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ANTI-SECONDARY RADIATION DENTAL X-RAY CONE

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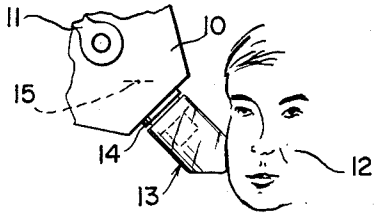


FIG. 1.

FIG. 2.

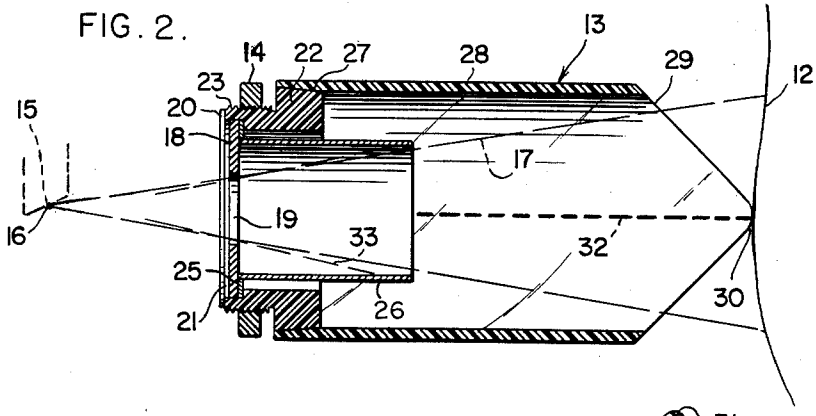


FIG. 3.

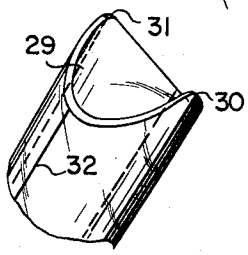


FIG. 4.

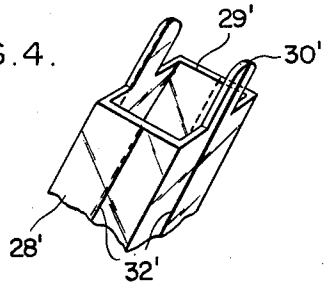
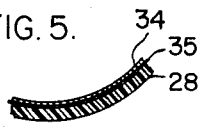


FIG. 5.



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3,102,957 ANTI-SECONDARY RADIATION DENTAL X-RAY CONE

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This invention relates to dental X-ray apparatus, and more particularly, to a dental cone for establishing a desired relationship between a point source of X-radiation and a radiographic film.

Dental cones of a type traditionally used by practicing dentists are screwed or otherwise fastened onto an X-ray generator casing. By virtue of being formed to a single point at one end, they assist the dentist in directing the axis of a conical X-radiation beam normal to an imaginary plane that bisects planes, at an angle with each other, that are defined by the plane of a film inside the patient's mouth and the plane of his skin.

Although the pointed solid tipped dental cone greatly assists the dentist in directing the X-ray beam, it is not without its disadvantages. For instance, it is evident that the X-radiation, in order to pass through the patient's tissue to the film, must also pass through the cone. This causes some of the X-radiation to be scattered in a direction other than directly toward the film, in which case it is strongly absorbed by the patient's skin and tissue adjacent the area of exposure, and to a lesser degree by the more remote radiation sensitive parts of the body such as the gonads. Because of infrequency of dental examination, this scattered radiation is not known to have given any patient an overdose but it is, nevertheless, desirable to minimize it lest the patient's allowable cumulative lifetime dose limitation be approached prematurely.

Prior art closed-end dental cones have been made of relatively soft material, such as plastic, to afford maximum transmission of the primary X-ray beam to the film. These plastic materials are usually composed of low atomic number elements that have a greater tendency to scatter radiation than the heavier elements. It is, therefore desirable to eliminate the cone material from the X-radiation path to the extent that this can be done without sacrificing the advantage of allowing accurate positioning of the beam and with the attendant advantages of reducing scattered radiation dose to the operator and the patient.

Accordingly, it is a primary object of this invention to overcome the above indicated disadvantages by providing a new and more efficient dental cone assembly.

Other objects of the invention are to provide a dental cone assembly that: minimizes scattering of radiation; allows easy determination of the beam path axis and brackets the area being subjected to the beam; allows practice of the usual dental radiographic techniques by maintaining conventional focal spot-to-patient's skin distance; allows normal angulation with respect to the patient; and, that is inexpensive, attractive, lightweight and transparent.

Achievement of the foregoing objects together with other objects and advantages will appear from time to time throughout the course of the ensuing specification.

In general terms, a preferred form of the new cone comprises a transparent plastic cylinder whose patient contacting end is defined by opposite planes passing through the side wall of the cylinder and intersecting substantially at diametrically opposite points on a plane containing the axis of the cylinder. Thus, there are at least two points of contact and at least two open sides that present a minimum total surface for scattering the primary or secondary radiation. The cylinder is provided with a screw adapter at one end for attaching it to any X-ray tube casing. In the adapter there is a perforated diaphragm that defines a cone of radiation from the variously directed radiation produced by the source. Also within the cone assembly, in the region of the adapter, is a tubular member or sleeve through which the cone of radiation passes but which does not contribute toward defining its periphery. The sleeve, however, is of such diameter and location as to absorb secondary or scattered radiation that might be developed by the X-ray tube or the collimator parts, whereby it prevents scattered radiation from getting to the patient's tissue where it would only contribute to undesirable dosage and, possibly fogging of the film.

The invention will now be discussed in greater detail in connection with drawing in which:

FIG. 1 illustrates how the cone is used in connection with dental X-ray apparatus;

FIG. 2 is a partial sectional view of the preferred dental cone assembly;

FIG. 3 is an end perspective view of the preferred cone with parts removed;

FIG. 4 is an alternative form of a cone assembly part; and,

FIG. 5 is fragmentary alternative cone part.

In FIG. 1 there is illustrated a dental X-ray head 10, partially broken away, and supported by a yoke 11 that allows the head to be swung vertically in the plane of the paper. Other components that allow the head to be supported for universal movement are omitted. Head 10 may be brought into proximity with the patient 12 who is to be subjected to dental radiography. Angulated with respect to the vertical plane of the patient's face and extending from casing 10 is the new cone assembly 13 whose one end is bearing on the patient's face and whose other end is screwed into the casing and locked in rotational position by a jam nut 14. X-rays generated by a tube, not completely shown, emanate from a target 15 that is shown as a broken line in casing 10. As will be described more fully later, X-rays are emitted from a point on the target and directed in a conical beam toward the patient who may have a radiographic film in his mouth in alignment with the anatomical region of interest.

In FIG. 2, the construction of the new cone assembly is shown in greater detail in association with an X-ray source and a patient.

The X-ray source may be a conventional X-ray tube located in casing 10 and including an angular target surface 15. The target is impacted by a sharply focused beam of electrons to produce a field of X-radiation emanating from a point source 16 as is well known in the art. A portion of the radiation emitted in all directions is defined into a cone 17 of primary radiation by a primary diaphragm 18 that is preferably of lead or other high atomic number material. Primary diaphragm 18 performs its function by virtue of being provided with an aperture 19 that limits the diameter of the beam as it diverges from point 16 to patient 12.

Since the radiation produced by the target has various wavelengths, and accordingly, penetrating powers, it is desirable to eliminate the softer radiation which would only be absorbed by the patient's tissue and would not contribute to a sharp image on the film. For this purpose, a filter 20 may be interposed to prevent passage of the less penetrating radiation. A filter disk commonly used is one made of aluminum 2 mm. thick.

The primary diaphragm of beam collimator 18 is set in an annular recess 21 provided in the beam admitting end of a circular adapter 22 which may be acrylic resin. The diaphragm may be secured in the adapter by a fillet of epoxy resin, for example, or by a forced fit. Aside

from supporting and joining the various parts of the cone assembly, the adapter 22 is provided with an external screw thread 23 that allows it to be turned into an appropriate mating thread, not shown, in the base of tube casing 10. In order that the assembly may be held in any selected rotational position, it is provided with a jam or lock nut 14, which when turned tightly against the tube casing, prevents turning of the cone assembly about its longitudinal axis.

Recess 21 of the adapter also contains a flat ring 25 which has a central hole for admitting a hollow cylinder or sleeve 26. Ring 25 may be joined to sleeve 26 by silver brazing, by a compression fit, or by any other suitable means.

Adapter 22 is provided with an enlarged flange portion whose periphery is beveled as at 27. This wide beveled area provides a surface for joining the adapter to a substantially cylindrical cone tube 28. The cone tube is preferably made of a transparent substance such as an acrylic resin so that the X-ray operator can see through it for locating the tube 28 in the desired position on the patient's face 12. It may be round, square or other cross sectional configuration. Tube 28 is appropriately beveled to fit on the adapter at 27 where it is joined concentrically therewith by an acrylic cement or other suitable substance.

It will be noted that the right hand end of tube 28 in FIG. 2 is cut at a bias from opposite sides so as to create side openings 29 and a couple of points 30 and 31 that aid in locating the center point of primary beam 17 on an imaginary line that extends between points 30 and 31. A preferred angle of cutting is 45° from the axis to each side so that a total angle of about 90° is formed. But tube 28 may be cut saw-toothed, rounded or of other shape at its end.

Points 30 and 31 are preferably rounded slightly for esthetic reasons and to eliminate the possibility of making an unpleasant impression on the patient's tissue. To further assist in locating the points and aligning the tube 28 with the area of interest, the tube is provided with four exterior lines 32 that extend at least part way over the length of the tube from an origin on the points 30 and 31 and at positions 90° from each of these points. Thus, two points and four reference lines are provided for assisting the operator in obtaining correct alignment of the dental cone. Lines 32 may be painted or engraved on the plastic tube wall.

To allow substitution of the new cone for prior dental cones, it is desirable to make the distance from focal spot 16, when combined with a length of the cone assembly, equal eight inches so that the operator need not alter his established technic. The plastic tube 28 is preferably about three inches in diameter and may have a wall thickness of around one-eighth inch.

The merits of the new dental cone assembly will be seen by examining its operating mode. As mentioned above, X-radiation is emitted over a field from which is selected a primary cone of rays 17 by passing the beam through a primary diaphragm 18 with a suitable collimating aperture 19. The primary rays pass through sleeve 26, but do not impinge on it, so as to avoid generating any reflected or secondary radiation which would be misdirected and only contribute to patient does at the further expense of reducing film sharpness. It will be observed that primary beam 17 intercepts the face of patient 12 over such diameter at the plane of intersection as to not strike the interior of plastic tube 28 whereby primary or secondary radiation may be scattered. In fact, tube 28 is almost completely removed from the vicinity of the patient's face except for the points of contact 30 and 31. Any soft radiation inescapably scattered by the patient's tissue is unlikely to be reflected or further scattered by tube 28 back to the patient because of side openings 29.

In an X-ray generator, and from the physical parts associated with it, there is always produced some undesirable, misdirected, secondary radiation. Such radiation emanates from filter 20, for instance, and from the edges and surfaces of the collimator diaphragm 18 and other parts. As this radiation passes through the collimator at an angle acute with respect to the axis of the primary beam it is desirable to intercept it before it gets to the patient or penetrates the tube 28. It is for this reason that sleeve 26 is provided. To further illustrate the phenomena we may consider a misdirected ray 33 that emanates from filter 20. Note that this ray impinges upon sleeve 26 where it is efficiently absorbed by virture of the sleeve being made from a high atomic number alloy such as brass. Thus, this stray ray and the many others which are created in the vicinity of the entrance end of the cone assembly are effectively absorbed and do not contribute to fogging the film nor to patient or operator dosage.

Cutting the side openings 29 in plastic cylinder 28 has another advantage when a frontal radiograph is to be taken, in which case the tube 28 might be brought closely to the patient's face in such manner as to embrace his nose so as to affect breathing. With the preferred design here described, one or the other of the openings 29 is always available to breathe through. A further advantage flowing from beveling or tapering the end of tube 28 is that it allows disposing the X-ray source with respect to the patient's face at any desired angulation without affecting the focal spot-to-film distance.

An alternative form of transparent X-ray directing cone is shown in FIG. 4 where parts having a similar function are identified by the same reference numerals as in the previous figures except that they are primed. In this embodiment the cylinder 28' has a square cross section and has two tips 30' that are defined by cutting partially transversely from opposite sides of the cylinder and then in parallel planes endwise thereof. Locating guide lines 32' are provided and side openings 29' are also created in this case. Although two tips are preferred, four or more may be cut if desired on this square cross sectional tube or on a round tube 28 shown in the other figures. A round tube shaped on its end in accordance with FIG. 4 is preferred, of course, to a square one since the former minimizes the material content and does not leave a space in corners about the circular cross section of the primary beam and the adapter 24 can be made round less expensively.

FIG. 5 shows a fragmentary cross section of a hollow cylindrical cone which results in an assembly that reduces secondary radiation to a further extent. In this case the plastic cylinder 13 has applied to its interior, by any suitable adhesive, a thin foil 34 of lead or other high atomic number metal that is adhered to a paper-like web 35. In FIG. 5 the thickness of foil and paper are exaggerated for clarity. In this construction, misdirected radiation that is not intercepted by tubular element 26, or in the absence of such element, impinges upon and is absorbed by the foil rather than penetrating cylinder 28 to the atmosphere. The effectiveness of the foil in absorbing more penetrating stray radiation depends upon foil thickness. Those versed in the art will, of course, chose a foil thickness appropriate to the energy of the X-ray generator with which the cone is to be used. In most cases a lead foil ten-thousandths of an inch thick is satisfactory.

In summary, a new open ended dental cone assembly has been described which tests have shown reduces X-ray scattering outside of the direct beam by ninety percent or more and reduces exposure to undesirable X-radiation at distances as far as the gonads by about thirty-five percent as compared with prior art cones. The positioning of a lead primary diaphragm and the cooperating brass cylinder results in reducing and absorbing non-useful, secondary radiation that ordinarily accompanies X-ray generation.

Although an illustrative embodiment of the new cone assembly has been described, this is not to be construed as limiting the invention to the precise construction shown, for it may be variously embodied and is to be interpreted

in accordance with the scope of the claims which follow.

It is claimed:

1. An anti-secondary radiation dental X-ray cone assembly comprising a collimator means including an aperture defining a conical beam of X-radiation, an elongate hollow cylinder means having a wall coaxial with and extending away from the collimator means toward an object being radiographed, said conical beam diverging to nearly the interior size of said cylinder, an end on said cylinder for proximating the object, said end being defined by cutting planes developing substantially opposed points and side openings in said cylinder wall.

2. An anti-secondary radiation dental X-ray cone assembly comprising a collimator means including an aperture defining a conical beam of X-radiation, a transparent open ended cylinder means having a wall extending away from the collimator means toward an object being radiographed, said conical beam diverging to nearly the interior wall of said cylinder where the beam intersects the object, an end on said cylinder for proximating the object, said end terminating in a pair of cutting planes passing through said wall from opposite sides of said cylinder to define a pair of opposed end points and opposed openings in the cylinder wall.

3. An anti-secondary radiation dental X-ray cone assembly comprising adapter means, collimator means mounted on said adapter means and including an aperture for defining a conical beam of primary X-radiation, a tubular element fixedly mounted coaxially with the collimator means and extending in the diverging direction of the primary beam up to near intersection therewith, said tubular element being adapted to intercept and absorb secondary radiation directed at angles greater than the diverging angle of the primary beam, and a hollow cylindrical element having its longitudinal axis coincident with the axis of the primary beam and extending away from said collimator toward an object to be radiographed, said cylindrical element terminating in an oppositely beveled end defining side openings therein and opposed terminal points.

4. The invention set forth in claim 3 wherein said cylindrical element is transparent and includes at least a pair of reference position lines inscribed in the exterior of said cylindrical element in parallelism with its axis and each other.

5. An anti-secondary radiation dental X-ray cone assembly comprising a circular adapter having a threaded extension and radially disposed flange, a collimator diaphragm having an aperture in alignment with an aperture in the adapter for defining a conical beam of primary X-radiation, a tubular element projecting away from the diaphragm in the diverging direction of the primary beam and into near circular intersection therewith, said tubular element being adapted to intercept secondary radiation directed in paths other than that of the primary beam, and a transparent cylindrical element engaged concentrically with said flange and extending in the direction of the diverging beam, said cylindrical element being of such internal size as to encompass the primary beam in radial spaced relationship at its cross sectional plane of intersection with an object to be radiographed, said cylindrical element also being oppositely beveled at its end to define side openings and opposed terminal points.

6. An anti-secondary radiation dental X-ray source director comprising: means for defining a cone of primary radiation emanating from an X-ray source, a hollow right circular cylinder of plastic through which an X-ray beam may pass toward a body to be subjected to dental radiography, said cylinder terminating in an open end having a pair of position determining diametrically opposed points and a pair of side openings defined by cutting planes intersecting each other on a line intersected by the cylinder axis at a right angle, the diverging radiation cone being smaller than the interior diameter of the cylinder at all planes transverse to the axis of the cylinder and within its length.

7. The invention of claim 6 wherein the cylinder is provided with at least a pair of external longitudinal line markings in parallel with each other and the axis thereof and terminating coincident with said points.

8. The invention of claim 6 including a lead foil adhered interiorly of said cylinder.

9. An anti-secondary radiation dental X-ray cone assembly comprising a collimator means including an aperture defining a conical beam of X-radiation, an elongate hollow cylinder means having a wall coaxial with and extending away from the collimator means toward an object being radiographed, said conical beam diverging to nearly the interior size of said cylinder, an end on said cylinder for proximating the object, said end being defined by cutting planes developing substantially opposed points and side openings in said cylinder wall, and a lead foil adhered to at least a part of the interior surface of said cylinder.

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