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DENTAL COLOUR MIXTURE INDICATOR DEVICE

Field of the Invention

The present invention relates to dentistry and, in particular, to
5 an improved colour mixture indicator device which finds particular
application in the selection of desired artificial tooth colouring in
the fabrication of bridges, crowns, partial dentures, and the like.

Related Disclosure

10 The present application is related to U.S. Patent No. 4,657,399
issued in the name of Neil R. Hall, who is also the inventor and
applicant in respect of the present application. The noted U.S. patent
claims priority from Australian application No. PG3002 lodged on 23
December 1983. The disclosure of the U.S. patent is incorporated
15 herein by cross-reference.

Description of the Prior Art

The dental colour mixture indicator device and method disclosed
in the noted U.S. patent has not yet experienced any commercial
20 success. The device is intended to assist dentists and/or dental
technicians in the selection of a desired tooth colour when replacing
or repairing teeth or when fabricating crowns, bridges or dentures.
The device also permits proper colour mixing where necessary to achieve
a selected colour.

25 To aid in the description of the present invention, Figs. 1-5 of
the noted U.S. patent have, for convenience, been reproduced as Figs.
1-5 of the present specification. Thus,

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Fig. 1 is a representation of the possible range of dental colours in a first "vertical" plane of a visual colour system,

Fig. 2 is a representation in a second "horizontal" co-ordinate plane of the same range of dental colours,

5 Fig. 3 is a schematic perspective view of the colour body of Figs. 1 and 2 represented in a different co-ordinate system,

Fig. 4 is a front elevation of the colour mixture indicator device, and

10 Fig. 5 illustrates how the device of Fig. 4 is held over a patient's teeth for comparison purposes, which was intended to allow part of a tooth to be viewed while the rest is obscured.

The preferred form of three-dimensional colour system is a cartesian colour system having a uniform colour scale, such as the CIELAB psychometric colour system. In this system the majority of the
15 range of dental colours fall within a substantially ellipsoid body 10 which is illustrated in Figs. 1 and 2. The CIELAB system represents colours in a three-dimensional cartesian co-ordinate system in which the "horizontal" chromaticity co-ordinates are designated "a" (positive representing red and negative representing green) and "b" (positive
20 representing yellow and negative representing blue). Thus the positive and negative portions of the "horizontal" axes represent opposed colours. In this system the "vertical" axis represents luminance or lightness "L". These expressions are used interchangeably. A variant of the co-ordinate system expresses the rectangular co-ordinates "a"
25 and "b" as polar co-ordinates "C" and "h", where "C" is the magnitude component representing chromacity and "h" is the angular component representing hue.

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As can be seen in Fig. 2 a grid is superimposed on the body 10. The grid is arbitrarily chosen to cover the majority of the range of dental colours embraced by the body. The body 10 is approximated to the elongate colour body shown in Fig. 3, with the intersection points of the grid (defined by the a and b axes) covering a broad range of colours; each point corresponds with one of the colours 1 to 9 shown in Fig. 3. The horizontal cuts 26 through the colour body of Fig. 3 are equally spaced, and therefore represent each of the colours 1 to 9 at various discrete values of luminance, L.

10 It is also convenient to briefly restate the manner in which the indicator device 20 is used to match tooth colour. The colour mixture indicator device 20 shown in Fig. 4 has nine colour samples 11 to 19 arranged in accordance with the co-ordinate system of Fig. 3 to allow correct matching of tooth colour with one of the colours 1 to 9, or as
15 a mixture of any two adjacent colour samples (say, 11 and 12, or 19 and 16).

In assessing the desired colour for the artificial teeth to be fabricated for a patient, it was intended that the dentist select one of the five colour mixture indicator devices 20 (there being one device
20 20 for each of the cuts or lightness levels 26 of Fig. 3). This device would then be held against the existing or remaining teeth 28, 29 and 30 of the patient as indicated in Fig. 5. It is apparent from Fig. 5 that the size of the colour samples 11 to 19 and the spaces 22 to 25, facilitate the colour comparison since, for example, all the colours 2,
25 6, 1 and 9 of the corresponding samples 12, 16, 11 and 19 can be directly compared with the colour of the tooth 29. If neither of these colours is an exact match, then an evaluation of the mixture of colours

1 and 2, for example, can be made by estimating the resultant colour formed from a mixture of colour samples 11 and 12.

If none of the colours of a particular device 20 appear to match the patient's teeth, then a different device 20 could be selected corresponding to a different cut 26. For each indicator device 20 of the set of indicator devices, the colours will range in chromaticity with various degrees of saturation of yellow and red in the direction from colour sample 12 towards colour sample 14 of the device 20.

As noted, the regular grid ascribed to the ellipsoid body 10 shown in Fig. 2 and translated onto Fig. 3 is arbitrary, and was chosen so as to cover what was thought to be the possible range of tooth colouring. The grid was centred on $a = 3$, $b = 15$ (with respect to the co-ordinate system), and remained so for each cut 26.

Since the issue of the noted U.S. patent it has been recognised by the inventor that 80% of all tooth colours are matchable to the three central colours samples 11, 12 and 14, or combinations of adjacent colour samples 16-19. This unexpectedly leads to a simplification, since the inventor has now realised that it is possible to eliminate the extreme side colour samples 13 and 15, thereby decreasing the cost of the devices to the user, and meaning that the user can stock a smaller range of tooth restorative materials.

On further investigation, the inventor discovered that the ellipsoid body 10 representing the assumed range of all tooth colours under the CIELAB system (as represented in Fig. 2) was actually constituted by a series of narrower ellipsoids located at different luminance levels, and that previous assumptions about the range and nature of tooth colours were incorrect. The reason for the false

assumptions appears to be that the correct tooth colour volume represented by these narrower ellipsoids tended to blend into the one larger ellipsoid 10 when notionally viewed from above the a-b plane, for reason of actually viewing hue shifts, and seeking to bound all those hue values over the presumed luminance range.

Upon further investigation it was realised by the inventor that as the central colour 1 was varied in luminance (darkened or lightened) the hue shift was quantifiable, which the inventor has now determined to be approximately 3 degrees of h for every five units of luminance, L.

10 A further discovery was made by selection of the central colour 1 for each cut 26 or luminance level to be plus or minus three degrees of the central colour of an adjacent cut 26. Under these restricted conditions up to 95% of all tooth colours could be reproduced by only the three central colours 1, 2 and 4. It was also discovered that it would now be possible to apply a further restriction of only four cuts 15 26, each one corresponding to a spacing of five units of L, in order to cover the desired 15-20 unit range. Consequently, only four devices 20 are required, and the set of colour materials needed to be stocked by manufacturers and suppliers can be reduced.

20 The present invention takes advantage of these important discoveries.

Summary of the Invention

Therefore, according to one aspect of the invention, there is disclosed a set of dental colour mixture indicator devices comprising a 25 plurality of component indicator devices, each said component indicator device having a plurality of colour samples located in an array and

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arranged about a central one of the colour samples with each sample spaced apart from samples adjacent thereto, the colours of said samples being representative of colours of a predetermined colour system having a co-ordinate system aligned with said array wherein the colour of each of said samples corresponds to the colour of the corresponding location in said co-ordinate system, the colours of the samples of each said component device being located on a plane of said co-ordinate system and the plane corresponding to each device being substantially parallel to, and spaced from, the planes of the other ones of said component devices and such that the central colour samples of adjacent planes are offset with respect to the co-ordinate system, and whereby, in use of the said set, a patient's tooth can be compared against any one of said component devices and a desired dental colour intermediate a selected pair of said colour samples can be mixed for fabrication by a mixture of the colouring materials used to fabricate said selected pair.

According to another aspect of the invention, there is disclosed a dental colour mixture indicator device comprising a plurality of component devices, each of said component devices having a plurality of colour samples located in an array and arranged about a central one of the colour samples with each sample spaced apart from samples adjacent thereto, the colours of said samples being representative of colours of a predetermined colour system having a co-ordinate system aligned with said array wherein the colour of each of said samples corresponds to the colour of the corresponding location in said co-ordinate system, the colours of the samples of each said device being located on a plane of said co-ordinate system and the plane corresponding to each device being substantially parallel to, and spaced from, the planes of the

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other ones of the component devices and such that the central colour samples of adjacent planes are offset with respect to the co-ordinate system, and whereby, in use of the indicator device, a patient's tooth can be compared against any one of said component devices and a desired
5 dental colour intermediate a selected pair of said colour samples can be mixed for fabrication by a mixture of the colouring materials used to fabricate said selected pair.

According to a further aspect of the invention, there is disclosed a method of selecting a dental colour from an elongate body
10 of possible dental colours represented on a colour co-ordinate system, said body having a longitudinal axis, and said method comprising the steps of notionally cutting said body at points along said axis with a plurality of substantially parallel cuts, notionally locating a regular grid of lines on each of said cuts, said lines having intersections
15 forming an array of locations arranged about a central location, selecting a plurality of colour samples for each cut, each of said colour samples corresponding to a colour lying at a corresponding intersection location of the grid on said cut, the central one of the colour samples for adjacent cuts being coincident on the longitudinal
20 axis of the body but offset with respect to an axis normal to the plane of the said parallel cuts, and selecting a desired shade of said dental colour by firstly selecting one of said cuts, and secondly selecting the desired shade to be either one of said selected colour samples for the selected cut or a colour mixture of at least two adjacent ones of
25 said selected colour samples for the selected cut.

According to yet a further aspect of the invention, there is provided a method of enabling selection of a dental colour from an

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elongate body of possible dental colours represented on a colour co-ordinate system, said body having a longitudinal axis, and said method comprising the steps of notionally cutting said body at points along said axis with a plurality of substantially parallel cuts, 5 notionally locating a regular grid of lines on each of said cuts, said lines having intersections forming an array of locations arranged about a central location, and selecting a plurality of colour samples for each cut, each of said colour samples corresponding to a colour lying at a corresponding intersection location of the grid on said cut, the 10 central one of the colour samples for adjacent cuts being coincident on the longitudinal axis of the body but offset with respect to an axis normal to the plane of the said parallel cuts so as to enable the subsequent selection of a desired shade of said dental colour.

According to a still further aspect of the present invention, 15 there is disclosed a set of dental colour materials from which artificial tooth material can be fabricated from either one of said dental colour materials or a colour mixture of only two of said dental colour materials, said set of dental colour materials enabling substantially all the range of naturally occurring tooth colours to be 20 fabricated, said set of dental colour materials comprising a plurality of colours selected from an elongate body of possible dental colours represented on a colour co-ordinate system and having a longitudinal axis, by notionally cutting said body at points along said axis with a plurality of substantially parallel cuts, notionally locating a regular 25 grid of lines on each of said cuts, said lines having intersections forming an array of locations including a central location, and selecting a plurality of colour samples for each cut, each of said

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colour samples corresponding to a colour lying at a corresponding intersection location of the grid on said cut, the central one of the colour samples for adjacent cuts being coincident on the longitudinal axis of the body but offset with respect to an axis normal to the plane
5 of the said parallel cuts.

Preferably, an artificial tooth can be fabricated from a colour mixture of two of said dental colour materials lying in a vertical plane of the said grid and two of said dental colour materials lying in a horizontal plane of said grid.

10 Preferably there are four cuts spaced apart by 5 units of L and three colour samples per plane or cut so that the abovementioned set of dental colour materials has only $4 \times 3 = 12$ members. This represents a very substantial reduction in the current range of dental colours required to fabricate an adequate range of tooth colours which
15 typically encompasses 50-100 colour materials. The preferred offset is in the range of from 2-4 degrees of hue towards the red for each 4-6 unit decrease in luminance.

According to yet another aspect of the invention, there is disclosed a colour guide for selection of artificial tooth material
20 from which artificial teeth can be fabricated, the colour guide enabling substantially all the range of naturally occurring tooth colours to be selected for fabrication, said set of dental colour materials comprising a printed colour representation of a plurality of colours selected from an elongate body of possible dental colours
25 represented on a colour co-ordinate system and having a longitudinal axis, by notionally cutting said body at points along said axis with a plurality of substantially parallel cuts, notionally locating a regular

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grid of lines on each of said cuts, said lines having intersections forming an array of locations including a central location, and selecting for each cut a plurality of colours, each of said colours lying at a corresponding intersection location of the grid on said cut, 5 the central one of the colour samples for adjacent cuts being coincident on the longitudinal axis of the body but offset with respect to an axis normal to the plane of the said parallel cuts.

According to one other aspect of the invention, there is disclosed a worksheet for assisting in the prescription of artificial 10 tooth material from which artificial teeth can be fabricated, the worksheet displaying a grid for each of said planes as referred to above, and whereby, in use of a device referred to above, the resulting proportional combination of adjacent vertical colour samples and adjacent horizontal samples is noted on the worksheet, the worksheet 15 then being provided as a reference from which artificial tooth material can be mixed to achieve the desired matching tooth colour for a tooth to be replaced or restored.

Brief Description of the Drawings

20 Preferred embodiments of the invention will now be described with reference to the drawings, in which:

Figs. 1 to 5 are prior art and correspond to Figs. 1-5 of U.S. patent No. 4,657,399 as explained above;

Fig. 6 is a representation of the colour body of all tooth 25 colours when mapped under the CIELAB system;

Fig. 7 is a representation of the colour body at each slice or luminance level mapped onto the a and b axes;

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Fig. 8 is a representation of the locus of the range of "a" values (red to green) with respect to luminance;

Fig. 9 shows a representation of the locus of the range of "b" values (yellow to blue) with respect to luminance;

5 Fig. 10 is a representation of a co-ordinate system in one embodiment;

Fig. 11 is a front elevation of a colour mixture indicator device constructed in accordance with a first embodiment;

10 Fig. 12 is a front elevation of a colour mixture indicator device of a further embodiment;

Fig. 13 is a front elevation of a set of colour mixture indicator devices in accordance with another embodiment;

Fig. 14 illustrates how the embodiment of Fig. 13 can be utilised in conjunction with a worksheet to construct an artificial tooth, or
15 repair an existing tooth; and

Fig. 15 is a representation of another embodiment for a co-ordinate system.

Description of Preferred Embodiments

20 It will be appreciated from Figs. 2 and 3 that the body of all tooth colours was previously assumed to be a regular elongate ellipsoidal body 10 having a longitudinal axis normal to the a and b axes. As has now been discovered, the body of tooth colours is less regularly shaped, and constituted by a narrower ellipsoid. Fig. 6
25 shows the colour body 50 in a 3-dimensional representation mapped against the a, b and L axes under the CIELAB system. The body covers a 15-20 unit range in luminance, the range of "a" values is approximately

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5 units whilst the range of "b" values remains about 10 units as previously thought to be.

Fig. 6 also shows a longitudinally extending principal axis 60 for the body 50, which lies generally in the L plane. The principal axis 60 is at an angle with respect to the normal of the a-b plane. The body 50 has notional cuts or slices, identified as D, M, L and XL, made parallel to the a-b plane at equally spaced points along the principal axis 60. When the four ellipsoids that result from the cuts D-XL are viewed in cross-section, and superimposed onto the a and b axes, as shown in Fig. 7, their relative offset between the centre point 20 becomes more recognisable. That is, the angular offsets in hue (h) α , β , γ can be seen to be equal. The dashed outlined generally represents the locus of all a and b values taken by the colour body over the range of L values. This locus approximates the colour body 10 as it was previously thought to be. As previously noted, the present inventor realised that what actually was being observed was phase shifts which tended to smear the narrow ellipsoid body 50 into one larger ellipsoid 10.

A centre point or colour 201 is again shown for each ellipsoid. This centre colour 201 is chosen to lie on the principal axis 60, as can be more clearly seen in Figs. 8 and 9. Fig. 8 shows how the centre colours 201D-201XL become less red as luminance increases (i.e. the positive a value reduces with increasing L). This shift has been quantified by the inventor as a three degree hue shift for every 5 luminance units, in which case only four cuts are required to embrace the desired 15-20 unit luminance range. The centre colours 201D-201XL sited on the principal axis 60 at each cut D-XL represent an

approximate three degree hue shift for each luminance level.

Therefore, the four cuts D-XL are parallel with respect to the plane of the a and b axes, and the central colours 201D-201XL are offset from one another by three degrees with respect to the L axis.

Fig. 10 shows the chosen co-ordinate system centred about the centre colour 201. The grid of the co-ordinate system is sized to map onto the area of each individual ellipsoid 100 to 103 with respect to the a and b axes. The colours at the intersection of the grid of the co-ordinate system are identified by the numerals 201 to 207. The
10 distance between any two adjacent colours in the b plane (i.e. the 'height' of the grid) is approximately 5 units, whilst the distance between adjacent colours in the a plane (i.e. one half of the 'width' of the grid) is about 2.5 units.

Fig. 11 shows a colour mixture indicator device 200 which has
15 colour samples 211-217 as would be constructed from a particular tooth restorative material and which correspond to the colours 201-207. The shape of the colour samples may be tooth-like as shown, but could also be other shapes, and for example, circular. Typically a set of the devices 200 comprises four devices of the same configuration, each one
20 representing a one of the cuts, and with a three degree hue shift between central colour samples of adjacent ones of the devices. The operation of the colour mixture indicator device 200 is the same as previously described in U.S. Patent No. 4,657,399 in that a tooth can be matched with one of the colour samples 211 to 217, or to fall
25 between adjacent ones of those colour samples; for example, between samples 216 and 214, or samples 211 and 212. The device 200 is constructed of three metal blades or handles 251 to 253, to which each

has two or three colour samples affixed to the free end. The outer blades 252 and 253 are pivotably mounted to a base 255 so that, optionally, they can be swung out of the way of the central blade 251 to enable better access in matching the tooth colour with only the three central colour samples 211, 213 and 215 mounted on the central handle 251.

Another embodiment of an indicator device 300 is shown in Fig. 12. This device has been modified to provide only the central three colour samples 311, 312 and 314, with each being mounted on an individual blade 317-319. The three separate blades are pivotally fastened to each other at one end 316. This device 300 is most suitable for the XL luminance level, for which it is believed there is only a very small range of a and b values (see Figs. 7 and 8). It can, however, also be used for the D, M and L levels if tooth colour matching is less crucial, for example, in fabricating composite restorations.

Figure 13 shows another embodiment of a colour mixture indicator device 420 which constitutes a complete set of devices 400-403 for each luminance level mounted on a common base 410. Each central or side group of samples for each individual device 400 plugs into, and is retained by the base. The samples are each mounted on an individual blade 430, 440-442, 450-452, 460-462, and again, each group of samples is pivotably interconnected. This means each group of blades and samples can be used in a fan-like manner. The samples at the end of each blade are also rotatable in the plane of the blade so the sample can be oriented with a tooth against which it is being compared. The individual devices 400 identified as D, M and L are generally similar

to the device 200 shown in Fig. 11, while the device identified as XL is equivalent to the device 300 shown in Fig. 12.

Each device 400-403 uniquely identifies each colour sample as shown. The left side samples are more 'red' than the right sample
5 which are respectively more 'yellow', hence the use of "Y" and "R". Clearly "C" refers to the central colour samples.

In use, the samples of the device 420 are to be held at arms length adjacent the tooth to be matched to adjudge the appropriate lightness/ luminance level. It is important to view the samples at
10 arms length, as the human eye can only effectively detect variations in luminance at that distance. The eye cannot make correct distinctions of relative luminance at distance closer than arms length. Therefore each central three blades and samples for the four luminance levels are plucked out of the base 410 in turn to determine the correct luminance
15 level.

It is then necessary to determine where the tooth colour to be matched lies with respect to the three central vertical colour samples. Say the "M" luminance level has been selected, in which case a tooth is then compared against samples MC1, MC2, MC3 to determine
20 which two samples it falls between. This represents a decision as to the yellow/blue colour mix in the tooth colour. It is possible to estimate a proportion of, say, MC1 and MC2, to be, for example, 25% MC1 and 75% MC2. That estimation is then marked on the work sheet shown in Fig. 14.

25 This step is then followed by considering the red/green colour mix by bringing the colour samples MY1 and MR1 beside the tooth. Again, it is possible to estimate the proportional mix to be, for

example, 25% MY1 and 75% MR1. This estimation is then marked on the work sheet, and therefore locates the desired colour accurately as the intersection of those two points. A dental technician can then simply mix up the restorative materials corresponding to MC1, MC2, ML1 and MR1 in the appropriate proportions to achieve the desired result. It is as a direct result of the allocation of the strictly spaced co-ordination system that a proportional mix as specified above with respect to 'b' axis colours and 'a' axis colours results in the required colour being achieved. Manufacturers of the restorative materials can fabricate
0 colours for the complete range of colour samples based solely on the specification of each sample by the L,a,b or L,C,h co-ordinates.

It is often necessary to mix up different colours for the one tooth, as a tooth normally varies in colour throughout its length, especially in patient's of middle age or older. For this purpose the
15 worksheet shown in Fig. 14 can be supplemented with a plan of all the teeth in the mouth in appropriate views, with those views marked up as to what part of the tooth is to be restored with each particular determined mixture. The worksheet may also show only one 'grid', and the appropriate luminance level prescribed to that grid, rather than
20 having a separate grid for each luminance level.

By using the device 410, it is possible to more accurately approximate the true tooth colour in a restorative material, for reason of enabling the three co-ordinates L,a,b or L,C,h to be substantially more accurately estimated than in the prior art. Prior art systems,
25 except for U.S. Patent No. 4,657,399 referred to above, do not in any way arrange colours or samples in strict spaced relation to a colour co-ordinate system.

A further aid to the device shown in Fig. 11, Fig. 12 and Fig. 13 is a colour chart (not shown) which displays, in printed form, the colour samples in like relation as the devices 200, 300, 400, and also cross-matches with restorative materials corresponding to each colour sample. The restorative materials can be specified as one or more types, such as porcelain, powders or artificial teeth.

A further embodiment of the co-ordinate system shown in Fig. 15 relates to the instance where it is very important to attain as close a match of tooth colour as is possible. In this case additional
10 intermediate colours 320-323 are introduced to the existing co-ordinate system at each luminance level to enable a more detailed comparison. Even so, the principle of selecting the central colours to be offset by approximately 3 degrees in hue with respect to an adjacent cut still applies. The intermediate colours are chosen to fall between the
15 existing colours 201-207, and their location with respect to the previously described co-ordinate system is shown in Fig. 15. Although not specifically illustrated, clearly a colour mixture device embracing the colours 201-207 and 320-323 could be constructed on similar lines to that shown in Fig. 11 or Fig. 13.

20 It can therefore be seen that the invention provides an improved system for matching tooth colour, which, by appropriate selection of the central colour for each luminance level in accordance with a determined relation of hue shift with respect to luminance, results in a reduction in the number of colour samples, matching devices and
25 dental materials needed to be stocked. This had advantages for both the manufacturer of the tooth restorative materials and matching devices, and to dentists and/or dental technicians who can still ensure

a high percentage of match of tooth colour but at a lesser expense to themselves and their patients.

The foregoing describe only some embodiments of the present invention, and modifications, obvious to those skilled in the art, can be made thereto without departing from the present invention.



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CLAIMS:

The claims defining the invention are as follows:

1. A set of dental colour mixture indicator devices comprising a plurality of component indicator devices (200), each said component indicator device (200) having a plurality of colour samples (211-217) located in an array and arranged about a central one of the colour samples (211) with each sample spaced apart from samples adjacent thereto, the colours of said samples (211-217) being representative of colours of a predetermined colour system having a co-ordinate system (L,a,b) aligned with said array wherein the colour of each of said samples corresponds to the colour of the corresponding location (201-207) in said co-ordinate system (L,a,b), the colours of the samples (211-217) of each said component device being located on a plane of said co-ordinate system and the plane corresponding to each device (200) being substantially parallel to, and spaced from, the planes of the other ones of said component devices (200) and characterized in that such that the central colour samples (211) of adjacent planes are offset with respect to the co-ordinate system, and whereby, in use of the said set, a patient's tooth can be compared against any one of said component devices (200) and a desired dental colour intermediate a selected pair of said colour samples (211-217) can be mixed for fabrication by a mixture of the colouring materials used to fabricate said selected pair.

2. A set of dental colour mixture indicator devices as claimed in claim 1, wherein the colour samples (211-217) of a component indicator device (200) are fixed to an end of a handle or blade

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(251-253) and the other ends of the handles or blades are commonly connected.

3. A set of dental colour mixture indicator devices as claimed in claim 2, wherein the common connection is formed by a base (255).

4. A set of dental colour mixture indicator devices as claimed in claim 2, wherein the common connection is formed by a pivoting fastener (316) so that the handles or blades are arranged in a fan-like manner.

5. A set of dental colour mixture indicator devices as claimed in claim 2, wherein one, two or three colour samples (211-217) each are arranged on one, two or three blades or handles (251-253) forming each component indicator device (200) in the said set.

6. A set of dental colour mixture indicator devices as claimed in any one of claims 1 to 5, wherein there are three colour samples (311, 312, 313) per component indicator device (300) and four said component devices (300) in the said set.

7. A set of dental colour mixture devices as claimed in any one of claims 1 to 6, wherein the said co-ordinate system is the CIELAB system, and the said offset is approximately 3 degrees in hue (h) towards red for each adjacent plane (XL, L, M, D) in a direction of decreasing luminance (L).

8. A dental colour mixture indicator device (400) comprising a plurality of component devices (400-403), each of said component devices (400-403) having a plurality of colour samples (Y1-2, C1-3, R1-2) located in an array and arranged about a central one of the colour samples (C2) with each sample spaced apart from samples adjacent thereto, the colours of said samples being representative of colours of a predetermined colour system having a co-ordinate system (L, a, b)

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aligned with said array wherein the colour of each of said samples (Y1-2,C1-3,R1-2) corresponds to the colour of the corresponding location (201-207) in said co-ordinate system (L,a,b), the colours of the samples of each said device (400-403) being located on a plane (XL,L,M,D) of said co-ordinate system and the plane corresponding to each device (400-403) being substantially parallel to, and spaced from, the planes of the other ones of the component devices (400-403) and characterized in that the central colour samples (C2) of adjacent planes are offset with respect to the co-ordinate system, and whereby, in use of the indicator device (420), a patient's tooth can be compared against any one of said component devices and a desired dental colour intermediate a selected pair of said colour samples can be mixed for fabrication by a mixture of the colouring materials used to fabricate said selected pair.

9. A dental colour mixture indicator device as claimed in claim 8, wherein the colour samples (Y1-2,C1-3,R1-2) of each component device (400-403) are fixed to an end of a blade (450,451,452) and the other end of each blade of each component device (400-403) is connected to a common base (410) of the dental colour mixture indicator device (420).

10. A dental colour mixture indicator device as claimed in claim 9, wherein one, two or three colour samples (Y1-2,C1-3,R1-2) each are arranged on one, two or three blades (450,451,452) forming each component device.

11. A dental colour mixture indicator device as claimed in any one of claims 8 to 10, wherein there are three colour samples (C1-3) per component device (400) and four said component devices (400) comprise the dental colour mixture indicator device (420).

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12. A dental colour mixture indicator device as claimed in any one of claims 8 to 11, wherein the said co-ordinate system is the CIELAB system, and the said offset is approximately 3 degrees in hue (h) towards red for each adjacent plane (XL,L,M,D) in a direction of decreasing luminance (L).

13. A method of selecting a dental colour from an elongate body (50) of possible dental colours represented on a colour co-ordinate system (L,a,b), said body having a longitudinal axis (60), and said method comprising the steps of:

notionally cutting said body (50) at points along said axis with a plurality of substantially parallel cuts (XL,L,M,D);

notionally locating a regular grid of lines on each of said cuts, said lines having intersections forming an array of locations arranged about a central location;

selecting a plurality of colour samples for each cut (XL,L,M,D), each of said colour samples corresponding to a colour lying at a corresponding intersection location of the grid of said cut, and characterized in that the central one of the colour samples (20) for adjacent cuts (XL,L,M,D) coincident on the longitudinal axis (60) of the body (50) but offset with respect to an axis (L) normal to the plane of the said parallel cuts; and

selecting a desired shade of said dental colour by firstly selecting one of said cuts (XL,L,M,D), and secondly selecting the desired shade to be either one of said selected colour samples for the selected cut or a colour mixture of at least two adjacent ones of said selected colour samples for the selected cut.

14. A method as claimed in claim 13, wherein the said co-ordinate system is the CIELAB system, and the said offset is

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approximately 3 degrees in hue (h) towards red for each adjacent cut (XL,L,M,D) in a direction of decreasing luminance (L).

15. A method of enabling selection of a dental colour from an elongate body (50) of possible dental colours represented on a colour co-ordinate system (L,a,b), said body having a longitudinal axis (60), and said method comprising the steps of:

notionally cutting said body (50) at points along said axis with a plurality of substantially parallel cuts (XL,L,M,D);

notionally locating a regular grid of lines on each of said cuts, said lines having intersections forming an array of locations arranged about a central location; and

selecting a plurality of colour samples (201-207) for each cut (XL,L,M,D), each of said colour samples corresponding to a colour lying at a corresponding intersection location of the grid on said cut, and characterized in that the central one of the colour samples (201) for adjacent cuts (XL,L,M,D) coincident on the longitudinal axis (60) of the body (50) but offset with respect to an axis (L) normal to the plane of the said parallel cuts so as to enable the subsequent selection of a desired shade of said dental colour.

16. A set of dental colour materials from which artificial tooth material can be fabricated from either one of said dental colour materials or a colour mixture of at least two of said dental colour materials, said set of dental colour materials enabling substantially all the range of naturally occurring tooth colours to be fabricated, said set of dental colour materials comprising a plurality of colours selected from an elongate body (50) of possible dental colours represented on a colour co-ordinate system (L,a,b) and having a

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longitudinal axis (60), by notionally cutting said body (50) at points along said axis (60) with a plurality of substantially parallel cuts (XL,L,M,D), notionally locating a regular grid of lines on each of said cuts, said lines having intersections forming an array of locations including a central location, and selecting a plurality of colour samples (201-207) for each cut (XL,L,M,D), each of said colour samples corresponding to a colour lying at a corresponding intersection location of the grid on said cut, and characterized in that the central one of the colour samples (201) for adjacent cuts (XL,L,M,D) is coincident on the longitudinal axis (60) of the body (50) but offset with respect to an axis (L) normal to the plane of the said parallel cuts.

17. A set of dental colour materials as claimed in claim 16, wherein the said co-ordinate system is the CIELAB system, and the offset is approximately 3 degrees in hue (h) towards red for each adjacent cut (XL,L,M,D) in a direction of decreasing luminance (L).
18. A set of dental colour materials as claimed in claim 16 or 17, wherein there are four cuts (XL,L,M,D) spaced apart by approximately five units of luminance (L).

19. An artificial tooth fabricated from a colour mixture of dental colour materials as claimed in any one of claims 16 to 18.

20. An artificial tooth as claimed in claim 19, wherein two of the mixed dental colour materials lie adjacent in a vertical plane (b) of the said grid and two of the mixed dental colour materials lie adjacent in a horizontal plane (a) of the said grid.

21. An artificial tooth as claimed in claim 19, wherein a colour mixture of only two of said dental colour materials are mixed, and

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whereby the two dental colour materials either lie adjacent in a vertical plane (b) of said grid or lie adjacent in a horizontal plane (a) of said grid.

22. A colour guide for selection of artificial tooth material from which artificial teeth can be fabricated, and characterized in that the colour guide enabling substantially all the range of naturally occurring tooth colours to be selected for fabrication, said set of dental colour materials comprising a printed colour representation of a plurality of colours selected from an elongate body (50) of possible dental colours represented on a colour co-ordinate system (L,a,b) and having a longitudinal axis, by notionally cutting said body at points along said axis (60) with a plurality of substantially parallel cuts (XL,L,M,D), notionally locating a regular grid of lines on each of said cuts (XL,L,M,D), said lines having intersections forming an array of locations including a central location, and selecting for each cut (XL,L,M,D) a plurality of colours, each of said colours lying at a corresponding intersection location of the grid on said cut, the central one of the colour samples for adjacent cuts (XL,L,M,D) being coincident on the longitudinal axis (60) of the body (50) but offset with respect to an axis (L) normal to the plane of the said parallel cuts.

23. A colour guide as claimed in claim 22, wherein the said co-ordinate system is the CIELAB system, and the offset is approximately 3 degrees in hue (h) towards red for each adjacent cut (XL,L,M,D) in a direction of decreasing luminance (L).

24. A worksheet for assisting in the prescription of artificial tooth material from which artificial teeth can be fabricated, the

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worksheet being for use with the set of devices as claimed in claim 1, and displaying a plurality of grids for each plane, and whereby, in use of the respective devices, the resulting proportional combination of adjacent vertical colour samples and adjacent horizontal samples is noted on the worksheet, the worksheet then being provided as a reference from which artificial tooth material can be mixed to achieve the desired matching tooth colour for a tooth to be replaced or restored.

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