May 12, 1925. 1,537,450

J. BABIN

MACHINE WITH FREE FLYING PISTON

Filed July 7, 1922 2 Sheets-Sheet 1

Fig. 1

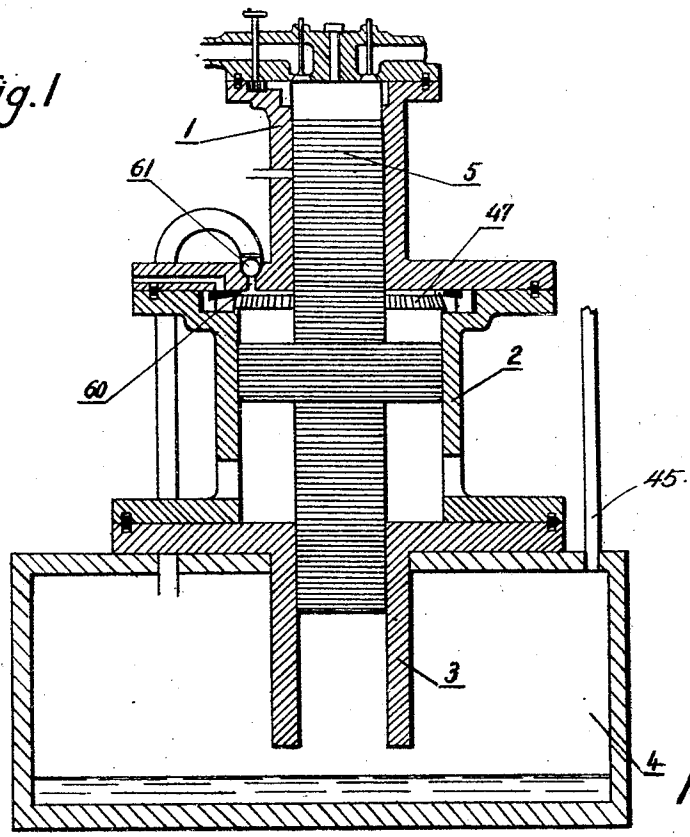


Fig. 3

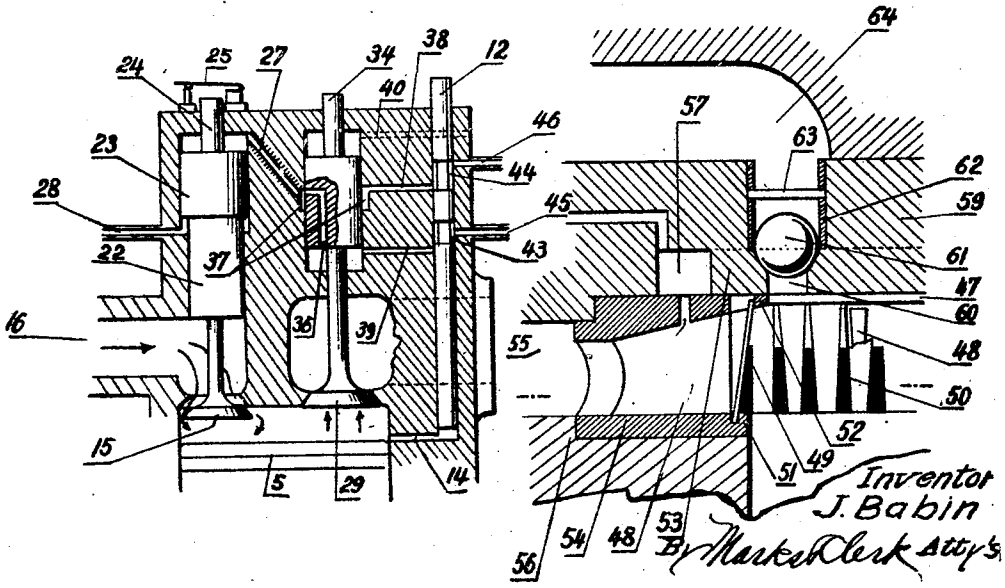


Fig. 5

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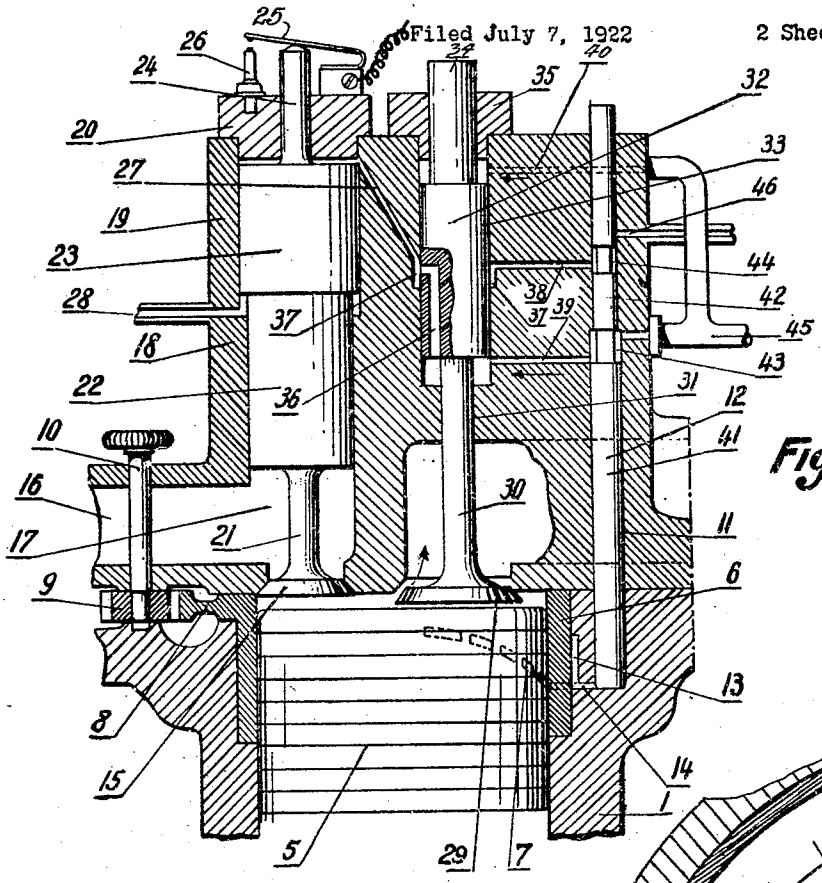


Fig. 2.

Fig. 6

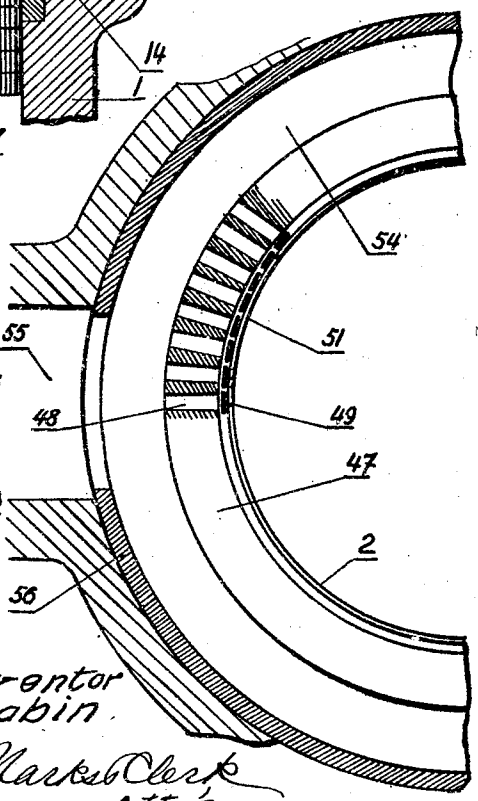
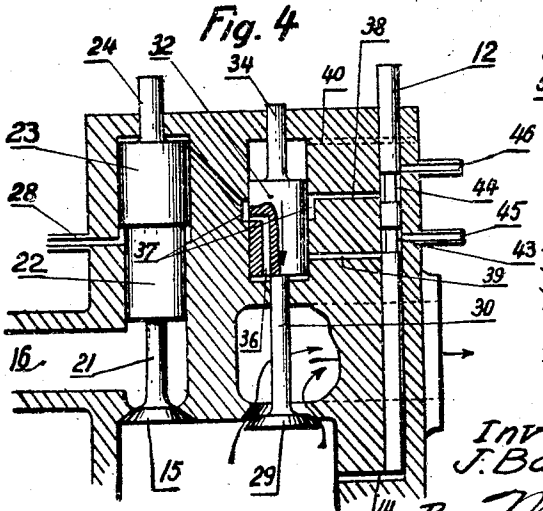


Fig. 4



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Patented May 12, 1925. 1,537,450

UNITED STATES PATENT OFFICE.

JULES BABIN, OF PARIS, FRANCE.

MACHINE WITH FREE FLYING PISTON.

Application filed July 7, 1922. Serial No. 573,492.

To all whom it may concern:

Be it known that I, JULES BABIN, citizen of the French Republic, residing 25 Boulevard Malesherbes, Paris, France, have invented certain and useful Improvements in Machines with Free Flying Pistons, of which the following is a specification.

This invention relates to a device for gas control in internal combustion engines with free flying pistons and artificial atmosphere, as well as in devices utilizing said engines, such as engine and compressor group or the like.

Apparatus of this type comprise no elements at the exterior of the cylinders which are in mechanical connection with the pistons, and it appears difficult to provide any such elements susceptible of affording good results, especially since the piston stroke has not necessarily a constant length.

According to my invention, the compressed air produced by the apparatus itself, or by an auxiliary air compressor, is chiefly used to control the valve gear, and in order to provide for quick action as well as the required exactness and safety, the control of each operation is effected by the element employed to effect the preceding operation. By reason of the high piston speed employed in this type of engine, I have been led to utilize special arrangements for the fluid control elements of the air pump.

The following description together with the accompanying drawings which are given by way of example, set forth an embodiment of said invention as applied to a motor compressor group as set forth in the copending application 574,413 filed July 12, 1922.

Fig. 1 is a diagrammatic view of the motor-compressor group, and Fig. 2 a like view of the fluid control system. Figs. 3 and 4 show the position of the elements of Fig. 2 in the various stages of operation. Figs 5 and 6 show in sectional elevation and plan view on the line A—B of Fig. 5, the suction and delivery valve devices as applied to the air pump of a motor-compressor.

The motor-compressor group Fig. 1 is essentially constituted as follows:

The explosion cylinder 1 is situated above the pump cylinder 2 in the upper part whereof is effected the suction and compression of air, the lower part being open to the atmosphere. A lower or "counter pressure" cylinder 3 opens freely into a large-sized compressed air reservoir 4 which is maintained at a constant pressure by a regulator not shown corresponding to that disclosed in the copending application 574,-413. Cylinder 3 has a slightly smaller bore than cylinder 1, and the common piston 5 will therefore comprise three different cross-sections.

The fresh gas mixture is admitted at the pressure of reservoir 4 into cylinder 1 when the piston 5 is at the top of the stroke. It effects the slow descent of piston 5 during the first part of the stroke by reason of the difference between cross-sections of cylinder 1 and cylinder 3. The explosion effects the descent of the pistons against the pressure in tank 4. Upon the completion of the down stroke of the piston, the same is driven upwardly by the pressure of the compressed air of the reservoir 4; the burnt gas is thus discharged from cylinder 1 into the atmosphere, and the series of operations recommences.

The fluid control devices are shewn in detail in Fig. 2. At the upper part, the explosion cylinder 1 has an enlarged portion adapted to receive a movable concentric ring 6 which is bored to the same diameter as the cylinder and contains a plurality of ports 7 in helical disposition. Said ring is provided with a toothed flange 8 co-operating with the pinion 9 actuated by the rod with milled head 10. In the wall of cylinder 1 and parallel to the axis is formed the bore 11 constituting a cylinder for the piston valve 12. A vertical duct 13 and a horizontal duct 14 serve to connect any one of the ports 7 with the bottom of cylinder 11 when said ports are brought into coincidence with the vertical duct 13 by means of the pinion 9.

The admission valve is shown at 15. The gas mixture which is compressed to about 5 kilogrammes per square centimeter, is brought by the conduit 16 into the chamber 17 above which are disposed two cylinders of different diameter 18, 19, the latter cylinder being closed by the cover 20. The rod 21 of valve 15 has mounted thereon two differential pistons 22, 23 slidable respectively in cylinders 18, 19. Piston 22 has a

greater cross-section than the disk of the valve 15, piston 23 has a greater cross-section than piston 22 and is provided with a shank 24 traversing the cover 20 with a fluid-tight guiding fit.

Ignition of the mixture is effected for instance by the break of a primary current passing from the spring 25 to the platinum pointed screw 26 when the rod 24 lifts spring 25 by the closing of the valve 15.

An oblique duct 27 communicates with the top of cylinder 19. The annular space at the bottom of said cylinder may be closed, or connected with the atmosphere by a narrow passage 28 acting as a dash-pot, or it may be fully open. The exhaust valve 29 is provided with the stem 30 which passes through the fluid-tight guide 31; said stem is extended by a piston valve 32 moving within the cylinder 33 and secured to a rod of smaller cross-section 34 slidable in the cylinder cap 35 which is open to the air. The bottom of said piston valve has formed therein an orifice whence proceeds a duct of right-angled form 36 opening into the annular groove 37 of cylinder 33 having opening therein the lower end of port 27 above-mentioned, as well as a duct 38. The duct 39 also opens into cylinder 33 somewhat above the bottom of the latter. The duct 40 communicates with the upper annular portion of cylinder 33 and with the reservoir of air under pressure.

The piston valve 12 has two different cross-sections at 41 and 42 and is provided with two annular grooves 43 and 44. The groove 43 co-operates with duct 39 and duct 45 communicating with the compressed air reservoir 4. The groove 44 has opening therein on one side the duct 38 and on the other the duct 46 opening to the air.

Said device is operated in the following manner:

Having previously determined the volume of the charge of gas mixture, the ring 6 is rotated by means of pinion 9 so as to bring into coincidence with duct 13 the given orifice 7 which the piston 5 will uncover when on the descent at the exact moment when the whole of said charge has been admitted into cylinder 1.

Fig. 2 shews the arrangement at the moment when piston 5 is about to complete the up stroke and has entered into contact with the open valve 29 and is about to close the same. At this moment, admission valve 15 is in the closed position for reasons to be set forth hereunder; the piston valve 12 is at the bottom of the stroke. When the disc of valve 29 comes very near its seat, the lower edge of piston valve 32 will uncover duct 39; the compressed air which enters through passage 45, groove 43 of the valve 12 will suddenly enter the lower part of cylinder 33 and the duct 39 raising the piston valve 32 and thus completing the closing action of valve 29; this compressed air proceeds through duct 36, groove 37 and duct 27, into the space above piston 23, thus opening the valve 15 which is at once caused to bear upon the top of piston 5.

The pressure of the mixture causes the descent of piston 5, Fig. 3 thereby enabling valve 15 to open to its full extent, and also uncovering the port 7 corresponding to the quantity of gas mixture admitted. The compressed mixture is thus introduced below the piston valve 12 by ducts 13 and 14, thereby raising the latter; this movement first closes the communication between duct 39 and the compressed air reservoir and then opens duct 38 to the atmosphere through the groove 44 of valve 12 and the duct 46.

The compressed air which exerted pressure upon the top of piston 23 of admission valve 15 will now be discharged through duct 27, groove 37, ducts 36 and 38, groove 44 and duct 46, and the valve 15 will be closed by the pressure of the gas mixture, which enters through conduit 16 and alone acts upon the bottom of piston 22. When rising, the shank 24 lifts the contact spring 25 and breaks the current, thereby igniting the charge of gas. At the same time, the pressure in the lower part of cylinder 33' will have diminished and become equal to atmospheric pressure; the exhaust valve 29 will, however, remain closed under the effect of the pressure exerted thereupon in the first place by the mixture in the cylinder and subsequently by the gas of the explosion.

When piston 5 under the effect of the explosion is near the bottom of the stroke, Fig. 4, the pressure of the burnt gas will be reduced to such degree that its action upon the valve 29 becomes less than the pressure of the compressed air upon the annular surface at the top of the valve 32, and therefore the valve 29 will open to permit the escape of the burnt gas to the atmosphere. At the same time, and by reason of the pressure of the compressed air upon the differential sections of the groove 44, valve 12 will return to the lower position. When this takes place, the whole device is in the proper position for commencing a new cycle of operations as above set forth.

With said arrangement, it is observed that each operation, at the exact moment when it is completed, controls the immediately following operation. By reason of what may be termed a pneumatic interlocking action, the failure of any one element will not give rise to any accident, but will only cause the stopping of the apparatus.

Figs. 5 and 6 shew arrangements of the valve gear of the air pump.

By reason of the high piston speed resulting from the operation of the motor, it is

found preferable to give ample cross-sections to the air conduits and hence to adopt an arrangement of multiple valves.

The suction valves have a common seat upon the ring 47, Figs. 1, 5 and 6, which is mounted at the top of the compressor cylinder 2 and provided upon the entire circumference with orifices having the trapezoidal shape shown in Figures 5, 6. The radius of the bore 65 in which the said orifices 48 open is larger than the radius of cylinder 2 by somewhat more than the thickness of the clack valves 49 serving to close said orifices. The inner wall 65 of the ring 47 is circular so that it may be produced by machining and may be used as a common seat for the clack valves 49. Plates 50 also having a trapezoidal shape, as shown, are provided after casting so as to eliminate any milling and in order to guide the said valves. The said plates may be considered as fragments of a tube which just enter the ring 47 and do not extend so high as the ports 48 as shown in Fig. 5. The valves 49 oscillate upon their base and are engaged in the rear of a flange 51, whilst the movement of the top of the valves is limited laterally by a slotted ring 52 and at the top by a lower surface of the plate 53.

The passages 48 open at the rear into a circular passage 54 connected with the exterior by the apertures 55 formed around the entire periphery of the pump cylinder 2; said apertures are adapted to be gradually closed by a revolving shutter 56. The cooling water which is brought by the circular passage 57 is supplied through ducts 58 into each of the passages 48.

The discharge valves are mounted on a heavy plate 59 which is held pressed between the flanges of the explosion cylinder and the flanges of the compressor cylinder, said plate being provided around the circumference with the circular apertures 60 which are narrowed at the bottom in order to form seats for the valves. Said valves are preferably constituted by the balls 61 of metal, hard stone or the like which are vertically guided by a cage 62 bored to the diameter of the ball and provided with a cross-piece 63 for limiting the upward movement; all the apertures 60 open into a circular passage 64.

What I claim is:

1. Gas control system particularly applicable to motor compressor apparatus of the internal combustion type with free flying piston and reservoir of compressed air constituting an artificial atmosphere, comprising an admission valve for previously compressed explosive mixture, a rod for said valve, two admission pistons mounted on said rod, the cross section of the upper admission piston being greater than the cross section of the lower admission piston, means whereby the lower face of the lower admission piston is submitted to the pressure of the gas mixture, an exhaust valve for burnt gas, a rod for said valve, an inner exhaust piston on said rod, an exhaust cylinder for said inner exhaust piston, a duct for the communication of said exhaust cylinder with the upper face of the upper admission piston, a duct through said inner exhaust piston, an outer exhaust piston above said inner exhaust piston, a cylinder cap for said outer exhaust piston, a piston slide valve, grooves in said piston slide valve, means for the communication through one of said grooves of above said exhaust cylinder with the compressed air reservoir, means for the communication through another groove of said exhaust cylinder with the atmosphere, a cylinder for said piston slide valve and means for the communication of the bottom of said cylinder with the upper part of the power cylinder.

2. Gas control system particularly applicable to motor compressor apparatus of the internal combustion type with free flying piston and reservoir of compressed air constituting an artificial atmosphere comprising an admission valve for previously compressed explosive mixture, a rod for said valve, two admission pistons mounted on said rod, the cross section of the upper admission piston being greater than the cross section of the lower admission piston, means whereby the lower face of the lower admission piston is submitted to the pressure of the gas mixture, a shank provided on said upper admission piston, an electrically connected spring lying on said shank, a platinum pointed screw opposite said spring, an exhaust valve for burnt gas, a rod for said valve, an inner exhaust piston on said rod, an exhaust cylinder for said inner exhaust piston, a duct for the communication of said cylinder with the upper face of the upper admission piston, a duct through said inner exhaust piston, an outer exhaust piston above said inner exhaust piston, a cylinder cap for said outer exhaust piston, a piston slide valve, grooves in said piston slide valve, means for the communication through one of said grooves of above said exhaust cylinder with the compressed air reservoir, means for the communication through another groove of said exhaust cylinder with the atmosphere, a cylinder for said piston slide valve and means for the communication of the bottom of said cylinder with the upper part of the power cylinder.

3. Gas control system particularly applicable to motor compressor apparatus of the internal combustion type with free flying piston and reservoir of compressed air constituting an artificial atmosphere comprising an admission valve for previously compressed explosive mixture, a rod for said valve, two admission pistons mounted on

said rod, the cross section of the upper admission piston being greater than the cross section of the lower admission piston, means whereby the lower face of the lower admission piston is submitted to the pressure of the gas mixture, an exhaust valve for burnt gas, a rod for said valve, an inner exhaust piston on said rod, an exhaust cylinder for said inner exhaust piston, a duct for the communication of said exhaust cylinder with the upper face of the upper admission piston, a duct through said inner exhaust piston, a cylinder cap for said outer exhaust piston, a piston slide valve, grooves in said piston slide valve, means for the communication through one of said grooves of above said exhaust cylinder with the compressed air reservoir, means for the communication through another groove of said exhaust cylinder with the atmosphere, a cylinder for said piston slide valve, a revoluble ring constituting the upper part of the power cylinder, a plurality of orifices, which are situated at different heights provided in said ring, and means for the communication of the bottom of the cylinder of the piston slide valve with the power cylinder through one of said orifices.

In witness whereof I have hereunto set my hand.

JULES BABIN.