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DEVICE FOR DETERMINING THE RED BLOOD CELL COUNT

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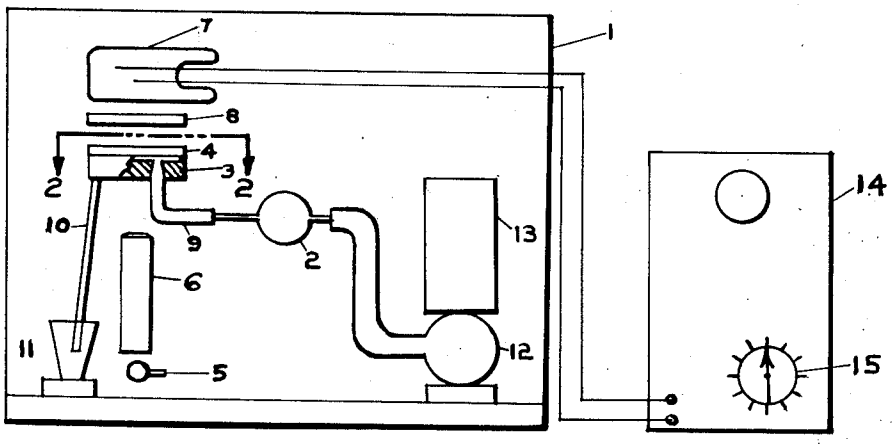


Fig. 1

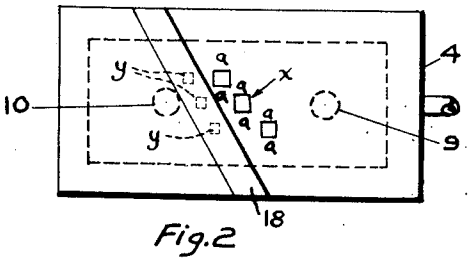


Fig. 2

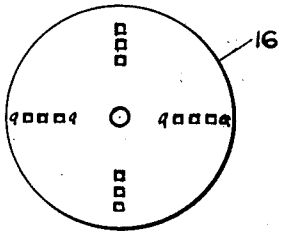


Fig. 4

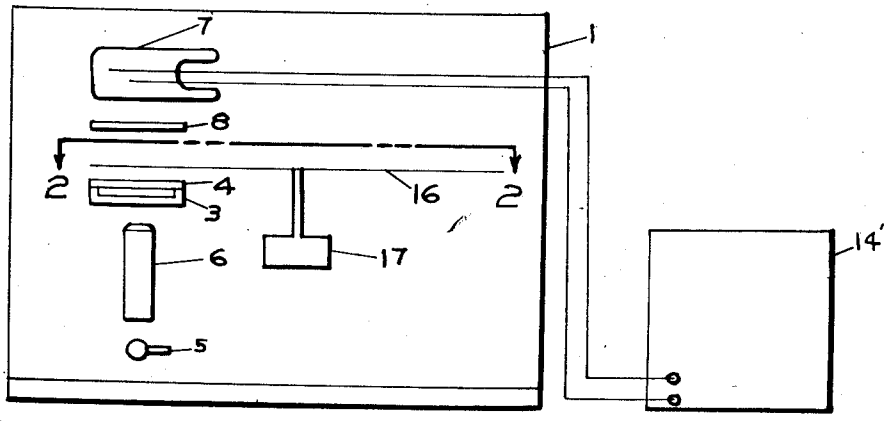


Fig. 3

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DEVICE FOR DETERMINING THE RED BLOOD CELL COUNT

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3 Claims. (Cl. 88—14)

This invention relates to a device for determining the red blood cell count.

The primary object of this invention is to provide a device that will give the correct blood cell count regardless of variations in the size of the blood cells. A further object is to provide a device whose speed of operation and accuracy greatly exceeds microscope counting of the blood cells.

The novel features of my invention will be understood from a description of the drawings, of which:

Figure 1 illustrates a front view of one embodiment of the device, arranged for flow of the blood cell sample.

Figure 2 shows a top view of the cell chamber from lines 2—2 of Figure 1.

Figure 3 shows a front view of another embodiment of the device, with a rotating sector.

Figure 4 shows a top view of the rotating sector from line 2—2 of Figure 3.

Like numerals designate like parts throughout the several drawings.

In Figure 1, the various components are mounted inside a box member **1**. Pipette **2** contains the red blood cell sample which has been diluted 200 times with one percent sodium chloride solution, according to standard procedure. Cell chamber **3** of transparent glass, is made with a spacing of 0.1 mm. with cover plate **4**. A beam of light from lamp **5** is projected through the cell chamber by lens **6** to reach photocell **7**. The blood cells strongly absorb blue light so that blue filter **8** placed in the light beam increases the sensitivity of the device.

The novel features of my invention will be understood from a description of its operation. The blood cell sample in pipette **2** flows through rubber fitting **9**, cell chamber **3**, and outlet fitting **10**. The waste dilution is collected in vessel **11**. Constant flow of the cell dilution through chamber **3** is maintained by pressure from rubber bulb **12** and weight **13**.

The special construction of glass plate **4** is shown in Figure 2. The top surface of this plate has a photographic emulsion which is made opaque to light, except for a plurality of transparent openings. Figure 2 shows three such openings. The openings are about 15 microns square, but are drawn to an enlarged scale for illustration.

When the blood cells flow past the openings, they form a single layer and cause interruptions of the light reaching the photocell. In normal bloods, the cells have essentially the same diameter. In some pathological conditions the average diameter of the red cells is increased, in other conditions the average diameter is decreased.

Large cells passing along edges *a* of the openings will enter the light beam, while small cells will fail to intersect the light beam. With a single opening this excess of large cells over small cells may be 20 percent. By using a plurality of openings, say three, the excess effect of large cells on the interruptions of the light beam is reduced to a negligible value, around five percent.

This effective reduction is obtained in the following manner. Whenever a large cell overlaps an edge *a*, a cell may be present at the same time near the center of any one of the three openings. The two cells act as one to pulse the light beam. The more edges *a* and the more openings present, the more chances there are for this effect to occur.

The frequency of the pulsations in the photocell current is thus determined by the number of cells present; the size of the cells having a negligible effect. The frequency of the photocell current is indicated by a suitable electronic circuit. A standard cathode ray oscilloscope **14**, with a simple circuit added that can be tuned to the frequencies obtained, is illustrated. This tuned circuit **15** may be a condenser shunted by an inductance. Varying the inductance until the cathode ray tube shows maximum deflection, shows the circuit is tuned to the frequency supplied by the photocell. By using blood samples of known cell values the dial of the tuning condenser may be calibrated.

Another kind of circuit, an electronic scaler **14'**, may be used to record the pulses in the photocell current. These scalers are commercial instruments used to record the ionization pulses produced by atomic radiation. In my device, the scaler would record the pulses produced by the blood cells as they passed the apertures in plate **4**. The number of pulses per unit time would be directly related to the number of red blood cells in the sample.

The edge effect may be further reduced by a suitable bias on one of the electronic tubes, in either circuit. Single blood cells projecting over an edge *a* give only a small pulse to the light beam. The bias will prevent small pulses from effecting the output of the indicating circuit. A bias which will reject pulses up to 5 percent of the maximum will reduce the error due to cell size close to zero.

Plate **4** may be made with two sets of apertures, *x* and *y*. The apertures of one set, *x* are made slightly larger than those of the other set, *y*. The pulsating light from set *x* of apertures is allowed to reach the photocell, the other set of *y* apertures being masked by a mask **18**. The frequency of this light beam is noted. The mask **18** is then transferred to the set *x* and the pulsating light from the set *y* of apertures allowed to reach the photocell. The frequency of the light beam is again noted.

The cells overlapping the edges are the same in both sets of apertures, and effect both frequencies the same amount. For each set of apertures, the remeainder of the frequency is determined by the number of blood cells in the sample. Operation of the device requires a table listing the frequencies obtained from both sets of apertures with blood samples of known cell counts and cell sizes, covering the ranges obtained in use.

Another embodiment of my invention is illustrated in Fig. 3. In this device, the blood cells are held in a fixed position, while the scanning apertures are moved over the cells. The blood cell dilution is flowed into chamber **3**, and the cells allowed to settle to the bottom. Cover plate **4** and chamber **3** are transparent. Wheel **16** is opaque to light except for the series of transparent apertures, which act the same as the apertures shown in Fig. 2.

Wheel **16** is rotated by motor **17**. Pulsations in the light beam are caused by the passage of an aperture over a blood cell. A multiplicity of apertures compensates for the variations in cell size. The photocell current is detected by a tuned circuit or an electronic scaler. With an electronic scaler the passage of one group of apertures over the blood cells is sufficient to give the red cell count.

Wheel 16 may be supplied with two sets of apertures of different sizes, as already described for plate 4. Taking readings of the two frequencies generated by a blood sample when viewed by each set of apertures in succession and referring these readings to a calibration table will give the correct blood cell count, corrected for the edge effect due to cell size.

I claim:

1. Apparatus for counting blood cells per unit volume in a diluted blood sample of predetermined concentration comprising: conduit means for said sample having at least a portion with transparent walls so placed as to constrict said sample to a ribbon-like stream containing substantially a single layer of blood cells; light source and photocell means positioned respectively on opposite sides of said chamber whereby light rays from said source to said photocell means pass perpendicularly through said layer; two spaced apertures interposed in said light rays, one of said apertures having an area on the order of that of a normal blood cell, and the other having a larger area than the first aperture; means to effect substantially uniform motion of said sample relative to said light rays in a plane perpendicular thereto whereby to move cells in said sample past said apertures to cause pulses in the output of said photocell means; means selectively to render one or another of said apertures ineffective to produce said pulses; and means coupled to said photocell means to record the number of said pulses per unit time.

2. Apparatus for counting blood cells per unit volume in a diluted blood sample of predetermined concentration comprising: conduit means for said sample having a portion with transparent walls; light source means positioned to direct light through said transparent walls; light-sensitive means for providing an electrical output related to beam intensity and interposed in the beam of light passing through said transparent walls; means forming a pair of spaced apertures interposed in said light rays and being of different size; means to effect relative motion between said sample and said light source means to cause pulses in the output of said light-sensitive means; means selectively to render one or the other of said apertures ineffective to produce said pulses; and means coupled to said light-sensitive means for providing a measure of the number of pulses in the output thereof.

3. Apparatus for analyzing blood cells in a diluted blood sample of predetermined concentration comprising: conduit means for said sample having a portion with transparent walls; light source means and light-sensitive means for providing an electrical output related to beam intensity and positioned respectively on opposite sides of said conduit means; the light-sensitive means being in the path of a beam of light of said light source means emerging from said transparent walls; means forming apertures of the order of the size of the blood cells and of different areas in the path of said light beam; means for imparting relative motion between said sample and said light source means in a plane perpendicular to the direction of the light beam from said light source means to cause pulses in the output of said light-sensitive means as individual cells interrupt portions of said beam; measuring means for measuring the output of said light-sensitive means, and means for selectively closing different apertures.

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