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GOVERNMENT OF INDIA : THE PATENT OFFICE, 214, LOWER CIRCULAR ROAD, CALCUTTA-17.

Specification No. 65611. Application No. 65611, dated 29th October 1958. Complete Specification left on 28th May 1959. (Application Accepted 28th April 1960.)

A FILTER FOR CALIBRATING THE WAVE-LENGTH SCALES OF OPTICAL INSTRUMENTS SUCH AS THE SPECTROPHOTOMETER.

PROVISIONAL SPECIFICATION.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, OLD MILL ROAD, NEW DELHI-1, INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860).

The following specification describes the nature of the invention.

This is an invention by Dr. INDRA SANGHI and NAMMAKKAL VIJAYAM PARTHASARATHY, both of the Central Electrochemical Research Institute, Karaikudi, India, both Indian citizens.

This invention relates to a new type of filter cell which works on the principle of isobestic points and is based on the null method, and which can be used for the calibration of the wave length scale of the optical instruments. More particularly, it relates to a method of preparing cheaper and with much greater ease, simplicity and accuracy light filters which can be used as wavelength standards and to the design of a simple cell which serves and suits the purpose.

According to the usual commercial systems, costly glass or gelatine filters are specially prepared to give sharp maxima or minima absorption at particular wavelengths which can be taken as standards. Such filters are often composite in nature consisting of more than one filter joined together and may contain special compounds such as didynium, in their specialised manufacture. We have found that any two suitably chosen differently coloured pieces of transparent material can easily be used as wavelength standards and filters by pre-determining their isobestic points, *i.e.*, the point at which the absorbence curves of the two differently coloured material pieces intersect each other. The wavelength corresponding to the isobestic point then becomes a characteristic of the filters and may be used to calibrate an optical instrument with unknown wavelength scale by comparing the absorbence of the two differently coloured materials at different wavelengths, till the difference tends towards zero at a particular wavelength corresponding to the pre-determined wavelength of the isobestic point. Another advantage with this method is that unlike other previous methods in which maxima or minima of absorption have to be determined, in this method only the difference between the absorption of two differently coloured materials is to be determined and this can often be done with greater accuracy and ease than otherwise possible with previously known methods. Further, this method is based on the null principle and avoids all systematic errors. Also it is possible by this technique to obtain accuracy of about 0·2m μ which is usually not possible with the other known techniques. The following examples further illustrate the invention:

Example 1

Two differently coloured solutions (having different pH) which were made out of equal amounts of the same stock solution of methyl orange were kept in two cells, and the difference in their absorbence, at different wavelengths was observed in a spectrophotometer whose wavelength scale was to be calibrated. The wavelength where the absorbance was found to be the same for both the solutions, was set at 469 m μ which is pre-determined isobestic point for methyl orange. Similarly other indicators could be used.

Example 2

A simple cell has been designed as shown in the attached drawing (Sheet no. 1, Figs. 1-3). It has a square cross-section (1·2 cm. each side). The adjacent sides of the cylinder consist of 2 suitably combined matched and paired glass strips of different colours so as to give one single, sharp and well-defined point of intersection in their transmittance (or absorbence) curves, the other two sides having observation windows. During the selection, matching and pairing of the differently coloured glass strips, necessary care is exercised and the particular wavelength at which both the strips give the same transmittance is determined. The desired standard wavelength can be obtained in any region of the visible spectrum depending on the suitable choice of the various colours and tints of the glass strips used. Our method then consists of putting the cell in the light path of the spectrophotometer and determining the transmittance (or absorbence) when the light passes through one of the coloured strips. The cell is then rotated through 90° so as to make the light pass through the other strip. By repeating the process thus, at a particular wavelength both the coloured sides of the designed cell give the same transmittance and this wavelength of the spectrophotometer can then be set to the pre-known standard wavelength value for the particular cell. The above idea can be further extended and mechanised in various ways. For example, we may make an arrangement for rotating a circular disc, the two halves of which may consist of suitably chosen and paired differently coloured transparent materials so that the light beam would fall alternately on the two halves and the difference in their transmittance would give rise to an alternating current in the photo cell. Now if the prism is rotated or the wavelength of the light passing through the disc varied, the alternating current generated by the photo cell would also vary, till at a particular wavelength at which both the halves of the disc give the same transmittance, the photo cell would show a steady current. Other synchronous and servo arrangements can also be made to quickly vary the wavelengths and to automatically stop at the particular wavelength where only a steady response from the photo cell is received. Thus, numerous slight variations and applications of the idea can be made.

Here only a simple cell has at present been designed in which the preferred combination is a particular yellowish-brown and greenish-blue glass strips, giving an isobestic point at 516 m μ which is roughly in the middle of the visible region. For the red region, a combination of greenish-blue and red is preferred which gives an isobestic point at 680 m μ. Similarly, for the blue region, deep blue and green can be used, giving equal transmittance at 493 m μ. Similarly, other pairs can be combined. The inventive step lies in so combining, matching and pairing two ordinary but differently coloured glass strips on the principle discovered, so that they can be used for purposes for which they were singly and originally quite unsuitable.

Thus we have found:

(1) A new technique of standardising optical instruments based on the use of isobestic points.

(2) A method based on the null principle and giving more accurate and easier calibration of unknown wavelength scales.

(3) A method of preparing cheap commercial filter pairs of differently coloured transparent materials which may be suitably chosen, combined and paired to be useful for the above purposes.

(4) A method in which no special or controlled manufacture of glass or gelatine is required and a method in which any two common, coloured pieces of glass may be used.

(5) Same as (4) but in which suitably chosen and paired coloured solutions, plastics or other transparent materials may be used in place of glass.

(6) More particularly, a simple standard filter cell as shown in the diagram which based on the above technique can be used for calibrating the wavelength scale of optical instruments.

(7) Modifications or extensions substantially involving the operating principles described above.

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Dated this 16th day of October 1958.

COMPLETE SPECIFICATION.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Old Mill Road, New Delhi-1, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed.

This is an invention by Dr. INDRA SANGHI and NAMMAKKAL VIJAYAM PARTHASARATHY, both of the Central Electrochemical Research Institute, Karaikudi, India, both Indian citizens.

This invention relates to a filter for calibrating the wave-length scales of optical instruments such as spectrophotometers.

Hitherto the wave-length scales of optical instruments such as spectrophotometers have been calibrated by costly glass or gelatine filters imported from abroad. Such filters are often composite in nature consisting of more than one filter joined together and may contain special compounds such as didymium. Further, in using these filters for calibration of wave-length scales, the maxima or minima in transmission or absorption curves have to be determined.

The object of the present invention is to develop a much better and simpler method of preparing filters which can be used for calibrating the wave-length scale of optical instruments such as spectrophotometers.

We have found that a simple filter can be constructed out of readily available differently coloured transparent materials such as glass, gelatine, plastic, coloured solutions or the like. All that is necessary to make the filter is to mount a pair of suitably selected (the principle of selection will be fully explained hereinbelow) transparent materials on a frame or holder which can be introduced in path of the light beam in the spectrophotometer or like instrument which has to be calibrated. The essential merit underlying the present invention consists in the principle which the Inventors have discovered for selecting the colours of the transparent materials to be fixed in the filter. This discovery consists in the finding that the two colours selected and paired should fulfil the following criterion, namely, that the transmission curve of each of the two materials should have a sharp point of intersection. The technical advantage flowing from the discovery is that the determination of an intersection point is easier and more accurate than the conventional method of determining the maxima or minima.

The method of selecting and pairing the colours in accordance with the present findings is as follows:

(a) determine and plot graphically (see Fig. V of the accompanying drawings) the transmission and absorption curves of differently coloured transparent and stable materials such as glass, gelatine, plastic, coloured solutions or the like, *e g.*, by means of a standard calibrated spectrophotometer ;

(b) find out points of intersection in the above transmission curves (*e g.*, points marked 1 to 11 of Fig. V of the accompanying drawings) ;

(c) choose and pair two differently coloured materials having one sharp and clear-cut intersection (*e.g.*, points of intersection marked 1, 3, 4, 6, 9 and 10 in Fig. V of the accompanying drawings) The point at which the transmission curves of two differently coloured transmission materials intersect each other on the graph is known as the "isobestic point" of the said two materials.

The wave-length corresponding to the isobestic point thus becomes a characteristic of the filter, and this wave-length is marked on the filter cell. Such filter cell is placed in the light path of the spectrophotometer which has to be calibrated. By operating the cell in the manner to be described hereinafter, the wave-length scale of the uncalibrated instrument can be made to tally with the wave-length marked on the filter cell.

The invented method of making a filter for calibrating the wave-length scales of optical instruments such as spectrophotometers consists of the following steps

(a) determining and plotting graphically (as illustrated in Fig. V of the accompanying drawings) the transmission (or absorption) curves of differently coloured transparent materials (such as glass, gelatine plastic, coloured solutions or the like) *e.g.*, by means of a standard calibrated spectrophotometer ;

(b) finding out the points of intersection in the above transmission curves (*e.g.*, points marked 1 to 11 of Fig. V of the accompanying drawings) ;

(c) choosing and pairing of two differently coloured materials having one sharp and clear-cut point of intersection (*e.g.*, points of intersection marked 1, 3, 4, 6, 9 and 10 of the transmission curves shown in Fig. V of the accompanying drawings) and

(d) fixing the selected pair of differently coloured materials in a frame or holder

During the selection, matching and pairing of the differently coloured glass strips, necessary care is excercised and the particular wavelength at which both the strips give the same transmittance is determined. The desired standard wave-length can be obtained in any region of the visible spectrum depending on the suitable choice of the various colours and tints of the glass strips used. The following are examples of differently coloured materials paired in accordance with the principle enunciated in sub-paragraph (c) of the preceding paragraph

Paired colours of transparent materials.	*Wavelength of equal absorbance (in mμ)*
Deep blue—Greenish blue	473·8
Deep blue—Green	493·2
Yellowish brown—deep blue . . .	494·0
Yellowish brown—Greenish Blue . .	516·0
Deep blue—Red	671·6
Red—Greenish blue	685·3

The invention includes within its scope a filter cell for calibrating the wave-length scale of optical instruments such as the spectrophotometer which consists of a frame or holder holding a pair of differently coloured materials selected according to the method just defined.

Thus a pair of selected coloured materials, which may consist of strips of glass, gelatine, plastic or the like, are fixed in slits in two adjacent sides of a rectangular cell. Observation windows are fitted in the sides opposite to the said adjacent sides.

In an alternative construction, the holder used may consist of a spectacles shaped holder with a nose-bridge, on the left and right sides of which, two coloured transparent materials are attached.

The wavelength corresponding to the point of intersection of the transmission curves of the two differently coloured materials is marked on the cell, and thereafter serves as the pre-known standard wavelength value of the cell.

The method of operating the cell for calibrating an optical instrument such as an uncalibrated spectrophotometer.

Place the filter cell in the uncalibrated spectrophotometer and alternately bring the two differently-coloured glass strips in the path of the selected light beam, and measure the differences in the transmission or absorption in the spectrophotometer under calibration. Go on varying the wavelength and note the difference in the transmissions or absorptions of the paired materials. Carry on the process until a wavelength is reached at which there is no difference in the absorption or transmission of the paired materials. This wavelength corresponds to the wavelength marked on the filter cell. The wavelength scale of the uncalibrated instrument is thus made to tally with the marking on the cell at that particular point of equal transmission or absorption.

The method avoids all systematic errors, and makes it possible to obtain accuracy of about 0·2 mμ which is not easily possible with hitherto known techniques.

The invention will now be described with the help of the accompanying drawings wherein Fig. I shows a perspective view of an embodiment of the invented filter cell, and Figs. II and III are side views of the cell. Fig. IV shows a "spectacles" type cell, with a nose-bridge, and two arms on either side thereof for holding the coloured pieces.

Referring to the embodiment illustrated in Figs. I, II and III, A is the outer cell casing, made of pressed or cast metal; B is a piece of yellowish-brown glass and C is a piece of greenish blue glass. The distances a, b and c are respectively 1 cm, 1·2 cm. and 4 cm. The glass strips B and C give one single, sharp and well-defined point of intersection in their transmittance (or absorbence) curves. The other two sides F & G of the outer cell are provided with observation windows H & J.

The cell is put in the light path of an uncalibrated spectrophotometer and the transmittance (or absorbence) when the light passes through one of the coloured strips is determined. The cell is then rotated through 90° so as to make the light pass through the other strip. By repeating the process thus, at a particular wavelength both the coloured sides of the cell give the same transmittance and this wavelength of the uncalibrated spectrophotometer can then be set to the pre-known standard wavelength value of the particular cell.

The above idea can be further extended and mechanised in various ways. For example, we may make an arrangement for rotating a circular disc, the two halves of which may consist of paired coloured transparent materials. The light beam would fall alternately on the two halves and the difference in their transmittance would give rise to an alternating current in a photo cell. Now, if the prism is rotated or the wavelength of the light passing through the disc varied, the alternating current generated by the photo cell would also vary till at a particular wavelength at which both the halves of the disc give the same transmittance, the photo cell would show a steady current. Other synchronous and servo arrangements can also be made to quickly vary the wavelengths and to automatically stop at the particular wavelength where only a steady response from the photo cell is received. Thus numerous slight variations and applications of the idea can be made.

In the simple cell herein illustrated the preferred combination of colours is a particular yellowish-brown and greenish-blue strips, giving an isobestic point at 516 mμ, which is roughly in the middle of the visible region. For the red region, a combination of greenish-blue and red is preferred which gives an isobestic point at about 680 mμ. Similarly, for the blue region, deep blue and green can be used, giving equal transmittance at 493 mμ. Similarly other pairs can be combined. The inventive step lies in so combining, matching and pairing two ordinary but differently coloured glass strips on the principle discovered, so that they can be used for purposes for which they were singly and originally quite unsuitable.

Example 1

Five pieces cut out of various coloured ordinary glass sheets were taken and their transmittance curves were determined as shown in the Fig. V of the accompanying drawings.

Various points of intersections between different pairs of glass strips are tabulated in the following Table I:

TABLE I

Paired colours of transparent materials.	*Wavelength of equal absorbence in mμ.*	*Number referred to in the graph.*
Deep blue—Greenish blue	473·3	1
Green—Yellowish brown	489·0	2
Deep blue—Green	493·2	3
Yellowish brown—deep blue	494·0	4
Green—Greenish blue	509·0	5
Yellowish brown—Greenish blue	516·0	6
Green—Yellowish brown	535·5	7
Red—Green	597·0	8
Deep blue—Red	671·0	9
Red—Greenish blue	686·3	10
Red—Green	693·8	11

Example 2

The use of a filter comprising coloured solutions is illustrated in the following example:

Two different coloured solutions (having different pH) made out of equal amounts of the same stock solution of methyl orange, were kept in two cells, and the difference in their absorbence at different wavelengths was observed in a spectrophotometer whose wavelength scale was to be calibrated. The wavelength where the absorbence was found to be the same for both the solutions, was set at 469 mμ which is the pre-determined isobestic point for methyl orange. Similarly, other indicators could be used.

Example 3

An alternative construction of the cell is the "spectacles"-type of cell shown in Fig. IV of the accompanying drawings. This consists of a pressed or cast metal holder D with a nose bridge E, on the left and right side of which the two selected and matched pairs of coloured transparent materials B & C are attached and held by the said holder D, as shown in the drawing. This type of cell has been designed to fit the sliding cell-carrier of some of the commercially available spectrophotometers and the actual dimensions of this cell can be altered to suit the various cell carriers. When the cell is placed in the carrier, the light beam would pass through one of the coloured strips and give a particular deflection. The cell carrier can then be simply slided to bring the other coloured strip in the light path. This process can then be repeated with varying wavelengths till a steady transmission or absorbence response is received, and at that point the instrument scale can be set to the predetermined standard wavelength for the pair of strips used.

No special or controlled manufacture of glass or gelatine is required in respect of the coloured pieces employed in the invented method. Any two common, coloured pieces of glass can be used for pairing in accordance with principle described hereinabove. Coloured solutions, plastics or other transparent materials may be used in place of glass.

The invention includes within its scope obvious modifications or extensions substantially involving the operating principles described hereinabove.

We claim:

1. A method of making a filter for calibrating the wavelength scales of optical instruments such as spectrophotometers which consists of the following steps:

(a) determining and plotting graphically (as illustrated in Fig. V of the accompanying drawings) the transmission (or absorption) curves of differently coloured transparent materials (such as glass, gelatine, plastic, coloured solutions or the like) e.g., by means of a standard calibrated spectrophotometer ;

(b) finding out the points of intersection in the above transmission curves (e.g., points marked 1 to 11 of Fig. V of the accompanying drawings) ;

(c) choosing and pairing of two differently coloured materials having one sharp and clear-cut point of intersection (e.g., points of intersection marked 1, 3, 4, 6, 9 and 10 of the transmission curves shown in Fig. V of the accompanying drawings) ; and

(d) fixing the selected pair of differently coloured materials in a frame or holder.

2. A method as claimed in Claim 1 wherein the paired colours of transparent materials are as follows :

Paired colours of transparent materials.	*Wavelength of equal absorbence (in m μ)*
Deep blue—Greenish blue	473·3
Deep blue—Green	493·2
Yellowish brown—deep blue	494·0
Yellowish brown—Greenish Blue	516·0
Deep blue—red	671·0
Red—Greenish blue	685·3

3. A filter cell for calibrating the wavelength scale of optical instruments such as the spectrophotometer which consists of a frame or holder holding a pair of differently coloured materials selected according to the method described in Claim 1 or 2.

4. A filter cell as claimed in Claim 3 wherein the coloured materials consist of strips of glass, gelatine, plastic or the like.

5. A filter cell as claimed in Claim 3 or 4 wherein the paired coloured materials are fixed in slits in two adjacent sides of a rectangular cell and observation windows are fitted in the sides opposite to the said adjacent sides.

6. A filter as claimed in Claim 3 wherein is used a spectacles shaped holder with a nose-bridge, on the left and right side of which, two coloured transparent materials are attached.

7. A filter cell as claimed in any of the preceding Claims 3 to 6 on which the wavelength corresponding to the point of intersection of the transmission curves of the two differently coloured materials is marked.

8. A filter cell for calibrating the wavelength scale of optical instruments such as spectrophotometers substantially as hereinbefore described.

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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH.

Dated this 25th day of May 1959.

MGIP Santh.—S1—27 Patent/60—27-2-61—100.

PROVISIONAL SPECIFICATION

NO. 65611

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

SHEET NO. 1

Fig. 1

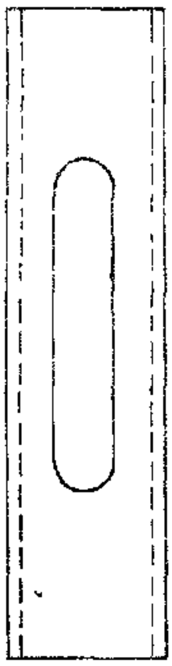

Fig. 2

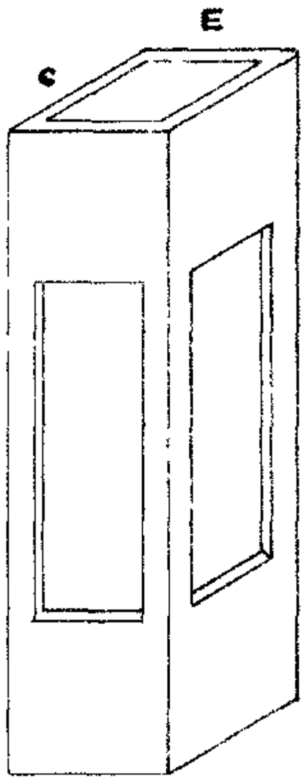

Fig. 3

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NO. 65611

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NO OF SHEETS-2

SHEET NO---1

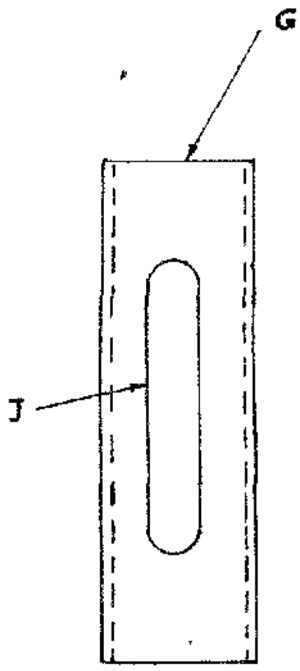

Fig II

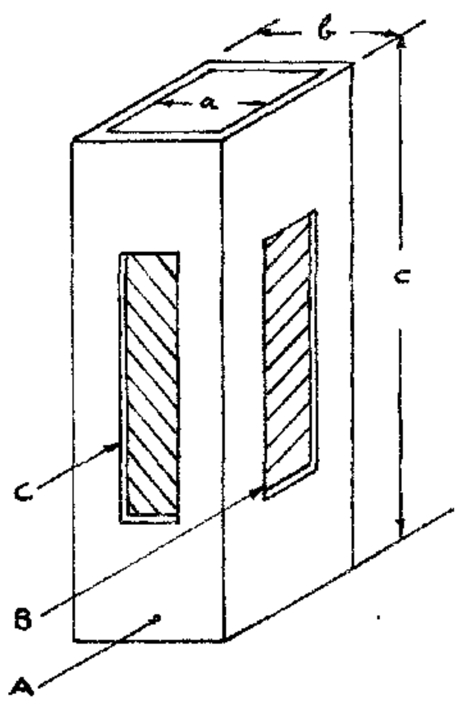

Fig I

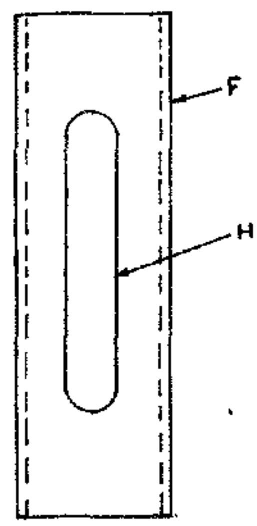

Fig III

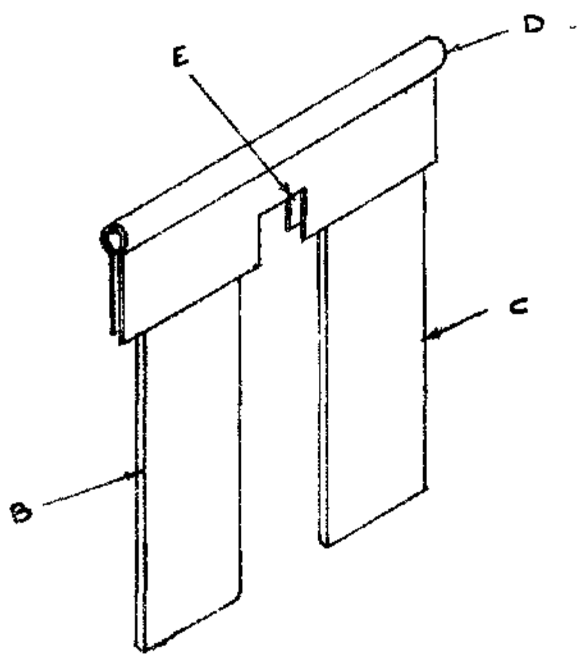

Fig IV

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