

SPECIFICATION

A Diagnostic Lamp

The invention relates to a diagnostic lamp for fluorescent excitation of a fluorescible material applied to teeth.

It is known to make plaque, i.e. the deposits on the teeth consisting mainly of bacteria and causing diseases of the teeth and gums, which is not normally visible, easily recognisable by painting a fluorescible material on the teeth so that fluorescent radiation can then be stimulated by means of a suitable lamp. It has been shown that fluorescible materials adhere solely or at least preferably to the plaque, but not to the clean and healthy areas of the teeth and gums. The same is true for those places where tartar has formed due to mineralisation of the plaque or which have already fallen prey to caries.

Therefore, these critical or unhealthy parts of the teeth can be made visible and localised in a simple manner by the afore-described inspection, since when illuminated, only these areas fluoresce and thus stand out from the other non-fluorescent areas.

A diagnostic lamp for inspecting the teeth, which is constructed in the form of a pocket appliance and is provided with an exchangeable dispenser for a fluorescible material is already known from United Kingdom Patent Application No. 24607/77 (Serial number 1,550,263) filed by the same applicant. The following difficulties occurred in the search for improvements to the degree of optical efficiency of this diagnostic lamp, which is preferably operated with the lowest possible power, and in the search for ways of increasing the visible contrast between fluorescent areas and non-fluorescent areas which are solely reflecting areas:

A fluorescible material which is best suited in practice is a fluorescein solution. The spectrum for the stimulation of a typical fluorescein solution with visible light comprises the wave length range of between approximately 450 and 104 nm, i.e. substantially blue light, the absorption maximum in a typical case being 495 nm. The maximum fluorescent radiation emitted is at only slightly higher wave length, namely at approximately 525 nm. In order that this fluorescence spectral range and as far as possible the remaining visible light

of longer wave lengths are blocked out in a satisfactory manner from the light of the incandescent bulb, a dichroic filter of corresponding dimensions is most suitable, whose transmission curve falls steeply at approximately 500 nm and, for perpendicularly incident light, only allows light to pass therethrough again in the long wave red or infrared range. However, in order that the light strikes the filter substantially at right-angles, one must have a beam of parallel rays, in which case the cross section of this beam of rays should be sufficiently large in order that at least approximately the entire set of teeth or the entire mouth cavity is illuminated upon inspection.

However, a substantially larger lamp with a correspondingly more complicated optical arrangement would be necessary to fulfil this requirement. However, if in order to avoid the use of a parallel beam of rays with relatively large cross section, one were to use a divergent beam of rays, then as was ascertained, a dichroic filter would allow all the more light to pass in the visible red range, the greater the angle of incidence of the radiation, i.e. the further the rays from the geometric axis of the beam. For rays striking the filter at an angle of 45° the transmission curve of a dichroic filter once more increases steeply at approximately 650 nm. This has the result that when using a suitable divergent beam of rays, the illuminated area to be inspected appears red in the vicinity of the edge, in which case this reflected red light virtually covers any possible fluorescent radiation and makes the latter invisible, so that a reasonable inspection is impossible.

The object of the invention is to provide a diagnostic lamp for inspecting teeth improved over those known hitherto and which produces a beam of light that both illuminates a sufficiently large area of the mouth for convenient inspection and produces a good optical contrast between the fluorescent and non-fluorescent areas within the entire illuminated area.

According to the present invention there is provided a portable diagnostic lamp for fluorescent excitation of a fluorescible material applied to teeth, which fluorescible material is stimulated essentially by blue light, the lamp comprising a casing; a small battery-powered incandescent bulb; a filter device adapted to the fluorescent substance and comprising in combination a dichroic first filter and a blue colour second filter whereby the device transmits at least a substantial portion of the spectral range of the incandescent bulb necessary for stimulating the fluorescible material and absorbs at least a substantial portion of the spectral range of the fluorescent light; a folding mirror attached to the casing, which mirror enables the user to observe the illuminated teeth; and a lens which is located in the path of rays of the light emitted by the incandescent bulb and which provides a diverging emergent beam of rays for passage through the filter device to illuminate the teeth.

The technical advantages of this lamp is that the radiation emitted by the small incandescent bulb is utilised in an optimum manner and that despite a divergent beam of rays and the use of a dichroic filter, inspection of the teeth not impaired by the colouration of the edge regions of the inspected area red. Furthermore, the diagnostic lamp according to the invention has the advantage that those parts of the teeth not covered with the fluorescible material and that reflect blue light on account of the blue filter, contrast particularly well against the yellow or greenish yellow fluorescent radiation of the parts covered with the fluorescible material.

In this respect it is worthy of note that in

another known, substantially more complicated construction of inspection lamp for teeth, apart from a dichroic reflector behind the lamp and a dichroic filter in front of the lamp, a dichroic observation mirror is also provided, which has the same transmission and reflection properties as the filter and therefore allows the passage of the blue stimulating radiation, so that in the mirror, the illuminated teeth or areas of the teeth emitting no fluorescent radiation seem substantially yellow to the observer, since only the yellow is reflected by the dichroic mirror. Therefore, the contrast with respect to the yellow or greenish yellow fluorescent radiation is greatly reduced or even eliminated, so that a reliable inspection is at least made difficult. As aforementioned, the diagnostic lamp according to the invention provides a substantially better contrast, which allows a particularly reliable inspection, whereby it is also possible to dispense with the expenditure for a separate dichroic mirror or mirror allowing partial light transmission in favour of a completely normal mirror.

One embodiment of the invention is described in detail, by way of example, hereafter with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal sectional view through the casing of a diagnostic lamp in the direction of arrow I in figure 2, a lid of the lamp provided with a mirror being closed;

Figure 2 is a longitudinal sectional-view on line II-II of figure 1 with a plan view of batteries, an incandescent bulb and a dispenser of the lamp;

Figure 3 is a sectional view on line III-III of figure 2, the lid of the lamp in the closed position being shown in full line and in an open position being shown in dot-dash lines; and

Figure 4 is a graph showing the transmission characteristics of a dichroic filter.

The diagnostic lamp as shown in the drawings is constructed as a pocket appliance and has an elongated flat casing 1, whose narrow sides are rounded-off (figure 3) and which is selectively provided at one end with a securing clip 2 (figure 1). A lid 3 on whose inner side a concave mirror 4 is attached, is pivotally connected in the central region of the casing by means of a flexible part 5 consisting of synthetic material (figure 3), which is stuck to the inner surfaces of one longitudinal side of the casing and of the lid and serves as a hinge. Located in the casing 1 are an insert 7 supporting the batteries 6 together with other electrical parts, which insert can be pushed into one end face of the casing and an insert 8 for the dispenser 9 containing a fluorescible liquid material, preferably fluorescein, which insert 8 can be pushed into the other end face of the casing.

Located approximately at the centre of the casing 1, below the lid 3 and between the two inserts 7 and 8 is a lamp holder 10 with a miniature incandescent bulb 11, whose front part is constructed as a converging lens 12, in which the object distance, i.e. the distance between the

filament 11a shown in figure 2 and the collecting lens 12 is less than the focal length of the lens 12, so that this lens 12 produces an emerging divergent beam of rays. The incandescent bulb 11 is arranged in the lamp holder 10 so that its filament 11a is arranged at least approximately parallel to the pivot axis of the lid 3 with the mirror 4. Furthermore, the lamp holder 10 is inclined with respect to the lower and upper walls of the casing (figure 3) so that the incandescent bulb 11 and thus the beam of rays emitted is directed obliquely upwards, if the user holds the casing horizontally in front of his mouth.

Observation in the unfolded mirror is thus made easier. The lamp holder 10 is attached to the inner wall of the insert 7 and can therefore be removed from the casing 1 together with this insert 7. Attached between lateral projections on the inner wall of the insert is a securing plate 13 of a locking part 14 (figure 1), which is connected to the securing plate 13 by a flexible area 15 having a smaller wall thickness and at this point is bent at right-angles to the securing plate 13. The upper side of the locking part 14 is knurled as at 16 which is accessible after the lid 3 has been opened. A projection 17 serving as a hook, which in the inserted position of the insert 7 illustrated in figure 1 locks the latter against an edge 18 of the casing 1, is also formed on the upper side of the locking part 14. In order to remove the insert 7, it is necessary to bend the locking part 14 elastically inwards, by means of slight pressure on the knurled part 16, to such an extent that the projection 17 can slide below the edge 18 of the casing.

In the example in question, the insert 7 supports three batteries 6 (figure 2), which are connected electrically in series and retained in known manner by way of electrical leads 19 with resilient tongues 20. The left-hand pole of the lower battery 6 in figure 2 is in contact with one side of a curved metal contact spring 21 approximately of S-shape, the other side of which inside the lamp holder 10 forms one connection contact for the incandescent bulb 11. The first-mentioned, namely the right-hand side of this contact spring 21 according to figure 2 is located between two parallel wall portions of the insert 7, which form the inner wall of the insert 7 constructed as a double wall. The right-hand pole of the upper battery 6 according to figure 2 is in contact with a contact strip 22, which consists essentially of a strip extending along the upper battery and of a section bent at right-angles at its inner end, in the direction of the lid 3, the free end of which section forms a spherically curved spring contact 23 (figure 3). Located opposite this spring contact 23 in the form of a mirror image is a likewise spherically curved spring contact 24 (figure 3), which is formed at one end of a further bent contact strip 25, whose other end forms the other connection contact for the rear end of the incandescent bulb 10 (figure 2). Both contact strips 22 and 25 are attached with the interposition of an insulating member 26 to a

projection 27 of the insert 7 by means of a bolt 28 of insulating material, which passes through corresponding openings in the two contact strips 22 and 25. The two spherically curved spring contacts 23 and 24 are arranged such that when the lid 3 is closed, as illustrated in full line in Figure 3, they are spread apart by a wedge-shaped flat projection 29 formed on the lid, so that the circuit of the incandescent bulb 11 is interrupted. On the other hand, when the lid 3 is opened, the flat projection 29 is removed from between the two spring contacts 23 and 24, as shown in dot-dash line in figure 3, so that on account of their elasticity, these two spring contacts are able to come into contact and thus close the circuit for the incandescent bulb 11.

A filter device 30 is inserted in the casing 1 in front of the incandescent bulb 11. This filter device consists of a rectangular blue coloured glass 31, which is preferably coloured throughout and of a dichroic filter 32 formed by layers applied to the inner side of this coloured glass 31. When using fluorescein, the dichroic filter 32 has a transmission characteristic as illustrated diagrammatically in figure 4. The wave lengths are plotted in nm on the X-axis of the diagram and the transmission is plotted as a percentage on the Y-axis. The curve drawn in full line relates to a beam of rays arriving at right-angles to the plane of the filter, the curve drawn in broken lines relates to beams of light which arrive at an angle of approximately 45° . It can be seen that this filter allows light to pass in the range of short wave lengths of up to 500 nm and then the transmission drops suddenly and steeply with increasing wave length, in which case for a wave length of approximately 505 nm, the transmission or absorption is approximately 50% and for only slightly greater wave lengths of approximately 510 to 520 nm, the transmission amounts to less than 10%. This transmission or absorption curve is adapted to a fluorescein solution, which is stimulated essentially by rays with wave lengths of 495 nm and whose emitted radiation essentially has wave lengths of 525 nm. In this way, the range of fluorescent radiation to be observed is filtered out of the incandescent bulb light, in order to obtain an easily visible contrast. As is also shown by the curve according to figure 4, the dichroic filter blocks out perpendicularly incident rays up to wave lengths of approximately more than 700 nm, i.e. into the long wave visible red range and then in the infrared range once more allows light to pass. This transmission in the infrared range has no function, insofar that only the visible red is filtered out in a satisfactory manner, the presence of which would cover any fluorescent radiation.

However, since one uses a divergent beam of rays according to the invention, the rays strike the dichroic filter at a greater angle of incidence the further they are from the optical axis. The transmission or absorption properties of this filter thus alter accordingly, which filter, according to the interrupted curve of figure 4 is highly

transmissive for rays with an angle of incidence of approximately 45° with wave lengths of 650 nm, i.e. in the visible red range. This has the result that the illuminated area to be inspected appears red in the vicinity of the edge, which prevents a reasonable diagnosis. In order to prevent this effect in a simple manner, which in effect is caused by the use of a divergent beam of rays and of a dichroic filter, the filter device 30 comprises an additional blue filter 31, which absorbs the visible red light allowed through by the dichroic filter with a greater or lesser angle of incidence.

Furthermore, the additional blue filter has the advantage that parts of teeth or the teeth not covered with a fluorescent solution appear blue and therefore contrast particularly well with respect to the fluorescent light, which appears yellow or yellowish/green.

In conjunction with the filament 11a of the incandescent bulb 11, which filament is directed horizontally when the casing 1 is held horizontally, the afore-mentioned lens 12 provides a divergent beam of rays with substantially oval cross section, the arrangement being such that the illuminated oval region corresponds at least approximately to the size of the open mouth, when the diagnostic lamp is held at a distance of 8 to 12 centimetres, preferably approximately 10 centimetres from the mouth. In order to eliminate any stray light and in particular to prevent the user from being dazzled, the plate forming the filter device 30, as afore-mentioned, is rectangular, the long rectangular side being parallel to the pivot axis of the lid 3. In this way, the filter device 32 forms a corresponding rectangular aperture which limits the size of the beam of rays emitted.

In order to achieve adequate brightness, on the one hand a reflector in the form of a concave mirror is preferably provided behind the front area of the incandescent bulb 11, as shown in figure 2 and on the other hand, the incandescent bulb 11 is preferably supplied with an excess voltage of 20 to 30% for example. In the example in question, three $1\frac{1}{4}$ volt batteries are provided, thus giving a voltage of 4.5 volts, by which an incandescent bulb 11 with a rated voltage of only 3.7 volts is operated.

The complete illumination of all the teeth and gums as well as the convenient observation is further facilitated due to the fact that the lid 3 with the mirror 4 is adjustable, i.e. can be folded back into any position, where it is held by friction and also that as afore-mentioned, the incandescent bulb 11 is arranged somewhat obliquely in the casing 1 (figure 3). In this way, each user is able to adapt the diagnostic lamp as regards the direction of illumination and the direction of observation, to his own particular morphology.

On its upper side, the insert 8 for the dispenser 9 likewise has a locking part with knurling 35 (figure 1) and a hook-like projection 36, which in the inserted state locks the insert 8 against one edge 37 of the casing 1. The insert 8 can be easily

unlocked and then easily removed from the casing 1 by pressing on the knurling 35 which is accessible when the lid 3 is opened.

The dispenser 9 is an approximately square

- 5 container consisting of a resilient flexible synthetic material and comprises an outlet connection 38, to which is screwed a bush 39 with a hinged outlet pipe 40. In the folded inoperative position of this outlet pipe 40
- 10 illustrated in figure 2, in which it fits in a recess on the end face of the insert 8, the inner opening 41 of the bush 39 and thus the outlet connection 38 are closed-off by the side wall of the end of the outlet pipe 40 adjacent the pivot. In order to use
- 15 the dispenser 8, the outlet pipe 40 is swung out above its pivot point 42 in counter-clockwise direction according to figure 2, so that now the inner channel of the outlet pipe 40 opening into the outlet opening 43 is in alignment with the
- 20 inner opening 41 of the bush 39 and the outlet connection 38. Now in order to eject liquid from the dispenser 8 through the outlet pipe 40, the user needs to press solely on the protruding area 9a of the dispenser 9, which area is provided in the lower wall of the dispenser and is accessible
- 25 through a corresponding opening 44 on the underside of the casing 1 (figure 1). After this, the outlet pipe 40 is swung back into its folded inoperative position, in which it closes-off the dispenser 9.
- 30

In order to carry out an inspection of the teeth, it is solely necessary to open the lid 3, which in the closed position covers the filter device 30 and thus protects the latter (figure 3), due to which

35 opening operation, as afore-described, the incandescent bulb 11 is switched-on.

The afore-described diagnostic lamp, which in the drawings is illustrated with a scale of approximately 2:1, is in the form of a portable

40 pocket appliance with a length of approximately 110 mm, a width of approximately 55 mm and a thickness of approximately 22 mm. The filter device 30 limiting the emergent beam of rays has dimensions of approximately 18 mm x 14 mm.

45 With a supply voltage of approximately 4.5 volt, the incandescent bulb 11 consumes only approximately 2.4 watts.

The invention is not limited to the embodiment described, but may have many variations as

50 regards the construction of the casing, the electrical parts, the dispenser and the optical system. Thus, in particular, the filter device may

consist of two separate filters, namely a blue coloured filter and a dichroic filter.

55 Claims

1. A portable diagnostic lamp for fluorescent excitation of a fluorescible material applied to teeth, which fluorescible material is stimulated essentially by blue light, the lamp comprising a casing; a small battery-powered incandescent bulb; a filter device adapted to the fluorescent substance and comprising in combination a dichroic first filter and a blue colour second filter whereby the device transmits at least a
- 60 substantial portion of the spectral range of the incandescent bulb necessary for stimulating the fluorescible material and absorbs at least a substantial portion of the spectral range of the fluorescent light; a folding mirror attached to the casing, which mirror enables the user to observe the illuminated teeth, and a lens which is located in the path of rays of the light emitted by the incandescent bulb and which provides a diverging emergent beam of rays for passage through the
- 70 filter device to illuminate the teeth.
2. A diagnostic lamp as claimed in claim 1, in which the lens is arranged so that at a distance of 8 to 12 centimetres from the incandescent bulb, an area corresponding to the oval defined by the
- 80 open mouth is illuminated.
3. A diagnostic lamp as claimed in claim 2, in which, in use, the incandescent bulb is arranged with its axis inclined towards the upper side of the casing and with its front end pointing obliquely upwards.
4. A diagnostic lamp as claimed in any one of claims 1 to 3, in which the blue coloured glass second filter has layers deposited thereon, which layers form the dichroic first filter.
- 90 5. A diagnostic lamp as claimed in any one of claims 1 to 4, in which a concave reflector is provided on the incandescent bulb.
6. A diagnostic lamp as claimed in any one of claims 1 to 5 in which a mirror is adjustably mounted on the casing and is constructed as a
- 95 concave mirror.
7. A diagnostic lamp as claimed in any one of claims 1 to 6, in which the incandescent bulb and the lens are constructed in one-piece.
- 100 8. A diagnostic lamp for fluorescent excitation of a fluorescible material applied to teeth substantially as hereinbefore described with reference to the accompanying drawings.



unlocked and then easily removed from the casing 1 by pressing on the knurling 35 which is accessible when the lid 3 is opened.

The dispenser 9 is an approximately square container consisting of a resilient flexible synthetic material and comprises an outlet connection 38, to which is screwed a bush 39 with a hinged outlet pipe 40. In the folded inoperative position of this outlet pipe 40 illustrated in figure 2, in which it fits in a recess on the end face of the insert 8, the inner opening 41 of the bush 39 and thus the outlet connection 38 are closed-off by the side wall of the end of the outlet pipe 40 adjacent the pivot. In order to use the dispenser 8, the outlet pipe 40 is swung out above its pivot point 42 in counter-clockwise direction according to figure 2, so that now the inner channel of the outlet pipe 40 opening into the outlet opening 43 is in alignment with the inner opening 41 of the bush 39 and the outlet connection 38. Now in order to eject liquid from the dispenser 8 through the outlet pipe 40, the user needs to press solely on the protruding area 9a of the dispenser 9, which area is provided in the lower wall of the dispenser and is accessible through a corresponding opening 44 on the underside of the casing 1 (figure 1). After this, the outlet pipe 40 is swung back into its folded inoperative position, in which it closes-off the dispenser 9.

In order to carry out an inspection of the teeth, it is solely necessary to open the lid 3, which in the closed position covers the filter device 30 and thus protects the latter (figure 3), due to which opening operation, as afore-described, the incandescent bulb 11 is switched-on.

The afore-described diagnostic lamp, which in the drawings is illustrated with a scale of approximately 2:1, is in the form of a portable pocket appliance with a length of approximately 110 mm, a width of approximately 55 mm and a thickness of approximately 22 mm. The filter device 30 limiting the emergent beam of rays has dimensions of approximately 18 mm x 14 mm. With a supply voltage of approximately 4.5 volt, the incandescent bulb 11 consumes only approximately 2.4 watts.

The invention is not limited to the embodiment described, but may have many variations as regards the construction of the casing, the electrical parts, the dispenser and the optical system. Thus, in particular, the filter device may

consist of two separate filters, namely a blue coloured filter and a dichroic filter.

55 Claims

1. A portable diagnostic lamp for fluorescent excitation of a fluoreescible material applied to teeth, which fluoreescible material is stimulated essentially by blue light, the lamp comprising a casing; a small battery-powered incandescent bulb; a filter device adapted to the fluorescent substance and comprising in combination a dichroic first filter and a blue colour second filter whereby the device transmits at least a substantial portion of the spectral range of the incandescent bulb necessary for stimulating the fluoreescible material and absorbs at least a substantial portion of the spectral range of the fluorescent light; a folding mirror attached to the casing, which mirror enables the user to observe the illuminated teeth, and a lens which is located in the path of rays of the light emitted by the incandescent bulb and which provides a diverging emergent beam of rays for passage through the filter device to illuminate the teeth.

2. A diagnostic lamp as claimed in claim 1, in which the lens is arranged so that at a distance of 8 to 12 centimetres from the incandescent bulb, an area corresponding to the oval defined by the open mouth is illuminated.

3. A diagnostic lamp as claimed in claim 2, in which, in use, the incandescent bulb is arranged with its axis inclined towards the upper side of the casing and with its front end pointing obliquely upwards.

4. A diagnostic lamp as claimed in any one of claims 1 to 3, in which the blue coloured glass second filter has layers deposited thereon, which layers form the dichroic first filter.

5. A diagnostic lamp as claimed in any one of claims 1 to 4, in which a concave reflector is provided on the incandescent bulb.

6. A diagnostic lamp as claimed in any one of claims 1 to 5 in which a mirror is adjustably mounted on the casing and is constructed as a concave mirror.

7. A diagnostic lamp as claimed in any one of claims 1 to 6, in which the incandescent bulb and the lens are constructed in one-piece.

8. A diagnostic lamp for fluorescent excitation of a fluoreescible material applied to teeth substantially as hereinbefore described with reference to the accompanying drawings.