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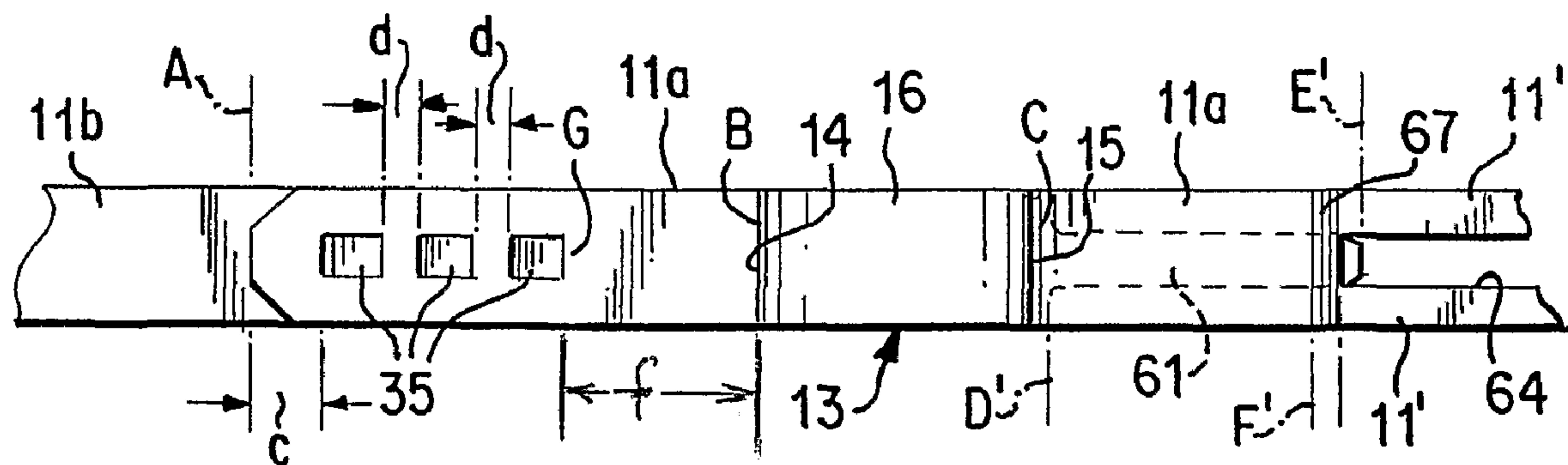
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PROCEDE DE FABRICATION DUDIT COLLIER  
(54) Title: HOSE CLAMP WITH STEPLESS INTERNAL CLAMPING SURFACE AND METHOD OF MAKING THE SAME



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A clamp made from clamping band material in which optimization for the length of the necessary blank is realized in dependence on the length of the bridging portion (16) of a so-called "Oetiker" ear whereby this bridging portion length is used to determine the length of the overlapped full-band-width inner clamping band portion (11b) as well as the location of the beginning of the step-like portion (67) and the length of the tongue-like extension (61) at the end of the full-band-width inner clamping band portion (11b).

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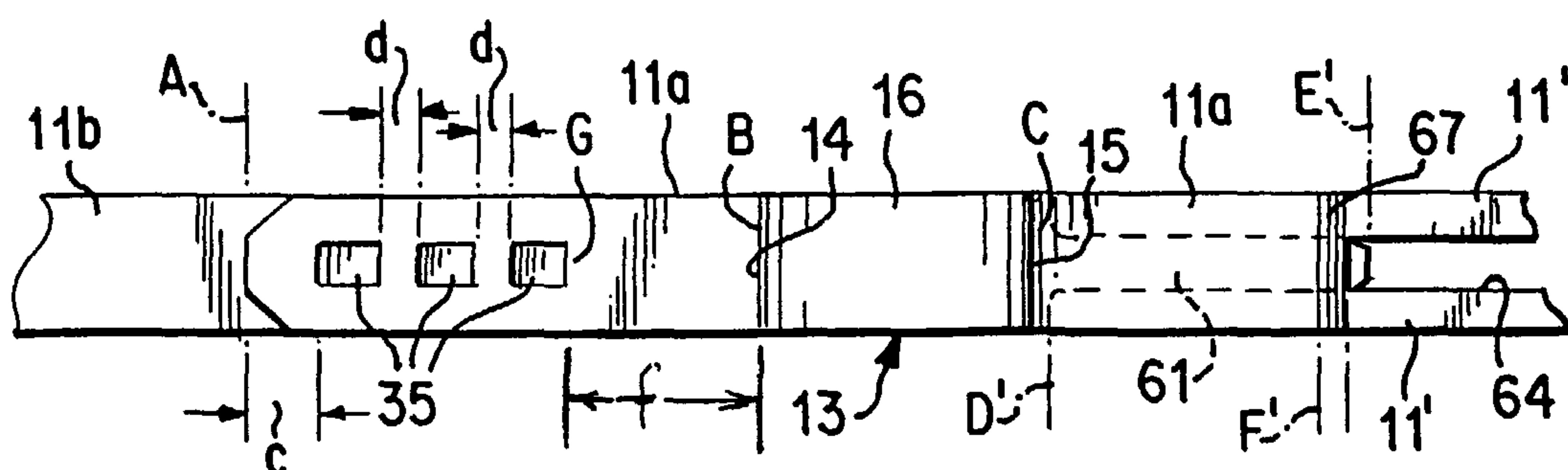
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(54) Title: HOSE CLAMP WITH STEPLESS INTERNAL CLAMPING SURFACE AND METHOD OF MAKING THE SAME



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(57) Abstract: A clamp made from clamping band material in which optimization for the length of the necessary blank is realized in dependence on the length of the bridging portion (16) of a so-called "Oetiker" ear whereby this bridging portion length is used to determine the length of the overlapped full-band-width inner clamping band portion (11b) as well as the location of the beginning of the step-like portion (67) and the length of the tongue-like extension (61) at the end of the full-band-width inner clamping band portion (11b).

HOSE CLAMP WITH STEPLESS INTERNAL CLAMPING SURFACE  
AND METHOD OF MAKING THE SAME

FIELD OF THE INVENTION

The present invention relates to hose clamps provided with internal clamping surfaces devoid of any step, discontinuity or gap and to a method for determining optimum length of the blanks for such hose clamps.

5

BACKGROUND OF THE INVENTION

With the use of new, relatively harder and thinner plastic hose materials, it became essential with so-called open hose clamps made from galvanized or stainless steel 10 band material to provide internal clamping surfaces devoid of any step, gap or discontinuity, particularly at the end of the inner overlapped clamping band portion. Equally important remained the need to prevent the deflection or escape of the underlying inner band portion into the ear 15 during plastic deformation of the ear and to reliably bridge any remaining gap underneath the plastically deformed ear of a so-called "Oetiker" ear. An effective solution which proved commercially immensely successful and which was used in hundreds of millions of clamps is described in U.S. 20 Patent 4,299,012 which, as shown in Figure 1 of this application and corresponding to Figure 19 of this patent, includes a narrow tongue-like extension (61) at the end of the full-width inner band portion (11b) adapted to engage through an opening (62) that commences in the outer band 25 portion (11a) at the beginning of a step-like portion (67). In addition to a typical "Oetiker" ear generally designated by reference numeral (13), which consists of two parallel outwardly extending leg portions 14 and 15 interconnected by a bridging portion (16) and provided with a reinforcing

groove (17), Figure 1 also shows the then-improved mechanical connection consisting of a so-called guide or suspension hook (31) and of two cold-deformed, deep-drawn support hooks (32) adapted to engage in apertures (35) in 5 the outer band portion (11a) as also more fully described in the aforementioned U.S. Patent 4,299,012. According to this patent, a channel is formed by the cuts for the elongated opening and by then pressing-out the center part (63) extending over and externally covering the tongue-like 10 portion (61). However, the cover (63) can also be omitted by simply cutting off the material forming the opening so that the tongue-like extension (61) is then freely exposed to the outside as disclosed in U.S. Patent 4,315,348 and as shown in Figure 2 herein, corresponding to Figure 12 of this 15 last-mentioned patent. Reference numeral (20) also generally designates in Figure 2 a different type of connection with the use of a tab-like member (20) bent-out from the inner band portion (11b) and extending through a corresponding aperture in the outer band portion (11a).

20 With annual productions of clamps utilizing these features exceeding several 100 millions per year, it is of interest to analyze these clamps with a view to rationalize production in order to cut material costs involving the clamping band as such. In other words, even small amounts 25 in the length of the blank of clamping band required for a given size clamp become significant. For example, with a saving of as little as 0.25 inches in the average overall length of the blank, such saving is significant with a production of 100,000,000 clamps a year in which case the 30 total savings would be 25,000,000 inches or 283,333 feet or 94,444 yards.

SUMMARY OF THE INVENTION

It is therefore a principal object of the present invention to provide a clamp having an internal clamping surface devoid of any gap, discontinuity or step which 5 optimizes the length of the blank necessary for making a given clamp size.

According to this invention, this is achieved by determining the minimum length of the blank of clamping band necessary to achieve reliable operation of the clamp which 10 involves locating certain key points of the clamp at well-defined, readily ascertainable distances. This includes locating the end of the full-width inner clamping band portion at a small distance from the one of the leg portions of the pair of leg portions of the plastically deformable 15 ear away from the free end of the outer clamping band portion and to coordinate the location of the step-like portion and the length of the tongue-like portion in dependence of the length of the gap underneath the ear in its non-deformed condition.

20 Certain exemplary embodiments may provide a clamp comprising clamping band means having overlapping inner and outer clamping band portions, a connection for connecting overlapping band portions, a tightening device for reducing the diametric dimension of the clamp to tighten the clamp 25 about an object to be fastened thereby, said tightening device including a plastically deformable ear having a pair of generally outwardly extending leg portions interconnected by a bridging portion extending in the longitudinal direction of the clamping band means, the inner ends of said leg portions 30 being spaced from one another a first distance, said connection being located closer to the free end of

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the outer clamping band portion than said tightening device, and further means for providing an inner clamping surface substantially devoid of steps, gaps or discontinuities in the clamping surfaces including a tongue-like extension at the end 5 of said inner clamping band portion and a step-like portion in the outer clamping band portion having a radial height substantially corresponding to the thickness of the clamping band and provided with an opening of such size that said tongue-like extension can extend therethrough, wherein the 10 full width of the inner clamping band portion extends beyond the inner end of the one of the pair of leg portions further away from the free end of the outer clamping band portion by a second distance sufficient to extend at most only a small distance beyond the connection of the inner end of said one 15 leg portion with the outer clamping band portion when the connection has been engaged and the tightening device is still in the non-tightened condition, in that said step-like portion is located fourth a distance from the end of the full-width inner band portion, the fourth distance being about equal to 20 said first distance, and in that said tongue-like extension has a length greater than said first distance such that said tongue-like extension extends through said opening only a fifth distance, and wherein said second distance is considerably smaller than said first distance, preferably is 25 equal to about 0.05 to about 0.15 times said first distance.

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BRIEF DESCRIPTION OF THE DRAWINGS

These and further objects, features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings which show, for purposes of illustration only, one embodiment in accordance with the present invention, and wherein:

Figure 1 is a perspective view of a prior art clamp of the type disclosed in U.S. Patent 4,299,012;

Figure 2 is a perspective view of a prior art clamp as disclosed in U.S. Patent 4,315,348;

Figure 3 is a schematic axial view of a clamp with an already plastically deformed "Oetiker" ear and illustrating

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in heavy lines the parts of the clamp under tensional stresses;

Figure 4 is a somewhat schematic axial view of a clamp with a plastically deformed "Oetiker" ear, similar to Figure 5 3, and illustrating in heavy lines the internal clamping surfaces producing the holding force on the hose;

Figure 5 is a somewhat schematic axial view of a clamp with the hook-like members in the inner clamping band portion of the mechanical connection engaging in apertures 10 of the outer clamping band portion and with the ear in the not-yet-tightened condition corresponding generally to Figure 7 of U.S. Patent 4,299,012 and illustrating a prior art clamp;

Figure 6 is a partial schematic plan view, flattened 15 out for better understanding, on the area including the mechanical connection, the plastically deformable ear, the end of the full-width inner band portion and the end of the tongue-like extension of a prior art clamp with the hook-like member in the inner clamping band portion of the 20 mechanical connection engaging in apertures of the outer clamping band portion and with the ear in the not-yet-tightened condition;

Figure 7 is a partial schematic side elevational view of Figure 6;

25 Figure 8 is a partial schematic plan view, similar to Figure 6 and illustrating the present invention; and

Figure 9 is a side elevational view of Figure 8.

#### DETAILED DESCRIPTION OF THE DRAWINGS

30 Referring now to the drawing wherein like reference characters are used throughout the various views to designate like parts, Figure 3 illustrates schematically a tightened clamp with a plastically deformed ear generally

designated by reference numeral 13'. The hose and nipple are omitted for the sake of clarity. In Figure 3, the parts which are under tensional stress in the tightened condition are shown in heavy lines. As a clamp of a given nominal size must cover a certain range of tolerances of the hose and nipple, it is assumed in Figures 3 and 4 that both the hose and nipple (not shown) have outer diameters greater than the minimum dimensions in the tolerance range but smaller than the maximum dimensions so that a small gap 10 remains underneath the plastically deformed ear 13'. Omitting any stresses which exist in the plastically deformed ear 13', the parts of the clamp under tensional stress in the tightened condition can be traced as follows: starting from the right inner end of the plastically deformed ear 13', as viewed in Figure 3, the path of the tensional stresses can be traced in the clockwise direction 15 through the outer band portion 11a, the step-like portion 67, the lateral remaining band portions 11', the clamping band 11 up to the mechanical connection generally designated by reference numeral 30 which includes, for example, a so-called guide hook 31 and one or more deep-drawn support hooks 32, and from there through the outer band portion 11a 20 up to the inner end of the left leg portion of the plastically deformed ear. These tensional forces, caused by 25 a reduction of the diameter of the clamp as a result of the plastic deformation of the ear, in turn, produce the radially directed clamping forces.

Turning next to Figure 4 which illustrates in heavy lines the parts of the clamp producing the radial clamping 30 forces, the clamping surfaces which produce these radially directed clamping forces can be traced from the point of the beginning of overlap of the inner clamping band portion 11b, coinciding with the free end of the outer clamping band end

portion, to the tongue-like extension 61, the remaining lateral portions 11', the main clamping band 11 and back to the point of beginning of the overlap of the inner clamping band portion 11b. This analysis indicates that the inner 5 clamping band portion 11b to the right of the mechanical connection 30, 31, 32 as viewed in Figures 3 and 4 as well as the tongue-like extension 61 are substantially without any tensional stresses and therefore depend for producing the necessary clamping forces on the tensional stresses in 10 the overlapping outer band portion 11a. This also explains why any gap underneath the plastically deformed ear, no matter how small, must be covered by the full band width of the inner clamping band portion in order to minimize the likelihood of a deflection or escape of the inner clamping 15 band portion into such a gap which might cause leakages.

Turning next to Figure 5, the following key points will be used in discussing the present invention. Reference character A designates the beginning of overlap between inner and outer band portions 11b and 11a that starts with 20 the free end of the outer band portion 11a. Reference characters B and C designate, respectively, the inner ends of the leg portions 14 and 15 at their connections with the outer band portion 11a. Reference character D designates the end of the full-width inner band portion 11b and the 25 beginning of the tongue-like extension 61, reference character E the end of the tongue-like extension 61 and reference character F the beginning of the step-like portion 67. The maximum contraction of the ear 13 producing the maximum reduction in the diametric dimension of the clamp 30 also corresponds to the maximum plastic deformation of the ear. This occurs when the inner ends B and C of the leg portions 14 and 15 come in contact with one another. The maximum reduction in diameter of a given size clamp is

therefore substantially equal to the spacing between the leg portions of the non-deformed ear less twice the thickness of the clamping band. In order to assure that the hose is securely fastened even when the hose diameter and nipple 5 diameter have minimum external diametric dimensions within a given tolerance range for a given clamp size, it is necessary that this takes place on or before the inner ends of the plastically deformed leg portions come in contact with one another.

10 On the assembly line, the pneumatically actuated pincer-like tools will always deform the ear with a constant force to produce a constant clamping force regardless of the actual external dimensions of the hose and of the nipple. As a given clamp size is intended to cover a certain 15 tolerance range, it is not unlikely that a small gap remains underneath the ear. As mentioned before, it therefore becomes important that the gap underneath the ear be bridged by the full band width of the inner clamping band because a narrow tongue-like extension is far more likely to yield and 20 escape into the gap as a result, for example, of thermal expansion or increases in internal pressures. With relatively hard and thin plastic hoses, this is likely to produce a leakage place, and this is why the German Gebrauchsmuster GM 75 41 277, in which any gap can be 25 bridged only by the narrow tongue-like extension does not meet these important requirements.

The foregoing also indicates that the full width inner band portion should be of sufficient length to bridge any gap underneath the plastically deformed ear when the 30 mechanical connection 30, 31, 32 is already engaged but before the ear is plastically deformed. This is achieved in the prior art clamp of Figure 5 by a length of the full-width inner clamping band portion 11b which extends a

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substantial distance C-D beyond the leg portion 15. This in turn also requires that the tongue-like extension 61 has a length from point D to point E in order to extend through the opening in the step-like portion 67 which itself is 5 located at an unnecessary great distance D-F from point D. The distances C-D, D-E as also D-F in the prior art clamp, however, are not limited to optimum size. As the length of the arcs can also be expressed in terms of the angle subtended thereby, the arc of the inner clamping band portion 11b underneath the non-deformed ear 13 subtends an angle  $\alpha$  so that its length is equal to  $\frac{2\pi r \times \alpha}{360}$ , where r is

the given radius of the clamp. By the same token, the arc of 15 the inner clamping band portion 11b from point C to point D would be equal to

$\frac{2\pi r \times \alpha'}{360}$  and the length of the arc of the tongue-like

extension 61 would be  $\frac{2\pi r \times \beta}{360}$ . The overall length of the

inner clamping band portion would therefore be, beginning at 20 point A,

equal to  $\frac{2\pi r(\delta + \alpha + \alpha' + \beta)}{360}$ .

25 If one assumes that the length of the arc from points B-C is equal to the length L and omitting the extra clamping band length due to the step-like portion, then the length of the blank required for a given clamp size of radius r is equal

30 to

$2\pi r + \frac{2\pi r \times (\delta + \alpha + \alpha' + \beta)}{360} + 2H$ , where H is the height of the ear.

35 Figures 6 and 7 illustrate a prior art clamp which requires a length of blank as determined by the above

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equation that utilizes, however, excessive clamping band material.

This is so as the full-width inner clamping band portion only needs to extend to a point just beyond point C, 5 indicated in Figure 5 by point D', thereby saving the clamping band material from point D' to point D. Similarly, the point F of the beginning of the step-like portion 67 only needs to be located a distance from point D' sufficient to allow the end of the full band width inner clamping band 10 portion to end just ahead of the beginning of the step-like portion 67 when the ear has been plastically deformed to the maximum possible extent. This means that the distance D-F can be shortened to correspond to the distance B-C or to a distance slightly larger than B-C as a safety precaution. 15 In other words, the angles  $\alpha'$  and  $\beta$  can be reduced according to this invention as the tongue-like extension only needs to extend a small distance beyond point F'.

According to this invention, a considerable saving in the required length of the blank is achievable by locating 20 the point D close to the point C as there is no need for proper functioning of the clamp to have considerable overlap between the outer clamping band portion 11a and the inner clamping band portion 11b beyond the point C. By the same token, as the maximum plastic deformation of the ear 13 is 25 limited by the contact of the inner ends of leg portions 14 and 15, the beginning F of the step-like portion 67 only needs to be located at a point F' which is located at a distance B-C from the point D or for precautionary reasons, only a distance slightly greater than B-C. The tongue-like 30 portion 61 can then also be reduced to the distance D' - E'. Looking at a comparison of Figures 6 and 7, on the one hand, illustrating a typical prior art clamp, and Figures 8 and 9, on the other, illustrating the present invention, a saving

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of blank material equal to  $S$  (Figure 6) is attainable with this invention.

As mentioned before, the angle  $\alpha'$  only needs to be large enough to assure that the full band width of the inner 5 band portion 11b extends to a point schematically indicated at  $D'$  in Figure 5. The angle  $\alpha'$  which may approach the value zero, in accordance with this invention may be as a precaution between about 0.02 to about 0.15, the value of  $\alpha$  depending on the size of the clamp as the length of the arc 10 is a direct function of the radius of the clamp. The point  $F'$ , corresponding to the beginning of the step-like portion 67, only needs to be located at a distance from point  $D'$  to be equal to the angle  $\alpha$  or slightly larger for precautionary 15 reasons to assure that the end of the full-width inner band portion 11b finds itself at or slightly ahead of the step-like portion 67 in case of maximum plastic deformation of the ear. The length of the tongue-like portion 61, i.e., angle  $\beta$  then only needs to be of a size sufficient to extend just through the opening in the step-like portion, as 20 measured from the point  $D'$  which means that the angle  $\beta$  should be larger than the angle  $\alpha$ , for example, by an amount of about 0.1 to about 0.25 of the angle  $\alpha$ .

The angle  $\delta$  from the point  $A$  to the point  $B$  can be subdivided into the angle  $\delta'$  and  $\delta''$ , whereby the angle  $\delta'$  25 subtends the arc from the point  $A$  to the point  $G$ , i.e., the arc from the free end of the outer band portion 11a to the edge of the last aperture 35 away from the free end of the outer band portion. The length of this arc is thereby determined by the mechanical connection used, i.e., the type 30 of hooks and the number of apertures as well as by the material used with the clamp, i.e., thickness and type of material as well as the maximum stresses in the circumferential direction expected in the clamping band. In

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other words, the distances  $d$  (Figure 8) of the web portions between adjacent apertures 35 must be sufficient to avoid tearing out of the material. The same is also true of the distance from the edge nearest the free end of the outer

5 band portion of the first aperture and the end of the outer band portion. With respect to the length  $f$  between points  $G$  and points  $B$  of the clamp, no specific requirements exist, as such, from a strength of material point of view.

However, the length  $f$ , i.e., angle  $\delta''$  must be sufficient to

10 permit application of the jaws of the pincer tool without interference with the mechanical connection. At any rate, the angle  $\delta''$  can be significantly smaller than the angle  $\delta'$  and the optimum values can be empirically determined or calculated for a given size and given material as well as

15 predetermined clamping forces required of the clamp.

The method of determining optimum length for a so-called stepless clamp of a given size can then be determined according to this invention in dependence on the arc subtended by the inner ends  $B$ ,  $C$  of the leg portions 14, 15

20 or on the length  $L$  of the bridging portion which can be assumed to correspond or be almost equal to a safe distance  $B-D'$  such that the full-width inner clamping band portion extends beyond the gap underneath the non-deformed ear, when the mechanical connection is engaged. This assumption is

25 based on the fact that maximum plastic deformation of the ear 13 is limited by two times the clamping band thickness.

If necessary, a distance only slightly greater than this distance  $L$  can be chosen as a precautionary measure while the tongue-like extension then has a length  $D'-E'$  extending

30 only a small distance beyond the opening in the step-like portion whose beginning  $F'$  is located at a distance from the end  $D'$  of the full-width inner band portion about equal to or only slightly larger than the distance  $L$ .

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Reference to the length **L** of the bridging portion in this application assumes that the leg portions **14** and **15** are rectilinear and parallel. However, in case these leg portions are non-parallel and/or non-  
5 rectilinear, as disclosed in the co-pending Canadian Application 2,356,247 filed April 5, 2000 and entitled "Improved Tightening Means for Hose Clamps", it is the spacing from one another of the inner ends of the leg portions at their connections with the clamping band that  
10 should be considered as the significant dimension in lieu of the length **L** of the bridging portion, and any reference in this description or in the claims should be so interpreted.

As the required circumference for a given clamp size is fixed by the equation  $2\pi r$ , this invention proposes a  
15 solution for optimization of the necessary length of the blank by recognizing that this can be achieved only by applying certain limitative criteria to the area of overlap between inner and outer band portions and that this can be done as a function of the spacing of the inner ends of the  
20 leg portions of the plastically deformable ear.

While I have shown and described only one embodiment in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled  
25 in the art. For example, this invention can be used with any clamp having an "Oetiker" ear and the aforementioned structural features to avoid any step, gap or discontinuity in the internal clamping surfaces. Additionally, the tongue-like extension may be convexly shaped in transverse cross  
30 section which permits a slightly narrower opening in the step-like portion and a corresponding slight increase in the width of the clamping band parts on each side of the opening which have to absorb the maximum tensional stresses

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occurring in the clamping band, when tightened. I therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the  
5 appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A clamp comprising clamping band means having overlapping inner and outer clamping band portions, a connection for connecting overlapping band portions, a tightening device for reducing the diametric dimension of the clamp to tighten the clamp about an object to be fastened thereby, said tightening device including a plastically deformable ear having a pair of generally outwardly extending leg portions interconnected by a bridging portion extending in the longitudinal direction of the clamping band means, the inner ends of said leg portions being spaced from one another a first distance, said connection being located closer to the free end of the outer clamping band portion than said tightening device, and further means for providing an inner clamping surface substantially devoid of steps, gaps or discontinuities in the clamping surfaces including a tongue-like extension at the end of said inner clamping band portion and a step-like portion in the outer clamping band portion having a radial height substantially corresponding to the thickness of the clamping band and provided with an opening of such size that said tongue-like extension can extend therethrough,  
wherein the full width of the inner clamping band portion extends beyond the inner end of the one of the pair of leg portions further away from the free end of the outer clamping band portion by a second distance sufficient to extend at most only a third distance beyond the connection of the inner end of said one leg portion with the outer clamping band portion when the connection has been engaged and the tightening device is still in the non-tightened condition, in that said step-like portion is located a fourth distance from the end of the

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full-width inner band portion, the fourth distance being about equal to said first distance, and in that said tongue-like extension has a length greater than said first distance such that said tongue-like extension extends through said opening only a fifth distance, and wherein said second distance is considerably smaller than said first distance, preferably is equal to about 0.05 to about 0.15 times said first distance.

2. The clamp according to claim 1, wherein the length of  
 10 said tongue-like extension is at least equal to or greater than said first distance by an amount equal to about 0.15 to about 0.2 times said first distance.

3. The clamp according to any one of claims 1-2, wherein the  
 15 length of a blank for a clamping having a radius  $r$  is equal to the following equation

$$\frac{2\pi r + 2\pi r(\delta + \alpha + \alpha' + \beta) + 2H}{360}$$

20 where  $\delta$  is the angle subtended by the length of the clamping band from the free end of the outer clamping band portion to the inner end of the other of said pair of leg portions,  $\alpha$  is the angle subtended by said first distance,  $\alpha'$  is the angle  
 25 subtended by said second distance,  $\beta$  is the angle subtended by the length of the clamping band portion from the end of the full-width inner band portion to the end of the tongue-like extension and  $H$  is the height of the bridging portion, with the assumption that the first distance corresponds  
 30 substantially to the length  $L$  of the bridging portion and if one omits the small length of the clamping band due to the height of the step-like portion.

4. The clamping band according to any one of claims 1-3, wherein said tongue-like extension is convexly shaped in transverse cross section.

5

5. The clamp according to any one of claims 1-4, wherein said opening is located substantially centrally in the clamping band and has a width in the clamping band transverse direction of about 30% to about 50% the width of the clamping  
10 band.

6. The clamp according to any one of claims 1-5, wherein the width of said opening in the clamping band transverse direction is about equal to the width of each of the remaining  
15 lateral portions of the clamping band in said step-like portion.

7. The clamp according to any one of claims 1-6, wherein said connection includes at least one outwardly extending hook  
20 in said inner band portion adapted to engage in at least one aperture in said outer band portion, and wherein the transverse edge of the last of said apertures away from the free end of the outer band portion is spaced from the other leg portion of said pair of leg portions by a sixth distance  
25 at most equal to said first distance.

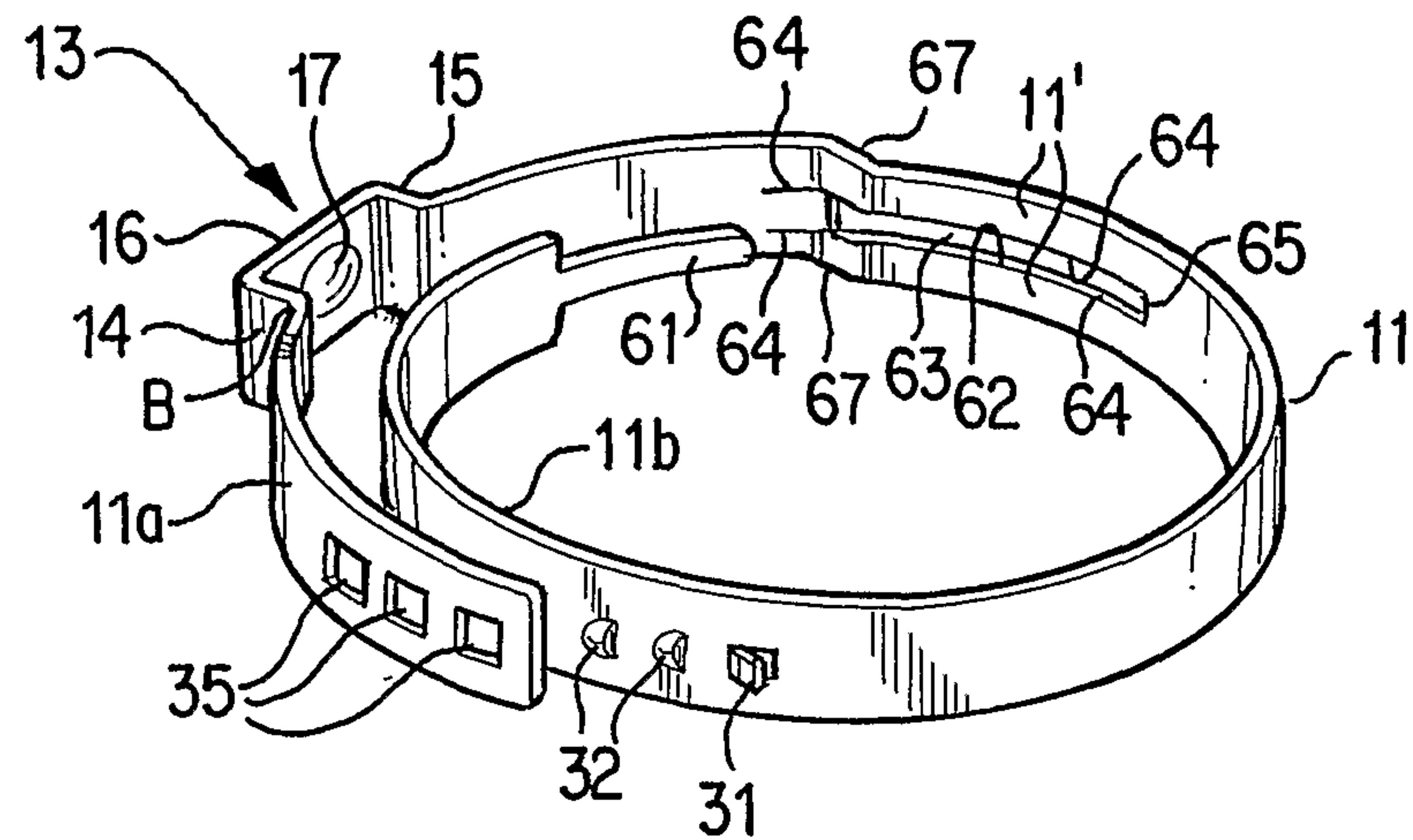


FIG. 1 PRIORITY ART

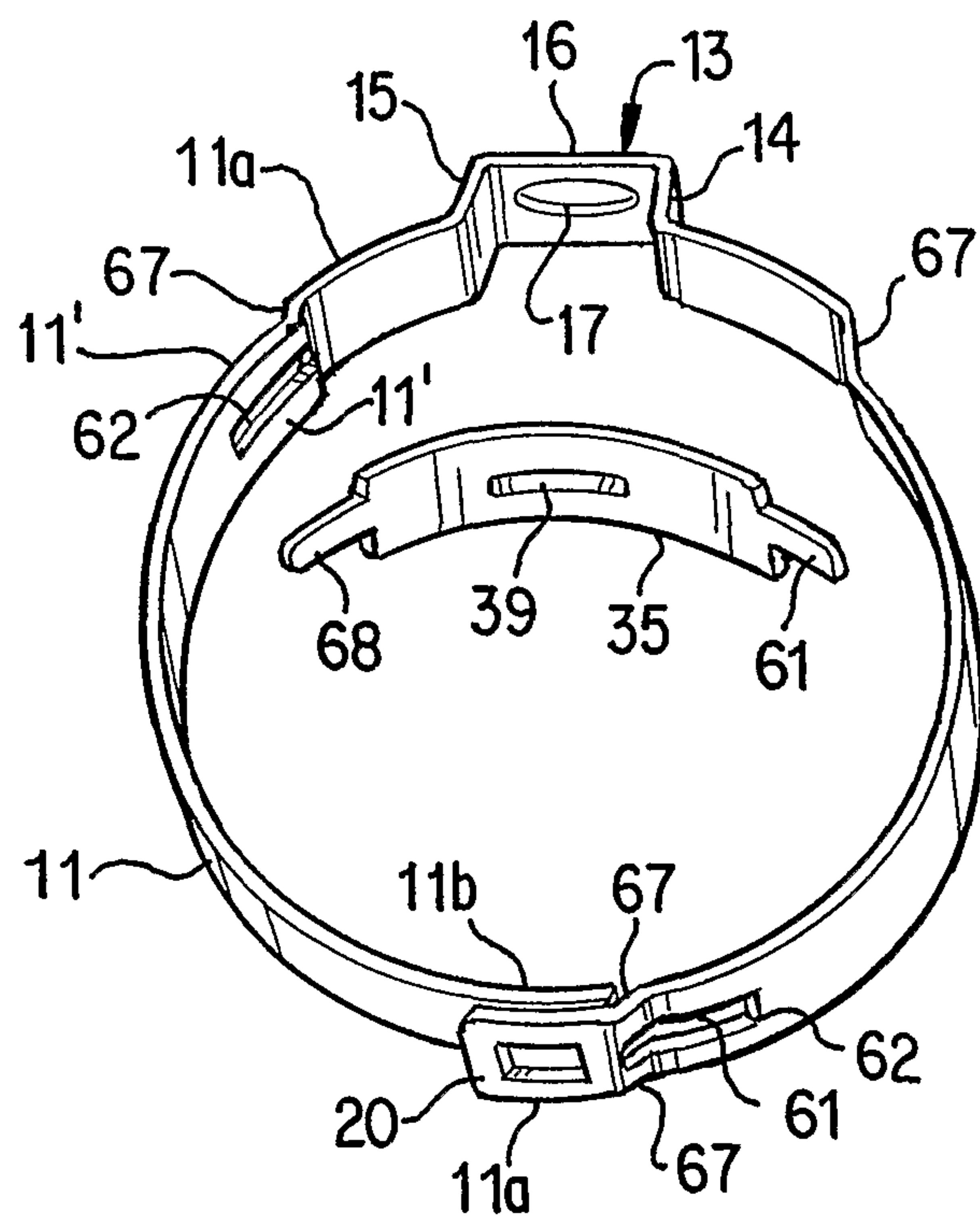


FIG. 2 PRIORITY ART

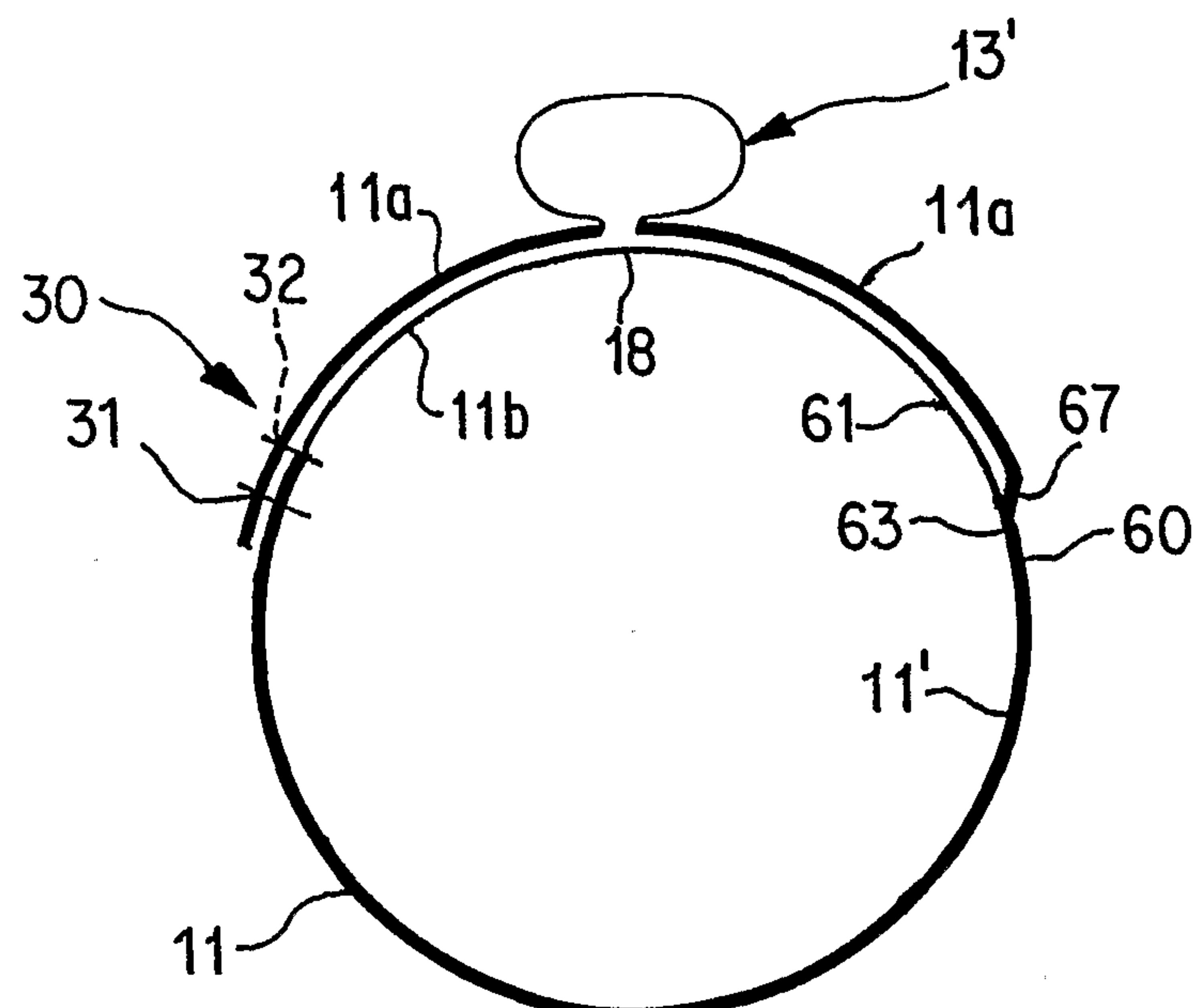


FIG. 3

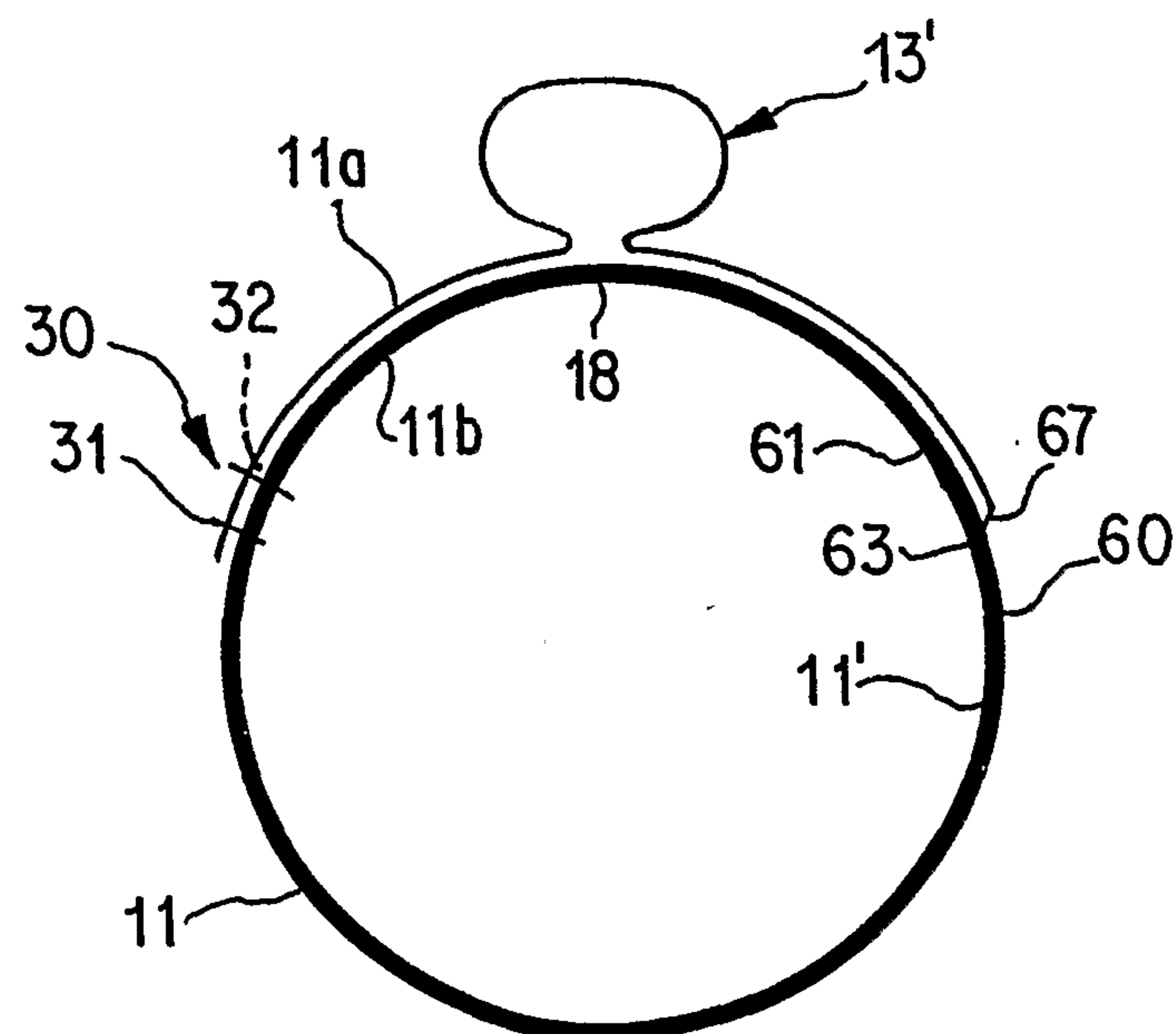


FIG. 4

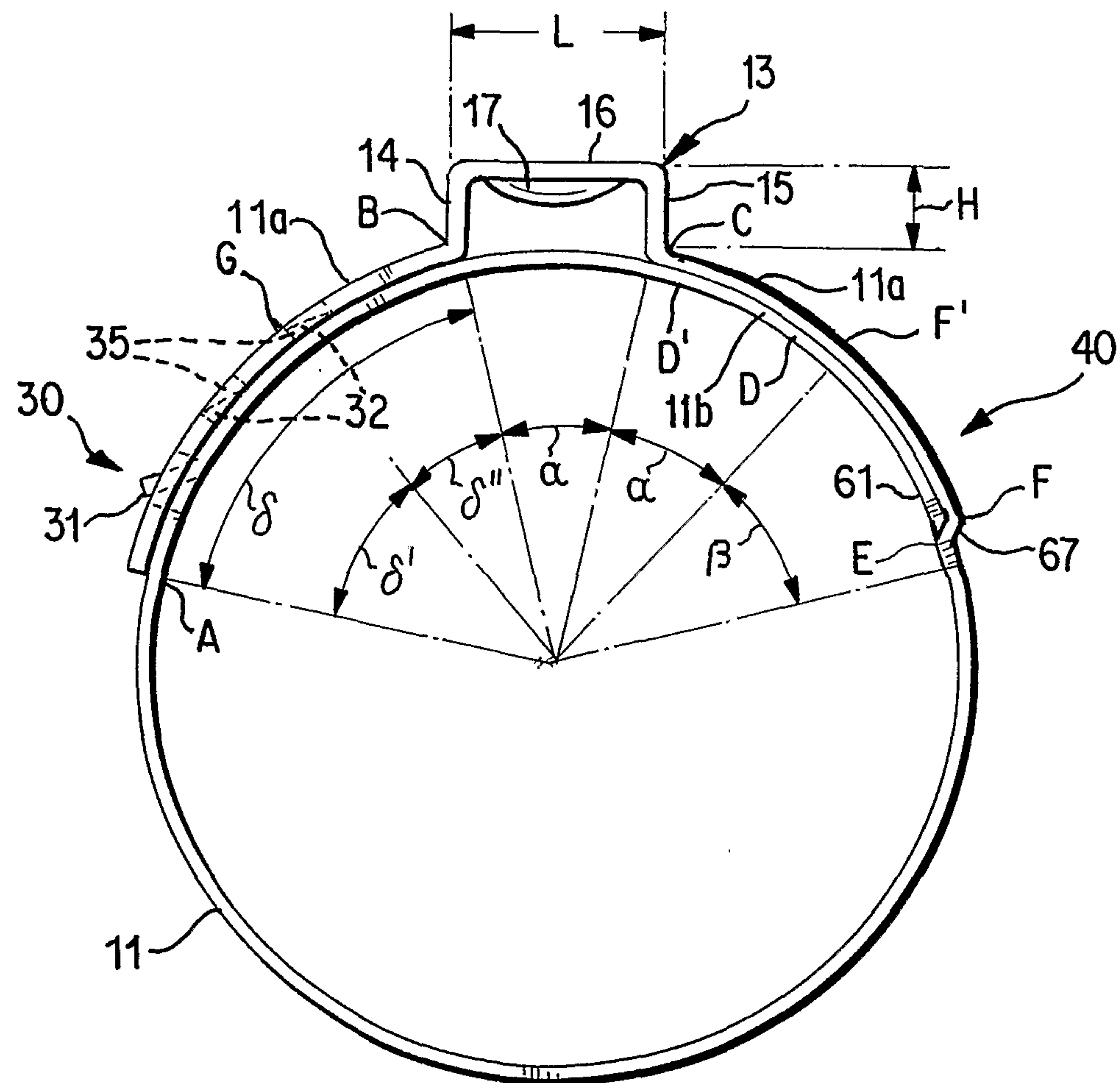
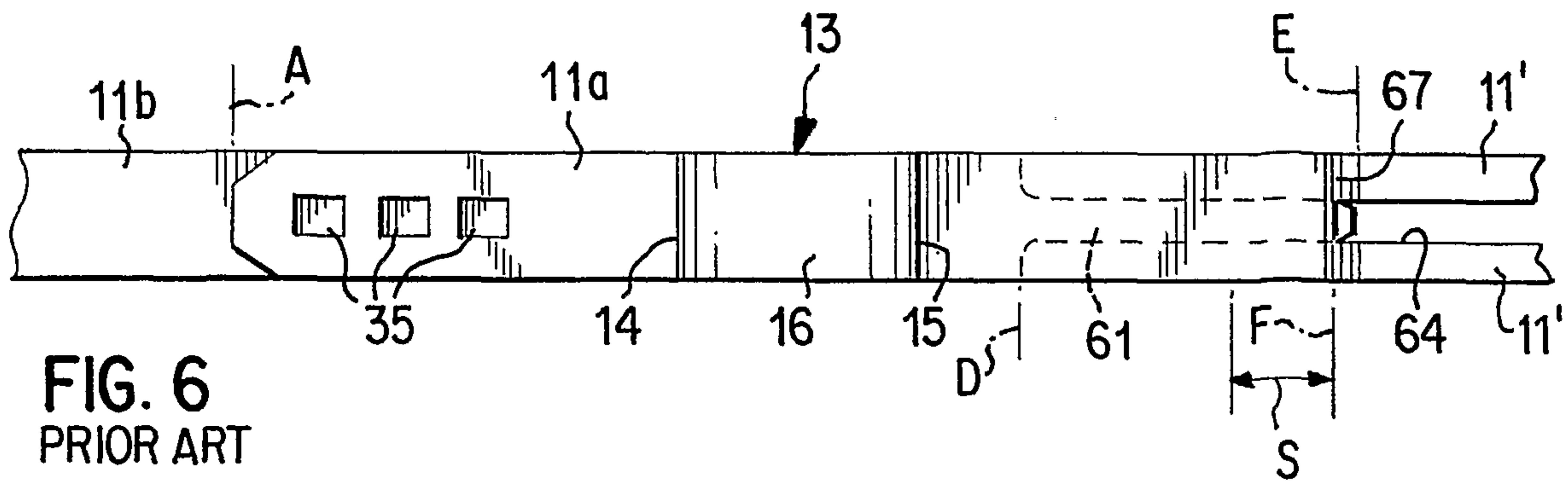
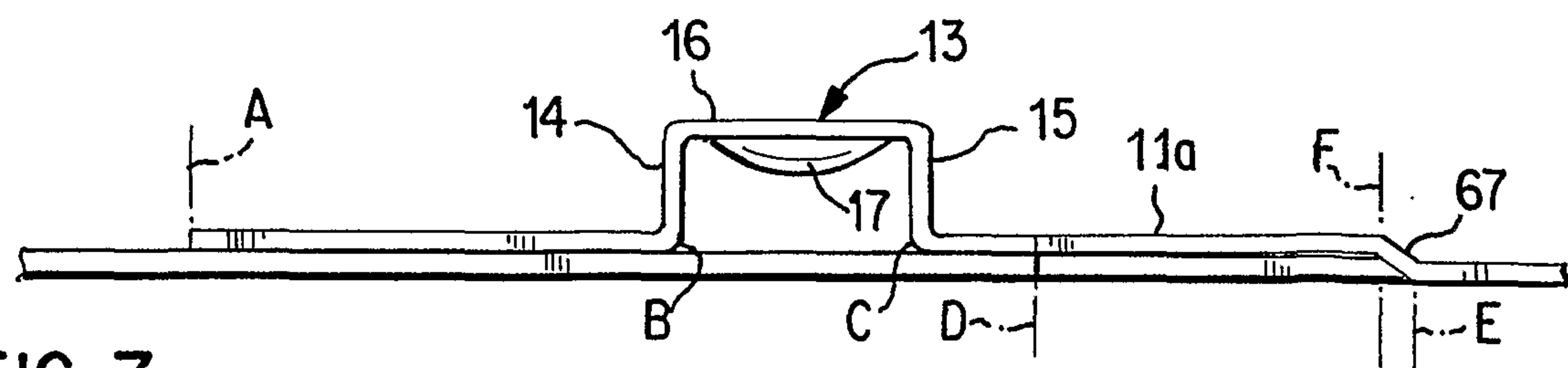


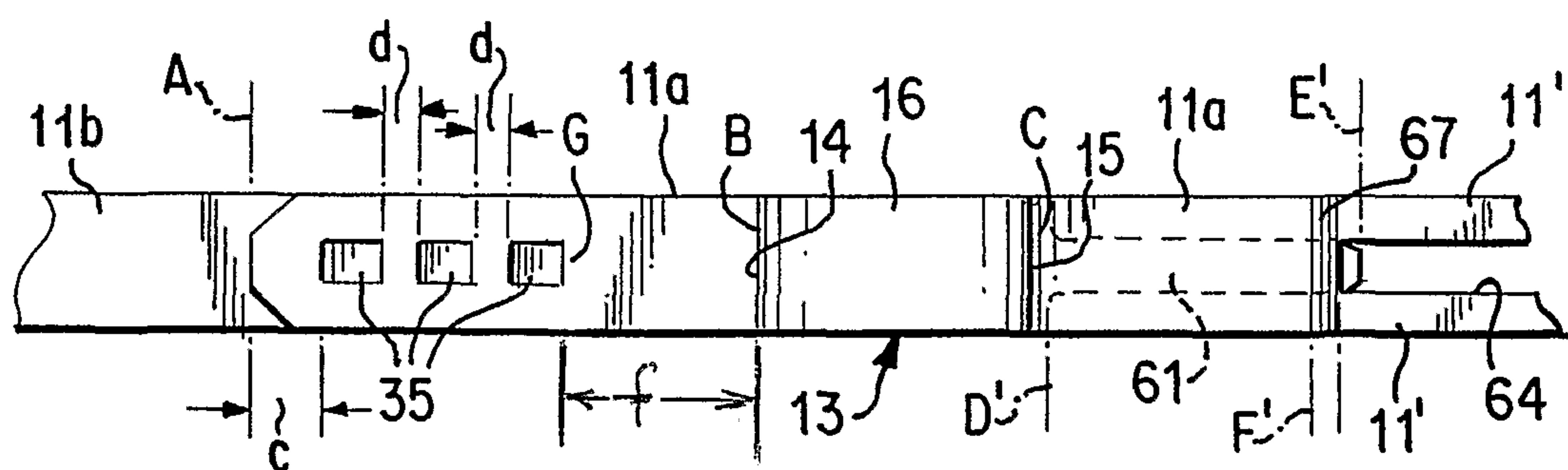
FIG. 5 PRIOR ART



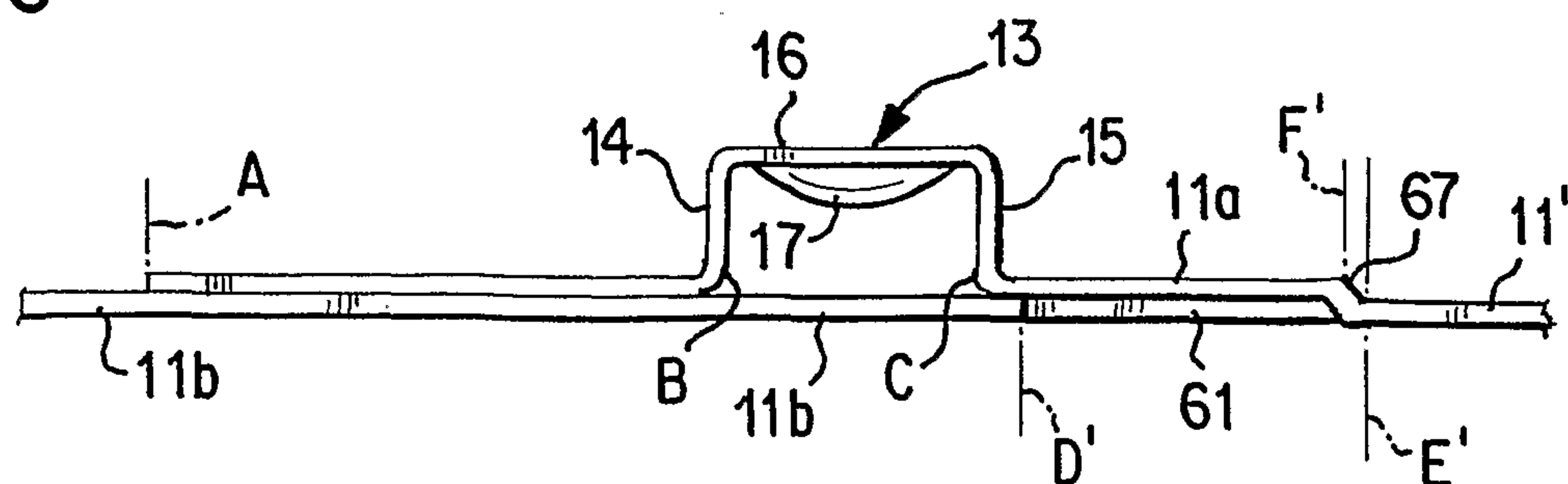
**FIG. 6**  
PRIOR ART



**FIG. 7**  
PRIOR ART



**FIG. 8**



**FIG. 9**

