle. Moreover, the sensors 40 suited to position the fixing means 12 correctly, guarantee the correct positioning of the same even when the carriage 28 carrying the fixing means itself goes at high speed. Such result is achieved also thanks to a plurality of contrasting elements 11 which allow an easy recognition of the welding area, since the fixing means 12 has not to identify the elements to fix directly, but limits itself to detect the presence of the contrasting elements 11 which are already at the selected joint to fix.

[0073] The contrasting elements 11, which are hook-shaped as illustrated, advantageously do not require any

type of steady electric or fluid dynamic connection for their functioning. Moreover the contrasting elements 11 are most suitably represented as a couple of elements positioned as a fork, but it is obviously possible to provide for them any other shape which enables to carry out the contrasting action behind the bar 4 at a position substantially corresponding to the stirrups 3 and to release the pre-cage in order to avoid any interference.

[0074] The cited contrasting elements are prearranged to grip the elements constituting the joint and this constitutes an advantage in comparison with different systems, according to which the contrasting elements are not prearranged, because it allows to gain the time necessary for the contrasting elements to go out, to be taken to the right position behind the bar, corresponding to the stirrup, and the time for the return travel after fixing.

[0075] An essential feature of the apparatus according to the present invention is the arrangement of the contrasting elements 11 as well as of the fixing means 12 on the same side and the possibility of releasing such contrasting elements 11 below the work surface 7. This feature is essential to carry out the fixing of a tri-dimensional handiwork such as a cage with closed profile, since it is essential not to have any obstacle to the handling of the handiwork itself during formation as well as to the aim of reaching the joints during the fixing phases. It is worth noting that in the known art constituted by the machines for the formation of electro-welded meshes, since two-dimensional handiworks have to be worked, on the contrary the operational tools are carried on opposite sides of the product in process, which so can freely slide in the middle and whose joints can be reached without any obstacle thanks to the kind of the product itself. Consequently such a known technique is not usable in case of tri-dimensional products, such as the mentioned cages.

[0076] It is to be noticed that the claimed apparatus allows the widest adjustment range for the positioning of all the tools intended for the fixing.

[0077] Another important prerogative is constituted by the advantage that no data entry is required, relating either to the thickness of the joint components, or to the position and the length of the bars to fix.

[0078] A further prerogative of the invention consists in the fact that the use of the apparatus by the operators results simple and secure, in particular thanks to the recesses 60 provided at the folding portion of the bench 6 and to the fact that the phase of drawing near the contrasting elements 11 to the joint to weld is obtained through the sole action of the force of gravity and consequently any risk connected to the crushing of the upper limbs is avoided.

[0079] Materials adopted for the actual realization of the invention, as well as their shapes and sizes, can be various, depending on the requirements.

[0080] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such

reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Method for fixing metal structures, in particular for the completion of metal cages (2) starting from a metal pre-cage (2a) constituted by a series of stirrups (3) suitably spaced out on substantially parallel planes, constrained to one auxiliary longitudinal wire (8) at least, **characterized in that** it comprises the phases of:

- (a). prearranging, along a fixing axis, contrasting means (11) acting at selected fixing areas (10) suitably spaced out depending on the position of the selected stirrups (3) to fix to longitudinal reinforcement bars (4) in a position provided by the design and the relevant structural computation, for the completion of said cage (2);
- (b). prearranging said metal pre-cage (2a) on a work surface (7), with at least one portion of said stirrups (3) to fix, positioned at said contrasting means (11);
- (c). inserting inside said metal pre-cage (2a) a first longitudinal reinforcement bar (4) at least, at said fixing axis, at said selected fixing areas (10) where the said contrasting means (11) acts;
- (d). tightening said first longitudinal reinforcement bar (4) to said stirrups (3) of the pre-cage (2a) at said design position through said contrasting means (11);
- (e). carrying out the fixing of said first longitudinal reinforcement bar (4) to said stirrups (3) at said contrasting means (11) through fixing means (12) acting along a longitudinal axis at said work surface (7);
- (f). translating said pre-cage (2a) transversally to the longitudinal axis on said work surface (7) and /or rotating the same pre-cage (2a) in suitable phase relationship around an axis parallel to said longitudinal axis, for positioning said pre-cage (2a) in the position suitable for the fixing of further longitudinal reinforcement bars (4) to said stirrups (3) at a relevant further position provided by the design and the relevant structural computation;
- (g). inserting, in suitable phase relationship, the further longitudinal reinforcement bars (4) provided by said design and the relevant structural computation inside said pre-cage (2a);
- (h). fixing all the longitudinal reinforcement bars (4) to some of said stirrups (3) at least, at said further positions of the design and the relevant structural computation, for completing the production of said cage (2).

2. Method according to claim 1, **characterized in that** during said phase of translation and /or rotation of the said pre-cage (2a) for the fixing of said bars (4), said contrasting means (11) is suited to be taken below said work surface (7) for enabling the overcoming of the auxiliary wires (8) of the same pre-cage (2a).
3. Method according to claim 1, **characterized in that** it provides for carrying out the shifting of said contrasting means (11) to operational positions at different levels as to said work surface (7).
4. Method according to claim 1, **characterized in that** it provides for carrying out the contrasting and the fixing of said longitudinal reinforcement bars (4) to said stirrups (3) through contrasting and fixing means (11, 12) carried on the same side as to said pre-cage (2a), so as to enable to enter the volume of said pre-cage (2a), tighten said bar (4) against said stirrups (3) of the pre-cage (2a) and disappear below the work surface (7), releasing said pre-cage (2a) in order to avoid interference during the handling of the pre-cage (2a).
5. Apparatus for fixing metal structures, in particular for the completion of metal cages (2) starting from a metal pre-cage (2a) constituted by a series of stirrups (3) suitably spaced out on substantially parallel planes, constrained to a longitudinal auxiliary wire (8) at least, **characterized in that** it comprises a work surface (7) whereon said pre-cage (2a) is suited to be prearranged; a plurality of selected fixing areas (10) defined along said work surface (7) and lined up along a longitudinal axis for the fixing of said stirrups (3) to one of said longitudinal reinforcement bars (4); contrasting means (11) suited to contrast said longitudinal bar (4) in a design position (5) wherein said bar (4) has to be fixed to said stirrups (3) of the pre-cage (2a), corresponding to said selected fixing areas (10) wherein said contrasting means (11) acts; fixing means (12) suited to cooperate with said contrasting means (11) in order to carry out the fixing of said longitudinal bar (4) to said stirrups (3).
6. Apparatus according to claim 5, **characterized in that** said fixing means (12) is mobile longitudinally to said work surface (7).
7. Apparatus according to claim 5 or 6, **characterized in that** said fixing means (12) is provided with a bidirectional work travel along said work surface (7), so as to carry out said phase of fixing said bars (4) to said stirrups (3) in both ways.
8. Apparatus according to claim 5, **characterized in that** it provides for a plurality of said contrasting means (11) prearranged longitudinally to said work surface (7) respectively at said fixing areas (10).
9. Apparatus according to claim 5 or 8, **characterized in that** said contrasting means (11) is mobile between a lowered release position below said work surface (7), a lifted position above said work surface (7) at such a level as to enable the free insertion of the joint constituted by said stirrup (3) and said reinforcement bar (4), and an intermediate position contrasting said joint, in order to cooperate with said fixing.
10. Apparatus according to claim 5 or 8, **characterized in that** said contrasting means (11) and said fixing means (12) are carried on the same side as to the pre-cage (2a), so as to enter the volume of said pre-cage (2a), tighten said bar (4) against said stirrups (3) of the pre-cage (2a) and disappear below said work surface (7), releasing the pre-cage (2a) in order to avoid interference with the auxiliary wires (8) during the handling of said pre-cage (2a).
11. Apparatus according to claim 5, **characterized in that** said contrasting means (11) is suited to push the joint constituted by said longitudinal bar (4) and by said stirrup (3) against a reference surface constituted by said work surface (7), so as to tighten the joint itself independently from the diameter of said longitudinal bar (4) and of said stirrup (3) and to continue tightening spontaneously even when the diameter changes during the fixing phase, without causing undesired deformations or shifting of the said elements constituting the joint.
12. Apparatus according to claim 5 or 8, **characterized in that** said contrasting means (11) is fork-shaped so as to define a space suited to allow the interposition of a portion of said stirrup (3) to fix to said longitudinal reinforcement bar (4).
13. Apparatus according to claim 5 or 9, **characterized in that** said contrasting means (11) presents upper and lower end portions (13, 14) positioned substantially orthogonal to an intermediate portion (15) and suited to contrast the joint to fix with said upper portion (13) and said fixing means (12) with said lower portion (14).
14. Apparatus according to claim 5 or 13, **characterized in that** said contrasting means (11) is made with a conductive material.
15. Apparatus according to claim 5, **characterized in that** said fixing means (12) comprises a first fixing tool (22), suited to contrast said stirrup (3) at an upper portion at said design position (5), and a second fixing tool (23) suited to contrast at a lower portion said

contrasting means (11) for the fixing of said longitudinal bar (4) to said stirrup (3).

16. Apparatus according to claim 15, **characterized in that** said first and second fixing tool (22, 23) constitute respective electrodes suitably powered by a power supplying device. 5
17. Apparatus according to claim 5, **characterized in that** said fixing means (12) comprises a first electrode (32) and a second electrode (33) parallel each other, suited to be operated on the same side, preferably upwards, so as to contrast respectively said longitudinal reinforcement bar (4) and said stirrup (3) constituting the joint to fix in the selected fixing area (10). 10
18. Apparatus according to claim 17, **characterized in that** said first and second electrode (32, 33) are suited to be operated simultaneously by a single actuator, by the interposition of elastic means suited to compensate for the different travel of the electrodes (32, 33) themselves. 15
19. Apparatus according to claim 5, **characterized in that** said fixing means (12) is provided with sensors (40) suited to detect the presence of said contrasting means (11) during the bidirectional advance motion along said work surface (7). 20
20. Apparatus according to claim 5, **characterized in that** it comprises sensors suited to automatically recognize the end of said longitudinal bars (4) in process, by detecting that the contrasting means (11) whereat said fixing means (12) is positioned, in case it doesn't contrast the bar (4) itself, comes substantially in contact with said fixing means (12) due to gravity, thus indicating the absence of said bar (4) to fix with no need of any data entry relating to the length or the position of the bars (4) themselves. 25

Patentansprüche

1. Verfahren zum Befestigen von Metallkonstruktionen, insbesondere zum Fertigstellen von Körben (2) aus Metall ausgehend von einem Vorkorb (2a) aus Metall, der aus einer Reihe von Bügeln (3) besteht, die in im Wesentlichen parallelen Ebenen mit einem geeigneten Abstand angeordnet sind und von mindestens einem längsverlaufenden Hilfsbindendraht (8) fixiert werden, **dadurch gekennzeichnet, dass** es die folgenden Phasen vorsieht: 30
- a. Vorbereiten längs einer Befestigungsachse von in Entsprechung mit vorbestimmten Befestigungszonen (10) wirkenden Anschlagmitteln (11), die in Abhängigkeit von der Position der 35

vorbestimmten Bügel (3) angemessen beabstandet sind, die an Längsbewehrungsstäben (4) in einer vom Projekt und der zugehörigen Strukturberechnung vorgesehenen Position (5) zum Fertigstellen des Korbs (2) zu befestigen sind;

b. Vorbereiten auf einer Arbeitsfläche (7) des Vorkorbs (2a) aus Metall, wobei mindestens ein Abschnitt der zu befestigenden Bügel (3) in Entsprechung mit den Anschlagmitteln (11) angeordnet ist;

c. Einführen in den Vorkorb (2a) aus Metall von mindestens einem ersten Längsbewehrungsstab (4) in Entsprechung mit der Befestigungsachse in Übereinstimmung mit den vorbestimmten Befestigungszonen (10), in denen die Anschlagmittel (11) wirken;

d. Klemmen des ersten Längsbewehrungsstab (4) auf die Bügel (3) des Vorkorbs (2a) in der vom Projekt vorgesehenen Position (5) mit Hilfe der Anschlagmittel (11);

e. Ausführen der Befestigung des ersten Längsbewehrungsstabs (4) an den Bügeln (3) auf Höhe der Anschlagmittel (11) mit Hilfe von Befestigungsmitteln (12), die längs einer Längsachse in Entsprechung mit der Arbeitsfläche (7) wirken;

f. Verschieben des Vorkorbs (2a) quer zur Längsachse auf der Arbeitsfläche (7) und/oder Drehen in einer geeigneten Phasenbeziehung des Vorkorbs (2a) um eine zu dieser Längsachse parallelen Achse, um den Vorkorb (2a) in der zum Befestigen weiterer Längsbewehrungsstäbe (4) an den Bügeln (3) in einer entsprechenden weiteren vom Projekt und der zugehörigen Strukturberechnung vorgesehenen Position geeigneten Position anzuordnen; 35

g. Einführen in einer geeigneten Phasenbeziehung der weiteren vom Projekt und der zugehörigen Strukturberechnung vorgesehenen Längsbewehrungsstäbe (4) in den Vorkorb (2a);

h. Befestigen aller Längsbewehrungsstäbe (4) an mindestens einem Teil der Bügel (3) in den weiteren vom Projekt und der zugehörigen Strukturberechnung vorgesehenen Positionen, um die Herstellung des Korbs zu vervollständigen. 40

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Anschlagmittel (11) während der Phase der Verschiebung und/oder Drehung des Vorkorbs (2a) für die Befestigung der Bügel (4) unter die Arbeitsfläche (7) gebracht werden können, um das Überwinden der Hilfsbindendrähte (8) des Vorkorbs (2a) zu ermöglichen. 45
3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es das Verstellen der Anschlagmittel 50

- (11) in Arbeitspositionen vorsieht, die sich auf verschiedenen Höhen bezogen auf die Arbeitsfläche (7) befinden.
4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es das Anschlagen und Befestigen der Längsbewehrungsstäbe (4) an den Bügel (3) mit Hilfe von Anschlag- und Befestigungsmitteln (11, 12) vorsieht, die auf einer selben Seite des Vorkorbs (2a) gelagert sind, so dass sie in das Volumen des Vorkorbs (2a) eintreten, den Stab (4) gegen die Bügel (3) des Vorkorbs (2a) spannen und unter die Arbeitsfläche (7) versenkt werden können, wodurch sie sich aus dem Vorkorb (2a) zurückziehen, um während der Handhabung des Vorkorbs (2a) nicht zu stören.
5. Vorrichtung zum Befestigen von Metallkonstruktionen, insbesondere zum Fertigstellen von Körben (2) aus Metall ausgehend von einem Vorkorb (2a) aus Metall, der aus einer Reihe von Bügeln (3) besteht, die in im Wesentlichen parallelen Ebenen mit einem geeigneten Abstand angeordnet sind und von mindestens einem längsverlaufenden Hilfsbindedraht (8) fixiert werden, **dadurch gekennzeichnet, dass** sie umfasst,
- eine Arbeitsfläche (7) auf der der Vorkorb (2a) vorgesehen werden kann;
 - eine Vielzahl von längs der Arbeitsfläche (7) festgelegten und entlang einer Längsachse gefluchteten vorbestimmten Befestigungszonen (10) für die Befestigung der Bügel (3) an einem der Längsbewehrungsstäbe (4);
 - Anschlagmittel (11), die geeignet sind, in einer vom Projekt vorgesehenen Position (5) an den Längsstab (4) anzugreifen, in welcher der Stab (4) an den Bügeln (3) des Vorkorbs (2a) in Übereinstimmung mit den vorbestimmten Befestigungszonen (10) befestigt werden muss, in denen die Anschlagmittel (11) wirken;
 - Befestigungsmittel (12), die geeignet sind, mit den Anschlagmitteln (11) zusammenzuarbeiten, um die Befestigung des Längsstabs (4) an den Bügel (3) auszuführen.
6. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Befestigungsmittel (12) längs zur Arbeitsfläche (7) beweglich sind.
7. Vorrichtung nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** die Befestigungsmittel (12) über einen bidirektionalen Arbeitsweg längs der Arbeitsfläche (7) verfügen, so dass sie die Phase der Befestigung der Stäbe (4) an den Bügeln (3) in beiden Verfahrrichtungen ausführen können.
8. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** sie eine Vielzahl der Anschlagmittel
- (11) vorsieht, die jeweils längs zur Arbeitsfläche (7) in Übereinstimmung mit den Befestigungszonen (10) angeordnet sind.
9. Vorrichtung nach Anspruch 5 oder 8, **dadurch gekennzeichnet, dass** die Anschlagmittel (11) zwischen einer abgesenkten Rückzugsstellung unterhalb der Arbeitsfläche (7), einer auf eine Höhe, die das unbehinderte Einführen der aus dem Bügel (3) und dem Bewehrungsstab (4) bestehenden Verbindung ermöglicht, über die Arbeitsfläche (7) angehobenen Stellung und einer dazwischen liegenden Eingriffsstellung dieser Verbindung bewegt werden können, um an der Befestigung mitzuwirken.
10. Vorrichtung nach Anspruch 5 oder 8, **dadurch gekennzeichnet, dass** die Anschlagmittel (11) und die Befestigungsmittel (12) auf einer selben Seite des Vorkorbs (2a) gelagert sind, so dass sie in das Volumen des Vorkorbs (2a) eintreten, den Stab (4) gegen die Bügel (3) des Vorkorbs (2a) spannen und unter die Arbeitsfläche (7) versenkt werden können, wodurch sie sich aus dem Vorkorb (2a) zurückziehen, um während der Handhabung des Vorkorbs (2a) nicht mit den Hilfsbindedrähten (8) zu kollidieren.
11. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Anschlagmittel (11) geeignet sind, die aus dem Längsstab (4) und dem Bügel (3) bestehende Verbindung im Anschlag gegen eine Referenzfläche zu drücken, die in der Arbeitsfläche (7) besteht, um die Verbindung unabhängig vom Durchmesser des Längsstabs (4) und des Bügels (3) einzuspannen und diese Einspannung selbsttätig auch dann aufrechtzuerhalten, wenn sich dieser Durchmesser während der Befestigungsphase ändert, ohne unerwünschte Verformungen oder Verschiebungen der Elemente zu bewirken, aus denen die Verbindung besteht.
12. Vorrichtung nach Anspruch 5 oder 8, **dadurch gekennzeichnet, dass** die Anschlagmittel (11) gabelförmig gestaltet sind, so dass sie einen Raum definieren, der geeignet ist, das Einfügen eines Abschnitts des an dem Längsbewehrungsstab (4) zu befestigenden Bügels (3) zu ermöglichen.
13. Vorrichtung nach Anspruch 5 oder 9, **dadurch gekennzeichnet, dass** die Anschlagmittel (11) einen oberen und einen unteren Endabschnitt (13, 14) aufweisen, die im Wesentlichen rechtwinklig zu einem Zwischenabschnitt (15) angeordnet und geeignet sind, mit dem oberen Abschnitt (13) an der zu befestigende Verbindung und mit dem unteren Abschnitt (14) an den Befestigungsmitteln (12) anzuschlagen.
14. Vorrichtung nach Anspruch 5 oder 13, **dadurch ge-**

kennzeichnet, dass die Anschlagmittel (11) aus einem leitenden Material ausgeführt sind.

15. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Befestigungsmittel (12) ein erstes Befestigungselement (22), das geeignet ist, oben in Entsprechung mit der vom Projekt vorgesehenen Position (5) am Bügel (3) anzuschlagen, und ein zweites Befestigungselement (23) umfassen, das geeignet ist, für die Befestigung des Längsstabs (4) am Bügel (3) unten in die Anschlagmittel (11) einzugreifen.
16. Vorrichtung nach Anspruch 15, **dadurch gekennzeichnet, dass** das erste und das zweite Befestigungselement (22, 23) jeweilige Elektroden bilden, die von einer Einrichtung für die Versorgung mit elektrischer Energie angemessen gespeist werden.
17. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Befestigungsmittel (12) eine erste Elektrode (32) und eine zweite Elektrode (33) umfassen, die zueinander parallel und geeignet sind, auf einer selben Seite und vorzugsweise von unten nach oben betätigt zu werden, so dass sie an dem Längsbewehrungsstab (4) beziehungsweise dem Bügel (3) angreifen, welche die Verbindung bilden, die in der vorbestimmten Befestigungszone (10) zu befestigen ist.
18. Vorrichtung nach Anspruch 17, **dadurch gekennzeichnet, dass** die erste und die zweite Elektrode (32, 33) geeignet sind, von einem einzigen Aktuatorelement mittels Einfügung von elastischen Mitteln gleichzeitig betätigt zu werden, welche den unterschiedlichen Ausschlag der Elektroden (32, 33) ausgleichen.
19. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Befestigungsmittel (12) über Sensorelemente (40) verfügen, die geeignet sind, das Vorhandensein der Anschlagmittel (11) während der bidirektionalen Vorschubbewegung längs der Arbeitsfläche (7) festzustellen.
20. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** sie Sensorelemente umfasst, die geeignet sind, eigenständig das Ende der in Bearbeitung befindlichen Längsstäbe (4) zu erkennen, indem sie feststellen, dass sich die Anschlagmittel (11), auf denen sich die Befestigungsmittel (12) positioniert haben, falls sie nicht am Stab (4) angreifen, aufgrund der Schwerkraft im Wesentlichen in Kontakt mit den Befestigungsmitteln befinden, und so auf das Fehlen des zu befestigenden Stabs (4) hinweisen, ohne dass Daten bezüglich der Länge und der Position der Stäbe (4) eingegeben werden müssen.

Revendications

1. Méthode pour la fixation de structures métalliques, en particulier pour compléter des cages (2) métalliques à partir d'une ébauche de cage (2a) constituée d'une série d'étriers (3) convenablement espacés sur des plans essentiellement parallèles, liés par au moins un fil longitudinal auxiliaire (8), **caractérisée en ce qu'elle comprend les étapes de :**
- a. prédisposer, le long d'un axe de fixation, des moyens de contraste (11) agissant au niveau de zones de fixation (10) sélectionnées convenablement espacées en fonction de la position des étriers (3) à fixer sélectionnés à des barres longitudinales (4) d'armature dans une position prévue par le projet et relatif calcul structurel, pour compléter ladite cage (2) ;
- b. prédisposer ladite ébauche de cage (2a) métallique sur un plan de travail (7), avec au moins une portion desdits étriers (3) à fixer, positionnée au niveau desdits moyens de contraste (11) ;
- c. introduire à l'intérieur desdites ébauches de cage (2a) métallique au moins une première barre longitudinale (4) d'armature, au niveau desdits axes de fixation, en coïncidence avec lesdites zones de fixations (10) sélectionnées où agissent lesdits moyens de contraste (11) ;
- d. serrer ladite première barre longitudinale (4) d'armature auxdits étriers (3) de l'ébauche de cage (2a) au niveau de ladite position de projet au moyen desdits moyens de contraste (11) ;
- e. opérer la fixation de ladite première barre longitudinale (4) d'armature auxdits étriers (3) au niveau desdits moyens de contraste (11) au moyen de moyens de fixation (12) agissant le long d'un axe longitudinal au niveau dudit plan de travail (7) ;
- f. transférer ladite ébauche de cage (2a) transversalement à l'axe longitudinal sur ledit plan de travail (7) et/ou faire tourner la même ébauche de cage (2a) dans une relation de phase appropriée autour d'un axe parallèle audit axe longitudinal, pour le positionnement de ladite ébauche de cage (2a) dans la position propre à la fixation d'ultérieures barres longitudinales (4) d'armature auxdits étriers (3) au niveau d'ultérieures positions relatives prévues par le projet et relatif calcul structurel ;
- g. introduire, dans une relation de phase appropriée, les ultérieures barres longitudinales (4) d'armature prévues par lesdits projet et relatif calcul structurel à l'intérieur de ladite ébauche de cage (2a) ;
- h. fixer toutes les barres longitudinales (4) d'armature à au moins une partie desdits étriers (3), au niveau desdites ultérieures positions du projet et relatif calcul structurel, pour compléter la

- production de ladite cage (2).
2. Méthode selon la revendication 1, **caractérisée en ce que** durant ladite étape de translation et/ou rotation de ladite ébauche de cage (2a) pour la fixation desdites barres (4), lesdits moyens de contraste (11) sont propres à être portés en dessous dudit plan de travail (7) pour permettre le dépassement des fils auxiliaires (8) de la même ébauche de cage (2a). 5
 3. Méthode selon la revendication 1, **caractérisée en ce qu'elle** prévoit d'opérer le déplacement desdits moyens de contraste (11) vers des positions opérationnelles à différents niveaux par rapport audit plan de travail (7). 10
 4. Méthode selon la revendication 1, **caractérisée en ce qu'elle** prévoit d'opérer le contraste et la fixation desdites barres longitudinales (4) d'armature auxdits étriers (3) au moyen de moyens de contraste et de fixation (11, 12) portés du même côté que ladite ébauche de cage (2a), de manière à permettre d'entrer dans le volume de ladite ébauche de cage (2a), serrer ladite barre (4) contre lesdits étriers (3) de l'ébauche de cage (2a) et disparaître en dessous du plan de travail (7), en relâchant ladite ébauche de cage (2a) dans le but d'éviter une interférence pendant la manipulation de l'ébauche de cage (2a). 20 25
 5. Appareil pour la fixation de structures métalliques, en particulier pour compléter des cages (2) métalliques à partir d'une ébauche de cage (2a) métallique constitué d'une série d'étriers (3) convenablement espacés sur des plans essentiellement parallèles, liés à au moins un fil longitudinal auxiliaire (8), **caractérisé en ce qu'il** comprend 30 35
 - un plan de travail (7) sur lequel est propre à être disposée ladite ébauche de cage (2a) ;
 - une pluralité de zones de fixation (10) sélectionnées définies le long dudit plan de travail (7) et alignées le long d'un axe longitudinal pour la fixation de dits étriers (3) à au moins une desdites barres longitudinales (4) d'armature ;
 - des moyens de contraste (11) propres à contraster lesdits barres longitudinales (4) dans une position de projet (5) dans laquelle ladite barre (4) doit être fixée auxdits étriers (3) de l'ébauche de cage (2a), correspondant auxdites zones de fixation (10) sélectionnées dans lesquelles lesdits moyens de contraste agissent ;
 - des moyens de fixation (12) propres à coopérer avec lesdits moyens de contraste (11) dans le but d'opérer la fixation de ladite barre longitudinale (4) auxdits étriers (3). 40 45 50
 6. Appareil selon la revendication 5, **caractérisé en ce que** les moyens de fixation (12) sont mobiles en di- 55
 - rection longitudinale par rapport audit plan de travail (7).
 7. Appareil selon la revendication 5 ou 6, **caractérisé en ce que** lesdits moyens de fixation (12) sont pourvus d'une course de travail bidirectionnelle le long dudit plan de travail (7), de manière à opérer ladite étape de fixation desdites barres (4) auxdits étriers (3) dans les deux sens.
 8. Appareil selon la revendication 5, **caractérisé en ce qu'il** prévoit une pluralité de dits moyens de contraste (11) prédisposés en direction longitudinale par rapport audit plan de travail (7) respectivement au niveau desdites zones de fixation (10).
 9. Appareil selon la revendication 5 ou 8, **caractérisé en ce que** lesdits moyens de contraste (11) sont mobiles entre une position de désengagement abaissée en dessous dudit plan de travail (7), une position soulevée au dessus dudit plan de travail (7) à un niveau tel qu'il permet l'introduction libre du joint constitué par ledit étrier (3) et ladite barre (4) d'armature, et une position intermédiaire contrastant ledit joint, dans le but de coopérer avec ladite fixation.
 10. Appareil selon la revendication 5 ou 8, **caractérisé en ce que** lesdits moyens de contraste (11) et lesdits moyens de fixation (12) sont portés sur le même côté que l'ébauche de cage (2a), de manière à entrer dans le volume de ladite ébauche de cage (2a), serrer ladite barre (4) contre lesdits étriers (3) de l'ébauche de cage (2a) et disparaître en dessous dudit plan de travail (7), en relâchant l'ébauche de cage (2a) pour éviter une interférence avec les fils auxiliaires (8) durant la manipulation de ladite ébauche de cage (2a).
 11. Appareil selon la revendication 5, **caractérisé en ce que** lesdits moyens de contraste (11) sont propres à pousser le joint constitué par ladite barre longitudinale (4) et par ledit étrier (3) contre une surface de référence constitué par ledit plan de travail (7), de manière à serrer le joint lui-même indépendamment du diamètre de ladite barre longitudinale (4) et dudit étrier (3) et à continuer de serrer spontanément même quand le diamètre change pendant l'étape de fixation, sans causer de déformations ou déplacements non désirés desdits éléments constituant le joint.
 12. Appareil selon la revendication 5 ou 8, **caractérisé en ce que** lesdits moyens de contraste (11) ont une forme de fourche de manière à définir un espace propre à permettre l'interposition d'une portion dudit étrier (3) à fixer à ladite barre longitudinale (4) d'armature.

13. Appareil selon la revendication 5 ou 9, **caractérisé en ce que** lesdits moyens de contraste (11) présentent des portions finales supérieure et inférieure (13, 14) en position essentiellement orthogonale à une portion intermédiaire (15) et propres à contraster le joint à fixer avec ladite portion supérieure (13) et lesdits moyens de fixation (12) avec ladite portion inférieure (14). 5
14. Appareil selon la revendication 5 ou 13, **caractérisé en ce que** lesdits moyens de contraste (11) sont faits d'un matériau conducteur. 10
15. Appareil selon la revendication 5, **caractérisé en ce que** lesdits moyens de fixation (12) comprennent un premier organe de fixation (22), propre à contraster ledit étrier (3) au niveau d'une portion supérieure en coïncidence avec ladite position de projet (5), et un second organe de fixation (23) propre à contraster au niveau d'une portion inférieure lesdits moyens de contraste (11) pour la fixation de ladite barre longitudinale (4) audit étrier (3). 15
20
16. Appareil selon la revendication 15, **caractérisé en ce que** lesdits premier et second organes de fixation (22, 23) constituent de respectives électrodes convenablement alimentées par un dispositif d'alimentation en énergie électrique. 25
17. Appareil selon la revendication 5, **caractérisé en ce que** lesdits moyens de fixation (12) comprennent une première électrode (32) et une seconde électrode (33) parallèles l'une à l'autre, propres à être actionnées du même côté, préférablement vers le haut, de manière à contraster respectivement ladite barre longitudinale (4) d'armature et ledit étrier (3) constituant le joint à fixer dans la zone de fixation (10) sélectionnée. 30
35
18. Appareil selon la revendication 17, **caractérisé en ce que** lesdites première et seconde électrodes (32, 33) sont propres à être actionnées simultanément par un seul actuateur, par l'interposition de moyens élastiques propres à compenser la course différente des électrodes elles-mêmes. 40
45
19. Appareil selon la revendication 5, **caractérisé en ce que** lesdits moyens de fixation (12) sont pourvus de capteurs (40) propres à détecter la présence desdits moyens de contraste (11) durant le mouvement d'avancement bidirectionnel le long dudit plan de travail (7). 50
20. Appareil selon la revendication 5, **caractérisé en ce qu'il** comprend des capteurs propres à reconnaître automatiquement la fin desdites barres longitudinales (4) en élaboration, en relevant que les moyens de contraste (11) au niveau desquels sont positionnés les moyens de fixation (12), au cas où ils ne contrastent pas la barre (4) elle-même, vient essentiellement au contact desdits moyens de fixation (12) du fait de la gravité, indiquant ainsi l'absence de ladite barre (4) à fixer sans devoir entrer aucune donnée relative à la longueur ou la position des barres (4) elles-mêmes. 55

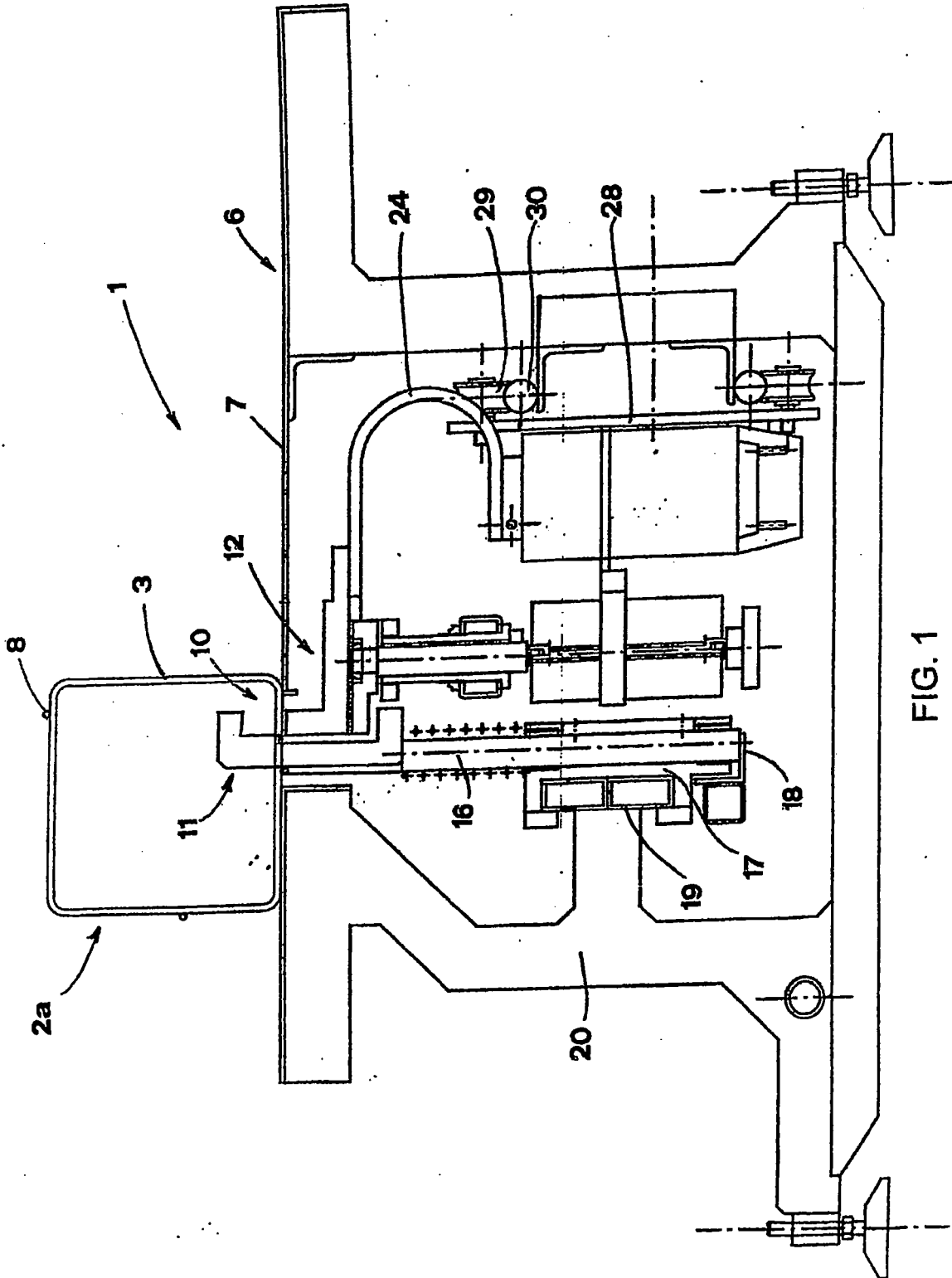


FIG. 1

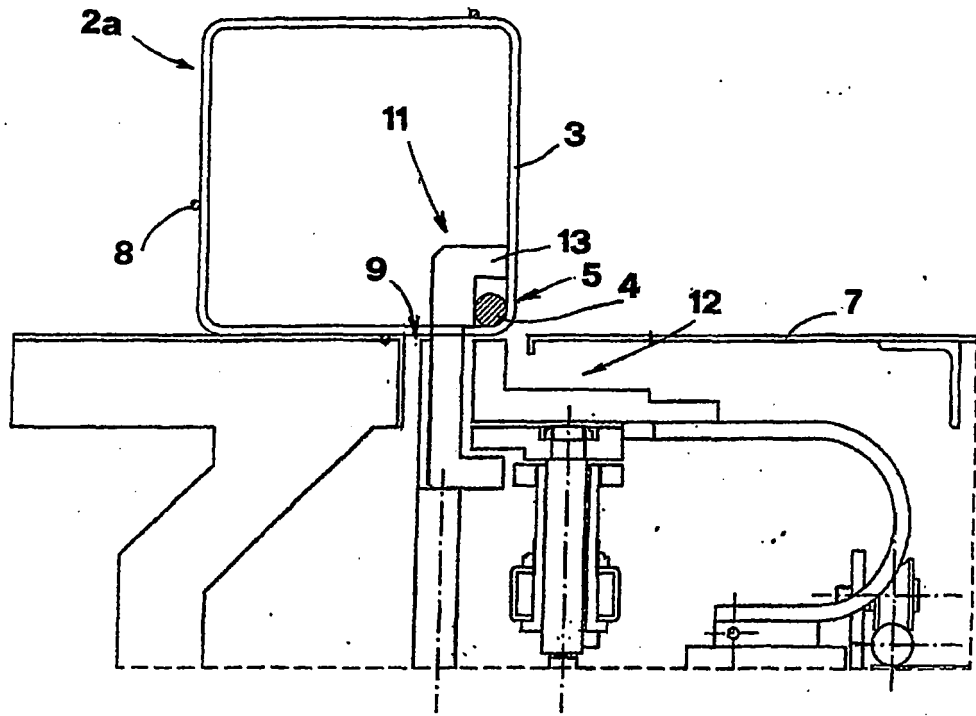


FIG. 2

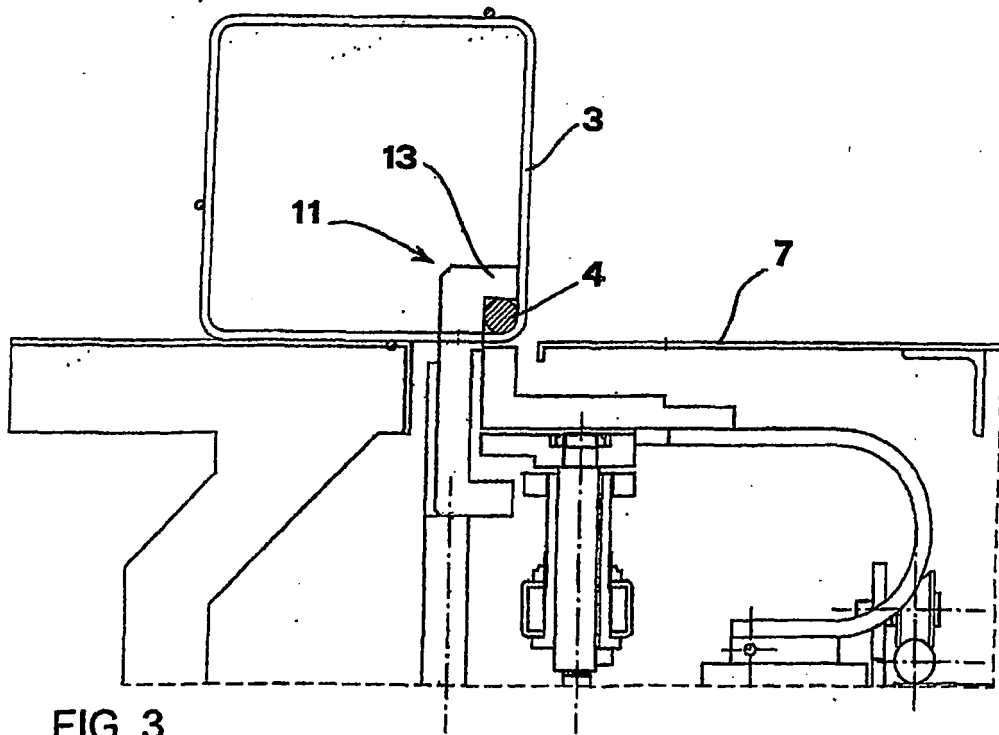


FIG. 3

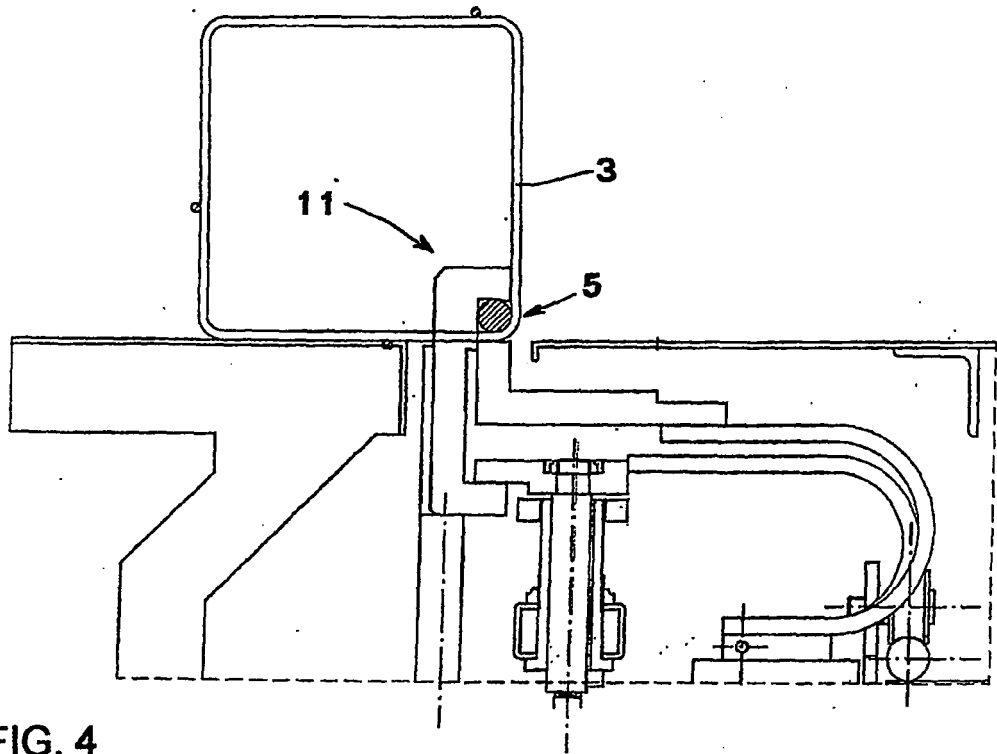


FIG. 4

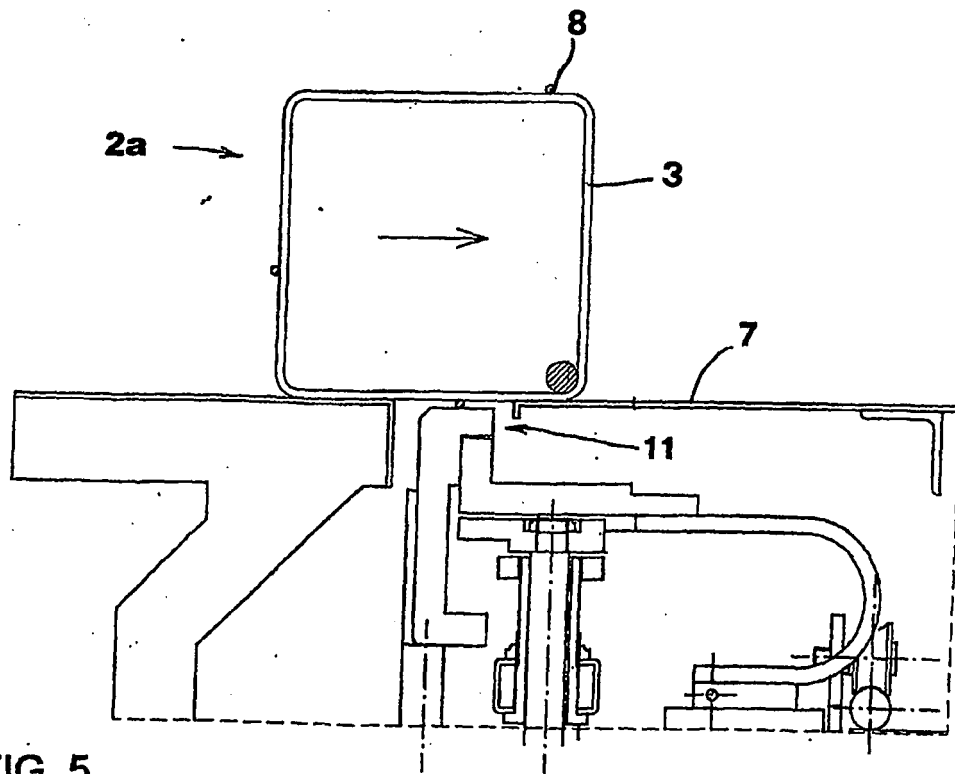


FIG. 5

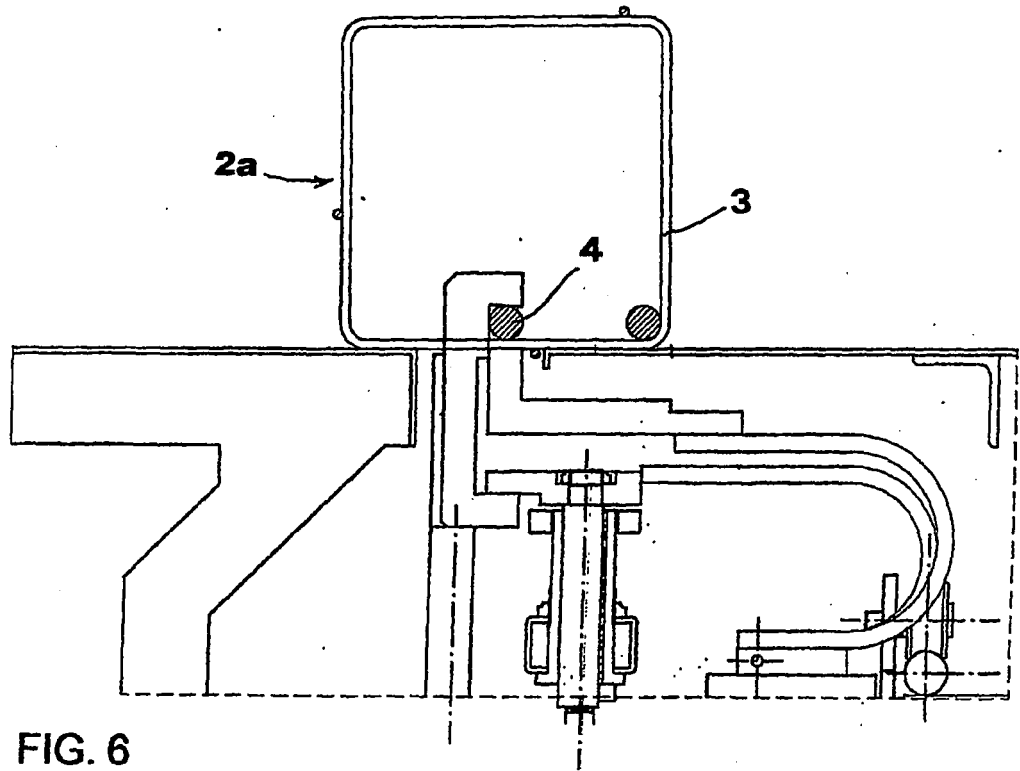


FIG. 6

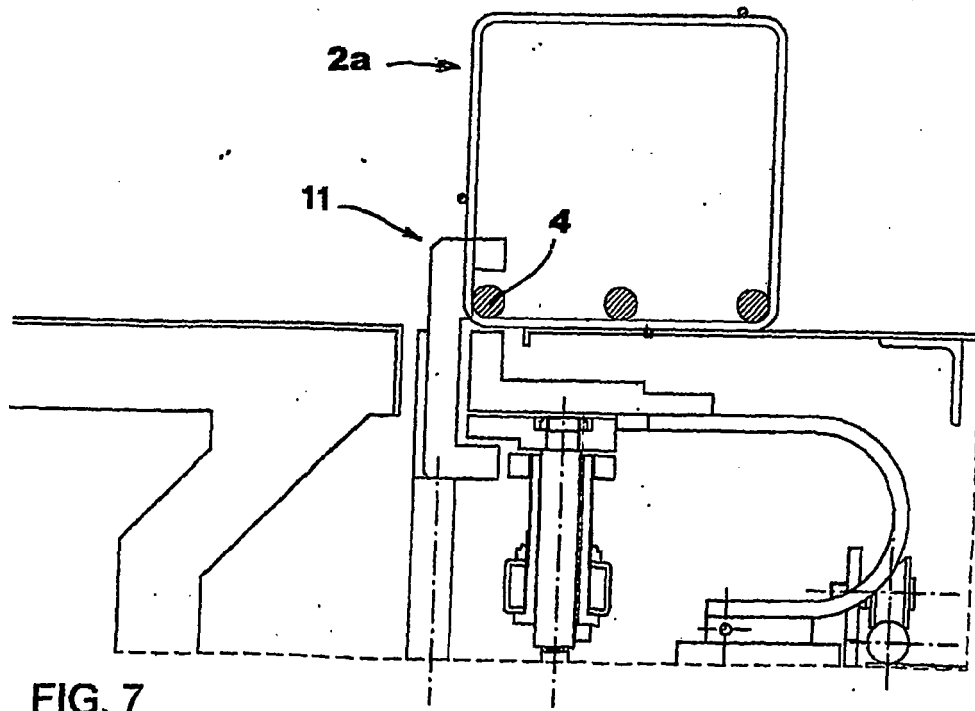


FIG. 7

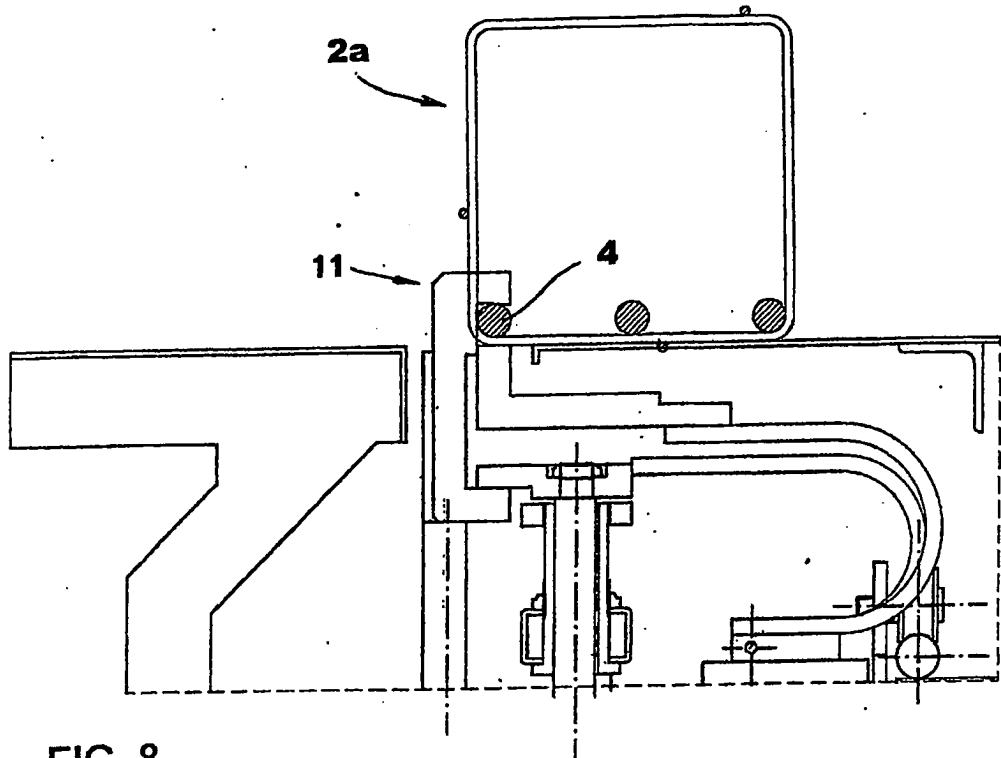


FIG. 8

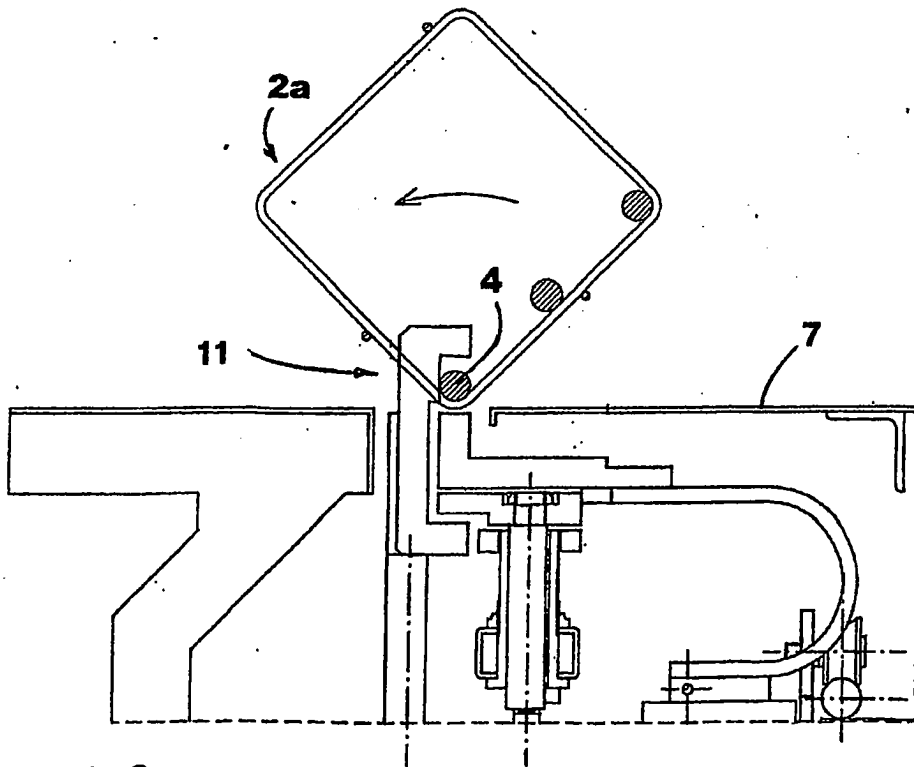


FIG. 9

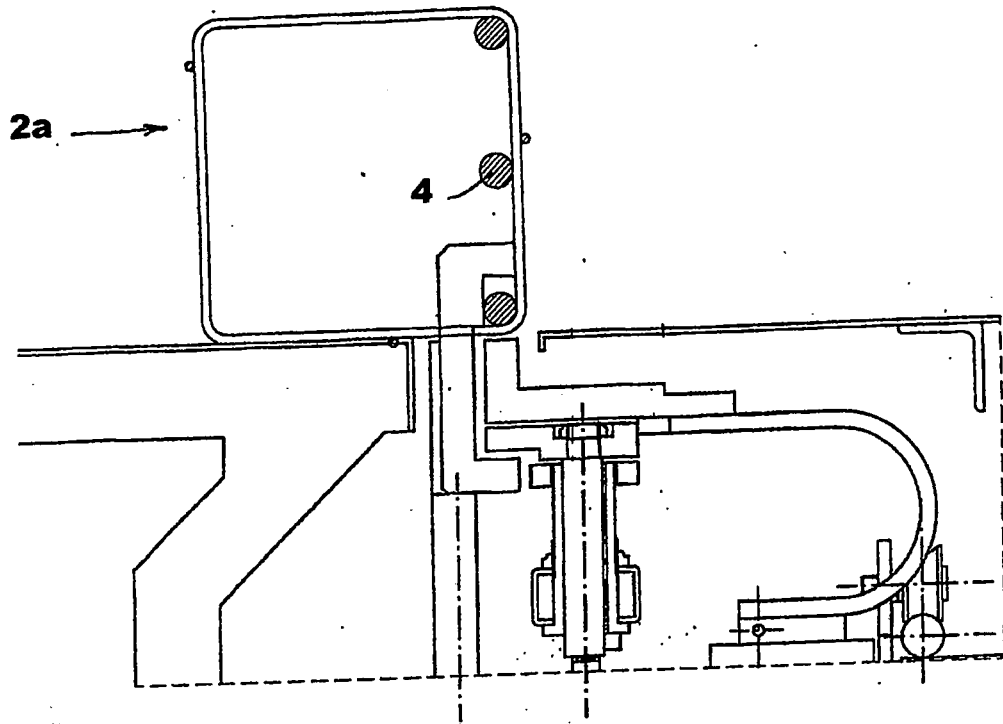


FIG. 10

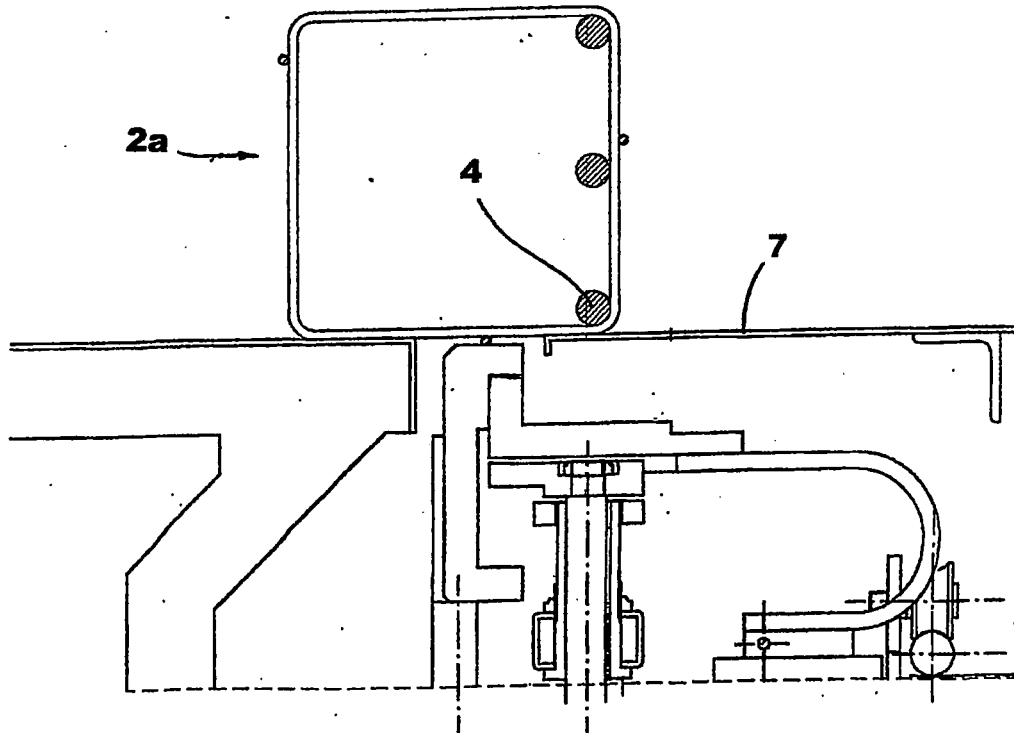


FIG. 11

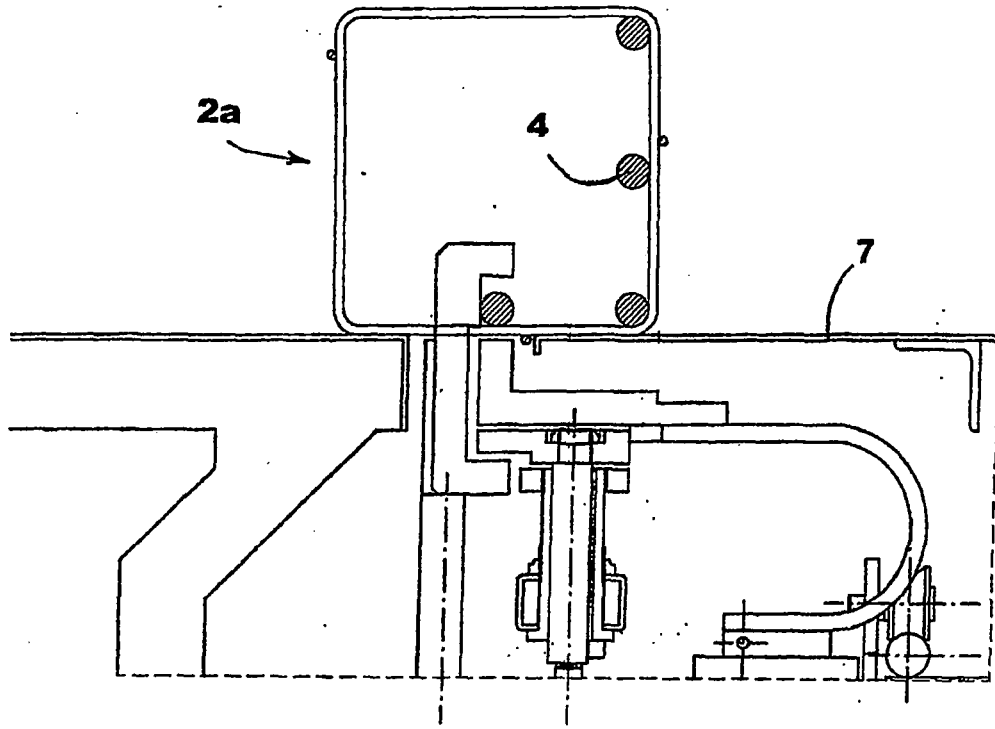


FIG. 12

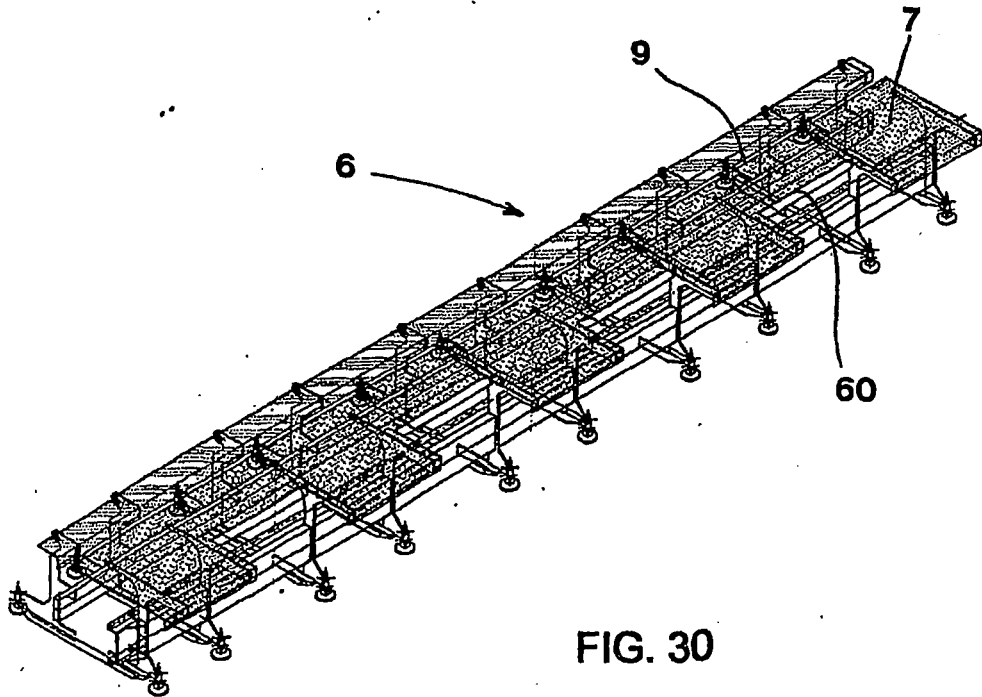


FIG. 30

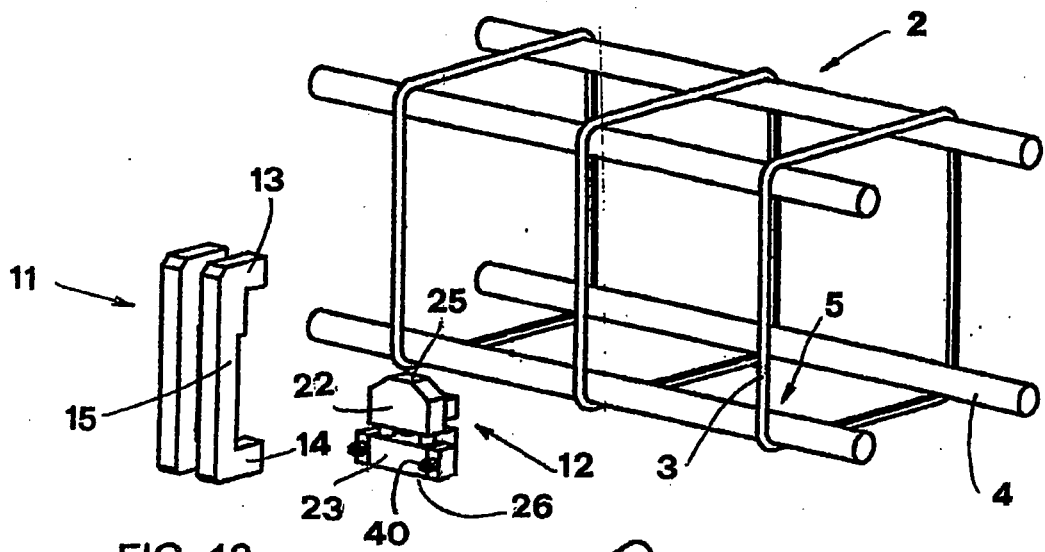


FIG. 13

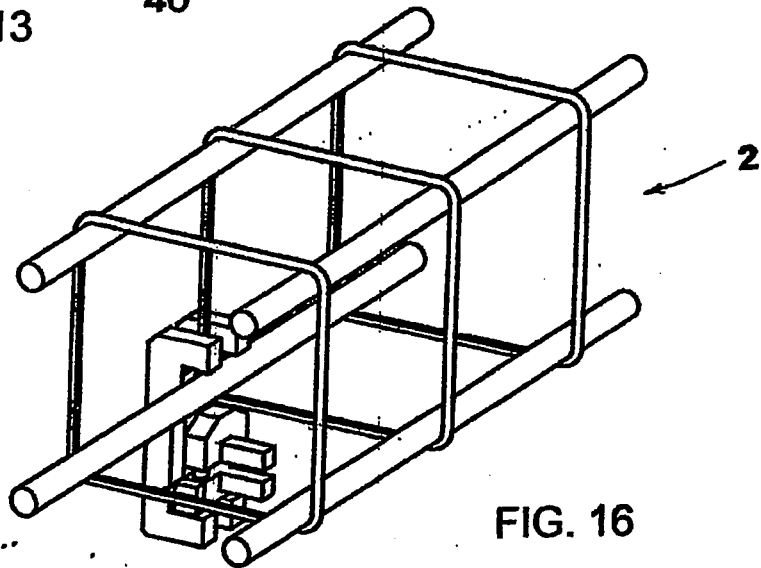


FIG. 16

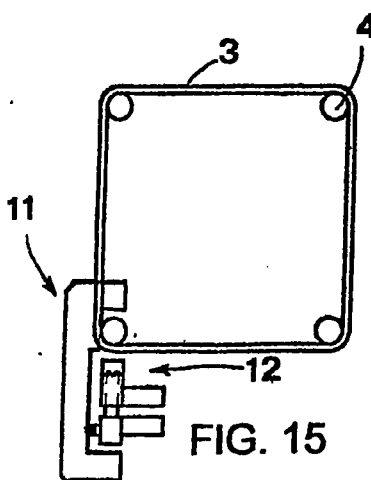


FIG. 15

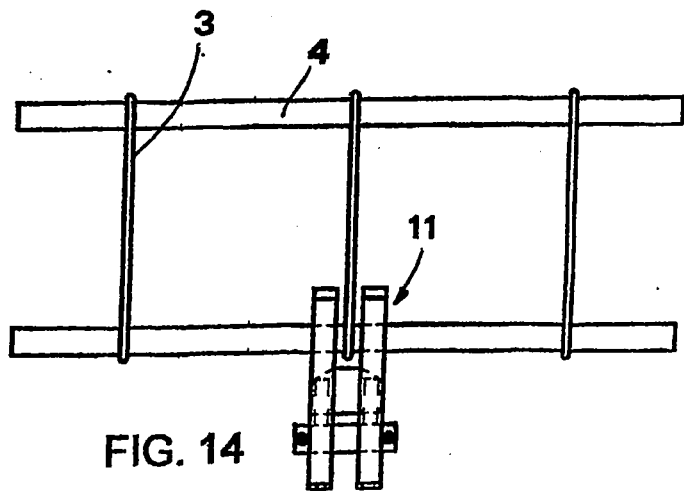


FIG. 14

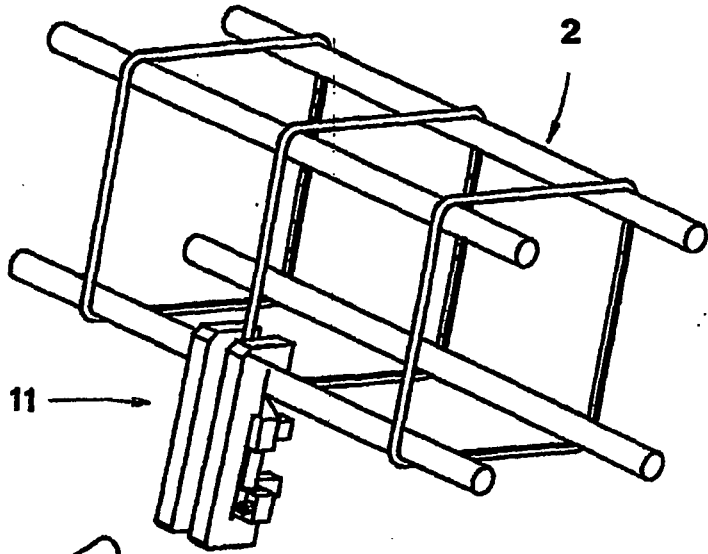


FIG. 19

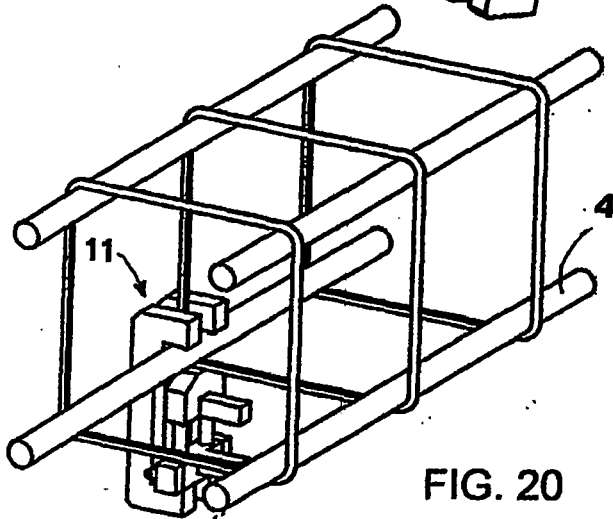


FIG. 20

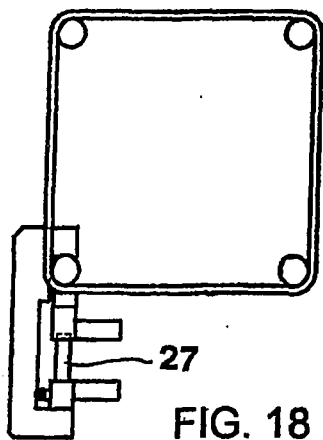


FIG. 18

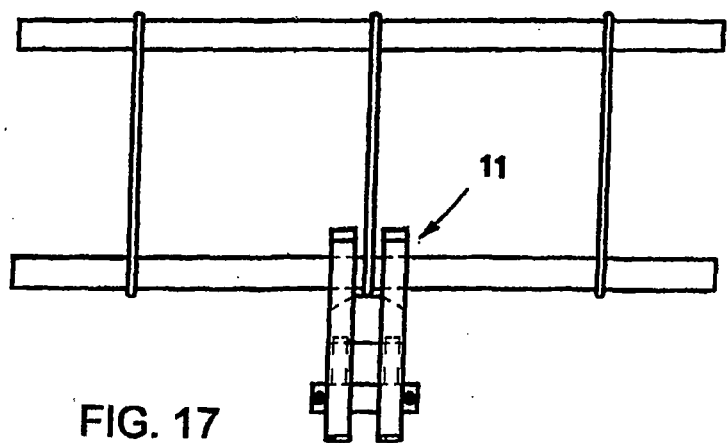


FIG. 17

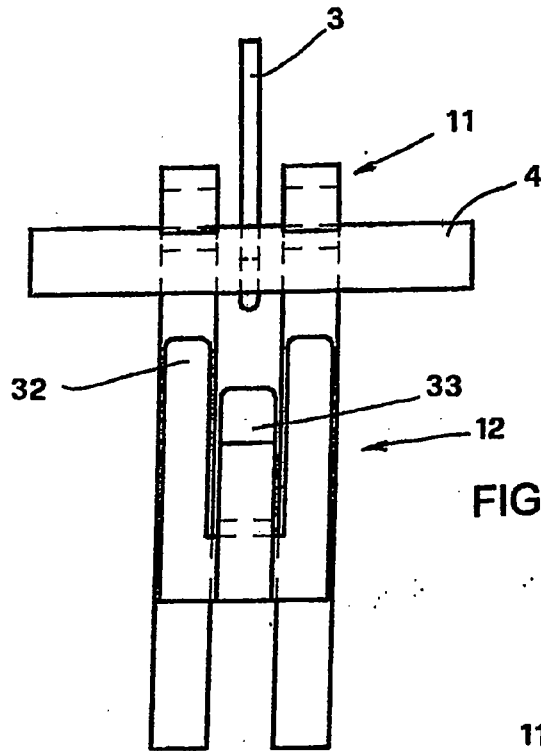


FIG. 23

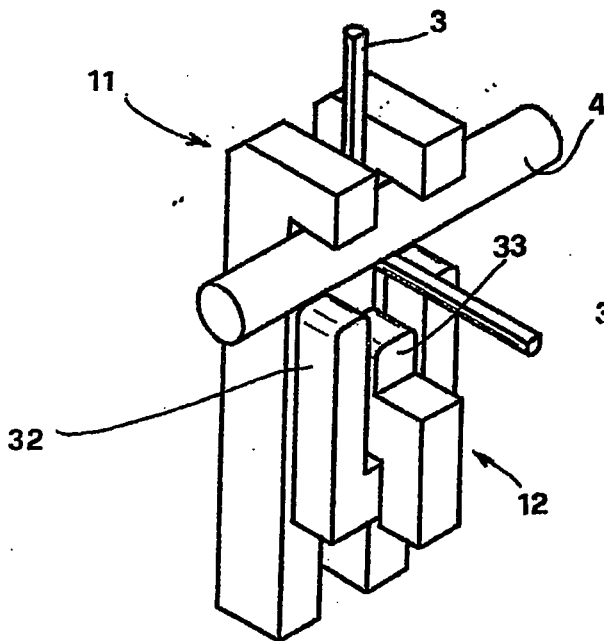


FIG. 21

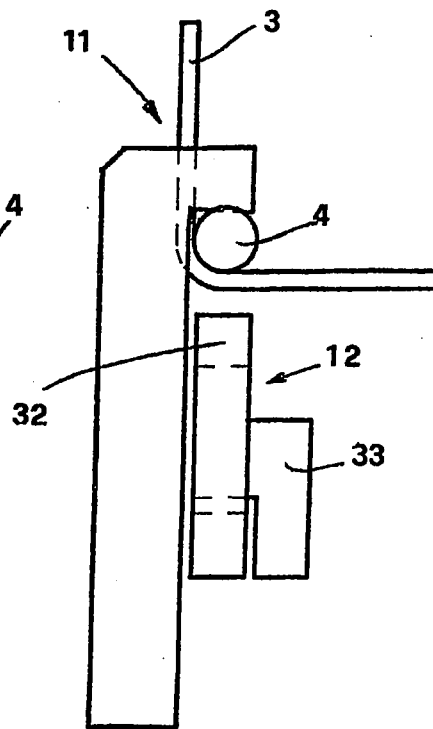


FIG. 22

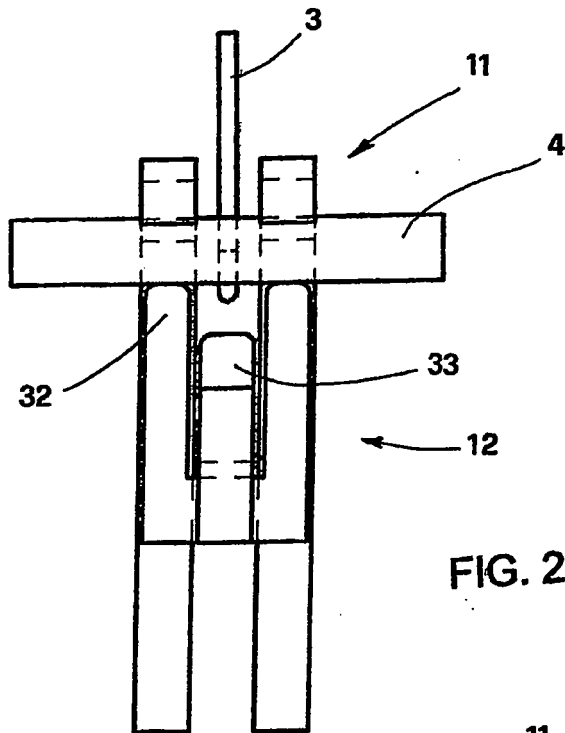


FIG. 26

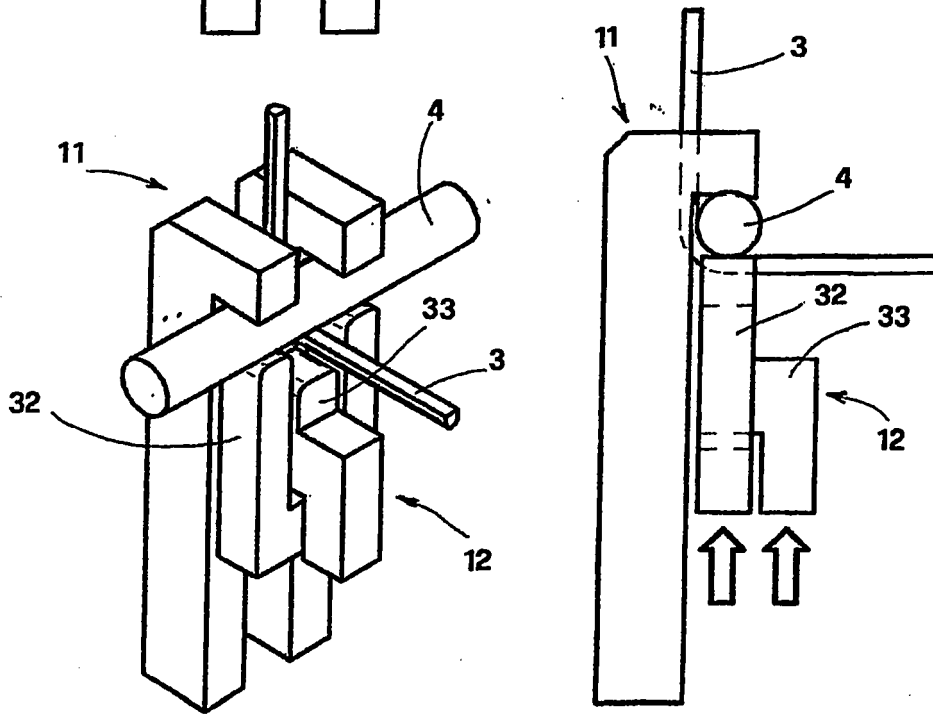


FIG. 24

FIG. 25

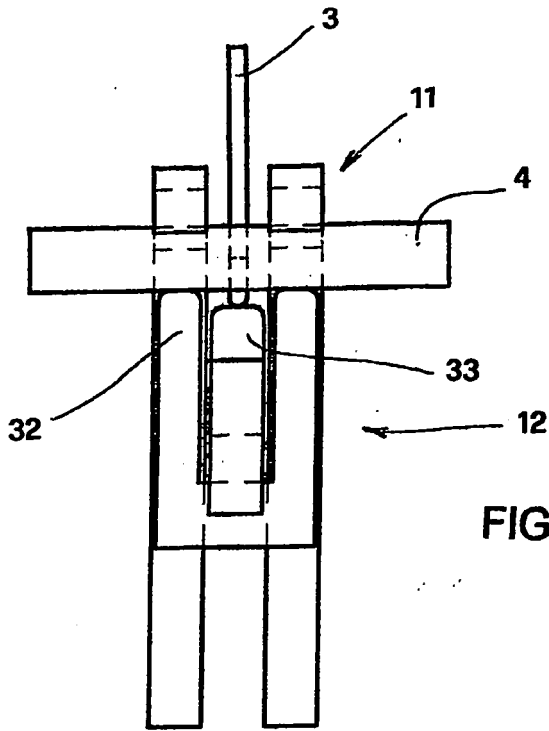


FIG. 29

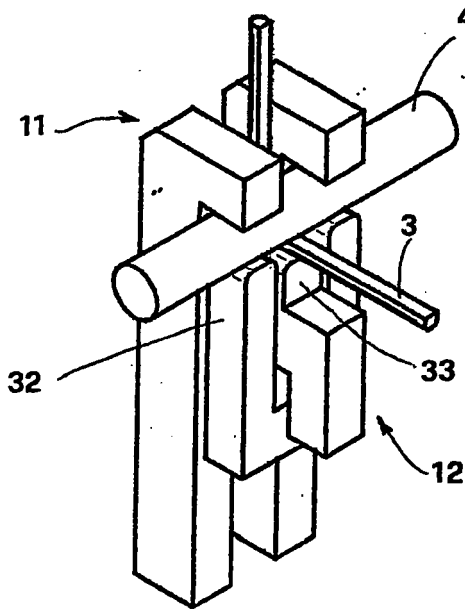


FIG. 27

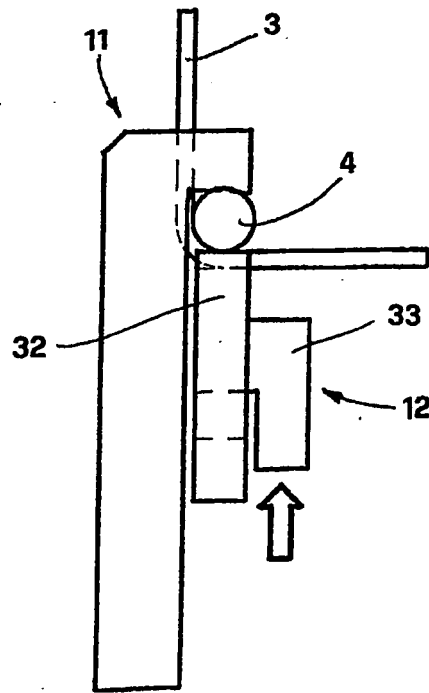


FIG. 28

REFERENCES CITED IN THE DESCRIPTION

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