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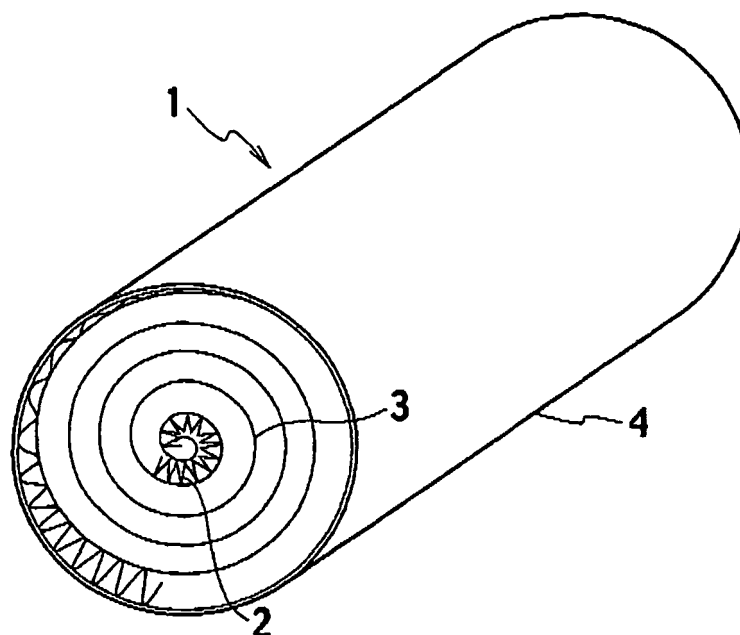
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(54) **Metal carrier and manufacturing method of metal carrier**

(57) A metal carrier according to the present invention is produced by superposing a metal flat sheet (3) and a metal corrugated sheet (2) on each other and wind-

ing them. In a winding end when the corrugated sheet (2) and the flat sheet (3) are wound, a corrugation height of the corrugated sheet (2) is gradually lowered.

FIG. 7



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Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2006-019107 filed on January 12, 2006, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a metal carrier and a manufacturing method thereof for cleaning exhaust gas discharged from an internal combustion engine of an automobile and the like.

2. Description of Related Art

[0003] There has been a conventional cleaning apparatus having a metal carrier therein, such as one shown in Fig. 1. According to this conventional cleaning apparatus, a corrugated sheet 101a and a flat sheet 101b of stainless sheet material constitute a metal carrier 101 of a honeycomb structure, and the metal carrier 101 is press-fitted into a container 102. According to this cleaning apparatus, the corrugated sheet 101a and the flat sheet 101b are diffused-bonded to each other, the container 102 and the metal carrier 101 are brazed with each other and in this state, the catalyst is applied to the metal carrier 101. Diffusers 104 are welded to both ends of the container 102, and function as an inlet and an outlet through which exhaust gas is introduced into and out from a catalyst section (see Japanese Patent No. 2779516).

[0004] As shown in a front view of Fig. 2 and an enlarged view of relevant parts of Fig. 3, the metal carrier 101 of the honeycomb structure is formed in such a manner that the band-like corrugated sheet 101a and the flat sheet 101b are superposed on each another, they are wound around a core metal 105 in a form of a roll and in this state, a top of the corrugated sheet 101a and the flat sheet 101b are bonded to each other so that exhaust gas flows through cells 106 surrounded by the corrugated sheet 101a and the flat sheet 101b. In the state where they are wound in the form of the roll, the metal carrier 101 is press-fitted into the cylindrical container 102 as shown in Fig. 4.

[0005] In the metal carrier 101 formed by winding the corrugated sheet 101a and the flat sheet 101b are wound in the form of the roll, a step H corresponding to a corrugation height is generated at a winding end as shown in Fig. 2. Therefore, when the metal carrier 101 is press-fitted into the cylindrical container 102, the metal carrier 101 is locally deformed due to the step H of the winding end. This deformation propagates toward the center of

the metal carrier 101, the shape of the cell 106 of the metal carrier 101 becomes different from the designed shape and there is a problem that performance of the metal carrier is deteriorated.

[0006] This problem occurs more clearly when the shape of the corrugated sheet 101a to be used is changed from a type B having a low corrugation height fh shown in Fig. 5B to a type A having high corrugation height fh shown in Fig. 5A. In the corrugated sheet of type B, a ratio fh/fp of corrugation height fh and corrugation pitch fp is less than 1 ($fh/fp < 1$). In the corrugated sheet of type A, the ratio fh/fp of the corrugation height fh and the corrugation pitch fp is equal to or higher than 1 ($fh/fp \geq 1$).

[0007] As shown in Figs. 6A and 6B, there is a known cleaning apparatus having a ceramic carrier therein. According to this cleaning apparatus, a ceramic carrier 111 of a honeycomb structure is inserted into a cylindrical container 112 in a state where a shock absorbing material 113 is attached and in this state, the container 112 is provided at its opposite ends with tapered diffusers 114 and the ceramic carrier 111 is held by the spinning rollers SP. In this case, the ceramic carrier 111 to be handled is of substantially circular, and there is no step at the winding end unlike the metal carrier 101. Therefore, the shock absorbing material 113 has a constant thickness (see Japanese Patent Application Laid-open No. 2004-36398).

SUMMARY OF THE INVENTION

[0008] According to the metal carrier 101 proposed in Japanese Patent No. 2779516, as described above, the cell shape is locally deformed when the metal carrier 101 is press-fitted into the cylindrical container 102 due to the step H in the winding end, this deformation propagates toward the center, the shape of the metal carrier 101 becomes different from the designed shape, and there is a problem that this deteriorates the performance.

[0009] When the shock absorbing material 113 having the constant thickness is used for holding the metal carrier like the ceramic carrier 111 of the honeycomb structure proposed in Japanese Patent Application Laid-open No. 2004-36398, the shock absorbing material 113 cannot absorb the step H of the winding end, the holding force of the carrier is not stabilized and thus, there is a problem that the metal carrier may fall out. Further, since the shock absorbing material 113 is required as an additional member, this increases the cost.

[0010] It is an object of the present invention to provide a metal carrier and a manufacturing method thereof in which a step in a winding end of the metal carrier is eliminated and even when the metal carrier is press-fitted into the container, the cell shape is not locally deformed.

[0011] To achieve the above object, the present invention provides a metal carrier produced by superposing a metal flat sheet and a metal corrugated sheet on each other and winding them, wherein a corrugation height of

the corrugated sheet is gradually lowered in a winding end when the flat sheet and the corrugated sheet are wound.

[0012] The present invention also provides a manufacturing method of a metal carrier produced by superposing a metal flat sheet and a metal corrugated sheet on each other and winding them, wherein in a winding end when the flat sheet and the corrugated sheet are wound, tops of corrugations of the corrugated sheet are sandwiched and fixed from a mountain side, and a valley side, machining is performed such that an interval between the fixed tops of the corrugations is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet, the machined corrugated sheet and the flat sheet are wound, thereby producing the metal carrier.

[0013] Further, the present invention also provides a manufacturing method of a metal carrier produced by superposing a metal flat sheet and a metal corrugated sheet on each other and winding them, wherein in a winding end when the flat sheet and the corrugated sheet are wound, machining is performed such that tops of corrugations of the corrugated sheet are pushed, one by one, into grooves formed such that interval therebetween is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet, the machined corrugated sheet and the flat sheet are wound, thereby producing the metal carrier.

[0014] Further, the present invention also provides a manufacturing method of a metal carrier produced by superposing a metal flat sheet and a metal corrugated sheet on each other and winding them, wherein in a winding end when the flat sheet and the corrugated sheet are wound, pins are inserted into valleys of corrugations of the corrugated sheet from both sides of the corrugated sheet, machining is performed such that an interval between the inserted pins is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet, and after the machined corrugated sheet is subjected to press machining, the press machined corrugated sheet and the flat sheet are wound, thereby producing the metal carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a sectional view showing a structure of a cleaning apparatus incorporated in a conventional metal carrier;

Fig. 2 is a sectional view showing a structure of the conventional metal carrier;

Fig. 3 is an enlarged view of relevant parts in Fig. 17;

Fig. 4 is a sectional view showing a state where the metal carrier shown in Fig. 17 is to be press-fitted into the container;

Figs. 5A and 5B are enlarged views showing types of corrugations of corrugated sheet constituting the

metal carrier; and

Figs. 6 are diagrams showing a structure of the cleaning apparatus incorporated in a conventional ceramic carrier, where 6A is a side sectional view, and 6B is a transverse sectional view.

Fig. 7 is a perspective view showing a structure of a metal carrier according to a first embodiment of the present invention;

Fig. 8 is an explanatory diagram of a shape of a corrugated sheet in a winding end of the metal carrier according to the first embodiment;

Fig. 9 is an explanatory diagram of a problem of a normal press machining;

Figs. 10A-10C are explanatory diagrams of a relationship between a corrugation pitch and a corrugation height;

Fig. 11 is a side view showing a structure of a machining apparatus of the metal carrier according to the first embodiment;

Fig. 12 is a side view showing a state where a machining operation in the machining apparatus of the metal carrier according to the first embodiment is completed;

Fig. 13 is a side view showing a structure of a machining apparatus of a metal carrier according to a second embodiment of the present invention;

Fig. 14 is a side view showing a state where the machining operation in the machining apparatus of the metal carrier according to the second embodiment is being performed;

Fig. 15 is another side view showing a state where the machining operation in the machining apparatus of the metal carrier according to the second embodiment is being performed;

Fig. 16 is a side view showing a state where the machining operation in the machining apparatus of the metal carrier according to the second embodiment is completed;

Fig. 17 is a front view showing a structure of a machining apparatus of a metal carrier according to a third embodiment of the present invention;

Fig. 18 is a plan view showing a structure of the machining apparatus of the metal carrier according to the third embodiment;

Fig. 19 is a side view showing a structure of the machining apparatus of the metal carrier according to the third embodiment;

Fig. 20 is a plan view showing a state where the machining operation in the machining apparatus of the metal carrier according to the third embodiment is being performed;

Fig. 21 is a side view for explaining a press machining in the machining apparatus of the metal carrier according to the third embodiment;

DETAILED DESCRIPTION OF EMBODIMENTS

[0016] A first embodiment of the present invention will

be explained below with reference to the accompanying drawings. Fig. 7 is a perspective view showing a structure of a metal carrier according to the first embodiment.

[0017] As shown in Fig. 7, a metal carrier 1 according to the first embodiment is formed in such a manner that a metal band-like corrugated sheet 2 and a flat sheet 3 are superposed on each other, and they are spirally wound. A braze sheet material is wound around an outer periphery thereof, and this is press-fitted into a container 4 that is made of metal, and this is heated in a vacuum state. With this structure, the corrugated sheet 2 and the flat sheet 3 are diffused-bonded to each other, the corrugated sheet 2 and the flat sheet 3 are brazed and bonded between the container 4, and the metal carrier 1 is formed.

[0018] The shape of the corrugated sheet 2 in the winding end of the metal carrier 1 will be explained based on Fig. 8. As shown in Fig. 8, the corrugation pitch of the corrugated sheet 2 having the corrugation height of A is gradually widened, thereby lowering the corrugation height to B. This corrugation height B is height from 1/3 to 1/4 of the corrugation height A. The length required for lowering the corrugation height A to the corrugation height B is in a range of about 1/2 to 1/1 of the outer periphery of the metal carrier 1.

[0019] In the metal carrier 1 according to the first embodiment, in the winding end when the flat sheet 3 and the corrugated sheet 2 are wound, the corrugation height of the corrugated sheet 2 is gradually lowered. Therefore, a step in the winding end can be eliminated. With this structure, the local deformation of the cell caused when it is press-fitted into the container 4 can be prevented, and it is possible to prevent the cleaning performance from being deteriorated. Since the carrier holding force is stabilized, the metal carrier can be prevented from falling out. Further, since additional members such as a shock absorbing material are unnecessary, it is possible to suppress the increase in cost.

[0020] Next, a manufacturing method of the metal carrier according to the first embodiment will be explained with reference to the accompanying drawings. Like the metal carrier 1 according to the present embodiment, as a machining method for gradually lowering the corrugation height in the winding end of the corrugated sheet 2, it seems possible to employ a press machining. However, if attempt is made to gradually lower the corrugation height of the corrugated sheet 2 by a normal press machining, as shown in Fig. 9, since shapes of an upper die 31, a lower die 32 and the corrugated sheet 2 are largely different from each other and thus, the corrugated sheet 2 is deviated from the dies and is deformed.

[0021] Hence, in this embodiment, as shown in Figs. 10A-10C, utilizing the fact that if the corrugation pitch is increased, the corrugation height is reduced, the corrugation height in the winding end of the corrugated sheet 2 is gradually lowered in the order of Fig. 10A, 10B, and 10C.

[0022] Fig. 11 shows a structure of a machining appa-

ratus for gradually lowering the corrugation height of the corrugated sheet 2. As shown in Fig. 11, a machining apparatus 51 includes a plurality of dies 53 each formed with a groove 52 for fixing a top of a corrugation of the corrugated sheet 2, die retainer bolts 54 for connecting between the dies 53, punches 55 inserted into valleys of corrugations of the corrugated sheet 2, punch holders 56 for holding the punches 55, punch retainer bolts 57 for connecting between the punch holders 56, and a slide base 58 for supporting the punch holders 56 such that the punch holders 56 can move laterally.

[0023] In the machining apparatus 51 having such a structure, Fig. 11 shows a state before machining, and the number of the dies 53 is equal to the number of mountains of the corrugated sheet 2. Each of the grooves 52 is formed in the upper surface of the die 53. The groove 52 has the same R-size as that of the top of the corrugation of the corrugated sheet 2, and the dies 53 are connected to each other through the die retainer bolt 54.

[0024] Meanwhile, each the punch 55 is inserted into a hole (not shown) formed in the punch holder 56 and held therein, and the number of the punches 55 and the number of punch holders 56 are equal to the number of valleys of the corrugated sheet 2. The punch holders 56 are connected to each other through the punch retainer bolts 57, and are placed on the slide base 58.

[0025] In the initial state shown in Fig. 11, the dies 53 and the punch holders 56 are pushed in a winding direction by an actuator such as an air pressure cylinder and they come into intimate contact with each other. In this state, the width between the grooves 52 formed in the die 53 is the same as a pitch of the mountains of the corrugated sheet 2. The shape of the corrugated sheet 2 corresponds to the shape of the groove 52 as shown in Fig. 11. Meanwhile, each punch 55 is held in a state where the punch 55 matches with a position of the valley of the corrugated sheet 2.

[0026] If the punch 55 lowers in unison with the punch holder 56 and the slide base 58, the punch 55 is inserted into the valley of the corrugated sheet 2, and is fixed by sandwiching the top of the corrugation of the corrugated sheet 2 between the die 53 and the groove 52.

[0027] If the punch holder 56 and the die 53 are then spread in synchronization with each other in the direction opposite from the winding direction by an actuator (not shown) such as an air pressure cylinder, as shown in Fig. 12, the corrugation height of the corrugated sheet 2 is gradually lowered, and the machining of the corrugated sheet 2 by the machining apparatus 51 according to the present embodiment is completed.

[0028] At that time, an opening distance between the punch holder 56 and the die 53 is preset by the punch retainer bolt 57 and the die retainer bolt 54. Therefore, the corrugated sheet 2 is formed into a preset shape.

[0029] In the die retainer bolts 54 and the punch retainer bolts 57, fourth retainer bolts 54 and 57 from the left side are omitted in Fig. 11, and fifth retainer bolts are illustrated therein. This is because that the fifth and sub-

sequent retainer bolts are longer than the dies, and retainer bolts extend over the right side dies as compared with the adjacent dies. Retainer bolts in this case are offset in a plan direction.

[0030] According to the manufacturing method of the metal carrier 1 of the first embodiment, in the winding end when the flat sheet 3 and the corrugated sheet 2 are wound, the top of the corrugation of the corrugated sheet 2 is sandwiched between the mountain side and the valley side and fixed therebetween, they are spread such that the interval between the fixed tops of the corrugations is gradually increased and the corrugation height of the corrugated sheet 2 is gradually lowered. Therefore, the step in the winding end of the produced metal carrier 1 can be eliminated. Particularly in the present embodiment, since the top of the corrugation of the corrugated sheet 2 is sandwiched between the mountain side and the valley side and fixed, it is possible to perform the machining operation in a state where the shape of the corrugated sheet 2 is stabilized.

[0031] Next, a manufacturing method of a metal carrier according to a second embodiment of the present invention will be explained with reference to the accompanying drawings. Fig. 13 shows a structure of a machining apparatus for gradually lowering the corrugation height of the corrugated sheet 2. As shown in Fig. 13, the machining apparatus 71 includes a die 73 formed with grooves 72a to 72g for fixing tops of corrugations of the corrugated sheet 2, and punches 74a to 74g to be inserted into valleys of the corrugations of the corrugated sheet 2. As a mechanism for lowering the punches 74a to 74g, a general method such as a method using a cam mechanism and a method using an actuator can be employed.

[0032] In the machining apparatus 71 having such a structure, Fig. 13 shows a state before machining. The number of grooves 72a to 72g formed in the die 73 is equal to the number of mountains of the corrugated sheet 2 at positions of a machining-completion state.

[0033] Meanwhile, the shapes of the punches 74a to 74g correspond to spreading angles of the corrugated sheet 2. Positions of the punches 74a to 74g correspond to the grooves 72a to 72g.

[0034] In the initial state shown in Fig. 13, the top of the corrugation of the corrugated sheet 2 is set at the position of the groove 72a. In this state, only the position of the groove 72a matches the position of the top of the corrugated sheet 2 and the position of the groove 72, and the corrugated sheet 2 is placed on the die 73.

[0035] First, as shown in Fig. 14, only the punch 74a is lowered, the top of the corrugation of the corrugated sheet 2 is sandwiched between the groove 72a to spread the first mountain. With this machining, the position of the corrugated sheet 2 is deviated rightward in Fig. 14, and the second mountain of the corrugated sheet 2 enters the groove 72b.

[0036] Thereafter, as shown in Fig. 15, if the second punch 74b is lowered to spread the second mountain of the corrugated sheet 2, the corrugated sheet 2 further

moves rightward. The punches from 74c to 74g are lowered in this order and the corrugated sheet 2 is pushed and spread and finally, as shown in Fig. 16, all of the punches 74a to 74g are lowered the corrugated sheet 2 is pushed and spread to the preset state. With this structure, the corrugation height is gradually lowered, and the machining of the corrugated sheet 2 by the machining apparatus 71 according to the second embodiment is completed.

[0037] In the manufacturing method of the metal carrier according to the second embodiment, in the winding end when the flat sheet 3 and the corrugated sheet 2 are wound, the tops of the corrugations of the corrugated sheet 2 are pushed, one by one, into the grooves 72a to 72g formed such that the interval is gradually widened so that the corrugation height of the corrugated sheet 2 is gradually lowered. Therefore, the step in the winding end of the produced metal carrier 1 can be eliminated. Particularly in the present embodiment, since a mechanism for moving the punches 74a to 74g and the grooves 72a to 72g is unnecessary, the apparatus cost can be reduced.

[0038] Next, a manufacturing method of a metal carrier of a third embodiment of the present will be explained with reference to on the accompanying drawings. Figs. 17 to 19 show a structure of a machining apparatus for gradually lowering the corrugation height of the corrugated sheet 2, wherein Fig. 17 is a front view, Fig. 18 is a plan view as viewed from above, and Fig. 19 is a side view showing a corrugated sheet of a state wherein it is set in the machining apparatus.

[0039] As shown in Figs. 17 and 18, the machining apparatus 81 includes a die 82 formed with a shape of the completed (spring biasing force considered) corrugated sheet 2, lifters 83 on which the corrugated sheet 2 is placed, pins 84 to be inserted into valleys of corrugations of the corrugated sheet 2, pins 84 to be inserted into valleys of corrugations of the corrugated sheet 2, blocks 85 for holding the pins 84, retainer bolts 86 for connecting the blocks 85, springs 87 for biasing the blocks 85, and punches 88 formed with the shape of the completed corrugated sheet 2.

[0040] In the machining apparatus 81 having such a structure, the corrugated sheet 2 is placed on the lifters 83 placed on the die 82 before machining. The punches 88 are disposed above the die 82, and the die 82 and the punches 88 are formed with shapes which can be obtained when the machining is completed. The pins 84 are held on the opposite sides of the corrugated sheet 2 by the blocks 85 and the springs 87. The number of the pins 84 is equal to the number of mountains of corrugations to be machined as shown in Fig. 12. The blocks 85 are connected through the retainer bolts 86.

[0041] In the initial state shown in Fig. 17, initial positioning of the corrugated sheet 2 is performed on the lifter 83. Next, as shown in Fig. 18, the pin 84 is pushed out in the direction of the arrow (1) against the biasing force of the spring 87 by an actuator such as an air pressure

cylinder (not shown), and the pin 84 is inserted into the valley of the corrugated sheet 2. Similarly, the other pin 84 is also inserted into the valley of the corrugated sheet 2. At that time, the relationship between the corrugated sheet 2 and the pins 84 is as shown in Fig. 19.

[0042] The block 85 is then moved in the direction of the arrow (2). If the movement is completed, the state shown in Fig. 20 is obtained. At that time, as shown in Fig. 20, since the interval of the block 85 opened by the retainer bolt 86 is previously set, the corrugated sheet 2 is widened into a preset shape.

[0043] Next, the lifter 83 and the pin 84 are brought into standby states, the die 82 is moved upward and the punch 88 is moved downward as shown in Fig. 21, the corrugated sheet 2 is subjected to the press-machining by the molding shape between the die 82 and the punch 88, and the machining of the corrugated sheet 2 by the machining apparatus 81 according to the present embodiment is completed.

[0044] In the manufacturing method of the metal carrier 1 according to the third embodiment, in the winding end when the flat sheet 3 and the corrugated sheet 2 are wound, the pins 84 are inserted from both sides of the corrugated sheet 2 toward the valleys of the corrugation of the corrugated sheet 2, the corrugated sheet 2 is widened so that the interval between the inserted pins 84 is gradually widened, and the machining is performed such that the corrugation height of the corrugated sheet 2 is gradually lowered. Therefore, the step in the winding end of the produced metal carrier 1 can be eliminated. Particularly in the present embodiment, the pins 84 are inserted into the valleys of the corrugation of the corrugated sheet 2 from both sides of the corrugated sheet 2, the corrugated sheet 2 is widened so that the interval of the inserted pins 84 is gradually widened and then, the press machining is additionally performed. Therefore, the shape of the corrugated sheet 2 can precisely be formed.

[0045] Although the metal carrier and the manufacturing method thereof of the present invention have been explained based on the exemplary embodiments, the present invention is not limited to the embodiments, and the structure of each portion can be replaced by an arbitrary structure having like functions.

[0046] According to the metal carrier of the present invention, the corrugation height of the corrugated sheet is gradually lowered in the winding end when the flat sheet and the corrugated sheet are wound. Therefore, the step in the winding end can be eliminated, and the local deformation of the cell shape which occurs when the cell is press-fitted into the container can be prevented, and it is possible to prevent the cleaning performance from being deteriorated.

[0047] According to the manufacturing method of the metal carrier of the present invention, in a winding end when the flat sheet and the corrugated sheet are wound, tops of corrugations of the corrugated sheet are sandwiched and fixed from a mountain side and a valley side, machining is performed such that an interval between

the fixed tops of the corrugations is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet. Therefore, the step in the winding end of the produced metal carrier can be eliminated. Particularly, since the tops of corrugations of the corrugated sheet are sandwiched from the mountain side and the valley side and fixed therebetween, the machining can be performed in a state where the shape of the corrugated sheet is stabilized.

[0048] According to the manufacturing method of the metal carrier of the present invention, in a winding end when the flat sheet and the corrugated sheet are wound, machining is performed such that tops of corrugations of the corrugated sheet are pushed, one by one, into grooves formed such that interval therebetween is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet. Therefore, the step in the winding end of the produced metal carrier can be eliminated. Particularly, since a mechanism for moving the groove is unnecessary, it is possible to reduce the apparatus cost.

[0049] According to the manufacturing method of the metal carrier of the present invention, in a winding end when the flat sheet and the corrugated sheet are wound, pins are inserted into valleys of corrugations of the corrugated sheet from both sides of the corrugated sheet, machining is performed such that an interval between the inserted pins is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet, and after the machined corrugated sheet is subjected to press machining, the press machined corrugated sheet and the flat sheet are wound. Therefore, the step in the winding end of the produced metal carrier can be eliminated. Particularly, the pins are inserted into the valleys of the corrugations of the corrugated sheet from both sides of the corrugated sheet, the interval between the inserted pins is widened such that it is gradually widened and then, the press machining is additionally performed. Thus, it is possible to precisely machine the shape of the corrugated sheet.

[0050] Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art, in light of the teachings. The scope of the invention is defined with reference to the following claims.

Claims

1. A metal carrier produced by superposing a metal flat sheet (3) and a metal corrugated sheet (2) on each other and winding them, wherein a corrugation height of the corrugated sheet (2) is gradually lowered in a winding end when the flat sheet and the corrugated sheet are wound.

2. A manufacturing method of a metal carrier produced by superposing a metal flat sheet (3) and a metal corrugated sheet (2) on each other and winding them, wherein
 in a winding end when the flat sheet (3) and the corrugated sheet (2) are wound, tops of corrugations of the corrugated sheet (2) are sandwiched and fixed from a mountain side and a valley side, machining is performed such that an interval between the fixed tops of the corrugations is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet (2), the machined corrugated sheet (2) and flat sheet (3) are wound, thereby producing the metal carrier.
3. A manufacturing method of a metal carrier produced by superposing a metal flat sheet (3) and a metal corrugated sheet (2) on each other and winding them, wherein
 in a winding end when the flat sheet (3) and the corrugated sheet (2) are wound, machining is performed such that tops of corrugations of the corrugated sheet (2) are pushed, one by one, into grooves (72a to 72g) formed such that interval therebetween is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet (2), the machined corrugated sheet (2) and flat sheet (3) are wound, thereby producing the metal carrier.
4. A manufacturing method of a metal carrier produced by superposing a metal flat sheet (3) and a metal corrugated sheet (2) on each other and winding them, wherein
 in a winding end when the flat sheet (3) and the corrugated sheet (2) are wound, pins (84) are inserted into valleys of corrugations of the corrugated sheet (2) from both sides of the corrugated sheet, machining is performed such that an interval between the inserted pins (84) is gradually widened, thereby gradually lowering a corrugation height of the corrugated sheet (2), and after the machined corrugated sheet (2) is subjected to press machining, the press machined corrugated sheet (2) and flat sheet (3) are wound, thereby producing the metal carrier.

FIG. 1
RELATED ART

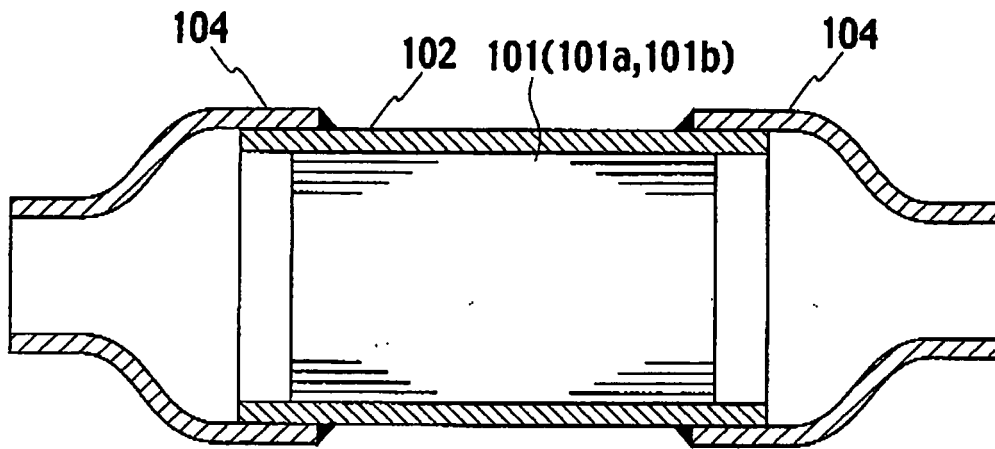


FIG. 2
RELATED ART

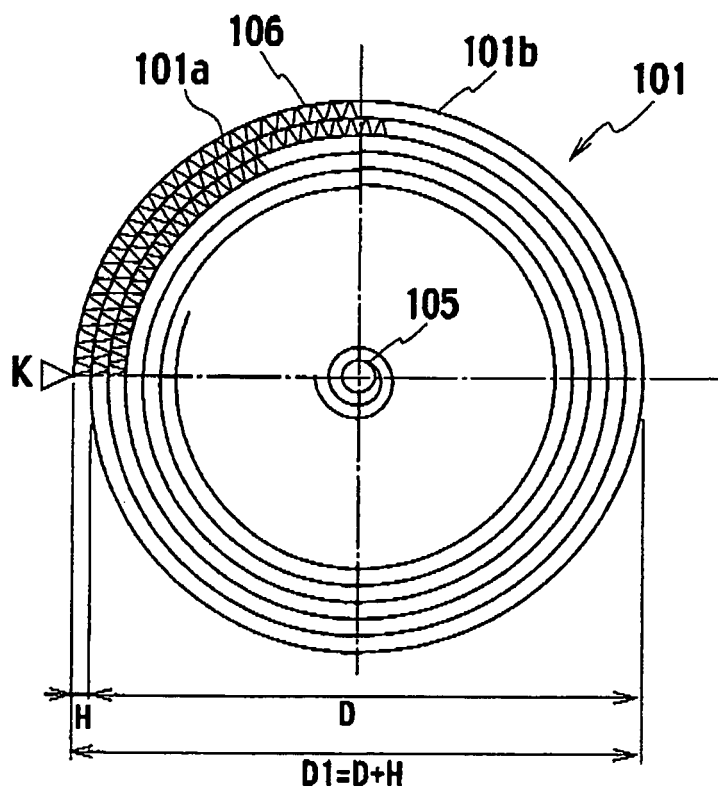


FIG. 3
RELATED ART

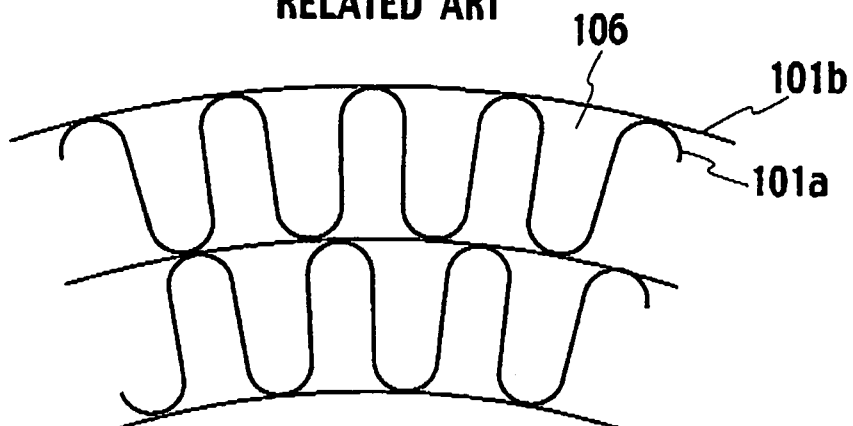


FIG. 4
RELATED ART

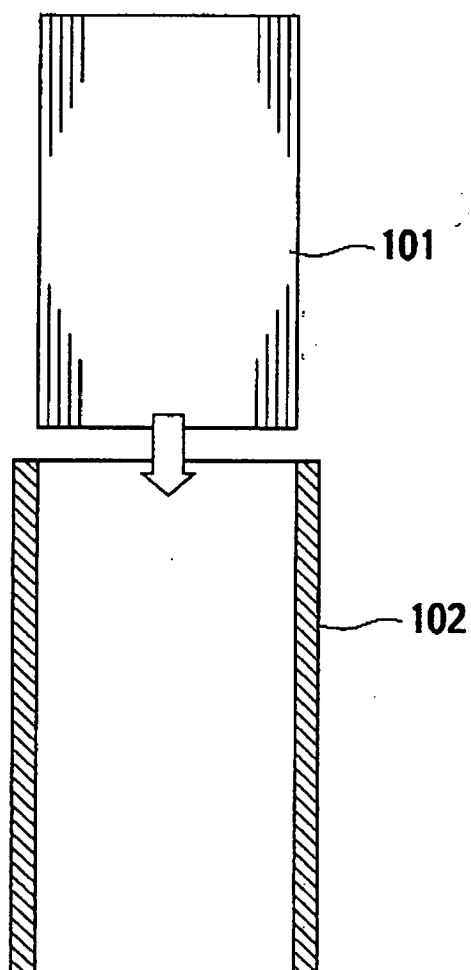


FIG. 5A
RELATED ART

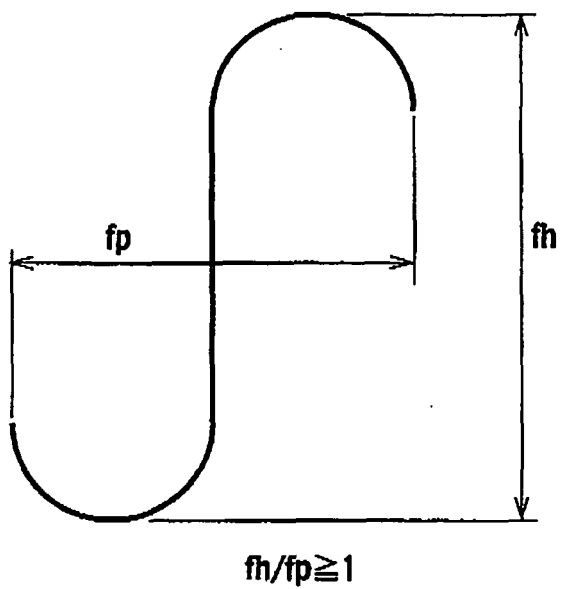


FIG. 5B
RELATED ART

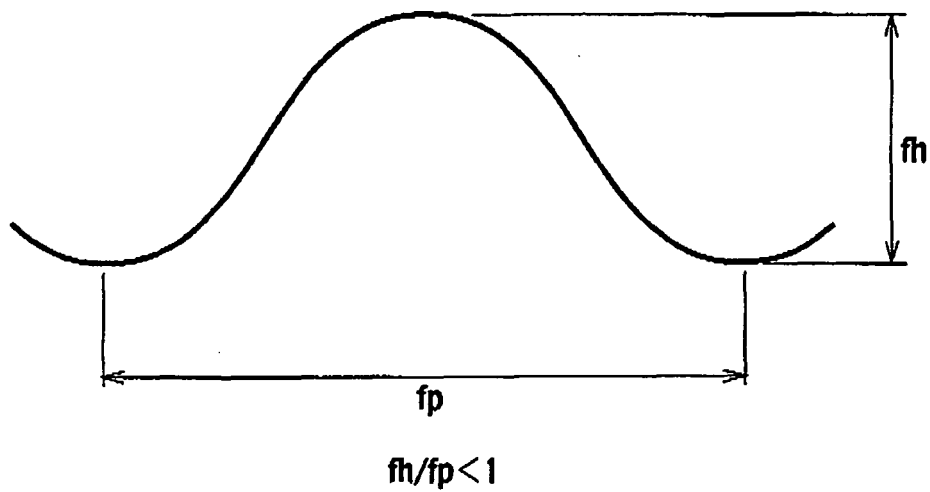


FIG. 6A
RELATED ART

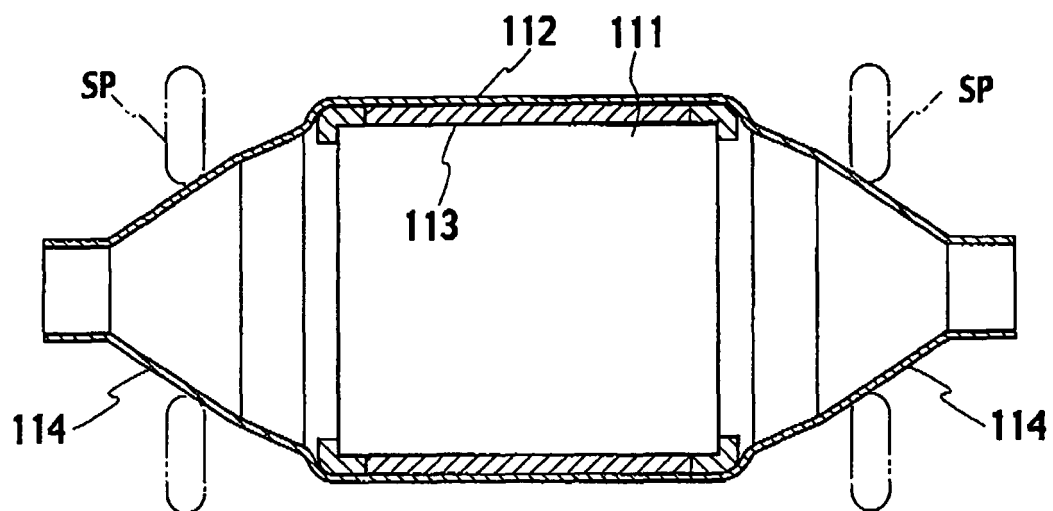


FIG. 6B
RELATED ART

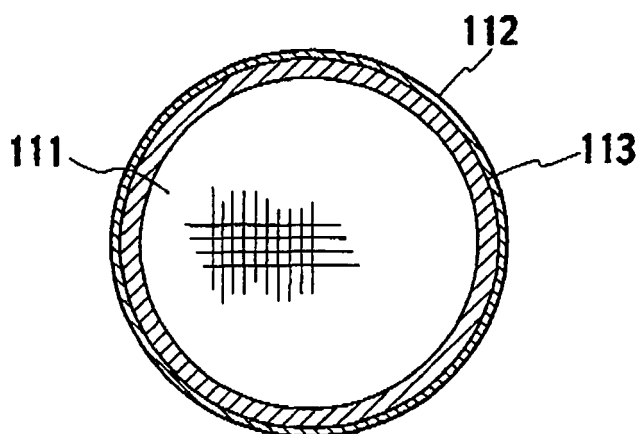


FIG. 7

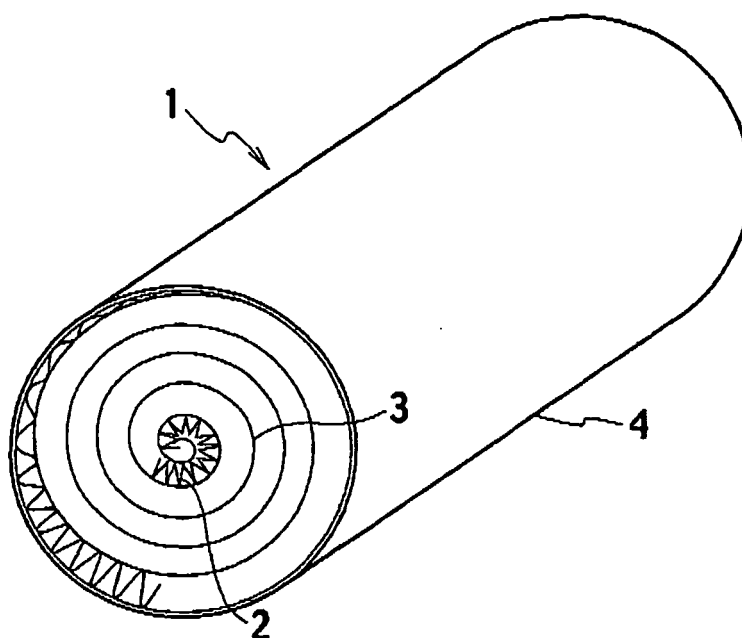


FIG. 8

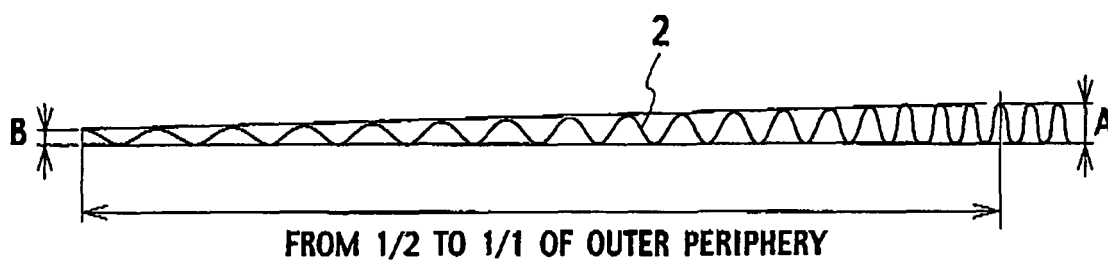
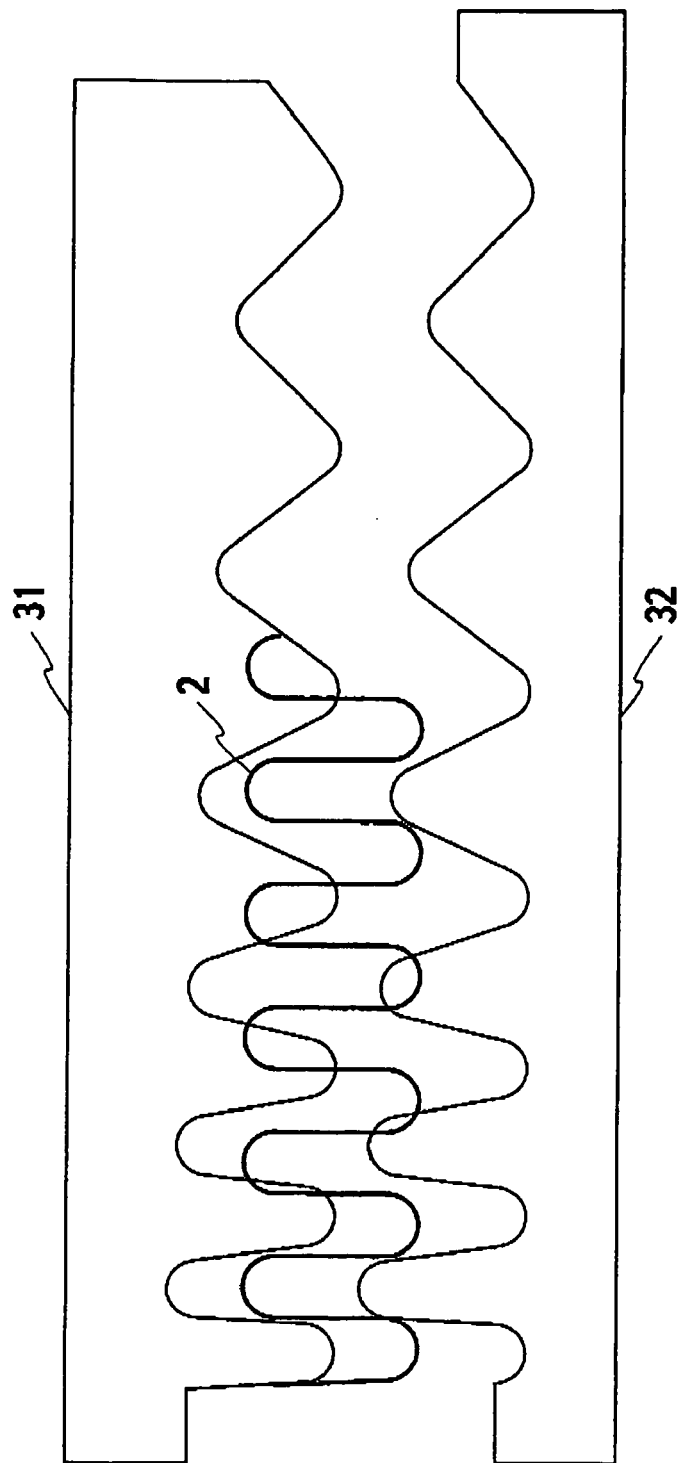


FIG. 9



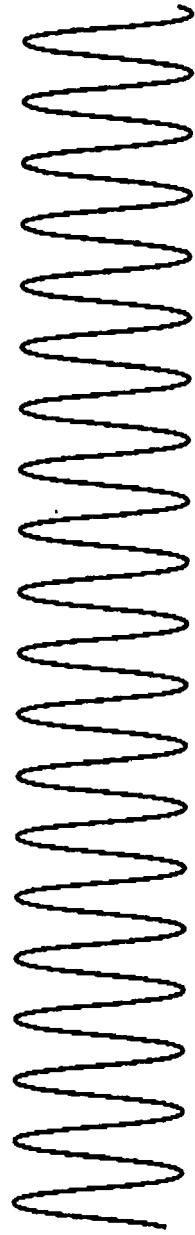


FIG. 10A

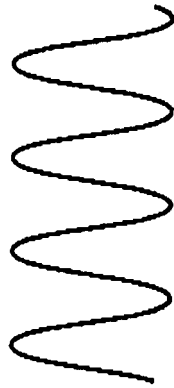


FIG. 10B



FIG. 10C

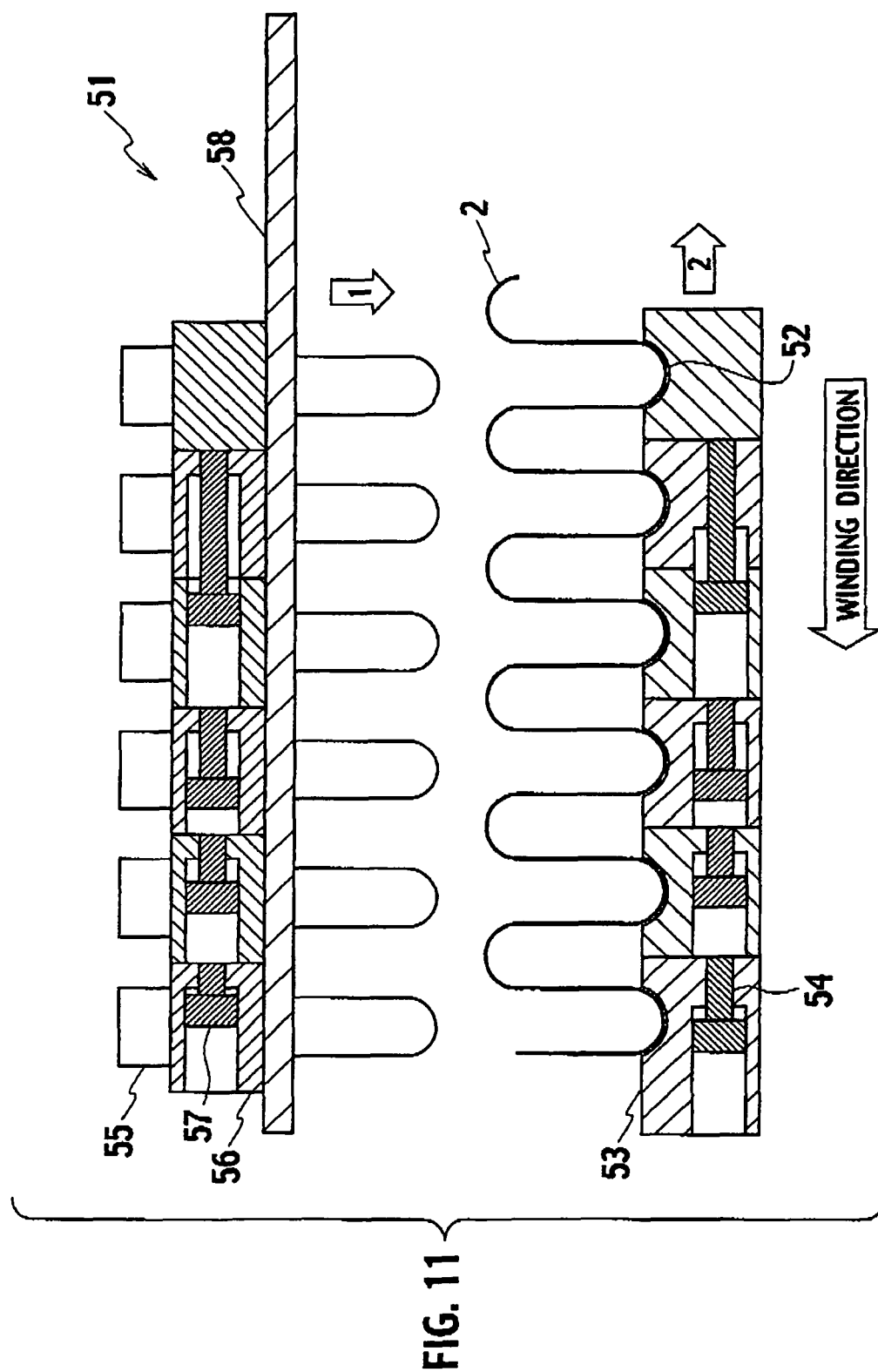
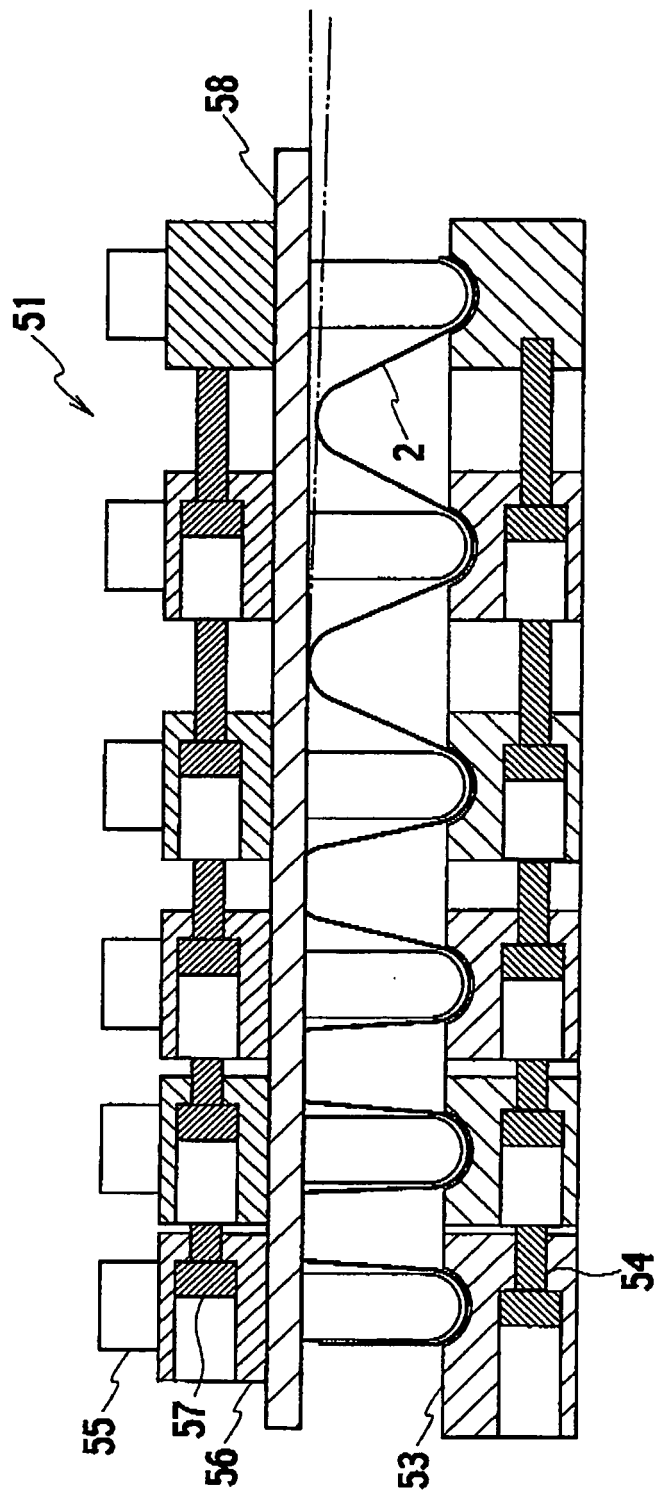
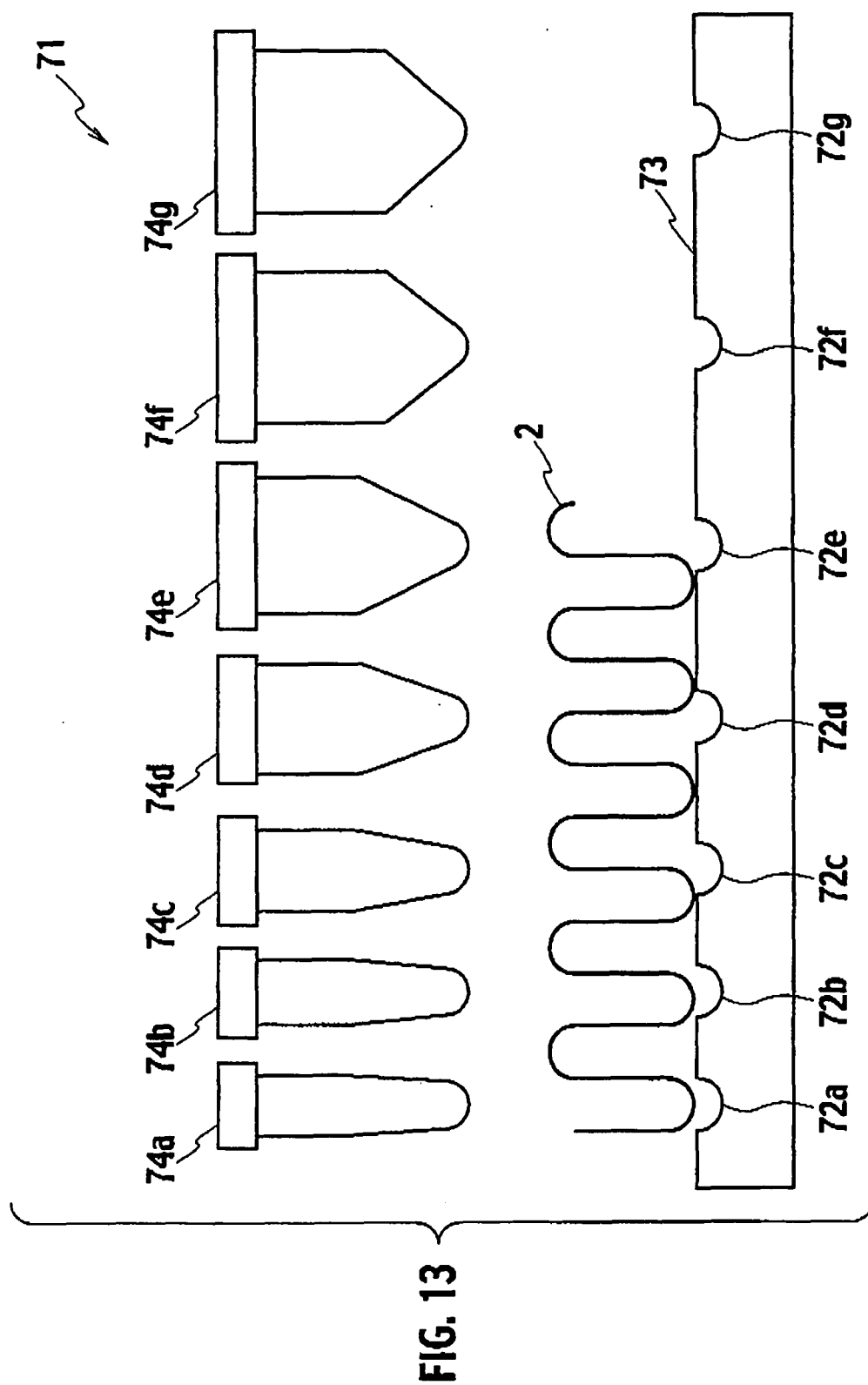
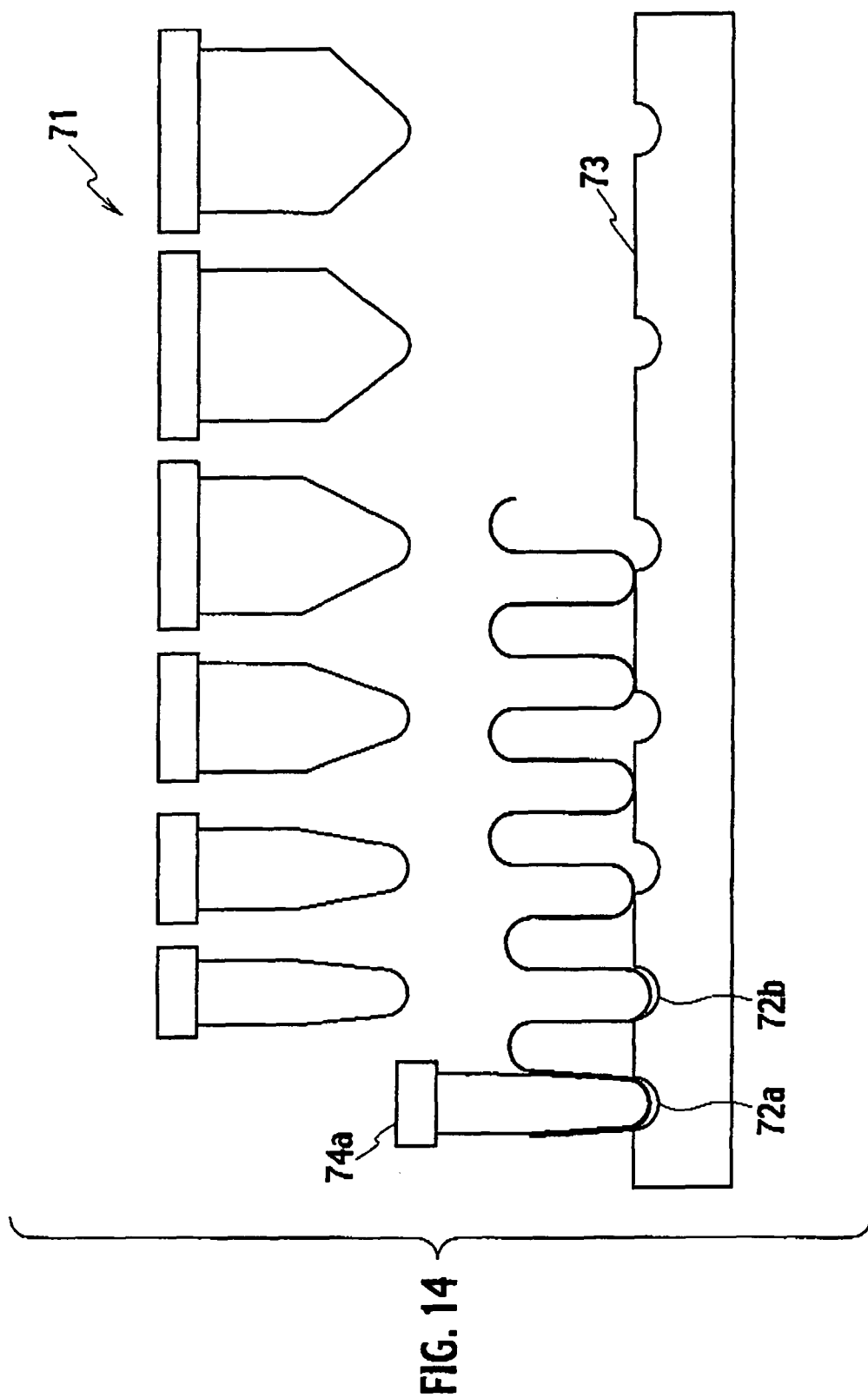


FIG. 12







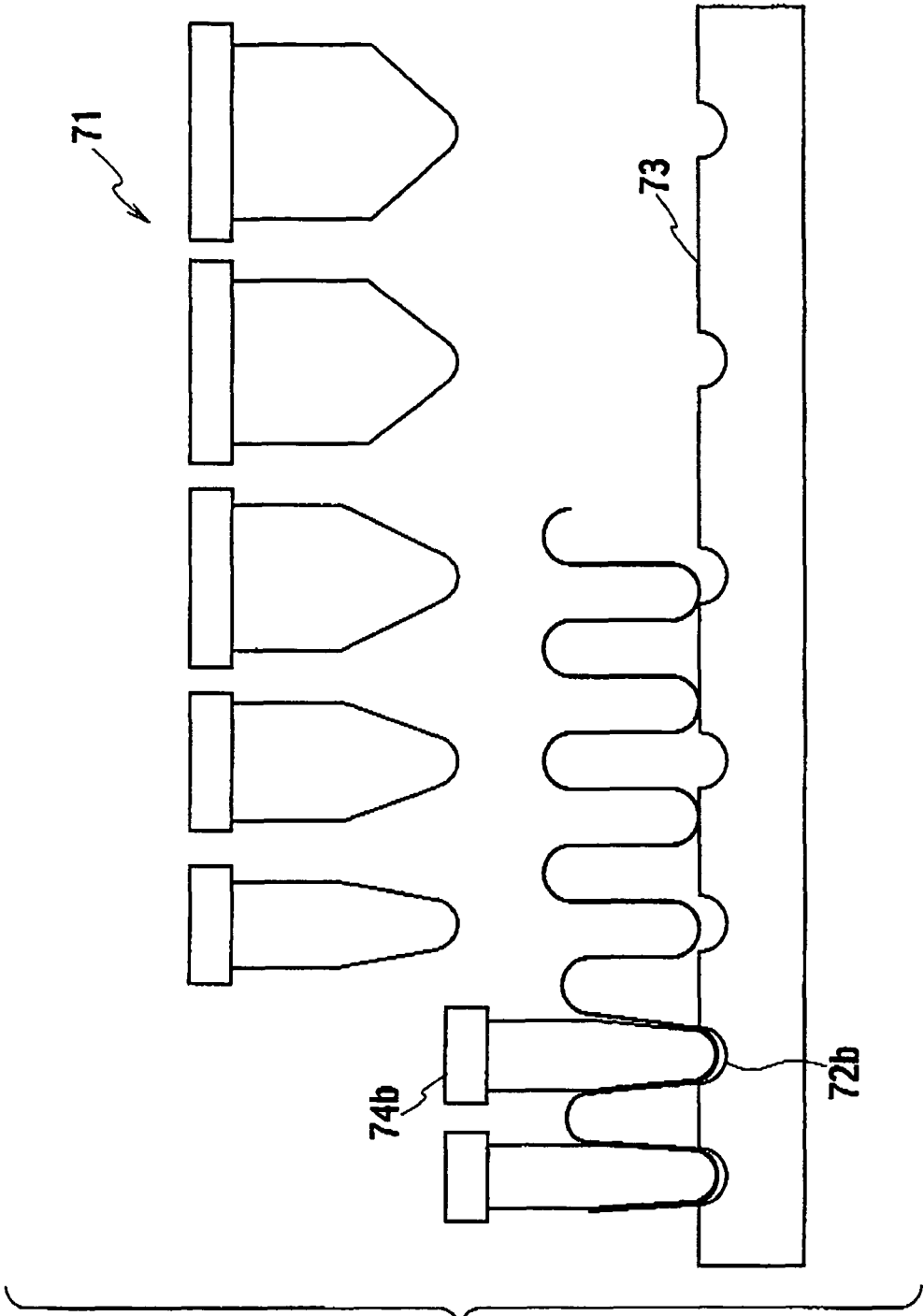


FIG. 16

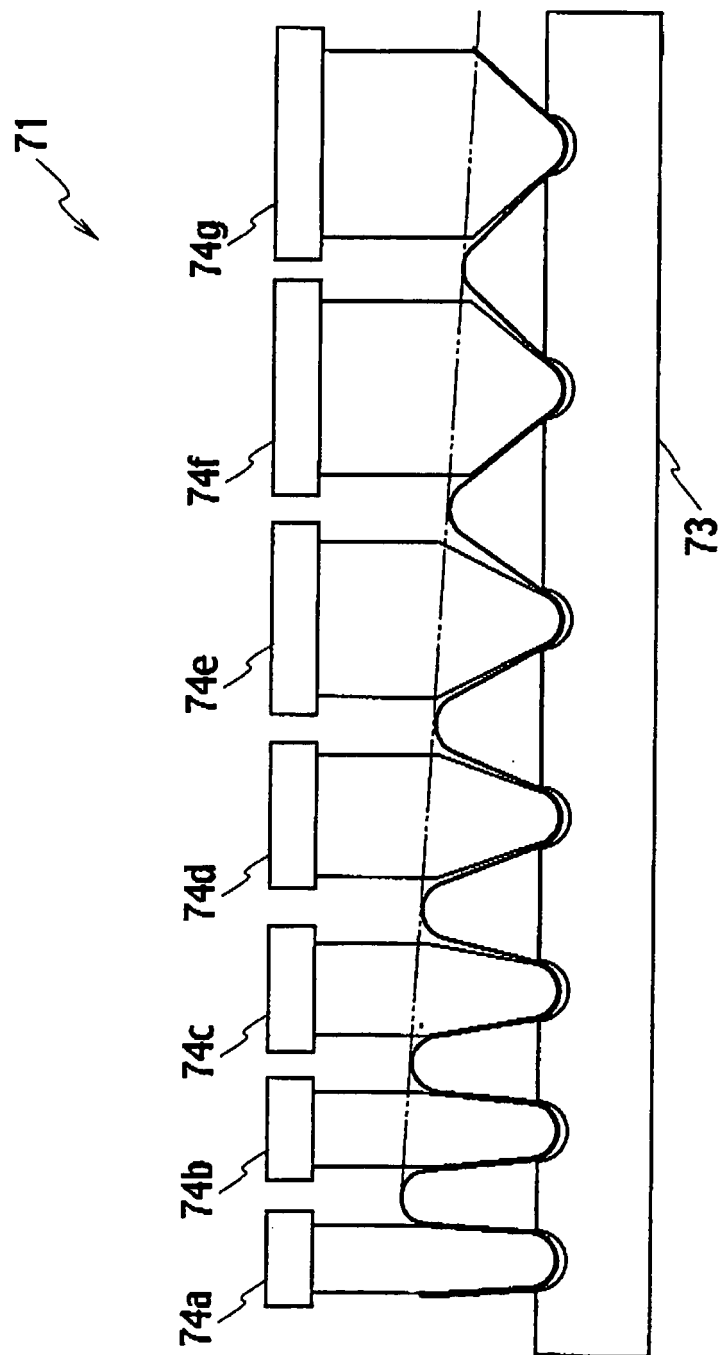


FIG. 17

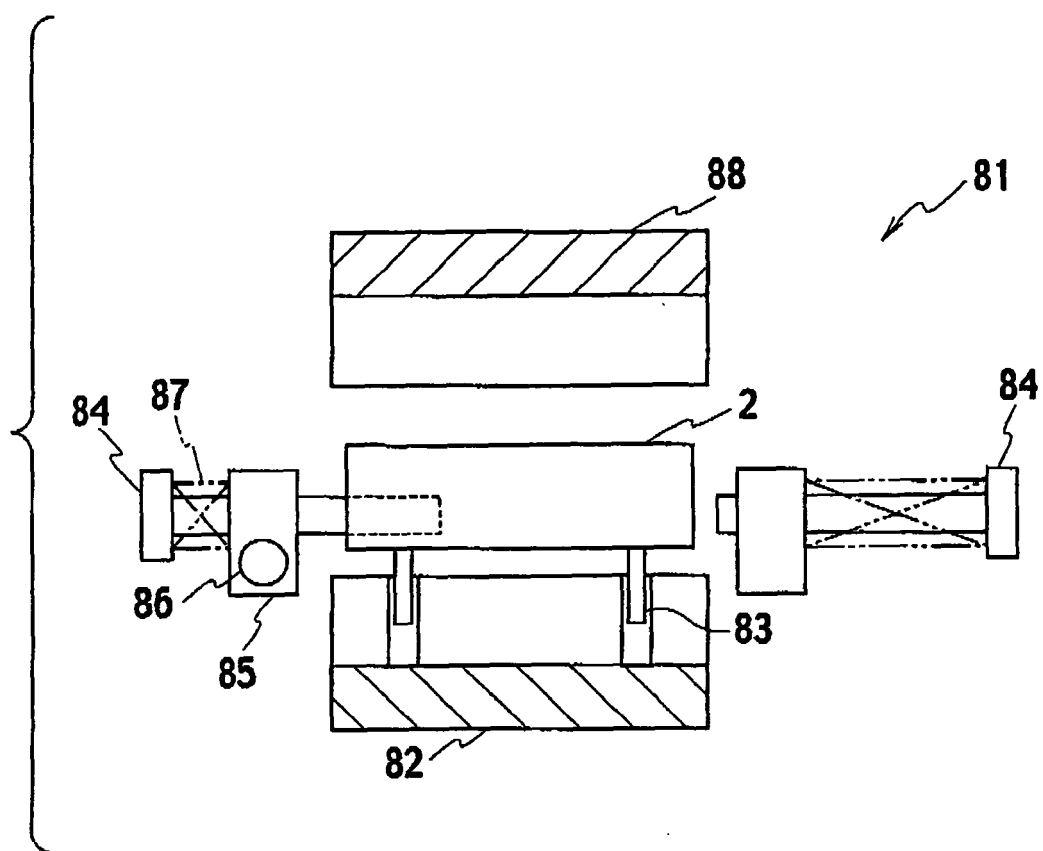


FIG. 18

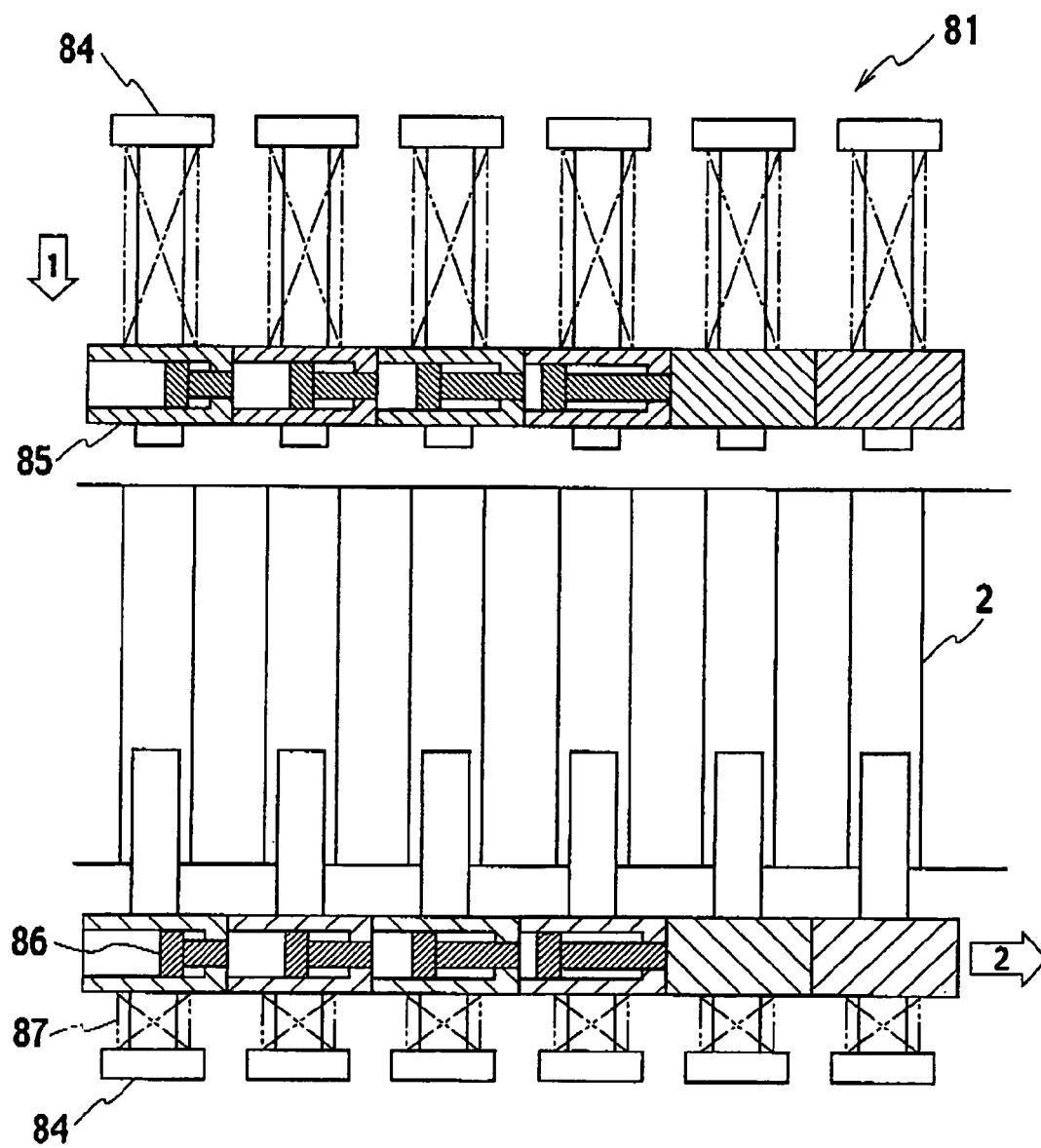
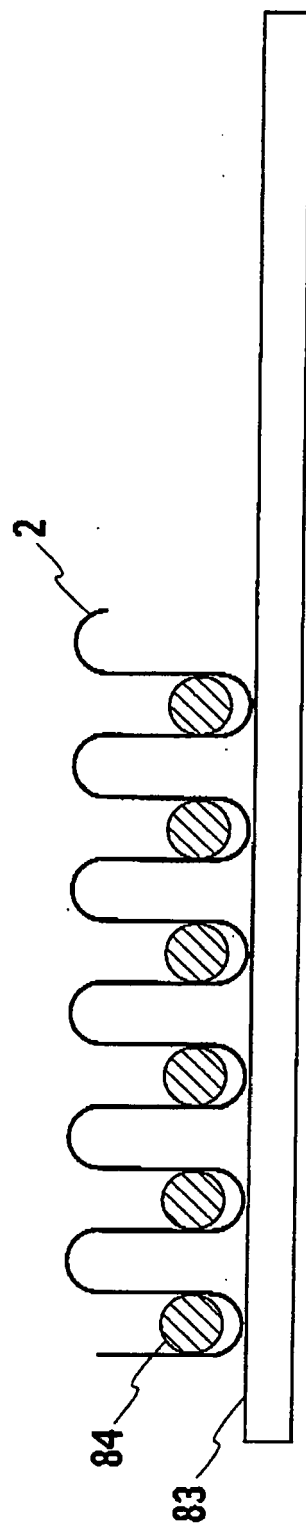


FIG. 19



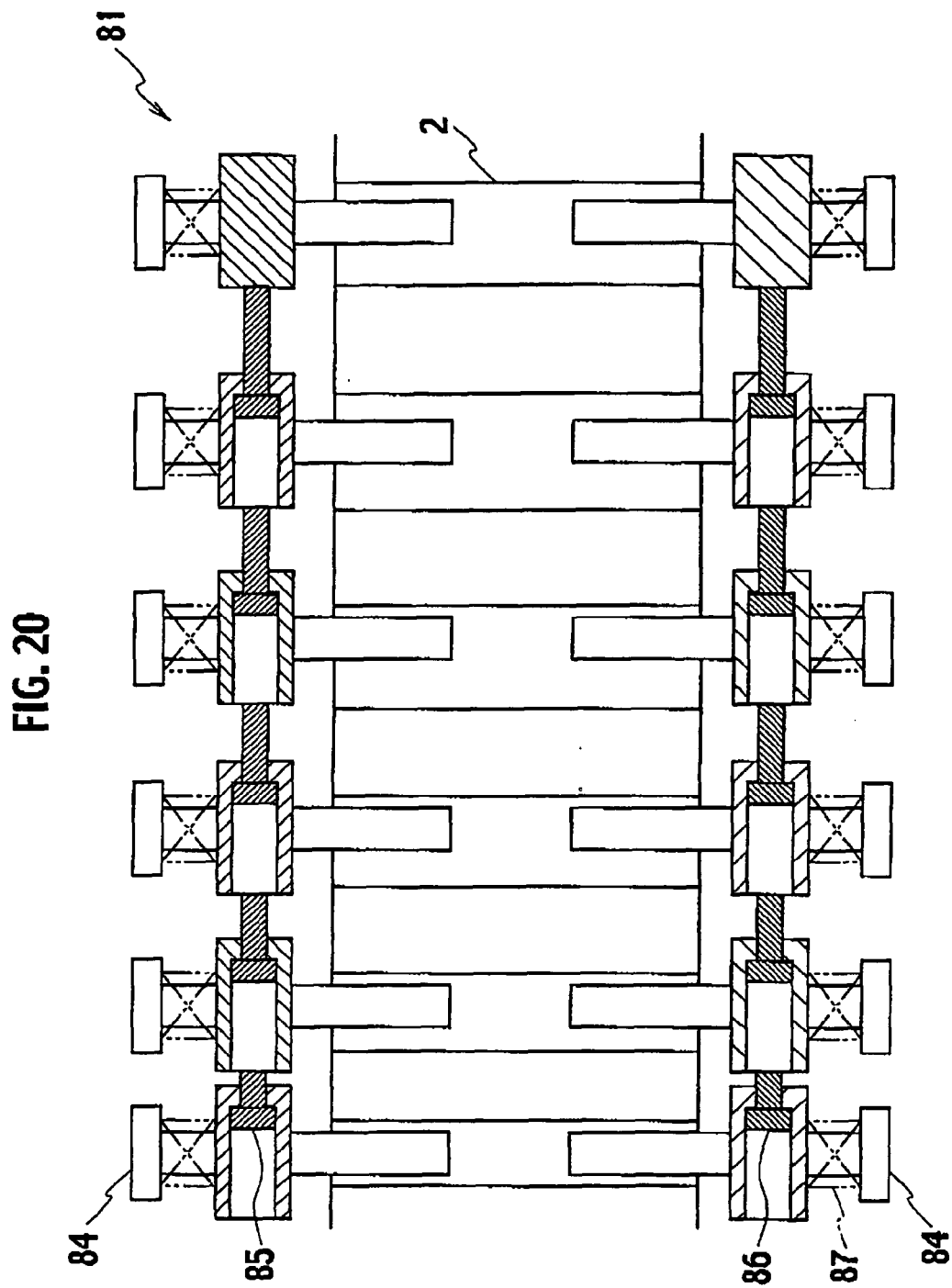
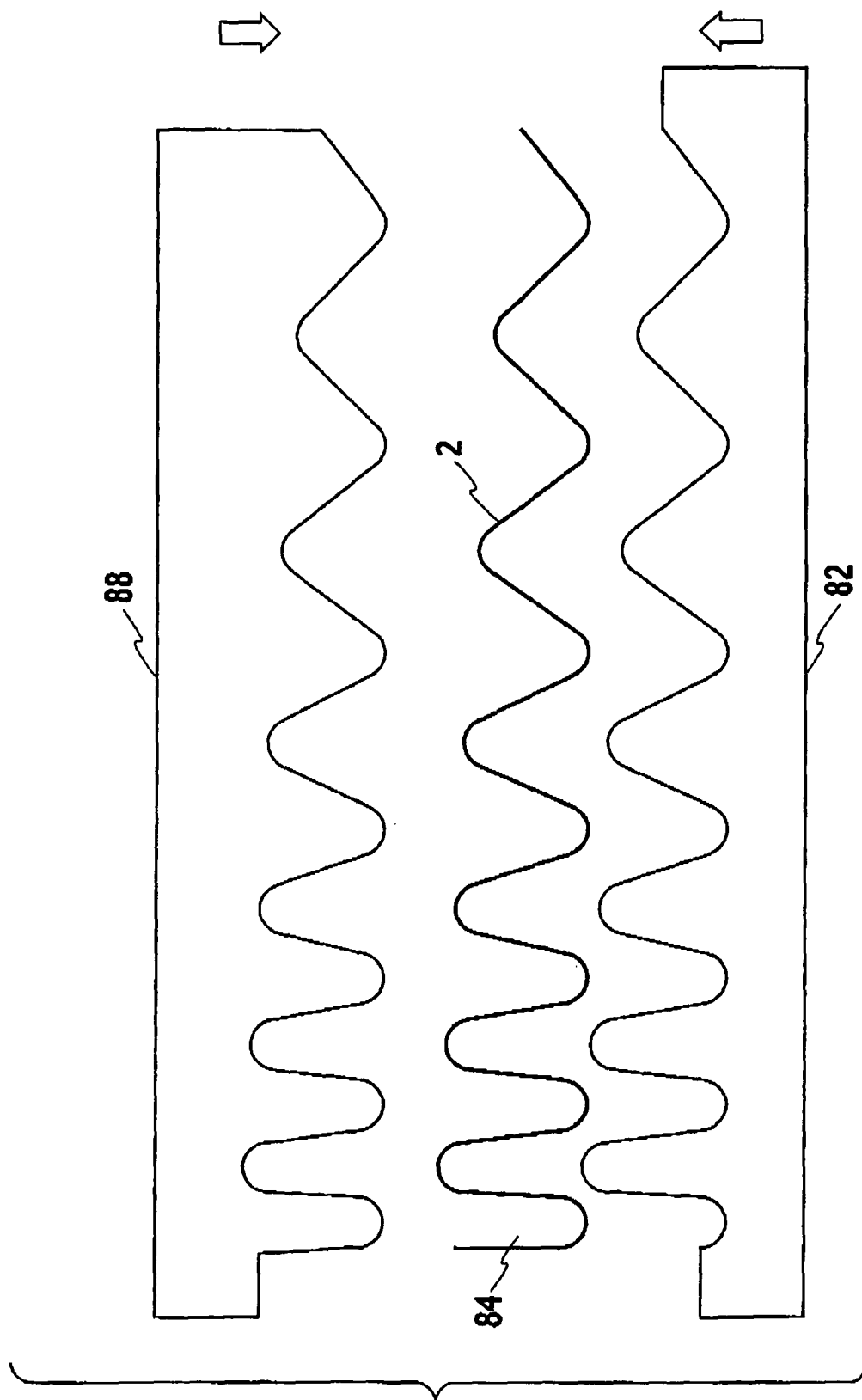


FIG. 21



REFERENCES CITED IN THE DESCRIPTION

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