July 10, 1951 A. PREGEL 2,559,793

BETA IRRADIATION METHOD AND MEANS

Filed Jan. 27, 1949

Fig. 1

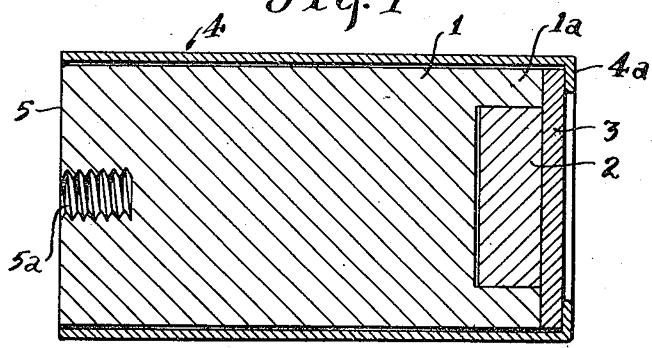


Fig. 3

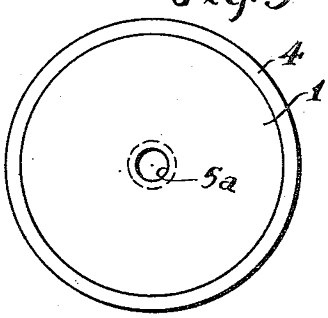
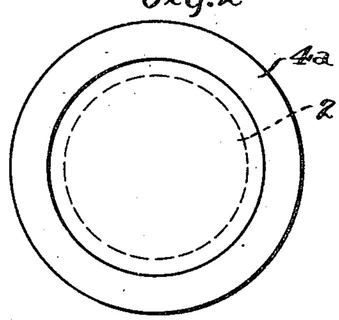


Fig. 2



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Patented July 10, 1951

2,559,793

UNITED STATES PATENT OFFICE

2,559,793

BETA IRRADIATION METHOD AND MEANS

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Application January 27, 1949, Serial No. 73,080

5 Claims. (Cl. 128—1.2)

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This invention relates to the use of pure beta irradiation or substantially pure beta irradiation for therapeutic purposes, and more particularly for ophthalmic purposes.

It has heretofore been proposed to use a radon applicator for the treatment of certain lesions of the eyelids and anterior ocular segments, and such treatment has been extensively tested at the Eye Department of the Cleveland Clinic with good results. (Cleveland Clinic Quarterly, April, 1946). The radon applicator has required the use of a 250–275 millicurie radon glass bulb applicator, having a diameter of 5 millimeters and a wall thickness of one millimeter. This radon technique could be duplicated only in a few large medical centers.

Tests have shown that the elimination of the gamma ray radiation of the radon applicator is a great advantage to the physician and the patient, and that pure beta rays are effective for treating many ophthalmic conditions.

By eliminating the gamma ray radiation, the physician is not endangered by continuous exposure to penetrating gamma rays, and no essential radiation reaches the crystalline lens of the patient. Also, an applicator which emits substantially no gamma rays can be easily stored, because one millimeter of lead blocks out all essential radiation.

The improved applicator and the tests and uses thereof are described in the "Mississippi Valley Medical Journal and Radiologic Review" vol. 70, pp. 71–72 (March, 1948) and in the November 1948 issue of "First Annual Radiation Therapy Number of the Mississippi Valley Medical Journal and Radiologic Review."

As stated therein, the use of radium element was tried, but it was not possible to concentrate enough of radium element in a small applicator to give the treatment rapidly.

Radium element disintegrates to produce radon gas, which disintegrates to produce a series of disintegration products.

One of these intermediate products is radium D, which has an atomic weight of 210, an atomic number of 82, and a half-period of 22 years. Radium D emits beta and gamma rays. The maximum energy of the beta rays of radium D is about 0.0255 Mev. (million-electron-volts).

Radium D disintegrates to produce radium E, which has an atomic weight of 210, an atomic number of 83, and a half-life of five days. Radium E emits beta and gamma rays. The maximum energy of the beta rays emitted by radium E is about 1.17 Mev.

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Radium E disintegrates to produce radium F, also designated as polonium, which emits alpha rays, with a feeble emission of beta rays.

As one example, the improved applicator is a circular silver foil or plaque, whose radio-active diameter is 5.6 millimeters and whose thickness is one millimeter.

This disc-shaped plaque has 25 square millimeters of active surface area. This plaque is provided with a filter or window of aluminum, whose thickness is 0.05 millimeter. This plaque fits closely in the recess of a holder body which is made of Monel metal. As described at page 444 of the 1942 edition of "The Condensed Chemical Dictionary" published by Reinhold Publishing Corporation, Monel metal contains 60%–70% nickel; 25%–35% copper; 1%–3% iron; 0.25%–2% manganese; 0.02%–1.5% silicon; 0.3%–0.5% carbon.

This plaque contains 10 millicuries of radium D, although variable concentrations of radium D may be used.

A 10 millicurie applicator of this size contains 800% of the amount of radioactive material per squire millimeter of surface area, as compared with a full-strength radium-element plaque, in which the radium-element has an atomic weight of 226, and an atomic number of 88.

The aluminum filter can be replaced by other filtering material of low filtering density, such as mica. Monel metal can also be used.

The density of this preferred aluminum filter is about 16% of the density of a filter of Monel metal which has a thickness of 0.1 millimeter, thus greatly increasing the effective beta ray output.

Tests have shown that a few feeble gamma rays are emitted by the improved applicator. Such tests have shown that this applicator is a source of substantially pure beta radiation. The electro-magnetic radiation consists mainly of a feeble, low energy gamma radiation from radium D, and from "Bermsstrahlung," namely, from the continuous X-rays which are produced by the interaction of the beta rays of the radium E with the Monel metal backing of the applicator. The maximum ionization of these gamma rays and X-rays is less than one-tenth per cent of the ionization due to the emitted beta rays.

Since more than 99.9% of the total ionization produced by all the radiations of the applicator is produced by beta rays, the presence of the very feeble gamma radiation having a quantum energy of only 0.047 Mev. is therapeutically unimportant, and of no biologic effect in comparison with the energetic beta rays of radium E, which have a maximum energy of about 1.17 Mev.

The beta ray output which is produced substantially wholly by the high energy beta rays of radium E, averages about 11,000 equivalent Roentgens (rep) of surface beta ray dosage per hour.

Since radium E is in equilibrium in the applicator with radium D, the beta ray activity decreases with a half-period of 22.2 years, which is characteristic of radium D. The filter completely absorbs the soft beta radiation of radium F (polonium). Substantially only the penetrating beta rays of radium E emerge from the applicator.

These beta rays which are thus emitted, have the same qualities as gamma rays, in selective tissue destruction, but penetrate only 3–4 millimeters of tissue, thus making it possible to treat superficial conditions without endangering the lens, and preventing possible formation of a cataract.

The greatest effect of these emitted beta rays is superficial, because their effect is inversely proportional to the square of the distance from the source.

Favorable tests have been made with the improved applicator for various eye conditions, such as (1) corneal scars, except those which are calcified or very dense; (2) corneal vascularizations from any cause; (3) papillomas of the lids; (4) hemangioma; (5) vernal conjunctivitis; (6) pterygium, if not too dense.

By eliminating or substantially eliminating gamma rays, it is possible to use a larger dosage of the beta rays.

When using the 10 millicurie applicator, a 4–5 minute contact is used in treating vascularizations of the cornea, and the treatments may be repeated at intervals of 2–4 weeks.

The applicator should be placed as close to the lesion as possible, preferably in contact with the tissue.

Fig. 1 is a diagrammatic cross-section, not to scale, of one embodiment of the improved applicator;

Fig. 2 is a front end-view.

Fig. 3 is a rear end-view.

This applicator comprises a cylindrical body **1**, which is made of Monel metal. At its front, said body **1** has a cylindrical recess or cavity, whose diameter is 5.6 millimeters and whose depth is one millimeter.

A silver foil or plaque **2** fits snugly in this recess. The thickness of the annular wall **1***a* of said recess is 1.7 millimeter.

This disc-shaped foil or plaque **2** contains 10 millicuries of radium D, although this concentration may be varied. A filter **3**, made of aluminum, and having a thickness of 0.05 millimeter, abuts the front annular face of wall **1***a* and the front wall of the disc-shaped foil or plaque **2**.

This filter **3** is held in place by the flange **4***a* of a collar **4**, which is made of Monel metal, and which has a thickness of 0.1 millimeter. The flange **4***a* is of minimum diameter. Said collar **4** fits snugly on body **1**.

The initial length of the cylindrical body of collar **4** exceeds the length of body **1**. After collar **4** has been applied, it is soldered to body **1** at the rear face **5** of body **1**. The collar **4** is then cut transversely to be flush with rear face **5**. Said rear face **5** has a tapped recess **5***a*, and the threaded end of a handle, not shown, may be fixed detachably to the internally threaded wall of recess **5***a*.

The active diameter of the plaque **2** in the finished applicator is substantially 5.6 millimeters, with an active surface of substantially 25 square millimeters.

The improved applicator therefore has a radioactive source which consists substantially of radium D in equilibrium with radium E, so as to deliver substantially constant beta rays over a long period. While some polonium is produced in the applicator, its effect is insignificant.

The filter preferably blocks the alpha rays which are emitted by the polonium which results from the disintegration of the radium E.

The thin carrier **2** is permeable to the beta rays of radium E, so that the entire mass of carrier **2** emits the beta rays of radium E.

The parent radium D is optionally and preferably uniformly incorporated in the entire mass of the carrier **2**.

The length of body **1** is about 3 to 4 inches, so that when solder is applied at rear face **5**, the heat of the soldering operation will not affect the thin carrier **2** or the thin filter **3**.

While element **3** may be a window, each element **3** is preferably and optionally imperforate, in order to block the undesired radiation.

The radium D may be deposited upon the surface of the carrier **2**, as an alternative to impregnating carrier **2** with the radium D.

Electro-deposition may be used for depositing the radium D upon the surface of carrier **2**.

For this purpose, a salt of radium D and a salt of lead are dissolved in water, in order to provide an electrolytic bath. I can use the nitrate or chloride of radium D, and the nitrate or chloride of lead.

I thus produce a co-deposit of radium D and lead by electrolysis upon the surface of the metal carrier **2**, which is preferably the cathode.

This method of simultaneously electro-depositing radium D and lead on a metal carrier is well-known per se, so that the details thereof, such as the proper pH of the electrolytic bath, are not described herein.

I have described preferred embodiments of my invention, but numerous changes and substitutions and omissions and additions can be made without departing from its scope.

I claim:

1. An ophthalmic applicator which has radioactive material which consists substantially wholly of radium D and radium E and radium F, said applicator having filter means which are permeable substantially only to beta rays emitted at the energy level of the beta rays emitted by radium E.

2. An ophthalmic applicator according to claim 1, in which said betay ray output is substantially 11,000 equivalent Roentgens (rep) of surface beta ray dosage per hour.

3. An ophthalmic applicator according to claim 1, in which said radium E and radium F are the successive derived disintegration products of radium D originally incorporated in said applicator, said derived radium E being in equilibrium with said original radium D.

4. A method of treating living eye tissue which consists in applying substantially only the beta rays emitted substantially only by radium E to said living tissue, the maximum energy of said emitted beta rays being substantially 1.17 Mev.

5. An ophthalmic applicator which has a radio-active source which consists substantially wholly of radium D, radium E and radium F, said radium E and radium F being the disintegration

products of original radium D of said source, said source originally having at least substantially 0.4 millicurie of radium D per square millimeter of active surface area, said applicator having a filter which is permeable substantially only to the beta rays emitted substantially only by radium E, the maximum energy of said emitted beta rays being substantially 1.17 Mev.

ALEXANDER PREGEL.

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