

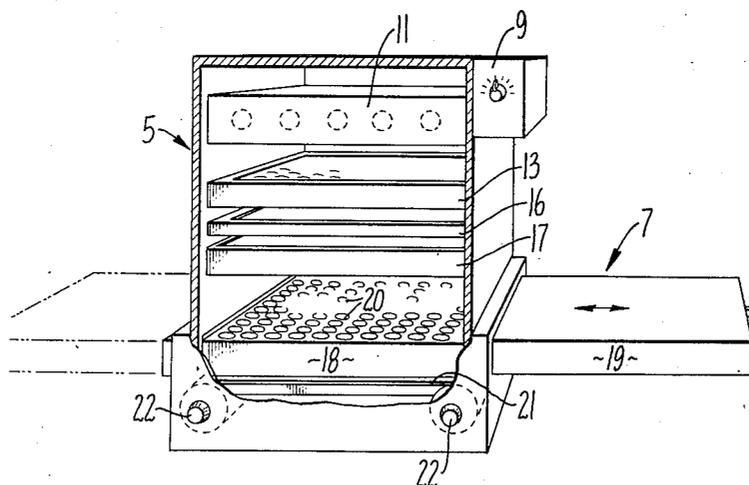
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[21] Appl. No.	<b>887,122</b>	2,866,900 12/1958	Busignies et al. ....	250/43.5
[22] Filed	<b>Dec. 22, 1969</b>	2,942,515 6/1960	Bernardini.....	356/180
[45] Patented	<b>Dec. 14, 1971</b>	3,503,683 3/1970	Isreeli et al. ....	356/181 X
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- [54] **DENSITOMETER**  
**1 Claim, 5 Drawing Figs.**
- [52] **U.S. Cl.**..... **356/180,**  
 250/218, 250/226, 356/201, 356/208, 356/244,  
 356/246
- [51] **Int. Cl.**..... **G01j 3/46,**  
 G01j 3/50
- [50] **Field of Search**..... 250/43.5,  
 218, 226; 356/51, 175, 180, 181, 183-186, 201,  
 208, 244, 246, 206, 195

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**ABSTRACT:** A colorimeter or densitometer wherein a number of samples can be read simultaneously. Preferably the instrument incorporates a filter so that the optical density of all samples can be compared on a gray scale. The reading is taken on a photosensitive surface which can be an ordinary photographic paper or a photoelectric cell.



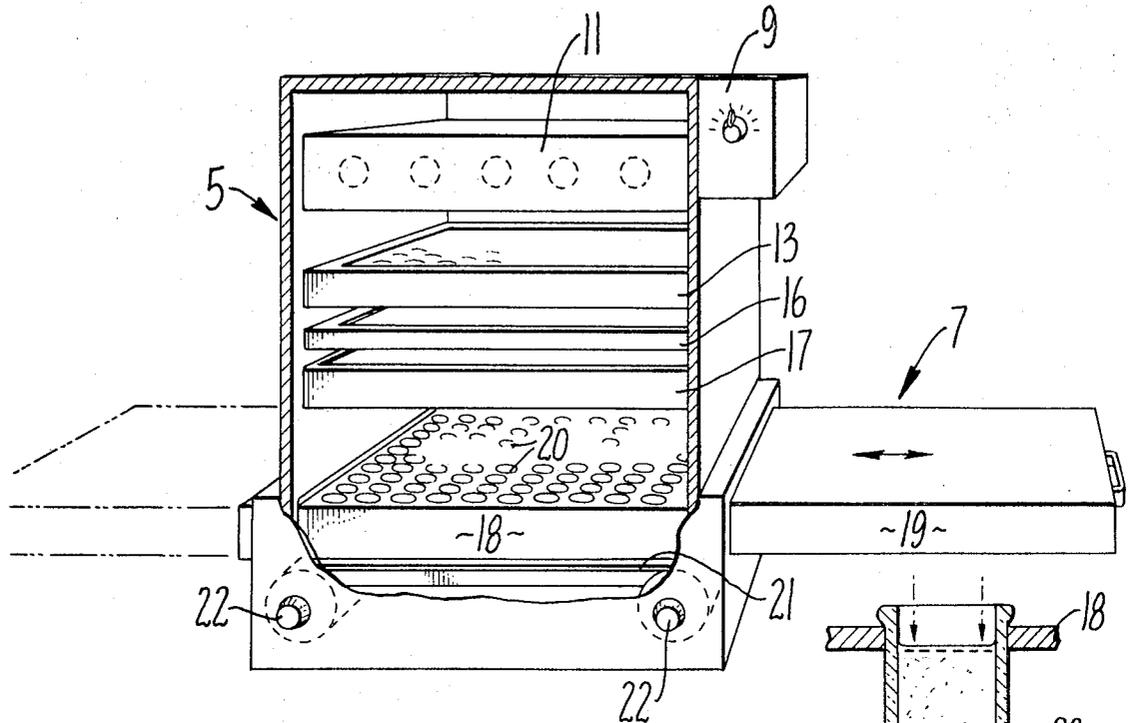


FIG. 1.

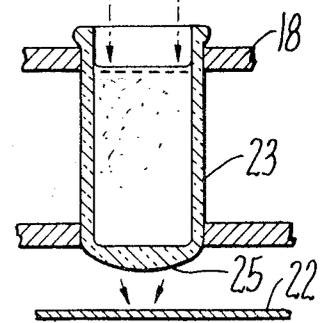


FIG. 2.

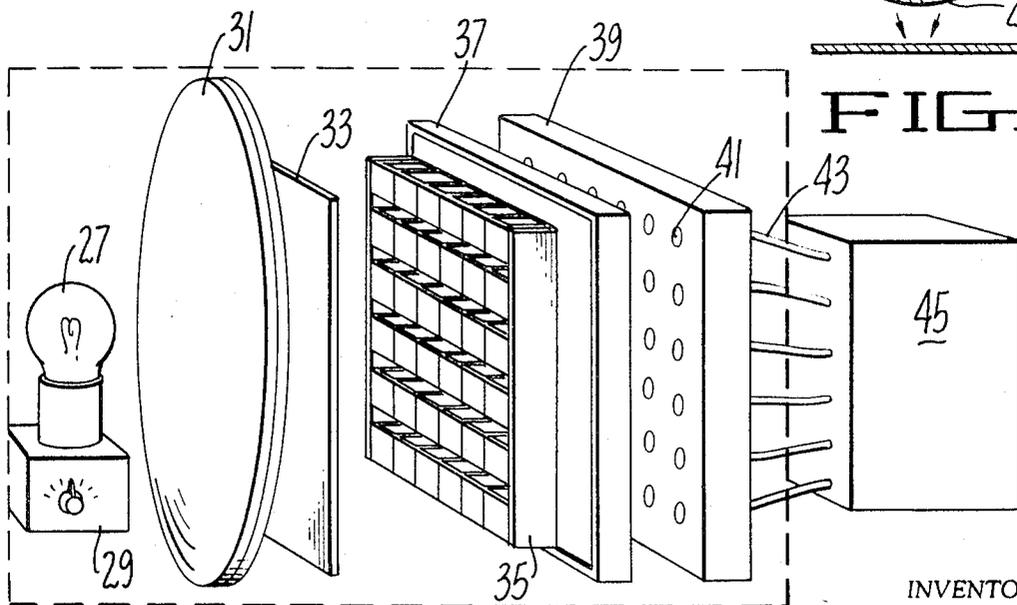


FIG. 3.

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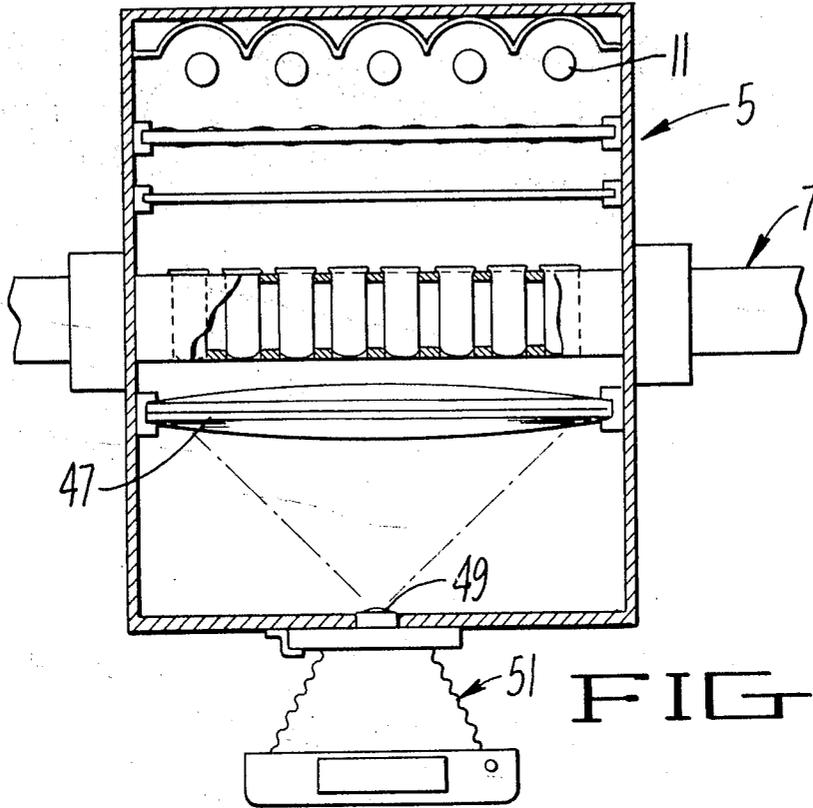


FIG. 4.

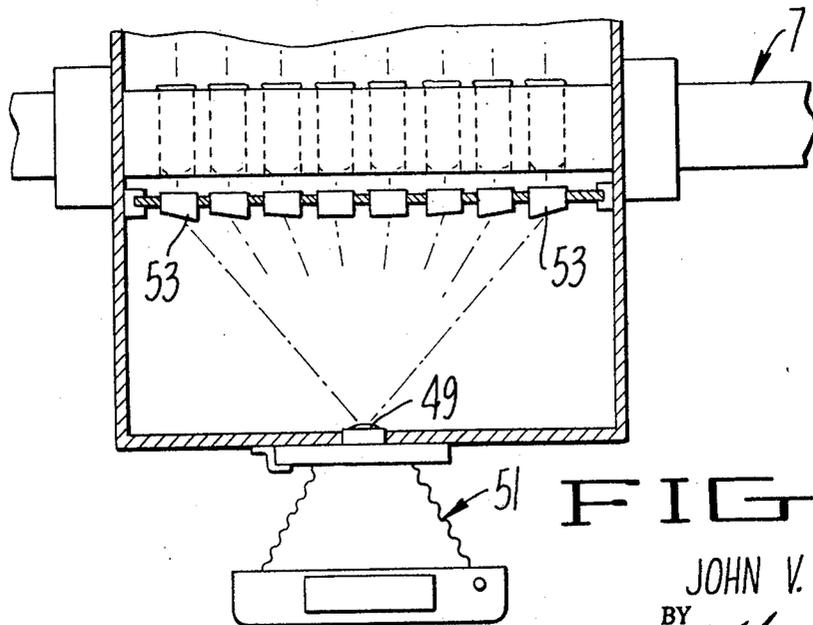


FIG. 5.

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## DENSITOMETER

## SUMMARY OF THE INVENTION

In making many tests wherein color or turbidity of a sample is involved, there frequently is a progressive color change with time. In other words, color indicators or modifiers are often added to sample solutions and there will be a progressive change over a period of time in the color or turbidity. In the past, in preparing dilutions or in adding color indicators, the materials were combined and one waited a certain length of time before a reading was taken on a densitometer or colorimeter. Since individual dilutions were being made, this involved no real problem since the dilutions were made one at a time and the subsequent readings were also taken one at a time so that the interval was substantially the same for each.

However, multiple dilution pipettes have now been developed wherein a large number of samples are simultaneously diluted and/or processed to develop a color in performing tests. In making such tests, there is frequently a progressive change in the color so that for a meaningful comparison to be made between various samples, it is necessary that a colorimetric or densitometric reading be made on all of the samples simultaneously. Obviously if the samples were read one at a time when the dilutions have all been made simultaneously, there would be no uniformity and it would be impossible to make a meaningful comparison of one sample with another or any samples with a standard.

The device of the present invention obviates these difficulties by providing a densitometer or a colorimeter whereby a large number of samples can be read at the same time. Thus, the results are directly comparable.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings forming part of this application:

FIG. 1 is a perspective view of an embodiment of the present invention wherein the light passes vertically through the samples and wherein a photographic paper is used as the recording means.

FIG. 2 is an enlarged view of a single sample cell wherein the cell itself incorporates a lens.

FIG. 3 is another embodiment of the invention wherein the light passes horizontally through the samples.

FIG. 4 is a side view in section of a device similar to that shown in FIG. 1 except that an ordinary camera is employed for recording and a condensing lens is used to focus the image of the bottom of the cells into the camera lens.

FIG. 5 is a partial view of a device similar to that shown in FIG. 4 except that prisms are employed instead of the condensing lens.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a colorimeter which is built in the form of a cabinet, generally designated 5, having a sample holder 7 thereon. Mounted on the side of the cabinet is a control timer 9 for lights 11. A diffuser 13 is provided so that the light will be uniform on all of the samples. In this embodiment of the invention, the diffuser is a sheet of ground or opal glass. In making many tests, it is necessary to provide a filter 16 which yields a gray scale which is indicative of concentration or the like so that the optical density of the test sample can be determined. Filter 16 is not necessary in all instances.

A shutter mechanism 17 may be employed if desired although this is ordinarily not necessary since it is sufficient that the light source merely be turned on and off for the desired length of time. The sample holder generally designated 7 consists of a slide member having a first section 18 adapted to hold a plurality of sample tubes and a second section 19 which serves as a guide and also as a light barrier. For loading, the holder 7 is moved to the left as is shown in dash-dot lines and a plurality of sample tubes 20 inserted therein. Mounted directly below the sample carrier is a sheet of photographic film 21 and when the slide is to the left, the

section 19 prevents any stray light from striking film. The carrier is then moved to the right, as is shown in solid lines in the drawing, and the exposure can be made by the use of the timing mechanism 9 and/or the shutter mechanism 17.

The photographic paper 21 may be cut film which is loaded into the usual carrier or, in the embodiment illustrated, it is carried on the rolls and advanced between exposures by means of the knobs 22. After making the exposure, the paper would be removed and developed and fixed in the usual way and would contain a light spot for each sample whose density would correspond with some accepted standard. Naturally, the selection of the photosensitive material, light filter, light source, time of exposure and type of development would be chosen so that a gray scale matches or has a direct or indirect relationship to the colorimetric optical density of the test samples at a wavelength that is desirable for the tests.

In the embodiment of the invention illustrated in FIG. 1, ordinary flat bottomed sample cells can be employed or the cells can be as shown in FIG. 2. Here there is shown a holder 17 which holds a sample tube 23, having a convex bottom 25. Thus, the bottom of the sample holder acts as a concentrating lens and by placing the photographic paper at the proper distance from the bottom of the tube, a concentration of light is obtained. This gives more accurate results in many instances. The tube itself may also include a filter. The bottom of the cell might be concave for microsamples.

Another embodiment of the invention is illustrated in FIG. 3. Here, a light source 27 is provided with a timer 29 and a condensing lens 31. A filter 33 is provided as well as a vertical sample holder 35. The vertical sample holder contains a number of cells as at 37 each of which preferably has parallel sidewalls although round cells could be used so that the light can be passed sidewise through the panel rather than vertically as was previously described. The sample holder 35 fits into a frame 37 shown exploded in FIG. 3. Mounted behind frame 37 is a holder 39 containing a number of photoelectric pickup cells 41. Each cell is connected by suitable wiring, as at 43 to an electronic recording device 45. The electronic recording device can record the results from the photoelectric cells on magnetic tape or the like by scanning the cells. Since the scanning takes place at an extremely high rate of speed compared with the normal color change, a continuous record may be made over a period of time and for all practical purposes, the time will be the same for each of the sample cells.

In FIGS. 4 and 5, embodiments of the invention are shown wherein an ordinary camera is used to record the densities. It is particularly advantageous to use a camera of the Polaroid type so that the film can be developed and results obtained immediately.

In FIG. 4, the cabinet 5 is equipped with the usual lights 11 and sample slide 7 as previously described and a condensing lens 47 is provided to pick up the light from the bottom of the sample cells and direct it into the lens 49 of camera 51. This provides the advantage that a smaller filter and film can be used for a given number of sample cells than is the case of FIG. 1 wherein the film and filter must be of the same size as the area of the total number of sample holders.

A somewhat similar structure is shown in FIG. 5 but here a series of prisms 53 is employed, one under each sample tube, to direct the parallel rays of light from the bottoms of the sample tubes into the lens 49 of the camera 51. Naturally, the prisms at the edge will have a greater angle than those near the center and the prisms at the very center will have parallel faces. Instead of utilizing a separate series of prisms, the prisms could, of course, be built into the sample tubes themselves. Similarly, fiber optics might be employed or the tubes themselves may be directed toward the camera lens.

Although a conventional light source has been illustrated, it is obvious that other forms of electromagnetic waves may be employed such as ultraviolet and infrared rays. Instead of an ordinary filter, one may employ polarizers, diffraction gratings and electromagnetic fields. Other methods can be used to record the intensity of the electromagnetic waves.

The inventor claims as his invention the use of electromagnetic waves passing through many test samples simultaneously for turbidity, density, or color determination, and passing to an electromagnetic wave sensitive medium. Modifiers and controls as diffraction gratings, filters, polarizers, lenses, prisms, electromagnetic fields, electromagnetic wave transporting mediums, and/or shutters may be used in the electromagnetic wave pathway between its source and the electromagnetic wave sensitive medium.

Although certain specific embodiments of the invention have been described, it will be obvious to those skilled in the art that many variations can be made in the exact structure shown without departing from the spirit of this invention.

I claim:

- 1. A multiple colorimeter for obtaining a record of the amount of color or turbidity in a large number of samples simultaneously comprising in combination:
  - a. a generally light tight chamber,
  - b. a source of light located near the top of said chamber,
  - c. means for controlling said source of light,

- d. a photosensitive photographic paper located near the bottom of said chamber,
- e. slots on each side of said chamber, located between said light source and said photographic paper whereby a slide can be passed through said slots intercepting said path of light,
- f. a slide adapted to pass through said slots in light tight relationship,
- g. said slide having a length of approximately twice the width of said container and being divided into two equal sections including a first section having a plurality of pockets for holding sample tubes and a second section being a blank section whereby said slide can be moved to a first position wherein said blank section intercepts the light from said light source to said photographic paper while samples are loaded into said sample section and said slide can then be moved to a second position wherein said samples are interposed between said light source and said photographic paper.

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