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J. W. MAGEE ET AL

2,809,020

SHAKER

Filed April 9, 1954

2 Sheets-Sheet 1

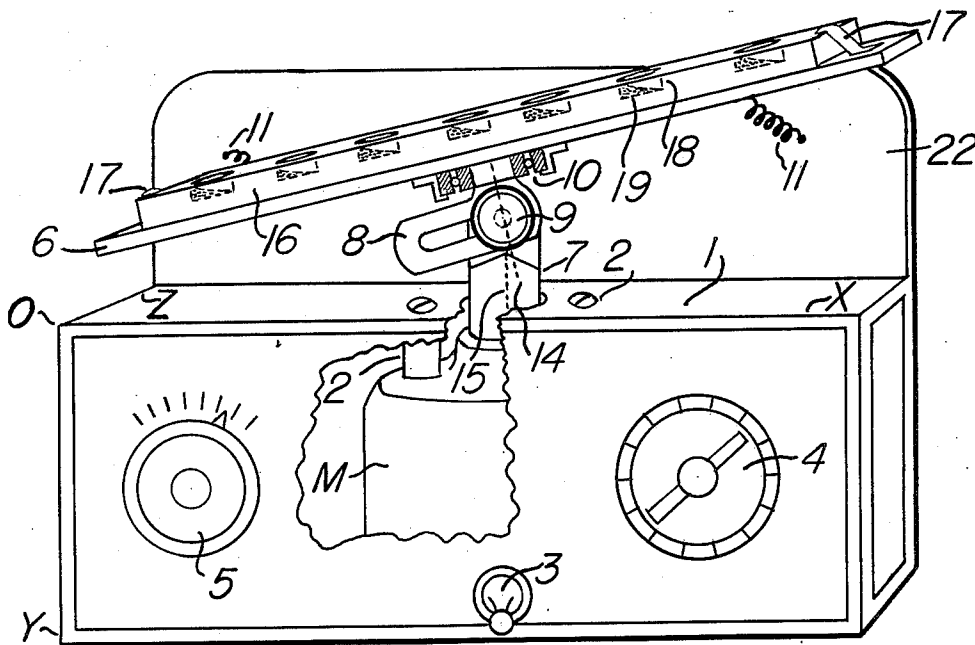


FIG. 1

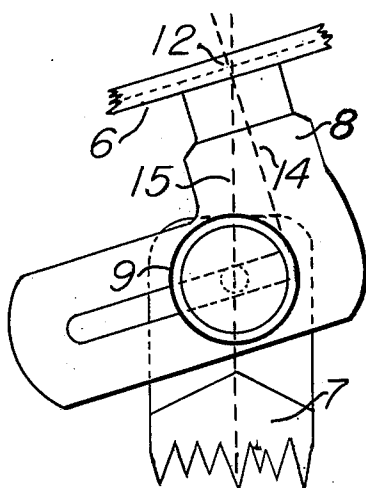


FIG. 2

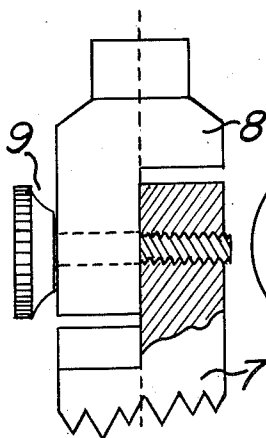


FIG. 3

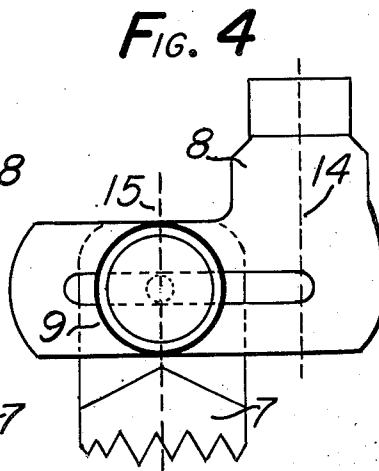


FIG. 4

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2 Sheets-Sheet 2

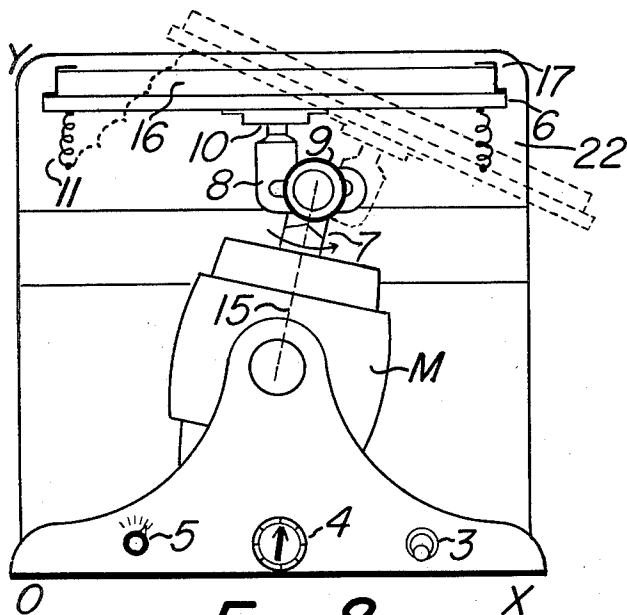
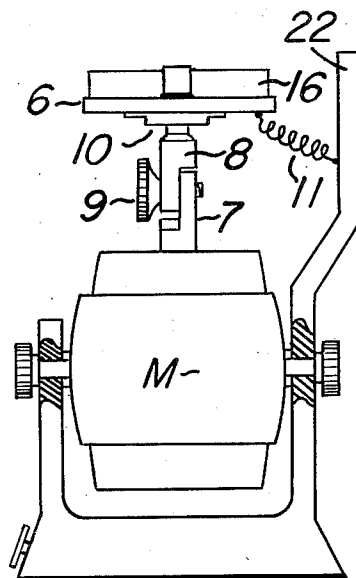


FIG. 8



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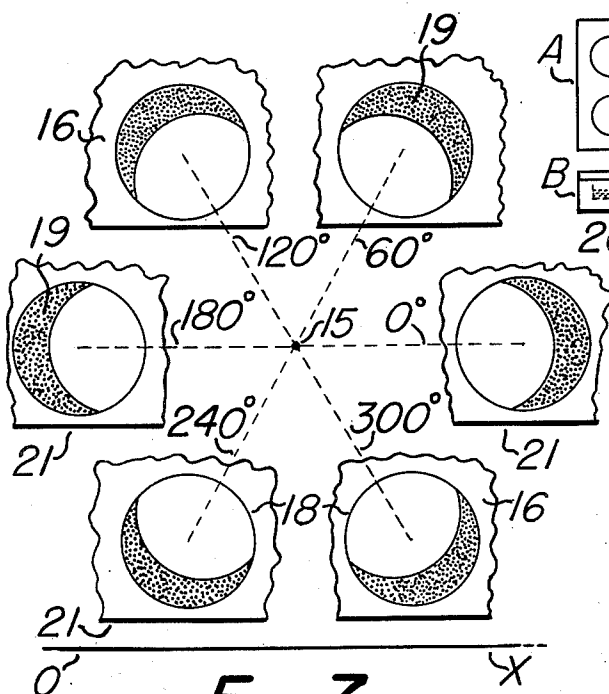


FIG. 7

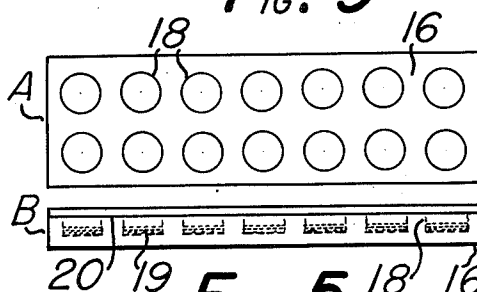


FIG. 5

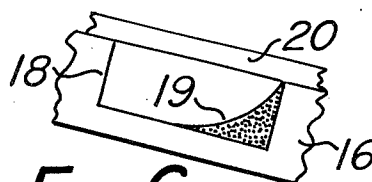


FIG. 6

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SHAKER

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7 Claims. (Cl. 259—72)

This invention relates generally to shakers and more particularly to new and useful improvements in shakers of the type used in laboratories and clinics to perform certain routine operations as in making a Kline test or as in blood typing of fresh blood or grouping of dried blood.

Although in the interest of clarity the present description is directed to a shaker for blood grouping or typing, it will be manifest to those skilled in the art that the principles of the present invention are readily capable of application to shakers for a wide variety of other purposes.

It is well known that in clinical and related work, particularly in the field of serology, many procedures require the agitation of the substance or substances under examination, in order to insure the proper mixture or reaction of the materials involved. For example, in performing grouping tests on dried blood, a portion of the routine involves shaking absorbed globulins, such as Anti-A and Anti-B globulins, with known group "B" or group "A" red blood cells, respectively. It can readily be appreciated that in the grouping or typing of hundreds of blood specimens, manual agitation or mixing not only would be fatiguing and wasteful of many man-hours of effort, but also would introduce serious questions of uniformity and reproducibility of technique, particularly where several technicians are employed in simultaneous mixing operations. Laboratory experience therefore reflects a need for an inexpensive, simple shaker capable of performing such operations with a maximum of uniformity and with a minimum of attention from the supervising technician.

Accordingly, a primary object of the present invention is to provide a novel mechanical shaker which will simulate as nearly as possible the various manual shaking motions heretofore found by experience to provide best results in laboratory and clinical techniques of the type described.

A further object of the invention is to provide a shaker of the character described which is relatively simple and inexpensive to manufacture, and which will require a minimum of maintenance, repair, and operational expense.

Still a further object of the invention is to provide a shaker of the type set forth which is extremely quiet in operation.

With the foregoing objects in view, the invention consists in the novel combinations and arrangements of features, as will be hereinafter more fully described, illustrated in the accompanying drawings, and defined in the appended claims.

In the accompanying drawings, wherein are illustrated different practical embodiments of the invention and wherein like characters of reference denote corresponding parts in related views:

Figure 1 is a perspective view partly broken away illustrating a shaker made according to and embodying the present invention.

Fig. 2 is a front view, partly phantom, illustrating the

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nature of the adjustable mechanical linkage between the driving motor and the shaker platform.

Fig. 3 is a side view partly broken away showing further detail of the linkage illustrated in Fig. 2.

Fig. 4 is a front view of the linkage illustrated in Fig. 2 showing linkage in differently adjusted position.

Fig. 5 illustrates at A a top plan and at B a vertical section respectively of a "multiple well" slide such as is commonly used in serological work.

Fig. 6 is a vertical section of a single well of a well slide, such as shown in Fig. 5, containing a normal quantity of serological materials and tipped at a normal shaking angle.

Fig. 7 is a top plan view of a single well, such as that illustrated in Fig. 6, at six successive points in a preferred shaking cycle.

Fig. 8 is a front view of an alternative shaker made according to and embodying the present invention.

Fig. 9 is a side view of the shaker illustrated in Fig. 8.

Referring now to the drawings in further detail there is designated generally by reference character M a relatively low, variable speed motor. In Fig. 1, motor M is suspended from the top of case 1 by suspension mounts 2. Switch 3 serves to turn motor power "on" and "off" and variable timer 4 controls the duration of operation. Speed control 5 controls speed of the motor M. At 6 is shown the movable shaker platform which is driven by motor M through mechanical linkage consisting of driving member 7, adjustable driven member 8, clamping screw 9 and combination radial and thrust bearing 10. The plane of platform 6 is maintained perpendicular to the axis 14 of member 8 at all times by bearing 10, said bearing permitting member 8 to rotate freely (relative to platform 6) about said axis. Platform 6 is restrained from following the rotation of member 8 by restraining springs 11, which do however permit limited movement of platform 6 in any direction. The case 1 forms a foundation frame or base for the equipment and at one side thereof there is a vertically disposed member 22 which extends above the normal plane of the platform 6 when the platform is in a horizontal position. The springs 11 constitute resilient members that are symmetrically spaced with respect to the drive means for platform 6 and extend between one peripheral edge of platform 6 and spaced positions on the vertically disposed member 22. The directions of angularity of resilient members 11 change over a wide range as the platform 6 varies in position. The axis 14 of adjustable member 8 may be adjusted relative to the axis 15 of driving member 7 through any angle from 0° up to the practical limit set by component design. In practice, an angle of approximately 20° to 30° between said axes has been found to be an entirely satisfactory upper limit. Similarly the axis 14 of member 8 may be laterally (radially) displaced relative to the axis 15 of member 7, while maintaining any desired angle between said axes. For example, in Fig. 2 wherein is illustrated in detail this mechanical linkage, an adjustment of member 8 is shown which causes the axis 14 of member 8 to intersect the axis 15 of member 7 at point 12 which point lies in the plane of the shaker platform 6. On the other hand, in Fig. 4 is shown an adjustment of member 8 providing a lateral displacement but zero angle between the axes 14 and 15 of members 8 and 7 respectively.

For convenience of reference a 3-dimensional rectangular coordinate system is superimposed on the shaker having origin at O and axes OX, OY, and OZ. Thus, from the foregoing description it will be observed that as driving member 7 rotates about its axis 15 (parallel to y axis) the axis 14 of driven member 8 will generate a conical surface of revolution, the position of the vertex of which and the angle of which may be independently

varied through adjustment of member 8 in relation to member 7. Similarly, it will be observed that platform 6 will undergo a continuous, progressive angular tilting motion, being maintained as aforesaid perpendicular to the conical generatrix 14. In addition it will be further observed that if the axes of members 7 and 8 intersect within the plane of platform 6 as shown at 12 in Fig. 2, the motion of platform 6 will be a pure, progressive, angular tilting motion, without any element of eccentricity relative to the axis of rotation 15 of member 7. If however, the axes of member 7 and 8 are adjusted to intersect at a point not within the plane of platform 6, then in addition to the progressive tilting motion described above there will be included an eccentric motion of platform 6, the radius of eccentricity being determined by the length of the perpendicular drawn from the axis 15 of member 7 to the point at which the axis 14 of member 8 intersects the plane of platform 6.

Alternatively, if the axes 14 and 15 do not lie in the same plane, the surface of revolution generated by axis 14 rotating about axis 15 will in general be a hyperboloid rather than a cone, and there will always be some eccentricity to the motion of platform 6 in addition to the progressive tilting motion resulting from the angular relation between axis 14 and axis 15, the radius of eccentricity again being determined by the length of the perpendicular from axis 15 to the point at which axis 14 intersects the plane of platform 6.

Although a variety of adjustments may be employed for various shaker applications, it has been found that an axial angle of approximately 15° and an eccentricity of approximately $\frac{3}{16}$ " radius furnishes excellent results in serological operations such as blood grouping, and accordingly this represents a preferred adjustment for the purpose indicated, using a "multiple well" slide 16 as a reagent container held to shaker platform 6 by clamps 17. (Refer Fig. 1.)

In Fig. 5 is shown in detail at A a top plan of a typical well-slide 16, the individual wells being shown as 18, and at B a vertical section of the same slide 16 and slide cover 20. Shaded areas 19 in wells 18 of 5B represent the reagent mixture requiring agitation for proper reaction.

In Fig. 6 is shown a vertical section through a single well 18 of slide 16 showing the general position taken by the reagent mixture 19 when the slide is tilted at an angle with the horizontal as in the normal shaking cycle.

In order to illustrate more clearly the shaking or agitating action produced under the present invention, reference is made next to Fig. 7 wherein is shown a top plan view of a single typical well 18 at six successive stages in a shaker cycle according to the embodiment illustrated in Fig. 1. The six stages are marked 0°, 60°, 120°, 180°, 240°, and 300° respectively to correspond to the corresponding relative rotational positions of driving element 7 of Fig. 1. A base line 21, fixed with respect to well 18 is drawn to represent diagrammatically an edge of well slide 16 and thus serves to show the relative orientation of the well slide with respect to the x axis, OX. Shaded areas 19 as before reflect the relative positions of the reagent mixture, and it will be observed that the mixture progressively moves around within the well 18 as the shaker progressively changes the relative angular tilt throughout the cycle. As further reflected in Fig. 7, the well 18 in this instance also partakes of an eccentric motion, as for example about point 15, the axis of rotating member 7 of Fig. 1. Thus, as a result of repeated cycles of the type shown in Fig. 7, the reagent mixture 19 received the thorough, controlled intermixing necessary to insure proper reaction of the mixed reagents.

In Fig. 8 is shown another embodiment of the invention similar in operation to that illustrated in Fig. 1 with the added provision for limited tilting of the axis 15 relative to the vertical (y axis) in an xy plane. This

additional adjustment makes it possible to have platform 6 in a horizontal plane at one stage in the shaker cycle as shown in Fig. 8. In such horizontal position, the reagent mixtures 19 assume the distributions shown at B in Fig. 5, and thus during the course of the shaker cycle would progressively change from such distribution through a swirling motion to a distribution similar to that of Fig. 6. This shaking cycle has the prime advantage of repeatedly covering or bathing the entire well floor with reagent mixture, even where only limited reagent material is available, a distinct advantage where one of the reagents may be in a flat thin flake form which lies on the well floor. Fig. 9 is a side view of the shaker shown in Fig. 8.

In operation of the embodiments of either Fig. 1 or Fig. 8, it is merely necessary for the supervising technician or operator to fasten the well-slide or other desired container to the shaker table by means of clamps 17, set the speed of the motor M by control 5 to a value previously determined to be optimum for a given procedure, set the timer 4 for the desired duration of shaking, and turn switch 3 to the "on" position. The operation thereafter is fully automatic, with automatic stopping at expiration of desired shaking time. From the above it will be apparent that the present invention provides a novel shaking device ideally suited to serological and related laboratory applications, since it substantially duplicates the manual shaking motion which heretofore had been found by experience to provide the most reliable shaking technique prior to the present invention, and since the present invention improves on the prior manual technique from the standpoint of mass reproducibility of results. It will further be apparent that this shaker is substantially noiseless in operation and requires negligible maintenance, since the desired gyratory motion has been accomplished with an absolute minimum of moving parts.

While only certain embodiments of the invention have been illustrated and described to convey the general concept of the invention, it is to be understood that the same is readily capable of various other embodiments within its spirit and scope as defined in the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A shaker comprising a foundation frame; a driving motor mounted in said frame; a driven shaking platform; linkage means interconnecting said motor and said platform, said foundation frame projecting above one side of said platform and resilient means interconnecting said frame and the periphery of said platform at symmetrically spaced positions on opposite sides of the axis of said platform for imposing restraining forces on said platform whereby said motor imparts to said platform a motion such that an axis of said platform generates a conicoid surface of revolution.

2. A laboratory shaker comprising a foundation frame; a driving motor mounted in said frame; a plane driven shaking platform; adjustable linkage means interconnecting said motor and said platform, said foundation frame having a vertically disposed projection extending above the plane of said platform adjacent one side thereof and resilient means interconnecting symmetrically spaced positions on the periphery of said platform and the projection of said foundation frame on opposite sides of said adjustable linkage means for imposing yielding restraining forces on said platform whereby said motor imparts to said platform a motion such that a line perpendicular to the plane of said platform generates an adjustable conicoid surface of revolution.

3. A laboratory shaker comprising a base structure; a platform; means for moving said platform relative to said base structure, said moving means including a rotating driving member, a driven member adjustably mounted on said driving member, a combination radial and thrust bearing mounted on said driven member and linking said driven member to said platform, whereby the axis of said

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bearing is maintained in a fixed relation to said platform, said base structure having a vertical extension on one side thereof projecting above said platform and resilient means interconnecting symmetrically spaced positions at one side of said platform with said vertical extension at one side of said base structure on opposite sides of the axis of said bearing for imposing yielding restraining forces on said platform and whereby rotation of said driving member causes the axis of said bearing to generate a conicoid surface of revolution, thereby causing said platform to execute a progressively changing angular tilting motion in combination with an eccentric motion.

4. A shaker as set forth in claim 3 in which the axis of the combination radial and thrust bearing comprise two members coupled by an adjustable connection to form any desired angle with the axis of the rotating driving member, thereby effectively changing the vertex angle of the conicoid surface of revolution generated by said bearing axis and thus changing the corresponding tilt of said platform; and in which the axis of said bearing may be radially displaced relative to the axis of said driving member, thereby effectively moving along a line parallel to said driving member axis the vertex of the conicoid surface of revolution generated by said bearing axis, and thus changing the corresponding radius of eccentricity of platform motion and in which said resilient means act in directions varying in angularity with respect to the plane of said platform and the plane of said vertical extension.

5. A shaker as set forth in claim 3 in which the orientation of the axis of the rotary driving member is adjustable through a limited range relative to the position of the base structure, whereby the platform is brought into a substantially horizontal plane in at least one recurrent phase of the shaking cycle.

6. In a device of the character described, the combination consisting of a base structure, a vertically disposed member connected with one side of said base structure, an approximately vertical rotatable driving shaft having ad-

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justable axial orientation relative to said base structure, a driven shaft adjustably fastened to said driving shaft whereby said driven shaft may rotate relative to said base structure only about the axis of said driving shaft and whereby the angular orientation and radial displacement of the axis of said driven shaft relative to the axis of said driving shaft may be independently varied, a combination radial and thrust bearing mounted coaxially on said driven shaft, a platform rigidly fastened to said bearing whereby said driven shaft imparts to said platform substantially no component of rotational motion about the axis of said driven shaft but does impart to said platform substantially all other components of motion including radial and thrust motion imparted to said bearing by said driven shaft, resilient means extending between spaced positions on the same side of the periphery of said platform and said vertically disposed member for restraining the movement of said platform and means for rotating said driving shaft relative to said base structure.

7. A device as set forth in claim 6 in which the relative axial orientation and radial displacement of the driving and driven shafts are permanently fixed at preferred settings.

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