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(54) INTEGRAL STRUCTURE OF SHEET MATERIAL AND CYLINDRICAL MEMBER AND PRODUCTION METHOD THEREOF

(57) There is provided an integral structural member comprising a plate and a tubular body, in which the rigidity of connection between the two is high, and the firm connection is achieved. Further, there is provided a production method of producing it easily.

Part of a cylindrical wall 3 of the tubular body 2 is defined by superposed walls 6 held in intimate contact with each other, and that the outermost one 5 of the superposed walls 6 is folded back to be integrally continuous with the plate 1.

FIG. 1A

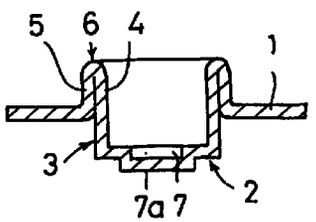
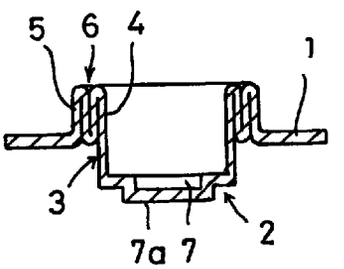


FIG. 1B



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Description

TECHNICAL FIELD

[0001] This invention relates to an integral structural member, comprising a plate and a tubular body, and also relates to a method of producing it.

BACKGROUND ART

[0002] Examples of conventional members, such as a fuel cap and a pipe mounting member, comprising a plate (flange) of metal and a tubular body of metal extending through and formed integrally with this plate, include one in which a plate member 100 and a tubular body 101 are formed integrally with each other by hot forging as shown in Fig. 10, and another in which a plate member 102 and a tubular body 103, which are formed by pressing, are united by a weld 104 as shown in Fig. 11.

[0003] However, although the above forged article has a high strength because of the integral construction, this product has a rough surface and poor dimensional accuracy, and therefore need secondary processing, and besides a furnace and dies of a high rigidity are required as manufacturing facilities, and therefore the cost of the manufacturing facilities is high.

[0004] The above product, formed by pressing, need the union by welding or the like, and besides restrictions on the welding position and so on are encountered, so that the degree of freedom of the design is limited, and further a welding strain is liable to develop.

[0005] Therefore, it has heretofore been desired to provide an integrally-shaped product, which can be easily produced, and is inexpensive, as well as a method of producing it.

[0006] In order to meet this demand, for example, as shown in Figs. 12A and 12B, there can be proposed a double-cylinder drawing process in which a plate material is first drawn in a direction of an arrow in Fig. 12A by ordinary pressing, to form it into a cylindrical body 105 shown in the drawings, and then the cylindrical body is reversely drawn in a direction of an arrow in Fig. 12B, thereby forming an inner tubular portion 106.

[0007] However, if the product is produced by the above double-cylinder drawing process, the tubular wall portions, defined respectively by the outer and inner tubes 105 and 106, are spaced from each other with a large gap 107 formed therebetween, and besides since the outer and inner tubular portions 105 and 106 are connected to a plate portion 108 with a large radius R, the rigidity of connection (relative displacement strength) between the plate portion 108 and the tubular wall portions is low, and the positional relation therebetween can be easily changed. Therefore, this production method can not be used for the product in which the plate portion and the tubular walls need to be firmly united.

[0008] And besides, in the above double-cylinder drawing process, the plate is once drawn into a cylindrical shape having a small plate thickness, and the cylindrical drawing is again effected while restraining the work-hardened portion, and therefore the configuration (particularly the height and diameter), obtained by the second cylindrical drawing, is limited, thus inviting a problem that the degree of freedom is limited.

DISCLOSURE OF THE INVENTION

[0009] It is therefore an object of this invention to provide an integral structural member, comprising a plate and a tubular body, in which the rigidity of connection between the plate and the tubular body is high, and its production can be effected easily, and also to provide a production method in which the degree of freedom of its configuration is high.

[0010] In order to solve the above problems, the invention recited in claim 1 is directed to an integral structural member, comprising a plate and a tubular body, CHARACTERIZED in that part of a cylindrical wall (3) of the tubular body (2) is defined by superposed walls (6) held in intimate contact with each other, and that the outermost one (5) of the superposed walls is folded back to be integrally continuous with the plate (1).

[0011] The invention recited in claim 2 is directed to a method of producing an integral structural member comprising a plate and a tubular body, CHARACTERIZED by the steps of projecting the tubular body (2) from the plate (1); inverting an end portion of a cylindrical wall (3) of the tubular body (2) outwardly, thereby forming an outer wall (5), and bringing the outer wall (5) into intimate contact with the cylindrical wall (3) to form a superposed wall (6).

[0012] In the invention recited in claim 3 according to the invention recited in claim 2, one or both of the plate (1) and the tubular body (2) are moved in a direction of an axis of the tubular body (2) so as to invert the cylindrical wall (3) .

[0013] In the invention recited in claim 4 according to the invention recited in claim 2, the outer wall (5) is brought into intimate contact with the cylindrical wall (3) by the decrease of a diameter of the outer wall (5), or by the increase of a diameter of the cylindrical wall (3), or by the decrease of the diameter of the outer wall (5) and the increase of the diameter of the cylindrical wall (3).

[0014] In the invention recited in claim 5 according to the invention recited in claim 2, the cylindrical wall (3) is formed into a small thickness by drawing at the time of projecting the tubular body (2).

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 A and Fig. 1B respectively show integral structural members each comprising a plate and a

tubular body, and Fig. 1A shows a first embodiment, and Fig. 1B shows a second embodiment.

Fig. 2 is a cross-sectional view of a shaping machine showing a second step of a production method according to the first embodiment of the present invention.

Fig. 3 is a cross-sectional view of a shaping machine showing a third step of the above method.

Fig. 4 is a cross-sectional view of a shaping machine showing a fourth step of the above method.

Figs. 5A to 5D are cross-sectional views of products showing the steps of the production method according to the first embodiment of the present invention.

Figs. 6A and 6B show an example in which threads are formed on a structural member according to the present invention, and Fig. 6A is a side cross-sectional view, and Fig. 6B is a plan view.

Fig. 7 is a cross-sectional view of a shaping machine, showing a thinning process in a production method according to the second embodiment of the present invention.

Fig. 8 is a cross-sectional view of a shaping machine, showing a step of the above method, in which a connection portion, interconnecting a tubular body and a plate, is shaped into a curved portion.

Figs. 9A to 9D are cross-sectional views of products, showing the steps of the production method according to the second embodiment of the present invention.

Fig. 10 is a cross-sectional view of a product formed by conventional hot forging.

Fig. 11 is a cross-sectional view of a product united by conventional welding.

Fig. 12A and Fig. 12B show a conventional double-cylinder drawing process, and Fig. 12A is a cross-section showing a first drawing operation, and Fig. 12B is a cross-section showing a second reverse drawing operation.

BEST MODE FOR CARRYING OUT THE INVENTION

[0016] Embodiments according to the present invention will now be described with reference to Figs. 1A to Fig. 9E.

[0017] Figs. 1A and 1B respectively show two embodiments according to integral structural members of the present invention each comprising a plate and a tubular body.

[0018] In the embodiment shown in Fig. 1A, reference numeral 1 denotes the plate of metal, and reference numeral 2 denotes the tubular body of metal. Part of a cylindrical wall 3 of the tubular body 2 is folded back and inverted at an open end of an inner wall 4, and this inverted outer wall 5 is held in intimate contact with the inner wall 4 to form a superposed wall 6. A distal end portion of the outer wall 5 is bent outwardly in a direction perpendicular to the cylindrical wall 3 to form the plate 1, thereby forming the plate 1 and the tubular body 2 integrally with each other.

[0019] In the embodiment shown in Fig. 1B, the outer wall 5 of the above embodiment is further folded and inverted upwardly and downwardly in a meandering manner to form a superposition wall 6 comprising four plate portions superposed and held in intimate contact with one another. A distal end portion of the outermost wall 5 of the superposition wall 6 is bent outwardly in a direction perpendicular to the cylindrical wall 3 to form the plate 1, thereby forming the plate 1 and the tubular body 2 integrally with each other.

[0020] Incidentally, a recess 7 is formed in an inner bottom surface of the tubular body 2, and with this construction a hexagonal convex portion 7a, with which a tool can be engaged, is formed on the outer surface, as shown in Figs. 6A, 6B.

[0021] Next, a method of producing the structural member, shown in Fig. 1A, will be described with reference to Figs. 2 to Fig. 5D.

[0022] First, as shown in Fig. 5A, in a first step, a metal plate is formed by a known pressing machine into a hat-shaped product 12 comprising a tubular portion 11 with a closed bottom and a plate 1 formed continuously with an open end of this tubular portion.

[0023] Then, in a second step, the product 12 is deformed by the use of a shaping machine shown in Fig. 2.

[0024] The shaping machine, shown in Fig. 2, will be described. A die 14 is fixedly mounted on a lower base 13, and a cushion plate 15 is upwardly and downwardly movably provided in a center portion of the die 14. Reference numeral 16 denotes a spring normally urging the cushion plate 15 upwardly.

[0025] An upper base 17 can be moved upward and downward by upward-downward movement drive means (not shown) such as a hydraulic cylinder.

[0026] A die 18 is fixedly secured to a lower surface of the upper base 17, and in order to relieve a processing load, an inner peripheral surface 19 of this die at its lower end is formed into a relatively-large curved surface, and more specifically into a curved surface with a radius R of 1 mm. An inner die 20 is fixedly secured to the upper base 17, and is located in the center portion of the die 18.

[0027] A knockout 21 is interposed between the die 18 and the inner die 20 for upward and downward movement, and is normally urged downwardly by a spring 22.

[0028] Reference numeral 23 denotes the product formed in the second step.

[0029] Incidentally, a recess-forming surface 24 for forming the recess 7, shown in Figs. 1A and 1B, is formed on an upper surface of the cushion plate 15, and a convex portion-forming surface 25, corresponding to the recess-forming surface 24, is formed on a lower surface of the inner die 20. A length of the knockout 21 in

the upward-downward direction is shorter than that of the die 18 so as to form the outer wall 5, shown in Figs. 1A and 1B, and a wall thickness D_1 thereof is not less than twice a plate thickness of the plate to be shaped, and in the embodiment this wall thickness is about three times as large as the plate thickness.

[0030] In the shaping operation, in a condition in which the upper base 17 is raised from the condition of Fig. 2, with the die 18 and the inner die 20 located in their respective upper positions, the member 12, shaped in the first step, is first brought to be interposed between the cushion plate 15 and the inner die 20, with the center of the member 12 coinciding with the center of the cushion plate 15.

[0031] Then, when the upper base 17 is moved downward, a lower portion of the inner die 20 is first fitted into the tubular portion 11 shown in Fig. 5A, and subsequently an upper portion of the tubular portion 11 is sequentially bent outwardly by the lower end of the downwardly-moving knockout 21, and also this bent portion is downwardly inverted and bent by the die 18, and at a final stage, an outer peripheral portion of the plate 1 is held under pressure between the die 14 and the die 18 as shown in Fig. 2, thereby forming the product 23 in which the inner wall 4, the tubular outer wall 5 spaced from the inner wall, and the plate 1, disposed perpendicular to the inner wall 4, are bent in a continuous manner as shown in Figs.2 and 5B.

[0032] The recess 7 and the convex portion 7a are formed by the recess-forming surface 24 and the convex portion-forming surface 25.

[0033] Then, in a third step, the above member 23 is deformed by the use of a shaping machine shown in Fig. 3.

[0034] In this shaping machine shown in Fig. 3, a knockout 21A, having a wall thickness D_2 twice as large as the plate thickness of the plate 1, is used instead of the knockout 21 of Fig. 2, and therefore instead of the die 18, there is used a die 18A having such an inner diameter that its inner periphery is in contact with the knockout 21A. In order to relieve a processing load, an inner peripheral surface 19A of the die 18A at its lower end is formed into a curved surface larger than that of the surface 19, and more specifically this surface 19A is formed into a curved surface with a radius R of 5 mm. The other construction is similar to that of the shaping machine used in the second step, and therefore explanation thereof will be omitted.

[0035] In the third step, the product 23, formed in the second step, is shaped by using an operation similar to that of the second step. In this shaping operation, the outer wall 5, bent in an inverted manner in the second step, is moved toward the inner wall 4, and is brought into intimate contact with the inner wall 4 as shown in Fig. 3. As a result, there is formed a product 26 in which the superposition wall 6, defined by the inner wall 4 and the outer wall 5 superposed and held in intimate contact with each other, is formed at part of the cylindrical wall 3 at the open end thereof as shown in Figs. 3 and 5C.

[0036] Then, in a fourth step, the product 26 is deformed by the use of a shaping machine shown in Fig. 4.

[0037] In this shaping machine shown in Fig. 4, a curved surface, formed on an inner peripheral surface 19B of a die 18B at its lower end, is smaller than the curved surfaces of the lower end inner peripheral surfaces 19 and 19A of the dies 18 and 18A used respectively in the second and third steps, and more specifically this surface 19B is formed into a curved surface with a radius R of 0.5 mm. The other construction is similar to that of the shaping machine used in the third step, and therefore explanation thereof will be omitted.

[0038] In the fourth step, the product 26, formed in the third step, is shaped by using an operation similar to that of the second step. In this shaping operation, the radius R of the curved surface of a connecting portion 8 interconnecting the outer wall 5, shaped in the third step, and the plate 1, is amended into a small value of 0.5 mm, thereby forming a product 27 shown in Fig. 5D. Thus, the product, shown in Fig. 1A, is formed.

[0039] Then, as shown in Fig. 6A, threads 28 are formed on the outer peripheral surface of the outer wall 5 of the product 27 if necessary.

[0040] Next, description will be made of the case where the tubular body 2 of the product, shown in Fig. 1A, is formed into a small thickness.

[0041] In this case, in the second step, the product 12 of Fig. 5A is deformed as shown in Fig. 9A by the use of a shaping machine shown in Fig. 7.

[0042] The shaping machine, used in this second step, comprises the same parts as those of the shaping machine shown in Fig. 2, and differs from the shaping machine of Fig. 2 in that a gap D3 between a die 14 and an inner die 20 is smaller than the thickness of a plate 1, and is, for example, a half of the thickness of the plate, that the die 14 is much longer than a cushion plate 15, and that a die 18 and a knockout 21 have the same length.

[0043] When the product 12 is supplied to this shaping machine, and is subjected to a shaping operation as described above, a tubular portion 11 of the product 12 is drawn by the die 14 and the inner die 20, and is thinned uniformly, thereby forming a product 29 shown in Fig. 9A.

[0044] Then, in a third step, the product 29 is deformed by the use of a shaping machine shown in Fig. 8.

[0045] This shaping machine differs from the shaping machine, used in the second step, in that a recess 21a, defined by a curved surface, is formed in a lower surface of the knockout 21 and that a convex portion 14a is formed on an upper surface of the die 14.

[0046] When the product 29 is supplied to this shaping machine, and is subjected to a shaping operation as described above, the connecting portion, interconnecting the tubular portion 11 and the plate 1, is formed into

an upwardly-directed, curved portion 30 by the convex portion 14a and the recess 21a as shown in Fig. 8, thereby forming a product 31 shown in Fig. 9B. In Fig. 9B, with respect to the radius R of the curved portion 30, the radius R of its inner surface is 1 mm, and the radius R of its outer surface is 3 mm.

[0047] By forming the curved portion 30, the cylindrical portion 11, though formed into a small thickness as described above, can be prevented from being buckled in the subsequent step.

[0048] Then, in a fourth step, the product 31 is shaped as shown in Fig. 9C, using a shaping machine similar to that of Fig. 2. Then, in a fifth step, the product is shaped as shown in Fig. 9D, using a shaping machine similar to that of Fig. 3. In a sixth step, the product is further shaped as shown in Fig. 9E, using a shaping machine similar to that of Fig. 4.

[0049] As a result, the thickness of the tubular body 2 is reduced, and the thickness of its superposition wall 6 can be made equal to the thickness of the plate 1.

[0050] The above embodiments may be modified as follows.

[0051] Although the plate 1 in the above embodiments is short so as to form a flange, this plate 1 may be long, and for example in the case where it is used in an oil filler port in a large-size tank, the plate 1 may constitute a wall of this tank.

[0052] The bottom surface of the tubular body 2 is not limited to the hexagonal convex portion 7a as in the above embodiments, but may be formed into a square convex portion or a flat surface, or this bottom may be open. This bottom surface may be shaped in any of the steps.

[0053] The position of formation of the plate 1 relative to the tubular body 2 is not limited to that of the above embodiments, but the plate may be formed at a desired position. Further, the angle of the plate 1 relative to the axis of the tubular body 2 is not limited to such an angle that the plate 1 is perpendicular to this axis, but the plate may be inclined. In this case, the opposed surfaces of the die 14 and the die 18 are inclined.

[0054] After the step shown in Fig. 4, the plate 1 is further bent upwardly by the die 14 and the die 18, and then the step of Fig. 2 and the subsequent steps are repeated. By doing so, the superposition wall 6 can be formed by a desired number of inverted plate portions. The superposition wall 6, shown in Fig. 1B, is formed in this manner. This superposition wall 6 is not limited to those of Figs. 1A and 1B, but may be formed by a required number of plate portions which is not less than two.

[0055] In the step of Fig. 2, although the die 18 is moved downward to press down the plate 1, the cushion plate 15 may be moved upward to press the tubular portion 11 upwardly, or the downward movement of the die 18 and the upward movement of the cushion plate 15 may be used in combination.

[0056] Although the threads 28 are formed on the outer surface of the outer wall 5 as shown in Fig. 6, threads may be formed on the inner surface of the inner wall 4.

[0057] In the step of Fig. 3, the outer wall 5 is reduced in diameter to be brought into intimate contact with the inner wall 4 of the tubular body 2. However, in this step, the inner wall 4 may be increased in diameter to be brought into intimate contact with the outer wall 5, or this intimate contact may be achieved using these methods in combination.

[0058] In the step of Fig. 9A, the product 12, shown in Fig. 5A, is subjected to the drawing process. However, the step of Fig. 5A may be omitted, and the tubular body may be projected and reduced in thickness directly in the step of Fig. 9A.

CAPABILITY OF EXPLOITATION IN INDUSTRY

[0059] As described above, in the invention recited in claim 1, that portion of the cylindrical wall of the tubular body, having the plate, is formed by the superposed walls held in intimate contact with each other, and therefore there can be provided the structural member, comprising the plate and the tubular body, in which the rigidity of connection (relative displacement strength) between the plate and the tubular body is high, and the firm connection is achieved.

[0060] In the invention recited in claim 2, the structural member recited in claim 1 can be easily produced by one press drawing operation, an inverting processing, and the diameter-increasing processing or the diameter-decreasing processing. And besides, in contrast with the conventional double-cylinder drawing process, the same portion does not need to be subjected a plurality of times to the press drawing operation, and therefore there can be provided the production method in which the processing limitation is less, and the degree of freedom of the configuration is high.

[0061] In the invention recited in claim 3, the inversion in the above claim 2 can be achieved not by the press drawing operation but by moving one or both of the plate and tubular body in the direction of the axis of the tubular body, and therefore the processing can be effected easily and surely.

[0062] In the invention recited in claim 4, the intimate contact in claim 2 can be effected by the easy conventional process, and therefore the processing can be effected easily and surely.

[0063] In the invention recited in claim 5, the tubular body and the cylindrical wall can be easily reduced in thickness.

Claims

1. An integral structural member, comprising a plate and a tubular body, CHARACTERIZED in that part of a cylindrical wall of the tubular body is defined by superposed walls held in intimate contact with each

other, and that the outermost one of said superposed walls is folded back to be integrally continuous with the plate.

2. A method of producing an integral structural member comprising a plate and a tubular body, CHARACTERIZED by the steps of projecting the tubular body from the plate; inverting an end portion of a cylindrical wall of said tubular body outwardly, thereby forming an outer wall, and bringing said outer wall into intimate contact with said cylindrical wall to form a superposition wall.

3. A method of producing an integral structural member comprising a plate and a tubular body, according to claim 2, in which one or both of the plate and the tubular body are moved in a direction of an axis of the tubular body so as to invert the cylindrical wall.

4. A method of producing an integral structural member comprising a plate and a tubular body, according to claim 2, in which the outer wall is brought into intimate contact with the cylindrical wall by the decrease of a diameter of the outer wall, or by the increase of a diameter of the cylindrical wall, or by the decrease of the diameter of the outer wall and the increase of the diameter of the cylindrical wall.

5. A method of producing an integral structural member comprising a plate and a tubular body, according to claim 2, in which the cylindrical wall is formed into a small thickness by drawing at the time of projecting the tubular body.

FIG. 1A

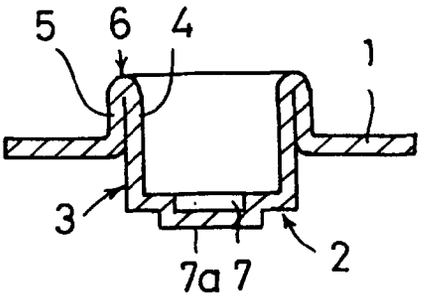


FIG. 1B

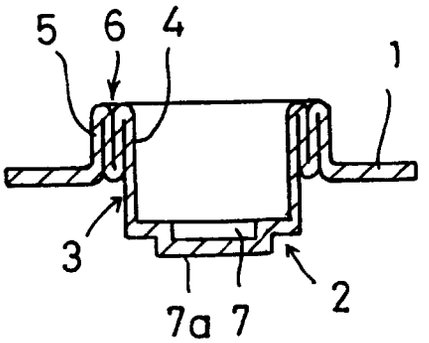


FIG. 2

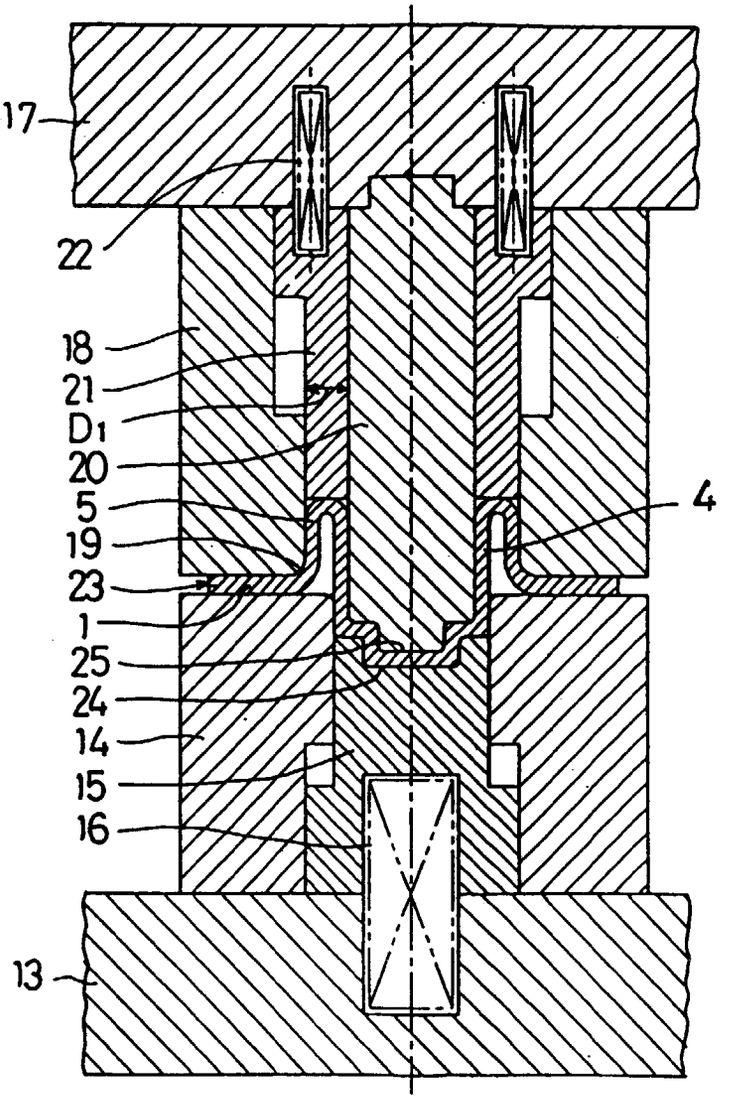


FIG. 3

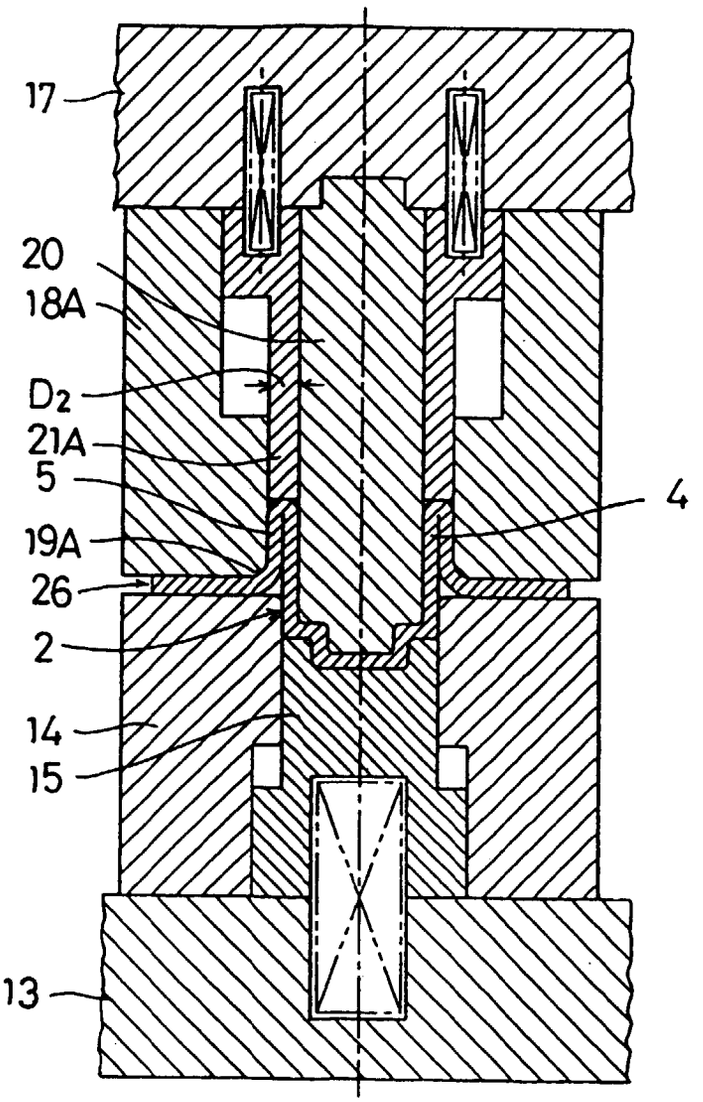


FIG. 4

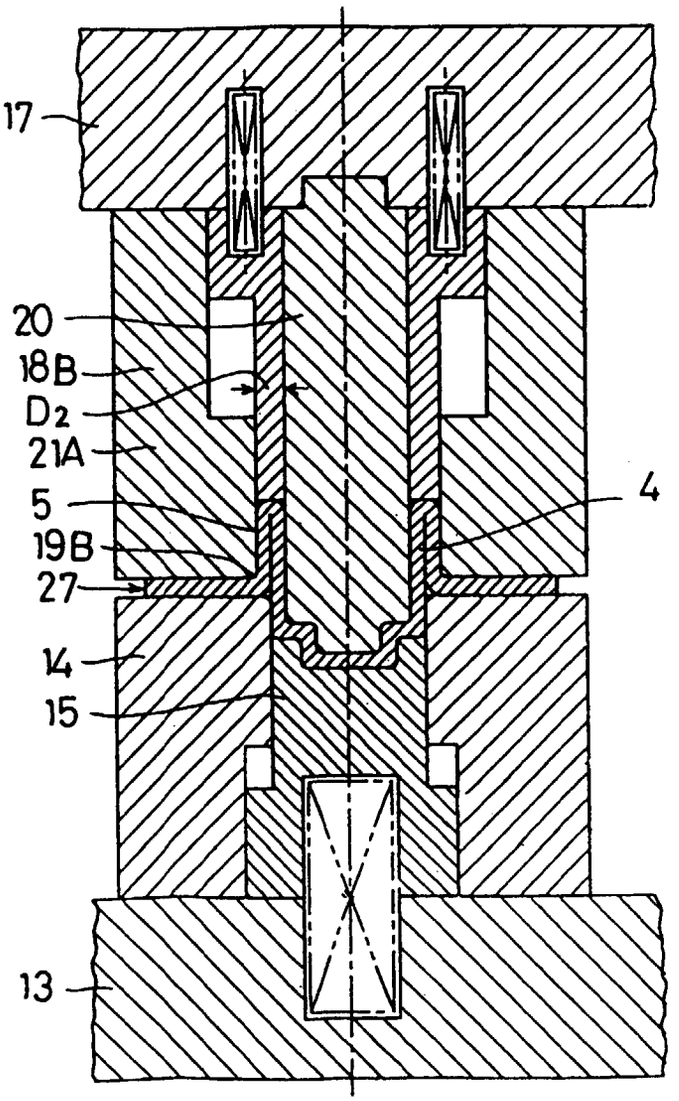


FIG. 5A

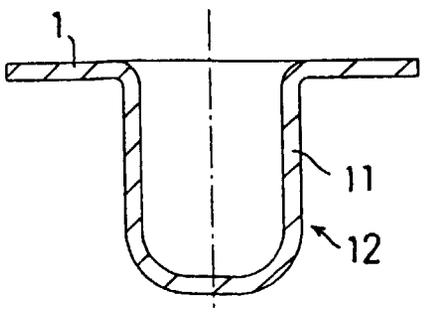


FIG. 5B

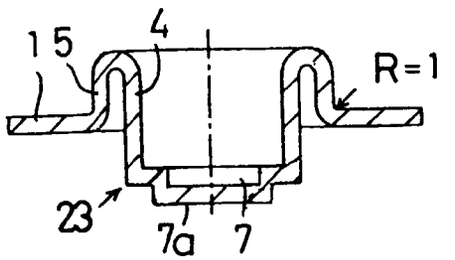


FIG. 5C

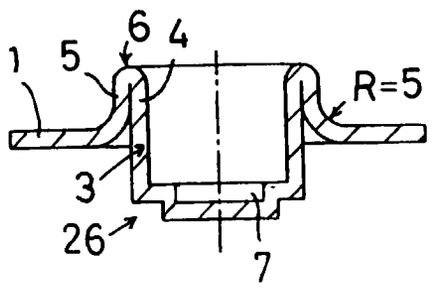


FIG. 5D

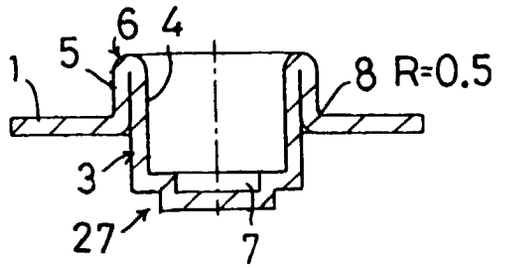


FIG. 6A

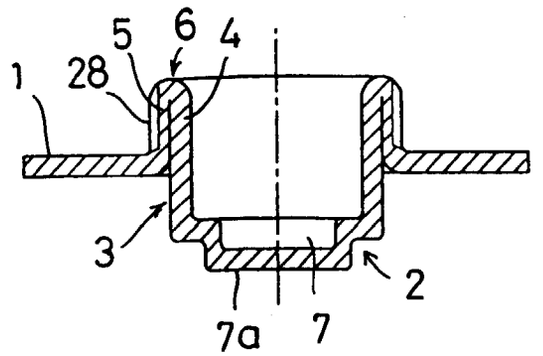


FIG. 6B

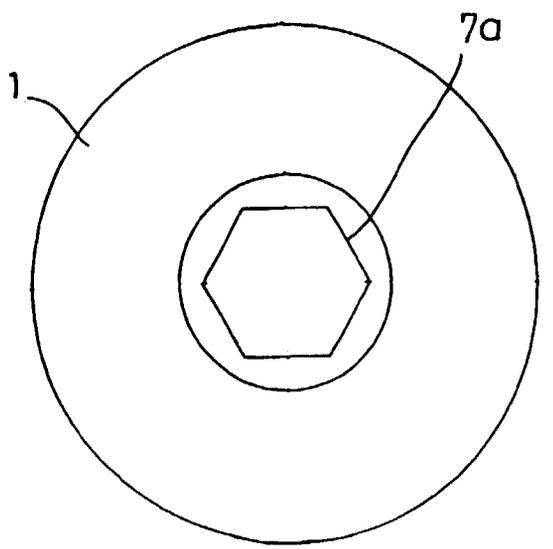


FIG. 7

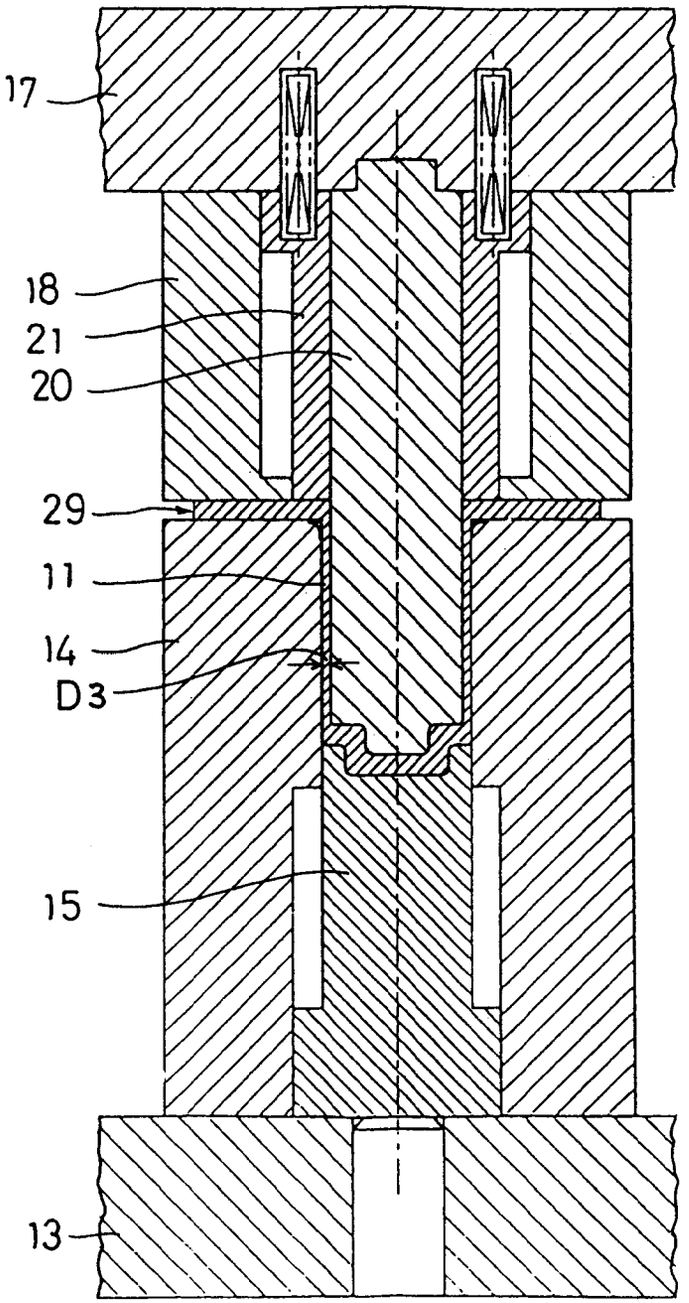


FIG. 8

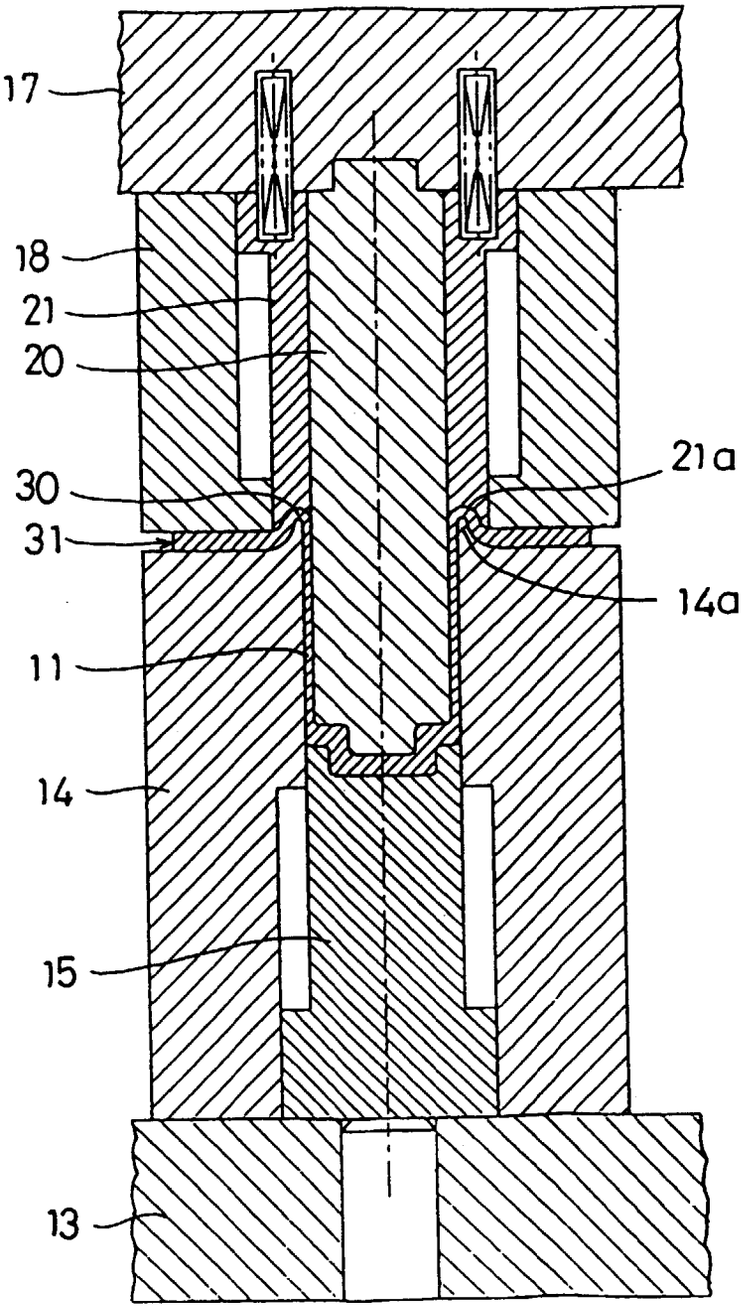


FIG. 9A

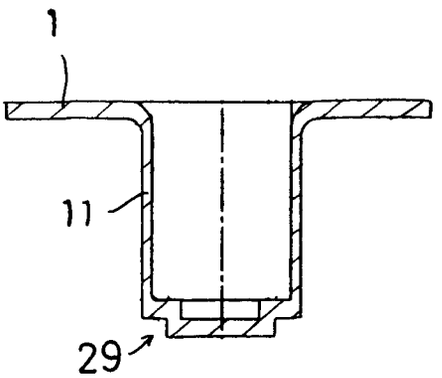


FIG. 9B

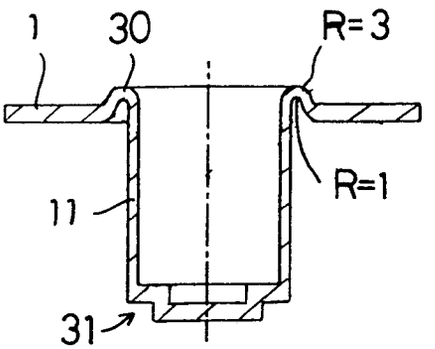


FIG. 9C

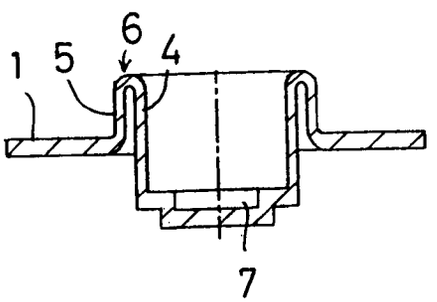


FIG. 9D

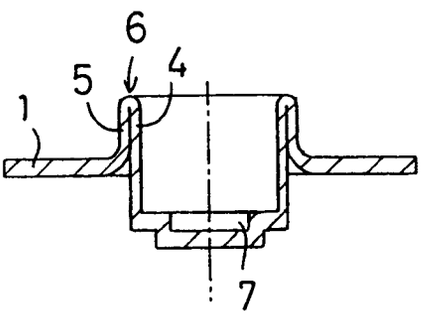


FIG. 9E

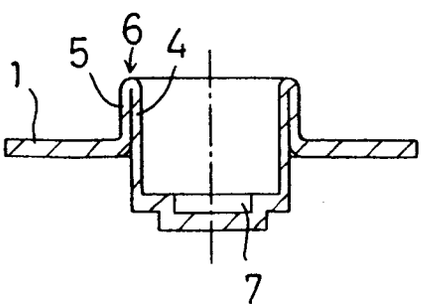


FIG. 10

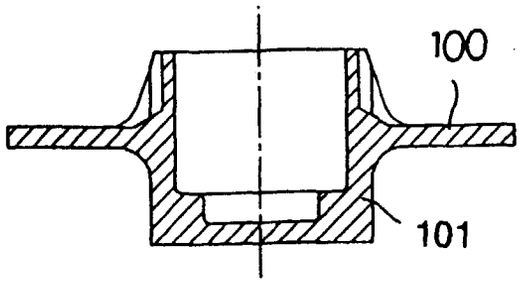


FIG. 11

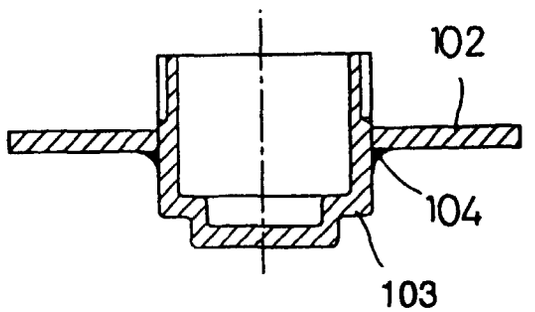


FIG. 12A

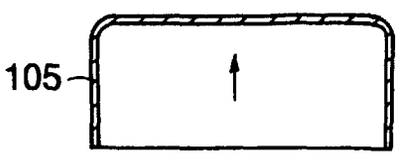
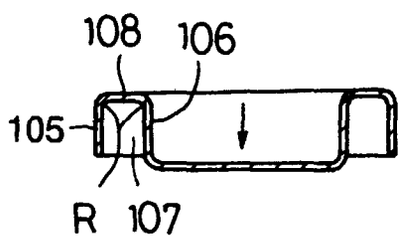


FIG. 12B



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/04251

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 B21K23/04

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^6 B21K23/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1996 Jitsuyo Shinan Toroku Koho 1996 - 1998
Kokai Jitsuyo Shinan Koho 1971 - 1998
Toroku Jitsuyo Shinan Koho 1994 - 1998

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, 61-195726, A (Tokai Rika Co., Ltd.), August 30, 1986 (30. 08. 86)(Family: none)	1 - 5

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
February 13, 1998 (13. 02. 98)	February 24, 1998 (24. 02. 98)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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