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(54) **Method and Machine for Production of Three-Dimensional Stirrups**

(57) Method and machine for production of three-dimensional stirrups (1a) with two converging legs (4,5), from rods, wire or other material of any cross-section, wherein first is produced with the aid of a bending head (19) by making two bending operations a planar stirrup (9) with parallel legs. Afterwards, utilizing a mechanism (25) located immediately following this bending head (19), which mechanism includes an arm (16) that may move in reciprocation with the aid of a suitable mechanism (18) and has a hook (17) at its end, the free leg (5) of the planar stirrup (9) is trapped by the hook (17). This trapped free leg (5) is pulled towards the opposite leg (4) as arm (16) reciprocates, covering an appropriate distance. Finally, the third dimension is generated by bending simultaneously at locations (12, 13) with a suitable bending mechanism (22) that is located after the mechanism (25).

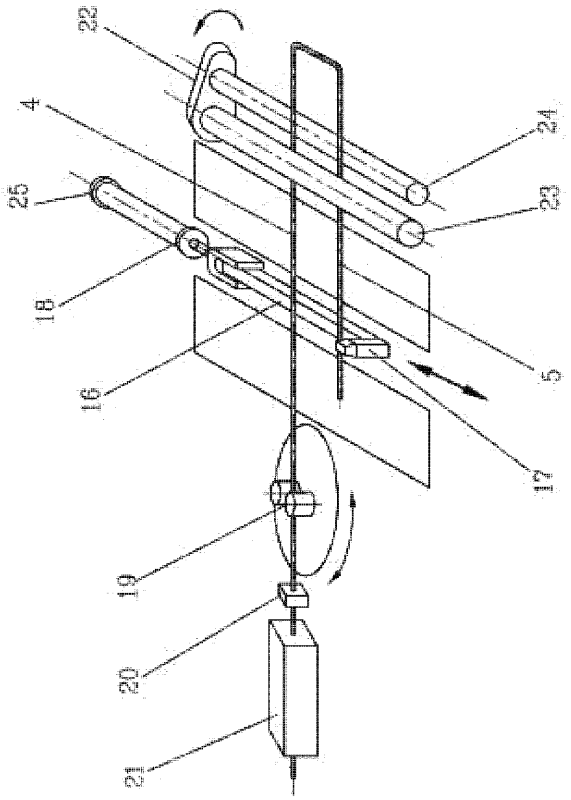

Fig. 11

EP 1 852 195 A2

Description

Technical Field

[0001] The invention refers to a machine and method for production of three-dimensional stirrups 1 a from rods, wire, or other material of any cross-section. Such three-dimensional stirrups may be employed for joining construction elements of reinforced concrete that are either fabricated on-site at construction sites, or are prefabricated.

Background Art

[0002] With reference to FIGS. 9-10, similar three-dimensional stirrups 1 a are produced currently according to the following manners:

(a) Manually with the aid of hand-operated or semiautomatic tools. US 919206 A (NEWLIN) 20.04.1909 discloses a manually-operated rod bending tool applicable in bending rods used for reinforcing concrete. US 1425261 A (KARDONG) 08.08.1922 also discloses a manually-operated rod bending tool applicable in bending rods used for reinforcing concrete. A more recent publication, US 6997030 A (WILLIAMS) 14.02.2006 also discloses a manually-operated rod bending tool applicable in bending rods used for reinforcing concrete. US 3908425 A (WARE) 30.09.1975 discloses a manually-operated power tool suitable for bending rods used for reinforcing concrete.

(b) With the aid of automated stirrup machines having a first bending mechanism, bending on only one plane, where is first produced a planar stirrup 3a with converging side legs 4,5. This first bending mechanism thus makes at least four bendings. Afterwards the planar stirrup 3a is manually positioned on another, usually hand-operated or semiautomatic suitable mechanism, where for the generation of the third dimension, bends are made of the two angles out-of-the plane at locations 12,13 simultaneously.

(c) With the help of automatic stirrup machines, which include an arrangement of two bending mechanisms, wherein a first bending mechanism generates the planar stirrup 3a, with converging legs 4,5. This requires at least four bendings. Then the second bending mechanism, which includes an arrangement of two parallel arms, one fixed and a second which moves cyclically about the fixed one, bends two angles simultaneously at locations 12,13 so that the third dimension of the product is formed. Prior US 235538A (KILMER)12/12/1880, discloses a bending mechanism for wires including an arrangement of two parallel arms, including one moving cyclically.

[0003] General relevance to the preceding categorizations (b), (c) may be found in several previous patent publications. For example, prior US 5511402 A (KAUFFMAN) 30.04.1996 , dated 1996-04-30, discloses a program-controlled automatic stirrup machine. EP 194478 A (MACCHINE ELETTRONICHE PIEGATRICCI) 17.09.1986 discloses an automated stirrup machine. US 4161110 A (RITTER ET AL.) 17.07.1979 discloses an automatic machine for producing concrete-reinforcing elements. Prior US 3563283 A (TUFEKTSHIEV) 16.02.1971 discloses an electrically programmed automatic apparatus for bending stirrups. US 2782832 A (SHAW) 26.02.1957 discloses a machine for angularly bending the leg portions of U-shaped workpieces. Prior US 1512002 A (KARDONG) 14.10.1924 discloses a machine for forming plural planar stirrups simultaneously.

TECHNICAL PROBLEM

[0004] These existing machines, methods, and techniques present numerous problems which it would be desirable to alleviate. Again having reference to FIGS. 9-10, first, it may be noted that such three-dimensional stirrups 1 a are typically placed in metallic cases with shape U or double-U, which are then covered with a suitably shaped cover of metal, synthetic materials, cardboard, or other suitable material. In this regard, it is required that their legs 4,5 which are located on one plane converge at suitable angle, that their opposing sides 6,7 that are located on the other plane be mutually parallel. Thus, in order that the three-dimensional stirrups 1 a be produced with these characteristics, it is necessary that at least five bendings must occur. First, four bendings on one plane, whereupon stirrups taking a planar shape 3a are formed. Subsequently there are formed the two angles that establish the third dimension, which usually are bent simultaneously in the fifth bending with a suitable mechanism.

[0005] The first method (a) discussed above has a high cost of production since it requires the manual involvement of laborers, it is time-consuming, and productivity is low. Furthermore, the quality of the resulting three-dimensional stirrups 1 a is not always that required for their further use. Since the shape of the in-question product does not have absolute precision as to its geometric characteristics this creates difficulties in its placement in the metallic cases.

[0006] In the second method (b) discussed above, there again must occur at least five bendings of the material.

[0007] In the third method (c) discussed above, there again must also occur at least five bends of the material. Here the disadvantage is that the bends in the third dimension must fall precisely on the two opposing locations 12,13 of the planar shape 3a, something which is not feasible with precision, because of the torsions that the material has and the qualitative alterations that are present within the same spool from which it originates. The result is that the thus-produced product creates dif-

ficulty in its further application.

[0008] It may be noted from the aforegoing discussion that all of the methods according to the state of the art have a common characteristic that the converging legs 4,5 are produced first in the planar stirrup 3a by effecting at least four bending operations. The third dimension is generated subsequently.

Technical Solution

[0009] The innovative machine and method that are here presented concern the automated production of three-dimensional stirrups 1a, 1b, 1c, 1d, 1e from rods, wire, or other suitable materials of any cross-section, wherein first a planar stirrup 9 is produced with parallel legs 4,5 by making two bends. Then the free leg 5 is pulled, at a suitable location 11 towards the opposite leg 4 which is held unmoved. Finally, a third dimension is created by bending simultaneously at suitable locations 12,13 the stirrup out of the plane. In this fashion the creation of the planar stirrup 9, which leads to the final three-dimensional stirrup 1a, may require only two bending operations.

Advantageous Effects

[0010] In relation to the enumerated disadvantages of the methods that existed, which we already referred to, and in contrast thereto, we set forth following several of our specific advantages:

- The time for production of the stirrups is shortened by far.
- As a result of the high quality of the product and the great precision of the shape the further placement of stirrups in the special cases is easy and in parallel time is economized here also.
- As a result of the requirement of two less bendings for the generation we have a fair amount of economization of energy during the production of each three-dimensional stirrup 1a as something very significant if we contemplate that these products are produced at many thousands.
- The cost of production is reduced to a great degree.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The details of the method according to the present invention will be understood from the following description and from the attached drawings, where:

[0012] FIG. 1 depicts a first form of three-dimensional stirrups that may be produced in accordance with the present invention.

[0013] FIG. 2 depicts a second form of three-dimensional stirrups that may be produced in accordance with the present invention.

[0014] FIG. 3 depicts a third form of three-dimensional stirrups that may be produced in accordance with the present invention.

[0015] FIG. 4 depicts a fourth form of three-dimensional stirrups that may be produced in accordance with the present invention.

[0016] FIG. 5 depicts a fifth form of three-dimensional stirrups that may be produced in accordance with the present invention.

[0017] FIG. 6 helps depict in idealization the method of production and its kinematic requirements, according to the present invention and shows a planar stirrup.

[0018] FIGS. 7-8 likewise help depict in idealization the method of production and its kinematic requirements, according to the present invention.

[0019] FIGS. 9-10 depict idealized the method of production of the three-dimensional stirrups according to the state of the art.

[0020] FIG. 11 depicts schematically one of the machines which effect the method of production of three-dimensional stirrups according to the present invention.

MODES FOR CARRYING OUT THE INVENTION

[0021] With reference to FIGS 1-8 and 11, the innovative method that is here presented concerns the automated production of three-dimensional stirrups 1a, 1b, 1c, 1d, 1e from rods, wire or other suitable materials of any cross-section. There is produced first a planar stirrup 9 with parallel legs 4,5 by making two bends, or alternatively there may be received a prepared and precut planar stirrup 9. Afterwards the free leg 5 is pulled at a suitable location 11 towards the opposite leg 4, which is held unmoved. Finally, we bend simultaneously at suitable locations 12,13 the stirrup out of the plane, so as to create a third dimension. In this fashion we may need for the creation of the planar stirrup 9 leading to the final three-dimensional stirrup 1a, only two bending operations.

[0022] This method effects the production of three-dimensional stirrups 1 a from rod, wire or other suitable material of any cross-section. Such three-dimensional stirrups 1a typically have the two legs 4,5 on which are found the two ends of the stirrup 1a, being on the same plane and converging at a particular angle, though some of the other sides, that are located on a different plane, may converge under a different angle or may be parallel. The present method is characterized in that there is produced first the planar stirrup 9 from suitable layout; afterwards, with a suitable mechanism the leg 5 having a free end is trapped at a suitable location 11 and is pulled towards the opposite leg 4, so that the two legs' 4,5 two sides converge under a suitable angle. Finally, with another suitable mechanism 22 there are created simultaneously at least two sides 6,7 under a suitable angle, outside of the plane, so that there is formed the third dimension. A cutting may follow. The result is that the two free legs 4,5 converge under the desired angle even though the opposite sides 6,7 in the other plane maintain their geometry as it was prior to the creation of the third dimension. In another embodiment of the method as de-

scribed above within the present paragraph, there may be produced simultaneously more than one three-dimensional stirrup 1a, applying the method to corresponding more than one locations.

[0023] In one embodiment, the method according to the immediately aforegoing paragraph may be yet further characterized in that the two-dimensional stirrups 9 may be prepared and shaped in the suitable dimensions and then be supplied to suitable mechanisms 25, 22 so as to undergo the further processing for the shaping of the end product.

[0024] As a further embodiment, the method according to the immediately preceding two paragraphs may be further characterized in that there can be received from the suitable layout more than one (i.e. plural) two-dimensional stirrups 9 simultaneously in more than one corresponding locations of receipt by suitable mechanisms so that they undergo further processing for the shaping of the final product.

[0025] It must be explained also, with particular reference to FIGS. 2-5, that with this method it is possible to produce three-dimensional stirrups, which in the third dimension can have any form, such as for example non-perpendicular angles, uneven leg sides with oblique slanted axial bend 1 b, with curved configuration 1 c, with triangular configuration 1 d, with polygonal configuration 1e and others.

[0026] In one aspect, and with reference to FIG. 11 of the appended drawings, our method may be implemented by an innovative mechanism 25 which is disposed in stirrup machines with the following characteristics: they have an arrangement of an advancement mechanism 21 for the rod, wire or other suitable material, that may come from a spool or from straightened pieces; they have a bending head 19 that bends the material in one place, creating planar stirrups; they have a cutter 20 for cutting the material after the creation of the three-dimensional stirrup 1a from a second bending mechanism 22, which comprises a stationary arm 23 and a second arm 24 that can move cyclically around the stationary arm 23 thus bending the two legs 4,5 of the planar stirrup simultaneously. In such an arrangement, the mechanism 25 which comprises our invention is placed between the first bending mechanism 19 and the second bending mechanism 22 and comprises one arm 16 that can move in an alternating, reciprocating manner with the aid of a suitable mechanism 18 and at a suitable angle as to the legs 4,5 of the planar stirrup 9 trapping with the aid of a suitable hook 17 the free leg 5 which it pulls towards leg 4, traversing a suitable distance, holds it until the second bending head 22 bends the two legs 4,5 at suitable locations 12,13 creating the third dimension. Afterwards the cutting of the material of leg 4 at a suitable location is made by cutter 20.

[0027] The machine of the present invention is further described with reference to FIG. 11 and FIGS. 1-8 of the appended drawings.

[0028] A mechanism 25 for the production of three-dimensional stirrups 1a, 1b, 1c, 1d, 1e, with converging free legs 4,5, from rod, wire, or other suitable material of any cross-section, which mechanism 25 is placed in stirrup machines. Such stirrup machines may include an arrangement of an advancement mechanism 21 for the rod, wire or other suitable material that may be supplied from a spool or from straightened pieces. In this case they may include a first bending mechanism 19 that bends the material in one plane to generate planar stirrups 9. Also in this case they may also include a cutter 20 for the cutting of the material after the generation of the three-dimensional stirrup 1a, 1b, 1c, 1d, 1e by a second bending mechanism 22.

[0029] This second bending mechanism 22 comprises a fixed arm 23 and a second arm 24 that can move cyclically around the fixed arm 23 bending thus the two legs 4,5 of the planar stirrup simultaneously.

[0030] Alternatively, such stirrup machines may receive prepared and precut planar stirrups 9 trapping one free leg 4 with the aid of a grip. In this case, the arrangement includes a grip that can receive the planar stirrup restraining it via leg 4. Thus mechanism 25 may be used also in stirrup machines that work prepared, precut planar stirrups 9 and have an arrangement including only the second bending head 22 that can create the third dimension. It will be readily understood from the aforegoing description that in this second case the first bending mechanism 19 is not necessary.

[0031] Assuming the first case, above, for illustration, the mechanism 25 is placed between the first bender 19 and the second bender 22, under the plane of the under-production product. It comprises an arm 16 that can move with the aid of suitable mechanism 18 in an alternating, reciprocating manner and at a suitable angle relative to legs 4,5 of the planar stirrup 9, trapping with the aid of a suitable hook 17 the free leg 5, 11, which it pulls towards the leg 4. The arm 16 traverses a suitable distance, holding it until the second bending head 22 bends the two legs 4,5 at the suitable locations 12,13 creating the third dimension.

[0032] As a further alternative, the mechanism 25 may be characterized in that it is placed above the plane of the subjected-to-generation product. Thus it will be understood that the mechanism 25 may be located either under the plane of the under-production part or above it.

[0033] As a further alternative the mechanism 25, according to the aforegoing description may be characterized in that the free leg 5 of the planar stirrup 9 can be trapped with the aid of grip. Thus it will be understood that the free leg 5 may be trapped also with the aid of a suitable grip in place of the hook 17.

[0034] Finally, in a further embodiment, a mechanism 25 according to the aforegoing description, may be further characterized in that the maintenance, coordination, and control of all the functions of the process of production of the three-dimensional stirrup 1a is made by a suitable electronic computer, in which are entered the necessary product characteristics for the production of the

three-dimensional product 1 a. Thus, the coordination and control of all the functions of the process of production of the three-dimensional stirrup 1a may be preferably effected by a suitable electronic computer, in which we enter all necessary product characteristics for the production of the product.

[0035] In the implementation of the invention the materials that are used as well as the dimensions of the individual elements can be in accordance with the requirements of the particular construction.

[0036] The present invention is not limited in any manner to the described and in-the-drawing-portrayed implementation, but may be implemented in many forms and dimensions without abandoning the region of protection of the invention.

Claims

1. A machine for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) comprising either a bending mechanism (19) configured to bend material in one plane to create a planar stirrup (9), or a grip configured to restrain one leg (4) of a prepared precut planar stirrup (9); and,
further comprising a second bending mechanism (22) having an arrangement of two parallel arms (23,24), said machine **characterized by**:

a mechanism (25) disposed to pull a free leg (5) of the stirrup towards the opposite stirrup leg (4), said mechanism (25) including an arm (16) configured to reciprocate with the aid of a suitable aiding mechanism (18) and at a suitable angle relative to legs (4, 5) of the stirrup (9).

2. A machine for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in Claim 1, further **characterized in that**: said arm (16) is disposed under the plane of the under-production stirrup (9).

3. A machine for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in Claim 1, further **characterized in that**: said arm (16) is disposed above the plane of the under-production stirrup (9).

4. A machine for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in any of Claims 1, 2, or 3 above, further **characterized by**:

a hook (17) or a grip, disposed on said arm (16) for trapping free stirrup leg (5) so that said arm (16) may pull the free stirrup leg (5) toward the opposite stirrup leg (4).

5. A machine for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in any of Claims 1, 2, 3, or 4 above, further **characterized by**:

a suitable electronic computer configured to control all of the functions of production of the three-dimensional stirrups (1a, 1b, 1c, 1d, 1e).

6. A process for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) comprising either the step of forming a planar stirrup (9) with a first bender (19), or the step of restraining a prepared precut planar stirrup (9) via a first leg (4) by receiving it in a grip; and, further comprising the step of providing a second bending mechanism (22) to bend the two legs (4,5) of the planar stirrup (9) simultaneously; **characterized by** the steps of:

reciprocating an arm (16) of a mechanism (25) with a suitable aiding mechanism (18) and at a suitable angle relative to the legs (4,5) of the stirrup (9), and
pulling a free leg (5) of the stirrup (9) towards the first leg (4) with said mechanism (25).

7. A process for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in Claim 6, further **characterized by** the step of:

either disposing said arm (16) under the plane of an under-production stirrup (9), or disposing said arm (16) above the plane of an under-production stirrup (9).

8. A process for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in any of Claims 6 or 7, further **characterized by** the step of:

trapping the free stirrup leg (5) with a hook (17) or with a grip disposed on said arm (16).

9. A process for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in any of Claims 6, 7, or 8, further **characterized by** the step of:

receiving plural two-dimensional stirrups (9) simultaneously in respective plural locations of receipt by respective suitable mechanisms (25) so that said plural two-dimensional stirrups (9) undergo further processing for the shaping of the final products.

10. A process for production of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) as claimed in Claim 6, further **characterized by** the step of:

producing simultaneously a plurality of three-dimensional stirrups (1a, 1b, 1c, 1d, 1e) by applying the process of production to a corresponding plurality of locations.

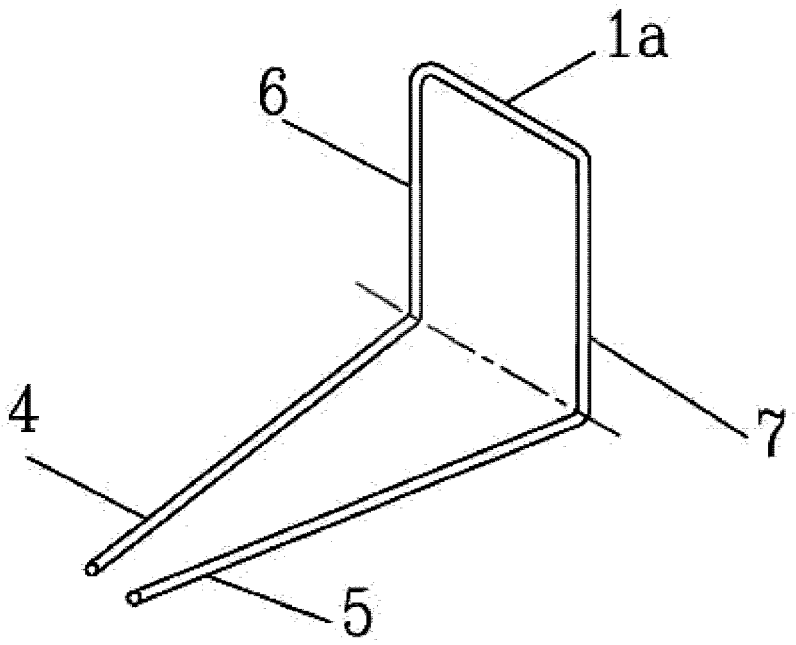

Fig. 1

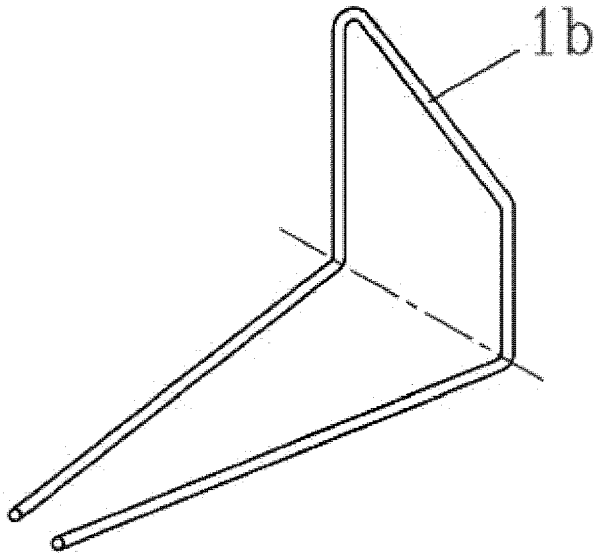

Fig. 2

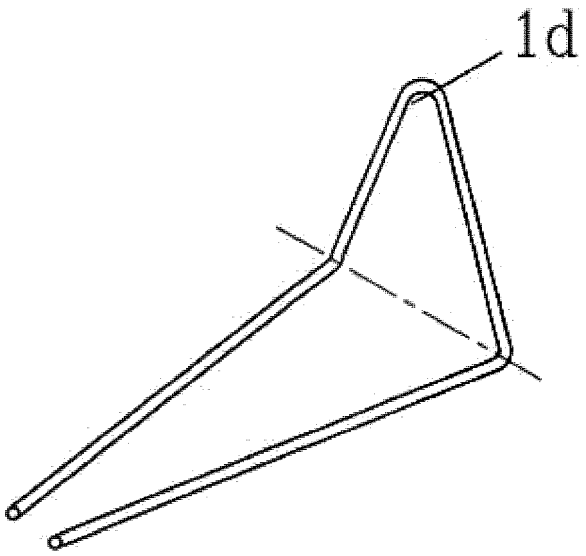

Fig. 3

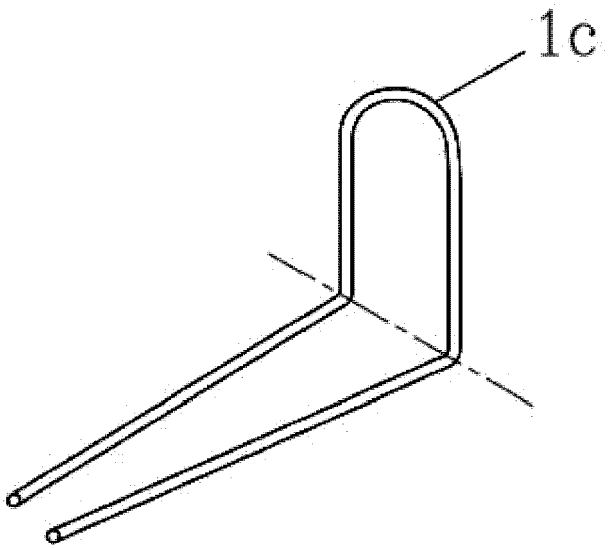

Fig. 4

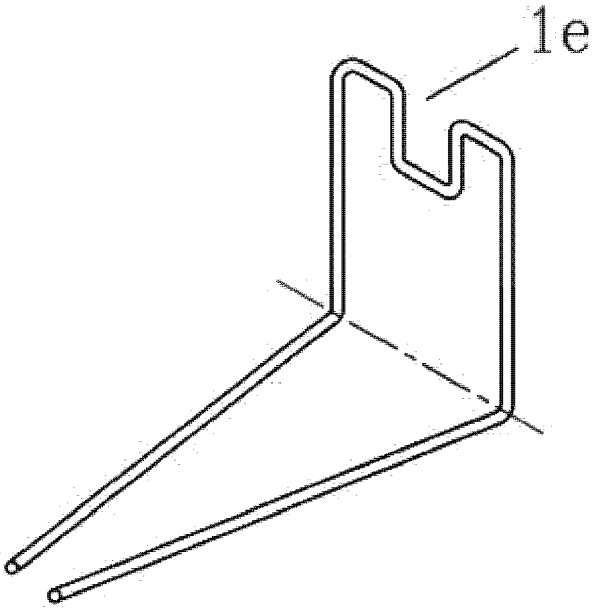

Fig. 5

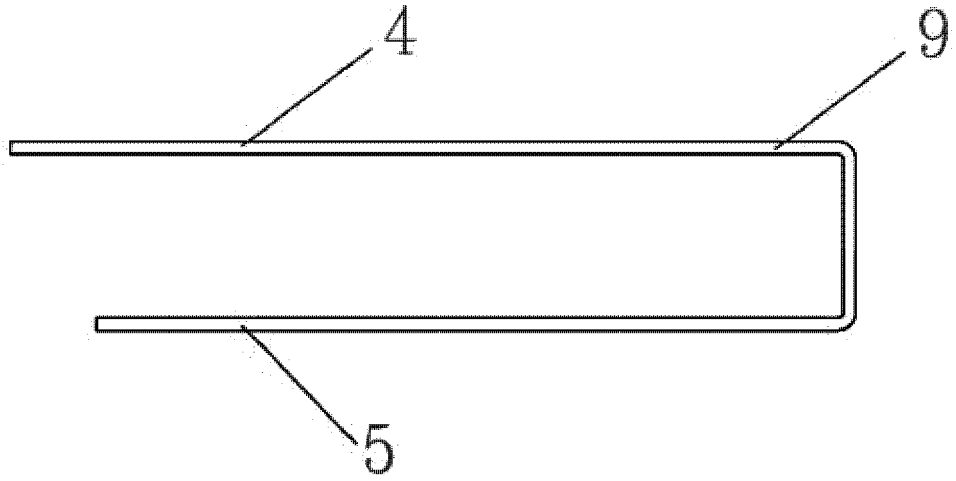

Fig. 6

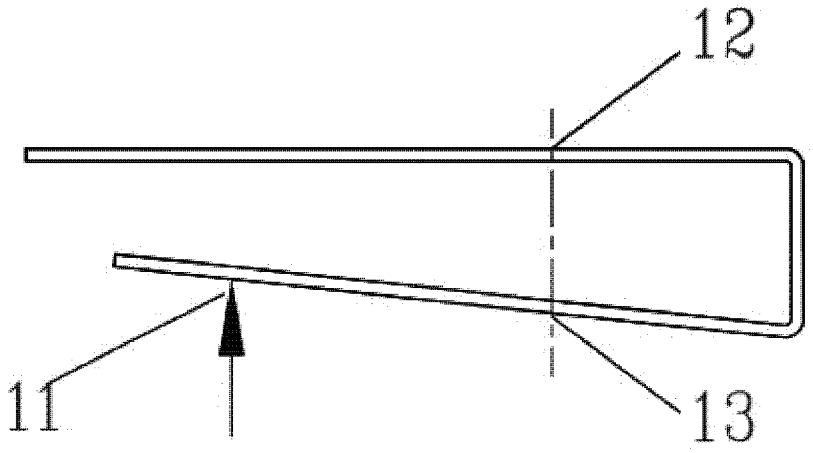

Fig. 7

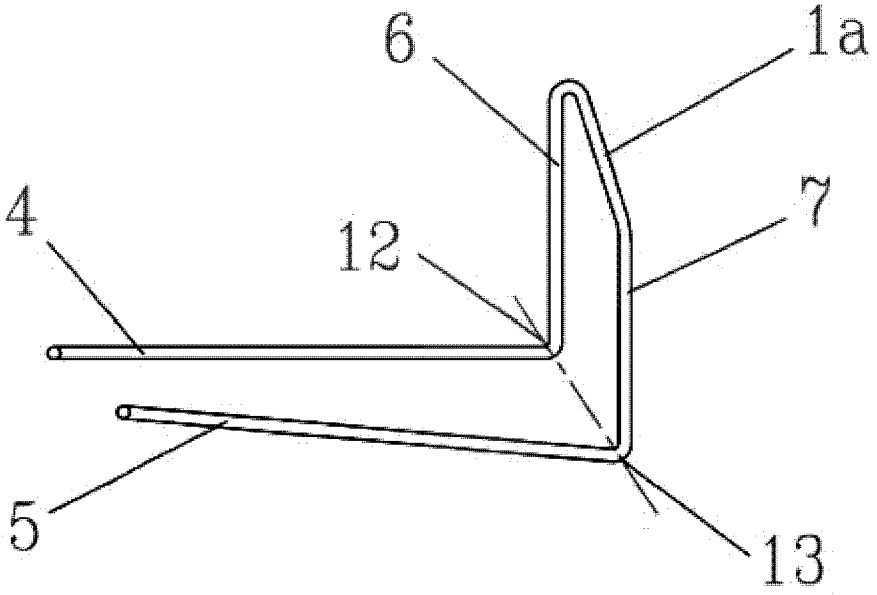

Fig. 8

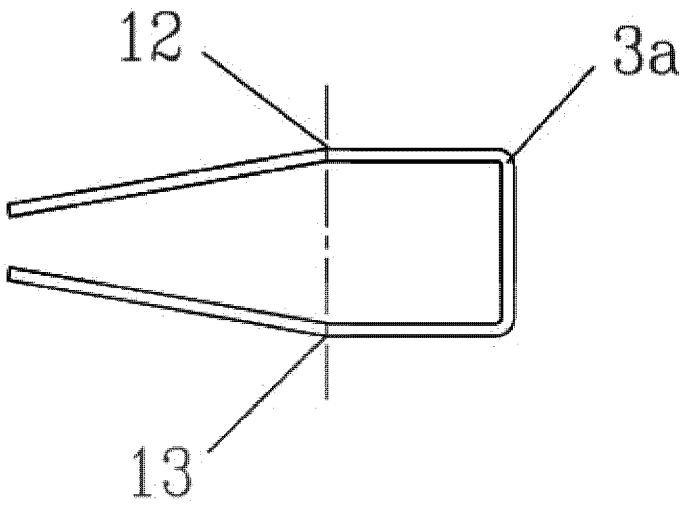

Fig. 9

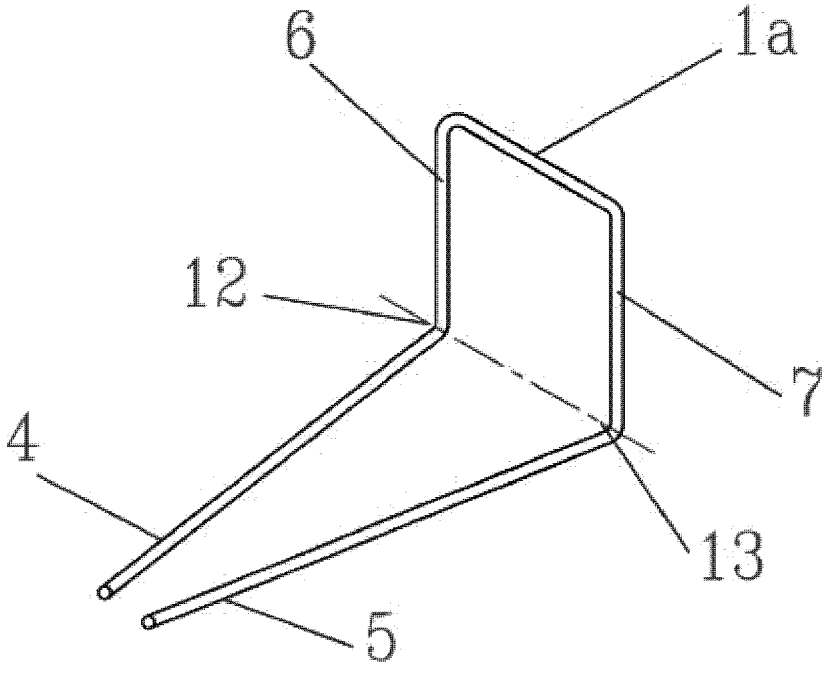

Fig. 10

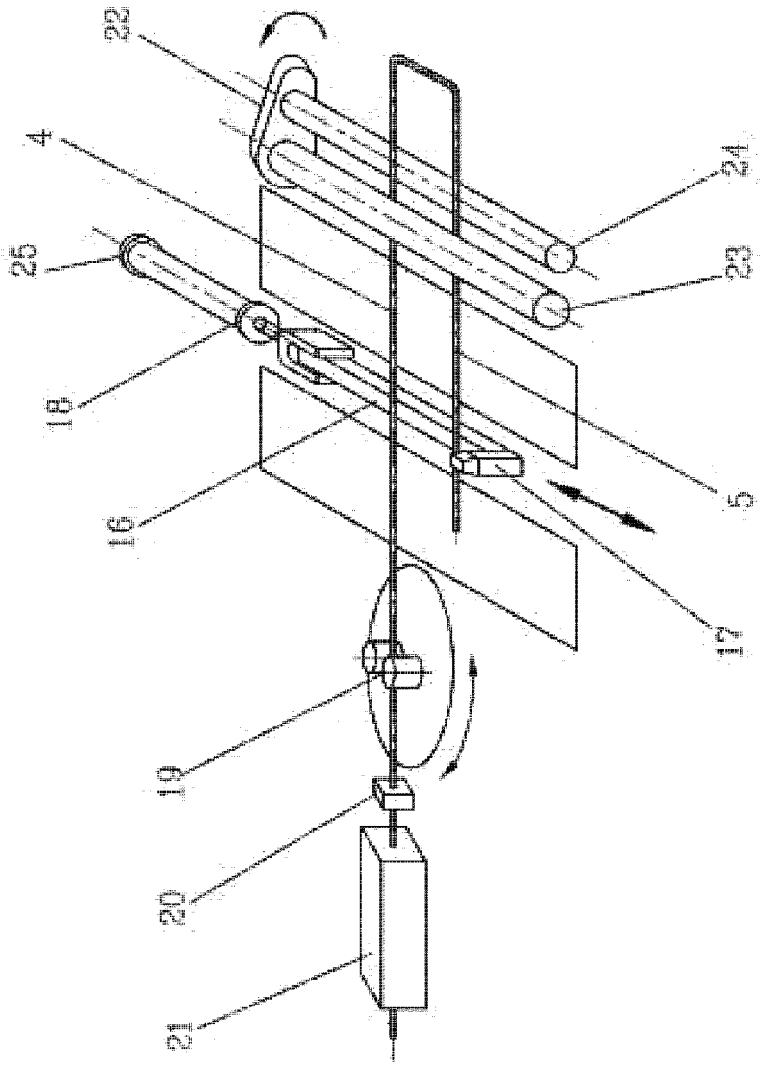

Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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