

Nov. 29, 1966

C. M. BLUMENFELD

3,288,019

PHOTOGRAPHIC TYPE SEDIMENTATION RECORDER

Filed May 8, 1962

2 Sheets-Sheet 1

FIG. 4

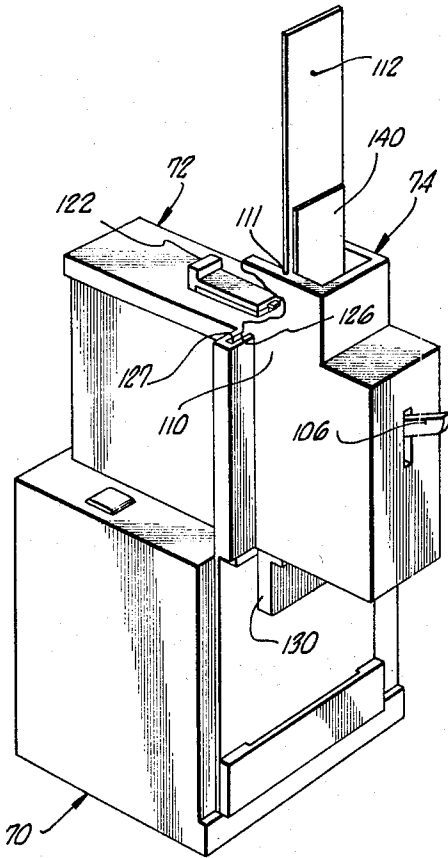


FIG. 6

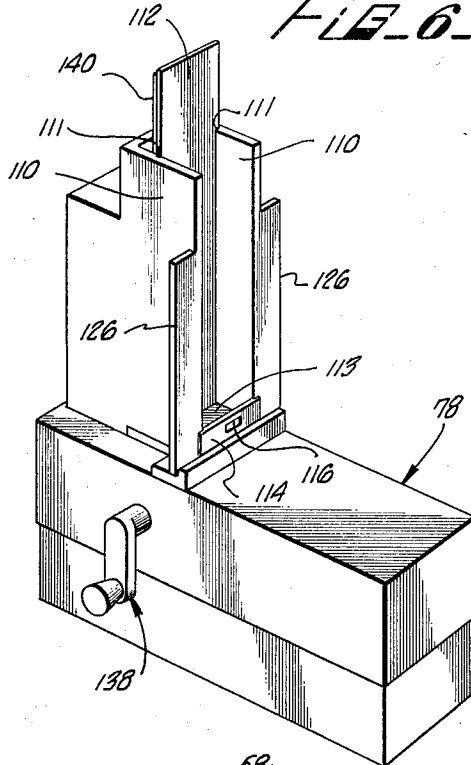


FIG. 2

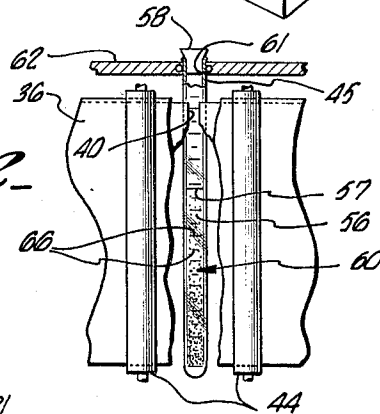
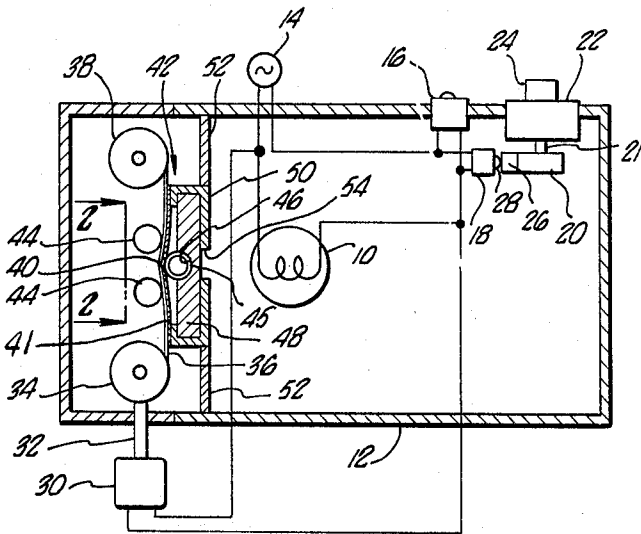


FIG. 1



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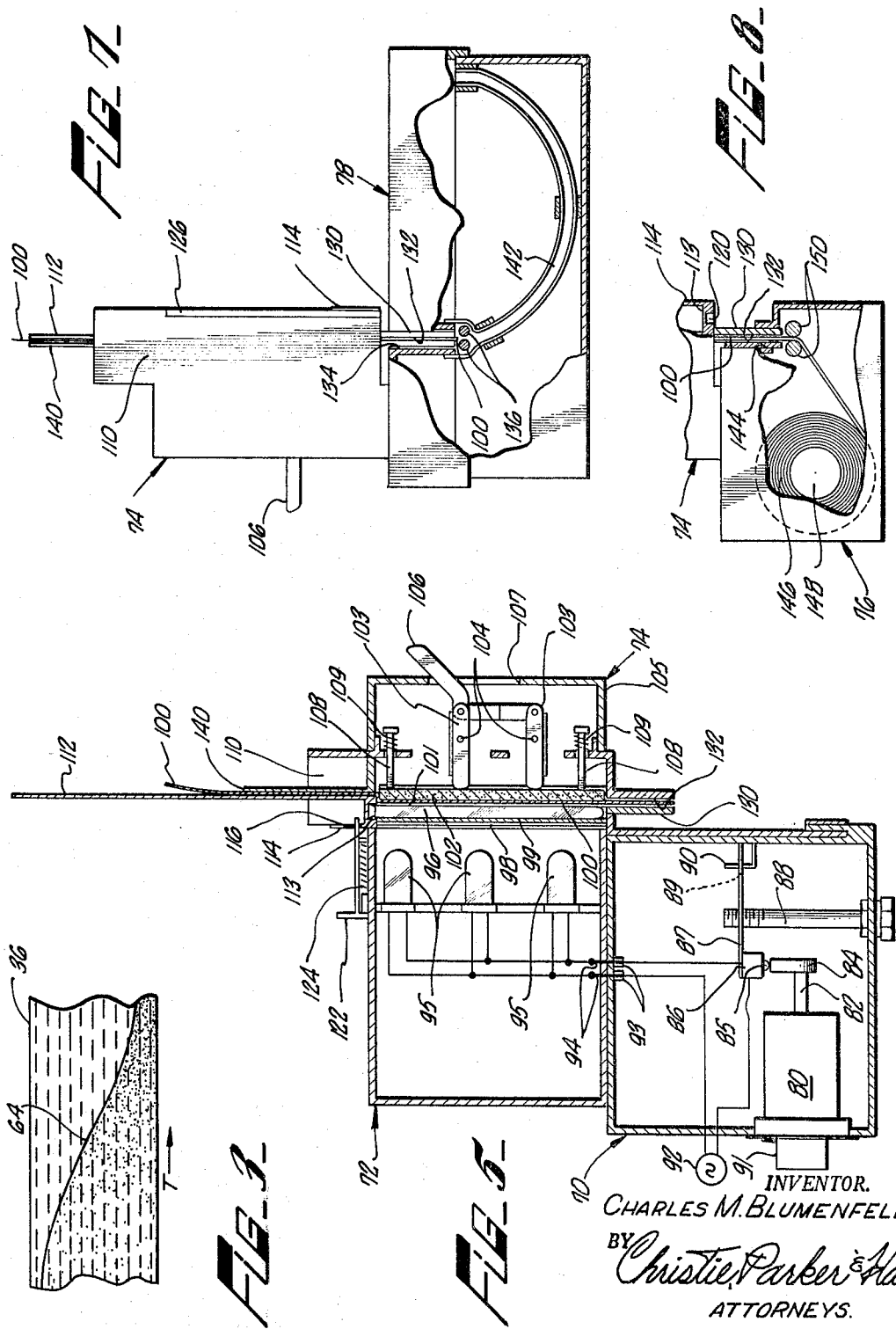
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PHOTOGRAPHIC TYPE SEDIMENTATION RECORDER

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1 Claim. (Cl. 88—14)

This invention relates to apparatus for automatically recording the sedimentation of solids in a liquid.

Although the invention may be used to record the sedimentation of solids in any liquid, it is ideally suited for recording the sedimentation in blood samples, and is specifically described with reference to that use.

The sedimentation rate of a blood sample has been obtained prior to this invention by placing the blood sample in a tube for a predetermined period of time, say one hour. At the end of the required time, a technician reads and records the top level of the settled solids in the sample. A disadvantage of this technique is the possibility of error in visually reading the sedimentation rate tube. Moreover, the technician may forget to take the reading at the end of the required period. Another disadvantage is that sometimes out-patients present blood samples for sedimentation tests less than an hour before closing time of the laboratory. With the technique prior to this invention, someone must stay overtime, or else the patient is required to return the following day.

With the apparatus of this invention, a photograph is automatically taken of the blood sample at the end of the required period to provide a permanent record of the blood sedimentation rate in the tube. This eliminates the possibility of error in visibly reading the manually recorded sedimentation rate, and provides a permanent infallible record. The invention also eliminates the possibility of the technician forgetting to read the sedimentation rate at the end of the required time period. Thus, technical personnel are relieved of the responsibility of being called away from other duties when the sedimentation rate must be read. Moreover, sedimentation rates can be started at any time of the day without regard to closing time of the laboratory. This avoids the need for laboratory personnel to stay overtime, or, alternatively, for out-patients to be required to come back a subsequent day.

Briefly, the apparatus of this invention includes means for holding a sample of the liquid with suspended solids. Means are provided for shining light through the liquid, and a light recording medium is disposed adjacent to the sample in the path of light passing through the sample.

One form of the invention includes means for turning the light on after the sample has been in the container for a preselected time. Means are also provided for adjusting the time at which the light is turned on after the sample is disposed in the container. Thus, sedimentation rates may be obtained at any desired time. Preferably, means are provided for adjusting the length of time the light is turned on to obtain the desired exposure, and to accommodate the photographic paper requiring different periods of exposure.

In one form of the invention, the photographic paper is held against the sample and the light is turned on after predetermined times so that a single "static" reading of sedimentation rate is obtained. However, in the preferred form of the invention, means are provided for moving film continuously, or at least intermittently, past the container with the sample. The light is shone continuously, or intermittently, through the sample, so that a record of settling rate is obtained over an extended period of time. Thus, a continuous photographic record of the settling of solids in the blood is obtained during the entire test

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period. This opens an avenue of blood chemistry research which as yet has been insufficiently explored.

These and other aspects of the invention will be more fully understood from the following detailed description and the accompanying drawings, in which:

FIG. 1 is a schematic plan view of the presently preferred embodiment of the invention;

FIG. 2 is a view taken on line 2—2, partially broken away, of FIG. 1;

FIG. 3 is a fragmentary elevation of a record obtained with the apparatus shown in FIGS. 1 and 2;

FIG. 4 is a perspective view of apparatus for obtaining a single photograph of settled solids after a predetermined time;

FIG. 5 is a sectional side elevation of the apparatus shown in FIG. 4;

FIG. 6 is a perspective view of a developer tank for receiving exposed film;

FIG. 7 is a side elevation, partly broken away, of the apparatus shown in FIG. 6; and

FIG. 8 is a fragmentary elevation, partly broken away, showing a system for loading photographic paper.

Referring to FIGS. 1 and 2, a light 10 is disposed inside a light-tight case 12, and is supplied power from a conventional source 14 through either a test switch 16 or a recording switch 18, connected in parallel with the test switch. The recording switch 18 is actuated by a cam 20 on a shaft 21 of a conventional mechanical timer 22 having a control knob 24 extending exteriorly of case 12. When the knob 24 is turned, a recessed portion 26 of the cam is moved away from a control button 28 of the switch 18, and the protruding part of the cam engages the switch contact and causes it to close. Power is then supplied to the light 10 and to a motor 30, which has a drive shaft 32 connected to a takeup reel 34 in the case. A strip of photographic film 36 is supplied from a supply reel 38, and extends across a vertical slit 40 in an opaque cover sheet 41 on a sample holder 42. A pair of idler rollers 44 hold the film in close contact with the cover sheet 41 on the sample holder. A transparent glass sedimentation rate test tube 45 or Wintrobe tube is disposed in a vertical concave groove 46 in a block 48 of translucent plastic, such as polytetrafluorethylene sold commercially under the trademark Teflon, held in a support 50, which has outwardly extending flanges 52 to make a light-tight fit against the sides of the case 12. The support 50 has a vertical slot 54 in it so that light from the light bulb 10 can enter the translucent plastic and diffuse into the sample tube 45, which makes a close fit over the slit 40 in the cover sheet 41.

As shown best in FIG. 2, the sample of liquid 56, say blood, is added to the sample tube to a level 57. The upper end of the tube is closed by a conventional stopper 58. After a period of time, a fairly well defined top level 59 of settled solids 60 is formed in the lower portion of the tube.

In using the apparatus of FIGS. 1 and 2, the test tube, or sedimentation rate tube, 45 is pulled out of the sample holder through an opening 61 in the top 62 of the case. The tube is cleaned if necessary, dried, and filled to a standard level 57 with a sample of liquid, say blood. The tube is then stoppered and placed as shown in FIGS. 1 and 2. The control knob 24 on the timer 22 is rotated to set the timer for the interval over which the test is to be made, say one hour. This rotation of knob 24 causes the shaft 21 to rotate to such position that the cam 20 engages the contact on switch 18 for one hour. Closing of switch 18 turns on the light 10 and motor 30 so that film is pulled past the slit 40 at a uniform rate. If necessary, the motor shaft 30 can be turned manually to insure that unexposed film is used

for the beginning of the run. After the run is completed, the film is removed from the case under suitable precautions against over-exposure, and developed to produce a record such as that shown in FIG. 3. The film 36 has on it an image which forms a line 64 having the general shape indicated in FIG. 3. The curve indicates the rate in which particles settle in the blood sample, time increasing in the direction shown by the arrow. The dashed horizontal lines on the film are made by the index marks 66 on the sample tube. Thus, the apparatus of FIGS. 1 and 2 provides a dynamic or continuous recording of settling rate in a blood sample, and opens avenues of research not previously available or explored.

The apparatus shown in FIGS. 4 through 8 is used to obtain an instantaneous permanent photographic record of sedimentation in a sample after a predetermined period of time. The apparatus includes a timer case 70, a sample holder 72, a photographic paper holder 74, a photographic paper supply box 76, and a developer tank 78.

Referring to FIGS. 4 and 5, the timer includes a conventional mechanical timer mechanism 80 with a rotatable shaft 82 and a cam 84 mounted to engage a contact button 85 on a switch 86. The switch 86 is secured to one end of a movable arm 87 through which is threaded a rotatable adjusting screw 88 having its head disposed exterior of the timer box. Arm 87 is free to move toward and away from the cam, but is prevented from rotating about the adjusting screw by engagement of a hole 89 in the arm over an upright guide pin 90 mounted on one side of the timer box. A control knob 91 on the timer mechanism is exterior of the box so that the timer can be set to place the cam 84 into contact with the switch 86 for any desired length of time. The position of adjusting screw 88 determines how long the cam 84 is in contact with the switch button 85 once the initial contact is made, because continued rotation of the cam eventually carries the cam out of contact with the switch button.

A source of electrical power 92 is connected through the switch 86 to a pair of female receptacles 93 mounted in the top of the timer case to receive a pair of downwardly extending male prongs 94 mounted in the bottom of the sample holder box 72. Three light bulbs 95 are connected in parallel with the male prongs 94 so that when the switch 86 is closed, power is supplied to the lights to turn them on. A sample tube 96 is mounted in the front (right as viewed in FIG. 5) end of a sample holder 97 in a manner substantially identical with that shown and described with respect to FIGS. 1 and 2. The light from the bulbs 95 shines through a vertical slot 98, through a translucent plastic body 99, and through the sample in the tube. A sheet of photographic paper 100 is held over a vertical slit 101 in the front of the sample holder by a movable platen 102 mounted in a paper holder 74.

As shown best in FIG. 5, the platen is urged to the left (as viewed in FIG. 5) against the paper by a pair of vertically spaced horizontal links 103 secured by transverse pivot pins 104 to the side walls of the paper holder box 105. An upwardly and outwardly extending toggle arm 106 is connected at its inner end to the right end of the upper link 103, and extends through an opening 107 in the rear wall of the paper holder box 105. The platen is moved away from the sample tube and photographic paper by pushing the toggle 106 down to pivot the links 103 in a clockwise (as viewed in FIG. 5) direction about their pivot pins 104. The left ends of the links 103 move upwardly and away from the platen, which is then urged to the right by a pair of vertically spaced horizontal screws 108 secured at their left ends to the platen and urged at their right ends by compression springs 109 to move to the right. Preferably, the face of the platen which engages the film is of a soft sponge

texture so that it presses the paper firmly in contact with the sample holder.

FIGS. 4, 5, 6, 7, and 8 show the construction of the paper holder, how it is loaded with unexposed paper from the paper supply box, and how exposed paper is discharged from it into the developer tank.

The paper holder includes a pair of side plates 110 with inwardly facing grooves 111 to receive the side edges of an elongated movable slide plate 112. The lower end of the slide plate includes a horizontal foot 113 with an upwardly extending toe 114 having an opening 116 in it. The under side of the foot 113 includes a downwardly opening recess 120 which makes a close fit over the upper end of tube 96 (FIG. 5). A horizontal latch 122 (FIG. 5) on the top of the sample holder box is urged to the right by a compression spring 124 so that the right end of the latch enters the opening 116 of the toe 114 and holds the slide plate in the position shown in FIGS. 4 and 5. The paper holder box includes a pair of outwardly extending flanges 126 which each make a sliding fit into a respective vertical groove 127 on the sample holder.

To remove the paper holder from the sample holder, the link 106 is pushed down so that the platen can slide to the right. Thereafter, the paper holder is lifted upwardly. The latch 122 holds the slide plate in a fixed position so that the paper holder slides upwardly with respect to the slide plate until the lower end of the slide plate comes to rest on one side of the upper edge of a downwardly extending tongue 130 having a vertical slot 132 opening from the interior of the paper holder and out the bottom of the tongue. The slide plate is now in the position shown in FIGS. 6, 7, and 8.

The tongue 130 is placed into an upwardly opening slit 134 in the top of the developing tank so that the lower edge of photographic paper 100 is directly over a pair of rollers 136, one of which is adapted to be turned by crank 138 on the outside of the developer tank. The upper end of the photographic paper extends above the upper edge of the slide plate 112 and an extension plate 140 mounted on the paper holder just to the left (as viewed in FIGS. 6 and 7) of the grooves 111. The paper is pushed down so that its lower end slides between rollers 136. The crank is turned and pulls the paper from the paper holder down into a guide track 142 in the developer tank. A conventional developing solution is maintained at a suitable operating level in the developing tank so that the paper is completely wetted with developing solution. The crank 138 is turned only far enough to put the exposed record portion of the paper into the developing solution. This leaves the upper end of the paper above the top of the developing tank. The paper holder is removed, and after a suitable length of time, the paper is then pulled from the developing tank and blotted dry. A recorded image of the sedimentation rate is thereby obtained.

To load the paper holder, the tongue 130 is worked over the upper end of a piece of photographic paper 100, which extends upwardly from a slit 144 in the paper supply box. A roll of paper 146 is mounted on a supply reel 148 in the paper supply box. The strip of paper extends between a pair of rollers 150 located directly under the slit 144. One of the rollers is turned by a conventional crank (not shown) so that the paper can be fed out of the supply box. After the upper end of the paper is worked into the tongue 130, the tongue is set down into the slit as shown in FIG. 8. The paper supply box crank is then turned so that paper is forced up the tongue, between the slide plate and platen, and out the top of the paper holder as indicated in FIG. 8. The upper end of the paper is then crimped over the plates 112 and 140. The paper is held in this position while the paper holder is lifted from the paper supply box, causing some paper to be pulled out of the supply box. Thereafter, the paper

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is torn by pulling it across a sharp edge 151 at the upper edge of the slit 144.

The apparatus is used for a blood sedimentation rate as follows. The timer is set for the required time to start the cam 84 rotating toward the switch 86, which is positioned by adjusting screw 88 to turn on the light bulbs for the required exposure time at the end of the run. The sample is poured into the tube, which is then stoppered and placed in the holder as shown in FIG. 5. The latch 122 (FIG. 5) is pulled to the left, and the opening 116 in the toe of the slide plate is positioned to receive the latch, which is then released so that it moves to the position shown in FIG. 5. The flanges 126 on the paper holder fit into vertical grooves 127 on the sample holder, and the paper holder is pushed down until the flanges come to rest in the bottom of grooves 127. During this movement, the latch prevents slide plates from moving downward so that the paper is allowed to come into direct contact with the vertical slit 100 adjacent the sample tube without exposure to light. The recess 120 in the bottom of the foot on the slide plate fits over the upper end of the sample tube and prevents the leakage of light.

When the timer cam 84 completes its run, it engages contact 85 on switch 86 to activate light bulbs 95, causing the film to be exposed through the sample tube and sample therein. The length of exposure is controlled by the position screw 88 to provide engagement of contact 85 with cam 84 in accordance with the position of arm 87 along the length of screw 88. In this way, lights of different intensity and papers of different photographic quality and characteristics can be used.

After exposure, the film is removed and developed as previously described.

I claim:

Apparatus for recording the sedimentation of solids

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in a liquid, the apparatus comprising a supply box adapted to hold a supply of photographic paper, a paper holder separate from the box, the supply box and holder each having a separate respective opening connecting the interior with the exterior, means for releasably securing the box and holder together so the openings in each of them are aligned, means for transferring paper from the box to the holder through the aligned openings while they are together and without exposing the paper to light, means for separating the holder from the box without exposing the paper in the holder to light, means for holding a sample of the liquid, means for shining light through the liquid, means for holding the paper in the holder in the path of light passing through the sample, a developer tank having an opening in it and adapted to hold a developer solution in the tank, means for releasably securing the holder to the tank in place of the supply box so the openings in them are aligned, and means for transferring the exposed paper in the holder through the opening in the tank and into the developer solution without exposure to light.

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