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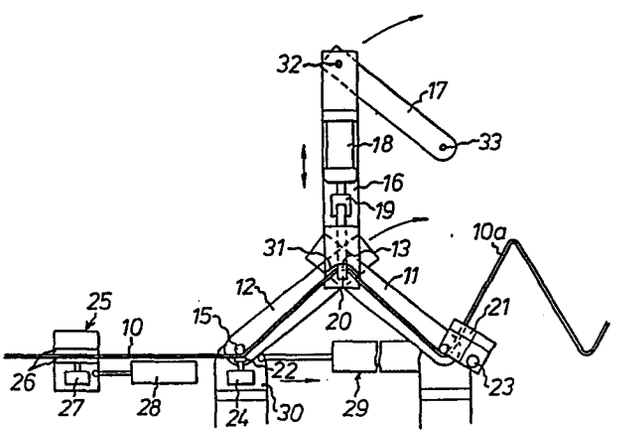
(54) A method and a device for bending a wire into a zigzag shape.

(57) A wire (10) is bent into a zigzag shape by being clamped at two spaced-apart points while a hook (20) engages a point of the wire midway between the two points and pulls the wire against an abutment (31). One of the points is thereafter displaced linearly towards the other point while the hook and the abutment (31) are being pivoted in a circular arc with the other point as centre of pivotment.



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A METHOD AND A DEVICE FOR BENDING A WIRE INTO A ZIGZAG SHAPE

The present invention relates to a method for bending a wire into a zigzag shape and a device for carrying out the method.

It is considerably more difficult than one can imagine to bend a wire into an accurate zigzag shape. The reason for this is that if the bending of a wire turning point deviates ever so little from the bending of the preceding one, the error will be accumulated and the zigzag shape will become skew or irregular, or an arcuate zigzag formation is obtained instead of a straight one. Such an exact zigzag shape is thus not obtainable by the commonest bending technique, namely that using wheels with zigzag-shaped peripheries engaging each other.

The object of the present invention is to provide a method for bending a wire into a zigzag shape in a simple and reliable way and at a high speed without any risk of imperfect bends. According to the invention, this method is achieved in that the wire is held clamped at a first and a second point which are spaced apart, that an engagement member is caused to engage the wire at a third point midway between said points and to pull it into engagement with an abutment by a force which is less than the clamping force at said first and second points, that said second point is displaced linearly towards said first point through a distance which is related to the distance between the turning points of the zigzag shape to be produced, under pivotment of third point with the first point serving as centre of pivotment, a complete bending being performed at the first and third points whereas only half a bending at the second point, and that the wire is thereafter fed, such that the half

bend is placed at the first point for completion during the next bending cycle.

A suitable device for automatically bending a wire into a zigzag shape has a first wire holding member which is movable in and out of the path of movement of the wire to be bent, a second wire holding member which is linearly movable a predetermined distance towards and away from said first wire holding member, a member for engaging the wire midway between the points of engagement of said first and second wire holding members by a force which is less than the force of retention of the first and second wire holding members, means for displacing the second wire holding member towards the first wire holding member in synchronism with a displacement of the wire engaging member in an arcuate path with the point of engagement of the first wire holding member serving as centre, whereby the wire will be completely bent at the points of engagement of the first wire holding member and the engagement member and half bent at the point of engagement of the second wire holding member, a reciprocating element for intermittently feeding the wire such a distance that the point where the wire is half bent is placed in the first wire holding member, and a frame supporting all of said components and having guide means for the wire.

An advantageous embodiment of the invention is characterised in that a first adjusting device is connected to the wire feeding means for changing the wire feeding distance during operation, that a second adjusting device is connected to the second wire holding member to cause it to engage the wire at a point whose spacing from and distance of displacement towards the point of engagement of the first wire holding member corresponds to the adjusted wire feeding distance, and that a third adjusting device is adapted to change the point of engagement of the wire engaging

member with the wire, such that it is constantly located midway between the points of engagement of the wire holding members.

The invention will be described in greater detail hereinbelow with reference to the accompanying drawings, which highly schematically illustrate an embodiment of the invention and in which Fig. 1 is a top plan view of a device for bending a wire with a constant spacing between the turning points of the zigzag shape, while Fig. 2 similarly shows a modified embodiment of the device for bending a wire into a zigzag shape with increasing or decreasing width.

In the drawings, 10 designates a straight wire, for instance of a diameter of 8-10 mm, which is bent into a zigzag shape by means of the illustrated device, as shown at 10a. The machine for bending the wire has two link arms 11, 12 which, at a first end, are pivotally interconnected by means of a bearing 13. The first arm 11 is pivotally mounted by means of a bearing 14 on a frame (not shown). Similarly, the other end of the second arm is pivotally mounted by means of a bearing 15 on an element 30 which is linearly displaceable towards and away from the other end of the first arm 11, as appears from the drawing. A further arm 16 is connected to the arms 11 and 12 by means of the common bearing 13 of said arms. The arm 16, with its distal end with respect to the bearing 13, is pivotally mounted by means of a bearing 32 at the end of an additional arm 17 the opposite end of which is mounted on the frame by means of a bearing 33 at a distance from the bearing 14 of the arm 11 that corresponds to the distance between the bearings 13, 32 of the arm 16, and the distance between the bearings 32, 33 of the arm 17 corresponds to the distance between the bearings 13, 14 of the arm 11. Thus, the arms 11, 16 and 17 form a parallelogrammatic arrangement.

The arms 11, 12, at said other ends, are provided with clamping jaws 21 and 22, respectively, of which the clamping jaw 21 of the first arm is displaceable, by means of a piston and cylinder assembly 23, at right angles to the plane of movement of the arm towards and away from an abutment connected to the frame at a point directly above the bearing of the arm 11 to clamp the wire and release it after the bending operation, while the clamping jaw 22 of the other arm is displaceable in the plane of movement of the arm towards and away from an abutment mounted on the frame concentrically with the bearing 15 of the arm, by means of a piston and cylinder assembly 24. Preferably, the clamping jaw 21 and its abutment are mounted on a supporting device pivotally adjustable on the frame in the plane of movement of the arm 11. The jaw 21 operates at right angles to the path of movement of the arm in order that it should be removable from the path of movement of the bent wire 10 when the wire should be advanced, as will be more fully explained hereinbelow. A piston and cylinder assembly 18 is mounted on the arm 16 and connected by a coupling 19 to a hook 20 which, by means of said piston and cylinder assembly, can be raised and lowered and pulled in the direction of a bearing housing and an abutment 31 in order, when in the lowered position, to draw the wire 10 against the surface of the abutment which is facing the wire and which is bevelled towards the centre from the vertical side edges.

A feeding device 25 is adapted to engage the wire 10 by means of a jaw assembly 26 which is brought into and out of engagement with the wire 10 by means of a piston and cylinder assembly, to feed it a predetermined distance. The feeding device is reciprocating in the longitudinal direction of the wire 10 with the aid of a piston and cylinder assembly 28.

The device described above operates in the following manner when used for bending a wire 10 into a zigzag shape 10a. It is assumed that the formation illustrated to the right in the drawing has previously been performed and that the machine is in the starting position for a new bending operation with the arms 11, 12 and 16 in their lowermost position in the drawing. On activation of the apparatus, the piston and cylinder assemblies 23 and 24 are operated and clamp the wire 10 against the pertaining abutment. At the same time, the piston and cylinder assembly 18 is activated, whereby the hook 20 is lowered over the wire and pulled with the wire against the abutment 31 where the wire is prebent because of the centrally directed bevel of the abutment surface and the shanks of the zigzag formation are stretched. When the piston and cylinder assembly 29 is activated, the element 30, which supports said other end of the arm 12, is pulled linearly towards said other end of the arm 11. As clearly appears from the drawing, the arms 11, 12 will then swing towards each other at the same time as the arm assembly is pivoted about the bearing 14. The arm 17 is so mounted on the frame that it extends in parallel with the arm 11 and since the bearings of the arm 17 are spaced the same distance from each other as those of the arm 11, the parallelogrammatic arrangement is obtained which during the movement of the arms maintains the arm 16 on a line which is an extension of the bisector of the angle formed by the arms 11 and 12. Of great importance for the bending operation is that the force by which the wire is retained by means of the clamping jaws 21, 22 exceeds the force by which the hook holds the wire and which is determined by the tractive force of the piston and cylinder assembly 18, such that the hook 20 can be extracted (by being resilient) a certain distance, about 5 mm, when the assembly 18 starts to pull. In actual practice, it has proved

suitable that the jaws 21, 22 hold the wire by a force of about 1 ton while the tractive force of the piston and cylinder assembly is about 350 kg. When the element 30 has been moved towards the bearing 14 to an extent corresponding to the desired profile width, the two bends produced at the clamping jaw 21 and at the hook 20, are complete whereas only half a bend has been achieved at the clamping jaw 22. The piston and cylinder assembly 29 is thereafter deactivated and the jaws 21, 22, like the hook 20, are released by deactivation of the pertaining piston and cylinder assemblies. The hook is thereafter lifted out of its engagement with the wire which has now been bent. During the bending operation, the feed device has been moved to the left in the drawing out of its engagement with the wire 10, and after the jaws 21, 22 and the hook 20 have been released, the piston and cylinder assembly 27 is activated, such that the jaw assembly 26 is clamped about the wire, whereupon the piston and cylinder assembly 28 is activated for moving the wire 10 to the right in the drawing such a distance that the wire portion half bent in the jaw 22 is placed in the jaw 21. As earlier mentioned, the jaw 21 is removed from the path of movement of the wire, such that it may move freely in the direction of feed. During the movement of the wire 10, the piston and cylinder assembly 29 is activated for returning the arms 11, 12 to their position of alignment, whereafter a new cycle can be commenced with the wire portion half bent in the clamping jaw 22, now in position in the clamping jaw 21.

Fig. 2 shows a modified embodiment of the invention which is intended for making zigzag shapes with increasing and/or decreasing width, for instance for use as webs in beams with increasing and/or decreasing spacings between the flanges. To make it possible to produce such zigzag formations, means must be pro-

vided for changing the wire lengths which are fed and thereafter bent, which means that the feed device must be adjustable, like the limits of the reciprocating movement of the proximal clamping jaw with respect to the feed device. Moreover, the point of engagement of the hook engaging the wire midway between the clamping jaws must be so adjustable that the hook will always engage the wire at the correct point. A device for carrying out this process is illustrated in Fig. 2.

In Fig. 2, 40 designates a clamping jaw corresponding to the clamping jaw 21 in Fig. 1 and being displaceable upwardly and downwardly in the vertical direction by means of a piston and cylinder assembly 41 in the same manner and for the same purpose as the clamping jaw 21. An element 42 equipped with a clamping jaw 43 and corresponding to the element 30 is provided, like a feed device 44 with clamping jaws 45. 46 designates a hook device for engaging the wire 10 midway between the points of engagement of the clamping jaws 40, 43, and 47 designates a device for operating the hook device 46. The hook device 46 and the device 47 for operating it may be designed in the manner shown in Fig. 1, and arms corresponding to the arms 11, 12 in Fig. 1 may also be provided but are not shown in Fig. 2 to indicate that there are also other possibilities for pivoting the hook device 46, for instance by means of an arrangement of piston and cylinder assemblies. The essential thing is that the hook device engages the wire midway between the bending points produced by the clamping jaws 40 and 43 and that the force of engagement of the hook device is less than the force by which the clamping jaws 40, 43 engage the wire 10, as in the previous embodiment.

In order to change the length of wire which is fed and thereafter bent, two motors 48 and 49 (Fig. 2) are provided which are each connected to a shaft 50 and 51, respectively. The first shaft 50 has a first

threaded portion 52 and a second threaded portion 53. The second shaft 51 has a first threaded portion 54 and a second threaded portion 55. The two threaded portions of the first shaft 50 and the first threaded portion of the second shaft 51 consist of threads of the same pitch while the second threaded portion 55 of the shaft 51 consists of a thread with but half said pitch. An abutment 56 with a threaded throughhole is disposed on the first threaded portion 52 of the first shaft 50. Similarly, abutments 58 and 59 with threaded throughholes are disposed on the first threaded portion 54 of the second shaft and on the second threaded portion 53 of the first shaft, respectively.

The feed device 44 has a projection 63 of shorter length and a projection 64 of greater length. As appears from the figure, the shorter projection 63 of the feed device engages a fixed abutment 57 in its forward position while the longer projection 64 engages an abutment 56 in the rear position of the feed device. By rotation of the shaft 50 and, hence, of the threaded portion 52, the position of the abutment 56 is changed and, in this way, it is easy to change the range of the distance within which the feed device 44 is moving, such that wire portions of different lengths can be fed. Similarly, the movable element 42 has a shorter projection 65 and a longer projection 66, the shorter projection 65 engaging the abutment 58 on the first threaded portion of the second arm when the element 42 is in its position to the left in the figure while the longer projection 66 engages the abutment 59 on the second threaded portion 53 of the first arm when the element 42 is in its end position to the right in the figure. This ensures that the element 42 is displaced a distance which corresponds to the extended or shortened wire length fed by the feed device 44. Naturally, the hook device 46 must also be adjusted to the adjusted wire length, which in the instant

is effected by means of a guide member 61 having a rounded entrance ramp 62. The guide member 61 has a protruding lug 60 with a threaded throughhole which engages the second threaded portion of the second shaft. The member 61 should be moved but half the distance as compared with the feed device 44 and for this reason the thread of the threaded portion 55 has but half the pitch as compared with the other threaded portions 52, 53 and 54. In Fig. 2, guide means (not shown) are adapted to activate the two motors 48 and 49 which are of a suitable type specific to the contemplated purpose, at the right moment of the bending cycle. Thus, the motor 49 is activated when the element 42 has started to move towards the clamping jaw 40 and the engagement device 46 has left the member 61. Thus, the abutment 58 and the lug 60 are displaced a predetermined distance in anticipation of the next bending cycle. When bending has been effected and the element 42 starts its movement to the left, the motor 48 is activated, which is of the same type as the motor 49, whereby the abutments 56 and 59 are moved the desired distance. In order to interrupt the movement of the elements 44 and 42, as their projections reach the pertaining abutment, microswitches or other means may be used. In Fig. 2, it is assumed that the feed device 44 and the element 42 with the clamping jaw 43, as in the previous embodiment, are displaced during the feeding and wire bending operations, respectively, by means of piston and cylinder assemblies of the same type as described above. However, it is of course also conceivable to have the shafts 50, 51 with the threaded portions directly engage the elements 44 and 42 for producing the feeding and bending movements, respectively, although the operational speed will thereby be reduced. It appears that the abutments 56 and 59 are always moved over equally long distances in the same direction, for which reason they may be interconnected.

In the foregoing, the wire 10 has been regarded as a rigid, unresilient body but a certain degree of resilience will of course always exist. This will however not affect the method of bending or the apparatus per se. However, regard should be paid when setting the apparatus.

The schematic figures of the drawings are primarily intended to illustrate the novel bending principle, and it goes without saying that, in actual practice, the machine has a number of components which are not shown in the drawings, for instance a straightening device before the feed device 25 and control means controlling the supply of fluid to the different piston and cylinder assemblies, such that these are activated in the correct order.

CLAIMS

1. A method for bending a wire (10) into a zigzag shape (10a), c h a r a c t e r i s e d in that the wire (10) is held clamped at a first and a second point which are spaced apart, that an engagement member (20) is caused to engage the wire at a third point midway between said points and to pull it into engagement with an abutment (31) by a force which is less than the clamping force at said first and second points, that said second point is displaced linearly towards said first point through a distance which is related to the distance between the turning points of the zigzag shape to be produced, under pivotment of said third point with the first point serving as centre of pivotment, a complete bending being performed at said first and third points whereas only half a bending at the second point, and that the wire is thereafter fed, such that the half bend is placed at the first point for completion during the next bending cycle.

2. Method as claimed in claim 1, c h a r a c - t e r i s e d in that the engagement member (20) pulls the wire into engagement with an abutment (31) forming an angle in the plane of bending, such that the wire (10) is prebent on either side of the point of engagement of said engagement member (20) at the same time as a tractive force is exerted in the wire portions between the point of engagement of the engagement member and the first and second points.

3. Method as claimed in claim 1 or 2, in which the width of the zigzag shape is continuously increased or decreased, e.g. for use of the wire as a web in beams with increasing and decreasing spacings, respectively, between the flanges, c h a r a c t e r i s e d in that the wire (10) is fed a distance which exceeds or falls below the preceding feeding distance, and

that the position and distance of displacement of said second point of engagement, like the point of engagement of the engagement member (20), are adjusted in correspondence with the change of the feeding distance.

4. A device for automatically bending a wire (10) into a zigzag shape (10a), c h a r a c t e r i s e d by a first wire holding member (21) which is movable in and out of the path of movement of the wire (10) to be bent, a second wire holding member (22) which is linearly movable a predetermined distance towards and away from said first wire holding member (21), a member (20) for engaging the wire (10) midway between the points of engagement of said first and second wire holding members (21 and 22, respectively) by a force which is less than the force of retention of the first and second wire holding members (21 and 22, respectively), means (29) for displacing the second wire holding member (22) towards the first wire holding member (21) in synchronism with a displacement of the wire engaging member (20) in an arcuate path with the point of engagement of the first wire holding member (21) serving as centre, whereby the wire will be completely bent at the points of engagement of the first wire holding member and the engagement member and half bent at the point of engagement of the second wire holding member, a reciprocating element (25) for intermittently feeding the wire (10) such a distance that the point where the wire is half bent is placed in the first wire holding member (21), and a frame supporting all of said components and having guide means for the wire.

5. Device as claimed in claim 4, c h a r a c t e r i s e d in that a first and a second link arm (11 and 12, respectively) are pivotally interconnected at a first end, said first arm (11), at its opposite end, being pivotally mounted on the frame concentrically

with the point of engagement of the first wire holding member (21) and said second arm (12), at its opposite end, being pivotally mounted on an element (30) which is guided on said frame and linearly displaceable towards and away from said opposite end of the first arm (11), and which also supports said second wire holding member (22) with the point of engagement thereof concentric with the bearing of said arm, and that the wire engaging member (20) is disposed at the point where the arms (11, 12) are pivotally interconnected.

6. Device as claimed in claim 5, c h a r a c t e r i s e d in that the wire holding member (21) at said opposite end of the first arm (11) consists of a hydraulic clamping jaw acting at right angles to the plane of movement of the arm (11) against an abutment on the frame, while the wire holding member (22) at said opposite end of the second arm (12) consists of a hydraulic clamping jaw acting in a plane parallel to the plane of movement of the arm (12), also against an abutment on the frame.

7. Device as claimed in claim 4 or 5, c h a r a c t e r i s e d in that the wire engaging member (20) is mounted on a third arm (16) one end of which is pivotally mounted in the bearing (13) by means of which the first and second arms are pivotally interconnected, and the other end of which is pivotally mounted adjacent one end of a fourth arm (17) the opposite end of which is pivotally mounted on the frame at a distance from the location of the bearing (14) at said opposite end of the first arm (11), corresponding to the distance between the bearings of the third arm (16).

8. Device as claimed in claim 6, c h a r a c t e r i s e d in that the wire engaging member (20) on the third arm (16) consists of a raisable and lowerable hook which is connected to a piston and cylinder assembly (18) by means of a shaft which extends cen-

trally through a bearing housing (31) whose surface facing the bearing of the first and second arms (11, 12) is bevelled in the wire bending plane towards the centre from the opposite end edges of the housing which extend perpendicularly to the bending plane, such that the hook (20) projecting centrally from said bevelled surface, after being lowered over the wire (10), can pull the wire (10) against said surface so that the wire is prebent and a tension is applied to the wire portions extending from the point of bending to the wife clamping members (21, 22) at said opposite ends of the arms (11, 12).

9. Device as claimed in claim 4, c h a r a c t e r i s e d in that the feed device (25) consists of a pneumatically or hydraulically operable jaw assembly (26) which is displaceable on the frame by means of a piston and cylinder assembly (27).

10. Device as claimed in claim 4, c h a r a c t e r i s e d in that a first adjusting device (52, 56, 57) is connected to the wire feeding means (44) for changing the wire feeding distance during operation, that a second adjusting device (53, 59, 54, 58) is connected to the second wire holding member (42) to cause it to engage the wire (10) at a point whose spacing from and distance of displacement towards the point of engagement of the first wire holding member (40) corresponds to the adjusted wire feeding distance, and that a third adjusting device (55, 60) is adapted to change the point of engagement of the wire engaging member (46) with the wire (10), such that it is constantly located midway between the points of engagement of the wire holding members (40, 42).

11. Device as claimed in claim 10, c h a r a c t e r i s e d in that the first adjusting device consists of a fixed and a movable abutment (57 and

56, respectively) between which the wire feeding means (44) is movable and of which the movable abutment (56) has a threaded opening which is disposed on a first threaded portion (52) of a first motor-powered shaft (50), that said second adjusting device comprises two movable abutments (58, 59) between which the second wire holding member (42) is movable and of which one has a threaded opening which is disposed on a first threaded portion (54) on a second motor-powered shaft (51) while the second abutment (59) has a threaded opening which is disposed on a second threaded portion (53) of said first motor-powered shaft (50) and that the third adjusting device consists of a lug (60) connected to the wire engaging member (46) and having a threaded opening which is disposed on a second threaded portion (55) of the second shaft (51), the threaded portions (52, 53) of the first shaft (50) and the first threaded portion (54) of the second shaft (51) consisting of threads of the same pitch, while the second threaded portion (55) of the second shaft (51) consists of a thread which has a pitch half that of the first-mentioned threads, and that means are provided for controlling the motors, such that the shafts (50, 51) will rotate at correct points of time in the bending cycle.

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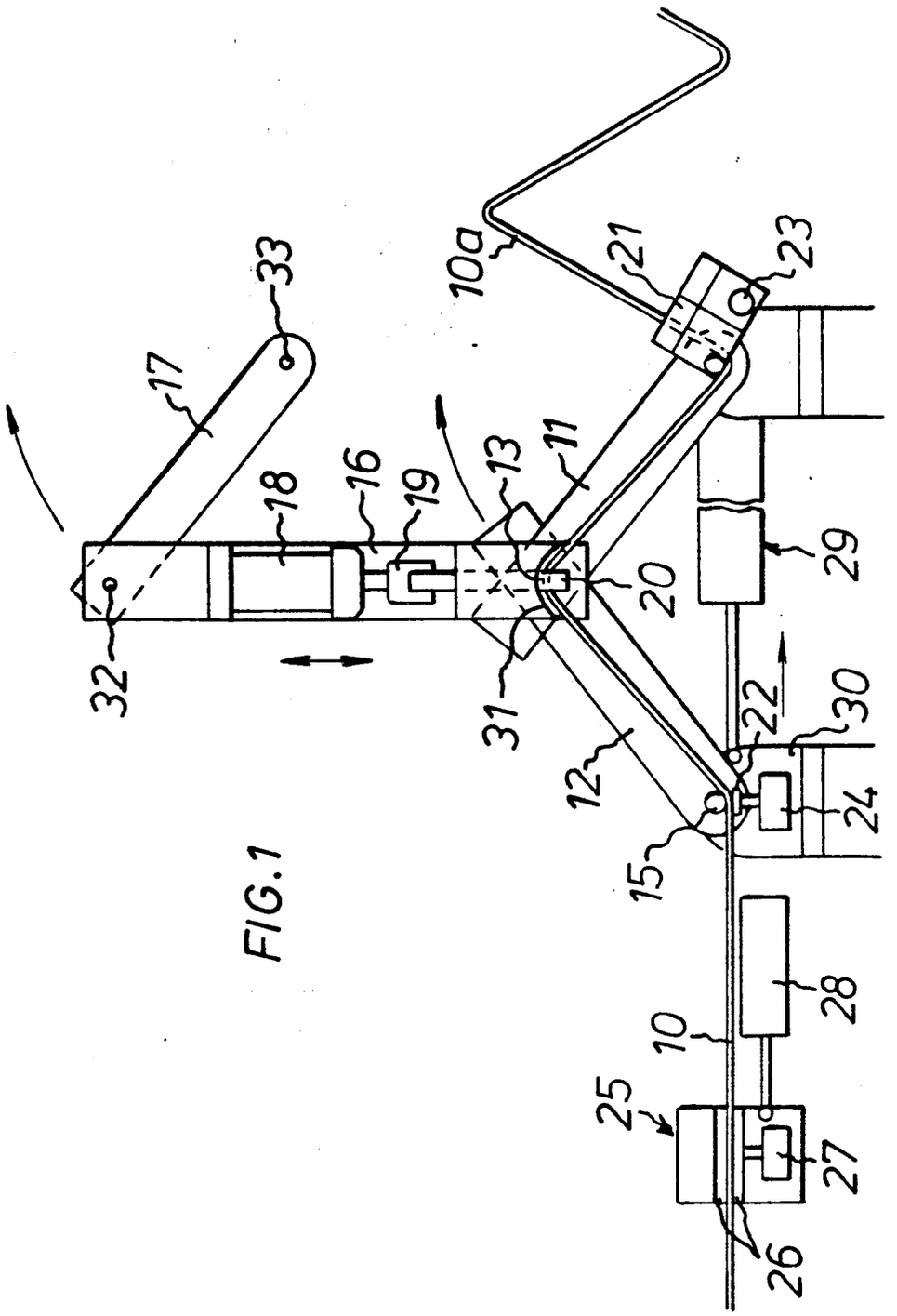
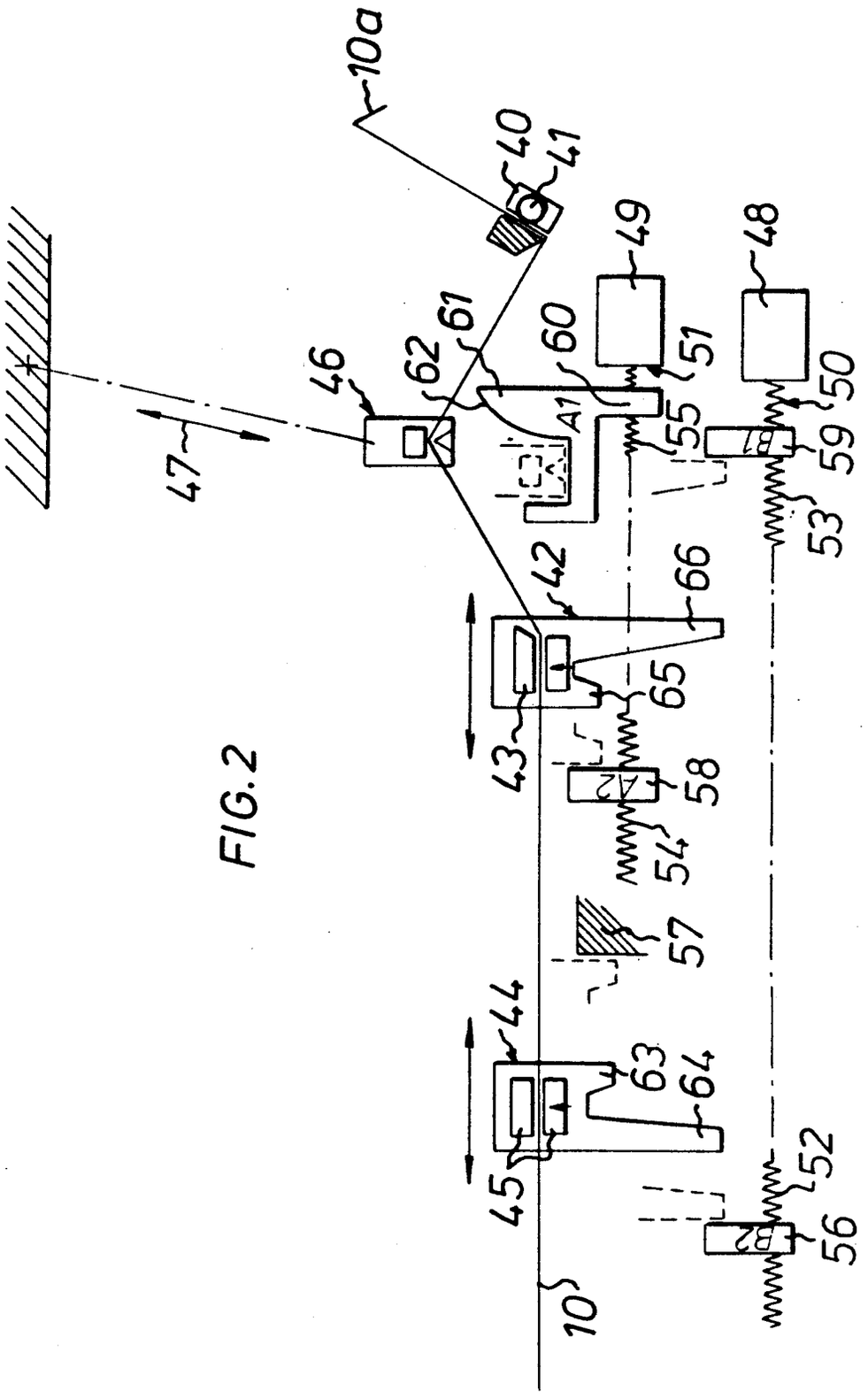


FIG.1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B2
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FIG.2