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(54) **TWISTING APPARATUS OF ELECTRIC WIRES**

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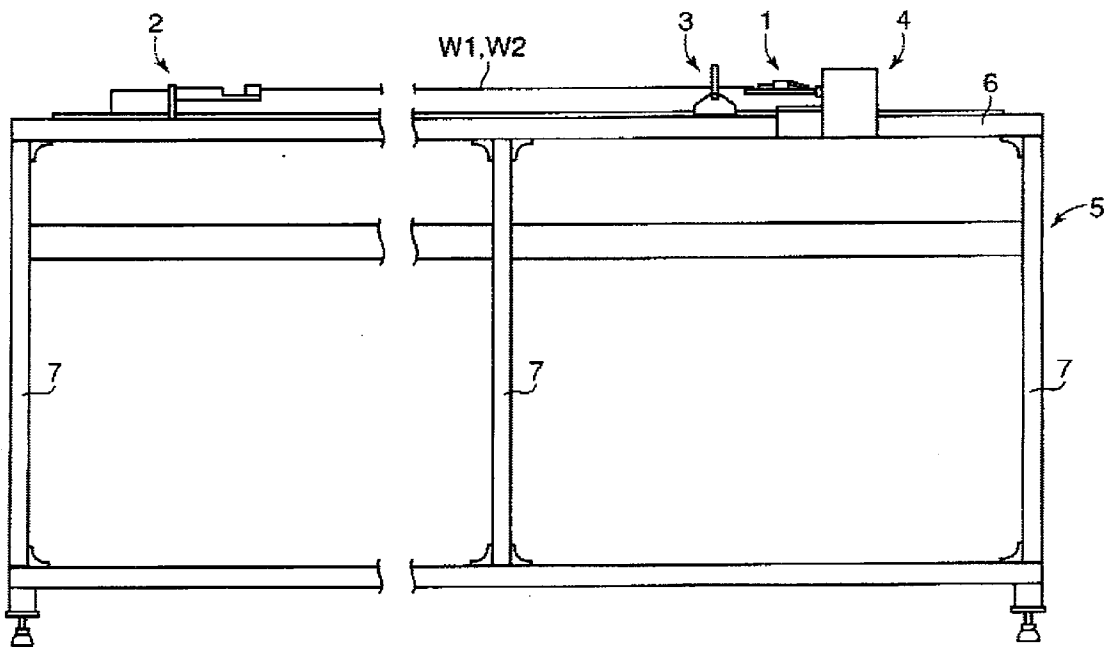
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(57) **ABSTRACT**

A twisting apparatus of electric wires includes a first holding unit (1) for holding first ends of a pair of electric wires (W1, W2), a second holding unit (2) for holding second ends of the electric wires (W1, W2), and a twist drive unit (4) for rotating the first holding unit (1) to twist the electric wires (W1, W2). The second holding unit (2) includes a pair of support members (27) that rotate together with the first ends of the electric wires (W1, W2), and a rotary synchronous mechanism (28) that rotates both support members (27) at the same speed and in the same direction by transmitting a rotary force from the one support member (27) to the other support member (27) when the one support member (27) rotates.



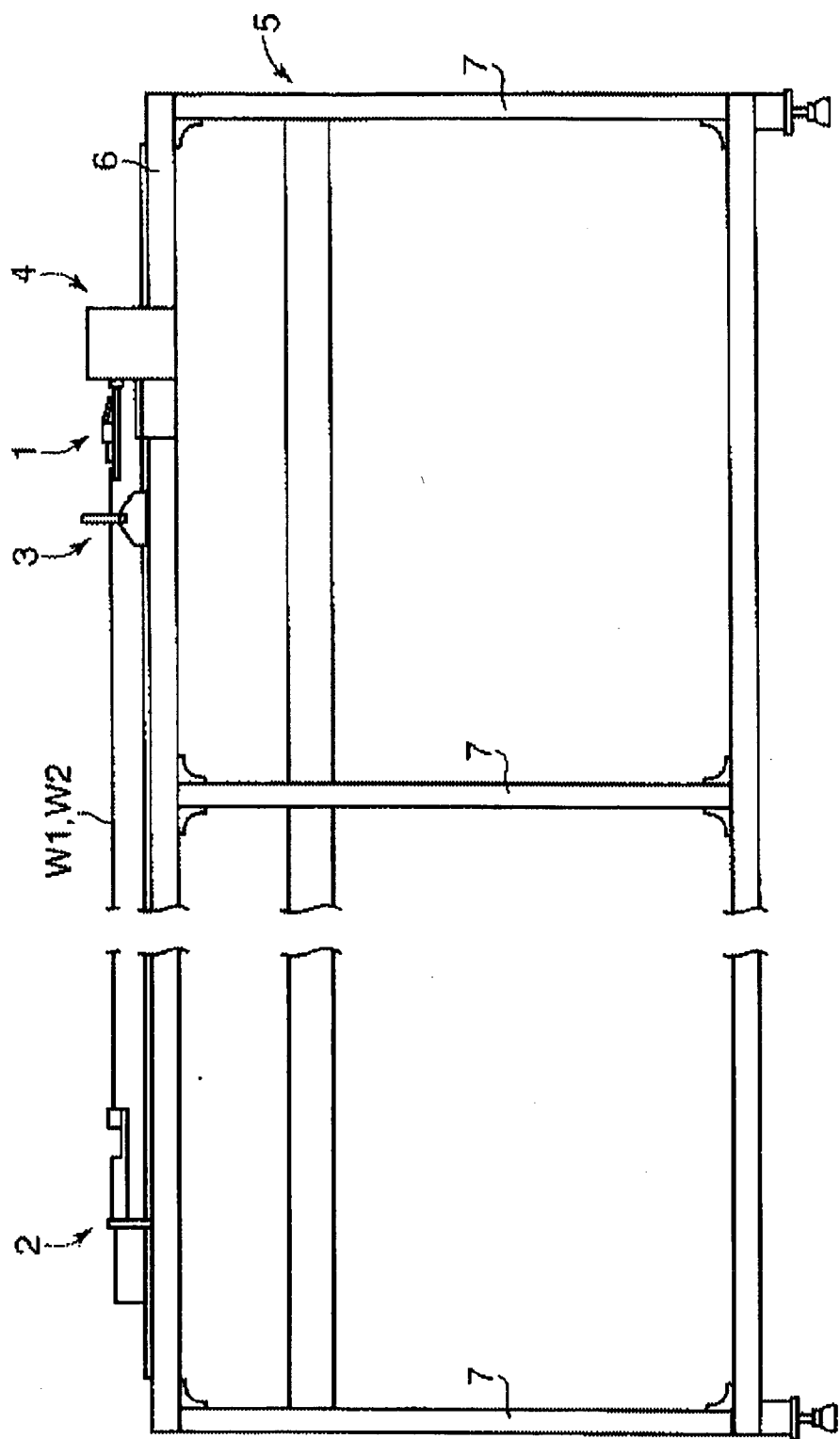
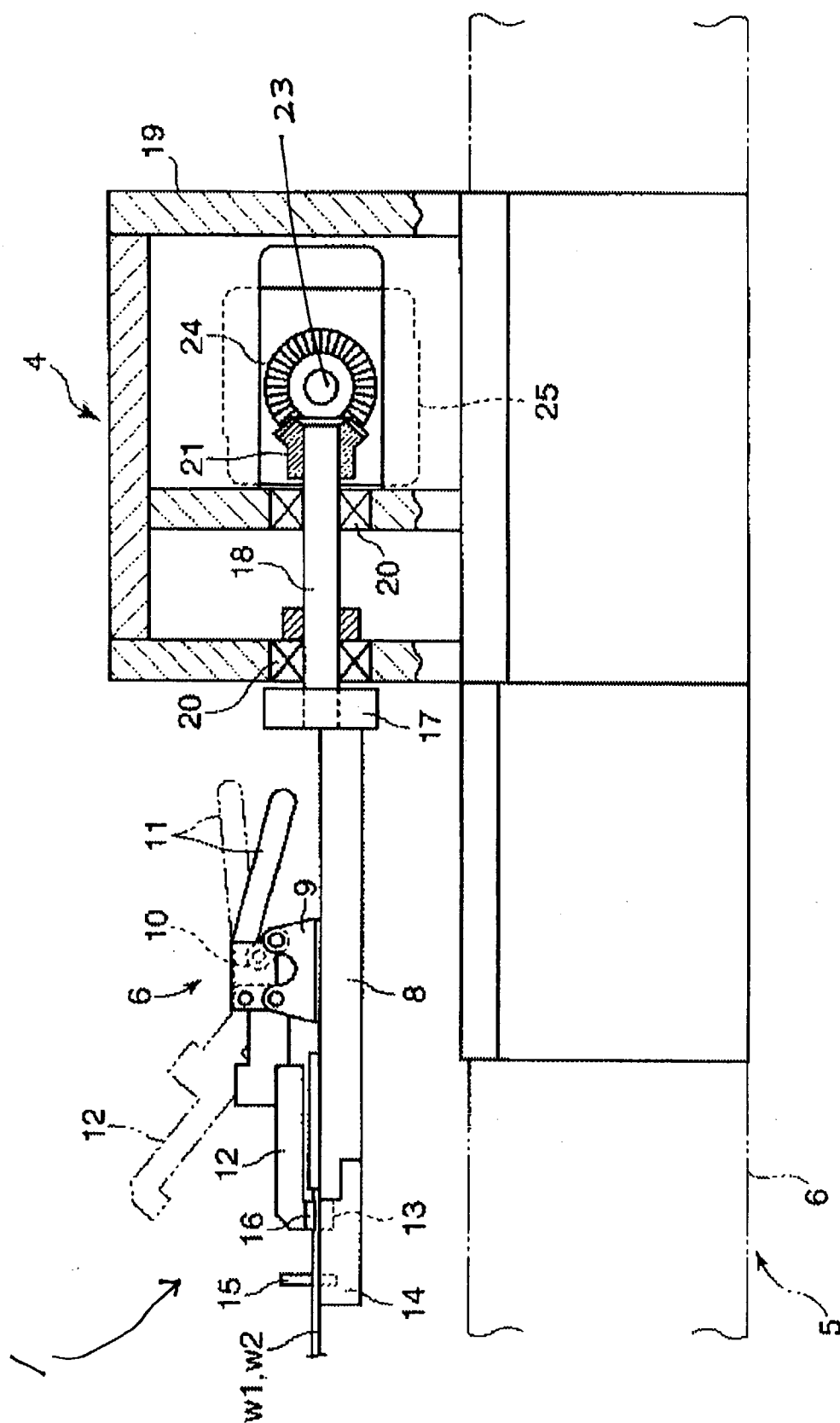


FIG. 1



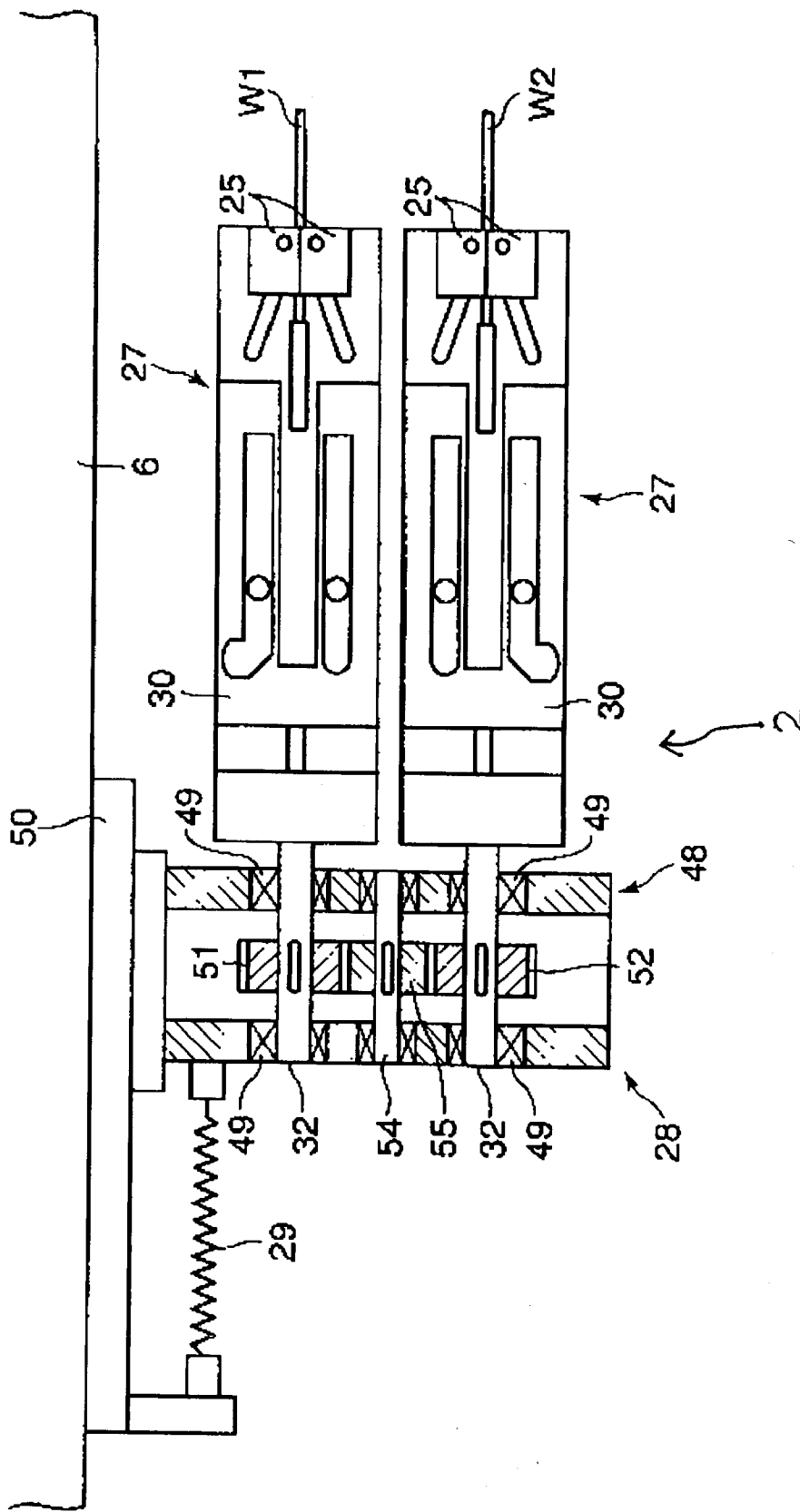


FIG. 4

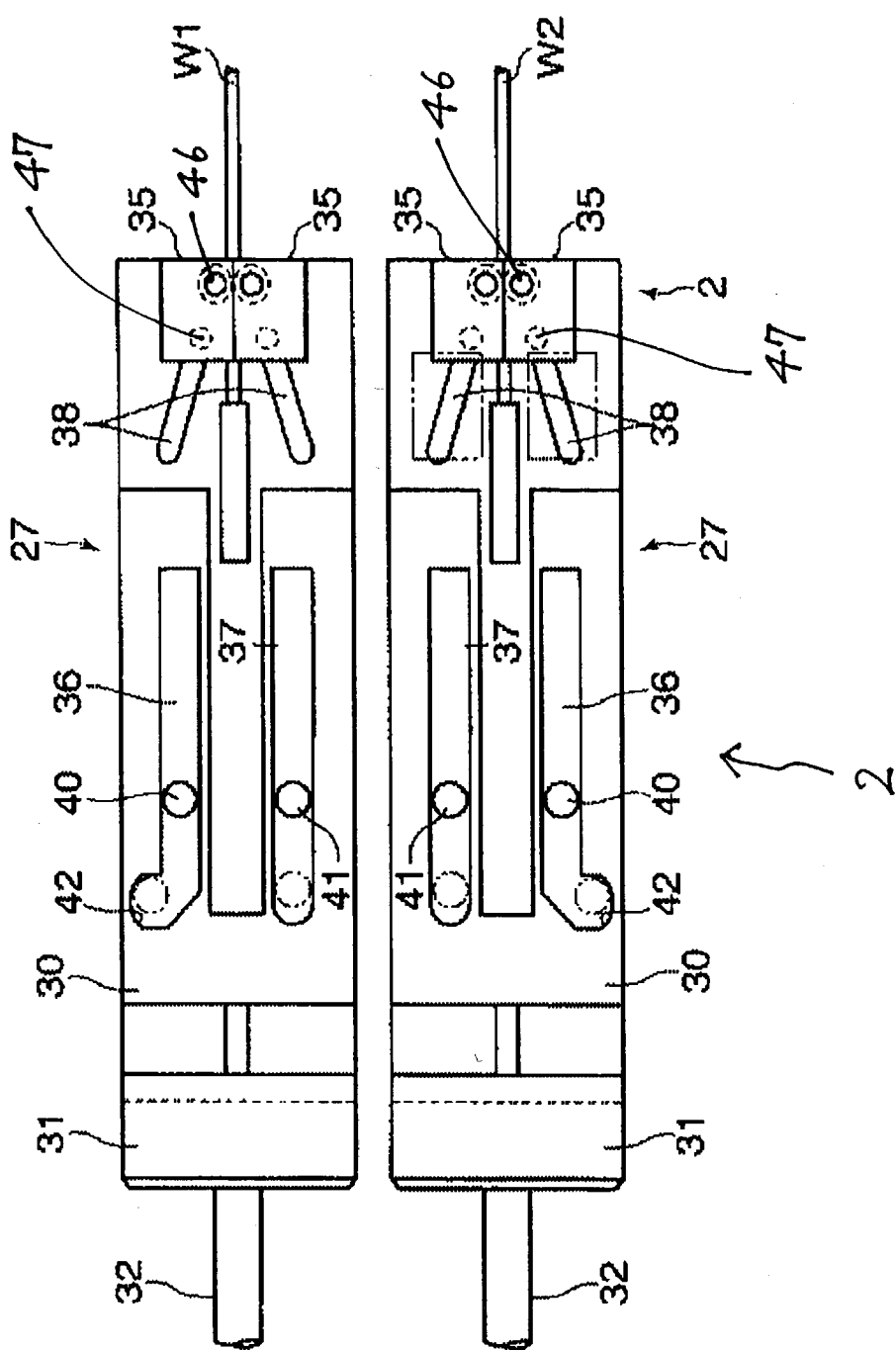


FIG. 5

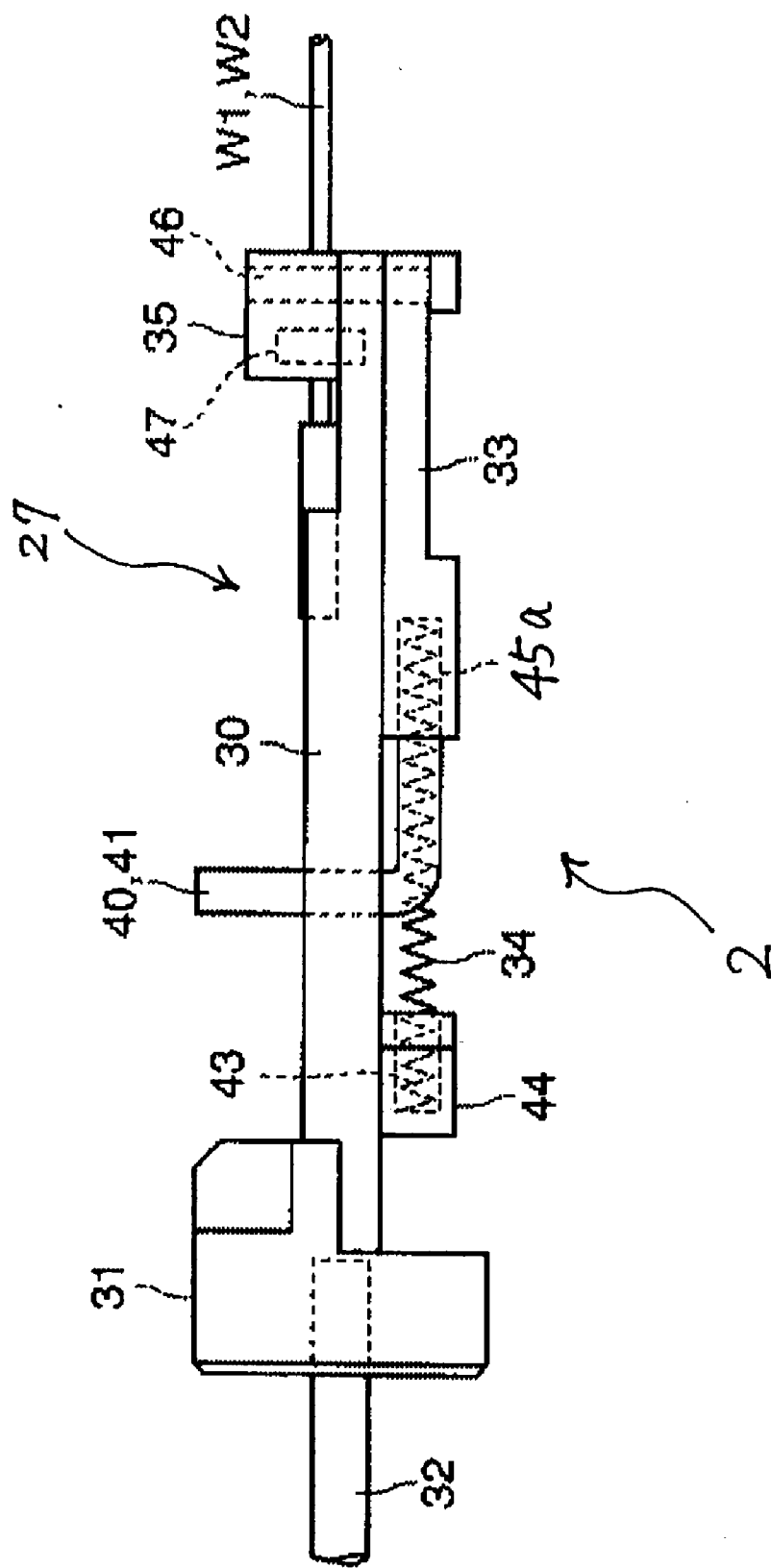


FIG. 6

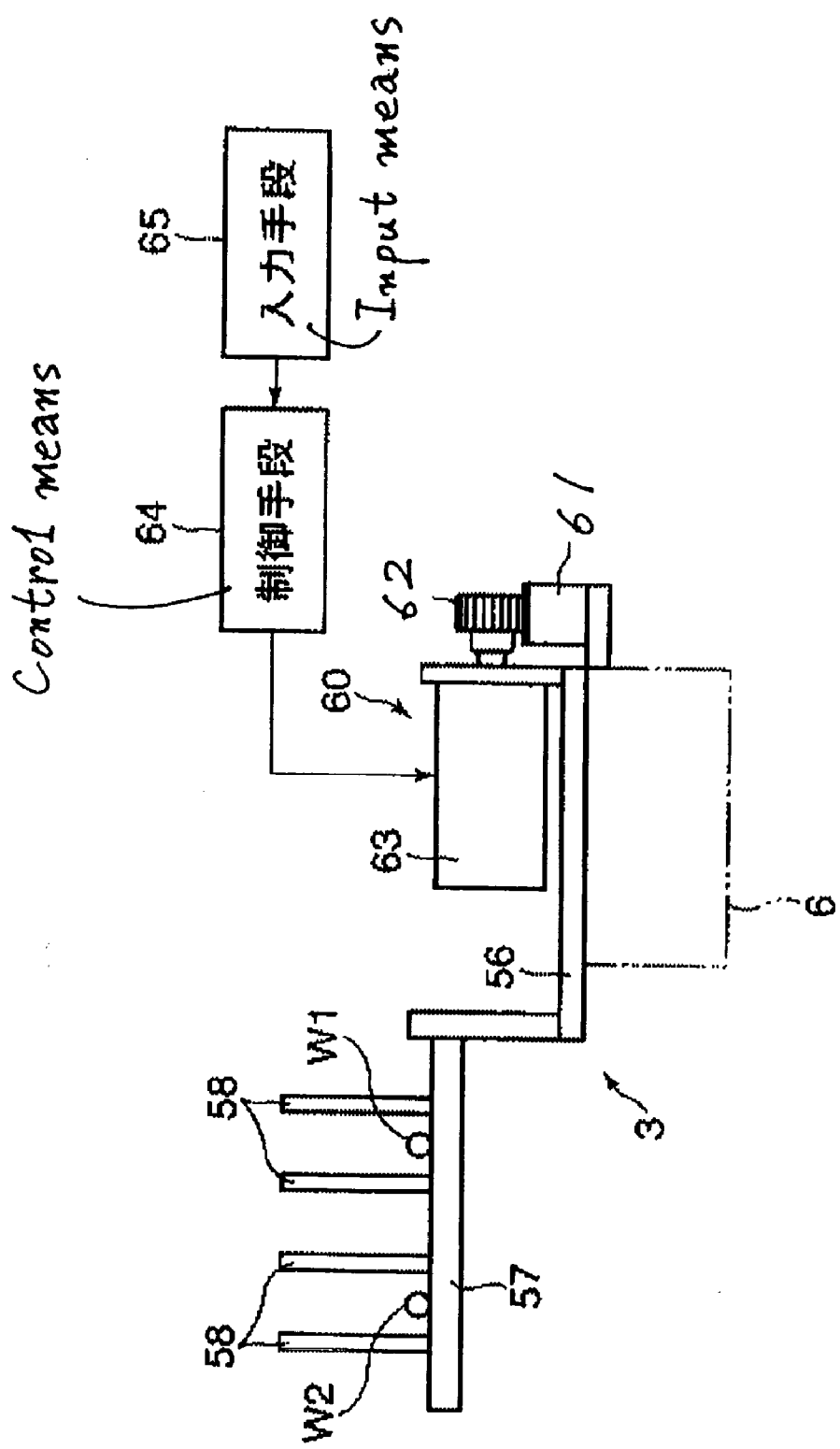


FIG. 8

FIG. 9(a)

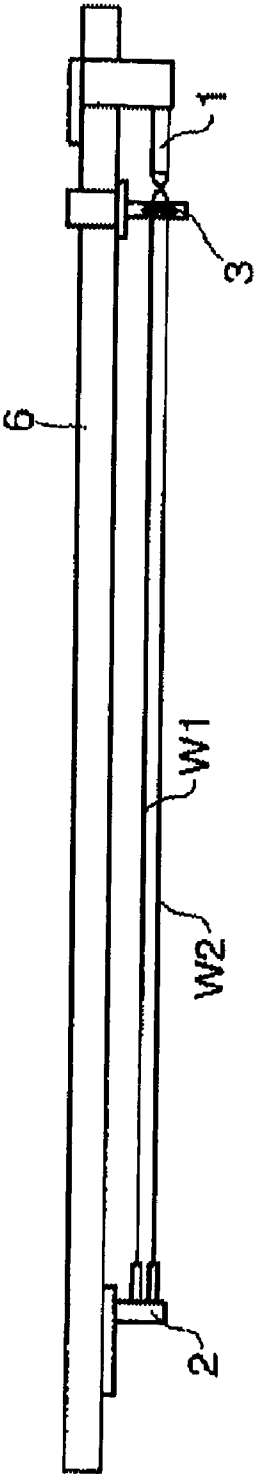
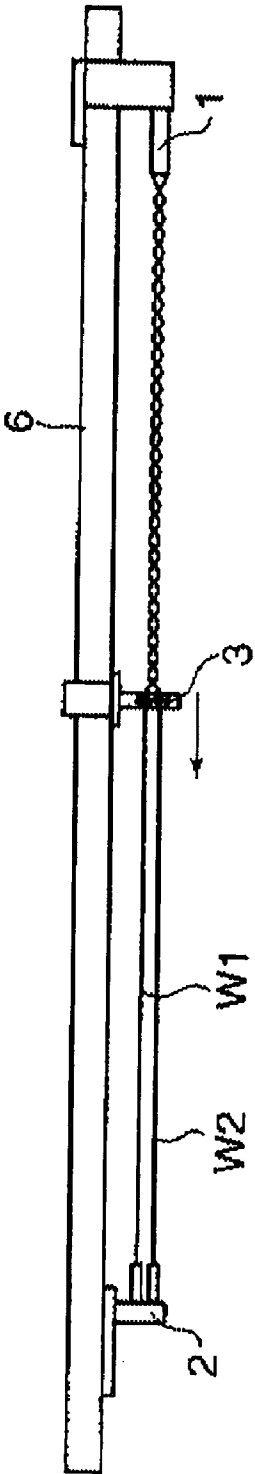


FIG. 9(b)



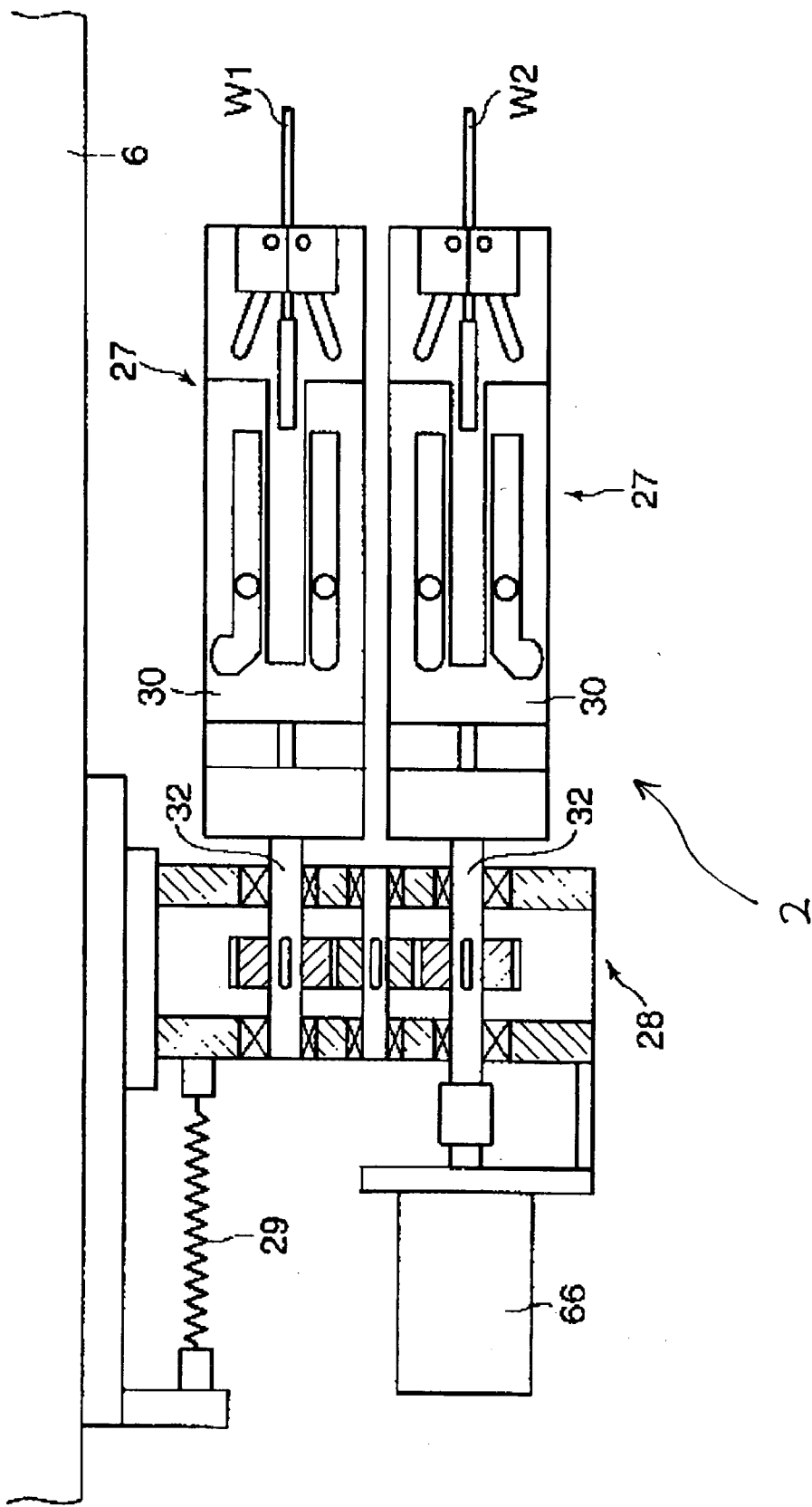


FIG. 10

FIG. 11
(PRIOR ART)

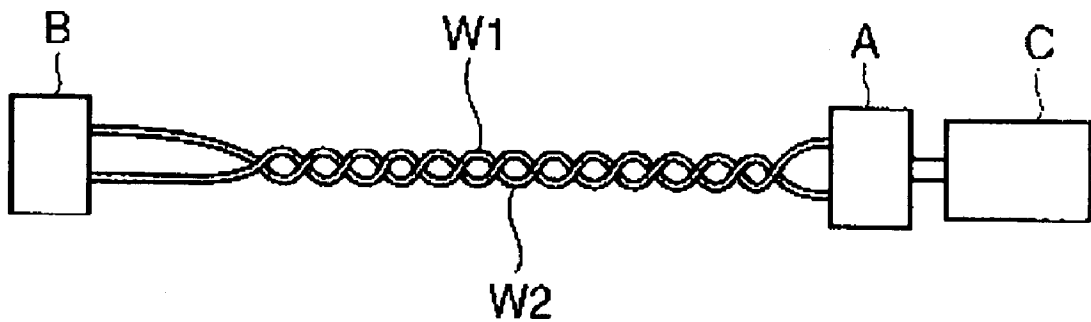
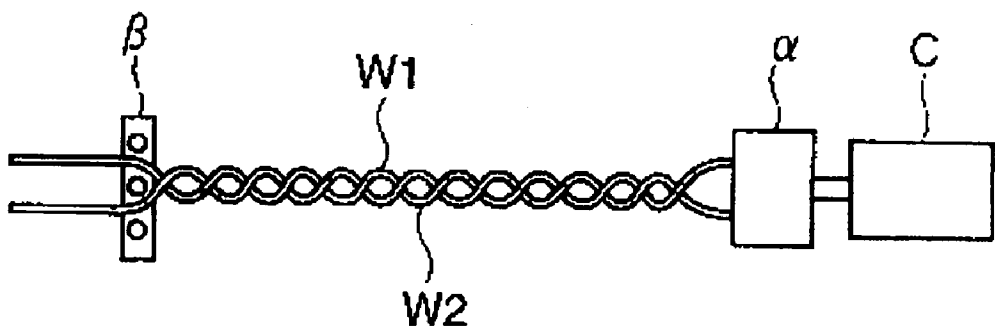


FIG. 12
(PRIOR ART)



TWISTING APPARATUS OF ELECTRIC WIRES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to a twisting apparatus for twisting a pair of electric wires.

[0003] 2. DESCRIPTION OF THE RELATED ART

[0004] A cable for transmission of signal generally has a pair of electric wires that are twisted to suppress an influence of noise and to reduce an attenuation of the signal.

[0005] U.S. Pat. No. 5,946,897 and FIG. 11 herein both show a first known twisting apparatus of electric wires. The apparatus shown in FIG. 11 is used by holding first and second ends of electric wires W1 and W2 with electric wire clamps A and B. The process continues by rotating the one electric wire clamp A with a driving source C including an electric motor to twist the first ends of the electric wires W1 and W2 while maintaining the other electric wire clamp B in a stationary state. Thus, the apparatus shown in FIG. 11 is operative for twisting the electric wires W1 and W2.

[0006] The twisting apparatus of FIG. 11 secures the second (left) ends of the electric wires W1 and W2 to the electric wire clamp B. The first (right) ends of the electric wires are held by the electric wire clamp A and are rotated. Thus, the electric wires W1 and W2 are twisted together. If the electric wires W1 and W2 have a large diameter, a high recovery force is exerted in the twisted electric wires after twisting. This high recovery force tends to spread out and untwist the electric wires W1 and W2. To avoid such problem, the electric wires W1 and W2 are distorted by twisting them at pitches more than desired pitches. Then, the electric wire clamp A is rotated in a reversed direction by the additional number of twisting to prevent the above-described untwisting. However, this construction will cause uneven pitches in the twisted electric wires W1 and W2 and form clearances between them.

[0007] Japanese Patent Public Disclosure No. 2001-319536 and FIG. 12 herein both show a second known twisting apparatus of electric wires. The apparatus shown in FIG. 12 is used by holding first ends of a pair of electric wires W1 and W2 with a holding unit a and holding the second ends of the electric wires W1 and W2 with a holding unit p so that each second end is not fixed, is but restrained from rotating together with the other. The process continues by rotating the holding unit a by a driving source C including an electric motor to twist the first ends of the electric wires W1 and W2. Then, the whole length of the electric wires W1 and W2 are twisted together.

[0008] The twisting apparatus of FIG. 12 fixes the second (left) ends of the electric wires W1 and W2, but allows the wires W1 and W2 to rotate individually and they are twisted. This apparatus can prevent the untwisting without twisting the first (right) ends of the electric wires W1 and W2 at pitches more than the desired pitches. However, there are some holding sections in the electric wire holding units p that cannot restrain the electric wires W1 and W2 from moving in an axial direction. In the case where the electric wires W1 and W2 have a small diameter and a long length, it is not possible to obtain a tension required for twisting the electric wires W1 and W2 in a suitable condition. Conse-

quently, the twisting pitches become uneven. Accordingly, the twisting apparatus of electric wires disclosed in FIG. 12 cannot be applied to the electric wires that have a long length and a small diameter.

[0009] In view of the above problems, an object of the present invention is to provide a twisting apparatus of electric wires that can precisely twist electric wires at a constant pitch regardless of their diameter and length.

SUMMARY OF THE INVENTION

[0010] The invention is directed to a twisting apparatus for electric wires including a first holding unit for holding first ends of a pair of electric wires, a second holding unit for holding second ends of the electric wires, and a twist drive unit for rotating the first holding unit to twist the electric wires. The second holding unit includes a pair of support members that rotate together with the first ends of the electric wires, and a rotary synchronous mechanism that rotates both support members at the same speed and in the same direction by transmitting a rotary force from the one support member to the other support member when the one support member rotates.

[0011] According to the above construction, the second ends of the electric wires are allowed to rotate. Thus, it is possible to prevent the second ends from untwisting when the twist drive unit rotates the first holding unit holding the first ends of the electric wires to twist the first ends of the electric wires. The second ends of the electric wires are rotated at the same speed and in the same direction. Thus, a suitable tension is applied to the electric wires upon twisting them and they are twisted properly at a constant pitch.

[0012] The second holding unit preferably is provided with a biasing member for biasing both of the support members in directions in which the electric wires are subject to tension stresses. Accordingly the tension stresses are exerted in the electric wires in association with a progress on twisting, and the electric wires are properly twisted.

[0013] The invention also is directed to a twisting apparatus of electric wires including a first holding unit for holding first ends of a pair of electric wires, a second holding unit for rotatably holding second ends of the electric wires, respectively, and a twist drive unit for rotating the first holding unit to twist the electric wires. The twisting apparatus of electric wires further comprises: a third holding unit disposed between the first and second holding units for holding the electric wires with each electric wire being allowed to rotate but being restricted from rotating together with the other upon rotation of the first holding unit. A slide drive unit is provided for moving the third holding unit from a start position adjacent the first holding unit to an end position adjacent the second holding unit; and control means is provided for controlling the slide drive unit to move the third holding unit at a speed corresponding to a rotary speed of the first holding unit.

[0014] According to the above construction, the third holding unit is moved toward the second holding unit in association with a progress on twisting when the twist drive unit rotates the first holding unit holding the first ends of the electric wires. Thus, the third holding unit can prevent a twisting force exerted in the first ends of the electric wires in the first holding unit from being transmitted to the second

ends of the electric wires in the second holding unit. Accordingly, the electric wires are twisted properly at an even pitch.

[0015] The foregoing and other features of the invention will become apparent to one skilled in the art to which the present invention relates upon consideration of the invention with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a schematic side elevation view of an embodiment of a twisting apparatus of electric wires in accordance with the present invention.

[0017] FIG. 2 is a partially broken-away front elevation view of a first holding unit in accordance with the present invention.

[0018] FIG. 3 is a partially broken-away plan view of a twist drive unit in accordance with the present invention.

[0019] FIG. 4 is a partially broken-away plan view of a second holding unit in accordance with the present invention.

[0020] FIG. 5 is a plan view of support members in accordance with the present invention.

[0021] FIG. 6 is a front elevation view of the support members in accordance with the present invention.

[0022] FIG. 7 is an exploded perspective view of the support members.

[0023] FIG. 8 is an explanatory view of a third holding unit in accordance with the present invention.

[0024] FIGS. 9(a) and 9(b) are explanatory views of a twisting process of electric wires.

[0025] FIG. 10 is a partially broken-away plan view of an alteration of the second holding unit in accordance with the present invention.

[0026] FIG. 11 is an explanatory view of a first conventional twisting apparatus of electric wires.

[0027] FIG. 12 is an explanatory view of a second conventional twisting apparatus of electric wires.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] FIG. 1 shows an embodiment of a twisting apparatus of electric wires in accordance with the present invention. The twisting apparatus of electric wires includes a first holding unit 1 that holds first (right) ends of a pair of electric wires W1 and W2, a second holding unit 2 that holds second (left) ends of the electric wires W1 and W2, a third holding unit 3 that holds intermediate portions of the electric wires W1 and W2 between the first and second holding units 1 and 2. The twisting apparatus further includes a twist drive unit 4 that rotates the first holding unit 1 to twist the electric wires W1 and W2, and a machine frame 5 that supports the units 1 to 4. The machine frame 5 includes a frame body 6 made of an elongated, lightweight section steel and disposed along the electric wires W1 and W2 to be twisted. The frame 5 further includes a plurality of support legs 7. The frame body 6 has a guide rail (not shown) on which the second and third holding units 2 and 3 slide.

[0029] As shown in FIGS. 2 and 3, the first holding unit 1 includes a base plate 8 made of a rectangular plate material. Support brackets 9 are secured to an upper surface of the base plate 8 by bolts, and an operation lever 11 is supported rotatably through a pair of links 10 on the brackets 9. A clamp arm 12 has a proximal end rotatably supported on the brackets 9 and on a distal end of the operation lever 11. A clamp plate 14 having a pad element 13 made of urethane rubber is attached to a distal end of the base plate 8. A reference pin 15 stands on an upper surface of a distal end of the clamp plate 14.

[0030] First ends (right) of the electric wires W1 and W2 are disposed on the base plate 8 and clamp plate 14 to interpose the reference pin 15 between the electric wires. The lever 11 then is pushed down from an upper position, shown by a broken line in FIG. 2, to a lower position, shown by a solid line in FIG. 2. The clamp arm 12 is moved down from an upper open position to a lower clamp position. The first ends of the electric wires W1 and W2 are pinched between the pad element 13 on the clamp plate 14 and a urethane rubber pad element 16 attached to the lower end surface of the clamp arm 12.

[0031] A rotary shaft 18 is attached through a coupling 17 to a proximal end of the base plate 8. The rotary shaft 18 is rotatably supported in bearing means 20, such as ball bearings, provided in a support frame 19 attached to side-walls of the frame body 6 of the machine frame 5. A driving force is transmitted from the twist drive unit 4 to the rotary shaft 18 coupled to the base plate 8. Then, the first holding unit 1 is rotated in the side space along the frame body 6.

[0032] The twist drive unit 4 includes a driven gear 21 having a bevel gear and secured to the rotary shaft 18 of the first holding unit 1. A drive shaft 23 is supported rotatably in bearings 22 and has ball bearings in the support frame 19. A drive gear 24 is fixed on the drive shaft 23 and engages the driven gear 21, and a drive motor 26 is provided for rotating the drive shaft 23 through a coupling member 25. The drive motor 26 may be a servomotor or the like that is controlled precisely at a variable speed within, for example, 300-1800 rpm (revolution per minute) and at a rotary angle (total amount of revolution) in accordance with a control signal from control means.

[0033] As shown in FIG. 4, the second holding unit 2 holds the second (left) ends of the electric wires W1 and W2. The unit 2 includes a pair of supports 27 that rotate together with the second ends of the electric wires W1 and W2. The second holding unit 2 also has a rotary synchronous mechanism 28 that rotates the supports 27 at the same speed and in the same direction. A biasing member 29 biases the supports 27 in a direction in which the electric wires W1 and W2 are subject to tension stresses during a twisting of the electric wires W1 and W2, as explained below.

[0034] As shown in FIGS. 5 to 7, each support 27 includes a rotary plate 30 having a rectangular shape in a plan view. A rotary shaft 32 is coupled through a coupling 31 to a proximal end of the rotary plate 30. The support 27 further includes a slide plate 33 and a compression coil spring 34. The slide plate 33 can slide along a lower surface of the rotary plate 30 and the compression coil spring 34 pushes the slide plate 33 toward a distal end of the rotary plate 30 and towards a holding position of the electric wires W1 and W2. Two clamps 35 are disposed on an upper end surface of the rotary plate 30 and are coupled to the slide plate 33.

[0035] An intermediate part of the rotary plate 30 has a first pair of guide grooves 36 and 37 that extend in a longitudinal direction and a distal end of the rotary plate 30 has a second pair of guide grooves 38 that extend longitudinally in a reversed V-shape. A distal end of the slide plate 33 has two opposed guide grooves 39 that extend in a width direction (see FIG. 7). Two L-shaped handles 40 and 41 are made of a round bar and project from a proximal end surface of the slide plate 33 (see FIG. 7).

[0036] Upper ends of the handles 40 and 41 are inserted upwardly into the first guide grooves 36 and 37 so that the handles 40 and 41 are slidably supported in the first guide grooves 36 and 37. When the handles 40 and 41 slide in the first guide grooves 36 and 37, the slide plate 33 slides longitudinally on the lower surface of the rotary plate 30.

[0037] The handle 40 is supported rotatably in the slide plate 33. An engagement portion 42 is provided in a proximal end of the first guide groove 36 into which the handle 40 is adapted to be inserted. When the upper end of the handle 40 engages the engagement portion 42, the slide plate 33 is locked on the proximal end of the rotary plate 30 against a pushing force exerted by the compression coil spring 34. Then, the clamp 35 is kept in a release position, as described below.

[0038] A holder 44 is secured to a lower surface of the proximal end of the rotary plate 30. The holder 44 has a depression 43 in which a second (left) end of the compression coil spring 34 is inserted. The slide plate 33 has a proximal end wall with a depression 45a in which a first (right) end of the compression coil spring 34 is inserted. Thus, the slide plate 33 is biased toward the distal end of the rotary plate 30 by the pushing force exerted by the compression coil spring 34 (see FIG. 6).

[0039] Each clamp 35 is formed into a block body having a pad element 45 made of urethane rubber on an inner side surface. Drive pins 46 and 47 stand on a lower surface of the clamp 35 to be inserted into one of the second guide grooves 38 in the rotary plate 30. The drive pins 46 and 47 are arranged in a slanting direction opposed to the second guide groove 38. The drive pin 46 disposed near the distal end of the rotary plate 30 is longer than the other drive pin 47. A lower end of the drive pin 46 is inserted into the guide groove 39 in the slide plate 33.

[0040] When the slide plate 33 slides on the lower surface of the rotary plate 30, the clamps 35 on the upper surface of the rotary plate 30 slide along the second guide grooves 38. Thus, the clamps 35 move between an approached clamp position to the electric wires W1 and W2 shown by a solid line in FIG. 5 and a spaced release position shown by an broken line in FIG. 5.

[0041] The handle 40 or 41 can be pulled back so that the slide plate 33 moves to a proximal end of the rotary plate 30 and towards the rotary shaft 32 against the force exerted in the compression coil spring 34. Thus, the drive pins 46 and 47 slide in the second guide grooves 38 in a rear outer direction. The clamps 35 are guided to move away from each other while retracting. However, the slide plate 33 can be moved toward the distal end of the rotary plate 30 by the pushing force exerted in the compression coil springs 34. In this situation, the drive pins 46 and 47 slide in the second guide grooves 38 in a front and inner direction. Thus, the

clamps 35 are guided to approach each other and press the second ends of the electric wires W1 and W2.

[0042] As shown in FIG. 4, the second holding unit 2 has a slide frame 48 that supports the supports 27 rotatably. The slide frame 48 has bearings 49 with ball bearings or the like for rotatably supporting the rotary shaft 32 that is coupled to the rotary plate 30. Each support 27 rotates about the longitudinal axis of the rotary shaft 32. Furthermore, the slide frame 48 is supported slidably on a holding frame 50 on the frame body 6. Thus, the supports 27 of the second holding unit 2 slide on sidewalls of the frame body 6 together with the slide frame 48.

[0043] The slide frame 48 has a rotary synchronous mechanism 28. The mechanism 28 includes first and second gears 51 and 52 having a pair of spur gears on the rotary shafts 32 of the supports 27. An intermediate shaft 54 is disposed between the rotary shafts 32, and intermediate gears 55 are fixed on the intermediate shaft 54. The intermediate gears 55 engage the first and second gears 51 and 52, respectively. In the rotary synchronous mechanism 28, the numbers of teeth of the first and second gears 51 and 52 are equal. If one of the supports 27 rotates during the twisting process of the electric wires W1 and W2 described below, a rotating force of the one gear 51 or 52 that rotates together with the one support 27 is transmitted through the intermediate gear 55 to the other gear 51 or 52. Consequently, the supports 27 are rotated at the same speed and in the same direction.

[0044] A biasing member 29 including a tension coil spring is disposed between the holding frame 50 supported on the frame body 6 of the machine frame 5 and the slide frame 48. The slide frame 48 is biased by the biasing member 29 in a direction in which the frame 48 moves away from the first holding unit 1 during the twisting process of the electric wires W1 and W2, as described below. Consequently, a tension stress is applied to each of the electric wires W1 and W2 supported on the support members 27.

[0045] The holding frame 50 is supported slidably on a guide rail (not shown) on the frame body 6 of the machine frame 5 and is restrained from sliding on the guide rail by a lock (not shown). The lock adjusts a locking position of the holding frame 50 on the frame body 6, namely a position of the second holding unit 2 holding the second ends of the electric wires W1 and W2 in accordance with the lengths of the electric wires W1 and W2.

[0046] As shown in FIG. 8, the third holding unit 3 includes a slide base plate 56 slidably supported on a guide rail (not shown) on the frame body 6 of the machine frame 5. A slide bar 57 projects from the slide base plate 56 toward sidewalls of the frame body 6, and four support bars 58 extend from an upper surface of the slide bar 57. The electric wires W1 and W2 are disposed between a pair of adjacent support bars 58. The electric wires W1 and W2 are allowed to rotate between the first and second holding units 1 and 2 during the twisting process of the electric wires W1 and W2, as described below. When the first holding unit 1 is rotated, the first ends of the electric wires W1 and W2 are twisted. The second ends of the electric wires W1 and W2 are restrained from rotating together with each other.

[0047] A slide drive unit 60 is provided between the slide base plate 56 of the third holding unit 3 and the frame body

6. The slide drive unit 60 includes, for example, a rack gear 61 extending along the frame body 6, a pinion gear 62 engaging the rack gear 61, and a drive motor 63 driving the pinion gear 62. The drive motor 63 is fixed on the slide base plate 56. The drive motor 63 is driven to rotate the pinion gear 62 in accordance with a control signal from controller 64 contained in a control box. The slide base plate 56 of the third holding unit 3 moves at a constant speed from a start position near the first holding unit 1 to an end position near the second holding position 2 in synchronization with rotation of the first holding unit 1.

[0048] The drive motor 63 may be a servomotor or the like in which a rotary speed is varied and a rotary angle (total amount of revolution) is controlled in accordance with a control signal from the controller 64. The controller 64 has a function of operating and setting a sliding speed of the slide base plate 56 (revolution speed of the drive motor 56) in accordance with a twisting number of the electric wires W1 and W2 from input means 65, namely a revolution number of the first holding unit 1 and a twisting length over a whole length of the electric wires W1 and W2. For example, in the case where the first holding unit 1 is rotated by 40 revolutions and the electric wires W1 and W2 having a twisted length of 1000 mm are provided with 40 twisted portions, the rotary speed of the drive motor 63 is set to displace the third holding unit 3 by a distance of 25 mm during one revolution of the first holding unit 1.

[0049] In the case where the twisting apparatus is used for twisting the electric wires W1 and W2, as shown in FIG. 9(a), the third holding unit 3 is moved to a start position adjacent the first holding unit 1. The operation lever 11 of the first holding unit 1 then is actuated to set the clamp arm 12 to the upper open position (see the broken line in FIG. 2). The first ends of the electric wires W1 and W2 are guided onto the base plate 8 through a space between the support bars 58 of the third holding unit 3 to interpose the reference pin 15 between the first ends of the electric wires W1 and W2. The operating lever 11 then is actuated, and the clamp arm 12 is moved down to the clamp position. The first holding unit 1 clamps the first ends of the electric wires W1 and W2 (see the solid line in FIG. 2 and FIG. 3).

[0050] The handles 40 and 41 on the supports 27 of the second holding unit 2 are disposed beforehand at a position corresponding to the length of the electric wires W1 and W2. The handles 40 or 41 of the supports 27 then are actuated, and the clamps 35 are locked at the spaced position and the second ends of the electric wires W1 and W2 are guided into a space between the clamps 35. The handles 40 then are released from the engagement portions 42 and the clamps 35 are moved to the clamp position. The second holding unit 2 clamps the second ends of the electric wires W1 and W2.

[0051] A start button (not shown) is turned on, and the drive motor 26 of the twist drive unit 4 begins driving. As a result, the base plate 8 of the first holding unit 1 is rotated to twist the first ends of the electric wires W1 and W2. As shown in FIGS. 8 and 9(b), the drive motor 63 of the slide drive unit 60 is actuated while twisting the electric wires W1 and W2 between the first holding unit 1 and the third holding unit 3. The third holding unit 3 is moved from the start position near the first holding unit 1 to the end position near the second holding unit 2 at a constant speed as the twisting process progresses.

[0052] The twisting process of the electric wires W1 and W2 is finished when the drive motor 26 of the twist drive unit 4 rotates the base plate 8 of the first holding unit 1 by a predetermined total number of revolutions. The twist drive unit 4 and slide drive unit 60 automatically stop driving when the third holding unit 3 reaches the end position. Thereafter, the first and second holding units 1 and 2 release the first and second ends of the electric wires W1 and W2 and the twisted wire is removed from the twisting apparatus. The third holding unit 3 then is returned to the start position, and new electric wires W1 and W2 are set on the twisting apparatus. The above steps then are repeated.

[0053] The length of the electric wires W1 and W2 and the number of twists could be changed on account of a change of a kind of electric wires W1 and W2 to be set. Thus, the input means 65 input data such as the length of the electric wires W1 and W2 and the number of twists into the control means 64. The set position of the second holding unit 2 is changed in accordance with a twisting length of new electric wires W1 and W2, and the new electric wires W1 and W2 are set on the twisting apparatus.

[0054] As described above, the invention is directed to a twisting apparatus of electric wires including the first holding unit 1 for holding the first ends of the pair of electric wires W1 and W2, the second holding unit 2 for holding the second ends of the electric wires W1 and W2, and the twist drive unit 4 for rotating the first holding unit 1 to twist the electric wires W1 and W2. The second holding unit 2 includes the pair of support members 27 that rotate together with the first ends of the electric wires W1 and W2, and the rotary synchronous mechanism 28 that rotates both support members 27 at the same speed and in the same direction by transmitting a rotary force from the one support member 27 to the other support member 27 when the one support member 27 rotates. Accordingly, the electric wires can be twisted precisely at a constant pitch regardless of their diameter and length.

[0055] That is, the second (left) ends of the electric wires W1 and W2 are rotatably held by the second holding unit 2. Thus, it is possible to prevent the twisted wire from being untwisted by a high recovery force, even if diameters of the electric wires W1 and W2 are great in size. Accordingly, it is not necessary to twist the electric wires W1 and W2 at pitches more than desired, and it is possible to twist the electric wires W1 and W2 precisely at a proper pitch.

[0056] The first ends of the electric wires W1 and W2 are rotated to carry out the twisting process, and a torsion force exerted in the electric wires W1 and W2 is transmitted to the second ends of the electric wires W1 and W2 to rotate them. A rotary force exerted in one of the electric wires W1 and W2 then is transmitted through the rotary synchronous mechanism 28 to the other. The electric wires W1 and W2 are rotated at the same speed and in the same direction. Accordingly, it is possible to prevent an unbalance, such as an excessive twisting, in only one of the electric wires W1 and W2. Consequently, it is possible to prevent one of the electric wires W1 and W2 from untwisting more than the other. It is also possible to prevent formation of clearances between the electric wires W1 and W2 due to the disturbance of twisting.

[0057] The supports 27 of the second holding unit 2 and the rotary synchronous mechanism 28 serve as a weight that

applies a tension to the electric wires W1 and W2 when electric wires W1 and W2 with a small diameter are twisted. This can twist the electric wires W1 and W2 properly with the electric wires W1 and W2 being tensioned over the entire length. Accordingly, even if the electric wires W1 and W2 have small diameters, it is possible to set a twisting pitch precisely and closely.

[0058] The biasing member 29 on the second holding unit 2 biases the supports 27 in a direction in which the electric wires W1 and W2 are subject to tension stresses. The tension applied to the electric wires W1 and W2 by the biasing member 29 enables a twisting pitch to be set more precisely and closely. As the twisting process of the electric wires W1 and W2 progresses, the supports 27 supporting the second ends of the electric wires W1 and W2 are pulled toward the first holding unit 1 in connection with the progress on the twisting process, thereby increasing the biasing force of the biasing member 29. Accordingly, when the electric wires W1 and W2 are twisted at the finishing stage of the twisting process, that is, at a position away from the first holding unit 1 that applies a torsion force to the electric wires W1 and W2, it is possible to suppress the disturbance of twisting.

[0059] As described above, the twisting apparatus of electric wires includes the first holding unit 1 for holding the first ends of the electric wires W1 and W2, the second holding unit 2 for rotatably holding the second ends of the electric wires W1 and W2, respectively, and the twist drive unit 4 for rotating the first holding unit 1 to twist the electric wires W1 and W2. The twisting apparatus of electric wires further comprises the third holding unit 3 between the first and second holding units 1 and 2 for holding the electric wires W1 and W2 such that each of the electric wires is allowed to rotate but is restricted from rotating together with the other electric wire upon rotation of the first holding unit 1. Additionally, the slide drive unit 60 moves the third holding unit 3 from the start position adjacent the first holding unit 1 to the end position adjacent the second holding unit 2, and the control means controls the slide drive unit 60 to move the third holding unit 3 at a speed corresponding to a rotary speed of the first holding unit 1. Accordingly, the third holding unit 3 prevents the twisting force exerted in the first ends of the electric wires W1 and W2 by the first holding unit 1 from being transmitted to the second holding unit 2. Consequently, the invention twists the electric wires W1 and W2 evenly and closely.

[0060] The third holding unit 3 approaches the first holding unit 1 at the beginning of the twisting process of the electric wires W1 and W2. Therefore, it is possible to twist the electric wires W1 and W2 properly and closely within a narrow space between the first and third holding units 1 and 3. As the twisting process of the electric wires W1 and W2 progresses, the third holding unit 3 gradually moves to the downstream side. Since the twisting force for the electric wires W1 and W2 can be concentrated at the upstream side from the third holding unit 3, it is possible to twist the electric wires W1 and W2 at a proper and even pitch.

[0061] The supports 27 are supported rotatably on the third holding unit 3 so that the supports 27 are rotated in synchronization with each other. However, the second holding unit 2 may have a rotation drive unit that rotates the supports 27 so that the electric wires W1 and W2 rotate in a direction opposite from the rotary direction of the first

holding unit 1 at a rotary speed corresponding to that of the first holding unit 1 driven by the twist drive unit 4.

[0062] More particularly, as shown in FIG. 10, a rotation drive unit 66 including a servomotor or the like may be provided to rotate one of the rotary shafts 32 coupled to the rotary plates 30 of the supports 27. As the first ends of the electric wires W1 and W2 are twisted when the first holding unit 1 is rotated by the twist drive unit 4, the rotary plates 30 may be rotated forcedly at the substantially same rotary speed of the first holding unit 1 in a direction in which a torsion of the electric wires W1 and W2 is eliminated. Such construction can more effectively suppress the untwisting of the electric wires W1 and W2 after twisting electric wires W1 and W2 of large diameter.

[0063] From the above description of the invention, one skilled in the art will perceive improvements, changes and modifications. Such improvements, changes and modifications within the skill of the art are intended to be covered by the appended claims.

What is claimed is:

1. A twisting apparatus of electric wires comprising:

a first holding unit (1) for holding first ends of a pair of electric wires (W1; W2);

a second holding unit (2) for holding second ends of said electric wires (W1; W2); and

a twist drive unit (4) for rotating said first holding unit (1) to twist said electric wires (W1; W2);

said second holding unit (2) including:

a pair of supports (27) that rotate together with said first ends of said electric wires (W1; W2); and

a rotary synchronous mechanism (28) that rotates both supports (27) at the same speed and in the same direction by transmitting a rotary force from the one support (27) to the other support (27) when the one support (27) rotates.

2. The twisting apparatus of electric wires of claim 1, wherein said second holding unit (2) has a biasing member (29) for biasing both of said supports (27) in directions in which said electric wires (W1; W2) are subject to tension stresses.

3. A twisting apparatus of electric wires comprising:

a first holding unit (1) for holding first ends of a pair of electric wires (W1; W2);

a second holding unit (2) for rotatably holding second ends of said electric wires (W1; W2);

a twist drive unit (4) for rotating said first holding unit (1) to twist said electric wires (W1; W2);

a third holding unit (3) disposed between said first and second holding units (1; 2) for holding said electric wires (W1; W2) with each of said electric wires (W1; W2) being allowed to rotate but being restricted from rotating together with the other of the electric wires (W1; W2) upon rotation of said first holding unit (1);

a slide drive unit (60) for moving said third holding unit (3) from a start position adjacent said first holding unit (1) to an end position adjacent said second holding unit (2); and

control means (64) for controlling said slide drive unit (60) to move said third holding unit (3) at a speed corresponding to a rotary speed of said first holding unit (1).

4. The twisting apparatus of electric wires of claim 3, wherein said second holding unit (2) includes first and second supports (27) that rotate together with said first ends of said electric wires (W1; W2); and a rotary synchronous mechanism (28) that rotates both said supports (27) at a uniform speed and in the same direction by transmitting a

rotary force from the first support (27) to the second support (27) when the first support (27) rotates.

5. The twisting apparatus of electric wires of claim 4, wherein said second holding unit (2) is provided with a biasing member (29) for biasing said both supports (27) in directions in which said electric wires (W1; W2) are subject to tension stresses.

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