US Patent & Trademark Office
Patent Public Search | Text View

United States Patent	12383388
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Gonsky; Michael E.

Dental aerosol protection system

Abstract

A dental aerosol protection system for controlling dispersion of aerosol and splatter particles produced during dental procedures, the system including a ring assembly, a support mask for supporting the ring assembly on a patient, and a suction generating device, the ring assembly and support mask having suction ports which are connectable to the suction generating device to provide a negative suction force around the oral cavity, wherein the ring assembly and support mask can be connected or used separately to control dispersion of aerosols depending upon the requirements of the dental procedure, and one or more flexible extensions connectable to the ring assembly and support mask extending superiorly away from the patient around and over the oral cavity, the flexible extensions forming an adjustable physical barrier between the dental professional and the patient's oral cavity.

Inventors: **Gonsky; Michael E. (Stroudsburg, PA)**

Applicant: **Aerosol Control Company** (Stroudsburg, PA)

Family ID: **1000008748717**

Assignee: **Aerosol Control Company (Stroudsburg, PA)**

Appl. No.: **17/337051**

Filed: **June 02, 2021**

Prior Publication Data

Document Identifier	Publication Date
US 20210369433 A1	Dec. 02, 2021

Related U.S. Application Data

us-provisional-application US 63033808 20200602
us-provisional-application US 63033805 20200602

Publication Classification

Int. Cl.: **A61C19/00** (20060101); **A61B90/00** (20160101); **A61B90/40** (20160101); **A61M16/06** (20060101)

U.S. Cl.:

CPC **A61C19/00** (20130101); **A61B90/05** (20160201); **A61B90/40** (20160201); **A61M16/06** (20130101);

Field of Classification Search

CPC: A41D (13/11); A41D (13/1184); A61B (2218/00); A61B (2218/001); A61B (2218/007); A61B (2218/008); A61B (90/05); A61B (90/40); A61B (2090/401); A61C (17/06); A61C (19/00); A61C (17/08); A61C (17/12); A61M (16/06-0694)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
3747599	12/1972	Malmin	N/A	N/A
4764990	12/1987	Markert	128/201.15	A61F 9/02
9827723	12/2016	Klockseth	N/A	N/A
10952812	12/2020	Saadat	N/A	A61B 90/40
2014/0366890	12/2013	Tao	128/849	A61M 16/009
2017/0173371	12/2016	Truex et al.	N/A	N/A
2018/0132550	12/2017	Czajka	N/A	A62B 18/045

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
111281321	12/2019	CN	N/A
202041051154	12/2019	IN	N/A

OTHER PUBLICATIONS

International Appln. No. PCT/US2021/035485—International Search Report and Written Opinion of the International Searching Authority, dated Sep. 21, 2021, 40 pages. cited by applicant

---

Primary Examiner: Ruddie; Elliot S

Attorney, Agent or Firm: Wilkinson Law Office

Background/Summary

FIELD OF THE INVENTION

(1) The present invention relates generally to systems and devices for controlling dispersion of potentially hazardous aerosol and splatter particles produced during dental treatments and

procedures. More particularly, the invention relates to a dental aerosol protection system which traps and collects aerosols and splatter droplets emitted from the oral cavity prior to being dispersed into the atmosphere, reducing the risk of transmission and exposure to airborne infectious diseases, including viruses such as COVID-19.

BACKGROUND OF THE INVENTION

(2) Any discussion of the related art throughout the specification should in no way be considered as an admission that such related art is widely known or forms part of common general knowledge in the field.

(3) Dental care professionals by necessity must work in close contact with their patients when performing dental procedures, and as a result are at risk of being exposed to aerosol and splatter particles expelled from the patient's oral cavity. Such particles may be expelled by the patient when talking, coughing, sneezing, or simply breathing, or may be generated by the procedure. Both splatter or droplet particles and bioaerosols may carry significant amounts of respiratory pathogens such as viruses, bacteria, and fungi. Viruses, particularly those causing respiratory and gastrointestinal infection, are the most common cause of infectious disease in indoor environments. Viruses responsible for respiratory infections include influenza viruses, rhinoviruses, corona viruses, respiratory syncytial viruses (RSVs), and parainfluenza viruses (PIVs), while viruses responsible for gastrointestinal infections include rotavirus, astrovirus, and Norwalk-like viruses (NLVs). Some infections, like the common cold, are very widely spread but are not severe, while others such as influenza-like infections are relatively more severe. A cough or sneeze possibly containing aerosolized influenza or coronavirus is especially concerning. Although dental professionals commonly utilize personal protective equipment such as masks, face shields, gloves, and gowns while treating patients, due to their small size dental aerosols may remain airborne long after the procedure has been completed and such protective equipment has been removed, increasing the likelihood of contamination.

(4) In recent months, with the outbreak of the SARS-CoV-2 virus, oral transmission of dental aerosols and splatter has become an increasing concern, as many dental procedures use high speed handpieces or ultrasonic equipment, which instruments generate high levels of aerosols and splatter which are potentially harmful to the dentist or hygienist, dental staff, and patients present in the dental office. Use of such equipment has been reduced or delayed until the pandemic subsides, leaving patients without the benefit of certain treatments and procedures.

(5) Endodontists routinely utilize a latex or nitrile dental dam during procedures that expose the interior of a tooth or require bonding. The dam is typically provided as a flexible, elastic rectangular sheet. One or more teeth to be treated are passed through a small hole made in the sheet, and a specialized clamp is then secured to the tooth to hold the dam in place. The edges of the dam sheet are stretched over projections on an outwardly facing surface of a frame positioned around the patient's oral cavity, such that the elastic nature of the dam sheet causes it to be secured to the frame.

(6) Dental dams are effective in isolating teeth to be treated from the remainder of the oral environment of the mouth. The dam also reduces the volume of aerosol and splatter particles expelled from the patient's mouth by acting as a barrier between the front and back of the mouth. However, standard dental dams do not remove aerosol particles produced by the patient. In addition, there are many dental procedures in which aerosol production is extremely high and use of a rubber dam is not feasible. Examples include hygiene procedures where ultrasonic scaling is used, drilling a cavity with water spray coolant, and implant bone drills where a water spray is used to keep the bone from overheating. These procedures produce massive amounts of airborne bacteria, viruses, and fungi. Aerosols are quickly spread into the operatory and even into the ventilation system of the building, which puts many people at risk of contracting illness.

(7) Handheld suction devices such as saliva ejectors for collecting moisture and high-volume evacuators (HVE) which draw relatively large volumes of air are also commonly used by dentists,

but nevertheless do not provide a physical barrier between the patient and dental professional. There therefore remains an urgent need for devices and systems for limiting the spread of aerosols in an operatory, providing increased protection for dental professionals and reducing the likelihood of infection for all present in the dental office. Recognizing this need, the present inventor has developed a dental aerosol protection system that effectively traps and collects aerosol and splatter particles before they can escape the mouth area and become airborne in the operatory, and provides a barrier between the patient and dental professional. This system utilizes a high-volume suction to collect the trapped aerosol and splatter particles and drastically eliminates aerosols at the source, before they are introduced into the environment, and is adaptable and equally effective for use in dental procedures requiring a rubber dam and procedures where a rubber dam cannot be used.

BRIEF SUMMARY OF THE INVENTION

(8) The present invention satisfies the above-described and other related needs by providing a dental aerosol protection system and method for use during aerosol and splatter generating dental procedures which provides a protective barrier between the dental professional and oral cavity of the patient, trapping and collecting potentially harmful particles prior to being dispersed throughout the operatory. In the several embodiments, the invention includes a ring assembly formed of an autoclavable plastic. In one mode of operation, the ring assembly is mountable to a supporting and protective face mask worn by the patient, while in another mode of operation the ring assembly and support mask can be used individually to protect dental professionals from exposure to aerosols and splatter depending upon the requirements of the particular procedure.

(9) The ring assembly includes a frame sized and dimensioned to extend around the oral cavity during a dental procedure, and a collar which extends superiorly away from the patient. A lip projects inwardly from the collar and forms a circumferential ring, the inner edge of which defines a center lumen or operating field which is positioned directly over the oral cavity. A pair suction ports are joined to the ring assembly, each having a suction nozzle connectable on an end to a high velocity vacuum source by a suitable hose. The opposite end of each suction nozzle is open along an inner surface of the ring assembly, and in an embodiment open on an inner surface of the collar at a position behind or underneath the inner lip. The outwardly extending collar and inwardly directed lip jointly form a first extension which traps aerosol and splatter particles emitted by the patient underneath the first extension, and a high-volume suction at the suction ports simultaneously creates a circumferential negative pressure in close proximity to the patient's mouth, providing a funneling of air flow away from operating room towards suction ports of the device.

(10) In another aspect, the dental aerosol protection system includes one or more flexible aerosol and splatter barrier extensions, which in an embodiment are made of a plastic film such as polyethylene. In an embodiment, the one or more flexible extensions are detachably secured to the ring assembly extending around the center lumen by elastic bands which are secured over connectors on the collar. The flexible extensions may be of different sizes and are oriented with one end tightly secured to the collar portion of the ring assembly and an opposite end extending superiorly away from the patient. The flexible extensions may be selectively positioned over the centrally located operating field and serve as another barrier between the patient's oral cavity and the operatory to further limit the spread of aerosols. The flexible extensions thus comprise an important component of the dental aerosol protection system in addition to the integral barrier formed by the collar and lip on the ring assembly. The flexible extensions are easily adjusted and repositioned by a dental professional as needed during each dental procedure without being obtrusive or hindering the dental professional's view or access to the oral cavity, and effectively contain aerosols and direct them into the high velocity vacuum ports.

(11) In another aspect, the ring assembly may be utilized as a standalone aerosol and splatter containment device, such as in dental procedures requiring use of a conventional dental dam and where the dam is adequately held in place by a clamp secured to a tooth. In an embodiment, the

frame portion of the ring assembly contains periodic spines over which the edges of the dam sheet are stretched and supported. Alternatively, the ring assembly may be connected to the supporting protective face mask structure, which holds or supports the ring assembly in a stable and balanced position on the patient. The support mask is a patient interface which is separately securable to the patient. In an embodiment, the support mask is integrally formed of a unitary clear or translucent plastic material and includes forehead, brow, eye, and cheek covering regions. The nose, mouth and chin areas of a patient wearing the support mask are left substantially uncovered by the support mask, allowing the patient freedom to breathe through both the nose and mouth, as well as complete freedom of jaw movement. An adjustable band or strap attached to the forehead covering region of the support mask is used to secure the mask to the patient. The brow and eye covering regions protect the patient's eyes (orbital process) as well as the upper part of the bridge of the nose, and are spaced outwardly away from the patient's face, slightly beyond where the lens of a pair of glasses would normally be located. The cheek covering regions extend downwardly over the cheek bones (malar process) on either side of the nose to a position below the corner of the patient's mouth. Posts located on the cheek covering regions of the support mask are configured to connect to corresponding sleeves on the ring assembly, and when connected secure the ring assembly over the front surface of the mask structure in a position extending between the cheek covering sections.

(12) When the ring assembly and support mask are connected and worn by a patient, the center lumen or opening of the ring assembly will be positioned superiorly over or in front of the patient's oral cavity. In use during aerosol generating dental procedures, activation of the vacuum source attached to the suction port nozzles on the ring assembly by suction tubing will deliver a high-velocity suction circumferentially around the entire field of operation, drawing potentially harmful aerosols and splatter into the nozzles and away from the operating field before being emitted into the operatory. The flexible extensions are secured to the connectors on the ring assembly in the same manner regardless of whether the ring assembly is used as a standalone device or is attached to the support mask. In some embodiments, similar connectors are provided on the cheek covering regions of the support mask, such that the flexible extensions may be secured directly to the support mask instead of the ring assembly, which is advantageous where the dental professional prefers a larger diameter work area bordered by the extensions. Alternatively, the flexible extensions may be secured to connectors on both the ring assembly and support mask, wherein in one arrangement the flexible extensions on the support mask may be draped over the outer edges of the support mask as a further barrier to prevent aerosol particles from leaking between the support mask and face of the patient.

(13) For aerosol generating dental procedures in which a dental dam is not suitable, and the dental professional prefers a larger work or operating field, in another aspect, integral suction ports are also provided on the cheek covering regions of the support mask. The suction ports on the support mask also include a nozzle which is similarly connectable to a high velocity suction source. The tab-like connectors on the support mask also enable one or more flexible extensions to be secured to the support mask in a position secured around the outer edges of the cheek covering regions and extending superiorly away from the patient around the nose and mouth area of the patient, such that the support mask also can be used as a standalone aerosol and splatter containment device. The flexible extensions serve as a barrier between the dental professional and the patient which aids in containing aerosol and splatter particles within the confines of the mask and extensions, and in guiding them towards the suction nozzle openings on the support mask. The flexible extensions are also easily maneuvered and positioned by the dental professional to suit the requirements of each individual procedure. Additional flexible extension barriers may also be positioned around the outer periphery of the outer edge of the ring assembly and support mask.

(14) Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific

examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The accompanying drawing figures, which are incorporated in and form a part of the specification, are illustrative of aspects of the present invention which will become more fully understood together with the following detailed description, and are not meant to limit the scope of the disclosure in any manner, which scope shall be based on the claims.

(2) FIG. **1** is a diagrammatic view of an embodiment of a dental aerosol protection system in accordance with the present invention.

(3) FIG. **2** is an isometric view of a connected ring assembly and mask structure in accordance with the invention.

(4) FIG. **3** is an exploded view of the ring assembly and mask structure shown in FIG. **2**.

(5) FIG. **4** is a front isometric view of an embodiment of the ring assembly.

(6) FIG. **5** is a rear isometric view of the ring assembly in FIG. **4**.

(7) FIG. **6** is a left-side elevation view of the ring assembly, the right-side elevation view being a mirror image thereof.

(8) FIG. **7** is a top elevation view of the ring assembly.

(9) FIG. **8** is a bottom elevation view of the ring assembly.

(10) FIG. **9** is a front top isometric view of an embodiment of the support mask.

(11) FIG. **10** is an isometric rear view of the support mask shown in FIG. **10**.

(12) FIG. **11** is a left-side elevation view of the support mask, the right-side elevation view being a mirror image thereof.

(13) FIG. **12** is a top view of the support mask.

(14) FIG. **13** is a bottom view of the support mask.

(15) FIG. **14** is a right-side diagrammatic view of the connected ring assembly and support mask secured to a patient in a use position and having a flexible aerosol barrier extension attached to the ring assembly.

(16) FIG. **15** is a diagrammatic view similar to FIG. **1** in which the ring assembly is also supporting a dam sheet.

(17) FIG. **16** is a diagrammatic view illustrating use of the ring assembly without the support mask including a dam sheet and a flexible aerosol barrier extension positioned around the field of operation.

(18) FIG. **17** is a diagrammatic view illustrating use of the support mask without the ring assembly and including a flexible aerosol barrier extension positioned around the field of operation.

(19) FIG. **18** is a front right-side view of the support mask including a flexible aerosol barrier extension as used without the ring assembly.

(20) FIG. **19** is an isometric front view of another embodiment of the ring assembly.

(21) FIG. **20** is an isometric rear view of the ring assembly shown in FIG. **19**.

(22) FIG. **21** is an isometric rear view of another embodiment of the ring assembly.

(23) FIG. **22** is an isometric rear view of another embodiment of the ring assembly.

(24) FIG. **23** is an isometric view of another embodiment of the support mask.

(25) FIG. **24***a* illustrates one of the flexible extensions of the present invention.

(26) FIG. **24***b* illustrates an embodiment of the flexible extensions provided in a roll form.

DETAILED DESCRIPTION OF THE INVENTION

(27) Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings. While the present invention will be described

in conjunction with the various embodiment(s), such description is not intended to be understood in a limiting sense, but to be an example of the invention presented solely for illustration thereof, and by reference to which in connection with the following description and the accompanying drawings one skilled in the art may be advised of the advantages and benefits of the invention. On the contrary, the present invention is intended to cover alternatives, modifications, and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Further, it will be appreciated that embodiments of the present disclosure may employ any combination of features described herein. Descriptions of well-known starting materials, equipment, components and processing techniques may be omitted so as to not unnecessarily obscure the embodiments herein.

(28) It is to be understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the full scope of the invention. The singular terms “a”, “an” and “the”, as used herein, are intended to include the plural forms as well, unless the context clearly indicates otherwise. The term “plurality”, as used herein, is defined as two or more than two. The term “another”, as used herein, is defined as at least a second or more. The terms “includes”, “including” and/or “having”, as used herein, are defined as comprising. The terms “joined” and/or “coupled,” as used herein, are defined as connected, although not necessarily directly, and not necessarily mechanically. To aid in describing the disclosure, directional terms may be used in the specification and claims to describe portions of the present disclosure (e.g., front, rear, left, right, top, bottom, upper, lower, inner, outer, side, etc.). These directional are intended to merely assist in describing and claiming the disclosure, but the present disclosure is not limited thereto. The terms “comprises,” “comprising,” or any other variation thereof are intended to cover a non-exclusive inclusion, such that an article, apparatus, process, or method that comprises a list of elements does not preclude the presence or addition of other elements not expressly listed or inherent to such article, apparatus, process, or method. An element proceeded by “comprises . . . a” does not, without more constraints, preclude the existence of additional identical elements in the article, apparatus, process or method that comprises the element. The terms “about” or “approximately” as used herein apply to all numeric values, whether or not explicitly indicated. These terms generally refer to a range of numbers that one of skill in the art would consider equivalent to the recited values (i.e., having the same function or result). Elements which are identical, similar, or functionally identical are provided in the figures with the same reference numerals and a repeated description of these elements is in some cases dispensed with in order to avoid redundancies.

(29) The present invention provides a dental aerosol protection system particularly well adapted for controlling dispersion of and collecting aerosol and splatter particles emitted from the oral cavity of patients during dental procedures. FIG. **1** illustrates an embodiment of the system **10**, which generally includes a ring assembly **12**, a head-mountable support mask **60**, and a high-speed dental vacuum source **100** which is shown connected to suction nozzles **36** on the ring assembly **12** by suction hoses **102**, **103**, and **104**. As shown at least in FIGS. **2** and **3**, the ring assembly **12** is detachably couplable to the support mask **60** such that depending upon the requirements of the particular dental procedure, the ring assembly **12** and support mask **60** may be utilized when coupled together as shown in FIGS. **1** and **14**, or as shown in FIGS. **16** and **17** the ring assembly **12** and support mask **60** may be used separately to control dispersion of aerosols and splatter from a patient's mouth depending upon the requirements of the dental procedure. FIGS. **4-8** illustrate additional features of the ring assembly **12**, FIGS. **9-13** illustrate additional features of the support mask **60**, and FIGS. **14-23** illustrate various uses and alternative embodiments of the invention.

(30) Referring now to FIGS. **4-8**, ring assembly **12** includes a thin frame **13** and has a front surface **14** and a rear surface **15**. Frame **13** includes left, right and lower sides which generally form a U-shape, having an inner edge **16**, and an outer edge **18**. When in a use position on a patient, rear surface **15** is oriented towards the patient's face and front surface **14** is oriented away from the

patient's face. As best illustrated in FIGS. **6-8**, frame **13** has a curvature such that rear surface **15** is concave to follow the convex contours of the face and to facilitate a close fit with the face. Frame **13** is dimensioned to extend around the oral cavity of a patient undergoing a dental procedure, such that as shown in FIG. **1** a central opening or lumen **19** is positioned directly in front and over of the patient's open mouth. In the presently illustrated embodiment, frame **13** also has a cutaway or reduced width portion **20** along the upper side of ring assembly **12** such that the ring assembly **12** fits more comfortably over the upper lip area of a patient without interfering with the patient's nose or breathing.

(31) Ring assembly **12** is preferably made of an autoclavable plastic and is manufactured using an injection molding and/or 3D printing process, although other suitable materials and conventional molding or cutting manufacturing techniques may alternatively be used. Assembly **12** may also be manufactured in different sizes for use with different age groups. When used without the support mask **60**, portions of rear surface **15** along the outer periphery of frame **13** will be supported either directly or indirectly on the patient's face (see FIG. **16**). In some embodiments, the outer edge **18** of frame **13** has a sinuating or dentate shape, forming a plurality of spaced apart outwardly directed spines or tines **21**. As illustrated in FIG. **16**, the spines or tines **21** are provided such that ring assembly **12** may be used to support a flexible, substantially planar dental dam sheet **50** of a type commonly used in certain dental procedures to isolate an area of the mouth from the remainder of the oral cavity. The largest commercially available rubber dam (dental dam) sheets typically are 6 inches by 6 inches, and therefore the frame portion will be large enough to support dam sheets of this size. The dam sheet **50** will first be secured in the patient's mouth around one or more teeth by a suitable clamp device, after which the outer edges of the dam sheet **50** are stretched over the rear side **15** of the frame **13** and then draped over the tines **21** and released, such that the stretchable dam sheet **50** is secured to frame **13**.

(32) Ring assembly **12** also includes a collar **22** which is joined to the inner edge **16** of frame **13** on an end. Collar **22** is oriented extending outwardly away from front surface **14**, preferably along the entire inner edge **16** of frame **13**, and has opposite inwardly and outwardly facing side surfaces **23** and **24**, respectively and an outer edge **25**. In addition, an inwardly directed lip **26** having a rim **27** is joined to collar **22** at a spaced location from inner edge **16** of frame **13**, preferably in close proximity to outer edge **25**. The inner rim **27** of lip **26** extends further inwardly on the ring assembly **12** than the inner edge **16** of frame **13**, and thus defines the perimeter of the central lumen or opening **19** as well as the work or operating field **19** in which a dental professional has access to the oral cavity when using the device **12**. In an embodiment, the dimensions of central lumen **19** as defined by inner rim **27** are about 2.5 inches from nose to chin and about 2 inches from left to right, although it will be understood that lumen **19** may have different dimensions in other embodiments. In the present embodiment, lip **26** is raised superiorly over the patient's mouth on collar **22**, such that together collar **22** and lip **26** form a peripheral barrier or first extension which will trap significant amounts of aerosol and splatter particles expelled from the patient underneath the lip **26**, which aerosols as explained in greater detail below will prevented from entering the operatory, instead being directed into high volume suction openings **44** formed in collar **22** underneath the lip **26**.

(33) Also joined to the ring assembly **12** on the outer surface **24** of collar **22** are several spaced-apart tab-like extension connectors **28**, which as discussed in greater detail below are used to secure one or more additional flexible extensions or aerosol barriers to the ring assembly **12**. Ring assembly **12** also includes one or more suction ports **32** and **34**, which may be placed in fluid communication with high-velocity suction source **100** such as by suitable flexible suction lines or hoses **102**, **103**, and **104**. Suction ports **32** and **34** are preferably integrally formed on ring assembly **12** at spaced apart locations on opposite sides of the work area **19**. In the presently illustrated embodiment, suction ports **32** and **34** are located on the front surface **14** of frame **13** against the outer wall surface **24** of collar **22**. Each suction port **32** and **34** includes a nozzle **36** which is joined

to frame **13** and further supported by a strengthening or reinforcing structure **38**. Reinforcing structure **38** is also joined to additional support housing **40** which connects to frame **13** and outer wall surface **24** of collar **22**. Each nozzle **36** has an interior channel **42**, and is oriented with outer end **43** extending outwardly away from frame **13**. As shown in FIG. **5**, the interior channel **42** of nozzle **36** has an inner end **44** which extends through collar **22** and forms a suction opening on the inner wall surface **23** of collar **22**, underneath or behind the lip **26**. In an embodiment, the diameter of interior channel **42** may narrow gradually from outer end **43** towards inner end **44** in order to increase the suction force generated at inner end **44**.

(34) Extension connectors **28** on collar **22** have a rounded shape (e.g. a bulb shape) and include a trunk section which is joined to collar **22**, and an outer section at least a portion of which has a larger outer diameter than the trunk section. In the presently illustrated embodiment, connectors **28** extend away from the outer wall surface **24** of collar **22**. As shown in FIGS. **1**, **14**, and **15**, extension connectors **28** are used to secure one or more flexible aerosol side wall or barrier extensions **56** to the ring assembly **12**. The flexible extensions **56** in an embodiment are made of a thin, clear plastic or plastic film with little rigidity, such as low-density or high-density polyethylene (LDPE, HDPE), while in other embodiments the extensions may be made of other suitable materials including but not limited to LLDPE or polyvinyl chloride (PVC), paper, and combinations of materials. The extensions **56** can vary in their dimensions and may be cut to different lengths according to the preference of the dental professional or the particular requirements of a dental procedure. Each extension **56** is preferably of a unitary construction generally having a tubular configuration with open opposite ends, although the extensions **56** may also be formed as a rectangular panel having its longitudinal or side edges sealed together or overlapping to form a unitary configuration. FIG. **24***a* illustrates one of the extensions **56** having a tubular form with open opposite ends **97***a* and **97***b*. FIG. **24***b* illustrates the extensions **56** provided in a roll form **98** with perforations **99** defining the individual extensions, which extensions **56** have open ends as well as an open longitudinal edge **100** such that the open edge can be easily overlapped, cut or otherwise fitted to the ring assembly **12** or face mask **60**. The extensions **56** have a circumference sufficient for an open end of the extensions **56** to extend around and loosely fit over connectors **28** on the outer wall **24** of the collar **22**, and in use form a flexible side wall around the work area **19** which can also be draped over the work area, and as explained herein further define an interior area in which a negative pressure is generated by the suction generating device **100** during use of the present invention.

(35) As shown in FIGS. **1**, **14**, and **15**, flexible extensions **56** are fastened to the extension connectors **28** by one or more securing members such as elastic bands **58**. Each band **58** is positioned around at least one of the extension connectors **28** or pair of connectors as well as over an inwardly positioned end of the flexible extension **56**. In other embodiments, the securing member may be a cap or clamp which fits over the connector **28** or other suitable securing apparatus. Once the extension **56** is secured to the connectors **28**, the opposite outwardly directed end of the extension **56** is extended superiorly away from the patient such that the extension **56** forms a flexible barrier around the operating field **19**. The extension **56** will then be positioned such that the outer end will drape inferiorly or towards the patient over the working area **19**. While the extensions **56** have little rigidity, the material used in forming the extensions **56** should have a thickness and/or stiffness such that when extended superiorly the extension **56** will not collapse inwardly to a substantial degree under its own weight or due to the suction force generated when the high velocity suction source **100** connected to suction ports **32** and **34** is activated, but should also be sufficiently flexible to be easily moved or adjusted with only a slight manual pressure exerted by the dental professional. The extensions **56** in an embodiment are transparent such that the amount of light directed into the oral cavity by a light source in the operating room is not substantially reduced by the extensions, although in some embodiments an additional light apparatus may be connected to or otherwise utilized with the system **10**. In an embodiment, the

extensions **56** may be a LDPE poly tubing having a 2 mil thickness. The position and orientation of the flexible extensions **56** with respect to the work area **19** can be quickly and almost effortlessly adjusted as needed to alternatively cover and expose portions of the work area **19** as needed. When the dental procedure is completed, the flexible aerosol barrier extension **56** is removed from the connectors **28** by releasing the bands **58** and then safely discarded. It will be evident that the extensions **56** are not integrally formed as a part of the ring assembly **12**, but rather are attachments which provide a barrier between the oral cavity of the patient and the dental professional, and also greatly enhance the capability of the system **10** to trap and collect aerosols which otherwise would be expelled into the operatory through central opening **19**.

(36) As shown in the rear view of ring assembly **12** in FIG. **5**, a small section of frame **13** is cut away on the rear side of the reinforcing structures **38**, and a pair of short tubular sleeves **46** extend rearwardly from reinforcing structures **38** in the area of the cutaway. As indicated above and shown in FIG. **1**, the ring assembly **12** is designed to be coupled to support mask **60**, which is a specifically designed patient interface capable of supporting the ring assembly **12** in an intended use position directly over the patient's oral cavity. The sleeves **46** serve as complementary fastener components which are used to matingly secure the ring assembly **12** to support mask **60**, as described below.

(37) Referring now to FIGS. **9-13**, support mask **60** is preferably integrally formed as a unitary continuous piece of clear or translucent plastic such as a polycarbonate material, although in other embodiments the support mask **60** may be formed of two or more separate component parts which are joined during the manufacturing process, and may also be formed of other suitable materials or combinations of materials. Support mask **60** includes an anterior or front surface **62**, a posterior or rear surface **63**, a forehead covering region **64**, a brow covering region **65**, eye covering regions **66** and **67**, and downwardly extending cheek covering regions **68** and **69**. As shown in FIG. **17**, the nose, mouth and chin areas of a patient wearing the support mask **60** are left substantially uncovered by the mask **60**, allowing the patient freedom to breathe unencumbered through both the nose and mouth, and complete freedom of jaw movement.

(38) Forehead covering region **64** comprises the uppermost portion of mask **60** and is dimensioned to extend over a major area of the forehead between the left and right temples. Region **64** has curvature such that posterior surface **63** is concave and contoured to the shape of an average forehead and fits closely to the forehead of the patient. Spaced apart slots or openings **70** are formed in the forehead covering region **64**, preferably in relatively close proximity to opposing side edges of region **64**. Slots **70** are configured to receive a band or strap **72** (see FIG. **1**) which is passed through the slots **70**. The band or strap **72** may be an elastic strap and is preferably length adjustable. It will be understood that the band or strap **72** may be connected to the mask **60** by other suitable means such as by an adhesive or other securing arrangement. Strap **72** is used to secure the support mask **60** to the patient's head with posterior surface **63** of forehead region **64** pressing against the patient's forehead. The large surface area of the forehead covering region **64** better supports and evenly distributes the weight of the mask **60**. Forehead covering region **64** also preferably can bend or flex slightly in order to accommodate more or less pronounced forehead shapes. In embodiments of the present invention where the mask **60** is made of plastic, for patients allergic to plastic or otherwise where desirable, an intermediate layer such as a soft tissue paper can be placed between the patient's forehead and the posterior surface **63** of forehead region **64**.

(39) Brow covering region **65** is joined to the forehead covering region **64** along a lower edge of the forehead covering region **64**, and eye covering regions **66** and **67** are similarly joined to brow covering region **65** along a lower edge of the brow covering region **65**. The brow and eye covering regions **65** and **66-67**, respectively, are fabricated to provide protection around the patient's eyes (orbital process) and upper part of the bridge of the nose. Brow covering region **65** in the illustrated embodiment extends substantially over the patient's entire brow area, while eye covering regions **66** and **67** substantially cover the patient's left and right eye areas. As best shown in FIG. **11**, brow

covering region **65** is angled forwardly and protrudes forwardly or outwardly with respect to forehead covering region **64**. As a result, when support mask **60** is secured to the patient by strap **72**, both the brow covering region **65** and eye covering regions **66** and **67** will be spaced apart or positioned superiorly away from the patient's face, preferably a distance slightly beyond where the lens of a pair of glasses would normally be located. The resulting space between the rear surface of the brow and eye covering regions **65** and **66-67** is more comfortable for the patient, allows for anatomical variance between different patients such that the support mask **60** fits a broader range of patients, and protects the eyes in a manner similar to a pair of safety glasses.

(40) Cheek covering regions **68** and **69** of mask **60** are joined to eye covering regions **66** and **67** along the lower edge of eye covering regions **66** and **67**, respectively, and are continuous with the eye covering regions **66** and **67**. Cheek covering region **68** has an outer margin **75**, an inner margin **76**, and a lower margin **77**, while cheek covering region **69** similarly has an outer margin **78**, an inner margin **79**, and a lower margin **80**. Cheek covering regions **68** and **69** are substantially mirror images of each other, as are eye covering regions **66** and **67**. The posterior surface **63** of cheek covering regions **68** and **69** is slightly concave. In addition, the outer margins **75** and **78** of cheek covering regions **68** and **69** have a slight outward or convex curvature extending from eye covering regions **66** and **67** to lower margins **77** and **80**, respectively. The inner margins **76** and **79** of cheek covering regions **68** and **69** have a more pronounced inward or concave curvature extending from eye covering regions **66** and **67** to lower margins **77** and **80**, respectively. When support mask **60** is worn, cheek covering regions **68** and **69** extend downwardly over of the cheek bones (malar process) on either side of the nose, and there is an open area between regions **68** and **69** for the lower nose and mouth which are left uncovered by the support mask **60**. The outward curvatures of cheek covering regions **68** and **69** provide an even larger work field for the dental professional. The lower margins **77** and **80** of regions **68** and **69** should extend below the corner of the patient's mouth.

(41) At least one pair of tab-like extension connectors **81** is joined to each of the cheek covering regions **68** and **69**. Extension connectors **81** are similar in structure to extension connectors **28** provided on the ring assembly **12** discussed above, and include a cylindrical trunk section attached to cheek covering region **68** or **69**, followed by a larger diameter outer section. The connectors **81** are spaced apart along outer margins **75** and **78** of the cheek covering regions **68** and **69**, respectively, and are oriented such that they protrude away from the outer margins **75** and **78**. As best shown in FIGS. **17** and **18**, connectors **81** facilitate attachment of one or more flexible extensions **56** to the cheek covering regions **68** and **69** of the support mask **60** using one or more securing members such as elastic bands **58** which are secured over the connectors **81** after an extension **56** is positioned over the connectors **81**, holding a lower portion of the extensions **56** to the connectors **81**. It will be evident therefore that the flexible aerosol barrier extensions **56** may be similarly coupled to either the ring assembly **12** or the support mask **60**, the advantages of which arrangement are discussed below.

(42) The presently described embodiment of support mask **60** also includes a pair of suction ports **88** and **89** which are joined to mask structure **60** at an intermediate position along the outer margin **75** and **78** of the cheek covering sections **68** and **69**, respectively. Each suction port **88** and **89** includes a suction nozzle **90** having an interior channel **91** which is open on opposite inner and outer ends **92** and **93**, and a support frame **94** joins the nozzle **90** to the respective cheek covering region **68** and **69**. Frame **94** of suction port **88** supports nozzle **90** in an orientation with inner end **92** extending over the anterior surface **62** of the cheek covering region **68**, facing towards inner edge **76**, and with outer end **93** oriented extending outwardly away from outer margin **75**. Similarly, frame **94** of suction port **89** supports nozzle **90** with inner end **92** extending over the anterior surface **62** of the cheek covering region **69**, facing towards the inner edge **79**, and with outer end **93** oriented extending outwardly away from outer edge **78**. Each nozzle **90** is positioned to be directly along the sides of the mouth and oral cavity of a patient wearing the support mask **60**.

(43) Also attached to the cheek covering sections **68** and **69** of support mask **60** projecting outwardly from anterior surface **62** are mounting posts **96**. As illustrated in FIGS. **2** and **3**, each post **96** is sized and positioned to serve as a mating fastening component with connector sleeves **46** on the rear surface **15** of ring assembly **12**. Mating fastening components **46** and **96** thus enable the ring assembly **12** and support mask **60** to be detachably joined. In an embodiment, the outer edge of the posts **96** has an outer circumference or shape substantially the same as the inner circumference or shape of the hollow connector sleeves **46**, such that a friction fit between sleeves **46** and post **96** is provided when posts **96** are received in sleeves **46**. As illustrated in FIG. **1**, when the support mask **60** is secured to a patient by strap **72** attached to brow covering region **64** as described above, and ring assembly **12** is joined to the support mask **60** by sleeves **46** and matching prongs **96**, the center lumen or opening **19** of the ring assembly **12** by necessity will be desirably positioned directly over the patient's open mouth. Posts **96** therefore provide direct support and positioning of the ring assembly **12** on the support mask **60**. It will be understood that the ring assembly **12** can be attached to the support mask **60** by other securing or alignment arrangements including but not limited to a snap fitting or other compression-type fittings.
(44) When the ring assembly **12** and support mask **60** are connected, in one mode of operation, shown in FIG. **1**, the suction nozzles **36** of suction ports **32** and **34** on ring assembly **12** are coupled on their outer ends **43** to suction generating device **100** by suitable flexible connecting hoses or tubing. Device **100** will typically but not necessarily be a high-speed dental vacuum system of a type used and already installed in most dental offices. An example of a suitable system is the ADC V105 External Oral Suction device manufactured by Affordable Dental Chairs, Inc. A suction force suitable for most dental procedures and for use in the present invention is between **11** to **12** bars. The connecting hoses or tubing may be a high-performance suction tube that will be connected in fluid communication between the outer end **43** of nozzles **36** of suction ports **32** and **34** on ring assembly **12** and a suction port on the dental vacuum system **100**. In FIG. **1**, a long tail section of tubing **102** connects to the vacuum system **100** on one end and to a t-connector, not shown, on the other end. The t-connector then connects to a pair of shorter-length respirator tubes **103** and **104**, while are also each connected to one of the nozzles **36** on suction ports **32** and **34**. As indicated by the arrows in tubes **102-104**, when the vacuum unit **100** is activated, a high powered vacuum suction is generated at the inner end **44** of suctions nozzles **36** on the inner surface **23** of collar **22**, generating a negative pressure and vortex around the oral cavity that draws in aerosolized particles. In another mode of operation, the suction hoses or tubing attached to the suction generating device **100** may be connected both to nozzles **36** on the ring assembly **12** and to nozzles **90** on the support mask **60**, providing an aerosol collecting suction force at four separate locations around the oral cavity rather than two. Alternatively, the suction hoses or tubing may be connected only to suction nozzles **90** on the support mask **60**, which may be preferred by dental professionals who also prefer to attach the flexible extensions **56** to connectors **81** along the outer margins or edges **75** and **78** of cheek covering regions **68** and **69** of mask **60** rather than to connectors **28** on the ring assembly **12** in order to provide a larger work area bordered by the extensions **56**. Additional plastic extensions **56** can also be positioned extending over the outer edges of the mask and cheek and jaw area of the patient in order to minimize leakage.
(45) When the ring assembly **12** is attached to the support mask **60**, as shown in FIGS. **1** and **14**, the weight of the ring assembly **12** will be more evenly distributed on the patient. It is particularly beneficial to use the support mask **60** to hold the ring assembly **12** in a secure and stable position around the patient's mouth for certain procedures where a dental dam sheet **50** cannot be stably or tightly secured in position around a tooth by a clamp or the like. In addition, using the ring assembly **12** and support mask **60** together is beneficial in procedures where a rubber dam is not required. This includes numerous dental procedures but especially hygiene procedures and implant procedures where use of a rubber dam is not possible, but high levels of contaminated aerosols are generated, all of which procedures are made much safer from using the present system **10**. The

support mask **60** will rest securely on the patient's face with rear surface **63** of forehead covering region **64** in contact with the forehead area, and with a portion of the inner surface of the cheek covering regions **68** and **69** resting against the check bone or Malar process. If the ring assembly **12** is used without the mask **60** with a dental dam **50** that is not adequately secured to a tooth, a slight turn of the head or sneeze by the patient, or a slight contact of the dental professional's hand against the assembly **12** may cause it to become ajar. The mask **60** therefore provides the additional support required to maintain the ring assembly **12** in a stable position around the oral cavity of a patient.

(46) FIG. **16** illustrates the ring assembly **12** in use with a dental dam sheet **50** without the support mask **60**. A small hole is made in the dam sheet **50** through which a tooth **52** to be treated is passed, thereby isolating the tooth **52** from the rest of the oral cavity. A clamp **54** of a conventional type familiar to those skilled in dentistry is utilized to hold the rubber dam sheet **50** around the isolated tooth **52**. The ring assembly **12** is then positioned over the front of the dam sheet **50** with rear surface **15** facing the patient, and the rubber dam sheet **50** is stretched outwardly and then folded or draped forwardly over tines or spines **21** on the outer edge **18** of the frame **13**. Due to the flexible and elastic nature of the dam sheet **50**, once draped over the spines **21** and released the sheet material will retract and be adequately secured to the frame **13**. Since the patient will be in a reclined position, the combination of the dam sheet **50** being secured to the tooth **52** by clamp **54** and to the ring assembly **12** by spines **21** is sufficient under normal conditions to hold the ring assembly in a position with central opening **19** which defines the work area centered over the patient's open mouth. In still another use arrangement, the dental dam sheet **50** may be secured to conventional dam frame, and the device **12** may then be overlaid on the conventional dam frame and sheet when desired, which makes it possible to easily remove and replace the ring assembly **12** without first disengaging the dam sheet from the frame **13**.

(47) FIGS. **17** and **18** illustrate the support mask **60** in another mode of operation in use as a standalone aerosol protection device without ring assembly **12**. In this mode of operation, extension connectors **81** on cheek covering regions **68** and **69** which are positioned around the field of operation are used to connect one or more flexible plastic aerosol barrier extensions **56** to the mask structure **60** by securing members such as elastic bands **58** which are positioned over the connectors **81** and inner end of the extensions **56**. Once connected to the support mask **60** by connectors **81**, the extension or extensions **56** are then arranged to extend superiorly away from the mask **60** and face of the patient, providing a flexible aerosol and splatter containment barrier extending around and outward from the work area, which barrier can be easily repositioned or adjusted by the dental professional as needed during a procedure. One or more additional extensions **56** may also be positioned between the outer margins **75** and **78** of cheek covering regions **68** and **69** and the patient's face to prevent any leakage in this area. It will be understood that other arrangements for securing the extensions **56** to the ring assembly **12** or support mask **60** may be utilized, such as an adhesive or differently shaped connector, while still falling within the intended scope of the invention. The outer end **93** of the nozzles **90** is in a convenient location to attach the suction tubing **103** and **104**, which tubing in turn is connectable to a high-volume suction source **100** of a type already found in most dental offices. As shown in FIG. **17**, the inner end **92** of the nozzles **90** is positioned over the front surface **62** of the cheek covering regions **68** and **69** and is facing in the direction of the inner edge **76**, **79** of the cheek covering region **68**, **69**, respectively, ensuring that the suction force generated in channels **91** of nozzles **90** is directed towards the work area between cheek covering regions **68** and **69**, and is optimally positioned to draw in aerosol and splatter particles emitted from the patient's mouth. In addition, the flexible extensions **56** provide an effective adjustable physical barrier between the oral cavity of the patient and the dental professional and operatory. Aerosolized particles expelled from the oral cavity which otherwise may have been escaped past the nozzles **90** will now be prevented from escaping into the operatory and will be drawn towards the nozzles **90**. The flexible extension **56** in combination with suction

nozzles **90** air will create a negative pressure within the work area and tend to cause air to flow towards the nozzles **90**, indicated by the arrows in FIG. **17**, rather than superiorly away from the patient. This air flow will both greatly reduce the number of aerosol particles which are able to escape beyond the extensions **56**, and also will tend to draw aerosol particles back towards suction nozzles **90**, without significantly hindering the ability of the dental professional to complete the dental procedure. The ability of the mask structure **60** as well as the ring assembly **12** to provide and maintain a constant hands-free high-volume suction force in close proximity to and on opposite sides of the operative site greatly expands the usefulness of the mask device **60**.

(48) FIGS. **19** and **20** illustrate another embodiment of the ring assembly **112** of the present invention, which is similar to ring assembly **12** in many respects, except that the frame **113** does not have a reduced width portion along its upper area **20**, although upper area **120** is still contoured to extend over the upper lip of the patient without interfering with the nose or nostrils, and the middle portion of the upper area **120** is free of any tines. In addition, extension connectors **128** which are used to attach one or more flexible aerosol barrier extensions to the ring assembly **112**, instead of being positioned on the outer wall surface **24** of collar **22** in ring assembly **12**, are attached facing inwardly on the inner wall surface **123** of collar **124**. Extension connectors **128** are also more globe-shaped than extension connectors **28**, which are more candle-shaped. Another modification is that inner lip or ring **126** is substantially continuous or aligned with frame **113**, rather than being connected to collar **24** in close proximity to the outer edge **25** of the collar **24**. The inner lip or ring **126** therefore is not raised superiorly away from the patient as in ring assembly **12**.

(49) Nozzles **136** of suction ports **132** and **134** on ring assembly **112** are secured to a strengthening member **138** formed on the front or outer surface **114** of frame **113**, which in turn is connected to a suction housing **140** also formed on surface **114**. The suction housing **140** extends through collar **124** on to inner lip or ring **126**, rather than being positioned underneath inner lip or ring **26** as in ring assembly **12**. As shown in FIG. **20**, a plurality of aligned branch channels **146** are formed in rear surface **115** of frame **113** in alignment with the suctions housings **140** and extend inwardly on to lip or rim **126**. Branch channels **146** connect on their outermost end to a main channel **148** also formed in frame **113** on rear surface **115**. A high-volume suction aperture **144** connects through an inner wall of the suction housings **140** into main channel **148**. Aperture **144** is also in fluid communication with nozzle **136**, such that each of the nozzles **136** is in direct fluid communication with the channels **146** and **148**. In use, the ring assembly **112** is connected to a high velocity suction source such as source **100** described above, such that a powerful suction flow is generated in the high-volume suction aperture **144**. The channels **146** and **148** provide an increased surface area on the inner surface **115** of the frame **113** and lip **126** in which the suction flow is generated, which distributes the suction circumferentially around the entire rear surface **115** of the dam frame **112**, drawing aerosol particles expelled from the patient's mouth into the aperture **144** to be collected by the associated vacuum system. The curvature of the frame **113** is such that the channels **146** and **148** are not flush against the skin or face of the patient and by design will be in close proximity to the oral cavity. In use therefore the inner lip or ring **126** will follow the convex contours of the face in general, but will be relieved superiorly at least a small distance positioned away from the mouth and lips. The ring assembly **112** may also include posts or similar connectors to be mounted to the support mask and may be used either alone or in combination with the support mask.

(50) FIG. **21** illustrates another embodiment of the ring assembly **212**, which is similar to ring assembly **12** in many respects, except that collar **224** is slightly wider than collar **24** on ring assembly **12**, such that the inner rim or lip **226** is spaced superiorly a greater distance away from the patient's mouth or face. In addition, a plurality of aligned channels **245** are formed in rear surface **215** of the ring assembly **212** on frame **213** in a position beside sleeves **246**. The channels **245** extend to inner edge **216**, and also open on to collar **224**. The channels **245** in collar **224** are

also aligned with inner aperture **244** of the nozzles **236** which open on to the inner surface of the collar **224** at apertures **244**. The aligned channels **245** aid in trapping aerosol particles under the frame **213** and in directing the particles towards the apertures **244**.

(51) FIG. **22** illustrates another embodiment of the ring assembly **312**, which is similar to ring assembly **12** in many respects, except that the plurality of connectors **328** are mounted on supports **329**. Supports **329** extend upwardly from the outer rim **325** of the collar **324**, and the connectors **328** are directed inwardly with respect to the ring assembly **312** and extend over inner lip or ring **326**. The raised position of connectors **328** on supports **329** enables the connectors to be positioned facing inwardly, rather than being positioned on the outer surface of collar **24** as in ring assembly **12**. Nozzles **336** are in the same position as in the previous embodiments.

(52) FIG. **23** illustrates another embodiment of the support mask **260**, which is similar to the support mask **60** in many respects, except that inverted C-shaped tabs **271** are formed on anterior surface **262** of forehead covering region **264** in alignment with the slots **270**. Tabs **271** are configured to receive a band or strap **72** extending underneath the tabs **271** which is also passed through the slots **270**. In addition, support mask **260** does not contain suction ports **88** and **89** as in support mask **60**, and therefore is designed primarily to be used in combination with the ring assembly **12** in accordance with embodiments of the present invention. In other embodiments, suction nozzles may be detachably mounted to the support mask which can be removed when the support mask is used in combination with the ring assembly or when the nozzles are not in use and may be attached when the support mask is used as a standalone device as described herein. For example, apertures may be provided in the cheek covering regions in which support members for the nozzles are coupled by a friction fit or other suitable attachment means. In addition, fittings **296** on cheek covering regions **268** and **269** of support mask **260** have an irregular outer surface rather than being formed as sleeves **96** on support mask **60**.

(53) In any of the alternate modes of use of the aerosol protection system **10**, the inwardly directed suction nozzles provide a powerful suction around the oral cavity which draws aerosolized particles emitted from the patient's mouth into the nozzles. In addition, the overall structure of both the ring assembly and support mask inhibit aerosol particles from escaping into the operatory. The inwardly directed lip **26** on the ring assembly **12** reduces the size of the working area **19** of the system **10**, and positioning the suction openings **44** under lip **26** facilitates provision of a negative pressure under the lip **26** when the suction source is activated. In addition, the flexible extensions **56** when secured to ring assembly or the support mask serve as an adjustable safety barrier between the dental professional and patient's oral cavity extending around and at least partially over the work area, further protecting those in the operatory against potentially infectious splatter and aerosols while also aiding in guiding or funneling the aerosols toward the suction apertures or source of suction.

(54) Collar **22** on the ring assembly **12** provides some structural support for the base or end of the flexible extensions attached to the connectors, and aids in holding the extensions extending superiorly away from the patient and draped partially over the work area. It will be understood that a single flexible extension may be secured extending around the periphery of the work area, or two or more extensions each extending partially around the work area may be utilized. Additional flexible extensions may be positioned around the side edges of the ring assembly and support mask to reduce possible aerosol leakage in the small spaces between the patient's face and the underside of the ring assembly or frame, or between the frame and ring assembly, as deemed necessary by the dental professional. The flexible extensions are preferably disposable, may have different lengths, and may be shaped or cut using standard scissors to allow the operator the proper access needed to the operating field during the dental procedure. Periodic stiffening members may also be attached to or formed with the flexible extensions to aid in maintaining the extensions in a desired extended position, or the extensions may have a ribbed pattern. In another embodiment, a semirigid plastic extension formed of a polycarbonate or polyester (PET) film material may be attached concurrently

with the flexible extensions **56** to the connectors on the ring assembly or mask, forming a somewhat more rigid shield extending superiorly away from the patient around the work area. In a further aspect, connectors may be provided on the underside of the collar or inner rim for attaching a light and/or camera to the ring assembly. The collar or rim may also be altered by the dental professional if needed to allow better access to the field of operation for a particular procedure using a large acrylic trimming bur/stone, similar to denture acrylic shaping burs/stones. The collar and rim on the ring assembly work in unison with the flexible extension as described herein to increase the power of the vacuum suction being utilized to remove aerosols, and to alter the trajectory of any remaining escaping aerosols into a lower arc that the plastic extension will likely catch. The inner perimeter of the work area is defined by the inner rim or ring, which may be continuous with the frame portion or joined to a forward lip or flange as in the embodiments herein. In ring assembly **12**, the open ends **44** of the nozzles **36** are situated underneath the inner lip or ring **26**, providing a funneling shelf that creates the adjustable mouth opening or aperture through which the operator has access. The ring assembly and support mask are reusable, sterilizable, easy to use, customizable and economical, and effectively contain aerosols. In a further aspect, the ring assembly may be connected to an external support arm such that the device is suspended from the arm, whereby the position of the support arm is adjusted to ensure that the device is maintained in a most useful position over the patient's mouth area, or to quickly move the device away from its use position if needed. In other embodiments, the support structure may have a different appearance while still serving the purpose of supporting the ring device in a stable position over the patient's mouth area.

(55) The foregoing description has been presented for purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise form disclosed. The descriptions were selected to explain the principles of the invention and their practical application to enable others skilled in the art to utilize the invention in various embodiments and various modifications as are suited to the particular use contemplated. Although particular constructions of the present invention have been shown and described, other alternative constructions will be apparent to those skilled in the art and are within the intended scope of the present invention.

Claims

1. A dental aerosol protection device comprising: a head-mountable face mask for protecting portions of a patient's face during a dental procedure having an anterior surface and a posterior surface, and including a forehead covering region, a brow covering region, eye covering regions, and cheek covering regions; wherein the posterior surface is contoured to conform to the face of the patient, the forehead covering region is adapted to directly engage with the patient's forehead, and the cheek covering regions extending from the eye covering regions on opposite sides of the patient's nose and mouth and each having an inner margin, an outer margin, and a lower margin dimensioned to extend at or below the corner of the patient's mouth; a ring assembly detachably securable to the face mask, the ring assembly having a front surface, a rear surface, and including a frame portion dimensioned to extend circumferentially around the oral cavity of the patient, a collar portion projecting outwardly from the frame portion, a lip portion having an inner edge defining a central opening in the ring assembly, a plurality of spaced apart extension connectors joined to the collar portion of the ring assembly, and one or more suction ports joined to the ring assembly each having a suction nozzle operably couplable on one end to a suction generating device and another end forming a suction aperture on the ring assembly; and one or more flexible extensions detachably connectable on an end to one or more of the spaced-apart connectors on the ring assembly with another end extending superiorly away from the front surface of the ring assembly; wherein the one or more flexible extensions act as a flexible side wall and a barrier to splatter and aerosols being emitted from the oral cavity of the patient, and wherein when a suction force is

generated by the suction device a negative suction pressure is exerted circumferentially within the central opening bordered by the flexible extensions, drawing potentially harmful aerosolized particles into the suction nozzle.

2. The oral aerosol protection device of claim 1 additionally comprising at least one fastening component on the ring assembly, and at least one mating fastening component on the cheek covering regions of the face mask, wherein the ring assembly is securable to the face mask in a fixed position extending between the cheek covering regions.

3. The oral aerosol protection device of claim 2 in which the at least one mating fastening component of the face mask is a mounting post attached extending outwardly from the anterior surface of the cheek covering regions of the face mask, and the mating fastening component on the ring assembly is a sleeve, wherein the mounting post is insertable into the sleeve and secured in the sleeve by a friction fit.

4. The oral aerosol protection device of claim 1 wherein the lip portion of the ring assembly extends inwardly from the collar portion.

5. The oral aerosol protection device of claim 4 wherein the suction apertures on the ring assembly are located on an inner surface of the collar portion underneath the lip portion.

6. The oral aerosol protection device of claim 1 additionally comprising a plurality of tines spaced apart on an outer edge of the frame portion of the ring assembly for detachably securing a dental dam sheet to the frame portion.

7. The oral aerosol protection device of claim 1 wherein the facemask additionally comprises a suction nozzle mounted extendingly over the anterior surface of a cheek covering region of the face mask, the suction nozzle having an outer end configured to be operably coupled by a suction line with the suction generating device, and an inner end forming a suction aperture directed to provide a suction force along the inner margin of the cheek covering region.

8. The oral aerosol protection device of claim 7 additionally comprising one or more extension connectors joined to the cheek covering regions of the face mask.

9. The oral aerosol protection device of claim 8 wherein one or more of the flexible extensions is detachably securable to the extension connectors on the face mask in an orientation extending superiorly away from the anterior surface of the cheek covering regions, forming an enclosure around the periphery of the patient's oral cavity and providing a barrier against aerosols and splatter emitted from the patient's mouth, and wherein during application of the suction force in the suction nozzle of the cheek covering region of the facemask a negative suction pressure is exerted circumferentially around the periphery of the oral cavity bordered by the flexible extension, drawing aerosols emitted from the oral cavity into the suction nozzle.

10. The oral aerosol protection device of claim 9 in which the extension connectors on the face mask are positioned along the outer margin of the cheek covering regions.

11. The oral aerosol protection device of claim 1 wherein the brow covering region of the face mask extends downwardly and outwardly from a lower end of the forehead covering region such that the brow covering region and eye covering regions are spaced outwardly from the patient's face.

12. The oral aerosol protection device of claim 1 additionally comprising an adjustable strap connected to the forehead covering region of the face mask for securing around the patient's head.

13. The oral aerosol protection device of claim 1 wherein the flexible extensions are formed of a flexible plastic having an open-ended tubular configuration.

14. The oral aerosol protection device of claim 1 wherein the face mask is formed of a transparent or translucent plastic material.

15. An oral aerosol protection device for limiting dispersion of aerosolized particles during dental procedures comprising a patient interface securable to the head of a patient, and a ring assembly detachably securable to the patient interface and configured to be aligned with the patient's oral cavity, wherein the patient interface and ring assembly may be operably used either secured

together or individually; the patient interface forming a head-mountable structure including an anterior surface and a posterior surface, cheek covering regions configured to extend over opposite sides of the patient's nose and mouth to a position below the corner of the patient's mouth, a suction nozzle mounted to the cheek covering regions having an outer end configured to be operably coupled by a suction line to a suction generating device, and an inner end forming a suction aperture directed to provide a suction force along an inner margin of the cheek covering regions; and one or more extension connectors joined to the cheek covering regions; the ring assembly including a frame dimensioned to extend circumferentially around the oral cavity of the patient, a collar projecting forwardly from the frame, an inwardly projecting lip having an inner edge defining a central opening in the ring assembly, a suction port attached to the frame having a suction nozzle configured to be operably coupled by a suction line to the suction generating device, a suction aperture opening on to the collar or rear surface of the frame, and a plurality of spaced-apart extension connectors attached to the collar; and a flexible side wall extension detachably securable to the extension connectors on the patient interface or ring assembly, the flexible side wall extension configured to form an open-ended aerosol and splatter barrier around the patient's oral cavity; wherein during application of a suction force generated by the suction generating device connected to at least one of the suction nozzles of the patient interface or ring assembly a negative suction pressure is generated around the periphery of the oral cavity bordered by the flexible side extension, drawing potentially harmful aerosols emitted from the oral cavity into the suction nozzle.

16. The oral aerosol collection device of claim 15 additionally comprising at least one fastening component on the ring assembly and at least one mating fastening component on the cheek covering regions of the patient interface, wherein the ring assembly is attachable to the patient interface in a fixed position extending between the cheek covering regions.

17. The oral aerosol collection device of claim 16 in which the collar of the ring assembly extends superiorly outwardly from an inner edge of the frame, and the inwardly projecting lip is connected to the collar at a spaced apart location from the inner edge of the frame.

18. The oral aerosol collection device of claim 17 in which the suction aperture of the suction nozzle of the ring assembly open on to an inner surface of the collar on an underside of the lip, forming a barrier which traps aerosol and splatter particles emitted by the patient underneath the lip, and wherein a high-volume suction at the suction apertures creates a circumferential negative pressure under the lip and funnels a flow of air towards the suction apertures.

19. The oral aerosol collection device of claim 18 in which the patient interface is a support mask having a forehead covering region configured to directly engage with the patient's forehead, and an adjustable strap connectable to the forehead covering region for securing the support mask to the patient's head.

20. The oral aerosol collection device of claim 19 in which a brow covering region is joined to the forehead covering region along a lower edge of the forehead covering region and is angled forwardly so as to protrude outwardly from the forehead covering region, eye covering regions joined to the brow covering region along a lower edge of the brow covering region, and wherein the check covering regions are joined to the eye covering regions along a lower edge of eye covering regions.