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Vural

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[54] **VARIABLE MASS OSCILLATION EXCITER**

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[52] **U.S. Cl.** **404/117;** 74/87; 259/DIG. 42; 404/130; 404/133

[51] **Int. Cl.²** **E01C 19/38**

[58] **Field of Search** ..... 404/117, 130, 133; 172/40; 318/114; 74/87; 259/DIG. 42, DIG. 43

[56] **References Cited**

UNITED STATES PATENTS

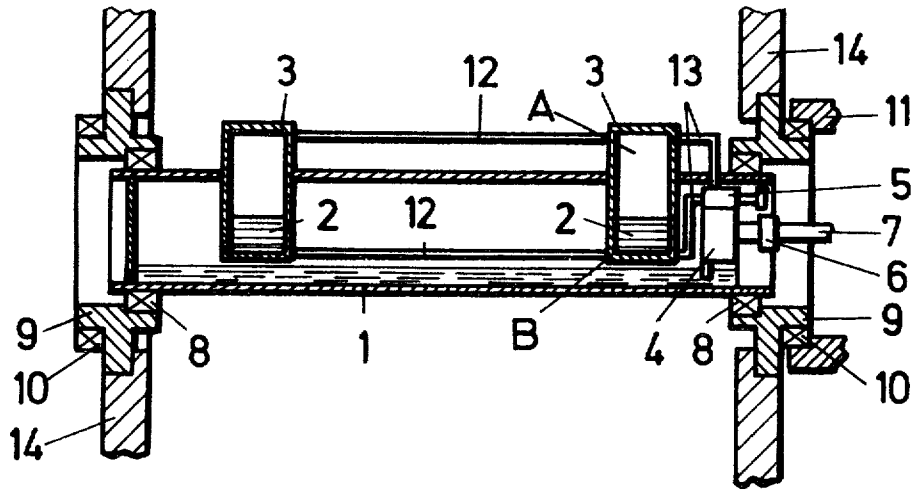
3,011,355	12/1961	Carrier	74/87
3,020,683	2/1962	Brandt	74/87
3,078,730	2/1963	Clements	74/87
3,605,584	9/1971	Kaltenegger	404/117
3,606,796	6/1969	Pappers	74/87
3,616,730	11/1971	Boone et al.	404/117
3,656,419	4/1972	Boone	404/117
3,813,950	6/1974	Ebersole	74/87

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Assistant Examiner—Steven Hawkins
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[57] **ABSTRACT**

An oscillation exciter, for use for example in vibratory ground rollers, comprises at least one rotatably mounted container, such as a cylinder, having a driving mechanism by which it can be rotated and having its interior divided into two chambers. Means such as a pump and control valve are provided for selectively injecting and venting hydraulic liquid into and from both the chambers to cause the container and the liquid which it contains to form an unbalanced mass, the magnitude of which can be varied in dependence upon the volume of liquid in each of the chambers. Preferably the container is divided into its two compartments by a movable partition in the form of a reciprocating piston or a rotary vane-piston.

14 Claims, 6 Drawing Figures



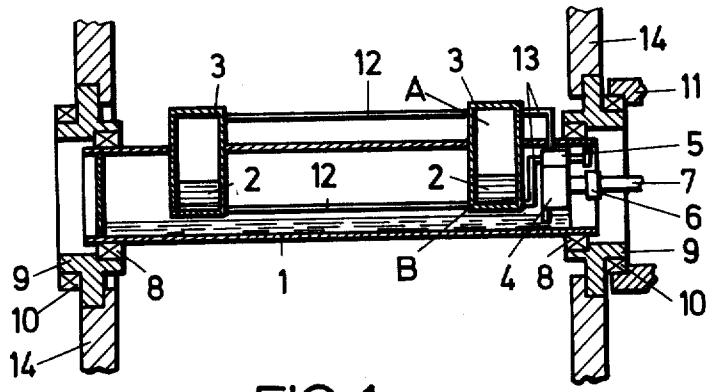


FIG. 1

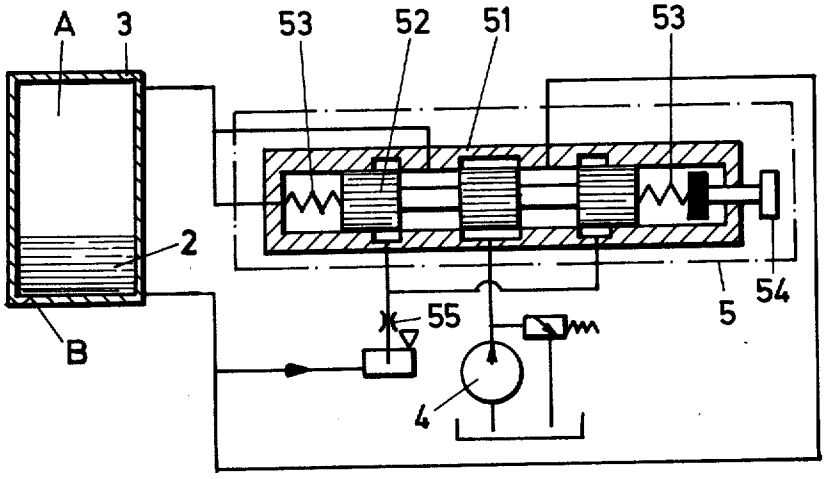


FIG. 2

FIG. 3

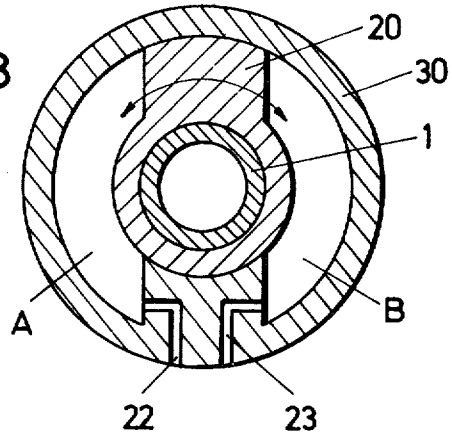
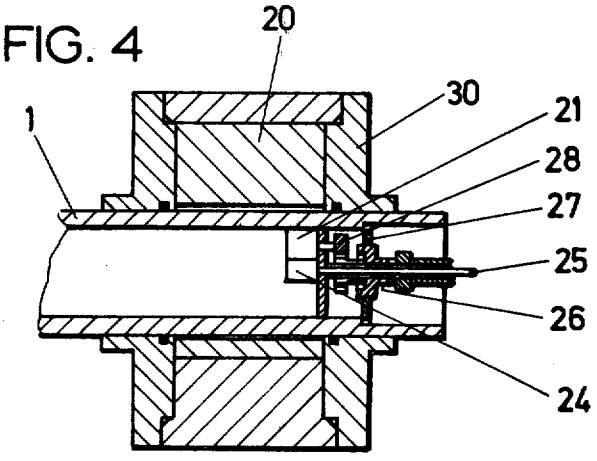


FIG. 4



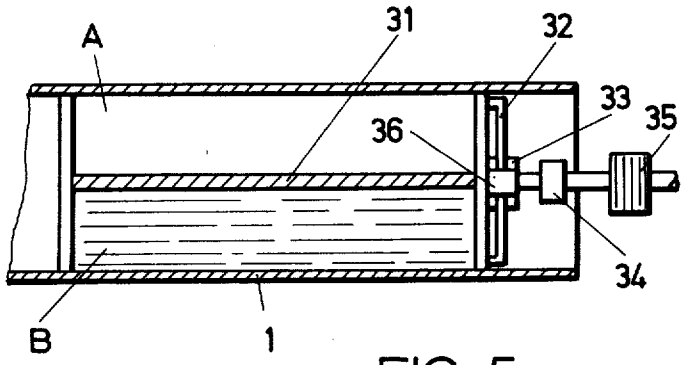


FIG. 5

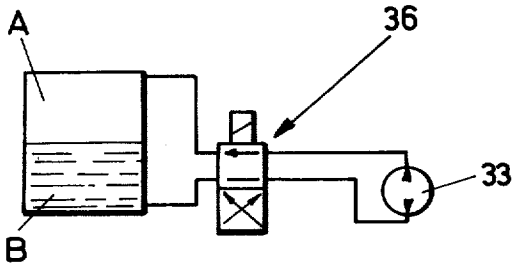


FIG. 6

VARIABLE MASS OSCILLATION EXCITER

BACKGROUND OF THE INVENTION

This invention relates to oscillation exciters for use for example in vibratory ground rollers and of the kind comprising at least one rotatably mounted container, the interior of which is divided into two chambers, means for rotating the container and means for selectively injecting and venting liquid into one of the compartments to cause the container and liquid contained in it to form an unbalanced mass.

In one oscillation exciter of this kind, a container in the form of a cylinder contains both hydraulic fluid and a spring-loaded piston which divides the cylinder into its two compartments. The hydraulic fluid is injected into the cylinder against the action of the spring, which is on the opposite side of the piston from the fluid and thus alters the position of the piston in the cylinder. A problem arises if it is desired to adjust the unbalanced mass to suit changes in the speed of rotation of the cylinder, in that the spring thrust must counteract the unbalanced mass of the liquid and piston. The spring is however capable of providing the necessary counterthrust only to a limited extent. Furthermore the hydraulic fluid tends to leak past the piston into the cylinder chamber containing the spring and consequently after a period of operation it becomes difficult to adjust the unbalanced mass accurately.

SUMMARY OF THE INVENTION

The aim of the present invention is to provide an improved oscillation exciter of the kind described above.

To this end, according to this invention, an oscillation exciter comprises at least one rotatably mounted container the interior of which is divided into two chambers, means for rotating the container and means for selectively injecting and venting liquid into and from both the chambers to cause the container and liquid contained in its chambers to form an unbalanced mass.

When the container is in the form of a cylinder divided into two chambers by a piston, the cylinder is entirely filled with hydraulic fluid.

The liquid injected into the other chamber of the cylinder then fulfils the function of the spring in the form of oscillation exciter described above. After hydraulic lines through which the liquid is injected and vented have been closed the liquid which fills the second chamber counteracts the thrust applied to the piston by the liquid in the first chamber. Furthermore any liquid leaking from one chamber into the other does not give rise to difficulties.

On the other hand, when the container is divided by a fixed wall, the container need not be entirely filled with hydraulic fluid. In this case, when the container is a cylinder which is rotated about its longitudinal axis the chambers are disposed one on each side of the axis of rotation and the liquid can conveniently be distributed between the two chambers so as to adjust the out of balance mass and thus the exciting force of the oscillation independently of the speed of rotation of the container. For example the exciting force can be kept constant as the speed of rotation varies. To keep the exciting force constant the quantities of liquid in the two chambers are made more nearly equal to each other as the speed of rotation increases and are conversely made more unequal as the speed decreases. The changing of the quantities of liquid in the two chambers can be effected by injecting more liquid into one of them, or by venting liquid from the other, or both. In the latter case, the quantities of liquid in the two chambers can be altered by pumping liquid from one chamber into the other.

To vent liquid from one chamber it is merely necessary to open an outlet valve, whereupon liquid is expelled from the chamber by centrifugally generated pressure, the liquid escaping radially outwardly. Liquid can be injected into the chamber through an inlet duct near the axis of rotation. The several techniques for changing the quantities of liquid in the chambers can if desired be combined.

A container in the form of a cylinder which is mounted to rotate about an axis coaxial with its longitudinal axis may contain a rotary-vane piston which is acted upon by hydraulic fluid in a manner analgous to that described above for an axially sliding piston. The rotary-vane piston forms an unbalanced mass and cooperates with a second unbalanced mass, preferably in the form of a stationary vane, in such a way that the exciting force, which excites the oscillation, can be varied or held constant by rotating the rotary-vane piston.

In one example of the invention, the two chambers of the container are connected together through a hydraulic line containing a pump which forms the means for injecting the liquid into the chambers. The pump may be mounted to rotate in common with the container. It is therefore not necessary to provide a rotary seal between the pump and the container. A seal of this kind is very difficult to engineer and consequently often gives trouble in operation.

Further advantages are obtained by using a rotary pump such as a gear-pump. This makes it possible to use a rotating pump housing and a pump shaft which is held stationary. It is therefore not necessary to provide a separate drive for the pump. As the container rotates, the pump housing also rotates and the pump shaft remains stationary to drive the pump.

The injection of liquid into the chambers is preferably controlled by a control valve of the sliding shuttle type installed in the delivery line between the pump and the container. When the injection of liquid has been completed, to make an adjustment of the exciting force, the control valve may connect the pump discharge to a reservoir for the liquid with the result that the pump circulates the liquid from and back into the reservoir. This arrangement is structurally advantageous in those cases where the reservoir is formed by a rotary hollow shaft on which the container, the pump and the control valve are mounted.

BRIEF DESCRIPTION OF THE DRAWINGS

Three examples of oscillation exciters constructed in accordance with the invention are illustrated diagrammatically in the accompanying drawings in which:

FIG. 1 is a diagrammatic sectional view of one example shown mounted in a rolling drum of a vibratory ground roller;

FIG. 2 is a diagram showing part of the example shown in FIG. 1, but to a larger scale;

FIG. 3 is a diagrammatic cross-section of part of a second example;

FIG. 4 is a diagrammatic axial section of the part of the second example shown in FIG. 3;

FIG. 5 is a diagrammatic axial section through part of a third example; and

FIG. 6 is a hydraulic circuit diagram showing part of a hydraulic circuit of the third example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a section through a ground-compacting drum of a vibratory ground roller having two parallel drums, one behind the other. The roller drum has a tire mounted on two end-walls **14**, each of which has a central opening containing a roller-bearing housing **9**, which has two functions. Each roller-bearing housing **9** supports a roller bearing **8** for a hollow rotary shaft **1** and also a roller bearing **10** on which the roller drum rotates in a machine frame **11** of the vibratory ground roller. The hollow rotary shaft **1** supports two cylinders **3** spaced equally from the end-walls **14** and situated in the same axial plane through the hollow rotary shaft **1**. Each cylinder **3** contains a piston **2**. Hydraulic fluid is fed to the cylinders **3** under pressure by a gear-pump **4** through hydraulic lines **13** and **12** so that hydraulic fluid under pressure can be applied to both the faces of both the pistons **2**. The hollow rotary shaft **1** has end-walls allowing it to act as a reservoir for containing hydraulic fluid. The gear-pump **4** sucks hydraulic fluid out of the hollow roatary shaft **1**. For controlling the flow and pressure of the hydraulic fluid applied to the faces of each of the two pistons **2**, the hydraulic line **13** contains a control valve **5**. The housing of the pump **4** is fixed to the hollow rotary shaft **1**, and the pump is driven by the rotation of the shaft. A pump spindle **7** which is coupled to the pump through a coupling **6**, is connected mechanically either to the roller-bearing housing **9** or to the machine frame **11** of the vibratory ground roller. The pump is therefore driven by the relative rotation between the hollow rotary shaft **1** and the roller-bearing housing **9** or the machine frame **11**.

The cylinders **3** which rotate with the hollow rotary shaft **1**, excite the roller drum into oscillation due to the fact that the piston **2** form unbalanced masses. The exciting force producing oscillation is controlled by adjusting the positions of the pistons **2**, by means of the hydraulic control valve **5** by admitting hydraulic fluid to the cylinder on one side of each piston and venting it from the other side. As shown in FIG. **2**, the valve **5** has a spring-loaded shuttle **52** which slides back and forth in a valve housing **51**. The shuttle **52** is thrust axially in opposite directions by two compression springs **53**, one at each end. The spring thrust is adjusted by the operator of the machine, preferably electromechanically by remote control, by means of a spring end-support **54** which can be adjusted in position axially, for example by means of a screw-thread. When, for example, the operator advances the end-support **54** inward this increases the thrust applied by the one spring to the piston valve, with the result that the piston valve slides axially until the two springs apply equal thrusts. Thus every change in the axial position of the end-support **54** produces a new and different position of equlilbrium of the shuttle **52** in the valve housing **51**.

In the example illustrated, inward movement of the end-support **54**, which increases the two spring thrusts, shifts the piston valve **52** in such a way that a radially outer cylinder chamber A is vented to the liquid reservoir and the pump **4** pumps hydraulic fluid from the liquid reservoir to the radially inward cylinder chamber B. On the other hand, outward movement of the end-support **54**, which reduces the two spring thrusts, shifts the piston-valve **52** in the opposite direction so that the radially inward cylinder chamber B is vented to the liquid reservoir and the pump now supplies hydraulic fluid to the radially outward cylinder chamber A.

When the pump is delivering fluid to cylinder chamber B, at the same time expelling fluid from the cylinder chamber A to the liquid-container, the resulting radially outward movement of the piston **2** is retarded by a throttling valve **55**, since the fluid expelled from the cylinder chamber A passes through the throttling valve **55** on its way to the liquid reservoir. Similarly, when the pump is delivering fluid to the cylinder chamber A, at the same time expelling fluid from the cylinder chamber B, the inward movement of the piston **2** is retarded because the liquid being expelled from the cylinder chamber B passes through the throttling valve **55**. Outward movement of the piston **2** increases the exciting force producing oscillation, and inward movement decreases it. The hydraulic lines **12** are balancing lines connecting the cylinder chambers A of the two cylinders **3** together and the cylinder chambers B together, ensuring that the two pistons **2** in the two cylinders **3** move synchronously.

After each piston movement the end-support **54** is returned to its position of rest and the shuttle **52** also returns to its position of rest in which it closes the hydraulic lines and locks the pistons **2** in position. When the valve **5** is closed, the pump **4** circulates the hydraulic fluid from and back to the reservoir formed by the shaft **1**. For example, the pump can simply vent the fluid out through a pressure-release valve into the reservoir, or the pump can deliver the fluid to the reservoir through the valve **5** and through a hydraulic line. Connections between the cylinder chambers A and B, the gear-pump **4** and the reservoir are arranged as follows. The two connections for the cylinder chambers A and B are positioned in the valve housing **51**, equally spaced at pre-determined axial distances on each side of the connection of the pump. The two connections for the hydraulic lines leading through the throttling valve **55** to the reservoir are also situated equally spaced on each side of the connection for the gear-pump **4**, but farther away from it. The shuttle **52** has two peripheral grooves or the like, of axial lengths greater than the distances between adjacent connections, the peripheral grooves being spaced closer together than the adjacent connections. The peripheral grooves are positioned so that when the shuttle **52** is in its position of rest the connections to the cylinder chambers A and B are each in the middle of a groove.

Instead of the arrangement shown in FIGS. **1** and **2**, with cylinders **3** the axes of which are radial with respect to the hollow rotary shaft **1**, each cylinder containing a piston **2**, the arrangement shown in FIGS. **3** and **4** can be used. This example of the invention has a cylinder **30** surrounding the hollow rotary shaft **1** coaxially. The cylinder **30** contains a rotary-vane piston **20** which rotates on the hollow rotary shaft **1**. The rotary-vane piston **20** can if desired be connected to the cylinder **30** through a torsion spring. The rotary vane provided by piston **20** is fixed to a bushing which is rotatably mounted on the hollow rotary shaft **1**. The vane piston projects radially outwardly from the bushing and its outer end slides over the inner suface of the cylinder **30**. A stationary vane projects radially inwardly from

the inner surface of the cylinder **30** and its inner end slides on the outer surface of the bush. The two vanes between them form cylinder chambers A and B.

When the two vanes are diametrically opposite each other, as shown in FIG. **3**, their masses exactly counterbalance each other and there is consequently no unbalanced mass. Hydraulic fluid delivered to one of the cylinder chambers A or B and vented from the other rotates the rotary vane, in one direction or the other, towards the stationary vane, with the result that the two vanes together now form an unbalanced mass. The greatest unbalanced mass is obtained when the two vanes are side by side in contact with each other. The arrangement makes it easy to adjust the exciting force to suit the speed of rotation of the hollow rotary shaft, if desired so as to keep the exciting force constant with variations in the speed of rotation. To obtain this effect the rotary vane is rotated away from the stationary vane as the speed of rotation increases and towards it as the speed decreases.

Hydraulic fluid is supplied to the chambers A and B by a pump **21** through hydraulic lines **22** and **23**, and through other lines which are not shown in the drawings forming a circuit which includes a control valve **24** which is housed inside the hollow rotary shaft **1** together with the pump **21**. The control valve **24** is actuated by a control spindle **25** which is mounted, coaxially with the hollow rotary shaft **1**, inside a hollow spindle **26** which drives the pump through a gear train **28**. The hollow spindle **26** rotates in bearings in a connecting piece **27** mounted inside the hollow rotary shaft **1**. The gear train consists of a pinion which is fixed to the hollow spindle **26** and meshes with a second pinion fixed to the drawing shaft of the pump. Rotation of the hollow spindle **26** relative to the hollow rotary shaft **1** drives the pump. When the pump is in operation it delivers hydraulic fluid through the control valve **24**, the fluid either flowing through the lines **22** and **23**, to one or the other of the two cylinder chambers, or returning to the hollow rotary shaft **1**, which acts as a liquid reservoir. It will be observed that the pump **21** can be constructed simply as a pressure pump. The liquid in the hollow rotary shaft **1** flows easily into the pump **21**, because the inlet of the pump is situated close to the inner surface of the hollow shaft. As the hollow shaft **1** rotates the liquid distributes itself evenly over the inner surface of the hollow shaft and is driven into the pump **21** through its inlet opening by centrifugal force.

The hydraulic fluid used for moving the pistons **2** or **20** in the two examples is oil which also functions as a lubricant. The pump **4** or **21** can for example also be used to pump the oil to lubrication points on the machine through a hydraulic line leading from the pressure line through which the pump **4** or **21** delivers oil to the control valve **5**.

In the example shown in FIGS. **5** and **6** a hydraulic fluid container which in this cause is formed by the hollow rotary shaft **1** is divided by a wall **31** extending parallel to the longitudinal axis of the shaft, so as to form the two chambers A and B, which are connected together through a hydraulic line **32** and a suction and pressure pump **33**. A driving shaft for the pump is coaxial with the hollow rotary shaft **1** and drives through an electric coupling **35** and through a flexible coupling **34**, so that the driving shaft can be accelerated or braked relative to the hollow rotary shaft **1**. The pump **33** is provided with a control valve **36**. The system allows hydraulic fluid to be pumped as desired between the two cylinder chambers A and B, making it possible, for example, to hold the exciting force of the oscillation exciter constant irrespective of variations in the speed of rotation of the hollow rotary shaft **1**. The electric coupling **35** can, for example, be actuated through a time relay, the coupling **35** being engaged for a period which depends on the pump output and the change in shaft speed, so that the desired quantity of hydraulic fluid is transferred from the one cylinder chamber to the other, in order to obtain the desired change in the exciting force.

I claim:

1. An oscillation exciter comprising at least one cylinder, means rotatably mounting said cylinder, means for rotating said cylinder, a piston movably mounted in said cylinder for dividing said cylinder into two chambers, and means for selectively injecting and venting liquid into and from both said chambers to move said piston so as to cause said piston and the liquid contained in said chambers to form an unbalanced mass.

2. An oscillation exciter as claimed in claim **1**, wherein said cylinder is oriented so that its longitudinal axis is transverse to the axis of its rotation and said piston is mounted for sliding movement in the direction of the longitudinal axis of said cylinder.

3. An oscillation exciter as claimed in claim **1**, wherein said rotatable mounting means mounts said cylinder for rotation about an axis coaxial with the longitudinal axis of said cylinder, and said piston is a rotary-vane piston.

4. An oscillation exciter as claimed in claim **1**, further comprising hydraulic duct means connected to said chambers, and wherein said injecting means comprise a pump connected into said hydraulic duct means.

5. An oscillation exciter as defined in claim **4** wherein said pump is a rotary pump.

6. An oscillation exciter as defined in claim **1** further comprising means defining a reservoir mounted for rotation with said cylinder.

7. An oscillation exciter as claimed in claim **4**, further comprising a reservoir, hydraulic duct means between said cylinder, said reservoir and said pump, and control valve means operatively connected in said hydraulic duct means, said control valve means being operative to selectively connect said pump to one of said chambers to inject liquid into said one chamber, and the other of said chambers to said reservoir to vent said other chamber.

8. An oscillation exciter as claimed in claim **7**, further comprising a hollow rotary shaft forming said reservoir and means mounting said cylinder, said pump and said control valve means on said hollow rotary shaft.

9. An oscillation exciter as claimed in claim **7**, wherein said means dividing said cylinder into two chambers is a rotary-vane piston, and further comprising means mounting said rotary-vane piston on said hollow rotary shaft and means fixing said cylinder to said shaft.

10. An oscillation exciter as claimed in claim **1** wherein there are two of said cylinders mounted on said mounting means, and further comprising duct means connecting each chamber of one of said cylinders to a respective chamber of the other of said cylinders.

11. An oscillation exciter comprising at least one container, means rotatably mounting said container,

means for rotating said container, means dividing said container into two chambers, and means including a pump for selectively injecting liquid into and venting liquid from both said chambers to cause said container and liquid contained therein to form an unbalanced mass, said pump including a part operatively coupled to said container for rotation therewith and a stationary part, relative rotation of said parts operating said pump.

12. An oscillation exciter as claimed in claim **11**, wherein said pump is a rotary positive displacement pump.

13. An oscillation exciter as claimed in claim **11**, wherein said pump includes a housing and a shaft, said housing forming said part operatively coupled to said container and said shaft forming said stationary part.

14. In a ground-compacting vibratory roller including a rolling drum and an oscillation exciter for vibrating said drum, the improvement wherein said oscillation exciter comprises at least one cylinder, means rotatably mounting said cylinder, means for rotating said cylinder, a piston movably mounted in said cylinder for dividing said cylinder, into two chambers, and means for selectively injecting and venting liquid into and from both said chambers to move said piston so as to cause said piston and liquid contained in said chambers to form an unbalanced mass.

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