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(54) **CONTINUOUS LINEAR DRAWING DEVICE FOR HORIZONTAL AUTOMATIC COLD FORGING PRESS**

(57) A drawing device (3) is described, for a process of continuous linear drawing of a wire (1) of the metal type made into a coil (20), said drawing device (3) being adapted to feed the wire (1), after the drawing performed by the drawing device (3) itself, to a press (4), of the horizontal automatic type, for cold forging. The drawing device (3) consists of a base (15) resting on the ground

on an inclined plane (16), and a mobile structure (6) adapted to perform the continuous linear drawing process by means of the action of two pairs of grippers (7, 12) integrated in two mobile slides (8, 11) actuated by planetary roller screws (10) operated by brushless motors (09), wherein the slides (8, 11) are slidably associated with the mobile structure (6).

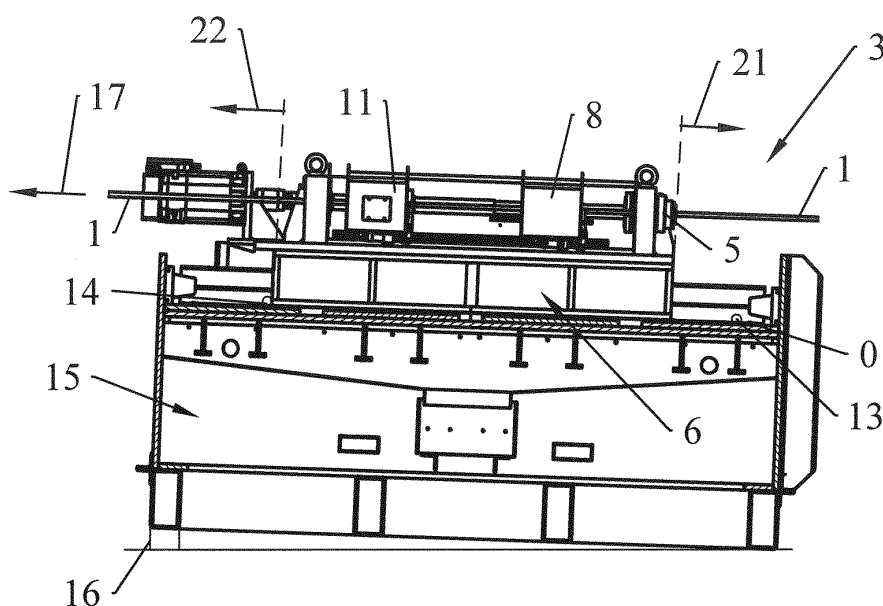


FIG.4

Description

[0001] The present invention relates to a continuous linear drawing device for horizontal automatic press for cold forging.

[0002] The cold forging of fasteners and other metal parts, obtained by means of a cold deformation process with horizontal automatic presses, is characterized by a jerky movement of the "advance and stop" type of the wire made into a coil which constitutes the raw material of these processes. The wire which slides, dragged by the press, is stopped by the press itself for a few moments to be cut and subsequently deformed in an appropriate manner; then, it starts sliding again, entering the press, and so on, to repeat this cycle.

[0003] The drawing process, placed upstream of the forging process described above, allows to calibrate the metal wire to the size required by the press by means of appropriate section reductions, obtained by dragging the wire inside drawing dies built with materials with appropriate shape and hardness, commonly called "spinnerets", the section of which reproduces in negative the shape and size of the wire section to be obtained. A drawing correctly performed requires a continuous movement of the metal wire inside the spinneret.

[0004] Disadvantageously, the continuous movement of the drawing is not directly compatible with the jerky movement of the "advance and stop" type of the wire, distinctive of the forging step.

[0005] In current production lines for the cold forging of wire from a coil, drawing operations are carried out by drawing machines placed outside the horizontal automatic presses.

[0006] No type of drawing machine used today in the production lines of fasteners and other metal parts uses the continuous linear drawing technique.

[0007] Known drawing techniques, applied in line to a horizontal automatic press are:

- a continuous non-linear drawing technique, and
- a non-continuous linear drawing technique.

[0008] Said known techniques are both implemented by dedicated machines external to the press, in which the kinematics of the wire during the drawing operations are linked to the commands of the press by means of sensors.

[0009] A known application of the continuous non-linear drawing technique is the one that today is largely applied in production lines and provides for the wire to be reduced in section, inserted into the spinneret by means of a special introducer and then dragged by a chain around a drum called "capstan". The capstan drags the wire through the spinneret thus obtaining the drawing. The wire is introduced into the press and, when production begins, the compensation between the continuous motion of the wire being drawn and the "advance and stop" motion of the wire characteristic of the forging is

performed by a series of adjustments made by sensors placed on the press which control the speed of rotation of the capstan and the action of a mobile electro-pneumatic compensator arm called "dancer", which has the function of creating a loop of free wire called "loop": such sensors are the functional connection between the two machines.

[0010] This technique has the following limitations and drawbacks:

- the formation of turns on the capstan after the drawing generates anomalous mechanical tensions in the wire, which induce a not perfectly straight shape in the piece of wire which is cut by the press so as to be processed; this slight curvature of the pieces, especially if of a certain length, may cause geometric difficulties in the forging operations (conventionally, the lack of centering between one end of the wire piece and the forging dies) and consequent anomalous wear and/or breakage of the forging equipment;
- it involves long coil changing times, due to the complex operations for dragging the wire with chain and capstan;
- the operators face a high risk, since, during the coil changing operations, the mechanical tensions in the wire may give rise to whiplashes when the wire is detached from the chain and introduced into the press.

[0011] A known application of the non-continuous linear drawing technique provides that the drawing occurs in a "jerky" manner. The wire is drawn when it is stationary (cutting step of the press) using a mobile spinneret which is dragged with a rapid movement in a direction opposite to the wire advancing one.

[0012] This "jerky" wire drawing mode is controlled by an electrohydraulic control unit which is activated by means of a sensor placed in the press when the wire stops to be cut by the press itself; such sensor is the functional link between the two machines.

[0013] This non-continuous drawing mode, described for example in EP-1671714, has had marginal industrial application since the movement of the spinneret, which is fast, "jerky" and in a direction opposite to the wire advancement one, is an actual "whiplash" and shows the following and decisive negative features:

- formation of an anomalous heating of the wire and consequent frequent damage to the spinneret, as well as formation of superficial scratches on the wire itself, which make it unusable;
- anomalous mechanical tensions generated inside the wire inhibit the use thereof for producing high resistance fasteners;
- the drawing occurs by applying on the mobile spinneret a dragging force in a direction opposite to the wire sliding one, which contrasts the request for wire

by the press, creating the conditions for the formation of shorter wire pieces with respect to what is required by the press itself.

[0014] Furthermore, the production equipment implementing this "jerky" technique is characterized by:

- long coil change times due to the complexity of the operations for inserting the wire into the mobile spinneret;
- extremely loud noise when the "whiplash" occurs;
- the functional connection with the press limits the speed of the press itself to the same low operating speed of the drawing machine, not allowing a productivity consistent with the potential of the press and making the production process economically inadequate for most of the processes;
- furthermore, the functional connection itself requires interventions on the adjustments whenever it is necessary to make the performance of the two machines consistent in terms of wire advancement speed, for example, at each small speed adjustment required by the forging activities performed by the press.

[0015] IT-UA20164496 describes a method for the linear drawing of a metal wire from a coil with the use of satellite roller screws or ball screws applied to a linear drawing cutting machine.

[0016] It is the object of the present invention to provide a device for the continuous linear drawing of metal wire made into a coil, which is adapted to feed a horizontal automatic press, in a production line of fasteners and other metal parts obtained by means of "forging", i.e., by means of cold plastic deformation.

[0017] A further object of the present invention is that said device is adapted to compensate the continuous motion of the wire being drawn and the jerky motion of the "advance and stop" type of the wire, characteristic of the forging in the press.

[0018] A further object of the present invention is that the continuous linear drawing device is adapted to work, within the same production line, with conventional horizontal automatic presses.

[0019] According to the invention, said and further objects are achieved by a drawing device for a process of continuous linear drawing of a wire of the metal type made into a coil, said drawing device being adapted to feed the wire, after the drawing performed by the drawing device itself, to a press, of the horizontal automatic type, for cold forging.

[0020] characterized in that the drawing device consists of

a base resting on the ground on an inclined plane, and a mobile structure adapted to perform the continuous linear drawing process by means of the action of two pairs of grippers integrated in two mobile slides actuated by planetary roller screws operated by brushless motors, wherein the slides are slidably associated with the mobile

structure, in which the mobile structure is adapted to slide with respect to the base with cycles of alternating linear movements in the direction of the wire, in opposite directions, controlled by the "advance and stop" movement of the wire entering the press.

[0021] Advantageously, the drawing device according to the present invention allows to:

- perform the entire production cycle in the same line in which the continuous linear drawing and forging technologies are integrated, as well as perform the respective operations in a coordinated and simultaneous manner,
- support the action of the wire dragging mechanisms of the cold forging technique (grippers or rollers) arranged in the forging area, exploiting the dragging action, or the sliding, with which the continuous linear drawing of the wire is obtained, thus improving the reliability of the dragging itself and preventing the risk of having, when entering the press, pieces of wire cut by a length shorter with respect to what is provided for by the forging technique.

[0022] The absence of a direct functional control exerted by the press on the drawing device, for example, by means of electromechanical or electrohydraulic commands, is the fundamental factor determining the possibility of integrating, within the same production line, two technologies which subject the wire to different advancement motions.

[0023] This is achieved since, while the grippers continue to exert the dragging action thereof on the wire ensuring the continuity of the linear drawing process, the back and forth alternating linear movement in the sliding direction of the wire of a mobile structure, within which the drawing just indicated occurs, allows to harmonize the continuous movement of the wire, characteristic of the drawing, with the "advance and stop" movement, characteristic of the forging.

[0024] Such drawing device has the following features:

- the linearity of the drawing avoids the formation of mechanical tensions in the wire after the drawing and the consequent bending induced in the pieces of wire cut in the press, thus making this drawing mode especially suitable for cold forging with horizontal automatic presses;
- the continuous movement of the wire within the spinneret avoids any abnormal overheating of the wire itself and minimizes the possibility of scratches being formed on the surface thereof as well as damage to the spinneret;
- the drawing occurs in the sliding direction of the wire by means of the dragging action of the grippers, which facilitates the introduction of the wire into the press and contributes to the formation of pieces of a proper length with respect to the needs of the press;

- the drawing device is integrated within the same production line; said production line occupies a space which is smaller with respect to the production lines using current drawing techniques, in which the dedicated conventional external drawing machine must be placed at a greater distance from the press;
- coil changes are extremely quick and do not require physically heavy and/or mechanically dangerous tasks to the operators;
- the phasing between different speeds with which the wire may be dragged by the press is performed automatically by the kinematics of the mobile structure controlled by the sliding of the wire, which activates the movements of such mobile structure and, by means of such movements, the electrical commands and the consequent adjustments of the drawing device.

[0025] These and other features of the present invention will become more apparent from the following detailed description of practical exemplary embodiments thereof, shown by way of non-limiting example in the accompanying drawings, in which:

Figure 1 shows a drawing and forging plant;

Figure 2 shows a top plan view of a drawing device, in a resting position;

Figure 3 shows a sectional view along the line III-III of Figure 2;

Figure 4 shows a sectional view of the drawing device similar to that of Figure 3, in a first working position;

Figure 5 shows a sectional view of the drawing device similar to that of Figure 3, in a second working position;

Figure 6 shows a drawing and forging plant, according to a different embodiment;

Figure 7 shows a side view of a portion of the plant of Figure 6;

Figure 8 shows a vertical sectional view of the drawing device of the plant of Figure 6, in a first position;

Figure 9 shows a vertical sectional view of the drawing device of the plant of Figure 6, in a second position;

Figure 10 shows a perspective view of the drawing device of the plant of Figure 6, in the position of Figure 8;

Figure 11 shows a perspective view of the drawing device of the plant of Figure 6, in the position of Figure 9.

[0026] A drawing and forging plant 100 comprises a drawing device 3 and a press 4 (Figure 1).

[0027] The drawing device 3 is formed by a fixed base 15 and by a mobile structure 6 within which a continuous linear drawing is obtained starting from a wire 1 of the metal type, made into a coil 20.

[0028] The mobile structure 6 is adapted to slide on

the fixed base 15 in the direction of the wire 1.

[0029] The drawing device 3 is adapted to feed the wire 1 to the press 4 after the drawing.

[0030] The press 4 is of the horizontal automatic type and performs a process for producing fasteners and metal parts obtained by means of cold forging.

[0031] The mobile structure 6 comprises a drawing die 5, two pairs of grippers 7, 12 mounted on respective slides 8 and 11, which move linearly in the direction of the wire 1, controlled by planetary roller screws 10 operated by brushless motors 9 (Figures 2-5).

[0032] The slides 8, 11 are adapted to slide with respect to a base of the mobile structure 6, in which said base is in turn slidable with respect to the fixed base 15. The sliding direction is always the same, i.e., that of the wire 1.

[0033] At each change of coil 20, the end of the wire 1 is inserted into an introducer apparatus 2 of the plant 1 adapted to feed the wire 1 to the drawing die 5 of the drawing device 3.

[0034] The drawing and forging process consists of two steps, a transitory step for introducing the wire 1 into the press 4, and a production step, i.e., a forging step.

[0035] In the transitory step, at each change of coil 20, the end of the wire 1 is inserted, by means of the introducer apparatus 2, into the drawing die 5 which reduces the section thereof; then, the drawing device 3 draws a few meters of wire 1 and introduces it into the press 4, manually controlled in "pulse" operating mode.

[0036] The drawing is performed inside the mobile structure 6 and is achieved by dragging the wire 1 through the drawing die 5 with the action of the two pairs of grippers 7 and 12.

[0037] The grippers 7 are closed onto the wire 1 with an electrohydraulic command and the slide 8 which contains them performs a linear movement in the direction of a sliding movement 17 of the wire 1, dragging the wire 1 itself inside the drawing die 5 which is integral with the base of the mobile structure 6.

[0038] In the meantime, the grippers 12 placed on the slide 11 and open on the wire 1 approach the grippers 7 placed on the slide 8 with a linear movement of mutual approach.

[0039] At the point of maximum approach between the two slides 8, 11, the grippers 12 are in turn closed onto the wire 1 and at the same time the grippers 7 are opened.

[0040] At this point, both grippers 7, 12 reverse the sliding direction thereof and start a mutual linear receding movement in which, while the grippers 7, now open on wire 1, move in a direction opposite to the sliding direction 17 of the wire 1, the grippers 12 continue the action of dragging and drawing the wire 1 previously started by the grippers 7.

[0041] The uninterrupted repetition of this cycle of movements of the slides 8 and 11, and of the consequent action of dragging the grippers 7 and 12, allows to seamlessly perform the linear drawing of the wire 1, i.e., a continuous linear drawing of the wire 1.

[0042] During the transitory introduction step:

- the brushless motors 9 which provide the driving force for the sliding of the slides 8, 11 and the consequent drawing activities described above, are activated by a manual command,
- while the mobile structure 6 remains locked in a "resting" position at a point 0.

[0043] It should be noted that the point 0 is not necessarily at the extreme right of the fixed base 15 as shown in Figure 3. It is possible to provide a stop which keeps the mobile structure 6 furthest to the left during the transitory step, or not at the end of a guide integral with the fixed base 15 along which the mobile structure 6 is adapted to slide.

[0044] In the production step, namely the forging step, when the press 4 is started for production, the wire 1 which feeds it is dragged to be forged and drags the mobile structure 6 past a proximity sensor 13 which activates a continuous working mode for the drawing device 3.

[0045] During the production step, the brushless motors 9 are activated by the movements of the mobile structure 6, since the wire 1 is anchored to the mobile structure 6 at the drawing point inside the drawing die 5 and controls a movement 22 of the mobile structure 6 itself when it is dragged by the press 4 with the sliding 17.

[0046] This movement 22 activates the proximity sensor 13, placed on the fixed base 15 to control the mobile structure 6, which automatically starts the brushless motors 9 which, by means of the satellite roller screws 10, control the sliding of the two slides 8, 11, activating the continuous linear drawing cycle described above.

[0047] The movement 22 of the mobile structure 6 brings the mobile structure 6 itself to a second proximity sensor 14 which has the function of adjusting the speed of the brushless motors 9 and the consequent drawing speed, thus allowing to manage the dynamic balance of the mobile structure 6 described below.

[0048] In the time interval during which the wire 1 stops the sliding 17 thereof to be cut by the press 4, the mobile structure 6, in turn, stops and immediately afterwards begins to linearly slide in the direction of the movement 21 opposite to the previous movement 22, to due to the combined action of two parallel and concordant forces, i.e., the horizontal component of the weight of the mobile structure 6 due to an inclination 16 of the fixed base 15 with respect to the horizontal plane, and the reaction force which the continuous linear drawing exerts on the wire 1 which is stationary. The weight of the mobile structure 6 therefore assists the movement 21.

[0049] In essence, despite the wire 1 being stationary, a further drawing action occurs due to the return of the mobile structure 6 towards the point 0 which is not reached during the production step.

[0050] At the end of the cutting operation inside the press 4, the wire 1, dragged by the press 4 itself, resumes the sliding 17 thereof and again induces the movement

22 of the linear type of the mobile structure 6.

[0051] The cycle of the movements 22 and 21 of the mobile structure 6 is repeated at each cycle of sliding 17 and blocking the wire 1, or "advance and stop" movement of the jerky type of the wire 1.

[0052] The dynamic balance of the mobile structure 6 is characterized by a slight oscillation with small alternating linear movements 22 and 21 near the proximity sensor 14 which has the function of adjusting the speed of the brushless motors 9 and the consequent drawing speed, so as to keep it consistent with the average speed which characterizes the sliding 17 of the wire 1 towards the press 4.

[0053] Maintaining such dynamic balance of the mobile structure 6 allows to:

- coordinate, within a production line, the continuous motion of the wire, characteristic of the drawing, with the "advance and stop" movement of the wire 1, characteristic of forging;
- automatically compensate for any variations in the average return speed of the wire 1 by the press 4, due to any changes in the working parameters of the press 4 itself.

[0054] When the press 4 interrupts its operation, the return of the wire 1 in the sliding direction 17 is canceled and the two parallel and concordant forces described above push the mobile structure 6 with a linear movement 21 to the point 0.

[0055] Such movement 21 activates the proximity sensor 13 which turns off the drawing device 3.

[0056] In a second embodiment (Figures 7-11) the fixed base 15 is not inclined and therefore the mobile structure 6 moves along a horizontal plane of the fixed base 15 which is integral with the press 4, substantially forming a single machine with the double drawing and forging function. Advantageously, the overall bulk is limited.

[0057] Consequently, in the time interval during which the wire 1 stops the sliding 17 thereof to be cut by the press 4, the mobile structure 6, in turn, stops and immediately afterwards begins to linearly slide in the direction of the movement 21 opposite to the previous one, due to the combined action of the reaction force which the continuous linear drawing exerts on the stationary wire 1 and the force generated by pneumatic pistons 80 which assist said movement 21.

[0058] Each pneumatic piston 80 connects the fixed base 15 to the mobile structure 6 so as to allow the controlled sliding of the mobile structure 6 on the horizontal plane of the fixed base 15 (Figures 8 and 9).

[0059] When the press 4 ends the working step thereof, the wire 1 definitively stops the sliding 17 thereof and the brushless motors 9, assisted by the pneumatic pistons 80, perform for the last time the movement of the upper mobile structure 6 in the direction 21 previously described, until the mobile structure reaches the proximity

sensor 13 that switches off the brushless motors 9.

[0060] The force generated by the pneumatic pistons 80 replaces the weight force due to the inclination 16 of the first embodiment. The effect is equivalent.

[0061] Advantageously, the drawing device 3 according to the present invention allows to:

- perform the entire production cycle with a single mechanical structure in which the continuous linear drawing and forging technologies are integrated, as well as perform the respective operations in a coordinated and simultaneous manner,
- support the action of the wire dragging mechanisms of the cold forging technique (grippers or rollers) arranged in the forging area, exploiting the dragging action, or the sliding 17, with which the continuous linear drawing of the wire 1 is obtained, thus improving the reliability of the dragging itself and preventing the risk of having, when entering the press 4, pieces of wire 1 cut by a length shorter with respect to what is provided for by the forging technique.

[0062] The absence of a direct functional control exerted by the press 4 on the drawing device 3, for example, by means of electromechanical or electrohydraulic commands, is the fundamental factor determining the possibility of integrating, within the same production line, two technologies which subject the wire to different advancement motions.

[0063] This is achieved since, while the grippers 7, 12 continue to exert the dragging action thereof on the wire 1 ensuring the continuity of the linear drawing process, the back and forth alternating linear movement in the sliding direction of the wire 1 of a mobile structure 6, within which the drawing just indicated occurs, allows to harmonize the continuous movement of the wire 1, characteristic of the drawing, with the "advance and stop" movement, characteristic of the forging.

[0064] Such drawing device 3 has the following features:

- the linearity of the drawing avoids the formation of mechanical tensions in the wire 1 after the drawing and the consequent bending induced in the pieces of wire 1 cut in the press 4, thus making this drawing mode especially suitable for cold forging with horizontal automatic presses;
- the continuous movement of the wire 1 within the spinneret avoids any abnormal overheating of the wire 1 itself and minimizes the possibility of scratches being formed on the surface thereof as well as damage to the spinneret;
- the drawing occurs in the sliding direction 17 of the wire 1 by means of the dragging action of the grippers 7, 12, which facilitates the introduction of the wire 1 into the press 4 and contributes to the formation of pieces of a proper length with respect to the needs of the press 4;

- the drawing device 3 is integrated with the press 4, therefore, the production line occupies a space which is smaller with respect to the production lines using current drawing techniques, which require a dedicated external drawing machine;
- the changes of coil 20 are extremely quick and do not require physically heavy and/or mechanically dangerous tasks to the operators;
- the phasing between different speeds with which the wire 1 may be dragged by the press 4 is performed automatically by the kinematics of the mobile structure 6 controlled by the sliding 17 of the wire 1, which activates the movements of such mobile structure 6 and, by means of such movements, the electrical commands and the consequent adjustments of the drawing device 3.

Claims

1. A drawing device (3) for a process of continuous linear drawing of a wire (1) of the metal type made into a coil (20), said drawing device (3) being adapted to feed the wire (1), after the drawing performed by the drawing device (3) itself, to a press (4) of the horizontal automatic type for cold forging, **characterized in that** the drawing device (3) consists of a base (15) resting on the ground on an inclined plane (16), and a mobile structure (6) adapted to perform the continuous linear drawing process by means of the action of two pairs of grippers (7, 12) integrated in two mobile slides (8, 11) actuated by planetary roller screws (10) operated by brushless motors (9), wherein the slides (8, 11) are slidably associated with the mobile structure (6), wherein the mobile structure (6) is adapted to slide with respect to the base (15) with cycles of alternating linear movements in the direction of the wire (1), in opposite directions (21, 22), controlled by the "advance and stop" movement of the wire (1) entering the press (4).
2. A drawing device (3) according to claim 1, **characterized in that** the wire (1) is anchored to the mobile structure (6) at the drawing point inside a drawing die (5), and is adapted to control a movement (22) of the mobile structure (6) itself when it is dragged by the press (4) with a sliding movement (17).
3. A drawing device (3) according to any one of the preceding claims, **characterized in that** in the time interval during which the wire (1) stops the sliding movement (17) thereof to be cut by the press (4), the mobile structure (6) is adapted to slide in one direction with a movement (21) opposite to the previous one due to the combined action of two parallel and concordant forces, i.e., the weight of the mobile

structure (6) in the direction of the wire (1), due to the inclination (16), and the reaction force which the continuous linear drawing exerts on the wire (1) which is stationary.

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4. A drawing device (3) according to any one of the preceding claims, **characterized in that** the cycle of movements (21, 22) of the mobile structure (6) is repeated at each cycle of the "advance and stop" movement of the wire (1) entering the press (4). 10
5. A drawing device (3) according to any one of the preceding claims, **characterized in that** it comprises electrical activation, shutdown and adjustment commands, controlled by proximity sensors (13, 14) in turn activated by the movement of the mobile structure (6). 15
6. A drawing device (3) according to any one of the preceding claims, **characterized in that** it is applied to wires (1) having a circular section and a diameter up to 38 mm. 20
7. A drawing and forging plant (100), comprising a drawing device (3) and a press (4) of the automatic horizontal type for cold forging, **characterized in that** the drawing device (3) is according to any one of the preceding claims. 25

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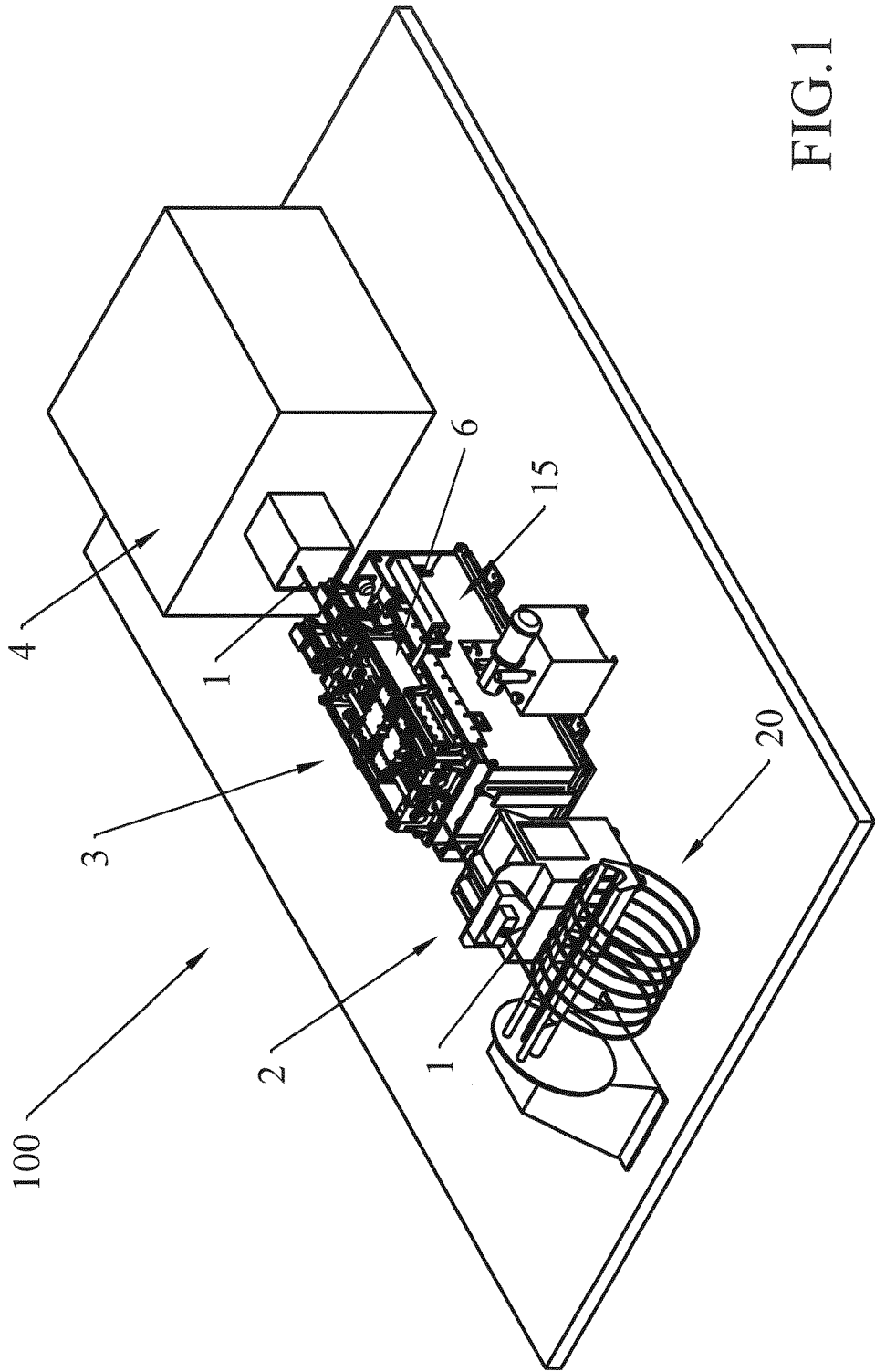


FIG.1

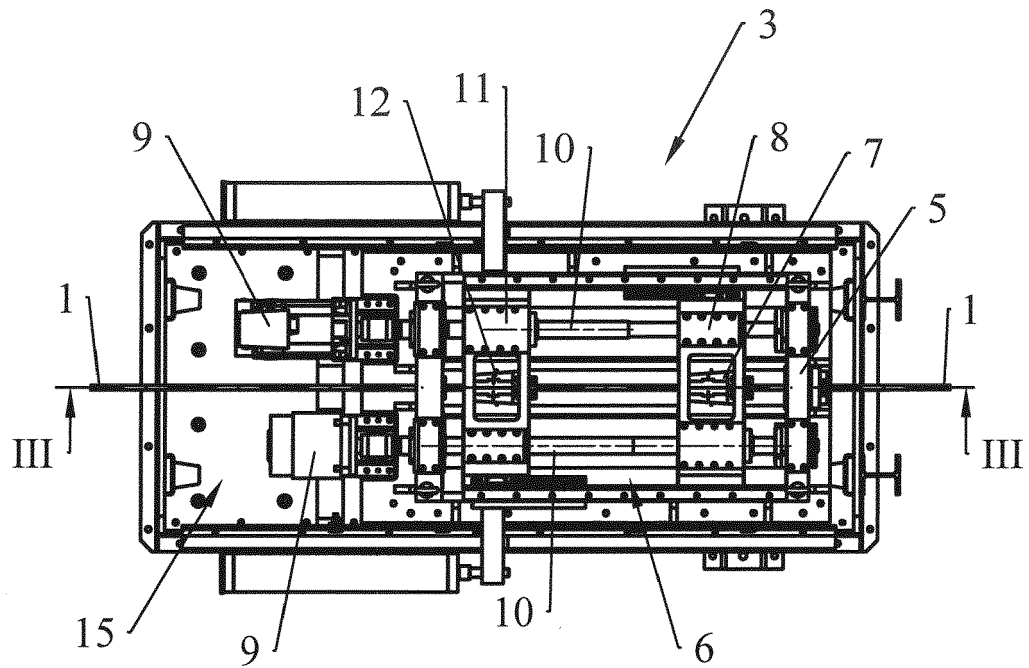


FIG. 2

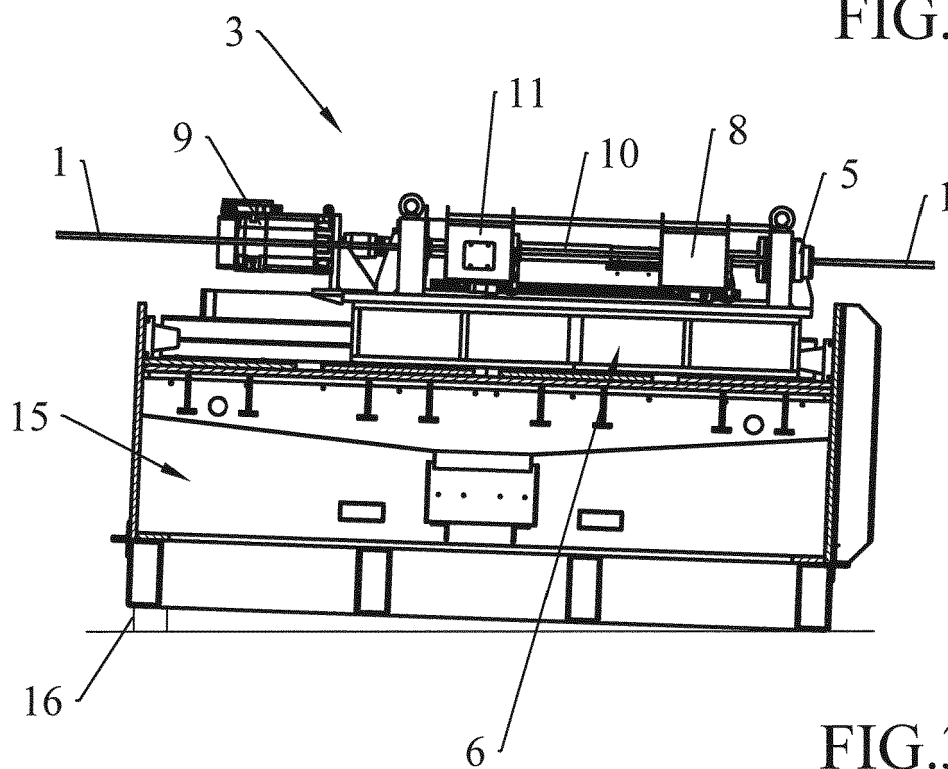


FIG. 3

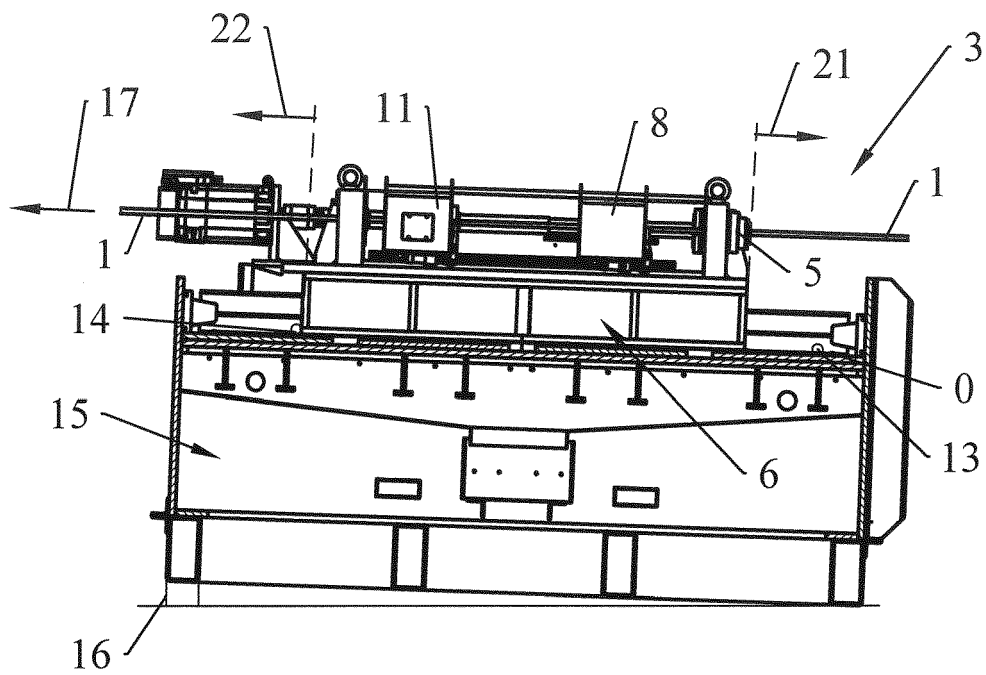


FIG. 4

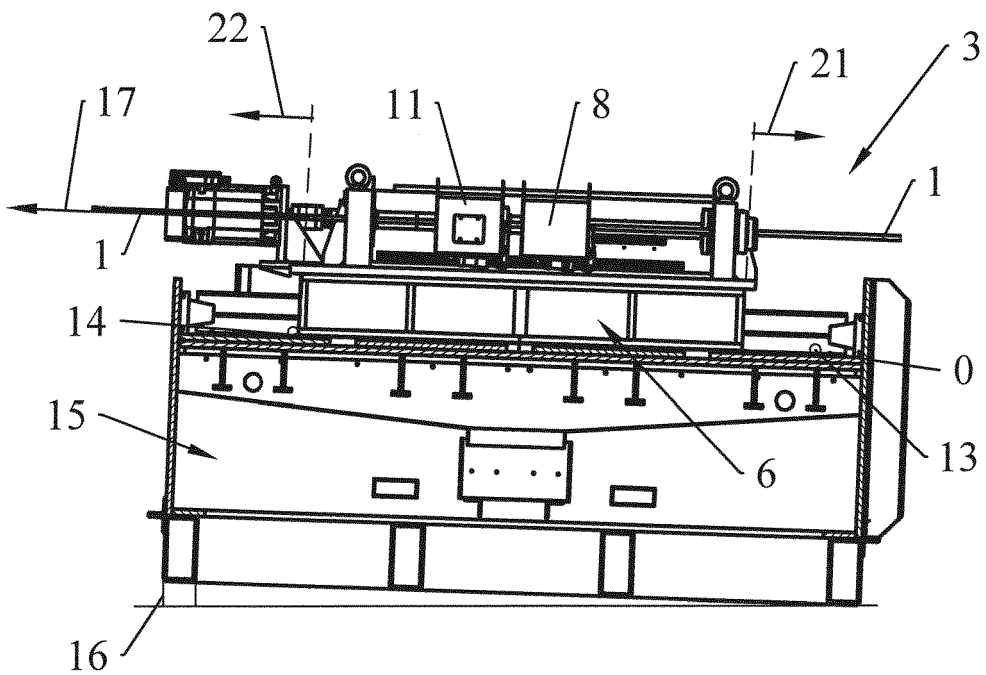


FIG. 5

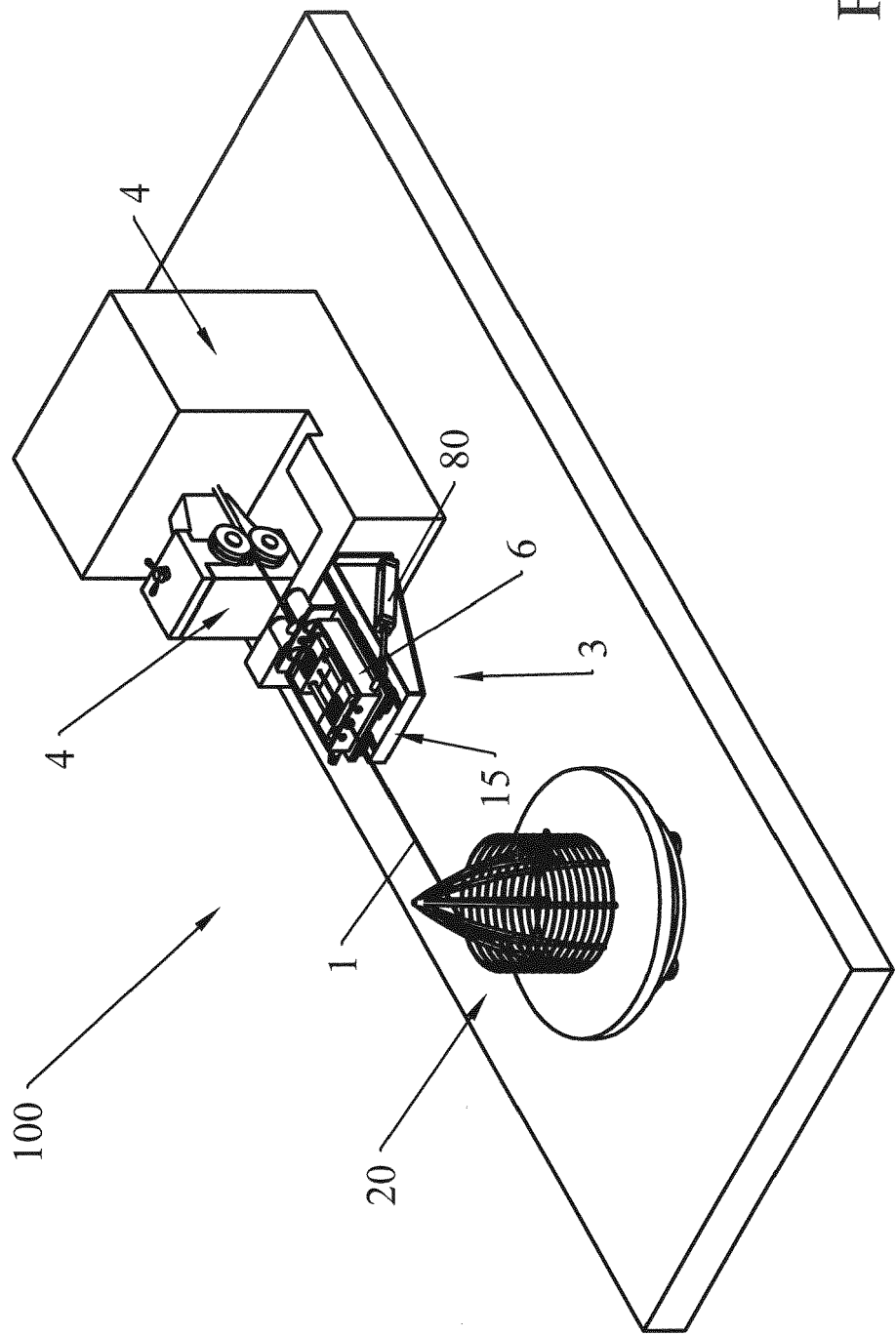


FIG.6

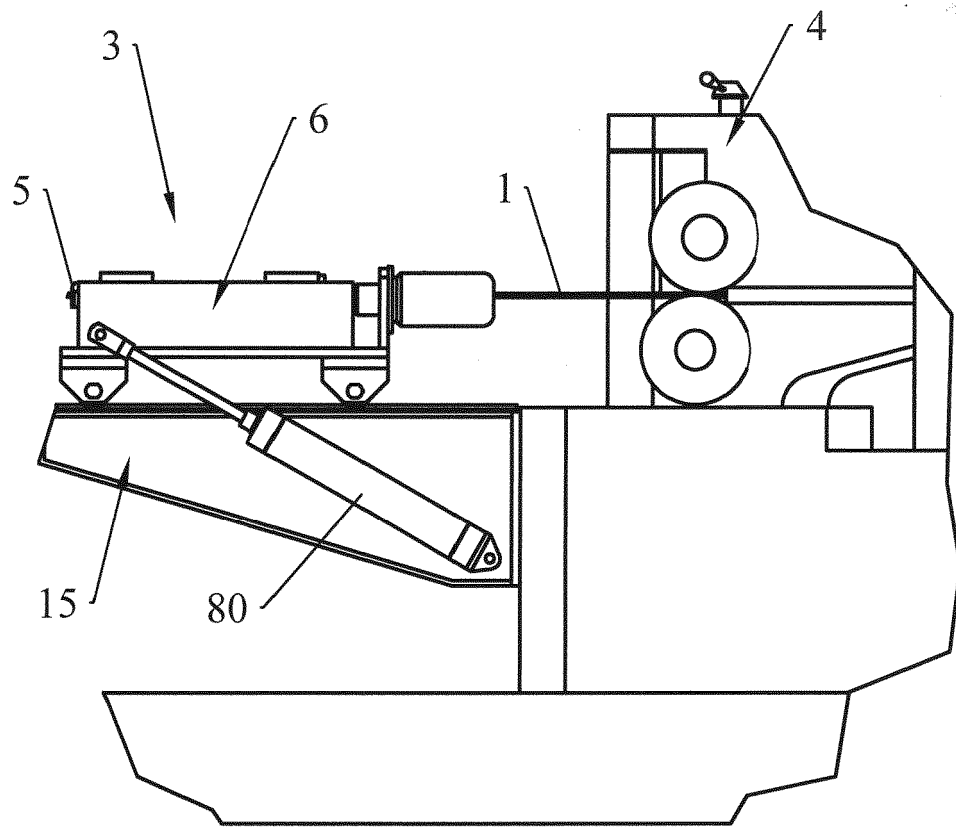


FIG.7

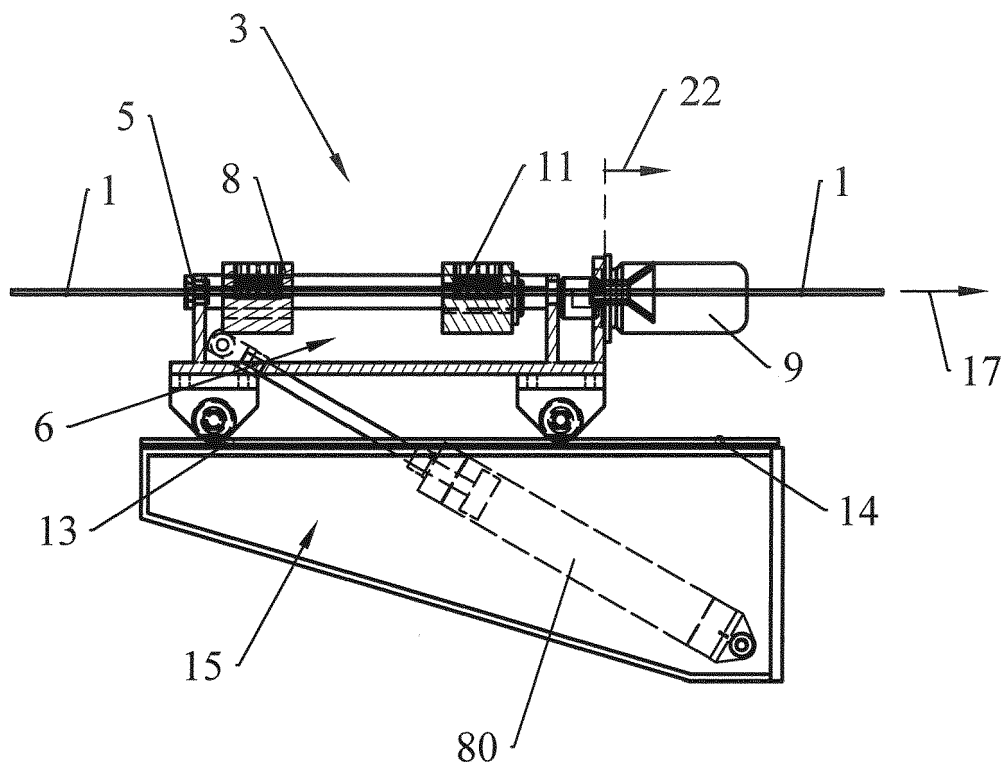


FIG. 8

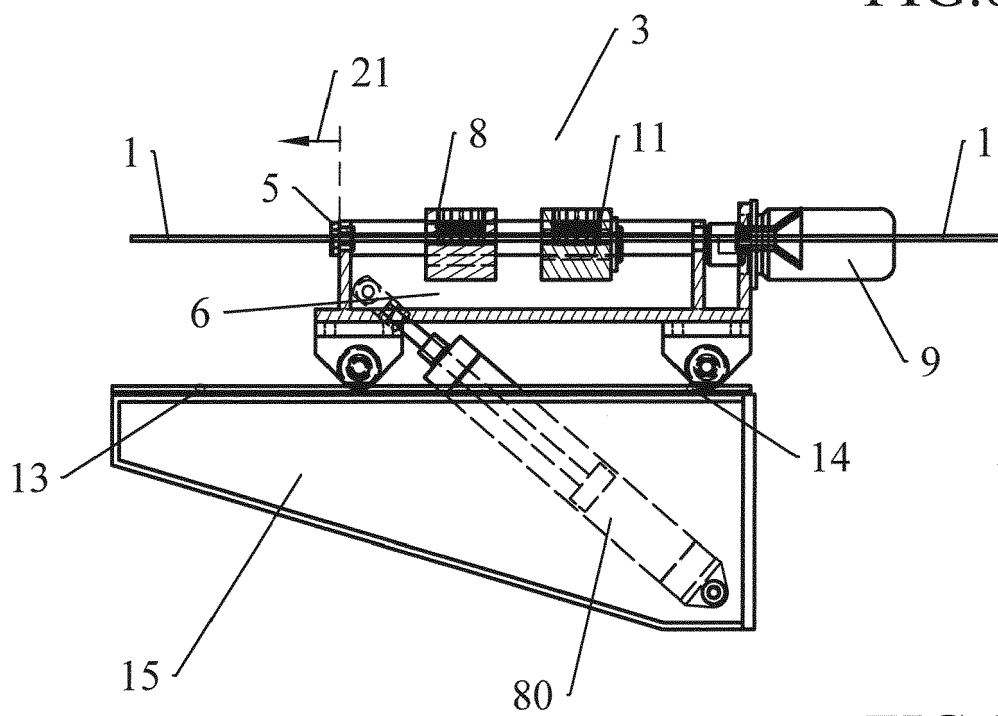


FIG. 9

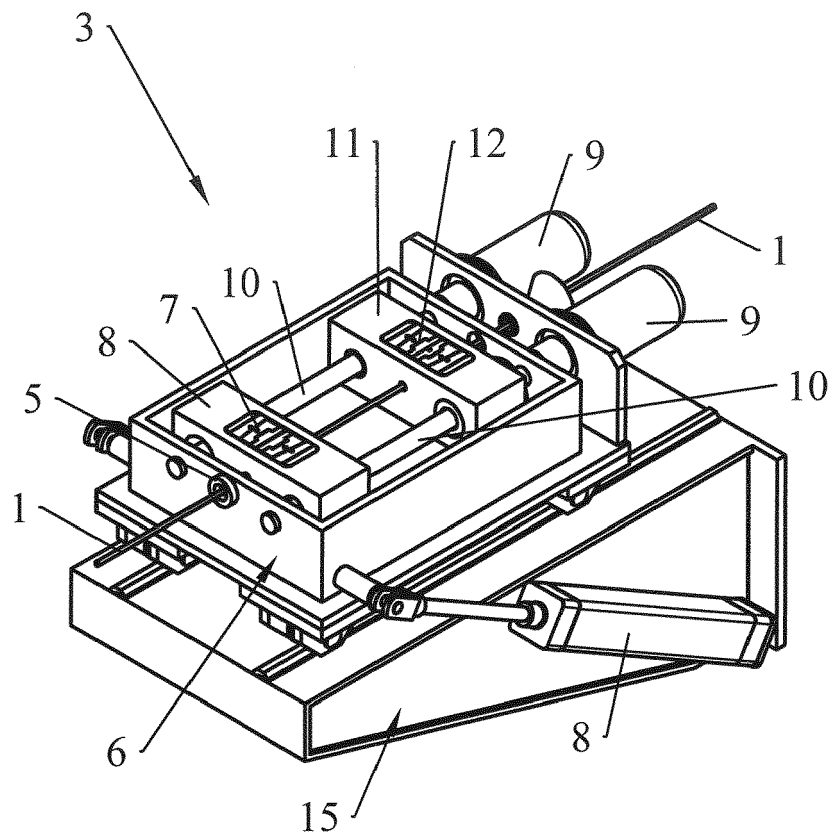


FIG.10

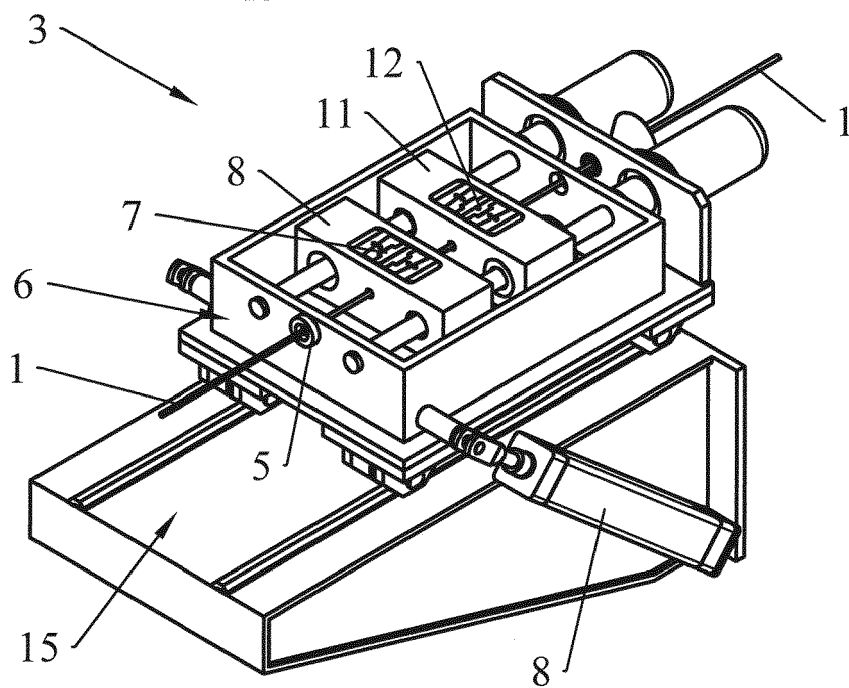


FIG.11



EUROPEAN SEARCH REPORT

Application Number
EP 20 20 4266

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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