Nov. 19, 1968 H. J. LAZARUS 3,411,214

DENTAL APPLIANCE

Filed May 16, 1966 2 Sheets-Sheet 1

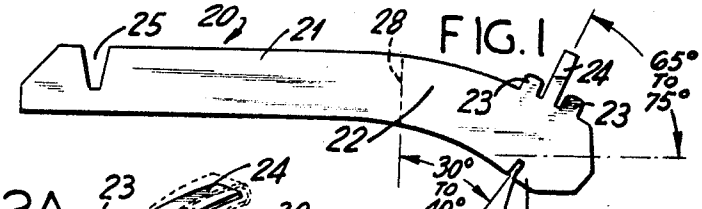


FIG. 1

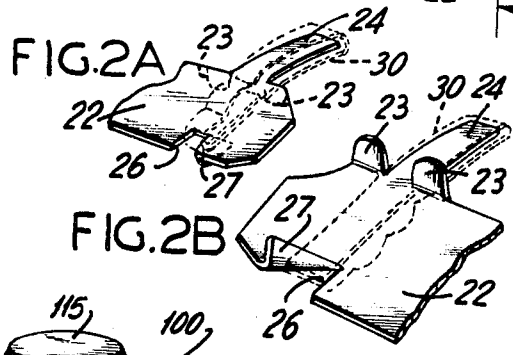


FIG. 2A

FIG. 2B

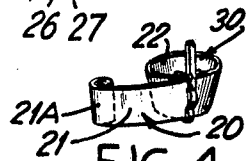


FIG. 4

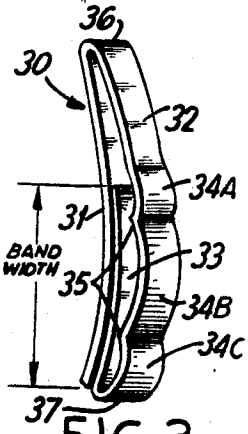


FIG. 3

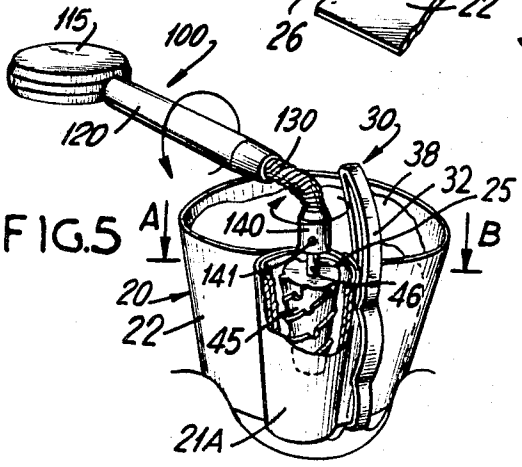


FIG. 5

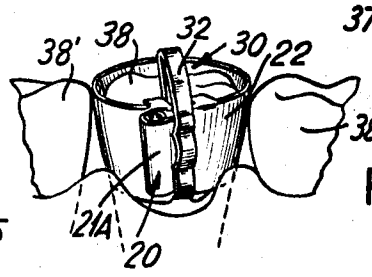


FIG. 6

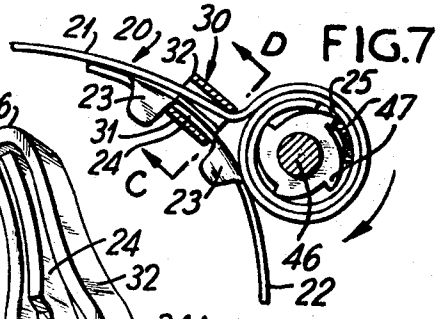


FIG. 7

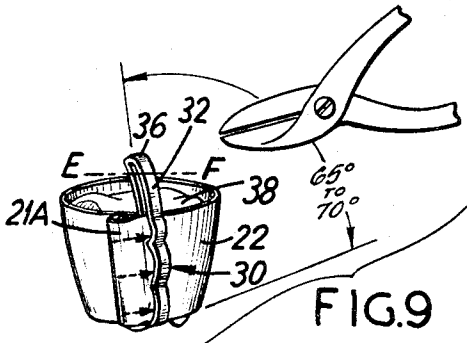


FIG. 9

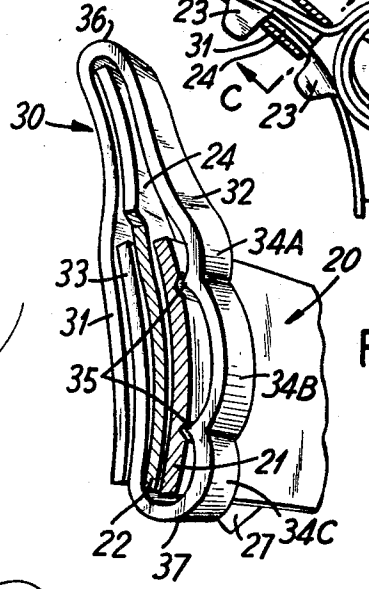


FIG. 8

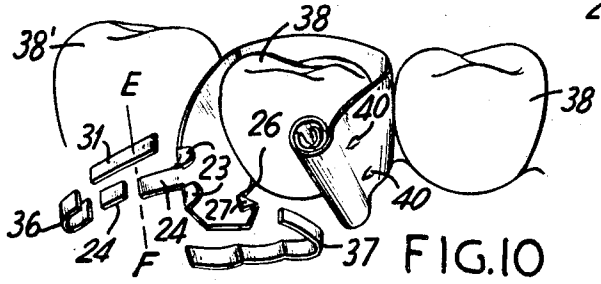


FIG. 10

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DENTAL APPLIANCE

Filed May 16, 1966 2 Sheets-Sheet 2

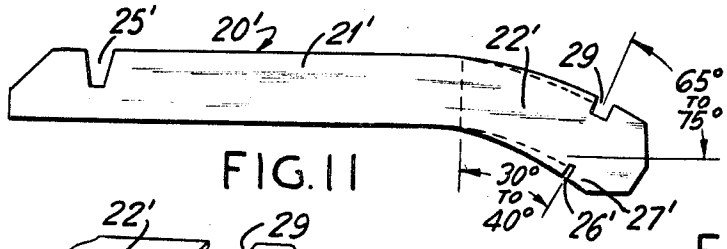


FIG. 11

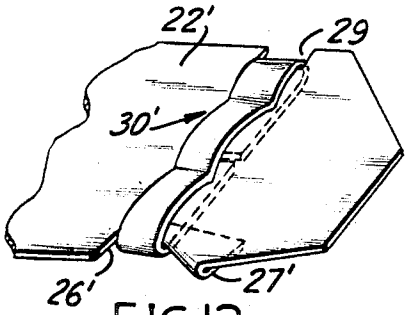


FIG. 13

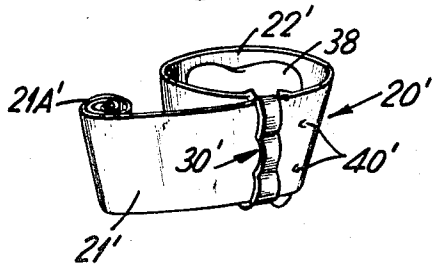


FIG. 15

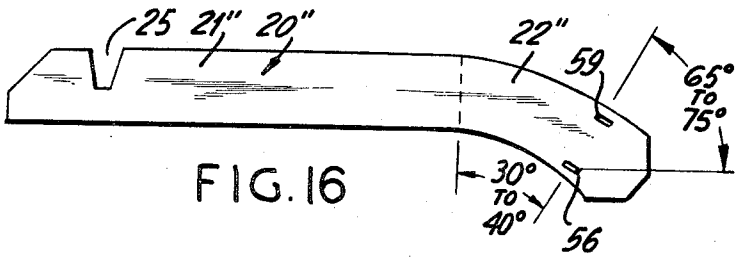


FIG. 16

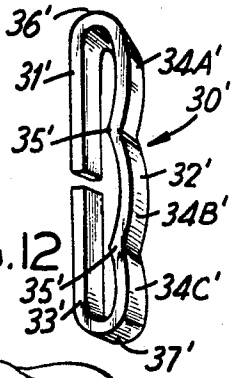


FIG. 12

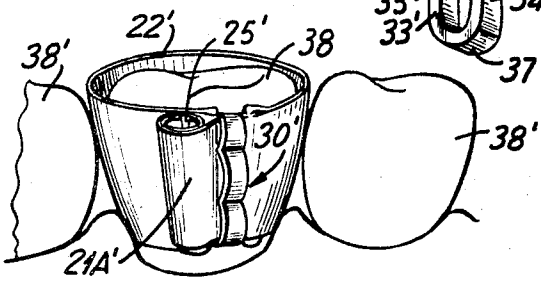


FIG. 14

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United States Patent Office 3,411,214 Patented Nov. 19, 1968

3,411,214

DENTAL APPLIANCE

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Filed May 16, 1966, Ser. No. 550,189
23 Claims. (Cl. 32—63)

ABSTRACT OF THE DISCLOSURE

A dental appliance for tooth matrix work comprises a unit consisting of a flexible metal band and a flattened loop metal bridge anchored transversely of the band adjacent one end the other end extended therethrough to form a circlet. One end of the band has a formation engageable with a rotatable winding member inserted into the inner convolution of a coiled portion of the band, for winding of the band to draw the circlet into tight conforming engagement about the tooth. The tool may be removed from the band with locking ridges on the bridge engaging in indentations in the band to hold the band tightly around the tooth. For removal of the band, the bridge is easily severed.

Background of the invention

This invention relates to bands adapted to be applied to teeth for use in dental matrix work and, more particularly, to an improved and simplified band of this type which may be applied more easily to a tooth, which has a more closely conforming fit with the tooth, and which may be readily, easily and simply disengaged and removed from the tooth when no longer needed.

In reconstruction of carious tooth surfaces, a tight anatomically self-contouring matrix band is required. This is particularly true at the interproximal gingival and sub-gingival portion of the tooth to be rebuilt or restored. The matrix acts as an anatomical tooth-encircling retaining wall for the amalgam that restores the carious surfaces of a tooth to its original anatomy. These surfaces are restored with silver amalgam or other suitable material which is plugged or forced into open and cleansed cavities while the plugging material is malleable. This anatomically formed matrix retains the shape of the restorative material until the same hardens, usually in minutes.

While contoured matrix bands have been used in the prior art, they have been subject to numerous disadvantages. For example, known bands of this type have required a retaining tool or the like to hold them in position after they are placed on the tooth, and this retaining tool has to remain in the mouth, along with the band, until the restorative work has been completed. The presence of the retaining tool in the mouth is very disadvantageous, as will be readily apparent. For example, such a retainer will lie across the surface of interproximal areas preventing insertion of wodges, and also interfering generally with work on the tooth. The retaining tool in the mouth not only restricts the clear field of vision for the dentist, but also restricts the space for manipulation and maneuvering necessary in doing the necessary work.

In addition, the bands as used hitherto have prevented the dentist from working on more than one restoration at a time. Attempts to do this have failed for the most part because of the protrusion of the retaining tools remaining in the mouth during the work period time. These present an obstacle which the dentist must work around. While, in view of these difficulties, matrix bands have been provided without the presence of a retaining tool, these have generally been very unsatisfactory in practice.

Bias cut bands are usually used because it is not feasible, with many tooth formations, to tighten a straight band sufficiently to conform it to the tooth without the banding

material fitting loosely at the sub-gingival. Thus, a straight band will result in a non-anatomical restoration.

It is essential in restorative dentistry that all restorations make positive contact with their abutting teeth, which amounts to a restoration of the tooth's former contact point. If the contact point is not restored, the space permits the passage of food between the adjacent teeth and into the interproximal gingival tissue, resulting in peridontal disease. As practiced hitherto, a dentist attempts to make such contact by burnishing of the matrix band in the mouth, but this has only limited success.

Furthermore, matrix bands have been used with bridge members or loops whereby the band may be drawn tightly around a tooth. However, the bridge members used hitherto in combination with these bands have likewise been disadvantageous. For example, such bridges cannot be removed, to release the band, without breaking the marginal ridges or edges of the newly placed filling in the tooth, and such fillings are often broken by removal of bridge-type or other types of matrices after the restoration is completed. Still other matrices are not designed to be cut open, and do cause broken fillings. With respect to bias cut conical matrices, it should be noted that these have little value unless some means is applied for tightening the same and drawing off all surplus material surrounding the tooth, as well as locking the bands sufficiently tight to prevent loosening of the band as the result of working pressure during filling of the tooth.

The object of the present invention is to provide a matrix which embodies such design as to afford a tight sub-gingivally fitted adaptation which when locked fast to the tooth constitutes a means which results in an anatomically formed restoration upon plugging of the amalgam.

Another object is to obtain an immobile intimate anatomical contact between the matrix and the sub-gingival portion of the tooth, with no undesirable spaces between said matrix and said tooth, thus preventing restorative material from extruding from spaces between the matrix and the tooth into the sub-gingival areas when plugging pressures are applied to the restorative material. This latter occurrence is called "overhang" which, in excess, causes peridontal disease.

A further object of this invention is to provide an anatomically adaptable matrix band having a bias or curved section which is the encircling portion of the matrix and takes the form of a conical shape, the smaller end of this conical configuration being applied to the gingival portion of the tooth.

Another object is to provide a band in flat blank form that when formed into a circlet takes the form of a truncated cone for close sub-gingival adaptation to the tooth.

A further object of the invention is to provide means to hold the band in circular formation for application to a tooth, this means comprising a bridge or loop arranged to cooperate in self-locking of the tightened band about the tooth and made of material thin enough so that it can be cut with the delicate tools used in dentistry, for the purpose of removing the band after restoration of the tooth surfaces is completed and the matrix is no longer needed, the bridge being further designed to prevent deformation during normal use and to provide clear visibility for the dentist as well as accessibility to the cutting area of the bridge.

Another object of the invention is to provide a dental band of the mentioned type which is contoured for cooperation with a novel winding tool by means of which it may be tightened into conforming relation with a tooth.

Yet a further object of the invention is to provide a matrix band which is combined with a novel bridge structure through which an end of the band is drawn and

which has a coiled formation at one end beyond the novel bridge structure whereby a coil winding member may be inserted into the coil to wind the band into tight conforming relation around the tooth, with the bridge member retaining the band against loosening until the bridge member has been removed or cut away.

Still another object of the invention is to provide, in a matxric band, an automatic self-locking arrangement which will retain the tight fit of the matrix band around the tooth and which does not need any attention whatsoever by the dentist and wherein the dentist may remove the winding tool without interfering with the self-locking of the band around the tooth.

Still a further object of the invention is to provide a novel dental band of the mentioned type in combination with a novel bridge member, with the band being formed in such manner as to assure accurate angular fastening of the bridge member on the band for the purpose of creating equal pressure of the coil against the bridge as the coil is being wound, thus relieving the full pressure from the gingival portion of the bridge which otherwise would tear the bridge from its anchorage on the band during normal use.

Another object of the invention is to provide both an easily engageable and subsequently an easily removable coil winding member.

A further object is to provide a winding means to tighten the coil on the band in such manner that the winding means will never bind inside the coil, as distinguished from slotted winding members which fail because they deform the material being coiled inside the slot, thereby jamming the material inside the slot and inhibiting removal of the slotted tool from the coil.

In accordance with the present invention, a bias band is provided initially in the form of a flat strip of flexible metal and having a suitable curvature or bias such that it will, when bent around a tooth and tightened, fit the tooth more properly than bands constituted by straight or rectilinear blanks. As previously stated, it is not feasible, with many tooth formations, to tighten straight bands sufficiently to conform to the tooth without the banding material fitting loosely at the sub-gingival, thus resulting in a non anatomical restoration.

More particularly, the matrix band of the present invention is supplied in the form of a circlet having a partially pre-wound coil at one end and with a bridge member holding the matrix in a circlet formation. In order to draw off all surplus tooth-encircling material, a coil winding member is inserted into the coil and rotated in a selected direction to effect further winding of the preformed coil. This coil is wound until it makes contact with the bridge structure, and further rotation draws off all surplus banding material that is encircling the tooth. The surplus material passes under the bridge and forms around the rotating coil. The winding is continued to such an extent as is necessary to secure a conforming fit to the tooth, resulting in an intimate sub-gingival anatomical adaptation preventing the extrusion of restorative material. The self-locking is accomplished by the bridge and coil working in combination with each other.

The winding member is so designed that, when rotated in a direction opposite to the coil winding direction, it is automatically released from its previous locking engagement within the coil. Thereby, the winding member and the tool for operating the same may be removed from the coil and from the mouth of the patient.

The arrangement of the present invention has a particular advantage in that more than one restoration may be packed at a time. In the past, attempts to do this have failed, for the most part, because of the protrusion of tools left in the mouth during the work period time and presenting an obstacle which the dentist must work around. With the present arrangement, any number of matrices may be applied to any number of teeth simultaneously or concurrently, and no tools are left in the mouth. This permits multiple or quadrant restorations.

To facilitate winding of the coil and thus drawing of the band into tight conforming engagement with the tooth, the preformed coil has a notch or leading edge designed to be engaged by teeth on a conical coil-winding member. This winding member will effectively engage the notch only when rotated in a selected direction, such as clockwise. Upon continuation of the winding in a clockwise direction with tightening of the coil against the bridge, the matrix is locked firmly on the tooth by an automatic locking arrangement which does not require any attention whatsoever from the dentists. The winding member has helically arranged ratchet teeth designed to engage only when the winding member is rotated in the selected direction, such as clockwise, so that the winding member will automatically and subsequently be fully disengaged when rotated in the opposite direction, such as counterclockwise.

For an understanding of the principles of the present invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a plan view of the novel band of the invention;

FIGS. 2*a* and 2*b* are partial plan views, of opposite surfaces, of the band shown in FIG. 1, illustrating the anchoring of the bridge to the band;

FIG. 3 is a perspective view of the bridge;

FIG. 4 is a perspective view illustrating the combined band, as it is supplied to the dentist with its preformed coil and bridge, as arranged to be applied to a tooth but before tightening of the matrix band;

FIG. 5 is a perspective view, partly broken away, illustrating the tightening of a coil and thus the matrix band by a winding tool;

FIG. 6 is a perspective view illustrating the band and its associated bridge and coil as applied to a tooth with the coil wound tight and the matrix fully tightened;

FIG. 7 is a sectional view taken on the line A–B of FIG. 5;

FIG. 8 is a sectional perspective view taken on the line C–D of FIG. 7;

FIG. 9 is a perspective view illustrating the band, as applied to a tooth, and just before the bridge is severed, as by a pair of nippers, for easy removal of the matrix band from the tooth;

FIG. 10 is a perspective view illustrating the appearance of the band as it springs open and free of the tooth after severing of the bridge;

FIG. 11 is a plan view of a band, embodying the invention, intended as a re-usable matrix;

FIG. 12 is a perspective view of a bridge useful with the band of FIG. 11;

FIG. 13 is a partial perspective view illustrating the application of the bridge to the band;

FIG. 14 is a perspective view illustrating the band of FIG. 11, with its associated coil and bridge, as applied to a tooth;

FIG. 15 is a perspective view of the band illustrating the uncoiling of the coil thereof preparatory to loosening of the circlet section from the tooth for subsequent removal of the band from a tooth; and

FIG. 16 is a plan view of a modified form of band, embodying the invention, intended as a re-usable matrix, with the band having rectangular bridge-holding slots near the outer and inner edges of the arcuate portion of the band.

Reference will be made first to the embodiment of the band which is in the form of a disposable pre-sterilized matrix, as shown in FIGS. 1 through 10.

The disposable matrix **20** illustrated in FIG. 1 is a die-cut metal strip having a straight or winding portion **21** and a bias or arcuately curved portion **22**. Strip **20** may be formed of any suitable metal, and a preferred material is

stainless steel. The stainless steel may be 0.002 inch thick and may be "one quarter hard", although other gauges and other hardness or slight variations thereof will also function properly.

The straight portion **21** is a band coiling or winding portion arranged to tighten the curved portion **22** around a tooth. This curved portion **22** extends through a predetermined arc such as, for example, 30° to 40°. The termination of the arc is indicated as the center line between a pair of relatively short tabs **23** which project from the outer arcuate surface of portion **22**. Between these tabs there extends a relatively elongated finger **24** which lies at an angle of 65° to 75°, as shown in FIG. 1, and which is separated from the tabs **23** and which is for a purpose to be described.

In alignment with the inner end of finger **24**, a relatively narrow notch **26** is formed in the inner arcuately curved surface of portion **22** to define a bendable tab or flap **27**. For a purpose to be described, a relatively deep and substantially trapezoidal notch **25** is formed in the "upper" edge of the straight portion **21** of band **20**, adjacent the free end of portion **21**. When the band is supplied to a dentist, the band is in the form of a circlet with a pre-formed coil as seen in FIG. 4. This coil receives a winding tool engageable with notch **25**.

The curved portion **22** is designed to form a substantially frusto-conical matrix surrounding the tooth and encircling the same, with its inner arcuate edge at the gingival portion of the tooth. Near the leading edge of the arcuate section, bendable tabs **23**, in conjunction with the notch **26** and the bendable flap **27**, are arranged to hold a bridge **30** in position on the band, and the finger **24** extends into the bridge as will be described.

Referring to FIGS. 2*a* and 2*b*, the operation of the tabs **23**, finger **24**, notch **26** and flap **27** will be clear. The tabs **23** are both bent from the same surface of band **20** and extend on opposite sides of the bridge **30**, indicated in dotted lines. Alternatively, they both may be bent from the opposite surface of the strip or band **20**, or one may be bent outwardly from one surface and the other tab **23** outwardly from the other surface. These bent tabs **23** hold bridge **30** in its angular position on the band portion **22** and prevent lateral displacement of the bridge when the bridge is placed under working pressures. As the bridge is affixed to portion **22** of band **20**, the leg **33** and bight **37** are drawn upwardly and this bends the flap **27** upon itself within the bight **37** of the bridge engaging between the remaining edge of the notch **26** and the bent edge of flap **27**. The bending of the flap **27** provides a double thickness of metal resisting movement of the bridge **30** or tearing of the bridge from its anchorage on the curved part **22** of the band.

After bridge **30** is affixed to portion **22**, the matrix is formed into a circlet by passing portion **21** through space between the inner side of leg **32** of bridge **30** and overlapping portion **22** of the matrix, thus forming the tooth encompassing circlet. Thus, portion **21** overlaps portion **22** as seen in FIGS. 4, 5, 6 and 8. The leading end of portion **21** is drawn through and under bridge **30** and up to dotted line **28** of FIG. 1. Then the entire portion **21** is wound into a clockwise coil **21**–A by winding portion **21** on a mandrel in manufacture, as clearly shown in FIG 4, thus forming a predetermined coil core diameter with notch **25** exposed within the inside of wall of coil core, the purpose for which such requirements will be later described. The matrix is supplied to the dentist in its circlet form and precoiled, as above described and as shown in FIG. 4.

Referring to FIG. 3, bridge **30** includes an elongated longitudinally arcuate leg **31** having a length substantially greater than the width of band **20**. Leg **31** is joined at an upper bight **36** to a second leg **32** which is joined, at a lower bight **37**, to an inner leg **33**. Leg **32** has a length substantially equal to that of leg **31**, whereas the length of leg **33** is substantially equal to the width of band **20**. It will be noted that the outer surface of the inner leg **33** lies against the inner surface of leg **31**. Leg **32** is formed with longitudinally extending rises or arches **34***a*, **34***b* and **34***c*. The arches or rises **34***a* and **34***c* prevent the edges of band or matrix **20** from engaging the edges of bridge **30**, thereby preventing shearing of the coil or matrix when the latter is in process of being wound up and tightened. The intersections of central arch **34***b* with the end arches **34***a* and **34***c* form relatively sharp locking ridges **35** which dig into band **20** as the latter is tightened, thereby preventing loosening of the band.

It will also be noted that the portions of legs **31** and **32** that extend above the width of the band are bent into a concave formation which gives the bridge extra resistance and prevents deformation under pressure of the coils, as the coil presses against the bridge. Such deformation would be of a nature to cause bridge **30** to spread open, thus losing the rigidity needed for locking ridges **35** to dig into band **20**, as well as losing its full contact with the band. Finger **24** extends into bight **36** with its end engaging the inside of bight **36**, thereby preventing displacement of bridge **30** laterally of band **20**. The bridge thereby is held at the aforementioned angle of 65° to 75°.

As will be clear from FIGS 4, 5 and 6, the bias cut represented by the arcuate section **22** of band **20**, develops a truncated cone when the band is applied to a tooth, so as to adapt readily to the sub-gingival of the tooth. Also, the portion **21** of band **20** is pre-coiled clockwise to form the starting coil for tightening the band about a tooth. FIG. 4 illustrates the band as the dentist receives it and before the tightening is started, whereas FIG. 6 illustrates the band after the tightening has been completed. Thus, in FIG 6, the band **20** is illustrated as wrapped around a tooth **38** and extending between tooth **38** and the adjacent teeth **38'**. The band **20** just described thus forms the matrix embracing tooth **38**.

The tightening of matrix or band **20** about tooth **38** is illustrated in FIGS. 5, 7 and 8. Preferably, such tightening is effected by winding the coil **21A** against bridge **30**, preferably by the tool disclosed and claimed in my copending application Serial No. 538,397, filed on March 29, 1966, for "Tool and Method of Manufacturing Same." As set forth in my copending application, the tool **100** comprises a disk-shaped grip **115** which may be grasped in the palm of one hand of the operator, such as a dentist. Furthermore, this tool includes a stiff but bendable core which maintains the angle of drive at any desired value without the necessity of holding the flexible sleeve tool in any prebent position. Driving is effected by the dentist grasping the grip **115** in the palm of one hand and using the thumb and a finger of the same hand to rotate a relatively elongated driving sleeve **120** in a clockwise direction. A flexible sleeve **130**, which embraces the bendable core, has one end secured to driving sleeve **120** for rotation thereby and its other end anchored to a chuck **140** so that, responsive to rotation of driving sleeve **120**, chuck **140** is rotated.

A conical coil winding member **45** has a stem **46** which is anchored in chuck **140** by means of a set screw or the like **141**. The frusto-conical surface of winding member **45** is formed with a series of ratchet teeth **47**, best seen in FIG. 7, which extend in a spiral configuration about the frusto-conical surface of the winding member, as best seen in FIG. 5. These ratchet teeth **47** exert a positive driving torque when drive member **120** is rotated in a clockwise direction, whereas they slip over engaging surfaces of notch **25** when drive member **120** is rotated backwards in a counterclockwise direction, which automatically disengages winding member **45** from notch **25** inside coil **21A**. The advantage of the tool **100** is that it is a tool which is designed for one hand operation, and furthermore is a tool which is designed to retain a preset drive angle without the flexible shaft being held to retain such presetting of the angle by the other hand. Thus, tool **100** is particularly adapted for working in re-

stricted spaces, such as in the mouth of a patient where there is not room enough for two hands to grasp a winding tool.

Section **21** is pre-wound in manufacture forming coil **21A** wound up to line **28** with a preset diameter of the coil core which matches, for insertion, the diameter of coil winding member **45**.

The flexible shaft **130** of tool **100** is bent to the desired drive angle and winding member **45** is inserted into the core of the preformed coil **21***a* of band **20**, as indicated in FIGS. 5 and 7. The frusto-conical shape of winding member **45**, in conjunction with the trapezoidal shape of the notch **25** within the preformed coil, allows ready insertion and engagement of the winding member by increasing downward pressure until engagement is effected, into the preformed coil **21***a*. As winding member **45** is rotated clockwise, the abrupt uni-directionally clockwise facing edges of teeth **47** engage the leading edge of notch **25** and begin to wind up the remaining portion **21** of band **20** until the coil **21***a* wraps itself around the winding member **45** with ratchet teeth **47** biting into the entire inner core of coil **21***a*. This initial engagement of teeth **47** with leading edge of notch **25** and rotation of winding member **45** begin the development of a strong centripetal force of coil **21***a* around winding member **45** which prevents slippage of winding member **45** inside coil **21***a*. This continued rotation of the winder member attains the tightened position of the band as illustrated best in FIGS. 6 and 9. The coiled portion **21***a* wraps tightly around winding member **45**, which causes the coil **21***a* to grow larger in diameter as it draws off all the surplus matrix band material from around the tooth, and thus draws the matrix into close tight contact with the gingival portion of the tooth which aids in preventing any "overhang", as previously referred to. The above is accomplished by a combination of several factors working together automatically and in unison, now to be described as follows:

In applying the matrix to a tooth, the matrix, as shown in FIG. 4 with its oversized circlet, is placed on the tooth. Winding member **45** is inserted into coil **21***a* and tool portion **120** is wound clockwise which in turn rotates winding member **45** and thus notch **25** which begins to rotate coil **21***a* clockwise. Such winding of coil **21***a* is continued until the coil comes into contact with bridge **30**. Further rotation of winding member **45** draws all surplus banding material from about the tooth until the circlet is drawn to its desired tightness about the tooth. Such surplus forms around the ever-enlarging coil **21***a*. When all free surplus is drawn off, the continuing pull of the winding member begins to stretch the matrix material at the sub-gingival contact points. This stretching in stainless steel develops a work-hardened condition of the steel at the contact points it makes with the sub-gingival of the tooth. This hardening of the bias section **22** which encircles the tooth eliminates, by close anatomical adaptation, all objectionable spaces between the stretched matrix and the sub-gingival area of the tooth, thus aiding in preventing objectionable "overhang" by inhibiting the extrusion of amalgam.

The automatic self-locking mechanism which holds the matrix tightly about the tooth during the period of restorative work, functions as follows:

The ever-enlarging coil **21***a* draws the surplus banding material from about the tooth and through bridge **30**. The material tends to rise up towards the top of the coil, thereby pressing the material upwardly into leg **32** of bridge **30** as seen in FIG. 7. This continuing interaction of the rotation of winding member **45** and the ever-enlarging of coil **21***a* causes increasing upward pressure of material that passes under the bridge leg **32** and forcing the material to become indented by contact with the sharp locking ridges **35** of bridge **30**. This action develops indentations into the rising material as seen at **35** in FIG. 8 and at **40** in FIG. 10. These indentations develop only at such time as the matrix band is at its maximum tightness. The sharp ridges **35** dig into matrix **20** causing such indentations to become work-hardened and sufficiently rigid to prevent disengagement of indentations **40** from ridges **35**, thus forming the automatic self-locking mechanism. This locking mechanism prevents the tightened matrix from loosening under normal working pressure of the amalgam plugging. The operator or dentist need do nothing special to activate the locking means. The mere rotation of tool member **120** causes all of the above to occur automatically, rendering the matrix self-locking.

The automatic disengaging of the winding member from the coil occurs as follows:

The previous tight formation of the coil causes it to become spring-like in nature as a result of the work-hardening of the material. To disengage winding member **45** from coil **21***a*, and thus the entire tool **100** from the coil and subsequently from the mouth, only a single step need be taken by the operator. The operator merely rotates tool member **120** one-half turn counterclockwise which releases the uni-directional teeth **47** of winding member **45**, which teeth become released from their bite into the core of coil **21***a* and notch **25**. The spring-like coil **21***a* opens substantially to its original pre-formed core diameter size, when member **120** of tool **100** is rotated counterclockwise, subsequently freeing contact between the notch **25** inside the core of the coil and winding member **45**, thus enabling the removal of the winding member from the coil and subsequently from the mouth. The bite of ridges **35** into the indentations **40** is in no way released when winding member **45** and tool **100** are removed from the coil. The automatic lock caused by engagement of ridges **35** into indentations **40** remains intact. Thus, the above condition offers a clear visual field of operation as the matrix remains tightly wound about the tooth without the encumbrance of a retainer to hold the matrix in place, as in other matrices.

After band **20** is tightened around tooth **38**, the bridge **30** extends at the previously mentioned angle of from 65° to 75° as indicated. The dotted arrows in FIG. 9 show the area of equalized pressure of the coil against the bridge during tightening of the coil. This angle equalizes the pressure of the coil evenly on all areas of the bridge from the occlusal to the gingival. If the bridge were at any other angle, the total pressure of the coil would be on the gingival portion of the band alone, and the inner leg **33** would tear and destroy the band before the band could be fully tightened and usable.

After the dental work has been completed on tooth **38**, the band or matrix **20** may be readily and easily removed from the tooth. Referring to FIG. 9, a pair of nippers, such as indicated at **41**, may be used to cut bridge **30** along line E–F of FIG. 9 and just below the bight of bridge **30**. This causes the bridge to fall apart, as indicated in FIG. 10. The work-hardened and subsequently spring-like band **20** springs open for easy removal without resultant broken marginal ridges of the new semi-hardened restoration, such as often caused by other winding and unwinding devices. The band **20** and the parts of bridge **30** are then discarded.

A matrix is in its best shape and can make the best restorations when the matrix material is new and has not been used before. Thus, a good matrix is one of new material and one which has not been deformed from repeated use. Yet, for reasons of economy and the pressures of busy dental practices, some dentists demand a re-usable product to avoid reloading of other types of matrix retainers. A re-usable type of matrix band must be removed with very great extra care to avoid fracturing a new restoration. FIGS. 11 through 15 illustrate the principles of the invention as applied to a re-usable matrix. In the matrix shown in FIGS. 11 through 15, the band is substantially identical to the band of the disposable matrix shown in FIGS. 1 through 10, and the bridge is substantially similar to the bridge of FIGS. 1

through 10. Accordingly, the same reference characters primed have been used to indicate identical or corresponding parts in FIGS. 11 through 15.

The band **20'** of FIGS. 11 through 15 differs from the band of FIGS. 1 through 10 in that the tabs **23** and finger **24** are replaced by a substantially rectangular notch **29** for anchoring the bridge **30'** in position. The bias of the portion **22'** may again be of the order of the disposable bands as it pertains to its arcuate formation. The angle of notches **26'** and **29** is also of the same order as that of finger **24** of band **20** of FIGS. 1 through 10.

In the same manner as the band **20** of FIGS. 1 through 10, band **20'** is formed with the trapezoidal winding notch **25'** adjacent to the end portion **21'**, and with the narrow notch **26'** and the bendable flap **27'** in the arcuate portion **22'**.

The bridge **30'** shown in FIG. 12 is similar to the bridge **30** shown in FIG. 3, but whereas the bridge **30** of FIG. 3 has a thickness of only 0.010 inch, the bridge of FIG. 12 has a thickness of 0.019 inch.

Bridge **30'** differs from bridge **30** in that, while it has three legs, the same as does bridge **30**, none of the legs overlap each other. This bridge **30'** cannot deform in use due to its increased thickness, although the increased thickness renders it less cuttable than the thinner bridge. Thus, bridge **30'** includes the intermediate leg **32'** having the arches **34***a'*, **34***b'* and **34***c'*, providing the ridges **35'**. Bridge **30'** has a height of an order somewhat less than the width of band **20'**. Leg **31'** has a length of an order of ½ that of leg **32'** and is connected to the latter at upper bight **36'**. Leg **33'** is again connected to the leg **32'** at the bight **37'**, but has a length of only one-half that of leg **32'**. The legs **31'** and **33'** are substantially aligned and do not overlap, there being a small gap between their facing ends. Bridge **30'** is assembled with band **20'** in such a manner that bight portion **36'** is substantially disposed in slot **29**, and bight portion **37'** engages one edge of notch **26'** and bears against the bent-over flap **27'** which prevents longitudinal and lateral displacement of the bridge on the band.

The combined band and bridge are illustrated in FIG. 13, and FIG. 14 shows the application thereof to tooth **38** to form a matrix band. The application and the winding are effected in exactly the same manner as described for the embodiment of the invention shown in FIGS. 1 through 10. However, when it is desired to remove the matrix, the coiled end **21***a* is unwound, as shown in FIG. 15, thus allowing the operator, by use of an instrument, to tug at the circlet and forcefully loosen the lock. This allows opening of the circlet and loosening of band **20'** from tooth **38** so that the band **20'**, together with the bridge **30'**, can be disengaged from tooth **38** by using the greatest extra care to be sure not to fracture any new restoration.

Stainless steel bridge **30'** does not require special curves to keep its shape and cannot be used on the disposable matrix of FIGS. 1 through 10 as it is too thick and strong to be cut while in the mouth and is not designed to fit over finger **24** of band **30**. However, bridge **30'** has the same automatic self-locking feature as bridge **30**, by virtue of the ridges **35'** biting into the band **20'** to form the indentations **40'**. The arches **34***a* and **34***c* of bridge **30'** function in the same manner as the corresponding arches of bridge **30** in preventing tearing of the coil from the band by the bridge.

The re-usable band blank **20''** of FIG. 16 differs from the band of FIGS. 11–15 in that notches **26'** and **29** are replaced by rectangular bridge holding slots **56** and **59** in the arcuate portion of the blank.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A dental appliance comprising a unit consisting of a flexible metal band for surrounding a tooth and a closed flattened loop metal bridge transversely embracing said band adjacent one end and having the other end of the band extended therethrough to form a circlet for surrounding a tooth; said band having notch means adjacent said one end engaged with said bridge to anchor the same to said band; said band, adjacent its other end, having a formation engageable with the teeth of a rotatable winding member for winding of said band about the winding member to draw said circlet into tight conforming engagement about the tooth.

2. A dental appliance, as claimed in claim **1**, in which said formation is a substantially trapezoidal notch extending inwardly from the upper edge of said band.

3. A dental appliance, as claimed in claim **1**, in which said circlet is a bias circlet and in which said band has, adjacent its said other end, a preformed coil with an inner convolution engageable with the teeth of said winding member for winding of said pre-formed coil about the winding member to draw said coil against the bridge to draw the surplus band material from around the tooth, and thus draw the circlet into tight conforming engagement about the tooth.

4. A dental appliance, as claimed in claim **3**, in which said bridge extends appreciably outwardly from said band and appreciably above the height of a tooth to which the band is supplied so that, after completion of the restorative work, the projecting portion of said bridge may be readily severed to release locking ridges on said bridge from indentations in said band whereby the work-hardened spring-like band will spring open free of the tooth for simple removal without breakage of the newly formed and still semi-malleable marginal ridges of the new resoration.

5. A dental appliance, as claimed in claim **4**, in which said bridge is made of a semi-hard material and is sufficiently thin to permit shearing of the same in the mouth of the patient, said bridge having overlapping legs to prevent distortation of the thin material and to retain its functioning formation; the projecting area of the bridge being bent into a concave formation to increase the resistance of the bridge to deformation under normal pressure of use.

6. A dental appliance, as claimed in claim **1**, in which said other end of said band is a rectilinear and substantially rectangular portion, and said one end is an arcuate portion extending from said rectilinear portion; said rectilinear portion of said band being overlapped with said arcuate portion and wound into a tight coil having a substantially cylindrical hollow core of a diameter such as to provide close conforming engagement with said winding member easily insertable therein.

7. A dental appliance, as claimed in claim **6**, in which said winding member is conical and has helically arranged ratchet teeth on its surface, the smaller end of said winding member having a diameter less than that of the coil of said core and the larger end of said winding member having a diameter greater than that of the core of said coil, whereby said winding member will engage within said core at at least one zone between its smaller and larger ends.

8. A dental appliance, as claimed in claim **1**, in which said notch means comprises rectangular apertures through said band for retaining said bridge anchored to said band.

9. A dental appliance, as claimed in claim **8**, in which said rectangular apertures are aligned, across the band, on a line extending at an angle of 65° to 75° to a line drawn parallel to the longitudinal edges of the rectilinear and rectangular portion of said band.

10. A dental appliance, as claimed in claim **1**, in which said notch means comprises notches for retaining said bridge anchored to said band; said notches being aligned, across the band on a line extending at an angle of 65° to

75° to a line drawn parallel to the longitudinal edges of the rectilinear and rectangular portion of said band.

11. A dental appliance, as claimed in claim **1**, in which said notch means includes a rectangular notch extending inwardly from an edge of said band, said bridge comprising a closed flattened loop having a bight engageable in said rectangular notch whereby to retain said bight of said bridge firmly in a preselected position on said band.

12. A dental appliance, as claimed in claim **1**, including a finger extending perpendicularly from one edge of said band adjacent said one end thereof; said notch means comprising a pair of longitudinally spaced tabs, one on either side of said finger, bendable from the plane of said band to form abutments engageable with said bridge to prevent lateral displacement of said bridge from its preselected anchored position on said band; and a relatively narrow slot extending inwardly from the other edge of said band and substantially aligned with the inner edge of said finger.

13. A dental appliance, as caimed in claim **12**, wherein said finger extends from said band at an angle of 65° to 75° to a line drawn parallel to the longitudinal edges of the rectilinear and rectangular portion of said band.

14. A dental appliance, as claimed in claim **12**, in which said bridge has a length greater than the width of said band; one bight of said loop engaging an edge of said last-mentioned slot; said finger extending into the other bight of said loop with its end engaging the inside of said other bight to prevent displacement of said bridge laterally of said band.

15. A dental appliance, as claimed in claim **14**, in which one leg of said loop is formed with plural longitudinally extending arches in the portion thereof overlapping said band, adjacent arches intersecting at relatively sharp ridges which bite into the surface of a portion of said other end of said band to lock said other end against retraction after tightening of the circlet around the tooth.

16. A dental appliance, as claimed in claim **1**, in which said bridge has plural successive arches longitudinally of one leg, adjacent arches intersecting at relatively sharp ridges which bite into the surface of a portion of said other end of said band to lock said other end against retraction after tightening of the circlet around the tooth; a pair of said arches extending around respective opposite edges of said band to prevent shearing off of said coil from the band while coil is being wound and tightened against the bridge.

17. A dental appliance, as claimed in claim **12**, in which said finger holds the bridge in a preselected position and extends at an angle such as to constrain said bridge to extend at a preselected angle wherein substantially all the forces of said coil against said bridge are distributed with substantially equal pressure over the entire length of said bridge to avoid shearing of the bridge from its engagement with said band.

18. A dental appliance, as claimed in claim **1**, in which, in plan, said band includes a substantially rectilinear and rectangular portion pre-wound into a coil to tighten the circlet around the tooth, and an arcuately curving portion extending from said rectilinear and rectangular portion through a predetermined arc.

19. A dental appliance, as claimed in claim **18**, wherein the radius of said arcuate portion adjacent the free end thereof extends through an angle of from 30° to 40° to the longitudinal edges of said rectilinear and rectangular portion whereby, when said arcuate portion is formed into a circlet, it forms a truncated cone whose smaller radius portion makes positive contact with sub-gingival and the larger radius portion makes positive contact with adjacent teeth.

20. A dental appliance, as claimed in claim **12**, in which said bridge includes a pair of outer legs and an inner leg; the first outer leg having a length substantially in excess of the width of said band and being joined to the second outer leg at a first bight, the second outer leg being joined to the third leg at a second bight, and the third leg lying intermediate the two outer legs and having a length of the order of the width of said band; said second bight engaging an edge of said slot and said other end of said band being overlapped with said one end of said band and engaging the inner surface of the second outer leg.

21. A dental appliance, as claimed in claim **2**, in which said bridge includes an intermediate leg having a length of the order of that of the width of said band and a pair of outer legs each connected to said intermediate leg at a respective bight; each of said outer legs having a length somewhat less than one-half the width of said band, and said outer legs lying in substantially the same plane with their ends spaced somewhat from each other; said loop having a close conforming fit with said band.

22. A dental appliance, as claimed in claim **2**, in which said bridge has a bight engageable with an edge of a slot in an edge of said band; said slot defining one edge of a triangular flap which is bent at an angle to said edge of said slot and forms a double thickness of material engageable by the bight of said loop.

23. A dental appliance, as claimed in claim **18**, wherein the radius of said arcuate portion adjacent the free end thereof extends through an angle of from 30° to 40° to the longitudinal edges of said rectilinear and rectangular portion whereby, when said arcuate portion is formed into a circlet forms a truncated cone whose smaller radius portion makes positive contact with sub-gingival and the larger radius portion makes positive contact with adjacent teeth; said bights seating in notches in the band edges, which notches constitute said notch means.

References Cited

UNITED STATES PATENTS

2,595,850	5/1952	Hicks	32—63
2,722,746	11/1955	Brenner	32—63

FOREIGN PATENTS

608,107	9/1948	Great Britain.

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