June 15, 1943. C. A. HAUSSER ET AL 2,322,128

ERYTHROCYTOMETER

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Fig. 1.

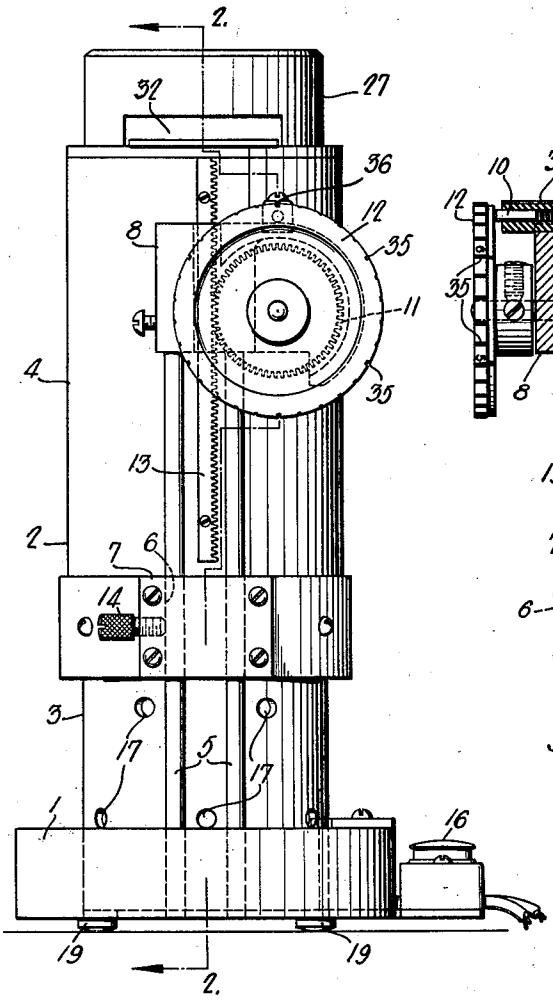
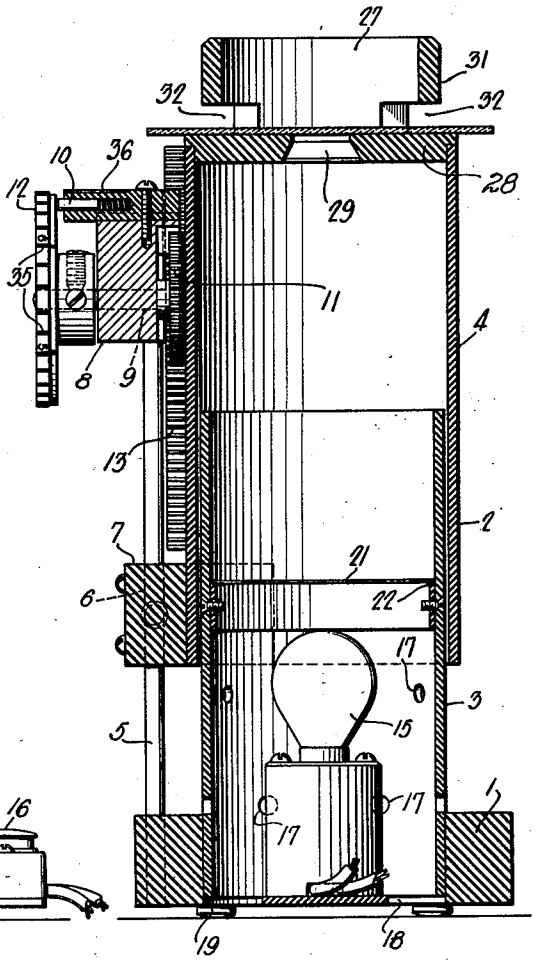


Fig. 2.



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Fig. 3.

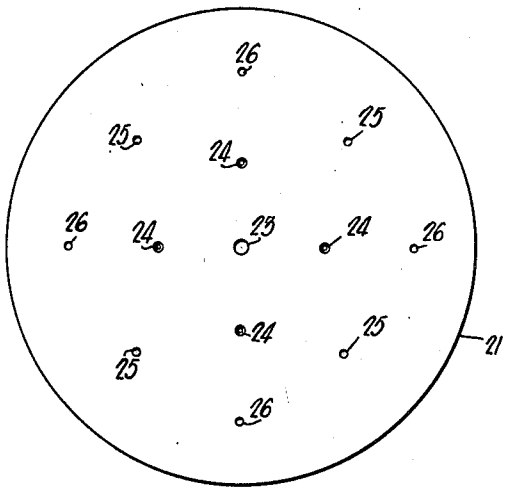


Fig. 4.

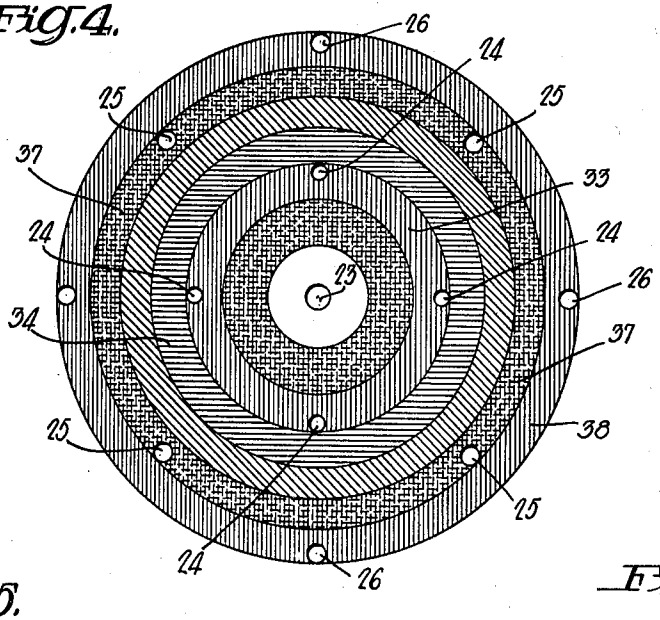


Fig. 5.

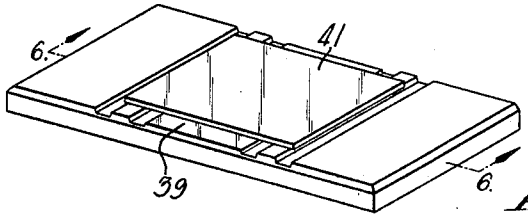
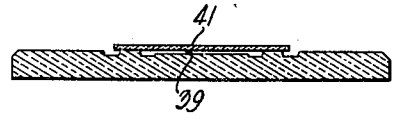


Fig. 6



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ERYTHROCYTOMETER

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Application February 13, 1941, Serial No. 378,806

3 Claims. (Cl. 88—14)

An object of the present invention is to provide an erythrocytometer of generally improved structural and operating characteristics.

To this general end, a specific object of the invention is to provide an improved and accurate means for adjusting the instrument in operation; and in conjunction with said adjusting device an improved mode of calibration wherein the said calibrations are conveniently arranged to afford a direct reading of the erythrocyte measurements.

Another object of the invention is to provide an instrument of the stated character which shall be highly efficient and accurate in the functional sense, and the invention contemplates the use of a particular character of light source contributing in substantial degree to this end.

A still further object of the invention is to provide an instrument which in addition to the normal function will incorporate novel and improved means for determining the presence in the test specimen of anisocytosis.

In the attached drawings:

Figure 1 is an elevational view of an erythrocytometer made in accordance with our invention;

Fig. 2 is a section on the line 2—2, Fig. 1;

Fig. 3 is a face view of one of the elements of the device;

Fig. 4 is a view illustrating more or less diagrammatically the spectral corona forming the basis for erythrocyte measurements by means of the instrument;

Fig. 5 is a view in perspective of the special specimen chamber which forms an element of the invention, and

Fig. 6 is a section on the line 6—6, Fig. 5.

The instrument illustrated in the drawings comprises a suitable base 1 which provides a support for an upstanding hollow housing 2. The housing 2 comprises in the present instance two tubular elements 3 and 4 which are telescopically fitted to provide for longitudinal expansion and contraction of the housing as a whole. The housing element 3 is suitably secured to the base 1; and the housing element 4, which is of greater diameter than the element 3 and which embraces the latter, is mounted, as hereinafter described, for vertical or axial adjustment with respect to the element 3.

Secured to and extending upwardly from the base 1 is a pair of rails 5, and these rails extend neatly through openings 6 formed in a boss-like extension 7 at the lower end of the housing element 4. Mounted at the top of the rails 5 is a head member 8 in which is journaled a shaft 9 extending in a horizontal plane at right angles to the axis of the cylindrical housing 4. The inner end of this shaft 9 carries a toothed pinion 11, and to the outer end of the shaft is secured a hand wheel 12 by means of which the shaft may be turned in its journals. The pinion 11 meshes with a rack 13 secured to the outside of the housing element 4 in parallel alignment with the longitudinal axis of the housing. By turning the hand wheel 12, the housing element 4, through the medium of the pinion 11 and rack 13, may be adjusted axially with respect to the housing element 3 and the base 1. A spring-pressed pin 10 in the head structure 8 bears against the inner face of the hand wheel 12 and creates friction tending to retain the wheel and associated elements in adjusted position. The housing element 4 is retained in adjusted position further by frictional engagement with the rails 5, which rails function to guide and support the housing element 4 in its vertical movement. The frictional engagement between the housing element 4 and the rails 5 may be regulated through the medium of a set screw 14 which is threaded into the side of the boss-like extension 7 and which at its inner end engages one of the rails 5. This set screw may be used also to fix or lock the housing element 4 in adjusted position.

Means is provided in the base 1 for mounting an electric bulb 15, said bulb being located within the lower end of the housing element 3 and centrally of the latter. Also associated with the base externally of the housing element 3 is a switch element 16 preferably of the press button type which controls the flow of electric current to the bulb 15 and which provides a simple and convenient method for lighting or extinguishing the bulb as desired. The housing element 3 may be provided with a number of apertures 17 providing for ventilation of the interior of the housing, and preferably the base 1 is provided with an opening 18 below the housing and is supported on casters 19 so as to provide for circulation of air under the base and upwardly through the housing. Preferably and as hereinafter more fully set forth, the electric bulb 15 is of the concentrated filament type employed in light-projecting apparatus.

Suitably supported within the housing element 3 is a disk 21 of metal or other suitable material, this disk in the present instance conforming closely in diameter to the internal diameter of the housing element 3 and seating upon an in-

ternal shoulder 22, said disk occupying a horizontal plane intersecting at right angles the vertical axis of the housing. The disk 21 is provided with a central relatively large perforation 23 and with three series of smaller perforations 24, 25 and 26, the perforations of each series being arranged on a circle concentric with the central aperture 23. The circles defined by the perforations 24, 25 and 26 respectively are of differing diameters so that the perforations of the respective series differ in radial distance from the central perforation 23 as shown. The central aperture 23 lies directly over the concentrated light source 15 so that through this aperture a concentrated and relatively intense beam of white light is projected upwardly through the center of the housing member 4. The aperture 24, 25 and 26 are relatively offset from the light source, so that the light passing therethrough is relatively lacking in intensity. The perforations 24 may be made smaller than the perforations 25 and 26 so as to compensate for the differences in distance from the light source and to more or less equalize the amount of light passing through these perforations.

At the upper end of the housing element 4 is a fitting 27 which comprises a bottom wall 28 having a central aperture 29 concentric with the longitudinal axis of the housing and an annular wall 31 which extends upwardly from the bottom wall 28 and which has at the bottom oppositely disposed slots 32, 32. The bottom wall 28 provides a stage or platform for the slide, cover glass, or chamber holding the test specimen, as hereinafter described, and the slotted openings 32, 32 provide for inserting the specimen onto the stage to a position overlying the aperture 29.

When a specimen is thus placed on the stage over the aperture 29, it lies directly in the path of the beam of light passing through the perforation 23 from the light source to the eye of an observer looking down through the open top of the housing 2. Under these conditions, the corpuscles in the specimen form obstacles in the path of the light beam and cause a diffraction of the light; and since the corpuscles are numerous and closely spaced, and the undiffracted rays are minimized, a large number of spectra are superimposed upon each other and become clearly visible to the unaided eye. The size of the spectral corona obtained under the conditions described above varies inversely with the size of the obstacle, and this principle of diffraction is employed in the instrument to measure the mean diameter of the large number of corpuscles in the test specimen.

In using the instrument, it will be noted that as the test specimen is moved toward or away from the disk 21 and from the light source, the spectrum becomes smaller or larger in diameter, and by this means different portions or areas of the spectrum or spectra may be made to coincide with the points of light emanating from the small apertures 24, 25 and 26 of the several previously described annular series. By measuring the distance between the specimen and the disk when the aforesaid points coincide with predetermined portions of the visible spectra, it is possible to determine the mean diameter of the corpuscles which constitute the spectra-generating obstacles. The further away from the disk the specimen has been moved in order to effect the predetermined coincidence, the larger are the corpuscles serving as the diffraction medium, and vice versa.

More specifically describing the function of the machine, the corona as seen by an operator will be substantially as shown in Fig. 4 of the drawings. This corona consists of circular bands of the several spectrum colors, which bands are concentric with the disk perforation 23. The annularly arranged perforations 24, 25 and 26 being smaller than the perforation 23 and offset with respect to the light source will not affect the corona, but will appear in the corona as small points of white light. In the present instance, the instrument is calibrated, as hereinafter described, so that when the light points from the perforations 24 occupy positions on or cloosely adjacent to the dividing line between the innermost red band 33 of the spectrum and the adjoining blue band 34, the instrument will afford a direct reading of the main size of the corpuscles in the test specimen. It will be noted that the dividing line between the inner red ring and the immediately adjoining blue ring is the sharpest in the spectrum, and it is for this reason that the instrument is calibrated for measuring with this portion of the spectrum.

The instrument is designed to give a direct reading of mean erythrocyte diameter in microns and fractions of microns, and to this end, we provide upon the periphery of the hand wheel 12 a scale comprising a plurality of main divisions 35, said divisions in the present instance being six in number, and each being divided into five equal parts. The main divisions numbered from 5 to 10 respectively represent microns, and each micron division as set forth is divided into five equal parts representing fifths of a micron. Thus the distance of the specimen from the disk 21 is translated on the dial into terms of microns and fifths of microns. When the specimen has been moved by adjustment of the hand wheel 12 to a position wherein the outer edges of the light points from the perforations 24 touch the sharp dividing line between the inner red and blue rings as shown in Fig. 4, the mean blood cell diameter is read directly from the indices upon the hand wheel 12 to a fifth of a micron. With reference to Figs. 1 and 2, it will be noted that we provide, in conjunction with the hand wheel 12 and in a position at the top of the head member 8, an element 36 affording a datum line which by coincidence with the indices on the periphery of the hand wheel affords an accurate reading of the adjustment in terms of microns. This device affords a highly accurate and convenient means for reading the measurements of the instrument.

The perforations 25 and 26 of the disk 21 are radially located with respect to the perforations 24 so that in a normal specimen the light points from the perforations 25 will occupy a position with respect to the division line between the outer yellow and red rings, 37 and 38 respectively, of the spectrum corresponding to the position of the points from the perforations 24 with respect to the inner red band and the adjoining blue band. Similarly the light points from the perforations 26 occupy the same position with respect to the dividing line between the outer red band 33 and the adjoining blue band (not shown) as do those from the perforations 24 with respect to the dividing line between the inner red and blue bands. The theory exists that aniscocytosis in the test specimen is indicated by a failure of the perforations 24, 25 and 26 to coincide with the respective portions of the spectral corona as described above. Thus if the instrument is adjusted so as to bring the perforations 24 into the proper

position at the outer diameter of the inner red band, and if when so adjusted the perforations **25** and **26** fail to coincide with the outer edges of the outer yellow and red bands respectively, the instrument indicates the presence of anisocytosis. This is the function of the perforations **25** and **26**.

The accuracy of the measurements afforded by the machine depends largely upon the character of the specimens and the manner in which they are prepared. The most satisfactory type of specimen is one in which the blood cells are uniformly spread so that they do not overlap, and which at the same time is not so thin that the cells are abnormally flattened or distorted. Variations in the thickness of the test film and in the uniformity of cell distribution are factors directly affecting the character of the spectrum. To the end of reducing error arising from variations in the test specimen, we have provided a chamber, illustrated in Figs. 5 and 6, which makes possible the use in the specimen of fresh wet preparations of erythrocytes, and which substantially eliminates the apparent discrepancies arising from variations in the test specimen. The chamber consists of the conventional glass body having in the top thereof an open chamber **39** of uniform 0.4 millimeter depth. In conjunction with this chamber, we employ a cover glass **41** of the character shown. In using this chamber, the blood to be tested may be drawn in a red cell haemacytometer pipette and diluted 1:250 with a fresh solution of 1.4% sodium oxalate which is isotonic with blood. A drop or two of the diluted blood is then placed in the special chamber and the cover glass placed carefully in position above the latter. The deposit of the blood solution should be sufficiently large to fill the chamber, and it is immaterial whether the solution overflows. Care is taken that there shall be no laked corpuscles, and such clumps of corpuscles may usually be detected with the unaided eye. The blood solution is now allowed to settle for about fifteen minutes in the chamber, after which the chamber with the specimen is placed in the instrument as described above, and the instrument then manipulated as described above to afford the proper reading. It will be noted that the dilution of the blood with the sodium oxalate is the same degree of dilution which is used commonly in other blood tests, and the chamber has been designed particularly as to the depth of the blood-receiving chamber to afford with a specimen of the stated dilution a test specimen of the best characteristics as regards the thickness of the film and the blood cell distribution.

In following the procedure described above, it will be apparent that a substantial uniformity of test specimen can be maintained with resulting uniformly accurate results in the measurements obtained by the instrument.

We claim:

1. In an erythrocytometer, the combination with a casing having telescoping longitudinally adjustable sections, a source of light in one of said sections, a support for a test specimen carried by the other of said sections, a partition in the first-named section interposed between the said source of light and said specimen support and having an aperture for creating a concentrated beam of light emanating from said source and for directing said beam towards said support, said partition having also a plurality of annular series of apertures concentric with the aperture first named and differing predeterminedly as to radial distance from said aperture, and means for relatively longitudinally adjusting said casing sections.

2. In an erythrocytometer, an upright tubular relatively fixed base section, a tubular relatively movable upper section telescopically fitted to the base section, a source of strong concentrated light mounted in the base section, a partition element relatively fixed in said base section with respect to said source and having a small aperture through which a concentrated light beam from said source is projected into the upper section, means in the last-named section for supporting a test specimen in the path of said beam for observation from above, said beam being of sufficient strength and concentration to produce with said specimen a sharply defined spectrum visible from the top of the upper section, means for relatively adjusting the upper section with respect to the base section to vary the distance between the partition and the test specimen, and means coactive with said spectrum and responsive to variations in the distance between said partition and the test specimen for affording erythrocytometer measurement.

3. In an erythrocytometer, an upright tubular relatively fixed base section, and means providing for circulation of air through said section, a tubular relatively movable upper section telescopically fitted to the base section, a source of strong concentrated light mounted in the said base section, a partition element relatively fixed in said base section with respect to said source and having a small aperture through which a concentrated light beam from said source is projected into the upper section, means in the last named section for supporting a test specimen in the path of said beam for observation from above, said beam being of sufficient strength and concentration to produce with said specimen a sharply defined spectral corona centering at said aperture, means for relatively adjusting the upper section with respect to the base section to vary the distance between the partition and the test specimen and to thereby correspondingly vary the mean diameter of said corona, said partition element having a second aperture illuminated by light from said source and predeterminedly spaced with respect to the aperture first named and constituting thereby a means coacting visibly with the said corona for affording erythrocyte measurement.

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