United States Patent

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[54] **PROCESS FOR THE QUANTITATIVE DETERMINATION OF LIGHT-ABSORBING OR LIGHT-REFLECTING SUBSTANCES DISTRIBUTED ON A CARRIER**
9 Claims, 1 Drawing Fig.

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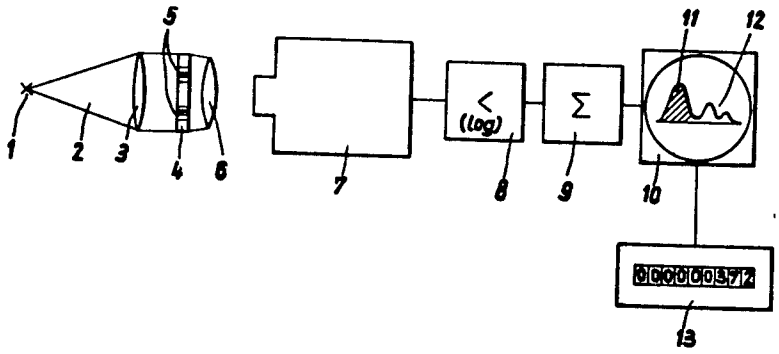
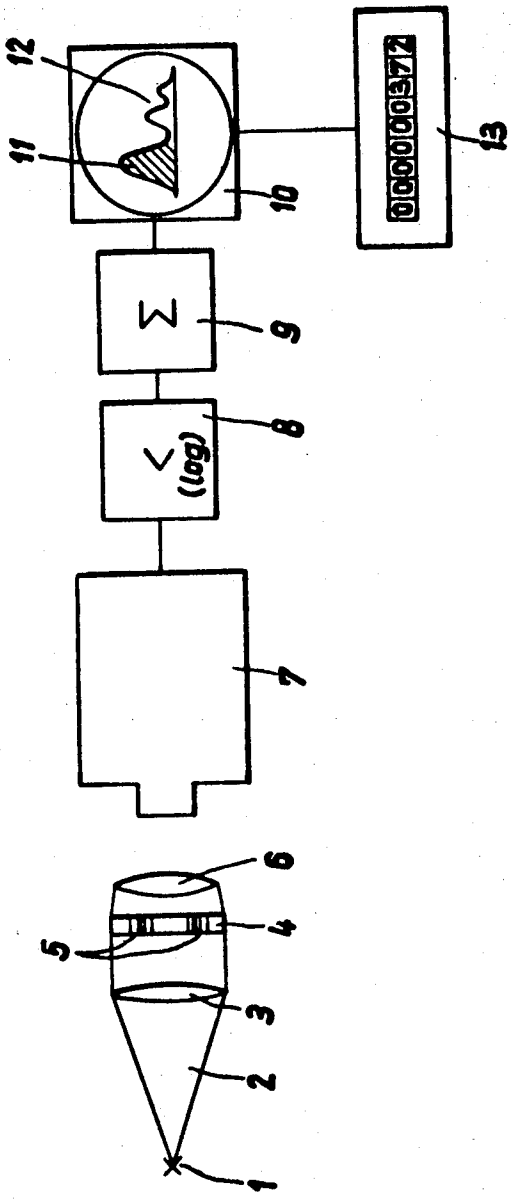
ABSTRACT: This invention relates to a process for the quantitative determination of light-absorbing or light-reflecting substances distributed on a carrier which comprises the steps of scanning line by line the distribution pattern of a substance selected from the group consisting of light-absorbing substances and light-reflecting substances distributed in a predetermined manner on a carrier, transforming the individual scanning points into current impulses corresponding with the optical densities of said substances, and integrating said current impulses belonging to a specific scanning line, whereby the optical densities of said substances are quantitatively determined.





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PROCESS FOR THE QUANTITATIVE DETERMINATION OF LIGHT-ABSORBING OR LIGHT-REFLECTING SUBSTANCES DISTRIBUTED ON A CARRIER

PRIOR APPLICATIONS

This application is a "streamlined" continuation of my copending application Ser. No. 681,271, filed Nov. 7, 1967, now abandoned.

THE PRIOR ART

The quantitative determination of light-absorbing or light-reflecting substances distributed on a carrier is of great interest with respect to numerous technical fields. For example, in the chromatographic or electrophoretic separation of mixed substances, the individual components are determined after their separation in that the stains associated with the individual components, as distributed on a carrier, are optically evaluated. These components can be distributed within the stain with equal or different density. Generally, to the present time, the evaluation of these stains was effected in that the stains were guided past an aperture, whereby a light beam, passing through carrier and aperture, falls, after a corresponding attenuation in passing through the stain, onto a photocell.

Such evaluations are of interest in other fields also, as, for example, in X-ray diffraction diagrams or electron microscopic pictures.

However, in the processes formerly known, the result of the evaluation depended on the form and density distribution of the stains to be measured, and greater errors occurred especially when the density varied across the length of the aperture.

OBJECTS OF THE INVENTION

An object of the present invention is the development of an improved process for the quantitative determination of light-absorbing or light-reflecting substances distributed on a carrier.

Another object of the present invention is the development of a process for the quantitative determination of light-absorbing or light-reflecting substances distributed on a carrier which comprises the steps of scanning line by line the distribution pattern of a substance selected from the group consisting of light-absorbing substances and light-reflecting substances distributed in a predetermined manner on a carrier, transforming the individual scanning points into current impulses corresponding with the optical densities of said substances, and integrating said current impulses belonging to a specific scanning line, whereby the optical densities of said substances are quantitatively determined.

These and other objects of the present invention will become more apparent as the description thereof proceeds.

DESCRIPTION OF THE INVENTION

In the drawing, the figure represents one schematic embodiment of the process of the invention.

According to the invention, these errors of the prior art are avoided in that the quantitative determination of light-absorbing or light-reflecting substances, distributed on a carrier, for example, of components of an electrophoretically separated mixture distributed on a carrier, is accomplished in that the pattern of distribution is scanned, line by line, and the individual scanning points are transformed into current impulses, corresponding with the optical density of the substances, and the current impulses belonging to a scanning line are integrated.

In this case, the term "carrier" shall indicate any medium chosen at random, for example, filter paper rendered either opaque or transparent, or a flat or round cuvette.

This process of the invention has the advantage that, even with an irregular shape of stain, an accurate measurement is obtained, and this measurement can be carried out in a considerably shorter time than it is possible when the evaluation is effected by means of an aperture.

When the distribution pattern on the carrier is of a size which is less suitable for a direct scanning, the process of the invention offers no difficulties, in that it is possible to enlarge or to reduce the distribution pattern to a useful size by means of an optical image. In particular, due to the possibility of enlarging the distribution pattern, the employment of carriers of the smallest size becomes possible, the evaluation of which was previously unheard of.

The scanning lines, which as a rule for a square carrier are allowed to run in parallel relation to one of the edges, can, of course, be arranged at any desirable angle with regard to the edges. This proves to be advantageous in the case where two stains are on the carrier which would be scanned in the same line. In this event, the carrier can be brought into a position which will prevent the scanning lines, running through one stain, from running simultaneously through another stain of the pattern, so that with integration no simultaneous evaluation for several stains would be obtained.

As a rule, an increase of the current impulses received, for example, by a photocell, will be necessary, and to facilitate the evaluation of the results of the measuring, this increase can be effected logarithmically in order to obtain directly the extinction as a result.

Advantageously, for the scanning of the pattern or of its enlarged or reduced image, an Iconoscope, and Orthicon or a Vidicon is used, either one being easily available nowadays on the open market. However, the scanning can also be accomplished with a fluorescent-screen scanning means, by which a light spot moving on the fluorescent screen is reflected on the carrier and the passing or reflected light is absorbed by means of a photocell.

The process can be rendered especially simple by the utilization of a mechanical scanning means where, for example, a nearly pointlike light source is reflected by means of revolving or tumbling mirrors on the carrier in such a manner that the entire surface of the carrier is successively scanned by the light spot.

The curves obtained from the integration are the curves of extinction distribution, which are composed of bell-shaped individual curves. These curves can be reflected on the picture screen of a cathode-ray oscillograph for direct observation. Here it will prove advantageous to electrically shield the remaining parts of the extinction distribution curves not belonging to a bell-shaped curve element, in such a manner, that the surface area values of the individual curves can be derived directly from electronic data. If so desired, these surface area values can also be indicated directly by an electronic recorder in relative percentages, which can be effected by suitable calibration of this indicator.

An exemplified form of the invention is described in the following, with reference to the figure of the drawing. In the single figure of the drawing, a device for the accomplishment of the process is depicted.

This figure shows a light source **1**, from which the light beam **2** emanates. This light beam **2** is aligned in parallel manner on passage through a condensing lens **3** and from there passes through the carrier **4**, on which two stains **5** are schematically indicated. The position of the carrier **4** may be vertical, horizontal or inclined in any direction at random, and instead of the light beam falling therethrough, in particular, if the carrier is not transparent, a light beam, striking the carrier and being reflected, can be employed. In the present example, the light beam **2**, travelling through the carrier **4** is guided through a schematically indicated optical device **6** to a scanning device **7**. This optical device **6** is capable of enlarging the light beam and its image. In other words, it can, be, for example, a microscope lens or it can also be capable of reducing the light beam, if the carrier **4** is relatively large. For practical requirements, a vario-optical device has proved useful, by means of which various enlargements can easily be achieved.

As an example of an image scanning device 7, a commercial Iconoscope is employed. The output of this Iconoscope is lead through an amplifier 8, for example, an amplifier with logarithmic characteristic. The integration element or device 9 can be fitted within the amplifier 8 or the integration device 9 is attached to the amplifier 8 as a separate structural member. From the integration device 9 the amplified and integrated impulses are guided to a recorder 10, for example, a cathode-ray oscillograph, to which, if so desired, a recording mechanism 13 may be attached, which indicates the surface area content 11 of the curve 12.

The preceding specific embodiment is illustrative of the practice of the invention. It is to be understood, however, that other expedients, either indicated above or known to those skilled in the art, can be employed without departing from the spirit of the invention or the scope of the appended claims.

1. A process for the quantitative determination of light-absorbing or light-reflecting substances distributed on a carrier which comprises the steps of scanning line by line the distribution pattern of a substance selected from the group consisting of light-absorbing substances and light-reflecting substances distributed in a predetermined manner on a carrier, transforming the individual scanning points into current impulses corresponding with the optical densities of said substances at said individual scanning points, amplifying said current impulses in a logarithmic manner, integrating said logarithmically amplified current impulses belonging to each specific scanning line, the integrated, amplified current impulses being proportional to the optical densities of said substances, and determining said proportions of said integrated, amplified current impulses.

2. The process of claim 1 wherein said distribution pattern is optically enlarged prior to said scanning step.

3. The process of claim 1 wherein said distribution pattern is optically reduced prior to said scanning step.

4. The process of claim 1 wherein said carrier is adjusted whereby in said scanning line by line of said distribution pattern of a substance distributed in a predetermined pattern on a carrier scans only one substance distributed on said carrier in any one scanning line.

5. The process of claim 1 wherein said scanning line by line is effected by a cathode-ray tube device.

6. The process of claim 1 wherein said scanning line by line is effected by a fluorescent-screen scanning device and transforming of the individual scanning points into current impulses is effected by a photocell.

7. The process of claim 1 wherein said scanning line by line is effected by a mechanical scanning means providing a moving narrow beam of light and said transforming of the individual scanning points into current impulses is effected by a photocell.

8. The process of claim 1 wherein said integrated amplified current impulses are converted by means of a cathode-ray oscillograph into individual bell-shaped curves of extinction distribution of said optical densities of said substances, whereby the surface area under said individual bell-shaped curves is proportional to said optical densities of said substances and can be quantitatively determined visually.

9. The process of claim 1 wherein said surface area under said individual bell-shaped curves is determined by means of an electronic indicator whereby said surface area values under said individual bell-shaped curves is quantitatively determined in relative percentages.