United States Patent [19]

Hahn

[11] **3,720,959**

[45] **March 20, 1973**

[54] **MANDIBULAR PROSTHETIC APPARATUS**

[76] Inventor: **George W. Hahn,** 1605 Pentagon Parkway, Dallas, Tex. 75224

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[21] Appl. No.: **67,029**

[52] **U.S. Cl.** .....**3/1,** 128/92 C
[51] **Int. Cl.** **A61f 1/24**
[58] **Field of Search** .....3/1; 128/92 R, 92 C, 89 A, 128/334 R, 334 C; 32/1; 29/515, 516

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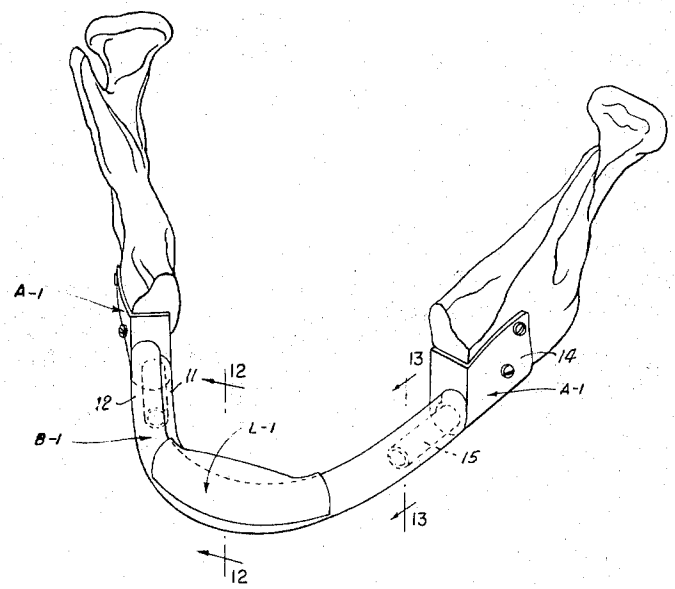
Primary Examiner—Richard A. Gaudet
Assistant Examiner—Ronald L. Frinks
Attorney—Cecil L. Wood

[57] **ABSTRACT**

A kit for forming a number of different forms of prosthetic devices to replace different portions of a mandible which have been removed. The kit includes a number of prefabricated members, fabricated from a malleable stainless steel mesh, including mating inner and outer tubular sleeve portions for assembling adjoining members, with the sleeve portions being crimped together to define rigid couplings. Screws are used to attach the end member of an assembled prosthetic device to the bone stump of the remaining mandible.

12 Claims, 16 Drawing Figures



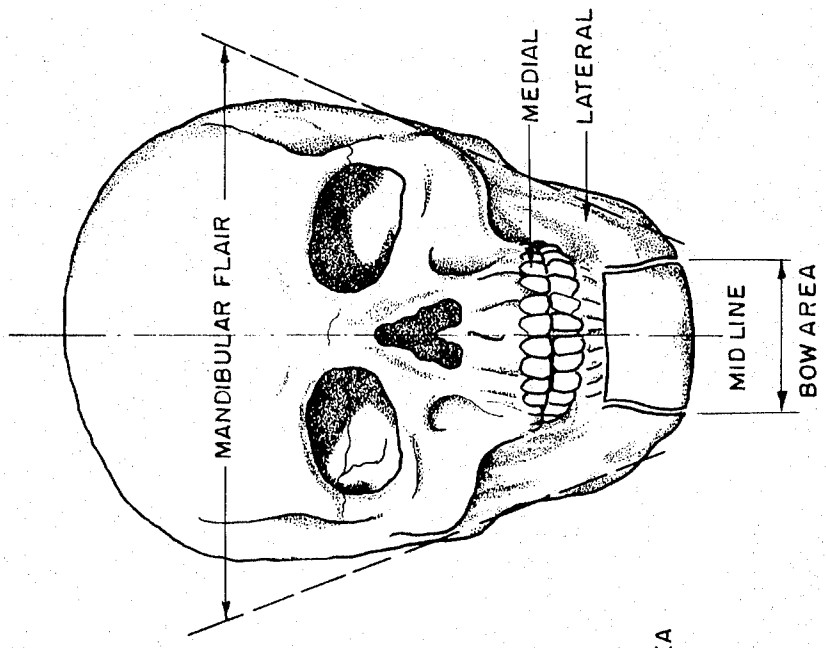


Fig. 2

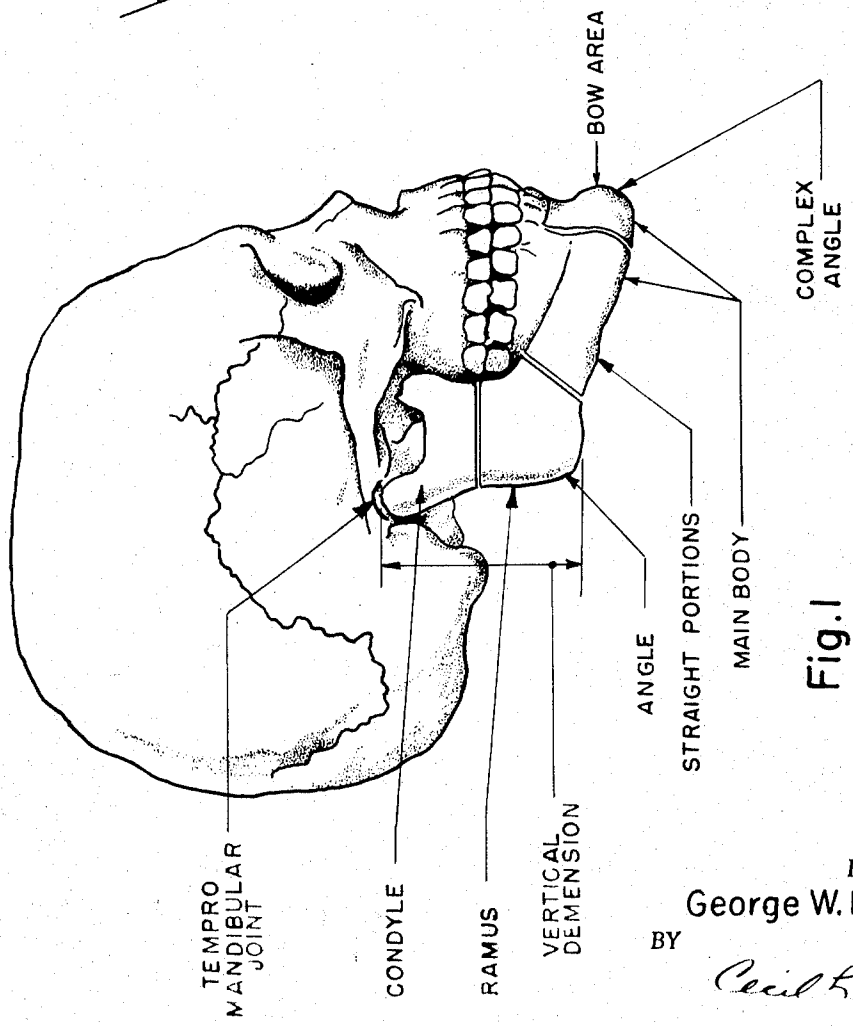


Fig. 1

INVENTOR.
George W. Hahn
BY
Cecil L. Wood
ATTORNEY

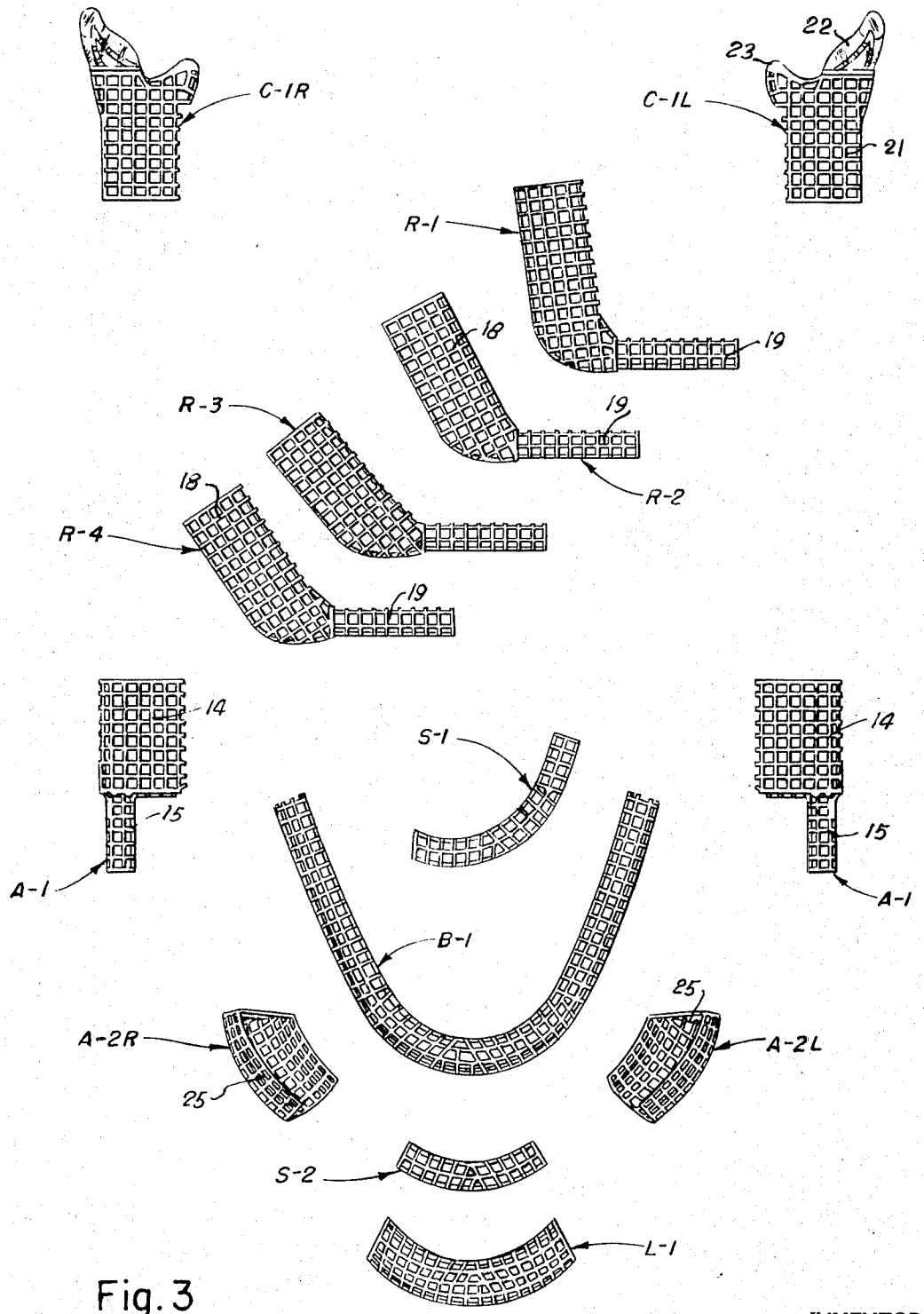


Fig. 3

INVENTOR.
George W. Hahn
BY
Cecil L. Wood
ATTORNEY

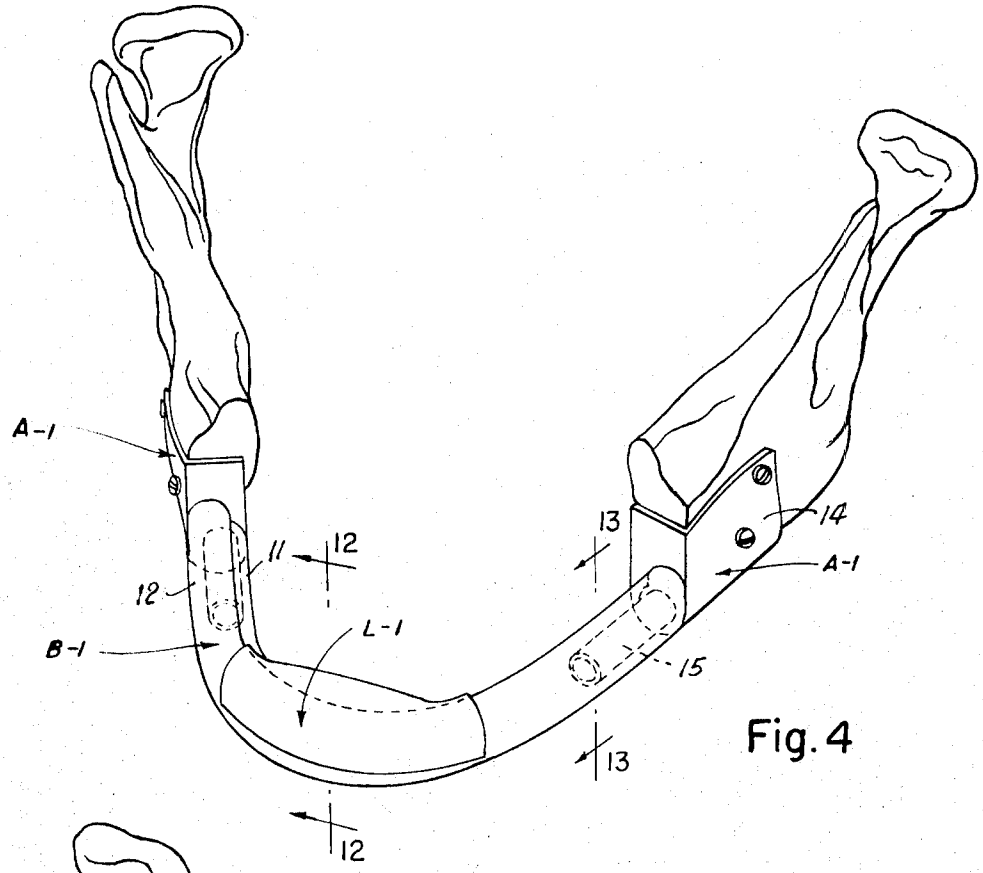


Fig. 4

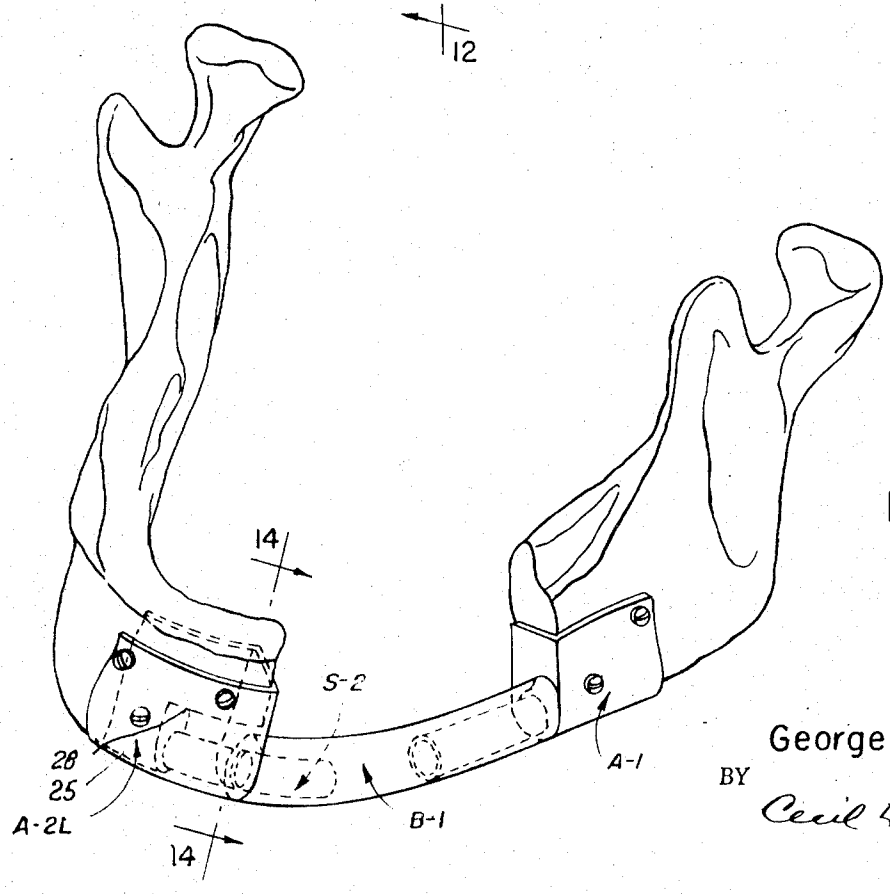


Fig. 5

INVENTOR.
George W. Hahn
BY
Cecil L. Wood
ATTORNEY

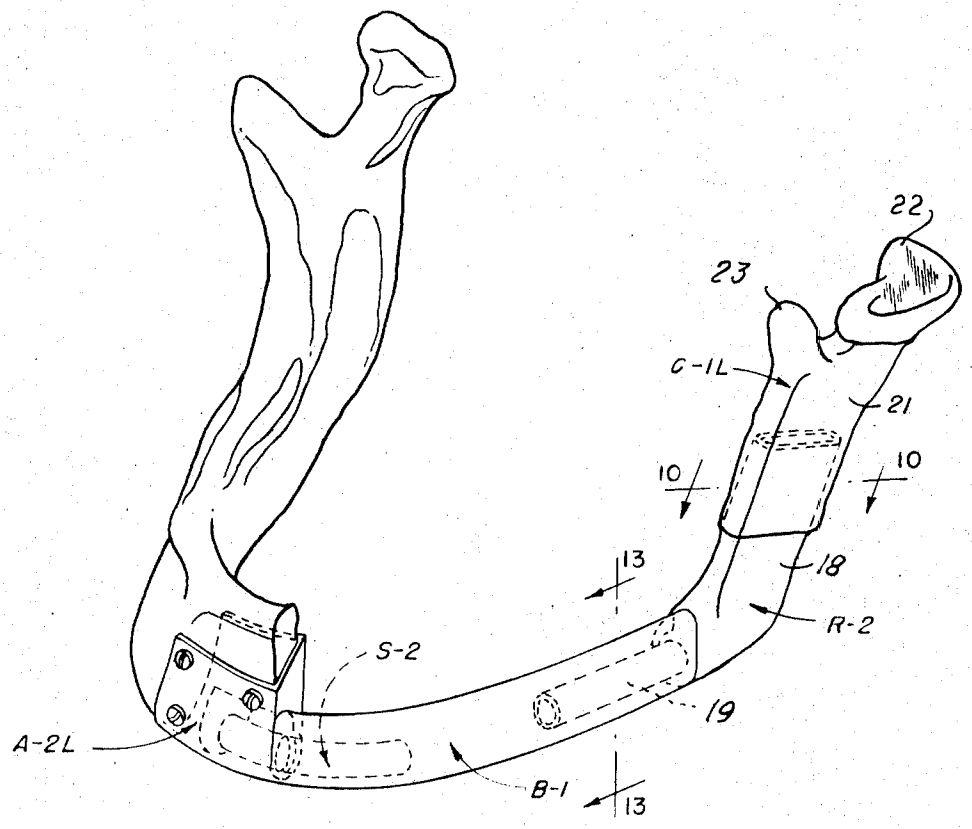


Fig.6

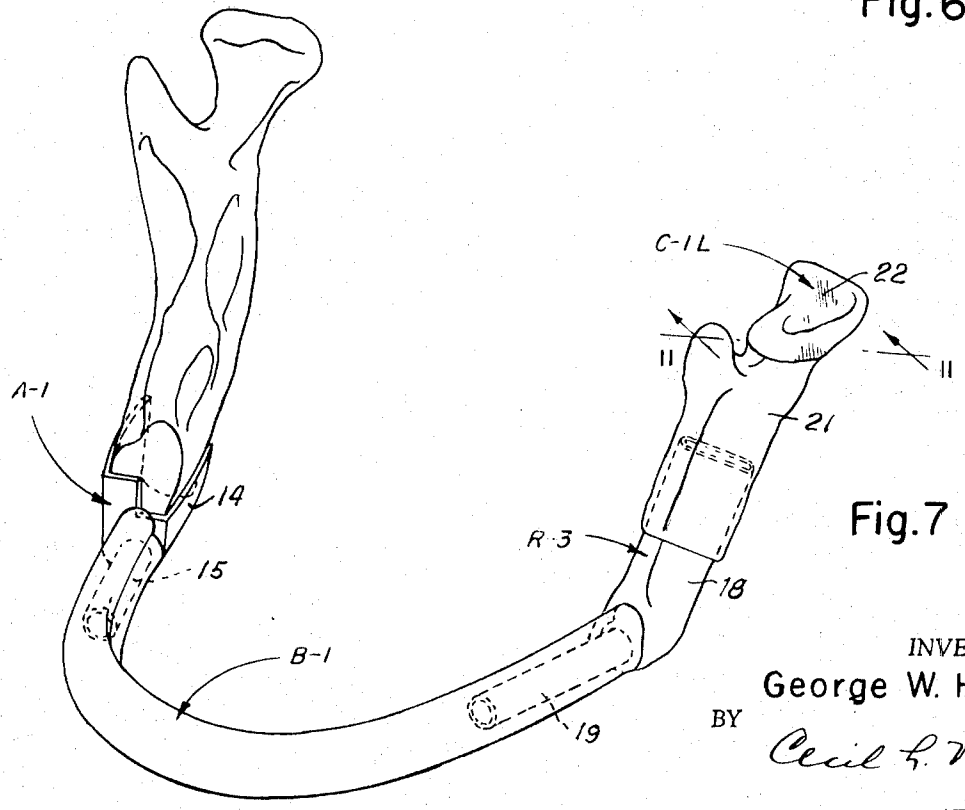


Fig.7

INVENTOR.
George W. Hahn
BY
Cecil L. Jones
ATTORNEY

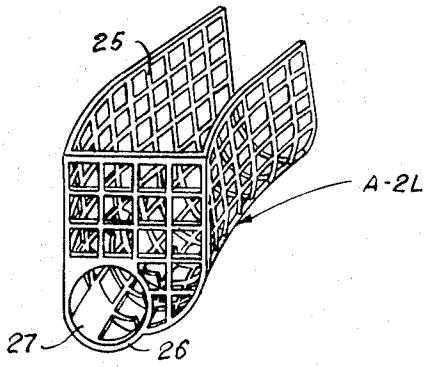


Fig. 8

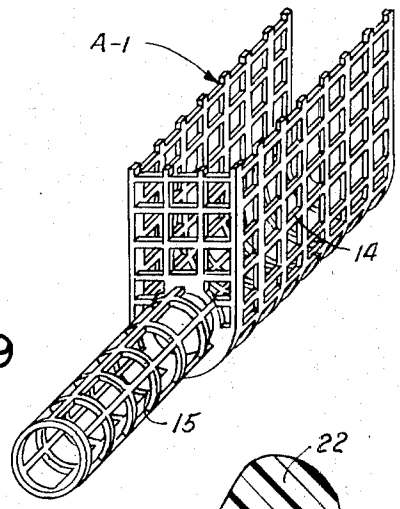


Fig. 9

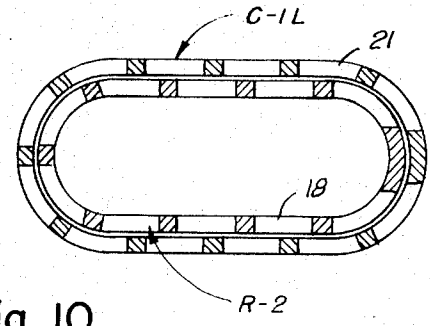


Fig. 10

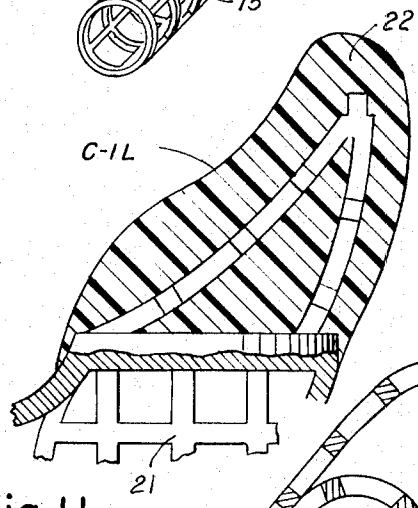


Fig. 11

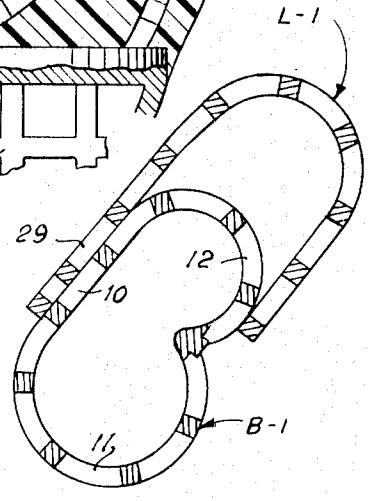


Fig. 12

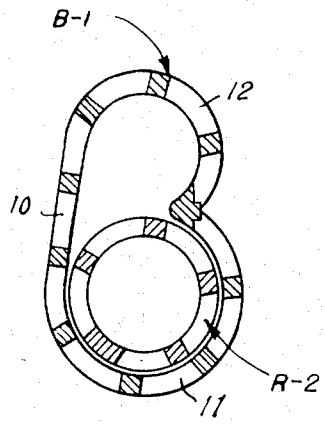


Fig. 13

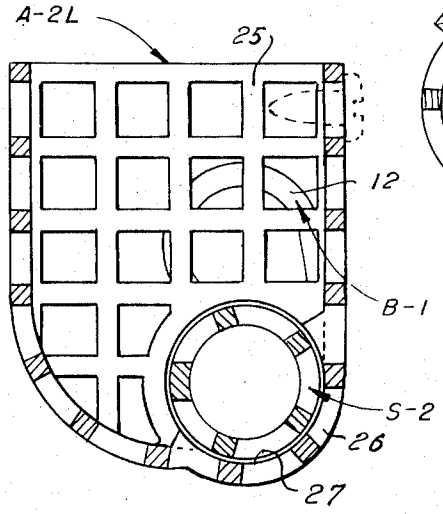


Fig. 14

INVENTOR.
George W. Hahn
BY
Cecil L. Thoa
ATTORNEY

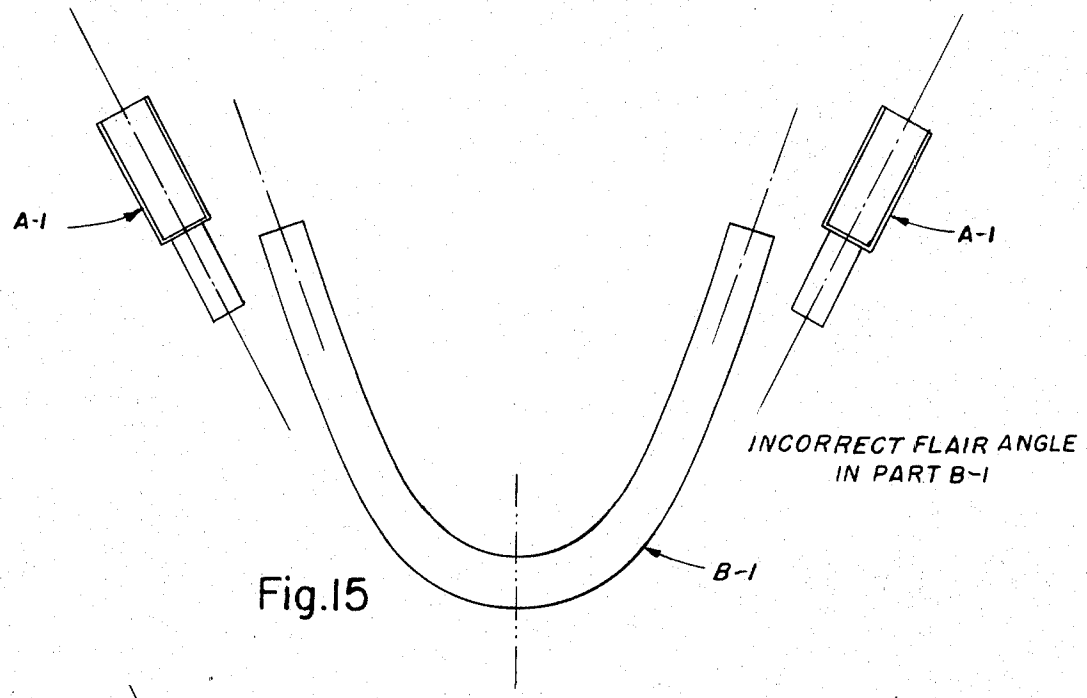


Fig.15

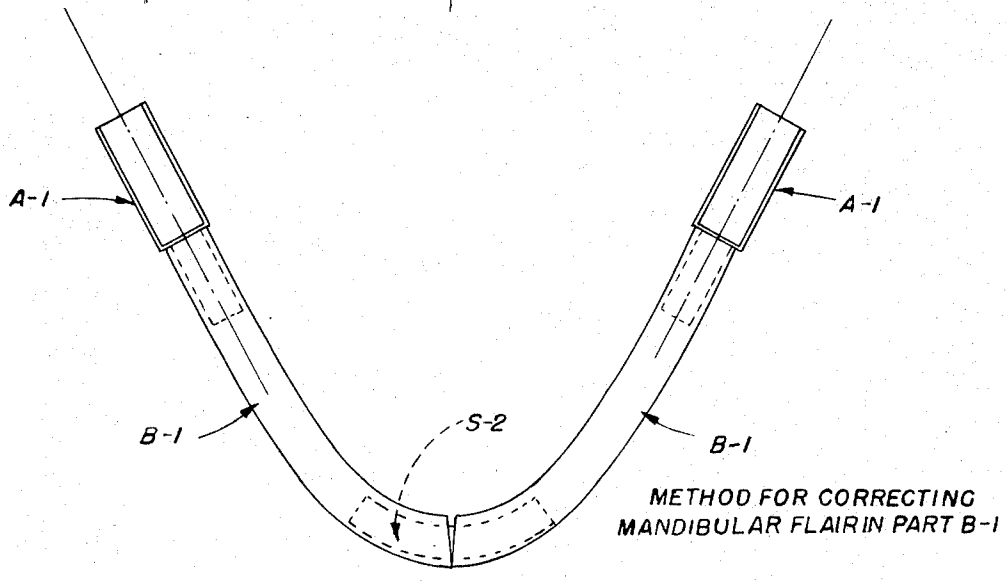


Fig.16

INVENTOR.
George W. Hahn
BY
Cecil L. Dod
ATTORNEY

MANDIBULAR PROSTHETIC APPARATUS

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to the field of mandibular prosthesis, and more particularly to an apparatus for forming an artificial mandible or part thereof.

The mandibular prosthetic apparatus of the present invention is an improvement of apparatus described in an article entitled Chrome Cobalt Mesh Mandibular Prosthesis published in Journal of Oral Surgery, Vol. 27, Jan. 1969, by Donald A. Corgill, M.D., and the inventor, George W. Hahn, D.D.S. In the apparatus described in that publication, the various members of a prosthetic assembly were attached together by means of screws which have the disadvantage of producing protrusions in the prosthetic device which sometimes caused exposures through the surface tissues of the face. Another disadvantage of this apparatus was that adjustability was provided in some cases by overlapping sleeve portions which produced abrupt edges in the assembled prosthetic device, again sometimes piercing the surface tissues.

An object of this invention is to provide an improved mandibular prosthetic apparatus for restoration or replacement of all or a part of a mandible.

Another object of this invention is to provide mandibular prosthetic apparatus including a kit of prefabricated parts which may be assembled in various combinations to replace substantially all mandibles lost.

A further object of this invention is to provide mandibular prosthetic apparatus consisting of a kit of prefabricated parts, which may be assembled in various combinations and rigidly coupled to provide a unitary prosthetic device without the use of screws except at the point of attachment to the mandible bone stump.

Still another object of this invention is to provide a mandibular prosthetic apparatus including a kit of prefabricated parts, which may be assembled to form a desired prosthetic device having a relatively smooth contour and eliminating sharp projections which tend to pierce the facial tissues.

A still further object of this invention is to provide a mandibular prosthetic apparatus which provides improved support for the facial tissues.

Apparatus according to the invention for accomplishing these objects includes, broadly, an assembly of members fabricated of malleable mesh including, at least, a bow member for replacing portions of the main body area of the mandible and a member for supporting one end of the bow member consisting of a body portion and an integral tubular extension. The bow member is elongated vertically in cross section to define an outer, tissue supporting wall. The bow member and the support member extension define respective outer and inner mating circular sleeves adapted to be crimped together to provide a rigid coupling between the members. More specifically, the support member body may include a housing for attachment to the bone stump by means of screws, or an oval tubular portion angled relative to the tubular extension to define a ramus portion of the prosthetic device. In another form the support member is that of a body defining another mating outer circular sleeve, whereby the support member and bow member may be joined by a mating inner circular sleeve received in the adjoining outer circular sleeves of the bow member and support member.

The novel features and the advantages of the invention, as well as additional objects thereof, will be understood more fully from the following description when read in connection with the accompanying drawings.

DRAWINGS

FIGS. 1 and 2 are respective side and front views of a human skull to illustrate the parts of the mandible;

FIG. 3 is an illustration of the several members which are assembled in various combinations to form prosthetic devices;

FIG. 4 is a perspective view of a mandible consisting of the natural posterior portions of the mandible and a prosthetic anterior bow portion;

FIG. 5 is a perspective view of a mandible in which a relatively small section of the main body and bow area is replaced with a prosthetic device;

FIG. 6 is a perspective view of a mandible consisting of a right half portion of the natural mandible and the left half portion being a prosthetic device;

FIG. 7 is a perspective view of a mandible wherein only the posterior portion on one side consists of the original mandible, the remainder of the mandible consisting of a prosthetic device;

FIGS. 8 and 9 are perspective views of two of the members illustrated in FIG. 3;

FIGS. 10, 12, 13 and 14 are transverse sectional views of portions of the prosthetic assemblies illustrated in FIGS. 4, 5 and 6, to show the assembled relationship of certain of the members illustrated in FIG. 3;

FIG. 11 is a sectional view taken along the line 11—11 of FIG. 7 illustrating structural details of the condyle member; and

FIGS. 15 and 16 are diagrammatic illustrations of means for compensating for differences in the mandibular flair angle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2 for orientation, the portions of the natural mandible which will be referred to are the main body, which is the anterior portion of the mandible, and the ramus and condyle which are the posterior portions of the mandible. The main body includes a bow area which is the anterior relatively sharply curved portion defining the chin, and posterior relatively straight portions extending rearwardly from the bow area at a diverging angle. The ramus extends upward from the main body, as viewed from the side in FIG. 1, forming an angle with the main body. The condyle at the upper end of the ramus includes an articulating prominence forming a portion of the tempromandibular joint.

The mandibular flair is the angle defined by the straight portions of the main body, and the angle of the main body bow area is a complex angle, since it is a function both of the mandibular flair and of the angle of the ramus relative to the main body, which angle varies considerably with different individuals.

Referring now to FIG. 3, there are shown several members of a kit, including different configurations of

certain of these members. These kit members are assembled in combinations to be described to provide a variety of forms of prosthetic devices for restoring various portions of a mandible which it is necessary to remove. All the members to be described are fabricated of a malleable metal mesh, particularly mesh fabricated, by casting, of No. 316 Stainless Steel. In general, the portions of the several members to be described are hollow tubular members or hollow boxlike members to encourage tissue retention to the prosthetic devices.

A bow member B–1 is an elongated tubular member curved in a generally U-shaped form to replace the main body of the natural mandible. This member has a fixed flair angle; and means will be described subsequently for changing the flair angle. The cross section of the bow member is best illustrated in FIG. **13** wherein it is seen that the member has an elongated cross section, the major axis of elongation being transverse to the plane of the member and, therefore, generally vertical in use. As best seen in FIG. **13**, the bow member includes a relatively flat outer wall **10**, with the opposite inner wall being depressed inwardly to define a double tube configuration which includes a lower socket portion **11**, which is circular in cross section and which is referred to as an "outer mating circular sleeve." This socket portion **11** extends the entire length of the bow member, since all or various portions thereof are employed in the various forms of devices to be described. The upper tubular rib portion **12** may be circular and may be smaller in cross section.

A retention member A–1 is one form of bow support member for supporting and attaching one end of a bow member to a remaining bone stump of a mandible. This member is used for attaching the bow member to a remaining straight portion of the main body; and the configuration of the retention member A–1 is the same for use on either side of the mandible. The structure of the retention member A–1 is shown more clearly in FIG. **9** to include an elongated body portion **14** defined by confronting side walls joined by a curved bottom wall and one end wall. An elongated tubular portion **15** extends longitudinally from the end wall, and is attached integrally to the end wall adjacent to the bottom wall. The tubular portion **15** is circular in cross section and has an outer predetermined diameter dimensioned for a sliding fit with the outer mating circular sleeve **11** defined by the bow member B–1. This tubular member will be referred to as "inner mating circular sleeve;" and these inner and outer circular sleeves are dimensioned to coact with each other in a manner that they may be crimped together to define a rigid coupling or joint between the respective bow and retention members.

Ramus members R–1, R–2, R–3 and R–4, as best shown in FIG. **3**, are members intended to replace the ramus portion of the natural mandible; and these members differ from each other in the angle between an upward extending, elongated tubular portion **19**. Referring to the ramus member R–2 for example, the tubular body portion **18** has an elongated oval cross section, as best seen in FIG. **10**, and this portion has a predetermined configuration and dimension to define an "inner mating oval sleeve." The tubular portion **19** of circular cross section extends at a predetermined angle relative to the body portion **18** to define the angle between the ramus member and bow member for a particular prosthetic device. A particular ramus member is selected relative to the desired angle. The tubular projection **19** then defines an inner mating circular sleeve for mating engagement with the outer mating circular sleeve of the bow member B–1.

Condyle members C–1L and C–1R have similar and related configurations corresponding to the natural left and right condyle portions of the natural mandible. Referring particularly to the member C–1L as illustrated in the drawings, this member includes a tubular body **21** having an elongated oval cross section, as best seen in FIG. **10**. The upper end of the body **21** is enlarged, and there is attached to the upper end adjacent the posterior edge thereof an artificial condyle **22**, which is preferably fabricated of an acrylic resin, for example, and which corresponds to the natural condyle or condyloid process which is a part of the tempromandibular joint.

Another protuberance **23** is formed at the upper end of the body **21** adjacent to the anterior edge representing the coronoid process of the natural mandible. The tubular body **21** has a predetermined configuration and dimension for a sliding fit over the tubular body portion **18** of a ramus member, and the tubular body **21** is further referred to as "outer mating oval sleeve." The inner mating oval sleeve of the ramus member and the outer mating oval sleeve of the condyle member then are slidably related, as best seen in FIG. **10**, to adjust the length of the ramus condyle portion of a prosthetic device, and these sleeves are crimped together to form a rigid coupling between the respective members. Additionally, or alternatively, these sleeves **18** and **21** may be secured together by means of one or more metal screws.

FIG. **11** illustrates how the artificial acrylic resin condyle **22** is formed about and thereby secured to a portion of the body **21** of the condyle member C–1L.

Retention members A—2R and A–2L are examples of another form of bow support member for securing the bow member to the stump of the mandible bone. Referring particularly to the member A–2L, which is more particularly illustrated in FIGS. **8** and **14** of the drawing, this member consists of a boxlike elongated curved body **25** formed of confronting side walls, a curved connecting bottom wall, and one end wall. This member defines a box having one open end and an open top for receiving a portion of the mandible bone stump in the bow area, and to which the member is secured preferably by means of tapered screws. The curved bottom wall of the body **25** is particularly formed to define a socket **26** formed by walls of circular cross section having an angular extent of approximately 180°. Access to the socket **26** is provided through a circular recess **27** provided in the body end wall and aligned with the socket. The socket walls and the opening **27** have a predetermined dimension to define an "outer mating circular sleeve," dimensioned to correspond to that of the bow member B–1.

The bow member and the retention member A–2L are joined by a curved connector member S–1 or S–2, as illustrated in the drawings. These connector members are similar, differing only in length and degree of curvature. The connector member S–2, for example, is

a uniformly curved tubular member of circular cross section having a diameter corresponding to those of the circular tubular projections of the ramus members and of the retention member A–1. The connector member S–2 then may be referred to as an inner mating circular sleeve for mating engagement with the outer mating circular sleeves of the retention member A–2L and the bow member B–1 for example.

The lip member L–1, seen in FIGS. 3 and 12, is an elongated actuate member of curved U-shaped cross section dimensioned to receive the upper rib portion 12 of the bow member B–1 and to be crimped thereto to define a rigid connection therewith. The lip member L–1 provides a flat forward or outer wall 29 which defines an upward extension of the flat outer wall 10 of the bow member, to provide additional support for the lip in the bow area of the prosthetic device.

FIGS. 4, 5, 6 and 7 illustrate, by way of example, several forms of mandibular prosthetic devices or apparatus which are formed from various assemblies or combinations of the members illustrated in FIG. 3.

Referring to FIG. 4, there is shown an anterior bow prosthetic device to replace most of the main body portion of the mandible. As seen in the drawing, the ramus-condyle portions of the natural mandible remain with short posterior stumps of the straight portions of the main body. The anterior bow prosthetic device consists of two retention members A–1 which are secured to the two main body stumps, a bow member B–1 which is fitted over the inner mating circular sleeve 15 of the retention members A–1, and a lip member L–1 forming an additional support for the lip of the patient in the bow area. As seen in the drawing, the lower portions of the mandible stumps are received within the bodies of the retention members A–1; and these members are secured to the bone by means of screws which are preferably tapered and fabricated of No. 316 Stainless Steel. The manner of coupling of the bow member B–1 to a retention member A–1 is best seen in FIG. 13 wherein the inner mating circular sleeve 15 of the retention member is slidably received within the outer mating circular sleeve 11 of the bow B–1. These circular sleeves are then crimped together to provide a rigid joint or coupling between the members A–1 and B–1.

The assembled relation of the lip member L–1 to the bow member B–1 is best seen in FIG. 12, which is a transverse sectional view of the assembled members. As seen in FIG. 12, the flat wall 29 of the lip member defines an extension of the flat wall 10 of the bow member, and the lip member is crimped over the rib section 12 of the bow member to define a rigid coupling between these members.

For the prosthetic device illustrated in FIG. 4, the bow member B–1 is formed to provide the correct configuration and flair angle for this particular prosthetic device.

FIG. 5 illustrates a sectional prosthetic device for a relatively small section of the main body of the mandible which has been removed. This prosthetic device includes one of the above-described retention members A–1 and a portion of a bow member B–1 which has been cut to an appropriate size to include a straight portion and a portion of the bow area of the main body of the mandible which has been removed. The anterior end of the prosthetic device is secured to the existing bow area portion of the mandible by means of a retention member A–2L and a sleeve member S–2. The body portion 25 of the retention member A–2L is secured to the bone stump by means of tapered screws in a manner similar to that of the member A–1.

FIG. 14 of the drawing, which is a transverse sectional view through the retention member A–2L adjacent to its end wall, illustrates the manner in which the bow member is jointed to the retention member. As seen in FIGS. 5 and 14, the sleeve member S–2, which defines an inner mating cylindrical sleeve is received within the sockets 11 and 26, respectively, of the bow member and retention member which define outer mating circular sleeves; and the sleeve member spans the sockets which are crimped around the sleeve member to form the necessary rigid coupling between the bow member B–1 and the retention member A–2L. As seen in FIG. 5, a portion of the bone stump, within the body of the retention member A–2L, is cut away to form a notch 28 for the purpose of accommodating the end of the sleeve member S–2 which is received within the retention member body.

Since the anterior end of this particular prosthetic device is joined to the existing mandible in the bow area, the retention member A–2L, along with a selection of sleeve members such as S–1 and S–2, provides greater flexibility in fitting the prosthetic device to the particular patient.

FIG. 6 of the drawing illustrates a hemi-section prosthetic device which replaces approximately one-half of the natural mandible. This prosthetic device includes a retention member A–2L, a bow member B–1 which is approximately one-half of the bow member illustrated in FIG. 3 and which is joined to the retention member by a sleeve member S–2, and a ramus member R–2 and a condyle member C–1L which form the left side ramus-condyle portion of the prosthetic device.

The anterior portion of this device is assembled and joined in the same manner as the device of FIG. 5. The ramus portion of the device which forms the angle of the prosthetic mandible is provided by selecting a ramus member R–2 with an appropriate angle. This member is joined to the bow member by inserting the inner mating circular sleeve 19 into the outer mating circular sleeve of the bow member B–1, these sleeves being crimped to define the rigid coupling as above described. The tubular oval body portion 18 extends upwardly and defines the inner mating oval sleeve which is received within the outer mating oval sleeve 21 of the condyle member C–1L; and when these members are adjusted to provide the desired length or height of the ramus-condyle section for the particular patient, these sleeves are screwed or crimped together to provide the rigid coupling. The sliding relation of the oval sleeves is best illustrated in FIG. 10.

FIG. 7 of the drawing illustrates a three-quarter section prosthetic device for replacing all of the natural mandible except the right side ramus-condyle portion and the small stump of the main body. For this device, the left hand ramus-condyle section is formed in the same manner as described with respect to the device of FIG. 6, a ramus member R–3 being shown to provide a slightly different angle for the ramus portion. FIG. 11 is a sectional view through the condyle member C–1L and illustrates the manner in which the acrylic resin

condyle **22** is secured to the body **21** of the condyle member. The acrylic resin condyle **22** is preferably cast or otherwise formed to duplicate as nearly as possible the configuration of the natural condyle which is being replaced.

In the device of FIG. **7**, a substantial length of the bow member B–**1** is used, and since the bow member is secured to a straight portion of the mandible main body on the right side, a retention member A–**1** is used in the same manner as for the prosthetic device of FIG. **4**.

It will become apparent, upon considering the three-quarter section prosthetic device of FIG. **7**, that a full prosthetic mandible can be assembled by providing an additional artificial ramus-condyle portion for the right hand side of the prosthetic device illustrated in FIG. **7**.

FIGS. **15** and **16** of the drawing are diagrammatic illustrations of an anterior bow prosthetic device as illustrated in FIG. **4**, composed of a bow member B–**1** and two retention members A–**1**. FIG. **15** illustrates the situation where the particular bow member B–**1**, as fabricated, has a much smaller flair angle than that required for the particular patient. FIG. **16** illustrates the manner of adjusting the flair angle, which consists in severing the bow member B–**1** at the midline of the bow area, and then rejoining the abutting severed ends at a different angle by providing a suitable sleeve member S–**2** which is received in the sockets **11** of the adjacent abutting ends. These members are then crimped together, as described previously, to provide a new rigid bow member assembly having the desired flair angle.

A method for forming a mandibular prosthetic device, as described above may include the steps:

providing an elongated curved bow member having an elongated socket portion defining an outer mating circular sleeve, for replacing various sections of the straight and curved areas of the main body of the mandible;

providing a first support member, for one end of the bow member, having a body and a projecting tubular portion defining an inner mating circular sleeve for a sliding fit with the bow member outer sleeve;

providing the first support member with a body for either anchoring the support member to a bone stump or defining a ramus-condyle portion of the prosthetic device for replacing the natural ramus and condyle; wherein the anchoring body may be provided with a socket portion defining an outer mating circular sleeve for receiving a separate mating sleeve member, to define the projecting inner mating circular sleeve;

providing a second support member, for the other end of the bow member, having a body and a projecting tubular member defining an inner mating circular sleeve for a sliding fit with the bow member outer sleeve;

providing the second support member with a body for either anchoring the support member to a bone stump or defining a ramus-condyle portion of the device for replacing a natural ramus and condyle; wherein the anchoring body may be provided with a socket portion defining an outer mating circular sleeve for receiving a separate mating sleeve member, to define the projecting inner mating circular sleeve;

assembling the bow member mating sleeve with the respective support member mating sleeves; and crimping the sleeves together to form a rigid assembly of the members.

What has been described is a novel mandibular prosthetic apparatus, and method for forming such apparatus, having a number of advantages over devices and apparatus previously used for this purpose. A particular feature and advantage of the apparatus and method described is the mating sleeve construction wherein the several members of a prosthetic device are assembled together by means of mating inner and outer sleeves which may be crimped together to provide the desired rigid coupling between adjoining parts and, ultimately, a rigid integral prosthetic device suitably formed to mate with the remaining portions of the natural mandible.

A related feature and advantage of the described apparatus and method is that the portions of the prosthetic devices to which the facial tissue will adhere are the defined outer mating sleeve portions, with the members being joined by the inner mating sleeves, to minimize or eliminate sharp edges of the prosthetic device which may pierce the surface tissues.

Another feature of the described apparatus is that the bow member is formed to provide an elongated, or double tubular cross section, thereby defining a flat outer wall surface for better support of the tissues in the main body area. An ancilliary feature is the provision of a lip member to provide additional tissue support area in the bow area of the prosthetic device.

Another feature of the apparatus is that the bow member may be severed and reassembled through the use of an interior joining sleeve to adjust the flair angle of the bow member and thereby adapt the device to the particular patient.

While a preferred embodiment of the invention has been illustrated and described, it will be understood by those skilled in the art that changes and modifications may be resorted to without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. Mandibular prosthetic apparatus comprising, in combination:

an assembly of members fabricated of a malleable mesh;

a bow member for replacing at least portions of the main body of a mandible; said bow member comprising an elongated curved member, elongated in cross section, and formed to include an elongated cylindrical socket portion along one edge thereof defining an outer mating circular sleeve;

a first bow support member comprising a body portion and a tubular portion extending therefrom; said tubular portion defining an inner mating circular sleeve dimensioned for sliding fit with the outer mating circular sleeve of the bow member;

said bow member outer mating sleeve fully receiving and enclosing said support member inner mating sleeve, for coupling said members.

2. The invention set forth in claim **1**

including an elongated curved lip member having a U-shaped cross section; said lip member dimensioned to partially enclose the bow member to define a lateral extension of the bow member cross section in the bow area.

3. The invention set forth in claim **1**

wherein said first bow support member defines a retention member for securing the bow member to a mandible stump; said support member body portion being formed to enclose a portion of the mandible stump for attachment thereto.

4. The invention set forth in claim 1

wherein said first bow support member comprises a ramus-condyle member for replacing the ramus and condyle of the mandible; the body portion of said ramus-condyle member being elongated and having means for attaching an artificial condyle at the end remote from the tubular extension portion.

5. The invention set forth in claim 4

wherein said tubular extension portion extends at an angle relative to said elongated body portion.

6. The invention set forth in claim 1

wherein said first bow support member comprises a ramus-condyle assembly including a ramus member and a condyle member;

said ramus member comprising an elongated tubular body portion of elongated cross section, defining an inner mating oval sleeve, and said tubular extension portion, defining said inner mating circular sleeve;

said condyle member comprising an elongated tubular body of elongated cross section, defining an outer mating oval sleeve, and an artificial condyle attached to one end of said tubular body;

said outer mating oval sleeve being dimensioned for a sliding fit with said inner mating oval sleeve and receiving and enclosing said inner oval sleeve to provide a rigid coupling between the ramus and condyle members.

7. The invention set forth in claim 6

wherein said tubular extension portion of said ramus member extends at an angle relative to the elongated tubular body portion of said member; and wherein said outer and inner oval sleeves are deformed in interfering relation to provide the rigid coupling between the ramus and condyle members.

8. The invention set forth in claim 1

including a second bow support member defining a retention member for securing the bow member to a mandible stump in the bow area of a mandible;

said second bow support member comprising a body formed to enclose a portion of the mandible stump for attachment thereto; said body including a socket portion defining an outer mating circular sleeve;

and a connector member comprising an elongated curved tubular member of circular cross section, defining an inner mating circular sleeve dimensioned for a sliding fit with the outer mating circular sleeves of the bow member and the second support member; said connector member being fully enclosed within said outer mating sleeves to couple said bow member to said second support member.

9. The invention set forth in claim 1

wherein said first bow support member defines a retention member for securing the bow member to a bone stump in the bow area of the mandible; said bow support member comprising a body formed to enclose a portion of the mandible stump for attachment thereto; said body including a socket portion defining an outer mating circular sleeve;

and a connector member comprising an elongated curved tubular member of circular cross section, defining an inner mating circular sleeve dimensioned for a sliding fit with said socket portion outer mating circular sleeve; said connector member defining said bow support member tubular portion.

10. The invention set forth in claim 1

wherein said bow member is severed to provide two abutting segments; and a curved connector member comprising an elongated curved tubular member of circular cross section dimensioned to define an inner mating circular sleeve for sliding fit with the outer mating circular sleeves of the two bow member segments, with the connector member being fully received in and enclosed by said bow member segments to couple said segments.

11. The invention set forth in claim 1

said inner and outer mating sleeves being deformed in interfering relation to provide a rigid coupling between the respective members.

12. The invention set forth in claim 10

said curved connector member and said bow member segments being deformed in interfering relation to provide a rigid coupling between the bow member segments.

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