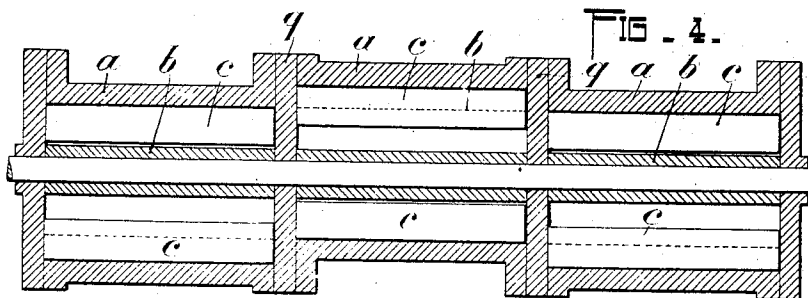
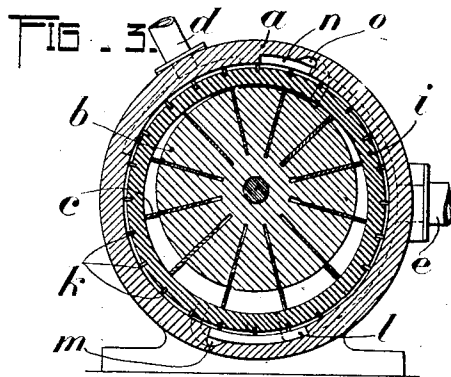
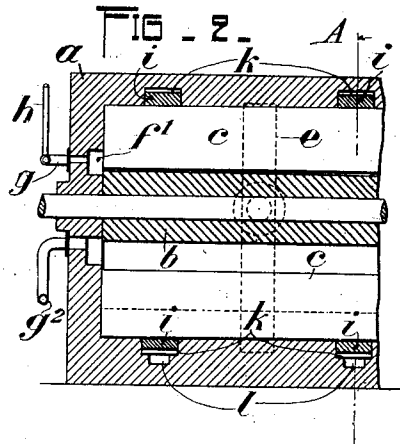


1,364,014.

E. WITTIG.
ROTARY MACHINE.
APPLICATION FILED OCT. 26, 1915.

Patented Dec. 28, 1920

3 SHEETS—SHEET 2.



Inventor

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By *Thasend Myers*

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3 SHEETS- SHEET 3.

FIG. 8.

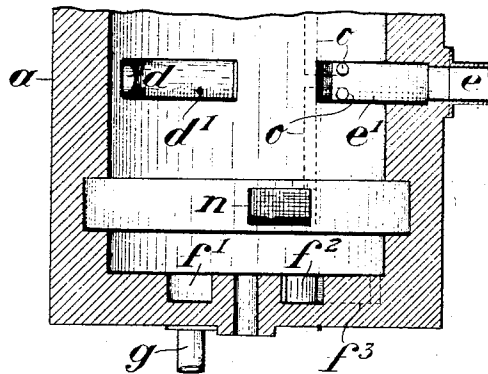


FIG. 7.

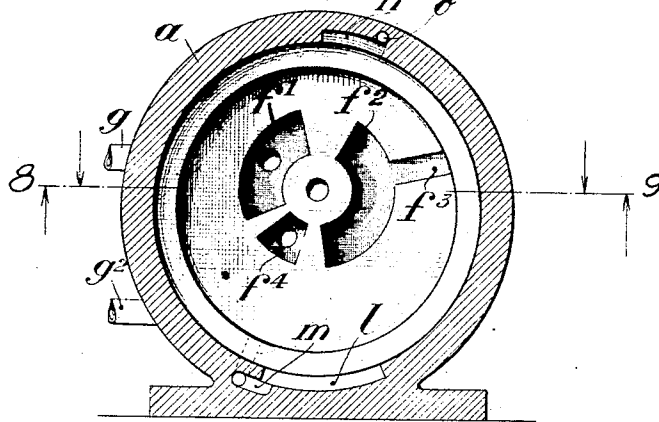
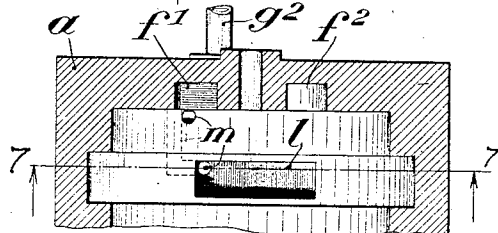


FIG. 9.



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UNITED STATES PATENT OFFICE.

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ROTARY MACHINE.

1,364,014.

Specification of Letters Patent.

Patented Dec. 28, 1920.

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To all whom it may concern:

Be it known that I, EMIL WITTIG, a subject of the King of Saxony, and resident of Basel, Switzerland, have invented new and useful Improvements in Rotary Machines, of which the following is a full, clear, and exact specification.

The present invention relates to improvements in rotary machines having a rotary drum arranged in a cylindrical or substantially cylindrical casing, said drum being provided with radially movable pistons and eccentrically supported in its casing to form therein a crescent-shaped working chamber, subdivided by the pistons in a plurality of cells.

In this kind of machines, which are applicable as air pumps (compressors and vacuum pumps) as well as motors and which generally work with a high speed it is necessary to have a correct mechanical working of the slidable pistons in the slots of the piston drum and against the walls of the casing. One object of the present invention is to compensate or counteract the friction of the sliding pistons in their slots, to correctly lubricate the pistons from the inner part of their guiding slots and to eliminate any unilateral forces which would increase the friction of the pistons on the inner wall of the casing.

Rotary machines with a great number of revolving pistons have the advantage that simple openings in the wall of the casing may suffice for the inlet and outlet of the working fluid, such as air, steam and the like, and the present invention particularly relates to machines of this kind, without, however, possessing the disadvantages of prior machines.

The accompanying drawings represent an embodiment of the present invention.

Figure 1 is a transverse section of a rotary machine provided with certain improvements according to the invention and which is capable of working as motor or as pump.

Fig. 2 is a partial longitudinal section thereof;

Fig. 3 is a transverse section on the line A—B of Fig. 2;

Fig. 4 is a longitudinal section of a rotary machine of the multiple type;

Fig. 5 is a partial longitudinal section of a modification of such a multiple machine;

Fig. 6 is a partial longitudinal section, similar to Fig. 2.

Fig. 7 is a sectional view (with rotor removed) on line 7—7, Fig. 9;

Fig. 8 is a sectional view (with rotor removed) on line 8—9, Fig. 7, looking in the direction of the upwardly pointing arrows;

Fig. 9 is a view similar to Fig. 8, looking in the direction of the downwardly pointing arrows.

Referring first to Figs. 1, 2 and 3, the cylindrical casing *a* incloses the eccentrically arranged rotary piston drum *b* provided with a great number of slidable pistons *c* arranged in radial slots of the drum. The pistons *c* separate or divide the crescent-shaped working chamber within the casing *a* into a great number of cells *z*. When the machine is designed to work as a motor with steam or the like, the driving fluid is admitted through the pipe *d* into an admission chamber *d*¹ and flows therefrom into such cells *z* that are freely open to said chamber. In Fig. 1 this would be the cells marked *z*¹. In the cells *z*² there takes place the expansion of the fluid with working, while the cells at *z*³ discharge the expanded fluid into the exhaust chamber *e*¹ connected to the exhaust pipe *e*. These operations take place successively in each cell during one revolution of the drum.

As the pressure of the steam acts not only upon the great side faces of the pistons, but also upon the outer longitudinal edges, that is the surfaces of the pistons which contact with the inner wall of the casing, it has been proposed to provide in the end plates of the casing lateral channels *f*¹ connecting the inner slot parts behind such pistons that are in the admission zone, which channels are supplied with steam at admission pressure by a pipe branch *g* connected with the admission pipe *d* and provided with a regulating valve *g*¹. In the same way, a pressure compensation is obtained in the exhaust zone by means of lateral channels *f*², *f*³ connecting there the inner slot spaces of the drum with the exhaust chamber *e*¹.

In the zone where the expansion takes place, that is in the zone of the working cells *z*², not only the capacity of said cells increases, but also that of the slot spaces belonging to the corresponding pistons; if consequently the said slot spaces have previ-

ously been put under the same pressure by means of the channels f^1 as the cells and the communication between the slot spaces and the channels has been closed, there will take
 5 place therein a similar expansion of the fluid, so that a pressure compensation relatively to the longitudinal edges of the pistons will be also insured completely or nearly during the period of expansion of the
 10 operation.

Now, the pistons which are in the zone of expansion are exposed to a considerable friction in their slots, as there are different pressures on their opposite sides. The pistons at that place may not so easily be
 15 moved outwardly in their slots as the pistons in the admission zone. This unlikeness of the friction of the pistons in their slots is obviated according to the present invention by the fact that the pressure compensation channels f^1 are prolonged to such an extent as to be connected also with one or more inner slot spaces which are already
 20 within the expansion zone. By these means, not only the pistons belonging to said slot spaces are easily moved outwardly, but in all slot spaces within the zone of expansion, the expansion of the admitted fluid will not have progressed to the same degree as in the
 25 corresponding working cells z^2 , so that there is always in each slot space a greater pressure than in the corresponding cell, which efficiently counteracts the frictional forces.

As in starting the machine there are no centrifugal forces that drive the pistons outwardly, the machine would not start automatically. According to another improvement, the pipe branch g is connected to the admission pipe d rearward of a regulating
 30 valve p in pipe d . When the machine is to be started, steam is first admitted through said pipe branch g , the valve p being closed, whereby the pistons c in the admission and in the expansion zone are pushed outward;
 35 after this operation, the valve p is opened, in successive steps in accordance with the increase of the speed of rotation and the consequent increase of the centrifugal forces of the pistons c .

The machine could not start in this way with the full or increased torque, as at the beginning of the starting operation there would not be any steam in the working cells z^2 , so that the latter could not efficiently work. In this respect, another improvement consists in the use, for the starting operation, of a valve controlled by-pass steam pipe g^2 connected with a channel f^1
 40 to allow admission of steam to the inner slot space of one or more pistons in the expansion zone, while the valve g^1 in the pipe branch g is closed, so that the pistons within the reach of the channels f^1 are previously not pushed outward and thus do
 45 not interfere with the admission of steam

beyond them to the expansion cells z^2 . In this case, some pistons in the expansion zone are pushed outward by steam admitted to their inner slot spaces and as said pistons project themselves out of their slots to a
 5 greater extent than those in the admission zone, the steam admitted to their working surface acts on a greater area and produces a great starting torque.

As rotary machines are called upon to run
 75 at a high speed, it becomes more difficult to lubricate the sliding parts of such machines, especially the pistons in the slots of the revolving drum. Oil used for this purpose has, of course, the tendency to traveling
 80 outward by the action of the centrifugal forces, and does not reach the innermost parts of the piston guide-slots if it is not forcibly introduced thereinto; but this introduction of oil into the slots is very difficult in constructions where the slots have
 85 a considerable axial length. According to another improvement, the steam current admitted by the pipe g , or by the pipe g^2 or by both of said pipes to the inner slot parts
 90 of certain pistons for friction compensation purposes is at the same time used as a conveyor for oil, which is admitted thereto by an oil tube h connected for example to the
 95 pipe g , said oil being thus distributed through the whole space of the inner slot parts and allowed to flow outward along the piston surfaces by the action of the centrifugal forces to amply lubricate said surfaces over their whole extent.
 100

It is advantageous to arrange the lateral channels f^1 , f^2 with such a length that each communicates with only a small group of piston slots, so as to give rise to a low pressure in the latter when they come within
 105 the reach of said channels. The working fluid, then flowing into the slot spaces under pressure induces a violent current therein, which conveys the oil far into said spaces. Obviously, such short channels or recesses
 110 may be provided alternately on both front walls of the machine, so that an oil charged current is first introduced into the slot space from one front side, conveying the
 115 oil far through said space, and then in further rotation another oil charged current from the other front side.

For supporting and counterbalancing the centrifugal forces of the pistons, it is old to use rotating balance rings i (Figs. 2 and
 120 3) freely adjustable upon the outer periphery of the pistons (eventually through intervening sliding shoes) and carried along with the revolving pistons. The inner wall of the casing insures only the circular guiding of the outer piston ends; it does not support at all or only to a small degree the centrifugal forces of the sliding pistons. The balance rings i have on their
 125 outer sides a plurality of confined pressure

chambers for receiving the same pressure as that existing on the inner sides of the rings. These pressure chambers are confined by movable ridges k arranged either in the balance rings i to bear against the inner wall of the casing or in the latter to yieldingly bear on the balance rings. These means prevent any injurious unilateral pressure upon the balance rings by the action of the working fluid.

Now, it is not possible to compensate all the forces acting upon the pistons and the balance rings in such a way that the inner peripheral wall of the casing is not subjected to pressure at all by the pistons owing to the difference in the degree of projection of the pistons from their guide slots during rotation.

It results therefrom that the pistons have the tendency to exert a resulting pressure upon one side upon the casing. This should not necessarily be injurious, if this tighter bearing of the pistons upon the inner wall of the casing were obtained on the advantageous side. At the side where in air pumps the compression and in motors the expansion takes place, it is desirable to have a tight joint between the pistons and the wall of the casing, in order to obviate losses by leakage. This is still more desirable in the zone of the smallest capacity of the cells, as a rapid variation of pressure takes place in said zone over a short part of the circumference in air pumps as well as in motors; for example, in the machine represented by Figs. 1, 2 and 3 the end of the exhaust chamber e^1 is only a small distance from the beginning of the admission chamber d^2 . It has been found that most of the resulting forces not supported by the balance rings tend to strongly press the pistons against the wall of the casing in the zone of the greatest cell capacity; for example, the greater centrifugal forces of the pistons in said zone have the described tendency, and the frictional forces in the slots directed outwardly are also greatest in the zone, where the pistons project to their greatest extent. Now, in this zone, a tight joint of the pistons would not be necessary; no injury would ensue if the pistons should be separated a little from the wall of the casing, as the difference of pressure on the sides of a piston is here very small.

To insure a tight joint of the pistons on the side where the cells have the smallest capacity, an additional force could be exerted upon the balance rings and directed toward the said side. As the balance rings must freely adjust themselves, this additional force should be an elastic one and could for example consist in the action of a weight or of a spring pressing by means of a roller upon the balance rings. If the machine is so arranged that the cells with

the smallest capacity are turned downward, instead of upward as in the present example, the weight of the balance rings will aid in a favorable sense. But, in most cases, all these means are insufficient.

Now, I have obtained the same result, but in a better way by the arrangement of an auxiliary pressure chamber l on the outside of the balance rings i , which is supplied with a convenient fluid under pressure. By this means, the amount of the applied additional force can at the same time be varied at will. In some machines, the fluid under pressure to be supplied to said chamber l may be tapped from the machine itself in an unvariable manner. For example in compressors, as long as the working cells have not yet reached a distributing opening, the compression is always the same and independent of what will be the final compression pressure. It is therefore possible to connect in this zone the pressure chamber l by a channel m (Fig. 3) with one of the cells in said zone, the chamber l being thus supplied with constant pressure. If a pressure chamber n is arranged on the outside of the balance rings in the zone of the smallest cell capacity, then I supply said chamber with a lower pressure than that existing at that place on the inside of the balance rings, the said pressure being taken by a channel o from the chamber e^1 (inlet chamber for the operation of the machine as air pump).

In a machine operating as air pump, the pressure chamber l is advantageously displaced somewhat toward the compression side, in order that the applied additional force may also compensate a part of the frictional forces of the pistons. When the machine operates as motor, the effect of this additional force is for the same reason displaced somewhat toward the exhaust side. The direction of the said additional force will thus always deviate somewhat from the line of junction between the places of the smallest and the greatest cell capacity.

In the rotary machines shown in the drawings, indifferently whether they work as pump or as motor, the cells in one half of the crescent-shaped work chamber are generally under a higher pressure than that in the other half. This results in a middle force upon the piston drum which is directed perpendicular to the axis thereof and often is of considerable amount.

The partial compensation or elimination of this force may be obtained by the arrangement wherein the machine is made of the multiple type with the working chambers of the adjacent elementary machines alternately displaced 180 degrees from each other, so that the zone of the smallest cell capacity in one elementary machine is on the same longitudinal line with the zone of

the greatest cell capacity in the adjacent elementary machine. By this arrangement, the pressures in the bearings in the partition wall g arranged between the elementary machines are compensated for if the machines work under the same load. At the ends of the multiple machine, the bearing pressures continued to subsist but they are reduced owing to the subdivision of the machine.

If the thus compounded units do not work in the same way, some uncompensated pressures will obviously result in the bearings in the partition walls g .

In compound or two-phase machines it is advantageous to substitute two low pressure units for one of the two units of greater capacity. The said two low pressure units are then of approximately the same aggregate capacity as the high, pressure unit and the three units can be arranged in such a way that the transverse bearing pressures of the piston drums are substantially compensated for. The construction according to Fig. 4 may comply with these conditions; in this case, the middle elementary machine would be of the high pressure type and the two outer elementary machines of the low pressure type.

As in machines coupled in the described manner the piston drums are heated to a higher degree than the corresponding casings, resulting in a considerable friction on the ends, it is advantageous to provide for a little axial play between the drums and the casings; but with such a play, the joint would give rise to leakages. To avoid losses by leakages, the construction may be modified according to Fig. 5 wherein the parts of the piston drums between the partition walls g have such a thickness that the pistons, when in their outermost positions, have their inner edges projecting inward beyond the edges of the bearing openings in said walls g . In other words, the piston drums of the different units have connections and tightening parts of the same diameter as the drum bodies located within the bearing openings of the partition walls g . In this case, the partition walls g are advantageously so arranged that they are slightly movable perpendicularly to the axis of the drums, in order to be capable of adjusting themselves in their housing. A spring r or the like may be provided to support or compensate for the weight of the partition walls g .

What I claim is:

1. In a rotary machine, a casing having side walls, a rotary drum arranged therein so as to form a crescent-shaped working chamber, numerous slidable pistons on said drum arranged to divide said chamber into a plurality of cells, said pistons being located in substantially radial slots of the drum; said parts being arranged to provide a

terminal zone for fluid inlet, a terminal zone for fluid outlet and an intermediate working zone, said pistons being so distributed over the said three zones that each zone contains several pistons, a channel in at least one of the side walls of the casing arranged to communicate simultaneously with the inner slot spaces of such pistons that are within one of the said terminal zones as well as with the inner slot space of at least one piston within the intermediate working zone, and a pipe connection for admitting fluid under pressure to said channel, substantially as and for the purpose described.

2. In a rotary machine, a casing having side walls, a rotary drum arranged therein so as to form a crescent-shaped working chamber, numerous slidable pistons on said drum arranged to divide said chamber into a plurality of cells, said pistons being located in substantially radial slots of the drum, said parts being arranged to provide a terminal zone for fluid inlet, a terminal zone for fluid outlet and an intermediate working zone, said pistons being so distributed over the said zones that each zone contains several pistons, a pipe system connected to said terminal zones, a controlling valve in said pipe system, a channel arranged to communicate with the inner slot spaces of such pistons that are within one of the said terminal zones as well as with the inner slot space of at least one piston within the intermediate working zone, and a pipe connected on the one hand to said channel and on the other hand to said pipe system beyond its controlling valve and adapted to allow preliminary admission of fluid under pressure to said channel for starting said machine as a motor, substantially as and for the purpose described.

3. In a rotary machine, a casing having side walls, a rotary drum arranged therein so as to form a crescent-shaped working chamber, numerous slidable pistons on said drum arranged to divide said chamber into a plurality of cells, said pistons being located in substantially radial slots of the drum, said parts being arranged to provide a terminal zone for fluid inlet, a terminal zone for fluid outlet and an intermediate working zone, said pistons being so distributed over the said three zones that each zone contains several pistons, a channel in at least one of the side walls of the casing for admitting fluid to the inner slot spaces of such pistons that are within one of the said terminal zones and within the working zone, an independent channel in the said side wall for admitting fluid to the inner slot space of at least one further piston within the working zone, and independent fluid admission pipe connections for said channels, substantially as and for the purpose described.

4. In a rotary machine, a casing, a rotary drum arranged therein so as to form a crescent-shaped working chamber, numerous slidable pistons on said drum arranged to divide said chamber into a plurality of cells, said pistons being located in substantially radial slots of the drum, said parts being arranged to provide a terminal zone for fluid inlet, a terminal zone for fluid outlet and an intermediate working zone, said pistons being so distributed over the said three zones that each zone contains several pistons, a channel for admitting fluid to the inner slot spaces of such pistons that are within one terminal zone as well as to the inner slot of at least one piston within the working zone, a fluid admission pipe connected to said channel for the admission of fluid thereto, and an oil pipe connected to said fluid admission pipe for supplying oil thereto in order to use the fluid current passing therethrough for conveying oil to the aforesaid inner slot spaces for lubricating purposes, substantially as described.

5. In a rotary machine, the combination of a plurality of elementary machines each having a casing, a rotary drum arranged therein so as to form a crescent-shaped working chamber, numerous movable pistons on said drum arranged to divide said chamber into a plurality of cells, said parts being arranged to provide a terminal zone for fluid inlet, a terminal zone for fluid outlet and an intermediate working zone, the working chambers of two adjacent elementary machines being angularly displaced for about 180 degrees from each other, a partition wall between the working chambers of two adjacent elementary machines, a bearing opening in said partition wall and a connection part between two adjacent piston drums tightly guided in said bearing opening and so arranged that the pistons of the drums, when in their outermost position have their inner edges inward of the edge of said bearing opening, substantially as and for the purpose described.

connection part between two adjacent piston drums tightly guided in said bearing opening and so arranged that the pistons of the drums, when in their outermost position, have their inner edge inward of the edge of said bearing opening, substantially as and for the purpose described.

6. In a rotary machine, the combination of a plurality of elementary machines having each a casing, a rotary drum arranged therein so as to form a crescent-shaped working chamber, numerous movable pistons on said drum arranged to divide said chamber into a plurality of cells, said parts being arranged to provide a terminal zone for fluid inlet, a terminal zone for fluid outlet and an intermediate working zone, the working chambers of two adjacent elementary machines being angularly displaced for about 180 degrees from each other, a spring-pressed partition wall between the working chambers of two adjacent elementary machines, said partition wall being slightly movable transversely to the axis of the piston drums, a bearing opening in said partition wall and a connection part between two adjacent piston drums tightly guided in said bearing opening and so arranged that the pistons of the drums, when in their outermost position have their inner edges inward of the edge of said bearing opening, substantially as and for the purpose described.

In witness whereof I have hereunto signed my name this 2d day of October, 1915, in the presence of two subscribing witnesses.

EMIL WITTIG.

Witnesses:

ARNOLD ZUBER,
AMAND HAUSE.