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FLUORESCENT ARTIFICIAL TEETH

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This invention relates to fluorescent artificial teeth.

As artificial teeth have developed hitherto, whether in efforts to duplicate natural teeth by jackets, crowns, bridge work, whole or partial artificial teeth, such as fillings, inlays and the like, the materials used have encompassed a wide range, including bone, metal, wood, rubber, porcelain, and the like ceramics, and finally acrylic resins. As each of the various materials were used they were found to possess one or more advantages, but also each, as heretofore developed, had at least one or more disadvantages. The art has now concentrated upon porcelain and the acrylic resins as the preferred materials for partial or complete tooth restorations, as they have come the closest to simulations of the natural teeth. However, even today, there is still at least one disadvantage attaching to teeth made from both of these materials, and this is that which is due to the phenomenon of the transformation of absorbed radiation known as "fluorescence." This is the property possessed by certain materials of converting incident invisible ultra violet radiation into visible light effects, frequently of a peculiar bright intensity.

It is well known that a sharp visual contrast between artificial teeth and natural teeth is instantaneously established when a combination of the two types is exposed to ultra violet radiation. This is so well known that many persons possessed of artificial teeth become self-conscious and embarrassed when they become aware of exposure to concentrations of ultra violet radiation, and the possibilities of such exposure become greater all the time, with the increased use of such forms of radiation for both their therapeutic and ornamentation factors, which need not be enlarged upon at this point. Such users have become aware by one reason or another, of the fact that while a natural vital tooth glows with fluorescence under strong ultra violet, the conventional artificial tooth remains black or deep purple in its visual reaction. The contrast in the human mouth under practically pure ultra violet light is so startling as to be shocking, as the artificial teeth are disclosed as gaps in the ranks of the glowing vital teeth to create an effect of empty sockets between live natural teeth. This is only the more startling because of the strength of the ultra violet concentration, but it maintains in degree with unintense ultra violet radiation, and with mixtures of ultra violet and visible radiation. Thus, the casually informed person who might be aware of the visual situation under concentrated ultra violet light may not be aware that the amount of ultra violet radiation in all types of light stimulus varies through a wide range indeed, and that consequently although the phenomenon of fluorescence may occur in response to stimulation by small amounts of radiant ultra violet, the visual effect created is modified by the presence and amount of visible radiation also present in the incident light energy. The natural vital tooth glows with fluorescence under ultra violet radiant stimulus alone, while having increased or a change in brightness under combinations of ultra violet and visible light. Owing to the wide variation in ultra violet distribution in sunlight during the year and between certain altitudes, the intensity of brightness of the vital tooth varies from incidence of sun's energy alone. On the other hand, the radiant energy from an incandescent source, indoors, for instance, contains very little ultra violet radiation, and vital teeth exposed thereto are of diminished brightness. As heretofore constructed artificial teeth of non-fluorescent materials do not become increasingly bright in the presence of ultra violet nor less brilliant in the absence of ultra violet. They therefore suffer visual contrast with vital teeth. It is thus in the range of percentage of ultra violet in the incident light, ranging from the practically pure ultra violet as used in industry, therapeutics, ornamentation, through the high percentage in the summer sunlight, through the smaller percentages in the winter sunlight, down to the minute amounts in artificial lighting including the incandescent that the artificial tooth should be conditioned for fluorescing in order to simulate the visual effect of the vital natural tooth under the same exposure of incident light. In other words, fluorescence is only one factor in the visual effect of an irradiated tooth, which is both modified by, and in itself modifies, the effects of varying visible light stimulation.

It is true that some efforts have been made to achieve a form of fluorescence in artificial teeth of the porcelain type, but so far as known, such teeth apparently have been conditioned for high wave length ultra violet radiation only, because of the almost certain visible radiation accompanying such rays, or at best for a mixture of an appreciable amount of visible radiation with the ultra violet stimulus, as it is only under such critical stimulation that even a rough approximation of the visual effect of vital natural teeth is attained. It has been found that as the proportion of visible radiation is decreased, and as the incident radiation changes toward either a com-

pletely invisible spectrum or one including appreciable amounts of ultra violet of low wave length, the visual reaction becomes such as to emphasize the artificiality of the porcelain tooth in its contrast with natural vital teeth. In all teeth of the prior art which attempted a form of fluorescence, the tooth, instead of continuing to be a white yellow green which it is under what might be termed mild but critical fluorescing conditions as just recited, changes to a deep yellow brown-violet as visible light is withdrawn from the incident stimulus. It will be clear that this latter visual effect is radically different from that of the natural vital teeth under similar stimulation.

Prior efforts with porcelain artificial teeth to secure some sort of fluorescence, has involved the use of uranium salts for the purpose, but so far as known the resultant products are variable in their fluorescence, even varying between adjacent artificial teeth, their fluorescence itself is visually in contrast to that of natural teeth and is completely unnatural, and the fluorescence tends toward unpredictability causing irregularities in responsiveness. Moreover, the uranium salts modify the visual appearance of the tooth under strong visible radiation as the amounts of the uranium required are so appreciable as to modify the tooth color itself. It has been found further that uranium salts cannot be successfully used in acrylic teeth or restorations because the proportion of the salts must be so high relative to the resins that the acrylic tooth structure is weakened.

It is among the objects of this invention; to provide a new series of brilliantly fluorescent materials not hitherto known for this characteristic of brilliance; to provide artificial teeth which simulate the fluorescence of natural teeth; to provide artificial teeth which simulate the visual responsiveness of natural teeth through substantially the entire visual and invisible light spectrum and combinations thereof; to provide an acrylic fluorescent artificial tooth; to provide artificial teeth which become less bright under artificial light deficient in ultra violet, just as natural teeth do; to provide a fluorescent material of such brilliance that such small amounts are necessary in a tooth as to have inappreciable effect upon the structure thereof, even when the tooth is formed of an acrylic resin; to improve methods of forming fluorescent teeth; and many other advantages of the invention will become more apparent as the description proceeds.

In carrying out the invention, I prefer to use a metallic salt of the quinine or quinine-like group, in the proportion, in the polymer, of from four to forty-eight grains of salt to from 1 to 3 pounds of the polymer, depending upon the amount and type of pigment used. In the case of restorations utilizing polymer and monomer, and for the procedure which is preferred in this case reference is made to my earlier filed copending application Serial Number 413,327, filed October 2, 1941, entitled "Materials and methods for restoring properly shaded lost tooth surfaces," it is preferred to use from six grains to thirty six grains of the salt to from one to three pounds of the polymer. This is approximately one part in ten thousand by weight, in a preferred proportion and is very minute indeed. In this latter case the fluorescent factor in the polymer is preferably augmented by a fluorescent factor in the monomer. Any desired sort may be used for the latter, but it is preferred to use a coal tar derivative such as one of the fluorescent aniline dyes. Illustratively, Primuline may be used. In the preferred form of restoration set forth in said application it is indicated as desirable to add clear polymer, and this would be free from the salt of the invention, to the shaded polymer, which has been treated in the proportions recited, in order to get a lighter tooth effect. If the monomer is added, it would tend to dilute the fluorescence contained in the fluorescent polymer. Its compensation is then secured by adding fluorescence to the monomer. The Primuline mentioned illustratively, strangely enough, will impart fluorescence to the clear polymer, but not to the pigmented polymer, so that the sum total of the visual effects is desirably uniform throughout the tooth. In this instance, a mere one part of Primuline in thirty thousand parts of monomer by weight, is sufficient to establish the fluorescence in the monomer and hence in the clear polymer after polymerization.

In carrying out the invention, I prefer to resort to the quinine and related groups and compounds, which all fluoresce strongly. Sulfuric acid is frequently used as an activator producing the (mono and bi) quinine; (mono) quinidine; cinchonine, and cinchonidine. A list of useable quinine and related compounds from which I prefer to select a metallic salt for the purpose of this invention, either alone or in various combinations as will be pointed out, is as follows:

Apoquinine
Cinchonodine
Cinchonidine sulfate
Cinchonine
Cinchonine sulfate
6-Hydroxyquinoline
8-Hydroxyquinoline
9-Hydroxyquinoline
Hydroquinone
Magnesium 8-hydroxyquinolinate
Quinine
Quininic acid
Quinine salicylate
Quinine uranate
Quinidine
Quinone

Progressing from quinine to the cinchona-like substances. Many ethanol solutions of 6, 8 and 9 hydroxyquinoline may be combined with metals forming a complex compound of bright fluorescence. As an illustration: Zinc is a green fluorescence; magnesium, a golden yellow fluorescence; lithium, a light blue; chromium, a dark blue; and germanium, a red fluorescence. It is seen that by a combination of these elementary colors that most any effect can be produced by combination. The combinations are not important in themselves as they vary with different compounded mixtures. Deviation of hue is quite common and is best controlled by continuance of a standard procedure. For instance, the precipitate of 6, 8 or 9-hydroxyquinoline ethanol solutions or their sulfates in water solution formed by the addition of the metallic metals in salt form already mentioned, are many and varied and depend on the quantities used. A list of cinchona-like substances:

Quinine
Quinine salicylate
Quinidine sulfate
Cinchonidine sulfate
6-Hydroxyquinoline
8-Hydroxyquinoline
9-Hydroxyquinoline

All of the above substances fluoresce to a rather strong degree and may be used in the present invention in any of their forms as well as by their salts made from an ethanol solution. Higher alcohols may also be used for this purpose.

Of all of the preceding, the preferred fluorescent material is a metallic salt of either 6, 8 or 9-hydroxyquinaline or hydroxyquinaline sulphate. Illustratively, any of the 6, 8 or 9-hydroxyquinaline sulphates, in water solution, with, for instance, a zinc salt, which may, illustratively only, comprise zinc acetate, for example, in water solution, forms a precipitate, which when washed and dried gives off a brilliant fluorescence under ultra violet radiation. Another mode of procedure is to secure a similar precipitate of a 6, 8 or 9-hydroxyquinoline in an alcohol solution, with a watery solution of a zinc salt. Illustratively only, this may comprise zinc sulphate, for example. Any other combination of the hydroxyquinolines and zinc salts may be used. Owing to variation in compounds, one experimental batch may have brighter fluorescence than another from supposedly similar compounds. Organic compounds of this sort are susceptible to this, so that some leeway must be granted in the choice of materials.

However formed, or combined, and with suitable combinations of the various colored fluorescences from the various salts of the respective components, minute quantities can be added to plastic resins, of the acrylic type, illustratively, to impart proper fluorescence to the resulting teeth or restorations made therefrom. The proportions used have been recited and it is pointed out that for the first time in the art the artificial tooth has been imparted a fixed, stable, predetermined fluorescence such that the glow and visual effect of exposure of the artificial tooth to incident radiation containing various widely diverse proportions of ultra violet radiation will be substantially identical with the glow and visual effect of a natural vital tooth under the same illumination.

Having thus described my invention, I claim:

1. As a fluorescent factor in artificial teeth, a metallic salt of the quinine group in the proportion of from four to forty-eight grains of the salts to between one and three pounds of the tooth material.

2. In artificial teeth of polymerized resin, a fluorescent factor comprising a metallic salt of the quinine group in approximately one part of the salt in ten thousand parts of polymer of the resin.

3. In artificial teeth, a fluorescent constituent comprising a metallic salt of the quinine group, in the proportions of from four to forty-eight grains to from one to three pounds of the tooth forming constituent.

4. In artificial teeth of polymerized resin, a fluorescent constituent comprising the metallic salt of the hydroxyquinoline group in approximately one part of the salt in ten thousand parts of polymer of the resin.

5. In plastic teeth of the acrylic resin type, formed from a polymer, a fluorescent factor which imparts the same visual effect by fluorescence as is derived from natural vital teeth under identical stimulus conditions, which comprises a metallic salt of the hydroxyquinoline group, in the proportions of from four to forty-eight grains of the salt to from one to three pounds of the polymer.

6. In restorations for teeth formed of a mixture of the polymer and the monomer of an acrylic resin, the fluorescent factor which comprises a metallic salt of the group formed of 6, 8 or 9-hydroxyquinoline sulphate in the proportions of from three to thirty-six grains of the salts to from one to three pounds of the polymer.

7. In restorations for teeth formed of a mixture of the polymer and the monomer of an acrylic resin, the fluorescent factor which comprises a metallic salt of the group formed of 6, 8 and 9-hydroxyquinoline sulphate in the proportions of from three to thirty-six grains of the salts to from one to three pounds of the polymer, with the addition of approximately one part in thirty thousand parts by weight of an aniline dye in the monomer.

8. The method of forming a fluorescent tooth restoration which comprises adding the metallic salt of the quinine group to the polymer of an acrylic resin in the proportions of from three to thirty-six grains of the salt to from one to three pounds of the polymer, in adding approximately one part of fluorescent aniline dye to thirty thousand parts by weight of a monomer, and in molding the treated polymer and monomer to form a restoration which is uniformly fluorescent in a degree and appearance simulating that of a natural tooth.

9. In restorations for teeth formed of a mixture of the polymer and the monomer of an acrylic resin, the fluorescent factor which comprises a metallic salt of 8-hydroxyquinoline in the proportions of from three to thirty-six grains of the salts to from one to three pounds of the polymer, with the addition of approximately one part in thirty thousand parts by weight of an aniline dye in the monomer.

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