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(54) Multi-cavity plate, method and apparatus of forming a joint therewith, and a ladder

(57) A ladder which comprises a first side rail. The ladder also comprises at least a second side rail in parallel and in spaced relationship with the first side rail. Moreover, the ladder is comprised of at least one rung (14) locked to each side rail (18) by a joint. The joint has at least one bead formed from the rung. The bead has a concentrated crimp extending at least along the bead preferably at its portion of greatest radius of curvature. An apparatus for forming an outside bead of a malleable metal rung (14) to lock the rung to a web (16) of a rail (18) of a ladder. A method for forming a joint of a malleable metal rung (14) to lock the rung to a web (16) of a rail (18) of a ladder. A plate (10) for forming a bead of a malleable metal rung (14) to fix the rung (14) to a web (16) of a rail (18) of a ladder.

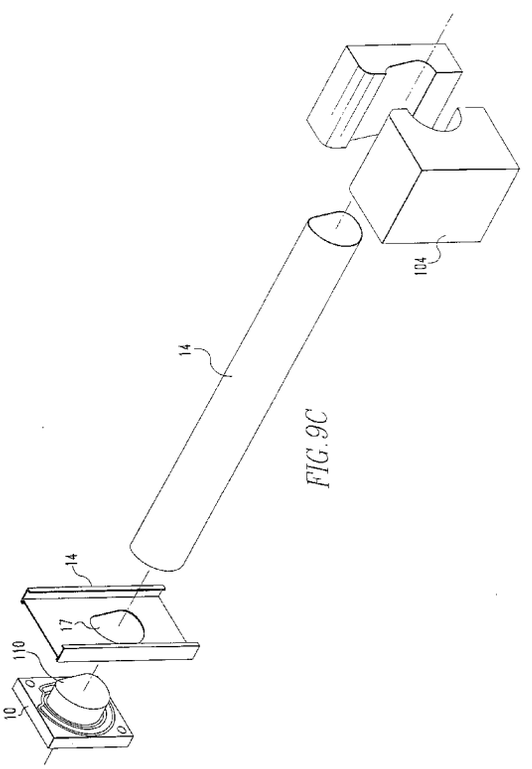

FIG. 9C

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Description

FIELD OF THE INVENTION

The present invention relates to joints of a ladder which lock a rung to a rail. More specifically, the present invention relates to a plate, method of forming a joint using the plate, an apparatus using the plate to form a joint, and a ladder having a joint formed that has a concentrated crimp.

BACKGROUND OF THE INVENTION

Aluminum ladders are typically formed of aluminum rails and aluminum rungs which serves as steps locked to the rails through joints. The joints are formed out of the rungs. The stronger the joint is that locks the rung to the rail, the more secure the rung is fixed to the rail and the more stable and safe is the rung to act as a step. The present invention pertains to a joint of an aluminum ladder that strongly and securely locks the rung to the rail.

SUMMARY OF THE INVENTION

The present invention pertains to a plate for forming a bead of a malleable metal rung to fix the rung to a web of a rail of a ladder. The plate comprises a first level. The plate also comprises a first land defining the first level. Preferably, the plate is comprised of at least a second level positioned about the first land. Additionally, the plate is comprised of at least a second land defining the second level. The second land has at least a first arc length portion. The first arc length portion extends along the bead at its portion of greatest radius of curvature while the bead is formed. Alternatively, adjacent the first land is a mechanism for restricting the radial expansion of the bead as it is formed. The mechanism is disposed adjacent the first land.

The present invention pertains to an apparatus for forming an outside bead inside bead, or both beads of a malleable metal rung to lock the rung to a web of a rail of a ladder. The apparatus comprises an assembly machine having a clamp which clamps a rung having an inside bead, preferably having a concentrated crimp formed against the rail. The apparatus also comprises a plate having at least a first arc length portion. The first arc length portion extends along the outside bead preferably at its portion of greatest radius of curvature while the outside bead is formed. The apparatus is comprised of a forming pilot in contact with and extending from the plate. The pilot has an outside diameter slightly larger than the inside diameter of the rung and a cross sectional shape essentially the same as the cross sectional shape of the rung so the pilot fits snugly into the rung. The pilot is positioned with the plate so the rung is properly rested with the plate. The apparatus additionally is comprised of a stroking machine connected to the plate which moves the plate with the pilot against the clamp to form the outside bead against the rail.

The present invention also pertains to a ladder. The ladder comprises a first side rail. The ladder also comprises at least a second side rail in parallel and in spaced relationship with the first side rail. Moreover, the ladder is comprised of at least one rung locked to each side rail by a joint. The joint has at least one bead formed from the rung. The bead has a concentrated crimp preferably extending at least along the bead at its portion of greatest radius of curvature.

The present invention pertains to a method for forming a joint of a malleable metal rung to lock the rung to a web of a rail of a ladder comprising the steps of placing a rung into a clamp of a beading machine so a first end of the rung is exposed. Then there is the step of forming an inside bead out of the rung at an inside portion of the web of the rail. Next there is the step of placing a first end of the rung against a plate. The plate has at least a first arc length portion extending along a greatest radius of curvature of a cross section of the first end of the rung. Then there is the step of forming an outside bead out of the rung at an outside portion of the web of the rail.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, the preferred embodiment of the invention and preferred methods of practicing the invention are illustrated in which:

Figure 1 is a front view of the plate of the present invention.

Figures 2, 3 and 4 are schematic representations of cross sectional views of the formation of an inside bead.

Figures 5, 6, 7 and 8 are schematic representations of cross sectional views of the formation of an outside bead.

Figures 9a and 9b are schematic representations of cross sectional views of the formation of a joint.

Figure 9c is an assembly view of a rung in conjunction with a portion of a side rail and a plate having a forming pilot, where the rung is held by an assembly machine.

Figure 10a is a schematic representation of a side view of a bead of the present invention.

Figure 10b is a schematic representation of a side view of a rung extending through a rail.

Figure 11 is a schematic representation of an overhead cross sectional view of a ladder.

Figure 12 is a schematic representation of a perspective view of a ladder.

Figure 13a is a schematic representation of a cross sectional view of a joint formed from a rung with a non-uniform wall in a non-uniform rail web.

Figure 13b is a schematic representation of a cross sectional view of a rung with a non-uniform wall.

Figure 13c is a schematic representation of a cross sectional view of a joint formed from a rung with a non-

uniform wall and a non-uniform rail web through prior art techniques.

Figure 14a is a schematic representation of a cross sectional view of a joint of the present invention formed from a rung with a uniform wall and a non-uniform rail web.

Figure 14b is a schematic representation of a cross sectional view of a rung with a uniform wall.

Figure 14c is a schematic representation of a cross sectional view of a joint formed of a rung with a uniform wall and a non-uniform rail web by prior art techniques.

Figure 15a is a schematic representation of a cross sectional view of a joint formed from a rung with a non-uniform wall and a uniform rail web.

Figure 15b is a schematic representation of a cross sectional view of a rung with a non-uniform wall.

Figure 15c is a schematic representation of a cross sectional view of a joint formed from a rung with a non-uniform wall and a uniform rail web by prior art techniques.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference numerals refer to similar or identical parts throughout the several views, and more specifically to figure 1 thereof, there is shown a front view of a plate 10 for forming a bead 12 of a malleable metal rung 14 to fix the rung 14 to a web 16 of a rail 18 of a ladder 20. The plate 10 comprises a first level 22. The plate 10 also comprises a first land 24 defining the first level 22. Preferably, the first land 24 is of a semi-circular shape with a first rounded corner 70 and a second rounded corner 72.

The plate moreover comprises at least a second level 26 positioned about the first land 24. There is additionally at least a second land 28 defining the second level 26. The second land 28 has at least a first arc length portion 30. The first arc length portion 30 extends along the bead 12 at its position of greatest radius of curvature while the bead 12 is formed. The plate 10 preferably also includes a second arc length portion 38 extending along the bead 12 at its other portion 40 of greatest radius of curvature while the bead 12 is formed. The first arc length portion 30 and second arc length portion 38 are positioned in correspondence with the first rounded corner 70 and second rounded corner 72, respectively, of the first land 24. Preferably, the arc length portion 30, 38 contains the metal of the rung 14 which forms the bead 12 along the bead's portion 29 and other portion 40 of greatest radius of curvature. The second land 28 preferably contains the metal of the rung 14 along the periphery 36 of the bead 12 while the bead 12 is being formed.

The second land 28 preferably has a semi-circular portion 42 which forms a connection with the first arc length portion 30 at its first end 44 and a second arc length portion 38 at its first end 44 through a first straight portion 46 and a second straight portion 48, respectively. The second land 28 preferably also has an elongate portion 50 which forms a connection with the first arc length portion 30 at its second end 52 and the second arc length portion 38 at its second end 52 through a third straight portion 54 and a fourth straight portion 56, respectively. Preferably, the second level 26 has an elongate portion 58 extending from and between the third and fourth straight portions 54, 56. The second level 26 also has a semi-circular portion 60 extending from and between the first and second straight portions 46, 48.

The plate 10 can have a mechanism for restricting radial expansion of the bead as it is formed. The restricting mechanism is disposed adjacent the first land 24 and preferably includes at least a third level 32 disposed between the first land 24 and the second level 26. The plate 10 preferably also includes a third land 34 defining the third level 32. The third land 34 is disposed between the third level 32 and the second level 26. Preferably, the third land 34 extends between the first arc length portion 30 and second arc length portion 38.

Preferably, the third level 32 has an elongate portion 62 corresponding with and extending essentially in parallel with the elongate portion 58 of the second level 26, and a semi-circular portion 64 corresponding with and extending essentially in unison with the semi-circular portion 60 of the second level 26.

The third land 34 preferably has an elongate portion 66 corresponding with and extending in parallel with the elongate portion 50 of the second land 28. The third land 34 preferably also has a semi-circular portion 68 corresponding with and extending in unison with the semi-circular portion 42 of the second land 28. The lands can be any desirable angle relative to the level from which they extend depending on the application.

The present invention pertains to an apparatus 100 for forming an outside bead 102 of a malleable metal rung 14 to lock the rung 14 to a web 16 of a rail 18 of a ladder 20, as shown in figures 5-8. The apparatus 100 comprises an assembly machine 104, such as that which is well known in the art, having a clamp 106 which clamps the rung 14 having an inside bead 108 formed against the rail 18. The apparatus 100 also comprises a plate 10 having at least a first arc length portion 30. The first arc length portion 30 extends along the outside bead 102 at its portion 29 of greatest radius of curvature while the outside bead 102 is formed. The apparatus 100 also is comprised of a forming pilot 110 in contact with and extending from the plate 10. The pilot 110 has an outside diameter essentially the same as the inside diameter of the rung 14 and a cross sectional shape essentially the same as the cross sectional shape of the rung 14 so the pilot 110 fits into the rung 14. The pilot 110 is positioned with the plate 10 so the rung 14 is properly seated with the plate 10, as shown in figure 6. Additionally, the apparatus 100 is comprised of a stroking machine 112, such as that which is well known in the art, connected to the plate 10 which moves the plate 10 with the pilot 110 against the clamp 106 to form the out-

side bead 102 against the rail 18. The plate 10 is preferably the same design as the plate 10 described above.

The present invention also pertains to a method for forming a joint 124 of a malleable metal rung 14 to lock the rung 14 to a web 16 of a rail 18 of a ladder 20. The method comprises the steps of placing the rung 14 into a clamp 106 of a beading machine 114 so a first end 116 of the rung 14 is exposed, as shown in figures 2-4. Next there is the step of forming an inside bead 108 out of the rung 14. Then, there is the step of placing the inside bead 108 against an inside portion 118 of the web 16 of the rail 18, as shown in figure 5. Then there is the step of placing the first end 116 of the rung 14 against a plate 10, as shown in figure 6. The plate 10 has at least a first arc length portion 30 extending along a portion 29 of greatest radius of curvature of a cross section of the first end 116 of the rung 14. Next, there is the step of forming an outside bead 102 out of the rung 14 against an outside portion 119.

The present invention pertains to a ladder 20, as shown in figures 11 and 12. The ladder 20 comprises a first side rail 120. The ladder 20 also comprises at least a second side rail 122 in parallel and in spaced relationship with the first side rail 120. The ladder 20 additionally comprises at least one rung 14 locked to each side rail 120, 122 by a joint 124. The joint 124 has at least one bead 12 formed from the rung 14. The bead 12 has a concentrated crimp 126 extending at least along the bead 12 at its portion 29 of greatest radius of curvature, as shown in figure 10a. Figure 10b shows the first end 116 of the rung 14 extending through the web 16 before the bead 12 is formed. Preferably, the bead 12 has a first rounded corner 70 and a second rounded corner 72. Each corner 70, 72 is a portion 29 or other portion 40 of the bead 12 having the greatest radius of curvature. Each corner has a concentrated crimp 126 extending along it. The rung 14 can have a variable wall thickness, as shown in figure 13a, but the bead 12 distributes forces applied to it uniformly. The first side rail 120 and the second side rail 122 can have a tapered web section, as shown in figure 14a, and the bead 12 is contoured to match the tapered web section 128.

In the operation of the preferred embodiment, a joint 124 to lock a rung 14 to a first side rail 120 is formed by first placing the rung 14 in a clamp 106 of a beading machine 114 as shown in figure 2. The first end 116 of the rung 14 extends beyond the clamp 106. The first end of the rung is placed in a sleeve 132 until it contacts a backup plate 134. The sleeve's length and the rung wall thickness determines the resultant bead 12 height inside and outside of the web 16 of the rail 18.

Once the rung 14 is clamped into the clamp 106, the forming pilot 110 moves inward to where the first end 116 of the rung 14 has bottomed against the backup plate 134. Next, the backup plate 134 is moved toward the clamp 106 of the beading machine 114. The rung 14 is not able to fold inward due to the pilot 110 backing up the rung 14 internally. As a result of this, the rung 14 starts to bend outward radially as shown in figure 3. Once the pilot 110, sleeve 132 and backing plate 134 have stroked fully forward, the bead 12 is crimped between the contoured clamp end 136 and sleeve, thus forming the inside bead 108, as shown in figure 4.

After the formation of the inside bead 108, the rung 14 is removed and clamped into an assembly machine 104. The first side rail 120 is placed against the inside bead 108. The assembled first side rail 120 having the rung 14 with the inside bead 108 is aligned with a forming pilot 110 that is positioned in a plate 10, as shown in figure 5.

The forming pilot 110 is then moved inward to where the first end 116 of the rung 14 is bottomed against the plate 10. The first side rail 120 is held against the inside bead 108 with spring loaded pins (not shown), as is well known in the art, as shown in figure 6.

The forming pilot 110 with the plate 10 is moved toward the clamp 106 of the assembly machine 104 causing the rung 14 to crimp. Since the rung is not able to fold inward due to the forming pilot 110 backing up the rung 14 internally, the rung 14 starts to bend outward radially, as shown in figure 7.

When the forming pilot 110 and the plate 10 have stroked fully forward under the action of the stroking machine 112, the crimped bead 12 between the first side rail 120 and the outside contoured plate 10 forms the outside bead 102 locking the first side rail 120 and rung 14 together, as shown in figure 8. This same process is then repeated for the other side of the rung 14 to lock the rung 14 to the second side rail 122.

Preferably, as shown in figure 9a, after the inside bead 108 is formed and the rail 14 is placed against the inside bead 108, a gap 200 exists between the rung 14 and the hole in the web 16 of the rail 18 before the formation of the outside bead 102, This gap 200 exists between the rung 14 and the hole in the web 16 through which the first end 116 of the rung 14 extends because the outside diameter of the rung 14 is of a size that purposely allows the gap 200 to exist. When the forming pilot 110 enters the rung 14 at its first end 116 and is moved towards the web 16, the rung 14 is expanded into the web 16 and into the inside bead 108 thereby interlocking the joint 124 with the web 16 in a more positive fashion than would otherwise be obtained if the outside diameter of the rung 14 fit with the web 16 so there is essentially no gap 200. By interlocking the joint 124 with the web 16 in this fashion, the joint is stiffened to a greater degree than would otherwise be the case and allows weight to be removed from the web 16 and the rung 14 since the joint 124 fits so well with the web 16. Figure 9b shows a finished joint 124 with the plate 10 and pilot 110 in a full stroke position. The pilot 110 has expanded the rung 14 into the hole of the web 16. Figure 9c shows the relationship of the rung 14 with a section of the rail 18 having a hole 17 in the web 16 through which the first end 116 of the rung 14 extends. The forming pilot 110 mounted on the plate 10 is aligned with the

rung 14 to fit into the rung 14. The rung 14 fits into and is held by the assembly machine 104.

During this formation process, the first arc length portion 30 and the second arc length portion 38 being part of the third land 34 causes the metal of the rung 14 to be contained and controlled as it is compressed. The compressed metal naturally attempts to move about the point of force that is causing it to bend and become compressed. But, because of the first arc length portion 30 and second arc length portion 38, disposed at the corners of the bead 12 being at a portion 29 or other portion 40 of greatest radius of curvature of the bead 12, the metal of the rung 14 is contained. By containing the movement of the metal and controlling it to be formed into a concentrated crimp 126, the integrity of the metal is maintained, and thus, stretching is essentially eliminated or completely precluded as well as any cracking occurring in the bead 12. The stretching or cracking would weaken the integrity of the bead 12, possibly raising a weakness in the joint 124.

Furthermore, the overall shape of the second land 28 essentially is of a shape that applies force to the rung 14 from the outside in. This contains the metal of the remaining portion of the rung 14 in a similar fashion as described above in regard to the concentrated crimp 126 so the bead 12 is formed in a controlled manner and direction. Thus, the metal of the rung 14 cannot move out from the periphery 36 of the bead 12.

The concentrated crimp 126 that is formed from the first arc length portion 30 and second arc length portion 38 compressing the rung 14 also serves to distribute the force along the portion 29 and other portion 40 of greatest radius of curvature to prevent or essentially eliminate the localized buildup of forces which could damage the metal of the rung 14 at that point. In similar fashion, the second land 28 concentrates forces on the rung as the bead 12 is formed to cause the bead at a portion other than its periphery 36 to be more firmly compressed due to concentration of forces on the second land 28. The first land 24 operates in a similar fashion and serves to smooth the edge of the bead 12 so there are no jagged or sharp edges.

The multiplicity of lands or levels in the plate 10 can be controlled in terms of thickness and shape to arrive at different types of bead structures. For instance, by contouring the levels and the lands, thicker at one portion than another, the tapered web section 128 can have a bead which conforms to its different thickness. The bead, as such, forms tightly against the entire length of the tapered web section 126, as shown in figure 14. Similarly, where the rung is a variable thickness, the thinner portions of the rung when they are crimped back upon themselves will form a thinner bead than the thicker portions when they fold upon themselves if the lands and levels did not correspond to the locations of the variable thicknesses. By making a land deeper at locations of greater rung thickness and by making the lands shallower at areas of thinner rung thickness, the bead that is formed after the plate 10 is fully stroked against the assembly machine will have essentially the same thickness throughout and thus be able to respond to forces uniformly across the bead 12.

Figure 13a shows a joint 124 formed from a plate 10 having multiple cavities. The rung 14 is of a non-uniform wall thickness, as shown in figure 3b. The multiple cavity plate 10 allows the joint 124 to be formed that is contoured with the web 16 of the rail 18. The web 16 is of a non-uniform thickness. Figure 13c shows a joint that is formed from a plate without multiple cavities to allow the joint to conform with the non-uniform web's 16 thickness. Without the multiple cavity plate 10, the joint that is loosely formed against the web 16 due to differences in rung 14 thickness if the bead has been formed using a tapered rail web.

Figure 14a shows a joint 124 that is formed with multiple cavity plate 10 where the rung 14 is of a uniform wall thickness but the web 16 is of a non-uniform thickness. The rung 14 is shown in figure 14b. The lands and levels of the plate 10 are-contoured to correspond to the non-uniform thickness of the web 16 in order to cause the joint 124 to be contoured with the web 16. Figure 14c shows a joint that is formed by a plate without contoured lands or levels. The joint is loosely formed against the web 16 due to the plate not being contoured or shaped in the same manner as the web 16 of the rail.

Figure 15a shows a joint 124 formed with contoured lands and levels of a plate 10 to conform with a uniform web 16 but a rung 14 that has a non-uniform wall thickness. Figure 15b shows a cross section of the rung 14 with a non-uniform wall thickness. Figure 15c shows a joint that is formed without contoured lands and levels in the plate. The joint is loosely formed against the web 16 due to the differences in the rung 14 thickness after the beads of the joint have been formed.

In order for a ladder section to be more rigid, it must have a tight interlock between the rung 14 and the ladder side rail 18, the rung 14 to rail joint 124 is this interlock. The tighter this joint 124 is able to be compressed in the areas that will increase the force needed for the rung 14 and the rail 18 to move independent of each other, the stiffer the joint 124 becomes. The joint 124 reduces the likelihood of the rung 14 being able to move with respect to the rail 18; after the joint 124 has been beaded. Forces are applied to the areas of the joint 124 that have the greatest effect on stiffening the joint 124. This in turn, enables weight to be taken out of the rail and/or rung 16 while still maintaining the ability to pass all of the required tests.

Thus, the plate 10 provides the following advantages.

1. More evenly distributes load on corners of bead. It also stakes in means that contains the metal which, in turn, reduces the likelihood of stress concentrations.

2. Allows the use of a variable wall rung. The cavity profile can be altered to ensure uniform forces regardless of nonuniform joint thickness after beading allowing the use of more efficient sections, therefore, reducing weight.

3. Allows a rung to be extruded with much more aggressive pips for greater slip resistance.

4. Allows the end of the rung to be better captured which in turn;

a) ensures that the bead forms in the correct direction.
b) stiffens outer bead by reducing bending moment.
c) reduces sharp edges on captured portion of joint.

5. Allows the periphery of bead to be captured which in turn;

a) localizes forces to extreme edges of bead, therefore, crimping more tightly in the area needed to gain joint stiffness.
b) contains periphery of bead by reducing the joint's natural tendency to radially stretch.

6. Allows joint to be contoured, matching that of the rails, when using tapered wall rail sections, ensuring a tighter joint.

7. Concentrates the forces to the periphery of the bead, increasing the actual contact area (by reducing radius) using same amount of material (reduces rung weight by eliminating the need for a larger bead).

Although the invention has been described in detail in the foregoing embodiments for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as it may be described by the following claims.

Claims

1. A plate 10 for forming a bead 12 of a malleable metal rung 14 to fix the rung 14 to a web 16 of a rail 18 of a ladder 20 characterized by:

a first level 22;

a first land 24 defining the first level 22;

at least a second level 36 positioned about the first land 24; and

at least a second land 28 defining the second level 26, said second land 28 having at least a first arc length portion 30, said first arc length portion 30 extending along the bead 12 at its portion 40 of greatest radius of curvature while the bead 12 is formed.

2. A plate 10 as described in Claim 1 characterized by the fact that the arc length portion 30 contains the metal of the rung 14 which forms the bead 12 along the bead's portion 29 of greatest radius of curvature.

3. A plate 10 as described in Claim 2 including at least a third level 32 disposed between the first land 24 and the second level 26; and a third land 34 defining the third level 32, said third land 34 disposed between the third level 32 and the second level 26.

4. A plate 10 as described in Claim 3 characterized by the fact that the second land 28 contains the metal of the rung 14 along the periphery 36 of bead 12 while the bead 12 is formed.

5. A plate 10 as described in Claim 4 including a second arc length portion 38 extending along the bead 12 at its other portion 40 of greatest radius of curvature while the bead 12 is formed wherein the third land 34 extends between the arc length portions 30, 38.

6. A plate 10 as described in Claim 5 characterized by the fact that the second land 28 has a semi-circular portion 42 which forms a connection with the first arc length portion 30 at its first end 44 and the second arc length portion 38 at its first end 44 through a first straight portion 46 and a second straight portion 48, respectively; and an elongate portion 50 which forms a connection with the first arc length portion 30 at its second end 52 and the second arc length portion 38 at its second end 52 through a third straight portion 54 and a fourth straight portion 56, respectively.

7. A plate 10 as described in Claim 6 characterized by the fact that the second level 26 has an elongate portion 58 extending from and between the third and fourth straight portions 54, 56, respectively, and a semi-circular portion 60 extending from and between the first and second straight portions 46, 48, respectively.

8. A plate 10 as described in Claim 7 characterized by the fact that the third level 32 has an elongate portion 62 corresponding with and extending essentially in parallel with the elongate portion 58 of the second level 26, and a semi-circular portion 64 corre-

sponding with and extending essentially in unison with the semi-circular portion 60 of the second level 26.

9. A plate 10 as described in Claim 8 characterized by the fact that the third land 34 has an elongate portion 66 corresponding with and extending in parallel with the elongate portion 50 of the second land 28; and a semi-circular portion 68 corresponding with and extending essentially in unison with the semi-circular portion 42 of the second land 28.

10. A plate 10 as described in Claim 9 characterized by the fact that the first land 24 is of a semi-circular shape with a first rounded corner 70 and a second rounded corner 72, said first and second arc length portions 30, 38, respectively, positioned in correspondence with said first rounded corner 70 and said second rounded corner 72, respectively.

11. An apparatus 100 for forming an outside bead 102 of a malleable metal rung 14 to lock the rung 14 to a web 16 of a rail 18 of a ladder 20 characterized by :

an assembly machine 104 having a clamp 106 which clamps the rung 14 having an inside bead 108 formed against the rail 18;

a plate 10 having at least a first arc length portion 30, said first arc length portion 30 extending along the outside bead 102 at its portion 24 of greatest radius of curvature while the outside bead 102 is formed;

a forming pilot 110 in contact with and extending from the plate 10, said pilot 110 having an outside diameter essentially the same as the inside diameter of the rung 14 and a cross-sectional shape essentially the same as the cross-sectional shape of the rung 14 so the pilot 110 fits into the rung 14, said pilot 110 positioned with the plate 10 so the rung 14 is properly rested with the plate 10; and

a stroking machine 112 connected to the plate 10 which moves the plate 10 with the pilot 110 against the clamp 106 to form the outside bead 102 against the rail 18.

12. A method for forming a joint 124 of a malleable metal rung 14 to lock the rung 14 to a web 16 of a rail 18 of a ladder 20 characterized by the steps of:

placing the rung 14 into a clamp 106 of a beading machine 114 so a first end 116 of the rung 14 is exposed;

forming an inside bead 108 out of the rung 14 at an inside portion 118 of the web 16 of the rail 18;

placing the first end 116 of the rung 14 against a plate 10, said plate 10 having at least a first arc length portion 30 extending along a portion 29 of greatest radius of curvature of a cross-section of the first end 116 of the rung 14; and

forming an outside bead 102 out of the rung 14 at an outside portion 119 of the web 16 of the rail 18.

13. A ladder characterized by:

a first side rail 120;

at least a second side rail 122 in parallel and in spaced relationship with the first side rail 120; and

at least one rung 14 locked to each side rail 120, 122 by a joint 124, said joint 124 having at least one bead 12 formed from the rung 14, said bead 12 having a concentrated crimp 126 extending at least along a length of the bead 12.

14. A ladder 20 as described in Claim 13 characterized by the fact that the bead 12 has a first rounded corner 70 and a second rounded corner 72, each corner 70, 72 being a portion 29 of the bead 12 having the greatest radius of curvature, each corner 70, 72 having a concentrated crimp 126 extending along it.

15. A ladder 20 as described in Claim 13 characterized by the fact that the rung 14 has a variable wall thickness but the bead 12 distributes forces applied to it uniformly.

16. A ladder 20 as described in Claim 13 characterized by the fact that the rail 120, 122 has a tapered web section, and the bead 12 is contoured to match the tapered web section.

17. A ladder 20 as described in Claim 13 characterized by the fact that the concentrated crimp 126 forms stiffness into the bead 12 to strengthen the bead 12 against bending movements.

18. A plate 10 for forming a bead 12 of a malleable metal rung 14 to fix the rung 14 to a web 16 of a rail 18 of a ladder 20 characterized by:

a first level 22;

a first land 24 defining the first level 22; and

a mechanism for restricting radial expansion of

the bead 12 as it is formed, said mechanism disposed adjacent the first land 24.

19. A plate 10 for forming a bead 12 of a malleable metal rung 14 to fix the rung 14 to a web 16 of a rail 18 of a ladder 20:

a first level 22; and

a first land 24 defining the first level 22, said first land 24 having at least a first arc length portion 30, said first arc length portion 30 extending along the bead 12 at its portion of greatest radius of curvature while the bead 12 is formed.

20. A ladder 20 characterized by:

a first side rail 120;

at least a second side rail 122 in parallel and in spaced relationship with the first side rail 120; and

at least one rung 14 locked to each side rail 120, 122 by a joint 124, said joint 124 having an inside bead 108 and an outside bead 102 formed from the rung 14, each bead 102, 108 having a concentrated crimp 126 extending along at least a portion 29 of the bead 12.

21. An apparatus 100 for forming an outside bead 102 of a malleable metal rung 14 to lock the rung 14 to a web 16 of a rail 18 of a ladder 20 characterized by:

an assembly machine 104 having a clamp 106 which clamps the rung 14 having an inside bead 108 with a concentrated crimp 126 formed against the rail 18;

a plate 10 having at least a first arc length portion 30, said first arc length portion 30 extending along the outside bead 102 while the outside bead 102 is formed;

a forming pilot 110 in contact with and extending from the plate 10, said pilot 110 having an outside diameter essentially the same as the inside diameter of the rung 14 and a cross-sectional shape essentially the same as the cross-sectional shape of the rung 14 so the pilot 110 fits into the rung 14, said pilot 110 positioned with the plate 10 so the rung 14 is properly rested with the plate 10; and

a stroking machine 112 connected to the plate 10 which moves the plate 10 with the pilot 110 against the clamp 106 to form the outside bead 102 against the rail 18.

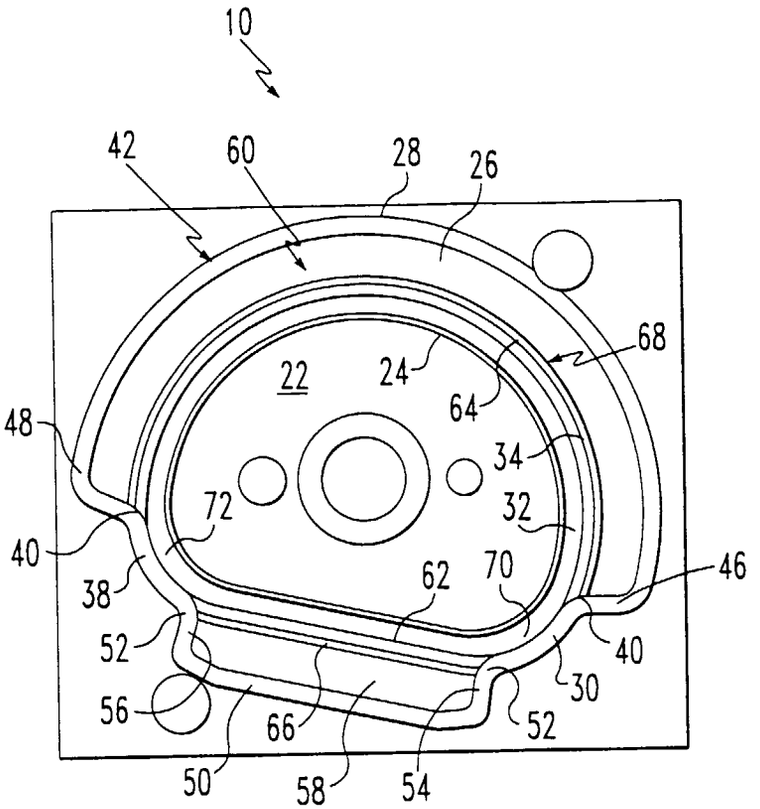
10
42
60
28
26
68
22
24
64
48
34
72
32
40
62
70
46
38
52
40
30
56
66
52
50
58
54

FIG. 1

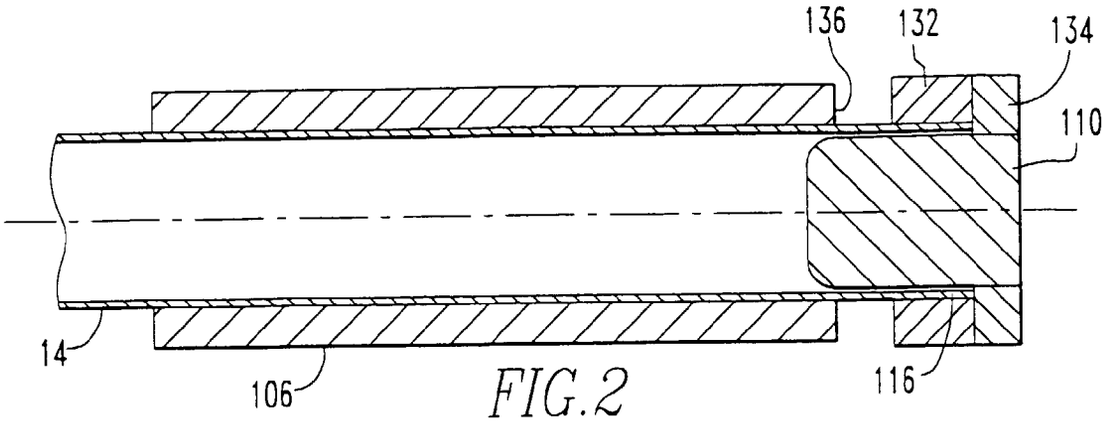

FIG.2

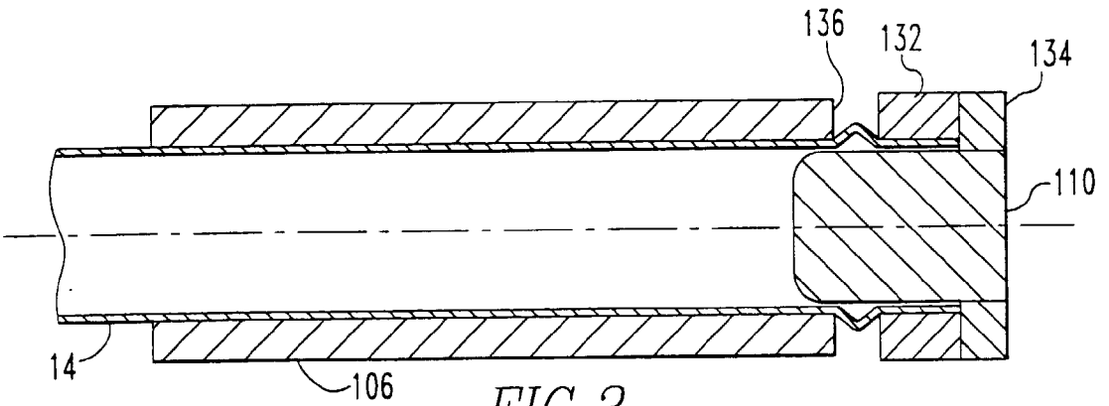

FIG.3

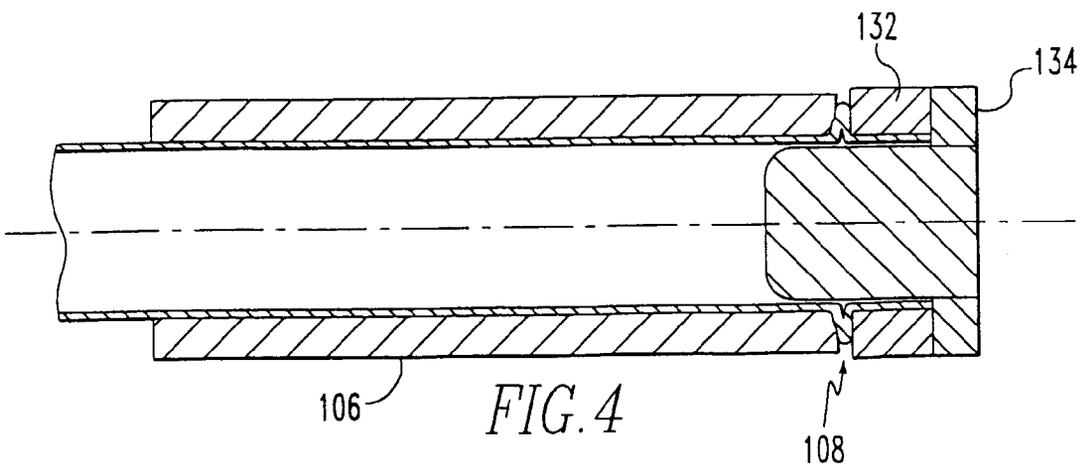

FIG.4

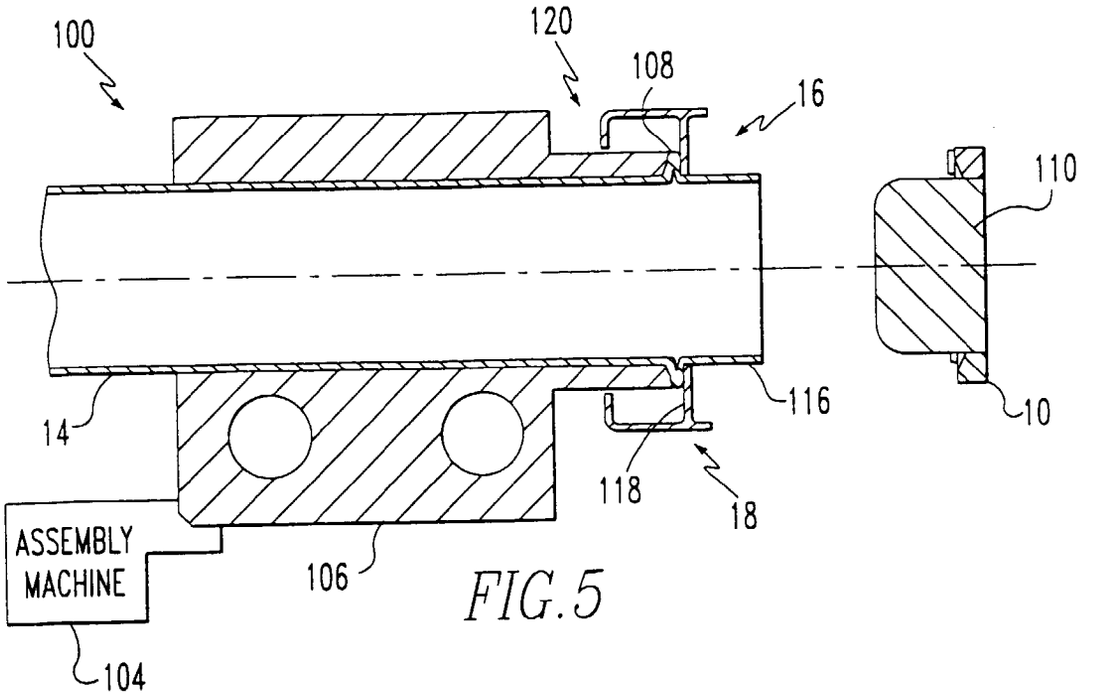
100
120
108
16
110
14
116
10
118
18
ASSEMBLY MACHINE
106
104

FIG.5

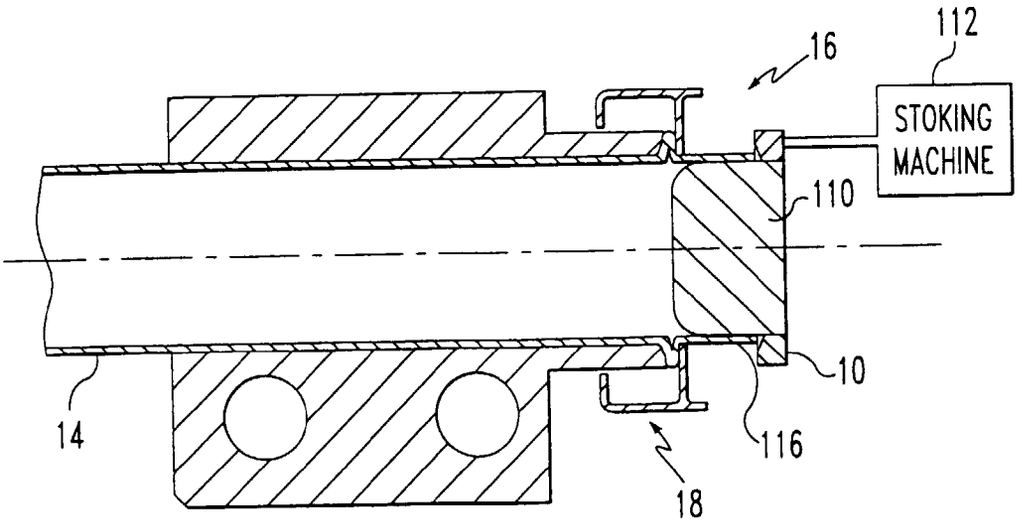
16
112
STOKING MACHINE
110
10
14
116
18

FIG.6

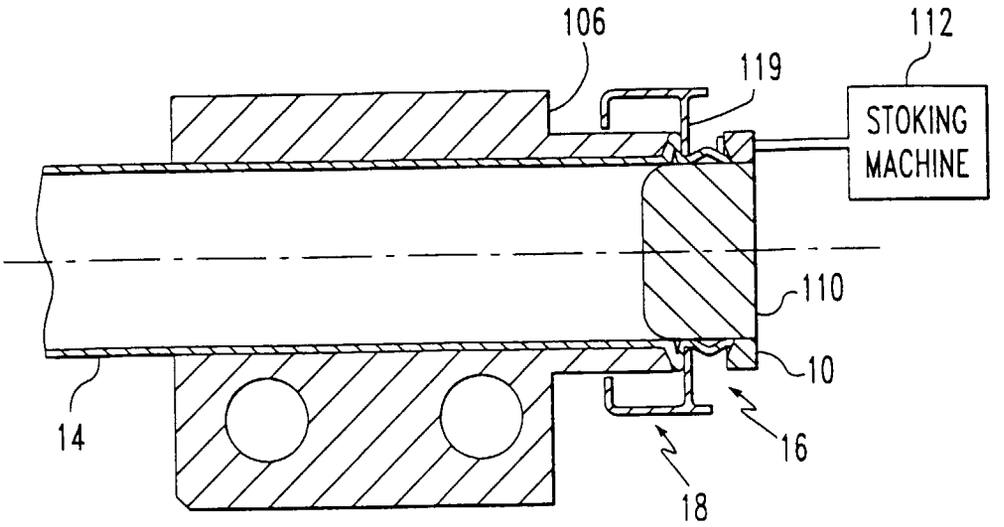
106
112
119
STOKING
MACHINE
110
10
14
16
18

FIG. 7

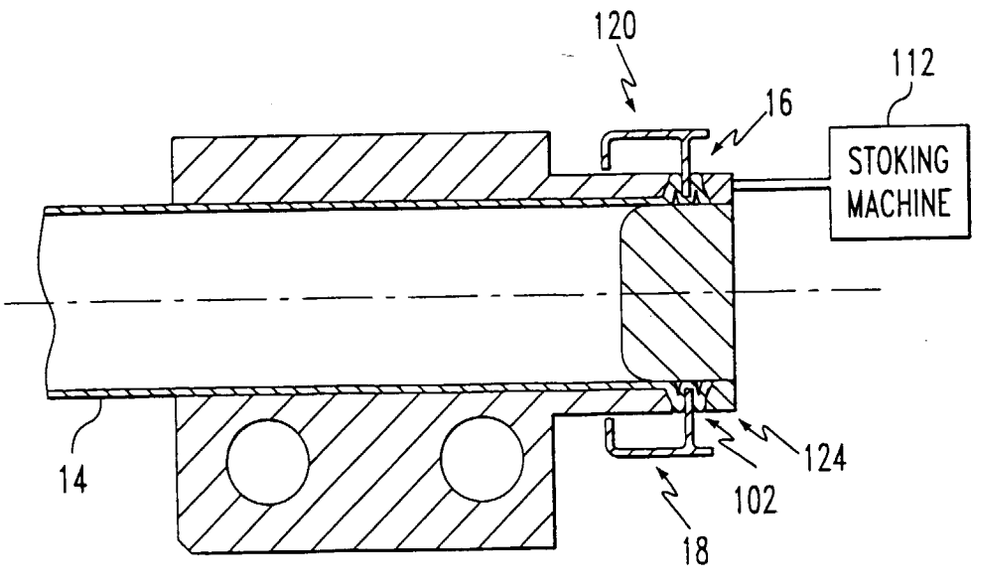
120
112
16
STOKING
MACHINE
14
124
102
18

FIG. 8

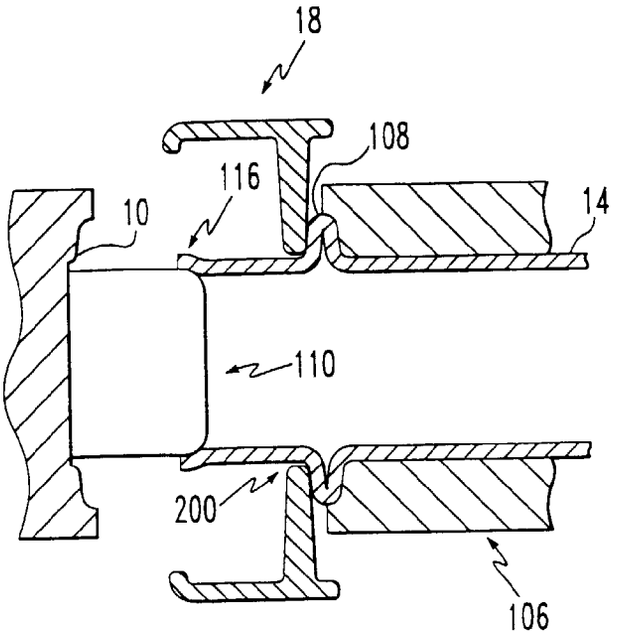

FIG. 9A

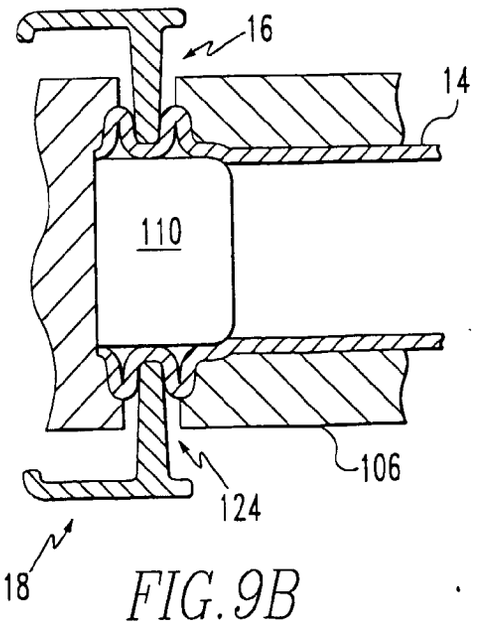

FIG. 9B

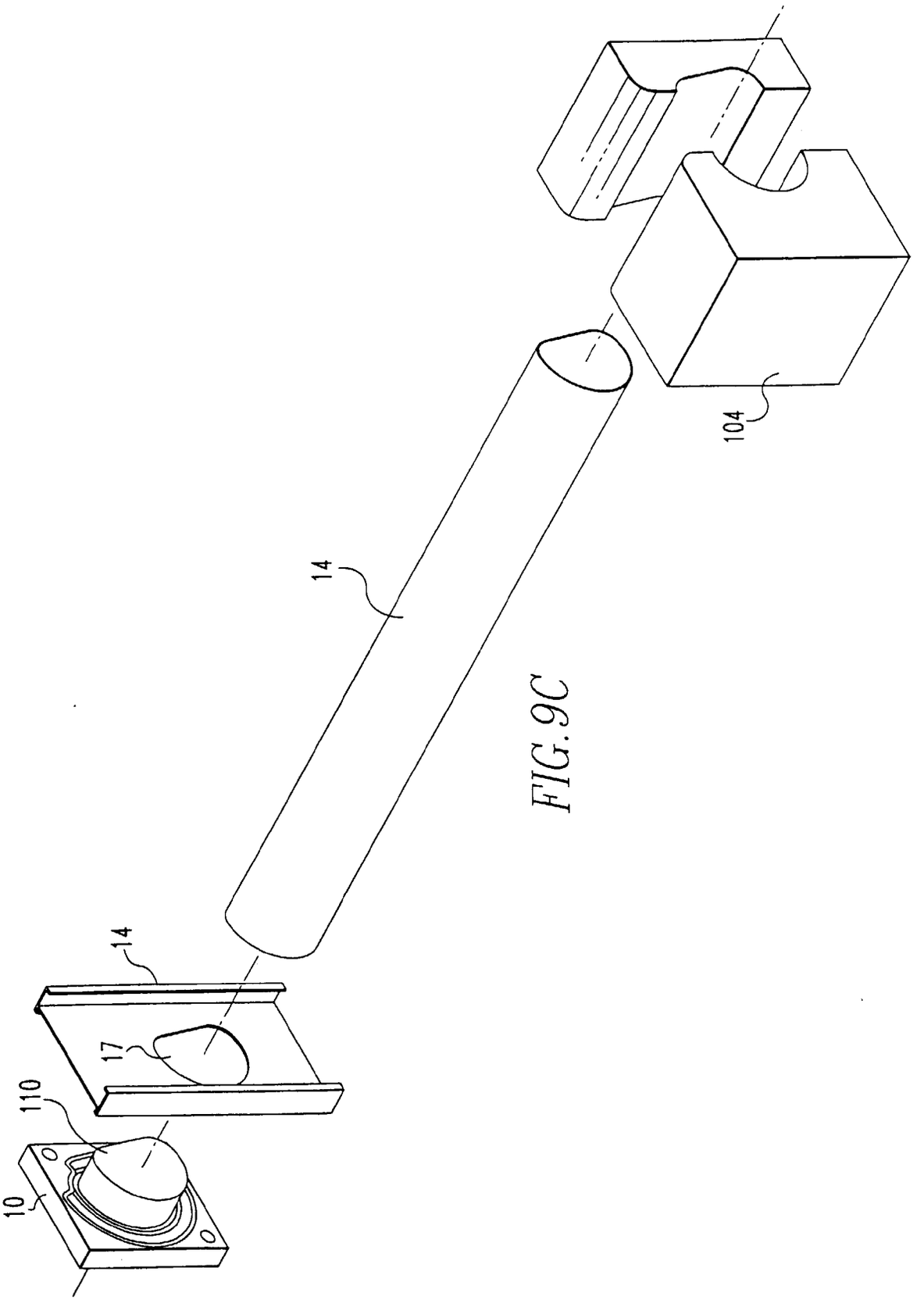

FIG. 9C

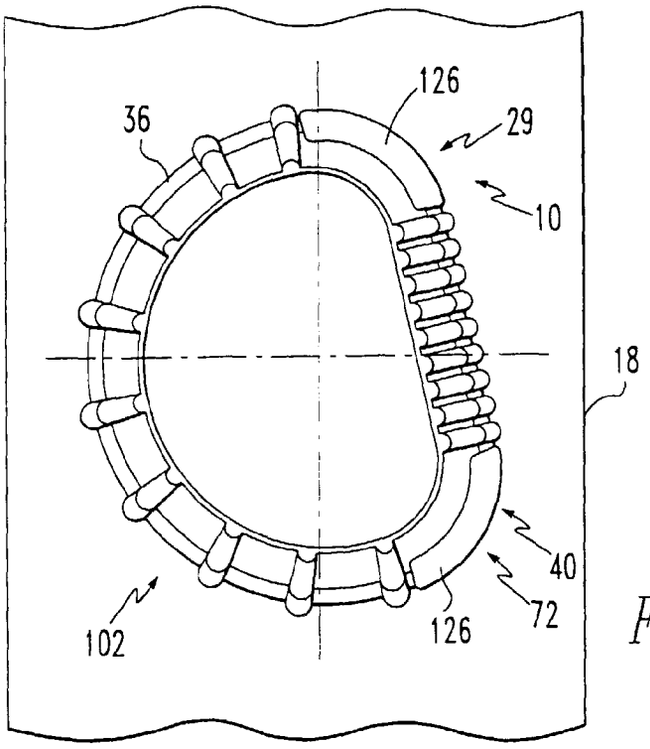

FIG. 10a

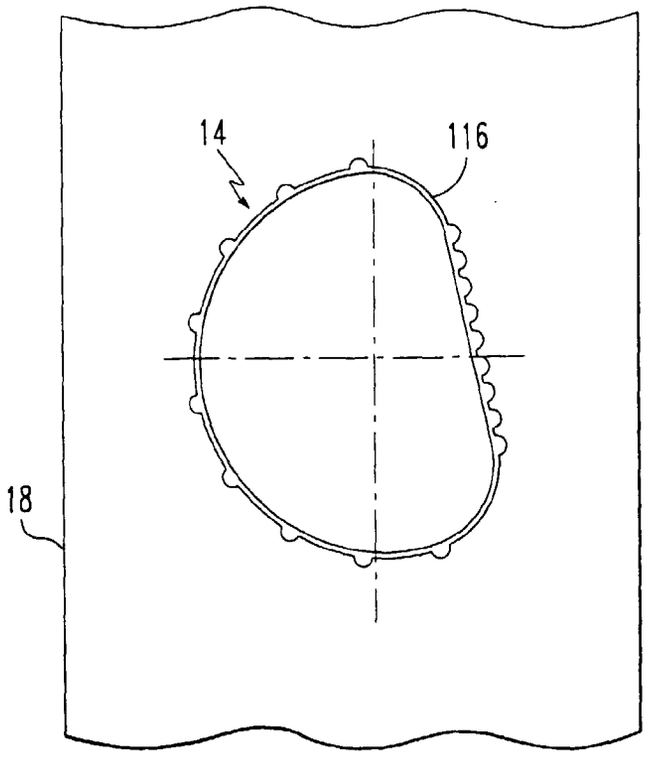

FIG. 10b

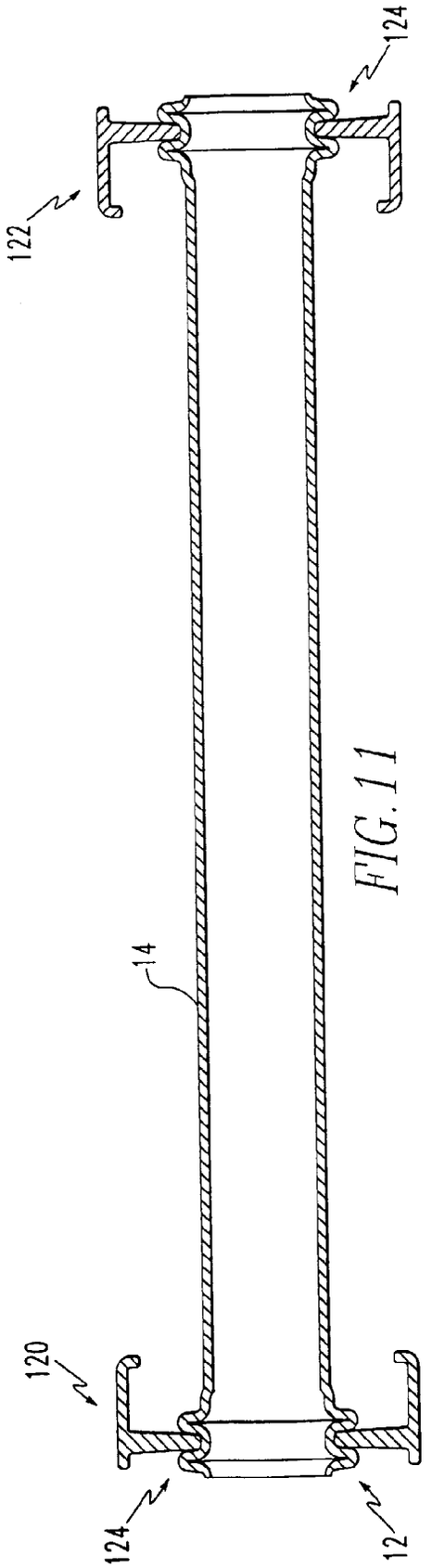

FIG. 11

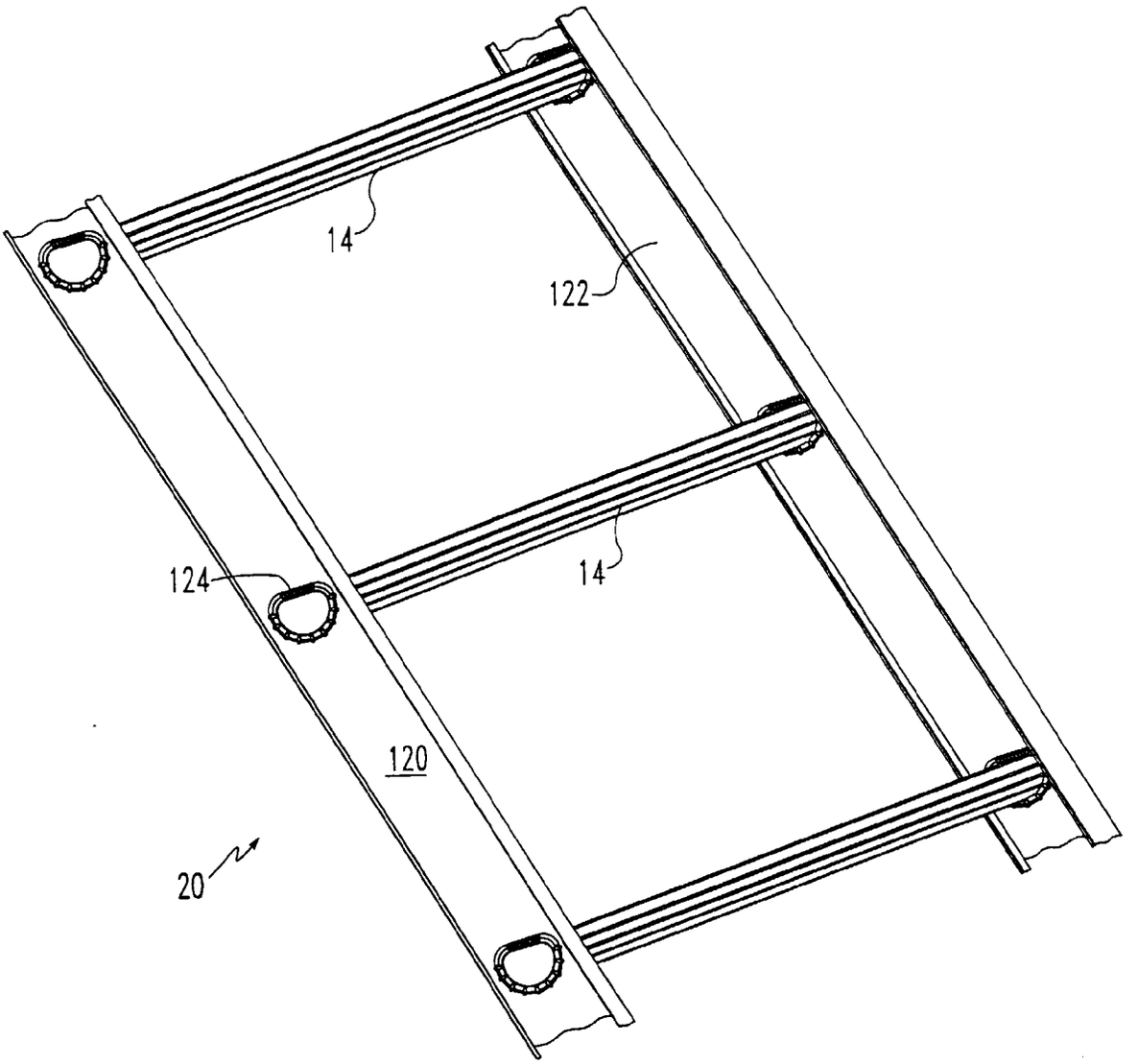

FIG. 12

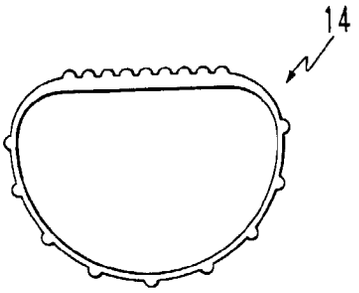

FIG. 13B

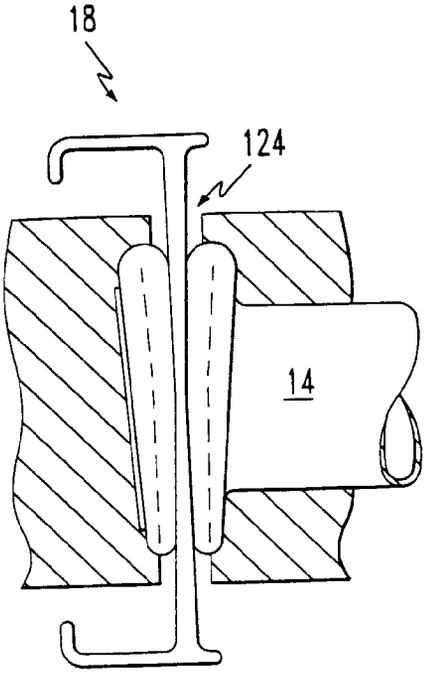

FIG. 13A

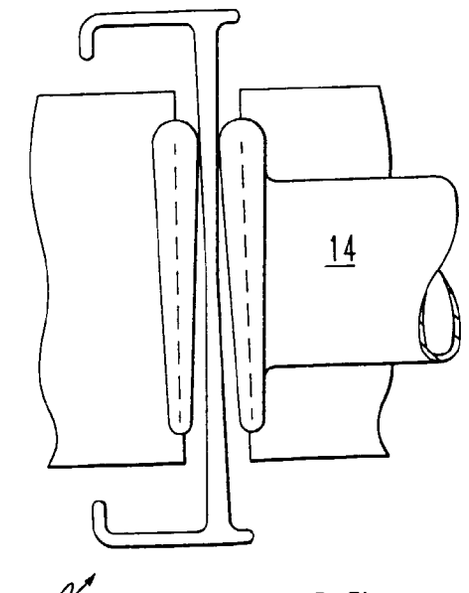

FIG. 13C
PRIOR ART

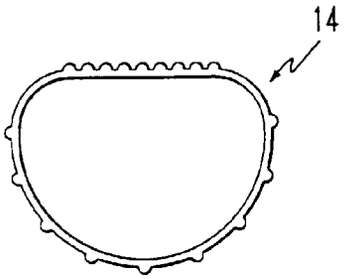

FIG. 14b

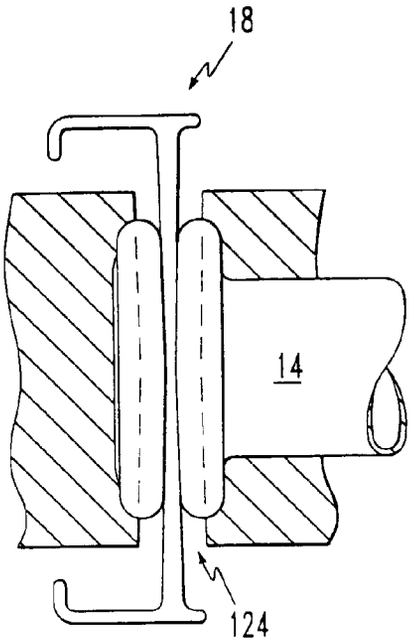

FIG. 14a

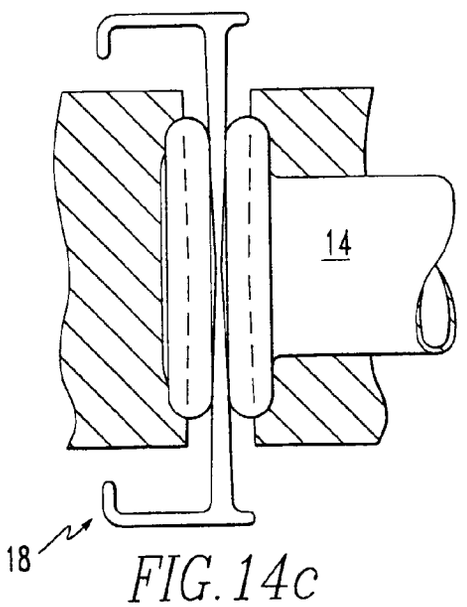

FIG. 14c

PRIOR ART

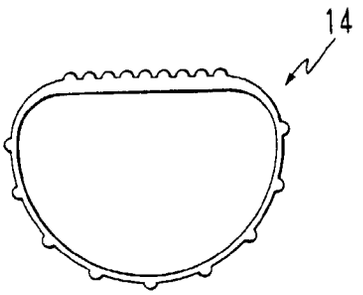

FIG. 15B

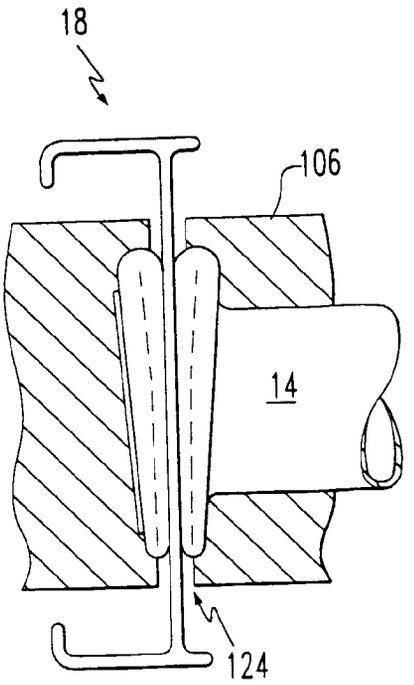

FIG. 15A

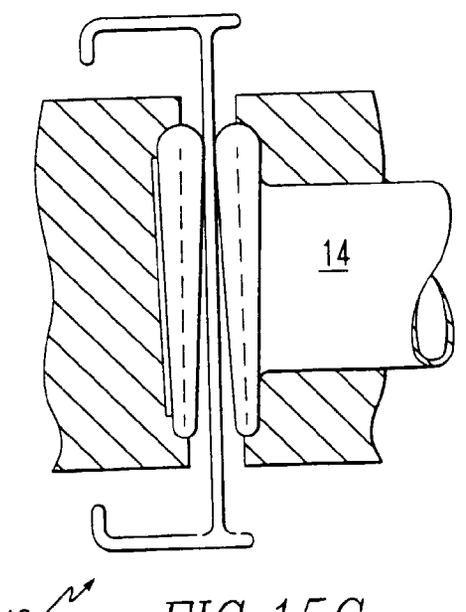

FIG. 15C
PRIOR ART

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 0808

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y A	US-A-3 545 072 (LINDESMITH ET AL.) * column 4, line 59 - column 5, line 9 * * column 5, line 59 - column 5, line 70 * * column 6, line 8 - column 6, line 24 * * figures 1-14 * ---	19,21 1,2,11, 14 9	E06C7/08 B21D39/06
X Y	FR-A-2 163 000 (AB CARL KEIJSER & CO.) * page 9, line 13 - page 10, line 10 * * figures 1,6 * ---	18,20 1,2,16, 19,21	
X Y	US-A-3 140 540 (GREENMAN) * column 3, line 60 - column 4, line 7 * * column 4, line 31 - column 5, line 35 * * column 6, line 7 - column 6, line 27 * * figures 1-11 * ---	12,13, 17,18,20 1,2,11, 14,16, 19,21	
X	US-A-3 279 051 (MINSHALL) * column 1, line 61 - column 2, line 10 * * column 2, line 54 - column 3, line 18 * * figures 1,5-8 * -----	11-13, 18,20,21	TECHNICAL FIELDS SEARCHED (Int.Cl.6) E06C B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 April 1996	Hendrickx, X

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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