April 24, 1956 G. L. MALAN 2,743,090

VIBRATOR

Filed Aug. 10, 1953 3 Sheets-Sheet 1

FIG. 1

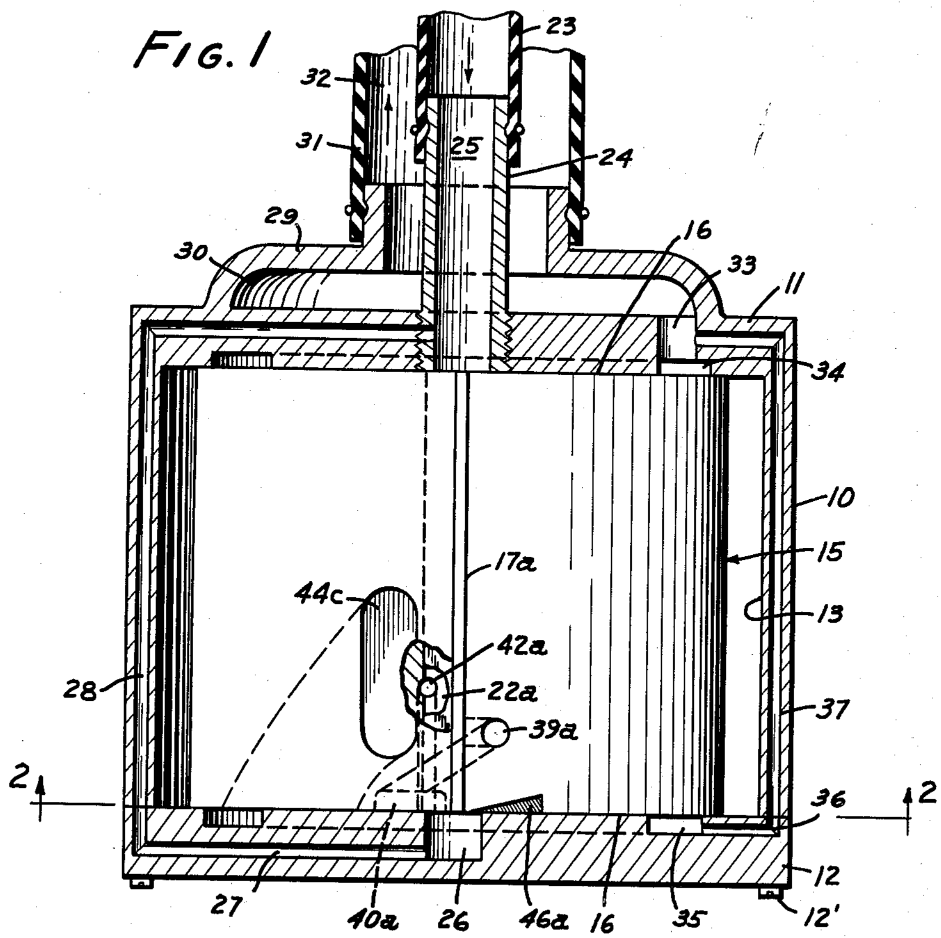

FIG. 6

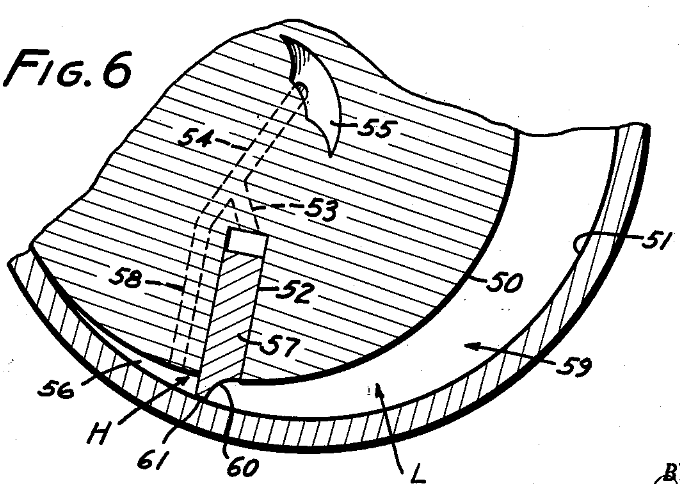

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FIG. 2

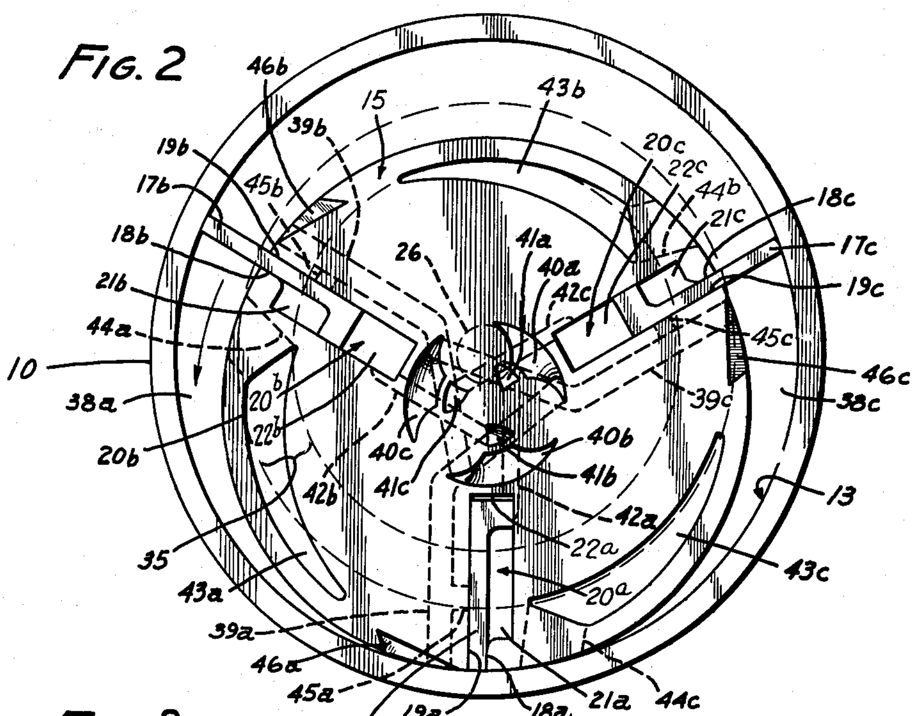

FIG. 3

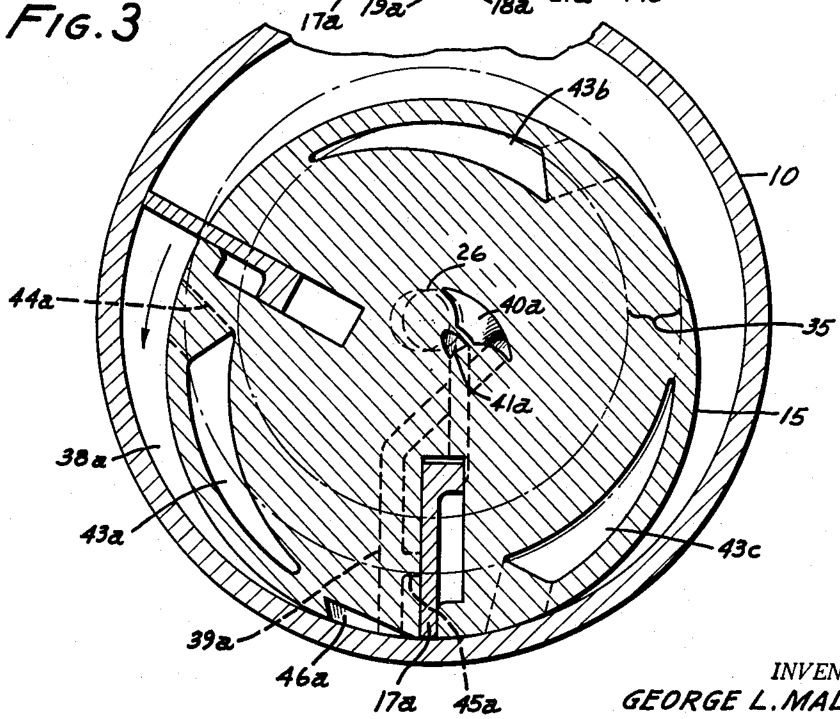

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FIG. 4

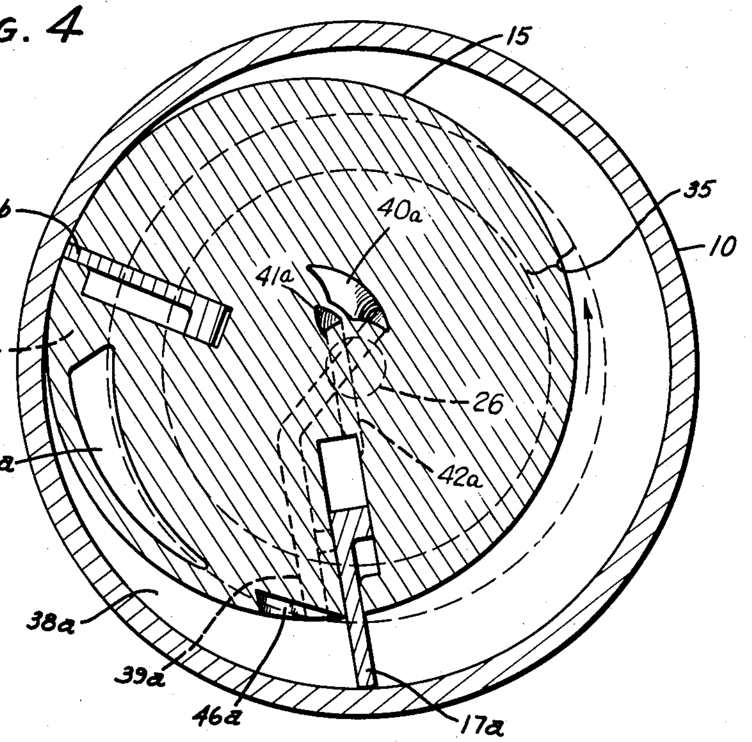
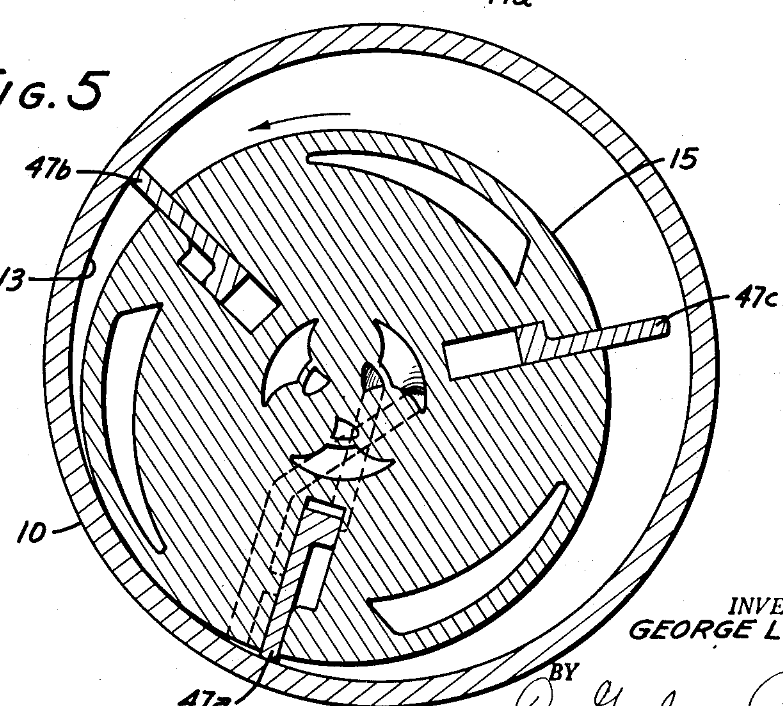


FIG. 5



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2,743,090

VIBRATOR

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Application August 10, 1953, Serial No. 373,310

19 Claims. (Cl. 259—1)

This invention relates to eccentric rotary devices such as rotary vibrators and the like, and more particularly to such devices of the type utilizing a rotor in rolling contact with the inside of a race.

An object of this invention is to provide such devices with a positive starting action.

Another object is to produce a relatively high rate of rotation.

Still another object is to decrease the compressed air consumption of such devices for a given rotary energy.

An additional object is to provide an arrangement producing a minimum of wear on the parts of the device.

There is disclosed in the Malan Patent 2,187,088 a rotary vibrator useful for packing wet concrete and the like. That machine comprises a casing having an inner cylindrical race within which there is provided a cylindrical rotor having an external diameter substantially less than the internal diameter of the race. The rotor is provided with a number of spaced vanes extending in a generally radial direction and reciprocable beyond the rotor surface so as to provide compartments within the casing defined by the casing wall, the rotor and the vanes.

For the purpose of producing rotation, air under pressure is introduced into the casing at an end of the rotor, and the rotor is provided with passageways leading from its end to the respective compartments, and also to the vanes. Pressurized air conducted to the vanes urges the vanes outwardly against the casing wall, and air conducted to a given compartment tends to expand the size of that compartment. Suitable exhaust ports are provided which communicate with the respective compartments at proper positions of exhaust. As the rotor moves, the air pressure is successively introduced to successive ones of the compartments and vanes, to cause the rotor to rotate rapidly within the casing.

In accordance with the present invention, I provide improvements in the type of device shown in the above-mentioned Malan Patent 2,187,088. A first feature of the present invention resides in the provision of separate channels for separately introducing the compressed air to a compartment and its respective vane. By reason of the introduction of the compressed air separately to the vane, I have found that the occasional undesired hesitation in starting is overcome with the result that the vane under pressure is immediately moved to operating position against the casing while air pressure is separately led to the compartment partly defined by this vane. This produces immediate positive starting.

Another allied but independent feature resides in the construction of the vanes whereby a larger area of the vane is exposed to supply air pressure so as to force the vane against the race than is exposed to high compartment pressure which would tend to force the vane back into the chamber. This aids in starting by insuring that the vane will quickly be moved to its operating position against the casing and assures a more positive contact of vane and wall, thereby cutting down air leakage past the vane.

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An optional feature is the provision of an additional passageway interconnecting the side wall of each chamber behind a vane with its associated compartment so that the passageway is open during the latter part of the vane's outward movement, and closed during the latter part of the vane's inward movement.

Another feature is the provision of a vane provided with a relatively short throw outwardly from the rotor surface so that while it is in contact with the casing when compressed air is initially supplied to its compartment, it is held out of contact with the casing wall at about the end of the pressure period and for a significant time thereafter. This results in a more rapid exhaust from the compartment and aids in increasing the speed of rotation.

The foregoing and other features of the invention will be better understood from the following detailed description and the accompanying drawings of which:

Fig. 1 is a side elevation, partly in section, showing a vibrator incorporating improvements in accordance with the invention;

Fig. 2 is a plan view, partly in section, taken along line **2—2** of Fig. 1;

Fig. 3 is a cross-section view taken at line **2—2** of Fig. 1;

Fig. 4 is a cross-section view also taken at line **2—2** of Fig. 1, showing the device in a second operating position;

Fig. 5 is a cross-section view of a modified form of device according to this invention, the view being taken at line **2—2** of Fig. 1; and

Fig. 6 is a fragmentary cross-section view showing an alternate type of vane.

Referring to the drawings the vibrator comprises an outer casing **10** in the form of a cylinder having an upper end portion **11** formed therewith and having a removable lower end member **12** which is held in place by screws **12'**. The lateral inner surface, or race **13**, of the casing is preferably cylindrical in shape, being a continuous curved peripheral wall, and the inner end surfaces are flat. Mounted within the casing is a cylindrical rotor **15** having flat upper and lower ends **16** sealing with the upper and lower end surfaces of the casing. The rotor is of substantially smaller diameter than the internal diameter of the casing, and in operation is always eccentrically positioned within the casing, contacting the latter along a line of contact parallel to their axes and rolling around within the casing under the force of air pressure against the rotor.

The rotor is provided with three radially extending vanes ***17a***, ***17b***, ***17c***, symmetrically spaced 120° apart, which are mounted in recesses ***18a***, ***18b***, ***18c*** in the rotor. These recesses each extend the length of the rotor and are parallel to its axis. Near the surface of the rotor, each recess has a fairly narrow opening ***19a***, ***19b***, ***19c***. Farther, within the rotor, the recess widens, thereby creating an enlarged chamber ***20a***, ***20b***, ***20c***, at the inward end of each recess. The vanes are L-shaped, the longer branch extending through and closely fitting the narrow opening. The shorter branch of the L-shaped vane extends transversely across the enlarged chamber in the recess, thereby dividing the chamber into outer sections ***21a***, ***21b***, ***21c*** and inner sections ***22a***, ***22b***, ***22c***. The vanes thus have two distinct cross-sections, one within the chamber and another in the opening. As will be further discussed below, the vane reciprocates in and out of its recess like a piston in response to forces from compressed air applied to the inner end of the L-shaped vane, and to forces from the casing when the line of contact approaches the recess opening.

A compressed air hose **23** is connected to a nipple **24** which is threaded into the upper end wall of the casing. This nipple constitutes a centrally disposed air inlet port **25** in the end wall of the casing for admitting compressed air thereinto. A second similar centrally disposed inlet port **26** is provided in the lower end member and is connected with the first inlet port by a passage **27** in the lower end member which communicates through a passage **28** in the casing with the first port. Thus air under pressure is applied to juxtaposed circular areas centrally positioned in the casing at opposite ends of the rotor. As will appear later, this air will pass through ports and passages in the rotor to the peripheral surface of the rotor.

The upper end portion of the casing is also provided with a connecting member **29** which surrounds the nipple, and which defines an annular discharge passage **30** around the nipple. An exhaust hose **31** is connected to this member, exhaust air from the vibrator passing out through the annular space **32** inside the exhaust hose and outside the compressed air hose, the two hoses being substantially concentric. Passages **33** extend from the region around the nipple through the upper end portion of the casing and communicate with an annular exhaust port **34** formed in the upper inner surface of the casing, which annular exhaust port is concentrically disposed about the inlet port. A similar annular exhaust port **35** is provided in the lower end member and is connected by passages **36**, **37** in the lower end member and in the casing, respectively, to the upper annular exhaust port. The annular exhaust ports in the opposite ends of the casing cooperate with compartment exhaust ports in the end surfaces of the rotor, which are connected by passages to the peripheral surface of the rotor, in removing exhaust gases from the compartments surrounding the rotor in suitable order.

The chambers at the inner end of the recesses, and the longer branch of the vanes, are of such length that the vane may extend from the surface of the rotor at least to a distance equal to the difference between the diameter of the race and the rotor. The vanes thus constitute radially extending barriers between the rotor and the casing, and will thus always contact the race and define three separate and distinct compartments **38*a***, **38*b***, and **38*c***. The compartment clockwise from each vane bears a letter corresponding to that vane, for example, compartment **38*a*** which is clockwise from and adjacent to vane **17*a***.

Fig. 2 illustrates the ports and passageways in the rotor itself. These ports and passageways are exactly duplicated at both ends of the rotor, so that only those at the lower end will be described, it being understood that the second set at the upper end of the rotor is symmetrically disposed so as to act in the same manner and at exactly the same time as the opposed set. It is desirable to provide these duplicate ports and passageways at opposite ends of the rotor, and to introduce and exhaust air at both ends to avoid the creation of any end thrust on the rotor as well as to provide a large effective passage area for accommodating sufficient airflow to operate the device.

Each of the compartments is connected by a passageway **39*a***, **39*b***, **39*c*** to one of three compartment supply ports **40*a***, **40*b***, **40*c*** in the end of the rotor. Each compartment supply port is connected to a single compartment. These ports are symmetrically disposed about the axis of the rotor in such relation to their respective compartments as to register with the compressed air inlet port only when the rotor is in a predetermined position within the casing. For example, compartment supply port **40*a*** is connected by passageway **39*a*** to that portion of the rotor surface lying between vanes **17*a*** and **17*b***, and in fact defining compartment **38*a***. Passageways **39*b***, **39*c***, similar to those just described connect the compartment supply ports **40*b***, **40*c***, to their respective compartments **38*b***, **38*c***. The rotor thereby has a set of three compartment supply ports which admit compressed air to individual compartments at the surface of the rotor when the ports are in registering position with the central air inlet port in the casing.

In order to cause the vanes to operate as pistons, particularly so they may be extended outwardly from the rotor, air pressure is supplied to the chamber behind each vane in proper sequence. For this purpose the rotor is provided with a separate set of three chamber supply ports **41*a***, **41*b***, **41*c*** symmetrically disposed about the rotor axis as each end thereof, each leading through an individual passageway **42*a***, **42*b***, **42*c*** respectively to a single chamber behind a vane. The positioning and design of these chamber supply ports will be discussed below. In order to supply pressure to the chambers behind the vanes, vibrators of this type have previously tapped the passageways leading to the compartments so that the chambers assumed approximately the same pressure as the associated compartment, and were therefore also timed with the compartments. Since the passageway was designed so that the greater part of the flow proceeded to the compartment, the branch leading to the chamber occasionally received less compressed air than was needed for optimum performance. I have found that operation of the entire device is greatly improved, and power requirements for the same energy output significantly reduced, if the separate supply ports of this invention are provided. Supplying air to the chambers through ports and passageways separate from those supplying the compartments has the additional advantage of permitting the vane action to be timed separately from that of the compartments (an advantage in starting), as well as assuring a better supply of air to the vane chambers.

Along with the supply ports and passages described above, the rotor is further provided with three compartment exhaust ports **43*a***, **43*b***, **43*c*** and passages **44*a***, **44*b***, **44*c*** at each end to permit exhausting the expanded air back to atmosphere. While previous devices have provided two sets of compartment exhaust ports at each end of the rotor, I have found that one set is sufficient. Since this unit receives rough usage, the greater strength resulting from fewer ports and passages is a distinct structural advantage. The compartment exhaust ports have a tapered three-sided shape and are disposed symmetrically in the end faces of the rotor in a generally circumferential manner. Each passageway **44** interconnects an individual compartment exhaust port with an individual compartment at the surface of the rotor. Each port is so disposed as to register periodically with the annular exhaust port during part of the time its compartment is to be exhausted.

To smooth out the vane operation, I have provided an additional passageway **45*a***, **45*b***, **45*c*** between each vane chamber and the compartment clockwise from it. This passageway is formed in the chamber wall on the side against which the longest side of the vane bears, approximately at the mid point of the chamber's side. This passageway is therefore open to compartment pressure when the vane is extended so far that it no longer covers the opening. When the vane is pressed back into the recess by the casing wall, it again covers the passage. This arrangement results in a cushioning action later to be described.

As a further refinement to aid in rapidly exhausting the chambers, small segments **46*a***, **46*b***, **46*c*** of the edge of the rotor are "shaved-off" just clockwise of each vane.

As an additional optional refinement to aid in quick exhaust and in speeding up the operation of this device, I may provide a modified form of vanes as shown in Fig. 5, wherein the maximum extension of the vanes less than the difference between the diameters of the race and the rotor. In using shorter vanes, the device is similar in all other respects to that shown in Figs. 1–4 except that vanes **47*a***, **47*b***, **47*c*** are shorter than the previously described vanes **17**.

Fig. 6 illustrates an optional vane which serves to reduce the amount of force effective to counteract the force tending to press the vane against the race. A rotor **50** is placed within a race **51**, and the other necessary parts, such as end members are attached. Being unimportant to the disclosure of this type of vane, the rest of the vibrator is not shown in this view. With this vane, a simple straight recess **52** may be used, which may, if desired, be supplied with pressurized air by a branch **53** of a supply passage **54** from supply port **55**, which also supplies compartment **56** clockwise of the vane **57** through branch **58**. Compartment **59** is formed counterclockwise of the vane.

The vane **57** is flat, and rectangular in cross-section for much of its length. At its outer end, however, an edge **60** is cut out for the full length of the vane parallel to the rotor axis. As viewed in Fig. 6, the cut out portion faces counterclockwise, that is, toward the lower-pressure side of the vane.

The device of Figs. 1 to 4 operates as a vibrator in the following manner. Until compressed air is supplied, the rotor will, of course, occupy some random position within the casing. Except for three special positions having very close bounds, wherever the rotor is in the casing, one of its chamber supply ports **41** will always register, at least in part, with the inlet port **26** owing to the proportions and dimensions given to the parts. Should the rotor occupy one of the three narrow positions against the race wherein no supply port is open to the inlet port, the device may simply be shaken to move it slightly, and operation will begin as outlined below. Similarly, the inlet port generally registers with the corresponding compartment supply port **40** for the same reason.

Assume now that the rotor is lying in such a position that the inlet port is in registration with chamber supply port **41*a***. Then when the compressed air is applied, the pressure will pass through passageway **42*a*** into chamber **22*a*** to slam the vane outwardly against the casing wall, which also moves the rotor itself toward the race where it becomes tangent at some point. For ease in exposition, it will be assumed that the rotor will start from a position where it is tangent to the race at vane **17*a*** as shown in Fig. 3. In action, the initial point of tangency could be any place, in which case the operation of the device would proceed from the middle of a cycle instead of from the start of one, as described. The chamber supply ports are located inwardly of the compartment supply port, and will therefore more likely be in relatively more complete registration with the air inlet port. This means that the action of the vane in starting will be more positive than in prior devices, since there is no division of airflow between the two as when they are supplied from a single passage. The vane is thus assured of a sufficient air supply for its operation. Also the starting action of the rotor is more positive because the vane's action is independent of compartment action, vane operation being possible even if a substantial part of a neighboring compartment supply port is not in registration with the air inlet port at a given moment. Such vane action will move the rotor so that a compartment supply port does register.

If the vane **17*a*** is initially tangent to the casing wall, then the pressure back of the vane from chamber supply port **41*a*** will push the rotor away from tangency at the vane, and will begin to open up the compartment **38*a*** into which pressure from compartment supply port **40*a*** and passageway **39*a*** is introduced, which also tends to enlarge that compartment by moving the rotor. If the rotor was not initially tangent at the position of vane **17*a***, then compartment **38*a*** is brought into existence, simply by the movement of vane **17*a*** to seal against the casing. In either event the pressure in compartment **38*a*** will push on the rotor and tend to rotate it in the counterclockwise direction as it rolls around the race in a clockwise direction (with reference to Fig. 3) so as to enlarge the size of compartment **38*a***.

Air cannot exhaust from chamber **38*a*** until the point of tangency has reached the opening of passageway **44*a*** on the periphery of the rotor. After the line of contact has reached that passageway, discharge therethrough will be controlled by the registration of compartment exhaust port **43*a*** with the annular exhaust port **35**. At about the time the line of contact coincides with passageway **44*a***, the rotation of the rotor has caused supply ports **40*a*** and **41*a*** to move out of registration with the inlet port **26** so that pressure is no longer supplied through passageways **39*a*** and **42*a***. However, after a short further movement resulting from the inertia of the rotor, the inlet port **26** comes into registration with the next supply ports **40*b*** and **41*b*** to pressurize vane **17*b*** and similarly pressurize compartment **38*b*** formed by vane **17*b***. Thus this pressure in the new compartment continues the counterclockwise rotation of the rotor. Again when the rotation has proceeded far enough, compartment **38*b*** ceases to be pressurized in the same manner previously described in connection with compartment **38*a***, when compartment **38*c*** goes through the same procedure. This process of successively pressurizing the three compartments continues rapidly and produces the rapid counterclockwise rotation of the rotor with corresponding clockwise advancement of the point of tangency around the inside wall of the casing.

As shown in Fig. 3 (which illustrates only one set of component elements) the clockwise part of compartment **38*a*** exhausts through compartment exhaust port **43*a*** to the annular exhaust port **35**, and continues to do so while the point of tangency approaches passageway **44*a*** from vane **17*a***. When they coincide, exhaust port **43*a*** has moved outward of the annular exhaust port **35** thereby cutting off exhaust therefrom until the rotor moves along approximately to the position of Fig. 4. During the time the point of tangency is between vanes **17*a*** and passageway **44*a***, the counterclockwise part of compartment **38*a*** will be under pressure, while the clockwise port exhausts, the two ports being separated by the sealing contact between the race and the rotor. Reference to Fig. 2 shows that at that position, compartment **38*b*** is exhausting directly into the annular exhaust port **35** instead of through its exhaust port **43*b***, which has moved inward of the annular exhaust port. At this same instant, compartment **38*c*** has completed its pressurized period, and exhaust port **43*c*** is nearly ready to move into registration with the annular exhaust port **35**. The shaved-off segment **46*c*** advances the exhaust of compartment **38*c*** slightly by interconnecting that compartment and the annular exhaust port as shown in Fig. 2. As will be seen from Figs. 2–4 the exhaust ports **43** move toward and away from the race (and therefore back and forth across the annular exhaust port) as the rotor rolls around the race.

At the position of Fig. 4, which shows the rotor advanced along the race, so that vane **17*b*** is tangent and compartment **38*b*** ready to start the cycle just described for compartment **38*a***, compartment **38*a*** has been shut off from its source of compressed air, and its exhaust port **43*a*** is closed off, but about to open again. Compartment **38*b*** is open to exhaust through port **43*b***; chamber **38*c*** is exhausting directly to the annular exhaust port **35**, and the shave-off **46*a*** has interconnected compartment **38*a*** with annular exhaust port **35**. It will be understood that these actions occur rapidly and in succession, resulting in sustained rotation of the rotor.

Significantly improved operation results if exhaust from compartments is accomplished quickly so that the compartment under pressure must work as little as possible against opposed pressure from other compartments. For that reason I have disposed the set of exhaust ports so as to be in registration with the annular port for a part of the exhaust period. For another part of the exhaust period, the annular port itself is over the chamber for direct exhaust, these actions actually overlapping at some positions. In addition, the shave-offs advance the discharge somewhat.

As indicated above, the vanes are intended to remain in constant contact with the race to provide separate compartments on the periphery of the rotor. The porting and passages to provide air back of the vanes has already been described. The L-shaped vane presents a large surface to this pressure, causing the vane to extend with greater force than the simple flat vane of prior devices. The vane continues to extend as to the rotor rolls so that the casing wall retreats from the rotor at the recess. After the vane is partway extended, the greater force needed for starting and for creating a compartment is no longer necessary, so vane **17***a*, for example, passes beyond passageway **45***a*, thereby opening the chamber **22***a* to the pressure existing in compartment **38***a*. This pressure is sufficient to guarantee proper vane action, but will be lower than the previous chamber pressure, since compartment **38***a* is expanding at that instant. Thus the force of extension for the latter part of the outward stroke is somewhat reduced.

Chamber **21***a* acts to cushion the impact of the vane against the rotor at full extension. Chamber **21***a* is not air-tight being in registration with the exhaust ports **34**, **35** much of the time, and thereby at a lower pressure than exists in the compartments adjacent to a given vane during the extension movement. Toward the end of the extension, however, the ends of the chamber **21***a* are blocked off and a small amount of air will remain therein and be compressed by the short branch of the vane, between it and the outer wall of the recess. This same sort of cushioning occurs when the vane is pressed back into the recess and chamber. Passageway **45***a* is covered again by the vane, and the air remaining in chamber **22***a* and passage **42***a* is compressed by the vane (supply port **41***a* being closed), thereby protecting the vane from unduly violent contact with the rotor. This smoother, more powerful action results in diminished vibratory rebound between the vanes and the casing wall. I have found that it is partly this rebound that causes consumption of compressed air to increase, by leakage past the edge of the vane. The greater force against the side has diminished air requirements substantially. It also reduces damage to parts from excessive forces which may result if the parts are slammed together.

As may be appreciated from Figs. 3 and 4 which show the relationship between the supply ports and the inlet port, the inlet port travels over an annular area centrally disposed on the end of the rotor as the rotor proceeds around the race. At any given instant, the center of the air inlet is located on an extended line passing through the point of tangency and the center of the rotor, being on the side of the rotor's center opposite the point of tangency. This consideration permits the supply ports to be placed in that annular path so that the action of the vanes and compartments may be timed as desired.

A substantially positive starting action, and an efficient continuing action of the vanes results from shaping the chamber supply ports **41** so that they extend slightly into the area covered by the inlet port when the associated vane is tangent to the race, as for example port **41***a* and vane **17***a* in Fig. 3. The device also runs better if the compartment supply ports **40** similarly extend slightly into the aforementioned area at the same time. While there is no compartment into which this air may pass at that moment, this advanced timing permits better air flow when the compartment does open up.

If desired, the timing of the vane action may be advanced ahead of the compartment action, in which case the chamber supply ports will be angularly spaced from the compartment supply ports at their counterclockwise end. The clockwise ends may be timed separately for shut-off.

The compartment supply ports **40** are formed with their edges in the shape of the air inlet port, thereby producing a fast off-on action. The chamber supply ports **41** are made somewhat more pointed at their counterclockwise extreme, resulting in a more gradual increase in chamber pressure, but their clockwise extremes have the shape of the air inlet port for quick shut-off.

The exhaust ports **43** are three sided, the longer edges generally conforming to the edges of the annular exhaust port **35**, the inner edge of the ports **43** having approximately the same radius of curvature as the outer boundary of the annular port, and the outer edge of ports **43** having approximately the radius of curvature of the inner edge of the annular port. Both are disposed so as to conform fairly closely to the edge of the annular port they resemble as they pass that similar edge.

In the event that short vanes **47** are used as shown in Fig. 5, instead of the longer vanes of Figs. 1 to 4, the same sequences of operations occur as described with respect to embodiments incorporating longer vanes. However, the maximum extension of the vanes occurs just as the next clockwise vane becomes tangent to the race. Thereafter the extended short vane is out of contact with the race until the vane counterclockwise from it is tangent to the race, at which time it again touches the race. With this arrangement, air may blow by the vane edge into the next compartment counterclockwise, resulting in a faster reduction in pressure in the compartment which has just finished its pressurized period.

It will be appreciated that at the high speed of this rotor, it remains in close contact with the race during operation.

The recess and vane assembly shown in Fig. 6 is simpler in construction than those shown in Figs. 1–5 since the notch is straight, and the vane is flat. It operates in the same way as the vanes previously described. In Fig. 6, compartment **59** will be at a lower pressure than compartment **56**. Since compartment **56**, and the chamber behind the vane, are at substantially the same pressure, any significant exposure of the outer end of vane **57** to pressure from compartment **56** would counteract at least some of the force tending to extend the vane. For that reason, the edge **60** is cut off, and the point of contact **61** of the vane and race is formed as far toward the higher pressure compartment **56** as is structurally possible. Thus the only opposition to extension results from the lower pressure in compartment **59**. In this manner, the least back force is exerted on the vane. Reversal of the vane so the cut out edge faces the high pressure compartment **56**, slows the operation of the vibrator materially. The cutting off of the edge, with the cut-off facing the low pressure side of the vane, has reduced air consumption by as much as ⅓, and increased the speed by as much as 20%. To illustrate the positioning of this vane compartment **56** is denoted "H," and compartment **59** as "L" for "high" and "low" pressure respectively.

By reducing the area of the end of the vane which may become exposed to high compartment pressure as compared to the area exposed to chamber supply pressure, by such means as L-shaped vanes, or vane with edges cut off, I have reduced air blow-by, along with vibratory rebound of the vane, and have improved the performance of my vibrator.

The use of the separate chamber supply system described above in connection with the L-shaped vanes has substantially eliminated the sluggishness occasionally experienced in starting devices equipped with flat vanes and supply passages leading from a port which also supplies the compartments. In addition, tests on the vanes have shown that the L-shaped vanes separately supplied move at about twice the rate of speed as the flat vanes, while requiring only about half the volume of compressed air for their operation. However, either of these improvements may be used without the other, since each improves the performance of the vibrator.

The L-shaped vanes, particularly those continually in contact with the race, have a longer life than straight blades due to the maintenance of the firm contact between the vane and race. The larger force on the vane discourages vibratory rebound between the two, and thereby reduces the beating of the vane which would result therefrom.

It will be noted that the provision of greater areas exposed to high pressure behind the vane than in front of it results in a greater net force tending to extend the vanes. L-shaped vanes or rectangular vanes with an edge trimmed off each accomplish the same result.

A vibrator of the type disclosed in the Malan Patent No. 2,187,088 has been operated at a rate of 6500 vibrations per minute using flat vanes supplied from the compartment supply port. When the L-shaped vanes of such length as to remain in constant contact with the race were installed in an enlarged chamber, and supplied with air from separate ports, the same device produced 7500 vibrations per minute with no appreciable increase in power required. Since centrifugal force is a function of the square of the speed, the vibratory energy resulting from the increased speed increases exponentially. Further increases in speed may be obtained by using the shorter vane which does not remain in constant contact with the race.

There is nothing critical about the number of vanes and ports used in this device. However, two would not be enough to assure an easily starting device, and more than four requires an excessive number of ports and passageways.

The description above has been concerned primarily with a device not limited to use of compressed gases as working fluid, since pressurized liquids will work as well.

I claim:

1. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: the improvement comprising means for supplying the pressurized fluids to the chambers independently of the compartment supply ports and passages, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source.

2. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: means for supplying pressurized fluids to the chambers independently of the compartment supply ports and passages, the rotor having a plurality of chamber supply ports equal in number to the chambers and an equal number of passageways each interconnecting a chamber supply port to an individual chamber, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source.

3. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust

ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: means for supplying pressurized fluids to the chambers independently of the compartment supply ports and passages, the rotor having a plurality of chamber supply ports equal in number to the chambers, and an equal number of passageways each interconnecting a chamber supply port to an individual chamber, the chamber supply ports being angularly spaced from the compartment supply ports, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source.

4. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: means for supplying pressurized fluids to the chambers independently of the compartment supply ports and passages, the rotor having a plurality of chamber supply ports equal in number to the chambers, and an equal number of passageways each interconnecting a chamber supply port to an individual chamber, the chamber supply ports being disposed inwardly from and angularly spaced with respect to the compartment supply ports, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source.

5. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: a chamber supply means separate from the compartment supply ports and passages, the rotor having a plurality of chamber supply ports equal in number to the chambers and an equal number of passageways to each interconnecting a chamber supply port to an individual chamber, there being some rotor positions where a chamber and a compartment adjacent to the vane in the chamber are simultaneously supplied with the pressurized fluids from the source, the rotor having additional passageways each interconnecting a side of a recess adjacent a vane with fluid at the pressure of an adjacent compartment.

6. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: a chamber supply

means separate from the compartment supply ports and passages, the rotor having a plurality of chamber supply ports equal in number to the chambers and an equal number of passageways each interconnecting a chamber supply port to an individual chamber, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source, the rotor having additional passageways each interconnecting a side of a recess adjacent a vane with the compartment supply passage leading to an adjacent compartment.

7. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising vanes in the recesses having a wider cross-section at its end disposed at the inner end of the recess than at its end at the outer end of the recess.

8. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising vanes having at least one branch extending transversely in the recess.

9. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, means for supplying the pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising L-shaped vanes, one branch of the L extending radially outward from the rotor, and the other branch extending transversely across the recess.

10. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis

of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in the flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising vanes having a maximum radial extension from the rotor less than the difference between the diameter of the race and the rotor.

11. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising L-shaped vanes having a maximum radial extension from the rotor less than the difference between the diameter of the race and the rotor.

12. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: a vane system comprising means for supplying pressurized fluids from the source to the chambers independently of the compartment supply ports and passages, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source, the rotor having a plurality of chamber supply ports equal in number to the chambers and an equal number of passageways each interconnecting a chamber supply port to an individual chamber, the rotor having additional passageways each interconnecting a side of a recess adjacent a vane with fluid at the pressure of an adjacent compartment, and L-shaped vanes, one branch of the L extending radially outward from the rotor, and the other branch extending transversely across the recess.

13. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber

of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing: a vane system comprising means for supplying pressurized fluids from the source to the chambers independently of the compartment supply ports and passages, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source, the rotor having a plurality of chamber supply ports equal in number to the chambers and an equal number of passageways each interconnecting a chamber supply port to an individual chamber, the rotor having additional passageways each interconnecting a side of a recess adjacent a vane with fluid at the pressure of an adjacent compartment and L-shaped vanes, one branch of the L extending outward from the rotor, and the other branch extending transversely across the recess, the maximum radial extension of the vane from the rotor being less than the difference between the diameter of the race and the rotor.

14. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, and members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising that each of said vanes is wider at the end of the vane disposed at the inner end of the recess than at the opposite end of the vane whereby each of said vanes is subject to a greater total air force on its inner end than on its outer end.

15. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising vanes in the recesses, each of said vanes being rectangular in cross-section, the outer end extending from the recess having an edge cut off parallel to the axis of the rotor whereby the end of the vane contacting the race makes contact near one side of the vane, the cut-off edge facing a compartment at a relatively lesser air pressure than the compartment adjacent the edge which is not cut off.

16. Apparatus according to claim 9 having in addition exhaust ports adjacent the ends of the rotor, and in which the portion of the recess between the transverse branch of the L-shaped vane and the outer wall of the recess moves in and out of registration with said exhaust ports.

17. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein, said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and

with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes having an end in a recess, and an end extending from the recess and rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and conduit means for supplying pressurized fluids from the source to the chamber, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising means for providing force tending to extend the vanes from their recesses, said means comprising a greater vane area on the end exposed to pressurized air supply within the recess than on the end extending outside the recess.

18. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid and one of said end members having a stationary exhaust port therein, said ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race and having a curved peripheral surface interrupted by a plurality of recesses formed therein said rotor having a central axis, and being positioned so as to roll around inside the race with the curved peripheral surface in rolling contact with the race and with each end of the rotor in flat sliding contact with an end member, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes having an end in a recess, and an end extending from the recess and rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed in an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port, and some of the compartment exhaust ports register with the stationary exhaust ports in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race, for successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids in the compartments in order to move the rotor in the casing, and conduit means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising means for providing force tending to extend the vanes from their recesses comprising vanes of such shape that the product of the air pressure and the vane area on the end exposed to supply pressure within the recess is greater than the product of the air pressure and the area on the end outside the recess.

19. In a machine of the type described including in combination a casing having an inner cylindrical curved race with a central axis, end members closing both ends of said casing, one of said end members having a stationary inlet port therein as a source of pressurized fluid, and one of said end members having a stationary exhaust port therein, said stationary ports being disposed in said end members symmetrically with respect to the central axis of the race, a free rotor of smaller lateral dimensions than the race positioned inside the race, and having a curved peripheral surface interrupted by a plurality of recesses formed therein, vanes slidable in and out of the recesses in a radial direction thereby defining a chamber of variable size at the inner end of each recess, the vanes extending from the rotor so that a plurality of vanes is in sealing contact with the chamber wall at any given time, the vanes thereby defining with the rotor surface and race a plurality of compartments surrounding the rotor, the rotor having compartment supply ports and passages and compartment exhaust ports and passages, said compartment supply and exhaust ports being formed at an end of said rotor adjacent the end members, and being so disposed and arranged that some of the compartment supply ports register with the stationary inlet port and some of the compartment exhaust ports register with the stationary exhaust port in said end members at various positions of the rotor when the central axis of the rotor is transversely displaced from the central axis of the race thereby successively connecting individual compartments to said inlet and exhaust ports in said end members in order to supply and exhaust pressurized fluids therein so as to move the rotor in the casing, and means for supplying pressurized fluids from the source to the chambers, there being some rotor positions where a chamber and a compartment adjacent to the vane in that chamber are simultaneously supplied with the pressurized fluids from the source: the improvement comprising L-shaped vanes in said recesses having a maximum radial extension from the rotor as great as the difference between the diameter of the race and of the rotor.

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