March 5, 1957 M. W. GRELA ET AL 2,783,938

CENTRIFUGE FOR CAPILLARY TUBES

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Fig. 1

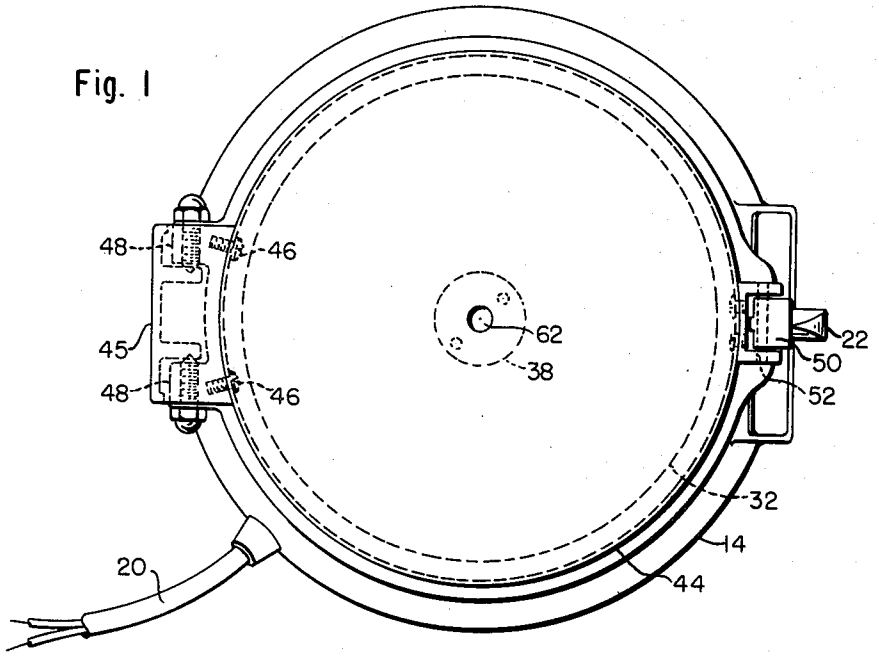

Fig. 2

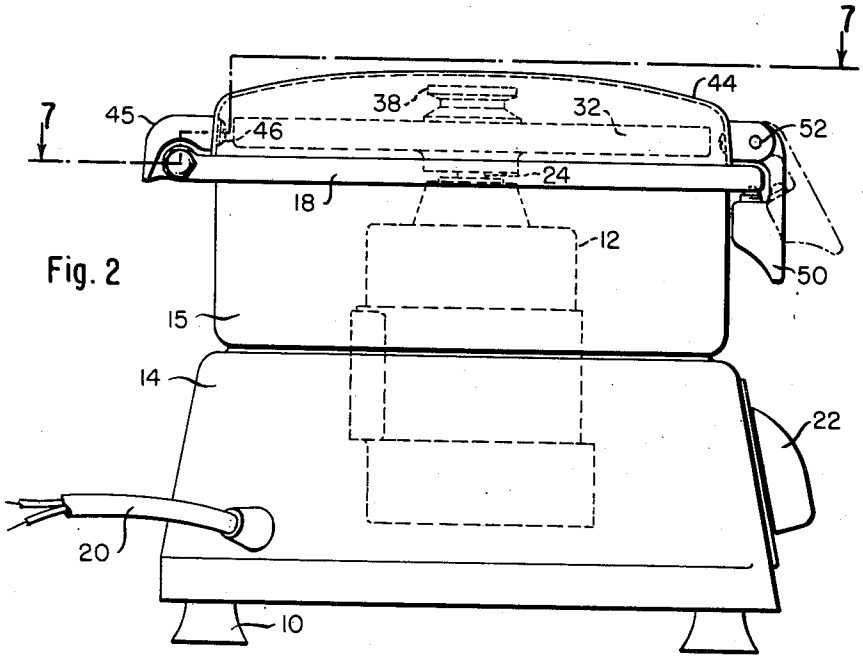

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Fig. 3

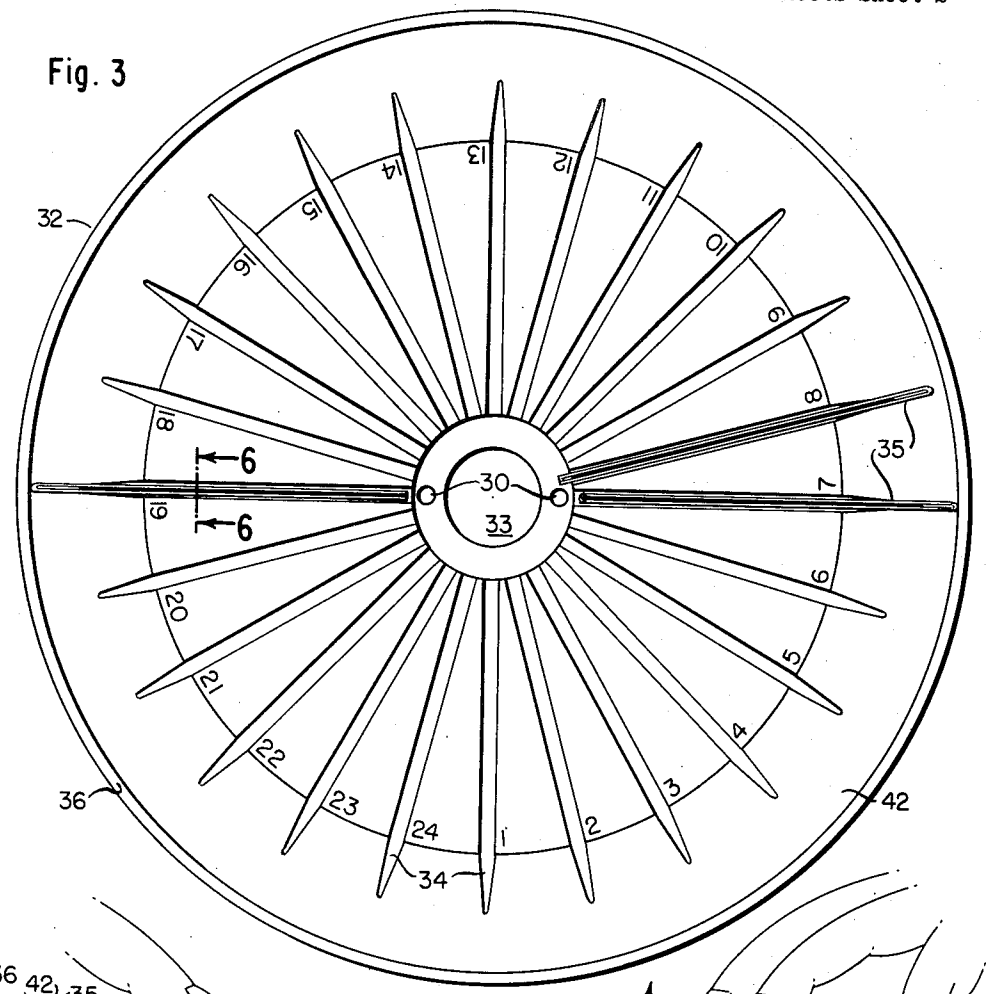

Fig. 4

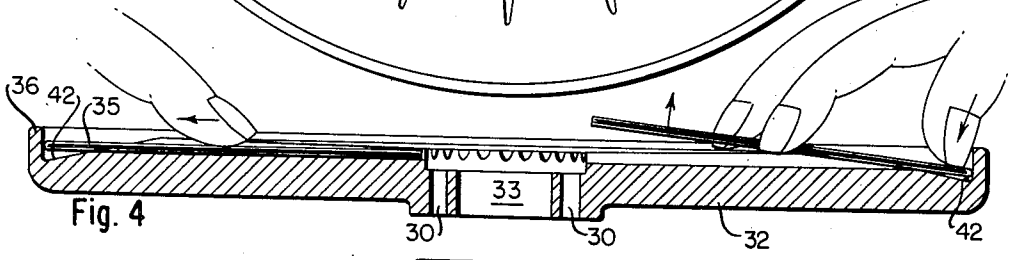

Fig. 5

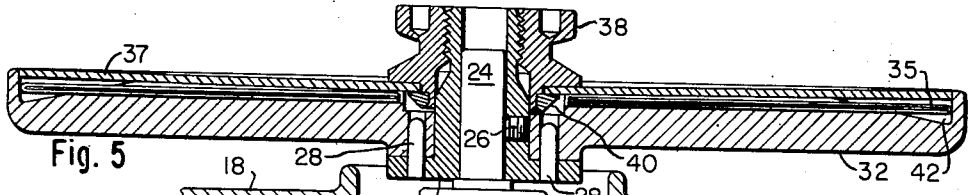

Fig. 6

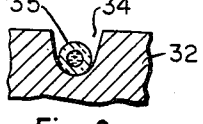

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Fig. 7

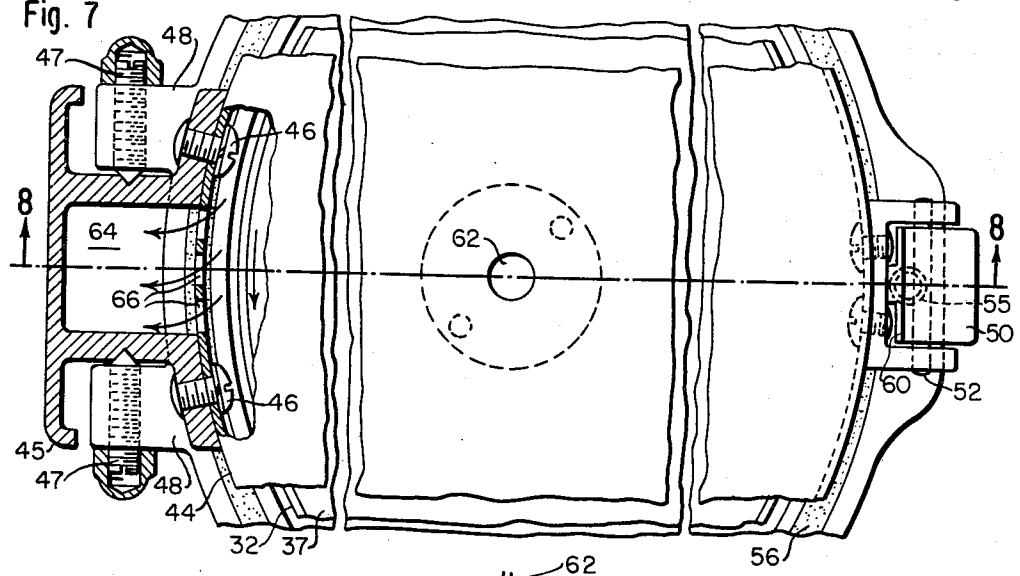


Fig. 8

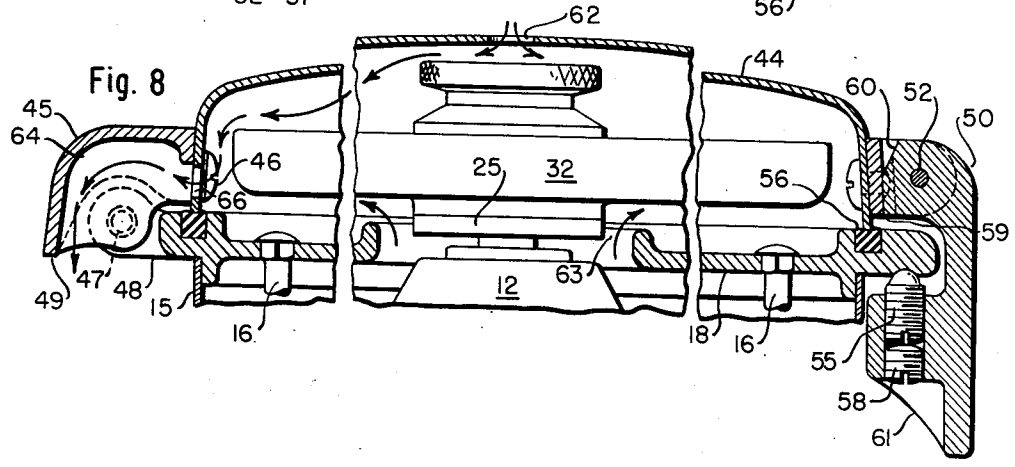
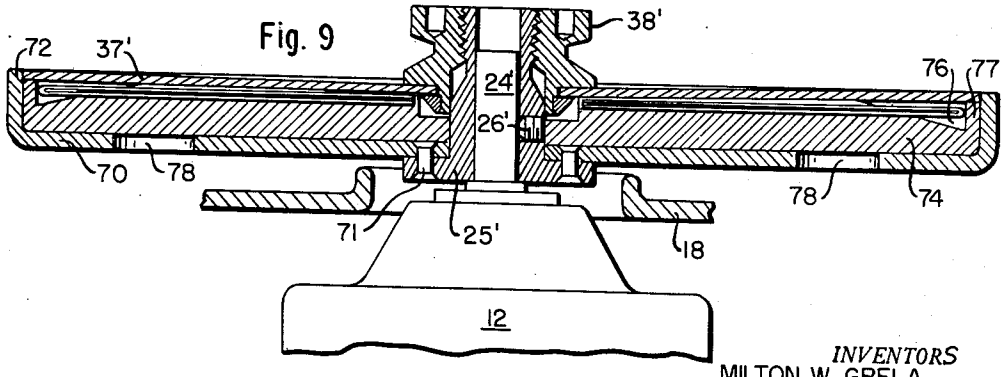


Fig. 9



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CENTRIFUGE FOR CAPILLARY TUBES

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Application November 15, 1954, Serial No. 468,676

7 Claims. (Cl. 233—11)

This invention relates to a novel and improved centrifuge particularly adapted to perform hematocrit determinations on blood samples to pack the red blood cells to the bottom of each small bore capillary tube so that accurate determinations of the red cell volume in whole blood can be obtained. The centrifuge includes a table for supporting the tubes in radial arrangement and for rapid rotation therewith about a vertical axis, and it will be understood that the invention is applicable to all micro techniques which require high centrifugal force to make separations of solids vs. liquids or liquids vs. liquids.

The table is radially grooved to support the capillary tubes and includes a marginal abutment flange for receiving and limiting outward movement of the tubes. The table is furthermore recessed adjacent to its outer margin to a depth below the grooves to permit easy removal of the tubes and easy cleaning of the table, all as hereinafter described. The top surface of the table is furthermore slightly inclined downwardly toward the center and is adapted to receive a disk over and covering the tubes. Means is provided in association with the disk and table to secure the disk tightly to the table and the inclined tube surface permits a slight dishing of the disk to hold it against fluttering or vibrating movements.

The rapidly rotating table is enclosed within an inverted pan-like cover and novel means is provided for mounting and securing the cover tightly on the table, such means including a hinge bracket and a cooperating latch. Releasing of the latch permits lifting of the cover and in its open position the latch serves as a lifting handle. A further feature of the invention includes novel air intake and exit passages to and from the cover for cooling the tubes and protecting the operator against blood and glass fragments in case of tube breakage.

These and other features of the invention hereinafter more specifically described have been combined to produce a superior centrifuge for handling capillary tubes and the primary object of the invention resides in the production of this improved combination as and for the purpose described.

These and other features of the invention will be best understood and appreciated from the following detailed description of preferred embodiments thereof, selected for purposes of illustration and shown in the accompanying drawings, in which:

Fig. 1 is a plan view of a centrifuge embodying the invention,

Fig. 2 is a side elevation thereof,

Fig. 3 is a plan view of the table,

Fig. 4 is a vertical sectional view through the table,

Fig. 5 is a like view through the table and its support,

Fig. 6 is a detailed sectional view taken on line 6—6 of Fig. 3,

Fig. 7 is an enlarged fragmentary plan view of the centrifuge, partially in horizontal section on line 7—7 of Fig. 2,

Fig. 8 is an enlarged fragmentary elevation, partially in vertical section on line 8—8 of Fig. 7, and

Fig. 9 is a vertical sectional view of a modified construction.

As illustrated in Fig. 2, the centrifuge includes a base supported on rubber feet 10 and carrying an electric motor 12. A lower housing 14 is mounted on the base and carries an upper housing 15. Also supported on the housing 15 and held by bolts 16 is a supporting plate 18. The motor is energized through a cord 20 and controlled by a timing switch 22.

The motor shaft 24 extends upwardly through the support 18 and has a bushing 25 mounted thereon and secured thereto by a set screw 26. The bushing carries two upwardly extending driving pins 28 to be received within holes 30 in a circular table 32, the table having a centrally disposed hole 33 for receiving the bushing and centering the table thereon as illustrated in Fig. 5. The top surface of the table is radially grooved at 34 to receive and support micro capillary tubes 35, the grooves being numbered as indicated in Fig. 3. The table includes an annular flange 36 at its margin in alignment with the grooves and adapted to serve as an outer end abutment for the tubes.

The tubes are placed in the grooves 34 as illustrated and are held therein by a disk 37 disposed to engage the top surface of the table. A securing nut 38 is swiveled to the center of the disk and carries a beveled ring 40 on its inner end. The nut and bushing 25 are threaded for coengagement as illustrated in Fig. 5 whereby the disk can be drawn down into tight engagement with the table. The top surface of the table is slightly tapered or inclined downwardly toward its center whereby to dish the disk and hold it more securely against fluttering or vibrating on the table, the center portion of the table top being about .010 inch lower than the outer portion. The swiveling of the nut about the disk permits tightening of the nut without rotating the disk and the bevel on the ring 40 is adapted to engage any tubes extending into the opening in the table and to force them outwardly toward the flange 36, it being understood that the tubes should be in contact with the flange before starting the machine.

Removal of the tubes from the grooves is facilitated by recessing the table at 42 outwardly of the grooves. This recess, as illustrated in the drawings, extends annularly about the table between the grooves and the flange 36 to a depth below the grooves, and the bottom of the recess inclines outwardly-downwardly in the direction of the flange. Removal of a tube is thus facilitated, as illustrated in Fig. 4, by pressing the outer end of the tube downwardly into the groove and grasping its raised inner end between the fingers. Since the tubes are very small and difficult to grasp, this novel and convenient method of removal is especially convenient and comprises an important feature of the invention.

During operation of the centrifuge the table is housed within a pan-like cover 44 inverted thereover as illustrated in Fig. 8. The cover is hinged to the support 18 by a hinge bracket 45 bolted to the side wall of the cover at 46 and pivotally engaged by opposed threaded studs 47 in lugs 48 integral with the support. The free end 49 of the hinge bracket is adapted to engage the upper housing 15 and serve as a stop limiting opening movement of the cover and holding it in open position.

A latch 50 pivoted at 52 to the cover, opposite to the hinge bracket 45, cooperates with the hinge bracket to secure the cover tightly in closed position. The latch includes a fibrous threaded plug detent 55 of nylon or like resilient material positioned to engage beneath the margin of the support 18, as illustrated in Fig. 8, to draw and hold the cover in tight contact with a resilient gasket 56 in the top surface of the support, thereby holding

the cover secured against vibration and chatter. The detent **55** can be rotatably adjusted to make the desired contact with the support and a locking plug **58** is threaded thereagainst to hold the detent secure in adjusted position. The latch is provided with a shoulder **60** which limits its outward pivotal movement to the position shown in broken lines in Fig. 2 in which position the latch serves as a handle for raising the cover. Cooperating shoulders on the latch and cover at **59** also serve to limit inward movement of the latch to the position illustrated in Fig. 8. The bottom end of the latch is beveled at **61** which bevel serves automatically to snap the latch to closed position should the cover fall, the bevel **61** in such case engaging the margin of the support **18** which thereupon snaps the latch outwardly with a reaction **60** that snaps the latch inwardly to closed position.

A further feature of the invention includes novel ventilating and cooling of the table and tubes, a centrally disposed hole **62** is provided in the cover over the table and rotation of the table draws air inwardly through the hole and onto the table. This air, together with air passing upwardly through the support at **63**, cools the table and tubes. The hinge bracket **45** is chambered at **64** to provide a passage outwardly and downwardly therethrough and exit holes **66** through the cover are located at this chamber. Such location of the exit holes serves to protect the operator and others against possible blood splash or glass particles in case of tube breakage.

In Fig. 9 we have illustrated a modified construction in which the rotary table comprises a circular pan **70** secured as by rivets **71** to the bushing **25'**, a set screw **26'** securing the bushing to the motor shaft **24'**. The pan has an annular flanged margin **72** and a tray insert **74** is mounted therein. The tray is radially grooved to support the tubes and its outer portion is annularly recessed at **76** including an annular abutment **77** for the same functions illustrated at **42** and **36** in Fig. 4, the tray preferably being formed of aluminum or other suitable light weight material. The flange **72** serves as an abutment for the tubes and the tubes are secured in place by a disk **37'** and nut **38'** in the manner already described. The pan is provided with finger holes at **78** to aid in removing the tray. This removable tray form of the invention is particularly useful where several trays are required for collections from different wards or laboratories, and since the pan **70** provides full support the tray can be made from various materials as by stamping, molding, etc. and thus substantially reduce the cost of manufacture.

The tray **32** and tray insert **74** are freely removable from the machine and each can be employed as a tray for collecting the tubes, it being understood that a record of the tubes by the numbers indicated in Fig. 3 is made at the time of collection. The tubes should be placed with their closed ends against the abutment flange **36** since otherwise their outward movement by centrifugal force might cause tube breakage. When the tubes and table are in place on the machine, the disk **37** is applied and tightened to the position shown in Fig. 5. The tapered ring **40** thereupon serves the function of moving outwardly any tube that extends into the table opening **33** and the slight dishing of the disk into tight contact with the top surface of the table fully encloses the tubes in their grooves and secures the disk against vibration.

The loaded table is rotated at high speed (11,000 R. P. M.) for a predetermined period of four or five minutes, the time period being automatically controlled by the switch **22**. During this operating period the table is housed within the cover **44** pivoted to the support **18 at 47** and secured tightly against a resilient gasket **56** by the latch **50**. The latch detent **55** cooperates with the resilient gasket to secure a tight closing of the cover and the adjustable mounting of the resilient detent aids substantially in this function. Rotation of the table causes air to be drawn in at **62** and **63** and to circulate over the table and outwardly through the holes **66** and chamber **64**. This air cools the table and tubes and the locating of the exit at and through the hinge bracket **45** protects the operator and others against possible blood splash and glass fragments in case of tube breakage.

The machine automatically stops at the end of the predetermined time period, whereupon the latch **55** is released to the broken line position (Fig. 2) and employed as a handle in raising the cover. The tubes are then conveniently removed as illustrated in Fig. 4 by depressing the outer end of the tube into the recess **42** and grasping the raised end between the fingers. The recess **42** serves the additional functions of receiving any blood or glass fragments caused by tube breakage and facilitating the thorough cleaning of the table.

Having thus disclosed our invention what we claim as new and desire to secure by Letters Patent is—

1. A centrifuge for capillary tubes, comprising a table, means for supporting the table horizontally on a vertical central axis and rotating it thereabout, the top surface of the table having a plurality of grooves disposed radially therein for receiving and supporting capillary tubes, a tube engaging abutment carried by the table outwardly of and in alignment with each groove at the margin of the table, a disk adapted to rest on the top surface of the table over the grooves, and means for securing the disk in tight contact with the top surface of the table, the table being recessed to a depth below the grooves between the outer end of each groove and the abutment and thereby permitting the outer end of each tube to be depressed downwardly to a position raising its inner end portion to a finger grasping position above the table.

2. The centrifuge defined in claim 1 in which the bottoms of the recesses at the outer ends of the grooves slope downwardly toward the abutments and limit said raising of the tubes to a predetermined position.

3. A centrifuge for capillary tubes, comprising a circular table, means for supporting the table horizontally on a vertical central axis and rotating it thereabout, the top surface of the table having a plurality of grooves disposed radially therein for receiving and supporting capillary tubes, a tube engaging abutment carried by the table outwardly of and in alignment with each groove at the margin of the table, a disk adapted to rest on the table over the grooves, means for securing the disk in tight contact with the top surface of the table, a fixed support beneath the table, an inverted pan-like cover disposed against the support over and housing the table, means including a hinge bracket attached to the side wall of the cover for holding the cover disposed over the table and permitting pivotal movement of the cover away from the table, and means including a centrally disposed hole through the cover over the table and a passageway through the hinge bracket and cover side wall for conducting air into the cover, over the table and outwardly through said passageway.

4. A centrifuge for capillary tubes, comprising a circular table having a centrally disposed opening, a vertically disposed member adapted to be received within the opening and center the table thereon, means for rotating the member and table, the top surface of the table having a plurality of grooves disposed radially therein for receiving and supporting capillary tubes, an upwardly extending annular flange at the margin of the table outwardly of and in alignment with the grooves, a disk adapted to rest on the table over the grooves, means including a knob loosely swivelled to the center of the disk for cooperating with said vertically disposed member to secure the disk in tight contact with the table, and means carried by the knob for engaging the inner ends of the tubes and forcing them longitudinally toward the annular flange.

5. A centrifuge for capillary tubes, comprising a circular table, means for supporting the table horizontally on a vertical central axis and rotating it thereabout, the top surface of the table having a plurality of grooves disposed radially therein for receiving and supporting capillary tubes, a tube engaging abutment carried by the table outwardly of and in alignment with each groove at the margin of the table, a disk adapted to rest on the table over the grooves, means for securing the disk in tight contact with the top surface of the table, the table comprising a circular pan and a removable disk-like insert therein provided with said grooves in its top surface, and an upwardly extending flange at the outer margin of the insert providing said tube engaging abutment outwardly of each groove.

6. A centrifuge for capillary tubes, comprising a table, means for supporting the table horizontally on a vertical central axis and rotating it thereabout, the top surface of the table having a plurality of grooves disposed radially therein for receiving and supporting capillary tubes, an upwardly extending annular flange at the margin of the table outwardly of and in alignment with the grooves, the top surface of the table tapering slightly downward toward said central axis, a disk adapted to rest on the table over the grooves, and means disposed at said axis for securing the disk in tight contact with said tapering top surface.

7. A centrifuge for capillary tubes, comprising a housing, an electric motor within the housing and having a rotary shaft disposed vertically upward therefrom, a shallow pan-like table mounted horizontally on the top

end of the shaft with the shaft disposed centrally of the table, the top surface of the table having a plurality of grooves disposed radially therein for receiving and supporting capillary tubes and the table having a marginal annular flange extending upwardly therefrom outwardly of the grooves, said top surface of the table being substantially horizontal and flat substantially throughout its area inwardly of said annular flange and the table being recessed downwardly from said top surface to a depth below and transversely across the grooves for facilitating the grasping and removal of the tubes, a cover disk disposed to fit the table and rest in surface contact on said top surface within the flange, and means for securing the disk in tight surface contact with the table over the grooves.

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