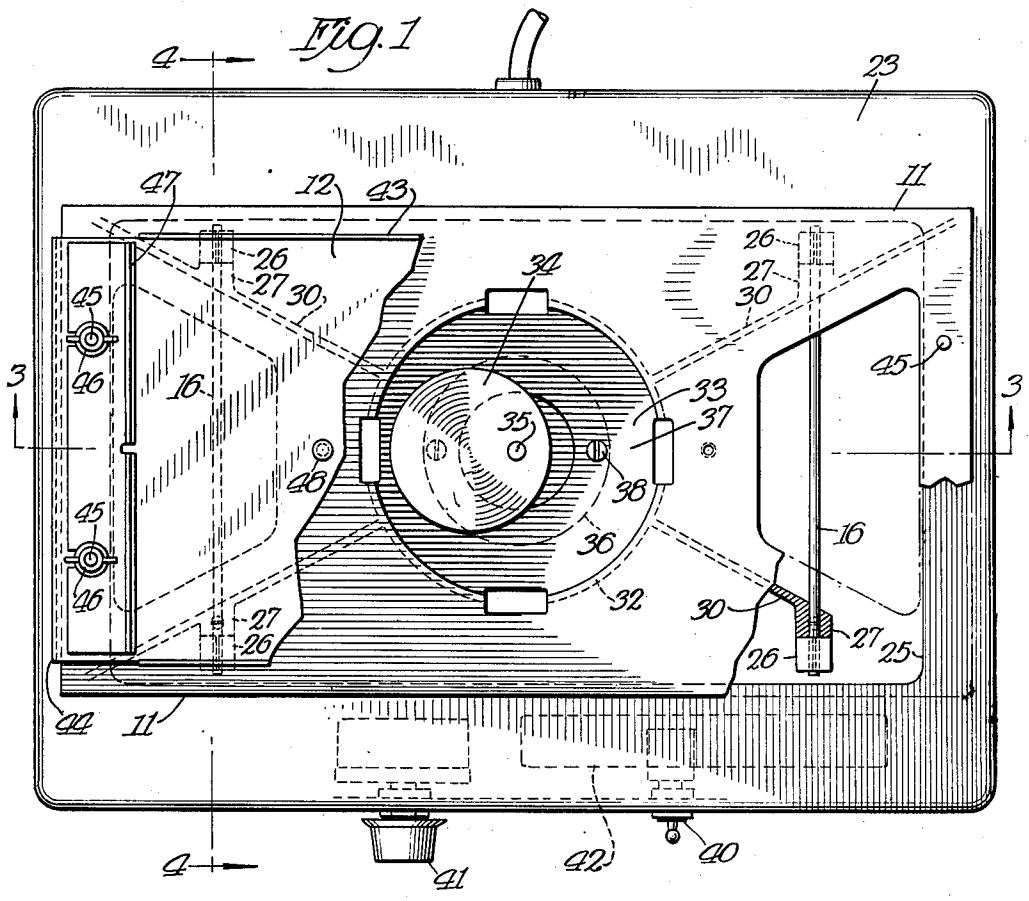
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SHAKER

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Fig. 1



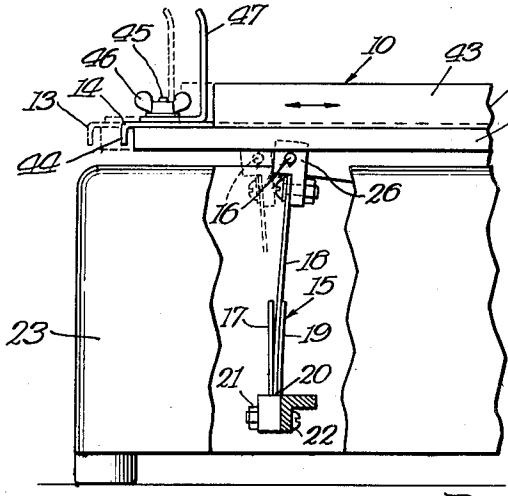




Fig. 2

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Fig. 3

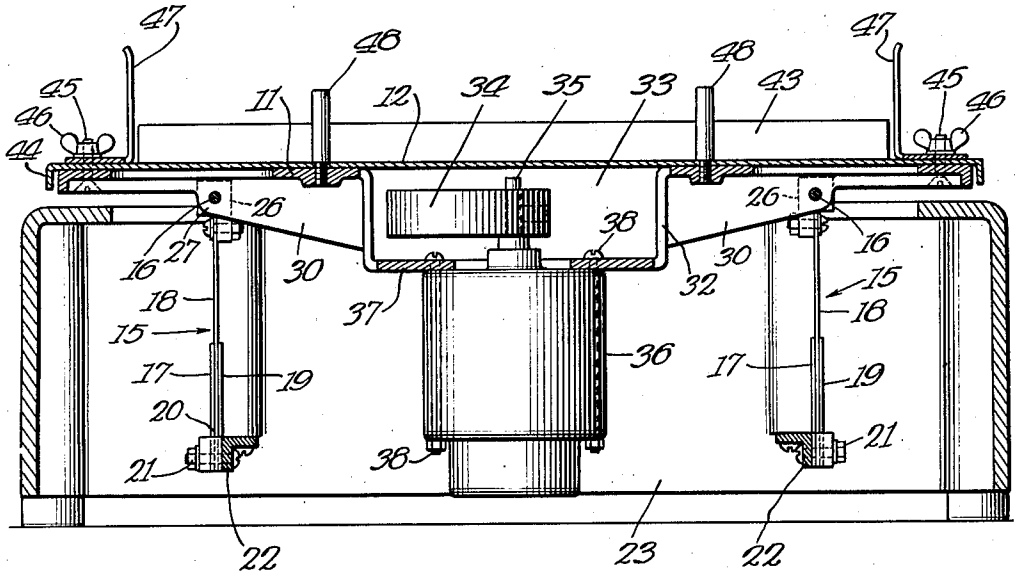
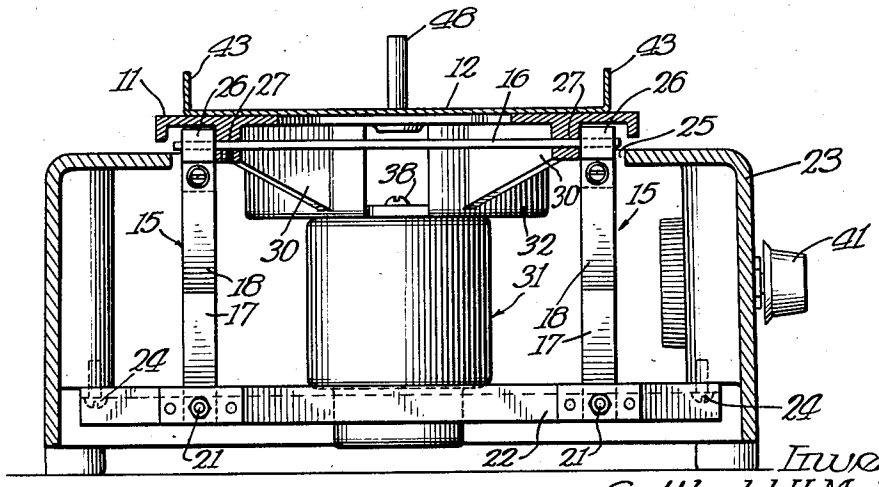



Fig. 4




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# UNITED STATES PATENT OFFICE

2,255,799

## SHAKER

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Application August 5, 1939, Serial No. 288,548

7 Claims. (Cl. 259—72)

The present invention relates generally to shakers and more particularly to shakers of the type employed in laboratories to perform certain routines as in making a Kahn test or the like.

This application is a continuation in part of my earlier application, filed April 15, 1938, for improvements in "Shaking machines," reference to which is hereby made.

Although the principles and characteristics of the present invention are susceptible to many other applications which will readily occur to persons skilled in the art, the illustration and description herein is directed to a Kahn type shaker for the sake of simplicity. The invention is therefore to be limited as to scope only as indicated in the appended claims.

In performing a Kahn test a portion of the routine involves shaking a liquid in small test tubes for a certain period of time and the technique is to shake the tubes at a predetermined constant rate and amplitude of oscillation. Conventionally, the tubes are loosely supported in racks so that they can be quickly handled before and after the shaking operation.

In the present invention, a Kahn type shaker is provided wherein the simple movement of a rotating eccentric flywheel, effective in all directions in a given plane, is controlled in a simple manner to oscillate the racks rectilineally at a predetermined and constant rate of oscillation.

Furthermore, in view of the fact that more tubes will be present in the racks for one test than another and it is necessary that the rate of oscillation be constant regardless of the load, I provide a Kahn type shaker wherein the amplitude and ability of the shaker to operate with various loads is controlled independently of the rate of oscillation.

Moreover, since a light load might be placed upon the shaker table when the shaker is adjusted to operate with a heavy load, I provide an improved support for a shaker table which opposes excessive movement of the table in direct relation to the force tending to cause the excess whether rising from load or excess of power, or both.

Another purpose of the invention is to provide a shaker which is simple and rugged in construction, efficient in its purpose and use and inexpensive to manufacture, operate and keep in repair.

These being among the objects and purposes of the present invention, other and further objects and purposes will become apparent from the drawings, the description relating thereto, and the appended claims.

Referring now to the drawings,

Fig. 1 is a top plan view partly broken away and partly in phantom, illustrating the preferred form of the invention as related to Kahn type shakers;

Fig. 2 is a partially broken away side view of a portion of the shaker showing the construction of the table support;

Fig. 3 is a vertical section taken upon the longitudinal center lines 3—3 of the shaker as shown in Fig. 1;

Fig. 4 is a transverse section taken upon the line 4—4 in Fig. 1;

Referring now to the drawings in further detail, a better understanding of the invention will be had by noting that, broadly speaking, the shaker illustrated comprises essentially an inverted horizontal pendulum 10.

The pendulum 10 comprises a table frame 11 with a tray support 12 which moves between the two positions indicated by 13 and 14 in Fig. 2. The table frame 11 is attached to the top of four elastic supports 15 by parallel pivot pins 16 extending transversely to the table frame and located adjacent the ends thereof. The elastic supports 15, which are four in number, each comprise three flat spring members 17, 18 and 19 adjustably secured as to length at their bottom ends 20 by bolts 21 secured to cross members 22 mounted upon the main housing or cabinet member 23 as at 24 (Fig. 4).

It is immaterial whether the supports 15 are arranged one to another at the four corners of the table as shown, or in some other suitable manner as long as they provide a balanced support for the table and lie in identical or parallel planes so that their flex is in the same rectilinear direction.

The middle spring blade 18 of each support 15 extends upwardly approximately to the level of the opening 25 in the top of the cabinet member 23 where brackets 26 are bolted to each of them. The brackets in turn receive the pivot pins 16 where they extend through and beyond bosses 27 formed upon the bottom of the table frame 11 at the end of the truss webs 30.

Although it is possible to secure the springs rigidly to the table frame and provide the pivotal connection at their bottom ends, I prefer the construction shown because the stress and tension developed in the springs are thus borne by the cabinet 23 which, as the stationary one of two members, namely, the cabinet and table frame,

is best suited to bear these forces. The use of the pivotal joint between the spring and the table frame makes of the spring a true pendulum whose amplitude may be changed without affecting materially its rate of oscillation.

Thus the table is supported for free rectilinear oscillation in one direction only and the period of oscillation is determined by the dimensions and elastic constants of the supporting springs. By this construction, once the table is deflected, a rate of oscillation follows which is independent of the mass of the oscillating system and it remains only to regulate the amplitude of the oscillation in relation to the load which the table carries in order to maintain the amplitude constant for all Kahn tests regardless of the number of test tubes carried by the shaker at any given time.

In regulating the amplitude of oscillation and the action of the table, the short spring blades 17 and 19 are provided upon both sides of the longer blades 18 to establish a modulus of operation which opposes any tendency of increased load to change the action of the table.

The shorter springs 17 and 19 operate at all times to provide a crisp action of the table when it oscillates, whether the load be heavy or light. This crispness of action is substantially constant for all loads because the added momentum factor of heavier loads is directly opposed by a proportional increase of tension in the flex of the short springs. Thus, for any increase in load, only sufficient deflecting force need be applied to the table to bring the amplitude of oscillation up to the limits 13 and 14.

Although it will be noted that the amplitude of oscillation is a balancing of two factors, namely, load and deflecting force, and that the amplitude of oscillation can be varied for any given deflecting force by varying the load, the relationship of these two factors in providing a machine for performing the shaking operation in Kahn tests is primarily one of varying the deflecting force in relation to the load.

For a better understanding of the regulation of the deflecting force it is to be noted that since the amplitude of oscillation is independent of the period of oscillation, and the amplitude of oscillation is directly related to the relationship between the mass and the deflecting force, it follows that the period of oscillation is independent of the deflecting force and regulation of the deflecting force does not change the period of oscillation.

The unit by which the deflecting force is generated is indicated at 31 where it is rigidly secured to the table frame 11 on the bottom side thereof where the truss webs 30 deepen and are joined by a circular web 32. The circular web defines a flywheel compartment 33 immediately below the plane and in the center of the table where an eccentric flywheel 34 is located and locked to the upper end of the shaft 35 upon a motor 36. The motor 36 is secured immediately below the flywheel compartment 33 against the bottom face of the floor 37 of the compartment 33 by bolts 38.

With the weight of the motor 36 located below the flywheel compartment and the load carried by the table disposed above the flywheel compartment the flywheel is adjusted vertically between these two centers of mass to balance them at the normally expected load.

The motor is preferably a series motor whose torque varies in relation to the impressed voltage as controlled by the main switch 40, the rheostat 41 and the resistance 42 connected in series therewith.

The offset or eccentricity and the weight of the flywheel 34 as a rotating mass, are so designed that within the power supplied to the motor, the deflecting impulses of the flywheel keep in step with the natural period of oscillation of the system. By way of example, the effective eccentric action of the flywheel should be close to the moments of inertia of the table, it being better to have the flywheel action more than enough for this purpose than too little. With it too little, the flywheel will cause the table to vibrate rather than oscillate.

The motor is first secured in place on the table and then the flywheel 34 is mounted and adjusted as to height. The top 12 of the table is then secured in place. The top comprises a stamped aluminum plate having upstanding side flanges 43 which serves as side rails and depending end flanges 44 which protect the ends of the table frame. Studs 45 locate the top and wing nuts 46 are employed to hold the top in place with L-shaped end brackets 47 adjustable thereby to serve as end rails for trays (not shown) placed upon he table. The shaker shown accommodates two trays of test tubes and two upstanding lugs 48 serve as dividers between them.

In operation, a tray of test tubes is placed upon the table, the switch 40 is turned "on" and the rheostat 41 adjusted to bring the amplitude of the oscillation up to the position indicated by 13 and 14. The center of the eccentric mass of the flywheel driven by the motor describes a path which is approximately an ellipse whose width is constant.

Referring to the ellipse as though divided into quadrants bounded by the longest and shortest diameters of the ellipse, and starting with the flywheel at the longest diameter, it will be found that for any cycle the table is deflected in the same direction as the center of mass of the flywheel with regard to the motor shaft.

In the first quadrant the table is moved by the springs toward its opposite position as the flywheel moves in the same direction, the reflex action of the springs being effective.

During the first quadrant, the torque of the motor accelerates the flywheel. Thereafter the momentum of the flywheel is partially expended in the second quadrant to carry the table past the middle point of the ellipse to the table's other limit, after which the action is repeated in the other two quadrants in the opposite direction.

Each acceleration quadrant is followed by a deceleration quadrant. In the acceleration quadrant, the torque of the motor is converted to flywheel momentum and in the deceleration quadrant, the momentum added by the motor is expended against the inertia of the table and its load. It is during the acceleration quadrant that the motor supplies energy to the eccentric mass in relation to the voltage impressed upon the motor by the adjustment of the rheostat and it is within the limits of the acceleration possible with the power output of the motor that the amplitude of oscillation of the table can be controlled in relation to the load upon the table.

Thus, as the load carried by the table varies from time to time the moments of inertia of heavier loads which tend to decrease the amplitude can be counteracted by increasing the torque output of the motor to accelerate the ec-

centric mass which converts the acceleration into increased application of force to overcome the increased load inertia and bring the amplitude of the table up to the limitation 13 and 14.

The construction shown and described is thus seen to be a pendulating one whose period varies but slightly under wide changes of load as controlled by the simple setting of the rheostat. Briefly, without rebalancing and resetting the moments of inertia to take care of each variation in load, the construction shown controls the amplitude constant by varying the deflecting force in relation to the load merely by varying the resistance in the series motor circuit.

Although the invention has been described in connection with a specific embodiment, the principles involved are susceptible to numerous other applications which will readily occur to persons skilled in the art. Consequently, it will be apparent to those skilled in the art that various uses, modifications and changes may be made without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. A laboratory shaker for shaking a container approximately at a certain required frequency and a certain required amplitude, comprising an oscillating system including a holder and supporting springs designed to have approximately the desired natural frequency of oscillation with the intended load, a motor forming a rigid part of the oscillating system and having the characteristics of controllable torque and a tendency to reach a speed in excess of said frequency; and a weight mounted on the system for eccentric rotation, driven by said motor and having sufficient mass with respect to a low controlled torque of the motor and the mass of the oscillating system to retard the speed of the motor approximately to said frequency whereby controlling the torque of the motor will control the amplitude of the oscillations substantially without changing their frequency, and means for controlling said torque.

2. A laboratory shaker for shaking a container approximately at a certain required frequency and a certain required amplitude, comprising an oscillating system including a holder and supporting springs rigid in all directions except for back and forth movement in one direction and designed to have approximately the desired natural frequency of oscillation with the intended load, a motor forming a rigid part of the oscillating system and having the characteristics of controllable torque and a tendency to reach a speed in excess of said frequency; and a weight mounted on the system for eccentric rotation, driven by said motor and having sufficient mass with respect to a low controlled torque of the motor and the mass of the oscillating system to retard the speed of the motor approximately to said frequency whereby controlling the torque of the motor will control the amplitude of the oscillations substantially without changing their frequency, and means for controlling said torque.

3. A shaker for shaking a container, comprising an oscillating system including a holder and supporting springs having a natural frequency of oscillation with a particular load, a motor forming a rigid part of the oscillating system and having the characteristics of controllable torque and a tendency to reach a speed at least as high as said frequency; and a weight mounted on the system for eccentric rotation, driven by said motor and having sufficient mass with respect to a low controlled torque of the motor and the mass of the oscillating system to retard the speed of the motor approximately to said frequency whereby controlling the torque of the motor will control the amplitude of the oscillations substantially without changing the frequency, and means for controlling said torque.

4. A shaker comprising an oscillating system including a holder, spring support means for the holder, and a motor, and an eccentric mass driven by the motor of such relative size that the motor may be retarded by it to the natural frequency of oscillation of the oscillating system, the support means comprising leaf spring members secured to the holder and to a support, and secondary leaf spring members having free moving ends and reinforcing the other leaf spring members against excessive deflection adjacent the points at which they are secured and increasing the stiffness of the spring members to give them a crisp action when they have been deflected by movement of the holder and thus provide a relatively high frequency of oscillation.

5. A laboratory shaker for shaking a container approximately at a certain required frequency and a certain required amplitude, comprising an oscillating system including a holder and supporting springs designed to have approximately the desired natural frequency of oscillation with the intended load, a motor having the characteristics of controllable torque and a tendency to reach a speed in excess of said frequency; and a weight mounted on the system for eccentric rotation, driven by said motor and having sufficient mass with respect to a low controlled torque of the motor and the mass of the oscillating system to retard the speed of the motor approximately to said frequency whereby controlling the torque of the motor will control the amplitude of the oscillations substantially without changing their frequency, and means for controlling said torque.

6. A laboratory shaker for shaking a container approximately at a certain required frequency and a certain required amplitude of oscillation, comprising an oscillating system including a holder and yieldable supporting and positioning means including spring means and designed to urge the holder to a given position and to have approximately the desired natural frequency of oscillation with the intended load, a weight mounted on the system for eccentric rotation, and a power system including a motor forming a rigid part of the oscillating system and having a rotor in driving relationship with the weight, the motor having a tendency to give the weight a speed in excess of said frequency but the relationship between torque output of the power system during normal running conditions and the mass and eccentricity of the weight and the mass and natural frequency of the oscillating system being such that the speed of the motor remains approximately at said frequency and approximately the required amplitude of oscillation is maintained, and said power system as it is normally started also having a sufficiently low starting torque with respect to the masses so that its speed will not jump beyond the critical speed at which the masses will cease to be able to retard it to the approximate required frequency.

7. A shaker for shaking a container approxi-

mately at a predetermined frequency, comprising an oscillating system including a holder and yieldable supporting and positioning means including a spring, urging the holder toward a given position and having a natural frequency of oscillation with a particular load approximately equal to said predetermined frequency, a weight mounted on the system for eccentric rotation, a motor in driving relationship to the weight, forming a rigid part of the oscillating system and having the characteristics of controllable torque and a tendency to drive the weight at a speed in excess of said frequency, said weight having sufficient mass with respect to the torque of the motor and the mass of the oscillating system to retard the speed of the motor to give the weight approximately said frequency whereby controlling the torque of the motor will control the amplitude of the oscillations substantially without changing the frequency, and means for controlling said torque.

GOTTHOLD H. MEINZER.

CERTIFICATE OF CORRECTION.

Patent No. 2,255,799. September 16, 1941.

GOTTHOLD H. MEINZER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 8 and page 4, second column, line 9, claims 3 and 7 respectively, for the article "the" after "changing" read --their--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of November, A. D. 1941.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)