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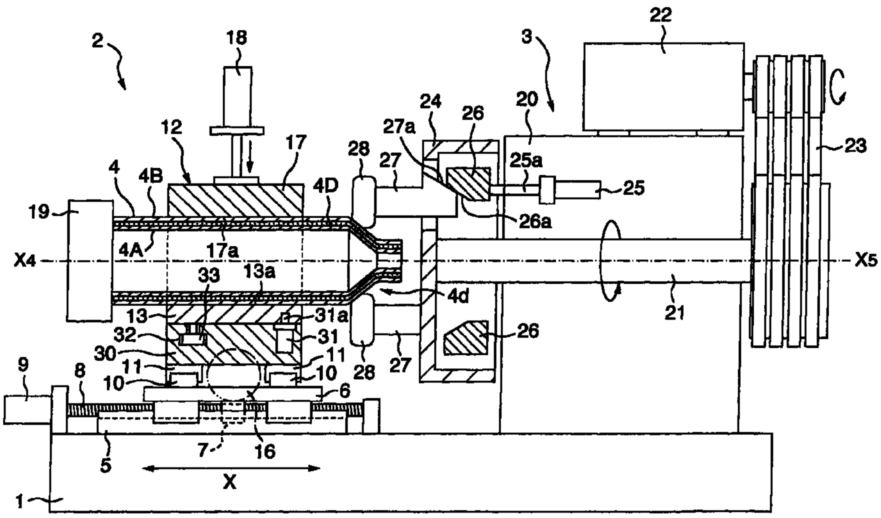
(54) PRODUCTION METHOD FOR DOUBLE-STRUCTURE CONTAINER

(57) In a method of producing a double-walled container having a space between an inner tube and an outer tube, in order to facilitate its production and to reduce its cost, the inner tube 4A is arranged in the outer tube 4B, with the space 4C formed therebetween, and a solid interposition material 4D is held between the tubes at least in one region of the space 4C extending in a direction of a tube axis, and in this condition, a spinning processing is applied to the outer tube 4B, thereby changing cross-sections of the inner and outer tubes 4A and 4B simultaneously.

FIG.1



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Description

Technical Field

[0001] This invention relates to a method of producing a double-walled container, and more particularly to a production method in which a double-walled container is obtained by changing the cross-sectional shapes of inner and outer tubes simultaneously.

Background Art

[0002] In exhaust-system parts of an automobile, such as a muffler and a catalytic converter, there is often used a heat-insulating tube structure in which an inner tube of an integral construction, continuously varying axially a cross-sectional shape, and an outer tube of an integral construction, decreasing in diameter in a tapering manner at its opposite ends, are arranged in concentric relation to each other, with a space formed therebetween.

[0003] Particularly, in a catalytic converter, it is a common practice to combine an inner tube 104 of metal, which contains a catalyst carrier 101 therein, and has tapering diameter-decreasing portions 102 and 103 formed respectively at opposite ends thereof, with an outer tube 107 of metal, having tapering diameter-decreasing portions 105 and 106 formed respectively at opposite ends thereof, so that a space 108 is formed between the inner tube 104 and the outer tube 105, as shown in Fig. 15. This construction is disclosed, for example, in JP-A-6-101465.

[0004] One method of producing the catalytic converter, shown in Fig. 15, is to apply a diameter-decreasing processing to the outer tube 107 held around the inner tube 104, beforehand subjected to a diameter-decreasing processing, with the predetermined space 108 formed therebetween. With this method, however, the production is difficult, and besides the production cost is high.

[0005] Particularly, there is a significant problem that is the shaping of the outer tube 107. Namely, in the formation of the outer tube 107 having a cross-sectional shape that generally conforms to a change of the cross-section of the inner tube 104 in the axial direction, and has the desired space 108 therebetween, it has been extremely difficult to shape the integral outer tube 107 while forming the desired space 108 over the entire axial length thereof.

[0006] Therefore, as a convenient production method, it is a common technique to arrange an outer tube, axially split into halves, around an inner tube, beforehand shaped, with a space formed therebetween, and to join the halves together by welding or the like. With this method, however, costly equipments, such as pressing dies and a welding apparatus, are needed, and much time and labor are required for the pressing process and the welding process.

[0007] Therefore, instead of the above production method, there has been proposed a technique as shown in Fig. 16, in which an increased-diameter portion 202 is formed at a proximal end of an inner tube 201, and a decreased-diameter portion 204 is formed at a proximal end of an outer tube 203, and the two tubes 201 and 203 are fitted together as shown in Fig. 16, thereby producing a double-walled catalytic converter having a predetermined space 205. This is disclosed, for example, in JP-A-9-108576.

[0008] In this production method of Fig. 16, however, the contact of the increased-diameter portion 202 of the inner tube 201 with the outer tube 203, as well as the contact of the decreased-diameter portion 204 of the outer tube 203 with the inner tube 201, is inevitable, and heat transfer occurs at these contact portions, and therefore, although the double-walled catalytic convertor has the heat-insulat-ing structure with the space 205, there is encountered a problem that its heat-insulating effect is reduced.

[0009] There is known a method of producing a thermos bottle, in which an inner tube, which is open only at one end thereof, and an outer tube, which is open only at one end thereof, are separately formed respectively into desired cross-sections by spinning processing, and these tubes are combined together. This is disclosed, for example, in JP-A-10-15631 and JP-A-7-284452.

[0010] In this production method, however, the spinning operations are required for the inner tube and the outer tube, respectively, so that the process becomes complicated, and besides there is required the additional step of decreasing the diameter of the mouth in the outer tube after the inner tube is inserted thereinto, and therefore the facilitation of the processing and the reduction of the processing cost can not be achieved also with this method.

[0011] Under the above circumstances, it has been desired to provide a method for easily producing at low costs a double-walled container, which has a predetermined space between an inner tube and an outer tube and in which each of the inner tube and the outer tube is integrally formed and has a varied cross-section in an axial direction, respectively.

Disclosure of the Invention

[0012] It is an object of this invention to provide a double-walled container-producing method which meets the above requirement.

[0013] Therefore, a production method of a first aspect of the invention is characterized in that an inner tube is arranged in an outer tube, with a space formed therebetween; a solid interposition material is held between the tubes at least in one region of said space extending in a direction of a tube axis; and in this condition, a spinning processing is applied to said outer tube, thereby changing cross-sections of said inner and outer tubes simultaneously.

[0014] Therefore, in the production method of the first aspect, the inner and outer tubes, holding the solid interposition material therebetween, are rotated about the tube axis, and spinning rollers are pressed against the outer tube to effect the spinning processing, so that the cross-section of the outer tube is changed by its pressing force, and further the pressing force is transmitted from the outer tube to the inner tube through the deformable solid interposition material, held in the space, so that the cross-section of the inner tube is changed simultaneously. Therefore, one end portions of the inner and outer tubes can be simultaneously formed into a desired shape with one spinning step.

[0015] In contrast, the inner and outer tubes are held stationary, and the spinning rollers are revolved, so as to press the spinning rollers against the outer tube, thereby effecting the spinning processing.

[0016] In this case, also, as in the case where the inner and outer tubes are rotated, the revolving spinning rollers are pressed against the stationary outer tube to effect the spinning processing, so that the cross-section of the outer tube is changed by its pressing force, and further the pressing force is transmitted from the outer tube to the inner tube through the deformable solid interposition material, held in the space, so that the cross-section of the inner tube can be changed simultaneously.

[0017] Therefore, as in the above method, one end portions of the inner and outer tubes can be simultaneously formed into a desired shape with one spinning step.

[0018] A production method of a second aspect of the invention is characterized in that an inner tube is arranged in an outer tube, with a space formed therebetween; a solid interposition material is held between the tubes at least in one region of the space extending in a direction of a tube axis; and in this condition, spinning rollers are revolved to apply a spinning processing to the outer tube, thereby simultaneously changing cross-sections of the inner and outer tubes in eccentric relation to a tube axis of a workpiece of the inner and outer tubes.

[0019] In the production method of the second aspect, by a similar function as described in the production method of the first aspect in which the spinning rollers are revolved, one end portions of the inner and outer tubes, changed in eccentric relation to the tube axis of the workpiece, can be formed simultaneously with one spinning step.

[0020] A production method of a third aspect of the invention is characterized in that an inner tube is arranged in an outer tube, with a space formed therebetween; a solid interposition material is held between the tubes at least in one region of said space extending in a direction of a tube axis; a tube axis of a workpiece of said inner and outer tubes is inclined with respect to an axis of spinning rollers, and said spinning rollers are revolved to apply a spinning processing to said outer tube, thereby changing cross-sections of said inner and outer tubes in slantingly-bending relation to the tube axis of the workpiece of said inner and outer tubes.

[0021] In the production method of the third aspect, by a similar function as described in the production method of the first aspect in which the spinning rollers are revolved, one end portions of the inner and outer tubes, changed in bending relation to the tube axis of the workpiece, can be formed with one spinning step.

[0022] In the production method of the present invention, before said spinning processing, a mandrel may be inserted into at least one of the inner and outer tubes at least at one region thereof.

[0023] Thus, the mandrel is inserted between the inner and outer tubes or in the inner tube, and therefore excessive deformation of the inner and outer tubes during the spinning operation can be prevented.

[0024] In the production method of the present invention, the solid interposition material may be one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

[0025] By heating this solid interposition material so as to soften and molt it, the charging of the solid interposition material into the space before the shaping of the inner and outer tubes, as well as the removal of the solid interposition material to the outside of the space after the shaping, can be easily effected.

Brief Description of the Drawings

[0026]

Fig. 1 is a vertical sectional view showing an example of a spinning machine used in a production method according to the present invention.

Fig. 2 is a partly-broken, plan view of the spinning machine in Fig. 1.

Figs. 3A and 3B are schematic perspective views showing a workpiece clamp portion and a roll portion of the spinning machine in Fig. 1, respectively.

Figs. 4A to 4D are views showing the process of a first embodiment in a production method according to the invention.

Figs. 5A to 5D are views showing the process of a second embodiment in a production method according to the invention.

Fig. 6 is a vertical sectional view showing a third embodiment in a production method according to the invention.

Fig. 7 is a cross-sectional view showing a fourth embodiment in a production method according to the invention.

Fig. 8 is a longitudinal cross-sectional view showing a fifth embodiment in a production method according to the invention.

Figs. 9A to 9C are views showing the process of the fifth embodiment in Fig. 8.

Fig. 10 is a longitudinal cross-sectional view showing a sixth embodiment in a production method according to the invention.

Fig. 11 is a view showing the process of the sixth embodiment in Fig. 10.

Fig. 12 is a perspective view of a workpiece shaped by the production method of the sixth embodiment in Fig. 10.

Fig. 13 is a view showing a condition in which a tube-narrowing step in Fig. 11 is applied to both ends of a workpiece tube, thereby providing a product of the embodiment in Fig. 10

Fig. 14 is a view showing the process of a seventh embodiment in a production method according to the invention.

Fig. 15 is a vertical sectional view showing a first conventional production method.

Fig. 16 is a vertical sectional view showing a second conventional production method.

Best Mode for Carrying Out the Invention

[0027] The mode for carrying out the present invention will be described with reference to embodiments shown in Figs. 1 to 14.

[0028] First, a spinning machine for performing a production method of the invention will be described.

[0029] Fig. 1 is a partly-broken, side-elevational view of a spinning machine , and Fig. 2 is a partly-broken, plan view of the spinning machine of Fig. 1. A workpiece drive portion 2 is mounted on one side portion of a fixed base 1, and a roller drive portion 3 is mounted on the other side portion thereof.

[0030] Two parallel X-direction slide rails 5 are fixedly mounted on a side of the base 1, on which the workpiece drive portion 2 is mounted, and extend in a direction (referred to as "X direction") parallel to an axis X5 of revolution of rollers 28 (described later). An X-direction slider 6 is mounted on the X-direction slide rails 5 for sliding movement in the X-direction, and a ball spline shaft 8 is threadedly engaged with a boss 7 formed on the X-direction slider 6. The X-direction slider 6 can be moved forward and backward in the X-direction in a desired distance by rotating the ball spline shaft 8 in normal and reverse directions in a desired amount by drive means 9 such as a motor.

[0031] Two parallel Y-direction slide rails 10 are fixedly mounted on the X-direction slider 6, and extend in a horizontal direction (referred to as "Y-direction") perpendicular to the X-direction. A Y-direction slider 11 is mounted on the Y-direction slide rails 10 for sliding movement in the Y-direction. A bed 30 is fixedly mounted on the Y-direction slider 11, and a ball spline shaft 15 is threadedly engaged with a boss 14 fixedly mounted on a lower surface of the bed 30. The bed 30 can be moved forward and backward in the Y-direction in a desired distance by rotating the ball spline shaft 15 in normal and reverse directions in a desired amount by drive means 16 such as a motor.

[0032] Angular-movement drive means 31 such as a motor is mounted on the bed 30, and an angular-movement drive shaft 31a of this angular-movement drive means 31 projects vertically from the upper surface of the bed 30. The angular-movement drive means 31 and the angular-movement drive shaft 31a jointly form means for inclining a workpiece 4.

[0033] A lower clamp 13, constituting a clamp device 12, is slidably mounted on the upper surface of the bed 30, and the drive shaft 31a is fixed to the lower clamp 13, and when the angular-movement drive shaft 31a is rotated in normal and reverses directions, the lower clamp 13 is angularly moved about the angular-movement drive shaft 31a in normal and reverse directions in a horizontal plane.

[0034] A guide groove 32 of an arcuate shape, having a center disposed at the angular-movement drive shaft 31a, is formed in the bed 30, and a guide roller 33, formed on and projecting from a lower surface of the lower clamp 13, is rotatably fitted in the guide groove 32. The angular-movement drive shaft 31a is disposed such that its axis perpendicularly intersects a tube axis X4 of the workpiece 4 placed on the lower clamp 13 (described later), as shown in Fig. 2.

[0035] A clamp surface 13a of a semi-circular shape for supporting a lower half surface of the workpiece 4 is formed on the upper surface of the lower clamp 13 in such a manner that when the workpiece 4 is placed on this clamp surface, the tube axis X4 of the workpiece 4 is disposed at the same level as that of the axis X5 of a rotation shaft 21 of the roller drive portion 3 (described later). Further, an upper clamp 17, having at its lower surface a clamp surface 17a for pressing and holding an upper half circle portion of the workpiece 4, is upwardly and downwardly movably provided above the lower clamp 13, and the upper clamp 17 can be driven upward and downward by drive means 18 such as a hydraulic cylinder, and when the upper clamp 17 is moved downward, the upper clamp 17 and the lower clamp 13 hold the workpiece 4 therebetween at a predetermined position against rotation, and when the upper clamp 17 is moved upward, the workpiece 4 can be attached and removed.

[0036] A stopper 19 is provided on a rear side of the clamp device 12, and the positioning of the workpiece 4 in the axial direction can be easily effected by abutting a rear end of the workpiece 4 against the stopper 19. For example, the stopper 19 is provided on the lower clamp 13, and is moved with the clamp device 12, and the position of this stopper can be adjusted in the direction of the tube axis X4 of the workpiece 4.

[0037] Next, the roller drive portion 3 on the base 1 will be described.

[0038] A rotation facility portion 20 is mounted on the base 1, and the rotation shaft 21 is rotatably provided on this portion 20, with its axis directed in the X-direction. The rotation shaft 21 can be rotated in one direction by a motor 22, serving as rotation drive means, through a belt 23. A roller holder 24 is fixed to the rotation shaft 21 on a side of the workpiece drive portion 2, and when the rotation shaft 21 is rotated, the roller holder 24 is rotated about the axis X5 of the rotation shaft 21.

[0039] Path changing means for changing a drive path of the rollers is provided on the rotation facility means 20. This means comprises a cylinder 25, serving as drive means, and a ring plate 26 which is mounted at a distal end of a rod 25a of the cylinder 25, and is disposed within the roller holder 24 so that it will not interfere with the rotation of the roller holder 24. The ring plate 26 is formed into an annular shape coaxial with the rotation shaft 21, and an outwardly-spreading, tapering surface 26a is formed on an inner surface of this ring plate at its distal end.

[0040] A plurality of (three in this embodiment) brackets 27 are mounted on the roller holder 24 at equal intervals in the circumferential direction, with their axes extending in the X-axis. Further, the brackets 27 are movable radially with respect to the axis X5 of the roller holder 24. A tapering surface 27a is formed, along the tapering surface 26a of the ring plate 26, at one side of each bracket 27 corresponding to the inner side of the roller holder 24, and the roller 28 is freely rotatably mounted at the outer end of each bracket 27.

[0041] Although not shown, means, which normally urges the bracket 27 toward the outer periphery of the roller holder 24, such for example as a return spring, is provided on each bracket 27, and when the ring plate 26 is moved forward (left in Fig. 1) by the cylinder 25, each bracket 27 is pushed toward the axis through the two tapering surfaces 26a and 27a, so that each of rollers 28 is moved the same amount toward the axis of the rotation shaft 21, respectively. When the ring plate 26 is moved backward (right in Fig. 1), each bracket 27 is returned radially outwardly through the two tapering surfaces 26a and 27a, so that each of rollers 28 is moved the same amount radially outwardly of the roller holder, respectively.

[0042] Next, a method of producing a double-walled container by deforming cross-sections of inner and outer tubes simultaneously by the use of the spinning machine will be described.

[0043] Figs. 4A to 4D show a first embodiment according to a production method of the present invention.

[0044] Fig. 4A shows a first step, and shows a condition in which a cylindrical outer tube 4B of metal, which is larger in diameter than a cylindrical inner tube 4A of metal, is arranged around the inner tube 4A in concentric relation thereto, and a solid interposition material 4D is filled in an annular space 4C of a predetermined width formed between the two tubes 4A and 4B. The product in this condition is the workpiece 4.

[0045] For example, a hot-melt resin is used as the solid interposition material 4D, and for filling it, the inner and outer tubes 4A and 4B are held by suitable means in such a manner that the predetermine space 4C is formed therebetween, and one end of this space 4C is closed, and a resin in a heat-molten state is poured into the space 4C through the other end thereof, and is cooled and solidified, and is interposed as the solid interposition material 4D between the inner and outer tubes 4A and 4B.

[0046] Preferably, the solid interposition material 4D has good filling and discharging abilities, and can be deformed to a certain degree when it is filled and formed into a solid state, and further has low compressibility (it may have non-compressibility), and preferably the solid interposition material is the above-mentioned hot-melt resin, but may be other material than this resin. Preferably, a melting point of the hot-melt resin is higher than a temperature of the workpiece 4 which is raised by the spinning. For example, a resin, marketed under the trade name "Seal Peal Hot" can be used as the above hot-melt resin.

[0047] Then, the process shifts to a second step in which the workpiece 4 is held by the clamp device 12 of the spinning machine, and the end portions of the workpiece 4 are decreased in diameter, as shown in Fig. 4B.

[0048] Before the diameter-decreasing operation, the ring plate 26 of the spinning machine is located at a position spaced right from its position shown in Fig. 1, and the rollers 28 are retracted outwardly of the outer periphery of the workpiece 4 prior to the processing, and are held in an open condition.

[0049] Then, the workpiece 4 is fitted in and placed on the clamp surface 13a of the lower clamp 13, with its rear end abutted against the stopper 19 set at a predetermined position, and thereafter the drive means 18 is operated to move the upper clamp 17 downward, so that the workpiece 4 is held between the upper and lower clamps 17 and 13 so as to prevent it from rotating. The position of the clamp device 12 in the Y-direction is set by the drive means 16 to a position where an extension line of the axis of the angular-movement drive shaft 31a intersects an extension line of the axis X5 of the rotation shaft 21.

[0050] If necessary, a mandrel 51 is inserted into that end of the inner tube 4A to be subjected to the spinning operation, as shown in Fig. 4B. The mandrel 51 includes a decreased-diameter portion 51a, corresponding to the decreased diameter of the inner tube 4A, a tapering portion 51b, which extends from this decreased-diameter portion, and is slanting radially outwardly, and a larger-diameter portion 51c which is continuous with this tapering portion, and extends parallel to the axial direction, the larger-diameter portion 51c having an outer diameter substantially equal to the inner diameter of the workpiece 4.

[0051] Then, the ball spline shaft 8 is rotated in one direction by the drive means 9, thereby moving the clamp device 12 right (in Fig. 1) in the X-direction parallel to the axis X5 of the rotation shaft 21, so that the rollers 28 are located at a diameter-decrease starting point A of the workpiece 4, as shown in Fig. 4B.

[0052] In this condition, the motor 22, serving as the drive means, is driven to rotate the roller holder 24 in one direction, and also the drive means 25 is operated to advance the ring plate 26 to move the path of revolution of the rollers 28 in the closing direction toward the center of the roller holder 24, and also the drive means 9 is driven to rotate the ball spline shaft 8 in a direction reverse to the above-mentioned direction, thereby moving the clamp device 12, together with the workpiece 4, backward left (in Fig. 1) in the X-direction.

[0053] As a result, the rollers 28, while freely rotating in press-contact with the outer peripheral surface of the outer tube 4B in the workpiece 4, revolves about the tube axis X5, and also the diameter of the path of revolution of these rollers gradually decreases, thereby effecting the spinning operation starting from the diameter-decrease starting point A, as shown in Fig. 4B.

[0054] As a result of this spinning operation, the outer tube 4B is deformed to be decreased in diameter, and also this deforming force is transmitted to the inner tube 4A through the solid interposition material 4D, so that the inner and outer tubes 4A and 4B and the solid interposition material 4D are simultaneously deformed.

[0055] Namely, a tapering portion 4b, decreased in diameter from a stock tube portion 4a of the inner and outer tubes 4A and 4B, and a neck portion 4c, extending from a distal end of this tapering portion 4b, are sequentially formed, with the solid interposition material 4D held between the inner and outer tubes 4A and 4B.

[0056] If necessary, the step of the above spinning operation may be effected with one pass or a plurality of passes of the rollers.

[0057] In the case where the mandrel 51 is inserted in this spinning operation, the diameter-decreasing processing of the neck portion 4c is accurately effected by the decreased-diameter portion 51a of the mandrel 51. Further, as shown in Fig. 4B, the spinning rollers 28 move along the tapering portion 51b of the mandrel 51 as indicated by an arrow in the drawing, and are moved away outwardly from the larger-diameter portion 51c of the mandrel 51.

[0058] Then, the inner and outer tubes 4A and 4B are cut at a portion C shown in Fig. 4B, and a discard portion 4e is removed.

[0059] Then, in a third step, the workpiece 4, shaped in the second step, is removed from the clamp device 12, and is inverted in the axial direction, and is again held by the clamp device 12, and as shown in Fig. 4C, the other tube end portion of the workpiece 4, opposite to that processed in the second step, is decreased in diameter by spinning process as in the second step. At this time, the mandrel 51 may be used if necessary as in the second step.

[0060] Then, the inner and outer tubes 4A and 4B are cut at a portion D shown in Fig. 4C, and a discard portion 4f is removed.

[0061] The cutting of the inner and outer tubes 4A and 4B in the second step and the cutting of these tubes in the third step may be effected at a time after the third step.

[0062] Although the discard portions 4e and 4f are not always necessary, it is preferred to form these discard portions 4e and 4f and to remove them by cutting in order to accurately form the shape of the tube end portions.

[0063] Thus, each of the opposite end portions of the workpiece 4 has been decreased in diameter by one spinning process.

[0064] Then, after the above shaping processing, the shaped product is removed from the clamp device 12, and this product, obtained in the third step, and having the solid interposition material 4D remaining in the space 3C, may be provided as a final product. Alternatively, as shown in Fig. 4D, the solid interposition material 4D may be removed in a fourth step so as to provide a final product having the space 4C formed between the inner and outer tubes 4A and 4B.

[0065] In the case where the solid interposition material 4D is hot-melt resin, the solid interposition material 4 can be easily flowed away and removed by heating the product in the fourth step.

[0066] In the case where a member with excellent heat-insulating properties, such as a heat-insulating mat, is used as the solid interposition material 4D, it is preferred that this solid interposition material should be left as it is. However, generally, when this container is used as an exhaust-system container of an automobile, a high heat-resistance is required, and therefore the solid interposition material 4D is removed.

[0067] In the thus shaped product of Fig. 4D, the opposite ends of the inner and outer tubes 4A and 4B are connected to other connection pipes or the like, with the space 4C held therebetween.

[0068] Fig. 5 shows a second embodiment of a production method according to the present invention.

[0069] This second embodiment is directed to an embodiment, in which an interior member is contained in the inner tube 4A of the first embodiment, and shows an example in which it is applied to a catalytic converter of an exhaust system of an automobile.

[0070] In a first step of Fig. 5A, a catalyst carrier 50 is inserted or press-fitted in the first step of the first embodiment shown in Fig. 4A.

[0071] Then, a second step (Fig. 5B), a third step (Fig. 5C) and a fourth step (Fig. 5D) as described above in the first embodiment are effected, thereby producing a double-walled pipe as shown in Fig. 5D which contains the catalyst carrier 50 therein, and has a space 4C formed between the inner and outer tubes 4A and 4B.

[0072] In this embodiment, also, the mandrel 51 is not always necessary, and may be used if necessary.

[0073] Fig. 6 shows a third embodiment of a production method according to the present invention.

[0074] This third embodiment is directed to an embodiment in which an interior member, such for example as a catalyst carrier 50 as described above in the second embodiment, is contained, and one ends of inner and outer tubes 4A and 4B are extended long, with a space 4C formed therebetween, and for example, a resonant-type muffler is formed integrally on the rear side of the catalytic converter 50 of the second embodiment. In Fig. 6, that portion, designated by reference numeral 54, is the resonant-type muffler.

[0075] The production process of this third embodiment is basically similar to the production process of the second embodiment, and resonance holes 52 are beforehand formed in the inner tube 4A, and a mandrel, which is similar to the mandrel 51 described in the second embodiment, but has an extended insertion portion, is used during the spinning operation, and the resonance holes 52 are closed by this extension portion from the inside of the inner tube 4A.

[0076] One ends (for example, left ends in Fig. 6) of the inner and outer tubes 4A and 4B, shaped in this third embodiment, are fixed to other connection pipe whereas a wire net ring 53 for holding the inner and outer tubes 4A and 4B in a manner to allow them to move relative to each other is held between the other ends (for example, the right end in Fig. 6), so that a relative movement between the inner tube 4A and the outer tube 4B due to thermal expansion can be allowed.

[0077] In the embodiment of Fig. 6, the space 4C on the left side (side A) of the catalyst carrier 50 has a gradually decreasing thickness (the distance of the gap between the inner and outer tubes), and for shaping this left-side portion, the inner tube 4A and the outer tube 4B are beforehand decreased in diameter into tapering portions and neck portions as shown in the drawing, and then this inner tube 4A is inserted into the outer tube 4B, and the diameter-decreased portion of the inner tube 4A is held by holding means (not shown), and a solid interposition material 4D is filled into the space 4C between the inner tube 4A and the outer tube 4B on the right side (side B) of the catalyst carrier 50, and a spinning operation as described above is applied to the outer tube 4B.

[0078] In the product produced in this third embodiment, exhaust gas is purified by the catalyst carrier 50, and also exhaust sounds flow through the resonance holes 52 into the gap 4C in the resonant-type muffler 54, so that the sounds are deadened by the gap 4C serving as a resonance space. This gap 4C also achieves an originally-intended, heat-insulating effect.

[0079] As described above, by arbitrarily determining the range of filling of the solid interposition material 4D, the range of use of the mandrel 51 and the shape of this mandrel, the inner and outer tubes 4A and 4B, having the space 4C therebetween, can be formed in a desired manner.

[0080] Fig. 7 shows a fourth embodiment of a production method according to the present invention.

[0081] This fourth embodiment shows an example in which a double-walled pipe, in which the axes of the inner and outer tubes 4A and 4B are eccentric with respect to each other, is produced.

[0082] Referring to the production method of this embodiment, in the first step of the first and second embodiments, the inner tube 4A and the outer tube 4B are suitably made eccentric with respect to each other, and a solid interposition material 4D is filled in a gap 4C between the two tubes, and then the similar steps as described above in the first and second embodiments are effected, thereby producing the product.

[0083] Fig. 8 shows a fifth embodiment of a production method according to the present invention.

[0084] This fifth embodiment shows an example in which one diameter-decreased portion of the double-walled tube (container) is offset respect to the other diameter-decreased portion.

[0085] This production process will be described.

[0086] First, there is used a workpiece 4 as shown above in Fig. 5A, in which a solid interposition material 4D is interposed between an inner tube 4A and an outer tube 4B, and an interior member (for example, a catalyst carrier 50) is contained in the inner tube 4A.

[0087] In Fig. 1, before the diameter-decreasing operation, the ring plate 26 is located at a position spaced right from its position shown in Fig. 1, and the rollers 28 are retracted outwardly of the outer diameter of the workpiece 4 prior to the processing, and are held in an open condition.

[0088] Then, the unprocessed workpiece 4 is fitted in and placed on the clamp surface 13a of the lower clamp 13, with its rear end abutted against the stopper 19 set at a predetermined position, and thereafter the drive means 18 is operated to move the upper clamp 17 downward, so that the workpiece 4 is held between the upper and lower clamps 17 and 13 against rotation. The angular-movement drive means 31 is operated to angularly move the clamp device 12, so that the tube axis X4 of the workpiece 4, held by this clamp device, is parallel to the axis X5 of the rotation shaft 21. Further, the drive means 16 is operated to adjustably move the clamp device 12 in the Y-direction, so that the tube axis X4 of the workpiece 4 is parallel to and is offset a predetermined amount OF1 (see Fig. 9A) from the axis X5 of the rotation shaft 21.

[0089] Then, the ball spline shaft 8 is rotated in one direction by the drive means 9, thereby moving the clamp device 12 right (in Fig. 1) in the X-direction to move the workpiece 4 forward (right in Fig. 1) toward the roller holder 24 by a predetermined amount in a direction parallel to the tube axis thereof, so that the rollers 28 are located at a diameter-decrease starting point A (see Fig. 9A) of the workpiece 4.

[0090] In this condition of Fig. 9A, the motor 22, serving as the drive means, is driven to rotate the roller holder 24 in one direction, and also the drive means 25 is operated to advance the ring plate 26 to move the path of revolution of the rollers 28 in the closing direction toward the center of the roller holder 24, and also the drive means 9 is reversely driven to rotate the ball spline shaft 8 in a direction reverse to the above-mentioned direction, thereby moving the clamp device 12, together with the workpiece 4, backward left (in Fig. 1) in the X-direction.

[0091] As a result, the rolls 28, while freely rotating in press-contact with the outer peripheral surface of the outer tube 4B, revolves about the tube axis X5, and also the diameter of the path of revolution of these rolls gradually decreases, thereby effecting the spinning operation starting from the diameter-decrease starting point A, as shown in Fig. 9B. At this time, since the axis X5 of revolution of the rollers 28 is offset a distance OF1 from the tube axis X4 of the workpiece 5, the tube end, subjected to the spinning operation, is plastically deformed into a tapering portion 4b of a truncated cone-shape having its axis coinciding with the revolution axis X5 offset a distance OF1 from the tube axis X4 of a stock tube portion (barrel portion) 4a of the workpiece 4, as shown in Fig. 9B.

[0092] After the tapering portion 4b is shaped, the workpiece 4 is continued to be moved backward, with the rollers 28 held in the closed position, and by doing so, a cylindrical neck portion 4c, having its axis coinciding with the revolution axis X5 and being parallel to the tube axis X4 of the workpiece 4, is formed at the distal end of the tapering portion 4b by plastic deformation.

[0093] Then, the workpiece 4, as well as the rollers 28, is moved backward in a direction opposite to that of the forward movement (that is, the diameter-decreasing movement), and the first spinning operation is finished with this one reciprocation (forward-backward movement).

[0094] After the first spinning operation is finished, the rollers 28 are returned to the open position, and also the drive means 9 is operated to rotate the ball spline shaft 8 in one direction to further advance the workpiece 4, together with the clamp device 12, by a predetermined amount in a direction parallel to the tube axis thereof, so that the rollers 28 are located at a point B in Fig. 9C. The drive means 16 is operated to rotate the ball spline shaft 15 in one direction to further move the workpiece 4, together with the clamp device 12, by a predetermined amount in the Y-direction, so that the amount OF2 of offset of the tube axis X4 of the workpiece 4 from the axis of the rotation shaft 21, that is, the axis X5 of revolution of the rollers 28, is made larger than the above offset amount OF1, as shown in Fig. 9C.

[0095] Then, in this condition, a spinning operation, similar to the above spinning operation, is effected in such a manner that the amount of closing movement of the rollers 28 is larger than that in the above first process. As a result, the tapering portion 4b is plastically deformed into the tapering portion 4b of a truncated cone-shape which has a larger tapering angle, and has its axis disposed on the revolution axis X5 offset an amount OF2 from the tube axis X4 of the stock tube portion (barrel portion) 4a of the workpiece 4. After this tapering portion 4b is shaped, the workpiece 4 is continued to be moved backward with the rollers 28 held in the closed position, and by doing so, the neck portion 4c, smaller in diameter than the neck portion of Fig. 9B, is formed at the distal end of the tapering portion 4b.

[0096] With the above process, a diameter-decreased portion 4d, having the offset tapering portion 4b and the offset tapering neck portion 4c which are integrally formed with each other, is formed at the end portion (right end portion in Fig. 8).

[0097] In the above spinning operation, the outer tube 4B is deformed to be decreased in diameter, and also this deforming force is transmitted to the inner tube 4B through the solid interposition material 4D, so that the inner and outer tubes 4A and 4B and the solid interposition material 4D are simultaneously deformed.

[0098] Namely, the tapering portion 4b, decreasing in diameter from the stock tube portion 4a of the inner and outer tubes 4A and 4B, and the neck portion 4c, extending from the distal end of this tapering portion 4b, are sequentially formed, with the solid interposition material 4D held between the inner and outer tubes 4A and 4B.

[0099] Then, the workpiece 4, shaped in the above process, is removed from the clamp device 12, and is inverted in the axial direction, and is again held by the clamp device 12, and the other tube end portion of the workpiece 4, opposite to that processed in the above process, is decreased in diameter by spinning process in a manner as described above.

[0100] Incidentally, at this time, by effecting the spinning operation in such a manner that the tube axis X4 of the workpiece 4 and the axis X5 of the rotation shaft 21 are disposed in coaxial relation to each other in Fig. 1, a tapering portion 4b and a neck portion 4c, which are coaxial with the stock tube portion 4a, are formed as the left end portion in Fig. 8.

[0101] Then, after the above shaping operation, the shaped product is removed from the clamp device 12, and this product, obtained in the third step, and having the solid interposition material 4D remaining in the space 4C, may be provided as a final product. Alternatively, as shown in Fig. 8, the solid interposition material 4D may be removed so as to provide a final product having the space 4C formed between the inner and outer tubes 4A and 4B.

[0102] Fig. 10 shows a sixth embodiment according to the present invention.

[0103] This sixth embodiment shows an example in which diameter-decreased portions and neck portions at opposite end portions are processed by bend-spinning.

[0104] A production process of this embodiment will be described.

[0105] In Figs. 1 and 2, before the diameter-decreasing operation, the ring plate 26 is located at a position spaced right from its position shown in Fig. 1, and the rollers 28 are retracted radially outwardly of the outer diameter of a workpiece 4, as shown in Fig. 11A.

[0106] Then, the workpiece 4, similar to that of Fig. 4A, is fitted in and placed on the clamp surface 13a of the lower clamp 13, with its rear end abutted against the stopper 19 set at a predetermined position, and thereafter the drive means 18 is operated to move the upper clamp 17 downward, so that the workpiece 4 is held between the upper and lower clamps 17 and 13 against rotation. The position of the clamp device 12 in the Y-direction is so set by the drive means 16 that an extension line of the axis of the angular-movement drive shaft 31a intersects an extension line of the axis X5 of the rotation shaft 21, as shown in Fig. 11A. Further, the angular-movement drive means 31 is operated to incline the clamp device 12 horizontally, so that the tube axis X4 of the workpiece 4 is horizontally inclined at a predetermined angle θ1 with respect to the axis X5 of the rotation shaft 21, as shown in Fig. 11A.

[0107] Then, the ball spline shaft 8 is rotated in one direction by the drive means 9, thereby moving the clamp device 12 right (in Fig. 1) in the X-direction parallel to the axis X5 of the rotation shaft 21, so that the rollers 28 are located at a diameter-decrease starting point A of the workpiece 4, as shown in Fig. 11A.

[0108] In this condition (the condition of Fig. 11A), the motor 22, serving as the drive means, is driven to rotate the roller holder 24 in one direction, and also the drive means 25 is operated to advance the ring plate 26 to move the path of revolution of the rollers 28 in the closing direction toward the center of the roller holder 24, and also the drive means 9 is driven to rotate the ball spline shaft 8 in a direction reverse to the above-mentioned direction, thereby moving the clamp device 12, together with the workpiece 4, backward left (in Fig. 1) in the X-direction.

[0109] As a result, the rolls 28, while freely rotating in press-contact with the outer peripheral surface of the workpiece 4, revolves about the tube axis X5, and also the diameter of the path of revolution of these rollers gradually decreases, thereby effecting the spinning operation starting from the diameter-decrease starting point A, as shown in Fig. 11B. At this time, since the tube axis X4 of the workpiece 4 is inclined at the angle θ1 with respect to the axis X5 of revolution of the rollers 28, the tube end, subjected to the spinning operation, is plastically deformed into a tapering portion 4b of a truncated cone-shape having its axis coinciding with the revolution axis X5 inclined at the angle θ1 with respect to the tube axis X4 of a stock tube portion (barrel portion) 4a of the workpiece 4, as shown in Fig. 11B.

[0110] After the tapering portion 4b is shaped, the workpiece 4 is continued to be moved backward, with the rollers 28 held in the closed position, and by doing so, a cylindrical neck portion 4c, having its axis coinciding with the revolution axis X5 inclined at the angle θ1 with respect to the tube axis X4 of the workpiece 4, is formed at the distal end of the tapering portion 4b by plastic deformation.

[0111] Then, the workpiece 4, as well as the rollers 28, is moved backward in a direction opposite to that of the forward movement (that is, the diameter-decreasing movement), and the first spinning operation is finished with this one reciprocation (forward-backward movement).

[0112] After the first spinning operation is finished, the rollers 28 are returned to the open position, and the drive means 9 is operated to rotate the ball spline shaft 8 in one direction to further advance the workpiece 4, together with the clamp device 12, by a predetermined amount in the X-direction, so that the rollers 28 are located at a point B in Fig. 11C, and also the angular-movement means 31 is operated to further incline the workpiece 4, together with the clamp device 12, by a predetermined amount, so that the angle θ2 between the tube axis X4 of the workpiece 4 and the axis of the rotation shaft 21, that is, the axis X5 of revolution of the rollers 28, is made larger than the angle θ1 in the above first step, as shown in Fig. 11C.

[0113] Then, in this condition, a spinning operation, similar to the above spinning operation, is effected in such a manner that the amount of closing movement of the rollers 28 is larger than that during the above first process. As a result, the tapering portion 4b, shaped in the first process, is plastically deformed into the tapering portion 4b of a truncated cone-shape which has a larger tapering angle, and has its axis disposed on the revolution axis X5 inclined at the angle θ2 with respect to the tube axis X4 of the stock tube portion (barrel portion) 4a of the workpiece 4. After this tapering portion 4b is shaped, the workpiece 4 is continued to be moved backward in the X-direction with the rollers 28 held in the closed position, and by doing so, the neck portion 4c, having its axis disposed on the above axis X5 and smaller in diameter than the neck portion of the first process, is formed at the distal end of the tapering portion 4b.

[0114] With the above process, a diameter-decreased portion 4d, having the tapering portion 4b and the tapering neck portion 4c having its axis coinciding with the axis X5 inclined with respect to the axis X4, which are integrally formed with each other, is formed at the end portion of the barrel portion 4a having its axis coinciding with the axis X4, the as shown in Fig. 12. It is not always necessary to effect the inclining movement only about the angular-movement drive shaft 31, and when the inclining movement about the angular-movement drive shaft 31 and the movement in the X- and/or Y-direction are used in combination, the degree of freedom of the shaping further increases.

[0115] Next, with the above process, the workpiece 4, decreased in diameter, is inverted in the forward-backward direction, and is again held by the clamp device 12, and a spinning operation, similar to the above spinning operation, is effected, and by doing so, the tapering portions 4d, 4d, as well as the neck portions 4c, 4c, subjected to bend spinning, are formed at the opposite ends, respectively, as shown in Fig. 13.

[0116] Then, after the above shaping operation, the product is removed from the clamp device 12, and this product, having the solid interposition material 4D remaining in the space 3C, may be provided as a final product. Alternatively, as shown in Fig. 10, the solid interposition material 4D may be removed so as to provide a final product having the space 4C formed between the inner and outer tubes 4A and 4B.

[0117] In the above embodiment, thermoplastic resin may be used as the solid interposition material 4D. Also, instead of this resin, a heat-insulating member may be used. In the case of using this heat-insulating member, it is preferred that the inner tube 4A of the workpiece 4 be press-fitted into the outer tube 4B, with the heat-insulating member wound around the outer periphery of the inner tube.

[0118] Furthermore, a muffler and a catalytic converter originally require a heat-insulating material, and therefore there is no need to remove the solid interposition material 4D after the shaping operation. In such a case, the step of removing the solid interposition material 4D can be omitted.

[0119] Further, as the solid interposition material 4D, ice may be used, in which case water is poured into the space 4C, and then is frozen into ice. Further, metal shots may be used. Other materials, which can be changed into a solid or a liquid upon application of heat, can be used, and examples thereof includes a molten salt, such as nitrate and nitrite, a metal of a low melting point, and a compound thereof.

[0120] In the above embodiments, although the mandrel 4A is inserted in the inner tube 4A, a mandrel may be inserted in the outer tube 4B.

[0121] In each of the above embodiments, although the workpiece 4 is moved in the direction of the tube axis during the spinning operation, the workpiece 4 may be fixed whereas the spinning rollers 28 are moved in the direction of the tube axis, or both may be moved. And, the drive path, that is, the means for continuously controlling the rollers in the deforming direction, is arbitrary.

[0122] In each of the above embodiments, the workpiece 4 is fixed while the spinning rollers 28 is revolved. However, in the case where the axis X5 of the roller drive portion 3 and the axis X4 of the workpiece drive portion 2 are parallel to each other, and are disposed on a common line, there may be used an arrangement in which the workpiece 4 is rotated about its axis, and also the mandrel 51 is rotated in the same manner, and the spinning rollers 28 are freely rotated without being revolved, and are moved radially and in the direction of the tube axis.

[0123] Although each of the above embodiments is directed to the containers of the exhaust-system parts of an automobile, the present invention can be applied to other articles such as a general-purpose container and an article for daily use such as a pot, and the invention is not limited to the above use.

[0124] As one such example, an eighth embodiment according to the present invention will be described below with reference to Figs. 14A to 14E.

[0125] This is an example in which the present invention is applied to the workpiece 4 closed at one end thereof in the first embodiment, and this can be applied to any container such as a pot, a bomb and an accumulator.

[0126] In a first step of Fig. 14A, an inner tube 4A is inserted into an outer tube 4B. Then, a solid interposition material 4D is filled into a space 4C formed between the inner and outer tubes as shown in Fig. 14B, thereby forming a workpiece 4 shown in Fig. 4C.

[0127] Then, as in Fig. 4B of the first embodiment, in a second step, this workpiece 4 is held by the clamp device 12 of the spinning machine, and one end portion of this workpiece 4 is decreased in diameter as shown in Fig. 14D.

[0128] With this spinning operation, the outer tube 4B is deformed to be decreased in diameter, and this deforming force is transmitted to the inner tube 4A through the solid interposition material 4D, so that the inner and outer tubes 4A and 4B and the solid interposition material 4D are simultaneously deformed.

[0129] Namely, a tapering portion 4b, decreased in diameter from a stock tube portion 4a of the inner and outer tubes 4A and 4B, and a neck portion 4c, extending from a distal end of this tapering portion 4b, are sequentially formed, with the solid interposition material 4D held between the inner and outer tubes 4A and 4B.

[0130] Then, the inner and outer tubes 4A and 4B are cut at a portion C shown in Fig. 14D, and a discard portion 4e is removed.

[0131] If necessary, the step of the above spinning operation may be effected with one pass or a plurality of passes of the rollers.

[0132] In the case where the mandrel 51 is inserted in this spinning operation, the diameter-decreasing processing of the neck portion 4c is accurately effected by the decreased-diameter portion 51a of the mandrel 51. Further, as shown in Fig. 14D, the spinning rollers 28 move along the tapering portion 51b of the mandrel 51 as indicated by an arrow in the drawing, and are moved away outwardly from the larger-diameter portion 51c of the mandrel 51.

[0133] With the above operation, the one end portion of the workpiece 4 is decreased in diameter by spinning operation.

[0134] Then, after the above shaping processing, the shaped product is removed from the clamp device 12, and this product, obtained in the third step, and having the solid interposition material 4D remaining in the space 4C, may be provided as a final product. Alternatively, as shown in Fig. 14E, the solid interposition material 4D may be removed in a fourth step so as to provide a final product having the space 4C formed between the inner and outer tubes 4A and 4B.

[0135] In this manner, the container, having one closed end thereof, is formed.

INDUSTRIAL APPLICABILITY

[0136] As described above, in the first aspect of the present invention, the inner and outer tubes of the double-walled container, having the space between the inner and outer tubes, can be simultaneously deformed and shaped into desired cross-sections by applying the spinning processing simultaneously to the inner and outer tube, and therefore as compared with the conventional method, the facilitation of the processing and the reduction of the processing time can be achieved, and the processing cost can be greatly reduced.

[0137] In the second aspect of the invention, the inner tube is arranged in the outer tube, with the space formed therebetween, and the solid interposition material is held between the tubes at least in one region of the space extending in the direction of the tube axis, and in this condition, the spinning rollers are revolved to apply a spinning processing to the outer tube, thereby simultaneously changing the cross-sections of the inner and outer tubes in eccentric relation to the tube axis of the workpiece of the inner and outer tubes. Therefore, the inner and outer tubes, changed in eccentric relation to the tube axis of the workpiece, can be produced while securing the above effects.

[0138] In the third aspect of the invention, the inner tube is arranged in the outer tube, with the space formed therebetween, and the solid interposition material is held between the tubes at least in one region of the space extending in the direction of the tube axis, and the tube axis of the workpiece of said inner and outer tubes is inclined with respect to the axis of the spinning rollers, and the spinning rollers are revolved to apply a spinning processing to the outer tube, thereby changing the cross-sections of the inner and outer tubes in slantingly-bending relation to the tube axis of the workpiece. Therefore, the inner and outer tubes, changed in bending relation to the tube axis of the workpiece, can be produced while securing the above effects.

[0139] Further, according to the present invention, excessive deformation of the inner and outer tubes can be prevented by the mandrel, and the desired cross-sectional shape can be positively obtained. Further, by selecting the position of the mandrel, the inner and outer tubes can be deformed into different cross-sectional shapes, respectively, in such a manner that the amount of deformation of the inner tube is different from that of the outer tube, and the cross-sectional shapes of the inner and outer tubes can be made different from each other by simultaneously spinning the inner and outer tubes.

[0140] Further, in the present invention, the mandrel is inserted into at least one of the inner and outer tubes at least at one region thereof, and by doing so, the charging and removal of the solid interposition material, can be effected easily and rapidly, and therefore the efficiency of the operation can be enhanced.

Claims

1. A method of producing a double-walled container characterized in that an inner tube is arranged in an outer tube, with a space formed therebetween; and a solid interposition material is held between the tubes at least in one region of said space extending in a direction of a tube axis; and in this condition, a spinning processing is applied to said outer tube, thereby changing cross-sections of said inner and outer tubes simultaneously.

2. A method of producing a double-walled container according to claim 1, in which before said spinning processing, a mandrel is inserted into at least one of said inner and outer tubes at least at one region thereof.

3. A method of producing a double-walled container according to claim 2, characterized in that said solid interposition material is one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

4. A method of producing a double-walled container according to claim 1, characterized in that said solid interposition material is one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

5. A method of producing a double-walled container characterized in that an inner tube is arranged in an outer tube, with a space formed therebetween; and a solid interposition material is held between the tubes at least in one region of said space extending in a direction of a tube axis; and in this condition, spinning rollers are revolved to apply a spinning processing to said outer tube, thereby simultaneously changing cross-sections of said inner and outer tubes in eccentric relation to a tube axis of a workpiece of said inner and outer tubes.

6. A method of producing a double-walled container according to claim 5, in which before said spinning processing, a mandrel is inserted into at least one of said inner and outer tubes at least at one region thereof.

7. A method of producing a double-walled container according to claim 6, characterized in that said solid interposition material is one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

8. A method of producing a double-walled container according to claim 5, characterized in that said solid interposition material is one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

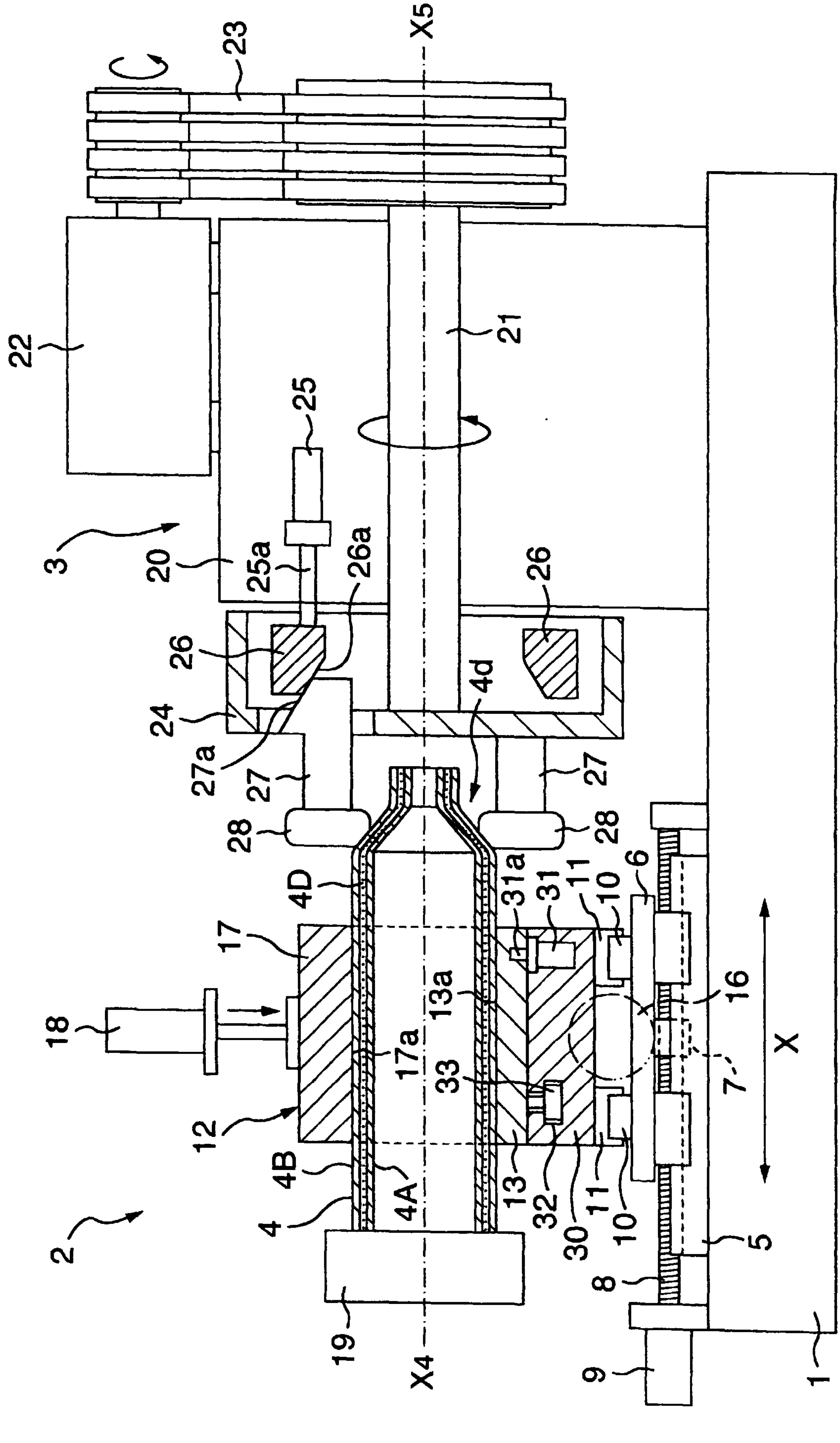
9. A method of producing a double-walled container characterized in that an inner tube is arranged in an outer tube, with a space formed therebetween; and a solid interposition material is held between the tubes at least in one region of said space extending in a direction of a tube axis; and a tube axis of a workpiece of said inner and outer tubes is inclined with respect to an axis of spinning rollers, and said spinning rollers are revolved to apply a spinning processing to said outer tube, thereby changing cross-sections of said inner and outer tubes in slantingly-bending relation to the tube axis of the workpiece of said inner and outer tubes.

10. A method of producing a double-walled container according to claim 9, in which before said spinning processing, a mandrel is inserted into at least one of said inner and outer tubes at least at one region thereof.

11. A method of producing a double-walled container according to claim 10, characterized in that said solid interposition material is one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

12. A method of producing a double-walled container according to claim 9, characterized in that said solid interposition material is one of hot-melt resin, thermoplastic resin and molten salt in a solidified condition.

FIG.1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4A
4B
4D
4d
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17a
18
19
20
21
22
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31
31a
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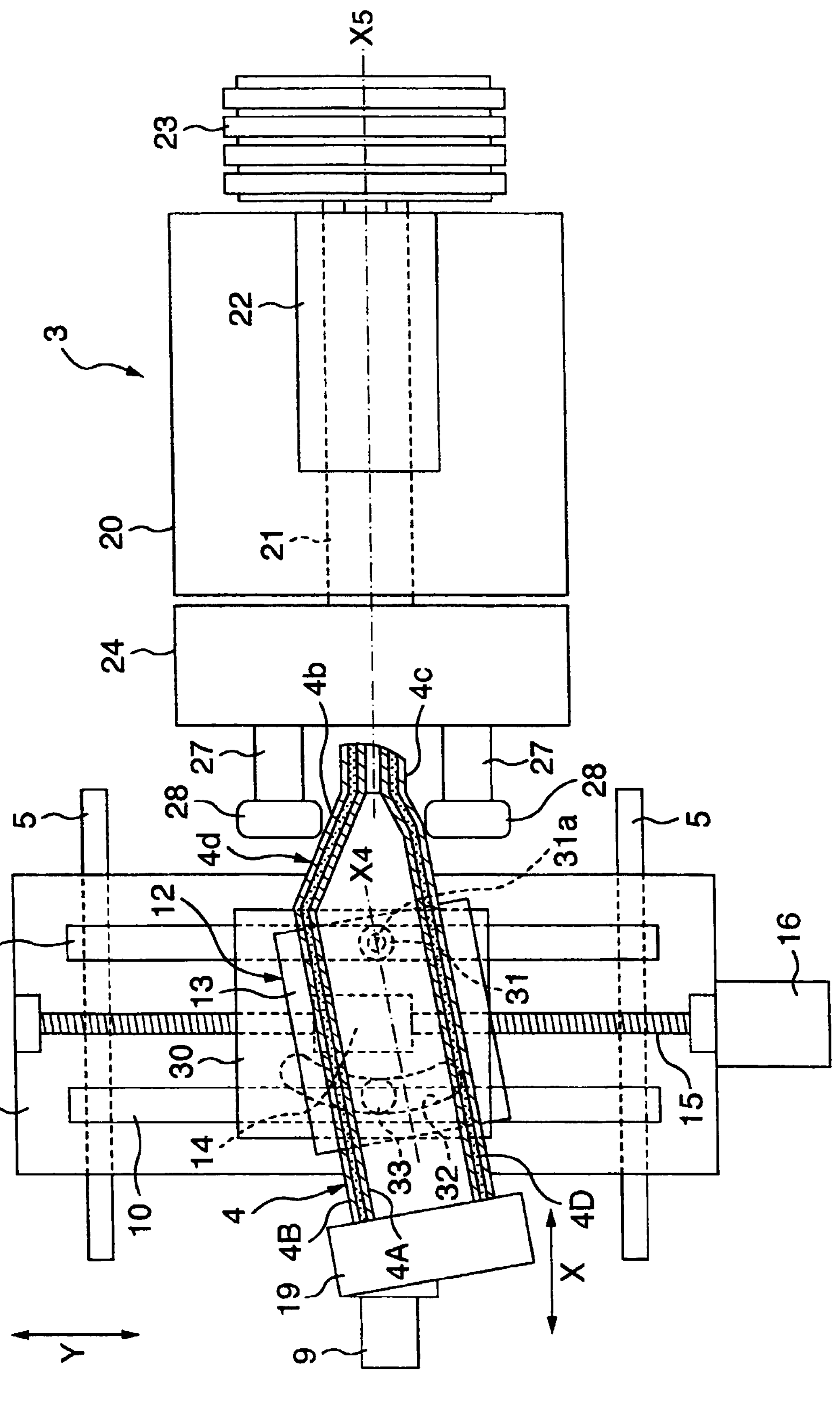
33
X
X4
X5

FIG.2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10
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4B
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19
X
Y
9

FIG.3A

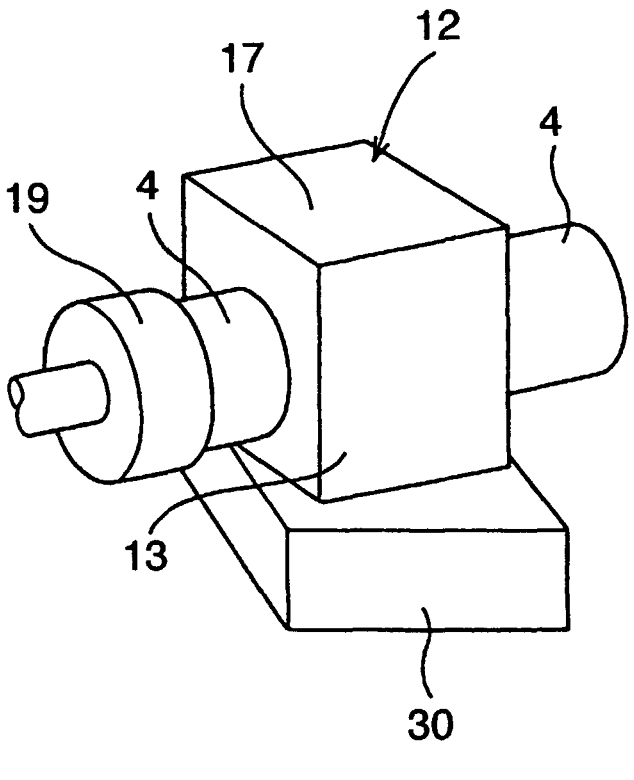


FIG.3B

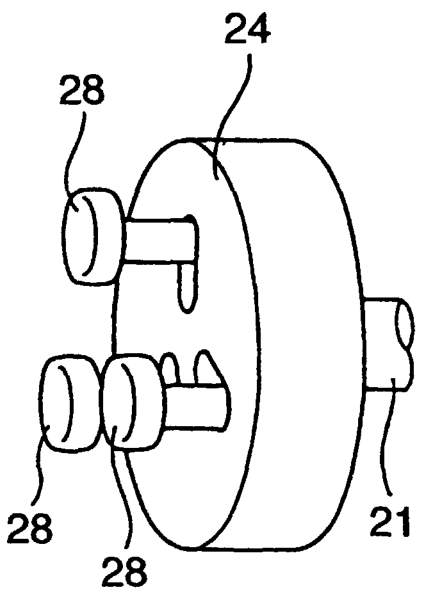


FIG.4A

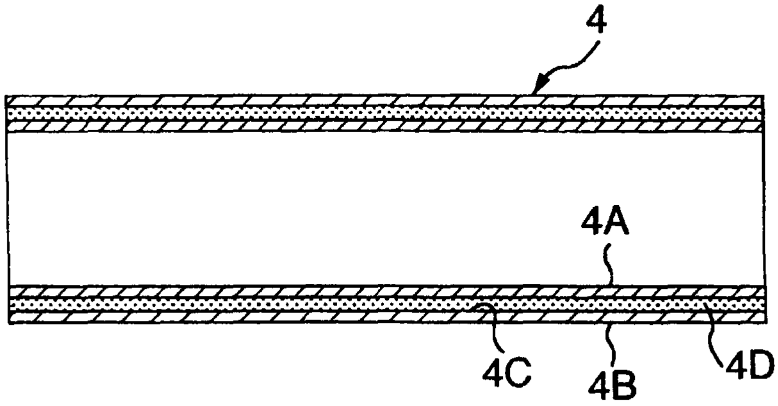


FIG.4B

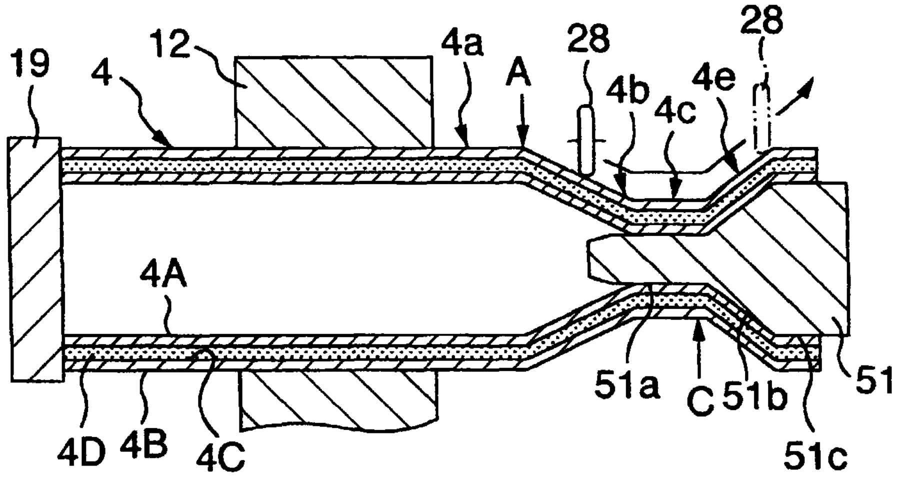


FIG.4C

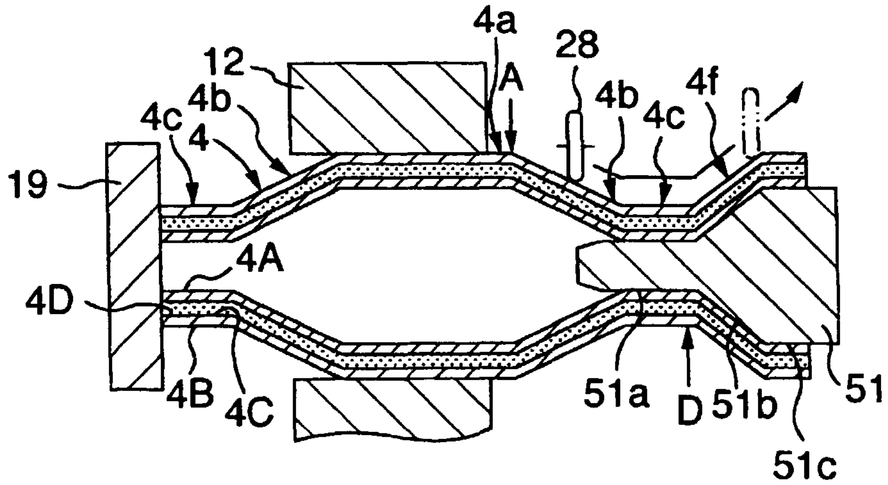


FIG.4D

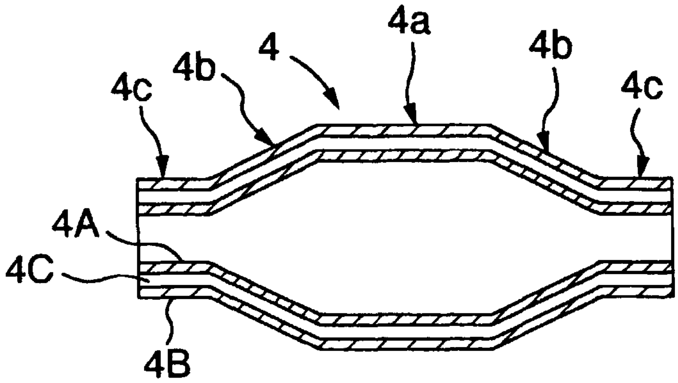


FIG.5A

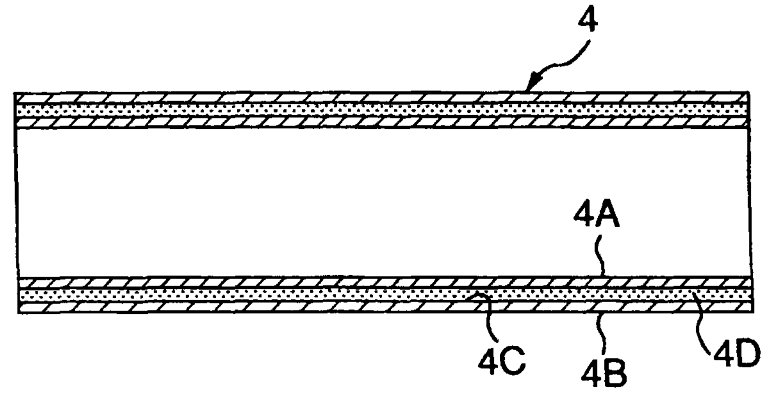


FIG.5B

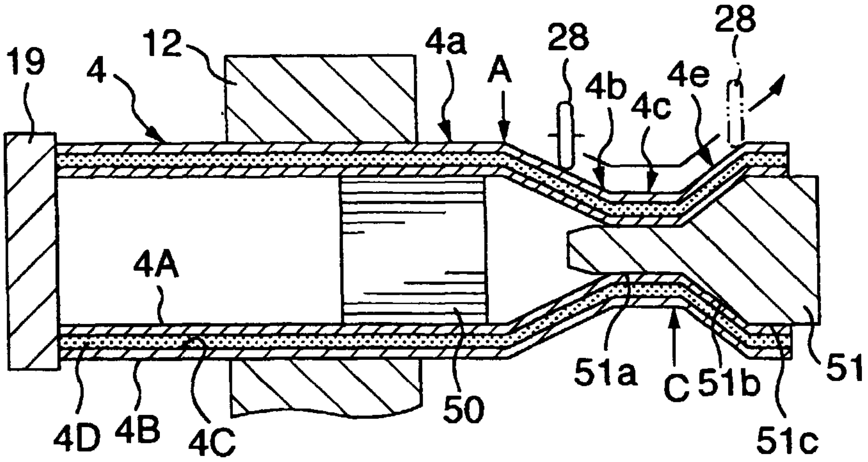


FIG.5C

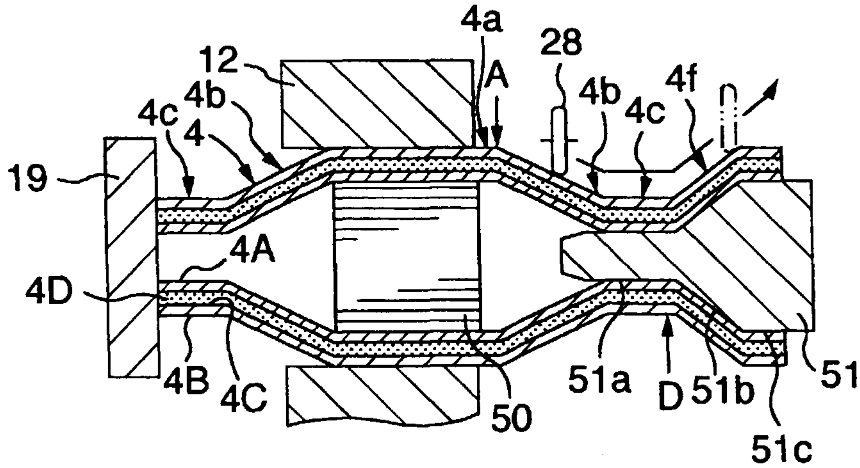


FIG.5D

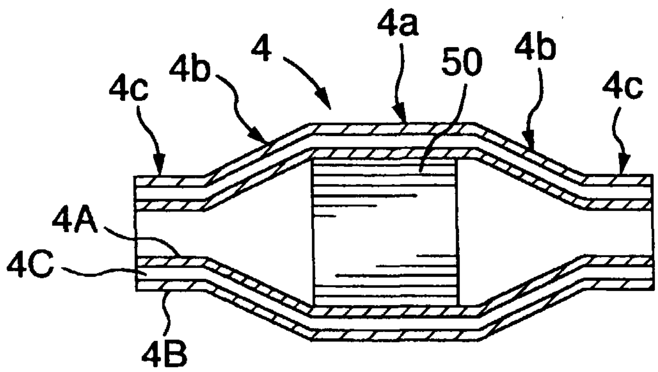


FIG.6

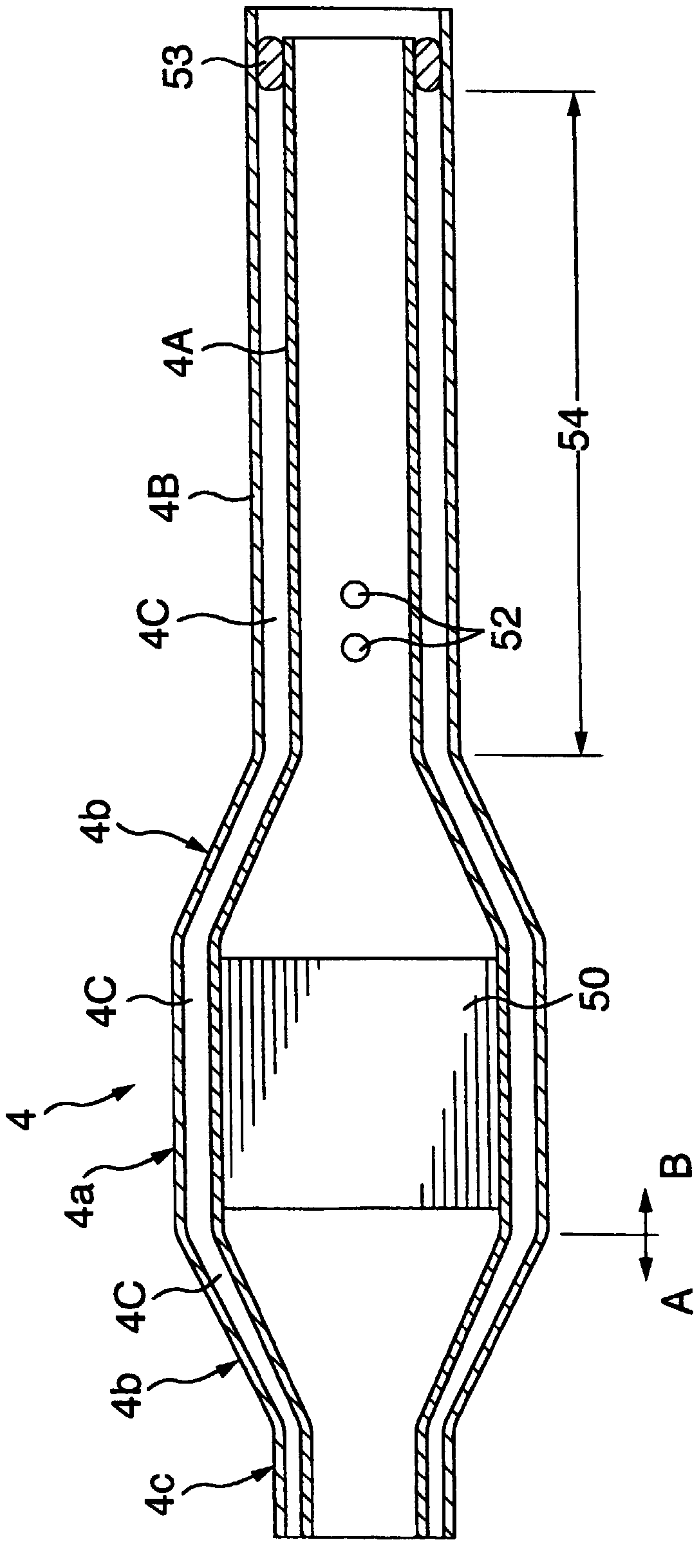


FIG.7

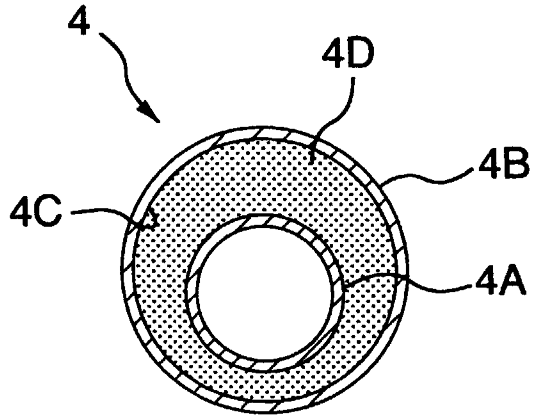


FIG.8

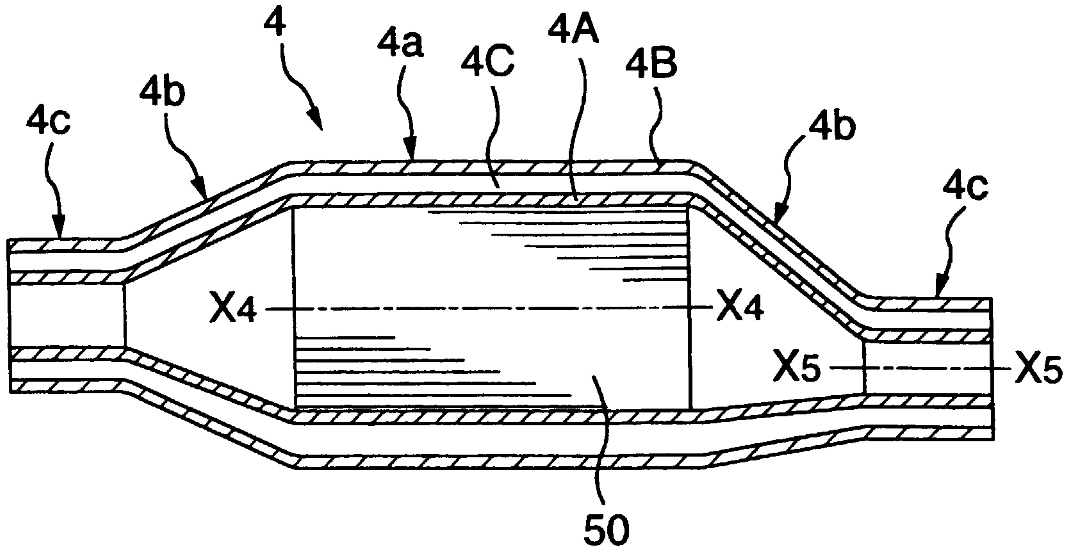


FIG.9A

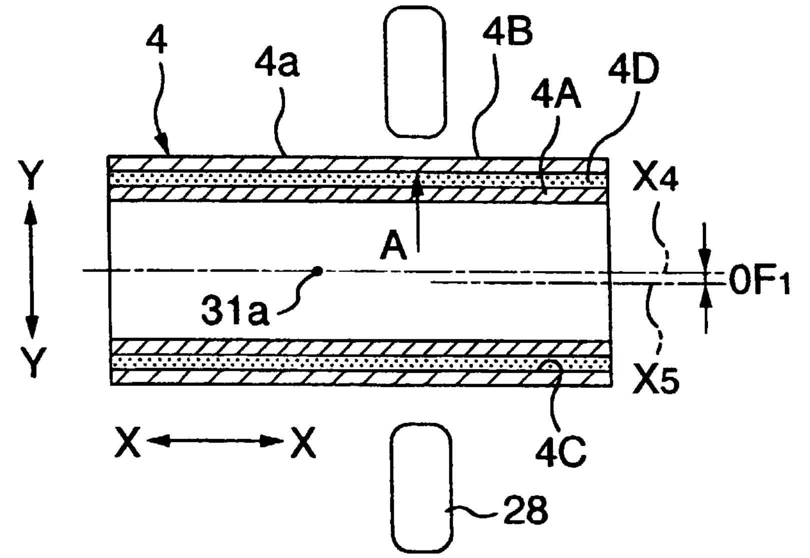


FIG.9B

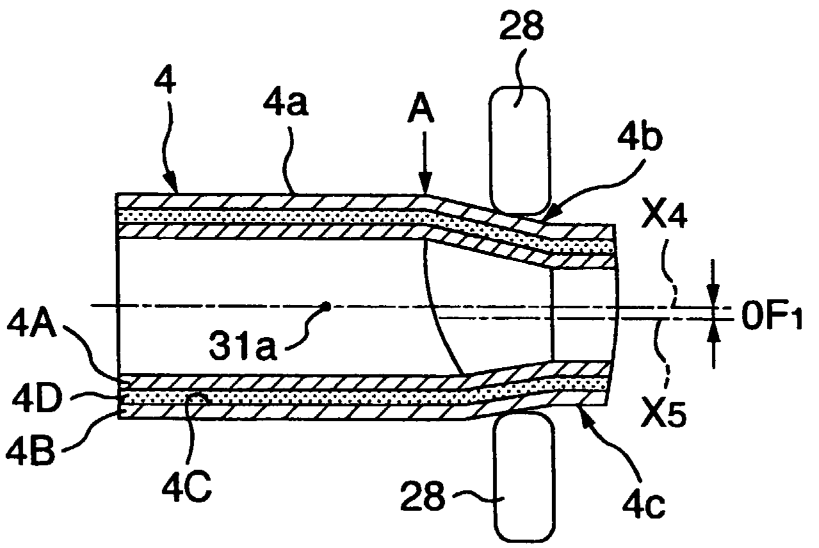


FIG.9C

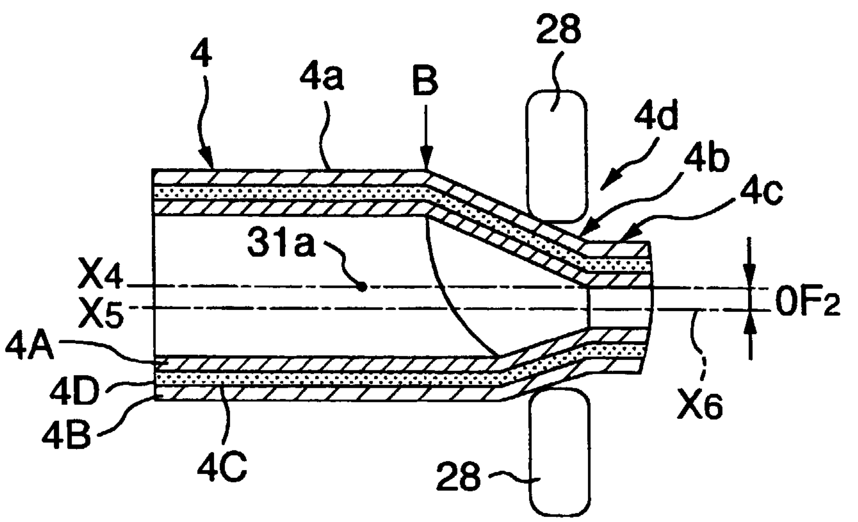


FIG.10

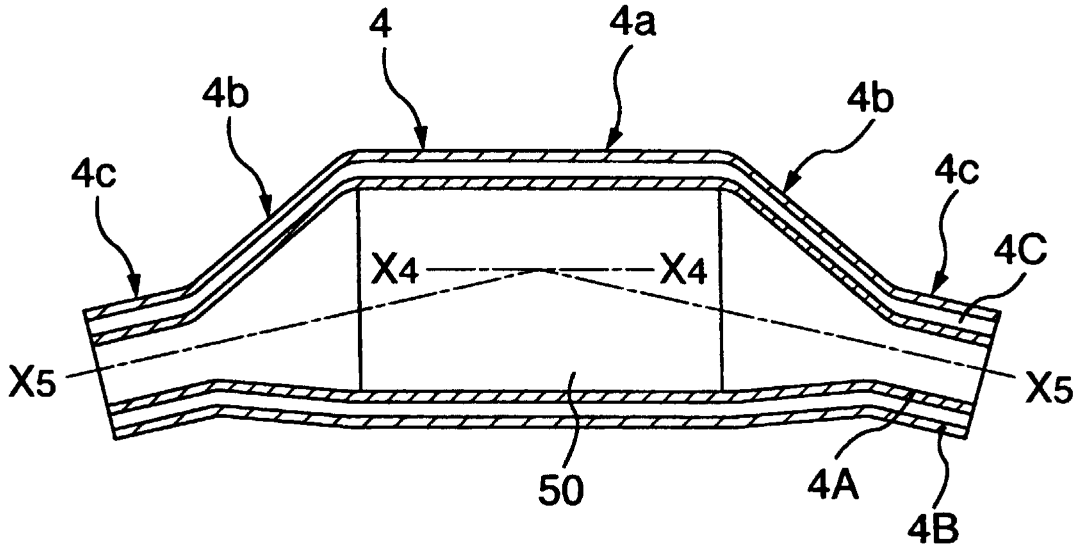


FIG.11A

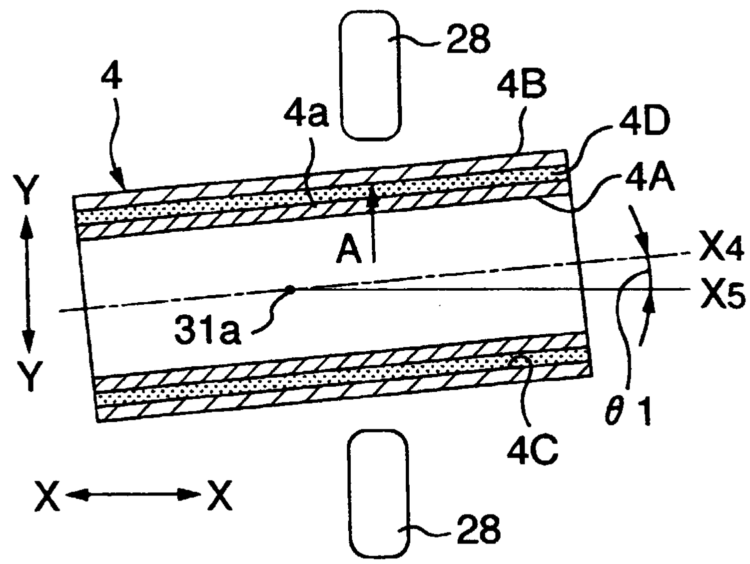


FIG.11B

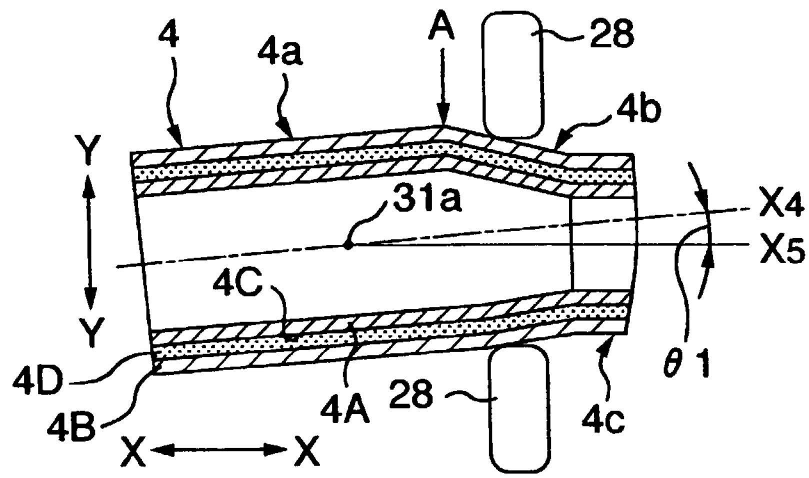


FIG.11C

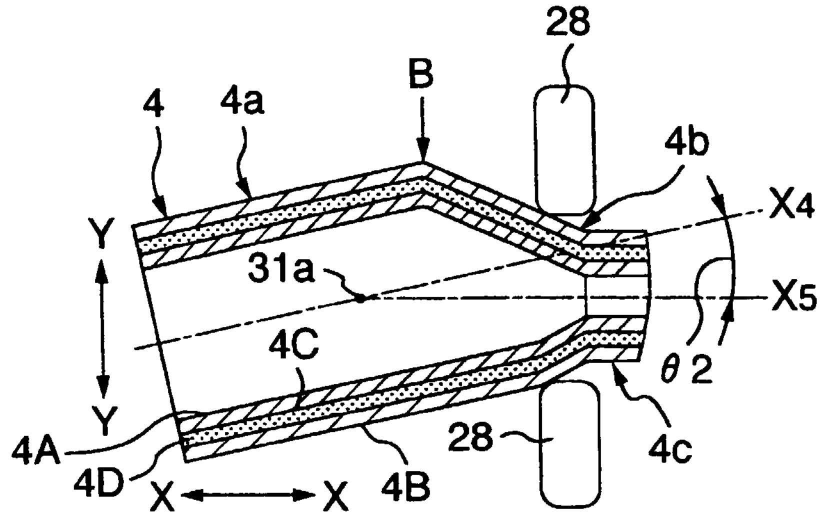


FIG.12

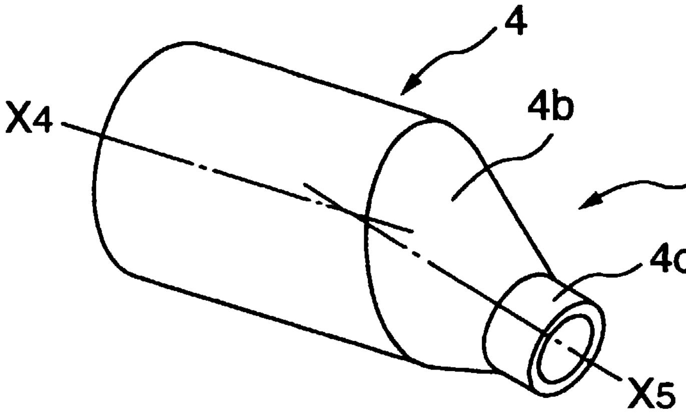


FIG.13

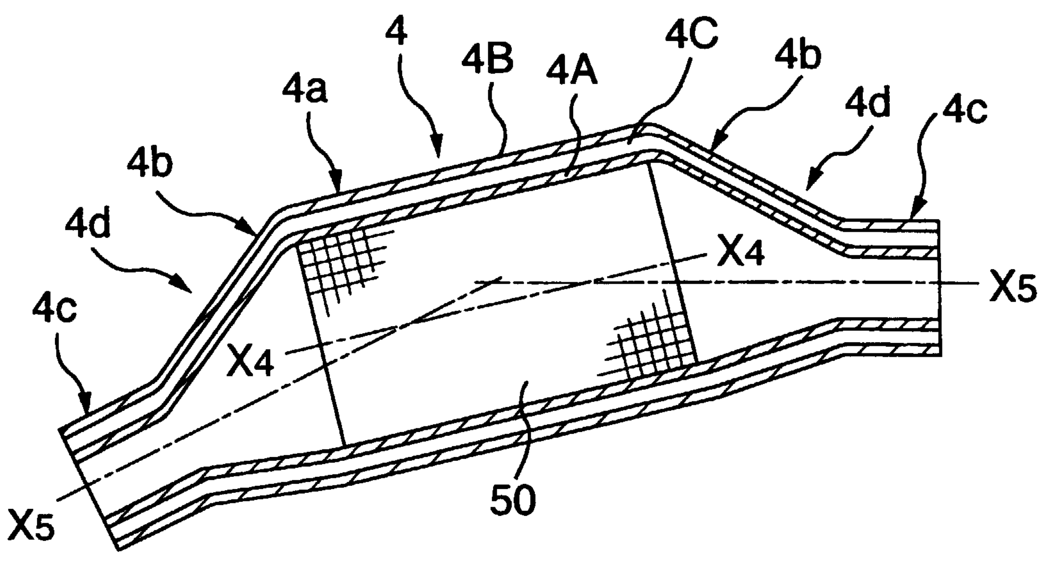


FIG.14A

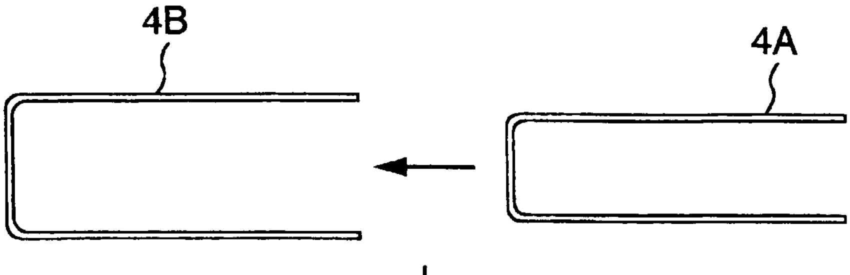


FIG.14B

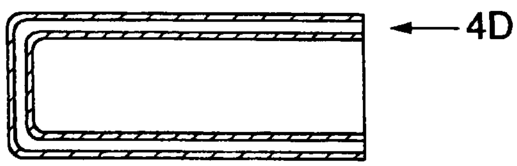


FIG.14C

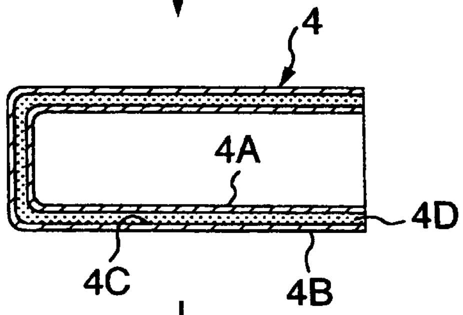


FIG.14D

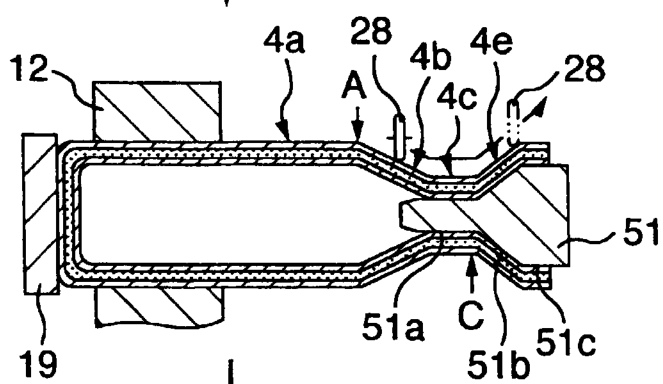


FIG.14E

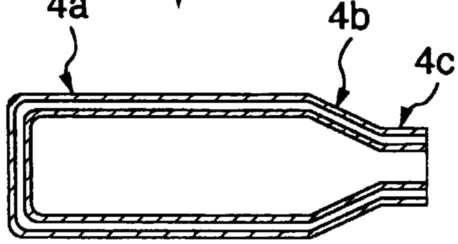


FIG.15

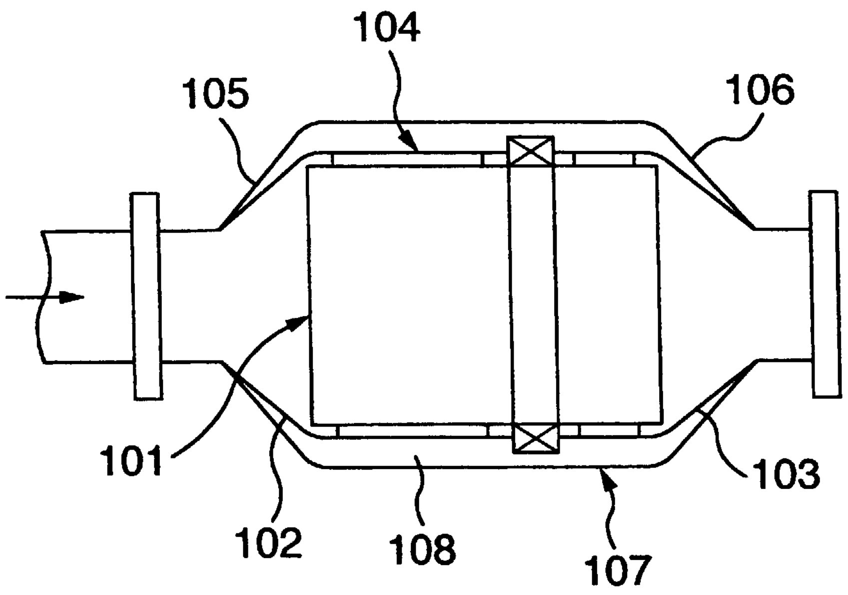
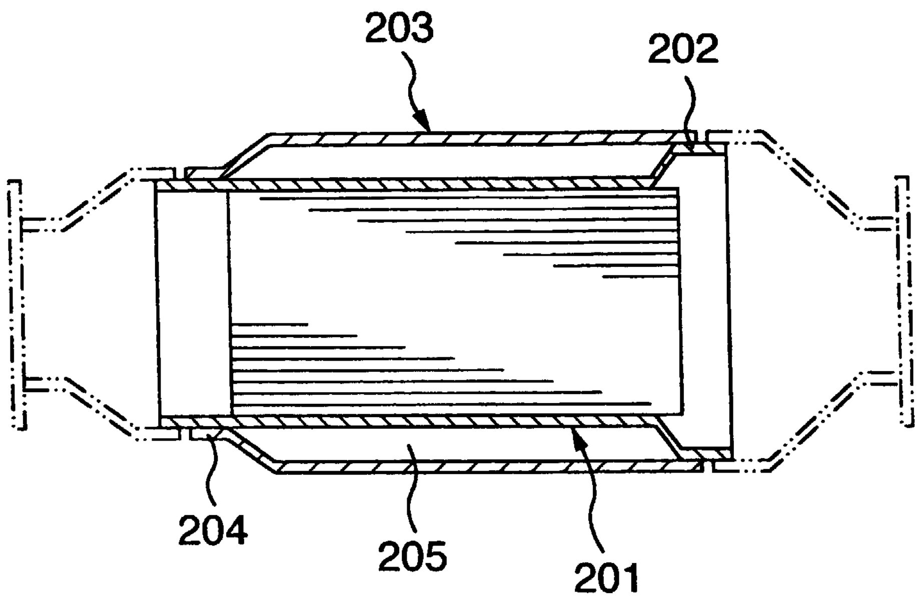


FIG.16



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/05184

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B21D22/16, 41/04, 53/84
F01N 3/28, 7/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B21D22/16, 41/04, 53/84
F01N 3/28, 7/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1995 Jitsuyo Shinan Toroku Koho 1996-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 6-101465, A (NISSAN MOTOR CO., LTD.), 12 April, 1994 (12.04.94), column 1, line 50 to column 2, line 30; Fig . 1 (Family: none)	1-12
A	JP, 9-108576, A (CALSONIC CORPORATION), 28 April, 1997 (28.04.97), column 3, line 4 to column 4, line 10; Figs. 1,2 (Family: none)	1-12
P	EP, 916426, A1 (Sango Co., Ltd.), 19 May, 1999 (19.05.99), column 5, line 25 to column 8, line 28; Figs. 1-4 & JP, 11-147138, A (Sango Co., Ltd.), 02 June, 1999 (02.06.99), column 5, line 4 to column 6, line 40; Figs. 1-3	1-12

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

- * Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
20 December, 1999 (20.12.99)	28 December, 1999 (28.12.99)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/05184

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P	EP, 916428, A2 (Sango Co., Ltd.), 19 May, 1999 (19.05.99), column 6, line 13 to column 9, line 27; Figs. 1-4 & JP, 11-151535, A (Sango Co., Ltd.), 08 June, 1999 (08.06.99), column 5, line 41 to column 7, line 41; Figs. 1-3	1-12
E	JP, 11-336537, A (Sango Co., Ltd.), 07 December, 1999 (07.12.99), column 3, line 8 to column 4, line 19; Figs. 1,2 (Family: none)	1-12

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