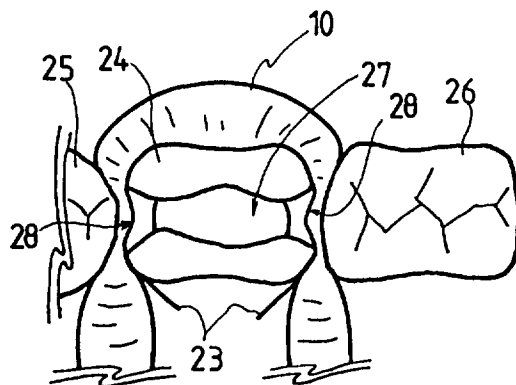


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(54) **DISPOSITIF DE MEDECINE DENTAIRE**  
(54) **DENTAL MEDICINE DEVICE**



(57) Dispositif de médecine dentaire comprenant un ballonnet gonflable allongé (10) destiné à être placé autour d'une matrice (23) en partie en périphérie de la dent cariée (24). Au moment du gonflement, le ballonnet (10) permet d'appuyer également la matrice (23) contre la dent.

(57) The dental medicine device comprises an elongated inflatable balloon 10 for placement around a matrix band 23 in part surrounding relationship with a decayed tooth 24. Upon inflation, the balloon 10 evenly applies the matrix band 23 against the tooth.

ABSTRACT

Dental medicine device

- 5 The dental medicine device comprises an elongated inflatable balloon 10 for placement around a matrix band 23 in part surrounding relationship with a decayed tooth 24. Upon inflation, the balloon 10 evenly applies the matrix band 23 against the tooth.

This invention relates to a dental medicine device for pressing a wall molding means against a decayed tooth for restoration thereof, comprising expandable means for urging said wall molding means against the decayed tooth  
5 wall to hold restorative material inserted into the tooth.

Dental restoration of cavities between teeth is common practice in dentistry. When it is necessary to restore  
10 the portion of a tooth which, prior to decay, contacted an adjacent tooth, it is indispensable to confine the restoration material during placement and until rigid enough, to support itself to conform exactly to the healthy portion of the tooth. Any surplus or overhang of  
15 restorative material in the hardly reachable approximal areas constitutes an irritation source which leads to plaque accumulation and constitutes enormous niches for the cariogenic flora. With time, the initially gram-positive flora transforms into parodontopathogenic gram-  
20 negative flora which leads to acute and/or chronic periodontal disease.

In order to position the restorative material, it is customary to fit, by means of an appropriate tensioner  
25 also called retainer or holder, a matrix band around the tooth for creating a mold to replace the wall lost by caries and cavity preparation during insertion of the restorative material into the tooth. To achieve its function, the matrix band must be fixed in position, and  
30 it must be formed as close as possible to the shape of the tooth so that the restorative material placed therein will conform to the outer surface of the healthy portion of the tooth. However, because of the convexity or concavity of the tooth at the site of restoration,  
35 the matrix band tends to stand away from the tooth, thereby allowing surplus or overhang of the restoration

material to pass between the tooth and the matrix band. This is especially the case when bonding agents and/or flowable composite materials are used to restore the tooth.

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Accordingly, a wedging of the matrix band is made, by means of a wedge which is forced between the adjacent teeth in the region between the former contact point and the gingiva to press the matrix band material against the tooth at the floor of the cavity preparation. The wedge is also aiming to perform an additional function in that it forces the teeth apart creating a wider space therebetween than would normally exist. This is important because the matrix band occupies an amount of space which would persist when the matrix band is removed if the elastic memory of the periodontal membrane would not move the teeth closer together after removal of the wedge which caused the temporary separation.

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Typical wedging technique provides for tapered elongated wooden wedges which may be inserted between adjacent teeth with friction being relied upon to maintain the wedge in position. Since the interdental papilla occupies the approximal space between the teeth, insertion of the wedge causes an injury inducing rubbing compression to the tissue between the teeth. Furthermore, the wedge tends to slip out of position due to the poor frictional engagement provided. As the material forming the wedge is only slightly deformable with practically no elastic memory, all the force applied for placement of the wedge is transmitted to the attachment of the teeth to the bone, with the risk of trauma at this level, whereby the force created by the wedge can be lost. And, most of all, as the tooth contour is quite variable at the site of restoration,

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with discontinuities and convexities, respectively concavities bordered with convexities, wedge cannot provide more than tangential or point contact between the wedge, the matrix band and the tooth. There is  
5 therefore significant pressure on the matrix band area where convexity of the tooth is most pronounced; other areas of the matrix band get only mild pressure or no pressure at all. The result is a loose fit of the matrix band to the tooth, with unavoidable surplus or overhangs  
10 of restorative material between the tooth and the matrix band. Of course, it is possible to try to tailor the wedge in an attempt to provide a better fit between wedge, matrix band and tooth; however, this is time consuming and the result is quite aleatory because of  
15 difficult to ascertain parameters such as the complex geometry of the tooth and the advance of the wedge between the teeth to assume the required friction fit and pressure of the wedge on the matrix band and tooth.

20 Where composite resin restorations for light curing technique are used, light transmitting plastic wedges have been developped to transfer light energy for curing of the restorative material. The problems outlined  
hereabove remain however unsolved, with the added risk  
25 that surplus and overhangs of the restorative material may result in leaks in the restorative material which may induce cracks or hollow spaces in the material, thereby reducing its efficiency and creating further niches for the pathogenic flora.

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There has been various attempts to provide better wedging.

For example, US Patent 3,890,714 shows a plastic wedge  
35 with a dihedral body the lateral walls of which are flexible and slotted to increase the friction

coefficient between the wedge and adjacent elements;  
although possibly reducing the risk of trauma at  
attachment level of the teeth and raising the friction  
anchor between the teeth, this wedge still cannot solve  
5 the problem of a loose matrix band fit; in addition,  
this wedge has a tendency to lacerate the gingival  
tissue.

US Patent 3,815,243 discloses a trihedral wedge of soft  
10 plastic material with serrations defined by transverse  
protrusions intended to more evenly distribute the  
pressure; although outlining the problem of poor matrix  
band application resulting in surplus of restorative  
material between the tooth and the matrix band, this  
15 wedge still cannot solve that problem because the  
serrations cannot evenly match the discontinuities,  
convexities, and concavities of the tooth contour at the  
site of restoration.

20 US Patent 4,337,041 refers to a wedge the elongated body  
of which is provided with depressions intended to  
positively engage the teeth and simulate the contour of  
the concave interdental papilla. The wedge is thus  
preshaped and it can consequently not match the tooth  
25 shapes which are different in each case of restoration.  
The problem of uneven pressure for the matrix band is  
thus unsolved. In addition, the edges of the depression  
simulating the contact of the interdental papilla may  
lacerate the tissue upon insertion of the wedge.

30 US Patent 5,573,400 describes an expanding dental wedge  
having a trihedral elongated tapered body. Other cross-  
sectioned shapes such as trapezoidal or round are  
possible. This wedge is made of compressed hydrophilic  
35 material, such as cellulose or synthetic foams, that  
expand in contact with moisture. Accordingly, after

placement of the matrix band, the wedge is inserted conventionally into the interproximal area between teeth. At this stage, addition of moisture is required to begin an expansion process. The moisture may be  
5 applied by the practitioner in the form of water and moisture from the interproximal tissues is said to also enter into matter for the expansion process. The document indicates that the moisture causes a pronounced expansion of the compressed material, providing  
10 reciprocal pressure to all points of the matrix band along the proximal surface, thus providing a matrix band seal. The document also indicates that the wedge is more gentle to interdental tissues due to its pliable nature when in contact with moisture. Although this technology  
15 may appear appealing, there are serious drawbacks. The expansion and pressure which may result therefrom are totally uncontrollable. The rate of expansion with respect to the amount of moisture is unknown; it is not only bound to the moisture applied by the practitioner,  
20 it also depends from variations of the moisture conditions of the gingival tissue and bucal environment, and it further varies as a function of the homogeneity of the compressed material along the length of the wedge. The practitioner has absolutely no means to know  
25 how the pressure resulting from the expansion will distribute. The pressure resulting from the expansion may be too low to properly apply the matrix band to sharp convexities or concavities or irregularities of the tooth contour, whereby the risk of poor or loose  
30 positioning of the matrix band against the tooth, and the added risk of insufficient force to take the teeth apart from one another. If the pressure is too high than would be required for proper application of the matrix band to the tooth contour there is the added risk of  
35 trauma for the teeth attachment. Once the moisture expansion initiated, there is no way to stop or to

reduce it otherwise than by a difficult if not impossible drying procedure, whereby the practitioner cannot change the matrix band positioning if he deems it advisable to do so before the restorative material filling procedure. The system therefore cannot be failproof to avoid the risk of surplus or overhangs of restorative material between the tooth and matrix band and the risk of trauma. Apart of this, the document is silent as to how the expanded wedge may be withdrawn from the interdental papilla; forcible withdrawal of the expanded wedge may cause injury to the interdental papilla as well as it may cause an overspacing of the teeth from one another and consequent trauma. Furthermore, rubbing insertion of the compressed dried material may also cause injury to the interdental papilla. And the compressed expandable material forming the wedge does not appear to be appropriate for the transmission of light energy as required for curing plastic or composite restorative materials. Moreover, the wedge is contraproductive since successful handling of filling materials requires 100% dryness. Moisture reduces the quality of restorations. Thus a rubber dam is to be applied to keep the operated area dry.

It is an object of the invention to propose a dental medicine device avoiding the aforesaid drawbacks. A further object of the invention is a dental medicine device which simplifies the matrix band installation in dental restoration procedures. Still a further object of the invention is a dental medicine device that is versatile and enhances the quality of restoration procedures.

To this effect, the dental medicine device according to the invention complies with the definitions given in the claims.

Accordingly, where the expandable means comprise inflatable flexible container means for urging the wall molding means against the decayed tooth wall, an even  
5 pressure may be applied to the wall molding means upon mere inflation of the inflatable flexible container means, whatever the discontinuities, convexities or concavities of the tooth contour. There is no more risk of having the wall molding means poorly or loosely  
10 applied to the tooth contour, which eliminates the risk of surplus or overhangs of restorative material between the wall molding means and the tooth. As the inflatable flexible container means are deformable with high elastic memory, the distribution of force is not limited  
15 to the attachment of the teeth to the bone, the risk of trauma at this level is strongly reduced, and there is no risk of losing the force created by the inflatable flexible container means which cannot slip out of the interdental space. Insertion of the inflatable flexible  
20 container means into the space between the teeth may be made with the inflatable flexible container means in deflated condition through the spacing created between the teeth by the restoration cavity preparation, with no risk of injury at interdental papilla level. The  
25 expansion of the inflatable flexible container means is fully controllable, merely depending on inflation which may be obtained by simple and reliable inflation fluid supplying means such as for example a syringe or a pump. Of course, inflation fluid may be a liquid or a gas,  
30 whatever the nature of its generation. The practitioner may at any time raise or reduce the pressure exerted by the inflatable flexible container means as well as he may easily interrupt the inflation procedure to modify the positioning of the wall molding means before the  
35 restorative material filling procedure. And withdrawal of the inflatable flexible container means is simplest,

being sufficient to deflate them for having them out of the interdental space. And as the inflatable flexible container means precisely and efficiently position and hold the wall molding means where needed, there is no  
5 more need for a tensioner or matrix holder or retainer for initial positioning of wall molding means such as matrix bands.

Where the inflatable flexible container means are  
10 elongated, it becomes possible to partly surround the tooth being restored in order to place the inflatable flexible container means into the interdental space on either side of the tooth for holding the wall molding means on both sides of said tooth to restore decay of  
15 said both sides. In such a condition, the inflatable flexible container means, in addition to forcing the teeth apart from one another, elongate the tooth being restored in a direction opposite to the tooth holding apparatus. Such an elongation solicits the elastic  
20 memory of the tooth holding apparatus which will retract the tooth in its original position upon release of the force. Accordingly, there will be more room on either side of the tooth for the restorative procedure, and the teeth will recover a close contact preventing food  
25 impaction. Such an elongated inflatable flexible container means may have one end closed and another end open for connection to a fluid supply source for ease of manufacture and ease of use without interference of the fluid supply source in the buccal environment of the  
30 restoration site.

The inflatable flexible container means may have a first portion with a first outer diameter and at least a second portion with a second outer diameter, said first  
35 and second outer diameters different from one another,

which configuration will allow easy matching of various dental configurations.

Where the inflatable flexible container means form an  
5 enclosure wherein a side wall thereof has an opening for connection to a fluid supply source, the device fully surrounds the tooth thereby becoming also applicable to restoration of a tooth without relying on interdental spacing and adjacent tooth to house and support the  
10 inflatable flexible container means.

Preferably, the inflation flexible container means have a substantially circular cross-section for ease of manufacture, and simplest adaptability to local  
15 conditions as, upon inflation that basic circular cross-section easily deforms in accordance with the contour of the room available around the tooth being restored.

The inflatable flexible container means may comprise  
20 means for supplying luminous energy to be effective for light curing of composite resin restorative materials. Within this frame, the inflatable flexible container means may comprise two lumina extending longitudinally therethrough wherein the luminous energy supplying means  
25 are arranged in one of said lumina the other lumen being connected to a fluid supply source, whereby there is no interference between the luminous energy arrangement and pressure setting equipment for the inflatable flexible container means. Also a one-lumen system is feasible  
30 since non-toxic natural enzyme derived, in situ activateable bio, respectively chemiluminescence, fluid can be used not only as light producing and transmitting means but also as pressure transmitting medium.

When the wall molding means are independent from the inflatable flexible container means, standard matrix material such as matrix bands may be used.

- 5 When the inflatable flexible container means are integral with the wall molding means, insertion of the whole in one step into the interdental space as well as removal therefrom also in one step greatly simplify matters for the practitioner. Respective positioning  
10 between inflatable flexible container means and wall molding means is systematic. In that case as well, the wall molding means may be formed of a matrix band.

When the wall molding means are formed by a wall of the  
15 inflatable flexible container means, simplification in handling and manufacturing goes even further, and a further step is achieved towards universality.

These and other objects, features and advantages of the  
20 invention will become readily apparent from the following detailed description with reference to the accompanying drawings which show, diagrammatically and by way of example only, preferred but still illustrative embodiments of the invention.

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Figures 1-3 are perspective views illustrating a tooth prepared for restoration, prior art matrix band/wedge installation, and resulting restoration.

- 30 Figure 4 is a side view of a first embodiment of the invention.

Figures 5 and 6 are perspective views of a tooth prepared for restoration with the first embodiment of  
35 Figure 4 and resulting restoration.

Figures 7 and 8 are top plan views of teeth prepared for restoration with the embodiment of Figure 1.

Figures 9 and 10 are elevational views illustrating the  
5 mode of operation of the embodiment of Figure 4.

Figure 11 is a side view of a second embodiment of the invention.

10 Figure 12 is a top plan view of a third embodiment of the invention.

Figure 13 is a top plan view of a fourth embodiment of the invention.

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Figure 14 is a cross-sectional elevation of a fifth embodiment of the invention.

Figure 15 is a cross-sectional elevation of a sixth  
20 embodiment of the invention.

Figure 16 is a cross-sectional elevation of a seventh embodiment of the invention.

25 The tooth 1 shown in Figure 1 has decay 2 on opposite sides thereof and presents a conventionally stepped cavity preparation 3 for restoration purposes.

As shown in Figure 2, restoration is being made with a  
30 matrix band 4 and two prior art wedges 5 have been forced between the tooth being restored and adjacent teeth (not shown) to cause the matrix band to be pressed against the tooth 1 at the floor 6 of the approximal cavity preparation 3. In the example shown, the cavity  
35 preparation 3 ends on a concave portion 7 of the tooth 1, and as a result, the wedges 5 cannot provide more

than a tangential contact between the matrix band 4 and the tooth 1. As shown in Figure 3, as the matrix band 4 cannot apply against the concave portion 7 of the tooth, the restorative material 8 inserted into the cavity preparation 3 causes an overhang 9 of surplus restorative material 8.

The first embodiment of the invention shown in Figure 4, comprises inflatable flexible container means formed by an elongated balloon 10 the end 11 of which tapers to terminate in a closure tip 12. The other end 13 is open and connected to a duct 14 connected to an inflation fluid supply source, in this example a syringe 15. Preferably, the balloon 10 is made of a polyamid such as nylon, and it has a circular cross-section. Other materials, eg. PET, and/or other cross-sectional geometries, e.g. tringular, are possible.

As shown in Figure 5, a tooth 16 having decay 17 on opposite sides thereof presents a conventionally stepped cavity preparation 18 for restoration purposes. Mesial-occlusal-distal (MOD) restoration is made with a conventional matrix band 19 and the balloon 10 of Figure 4 has been applied in part surrounding relationship to the tooth 16, between the tooth 16 and the adjacent teeth (not shown), so as to apply the matrix band 19 against the tooth 16 upon inflation thereof. In the example of Figure 5, the cavity preparation 18 ends in a concave portion 20 of the tooth 16. Upon inflation, the balloon 10 evenly applies the matrix band 19 against the tooth 16, closely following the concave portion 20. Figure 6 shows that, under such conditions, the restorative material inserted into the cavity preparation 18 properly seats at the margin floor 22 of the cavity preparation, without any overhang of surplus restorative material 21.

Figure 7 shows the balloon 10 of Figure 4 as applied around a matrix band 23 in part surrounding relationship to a tooth 24, between the tooth 24 and adjacent teeth 25 and 26. Tooth 24 has decay facing adjacent teeth 25 and 26 and MOD-cavity preparation 27 ends in concave portions 28 of the tooth 24. Figure 8 shows the same configuration as Figure 7 except that the decayed tooth 29 has decay facing adjacent teeth 30 and 31 and MOD-cavity preparation 32 ends in convex portions 33 of the tooth 29. In both the cases of Figures 7 and 8, the inflated balloon 10 properly and evenly applies the matrix band 23 against the central tooth 24 and 29.

Figures 9 and 10 illustrate further details of the mode of operation of the embodiment of Figure 4.

As shown in Figure 9 balloon 10 is arranged against a matrix band 34 in part surrounding relationship to a tooth 35, between tooth 35 and adjacent teeth 36 and 37. Upon inflation, initially circular cross-section of balloon 10 deforms substantially triangularly in accordance with the contour of interdental space 38 between tooth 35 and adjacent teeth 36 and 37. Accordingly, inflated balloon 10 bears against the interdental papilla and tooth holding apparatus 39 simultaneously to bearing against tooth 35 and adjacent teeth 36 and 37. As a result of force repartition, balloon 10 urges the teeth 36 and 37 apart from tooth 35 as shown by arrows 40. Simultaneously, balloon 10 urges or elongates tooth 35 in a direction opposite to tooth holding apparatus 39 as shown by arrow 41. Matrix band 34 is closely applied to the MOD-cavity preparation 43 and cannot slip out of interdental space 38. As shown in Figure 10, after the filling procedure of tooth 35, balloon 10 is deflated and withdrawn from interdental

space 38. Matrix band 34 is also withdrawn from interdental space 38. As teeth 35, 36 and 37 are no more subjected to pressure of balloon 10, the elastic memory of tooth holding apparatus 39 periodontal ligaments will retract teeth 35, 36 and 37 in their original position as shown by arrow 44 and arrows 45, respectively. A tight contact 46 is thus assured between teeth 35, 36 and 37, preventing food impaction between the teeth at that level.

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The second embodiment of the invention shown in Figure 11 comprises inflatable flexible container means formed by an elongated balloon 47 with circular cross-section and having a first portion 48 with a first outer diameter 49 and a second portion 50 having a second diameter 51 smaller than first outer diameter 49. Second portion 50 tapers at its end 52 to terminate in a closure tip 53. The free end 54 of first portion 48 is open and connected to a duct 55 connected to inflation supply means formed by a syringe 56. Preferably balloon 47 is also formed of a polyamid.

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The third embodiment of the invention shown in Figure 12 comprises inflatable flexible container means forming an enclosure 57 a side wall of which has an opening 58 for connection with a fluid supply source (not shown) via a duct 59. Enclosure 57 is formed of a plurality of tubular polyamid segments 60 welded to one another in a polygonal suite and communicating with one another and with duct 59.

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The fourth embodiment of Figure 13 also comprises inflatable flexible container means forming an enclosure 61 a side wall portion of which has an opening 62 for connection to a fluid supply source (not shown) via a duct 63. Enclosure 61 is substantially toric, being

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formed of polyamid by known molding techniques. Cross-section of enclosure 61 is circular.

The fifth embodiment of Figure 14 comprises inflatable  
5 flexible container means formed by a polyamid balloon 64 having a substantially triangular cross-section. Balloon 64 has two lumina 65 and 66, lumen 65 being for connection to a fluid supply means (not shown), and lumen 66 containing luminous energy supplying means such  
10 as, for example, a fluid which can be activated by means of bio, respectively chemiluminescence, to produce curing light to polymerize the bonding agent and the first incremental composite resin insertion at the margin of the proximal cavity floor, the fluid  
15 containing light reflecting flakes 67 distributed therein.

In the embodiment of Figure 15, an elongated polyamid balloon 68 is longitudinally affixed, for example  
20 adhesively or by welding as at 69, to a matrix band 70, being thus integral therewith.

In the embodiment of Figure 16, an elongated polyamid balloon 71 has a substantially triangular cross-section.  
25 One wall 72 of such a balloon, which extends beyond the triangular section, forms a matrix band configuration or wall molding means which will be pressed against the tooth upon inflation of the balloon 71.

30 Variants are available without departing from the scope of the invention.

For example, a short pad-like balloon may be used instead of the elongated balloon configuration shown,  
35 for situations where the device is for use in restoration of only one side decay of a tooth, i.e. so-

called mesial-occlusal (MO) or occlusal-distal (OD) cavity situations.

5 Cross-sections of the inflatable flexible container means described as circular may be other than circular, and similarly cross-section described as triangular may be circular or otherwise.

10 In the embodiment of Figure 11, there may be more than two portions of different diameter.

15 In the embodiment of Figure 14, the balloon may have only one lumen for the fluid supply and the luminous energy supply means. Same the luminous energy supplying means may be other than light reflecting flakes, for example, chemical components.

20 And of course other materials than polyamid may be used to form the inflatable flexible container means.

25

## CLAIMS

1. A dental medicine device for pressing a wall molding means (19, 23, 34, 70, 72) against a decayed  
5 tooth wall for restoration thereof, comprising expandable means for urging said wall molding means against the decayed tooth wall to hold restorative material inserted into the tooth, characterized in that the expandable means comprise inflatable flexible  
10 container means (10, 47, 57, 61, 64, 68, 71) for urging the wall molding means (19, 23, 34, 70, 72) against the decayed tooth wall.
2. A device according to claim 1, wherein said  
15 inflatable flexible container means (10, 47, 64, 68, 71) are elongated.
3. A device according to claim 2, wherein the elongated inflatable flexible container means (10, 47)  
20 have one end (12, 53) closed and another end (13, 54) open for connection to a fluid supply source (56).
4. A device according to any of claims 1 to 3, wherein the inflatable flexible container means (47) have a  
25 first portion (48) with a first outer diameter (49) and at least a second portion (50) with a second outer diameter (51), said first and second outer diameters (49, 51) different from one another.
- 30 5. A device according to claim 1, wherein said inflatable flexible container means form an enclosure (57, 61), and wherein a side wall thereof has an opening (58, 62) for connection to a fluid supply source.

6. A device according to any preceding claim, wherein the inflatable flexible container means (10, 47, 57, 61, 68) have a substantially circular cross-section.

5 7. A device according to any preceding claim, wherein the inflatable flexible container means (64) comprise means (67) for supplying luminous energy.

8. A device according to claim 7, wherein the  
10 inflatable flexible container means (64) comprise two lumina (65, 66) extending longitudinally therethrough, and wherein the luminous energy supplying means (67) are arranged in one (66) of said lumina, the other lumen (65) being connected to a fluid supply source.

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9. A device according to any preceding claim, wherein said wall molding means (19, 23, 34) are independent from said inflatable flexible container means (10, 47, 57, 61, 64).

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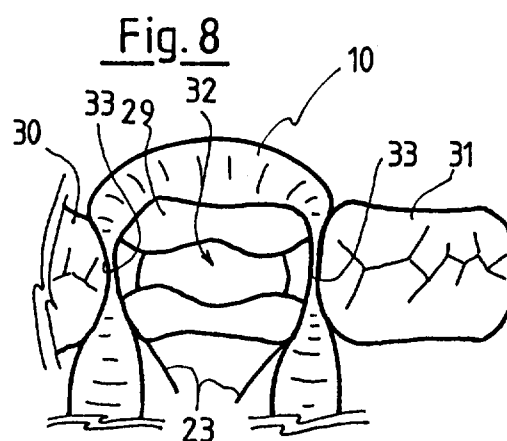
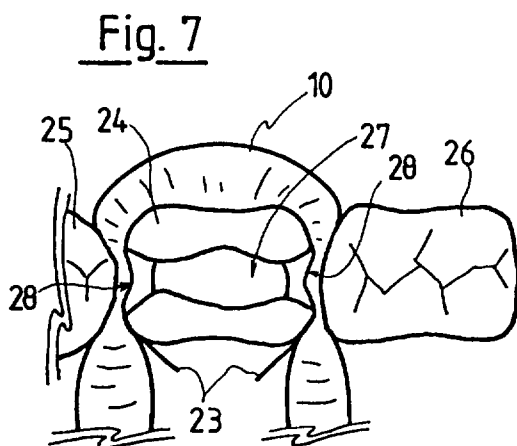
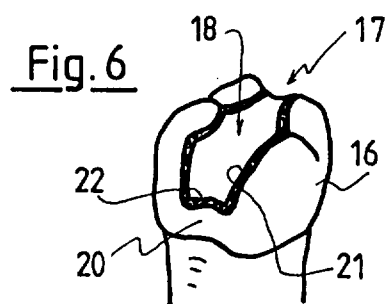
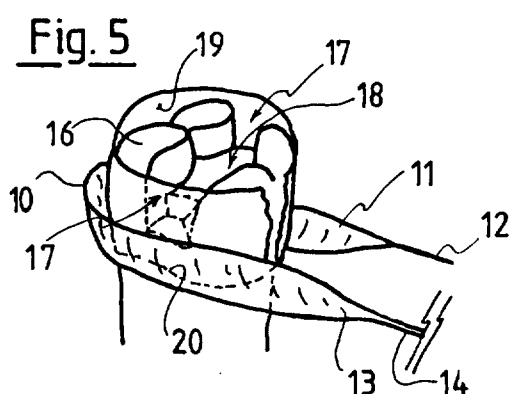
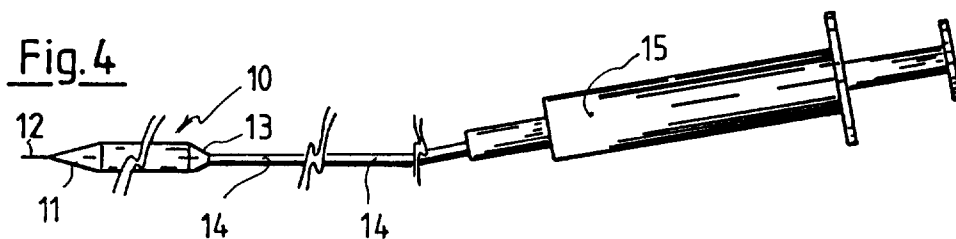
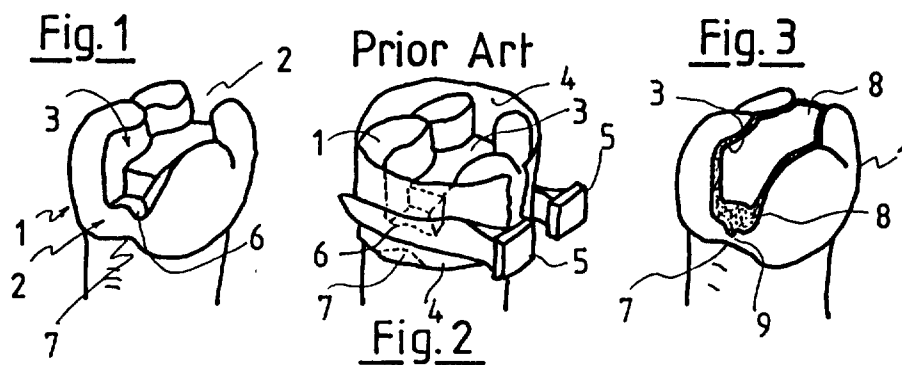
10. A device according to any preceding claim, wherein the inflatable flexible container means (68, 71) are integral with said wall molding means (70, 72).

25 11. A device according to any of claims 9 or 10, wherein said wall molding means comprise a matrix band (19, 23, 34, 72).

12. A device according to any of claims 1 to 8, wherein  
30 the wall molding means (72) are formed by a wall of the inflatable flexible container means (71).

13. A device according to any preceding claim, wherein  
35 the inflatable flexible container means (10, 47, 57, 61, 64, 68, 71) are made of a polyamid.

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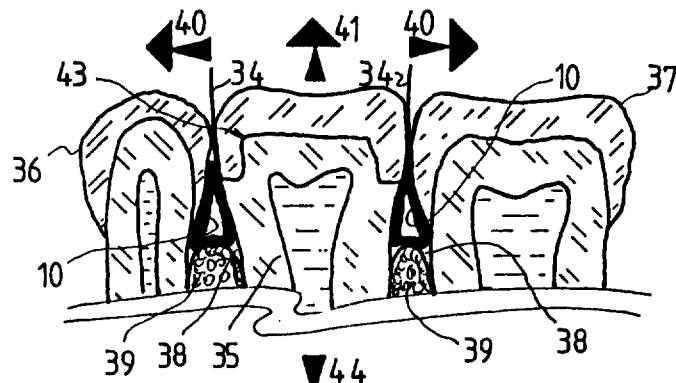


Fig. 9

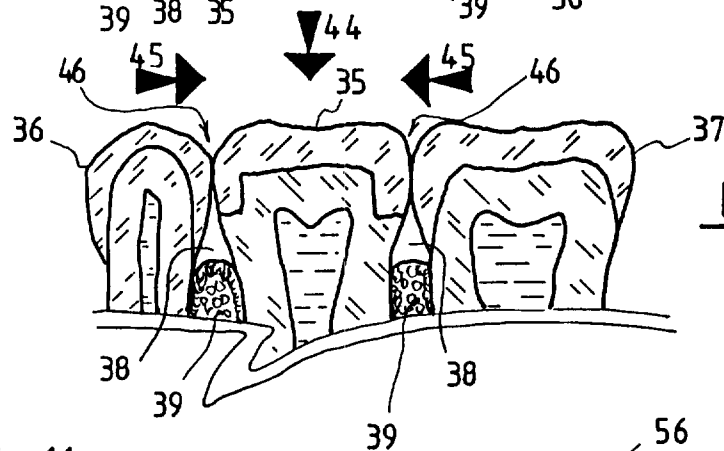


Fig. 10

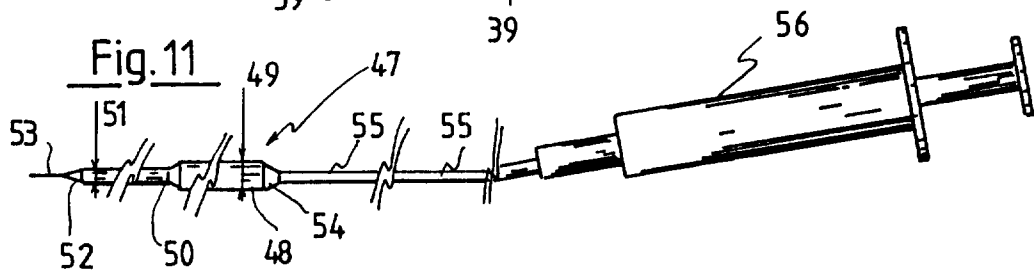


Fig. 11

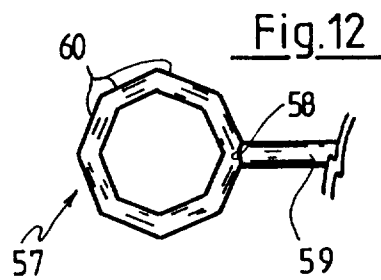


Fig. 12

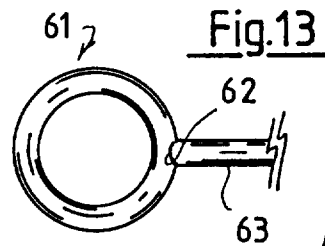


Fig. 13

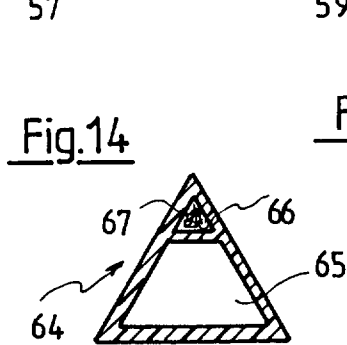


Fig. 14

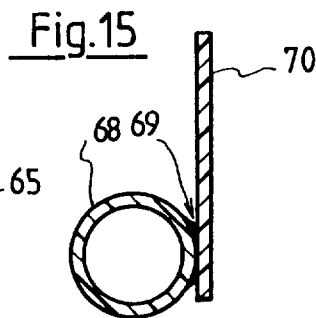


Fig. 15

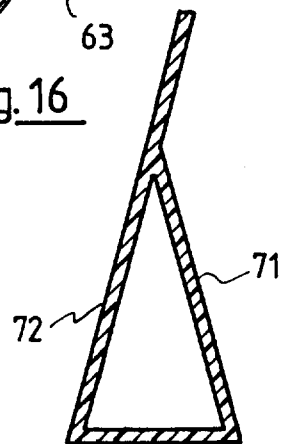


Fig. 16