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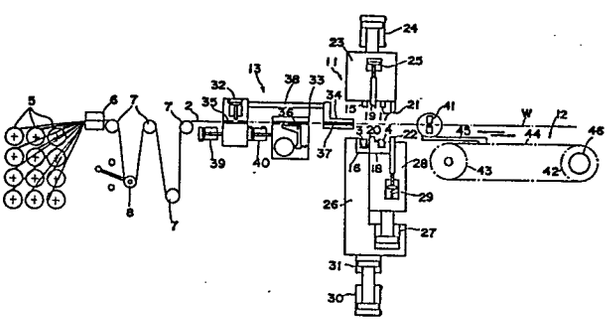
(54) Apparatus for making electrical harnesses.

(57) Apparatus for making electrical harnesses including wires and electrical connectors has a wire feed path (W) extending substantially horizontally and axially of the apparatus; a connector attaching device (11) located along the feed path (W), and comprising first and second cooperating pair of assembling punches (15, 17) and dies (16, 18) disposed on opposite sides of the wire feed path, and operable individually or synchronously. A cooperating pair of cutting punch (19) and die (20) are disposed between the first and second pairs of punches (15, 17) and dies (16, 18), the cutting punch (19) and die (20) being operable independently of the first and second assembling punches (15, 17) and dies (16, 18) and a connector supplying means is provided for supplying connectors (3, 4) of different types to the first and second assembling dies (16, 18). A wire length measuring and feeding device (12) is located along the wire feed path (W) and comprises a chuck (41) reciprocally movable along the wire feed path (W) for pulling out wires in its advancing movement for a distance corresponding to a desired length of the electrical harness, the moving distance and the frequencies of reciprocal movement of the chuck being adjustable in dependence upon the number of connectors (3, 4) to be affixed to the wires, the intervals thereof, and the types thereof.



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APPARATUS FOR MAKING ELECTRICAL HARNESSES

The invention relates to apparatus for making electrical harnesses automatically and, more particularly, to fully automatic apparatus for making electrical harnesses of the kind which comprise a plurality of insulation clad wires connected to one or more multi-contact connectors at their ends and/or at desired positions, the wires being cut to a desired length, and connector-free ends being stripped of their insulating coverings.

Previously proposed contact-type electrical connectors have included an open-topped insulating housing in which a plurality of contacts are provided in parallel so as to accommodate individual wires. Each contact includes a slot whose side edges function as blades for cutting the insulating covering of the wires, thereby allowing electrical connection between the conductors of the wires and the contact. The width of the slot is narrower than the outside diameter of the insulation-clad wires.

A combination of insulating clad wires and contact-type electrical connectors is called an "electrical harness", and there are three main types: one has connectors affixed to both ends of the wires, a second has connectors affixed to only one end of the wires, with the other end being free of connectors and a third type has the connectors affixed in a middle portion of the wires, this type being called a "through type". Of wires having a connector-free end, there are two types: one has the connector-free ends terminating in the same plane, which means that the wires have the same length, and the other has the connector-free ends terminating at different positions, so as to adapt the harness for ready connection to various electronic elements or devices.

It is among the objects of the invention to provide apparatus for making electrical harnesses which can perform a plurality of connector-to-wires assembling operations on a single process line preferably with the ability to make various types of harnesses on a single process line.

According to the invention, there is provided apparatus for making electrical harnesses including wires and electrical connectors and having a wire feed path extending substantially horizontally and axially of the apparatus; characterised in that a connector attaching device is provided

along the feed path, the device comprising first and second cooperating assembling punch and die pairs disposed on respective sides of the wire feed path, the first and second punch and die pairs being operable individually or synchronously, a cooperating cutting punch and die pair between the first and second punch and die pairs, with the cutting punch and die being operable independently of the first and second assembling punch and die pairs, and connector supplying means for supplying connectors of different types to the first and second assembling dies; and

a wire length measuring and feeding device located along the wire feed path, the device comprising a chuck reciprocally movable along the wire feed path for pulling out wires in its advancing movement for a distance corresponding to a desired length of the electrical harness, the moving distance and the frequencies of reciprocal movement of the chuck being adjustable dependently on the number of connectors to be affixed to the wires, the intervals thereof, and the types thereof.

The invention is diagrammatically illustrated by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic front view showing apparatus for making electrical harnesses according to the invention;

Figurs 2 to 5 are cross-sectional views on a larger scale showing the operating states of the main sections of the apparatus;

Figures 6(a) to (j) are diagrammatic views showing each step of a series of operations;

Figures 7 and 8 are diagrammatic views showing the operating states of another embodiment of apparatus according to the invention; and

Figures 9 to 14 show schematic views showing finished electrical harnesses made by apparatus according to the invention.

As best shown in Figure 1, apparatus for making electrical harnesses includes a connector attaching device 11 (hereinafter referred to as the attaching device), and a wire length measuring and feeding device 12. The attaching device 11 affixes connectors 3 and 4 to ends of a wire group 2A, the connectors 3 and 4 being of different types and the wire group 2A being a group of wires selected from a wire group 2. The wire length measuring and feeding device 12 includes a moving chuck 41 whereby the wire group 2A having one or more connectors is pulled out for a distance corresponding to a desired length of the intended electrical harness. The moving chuck 41

is reciprocally moved, and in its advancing movement it pulls out the wire group 2A. The connector 3 is of the "through type", and the connector 4 is of the "end type", and suitable for direct attached to a substrate.

The connectors 3, 4 are conveyed in known manner, using a known hopper, conveyor, magazine or the like, and a detailed description will be omitted for simplicity. As mentioned above, the apparatus of the invention can be applied to the production of various types of harnesses. Therefore, it is often necessary to change the pole number of the connectors depending on the intended type of harness. The apparatus can be provided with a selecting device whereby a connector having a desired pole number is automatically selected, but when a large number of harnesses of the same type are produced at one time, it is not necessary to use such a selecting device. With the use of ordinary supplying means, the connectors in a magazine or the like have only to be replaced with the next lot each time one operation is finished.

The reference numeral 5 denotes reels from which a plurality of wires 2 are supplied to the attaching device 11 via a wire selecting device 13, which selects a wire group 2A having a pole number corresponding to that of the connectors 3 or 4.

Each device 11, 12 and 13 will be hereinafter described in greater detail:

Referring to Figures 1, and 2 - 5, a first cooperating punch 15 and die 16 pair, and a second cooperating punch 17 and die 18 pair are respectively provided on vertically opposite sides of the feed path (W). Likewise, a wire cutting punch 19 and a wire cutting die 20, and presser chucks 21 and 22 are respectively opposedly provided.

The first and second punches 15 and 17 are fixed to the lower end of a slider 23 side by side, the slider 23 being movable up and down by means of a pneumatic cylinder 24. The cutting punch 19 is located between the punches 15 and 17 on the slider 23. The presser chuck 21 is mounted slightly outward of the second punch 17. By moving the slider 23, the punches 15, 17, the cutting punch 19 and the presser chuck 21 are caused to ascend or descend. Figures 2 to 5 show that these members 15, 17, 19 and 21 are lowered to the connector attaching position. The cutting punch 19 can be moved up and down by means of a pneumatic cylinder 25, independently of the above-mentioned members 15, 17 and 21, the pneumatic cylinder 25

being mounted on the slider 23.

The first die 16 is fixed to a top end of a slider 26, and the second die 18 is fixed to a top end of a slider 28, which is moved up and down by means of a pneumatic cylinder 27 mounted on the slider 26. The slider 28 is additionally provided with the presser chuck 22 in such a manner as to allow same to move up and down. The presser chuck 22 is normally urged upwardly under the action of a spring 29. The cutting die 20 is made in one body with the second die 18.

The slider 26 is moved up and down in two steps by means of two pneumatic cylinders 30 and 31. Firstly, the dies 16 and 18 are raised from the position shown in Figure 1 up to the position shown in Figures 2 and 3, the latter being hereinafter referred to as the preparatory position. Then, the pneumatic cylinder 31 is operated thereby to raise the dies 16 and 18 up to the pressing position shown in Figures 4 and 5, thereby effecting a cooperative punching operation by the punch 15 and die 16, and by the punch 17 and die 18. However, it is possible to retain the second die 18 at a lower position by means of the pneumatic cylinder 27, as shown in Figures 3 and 4. The first die 16 alone is raised to the preparatory position to the final attaching position, while the second die 18 is kept inoperative. In this way the connector attaching operation is conducted jointly by the first pair of punch 15 and die 16.

The wire selecting device 13 includes a first chuck 32, a second chuck 33 and a wire guide 34. The first chuck 32 feeds the wire groups 2 along the feed path (W), which wire groups are supplied from the reels 5 via a bundling device 6, guide rollers 7 and a tension roller 8, and holds all the wire groups 2 when necessary. The second chuck 33 holds all the wire groups except for a selected wire group 2A, which is made free for the subsequent connector attaching operation. The wire guide 34 is located adjacent to the attaching device 11, and guides the wire group 2A to the connector attaching position along the feed path (W).

The first chuck 32, the second chuck 33 and the wire guide 34 are provided with guide grooves 35, 36 and 37 respectively in number corresponding to that of the wires, usually 20 to 24, each groove being produced in parallel with the feed path (W). The grooves in each member are laterally spaced at equal intervals, which correspond to the pitches of the contacts loaded in the connectors 3, 4. Each wire in the wire groups is

individually fed to the attaching device 11 through the respective guide groove.

The first chuck 32 and the wire guide 34 are interconnected to each other by a connecting rod 38, and they are moved along the feed path (W) as a unit by means of a pneumatic cylinder 39. The second chuck 33 is moved along the feed path (W) by means of a pneumatic cylinder 40 mounted on the first chuck 32. The second chuck 33 is moved not only by the pneumatic cylinder 39 but also by the pneumatic cylinder 40 along the feed path (W).

The moving chuck 41 is designed to pinch the wire group 2A laterally of the feed path (W). The moving chuck 41 is fixed to a chain 44 through an arm 45, which chain 44 is supported on a driving sprocket 42 and a follower sprocket 43. The driving sprocket 42 is reversibly rotated by means of a d.c. motor 46, thereby enabling the chuck 41 to move reciprocally along the feed path (W). The chuck 41 can be stopped at any desired point by switching off the motor 46. More particularly, by varying the amount of one movement and the frequencies of reciprocal movement of the chuck 41, the wire group 2A can be fed by a desired length. When the wire group 2A to be pulled out of the attaching device 11 is relatively short, it is only necessary to predetermine the distance for one advancing movement of the chuck 41. But, when it is too long, one or more reciprocal movements will be required in accordance with a desired length of the intended electrical harness. In this case after the moving chuck 41 has fed the wire group 2A over the predetermined distance, it releases same. Then, the chuck returns to its original starting point, where it again pinches the wires. Then it operates a second feeding of the same wire group 2A. Depending on the desired length, this procedure is repeated until the desired length of the wire group 2A is pulled out.

A typical example of operation will be described:

Figure 6 shows the connector attaching process step by step. Firstly, the wire group 2 is fed through the grooves 37 in the wire guide 34 to the preparatory position shown in Figure 6(a), where the wire ends are cut in the same plane by the cutting punch 19 and die 20. Then the whole wire group is pinched by the first chuck 32, and as it is, the chucks 32, 33 and the wire guide 34 are slightly withdrawn along the feed path (W) until the cut end faces are returned to the attaching position (P) shown in Figure 6(b). The second chuck 33 is then operated to hold the wires other than the wire group

2A to which connectors are to be affixed, that is, the wire group 2A alone is kept free for the subsequent feeding. At this stage, the second chuck 33 is withdrawn by means of the pneumatic cylinder 40, thereby causing the captured wires to retreat from the attaching position (P) leaving the free wire group 2A behind. Meanwhile, the cutting punch 19 is returned to its original upper position and the slider 28 is lowered by the pneumatic cylinder 27, thereby causing the second die 18 and the presser chuck 22 to lower to their inoperative positions.

Then, by operating the pneumatic cylinder 31 to raise the slider 26, the first die 16 ascends to the attaching position shown in Figures 4 and 6(c) where it cooperates with the first punch 15 thereby to press the terminal ends of the wire group 2A into the contacts of the connector 3.

When the terminal ends of the wires are loaded in the connector 3, the first punch 15 and the die 16 are separated away from the feed path (W). At this moment the moving chuck 41 comes to the attaching position, and pinches the wire group 2A having the connector 3 (Figure 6(d)). Then the first chuck 32 releases the wire group 2, whereas the second chuck 33 continues to hold the wires other than the wire group 2A. The moving chuck 41 starts to advance along the feed path (W) as it carries the wire group 2A, thereby pulling same out of the attaching device 11 until it stops at a predetermined position. At this stage the first chuck 32 again pinches all the wire groups 2 including the wire group 2A, and the whole wires are stretched by the first chuck 32 and the moving chuck 41. The attaching device 11 is again operated so as to affix a connector 3 to another desired position of the wire group 2A (Figure 6(e)).

When the second connector attaching operation is finished, the punch 15 and die 16 are separated in the aforementioned manner, and the moving chuck 41 further pulls out the wire group 2A by a predetermined length. Then the second die 18 is raised by the pneumatic cylinder 27 up to its operating position shown in Figure 6(f). Subsequently, the first punch 15 and the second punch 17, and the first die 16 and the second die 18 are moved up to a position adjacent to the preparatory position shown in Figure 2, and the cutting punch 19 is lowered to cut the wire group 2A. In Figure 6(g) the cut wire group $2A_1$ and the connector 3 is held by means of the presser chucks 21 and 22 at a position adjacent to a position where the second punch 17 and the second die 18 come together.

The portion of the wire group 2A advancing behind is, as shown in Figure 6(b), returned by means of the pneumatic cylinder 39 as it is pinched.

The remaining portion of the wire group 2A is returned by means of the pneumatic cylinder 39 as it is being pinched by the first chuck 32 along the feed path (W). The cut ends of this portion of wire group 2A are located at the attaching position (P) for the punch 15 and die 16 (Figure 6(h)). The cutting punch 19 is returned to its original raised position.

Subsequently, the first die 16 and the second die 18 are raised to the position shown in Figures 5 and 6(i) so as to affix a connector 3 to the terminal ends of the wire group 2A by the first punch 15 and die 16 working in cooperation. At the same time, the second punch 17 and the die 18 cooperate to affix a connector 4 to the terminal ends of the advancing wire group 2A as shown in Figure 6(i), wherein the connector 4 is a different type, being suitable for direct attachment to a substrate. Likewise, then, the first punch 15 and the second punch 17, and the first die 16 and the second die 18 are separated from each other, and the moving chuck 41 pinching the wire group $2A_1$ starts to advance so as to pull out the connector 4 from the attaching device 11 (Figure 6(j)).

In this way a series of operations are accomplished, during which the wire group $2A_1$ is cut to a desired length and is provided with connectors at desired positions, such as both ends and a middle portion. In this case, as mentioned above, the connector 4 is a different type, being suitable for direct attachment to a substrate. In this way a finished harness 50 is produced. If the steps of Figures 6(f) to 6(h) are omitted, the resulting harness 51 will have connectors 3 at one end and connectors 4 at the other end.

A modification can be made by placing the second die 18 in its inoperative condition as shown in Figures 3 and 4, and operating only the first punch 15 and die 16 continuously. As a result, another type of harness 52 will be obtained, which, as shown in Figure 11, has a desired length and connectors of the same type at both ends and in its middle portion. Likewise, a further type of harness 53 can be obtained, which, as shown in Figure 12, has the connectors 3 only at both ends.

The second cooperating punch 17 and die 18 pair having the cutting die 20 mounted thereon, and the presser chucks 21 and 22 can be replaceable with a cutting die 47 opposing the cutting punch 19, and an insulating

covering stripper 48, harnesses 54 can be obtained having one or more connectors 3 at one end and having a connector-free end as shown in Figure 13. It will be noted that the insulating coverings at the connector-free ends have been stripped.

Figure 8 shows another embodiment, wherein a length varying rod 49 capable of vertical movement is provided, which per se is known in the art. A resulting harness 55 has wires of different lengths as shown in Figure 14. The connector-free ends terminate at different points, and it will be noted that the insulating covering at each end has been stripped off.

Thus one or more connectors of the same or different type can be affixed to both ends or one end of a wire group cut to a desired length on a single process line. It is also possible to affix a connector at a desired position on the wires, such as in a middle portion, with both ends or one end having a connector or alternatively with one end having no connector. The insulating coverings of the connector-free ends are removed for ready connection to electrical devices. When an extra wire length varying means is added, it is readily arranged that the connector-free ends terminate at different points, thereby facilitating connection of same to various electrical elements. All these operations can be conducted on a single processing line, thereby securing an efficient mass-production of electrical harnesses. This can also result in reduced production cost. The series of operations can be computerised to perform under a program, thereby to effect a full automatic connector-to-wire attaching operation.

CLAIMS

1. Apparatus for making electrical harnesses including wires and electrical connectors and having a wire feed path (W) extending substantially horizontally and axially of the apparatus; characterised in that a connector attaching device (11) is provided along the feed path (W), the device (11) comprising first and second cooperating assembling punch (15, 17) and die (16, 18) pairs disposed on respective sides of the wire feed path (W), the first and second punch and die pairs being operable individually or synchronously, a cooperating cutting punch (19) and die (20) pair between the first (15, 17) and second (16, 18) punch and die pairs, with the cutting punch and die being operable independently of the first and second assembling punch and die pairs, and connector supplying means for supplying connectors of different types (3, 4) to the first and second assembling dies (16, 18); and

a wire length measuring and feeding device (12) located along the wire feed path (W), the device (12) comprising a chuck (41) reciprocally movable along the wire feed path (W) for pulling out wires in its advancing movement for a distance corresponding to a desired length of the electrical harness, the moving distance and the frequencies of reciprocal movement of the chuck (41) being adjustable dependently on the number of connectors to be affixed to the wires, the intervals thereof, and the types thereof.

2. Apparatus according to claim 1, wherein the first punch and die pair (15, 16) are constantly operated, whereas the second punch and die pair (16, 18) are operated when the connector is to be affixed to the back ends of the wires cut to a desired length and already having the connector affixed to their forward terminal ends.

3. Apparatus according to claim 2, wherein the second punch and die pair (17, 18) are replaceable with a wire cutting means (47) and an insulating covering stripping means (48).

4. Apparatus according to claim 3, further comprising means (49) for varying the lengths of the connector-free end portions of the wires already having a connector affixed to their other ends.

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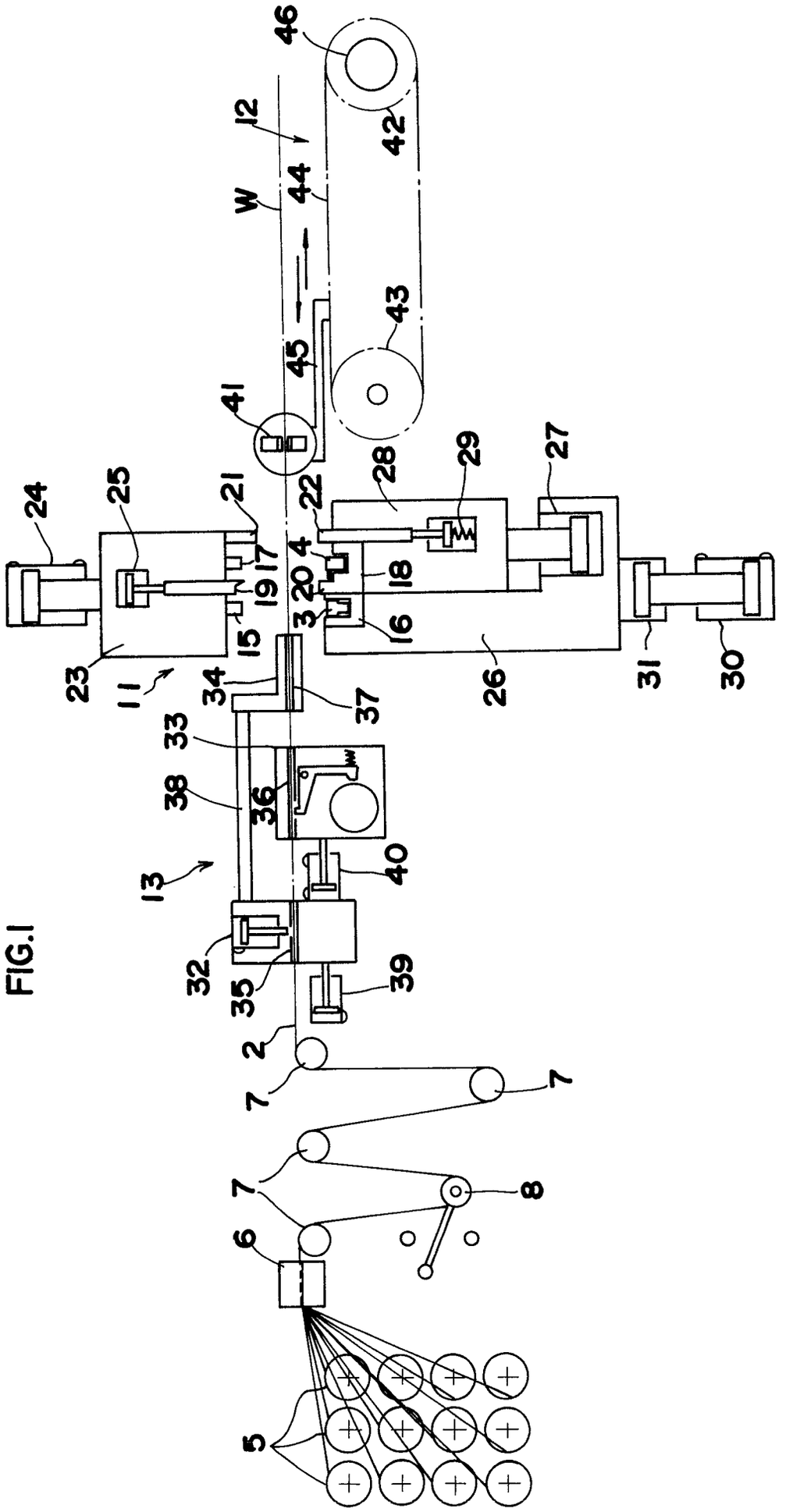

FIG.1

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FIG.2

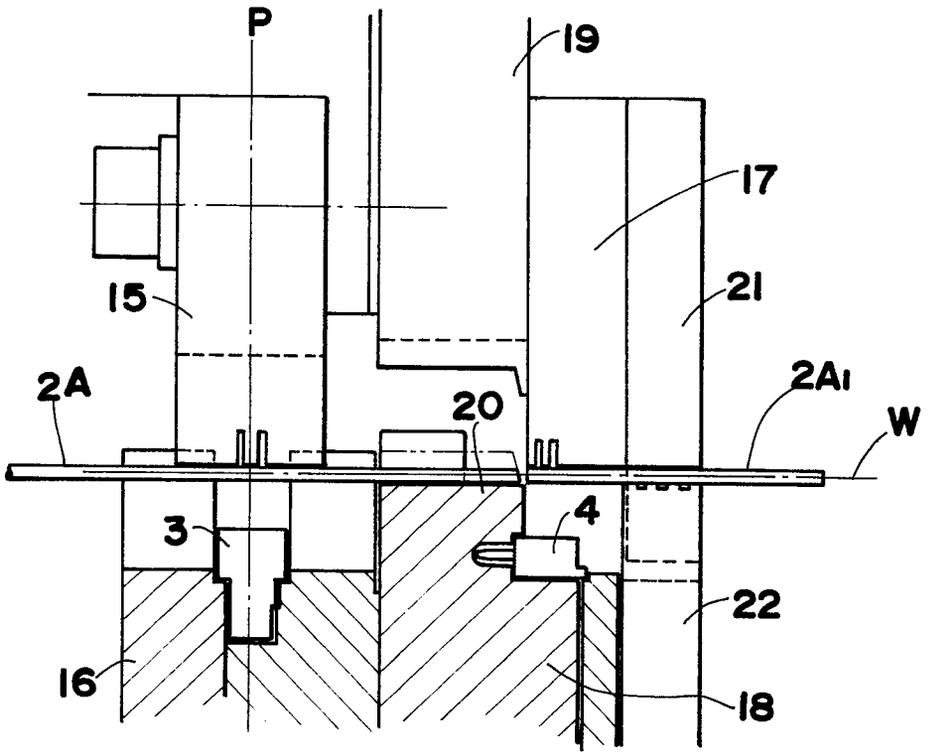

FIG.3

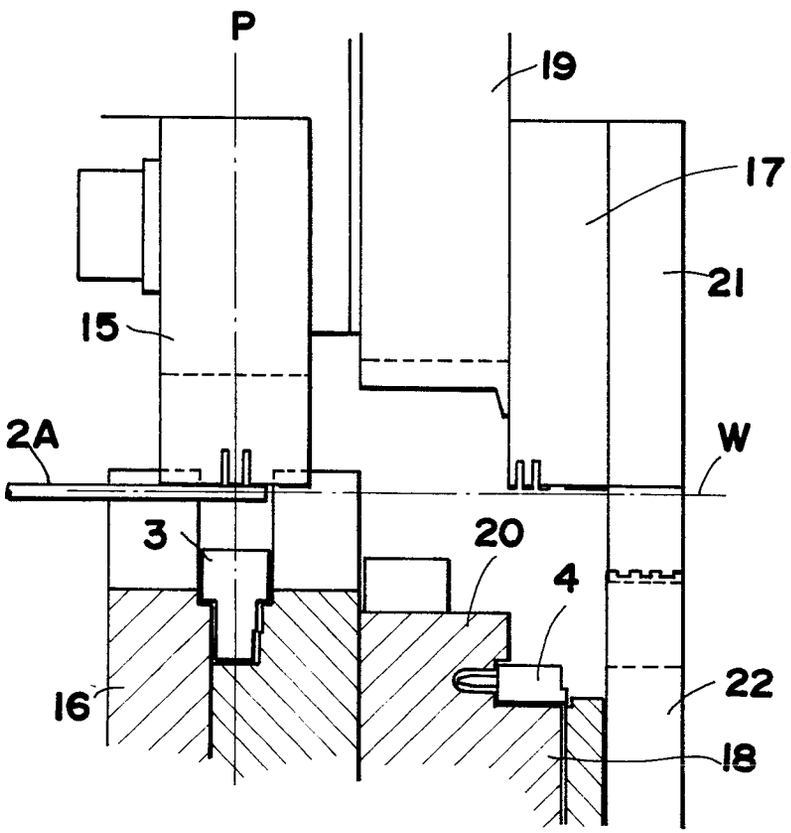

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FIG.4

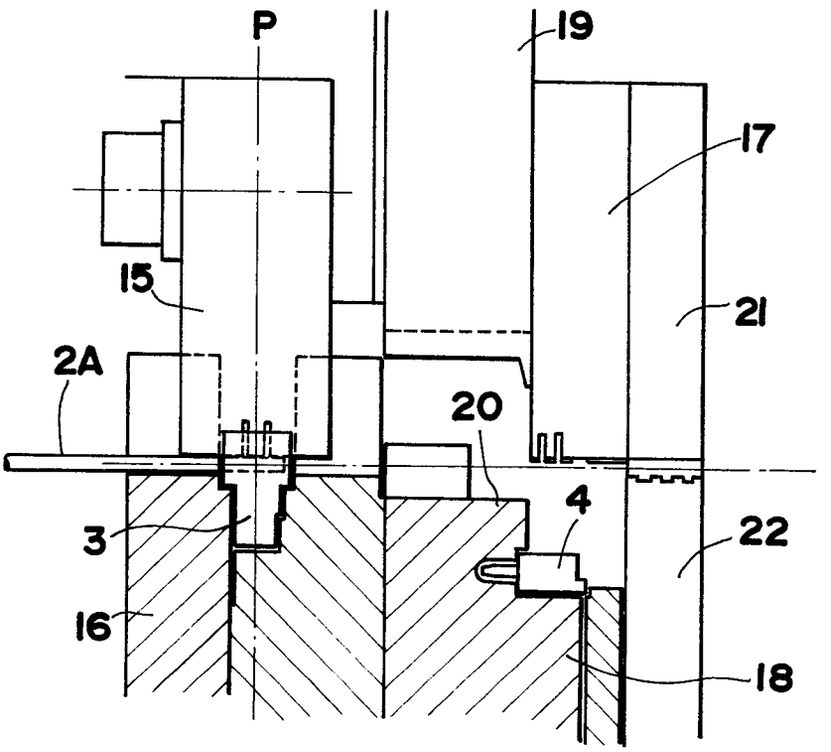

FIG.5

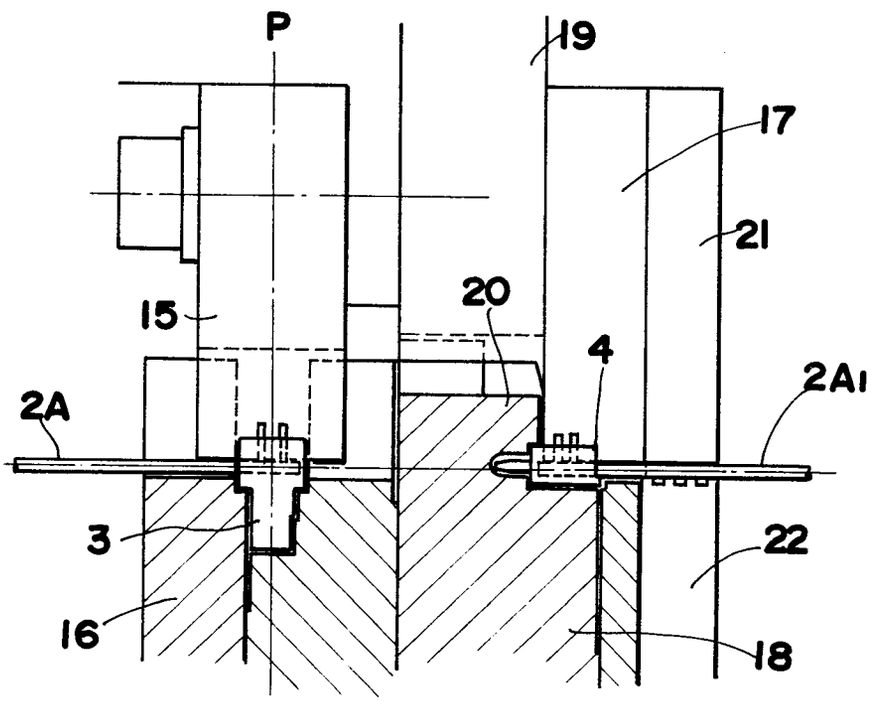

FIG.6a

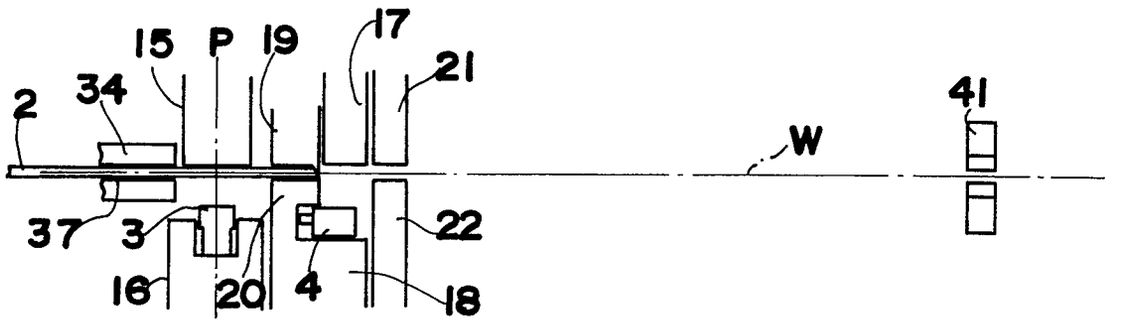

FIG.6b

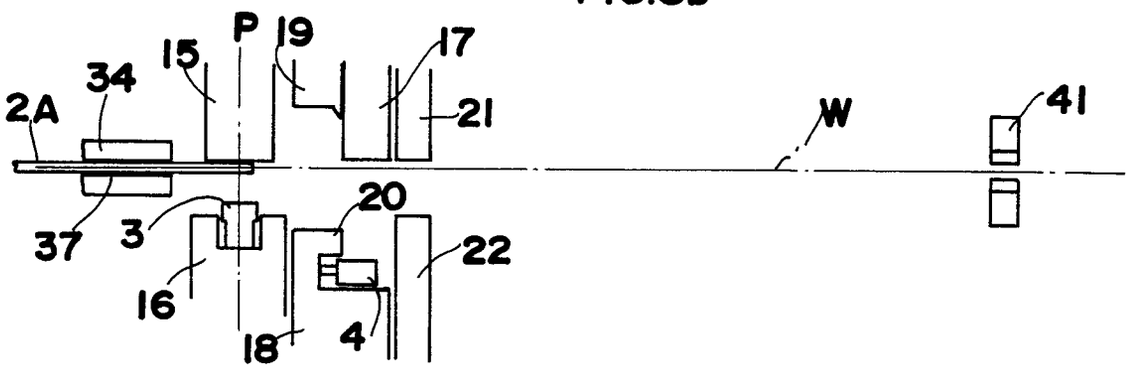

FIG.6c

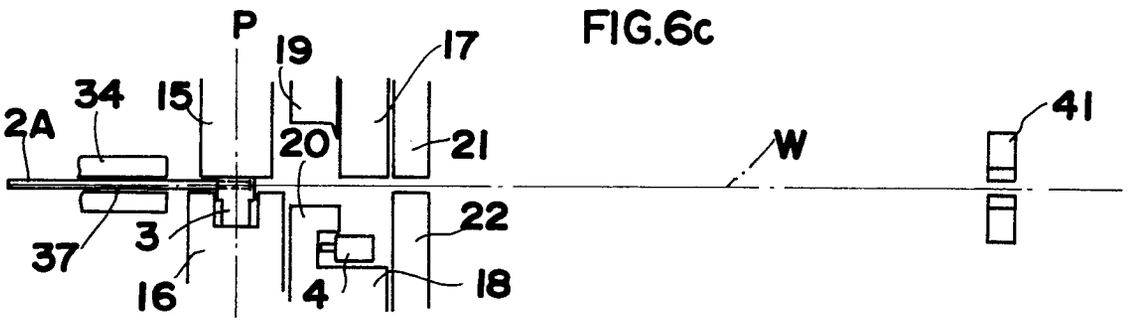

FIG.6d

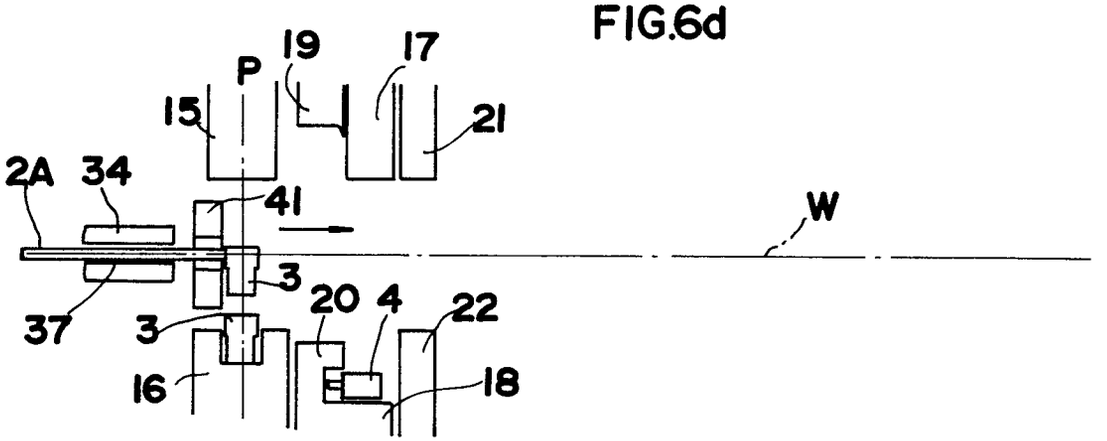

FIG.6e

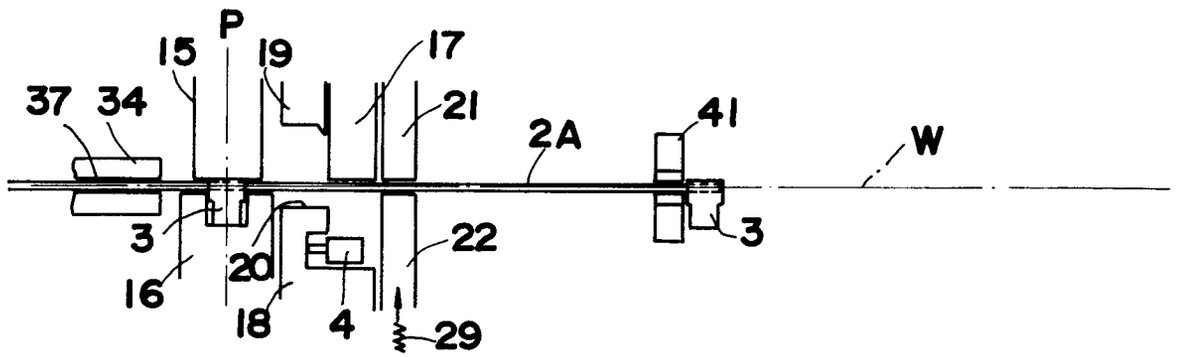

FIG.6f

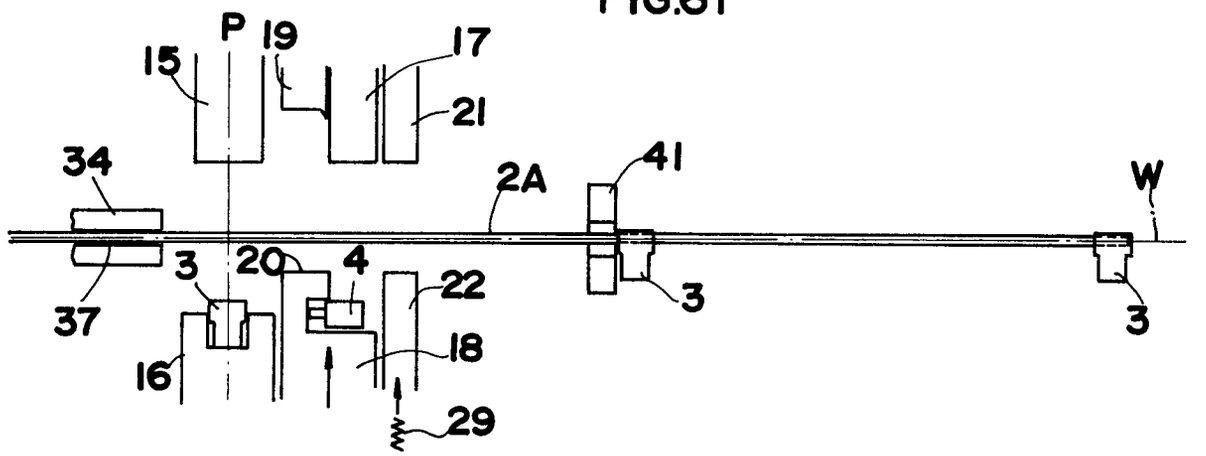

FIG.6g

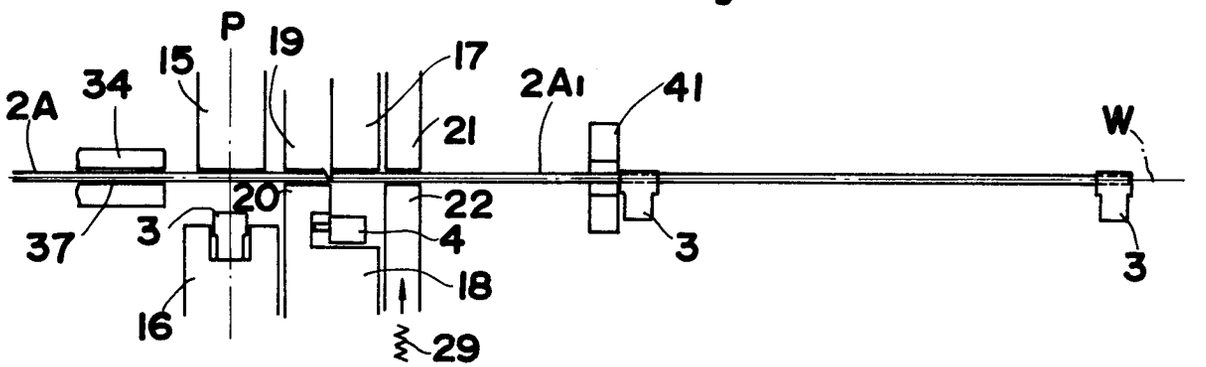

FIG.6h

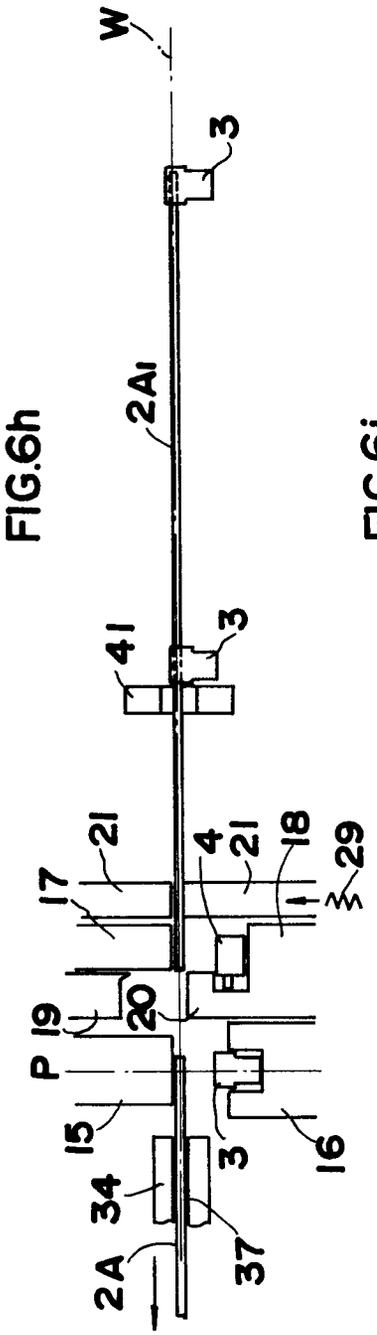

FIG.6i

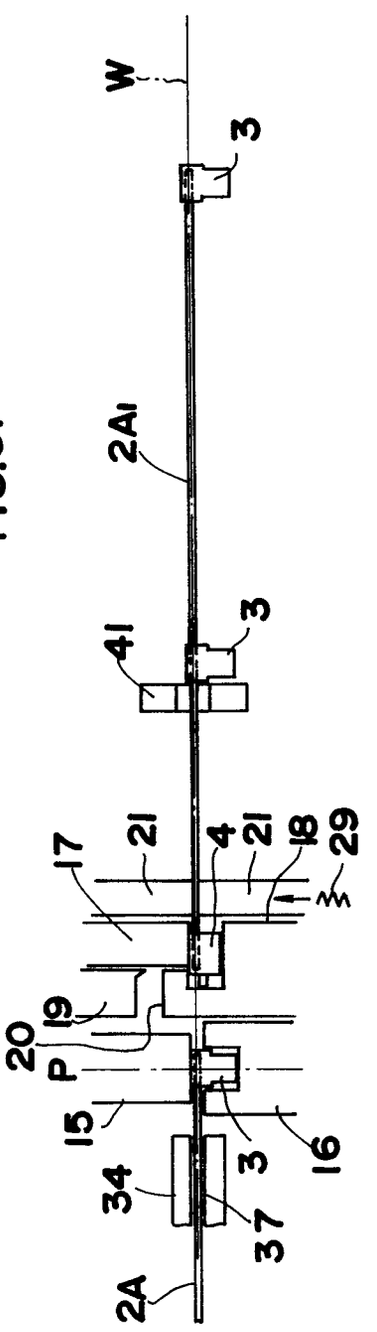

FIG.6j

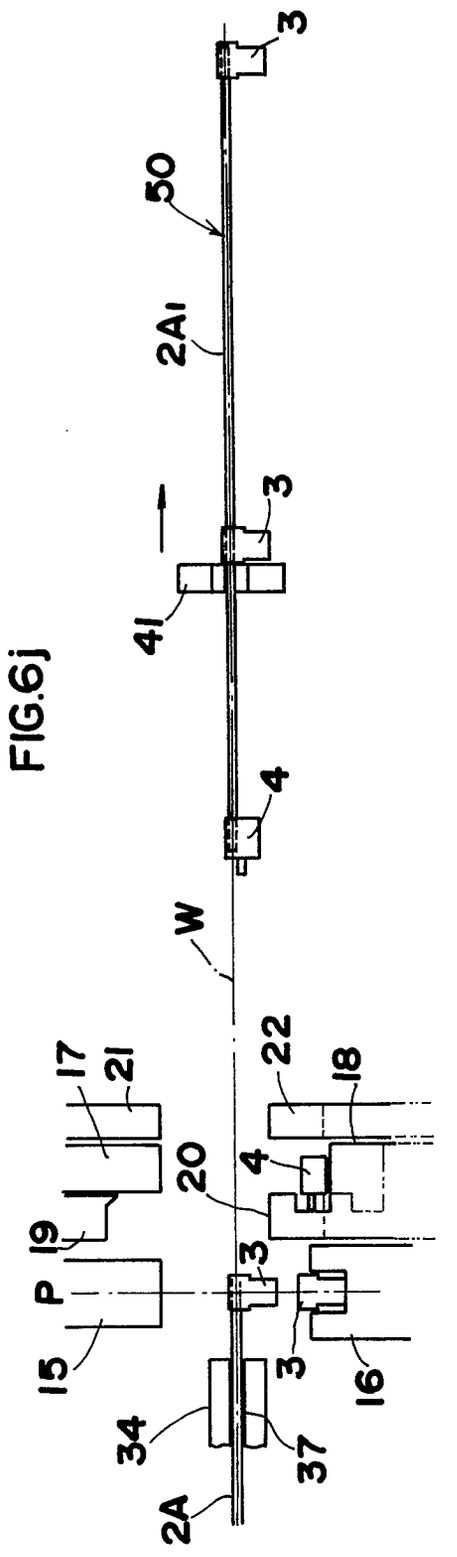

FIG.7

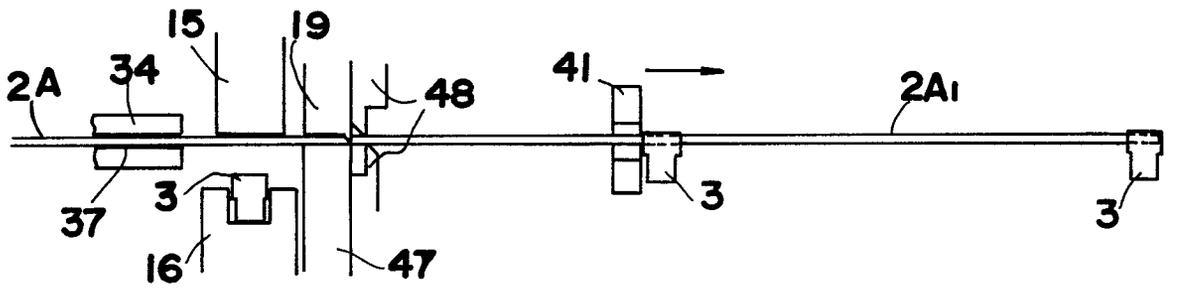
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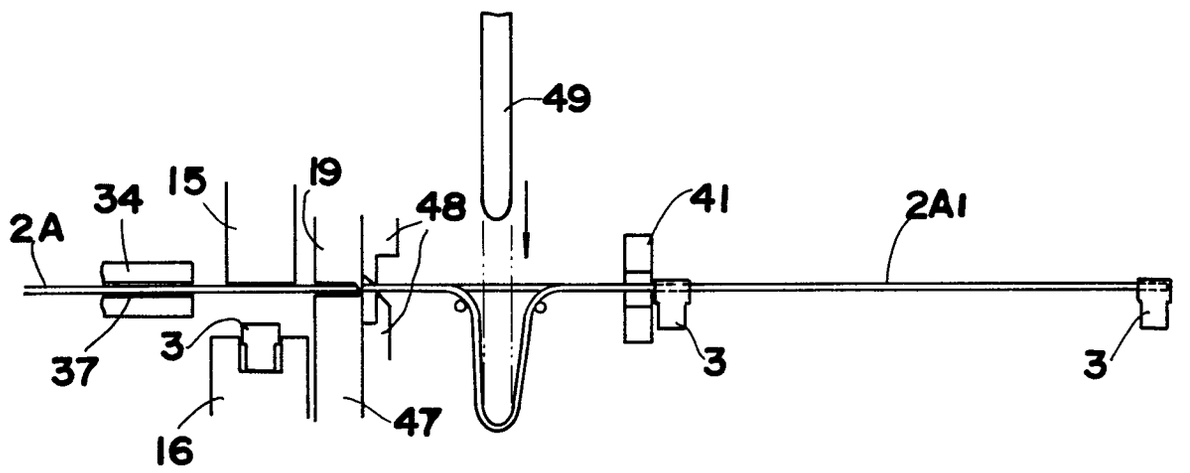
FIG.8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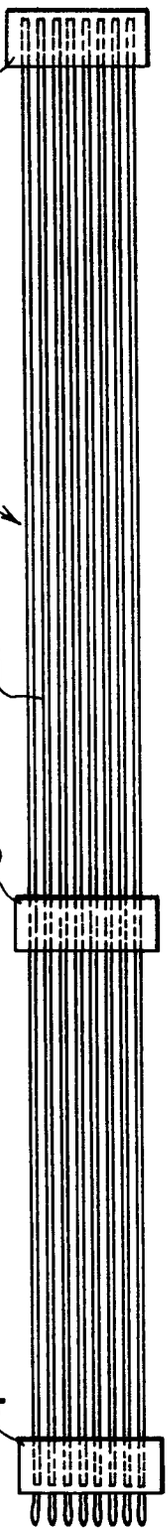

FIG.9

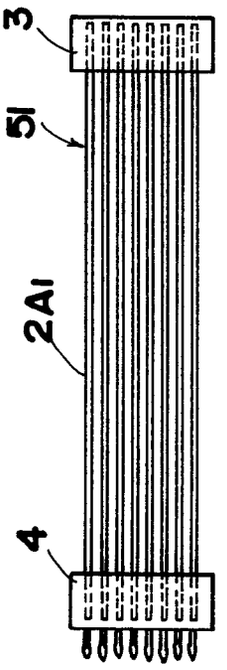

FIG.10

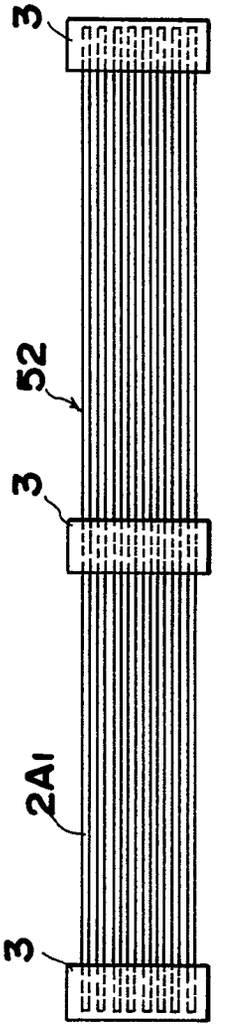

FIG.11

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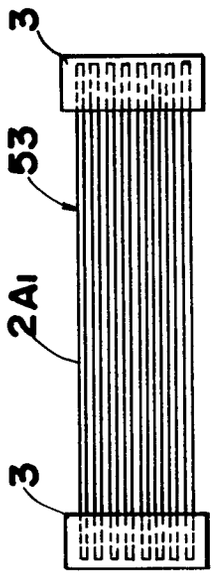

FIG.12

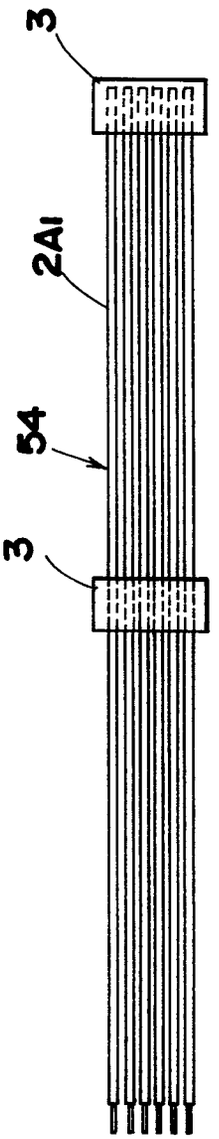

FIG.13

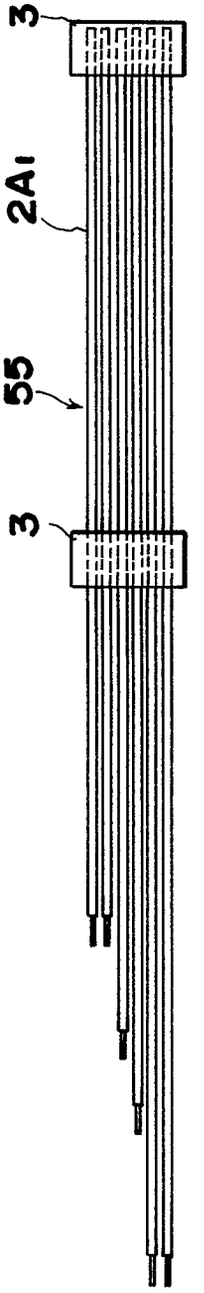

FIG.14