

United States Patent

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[73] Assignee the United States of America as represented
by the Secretary of Air Force

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[54] MINIATURE, PORTABLE, SELF POWERED, HIGH
SPEED, CLINICAL CENTRIFUGE
5 Claims, 4 Drawing Figs.

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233/26

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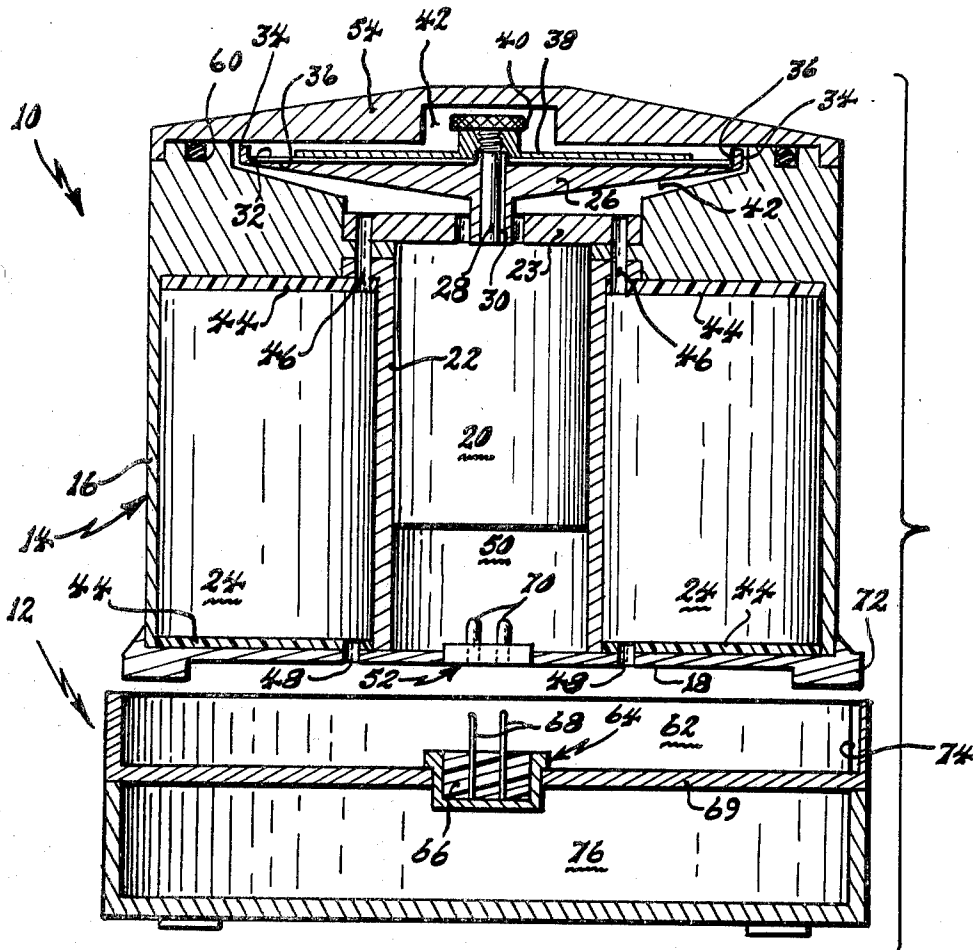
[50] Field of Search 233/24, 26

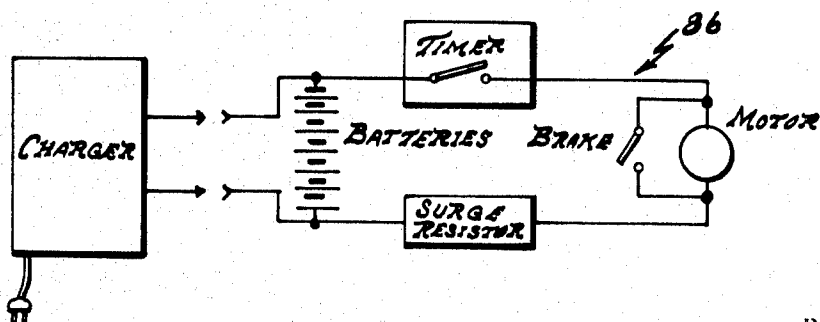
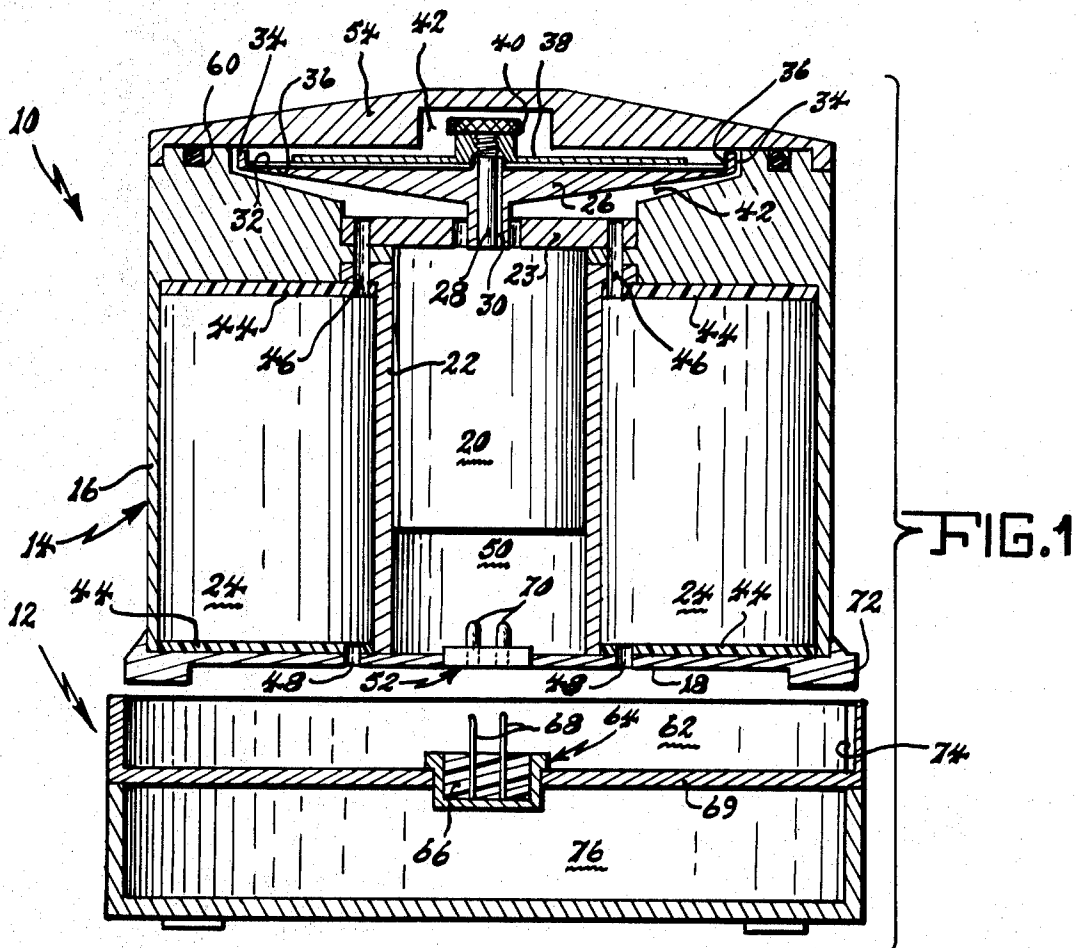
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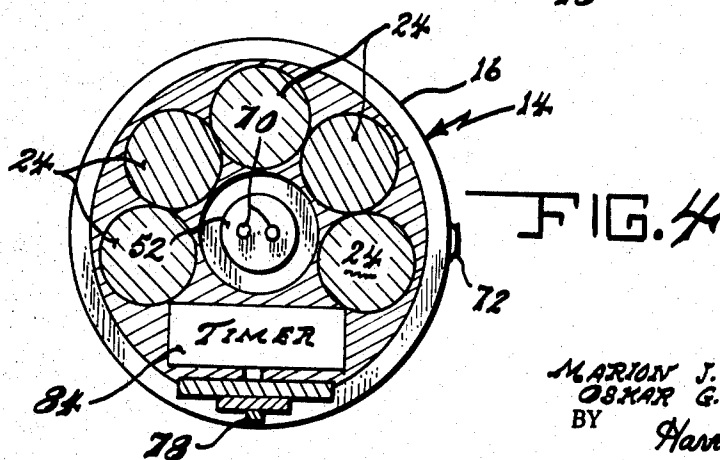
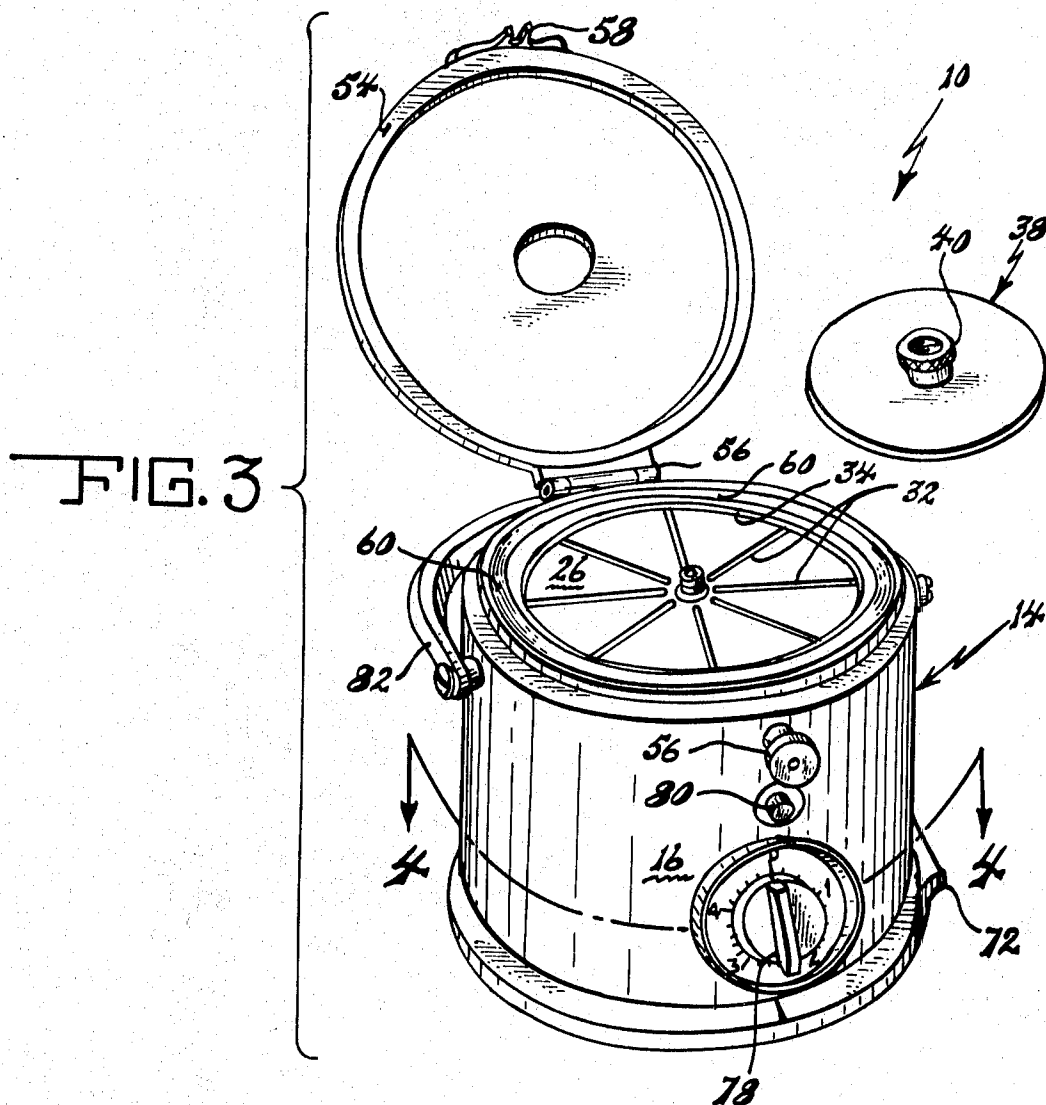
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ABSTRACT: A portable, miniature, self-powered, high-speed, clinical centrifuge having a housing, a motor, an energizing means, a rotor head and a rotor head cover. The energizing means for the motor is capable of being charged by a removable charger. Operation of the centrifuge rotates the rotor head at a high speed thereby separating blood cells from blood plasma within a capillary tube located within said rotor head. A timer regulates the length of time the centrifuge is in operation.





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MINIATURE, PORTABLE, SELF POWERED, HIGH SPEED, CLINICAL CENTRIFUGE

BACKGROUND OF THE INVENTION

This invention relates generally to centrifuges, and more particularly to a miniature, portable, hand-carried, self-powered, high-speed clinical centrifuge capable of performing rapid hematocrit determinations and plasma preparation.

Blood consists of two major fractions, a fluid portion and a cellular portion. The fluid portion (plasma) is made up of proteins, carbohydrates, lipids (fats), nonprotein nitrogenous material, and salts; the cellular portion contains erythrocytes (red blood cells), leukocytes (white blood cells), and platelets. When blood clots, the cellular elements are included in the clot and the remaining fluid is the serum, which differs from plasma only by the loss of fibrinogen (a protein) utilized in the process of clotting.

Blood is a dynamic tissue, the measure of which at any given time represents a balance between the rate of formation and the rate of utilization, storage, or excretion of all of its elements. The cellular elements are formed in the bone marrow and lymph nodes. They are destroyed primarily in the spleen or elsewhere in the reticuloendothelial system of the body. In the presence of disease, these cellular elements may be destroyed at a rapid rate. The dissolved substances of the plasma similarly represent a balance between the amount of materials ingested or formed in the various organs of the body, especially the liver, and the rate of disappearance.

The volume occupied by the packed cellular elements of the blood, in relation to the total volume, is referred to as the hematocrit. The normal range for men is 42—52 percent, for women 37—47 percent. Variations from the normal usually parallel the hemoglobin and erythrocyte values, but in pernicious anemia the hematocrit (and therefore the color index) is disproportionate. In general, anemias exhibit a low hematocrit value, whereas polycythemias or dehydration reveal high values. Calculation of cellular indices is made possible by relating the hematocrit values to the number of erythrocytes and the hemoglobin concentration. This information is of value in the diagnosis of the many types of erythrocytic disorders, particularly pernicious anemia, other macrocytic anemias, congenital hemolytic anemia, and the secondary anemias.

Heretofore, it was either impossible or required long, tedious and laborious medical operations to perform rapid hematocrit determinations and plasma preparation. The circumstances under which these determinations and preparations usually had to be performed included aeromedical evacuation operations, rugged combat zone operations, bedside operations or on flight lines and staging areas. In many instances, there is no external power available and there is no flat laboratory benches available on which to place the instruments which perform these determinations. Furthermore, the apparatus heretofore in use for performing hematocrit determinations and plasma preparation were cumbersome and therefore not easily lifted or carried. Thus, in many instances proper medical assistance could not be carried out and many lives were needlessly lost.

SUMMARY OF THE INVENTION

The instant invention overcomes the problems heretofore encountered and as set forth above. The invention is a miniature, portable, hand-carried, high-powered, high-speed, clinical centrifuge designed to provide rapid (30 sec.) determinations of a patient's packed blood cell volume (hematocrit) and to provide rapid separation of blood cells from blood plasma so that the plasma can be used to conduct chemical assays for body constituents.

The centrifuge of this invention contains a series string of rechargeable nickel-cadmium cells so that it can perform over 50 separate centrifugations before recharging, if necessary. Furthermore, the centrifuge is equipped with a carrying han-

dle so that it may be hand carried during operation. The unit is also equipped with an automatic timer, a brake button for rapid deceleration, a rotor head which accommodates a plurality of sizes of capillary tubes, a built-in surge resistor to prevent initial current surge and thus prolong battery life and motor commutator life, and its own lightweight, detachable, charger base which can be plugged into a variety of line voltages of varying frequency. The centrifuge of this invention is of high value in conducting measurements during aeromedical evacuation operations, on flight lines free of external power sources, in combat areas, in hospital wards, at the bedside, in clinical laboratories or under any conditions where rapid hematocrit determinations are desired or where plasma is needed immediately for chemical analysis.

The centrifuge of the instant invention is completely contained and requires no external power source for prolonged periods. The charger unit, by using a 60 Hz. transformer can be used on either 60 Hz. or 400 Hz. By simple circuit modification, the charger can operate on 24 to 28 volts DC or on any other available power source. The centrifuge, furthermore, features a high speed (up to 18,000 r.p.m.) motor, thus permitting especially short (30 sec.) centrifugation durations. The unit also has a thermal surge resistor which minimizes initial current surge, thus adding greatly to battery charge life and motor commutator life. A spring return, momentary contact, brake switch is utilized to bring the centrifuge to a rapid stop. The brake shorts the armature winding, and the reverse EMF creates an opposing magnetic field which brings the centrifuge rotor to a total stop from full speed in approximately 12 seconds. The internal nickel-cadmium cells, arranged radially about the motor can be recharged hundreds of times and their physical arrangement lends stability to the centrifuge. The centrifuge has its own handle permitting it to be carried while in operation and an O-ring seal is located between its body and its hinged lid. It also has vent holes connecting the rotor chamber to the outside thereby facilitating partial evacuation of the rotor chamber thus permitting a greater top angular velocity. A miniature hematocrit reading scale and a simple magnifying lens can be attached to and carried with the centrifuge of the instant invention.

It is therefore an object of this invention to provide a miniature, clinical centrifuge which will permit rapid hematocrit determinations and plasma preparation.

It is another object of this invention to provide a miniature, clinical centrifuge which eliminates the need for external power for prolonged periods of time.

It is a further object of this invention to provide a miniature, clinical centrifuge which is readily transportable and which can be easily lifted with one hand and carried by its own handle.

It is still another object of this invention to provide a miniature, clinical centrifuge which utilizes conventional, currently available components that lend themselves to standard mass-producing manufacturing techniques.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims:

DESCRIPTION OF THE DRAWING

FIG. 1 represents a front elevational view of the clinical centrifuge and charger of this invention in cross section;

FIG. 2 represents a schematic diagram of the electrical circuitry of the clinical centrifuge and charger of this invention;

FIG. 3 represents an isometric view of the clinical centrifuge of this invention showing the rotor head cover in its removed position; and

FIG. 4 is a cross-sectional view taken along line 4-4 of FIG. 3 in a reduced scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawing, numeral 10 represents the clinical centrifuge of this invention about to be inserted within its charger 12. The centrifuge 10 has a housing 14 made up of cylindrical side portion 16 and base portion 18. Located within housing 14 is any suitable motor 20 such as a high-speed 24 volt DC motor fixedly secured to inner housing wall 22 and motor mounting plate 23. Surrounding motor 20 is a plurality of rechargeable batteries, 24, shown more clearly in FIG. 4. The batteries 24 may be of the nickel-cadmium type and are connected in series. The total no-load voltage available from five such batteries is over 30 volts. This voltage stabilizes at near 25 volts DC during operation with the surge resistor shown in the circuit of FIG. 5.

Referring to FIGS. 1 and 3, a rotor head 26 is secured to the rotor shaft 28 of motor 20 by any suitable securing means such as by key 30 fixedly secured to shaft 28. The rotor head 26 has a plurality of grooves 32 (shown clearly in FIG. 3) therein of various sizes for holding capillary tubes. The rotor head 26 further has a raised lip 34 around its periphery. The lip 34 and grooves 32 are lined with a thin resilient substance 36 such as neoprene, thus obviating breakage of the capillary tubes (not shown) placed in the rotor head grooves 32. The grooves 32 are of various sizes to accommodate microhematocrit capillary tubes as well as larger capillary tubes (heparinized) used to prepare volumes of plasma for chemical analysis. A rotor head cover 38 screws onto the rotor shaft 28. The cover 38 holds the capillary tubes in place within grooves 32 during operation of the centrifuge 10. A knurled knob 40 permits easy removal of the cover 38 when the rotor head grooves 32 are to be exposed. A space 42 surrounds the rotor head 26. This space is partially evacuated during operation through the pumping action of the rotating rotor head 26. This evacuation minimizes air turbulence and permits higher rotor speeds.

There is a layer 44 of insulatory material at the bottom and at the top of batteries 24. Upper vent holes 46 permit evacuation of the rotor head chamber 42 while bottom vent holes 48 establish continuity with the upper vent holes 46, facilitating evacuation of air through the bottom of the centrifuge 10. There is a space 50 located under motor 20 to accommodate wire leads from charger jack 52 and the surge resistor (shown in FIG. 2). A lid 54 has a hinge 56 on one side and a locking-type clasp means 58 on the other side (see FIG. 3). An O-ring 60 provides a tight joint between the centrifuge housing 14 and lid 54.

Referring again to FIG. 1, numeral 12 designates the nickel-cadmium cell charger. The charger 12 has a space 62 into which the centrifuge base portion 18 fits when it is to be charged or operated from external power. A charger plug 64 having an insulation 66 and terminals 68 is imbedded within the charger base 69. The terminals 68 mate with terminals 70 of the charger jack 52. Appropriate polarity is assured by means of a projection 72 on the centrifuge base portion 18 which mates with a slot 74 in the sidewall of charger base 69. The centrifuge 10, therefore, can be fit into the charger 12 in only one way. A space 76 within the charger 12 houses an appropriate stepdown transformer and diode rectifiers, etc.

FIG. 3 shows the clinical centrifuge 10 with the cover 38 in its removed position. A timer mechanism 78 and a brake button 80 are located within side portion 16. The centrifuge 10 is easily carried by means of carrying handle 82 secured by any suitable means to side portion 16.

FIG. 4 shows in more detail the position of batteries 24 within housing 14 surrounding charger jack 52. The timer-forming part of timer mechanism 78 is located within chamber 84. The circuit diagram 86 of the centrifuge 10 is shown clearly in FIG. 2.

MODE OF OPERATION

A blood sample is obtained by means of capillary puncture (e.g. finger stick) or venipuncture. The heparinized capillary tube (not shown) is filled from one-half to three-fourths full with the blood. The blood is moved back and forth within the tube to promote mixing with the anticoagulant. The tube is then blocked at one end with a minute piece of clay or other pliable inert material.

The sealed tube is placed into an appropriately sized rotor head groove 32, the rotor head cover 38 is screwed in place and the lid 54 is shut and locked. The automatic timer mechanism 78 is set for the desired period of centrifugation (normally 30 seconds). While the centrifuge is operating, it may be carried or set aside onto most any irregular surface. After the timer switch opens, braking can be greatly increased by depressing the red brake button 80. The brake shorts the armature winding, and the reverse EMF creates an opposing magnetic field which brings the centrifuge rotor to a total stop from full speed in approximately 12 seconds. When the centrifuge rotor head 26 comes to a complete stop, the lid 54 is opened, the rotor head cover 38 is unscrewed, and the capillary tube is removed. The tube is then placed onto a microhematocrit reading scale and the percent packed cell volume is read off directly.

During storage periods, the centrifuge 10 can be conveniently placed on its charger 12 so that the ni-cad cells 24 are always in a fully charged state and the centrifuge 10 will be always ready for a self-powered mission wherever it may be needed.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims:

We claim:

1. A miniature, portable, self-powered, high-speed clinical centrifuge comprising a housing, a motor means fixedly secured to said housing, a means for energizing said motor means adjacent thereto, a rotor head having a plurality of grooves therein operably connected to said motor means, a rotor head cover removably secured to said motor means and proximate said rotor head, a lid removably secured to said housing for covering said rotor head and rotor head cover, said housing having a base portion, said base portion having a charger jack mounted therein and operably connected with said energizing means, and a removable charger having a charger plug thereon capable of being inserted within said charger jack for charging said energizing means, whereby energizing of said motor means operates to rotate said rotor head at a high speed thereby separating blood cells from blood plasma within a capillary tube located within said grooves.

2. A miniature, portable, self-powered, high-speed clinical centrifuge as defined in claim 1 further comprising a timer mechanism within said housing and operably associated with said motor means for regulating the operation thereof.

3. A miniature, portable, self-powered, high-speed clinical centrifuge as defined in claim 2 further comprising a brake within said housing and operably associated with said motor means for quickly bringing said rotor head to a total stop.

4. A miniature, portable, self-powered, high-speed clinical centrifuge as defined in claim 3 wherein said motor means is provided with a shaft secured thereto, said rotor head being fixedly secured to said shaft and said rotor head cover being removably secured to said shaft.

5. A miniature, portable, self-powered, high-speed clinical centrifuge as defined in claim 4 wherein said rotor head further has a raised lip around its periphery, said lip and said grooves being lined with a thin resilient substance to prevent breakage of capillary tubes placed therein.