United States Patent

Swerdfeger

[15] **3,650,509**

[45] **Mar. 21, 1972**

[54] FREE ROTOR VIBRATOR

[72] Inventor: **Leroy E. Swerdfeger,** Upland, Calif.

[73] Assignee: **Malan Vibrator Co. Inc.,** South El Monte, Calif.

[22] Filed: **Sept. 29, 1970**

[21] Appl. No.: **76,448**

[52] **U.S. Cl.** **259/1,** 259/DIG. 43

[51] **Int. Cl.** **B01f 11/00**

[58] **Field of Search**.....259/1, DIG. 42, DIG. 43, DIG. 44

[56] **References Cited**

UNITED STATES PATENTS

2,743,090	4/1956	Malan	259/1
2,891,775	6/1959	Malan	259/1
3,129,925	4/1964	Malan	259/1
3,193,256	7/1965	Malan	259/1
3,460,808	8/1969	Wilde	259/1

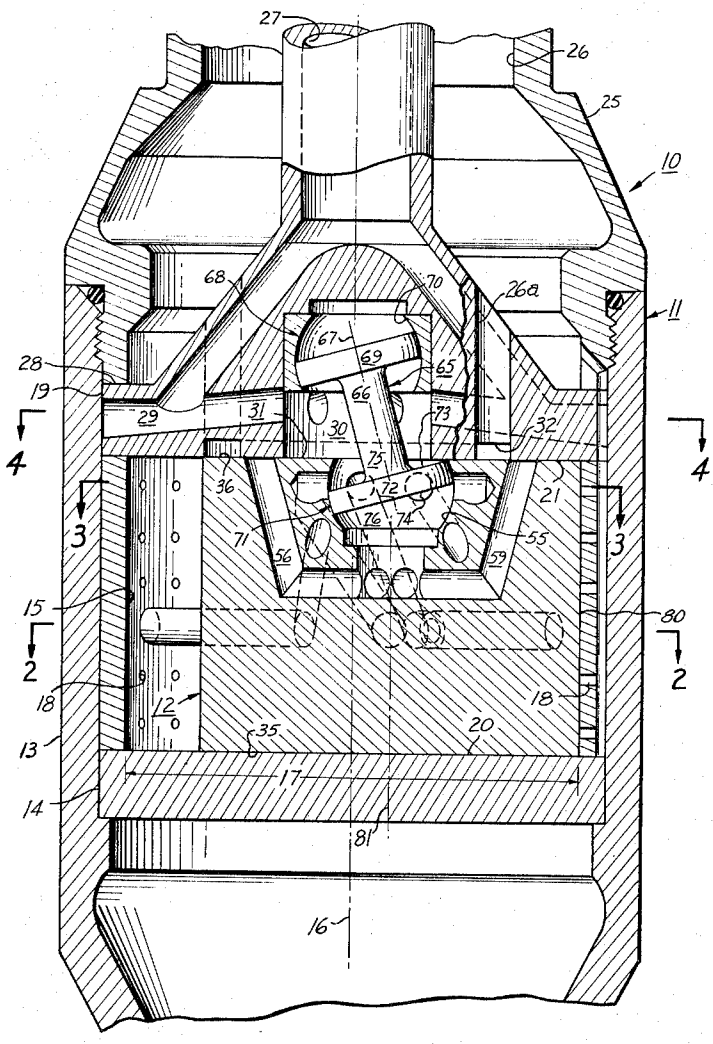
Primary Examiner—Robert W. Jenkins

Attorney—Angus and Mon

[57] **ABSTRACT**

A free rotor vibrator of the class including a case with an internal cylinder race within which a rotor of less diameter orbits in bearing contact therewith so as to exert a radial centrifugal force which is useful in fields such as the placement of concrete. The invention includes valving means for sequentially connecting force means such as plungers to sources of fluid under alternately elevated and reduced pressure so as to cause the rotor to orbit in the case. The valving means comprises a rigid rod with a universally pivoted joint at each end, one of which joints carries valving means which sequentially overlaps passages to the force means and connects them alternately to the regions of elevated and reduced pressure.

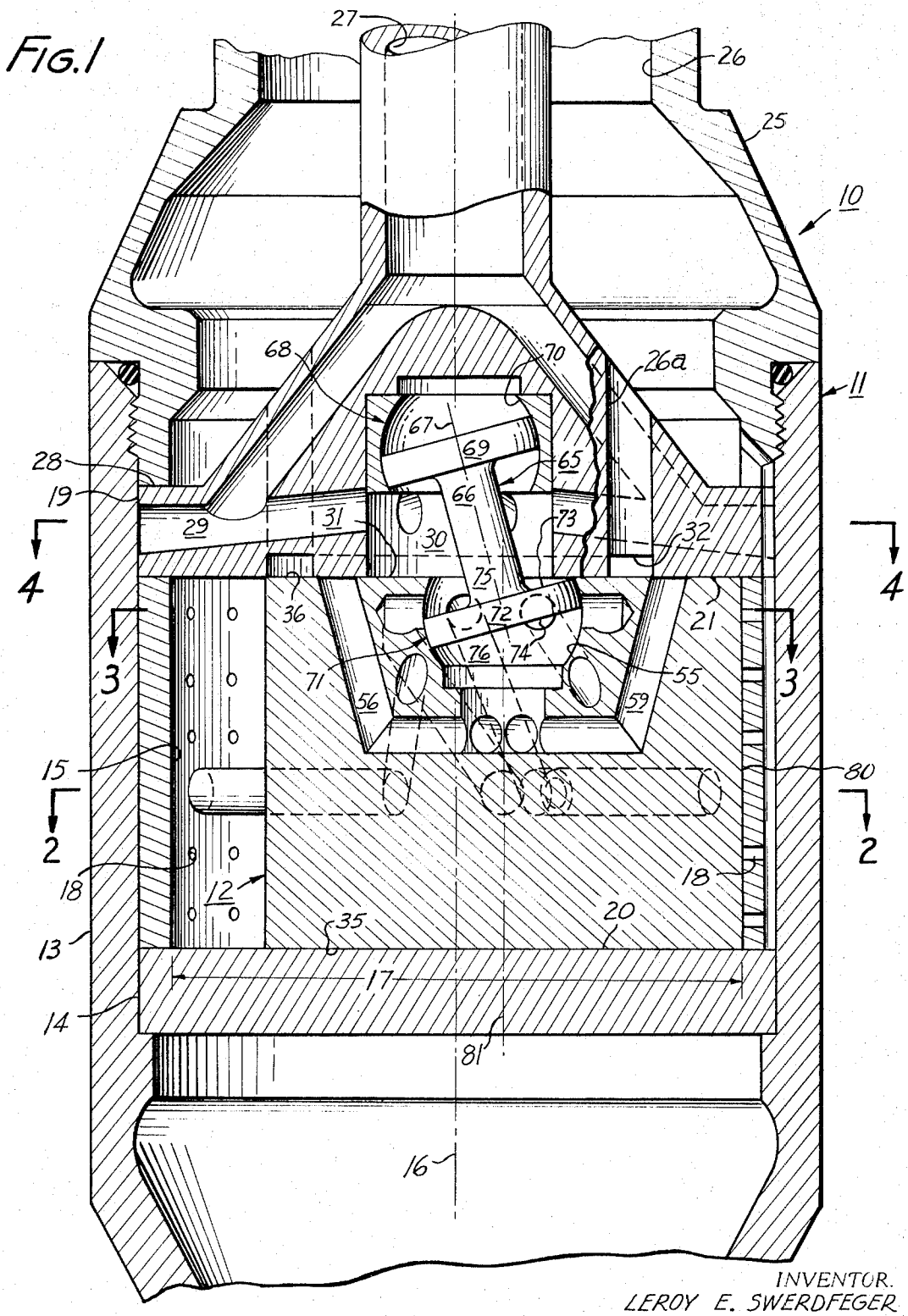
6 Claims, 5 Drawing Figures



Patented March 21, 1972 3,650,509

3 Sheets-Sheet 1

FIG. 1



INVENTOR.
LEROY E. SWERDFEGER

BY Arnos & Mon
ATTORNEYS.

FIG. 2

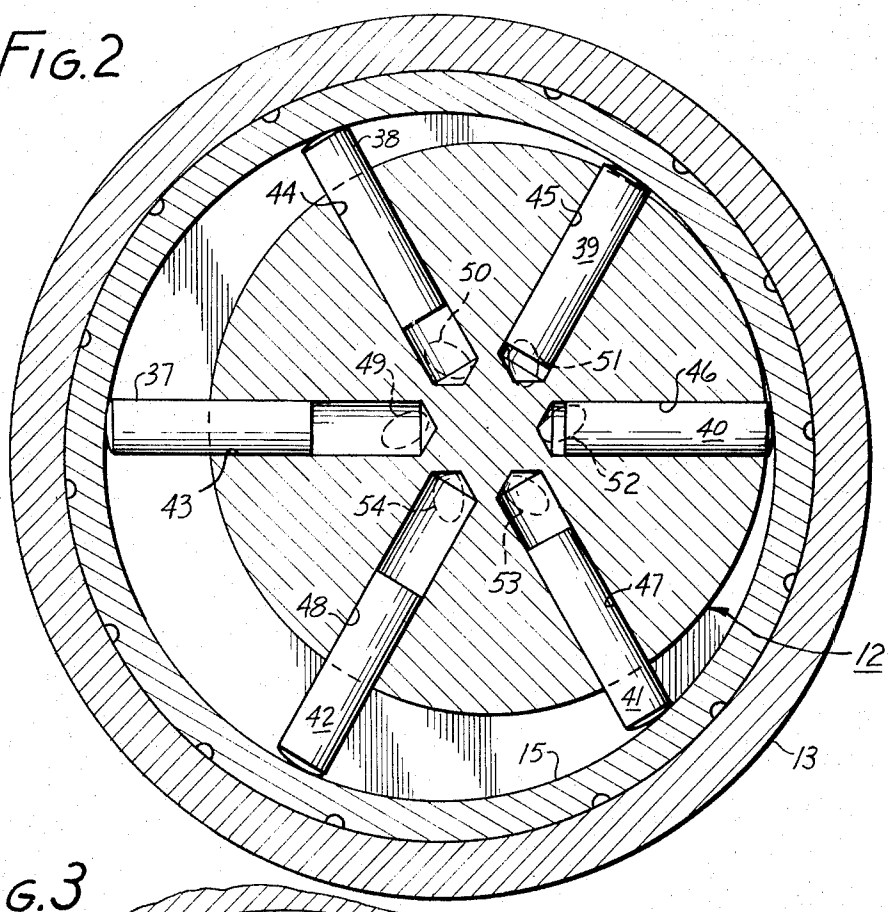
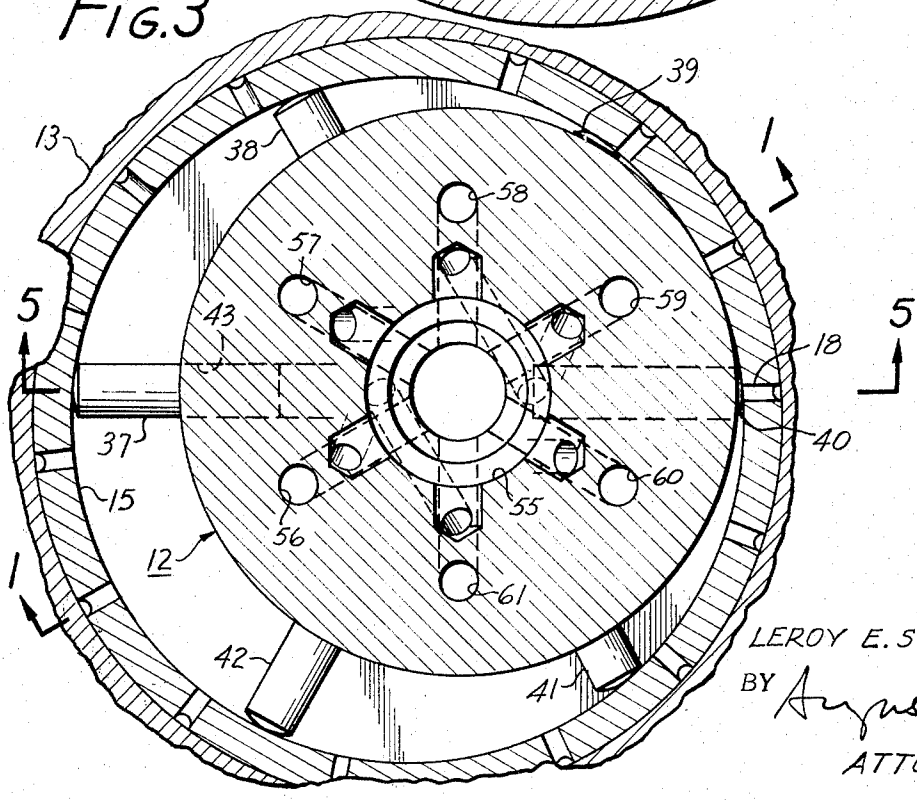


FIG. 3



INVENTOR.
LEROY E. SWERDFEGER
BY Arnes & Mon
ATTORNEYS.

FIG. 4

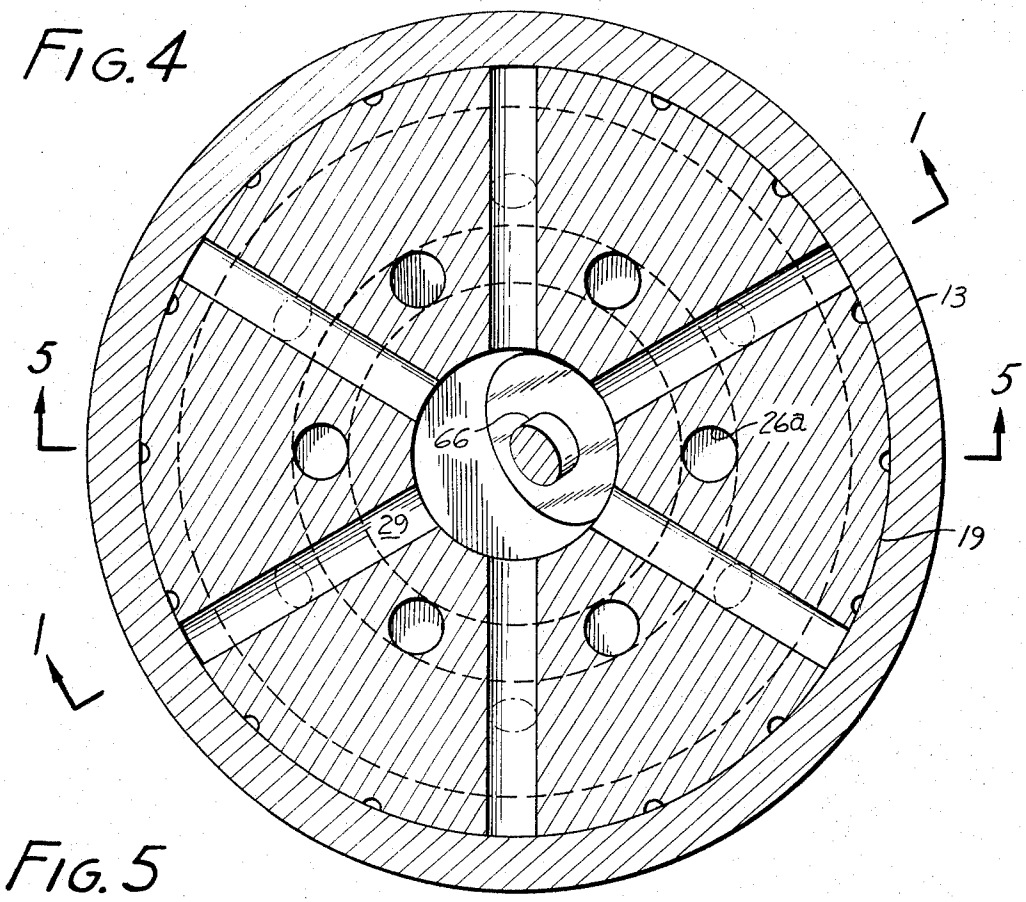
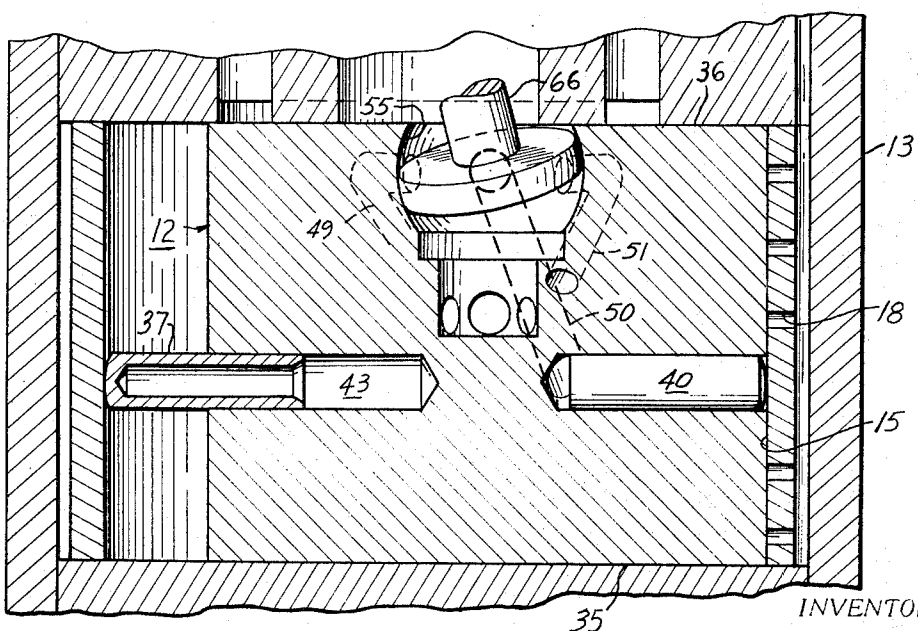


FIG. 5



INVENTOR.
LEROY E. SWERDFEGER
BY
Agnus & Mon
ATTORNEYS.

FREE ROTOR VIBRATOR

SPECIFICATION

This invention relates to a free rotor vibrator of the class having a rotor orbiting within a race in a case whereby to exert centrifugal force which is useful in the placement of concrete.

Free rotor vibrators as a class are generally shown in Malan, U.S. Pat. Nos. 2,743,090; 2,891,775 and 3,129,925 issued Apr. 24, 1956; June 23, 1959 and Apr. 21, 1964, respectively. It is a feature of these inventions that a rotor which absent driving fluid pressures can assume any random position within a range of available positions orbits within a race inside a case and in bearing contact therewith so as to exert a centrifugal force of a vibratory nature. The valving techniques for these vibrators are quite sophisticated and rely heavily on geometrical relationships. Most frequently, they involve a pair of sliding end faces, one on the end of the rotor and the other on the inside end of the case which make a mutual shear seal. These surfaces involve pressure ports and exhaust ports and passages within the rotor going to respective compartments or chambers, it being the objective to provide by geometric relationships alternate and sequential connection with a source of fluid under pressure and a region of reduced pressure. In such a manner, the rotor is caused to orbit in the case and the vibratory forces to be generated.

It is an object of this invention to provide valving means of a simpler nature. According to this invention, a cylindrical rotor is rotatable and orbitable within a case, the case having an internal cylindrical race and the rotor an outer cylindrical bearing surface which rolls around the race in bearing contact therewith. A plurality of force means is mounted in the rotor for reciprocating motion to extend beyond the rotor to contact the case so as to exert a separative force between the rotor and the case, and to retract within the rotor whereby the rotor will orbit within the case. The valving means is a rigid valve rod with a first universally pivoted joint joining one end of the valve rod to the case at the central axis of the rotor and a second universally pivoted joint joining the other end to the rotor at its central axis. Wobble plate means is rigidly attached to the rod at said other end and has valving means normal to the axis of the valve rod whereby the valving means has an upper and lower portion as viewed relative to the case as the rotor orbits therein. A passage is formed in the rotor to each of said force means terminating at a point contiguous to the second pivoted joint and disposed axially relative to the case axis so as to be periodically and sequentially overlapped by the upper and lower portions of the valving means.

According to a preferred but optional feature of the invention the pivoted joints are ball-and-socket assemblies in which the valve means is circular and lies normal to the axis of the valve rod.

According to still another preferred but optional feature of the invention, the second ball-and-socket assembly includes a ball-like member mounted to the valve rod bounded by a zone of a sphere making a fluid-sealing fit with a socket in the rotor. The zone is bounded by two terminal edges lying in planes normal to the axis of the valve rod. The casing provides fluid pressure to the upper portion and the passageway and an exhaust line is formed within the rotor to the lower portion to provide the alternate pressure conditions.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawings in which:

FIG. 1 is an axial view partly in cutaway cross section taken at line 1—1 of FIG. 4, showing the presently preferred embodiment of the invention;

FIG. 2, 3, and 4 are cross sections taken at lines 2—2, 3—3 and 4—4 respectively of FIG. 1; and

FIG. 5 is a cross section taken at line 5—5 of FIG. 4.

A vibrator **10** according to this invention includes a case **11** and a rotor **12**. The case includes an outer shell **13** which is customarily plunged into a region to be vibrated such as poured concrete to be settled in place. It is the function of this vibrator to exert vibratory forces to aid in this placement.

Within the shell there is an end plate **14** and a race **15**. The race is cylindrical and has a central axis **16** and a diameter **17**. Perforations **18** are provided in the wall of the race to provide drainage means for fluid which may otherwise accumulate therein.

The case includes a second end plate **19**. The first and second end plates have first and second end faces **20, 21**.

A head **25** is attached to the outer shell and includes an exhaust passage **26**. Within the exhaust line there is supply line **27** which is coaxial with the exhaust line and part of the second end plate. It is mounted by a flange **28** to the case. Supply line **27** provides fluid under elevated pressure to the vibrator, and exhaust line **26** returns either to reservoir or to atmospheric pressure as desired, in any event to a region of lower pressure. Ports **26*a*** connect line **26** to the second end face. A handle may be attached to the exhaust line to aid in immersing the vibrator in the material to be settled.

The second end plate includes passages **29** in fluid communication with a central cavity **30** whereby fluid under elevated pressure from line **27** is made available to a central region **31** in the second end plate. A peripheral ring groove **32** is formed in the second end face and is in fluid communication with the exhaust line through ports **26*a***.

Rotor **12** includes a first and a second end face **35, 36**, these being in respective sliding fluid sealing contact with end faces **20, 21** of the race. The rotor will, as it orbits, make a shear seal contact therewith.

A set of end faces may also be provided at the first end plate in the form of mirror images of those at the second end plate if desired or, as shown, only to one set at the second end plate need be provided. The rotor includes a plurality of force means **37, 38, 39, 40, 41, 42**. In this case, they are plungers in respective plunger passages **43, 44, 45, 46, 47**, and **48**. These plungers are adapted to reciprocate within the plunger passages to extend beyond the rotor to exert a separative force between the rotor so as not to exert such a separative force. By sequential application of fluid pressure and exhaust to the inside ends of these plunger passages, the motive force for orbiting the rotor within the race is developed.

A plurality of passages **49, 50, 51, 52, 53** and **54** is provided, each to a respective one of plunger passages **43–48**. These open to the inside of a socket **55** and are peripherally disposed around them. They are offset from their respective plungers by about 90°.

Exhaust passages **56, 57, 58, 59, 60** and **61** are provided which branch off the lower end of the socket and the upper end of the socket is in fluid communication with central region **31**. It will thereby be seen that the upper edge of the socket in FIG. **1** is constantly exposed to fluid under pressure from the pressure supply line, and the lower end is constantly exposed to the exhaust line. This latter connection is by virtue of the fact that there will always be some of exhaust passages **56–61** in connection with ring groove **32**.

Valve means **65** is provided so as to sequentially and alternately connect the plunger passages through passages **49–54** to the source of elevated or reduced pressure. For this purpose a valve rod **66** which is rigid and has its own respective axis **67** which will always be tilted relative to the central axis of both the rotor and the race is provided which has a first universally pivoted joint **68** at the upper end of the rod which includes a zone **69** of a sphere in contact with the wall of a socket **70** which also is the zone of a sphere. It will thereby be seen that the rod is universally axially tiltable to the extent that it will be permitted so to move by the surrounding structure of the rotor and of the case.

A second universally pivoted joint **71** is provided at the lower end which carries additional valve means including a zone **72** in socket **55**, this bearing a pair of valving edges **73, 74** which are circular and lie in planes normal to the axis of the valve rod. This valving means, comprising zone **72** and edges **73** and **74**, has an upper portion **75** which is the region above the edge **73** and a lower portion **76** which is the region below valving edge **74**. The upper portion is always exposed to pressure and the lower portion is always exposed to exhaust. The

platelike structure which carries zone **72** acts as a conventional "wobble plate".

Now with further regard to the rotor it will be seen that the rotor has an outer cylindrical bearing surface **80** which has a central axis **81** that is laterally offset from the central axis of the race. Furthermore, these will always remain axially offset because the geometry of the valving means is such as to exclude the rotor from moving directly radially inward.

The rotor will now tend to orbit in rotating bearing contact with the inside surface of the race and this develops the centrifugal force which comprises the function of the vibrator.

In this invention the force means are shown as plungers which make the sole operative force between the rotor and the race. It is possible for these, instead of being provided as plungers, to be provided in the form of vanes as shown in Malan U.S. Pat. No. 2,743,090, issued Apr. 24, 1956, and to provide supplemental fluid to be provided to exert further forces around the periphery of the rotor as is the case in the said Malan patent. In either event, the valving technique would be the same for the radially reciprocal elements carried by the rotor.

The operation of this device will now be described in greater detail. The rotor may assume any rotary position it chooses with respect to the valving element. It is immaterial as to its position relative to the case. It will always be maintained in contact with the race because of the construction of the valving element itself. When pressure is supplied through the supply line to the upper portion **75** then in FIG. **1** pressure would be admitted to those passages which are open to this region. In the example given, this will mean that pressure is on in passages **49**, **50**, and **51**, and that the lower portion is connected to passages **52**, **53** and **54**. This will cause a rotary impulse to be given to the rotor and as it rolls around the valve means, acting as a universal element, will cause sequentially the next passage in line to be connected to pressure and the next to exhaust, thereby sequentially connecting the plungers to pressure and exhaust so as to exert a continuing sequence of pressure impulses moving around the rotor sequentially from plunger to plunger, thereby causing it to orbit in the case and exert the desired centrifugal force.

It will be noted that the valve rod excludes the rotor from assuming any position not in contact with the rotor and thereby prevents the rotor from ever being in a position where it would dither or not be in an operative relationship with the pressure supply and exhaust lines.

The perforations **18** will permit the removal of any fluids which might leak into the race from that region. Their presence in that area tends to slow down the vibrator, and it will be found that there is a ready flow of leakage fluid out of these perforations such that this undesirable situation is avoided.

This invention thereby provides an elegant and simple valving means which overcomes the requirement found in many prior art vibrators for extremely careful manufacture of complicated geometric port shapes. It is rugged, simple in operation and long-lasting and is very suitable for hydraulic as well as for pneumatic motive fluid.

This invention is not to be limited by the embodiments shown in the drawings and described in the description which is given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

What is claimed is:

1. A free-rotor vibrator comprising: a case; an internal cylindrical race in the case having a central axis and a diameter; a rotor in said case; an outer cylindrical bearing surface on the rotor with a central axis and a diameter smaller than that of the race, the bearing surface being in rolling, bearing contact with the race so as to orbit in the race with the central axes laterally spaced from and parallel to one another and exerting a radial centrifugal force as it orbits; a plurality of angularly spaced-apart force means mounted in the rotor for reciprocating motion to extend beyond the rotor to contact the case so as to exert a separative force between the rotor and the case and to retract within the rotor so as to cause the rotor to orbit in the case; and valving means for sequentially connecting respective valving means to a source of fluid under pressure and alternately connecting the same to a region of lower pressure, said valving means comprising: a rigid valve rod; a first universally pivoted joint joining one end of the valve rod; a first universally pivoted joint joining one end of the valve rod to the case at the central axis of the case, and a second universally pivoted joint joining the other end of the valve rod to the rotor at the central axis of the rotor; wobble plate means rigidly attached to the rod at said other end having valving edges normal to the axis of the valve rod whereby the valving means has an upper and lower portion as viewed relative to the axis of the case, which portions rotate relative to the case as the rotor orbits therein; and a passage through the rotor to each force means terminating at a point contiguous to said second pivoted joint and disposed axially relative to the case axis such as to be periodically and sequentially overlapped by the upper and lower portions of the valve edge.

2. A vibrator according to claim **1** wherein the pivoted joints are ball-socket assemblies, and in which the valving edges are circular and lie normal to the axis of the valve rod.

3. A vibrator according to claim **2** wherein the ball of the respective ball-socket assembly is disposed on the valve rod, and the socket on the respective case or rotor.

4. A vibrator according to claim **1** in which the force means comprises plungers slidably fitted in respective plunger passages.

5. A vibrator according to claim **4** in which said plunger passages open onto the bearing surface.

6. A vibrator according to claim **1** in which the second pivoted joint includes a ball-like member mounted to the valve rod bounded by a zone of a sphere, making a fluid sealing fit with a socket in the rotor, the zone being bounded by two valving edges lying in planes normal to the axis of the valve rod, and in which the casing includes a pressure line adapted to be connected to a source of fluid under pressure and in fluid communication with one of said valving edges, an exhaust line in the rotor in fluid communication with the other of the valving edges and terminating also at an end face of the rotor, and in which the case further includes an exhaust groove in an end face facing and in sliding contact with the said end face on the vibrator, said groove and said exhaust line being in constant fluid connection with one another.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,650,509 Dated March 21, 1972

Inventor(s) LEROY E. SWERDFEGER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Abstract, line 2 "cylinder" should read --cylindrical--

Col. 1, line 68 "Fig." should read --Figs.--

Col. 4, line 17 (Cl. 1, line 14) "valving" should read --force--

Signed and sealed this 19th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
★ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334