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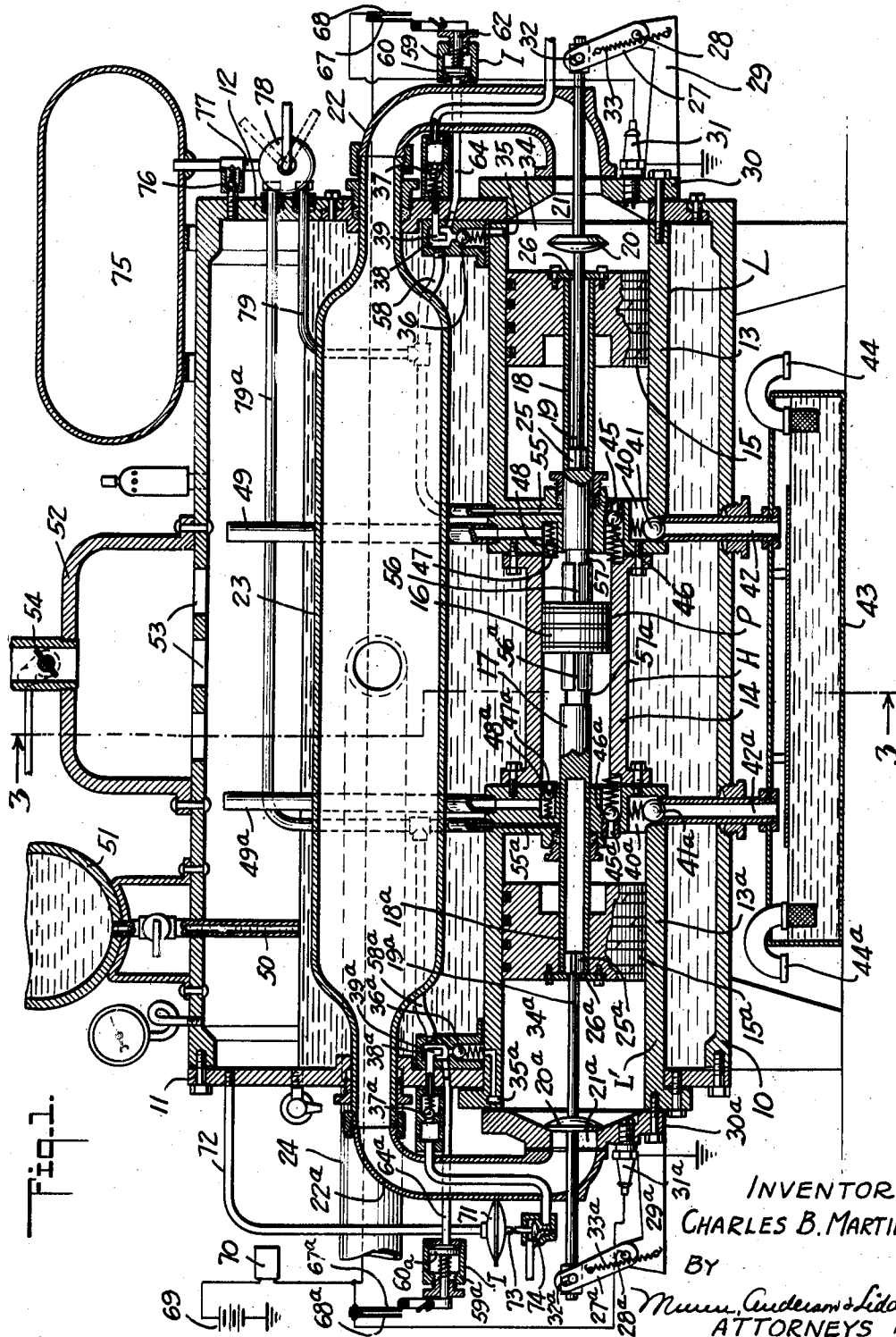
C. B. MARTIN

2,077,802

MOTOR COMPRESSOR

Filed Nov. 2, 1936

2 Sheets-Sheet 1



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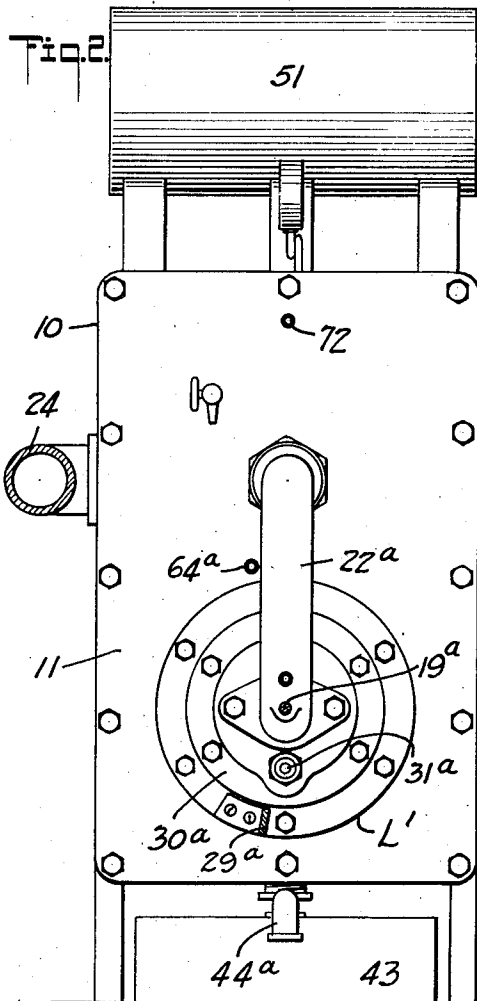
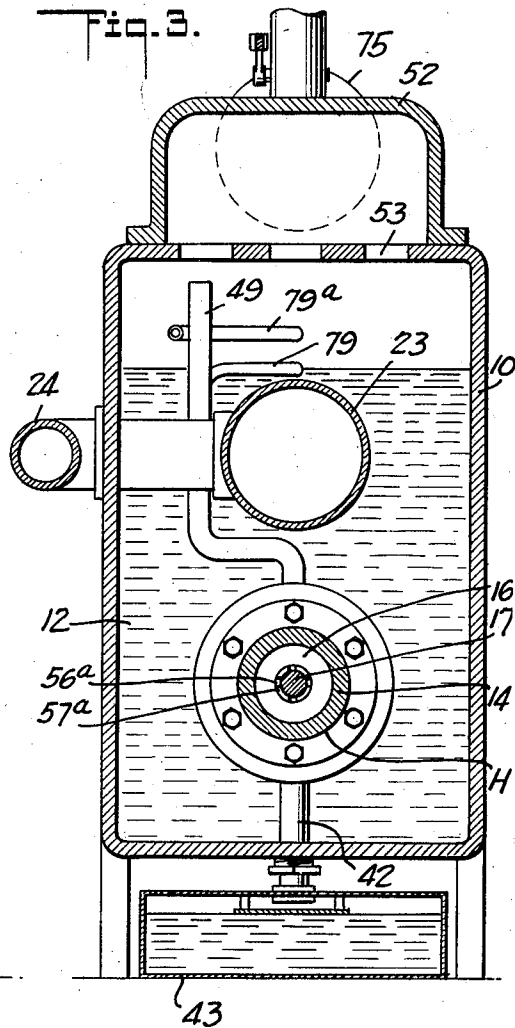
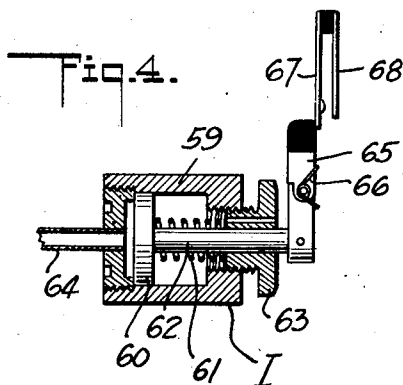
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2 Sheets-Sheet 2



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2,077,802

MOTOR COMPRESSOR

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Application November 2, 1936, Serial No. 108,778

15 Claims. (Cl. 230—56)

This invention relates generally to prime movers, and more particularly to mechanisms for generating and/or compressing and storing fluids such as steam and air for use in operating various devices such as turbines.

An object of the invention is to provide a motor-compressor which is characterized by a unitary structure embodying an internal combustion motor and a multi-stage compressor operatively associated to obtain maximum efficiency by rectilinear motion of its piston unit eliminating the relatively inefficient power transferring function of such mechanisms embodying a crank motion.

A further object of the invention is to provide a unitary motor-compressor wherein the heat of exhaust gases from the operation of the motor is utilized to convert water into steam for mixing with the compressed air delivered by the compressor, whereby to produce a pressure fluid highly desirable for use as a source of power in operating a turbine or other machine.

Another object of the invention is to provide a unitary motor-compressor wherein heat from the cylinder walls resulting from combustion of fuel and compressing of air, is utilized in the manner of the exhaust gases to heat water in a receiver which encloses the motor compressor, and from which the pressure fluid as delivered thereto by the compressor, can be dispensed in a mixture with the steam generated in the receiver.

A still further object of the invention is to provide a motor-compressor structure embodying means for automatically stopping operation of the motor, should the internal pressure in the receiver reach a predetermined maximum for safe operation; which provides for the supply of filtered air to the compressor to eliminate any foreign substances from the air which might damage working parts of the compressor; and which provides for the automatic storage of air under pressure in a manner to enable such air to be utilized to initiate operation of the mechanism.

With these and other objects in view, the invention consists in the combinations and arrangements of elements as set forth in the following specification and particularly pointed out in the appended claims.

In the accompanying drawings,

Figure 1 is a semi-diagrammatic view showing in vertical central longitudinal section the motor-compressor embodying this invention;

Figure 2 is a view of the motor-compressor in end elevation and with certain parts broken away;

Figure 3 is a vertical transverse sectional view taken on the line 3—3 of Figure 1;

Figure 4 is an enlarged detail sectional view of a circuit interrupter embodied in the invention.

Referring specifically to the drawings, the invention comprises a receiver 10 of generally rectangular outline from the end walls 11 and 12 of which is supported a rigid assembly composed of two identical low pressure units L and L' and a single high pressure unit H interposed between the low pressure units. The cylinders 13 and 13a of the units L and L' are reversely arranged end for end and are co-axially related to each other and to the cylinder 14 of the high pressure unit H. Working in the cylinders 13, 13a and 14, is a piston unit P composed of low pressure pistons 15—15a working in the respective cylinders 13 and 13a, and a high pressure piston 16 working in the cylinder 14. The pistons 15, 15a and 16 are rigidly connected by a piston rod 17 having tubular end portions 18 and 18a freely receiving the stems 19 and 19a of exhaust valves 20 and 20a controlling exhaust ports 21 and 21a communicating by pipes 22 and 22a with the opposite ends of an exhaust manifold 23 submerged in a body of water in the receiver 10, and opening to the atmosphere by means of an exhaust pipe 24.

The inner ends of the stems 19 and 19a are provided with angularly shaped heads 25 and 25a, respectively, freely slidable in the bores of the respective portions 18 and 18a to co-act with the inner ends of such bores and with abutment plates 26 and 26a fixed, respectively, to the pistons 15 and 15a to provide lost motion operative connections between the piston unit and the valves 20 and 20a. For operating the valves in conjunction with the lost motion operative connection, as thus provided, arms 27 and 27a are pivoted, respectively, at 28 and 28a on the brackets 29 and 29a secured to the cylinder heads 30 and 30a in which spark plugs 31 and 31a are supported. The outer ends of the arms have pin-and-slot connections 32 and 32a with the outer ends of the respective stems 19 and 19a, and are urged by springs 33 and 33a, respectively, to one extreme position or another to releasably retain the respective valve open or closed in accordance with the movement imparted thereto incident to movement of the piston unit P, all to be more fully described in the operation of the invention.

Fuel is adapted to be supplied from a suitable source of supply, under gravity flow or light pressure, to the combustion chambers 34 and 34a of the respective cylinders 13 and 13a through ports 35 and 35a in the cylinders controlled by pairs of inwardly opening check valves 36—37 and 36a—37a between which are atomizing chambers 55

38—38a into which project fuel nozzles 39—39a.

The low pressure cylinders 13 and 13a are, respectively, provided at their inner ends with air intake ports 40 and 40a controlled by check valves 41 and 41a seating against the inner ends of pipes 42 and 42a, respectively, communicating with a filter tank 43 containing a body of water to which the air is admitted for washing, through inlets 44 and 44a in the form of inverted U-shaped and screened pipes. The low pressure cylinders are also provided, respectively, with air discharge ports 45 and 45a controlled by check valves 46 and 46a past which air compressed in the low pressure cylinders is forced into the respective ends of the high pressure cylinder 14.

The high pressure cylinder is provided at its ends with air discharge ports 47 and 47a controlled by check valves 48 and 48a, respectively, past which the air as recompressed in the high pressure cylinder is discharged into pipes 49 and 49a, respectively, opening at their upper ends into the reservoir 10 above the maximum level of water therein as determined by the extent to which a delivery pipe 50 leading from a water supply tank 51 projects downwardly into the reservoir.

Compressed air in the reservoir is adapted to enter a dome 52 thereon, through openings 53, and to be dispensed from the dome under the control of a throttle valve 54, for use in the operation of a turbine or other fluid operated machine.

In their inner end walls, the low pressure cylinders 13 and 13a are, respectively, provided with air passages 55 and 55a adapted to be placed in communication with the respective ends of the high pressure cylinder 14 by longitudinal and circumferential grooves 56, 57 and 56a, 57a, formed, respectively, in the piston rod 17 at opposite sides of the high pressure piston 16. This communication is established as the high pressure piston reaches the respective extreme position, so that such piston is free to force air through the respective passage 55 or 55a.

The passages 55 and 55a are, respectively, in communication with the atomizing chambers 38 and 38a through branch pipes 58 and 58a so that high pressure air will co-act with the respective fuel nozzle 39 or 39a to suck fuel from the nozzle for mixing therewith and injection of the explosive mixture into the respective combustion chamber 34 or 34a, as the case may be.

For each low pressure cylinder an interrupter 1 is provided as shown in detail in Figure 4, and as the interrupters are identical in construction a description of one will suffice for both. To distinguish like parts of the interrupters from each other, the numerals designating the parts of one interrupter are provided with exponents.

Each interrupter comprises a cylinder 59 having a piston 60 therein normally urged to one extreme position by a coil spring 61 surrounding the rod 62 of the piston which passes through a cap 63 threaded into one end of the cylinder for adjustment to vary the loading of the spring whereby to vary the resistance of the piston 60 to the pressure of air from the atomizing chamber 38 which is in communication with the cylinder 59 by a pipe 64.

The outer end of the rod 62 carries a pivoted arm 65 of insulating material normally urged to one extreme position by a spring 66 wherein the outer end of the arm is so disposed that when the piston is moved from its urged position by air forced into the atomizing chamber from the high pressure cylinder, the arm will momentarily make

and then break an ignition circuit by wiping past flexible contact members 67 and 68 normally insulated from each other and having their free ends projecting at a right angle into the path of movement of the arm. During return movement of the piston by the spring which occurs when the pressure on the piston is relieved, the arm 65, in striking the contact member 68, will be rocked against the action of its spring 66 so as to reversely pass the contact members without bringing their free ends into engagement. As shown in Figure 1, the contact members of each of the two interrupters are included in the ignition circuit to supply current from a battery 69 through a spark coil 70 to the respective spark plugs 31 and 31a.

A conventional fluid responsive device 71 of the diaphragm or piston type is in communication with the reservoir 10 above the water level therein through a pipe 72 and has its actuating pin 73 disposed to close a fuel valve 74 should the fluid pressure in the reservoir reach a predetermined maximum for safe operation, so as to cut off the supply of fuel to one low pressure cylinder and thereby stop the machine.

An air storage tank 75 is supported on the reservoir and is in communication with the reservoir above the water level therein, through a check valve controlled pipe 76 so as to be supplied with air from the reservoir, to be utilized in starting operation of the machine. From the pipe 76 leads a pipe 77 to a three-way valve 78 by which air from the tank can be supplied to the branch pipe 58 through a pipe 79, or to the branch pipe 58a through a pipe 79a, all to be further described in the operation of the engine which is as follows:

To start the machine air under pressure in the tank 75 is supplied to the combustion chamber of one and then the other of the low pressure cylinders 13 and 13a through the respective pipes 79—58 and 79a—58a past the respective check valves 36—36a. This is accomplished by shifting the air control valve 78 from its neutral position shown in full lines in Figure 1 to one extreme position and then the other as shown in broken lines in this figure, so as to place one and then the other of the pipes 79 and 79a in communication with the storage tank, it being necessary to manipulate the valve 78 in this manner as the air can only function against one or the other of the low pressure pistons 15 and 15a depending on the position occupied thereby from a previous operation of the machine.

With operation of the machine thus initiated, and assuming that the piston unit P is moving towards the right as viewed in Figure 1, the exhaust valve 20 will be moved towards closed position by the co-action of the head 25 on the stem 19 of the valve with the closed end of the tubular portion 18 of the piston rod 17 in which the head is freely slidable. As the exhaust valve 20 approaches its closed position, the spring 33 co-acts with the arm 27 to suddenly snap the valve closed and maintain it in its closed position. Concurrently with closing of the valve 20 the exhaust valve 20a is moved towards its open position by co-action of the head 25a on the stem 19a of the valve 20a with the abutment plate 26a on the low pressure piston 15a, the spring 33a co-acting with the arm 27a as the valve 20a approaches its fully open position to suddenly snap the valve thereto and releasably retain it in such position.

As the closing movement of the exhaust valve 20 is being effected, the grooves 56 and 59 in the piston rod 17 place the right hand end of the

high pressure cylinder 14 in communication with the combustion chamber 34 of the low pressure cylinder 13 through the medium of the branch pipe 58, atomizing chamber 38 and fuel port 35, so that the high pressure piston 16 will force a jet of air past the check valve 36 into the combustion chamber 34 to momentarily scavenge the latter of any residual gases remaining from a previously burned fuel charge. The incoming air jet passing the end of the fuel nozzle 39 will suck fuel past the check valve 37 and intimately mix with the fuel to form a highly explosive mixture at high pressure in the combustion chamber 34.

Once the air pressure has reached its maximum in the combustion chamber 34 under the compressing action of the high pressure piston 16, the pressure reacts through the pipe 64 upon the piston 60 of the interrupter I to move the latter against its spring 61 and thereby cause the arm 65 to momentarily make and break the ignition circuit at the contact members 67 and 68, thus supplying current to the spark plug 31 to ignite the highly compressed charge of fuel in the combustion chamber 34.

It will be appreciated that during the movement of the piston unit P towards the right, filtered air will be drawn through the intake pipe 42 past the check valve 41, and through the intake port 40 into the low pressure cylinder 13 behind the piston 15. Air drawn into the low pressure cylinder 13a by the suction of its piston 15a, during the previous stroke thereof, will be forced past the check valve 48a into the high pressure cylinder 14 behind its piston 16, and air in advance of the latter will be forced from the high pressure cylinder past the check valve 48 through the standpipe 49 into the steam space of the receiver 10.

As movement of the piston unit P towards the left as viewed in Figure 1 is effected by the power of the ignited fuel charge in the combustion chamber 34, expended against the low pressure piston 15, air previously sucked into the low pressure cylinder 13 is forced therefrom by the piston 15 past the check valve 46 into the high pressure cylinder 14. Air previously forced into the high pressure cylinder by the low pressure piston 15a is concurrently forced by the high pressure piston 16 past the check valve 48a and through the standpipe 49a into the steam space of the receiver. Exhaust gases from a previously ignited fuel charge in the combustion chamber 34a are forced by the low pressure piston 15a through the exhaust pipe 22a into the exhaust manifold 23 so as to heat the water in the receiver 10 and convert the water into steam which mixes with the highly compressed air delivered to the receiver by the two stage compressor as just described. The air and steam mixture is dispensed from the dome 52 under the control of the throttle valve 54 to operate various devices, such as turbines, for example.

It will be apparent from the foregoing operation, that during each stroke of the piston unit P, filtered air will be drawn into one low pressure cylinder, and air forced from the other low pressure cylinder into the high pressure cylinder behind the piston 16, concurrently with which re-compressed air in advance of the piston 16 will be forced into the receiver. Thus, filtered air compressed in two stages will be delivered to the receiver from the compressor during each stroke of the piston unit.

Should the pressure in the receiver rise to a predetermined maximum which can be safely held

by the receiver, the line pressure responsive device 71 will operate to close the fuel valve 74, thus cutting off the supply of fuel to the combustion chamber 34a which is all that is necessary to discontinue operation of the engine automatically.

What is claimed is:

1. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; and a receiver into which the compressed air is discharged.

2. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; a receiver enclosing said cylinders and containing a body of liquid to which heat generated by the combustion of fuel and the compression of air is transferred so as to convert the liquid into vapor; and means for conducting the recompressed air from the high pressure cylinder to the steam space of the receiver for mixing with vapor therein.

3. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; a receiver enclosing said cylinders and containing a body of liquid; means for conducting exhaust gases from the low pressure cylinders through the liquid in the receiver so as to transfer heat from the gases to the liquid; and means for conducting recompressed air from the high pressure cylinder to the receiver above the level of liquid therein, for mixing with vapor rising from the liquid.

4. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; and means by which a portion of the air as compressed in the

high pressure cylinder by the piston working therein, will be delivered to the combustion chamber of each low pressure cylinder in such timed relationship to the exhaust stroke of the respective low pressure piston as to scavenge the combustion chamber of residual gases.

5. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting the fuel in the combustion chambers to effect reciprocation of said unit; means by which the said cylinders are adapted to co-act with the piston unit in compressing air in two stages; means by which a portion of the air as compressed in the high pressure cylinder by the piston working therein, will be delivered to the combustion chamber of each low pressure cylinder in such timed relationship to the exhaust stroke of the respective low pressure piston as to scavenge the combustion chamber of residual gases; and means for utilizing said portion of the air to draw fuel into the combustion chamber for the succeeding power stroke of the piston.

6. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; and means defining an air passage to the combustion chamber of each low pressure cylinder; the piston rod having means co-acting with said air passages to supply a portion of the air as compressed in the high pressure cylinder by the piston therein, to the combustion chamber of each low pressure cylinder during the final portion of the exhaust stroke of the respective low pressure piston, to scavenge the combustion chamber of residual gases.

7. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; means defining an air passage to the combustion chamber of each low pressure cylinder; the piston rod having means co-acting with said air passages to supply a portion of the air as compressed in the high pressure cylinder by the piston therein, to the combustion chamber of each low pressure cylinder during the final portion of the exhaust stroke of the respective low pressure piston, to scavenge the combustion chamber of residual gases; a fuel nozzle for each low pressure cylinder adapted for connection to a

source of fuel supply; and means defining atomizing chambers in which said nozzles are disposed, and to which said portions of air are delivered in transit from the respective low pressure cylinders, for co-action with the nozzles in drawing fuel therefrom, to form a volatile mixture when discharged into the respective combustion chamber.

8. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages in response to reciprocation of said unit; means by which a portion of air as compressed in the high pressure cylinder is caused to draw fuel from a source of supply into each combustion chamber to provide a volatile mixture of fuel and air therein; and means for igniting the fuel charges in the respective combustion chambers at such times in the cycle of operation that the piston unit will be reciprocated.

9. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages in response to reciprocation of said unit; means by which a portion of air as compressed in the high pressure cylinder is caused to draw fuel from a source of supply into each combustion chamber to provide a volatile mixture of fuel and air therein; and means responsive to the pressure of said portion of air to effect ignition of the fuel charges in the respective combustion chambers at such times in the cycle as to reciprocate the piston unit.

10. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages in response to reciprocation of said unit; means by which a portion of air as compressed in the high pressure cylinder is caused to draw fuel from a source of supply into each combustion chamber to provide a volatile mixture of fuel and air therein; an ignition circuit including an igniter in each combustion chamber, a source of current, and normally disengaged contact members; and means responsive to the pressure of said portion of air to effect ignition of the fuel charges in the respective combustion chambers at such times in the cycle of operation that the piston unit will be reciprocated.

11. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in com-

pressing air in two stages; a receiver into which the compressed air is discharged; means for storing air under pressure from the receiver; and means by which air from the last means can be delivered to the low pressure cylinders to initiate reciprocation of the piston unit.

12. A motor-compressor comprising a plurality of low pressure cylinders having combustion chambers, and a high pressure cylinder interposed therebetween in co-axial relationship thereto; a piston unit including pistons working in the cylinders, and a rod operatively connecting the pistons; means by which fuel is adapted to be supplied to the combustion chambers of the low pressure cylinders; means for igniting fuel in the combustion chambers to effect reciprocation of said unit; means by which said cylinders are adapted to co-act with the piston unit in compressing air in two stages; a receiver into which the compressed air is discharged; and means responsive to a predetermined maximum pressure in the receiver to stop operation of the piston unit.

13. A motor-compressor comprising two low pressure cylinders having combustion chambers provided with fuel and exhaust ports; a high pressure cylinder; interposed between and in co-axial relationship to the high pressure cylinders to form a rigid unitary structure; a piston unit including pistons working in the respective cylinders and a rod to which the pistons are secured; valves controlling said exhaust ports and having stems; lost motion operative connections between the stems of the respective valves and the piston rod for actuation of the valves to open and close the exhaust ports in timed relationship to reciprocation of the piston unit; means for supplying fuel to the combustion chambers; means for igniting the fuel at such times in the cycle of operation that the piston unit will be reciprocated; and means by which the cylinders are adapted to co-act with the piston unit in compressing air in two stages.

14. A motor-compressor comprising two low pressure cylinders having combustion chambers provided with fuel and exhaust ports; a high pressure cylinder; interposed between and in co-axial relationship to the high pressure cylinders

to form a rigid unitary structure; a piston unit including pistons working in the respective cylinders, and a rod to which the pistons are secured; valves controlling said exhaust ports and having stems; lost motion operative connections between the stems of the respective valves and the piston rod for actuation of the valves to open and close the exhaust ports in timed relationship to reciprocation of the piston unit; means for supplying fuel to the combustion chambers; means for igniting the fuel at such times in the cycle of operation that the piston unit will be reciprocated; means by which the cylinders are adapted to co-act with the piston unit in compressing air in two stages; a receiver enclosing the cylinders and adapted to contain a body of liquid to which heat from the combustion of fuel and compression of air will be transferred; and means for conducting air from the high pressure cylinder to the receiver.

15. A motor-compressor comprising two low pressure cylinders having combustion chambers provided with fuel and exhaust ports; a high pressure cylinder; interposed between and in co-axial relationship to the high pressure cylinders to form a rigid unitary structure; a piston unit including pistons working in the respective cylinders and a rod to which the pistons are secured; valves controlling said exhaust ports and having stems; lost motion operative connections between the stems of the respective valves and the piston rod for actuation of the valves to open and close the exhaust ports in timed relationship to reciprocation of the piston unit; means for supplying fuel to the combustion chambers; means for igniting the fuel at such times in the cycle of operation that the piston unit will be reciprocated; means by which the cylinders are adapted to co-act with the piston unit in compressing air in two steps; a receiver enclosing the cylinders and adapted to contain a body of liquid; an exhaust manifold communicating with said exhaust ports and disposed in the receiver to transfer heat from the exhaust gases to liquid in the receiver; and means for conducting air from the high pressure cylinder to the steam space of the receiver.

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