

May 24, 1927.

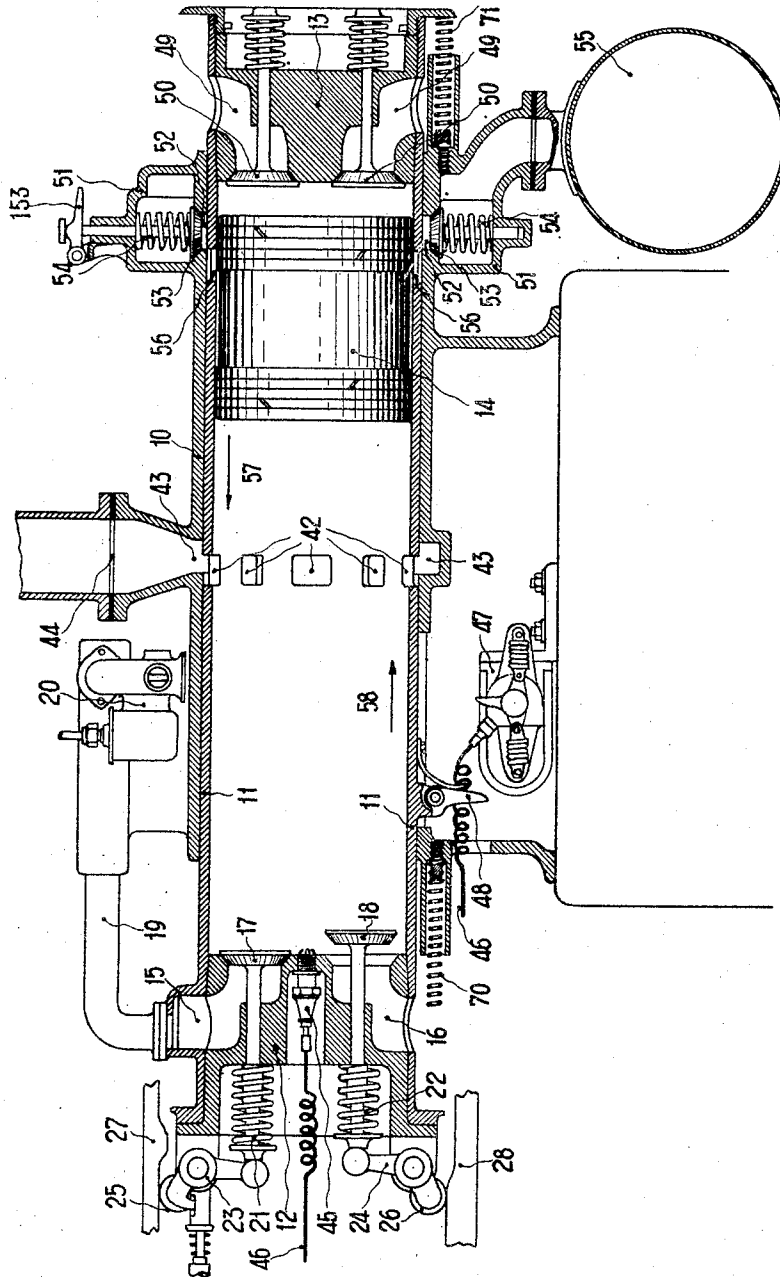
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MOTOR COMPRESSOR APPARATUS

Filed June 5, 1925

3 Sheets-Sheet 1

Fig. 1.



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3 Sheets-Sheet 2

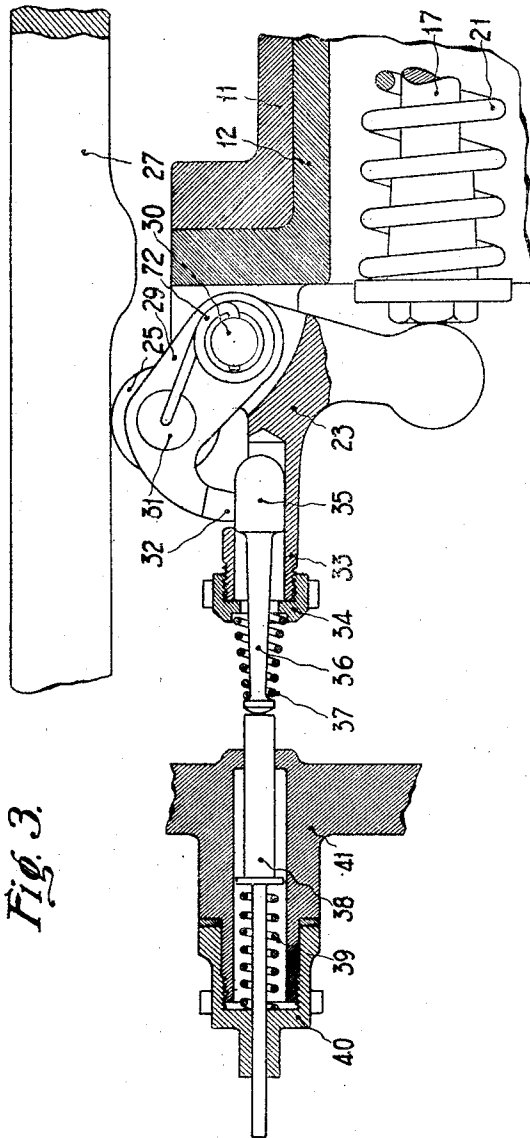


Fig. 3.

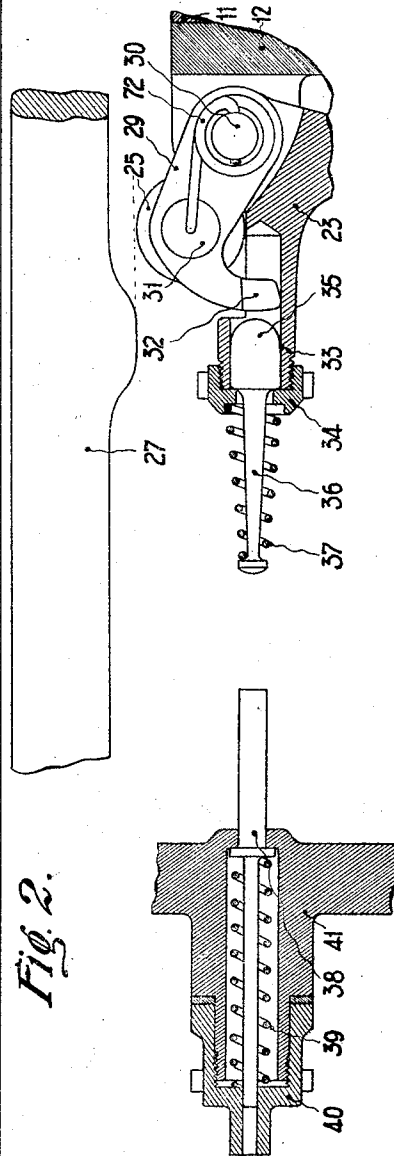


Fig. 2.

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Fig. 4.

3 Sheets-Sheet 3

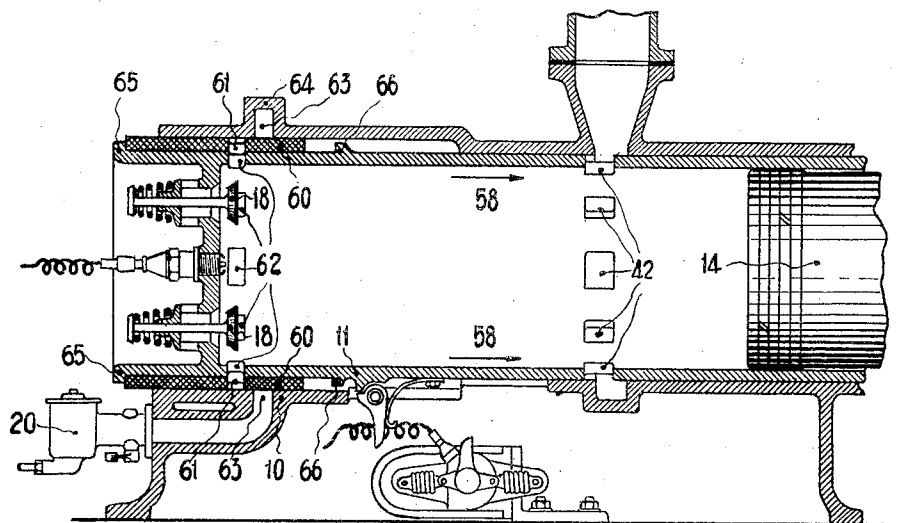
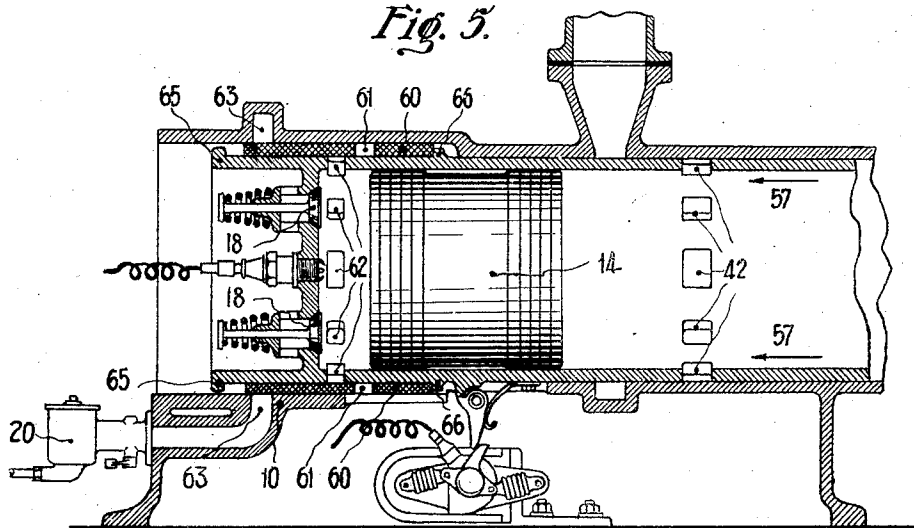


Fig. 5.



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UNITED STATES PATENT OFFICE.

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MOTOR-COMPRESSOR APPARATUS.

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This invention relates to machines which are at the same time producers and transformers of energy, without mechanical connection with the outside, such for example as compressor-motor units.

It has as its principal object the nullifying of the harmful effect of vibration due to the inertia of the mass of the oscillating piston.

The invention consists essentially in so mounting in a frame the cylinder of machines of the kind mentioned as to leave said cylinder free to oscillate in the direction of its axis. The cylinder thus acquires an oscillatory movement isochronous with that of the piston whose amplitude has a constant relation with the corresponding stroke of the piston.

The mutual damping of the two oscillatory movements at each end of a stroke is accomplished by means of elastic bodies such as gaseous masses compressed and interposed between the piston and the cylinder ends.

The invention further consists in utilizing the oscillatory movement of the cylinder to ensure, wholly or in part, the general distribution operations of the machine. Among such operations we will quote, by way of example, the opening and closing of the orifices for admitting fresh gas, the opening and closing of the orifices for the exhaust of burnt gas, the ignition of the charge, these functions being fulfilled either directly by the movement of the cylinder, provided with suitable ports and sleeves, or indirectly by the action of cams acting on suitable valves.

The invention thus generally described includes a large number of applications to which naturally the protection of the present patent should be extended, as also to apparatus of all kinds utilizing its principle, and to their separate parts.

The invention will be well understood by reference to the construction hereinafter described and shown in the annexed drawings, which however, as must be clearly understood, are only given by way of example.

In the accompanying drawings Figure 1 is a longitudinal section of a compressor motor unit constructed in accordance with the invention.

Figures 2 and 3 are sections on a large

scale representing the operation of the device for opening the carburetted air valves of said compressor motor unit.

Figures 4 and 5 are longitudinal sections of a modification in the distribution of carburetted air by means of sleeves.

In accordance with the invention and referring more especially to its constructional forms shown in Figures 1, 2 and 3, supposing it is desired to make a compressor motor unit, this can be done as follows or in some similar way. In a fixed horizontal frame 10, having a smooth cylindrical bore, there is arranged a cylinder 11 having an easy fit within the frame 10. The cylinder 11 is closed at both ends by the cylinder heads 12 and 13 rigidly connected to said cylinder; a gas tight piston 14 is free to oscillate within the cylinder 11.

The face of the piston turned towards the head 12 receives the driving impulse, that facing the head 13 does the work of compression.

To this end, the head 12 carries two conduits 15 and 16 to which correspond respectively the valves 17 and 18. The conduit 15 is connected by the sliding tube 19 with a carburettor 20. The conduit 16 leads to the atmosphere. The valves 17 and 18 are constantly under the action of the closing springs 21, 22 and their opening movement is produced by means of rocking levers 23, 24, contacting by means of rollers 25, 26 with the fixed cams 27, 28.

The rocking levers 23 and 24 differ one from the other. The one numbered 24 which controls the pure air opening 16 is a bent rocking lever of the ordinary type. The construction of the rocking lever 23 will be understood by a reference to Figures 2 and 3.

It will be noticed from these figures that the body of the rocking lever 23 carries, on one side, a pawl 29 which is pivoted to the lever 23 by means of a pin 30 and said pawl carries the roller 25 by means of a pin 31. The pawl 29 has a projecting end 32 which is kept constantly against the cam by the spring 72.

The body of the rocking lever 23 has also a tubular extension 33, closed by a threaded cap 34.

In the cylindrical space thus formed is arranged a small piston 35, having the form

of a projectile, terminated by a rod 36, on the head of which constantly acts a return spring 37.

Finally, on the fixed frame 41 of the apparatus and in line with the axis of the piston 35 is arranged a stop 38, constantly pushed forward by the spring 39. This spring is of such a strength that the pressure it exerts on the stop 38, while bearing against the threaded plug 40 in the fixed frame 41, must always be greater than that exerted on the rod 36 of the piston 35 by the spring 37 whether this latter is compressed or released.

From the point of view of the motor device it should further be remarked that the cylinder 11 carries at 42 openings for the exhaust of the burnt gas and which can correspond with openings 43 arranged in the frame 10. The openings 43 all lead into a circular channel which leads to the exhaust orifice 44.

Finally, the ignition of the charge is effected by means of a spark plug 45 arranged at the bottom of the cylinder head 12 and connected by the wire 46 with a brake magneto 47. The magneto 47 is rigidly attached to the frame of the apparatus and is actuated by means of a pawl 48 fixed to the cylinder 11 and moving with it.

On the compressor side of the apparatus, the cylinder head 13 is provided with conduits 49 communicating at one end with the atmosphere and at the other with the interior of the cylinder. The automatic suction valves 50 thus allow the intake of air into the cylinder 11 when a vacuum is there produced by the movement of the piston 14.

The frame 10 carries laterally a circular recess 51 pierced with various openings 52, controlled by the automatic discharge valves 53 which are held in closed position by the springs 54. The recess 51 is in communication with a pressure reservoir 55.

The cylinder 11 further carries a series of ports 56 which are capable of registering with the openings 52.

In order to keep the cylinder 11 in a mean position of oscillation with relation to the fixed parts of Figure 1, two sets of springs 70 and 71 have been provided, which bear against the fixed frame 10 of the apparatus. If, by chance, the cylinder 11 should happen to make an abnormal oscillation or even if its mean position tended to become displaced in one direction or the other, it would be returned elastically to the mean position by means of the action of one of the sets of springs 70 or 71. In Figure 1 only one spring 70 and only one spring 71 are shown; each set of springs comprises three springs but the other two springs are not visible in the section on said Figure 1.

The apparatus operates in the following way.

The reservoir 55 being filled with compressed air the piston 14 is brought so that its right-hand face is level with the ports 56, for example, by inserting a rod through the spark plug opening in the cylinder head. The cylinder 11 is positioned in such a way that its ports 56 correspond with the openings 53 in the frame 10. The spark plug 45 is replaced in position after gasoline has been injected into the cylinder 11. One of the valves 53 may be opened temporarily by means of the lever 153 so that compressed air from the reservoir 55 passes through the openings 52 and the ports 56 and acts on the compressor face of the piston.

This latter is thus forcibly pushed towards the cylinder head 12, in the direction of the arrow 57; after having passed the exhaust openings 42, it compresses in front of itself the air now highly carburetted with gasoline. The cylinder has also received the impulse of the compressed air and has started to move in the direction of the arrow 58. When the piston 14 arrives at the end of its stroke, the pawl 48 acts on the magneto 47. A spark is produced at the spark plug 45 and the explosion of the charge takes place.

From now on the apparatus is in normal working conditions and to explain its working more clearly we will examine what happens successively on the motor side and on the compressor side.

Forward stroke—Driving side.

The cylinder 11 is impelled in the direction of the arrow 57 and the piston 14 in the direction of the arrow 58.

The cylinder 11 carries with it, in its movement, the rollers 25 and 26 over the cams 27 and 28. Cam 27 does not act on its valve 17 because the piston 35 is in the position shown in Figure 2, and in consequence, the pawl 29 swings idly on the body of the rocking lever 23. However, the rod 36 of the piston 35 comes into contact with the stop 38 when the roller 25 is opposite to the raised portion of the cam. The spring 39 being stronger than the spring 37, it tends therefore to cause the piston 35 to pass under the projection 32 of the pawl 29. This will take place as soon as the roller 25 having passed over the raised portion of the cam, comes opposite the flat portion of the same, as shown in Figure 2. The stop 38 accompanies henceforward the rod 36 in its movement and constantly keeps the piston 35 under the projection 32.

Cam 28 causes the opening of the valve 18 as soon as the piston 14 has reached and just passed on its face opposite the cylinder head 12 the exhaust ports 42. At this mo-

ment, moreover, these ports 42 have come, owing to the movement of the cylinder 11, into registry with the openings 43.

Exhaust then takes place by the orifice 44. To this orifice is adapted a tube several meters long, in which the exhaust gases expand and acquire a great velocity. Their inertia thus creates, in the cylinder 11, a considerable degree of vacuum which sucks in, through the conduit 16, a large quantity of fresh air which scavenges the interior of the cylinder and expels the burnt gases. The exhaust openings 42 are calculated so as to remain open during the whole of the movement of the piston 14 backwards and forwards, between the ports 42 and the end of its stroke towards the head 13. Cam 28 causes the rising of the valve 18 during the above-named movements of the piston, with, however, a slight lag over the opening of the orifices 42.

Compressor side.

On the compressor side, the piston 14 and the head 13 of the cylinder 11 move towards each other, and produce at first a compression of the air contained in the cylinder space between the piston 14 and the cylinder head 13. This air, being unable to escape through the orifices 42 which are not in communication with the atmosphere except after the passage of the piston 14, is immediately driven into the reservoir 55 through the ports 56 and the openings 52, as soon as the pressure becomes sufficient to raise the weighted valves 53. Almost on arriving at the end of the stroke, the piston and cylinder damp their mutual movement on a gaseous mass which remains imprisoned between them and stores up enough energy to ensure the return of the piston 14 to the other end of its stroke.

Return stroke—Motor side.

The piston 14 and cylinder 11 are thus returned respectively in the direction of the arrows 57 and 58 by the gas buffer. The piston 14 first drives before it the burnt gases which have followed it beyond the exhaust ports 42. But as beyond said ports these gases meet with a strong current of fresh air coming towards them, they are unable to pass into the part of the cylinder comprised between the ports 42 and the cylinder head 12. They are driven out through the ports 42 which are still open as already explained above.

Shortly before the moment when the piston reaches the ports 42, the valve 18 closes, as has already been said above. At this moment the roller 25 engages with the slope of the cam 27, the piston 35 being still held in the position shown in Figure 3 by the stop 38. The valve 17 lifts and as there is still a certain amount of vacuum in the

motor side of the apparatus kept up by the inertia of the gases in the exhaust tube, a certain quantity of very highly carburetted air passes into the cylinder 11 through the carburetter 20, the sliding tube 19 and the conduits 15. The carburetter 20 is so regulated as to give a much richer charge than is customary, for the reasons about to be explained.

This air, very rich in combustible, mixes with the pure scavenging air coming from the conduits 16. During this period the piston 14 passes beyond the ports 42 which no longer communicate with the atmosphere owing to the movement of the cylinder 11 in an opposite direction. The valve 17 drops at once on to its seat and the piston 35, acted upon by the spring 37, no longer controlled by the stop 38, resumes its position shown in Figure 2.

The piston 14 and the cylinder 11 continue their movement compressing the carburetted air enclosed between them until the moment when the pawl 48 actuates the magneto 47 and a fresh explosion of the charge is produced.

Compressor side.

The air-buffer enclosed between the piston 14 and the cylinder 11, on the side of the cylinder head 13, expands at once. The movement of these two parts next produces a slight vacuum which causes the automatic valves 50 to lift.

Through the conduits 49, the cylinder 11 then fills with air, until the cessation of the movement at the instant of the explosion. It is interesting to note that the arrangement of the valves 50 in the cylinder head 13 offers certain advantages. Thus their opening takes place when the buffer of air has reached its full expansion, that is to say, when no acceleration is acting on the different oscillating bodies. Their closing, on the other hand, coincides with the comparatively sudden stoppage of the cylinder 11 and its sudden departure in an opposite direction due to the effect of the explosion. It is easy to see that the sudden acceleration caused by the movement of the cylinder 11 results in forcibly seating the intake valves 50 and in bringing about an extremely rapid closing of the conduits 49.

The movements of the piston 14 and the cylinder 11 continue in this way indefinitely.

The modification in the distributing device shown in Figures 4 and 5 relates to a device applicable to any of the distributing openings which have to be uncovered during a part or whole of the stroke of the piston 14, but which have to remain closed during the stroke in the opposite direction of said piston. According to the invention the distributing device is actuated by the movements of the cylinder. In order to simplify the explanation of this device, it will be sup-

posed that it is applied to a motor compressor unit of the kind which has just been described and that said device controls the ports for the admission of highly carburetted air.

The general principles and description of the apparatus, as also its working operation will not be given again except as regards such parts as are modified.

Besides the device for admitting richly carburetted air, the arrangement of the scavenging valves 18 has also been modified in that they have been made automatic, the scavenging being still effected by the suction of air created by the exhaust. The frame 10 has been made to conform to the new device and the carburetter 20 differently located.

Between the cylinder 11 and the frame 10 is arranged a sleeve 60, having an easy sliding fit, on the one hand, over the cylinder 11, and on the other hand in the frame 10. The sleeve 60 carries ports 61 capable of registering on the one hand, with the ports 62 arranged in the cylinder 11, and, on the other hand, with the orifices 63 in the wall of the frame 10, which communicate by means of a circular recess 64 with the carburetter 20. Finally the cylinder 11 is provided externally with two annular stops 65 and 66 adapted to limit the relative movements of the sleeve 60 with respect to the cylinder 11.

The whole apparatus operates in the following way: the cylinder begins its movement in the direction of the arrows 58 (Figure 4) and the sleeve 60 is thus held, owing to its inertia, against the lug 65 and is carried along with the cylinder 11. At this instant the ports 61 and 62 coincide.

The position of these ports is calculated with regard to the openings 63 in such a way that when the piston 14 is near the exhaust openings 42, the three openings 61, 62, 63 coincide. Richly carburetted air is then taken in. The movement of the cylinder 11 continuing, the ports 61 and 63 cease to be in communication and the cylinder space is closed.

At the end of the movement of the piston and cylinder, the sleeve 60, sliding on the cylinder, is again pressed by inertia against the stop 66 and occupies the position shown in Figure 5 so that the openings 61 and 62 cease in turn to coincide.

When the cylinder 11 returns, after the explosion, in the direction of the arrows 57 (Figure 5), the sleeve 60 is at first pressed against the stop 66, so that the passage of the ports 61 and 62 over the orifice 63 is not simultaneous and no communication can take place during this stroke between the interior of the cylinder 11 and the carburetter 20.

Towards the end of the stroke the movement of the cylinder is again restrained and

at the dead point the sleeve 60 slides by inertia from the stop 66 to the stop 65, towards the position shown in Figure 4.

The same operations are repeated indefinitely ensuring the intake of carburetted air during one stroke of the cylinder and piston, and preventing any communication with the carburetter during the return in the opposite direction of these members.

I claim:

1. An apparatus comprising a frame, a closed cylinder, a mechanically free piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame in the direction of its axis and means cooperating with the piston and cylinder to cause them to simultaneously reciprocate in opposite directions relative to one another.

2. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, there being ports in said cylinder, and a distributing device for the ports of the said cylinder, said device comprising means for controlling said ports, actuated by said cylinder.

3. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, there being orifices in the apparatus, and a distributing device for the orifices of the apparatus, said device comprising a rocking lever pivoted to the cylinder and a fixed cam actuating said lever when said cylinder moves.

4. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, there being ports in said cylinder, and a distributing device for the ports of said cylinder, said device comprising means for controlling said ports, actuated by said cylinder, and means for locking said controlling means during one stroke of the cylinder and unlocking them during the return stroke.

5. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, there being ports in said cylinder, and a distributing device for the ports of said cylinder, said device comprising a rocking lever pivoted to the cylinder, a pawl pivoted on the lever, a fixed cam cooperating with said pawl, a locking member for locking said pawl to said lever, a fixed elastic stop holding said locking member in engagement with the pawl before and after the change of directions of travel of the cylinder, and a return spring for said locking member.

6. In an apparatus comprising a frame, a cylinder closed at its ends, a piston re-

reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, valved openings in the cylinder, the valves being controlled by the movements of the cylinder, and means for returning the piston during the non-driving stroke, which means comprises a mass of compressed gas interposed at the end of the stroke, between the head of the cylinder and piston and which damps the relative movements of these members and returns them in the opposite direction with sufficient energy to effect all the operations of the following stroke.

7. An apparatus comprising a frame, a closed cylinder mechanically free to reciprocate in the frame, a mechanically free piston reciprocating in the cylinder, means for producing motive energy within the cylinder at one side of the piston to cause reciprocations of the piston and cylinder in opposite directions whereby the piston and cylinder cooperate to compress a gas within the cylinder at the other side of the piston.

8. An apparatus comprising a frame, a closed cylinder mechanically free to reciprocate in the frame, a mechanically free piston reciprocating in the cylinder, means for producing motive energy within the cylinder at one side of the piston to cause reciprocations of the piston and cylinder in opposite directions, and means controlled by the movements of the piston and cylinder to admit, compress, and discharge a gas at the other side of the piston.

9. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, and automatic valves in said cylinder, said valves being so arranged as to rapidly close, owing to their inertia, at the reversal of the travel of the cylinder.

10. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, a device for igniting the carburetted gases, said device consisting in a stroke magneto fixed to the frame, and a pawl fixed to the cylinder and actuating said magneto.

11. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being free mechanically to reciprocate with respect to said frame, and elastic stops between said frame and the ends of the cylinder for limiting the range of the reciprocations of the cylinder.

12. In a motor compressor unit comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, means for producing energy on one side of said piston, means for admitting,

compressing and discharging air on the other side, and including a compressed air delivery valve, and means for manually opening said valve to inject air from a compressed air reservoir into said cylinder in order to start the motor.

13. A motor-compressor unit comprising a frame, a cylinder, a piston reciprocating in said cylinder, means for producing and applying energy on one side of said piston, means for admitting, compressing and discharging air on the other side, including a compressed air delivery valve, a reservoir for compressed air with which this valve communicates, and means for manually opening said valve to inject compressed air from the reservoir into the cylinder in order to start the motor.

14. In an apparatus comprising a frame, a cylinder, a mechanically free piston reciprocating in said cylinder, said cylinder being free mechanically to reciprocate with respect to the frame, and resilient means between the frame and the ends of the cylinder for yieldingly limiting the range of the reciprocations of the cylinder.

15. In an apparatus comprising a frame, a cylinder, a piston reciprocating in said cylinder, said cylinder being free mechanically to reciprocate with respect to the frame, means for injecting carburetted gases in one end portion of the cylinder, and means actuated by the movements of the cylinder for igniting the gases.

16. An apparatus comprising a frame, a closed cylinder, and a mechanically free piston reciprocating in said cylinder, said cylinder being mounted to reciprocate in the frame simultaneously with the piston but in the opposite direction.

17. An apparatus of the class described, comprising a frame, a cylinder mounted for reciprocation in the frame, there being a port in the cylinder, a valve for closing the port, and means for opening the valve comprising a rocking lever pivoted on the cylinder, a fixed cam on the frame, a pawl pivoted on the lever, spring means for yieldingly holding the pawl in engagement with the cam, a locking member on the lever movable into and out of engagement with the pawl to lock same against movement independent of the lever, a spring for normally moving the locking member out of engagement with the pawl, and means mounted on the frame for moving the locking member to locking position.

18. An apparatus comprising a frame, a closed cylinder, a piston reciprocating in the cylinder, said cylinder being also mounted to reciprocate in the frame, an air inlet valve and a gas inlet valve in one end portion of the cylinder, fixed cams mounted on the frame, and means mounted on the cylinder for engaging the cams to open the valves

at predetermined times in the reciprocations of the cylinder.

19. An apparatus comprising a frame; a closed cylinder; a piston reciprocating in the cylinder, said cylinder being also mounted to reciprocate in the frame, an air inlet valve and a gas inlet valve in one end portion of the cylinder, and valve opening means partially carried by the frame and partially carried by the cylinder adapted to open the air valve during one longitudinal movement of the cylinder and close it during the following return movement, and adapted to momentarily open the gas valve during the return movement of the cylinder, the gas valve remaining closed during the first mentioned cylinder movement.

20. An apparatus comprising a frame; a closed cylinder; a piston reciprocating in the cylinder; said cylinder being also mounted to reciprocate in the frame, an air inlet valve and a gas inlet valve in one end portion of the cylinder, a carburetter mounted on the frame, and extensible pipe connections between the carburetter and the gas inlet valve, whereby part of these connections can reciprocate with the cylinder.

21. In an apparatus comprising a frame, a cylinder closed at both ends, a mechani-

cally free piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, means for producing motive energy within said cylinder on one side of the piston, and ports in said cylinder adapted to be opened or closed by the movement of said cylinder.

22. In an apparatus comprising a frame, a cylinder closed at both ends, a mechanically free piston reciprocating in said cylinder; said cylinder being mechanically free to reciprocate with respect to said frame, means for producing motive energy within said cylinder on one side of the piston, means for admitting, compressing and discharging a gas on the other side of the piston, within said cylinder, and ports in said cylinder adapted to be opened or closed by the movement of said cylinder.

23. In an apparatus comprising a frame; a cylinder, a piston reciprocating in said cylinder, said cylinder being mechanically free to reciprocate with respect to said frame, a port in said cylinder, a tube connected to said port, and a chamber carried by said frame, said tube having a sliding air-tight fit in said chamber and communicating therewith.

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