Aug. 12, 1969 R. L. WILDE **3,460,808**

APPARATUS AND METHOD FOR GENERATING VIBRATIONS

Filed June 23, 1966 4 Sheets-Sheet 1

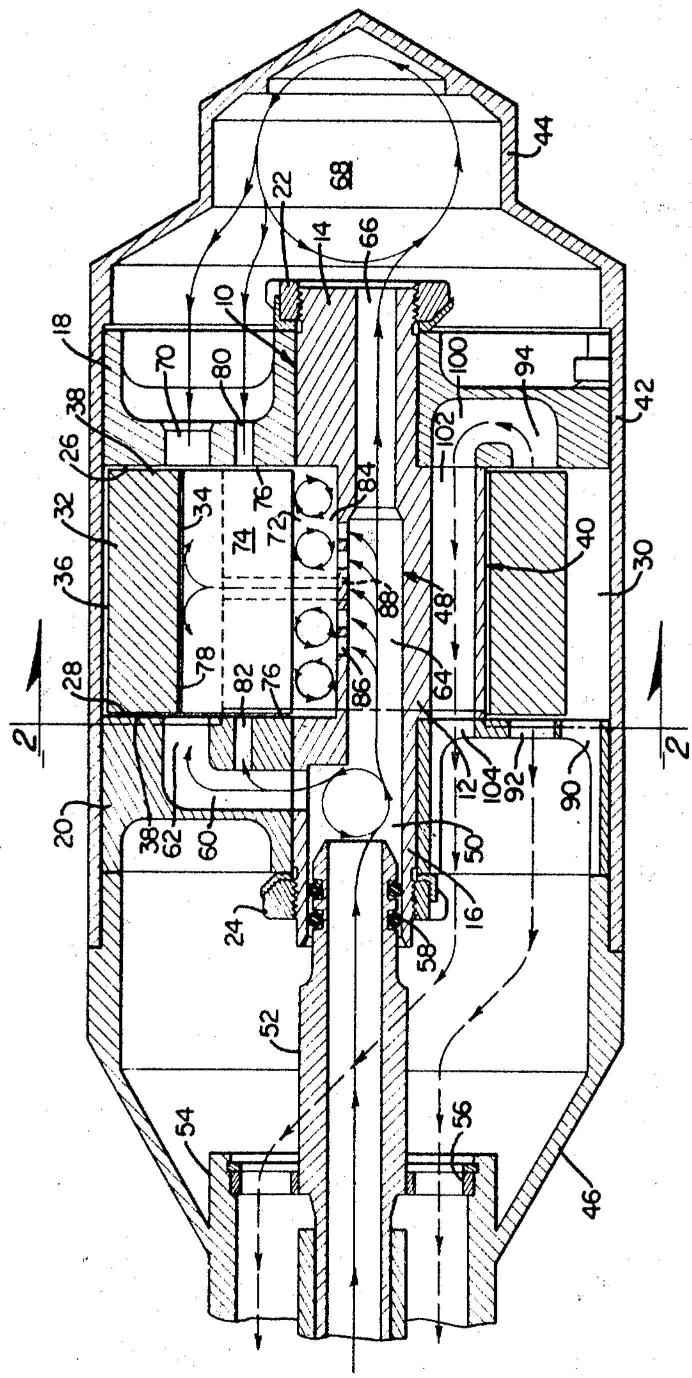

FIG. 1

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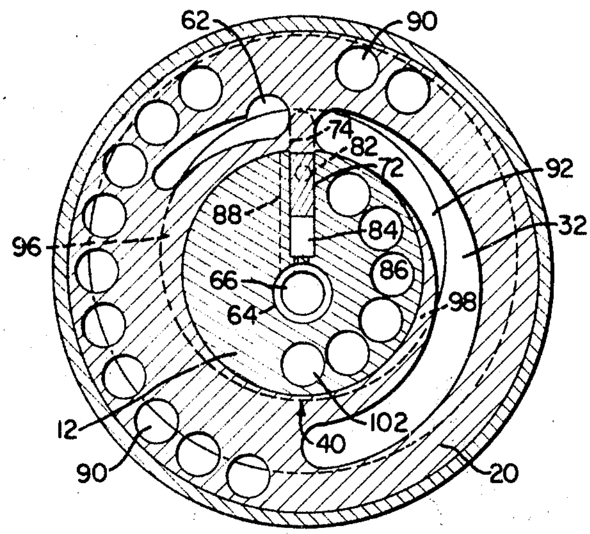

FIG. 2

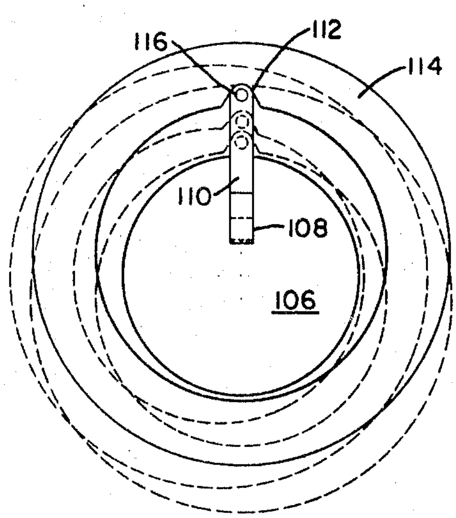

FIG. 12

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APPARATUS AND METHOD FOR GENERATING VIBRATIONS

Filed June 23, 1966 4 Sheets-Sheet 3

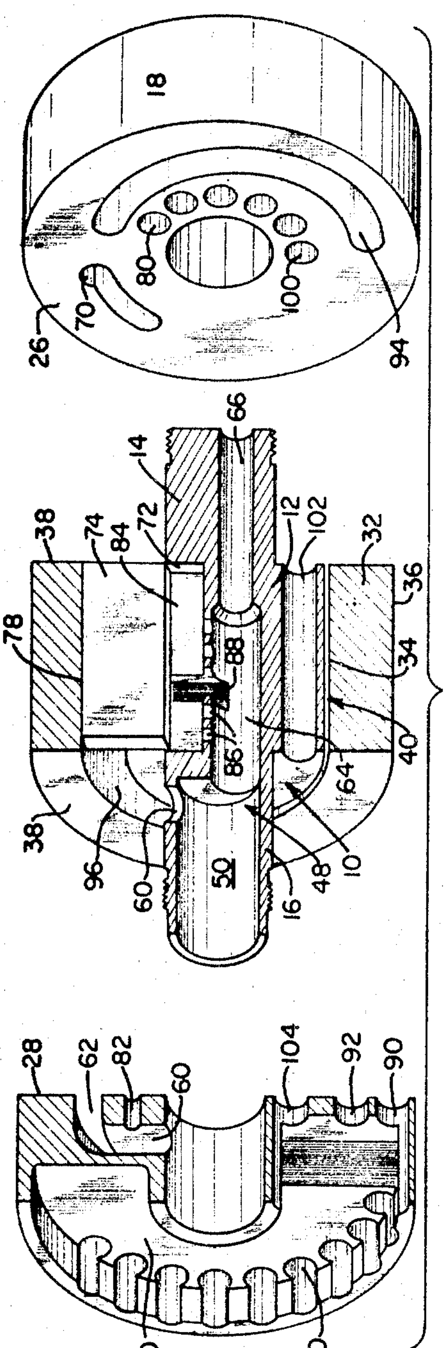

FIG. 3

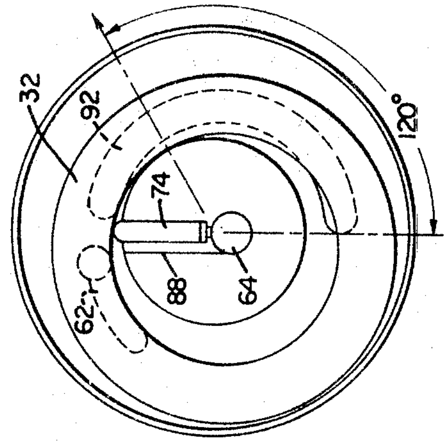

FIG. 6

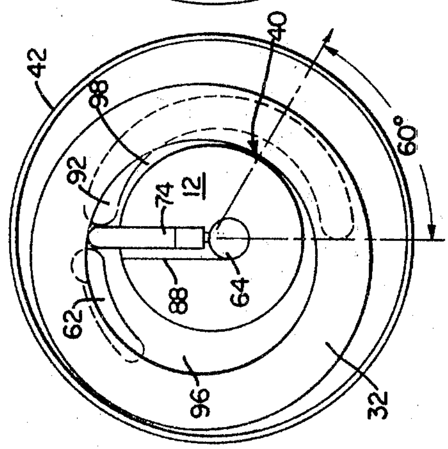

FIG. 5

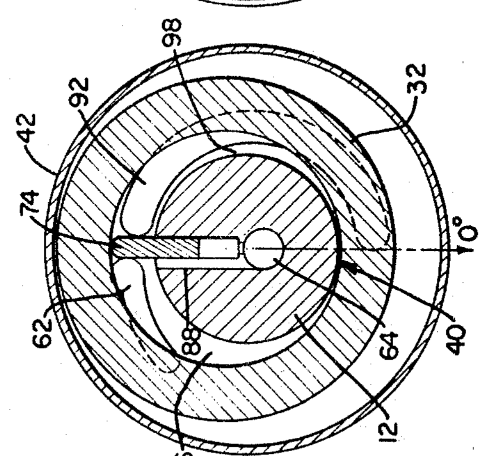

FIG. 4

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APPARATUS AND METHOD FOR GENERATING VIBRATIONS

Filed June 23, 1966 4 Sheets-Sheet 4

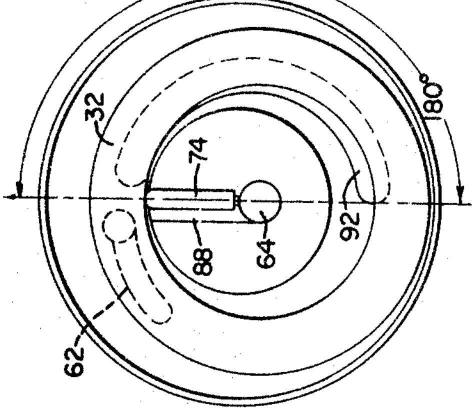

FIG. 7

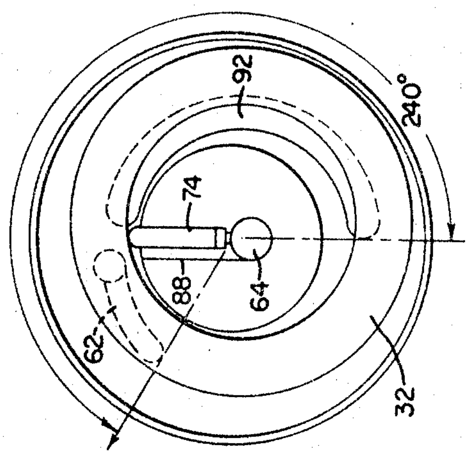

FIG. 8

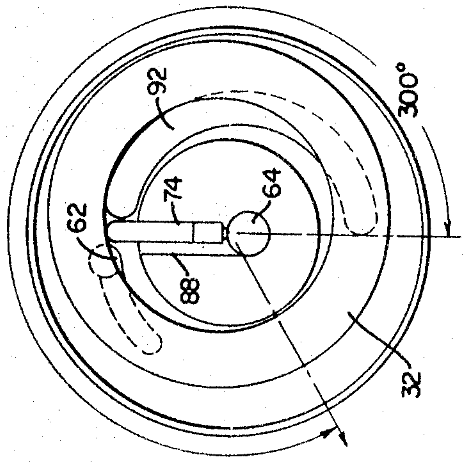

FIG. 9

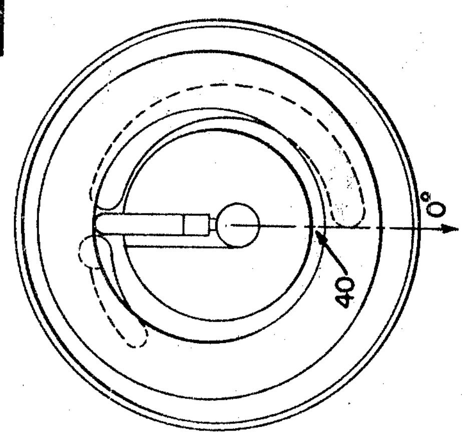

FIG. 10

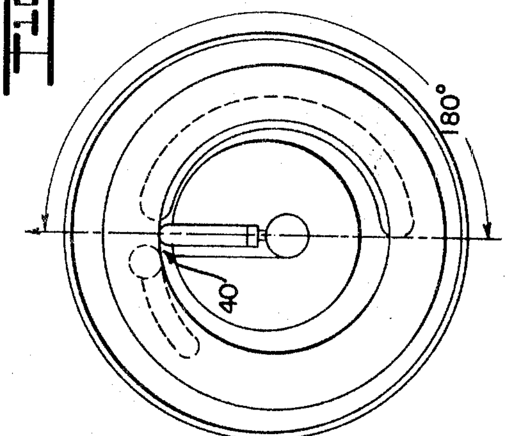

FIG. 11

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APPARATUS AND METHOD FOR GENERATING VIBRATIONS

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Int. Cl. B01f *11/00;* F16h *33/10*
U.S. Cl. 259—1 26 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for generating vibrations utilizing an inertia ring mounted for orbital movement relative to a member wherein a work chamber is formed between the opposed surfaces of the ring and the member, said apparatus being characterized in the use of means for moving the ring orbitally relative to the member while maintaining at all times during such movement a predetermined amount of minimum separation between the opposed surfaces of the ring and the member. The means for moving the ring orbitally relative to the member includes means for supplying to the motor cavity, during at least approximately one-half of each cycle, a predetermined amount of fluid of substantially constant pressure without substantially any linear mass velocity, the volume of fluid equaling the instantaneous volume of the motor cavity whereby the increase volume of fluid, to be disposed within the motor cavity, occurring from expansion of the fluid substantially equals the increased volume of the motor cavity during movement of the ring. The means for moving the ring orbitally relative to the member also includes means for effecting at least a partial decompression of the motor cavity and exhausting the exhaust cavity.

This invention lies in the field of vibration generators such as those used in compacting freshly poured concrete and operating shaking machines of various types but is not limited thereto. It is directed particularly to the type of apparatus in which a component of substantial mass is moved in an orbital path with respect to the balance of the apparatus to produce alternating force resultants in opposite directions. More specifically it is directed to the type of vibrator in which an inertia ring is caused to gyrate about a central core in an orbital path, using compressed fluid as the power source.

Devices of the type mentioned above are generally classed as "rotary vibrators" because in fact the unbalanced weight component has an axle which is mounted in bearings to allow rotation of the component, or the component actually rolls around a track of some kind. In one form, a solid or hollow cylindrical weight rolls in contact with the inner wall of a cylinder of larger diameter. In another form, a hollow cylindrical weight in the form of a ring rolls in contact with a core having a diameter less than the inside diameter of the ring.

The various types of vibrators mentioned above perform their intended functions quite well but they have drawbacks which reduce their efficiency or service life and in many cases are far more complicated mechanically than their basic operation can justify. The multiplicity of moving parts is one of the factors increasing the maintenance costs. Another is the fact that the parts which roll on each other are subject to rather heavy loads by the very nature of the operation, the whole purpose of which is to produce unbalanced loads. The wear on these parts is very rapid. When an excessive amount of pressure fluid is introduced in each cycle of operation, efficiency is reduced because only a low proportion of the available expansion energy in the compressed fluid is utilized. On the other hand, if insufficient pressure fluid is introduced, the power output is less than the theoretical capacity of the apparatus.

The present invention overcomes the disadvantages mentioned above by providing an apparatus which operates on the same broad principles as other inertia ring types but which encounters a minimum of wear by using the pressure fluid as a lubricant and as a natural mass preventing direct physical contact between the moving inertia ring and the stationary supporting member. The extent and timing of the opening of the inlet and outlet ports is such as to insure entry of the proper amount of working fluid in each cycle and adequate provision for exhausting the fluid at the proper time in the sequence. Moreover this is accomplished with a minimum of complexity, there being only two moving parts in the assembly.

Briefly and generally stated, the apparatus comprises a spool-shaped supporting member having a central cylindrical core and a pair of laterally extending end walls defining a cylindrical work chamber. An inertia ring is mounted in the work chamber for free oscillatory movement in any direction radial of the core. To provide for this free movement, the inner diameter of the inertia ring is substantially larger than the diameter of the core, and the length of the ring is slightly less than the longitudinal distance between the inner faces of the end walls. Thus the ring can gyrate about the core, following an orbital path, and produce centrifugal force successively in all directions radial of the core, the force being transmitted to the core and its associated elements through the medium of the mass of compressed fluid, which then apply the force externally for useful purposes such as compacting freshly poured concrete.

To drive the ring in its orbital movement it is necessary to provide a motor cavity and an exhaust cavity and to supply fluid under pressure to the motor cavity, the fluid being discharged out of the exhaust cavity after it has done its work. For these purposes a guide slot is formed in the core extending longitudinally between the end walls and extending radially from a location near the axis of the core to the surface of the core. A barrier blade is mounted in the slot with sufficient clearance to permit it to move readily in a radial direction. The blade is preferably flat and rectangular in planform and is slightly shorter than the axial distance between the end walls to provide clearance at each end of the blade. The outer free edge of the blade is straight and smooth and adapted to contact the inner surface of the inertia ring in sealing engagement at all times during operation to define the initial point of a motor cavity of variable volume and peripheral extent between the core and the inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between the core and the inertia ring.

Inlet and outlet ports are provided in one end wall, and in the presently preferred embodiment are provided in both end walls. The inlet port communicates with the work chamber on the motor side of the blade and the outlet port communicates with the work chamber on the exhaust side of the blade. The inertia ring is of such radial thickness that its end face completely covers the inlet and outlet ports when the ring closely approaches the core in the zone of each respective port. When the ring is spaced the maximum distance from the core in the zone of each port, it partially uncovers the port for the passage of fluid. The end face of the ring thus serves as the sole valving means for each of the ports and it successively opens and closes them at the proper time and to the proper extent during each cycle of its gyrations. The inlet port is in communication with a source of compressed fluid by way of a fluid passage.

The size, shape, location and relative attitude of the inlet and outlet port are so chosen that there is always in the work chamber between the ring and the core a sufficient mass of pressurized fluid to transmit the centrifugal force of the ring to the core while maintaining them slightly separated at the zone of closest approach. Hence the ring does not "roll" on the core, thus preventing the wear which would otherwise occur. Actually the ring need not rotate about its own axis in operation because it is free floating and oscillatory in nature.

In order to achieve maximum uniformity of operation the condition of the pressure fluid is modified in its travel from the source to the inlet port. As is known, flowing compressed fluid possesses both the kinetic or velocity energy resulting from its rate of flow and the potential expansion energy resulting from its compression. It has been found that the linear mass velocity of flow through a channel or passage is highly variable and to a great extent uncontrollable. On the other hand, the velocity of pure expansion is limited by a unique circumstance. At any constant temperature, if the back pressure or dumping area pressure is about one half the pressure of the compressed fluid or less, then the fluid will expand into the dumping area at a fixed velocity throughout a wide range of pressures, the velocity of expansion being related to the molecular, or atomic orbital velocity of the composition of the selected fluid.

It is therefore desirable to transform as much as possible of the velocity energy into potential expansion energy before utilizing the pressure fluid. This is done by incorporating an expansion chamber close to the inlet port. The chamber is much larger than the flow passage and is so arranged that the pressure fluid not only expands into it, transforming a major portion of the velocity energy into potential energy, but also encounters an abrupt change of direction which further reduces the velocity energy. Thus the primary action of the fluid in the work chamber is based on pure expansion velocity which produces a very uniform rate of operation.

Various other advantages and features of novelty will become apparent as the description proceeds in conjunction with the accompanying drawings, in which:

FIGURE 1 is a sectional elevational view of the apparatus embodying the invention;

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1;

FIGURE 3 is an exploded view in perspective of the principal working parts of the apparatus;

FIGURES 4 to 9 are schematic views illustrating the relation of parts at various stages in one cycle of operation;

FIGURES 10 and 11 are similar views illustrating the change in relation of parts under reduced load; and

FIGURE 12 is a schematic view illustrating a modification of the inertia ring and barrier blade.

One presently preferred form of the apparatus is illustrated somewhat schematically in section in FIGURE 1, in which the spool-shaped supporting member comprises an axle member **10** having an enlarged centrally located cylindrical core **12** and reduced first and second ends **14** and **16**, on which are mounted end walls or plates **18** and **20**. The end walls fit snugly on the axle ends and are held tightly in engagement with the core by the threaded members **22** and **24**. The flat, laterally extending inner faces **26** and **28** of members **18** and **20** define with the surface of core **12** a cylindrical work chamber **30**. A cylindrical inertia ring **32**, with cylindrical inner and outer faces **34** and **36** and flat, laterally extending end faces **38**, is mounted for oscillating movement in an orbital path within the work chamber.

The inner diameter of the inertia ring is substantially larger than the diameter of the core to permit substantial movement of the ring in all directions radial of the core, and its length in an axial direction is slightly less than the longitudinal distance between the inner faces **26** and **28** of the end walls to provide adequate clearance. In operation the ring oscillates or gyrates about the core in an orbital path in response to force exerted by pressure fluid admitted to the work chamber. In a sense it can be said to swing about the core so that it is always eccentrically located with one portion of its inner surface **34** always quite close to the surface of the core but separated by a small gap **40** for reasons to be explained later. The gap zone, of course, travels continually around the periphery of the core as the ring oscillates. A casing **42** having a closed end **44** snugly surrounds end walls **18** and **20** and completes the enclosure of the work chamber. A second casing member **46** forms a continuation of casing **42** to enclose the entire apparatus.

Means to provide pressure fluid to the work chamber includes a fluid passage **48** extending longitudinally through the axle member and slightly displaced laterally from its axis. The passage is divided into three sections. The first and largest section **50** is at end **16** of the axle and receives pipe **52** which transmits compressed fluid from a source not shown. The pipe is mounted within the neck **54** of casing member **46** by means of a spider fitting **56** and is sealed to the axle by conventional O-rings **58**. The pressure fluid may be any suitable compressible fluid but preferably is air because of cheapness and availability. Air compressors are almost universally available at construction sites and usually provide air at pressures of 90 to 120 p.s.i.

Since section **50** is considerably larger than the passage in pipe **52** it serves as an expansion chamber which transforms much of the velocity energy of the mass flow into potential expansion energy. Passage **60** in end wall **20** extends laterally from chamber **50** and then axially into inlet port **62** which opens into the work chamber **30**. These two bends which change the direction of flow serve to further transform velocity energy into potential expansion energy.

Central section **64** of passage **48** is considerably smaller than section **50** because approximately half of the total flow of fluid is diverted into passage **60**. End section **66** is smaller than section **64** to maintain a higher pressure in the latter for reasons to be mentioned later. Section **66** discharges into expansion chamber **68** which serves in the same way as section **50** to change the direction of flow and transform velocity energy into potential expansion energy. Inlet port **70** communicates directly with chamber **68** to admit pressure fluid into the work chamber. It is located directly opposite inlet port **62** and is of the same size and shape to provide balanced flow of pressure fluid.

A rectangular slot **72** is formed in core **12** and extends longitudinally for the length of the core and radially to its outer surface from a location near the core axis. Barrier blade **74** is mounted in the slot and is in the form of a flat rectangular plate slightly shorter than the distance between the end walls to provide clearances **76**. Its outer free edge **78** is straight and smooth for sealing contact with the inner surface **34** of the inertia ring. Auxiliary ports **80** and **82** are formed in end walls **18** and **20** in axial alignment with the blade to lead pressure fluid to clearances **76**. The balanced pressure against the two ends of the blade centers it and keeps it clear of the end wall faces to minimize friction.

In order to maintain the free edge **78** of the blade in sealing contact with the inner surface of the inertia ring at all times during operation it is necessary to provide means to yieldingly urge it outward. The bottom portion of slot **72** forms a pressure chamber **84** fed with pressure fluid from section **64** by way of apertures **86**. The back pressure in **64** resulting from the constriction in section **66** aids this operation. In addition passage **88**, adjacent to slot **72**, communicates at its lower end with section **64** and at its upper end with the work chamber for reasons to be detailed later.

The relationship of the parts just described is further illustrated in FIGURES 2 and 3, where it will be seen that inlet ports **62** and **70** include slots having a generally arcuate form extending peripherally part way around the core. Each port is on the motor side of the blade **74**, originates adjacent thereto, and extends about sixty degrees. It is arranged eccentrically or spirally so that the end adjacent to the blade is closer to the core. It will be apparent that in all positions of the inertia ring, its end faces cover some portions of ports **62** and **70** so that fluid pressure is exerted against the end faces and a small portion of the fluid passes through clearances **76** with the result that the ring is always spaced from the end walls and develops no friction. A plurality of passages **90** are arranged peripherally around the end wall and at least some of them are partially uncovered at all times so that the leakage fluid can discharge.

Outlet ports **92** and **94** are also elongate and generally arcuate or spiral. They extend peripherally around the core about one hundred eighty degrees with terminal ends adjacent to the blade **74** on the exhaust side and closer to the core than the originating ends. With the inertia ring and the blade in the positions shown in FIGURES 2 and 3 they combine with the core to form a motor cavity **96** to the left of the blade between the ring and the core and an exhaust cavity **98** between the ring and the core to the right of the blade. The orbital movement of the inertia ring is counterclockwise as viewed in these and subsequent figures. In FIGURE 2 it will be seen that both the inlet and outlet ports are partially uncovered or opened. Thus pressure fluid enters the motor cavity and the expanded fluid passes out of the exhaust cavity through ports **92** and **94**. Returning to FIGURE 1, it will be seen that outlet port **94** cannot be open entirely through its end wall **18** because it would communicate with expansion chamber **68**. Therefore cross passages **100** are provided which connect with auxiliary outlet passages **102** in the core and **104** in end wall **20**. All of the exhaust fluid finally passes out through casing member **46** and neck **54**.

The sequence of steps which produce the gyratory motion of the inertia wheel are schematically illustrated in FIGURES 4 to 9, with the apparatus operating at full design load. For purpose of explanation it will be considered that the arrangement of FIGURE 4 represents the zero degree position and the 360 degree position. At this stage the inertia ring is in its uppermost position, being held out of contact with the core, as indicated at gap **40**, by the fluid pressure as previously explained. Blade **74** is in its uppermost position in sealing contact with the ring, and the motor cavity **96** and exhaust cavity **98** are exactly equal in size. Inlet port **62** is open to its maximum extent, and the pressure fluid is entering and expanding to increase the size of the motor cavity. Outlet port **92** is open slightly less than its maximum extent, allowing the fluid to exit so that the exhaust cavity can decrease in volume.

FIGURE 5 represents the 60 degree stage. The inlet port is still wide open and the motor cavity has been enlarged. The outlet port and the exhaust cavity have been decreased in size. At this point the inlet port begins to close, and it will be seen that at the 120 degree position of FIGURE 6 the inlet port is closed while the pressure remaining in the motor cavity causes the cavity to generate counterclockwise in accordance with a constantly increasing exhaust port which becomes static at FIGURE 9 as the inlet port begins to open.

At FIGURE 7 the 180 degree position has been reached, the inlet port is still closed, and there is only one cavity, which is open to exhaust. As the ring passes this stage, the motor cavity of the next cycle begins to form but the increase is small, and fluid entering through passage **88** from passage **64** is sufficient to provide the motive power. At FIGURE 8 and 240 degrees inlet port **62** is still closed but outlet port **92** is wide open. At 270 degrees, not shown, the inlet port again begins to open and is partially open as shown in FIGURE 9 at 300 degrees. The inlet port continues to enlarge until it is again wide open

at zero degrees in FIGURE 4. Thus it can be said that the motor cavity is initiated at 180 degrees and increases through zero to a maximum at 120 degrees when the outlet port again begins to open, turning it into an exhaust cavity.

The sequence can be summarized as follows:

At 270, inlet area begins to open.
At 0, inlet area is wide open.
From 0 to 60, inlet area is constant.
From 60 to 120, inlet area gradually closes.
At 120, inlet area is fully closed.
At 120, outlet area begins to open at the bottom.
At 210, outlet area is wide open.
From 210 to 330, outlet area is constant.
From 330 to 120, outlet area gradually closes.
At 120, outlet area at the top cavity is fully closed.

With this timing and sequence the inlet port admits sufficient fluid to provide the necessary power for the full design load while allowing the full useful expansion of the fluid down to a practical exhaust pressure, and the inlet is fully cut off as the outlet port begins to open.

A better understanding of the variation in pressure occurring under the blade **74** in relation to the cycling of the inertia ring **32** is obtained from the following explanation. First of all, if an outlet port is disposed substantially at right angles to a flow channel, a flowing of fluid through the flow channel will produce a vacuum or pressure reduction adjacent such outlet port. Conversely, if a pressurized fluid is contained within but not permitted to flow through the flow channel, it will be observed that the pressurized fluid will flow into and through the outlet port. Thus, it will be readily understood that when the inlet port **70** is open and pressurized fluid is being supplied into the work chamber via the inlet port **70**, the rate of flow through passage **48** will be relatively high thereby producing a relative drop in pressure under the blade **74**. However, even under these circumstances the pressure under the blade will be slightly greater than the pressure existing within the working chamber thereby causing the blade to exert a predetermined amount of force against the inner surface of the inertia ring **32** to effect a seal at the point or along the line of contact. It will be understood that by proper design an effective seal will be obtained even though only a few ounces of force is exerted by the blade against the inertia ring. Further, this force will vary depending on the variation in pressure beneath the blade **74**. When the inlet ports **62** and **70** are closed, all of the pressure of the compressed fluid is directed under the blade causing the blade to move against the inertia ring with considerable force. It has been found that the change in pressure under the blade occurs gradually, the amount of change being relative to the opening of the inlet ports **62** and **70**. It has also been found that during that portion of the cycle in which the inlet ports are closed, the inner surface of the inertia ring **32** disposed opposite the upper portion of the blade **74** moves outwardly relative to the outer surface of the core **12** adjacent the slot **72** in which the blade **74** is disposed and that the pressure under the blade **74** increases and is timed coincidentally to the blade's outwardly motion. When the blade is required to move radially inwardly within the slots formed in the core **12** due to the changing position of the inertia ring, the pressure beneath the blade decreases while at the same time the area of the inlet port opening into the work chamber is increased. The foregoing is more easily visualized by examining FIGURES 7, 8 and 9 which show the radially outwardly movement of the blade during which time the inlet port is closed or substantially closed, and the radially inwardly movement of the blade in FIGURES 4, 5 and 6 during which time the inlet port opening into the chamber **30** degreases from a partial open condition to a closed condition.

With respect to a comparison between the orbital velocity of the inertia ring and the expansion velocity of the pressurized fluid within the working chamber, it has been found that when the back pressure or exhaust pressure is maintained approximately one-half of the pressure of the pressurized fluid at the inlet and the fluid is propelled through the working chamber under the influence of its own capacity to expand, the compressed fluid will expand at a fixed velocity relative to the temperature of the fluid. Further, where the fluid is propelled only by its own capacity to expand, it has been found that the orbital velocity of the inertia ring can be maintained equal to or slightly greater than the velocity of such expansion and thus through the use of a predetermined configuration and positioning of the inlet and outlet ports, the end walls, and the valving of the ports by the orbiting of the inertia ring, it is possible to maintain the rate of fluid expansion equal to or slightly less than the orbital velocity of the inertia ring. Thus, the volume of the fluid at any instant in time is substantially the same as the volume of the working chamber for the same instant of time and there is no instigation for volume increase of the working chamber which would result in the inertia ring contacting the exterior surface of the core **12**.

Referring now to FIGURE 4, it is easy to visualize the starting of the apparatus where the orbital position of the inertia ring is as depicted therein. However, the position of the inertia ring may very well by chance be other than as shown in FIGURE 4, for instance see the position as shown in FIGURE 7. Where the inertia ring is in the position as shown in FIGURE 7, the inlet ports are fully closed. When the inlet ports are closed, all of the fluid pressure is directed into the slot under the blade. As a consequence, a sufficient force is generated against the blade causing it to lift the ring into the starting position as shown in FIGURE 4. At the same time sufficient fluid flows through channel **88** and the slot **72** to cause an increase in the volume of the working chamber thereby initiating counterclockwise rotation of the inertia ring prior to the actual opening of the inlet ports.

The apparatus is designed to develop a constant external amplitude of motion over a wide range of external loads, producing maximum inertia ring eccentricity during maximum resistance and reduced eccentricity during reduced resistance. When the resistance against the apparatus is decreased, the frequency of the cycle of operation is increased. This higher frequency reduces the expansion time available for the fluid during the angular generation of the motor cavity, and therefore the instantaneous fluid volume and consequently the cavity volume will be less at any given instant. This is illustrated in FIGURES 10 and 11 which show the positions of the inertia ring at the zero and 180 degree stages. It will be noted that the gap **40** is considerably larger at the lower load. Also the lesser eccentricity of the ring reduces the maximum opening of the inlet and outlet ports, thus automatically reducing the quantity of fluid expended. The eccentric or spiral arrangement of the inlet and outlet ports also automatically adjusts the timing of inlet and exhaust for maximum efficiency, and compatibility with the load situation within the load capacity of the apparatus.

Since the inertia ring is always held spaced from the core by the fluid pressure in the minimum gap, the ring need not actually rotate about its axis as the prior art devices were required to do. Consequently it is feasible to secure the barrier blades to the inertia ring with a pivotal connection to insure that they always remain in sealing relation. As seen in FIGURE 12, the core **106** is basically similar to core **12** of FIGURE 1 and is provided with a similar slot **108**. Barrier blade **110** is slidably mounted therein, and its outer end fits into notch **112** in the inertia ring **114** in sealing relation. It is connected thereto for rocking motion by pivot pin **116** carried by the inertia ring. The motion and operation are just the same as in the embodiment previously described.

It will be apparent to those skilled in the art that various changes may be made in the construction and

operation of the apparatus as disclosed without departing from the spirit of the invention, and it is intended that all such changes shall be embraced within the scope of the following claims.

I claim:

1. Apparatus for generating vibrations comprising: a fixed, spool-shaped supporting member having a central axially directed cylindrical core and laterally extending end walls defining a work chamber; an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radial of said core; a barrier blade extending longitudinally of said core and mounted therein for sliding movement radially thereof in sealing engagement with said ring and arranged to define the initial point of a motor cavity of a variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said inertia ring; a pressure fluid inlet port in an end wall communicating with said work chamber on the motor side of said blade; a pressure fluid outlet port in an end wall communicating with said work chamber on the exhaust side of said blade; said inlet port being in the form of an elongate arcuate slot extending along the inner face of the end wall and originating adjacent said barrier blade; said outlet port being in the form of an elongate arcuate slot extending along the inner face of the end wall and terminating adjacent said barrier blade; said inlet port having a substantially constant maximum opening during approximately sixty degrees of travel of said inertia ring; said outlet port having a substantially constant maximum opening during approximately one hundred twenty degrees of travel of said inertia ring; said inertia ring being adapted to oscillate about said core in an orbital path with at least one of its end faces acting as a valve to open and close cyclically and successively said inlet and outlet ports; the opening of said inlet port serving to admit fluid to enlarge the motor cavity and provide the driving force for said inertia ring; the opening of the exhaust port serving to discharge fluid to decompress the exhaust cavity; both of said ports being so located in the path of orbital movement of said inertia ring as to be cyclically substantially covered and partially uncovered by the adjacent end face of the inertia ring in its orbital movement.

2. Apparatus as claimed in claim **1**; the beginning of the period of maximum opening of said outlet port occurring about one hundred fifty degrees after the ending of the period of maximum opening of said inlet port.

3. Apparatus for generating vibrations comprising: a fixed, spool-shaped supporting member having a central, axially directed cylindrical core and laterally extending end walls defining a work chamber; an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radial of said core; a barrier blade extending longitudinally of said core and mounted therein for sliding movement radially thereof in sealing engagement with said ring and arranged to define the initial point of a motor cavity of variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said inertia ring; a pressure fluid inlet port in an end wall communicating with said work chamber on the motor side of said blade; a pressure fluid outlet port in an end wall communicating with said work chamber on the exhaust side of said blade; means to supply pressure fluid to said inlet port; said inertia ring being adapted to oscillate about said core in an orbital path with at least one of its end faces acting as a valve to open and close cyclically and successively said inlet and outlet ports; the opening of said inlet port serving to admit fluid to enlarge the motor cavity and provide the driving force for said inertia ring; the opening of the exhaust port serving to discharge fluid to decompress the exhaust cavity; and a radially extending fluid inlet port disposed in said core communicating with the work chamber adjacent to said blade and on the motor side thereof to serve as an auxiliary pressure fluid supply during the period when the inlet port in said end wall is closed; said inlet port in said core being in communication with said means to supply pressure fluid.

4. Apparatus for generating vibrations comprising: a fixed, spool-shaped supporting member having a central, axially directed cylindrical core and laterally extending end walls defining a work chamber; an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radial of said core; a barrier blade extending longitudinally of said core and mounted therein for sliding movement radially thereof in sealing engagement with said ring and arranged to define the initial point of a motor cavity of variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said inertia ring, the outer edge of said barrier blade being pivotally connected to the inner face of said inertia ring; a pressure fluid inlet port in an end wall communicating with said work chamber on the motor side of said blade; a pressure fluid outlet port in an end wall communicating with said work chamber on the exhaust side of said blade; and means to supply pressure fluid to said inlet port; said inertia ring being adapted to oscillate about said core in an orbital path with at least one of its end faces acting as a valve to open and close cyclically and successively said inlet and outlet ports; the opening of said inlet port serving to admit fluid to enlarge the motor cavity and provide the driving force for said inertia ring; the opening of the exhaust port serving to discharge fluid to decompress the exhaust cavity.

5. Apparatus for generating vibrations comprising: a fixed longitudinally extending axle member having a centrally located axially directed enlarged cylindrical core; a pair of end plates on said axle member extending laterally at the ends of said core to define therewith a cylindrical work chamber; an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radially of said core; a casing surrounding all of said component and having a closed end defining a first expansion chamber at a first end of said axle member; said axle member having a longitudinal fluid passage therethrough communicating at said first end with said first expansion chamber; a conduit connected to a source of fluid pressure and with the fluid passage in the axle member at the second end of said axle member; a longitudinally and radially extending slot in said core; a barrier blade mounted in said slot for radial movement; the outer free edge of said blade being straight and smooth and adapted to contact the inner surface of said inertia ring in sealing engagement at all times during operation to define the initial point of a motor cavity of variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said inertia ring; a pressure fluid inlet port in each end wall communicating with said work chamber on the motor side of said blade; a pressure fluid outlet port in each end wall communicating with said work chamber on the exhaust side of said blade; a second expansion chamber in said axle member adjacent the second end of the axle member and comprising a portion of the longitudinal fluid passage; each of said inlet ports communicating with its adjacent expansion chamber to receive pressure fluid in which the major portion of the velocity energy has been transformed to expansion potential; the slot in said core communicating with said longitudinal passage to receive pressure fluid for urging said blade into contact with said inertia ring; said ring being adapted to oscillate about said core in an orbital path with its end faces acting as valves to cyclically and successively open and close said inlet and outlet ports; the openings of said inlet ports serving to admit fluid to enlarge the motor cavity and provide the driving force for said inertia ring; and the openings of the exhaust ports serving to discharge fluid to decompress the exhaust cavity.

6. Apparatus for generating vibrations in which a hollow cylindrical weight in the form of an inertia ring is movable in an orbital path about a centrally located cylindrical core having a diameter less than the internal diameter of the inertia ring and characterized by:

a partition dividing a work chamber defined between the core and the ring into two cavities of variable volume;

said partition including a blade mounted in a longitudinally extending slot formed in the core for radial sliding movement therein;

a fluid inlet port and a fluid outlet port which are opened and closed cyclically in response to movement of the ring relative to the core to permit one of the cavities to be subjected to fluid pressure and the other to be exhausted;

end walls defining walls of the work chamber, said inlet port and said outlet port being formed in at least one of the end walls, said inertia ring and said blade having axial lengths slightly less than the axial distance between the end walls so that the inertia ring and the blade are separated from each of said end walls by a clearance; and

means including auxiliary ports formed in said end walls for supplying fluid pressure to said clearances to prevent physical contact between the end walls and the end faces of the inertia ring and blade.

7. Apparatus for generating vibrations comprising: a fixed, spool-shaped supporting member having a central, axially directed, hollow, cylindrical core and laterally extending end walls defining a work chamber, said core having a longitudinally extending slot formed therein; an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radial of said core; a barrier blade extending longitudinally of said core and mounted within said slot for sliding movement radially thereof in sealing engagement with said ring and one of the surfaces of said slot to define the initial point of a motor cavity of variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said inertia ring; means for supplying pressurized fluid through said slot into said motor cavity; a pressure fluid inlet port in an end wall constructed to be disposed in intermittent communication with said motor cavity; a pressure fluid outlet port in an end wall constructed to be disposed in intermittent communication with said exhaust cavity the orbital movement of said ring effecting opening and closing of said inlet and outlet ports; and means for moving, during operation of the apparatus, said inertia ring orbitally relative to said core while maintaining at all times during operation of the apparatus a predetermined amount of minimum separation between opposed surface portions of said ring and said core, said means for moving said inertia ring orbitally relative to said core including means for supplying to said inlet port for introduction into said motor cavity, during at least approximately one-half of each cycle, a predetermined amount of fluid of substantially constant pressure and without substantially any linear mass velocity whereby the volume of fluid supplied to

said motor cavity in combination with the increase in volume of fluid occurring from expansion of the fluid within said motor cavity equals, during pressurization of the motor cavity, the instantaneous volume of said motor cavity, said outlet port when disposed in communication with said exhaust cavity effecting an exhaustion of said exhaust cavity.

8. Apparatus as claimed in claim **7**; said inlet port being in the form of an elongate arcuate slot, said arcuate slot being eccentric to said core, with the end of the slot adjacent to the barrier blade being closer to said core than is the opposite end of the slot.

9. Apparatus as claimed in claim **8**; the peripheral extent of said arcuate slot being approximately 60 degrees.

10. Apparatus as claimed in claim **7**; said outlet port being in the form of an elongate arcuate slot, said arcuate slot being eccentric to said core, with the end of the slot adjacent to the barrier blade being closer to said core than is the opposite end of the slot.

11. Apparatus as claimed in claim **10**; the peripheral extent of said outlet port slot being approximately 180 degrees.

12. Apparatus as claimed in claim **7**; said ports being so arranged with respect to each other that initiation of the opening of the inlet port occurs aproximately one hundred eighty degrees after completion of closure of the outlet port.

13. Apparatus for generating vibrations comprising:

a supporting member having a hollow core with a longitudinally extending slot formed in a wall portion thereof and end walls defining a work chamber;

an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radial of said core;

a barrier blade mounted for sliding movement substantially radially within the slot of said core and being adapted to contact in sealing engagement the inner surface of said inertia ring and a surface portion of said slot at all times during operation to define the initial point of a motor cavity of variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said ring;

means for supplying pressurized fluid through said slot into said motor cavity;

a pressure fluid inlet port in an end wall communicating with said motor cavity;

a pressure fluid outlet port in an end wall communicating with said exhaust cavity and having intermittent communication with said motor cavity;

said inertia ring being adapted to oscillate about said core in an orbital path with at least one of its end faces acting as a valve to cyclically and successively open and close said inlet and outlet ports;

means for moving said inertia ring orbitally relative to said core including means for supplying to said inlet port for introduction into said motor cavity, during at least approximately one-half of each cycle, a predetermined amount of fluid of substantially constant pressure and without substantially any linear mass velocity whereby the volume of fluid supplied to said motor cavity in combination with the increase in volume of fluid occurring from expansion of the fluid within said motor cavity equals, during pressurization of the motor cavity, the instantaneous volume of said motor cavity;

said outlet port, when disposed in communication with said motor cavity, effecting at least a partial decompression of said motor cavity, and said outlet port, when disposed in communication with said exhaust port, effecting an exhaustion of said exhaust cavity.

14. Apparatus for generating vibrations in which a hollow cylindrical weight in the form of an inertia ring is movable in an orbital path about a centrally located cylindrical core within said ring having a diameter less than the inner diameter of the inertia ring, a work chamber thus being formed between the ring and the core;

slot means formed in said core;

a partition disposed within said slot means and dividing the work chamber into two cavities of variable volume, one of said cavities being a motor cavity and the other being an exhaust cavity, said partition being disposed in sealing engagement with said slot means and a surface of said ring;

means for supplying pressurized fluid through said slot means into said motor cavity;

said work chamber having a fluid inlet port in communication with said motor cavity and a fluid outlet port in intermittent communication with said motor cavity and said exhaust cavity; said ports being opened and closed cyclically in response to movement of the ring relative to the core to permit:

(i) the motor cavity to be subjected to fluid pressure and at least partially decompressed; and

(ii) the exhaust cavity to be exhausted;

said apparatus being characterized by:

means for orbitally moving said inertia ring relative to said core during operation of the apparatus, including means for supplying to said inlet port for introduction into said motor cavity, during at least approximately ½ of each cycle, a predetermined amount of fluid of substantially constant pressure and without substantially any linear velocity whereby the volume of fluid supplied to said motor cavity in combination with the increase in volume of fluid occurring from expansion of fluid within said motor cavity equals ,during pressurization of the motor cavity, the instantaneous volume of said motor cavity;

said outlet port effecting

(i) at least a partial decompression of said motor cavity when disposed communication therewith; and

(ii) an exhaust of said exhaust cavity when disposed in communication therewith.

15. Apparatus as defined in claim **14** in which the inlet port originates adjacent one side of the partition and the outlet port terminates adjacent the other side of he partition.

16. Apparatus as described in claim **14** in which an expansion chamber is located upstream of said inlet port.

17. Apparatus as defined in claim **14** in which end walls are provided which define walls of the work chamber, the inlet port and the outlet port being formed in at least one of said end walls.

18. Apparatus as described in claim **17** in which the inlet port is an elongate arcuate slot formed in one end wall adjacent the path of orbital movement of the adjacent end face of the inertia ring such that the inlet port is subsantially covered by said end face during approximately one-half of each orbital cycle of the inertia ring.

19. An apparatus for generating vibrations comprising:

end walls and an inertia ring located therebetween and having a longitudinally extending, arcuately shaped surface;

a member having a longitudinally extending, arcuately shaped surface;

a work chamber formed between the arcuately shaped surfaces and said end walls;

means for eccentrically oscillating said inertia ring about said member so that at any given time a given portion of the arcuately shaped surface of said inertia ring is close to a given portion of the arcuately shaped surface of said member, to thereby form a continuously moving small gap between said inertia ring and said member;

a slot formed in said member;

a barrier disposed within said slot and in sealing engagement with both a surface of said slot and said inertia ring, said barrier blade cooperating, at any given time during operation of the apparatus, with said gap to divide the work chamber into:

(i) a motor cavity commencing adjacent one side of said barrier and terminating at said gap; and

(ii) an exhaust cavity commencing adjacent said gap and terminating at the other side of said barrier; said barrier being constructed for translatory movement in a direction generally radially of the arcuately shaped surface of said member, both cavities, during operation of the apparatus, being of variable volume varying between substantially zero and the substantial volume of the work chamber;

means for supplying pressurized fluid through said slot into said motor cavity;

a fluid inlet port in a wall of said work chamber and constructed to be disposed in intermittent communication with the motor cavity;

a fluid outlet port in a wall of said work chamber and constructed to be disposed in intermittent communication with the motor and exhaust cavities, said oscillatory movement of said inertia ring effecting opening and closing of said inlet and outlet ports;

said means for moving said inertia ring orbitally relative to said member including means for supplying to said inlet port for introduction into said motor cavity, during at least approximately one-half of each cycle, a predetermined amount of fluid of substantially constant pressure and without substantially any linear mass velocity whereby the volume of fluid supplied to said motor cavity in combination with the increase in volume of fluid occurring from expansion of the fluid within said motor cavity equals, during pressurization of the motor cavity, the instantaneous volume of said motor cavity;

said outlet port effecting:

(i) at least a partial decompression of said motor cavity when disposed in communication therewith, and

(ii) an exhaustion of said exhaust cavity when disposed in communication therewith.

20. An apparatus as described in claim **19** including means for moving said inertia ring radially during a predetermined portion of each cycle of said ring, said means including said barrier and means for supplying pressurized fluid against a surface portion of said barrier.

21. A method for generating vibrations by means of a device of the type in which an inertia ring is mounted for cyclic orbital movement relative to a member to form a work chamber between opposed surfaces of the inertia ring and the member, there being a barrier mounted between the opposed surfaces of the ring and the member for translatory movement with respect to one of said opposed surfaces, wherein said barrier is in sealing engagement with the other one of said opposed surfaces to divide the work chamber into a motor cavity commencing adjacent one side of said barrier and an exhaust cavity terminating at the other side of said barrier; said method comprising the steps of:

orbitally moving said inertia ring relative to said member by means of pressurized fluid;

maintaining a predetermined amount of minimum separation between the opposed surfaces of said ring and said member at all times during such movement; and

supplying a predetermined amount of fluid to the motor cavity during at least approximately one-half of each cycle, said fluid being supplied at substantially constant pressure without substantially any linear mass velocity, the volume of said fluid equaling the instantaneous volume of the motor cavity whereby the increased volume of fluid, during pressurization of said motor cavity, occurring from expansion of the fluid within said motor cavity substantially equals the increased volume of the motor cavity during movement of the ring.

22. Apparatus for generating vibrations comprising: a fixed, spool-shaped supporting member having a central, axially directed, hollow, cylindrical core and laterally extending end walls defining a work chamber, said core having a longitudinally extending slot formed therein; an inertia ring surrounding said core within said work chamber and having an inner diameter greater than the outer diameter of said core to permit oscillatory movement of said inertia ring in all directions radial of said core; a barrier blade extending longitudinally of said core and mounted within said slot for sliding movement radially thereof in sealing engagement with said ring and one of the surfaces of said slot and arranged to define the initial point of a motor cavity of variable volume and peripheral extent between said core and said inertia ring and the end point of an exhaust cavity of variable volume and peripheral extent between said core and said inertia ring; a pressure fluid inlet port in each end wall communicating with said work chamber on the motor side of said blade; a pressure fluid outlet port on each end wall communicating with said work chamber on the exhaust side of said blade; the two inlet ports being of the same size and in the same relative position with respect to the motor side of said work chamber and the two outlet ports being of the same size and in the same relative position with respect to the exhaust side of said work chamber; and means to supply pressure fluid to said inlet ports and through said slot into said motor cavity; said inertia ring being adapted to oscillate about said core in an orbital path with its end faces acting as a valve to open and close cyclically and successively said inlet and outlet ports; the opening of said inlet ports serving to admit fluid to enlarge the motor cavity and provide the driving force for said inertia ring; and the opening of the exhaust ports serving to discharge fluid to decompress the exhaust cavity.

23. Apparatus as described in claim **22**; said inertia ring having an axial length slightly less than the actual distance between said end walls to provide a clearance between the ring and said end walls; said inlet ports being of such size and location that the end faces of said inertia ring at least partially overlies same at all times; said inlet ports serving to supply pressure fluid to said clearances to prevent physical contact between the end walls and the end faces of said inertia ring.

24. A method of operating a vibration generator of the type in which a work chamber is defined by the volume between two end walls, a core member, and an inertia ring surrounding said core member, said work chamber being divided into a motor cavity and an exhaust cavity by a barrier blade, and wherein fluid is intermittently introduced into said motor cavity so as to cause said inertia ring to undergo oscillatory movement in all directions radial of said core member so that said motor and exhaust cavities have a variable volume depending upon the relative positions of said barrier blade and the nearest point of said inertia ring to said core member; and including means for intermittently directing fluid from said exhaust cavity out of an outlet port after having been directed into said inlet port of said motor cavity through a fluid supply conduit, said method comprising the steps of:

converting the kinetic energy of the fluid supplied to said conduit to potential energy by reducing the linear mass velocity of said fluid to substantially zero before introducing said fluid into said inlet port by expanding said fluid into an expansion chamber; and

introducing a volume of fluid into said motor cavity at any given time so that the thusly introduced volume of fluid substantially equals the instantaneous volume of said motor cavity at said given time, whereby said inertia ring maintains a substantially continuously spaced relationship from said core member as said inertia ring undergoes said oscillatory movement.

25. The method of claim **24** including the steps of changing the direction of said fluid by about 90° at least two times between entry of said fluid into said conduit and introduction of said fluid into said motor cavity.

26. A method of operating a vibration generator of the type in which a work chamber is defined by the volume between two end walls, a core member, and an inertia ring surrounding said core member, said work chamber being divided into a motor cavity and an exhaust cavity by a barrier blade; and wherein fluid is intermittently introduced into said motor cavity so as to cause said inertia ring to undergo oscillatory movement in all directions radial of said core member so that said motor and exhaust cavities have a variable volume depending upon the relative positions of said barrier blade and the nearest point of said inertia ring to said core member, and including means for intermittently directing fluid from said exhaust cavity out of an outlet port after having been directed into said inlet port of said motor cavity through a fluid supply conduit, said method comprising the steps of:

converting the kinetic energy of the fluid supplied to said conduit to potential energy by reducing the linear mass velocity of said fluid to substantially zero before introducing said fluid into said inlet port, and

providing an exhaust back pressure at said exhaust port of about one-half the pressure of said fluid at said inlet port, whereby said inertia ring maintains a substantially continuously spaced relationship from said core member as said inertia ring undergoes said oscillatory movement.

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