

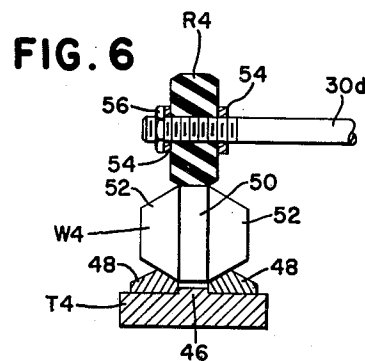
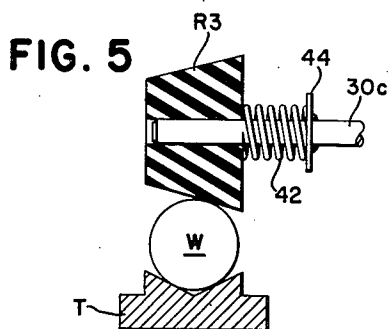
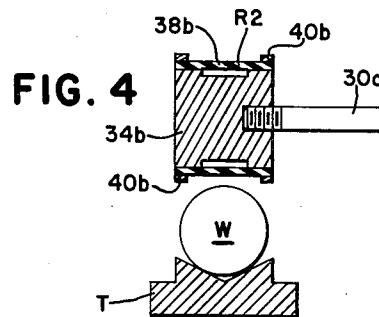
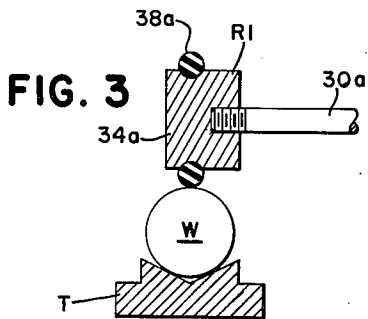
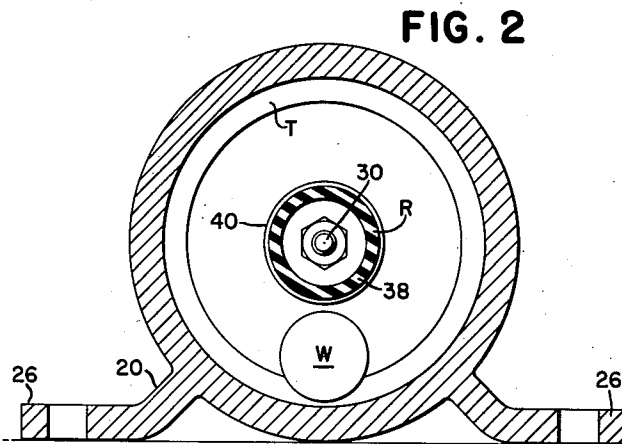
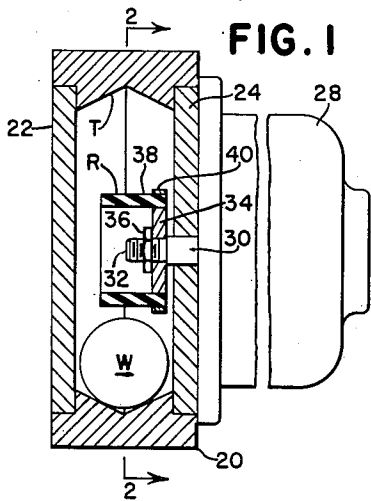
May 29, 1962

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EPICYCLIC VIBRATOR

3,036,471

Filed April 25, 1960

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 7

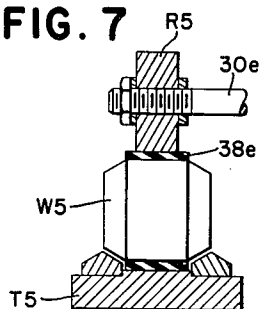


FIG. 8

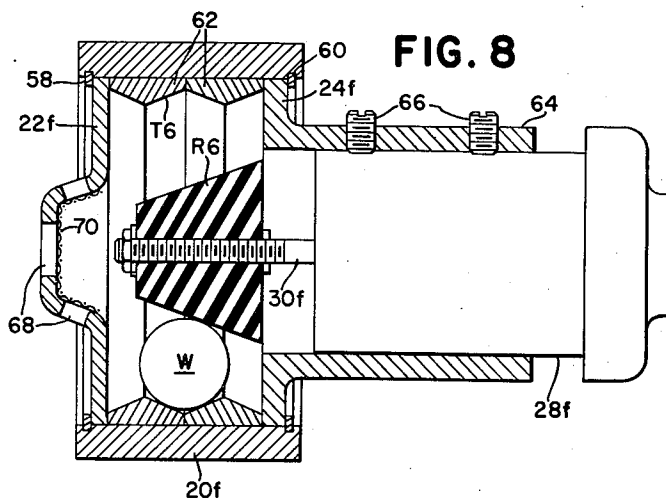


FIG. 9

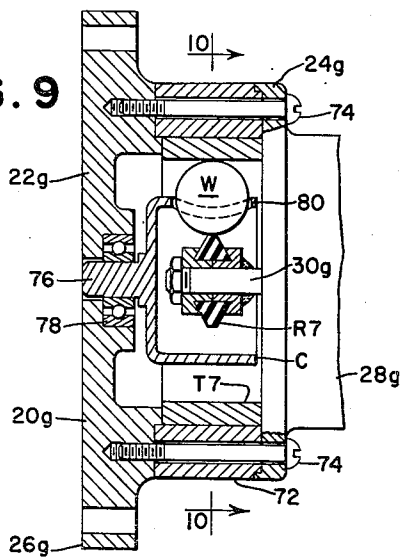


FIG. 10

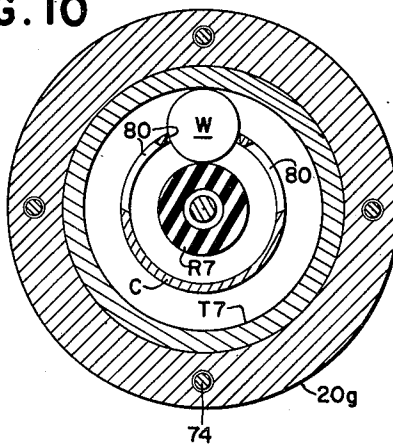


FIG. 11

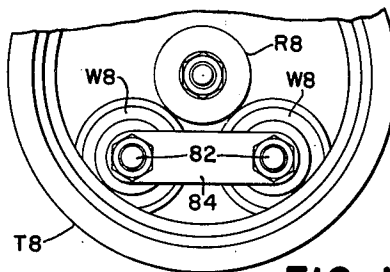
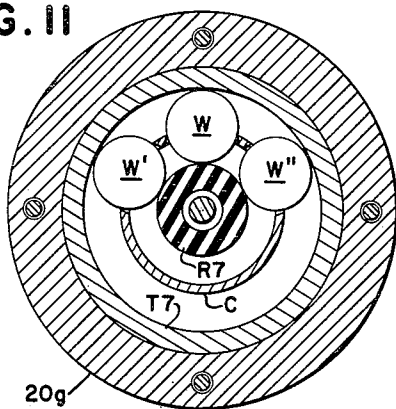


FIG. 12

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3,036,471

## EPICYCLIC VIBRATOR

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4 Claims. (Cl. 74-87)

This invention relates to a vibrator and more particularly to a type of vibrator employing the epicyclic principle in which a mass or weight is driven through an orbit concentric with the input or drive.

It is one of the principal objects of the invention to provide an improved vibrator employing the epicyclic principle, and more particularly to provide an economical and compact vibrator design that may be exploited in many sizes. It is a feature of the invention to adapt the novel vibrator design to use with high-speed drives and, by means of the epicyclic drive, to obtain the necessary speed reduction without resorting to complicated and expensive gearing and the like. It is a further object of the invention to utilize improved drive means between the input rotor and the weight, and to provide the weight in several forms, such as balls and cylindrical rollers having tapered ends. In this phase of the invention, the novel design features improved track means for guiding the rollers or balls, whereby sliding frictional contact with housing walls and the like is avoided. In another form of the invention, it is a principal object to employ a cage which functions in the nature of a planet carrier, the advantages of the cage being that the weight or mass is confined axially and yet is permitted to travel in its orbit. In a modified form of the invention, the cage is so constructed as to be capable of carrying a plurality of balls. In still another form of the invention, it is a feature to utilize a plurality of rolling weights mechanically linked together.

A still further significant object resides in improved housing means in which a driving source, such as an electric motor, may be incorporated in the housing. A subsidiary aspect of the invention in this respect is the provision of means for adjustably mounting the motor or equivalent source so that it may be axially adjusted, and in this design the input rotor is conical so that its effective driving diameter can be varied according to axial shifting of the motor and thereby enabling the use of weight rollers of different sizes.

The foregoing and other important objects and desirable features inherent in and encompassed by the invention will become apparent as preferred embodiments thereof are disclosed in the following detailed description and accompanying sheets of drawings, the figures of which are described below.

FIGURE 1 is a fragmentary sectional view of one form of epicyclic vibrator.

FIGURE 2 is a section as seen along the line 2-2 of FIGURE 1.

FIGURE 3 is a fragmentary section showing a modified form of arrangement.

FIGURE 4 is a similar view showing a still further modified form.

FIGURE 5 is a view in the nature of FIGURES 3 and 4 and shows a further modified form of arrangement in which the rotor is axially spring loaded.

FIGURE 6 illustrates a different form of drive and weight relationship.

FIGURE 7 is similar to FIGURE 6 but shows the relationship in which the driving tire is on the weight.

FIGURE 8 is a sectional view showing that form of the invention in which the input source is axially adjustable for enabling the use of weights of different diameters.

FIGURE 9 is a sectional view of a modified form of

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invention in which a cage or carrier is utilized for the weight.

FIGURE 10 is a section on the line 10-10 of FIGURE 9.

FIGURE 11 is a section similar to FIGURE 10 but showing the cage carrying a plurality of balls.

FIGURE 12 is a fragmentary section showing a design in which a plurality of weights or rollers are mechanically linked together in the epicyclic orbit.

In FIGURES 1 and 2, the numeral 20 designates a simple compact housing in the form of a relatively axially short cylinder closed at opposite ends by relatively closely spaced apart axial walls 22 and 24. The annulus or cylindrical wall of the housing has its inner periphery formed as a track ring T which, in section, is in the nature of a V-shaped channel for confining an orbital mass or weight W, here in the form of a ball, which is preferably of metal or other comparably heavy material, depending upon the design and the particular field in which the vibrator is to be employed. The housing 20 carries externally thereon, as by being formed integrally therewith, a pair of apertured ears 26 by means of which the vibrator assembly may be attached to an object to be vibrated.

The radial wall 24 is apertured, in a manner not material here, to serve as mounting means for the front portion of a flanged motor housing 28 which has a driving shaft 30 rotatable on the axis of the circular track T. The motor 28 is here representative of any conventional high-speed motor, especially those capable of rotating at 12,000-15,000 r.p.m.

Within the chamber defined by the track T and inner faces of the walls 22 and 24, the shaft 30 is fitted with a rotor R. In this case, the shaft 30 is reduced and threaded at 32 to receive an apertured disc 34 of relatively rigid material, which may be steel but which may also be any other material that will serve the purpose. A nut 36 secures the disc to the threaded portion 32 of the shaft 30. The disc in turn carries a peripheral tire 38 and this is fixed to the disc by a ring 40, which may be of steel.

The tire 38 projects axially from the disc 34 and when the rotor is at rest the tire is out of contact with the weight or ball. However, the tire is of flexible resilient material, such as rubber or any equivalent elastomer, for example, that has the necessary characteristics, and, when the rotor gains speed, the tire expands diametrically so as to establish driving contact with the weight. The weight is then driven in an orbit concentric with the axis of the shaft 30 and the periphery of the track T, but the travel of the weight is reduced below the speed of the rotor R because of the speed reduction obtained by the use of the epicyclic principle, in this case the rotor R corresponding to the sun gear, the weight W corresponding to the planet pinion, and the track T corresponding to a fixed ring gear. Accordingly, the reduction will be dependent upon the relative diameters of the rotor R and track T, which is here roughly 2½ to 1; although, this can be varied to suit particular circumstances. Because of the section of the track, the weight W travels in its orbit without sliding frictional contact with the inner faces of the walls 22 and 24. Here, as in the instances of the other forms of the invention disclosed herein, other inputs may be used and the same advantages may be exploited.

In that form of the invention shown in FIGURE 3, the motor shaft, shown here at 30a, is equipped with a different form of rotor, designated in its entirety at R1 and comprising a hub 34a threaded onto the shaft 30a so as to rotate therewith and having an annular groove which is fitted with a driving tire 38a. This tire is shown as a "O" ring of rubber or equivalent material and has fric-

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tional driving contact with the weight W. As will be readily seen, the details of FIGURE 3 could be readily incorporated in the basic housing structure of FIGURES 1 and 2. The principles of the invention are the same and need not be elaborated.

In the modification shown in FIGURE 4, the shaft 30a is fitted with a hub 34b on which is mounted a tire 38b having generally the characteristics of the tire 38 of the rotor R in FIGURE 1. In FIGURE 4, the assembly is completed by a pair of retaining rings 40b which establish a rotor R2 in which the tire is initially out of contact with the weight W when the shaft 30a is at rest. However, when the shaft gains speed, the tire R2 will expand, as in the case of the tire 38 in FIGURE 1, into contact with the weight W and will cause the weight to travel in its orbit about the track T. Again, the competing structure of FIGURES 1 and 2 may be employed with the modified form shown in FIGURE 4.

In that form of the invention shown in FIGURE 5, a motor or input shaft 30c carries a rotor R3, which is here in the form of a truncated cone of suitable material having an appropriate frictional driving contact with the weight W. The rotor R3 is shown as being of rubber but could be of any comparable material. The rotor R3 is carried by the shaft 30c in such manner as to rotate with the shaft but to be capable of axial shifting. This can be accomplished in any suitable manner, as by forming the terminal end of the shaft 30c of non-circular section, equipping it with a driving key, etc. In any event, the rotor R3 is axially spring-loaded by a spring 42 acting between the rotor and a stop disc or washer 44 rigidly secured, as by welding to the shaft 30c. The spring 42 acts in such direction as to maintain the effective driving contact between the rotor R3 and the weight W, automatically compensating for wear in the rotor.

In that form of the invention shown in FIGURE 6, which may be completed by the basic structure of FIGURES 1 and 2, for example, the track, designated at T4, is of different construction, as are the weight W4 and the rotor R4. The track is composed of a central portion of T-section 46 and a pair of flanking rings 48 which establish an annular guide for the weight W4, which is here in the form of a roller having a cylindrical central portion 50 and opposite conical portions 52. The rotor R4 is of solid elastomer material or the like and is fixed to the shaft 30d as by being confined between a pair of washers 54 and secured by a nut 56. The principles of the invention defined so far are applicable also to this modified form of the invention.

In FIGURE 7, the track T5 is similar to the track T4, and the weight W5 is generally similar to the weight W4 as to general configuration, except that in this case the weight W5 is equipped with a tire 38e and the rotor R5 may be of one-piece construction. It may be of metal or any other material having adequate frictional relationship to the tire 38e, and in this case the rotor R5 is mounted on a driving shaft 30e which is, of course, the equivalent of the input shafts previously described. Again, the basic structure may be completed by the housing and motor details of FIGURES 1 and 2; or, as already indicated, other inputs may be used. Of course, the principles of the invention may be exploited in the manner already described.

The design shown in FIGURE 8 comprises a housing 20f having its inner periphery provided as a track ring T6 and affording an enclosure within which are located the weight W and a rotor R6. The rotor is similar to the rotor R3 in FIGURE 5 but in this case is rigidly fixed to a motor shaft 30f which is driven by a motor 28f. The housing 20f is provided with a pair of closely axially spaced apart radial walls 22f and 24f, suitably retained as by snap rings 58 and 60, which also serve to confine two track rings 62 which make up the track ring T6. In this case, the radial wall 24f has an axial tubular extension 64 within which the casing of the

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motor 28f is carried. A pair of set screws 66 normally serve to secure the motor housing or casing 28f against axial displacement in the tubular extension 64, but the set screws may be loosened to enable manual shifting of the motor, and consequently axial shifting of the rotor R6, whereby the effective driving diameter of the rotor may be changed so that weights of different diameters may be used in the assembly. Once the selected adjustment has been achieved, it may be secured by re-tightening the set screws.

The radial wall 22f is shown as being apertured at 68 and the apertures are screened at 70 to accommodate cooling air which flows through the assembly, being drawn in from the right through the motor 28f and exhausted at the left through the screened apertures.

The rotor R6 is fixed to the shaft 30f in a manner similar to the arrangement used in FIGURE 6, and these details need not be elaborated.

In that form of the invention shown in FIGURES 9 and 10, the housing 20g takes a different form, being provided with a peripheral flange 26g which is apertured as shown for the purpose of enabling mounting of the vibrator on an object to be vibrated. An annular track ring T7 is confined between a pair of radial walls 22g and 24g, the wall 22g in this case forming the basic part of the housing 20g and the wall 24g comprising a mounting flange on a motor 28g. A housing ring 72 surrounds the track ring T7 and is held in place by a plurality of screws 74 passed therethrough and through the walls 24g and into the wall 22g.

The motor shaft 30g carries a rotor R7 which may be similar in principle to that of FIGURE 3, and the tire thereof is of rubber or equivalent elastomer material, which will be clear on the basis of the preceding description. A weight W, here in the form of a ball as in the case of FIGURES 1 through 5, is confined between the rotor R7 and track T7 and the general epicyclic principle is again employed, with the exception that in this case the weight is additionally received by a cage C. This cage may be of appropriate sheet metal or the like and has a stub shaft 76 coaxially rigidly secured thereto and mounted in an appropriate bearing 78 in the wall 22g, so that the cage is free to rotate. The cage is provided with a plurality of circular openings 80 which, in the case of FIGURES 9 and 10, loosely receives the weight W. The cage therefore confines the weight W against axial shifting and the track may be of simple configuration rather than of the grooved type shown heretofore. During operation, the cage C rotates idly and its function is to confine the weight W.

FIGURE 11 shows that the cage C, provided with the plurality of openings 80, is capable of carrying additional weights, designated at W' and W''. This enables a selection as to the size of the mass to be orbited in the vibrator.

In that form of the invention shown in FIGURE 12, a rotor R8, which may be similar to that shown in FIGURE 7, drives a pair of weights W8, each of which may be similar to the weight W5 in FIGURE 7. Each of these weights is equipped with a tire which may be like the tire 38e in FIGURE 7, and these weights are caused to travel in an orbit, guided by a track T8, which, again, may be similar to the track T5 shown in FIGURE 7. The difference in the structures is that two weights are employed and these are mechanically linked together as by being equipped with axles 82 which are spanned by a pair of circumferentially extending links 84, only one of which appears in the drawing but the presence of the other of which will be obvious. Here again, the principle of multiple weights is exploited, which is another demonstration of the flexibility and versatility of the design.

In all forms of the invention extreme simplicity is achieved relative to the nature of the results obtained and the speed reduction available in the epicyclic system may

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be economically exploited to obtain the greatest advantages from relatively low cost high-speed motors.

Features and advantages other than those set forth will readily occur to those versed in the art, as will the modifications and alterations in the preferred embodiments of the invention disclosed, all of which may be achieved without departure from the spirit and scope of the invention.

What is claimed is:

1. A vibrator, comprising: a stationary housing having an internal fixed annular track ring; a rotor journaled by the housing coaxially with and surrounded by and having a circular periphery concentric with said ring; and a sole weight unit comprising an element of circular section on an axis parallel to the rotor axis and disposed as an unbalanced planet between the rotor and ring and frictionally engageable with the rotor periphery to be rotated by the rotor so as to roll around the ring in an orbit concentrically between the rotor periphery and the ring and at a speed less than that of the rotor.

2. The invention defined in claim 1, in which: said rotor is fixed against axial displacement relative to the housing and weight unit and its periphery comprises a non-metallic tire, said tire and weight unit being of such relative diameters that the tire is clear of the weight unit when said rotor and weight unit are at rest, said tire material being radially flexible in and of itself so as to expand radially into driving engagement with the weight unit via centrifugal force as the rotor rotates.

3. The invention defined in claim 1, in which: the ro-

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tor includes a coaxially, relatively journaled concentric cage in surrounding relation to its periphery and surrounded by said ring, said cage has an opening therein loosely confining said weight unit, and said cage having a further opening therein circumferentially offset from said first-mentioned opening for loosely confining an additional weight unit similar to said first-mentioned weight unit.

4. The invention defined in claim 1, in which: a second weight unit similar to said first-mentioned weight unit is disposed between the rotor periphery and the ring in closely circumferentially spaced relation to said first-mentioned weight unit, and link means extends between and articulately interconnects the two units for orbital travel together but independent rolling over the ring clear of contact with each other.

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