

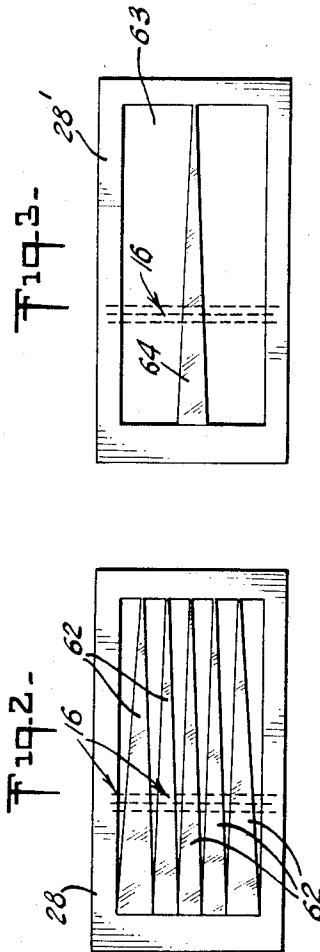
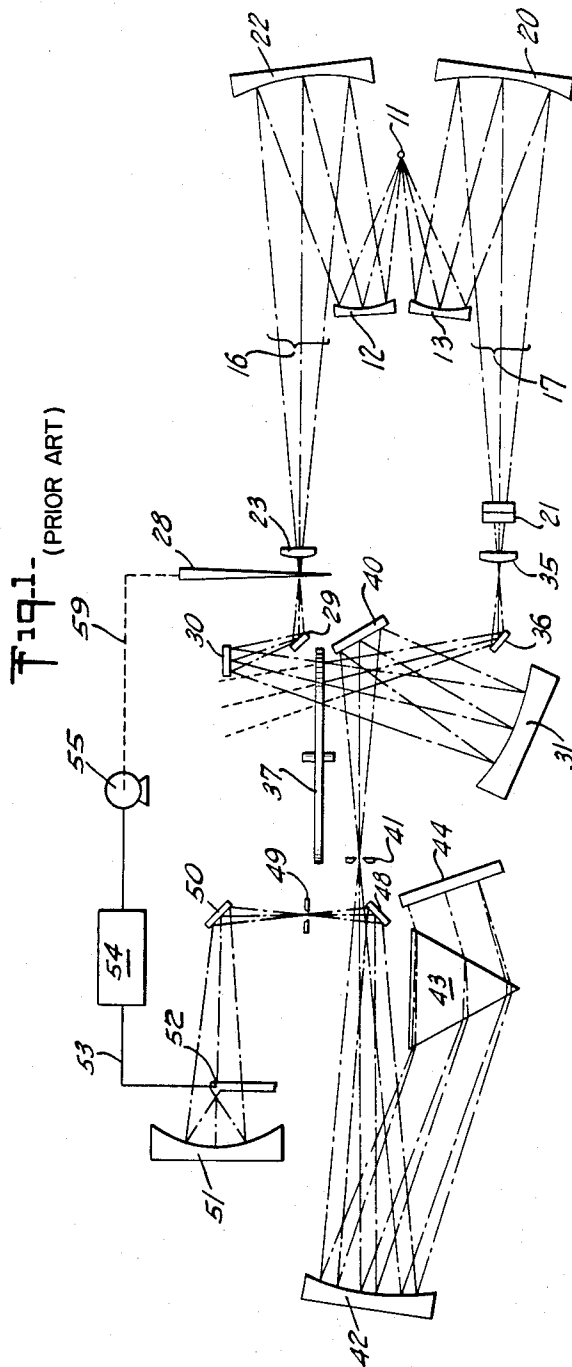
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W. A. PLISKIN

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WEDGE STRUCTURE FOR A DOUBLE BEAM SPECTROPHOTOMETER

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WEDGE STRUCTURE FOR A DOUBLE BEAM SPECTROPHOTOMETER

William A. Pliskin, Poughkeepsie, N.Y., assignor to Texaco Inc., a corporation of Delaware
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This invention is concerned with double beam spectrophotometers in general. More specifically it is concerned with an improvement in the wedge employed in such a spectrophotometer.

In a double beam spectrophotometer, a so-called wedge is employed in order to vary the percentage of energy in one of the beams, over a range that is to be expected, so as to be able to match the energy that is transmitted by the other beam. In certain investigations employing such a double beam spectrophotometer, it is desirable to investigate materials, or employ techniques such that the percentage absorption is quite small. In such cases the range of percentage absorption of energy by a sample is relatively small; and consequently the same small range should be covered by the wedge, that is expected in the sample beam of the double beam spectrophotometer. By thus employing a wedge having a range of percentage of energy passed, that is only a small portion of the complete one hundred percent energy range; amplification of the indication provided by the spectrophotometer, is created. However, the wedge structure heretofore suggested was merely a tapered window which changed the total energy of the beam that was transmitted, by reducing the length of the beam only at the extremities thereof. This produced an extremely non-linear change in the percentage of energy passed through the wedge window. Consequently the indications of the spectrophotometer were non-linear and therefore objectionable.

Therefore, it is an object of this invention to provide an improved wedge for a double beam spectrophotometer which produces a linear change over a small percentage absorption range.

Another object of the invention is to provide an improved structure for a wedge to be employed in a double beam spectrophotometer, having partially transparent material located in a window that is part of said wedge.

Another object of the invention is to provide a wedge for a spectrophotometer of the double beam type, wherein such wedge employs a window that has therein a thin film of plastic material for creating an absorption percentage of energy as desired, said thin film of material having no absorption bands in the spectrum range under investigation.

Another object of the invention is to provide an improved wedge structure for a double beam spectrophotometer, wherein the window of such wedge has a material which comprises a very thin metallic film evaporated onto a transparent plate in order to vary the range of absorption as desired.

Still another object of this invention is to provide an improved wedge structure for a double beam spectrophotometer, wherein the range of percentage absorption investigated is relatively small; and wherein such wedge structure includes a window having partially transparent material that is made up of a crystalline metal halide.

Briefly the invention is concerned with an improvement in a double beam spectrophotometer having an optical wedge for balancing the percentage of energy transmitted by a sample beam. The improvement comprises a linear wedge window type structure for varying the percentage transmission from one hundred percent to something greater than seventy-five percent. The said structure comprises partially transparent material located in said window. The percent transmission of said material

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is equal to the lower percent transmission of said window type structure. The said material is shaped to completely fill said window at one end and to leave said window unobstructed at the other end thereof.

The invention is described below in greater detail and is illustrated in the drawings, in which:

FIG. 1 is a schematic diagram, largely concerned with the optical system, but including some of the mechanical elements;

FIG. 2 is an elevation of a window that goes to make up the wedge of the spectrophotometer, showing the structure in accordance with one embodiment of the invention; and

FIG. 3 is an elevation of a window structure similar to that shown in FIG. 2, but illustrating another embodiment of the invention.

In spectrophotometry in general, measurements are made of a sample that is affected by a beam of electromagnetic energy in the range of frequencies at or near light energy. Certain particular investigations are carried out in the range of so-called infrared frequencies. More particularly, in certain studies involving infrared energy absorption investigations, it has been found desirable to employ an arrangement such that the indications may be magnified for small changes in absorption over a given range of frequencies being investigated. In thus magnifying the indications, a wedge structure has been employed such that the percentage absorption range employed is much less than a full one hundred percent.

This invention provides for an improved wedge to be employed in such a magnified indication arrangement. The wedge according to this invention is superior for the reason, among others, that it has an ability to provide for a linear change of the percentage of energy in the beam affected by the wedge.

Referring to FIG. 1, it is pointed out that there is shown schematically the principal elements of the system that is included in one type of a double beam spectrophotometer. Such a photometer has a source of energy 11 that may take any feasible form, e.g. a Nernst glower for generating infrared energy. A pair of beams of infrared energy are emitted from source 11 to impinge upon a pair of concave reflectors 12 and 13. These beams are indicated by three dashed lines in each case and are designated as a beam 16 and a beam 17, respectively. The beam 17 is directed from reflector 13 to another concave reflector 20, and from there is focused as it is directed to pass through a sample 21. The other beam 16 is directed from the reflector 12 to another reflector 22 (that corresponds to reflector 20) and from there beam 16 is directed to a lens 23. The structure is such that the two beams 16 and 17 are substantially equal in size and consequently have relatively equal energy in each.

On the other side of the lens 23, close to a focal point of the beam 16, there is an optical wedge 28. The wedge 28 acts to attenuate the amount of energy in beam 16 that is allowed to pass through the wedge, in order to equalize this energy with the energy of beam 17 that passes through the sample 21.

In FIG. 1 the wedge 28 is shown schematically as a wedge shaped element. The actual structure of the wedge is in the form of a window, as illustrated in the elevation view that is shown in FIG. 2 or 3. The details of this window structure will be described in more detail below.

After the beam 16 passes wedge 28 it is reflected from a reflector 29 upward (as viewed in FIG. 1) to another reflector 30.

From reflector 30 the beam 16 is reflected downward to a concave reflector 31, that acts as a common reflector for both of the beams 16 and 17, alternately.

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Beam 17, is directed through a lens 35, after it has passed the sample 21. Then the beam impinges upon a reflector 36. From reflector 36 the beam is directed upward, either to be lost in space or to be reflected from the lower surface of a rotating sector mirror 37. Thus, during half of each revolution of the sector mirror 37, beam 17 strikes the reflecting surface of the mirror 37 and is directed downward onto the concave reflector 31. At the same time the beam 16 which was being directed onto the same concave reflector 31, is intercepted by the sector mirror 37. During the other half of a revolution of mirror 37, it does not intercept the beam 16 and consequently the beam 16 is directed from the mirror 30 onto reflector 31, while the beam 17 is directed from the mirror 36 off into space.

The path of beams 16 and 17 thus becomes a common one as they are directed onto the surface of the concave reflector 31, in alternation. This common path may be followed from the concave reflector 31 upward to a reflector 40. From the reflector 40, the beams are directed through a slit 41 to a concave reflector 42. Then from reflector 42 the beams are directed to pass through a prism 43. Prism 43 bends the beams as they pass therethrough and directs them against a plain surfaced reflector 44. This bending is caused by refraction, which also causes a dispersion of the different wave lengths of the energy in the beams. The beams are then returned from the reflector 44 and further dispersed as they again pass back through the prism 43. The dispersed and rebent beams are directed against the concave reflector 42 once more, and this time (by reason of the difference in their angular paths) are directed onto a plane reflector 48 which directs them upward (as viewed in FIG. 1) to a slit 49 in order to selectively pass only a given desired wave length. It is pointed out that the slit 49 is arranged for transverse movement relative to the axes of the dispersed beams, substantially at a focal point so that the desired wave length (or frequency) of the alternate beams 16 and 17, may be selected.

The selected wave length of energy continues onto the surface of another plane reflector 50. From there, this energy is then directed so as to be reflected from a concave focusing reflector 51 onto a thermocouple element 52, that is situated at the focal point of the reflector 51.

In order to provide an indication of the percentage absorption of energy that exists for the selected wave length, the output of thermocouple element 52 is carried over an electrical circuit (indicated by line 53) and employed to control energization of a motor 55 which is in turn under control of a control circuit 54. The motor control circuit 54 controls energization of the electric motor 55 for reversible operation, and motor 55 is connected mechanically to the wedge 28 as indicated by a dashed line 59. Thus the position of the wedge 28 is made to correspond to the percentage of energy of the beam 17 that is absorbed by the sample 21, at any given wave length, as determined by the setting of the slit 49. The indication is therefore directly related to the mechanical output of the motor so that any feasible drive for a recording pen (not shown) or the like, may be used.

It may be noted that the arrangement is such that the motor 55 continuously adjusts the wedge 28 to a corresponding position for the percentage of energy being absorbed, but it remains at rest so long as the corresponding position is obtained. This is because the output of the thermocouple 52 is either an A.C. signal of one phase or the opposite phase, whenever the energy level is different between the alternate beams 16 and 17. But, so long as the energy levels are the same, the A.C. signal becomes zero and the motor 55 stops. The phase of the A.C. signal reverses whenever the difference in energy level shifts from a difference with the beam 16 as the larger, to the opposite condition when the difference is with the beam 17 larger.

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Referring to FIG. 2 it will be observed that the wedge 28 is in the form of a window, that is constructed of a sheet material that is opaque. However, within the opaque rectangular border of the wedge 28, there is a plurality of wedge shaped, or tapered sheet material inserts 62. These inserts 62 are evenly tapered from one edge of the window to the other, so that at the right hand edge of this window (when viewed as shown in FIG. 2) the beam 16 is substantially one hundred percent allowed to pass through the window unobstructed. At the left hand edge of the window, however, the beam 16 must substantially all pass through the partially transparent material of which inserts 62 are made. By means of this structure, the percentage energy of the beam 16 that passes through wedge 28 is varied, depending upon the position of the beam 16 relative to the window within the frame of wedge 28. This variation is between one hundred percent, and whatever percentage of the energy is allowed to pass by the partially transparent material that the inserts 62 are made of.

The inserts 62 may be made of various materials, depending upon what percentage absorption of the energy in the beam is desired at the left hand side of the window, i.e. when all of the energy of the beam 16 is passing through the material of the inserts 62. A plastic material may be employed, but in such case it is important to note that the plastic employed must be one such that the characteristics of the material does not have any absorption bands that lie within the range of frequencies that are to be investigated in the sample under consideration.

It is pointed out that the material of the inserts 62 may also be made up of a very thin metallic film on a transparent plate, the film taking the wedge shapes of the inserts 62. The transmission properties of such metallic film are much more nearly constant throughout the infrared region than is the case with plastic films. The film may be formed in any feasible manner, e.g. by evaporating onto a transparent plate.

It will also be appreciated that the inserts 62 could be formed by providing a coating or an evaporated film, of some other type than metallic. The coating being applied to a transparent plate, as before.

Furthermore, it is pointed out that the inserts 62 could be made out of other materials which are partially transparent in themselves, such as crystalline metal halide materials, e.g. cadmium fluoride, barium fluoride, silver chloride, etc.

Referring to FIG. 3 it is pointed out that there is shown an alternative wedge 28'. In this case again the border, or frame-work of the wedge is an opaque sheet substance which forms a rectangular window 63. However, there is only a single insert 64, therein. Insert 64 is tapered, or wedge shaped, like each of the inserts 62 of FIG. 2; and it extends from a point where it has substantially no width at the right hand side (as viewed in FIG. 3) of the window 63, to the left hand side where it connects to the border of the window. It will be appreciated that by employing a window structure in accordance with the FIG. 3 illustration, a greater magnification of the output of the spectrophotometer will be had because the percentage of energy that is passed by the window only varies a small amount, since the only obstruction to the one hundred percent passage of energy is the single insert 64. As was the case with the insert material for inserts 62, the material of insert 64 may be various substances in accordance with the desires for a particular range of percentage energy absorption that is to be investigated with the spectrophotometer. Hence, reference is made to the different materials set forth above in connection with inserts 62, because these same materials may be employed in the material used to construct the insert 64 of FIG. 3.

While certain embodiments of the invention have been described in considerable detail in accordance with the applicable statutes, this is not to be taken as in any way

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limiting the invention but merely as being descriptive thereof.

What is claimed as the invention is:

1. In a double beam spectrophotometer having a window in the path of one beam for matching the passage of a predetermined percentage of the energy in said beam with the energy passed by a sample beam, said matching percentage depending upon the relative position of said window and said beam, the improvement comprising said window having partially transparent material therein, said partially transparent material completely filling said window at one end thereof and said material having characteristics such that at least 75% of the energy in said beam is allowed to pass by said material, the configuration of said material being such that the percentage of energy passed by said window varies linearly from one hundred percent at one end to some percentage less than one hundred percent at the other end.

2. The invention according to claim 1 wherein said partially transparent material comprises a thin film of plastic material having no absorption bands in the spectrum range under investigation.

3. The invention according to claim 1 wherein said partially transparent material comprises a very thin metallic film evaporated onto a transparent plate.

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4. The invention according to claim 1 wherein said partially transparent material comprises a coating of non-metallic film on a transparent plate.

5. The invention according to claim 1 wherein said partially transparent material comprises a crystalline metal halide material.

6. The invention according to claim 1 wherein said configuration takes the form of a plurality of evenly tapered wedges.

7. The invention according to claim 1 wherein said configuration takes the form of a single centrally located wedge having evenly tapered edges.

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