

Aug. 12, 1941.

K. E. KYLÉN

2,252,187

ARRANGEMENT IN COMBUSTION MOTOR, COMPRESSOR, OR THE LIKE

Filed Oct. 4, 1940

5 Sheets-Sheet 1

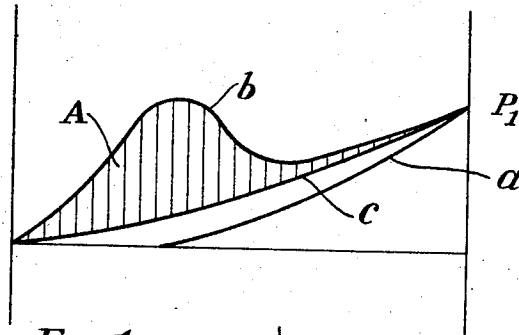


Fig. 1.

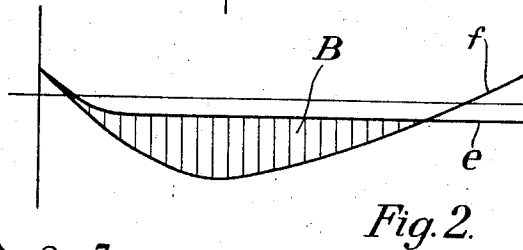


Fig. 2.

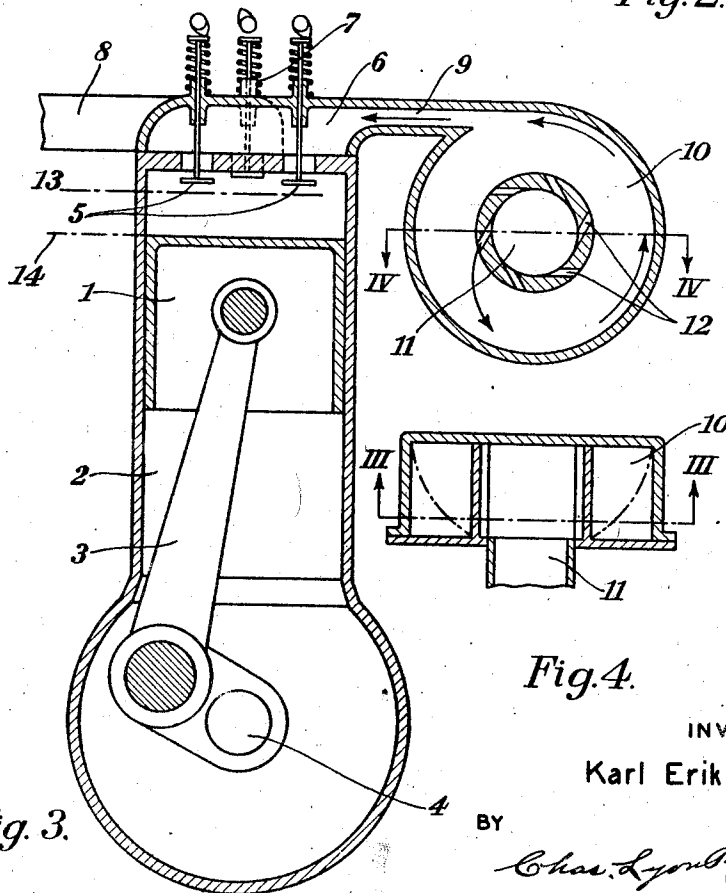


Fig. 3.

Fig. 4.

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5 Sheets-Sheet 2

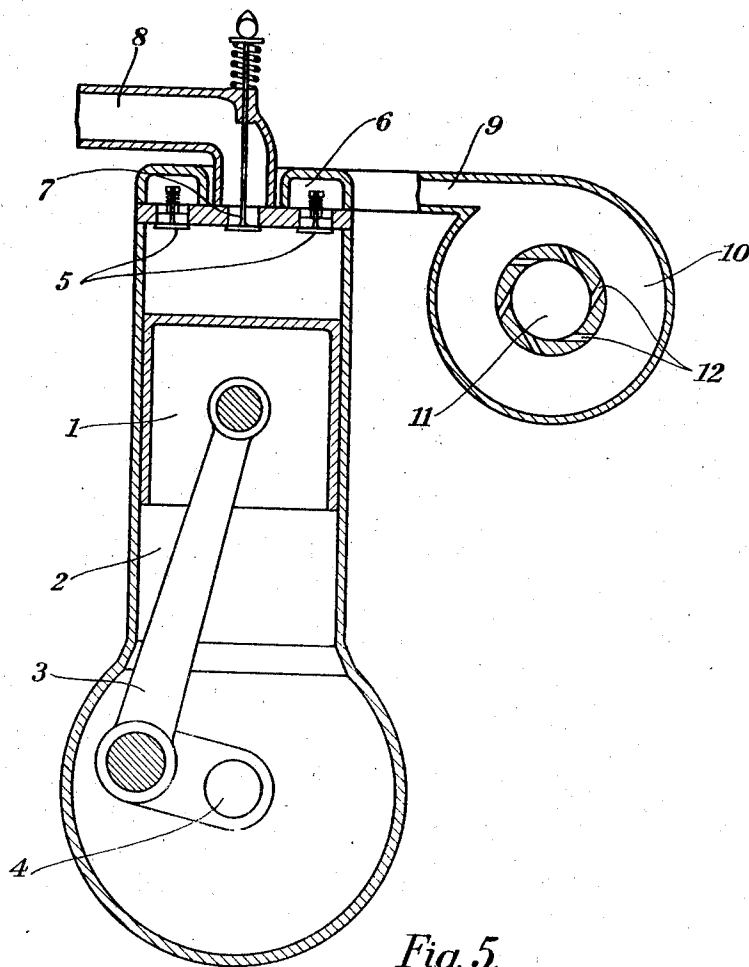


Fig. 5.

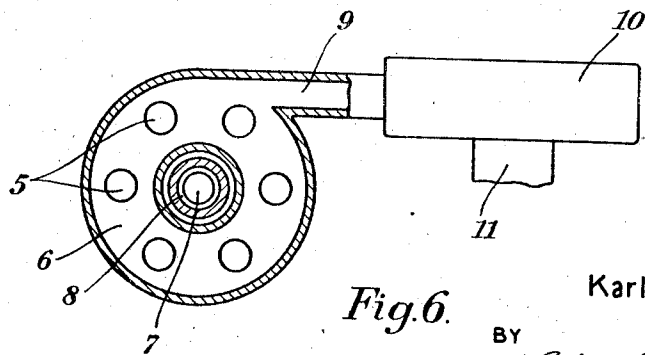


Fig. 6.

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5 Sheets-Sheet 3

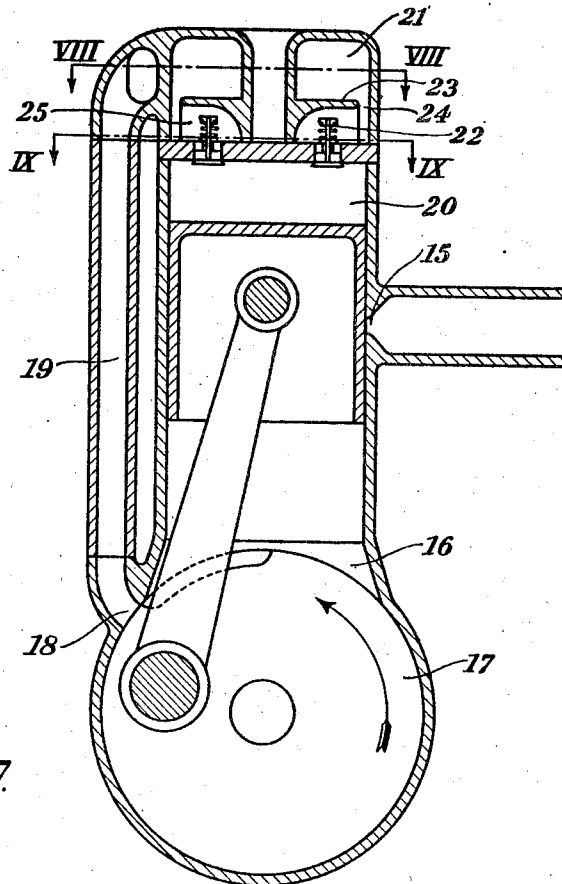


Fig. 7.

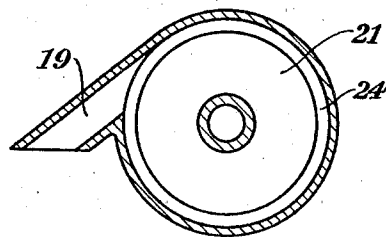


Fig. 8.

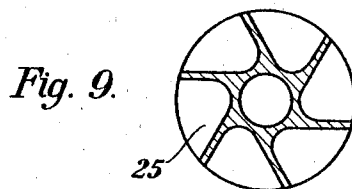


Fig. 9.

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5 Sheets-Sheet 4

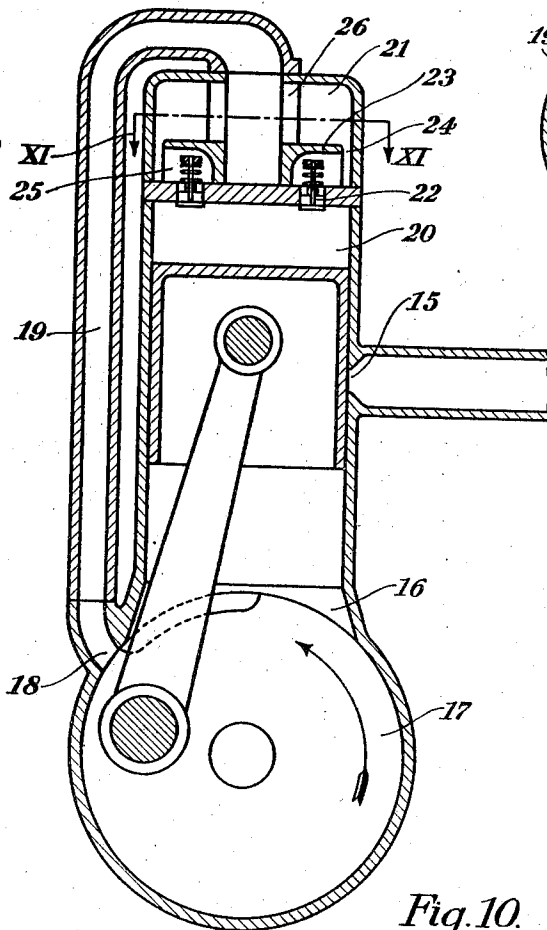


Fig. 10.

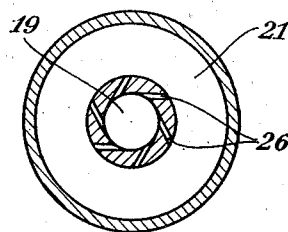


Fig. 11.

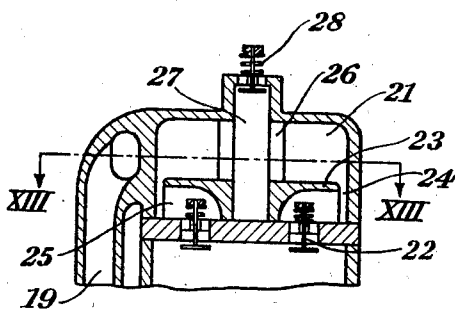


Fig. 12.

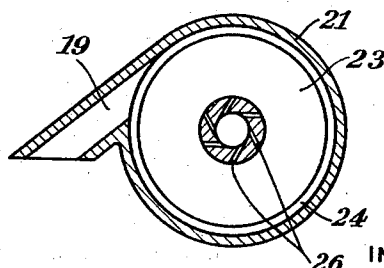


Fig. 13.

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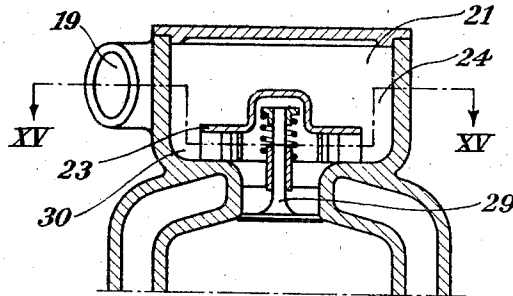


Fig. 14.

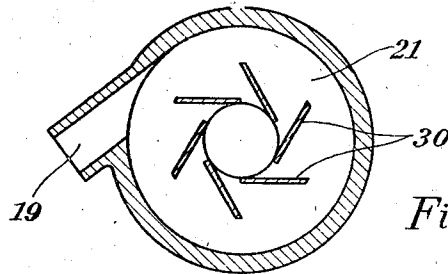


Fig. 15.

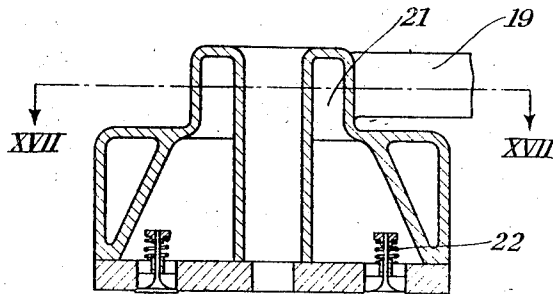
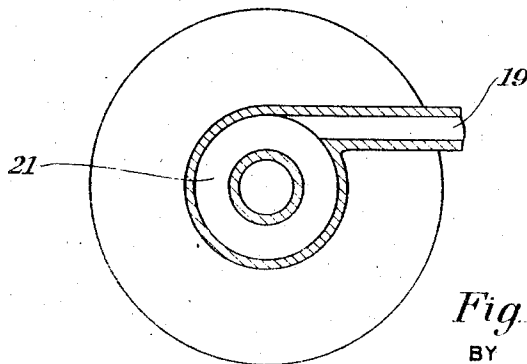


Fig. 16.



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Fig. 17
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UNITED STATES PATENT OFFICE

2,252,187

ARRANGEMENT IN COMBUSTION MOTOR,
COMPRESSOR, OR THE LIKE

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Application October 4, 1940, Serial No. 359,688
In Sweden November 27, 1939

16 Claims. (Cl. 123—65)

The present invention relates to an arrangement in combustion motors, compressors, or the like, and has for its purpose to increase the pressure of the gas or air around or adjacent to the inlet ports to the working chamber, for instance the cylinder. Another object of the invention is to permit the scavenging or the supply of fresh gas mixture or scavenging air to take place with the least possible consumption of power. A further object of the invention is to attain a full charge of gas mixture or air in the working chamber. According to the invention this can take place in such a manner that a certain amount of work is performed in a compressor, or the like, connected to the combustion motor or in the working chamber proper, in order to obtain a super- or subpressure respectively. The work thus performed is wholly or partly transformed into kinetic energy, which at or near the inlet ports of the working chamber is again transformed into pressure energy.

The invention is characterized substantially by one or more chambers, or the like, arranged in the inlet and/or outlet conduits of the working chamber, said chambers being preferably circular form and being provided with one or more substantially tangentially directed admission openings for the introduction of the combustive gas into the chamber, in order that the combustive gas may be given a speedy rotation in the chamber and having one or more exhaust openings for the escape of the combustive gas from the chamber, said ports being located at or adjacent the outer circumference of the chamber.

The invention is illustrated on the drawings annexed hereto, in which

Figure 1 shows a pressure diagram for the crank case and the distributing chamber of a two-stroke motor.

Figure 2 shows a corresponding diagram for a rotation chamber of a four-stroke motor.

Figure 3 is a section perpendicular to the crank shaft through a four-stroke motor, to which the invention is applied.

Figure 4 is a section along the line IV—IV in Figure 3.

Figure 5 is a section through a modified form of the motor shown in Figure 3.

Figure 6 is a section through the distributing chamber in Figure 5.

Figure 7 is a section perpendicular to the crank shaft through a two-stroke motor with crank housing compression, to which the invention is applied.

Figure 8 is a section along the line VIII—VIII in Figure 7.

Figure 9 is a section along the line IX—IX in Figure 7.

5 Figure 10 is a modified form of the motor according to Figure 7.

Figure 11 is a section along the line XI—XI in Figure 10.

10 Figure 12 is a vertical section through a modified form of a rotation chamber.

Figure 13 is a section along the line XIII—XIII in Figure 12.

15 Figure 14 is a vertical section through a rotation chamber with a single centrally disposed inlet valve to the working cylinder.

Figure 15 is a section along the line XV—XV in Figure 14.

20 Figure 16 is a vertical section through a rotation chamber of substantially conical form, and

Figure 17 is a section along the line XVII—XVII in Figure 16.

In the diagram shown in Figure 1 for a two-stroke motor the curve *a* designates the increase of pressure in a chamber, for instance the distributing chamber for the valves in a motor, in which the over-flow to the distributing chamber takes place at relatively low speed from another chamber, for instance a crank case compressor. Such an over-flow or increase of pressure occurs for instance, if the difference in pressure is relatively small at the beginning and if the channel connecting the two chambers is relatively ample, as well as if the machine is working at low speed. In the diagram no consideration is taken of the insignificant losses through friction in the over-flow channel. The pressure curve in the distributing chamber follows substantially the corresponding curve for the crank case compressor. The curve *a* can therefore also be said to represent the increase of pressure in the crank case. No work is required for transmitting the gases from the crank case to the distributing chamber, if account is not taken of the insignificant loss of friction.

45 If, on the other hand, the connecting conduit has a relatively small sectional area or if the gas mixture is compressed to a certain overpressure in the crank case, before the exhaust port from the crank case opens, a certain amount of work must be spent on the gas in the crank case. The flow of gas from the crank case to the distributing chamber then takes place with great velocity, and the increase of pressure in the crank case is 55 illustrated by the curve *b* in Figure 1. The curve

c gives the approximate increase of pressure in the gas chamber when the increase of pressure in the crank case is according to the curve b. The work spent on the gas in the crank case or the work required for pressing the gas from the crank case through the over-flow conduit to the distribution chamber is represented in the diagram by the hatched surface A shown between the curves b and c.

According to the invention the kinetic energy of the charge of gas indicated by the surface A in Figure 1 is accumulated by imparting rotation to the rapidly flowing gases in the preferably circular distributing chamber. This rotation is attained by the inlet conduit opening tangentially into the said chamber. Owing to the rapid rotation of the gases in the distributing chamber an increased pressure against the outer walls of the chamber and a corresponding decrease in pressure towards the centre of the chamber ensue. In other words, the pressure at the outer wall will be greater than the average pressure P_1 in Figure 1, and the pressure at the centre of the chamber will be less than the average pressure P_1 in the chamber.

If self-acting inlet valves to the combustion cylinder are disposed in such a manner that they are subjected to the higher pressure and the kinetic energy obtaining at the outer wall of the distributing chamber, they will open more rapidly than at the low pressure attained by an ordinary radial flow into the distributing chamber. The efficiency of the valves is thus substantially increased, and the distributing chamber is more effectively emptied of its contents. If the whole kinetic energy is not required for opening the valves, that is to say, if the gas mixture or scavenging air remaining in the chamber continues to rotate after the valves are closed, then this kinetic energy can be used for supercharging, in order to reduce the work of the compressor at the next compression stroke. At the next compression stroke in the crank case and the next period of admission into the distributing chamber the gas charge emanating from the crank case will thus have a lower pressure to overcome, if the gas mixture or air is admitted at the centre of the chamber. With the increased efficiency of the valves, a lower temperature of the gas mixture or scavenging air, a greater charge, a higher degree of efficiency of the motor and a lower fuel consumption are obtained.

Figure 2 shows a compression diagram for the distributing chamber of a four-stroke motor. The curve e indicates the variation of pressure when the cylinder is charged slowly or without the arrangement according to the invention, and the curve f shows the variation of pressure with the arrangement according to the invention applied. From the curves it is apparent that the final pressure in this case is higher than otherwise. The cross hatched surface B between the curves indicates the extra work performed for obtaining the increase of pressure, i. e. for the increased charge.

In the four-stroke motor, according to Figure 3, 1 designates the piston, which moves up and down in the cylinder 2, thereby driving the crank pin 3 and the crank shaft 4. The inlet valves 5 open from a chamber 6 and may either be of self-acting type or governed by a suitable mechanism of known type, for instance a cam device. The exhaust valve 7 connects the cylinder with the exhaust pipe 8. A rotation chamber 10 is connected to the chamber 6 by means of a conduit 9.

For reasons, which will be explained in the following, the chamber 10, as shown, is circular in section. For the admission of a charge into the chamber 10 there is an admission conduit 11, which is connected with the chamber 10 by means of a number of openings 12. The openings 12 are directed more or less tangentially relative to the annular chamber 10, and the connecting conduit 9 is connected tangentially to the outer wall of the chamber 10. The openings 12 are directed towards the opening of the connecting conduit.

The arrangement functions in the following manner. After the piston has moved a bit of its way downwards in the cylinder 2, the inlet valves 5 open, and the charge flows with great velocity into the cylinder under the influence of the difference in pressure caused by the partial vacuum obtaining in the cylinder. In order to obtain this partial vacuum, it is necessary to use some of the power of the motor. This power is then transformed into kinetic energy of the air or gas mixture to be introduced into the motor, and this kinetic energy is accumulated in the form of rotating movement of the air or gas mixture, thereby that the air or gas mixture which flows in through the openings 12 to the chamber 10 are given the desired movement by the oblique position of the openings 12 and the form of the chamber 10. Through this arrangement the energy developed in order to overcome the air resistance when the piston moves from the top position 13 to the position 14 is accumulated. When the piston reaches its bottom position, the air or gas mixture continues its rotation in the rotation chamber 10. Under the influence of the centrifugal force the pressure in this chamber will be greater towards the outer wall than near the centre, and a partial vacuum therefore obtains in the last mentioned part of the chamber. Air or gas mixture thus continues to flow into the rotation chamber in order to fill up this partial vacuum. The conduit 9, on the other hand, opens tangentially towards the outer wall 10 of the chamber, thus where the pressure in the chamber is greatest. In this manner a greater amount of air is supplied to the cylinder than corresponds to the volume of stroke of the cylinder. The rotation chamber will serve as a compressor, although the rotation of the air or gas mixture is not obtained by means of an impeller but by the aid of tangential inlet or exhaust conduits to and from the rotation chamber. The area of flow of the openings 12 can be varied in appropriate manner, for instance by means of a sleeve or the like slidable in the longitudinal direction of the conduit 11, whereby the sleeve can be operated so as to close a certain suitable part of the openings. Hereby the openings can be adjusted in such a manner, that the inflow takes place continuously and not only during the suction period of the motor. The time of inflow having thus been increased, it is possible to use a smaller carburettor than otherwise generally necessary with motors of the same size.

The embodiment shown in Figures 5 and 6 differs from that shown and described in connection with Figures 3 and 4 only that the distributing chamber 6 is also formed as a rotation chamber, and the conduit 9 opens tangentially to this chamber. The inlet valves 5 are disposed at a relatively great radius and are thus acted upon by the increased pressure caused by the rotation. The exhaust valve 7 is arranged at

the centre of the cylinder top, and the exhaust pipe 8 is connected to the cylinder inside the annular rotation chamber 6. Through this embodiment two rotation chambers are obtained, i. e., the chamber 10 and the distributing chamber 6, which offer the possibility to double the accumulation of kinetic energy.

Figures 7, 8, and 9 show the invention applied to a two-stroke motor, in which the air or gas mixture is admitted to the cylinder at one end and the burnt gases escape through exhaust ports 15 at the other end. In the motor shown, the crank case 16 is arranged as a compressor. The crank arms 17 are formed as circular discs, and the crank case is shaped to conform closely thereto, whereby the clearance in the crank house compressor can be reduced to a minimum. The flow of gases to and from the crank case can be conveniently regulated by members, particulars of which are not given here, but which may preferably be of the type explicitly described in the Patent No. 2,246,446. Through the regulating members the exhaust port 18 from the crank case 16 is laid free through a slot in the disc, when the piston has already travelled part of its way downwards, so that the air or gas mixture is compressed to a certain superpressure in the crank case, before connection between the crank case and the overflow channel occurs, which latter is connected to the exhaust port 18.

The channel 19 opens tangentially into a circular rotation chamber 21 positioned above the cylinder 20. The valves 22 are shown as of self-acting type. In order that the valve arrangements shall not impede the rotation of the gases in the chamber 21, they are separated from the rotation chamber 21 proper by means of a circular wall 23. Between the wall 23 and the outer wall of the chamber 21 there is a circular clearance 24, through which the gases flow from the chamber 21 to the valves 22. The valves 22 are arranged in pocket formed rooms 25, the openings of which are directed against the flow of incoming gases from the channel 19, in order to direct the said gases to the valves and as far as possible make use of their kinetic energy.

When the outlet conduit 18 from the crank case is laid free, the air or gas mixture flows from the crank case 16 through the opening 18 and the channel 19 into the chamber 21 located above the cylinder, into which chamber, as above stated, the channel 19 opens tangentially. The amount of work which has been consumed on the air or gas mixture in the crank case compressor is transformed into kinetic energy and accumulated in the rotation chamber 21, in which an intense rotating movement is imparted to the air or gas mixture. Through this rotating movement a considerably higher pressure obtains against the walls of the rotation chamber than nearer the centre of the same. From this outer part of the rotation chamber the annular clearance 24 opens, leading to the pockets 25, in which the valves 22 are arranged. A greater pressure is thus at disposal for opening the valves, than if an equal amount of air were introduced into the chamber 21 without the rapid rotation. The valves therefore open more speedily than if the quantity of air or gas mixture above the valves were at rest. Due to the rotation, the rotation chamber is also more completely emptied. The results are therefore similar to those already described in connection with Figure 3.

The motor according to Figures 10 and 11 differs from the one shown in Figure 7 substan-

tially thereby that the overflow channel 19 is connected centrally to the rotation chamber 21 instead of to its periphery. The rotating movement is imparted to the gases thereby that the inlet openings 26 from the channel 19 to the chamber 21 are arranged more or less tangentially. This embodiment offers the advantage, that the gases are introduced in the rotation chamber at the place where, owing to the rotation, the pressure and consequently the resistance against the in-flow is lowest. The conditions will therefore be similar to those in the rotation chamber, as shown in Figures 3 and 5.

The embodiment of rotation chamber shown in Figures 12 and 13 is based on that shown and described in connection with Figure 7. An additional central inlet 27 has however been applied here which is regulated by means of a valve 28 and which through tangentially directed openings 26 of the type above described are connected to the rotation chamber 21. Since the openings 26 are in connection with the rotation chamber at a place, where the pressure in the chamber is lowest, the additional amount of kinetic energy can be used for opening the valve 28 and thereby provide extra air or gas mixture to the chamber.

The arrangement according to Figure 14 provides only one valve 29 which is centrally positioned relative to the chamber 21. From the part of this chamber in which rotation takes place the valve is separated through the wall 23, but communication can take place through the annular space 24 at the periphery of the chamber. The over-flow channel 19 in this case also opens tangentially into the chamber 21. In order to deflect the rotating gases flowing in to the chamber 21 through the space 24 to the valve 29 there are provided a number of tangentially positioned guide blades 30 which are directed against the direction of rotation of the gases. This arrangement is specially useful in Diesel motors, where such guide blades impart a rotating movement of the gases flowing into the cylinder.

The rotation chamber according to Figures 16 and 17 is of substantially conical form. The flow into chamber 21 takes place tangentially from the inlet channel 19, and the valves 22 are disposed at a greater diameter than the diameter at the inlet place. Through this arrangement the gases flow in at a place near the axis of rotation of the gas mass, where the pressure is low which affords advantages, as mentioned above.

It is of importance that the cross-sectional area of the over-flow channel 19 should not be too great. This area should be in appropriate relation to the desired speed of rotation in the rotation chambers 10 and 21 respectively. The smaller the area, the greater the velocity of rotation and vice versa.

By means of the arrangement according to the invention it has been possible to attain the maximum efficiency of the motor at high speeds (exceeding 4000 R. P. M. in a two-stroke motor), although the valves were of self-acting type, which type otherwise has proven itself unsuitable at high speeds, and by means of which it was not possible, without the aid of the invention, to attain the maximum efficiency at higher speeds than 2000 R. P. M. with substantially lower mean effective pressure and substantially higher fuel consumption.

Another advantage is that the motor, owing to the rotation in the rotation chamber, becomes less sensible to gas oscillation in the exhaust conduit. It is also possible to provide a

rotation chamber, for instance the chamber shown in Figures 16 and 17, in the exhaust conduit, whereby the inlet to the chamber takes place at 19 and the outlet tangentially at the big end of the chamber. This arrangement provides a partial vacuum in the cylinder and makes the machine insensible to oscillations in the exhaust conduit.

Other embodiments of the invention can of course be contemplated without departing from the principle of the invention. The chamber 10 can thus for instance be dispensed with in the motor according to Figure 5, in which case the motor is provided only with the rotation chamber 6.

Having thus described my invention, I claim and desire to secure by Letters Patent:

1. In a gas apparatus, the combination with a working chamber, of a gas conduit leading to it, a rotation chamber in said conduit, said rotation chamber having a substantially circular outer wall, there being a complete, uninterrupted annular space adjacent to said wall, a substantially tangentially directed inlet from the conduit to the chamber for imparting rotation to the gases in the annular space of the chamber, and an outlet from said annular space of the chamber to the conduit, the said outlet being farther from the center of the chamber than the said inlet.

2. In a gas apparatus, the combination with a working chamber, of a gas conduit leading to it, a rotation chamber in said conduit, said rotation chamber having a substantially circular inner wall and a substantially circular outer wall substantially concentric thereto, the said walls enclosing a complete uninterrupted annular space, the said inner wall having a substantially tangentially directed inlet opening from the said conduit for imparting rotation to the gases in the chamber, there being an outlet opening from the chamber to the conduit disposed at or near the outer circumference of the chamber.

3. In a gas apparatus, the combination with a working chamber, of a gas conduit leading into it, a rotation chamber in said conduit, a tangentially directed inlet opening into such rotation chamber and a discharge opening disposed at its outer circumference, the said inlet and discharge being from and to the said conduit, inlet valves to the working chamber being provided in the rotation chamber and means for screening said valves comprising a circular wall of less diameter than the diameter of the rotation chamber at the same height and located substantially concentric with the rotation chamber, whereby an annular space is formed connecting the chamber of rotation proper with the distributing chamber.

4. An arrangement according to claim 3 in a motor having a number of valves, characterized by spacing walls between the valves.

5. An arrangement according to claim 3 in a motor having a number of valves, characterized by spacing walls between the valves which walls are located in a direction against the direction of movement of the rotating gases.

6. In a gas apparatus, the combination with a working chamber, of a gas conduit leading into it, a rotation chamber in said conduit, a tangentially directed inlet opening into such rotation chamber and a discharge opening disposed at its outer circumference, the said inlet and discharge being from and to the said conduit, there being a number of inlet valves and a dis-

tributing chamber for the distribution of gas thereto, the said distributing chamber being formed as a rotation chamber having a central opening, said rotation chamber having an annular form and the outlet conduit from the working chamber passing the central opening of the rotation chamber.

7. In a device of the character specified, the combination with a rotation chamber, an inlet opening into such chamber being directed substantially tangentially towards the outer wall of the chamber and an additional conduit opening into the middle of the rotation chamber.

8. An arrangement according to claim 7, characterized by a regulating valve being provided in the additional conduit.

9. An arrangement according to claim 7 having a single valve to the working chamber located in the middle of the rotating chamber, characterized by guide blades arranged about the valve and being preferably directed substantially tangentially and conducting the gases from the outer part of the rotation chamber to the valve.

10. An arrangement according to claim 1, wherein the rotation chamber has a diameter at one end greater than at the other, and wherein further the said inlet opening to the chamber is located at the smaller end and the said outlet opening from the chamber is located at the greater end.

11. An arrangement according to claim 1, wherein the rotation chamber has a diameter at one end greater than at the other, the said inlet opening to the chamber being located at the smaller end and the said outlet opening from the chamber being located at the greater end, and wherein further the rotation chamber is provided with a conical intermediate part forming a transition from the end of smaller diameter to the end of greater diameter.

12. In a device of the character specified, the combination with a working chamber, a pre-compressor, and a rotation chamber located between the working chamber and the pre-compressor, the outlet from said rotation chamber being in the outer peripheral area of the chamber.

13. An arrangement according to claim 1, characterized by self-acting valves connecting the rotation chamber with the working chamber.

14. In a gas apparatus, the combination with a working chamber, of means for charging said chamber with gas, said means comprising a rotation chamber having an inlet for said gas and an outlet to the working chamber, said rotation chamber having a substantially circular wall and adjoining said wall a complete uninterrupted annular space, said inlet being directed substantially tangentially for imparting rotation to the gas in said annular space, thereby increasing the pressure of the gas in the peripheral area of the chamber toward said wall, and said outlet being located in said peripheral area of increased pressure.

15. In a gas apparatus, the combination with a working chamber, of means for charging said chamber with gas, said means comprising a rotation chamber having an inlet for said gas and an outlet to the working chamber, said rotation chamber having a substantially circular wall and adjoining said wall a complete uninterrupted annular space, said inlet being directed substantially tangentially for imparting rotation to the gas in said annular space, thereby increasing the pressure of the gas in the peripheral area

of the chamber toward said wall, and said outlet being located in said peripheral area of increased pressure, and valve means between said chambers controlling the inlet to the working chamber.

16. In a gas apparatus, the combination with a working chamber, of means for charging said chamber with gas, said means comprising a rotation chamber having an inlet for said gas and an outlet to the working chamber, said rotation chamber having a substantially circular wall and adjoining said wall a complete uninterrupted annular space, said inlet being directed substan-

tially tangentially for imparting rotation to the gas in said annular space, thereby increasing the pressure of the gas in the peripheral area of the chamber toward said wall, and said outlet being located in said peripheral area of increased pressure, and valve means between said chambers controlling the inlet to the working chamber, said valve means being self-acting to admit gas to the working chamber and to preclude a reverse flow from the working chamber to the rotation chamber.

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