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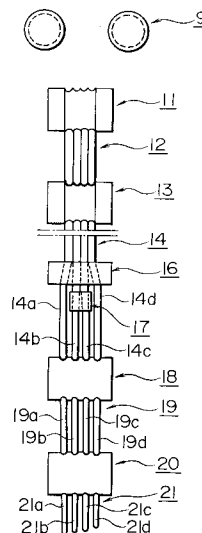
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(54) **METHOD OF MANUFACTURING METAL BARS AND APPARATUS THEREFOR.**

(57) An intermediate billet, which has been rolled by a rough roll train of a bar rolling mill, is finish rolled to obtain N pieces of strands connected to one another through thin connecting portions. Next, strands at opposite ends are cut off at the connecting portions by slit rolls, and subsequently, strands at opposite ends out of a plurality of intermediate strands, which have not been cut off, are cut off at the connecting portions by the slit rolls. Thenceforth, the cut-off of strands at opposite ends at the connecting portions is repeated, whereby all of the strands are cut off at the connecting portions by the slit rolls, and subsequently, the strands thus cut off are simultaneously rolled, to thereby manufacture N pieces of metal bars at the same time.

FIG. 1



Technical Field:

The present invention relates to methods and apparatuses for producing metal bars wherein at least four strands of metal bars, particularly steel bars, are obtained by simultaneously rolling from a single billet.

Background Art:

A steel bar of 9 to 20 mm in diameter as a concrete bar for reinforcing concrete is produced in large quantities. In this context, the bar includes not only a bar whose cross section is substantially round, but also a bar whose cross section is slightly oval or square-shaped and a ribbed bar which is the above-mentioned bar, on which ribs are formed.

Said bars are produced by a bar rolling mill generally having 16 to 20 stands in the following manner:

The bar rolling mill is roughly composed of a roughing rolling train and a finishing rolling train. In the roughing rolling train, a preformed billet is produced by rolling a billet of 100 to 150 mm in diameter and thus reducing a cross-sectional area of the billet to 70 to 95 % thereof. Then, a final product is obtained by rolling said preformed billet in the finishing rolling train. The method wherein a strand of metal bar is produced from a single billet in this way is popular. However, such a method is not effective in productivity of the bars.

Therefore, the following methods as methods for producing a plurality of bars from a single preformed billet in a finishing rolling train have been proposed:

(1) A method for simultaneously producing three strands of bars from a single preformed billet in a finishing rolling train, which is disclosed in Japanese Patent Application Laid Open No. 24,503/84 of February 8, 1984 (hereinafter referred to as the "Prior Art 1").

In the method of the "Prior Art 1", a finishing rolling train is composed of 4 stands K_4 , K_3 , K_2 , and K_1 . The K_4 and K_3 stands roll a preformed billet to produce three strands of bars 2a, 2b and 2c connected to each other by means of thin connecting portions 2d and 2e as shown in Figure 9 (A). A pair of slit rolls cuts the three strands of bars 2a, 2b and 2c along the connecting portions, and then K_2 stand, composed of a pair of calibrated rolls, rolls the three cut strands of bars 2a, 2b and 2c to produce bars of oval cross section as shown in Figure 9(B), and the K_1 stand, composed of a pair of rolls with a finishing caliber (a bore type), rolls the three strands to produce final product bars 3a, 3b, and 3c as shown in Figure 9(C). Figure 9(A)

shows a state of rolling a billet at the stand K_3 . Figure 9(B) shows a state of strands having been cut off by means of a pair of slit rolls, following the K_2 stand. Figure 9(C) shows the shapes of bars 3a, 3b and 3c after the bars have been rolled at the stand K_1 .

The "Prior Art 1" is limited to simultaneously producing three strands of bars from a single preformed billet by means of such a finishing rolling train.

(2) A method for simultaneously producing four strands of bars from a single preformed billet, which is disclosed in Japanese Patent Publication No. 92,001/85 of May 23, 1985 (hereinafter referred to as the "Prior Art 2").

The "Prior Art 2" was developed by the applicant of the present invention to enhance the productivity of the method of the "Prior Art 1". According to the method of the "Prior Art 2", bars are produced as follows:

Four strands 4a, 4b, 4c and 4d connected to each other by thin connecting portions 4e, 4f and 4g are formed as shown in Figure 10(A) by means of stands K_4 and K_3 . The four strands 4a, 4b, 4c and 4d as shown in Figure 10(B) are cut off along the central connecting portion 4f by means of a first pair of slit rolls (6) between stands K_3 and K_2 as shown in Figure 11. Then, four bars 4a, 4b, 4c and 4d as shown in Figure 10(C) are obtained by cutting off along the connecting portions (4e, 4g) by means of two pairs of second slit rolls (7, 8). Subsequently, bars 5a, 5b, 5c and 5d as final products, as shown in Figure 10(D), are produced by simultaneously rolling the four bars 4a, 4b, 4c and 4d. Processes of rolling and cutting the strands are shown in Figures 10(A) to 10(D) and the positions of the slit rolls on the plane are shown in Figure 11.

The method of the "Prior Art 2" has some difficulties in that this method is confined to a method of simultaneously producing four bars.

The present invention provides a method for producing metal bars, which solves said problems and is further improved, and it is an object of the present invention to provide a method for simultaneously producing at least four metal bars and an apparatus therefor.

Disclosure of the Invention:

The present invention proposes a new construction of a finishing rolling train and a new rolling method for producing metal bars wherein the conventional roughing rolling train is used.

The stands of a finishing rolling train are stands K_4 , K_3 , K_2 and K_1 arranged in series in the rolling direction.

① A flat preformed billet is supplied from a roughing rolling train to the stand K_4 in a finishing rolling train. The last roll stand in the roughing rolling train is the stand K_5 .

② If N strands of bars are planned to produce, the stand K_4 is composed of a pair of upper and lower rolls each having $(N - 1)$ of convex portions. The preformed billet is rolled to have concave portions by means of the rolls having the convex portions so that each cross section of the divided portions has substantially the same area.

③ The stand K_3 is composed of a pair of caliber rolls. The two outer calibers of the rolls of the stand K_3 have sections of an oval shape longer in width. An intermediate caliber of the rolls of the stand K_3 usually has a section of a diamond shape. The rolls of the stand K_3 , however, could have calibers of an oval shape longer in the vertical directions. In the stand K_3 , strands corresponding to the shapes of calibers are formed.

④ The present invention has a major feature in the arrangement of pairs of slit rolls positioned adjacent to the stand K_3 . The first pair of slit rolls having two edges is placed just behind the stand K_3 to cut off two outer strands of the preformed billet along connecting portions of the strands. Subsequently, when four strands of bars are simultaneously produced, the center connecting portion of the strands is cut by means of the second pair of slit rolls. When five strands of bars are simultaneously produced, the strands are cut off by the second pair of slit rolls with two edges. When six or seven strands of bars are simultaneously produced, a third pair of slit rolls is placed behind the second pair of slit rolls. The present invention has a feature in that the connected strands are sequentially cut off by means of the pairs of slit rolls from both the outer strands toward the central strands. This is because cut strands cannot be separated from each other when two strands or more are cut simultaneously.

⑤ After all the strands have been cut off from each other, all the strands are subjected to an ordinary oval rolling by means of the stand K_2 . Accordingly, a pair of upper and lower rolls having the same number of oval calibers as that of strands, which are simultaneously rolled, are arranged in the stand K_2 .

⑥ The stand K_1 for carrying out the finishing rolling is placed behind the stand K_2 . The strands having been rolled by means of the stand K_2 are rolled on the stand K_1 so that the strands can have dimensions and shapes of final products. Accordingly, a pair of upper and lower rolls having calibers of dimensions and shapes

of the final products are arranged in the stand K_1 .

Brief Description of the Drawings:

Figure 1 is a top plan view showing an arrangement of the finishing rolling train of an apparatus for producing metal bars by the present invention.

Figures 2(A) to 2(G) are explanatory views showing the roll calibers of each stand in the finishing rolling train as shown in Figure 1.

Figure 3 is a top plan view of an arrangement of the first and the second slit rolls placed just behind a stand K_3 .

Figure 4 is an explanatory view showing a caliber of the first pair of slit rolls.

Figure 5 is an explanatory view showing a caliber of the second pair of slit roll.

Figure 6 is an explanatory view showing the slit roll guide composed of the first pair of slit rolls and the second pair of slit rolls as shown in Figures 3 to 5.

Figures 7(A) to 7(H) are explanatory views showing the processes of deformation of the strands by roll calibers from the roll stands K_5 to K_1 in the case of simultaneously rolling five strands of bars.

Figures 8(A) to 8(I) are explanatory views showing the processes of deformation of the strands by roll calibers from the roll stands K_5 to K_1 in the case of simultaneously rolling six strands of bars.

Figures 9(A) to 9(C) are explanatory views showing the processes of rolling in the "Prior Art 1".

Figures 10(A) to 10(D) are explanatory views showing the processes of rolling in the "Prior Art 2".

Figure 11 is an explanatory view showing an arrangement pairs of slit rolls in the "Prior Art 2".

The Best Mode for Carrying out the Invention:

The present invention will now be described in detail with reference to the appended drawings.

In Figure 1, reference numeral 9 denotes a final stand K_5 in a roughing rolling train. The final stand has a pair of vertical rolls (hereafter referred to as "V roll") and finally controls the shape of a preformed billet supplied to the next stand K_4 . Reference numeral 11 denotes a stand K_4 , 13 a stand K_3 , 16 a first pair of slit rolls, 17 a second pair of slit rolls, 18 a stand K_2 and 20 a stand K_1 . An ordinary roughing rolling train (not shown) is arranged before the stand K_5 . Following the K_1 stand, a finishing billet yard is laid out, which includes cutting devices and cooling beds. Roll calibers arranged in the stands as shown in Figure

1 and a process of deformation of strands are described with specific reference to Figure 2.

Figure 2(A) shows a shape of a roll caliber of said stand K_5 and a shape of a preformed billet 10. The stand K_5 provides a shape of the preformed

billet 10 by means of a pair of V rolls required for rolling in the stand K_4 .
Figure 2(B) shows an oval caliber rolls 11 and the strands divided into four in the case of simultaneously rolling four strands. The caliber roll 11 has three convex portions 11a, 11b and 11c as shown in Figure 2(B) and divides the preformed billet 10 into four strands 12a through 12d having a substantially equal cross sectional area. In this case, the depth of the convex portions is from 1 to 4 mm, and the four strands are sufficiently connected to each other with shallow cleavages. The depth of the cleavages is from 10 to 20 % of the thickness of the strand 12. The four strands divided are substantially square-shaped or oval in shape.

Figure 2(C) shows that the connected four strands are further rolled by the stand K_3 . Both the outer roll calibers 13a and 13d are of oval shape or box-shaped and the roll calibers 13b and 13c at the intermediate portion are diamond-shaped in principle. Accordingly, both the outer strands 14a and 14d are box-shaped and the two strands 14b and 14c at the intermediate portion are diamond-shaped. The four strands are connected to each other by means of thin connecting portions (hereinafter referred to as the "connecting portion") 14e through 14g.

Figure 2(D) shows that the connecting portions 14e and 14g of the connecting portions are cut by means of a first pair of slit rolls.

Figure 2(E) shows the four strands 14a through 14d after the center connecting portion 14f has been cut by means of a second pair of slit rolls.

Figure 2(F) shows roll calibers 18a through 18d and strands 19a through 19d in the stand K_2 . The stand K_2 has oval roll calibers so that the four strands as shown in Figure 2(E) are rolled to be adapted to the final rolling, whereby four strands 19a to 19d of oval shape are formed.

Figure 2(G) shows roll calibers 20a through 20d on the stand K_1 for carrying out the final rolling. When the final product is a round bar, the roll caliber is a round caliber. When the final product is initially of oval shape or square-shaped, the roll calibers in the stand K_1 are required to have the shape of the final product. When the final product is a ribbed bar, the roll caliber should be a caliber which gives ribs on the bars.

Approximate dimensions of the preformed billet are shown to show specific examples of the present invention. In the above examples, initially, a square billet of 150 mm in each side was rolled by means of a roughing rolling train. A preformed billet

10 obtained in the final stand K_5 had a box-shape with a breadth of 41.24 mm and a thickness of 13.48 mm and the central portion of the preformed billet was swelling. Accordingly, the roll calibers also were box-shaped.

A roll caliber in the stand K_4 had a breadth of approximately 48.1 mm and had an oval shape as a whole, the maximum thickness of which was about 10.5 mm. The roll caliber had convex portions 11a through 11c at positions where the roll caliber was divided into about four equal portions. The breadth of each of the divided strands was from 11.5 to 12.5 mm.

Each of both the outer roll calibers 13a and 13d in the stand K_3 had a breadth of about 7.9 mm and a thickness of 9.5 mm and had an oval shape. Diamond-shaped roll calibers 13b and 13c at the intermediate portion had a breadth of about 11.4 mm and a thickness of 12 mm. The connecting portions had a breadth of about 0.8 mm and a thickness of 1 mm or less. Roll calibers 18a through 18d in the stand K_2 had a breadth of 17.8 mm and a thickness of 6.6 mm and were flat oval-shaped. Roll calibers 20a through 20d in the stand K_1 were round calibers of about 8.9 mm in diameter. In consequence, a bar of about 8.8 mm in diameter as a final product could be produced.

Said dimensions were only a part of the examples. Those dimensions are not limited and represented in approximate numerical values.

Subsequently, the construction of pairs of slit rolls covering a major part of the present invention will now be described with specific reference to Figures 3 to 8.

Figure 3 is a top plan view showing an arrangement of a first pair of slit rolls 16 and a second pair of slit rolls 17 placed just behind a stand K_3 . Reference numerals 16c, 16d and 17b denote guides for controlling the directions of movement of cut strands.

Now, the strands 14a through 14d are cut off as shown in Figure 4. The present invention is characterized in that connecting portions of two strands 14a and 14d on the outer sides out of divided four strands 14a through 14d are cut off by means of two edges 16a and 16b of a first pair of slit rolls 16. The important points in the shape of the two edges 16a and 16b consist in that the edges are formed so that the cut strands 14a and 14d can be directed outwardly, as shown by the arrows in Figure 3.

Subsequently, the two central strands 14b and 14c are cut off along the connecting portion 14f by means of the edge 17a of the second pair of slit rolls 17 as shown in Figure 5. The angle of the edge 17a of the second pair of slit rolls is formed so that the cut strand can be directed outwardly. As described above, the present invention is char-

acterized in that initially both the outer strands are cut off and then two inside strands are sequentially cut off, in contrast to the Prior Art 2.

In the present invention, as shown in Figures 3 to 5, a method is adopted wherein the strands are sequentially cut off from both the outer strands to the central portion thereof. This method has an advantage in that the position of the second pair of slit rolls 17 can be fixed in relation to the position of the first pair of slit rolls 16 independent of the rolling speed of the strands and that the cutting of the strands can be performed to change of the rolling speed and the like.

As shown in Figure 6, the first pair of slit rolls 16 and the second pair of slit rolls 17 are accommodated into a housing 22. Reference numeral 23 denotes a guide for leading cut strands. The device as a whole is referred to as a slit roll guide.

The above-described is an embodiment in the case where four bars are simultaneously produced.

Figure 7 shows an embodiment wherein five bars are simultaneously produced. Figure 8 shows an embodiment wherein six bars are simultaneously produced. The method for simultaneously producing five bars or six bars is quite the same as the method for simultaneously producing four bars. However, additional explanation is given below as follows:

Figure 7(A) shows a roll caliber 9a in a stand K_5 and a preformed billet 10.

Figure 7(B) shows a process in which five strands 25a through 25e, each having equal cross sectional area, are rolled by means of a pair of rolls 24 in the stand K_4 .

Figure 7(C) shows a process in which both the outer strands 27a and 27e are rolled to form strands of oval shape or of a box-shape, and intermediate three strands 27b through 27d are rolled to form strands of a diamond shape or oval shape which is longer in vertical directions, by means of a pair of rolls 26 in the stand K_3 .

Figure 7(D) shows a process in which both the outer two strands 27a and 27e are cut off by means of two edges 28a and 28b of the first pair of slit rolls 28.

Figure 7(E) shows a process in which connected three strands 27b, 27c and 27d are cut off by means of the second pair of slip rolls 29 having two edges 29a and 29b along the connecting portions 27g and 27h.

Figures 7(F) to 7(H) show a process in which the cut strands 27a through 27e are rolled on the stands K_2 and K_1 .

Figures 8(A) to 8(I) show roll calibers and deformation of the strands when six bars are simultaneously produced.

Figure 8(A) shows the deformation of the billet in the stand K_5 . Figure 8(B) shows the deformation

of the strands in the stand K_4 . Figure 8(C) shows the deformation of the strands in the stand K_3 .

Figure 8(D) shows a cutting procedure of the strands by means of the first pair of slit rolls 38. Figure 8(E) shows a cutting procedure of the strands by means of the second pair of slit rolls 39.

Figure 8(F) shows a cutting procedure of the strands by means of the third pair slit rolls 40.

If the number of bars to be simultaneously produced is N ($N \geq 4$), $1/2 \times N$ pairs of slit rolls are provided in the slit roll guide when N is an even number. When N is an odd number, $1/2 \times (N - 1)$ pairs of slit rolls are provided in the slit roll guide.

Figure 8(H) shows a rolling process at the stand K_2 . Figure 8(I) shows a rolling process at the stand K_1 .

Industrial Applicability:

As described above, the present invention is intended to simultaneously roll mainly four steel bars or more. It is clear that the present invention can be applied to the production of aluminium bars, copper bars and other metal bars in general.

Claims

1. A method for producing metal bars wherein N (N is 4 or more) strands of metal bars are simultaneously produced by finishing rolling of a single preformed billet rolled by a roughing rolling train of a bar rolling mill, comprising the steps of:

(1) rolling N pieces of strands connected to each other by means of thin connecting portions;

(2) cutting off both two outer strands out of said N pieces of strands along the thin connecting portions by means of a first pair of slit rolls;

(3) then cutting off both two outer strands out of a plurality of intermediate strands not yet cut off along the thin connecting portions by means of a second pair of slit rolls;

(4) then cutting off all strands connected to each other along the thin connecting portions by means of slit rolls by repeatedly cutting off in the same manner as defined in step (3); and

(5) simultaneously producing N strands of metal bars by simultaneously rolling said cut strands.

2. The method of claim 1, wherein said N strands of metal bars are four, and wherein:

(1) said first pair of slit rolls has two edges, and both two outer strands out of said four strands connected to each other are cut off

along the thin connecting portions by means of said two edges of said first pair of slit rolls; and

(2) said second pair of slit rolls has a single edge, and two strands not yet cut off are cut off along the thin connecting portion by means of said single edge of said second pair of slit rolls. 5

3. The method of claim 1, wherein said N strands of metal bars are five, and wherein: 10

(1) said first pair of slit rolls has two edges, and both two outer strands out of said five strands connected to each other are cut off along the thin connecting portions by means of said two edges of said first pair of slit rolls; and 15

(2) said second pair of slit rolls has two edges, and three strands not yet cut off are cut off along the thin connecting portions by means of said two edges of said second pair of slit rolls. 20

4. The method of claim 1, wherein said N strands of metal bars are six, and wherein: 25

(1) said first pair of slit rolls has two edges, and both two outer strands out of said six strands connected to each other are cut off along the thin connecting portions by means of said two edges of said first pair of slit rolls; (2) said second pair of slit rolls has two edges, and 30

four strands not yet cut off are cut off along the thin connecting portions by means of said two edges of said second pair of slit rolls; and 35

(3) a third pair of slit rolls has a single edge, and two strands connected to each other are cut off along the thin connecting portion by means of said single edge of said third pair of slit rolls. 40

5. A slit roll guide, which is placed at an intermediate position of a finishing rolling train of a bar rolling mill for simultaneously producing N strands (N is four or more) of metal bars, wherein: 45

1/2 x N pairs of slit rolls are provided in series in the rolling direction in the case when N is an even number, and 1/2 x (N - 1) pairs of slit rolls are provided in series in the rolling direction in the case when N is an odd number. 50

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FIG. 1

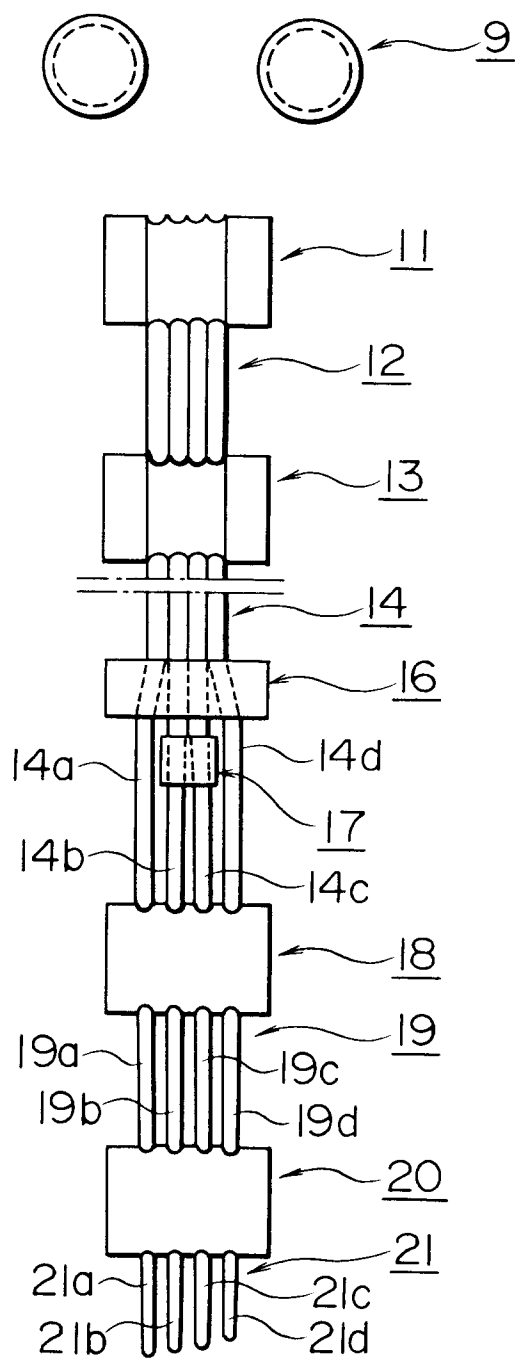


FIG. 2(A)

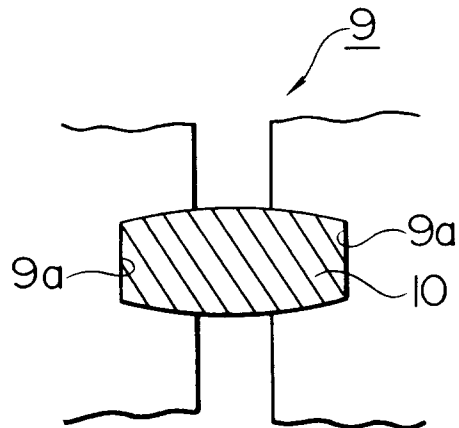


FIG. 2(B)

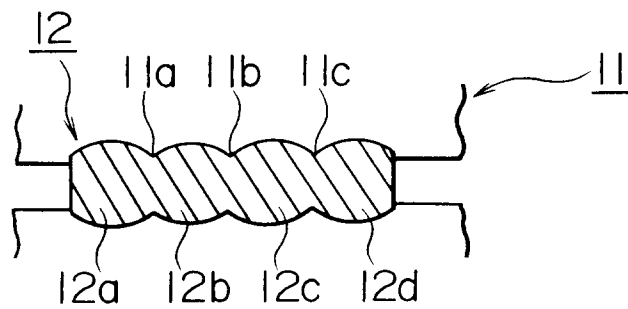


FIG. 2(C)

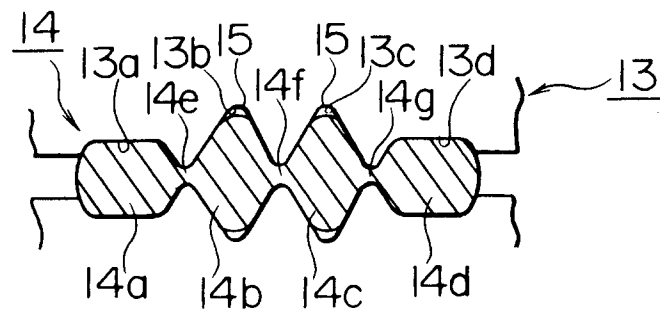


FIG. 2(D)

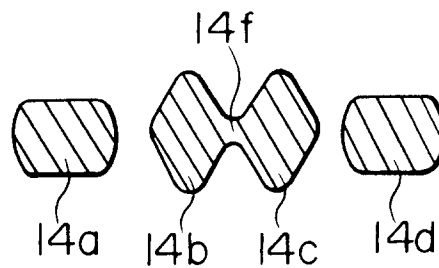


FIG. 2 (E)

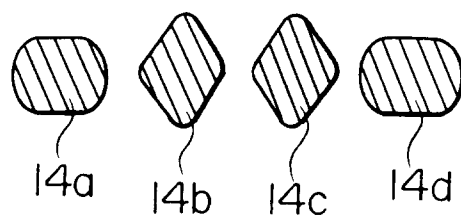


FIG. 2 (F)

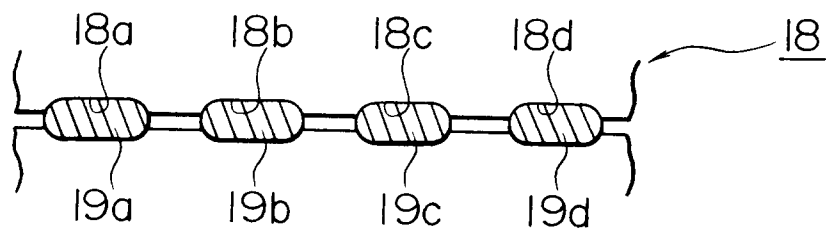


FIG. 2 (G)

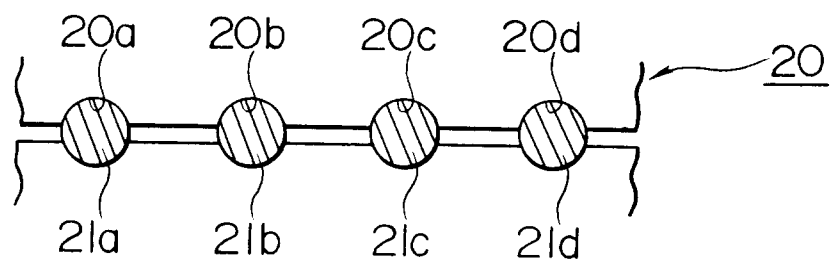


FIG. 3

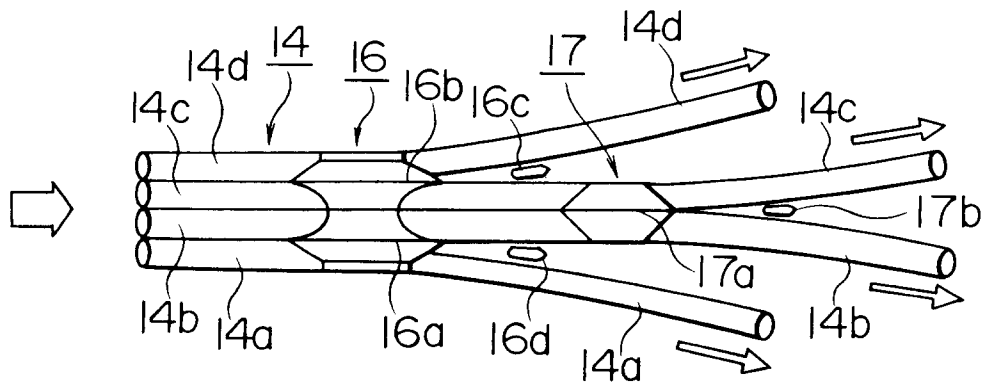


FIG. 4

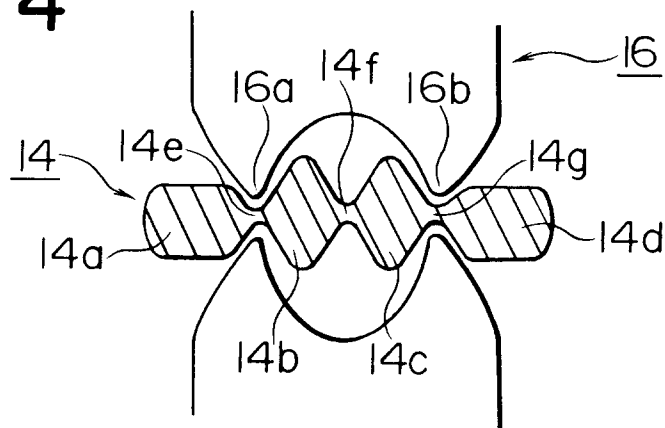


FIG. 5

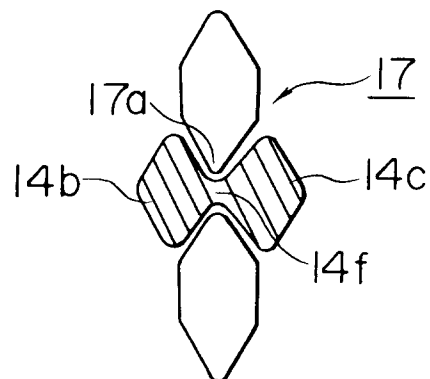


FIG. 6

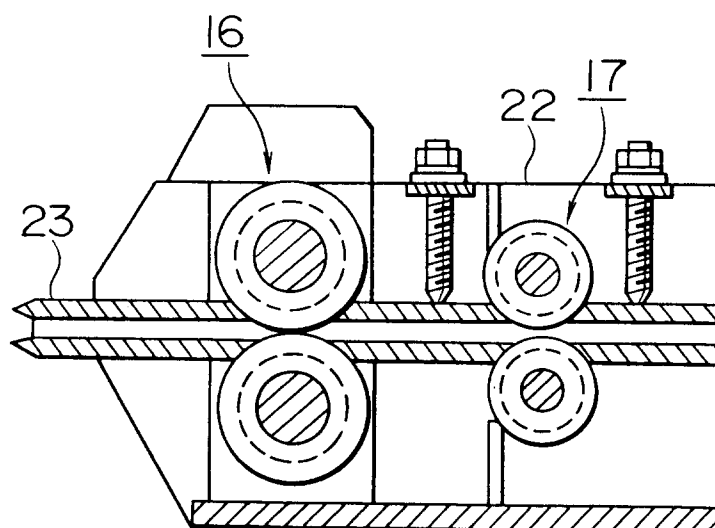


FIG. 7 (A)

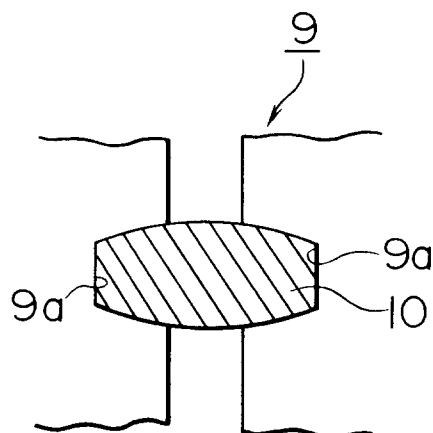


FIG. 7 (B)

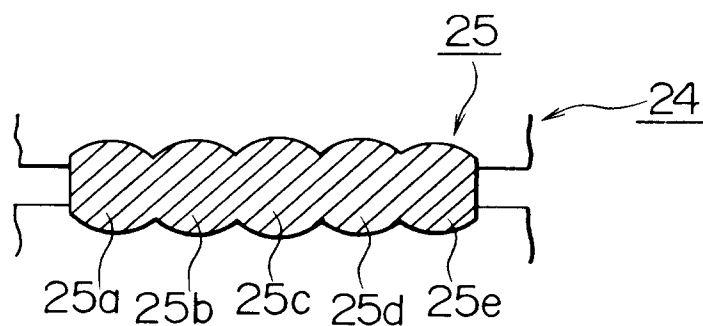


FIG. 7 (C)

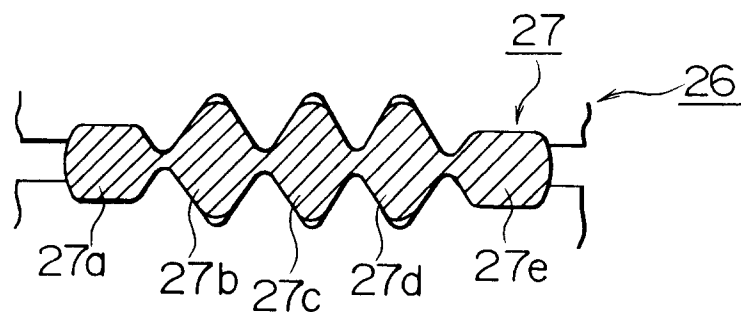


FIG. 7 (D)

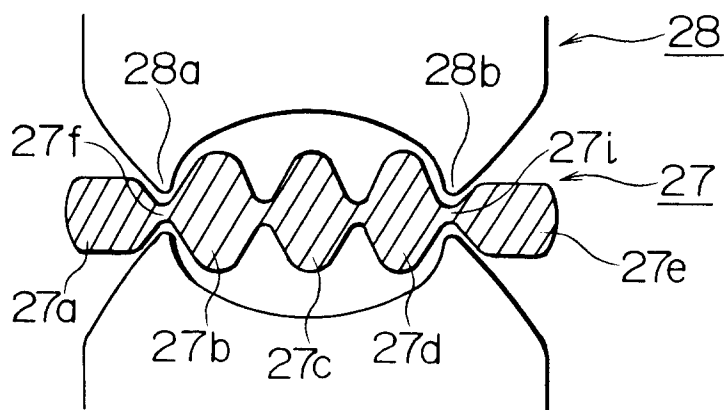


FIG. 7(E)

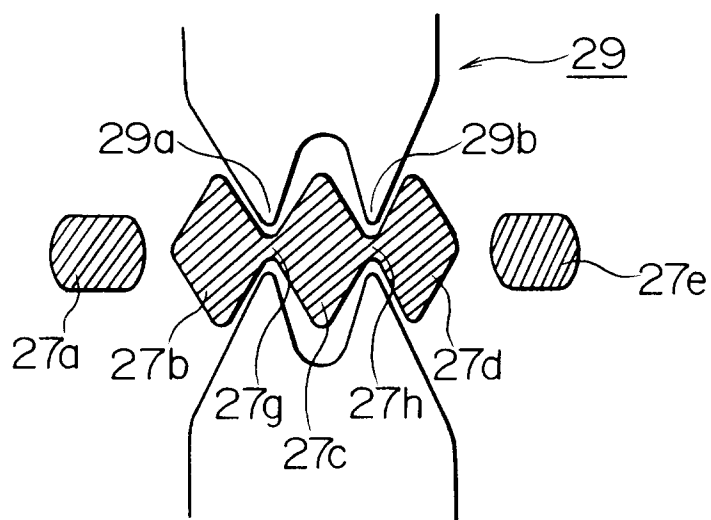


FIG. 7(F)

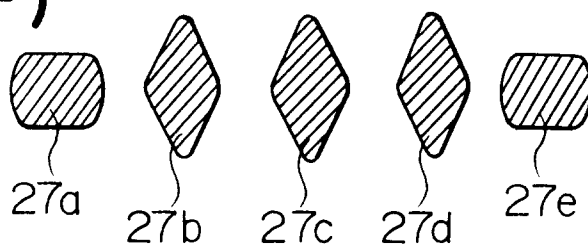


FIG. 7(G)

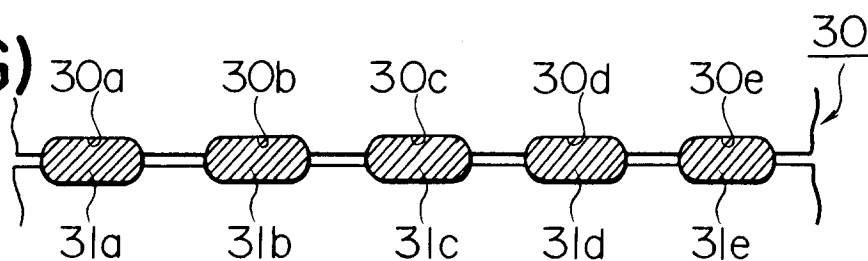


FIG. 7(H)

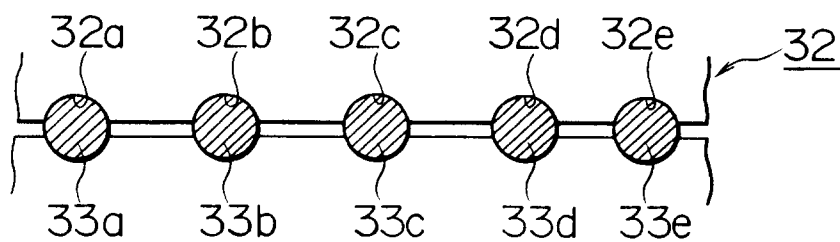


FIG. 8 (A)

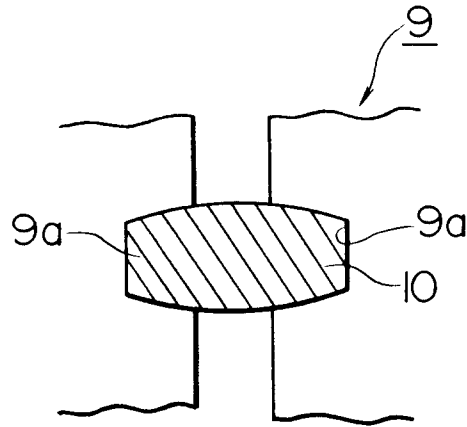


FIG. 8 (B)

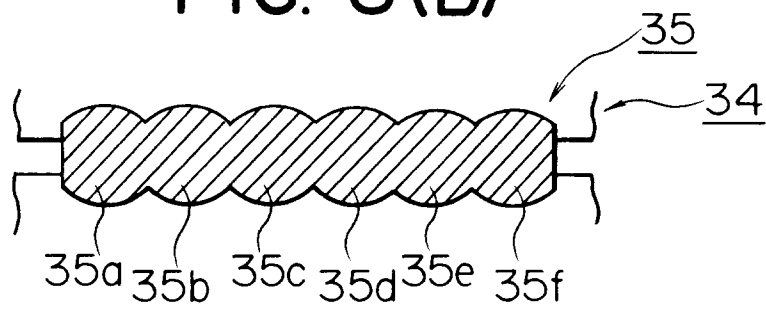


FIG. 8 (C)

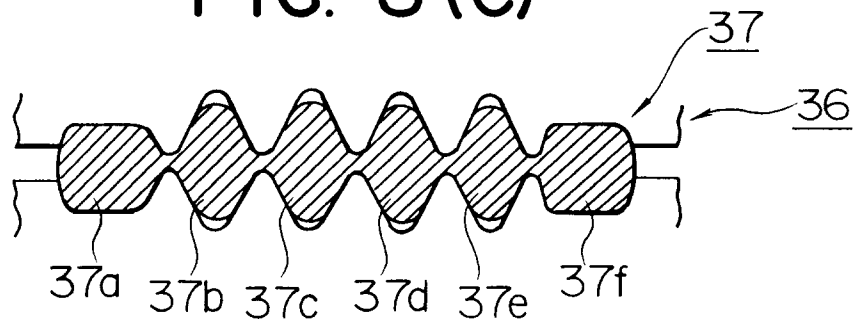


FIG. 8(D)

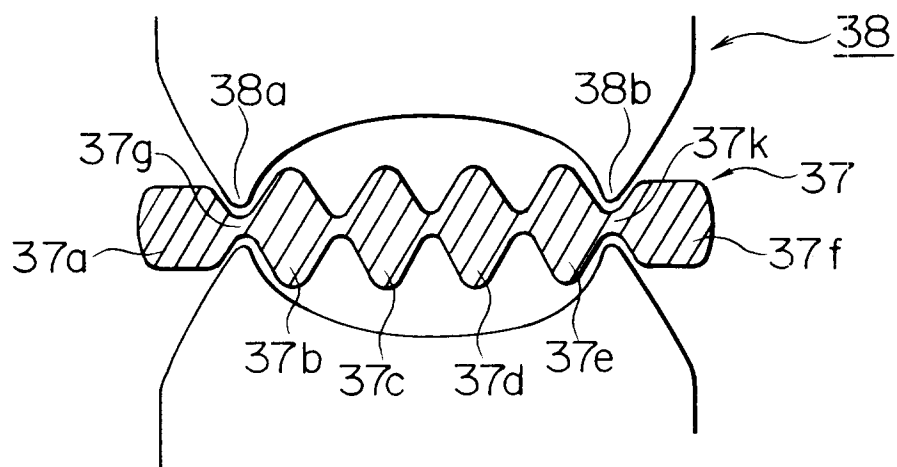


FIG. 8(E)

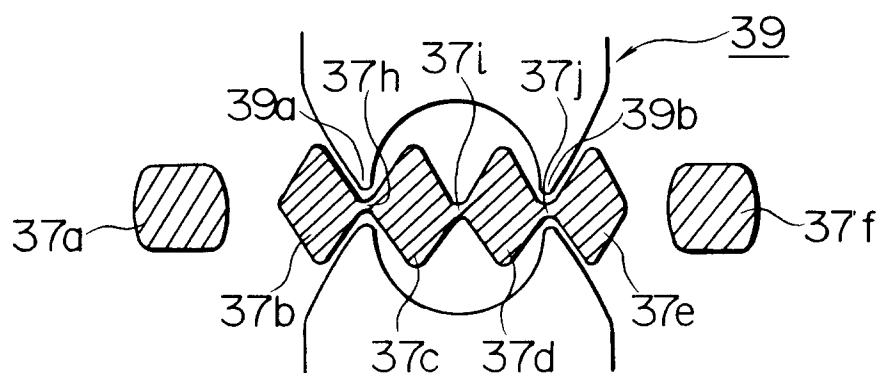


FIG. 8(F)

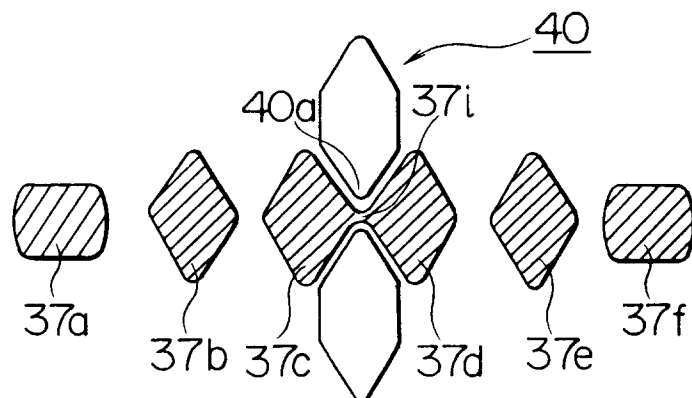


FIG. 8 (G)

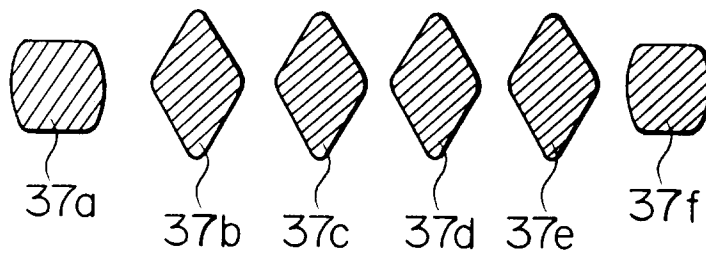


FIG. 8 (H)

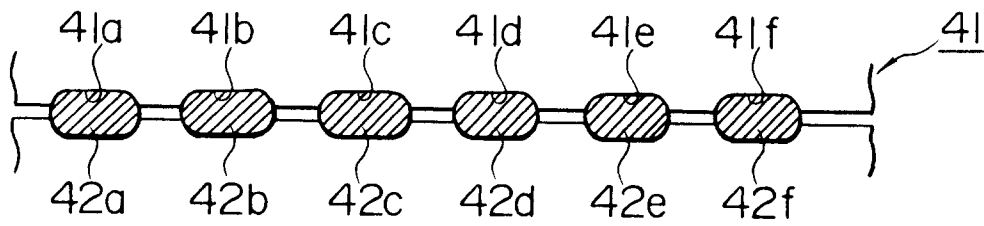


FIG. 8 (I)

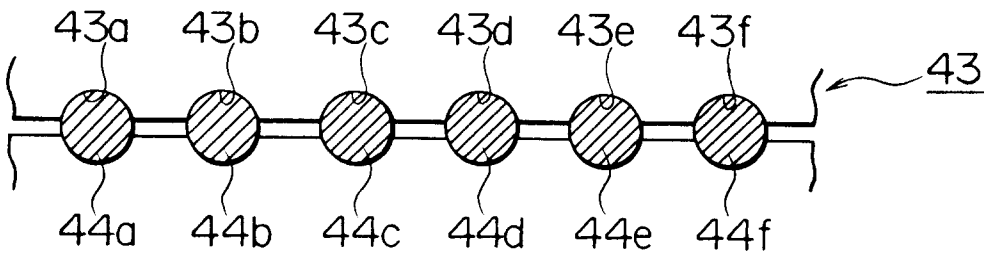


FIG. 9 (A)

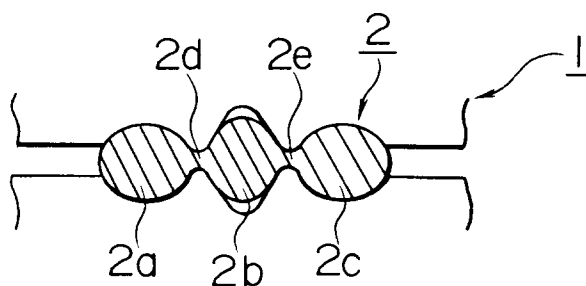


FIG. 9 (B)

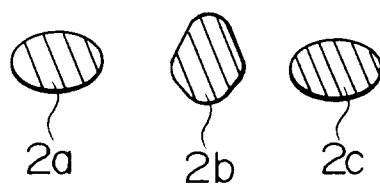


FIG. 9 (C)

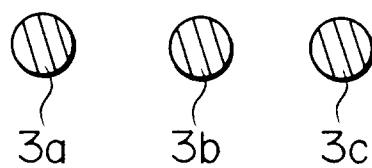


FIG. 10 (A) FIG. 10 (B)

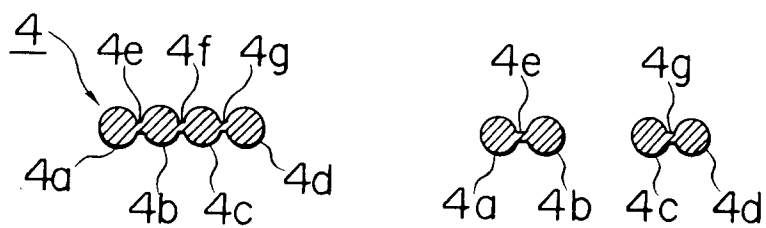


FIG. 10 (C) FIG. 10 (D)

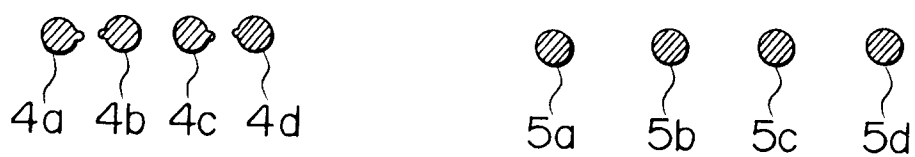
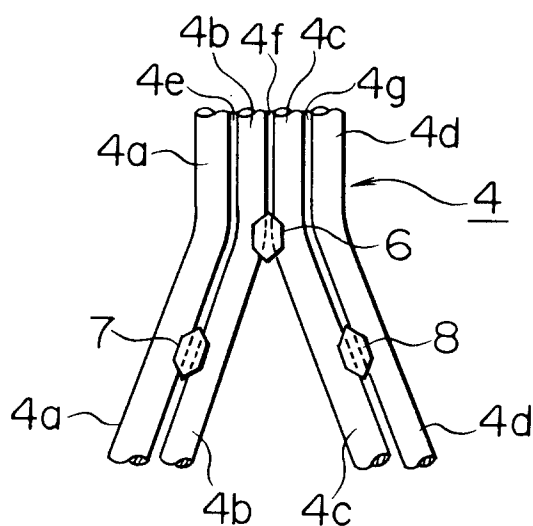


FIG. 11



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP91/01263

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl ⁵ B21B1/16, 15/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC	B21B1/02, 1/16, 15/00, B23D19/00	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
Jitsuyo Shinan Koho 1926 - 1991 Kokai Jitsuyo Shinan Koho 1971 - 1991		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with Indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	JP, B2, 1-53121 (Dayton W. Erey), November 13, 1989 (13. 11. 89), (Family: none)	1-5
Y	JP, B2, 60-18241 (Nippon Steel Corp.), May 9, 1985 (09. 05. 85), (Family: none)	1-5
A	JP, B2, 62-2882 (Nippon Steel Corp.), January 22, 1987 (22. 01. 87), (Family: none)	1-5
A	JP, B2, 2-21882 (NKK Corp.), May 16, 1990 (16. 05. 90), (Family: none)	1-5
¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
November 7, 1991 (07. 11. 91)	December 2, 1991 (02. 12. 91)	
International Searching Authority	Signature of Authorized Officer	
Japanese Patent Office		