July 18, 1933. R. WITKIEWICZ ET AL 1,918,882

MEANS FOR REGULATING CRANKLESS MOTOR COMPRESSORS

Filed Oct. 11, 1930 2 Sheets-Sheet 1

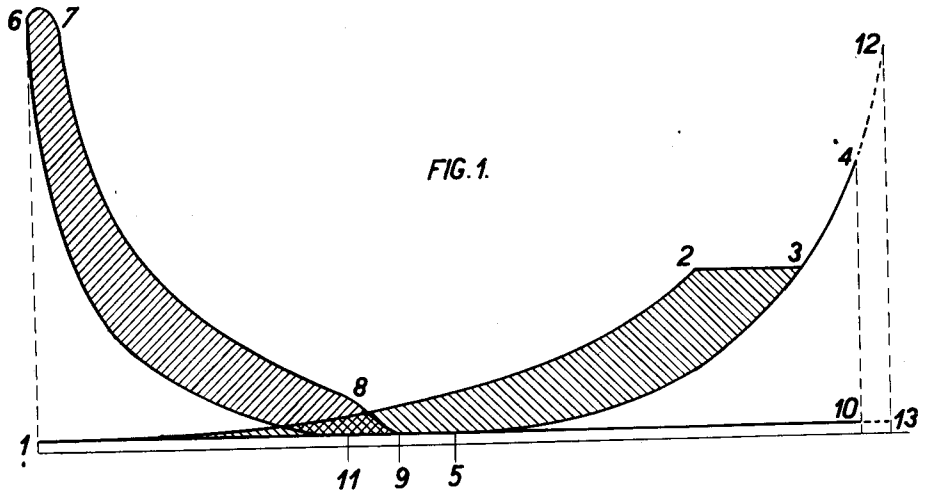


FIG. 1.

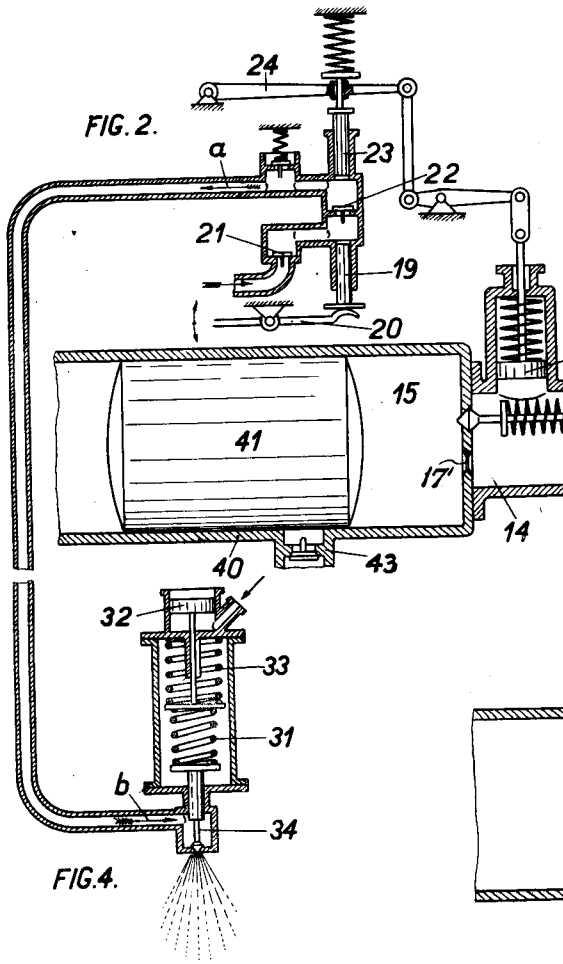


FIG. 2.

FIG. 4.

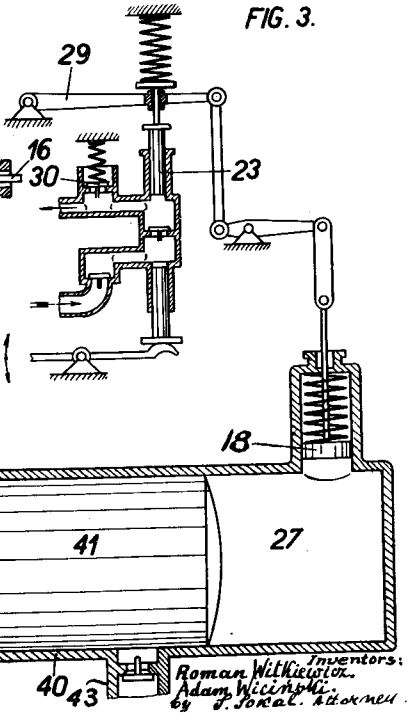


FIG. 3.

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FIG. 5.

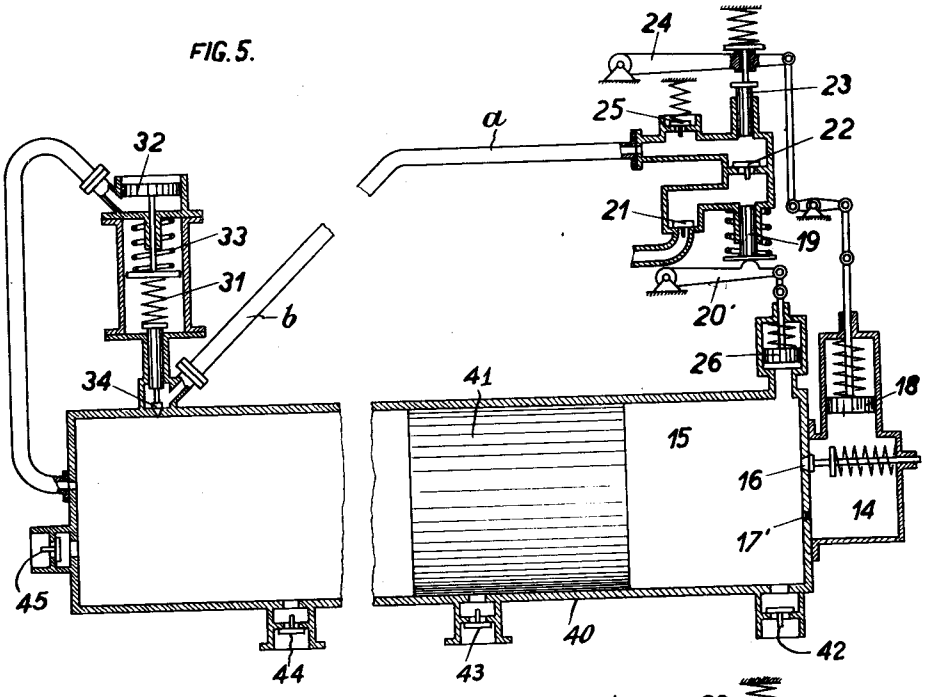
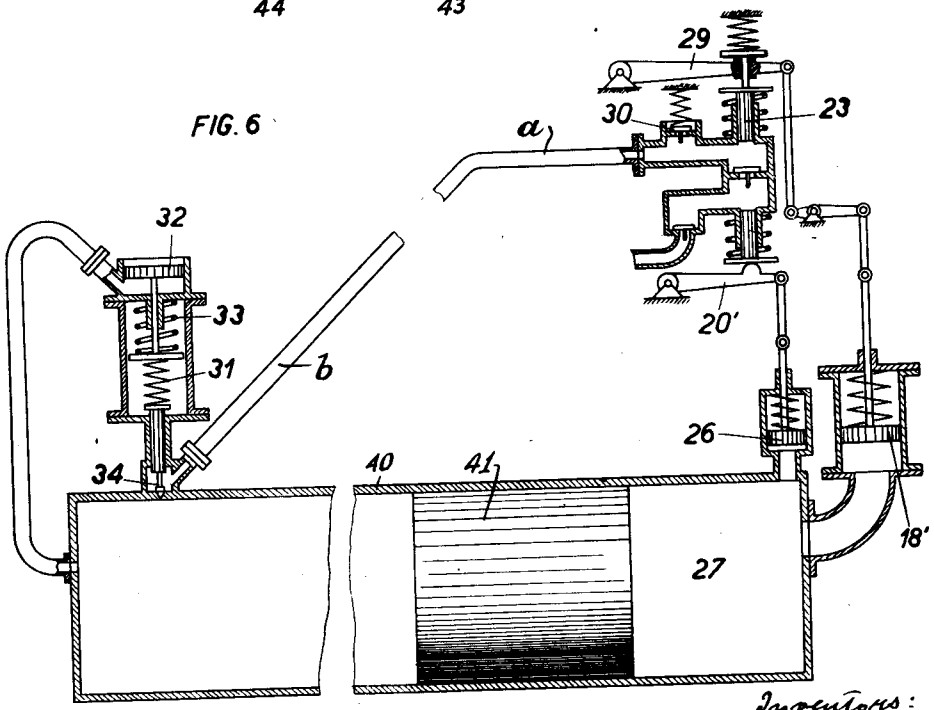


FIG. 6



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Patented July 18, 1933 1,918,882

UNITED STATES PATENT OFFICE

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MEANS FOR REGULATING CRANKLESS MOTOR COMPRESSORS

Application filed October 11, 1930, Serial No. 488,041, and in Poland December 24, 1929.

Application has been filed in Poland December 24, 1929.

The present invention relates to crankless motor-compressors particularly of the type wherein a prime mover such as for instance, an internal combustion engine is directly combined with a machine for compressing gas more particularly air. Such motor-compressors are owing to the fact that they do not employ at all any crank mechanism, much simpler than motor-compressors having a crank mechanism. In motor-compressors employing a crank mechanism, the weight, the safety of operation, the compression pressures within the engine and the piston velocities are limited by the employment of the crank mechanism. Motor-compressors not employing a crank mechanism have hitherto chiefly suffered from the difficulty of providing same with an automatic regulation. One object of the present invention is to provide crankless motor-compressors with an automatic regulation. Hitherto, motor-compressors of the crankless type were provided only with manually operated regulating means, and they were therefore unsuitable in those cases in which continuous regulation and attendance are difficult to provide. It is well known that such motor-compressors are particularly liable in the case of a failure of the regulation to race.

The improved automatic method of and means for regulating crankless motor-compressors answers substantially the requirements of the known methods used in connection with ordinary motor-compressors having a crank mechanism, but is based on the peculiarity of crankless motor-compressors that the degree of the compression pressure in the air or gas cushion of the compressor serves as a measure of the condition of balance between the power produced by the engine and the power consumed by the compressor.

The accompanying drawings illustrate by way of example constructions embodying the features of the invention.

Fig. 1 is a pressure and volume diagram,

Fig. 2 is a sectional elevation showing diagrammatically a portion of a crankless motor-compressor with the means for regulating the fuel supply.

Fig. 3 shows a slightly modified construction of the means for regulating the fuel supply,

Fig. 4 is a sectional elevation of a fuel injection valve which may be used both with the construction shown in Fig. 2 and with the construction shown in Fig. 3.

Fig. 5 shows in longitudinal section an entire crankless motor compressor together with the regulating device for the fuel supply, and

Fig. 6 shows in longitudinal section an entire crankless motor compressor provided with a modified form of regulating device for the fuel supply.

In the diagram shown in Fig. 1 the curve 1—2 illustrates on the compression side of the motor-compressor the increase of the air pressure from the atmospheric pressure to the pressure in the accumulator or other pressure air receiver, the line 2—3 indicates the pressure during the forcing of the compressed air into the accumulator or receiver, the line 3—4 illustrates the further compression of the air remaining in the air cushion of the compressor which is required for providing the energy required for returning the piston after the completion of the stroke. The curve 4—3—5 indicates also upon the compressor side the expansion of the air, whilst line 5—1 corresponds to the period of suction of fresh air. Whilst this cycle occurs in the compressor, there occur simultaneously in the engine: first, combustion and expansion along the curve 6—7—8, then partial exhaust on the line 8—9, then suction of fresh air along the line 9—10, and during the return stroke of the piston: expulsion of the combustion products on the line 10—11, and compression of the combustion products on the line 11—6.

During normal running the power produced by the engine which is indicated by the area 6—7—8—9—11—6, frictional losses being neglected, must be equal to the power consumed by the compressor which is represented by the area 1—2—3—5—1. If the engine output exceeds the power consumed by

the compression, the pressure indicated for instance by the point 4 in Fig. 1 will increase. The end pressure in the air cushion of the compressor as above defined, will accordingly vary with the load and it will fall with the increase of the load, if a static regulation is to be obtained. Fig. 2 and Fig. 5 illustrate an automatic regulation which is responsive to variation of the pressure of the air cushion, and serves for regulating the quantity of fuel to be injected into the engine in accordance with this variation.

Fig. 2 shows only one end of the cylinder 40 upon the compressor side, it being understood that the working space upon the right hand side of the working piston 41 represents the compressor whilst the working space on the left hand side of the piston 41 represents the internal combustion engine. The piston 41 is shown in the position which it assumes after passing the pressure air discharge valve 43. 15 is the space occupied by the air cushion and 14 indicates an additional chamber which communicates with the air cushion space 15, this communication being controlled by an automatic for instance, spring operated valve 16 and by an opening 17′ of small size. By this means the pressure in the space 14 is continually maintained to equal or correspond to the maximum pressure of the air cushion existing in the compressor, that is the pressure in the space 14 will be either the same as the maximum pressure of the air cushion or it will be a function of the maximum pressure. With the space 14 communicates another space in which works a spring loaded piston 18 which represents the member responsive to the maximum air cushion pressure and controlling the device regulating the fuel supply.

On comparing the ordinary regulation of a motor-compressor having a crank mechanism with the above described regulation of a crankless motor-compressor, it will be seen that in the case of an ordinary motor-compressor any change of the sped will be accompanied by a regulating movement of the speed regulator, whilst with the crankless machine, any change of the end or maximum pressure of the compressor air cushion will be accompanied by a corresponding movement of the piston 18, which will hereinafter be referred to as the regulator piston.

The movements of the regulator piston may be utilized in various ways for controlling or measuring the amount of fuel to be supplied to the engine of the motor-compressor. The fuel regulation may for instance, be obtained in a similar manner as in the case of ordinary motor-compressors having a crank mechanism by the employment of a device which varies the suction stroke of the piston of the fuel pump, the arrangement being such that the length of the piston stroke of the fuel pump determines the amount of fuel sucked in and injected. According to another method the movement of the regulator piston may be utilized for controlling or timing the opening of an overflow valve of a liquid fuel pump which is arranged to draw in a surplus of fuel. In a preferred construction according to the present invention, the fuel supply is regulated by controlling the movement and end positions of a device which may be termed a fuel accumulator. One construction of this device is shown in Fig. 2 and Fig. 5 and comprises a fuel pump having a working piston 19 diagrammatically shown as operated by an oscillating lever 20 as shown in Fig. 2; or lever 20′, as shown in Fig. 5. The oscillating movement of the lever 20′ may, for instance, be produced as shown by means of a spring-loaded piston 26 on which the air pressure in the space 15 operates directly. 21 represents the suction valve of the fuel pump. 22 is the pressure valve. 25 is a spring operated overflow valve in the discharge passage *a*, the latter passage leading to the bottom portion *b* of a fuel injecting apparatus, for instance, of the kind shown in Figs. 4, 5 and 6. 23 indicates an accumulator piston interposed between the valves 22 and 25. This accumulator piston is spring loaded and is limited in its upward movement by a lever 24 acting upon the end of the piston 23. The lever 24 is connected by a suitable linkage with the piston rod of the piston 18 so that the position of the piston 18 will determine the end position of the accumulator piston 23.

During the pressure period of the fuel pump, the fuel injection valve of the engine is closed so that the accumulator piston 23 must rise under the action of the fuel forced in through the valve 22, until its upward movement is stopped by the lever 24, the position of the lever 24 being determined by the position of the regulator piston 18. When the accumulator piston 23 reaches the limit of its upward movement, further fuel forced in by the piston 19 will escape through the automatic overflow valve 25. The upper end position of the accumulator piston 23 therefore determines the amount of fuel which is forced into and remains in the space behind the valve 22, and is later on, injected into the engine.

In the construction shown in Fig. 3 and Fig. 6, the amount of fuel injected is again determined by the end pressure of the air cushion of the compressor. The space containing the air cushion is here indicated by the numeral 27. 18 is the regulator piston, which however, in this construction, works in a space directly communicating with the space 27. The piston 18 is connected by a suitable linkage with the lever 29 which again determines the position of an accumulator piston 23 of the fuel pump, the latter is constructed in a similar manner as the previously described construction, the overflow valve

being indicated by the numeral 30. It will be understood that in this construction the stroke of the piston 18 will vary in accordance with the end pressure of the air cushion, and that the larger the stroke of the piston 18 the smaller will be the amount of fuel injected into the engine. The operation of this construction is therefore similar to that shown in Fig. 2. As is shown in Fig. 6, the lever 20′ is actuated by the spring-loaded piston 26 in similar manner to that illustrated in Fig. 5. After the forcing of the fuel by the fuel pump into the accumulator 23 has been completed, the lever 29 actuated by the regulator piston 18 acts upon the accumulator, surplus of fuel being removed through the automatic overflow valve 30. During this period the fuel injection valve is closed. It may be pointed out that the stroke of the piston of a motor-compressor having no crank mechanism is somewhat variable in accordance with the variation of the load. This variation of the stroke of the piston is indicated in Fig. 1 by the points 10 and 13 and the corresponding pressure curve 4—12.

The automatic regulation of the fuel supply by means of a fuel pump having a controlled accumulator, necessitates the employment of a suitable fuel injection valve, one construction of such a valve being shown by way of example in Figs. 4, 5 and 6. 34 indicates the fuel needle valve which is controlled by a spring 31. The spring 31 is acted upon by an auxiliary piston 32 which is loaded by a spring 33. The springs are so chosen that the pressure of the fuel produced by the spring loaded accumulator piston is by itself not sufficient to lift the valve 34 from its seat. The valve 34 therefore remains closed whilst the accumulator is being charged with fuel. The valve 34 is opened only by the admission of additional pressure acting upon the under side of the piston 32 at the required time, this additional pressure lifting the piston 32 and relieving the spring 31 to such an extent as to enable the fuel pressure to lift the valve 34, whereupon injection of the fuel occurs. The pressure acting upon the piston 32 may be derived from the compression side of the engine.

In Fig. 5 the reference numerals 42 and 43 respectively denote the admission and discharge valves of the compressor and the reference numerals 45 and 44 respectively denote those of the internal combustion engine.

We claim—

1. Apparatus for controlling the fuel supply of crankless motor-compressors comprising in combination: means for injecting a predetermined quantity of fuel into the engine, an accumulator piston having a variable stroke; and means for controlling said fuel injecting means, by controlling the length of the stroke of the fuel accumulator piston, said controlling means being operated by a piston actuated by the pressure of the air cushion of the motor-compressor.

2. Apparatus for controlling the fuel supply of crankless motor-compressors comprising in combination: means for injecting a predetermined but variable quantity of fuel into the engine, said means comprising a fuel pump, an overflow valve for discharging surplus of fuel; an accumulator piston having a variable stroke; a fuel injection valve actuated by pressure produced by the accumulator piston; spring means acting upon the fuel injection valve in opposition to the pressure produced by the accumulator piston; and fluid pressure means operated by the compression pressure of the engine to relieve the pressure of the said spring means upon the said fuel injection valve; and means for varying the stroke of the accumulator piston, said means being operated by the pressure of the air cushion, substantially as described.

3. Apparatus for controlling the fuel supply of crankless motor-compressors comprising in combination: means for injecting a predetermined but variable quantity of fuel into the engine; and means for controlling said fuel injecting means, comprising an air cushion chamber; a spring loaded regulator piston operatively connected with the fuel injecting means; and an intermediate chamber interposed between the regulator piston and the air cushion chamber; and means controlling the communication between said intermediate chamber and said air cushion chamber comprising an automatic spring loaded valve and an opening of small size, substantially as described.

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