May 5, 1959 K. E. H. DANIELSSON ET AL 2,885,145

CENTRIFUGES

Filed Oct. 15, 1957 3 Sheets-Sheet 1

Fig.1

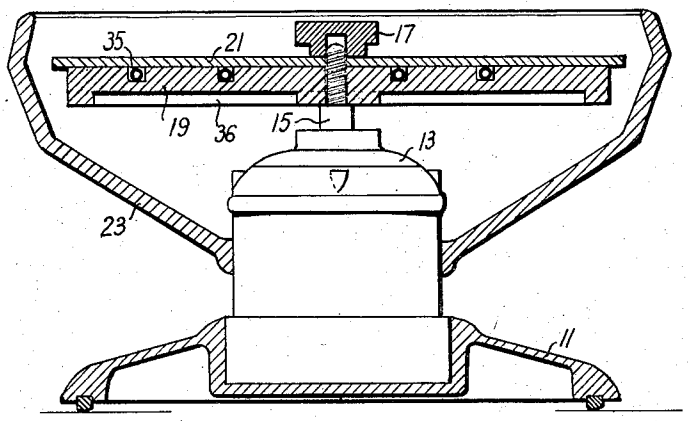
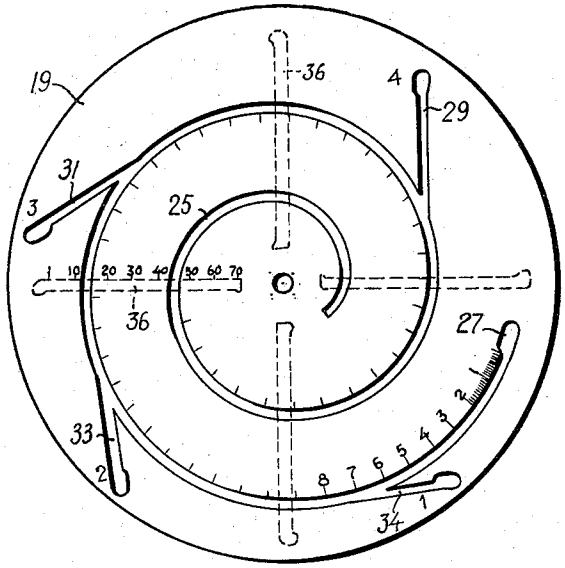



Fig.2




INVENTORS
KARL ERIK HARRY DANIELSSON
JOHAN FOLKE SIGURD LUNDMARK
BY Cushman, Darby & Cushman
ATTORNEYS

May 5, 1959 K. E. H. DANIELSSON ET AL 2,885,145

CENTRIFUGES

Filed Oct. 15, 1957 3 Sheets-Sheet 2

Fig. 3

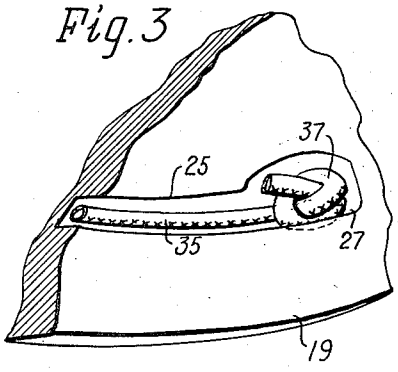



Fig. 4

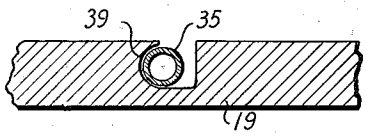



Fig. 6

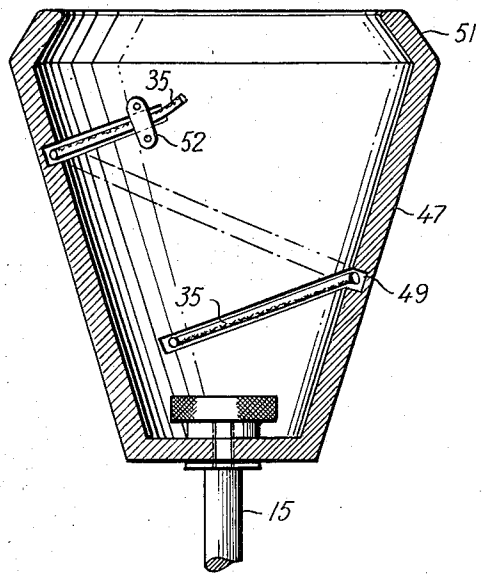
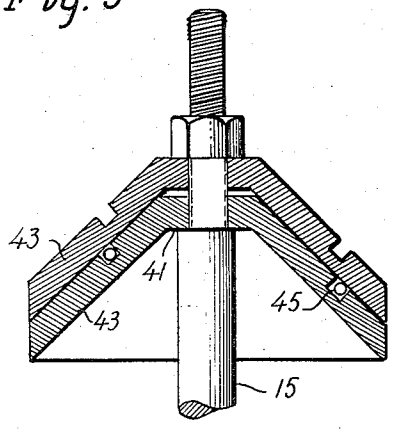



Fig. 5




INVENTORS
KARL ERIK HARRY DANIELSSON
JOHAN FOLKE SIGURD LUNDMARK
BY Cushman, Darby & Cushman
ATTORNEYS

May 5, 1959 K. E. H. DANIELSSON ET AL 2,885,145

CENTRIFUGES

Filed Oct. 15, 1957 3 Sheets-Sheet 3

Fig. 7

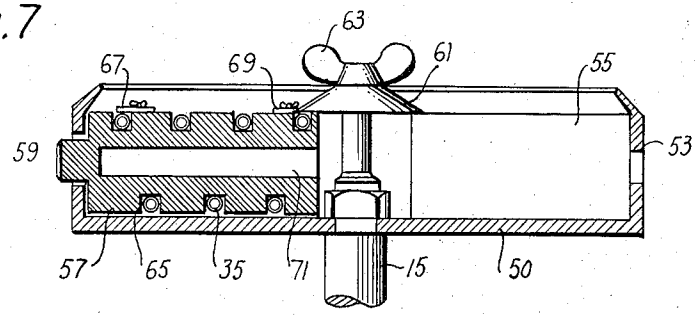
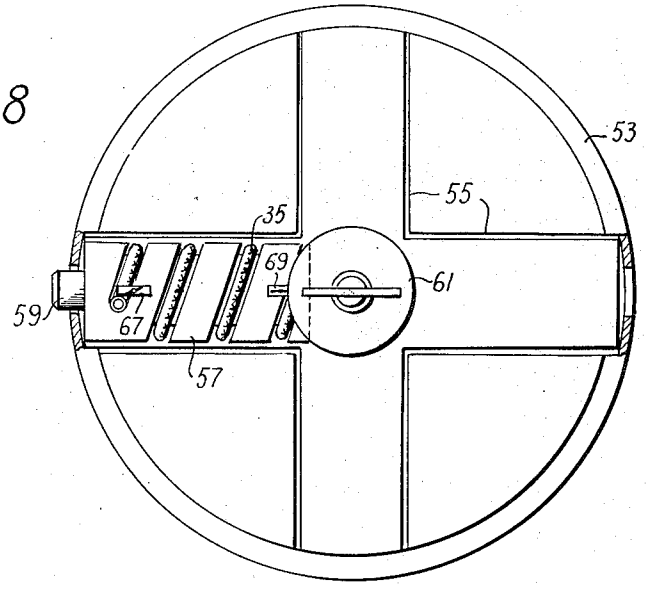



Fig. 8




INVENTORS
KARL ERIK HARRY DANIELSSON
JOHAN FOLKE SIGURD LUNDMARK
BY Cushman, Darby & Cushman
ATTORNEYS

United States Patent Office

2,885,145

Patented May 5, 1959



2,885,145

# CENTRIFUGES

Karl Erik Harry Danielsson and Johan Folke Sigurd Lundmark, Orebro, Sweden, assignors to Bo Nyman Abn Aktiebolag, Tyreso, Sweden, a company of Sweden

Application October 15, 1957, Serial No. 690,268

Claims priority, application Sweden October 19, 1956

14 Claims. (Cl. 233—26)

This invention relates to centrifuges of the type used in clinical and chemical laboratories for the purpose of subjecting samples of liquid suspensions to centrifugal forces.

It is an object of the invention to provide a centrifuge of the above character by which the suspended particles of the sample are easily separated from the liquid, or by which particles of different specific gravity or sedimentation rate are easily separated from each other.

It is a further object of the invention to provide a centrifuge of the above character which enables an accurate determination of the relative quantity of the particles suspended in the liquid.

Another object of the invention is to provide a centrifuge in which sample tubes of extraordinary lengths can be subjected to centrifugal action.

Still another object of the invention is to provide a centrifuge which is small, inexpensive and handy in operation, and which does not involve any hazards to the personnel operating the same.

Further objects of the invention will appear from the following description in which some embodiments of the invention have been set forth in detail with reference to the accompanying drawings.

Referring to the drawings:

Fig. 1 is an elevational cross-sectional view of a first embodiment of the centrifuge incorporating the present invention. Fig. 2 is a top plan view of a tube holder forming part of said centrifuge. Fig. 3 is a perspective fractional view on a larger scale of said tube holder and a sample tube held thereby. Fig. 4 shows a modification of a detail. Fig. 5 is a cross-sectional view of a second embodiment, and Fig. 6 is a similar view of a third embodiment of the tube holder. Fig. 7 is a cross-sectional view of a fourth embodiment of the head of the centrifuge, and Fig. 8 is a top plan view of the same.

Referring to Fig. 1, the numeral 11 designates a base carrying an electric motor 13 capable of running at a speed of 3000 revolutions per minute or more. Attached by means of a threaded knob 17 to the upper end of the vertical shaft 15 of the motor is a head consisting of a holder in the shape of a flat circular disk 19 and a flat covering disk 21. 23 designates a protecting bowl surrounding the rotary parts.

The holder disk 19, the diameter of which is of the order of 6 inches, is preferably made of a transparent thermoplastic material. Moulded in its upper side is a groove 25 of a rectangular cross-section running one or more turns around the centre of the disk and at an increasing distance therefrom, thus having the configuration of a plane spiral. The length of the groove may be about 20 inches. At its outer end the groove is widened. Straight branch grooves 29, 31, 33 and 34 extend tangentially from the spiral groove 25 and form different angles to the radial direction. Four radial grooves 36 are formed in the the lower face of the disk.

The sample tubes pertaining to the centrifuge consist



of a thin and flexible tube of a transparent or translucent plastic material, such as polyvinyl chloride, polyethylene or similar, cut in appropriate lengths, e.g. 20 inches. The inner diameter of the tube is of the order of 1/24 of an inch and the wall thickness is about 1/100 of an inch. Such a tube can easily be cut by an ordinary pair of scissors. The tube can easily be closed by doubling up the tube end and tying the same with a cord or simply by tying a knot on the tube end itself.

The spiral groove 25 of the disk 19 is of such a size that a tube piece 35 of the above-mentioned shape can be inserted therein, the knot 37 being placed into the widened part 27 of the groove. Preferably the depth of the groove corresponds closely to the outer diameter of the tube, and the width may be somewhat smaller than the diameter of the tube, whereby the tube is held by frictional engagement with the groove sides. When the cover 21 has been put on and the knob 17 screwed up, the tube is securely held and cannot be thrown out of the groove during the centrifugation. The cover 21 is made of a transparent plastic material, such as acrylate, which makes it possible after stopping the centrifuge but without removing the tube from the holder to inspect and read off the length of the column of heavier particles of the investigated liquid, collected in the end of the tube. When desired, the part of the tube containing such a column of interest may be sheared off and subjected to a further centrifugal action. In that case the tube piece cut off is placed in any of the straight grooves 29, 31, 33 and 34 forming angles to the radius of the disk, or the disk is turned upside down and the tube piece is placed in one of the radial grooves 36. When centrifuging blood samples the red blood cells are collected to form a column at the outermost end of the tube, the white blood cells which are not quite so heavy, form a short column at the inner side thereof and the innermost greater part of the tube is filled with the lighter, almost colourless blood plasma. The borders of the different columns are easily perceivable and if, for instance, it is desired to further investigate the white blood cells they can easily be separated by cutting off the corresponding part of the tube.

A number of samples can be treated by centrifugal action simultaneously, a corresponding number of holder disks 19 with tubes inserted in their spiral grooves being piled on top of each other and commonly attached to the shaft by the knob 17. An upper disk will then close the groove of a lower disk and confine the flexible tube. If the branch grooves 29, 31, 33 and 34 are dispensed with, a number of parallelly running spiral grooves may be provided in one and the same disk face.

Fig. 4 shows a preferable profile of the groove which can be made by a milling cutter. The outer side is undercut and given a circular cross-section so as to suit the shape of the tube 25. The narrow entrance of the groove has a slightly smaller width than the diameter of the tube, and therefore the tube is safely retained in the groove after having been forced through said entrance with a certain elastic deformation. The tube is pressed against the groove side 39 also due to its elastic resistance to being curved. During the centrifugal action the tube is pressed still more forcefully against the groove side 39, so that there is no risk for the tube being thrown out. Therefore, with said shape of the groove the cover disk 21 may be dispensed with.

Usually the spiral groove is of a uniform width except at its outer end. However, it may exceptionally be formed with narrow parts, where the flexible tube pressed down into the groove is more or less flattened, so that its cross-sectional area is diminished. In this way a short column of particles which is collected in said part of the tube is lengthened which makes it easier to estimate the

relative content of said particles or to separate the same by cutting off the tube. The same object can be reached by manufacturing the tube with narrow parts.

In the embodiment shown in Fig. 5 the holder consists of a central flat part 41 and a conical part 43. Cut out in the outer face of the conical part is a groove 45 having the configuration of a conical spiral with its centre on the axis of rotation of the holder and having a cross-section suitable to house the tube 35. A number of said holders may be piled and simultaneously attached to the motor shaft of the centrifuge. The groove 45 is closed and the tube 35 is prevented from being thrown out, by the holder following next in the upward direction.

In the embodiment shown in Fig. 6 the holder is made in the shape of a bowl 47 having an inner conical surface tapering downwardly, in which a groove 49 having the shape of a conical spiral is cut out. A tube placed in said groove is pressed down into the bottom of the groove by the centrifugal forces and therefore the groove may be left open during the centrifugation. The bowl has an inwardly directed edge 51 for catching the tube in case it would come loose anyway. Arranged at the upper and outermost end of the groove is a clamping device 52 by means of which the end of the coiled tube loosely tucked down into the groove is fastened, so that the tube cannot slide in its longitudinal direction. The clamping device also serves to close the tube end.

In the embodiment shown in Figs. 7 and 8, there is attached to the shaft of the motor of the centrifuging a disk 50 having at its periphery an annular flange 53 with an inwardly directed edge. Vertical plates 55 attached to the upper side of said disk form four radially directed compartments, in each of which a cylindrical tube holder 57 can be placed. One end of said holder is held by a pin 59 inserted into a bore in the annular flange 53, and the other end is held by a washer 61 and a wing nut 63 threaded upon the central shaft 15. The cylindrical surface of the holder 57 has a groove 65 in the shape of a square screw thread. When the flexible tube 35 is wound around the holder 57 and the holder clamped to the disk 50, the tube forms a cylindrical spiral with its axis located in an axial plane and at right angles to the axis of rotation. At the outer end as well as at the inner end of the groove there are provided clamping devices 67 and 69, respectively, by means of which the tube ends are fastened to the holder and closed during the centrifugation. The holder 65 has a central bore 71, into which a piece of the flexible tube or an ordinary sample tube of glass can be inserted for being centrifuged.

The above-described embodiments are merly examples which may be modified in various respects without departing from the general inventive idea as set forth in the following claims.

We claim:

1. In a centrifuge, a head mounted for rotation about a vertical axis, a flexible sample tube, and means for defining a spiral configuration of the sample tube when associated with said head.



2. In a centrifuge, a rotary head having a groove, a thin flexible sample tube inserted in said groove, said groove being at least as wide as the diameter of the tube and having a longitudinal orifice of a width smaller than diameter of the tube, whereby passage of the tube through said orifice requires elastic deformation of the tube.

3. In a centrifuge, a motor-driven vertical shaft, a horizontal circular disk centrally attached to said shaft, said disk having a spiral-shaped groove in its upper face for housing a flexible sample tube.

4. In a centrifuge, a motor driven vertical shaft, a circular disk centrally attached to said shaft, said disk having a spiral groove in its flat face, a flexible sample tube located in said groove, and a second disk bearing against said first-mentioned disk to confine said tube in said groove.

5. A centrifuge as set forth in claim 4, in which said disks and said tube are made of transparent material.

6. For use in a centrifuge, a circular disk having a central aperture for attachment, a spiral groove in the flat face of said disk, said groove encircling said central aperture and having a length greater than the diameter of the disk.

7. A disk as set forth in claim 6, in which the cross section of the groove is uniform over essentially the entire length of the groove, the outermost part of the groove being widened.

8. A disk as set forth in claim 6, in which the cross section of the groove is locally restricted.

9. A disk as set forth in claim 6, having a radially directed groove in the face opposite to the face having the spiral groove.

10. A disk as set forth in claim 6, having a straight groove tangentially joining the spiral groove.

11. A disk as set forth in claim 6, having a plurality of straight grooves forming different angles to the radial direction.

12. A disk as set forth in claim 6, being made of a plastic transparent material.

13. In a centrifuge, a head mounted for rotation about a vertical axis, said head comprising a conical tube holder having a groove forming a conical spiral on the surface of said tube holder, and a flexible sample tube confined in said groove.

14. In a centrifuge, a head mounted for rotation about a vertical axis, a spiral groove in said head, and clamping means on said head for attaching and closing the end of a flexible sample tube inserted in said groove.

**References Cited** in the file of this patent

UNITED STATES PATENTS

2,783,938 Grela ---------- Mar. 5, 1957