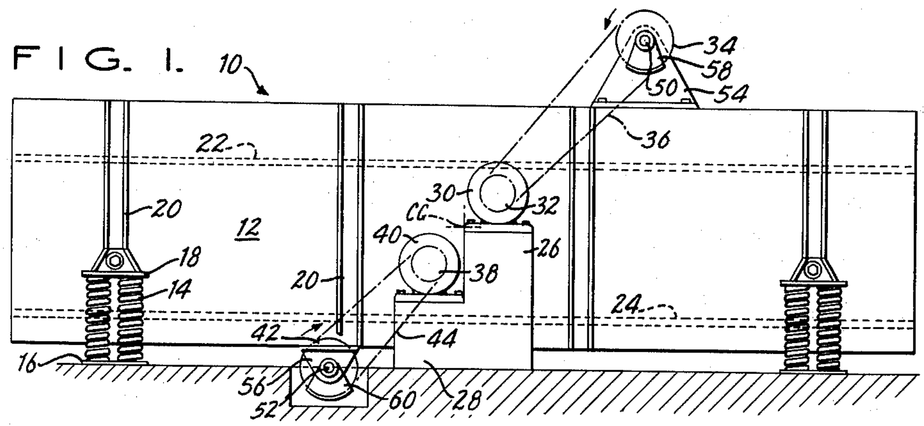
Jan. 4, 1966 S. D. ROBINS 3,226,989

VIBRATORY SCREEN SYSTEMS

Filed Nov. 7, 1961 2 Sheets-Sheet 1

FIG. 1.



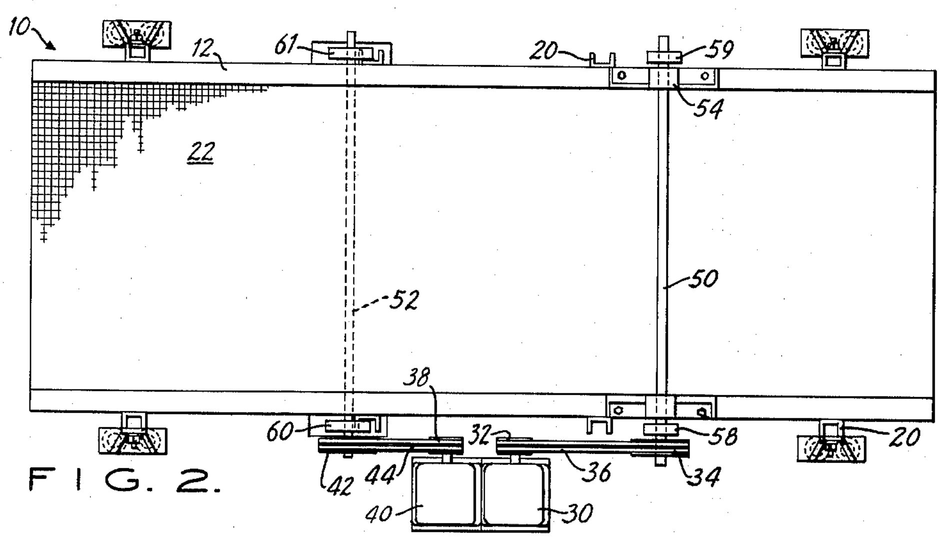


FIG. 2.

FIG. 3.

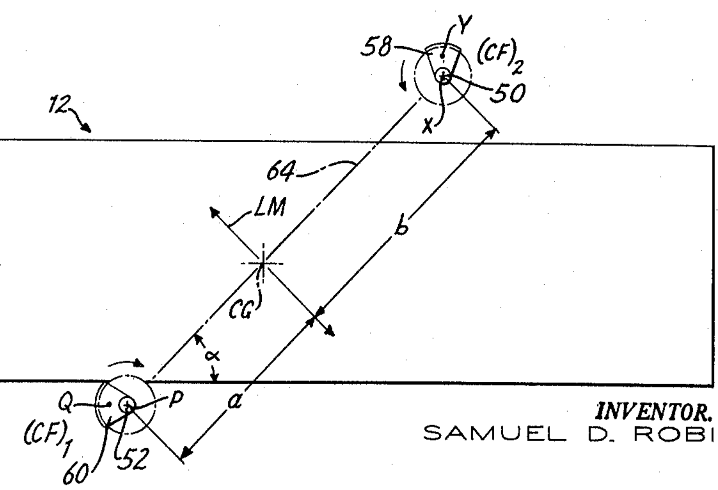


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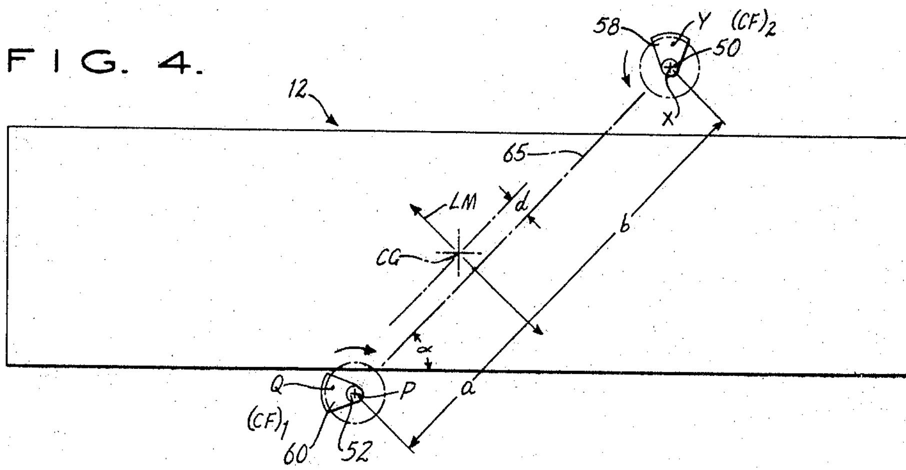
FIG. 4.



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United States Patent Office

3,226,989

Patented Jan. 4, 1966

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3,226,989

VIBRATORY SCREEN SYSTEMS

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Filed Nov. 7, 1961, Ser. No. 150,710
1 Claim. (Cl. 74—87)

This invention relates to a novel vibratory device of utility especially for classifying materials. In particular, this invention relates to an improved means of imparting gyratory movement to a freely suspended body, or a body otherwise supported for movement in a gyratory path, for agitating material to perform a classification or other operation.

It is known that a non-circular, substantially elliptical, gyratory motion in screen systems produces the combined advantages of rectilinear and circular motions. A rapid feeding action may be obtained, even with the screen deck arranged horizontally, while, at the same time, imparting a rotary movement to the material particles so that a very good separation between different particle sizes is effected. It is also known that very satisfactory results may be obtained when the gyratory movement of the screen is uniform, that is, all portions of the screen describe substantially the same path. A screen system capable of such gyratory movement is described in United States Patent No. 2,200,724, granted to me.

It is also known to produce vibrating apparatus having shafts which can be counter rotated to produce a "straight line" action or motion. It is further known that these, and particularly the latter types of devices, can consist of paired shafts which are not interconnected by positive drive means. However, so far as is known to me, no one has heretofore devised a machine having separate, rotatable vibrating means not interconnected by positive means for maintaining relative rotational position wherein elliptical paths of movement can be achieved, and wherein unequal forces can be employed to produce varied selected effects. Nor has a machine been devised heretofore utilizing certain principles and arrangements of elements, whereby different stroke values can be achieved in a single screen by utilizing variable positioning of shafts and varied relative values of unbalanced forces on the shafts, in a machine wherein the shafts are not connected by positive means for insuring a timed relationship between the shafts. Accordingly, among the objects of my invention is to provide an apparatus capable of improved elliptical movement having readily variable motion in a machine wherein independent vibrators are used to produce unequal and unbalanced forces.

It is an object of this invention to provide means for producing a smooth, uniform, non-circular, gyratory movement of a screen, or other body, which is substantially freely supported by means of a plurality of independently and synchronously driven, individually supported, counter-rotatable masses for producing centrifugal forces of unequal magnitude.

It is another object of this invention to provide means for producing a smooth, uniform, non-circular, gyratory movement utilizing independently driven and individually supported, substantially spaced-apart, counter-rotatable masses of unequal magnitude, associated with a substantially freely supported screen, or other body.

It is yet another object of this invention to provide means for producing a smooth, substantially elliptical gyratory movement of a screen, or other body, by which the substantially elliptical path may be varied.

It is a further object of this invention to provide means for producing a gyratory movement of a screen, or other body, by which different elliptical motions may be imparted to the two ends of the sceeen.

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Other objects, features, and advantages will become obvious to those skilled in the art from the detailed description of an illustrative embodiment as applied to vibratory screen devices, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is an elevational view of a screening device embodying the invention;

FIGURE 2 is a plan view of the screening device illustrated in FIGURE 1;

FIGURE 3 is a diagrammatic view illustrating the relationship between the counter-rotating masses and the center of gravity of the screen frame, or body, upon which the gyratory motion is to be imposed; and

FIGURE 4 is a diagrammatic view similar to FIGURE 3, illustrating another embodiment of this invention.

In the preferred embodiment, the desired, substantially elliptical gyratory motion of the screen frame, or other body, is achieved by rotation of masses in opposite directions, but at synchronous speeds, for establishing centrifugal forces of different magnitudes to impart the desired substantially elliptical gyratory motion to the screen frame or other body. The counter-rotatable masses are independently driven in synchronism with each other, with the masses mounted on their respective shafts such that the centrifugal forces established by the respective counter-rotating masses act, at certain instants, in the same direction and along the same or parallel lines, thereby directly combining the effects of these forces on the center of gravity of the screen frame, or other body, at given angles to the plane of the rotational axes. The unequal centrifugal forces may be produced by masses of unequal magnitude, or by masses of equal magnitude having their centers of gravity at unequal distances from the rotational centers of the shafts upon which the masses are mounted. In addition, the counter-rotatable masses are individually supported on shafts which are journalled for rotation on said rotational axes and are spaced at substantial distances apart from each other. Synchronous rotation of the independently driven and individually supported counter-rotatable masses is established by drive means, individual to each of the shafts, driving the shafts at the same rotational speed.

Referring now to FIGURE 1 of the drawings, there is shown a vibratory screening device of the active or live frame type, designated generally as **10**. The frame **12** of the screening device may be of any suitable construction, and in the embodiment illustrated in FIGURE 1, is of the double deck type having a pair of screening surfaces, or cloths, **22** and **24**, which extend horizontally across and substantially throughout the length of the frame. The screen cloths **22**, **24** may be of any suitable construction, and may be removably secured to the frame **12** in any well-known manner. Vertical stiffener members **20** may be spaced along the length of frame **12** to insure that the structure is rigid.

Frame **12** is resiliently supported by means of soft springs **14** located near each of the corners of the frame. The springs may rest on suitable foundation plates **16**, which, in turn, may rest on the ground, floor, or upon a specially provided stationary supporting frame. The upper end of each of the springs acts against a plate **18** suitably secured to frame **12**. Springs **14** support the frame **12** above, and out of contact with, the ground or supporting structure, and are, preferably, readily compressible, so that the natural period of vibration of the springs and supported mass will be low. Springs **14** in addition to serving as means for substantially freely supporting the frame **12**, also provide an effective means for lessening the transmission of vibrations from the live frame to the ground, or supporting structure upon which the frame may rest.

The means for imparting the desired gyratory movement to the frame includes rotatable parallel shafts **50** and **52**. Shaft **50** is suitably mounted for rotation in journals **54** suitably secured to the top of frame **12**, and shaft **52** is similarly rotatably mounted in journals **56** suitably secured to the bottom of frame **12**. It should be readily understood that suitable bearing surfaces are to be provided in the journals **54** and **56** to insure smooth rotation of shafts **50** and **52**. An electric motor **30** for independently driving shaft **50**, is mounted on a pedestal **26**, and is fitted with pulley means **32** on one end of the motor output drive shaft. A pulley means **34** is also located at one end of shaft **50**, and a belt means **36** is passed around the pulley means **32**, **34**. A second motor **40**, similar to motor **30**, for independently driving shaft **52**, is mounted on a pedestal **28**, and is provided with a pulley means **38**. A belt means **44** is passed around pulley means **38**, and also around a pulley means **42** secured to one end of shaft **52**. In the embodiment illustrated (see FIG. 2) a double-sheave pulley and double-belt drive is shown, but it should be understood that any convenient power transfer arrangement may be utilized to transmit the rotational drive to shafts **50**, **52**, independently. Sources of power other than electric motors may be utilized for independently driving shafts **50** and **52**, provided that the output of the power sources may be regulated to insure that each of the shafts may be rotated at the same speed, and in directions counter to each other. In addition, it should also be understood that through the provision of suitable belt-transmission means, not shown, the belt tension may be adjusted so that effective driving of the shafts may be accomplished, even though the frame, uon which the shafts **50**, **52** are mounted, oscillates.

Secured to shaft **50** are counter-weight elements of similar, or substantially similar, shape, but unequal in mass, designated **58**, **59**. Masses **58**, **59** are illustrated, for convenience, as sector-shaped, and may be mounted at, or near, each end of this shaft. Similarly shaped and similarly located counter-weight elements **60**, **61** are secured to shaft **52** which are also equal in weight to each other. The counter-weight elements **58**, **60** are shown, in FIGURE 1, in the positions they would occupy with the screening device at rest. Counter-weight elements **60**, **61** form a mass system for shaft **52** which has a mass greater than that formed by counter-weight elements **58**, **59** secured to shaft **50**. It should be understood that the counter-weight masses for each of shafts **50**, **52** need not be comprised of elements located at the ends of the shafts, but may comprise any convenient arrangement, as bars secured to, and running longitudinally of, the axes of the shafts, plates eccentrically mounted on the ends of the shafts, and similar arrangements. There is also no requirement that the mass system on each of the shafts be comprised of similar elements.

The considerations to be observed, however, are that the respective counter-weight masses be arranged not only with their centers of gravity located eccentrically of the shaft axis, but also be symmetrically distributed along the length of the shaft, and that the centrifugal force generated at a given speed by the counter-weight mass associated with one shaft, here the lower shaft **52**, be greater than that generated at the same speed by the mass on the other shaft, as the upper shaft **50**.

The gyratory movement imparted to the frame **12** will be further described in connection with the diagrammatic illustrations of FIGURES 3 and 4. The frame **12** in FIGURES 3 and 4 is illustrated as a free body, and corresponds to resiliently supported frame **12** of the vibratory screening device, heretofore described. The counter-weight masses **58**, **60** are illustrated, in these two figures, in the position they would occupy during an instant of their rotation.

In FIGURE 3, the center of gravity of the live frame or free body **12** is designated CG. The centers, or rotational axes X and P of the parallel shafts **50** and **52**, respectively, carrying the counter-weight masses lie in a plane **64** which passes through the center of gravity of the frame, CG. For the instantaneous angular position of the counter-weight elements **58** and **60**, shown in FIGURE 3, the center of gravity of counter-weight elements **58**, **59**, measured radially outwardly from the shaft center X, is shown at Y and the center of gravity of the counter-weight elements **60**, **61**, measured radially outwardly from the shaft center P, is shown at Q. The centrifugal force created by the lighter counter-weight mass, here the mass secured to shaft **50**, as it rotates, is designated $(CF)_2$. The centrifugal force created by the heavier counter-weight mass, here the mass secured to shaft **52**, as it rotates, is designated $(CF)_1$. It should be readily understood that since the shafts are intended to rotate at the same speed, the value of each of these forces may be made dependent on the masses of the counter-weights. This is especially so, when, as here, the counter-weight masses have the same general shape, that is, the distance XY equals the distance PQ. The distance between the center X of shaft **50** and center P of shaft **52** to CG is designated "b" and "a," respectively. The center to center distance or spacing of shafts **50** and **52** is "ab." The angle of inclination, α, of plane **64** to the horizontal is preferably in the range of 40°–50°, but may be more or less.

As the shafts **50** and **52** rotate counter to each other, the centrifugal forces created act radially outwardly from the center of gravity of each of the counter-weights, with the direction of the centrifugal force attributable to each of the masses, of course, changing constantly as the counter-weights rotate. If, in addition, as is contemplated by this invention, the counter-weight mass systems on shaft **50** is located and oriented with respect to the counter-weight mass system on shaft **52**, such that when a straight line may be drawn between CG, X and Y, a straight line may similarly be drawn through CG, P, and Q. As a result, when the centrifugal force created by one of the mass systems passes directly through the center of gravity CG of body **12**, the centrifugal force of the other mass will also pass through CG.

If counter-weight masses are selected such that

$$\frac{(CF)_2}{(CF)_1}=\frac{a}{b}$$

then, the resulting gyratory movement will be substantially elliptical, with the major axis of the ellipse lying along the line of motion, LM, that is, normal to the plane **64** passing through the rotational centers of shafts **50**, **52** and the center of gravity CG of the body **12**. The major axis of the ellipse will be determined by the sum of $(CF)_1$ and $(CF)_2$, and the minor axis by the difference between $(CF)_1$ and $(CF)_2$. I have found that for practical considerations in classification or screening operations, the ratio of the major elliptical axis to the minor elliptical axis, i.e.,

$$\frac{(CF)_1+(CF)_2}{(CF)_1-(CF)_2}$$

should be about 1 to 1½ as a minimum, and 7 to 1 as a maximum. To achieve, for example, a ratio of major axis to minor axis of 7 to 1, the distance "a" should be about 3 units, and the distance "b" should be about 4 units, then

$$\frac{(CF)_2}{(CF)_1}=\frac{a}{b}=\frac{3}{4}$$

I have found that the distance between the shafts should be substantial, and that the greater the spacing between shafts, the greater the tendency of the shafts to synchronize. In general, I have also observed that for effective screening, the spacing between the shafts may be equal to about one-half the length of the frame, assuming the frame has a uniform weight distribution along its entire length.

The embodiment of FIGURE 4 is similar to that illustrated in FIGURE 3, with the exception that the line, **65**, joining the centers of shafts **50**, **52**, does not pass through the center of gravity CG, but is oriented parallel to a line, such as **64** of FIGURE 3, passing through CG, and is displaced a distance "*d*" therefrom. The displacement of the shafts in this manner affects the gyratory movement and produces a non-uniform gyratory motion. Accordingly, this invention permits a variation in the gyratory motion when desired, for example, to impose a slightly greater stroke at the feed end than the discharge end of the screen.

Although the invention has been described with particular reference to specific embodiments, the same are not to be construed as in any way limiting the invention. Reference is, therefore, to be had solely to the appended claim for the purpose of determining the scope of the invention.

What is claimed is:

In an apparatus of the character described, the combination comprising: a frame; means for resiliently supporting said frame for a free gyratory motion with respect to said supporting means; means for imparting a substantially uniform gyratory motion to said frame, said means including, two substantially spaced apart shafts rotatably mounted on said frame with the axes of said shafts located substantially transverse to the longitudinal axis of said frame; counter-weight elements mounted on each of said shafts and rotatable therewith; prime mover means individual to each of said shafts for rotating said shafts and associated counter-weight elements in synchronism with each other but in directions counter to each other; each said shaft and associated counter-weight elements comprising a rotatable eccentric mass system; each said rotatable mass system upon rotation producing centrifugal forces, with the magnitude of said centrifugal forces produced by one mass system being greater than the magnitude of said centrifugal forces produced by the other said mass system, whereby said rotatable masses produce centrifugal forces of unequal magnitude with respect to each other; and each said mass system located on opposite sides of and at unequal distances from the center of gravity of said frame, and with the rotational centers of each of said shafts and the center of gravity of said frame lying in the same plane, such that the mass system for producing the centrifugal forces of lesser magnitude is located a distance of four units from said center of gravity and the mass system for producing centrifugal forces of greater magnitude located a distance of three units from said center of gravity, whereby upon rotation said mass systems establish moments with respect to said frame of equal magnitude, but opposite in sign, about said center of gravity.

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