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F. M. MACKEY.

MOTOR.

No. 602,086. Patented Apr. 12, 1898.

Fig. 5.

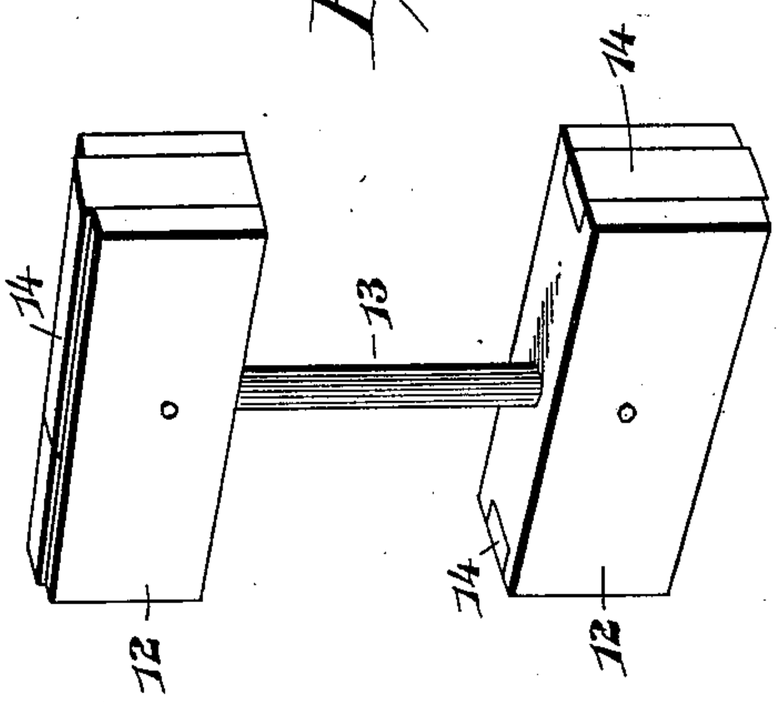

Fig. 1.

Witnesses

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No. 602,086. Patented Apr. 12, 1898.

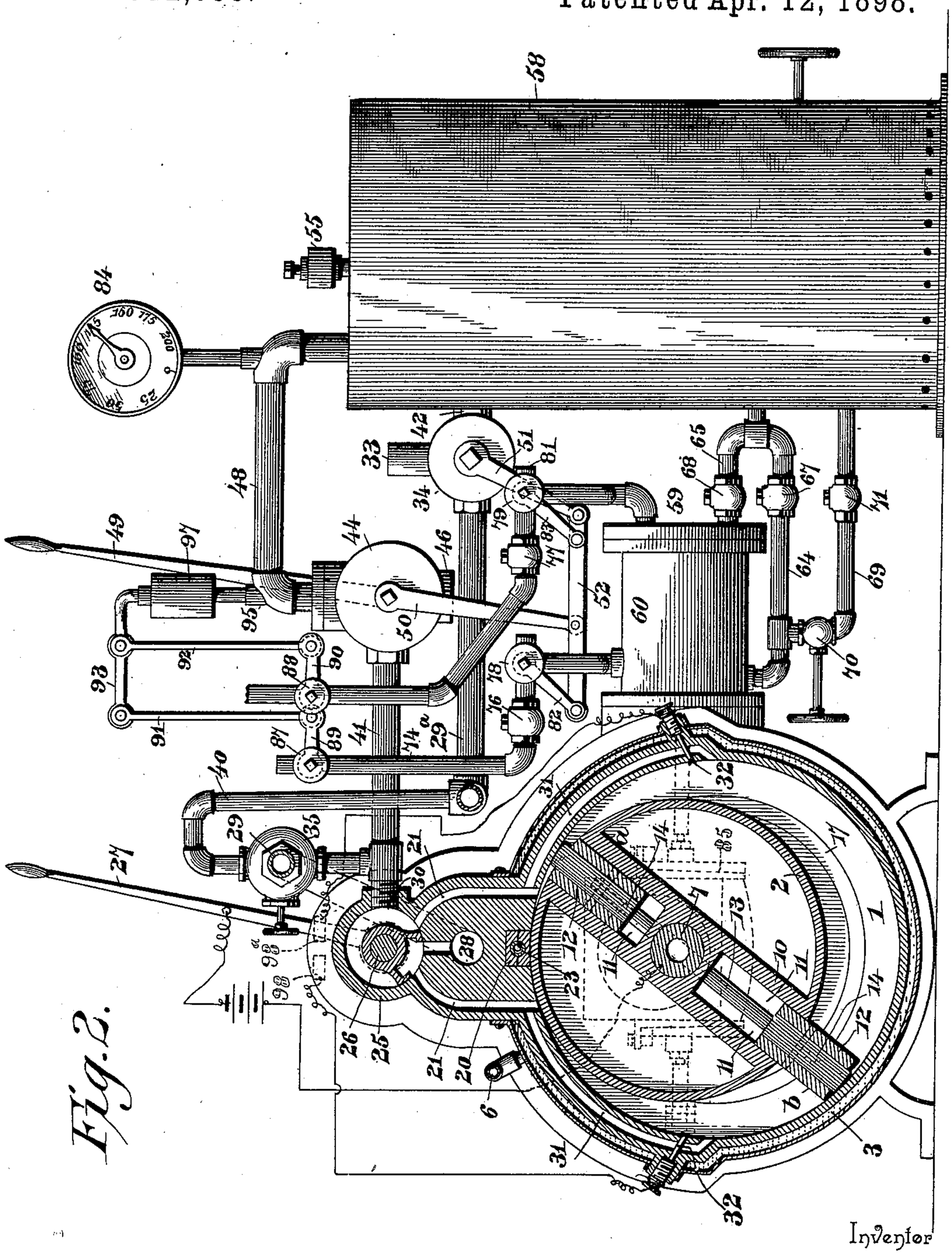

Fig. 2.

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4 Sheets—Sheet 3.

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Fig. 6.

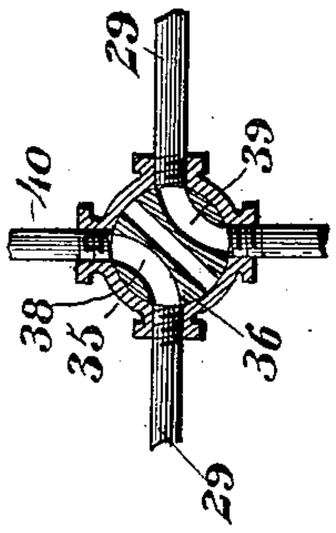

Fig. 3.

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(No Model.) 4 Sheets—Sheet 4.

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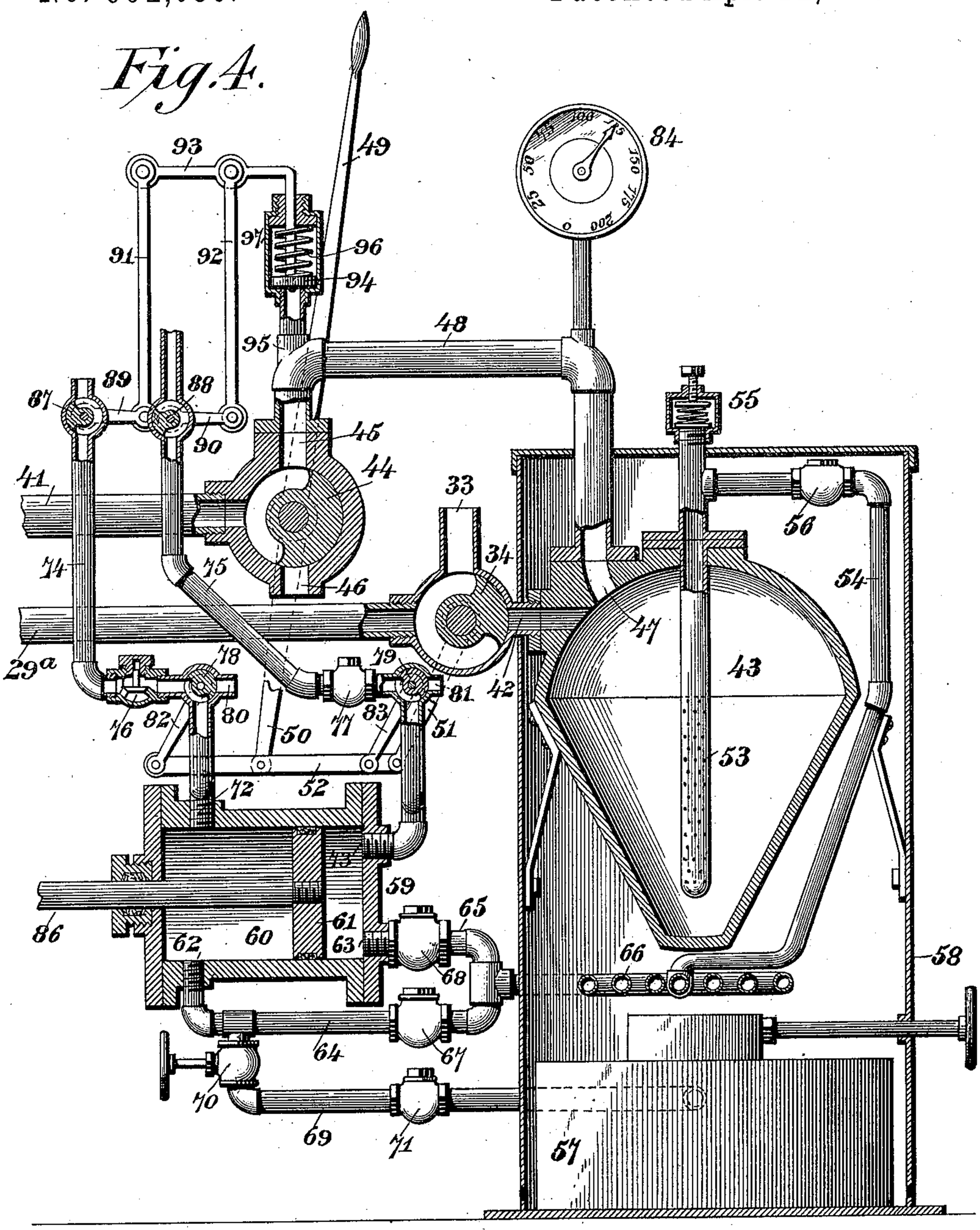
MOTOR.

No. 602,086. Patented Apr. 12, 1898.

Fig. 4.



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UNITED STATES PATENT OFFICE.

FRANK M. MACKEY, OF ELMIRA, NEW YORK.

MOTOR.

SPECIFICATION forming part of Letters Patent No. 602,086, dated April 12, 1898.

Application filed April 22, 1897. Serial No. 633,277. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. MACKEY, a citizen of the United States, residing at Elmira, in the county of Chemung and State of New York, have invented a new and useful Motor, of which the following is a specification.

My invention relates to motors of the portable type adapted for use in driving vehicles, including tram-cars and the like, said motor including a rotary engine of the eccentric-piston class and a combined vaporizer and reservoir, with means for conveying fluid-pressure from the vaporizer or reservoir to the cylinder, and vice versa, and for controlling the supply and exhaust of a motive agent.

The object of the invention is to provide a compact and efficient construction and arrangement of parts particularly adapted for portable use in connection with vehicles, whereby the same is applicable without vastly increasing the weight of the vehicle.

A further object of the invention is to provide a peculiar construction and relative arrangement of valves and conductors whereby the course of fluid-pressure may be reversed during the checking of the forward movement of a vehicle to cause the temporary storage of pressure in the vaporizer or reservoir to serve as an initial fluid-pressure supply to start the vehicle when desired and to provide a simple and efficient construction and arrangement of governor and of means for preventing back pressure for use in connection with the reversing devices, whereby loss of the motive agent when the mechanism is reversed is avoided.

A further object of the invention is to provide a simple and efficient arrangement of controlling-valve mechanism whereby the cooperating pistons may both be exposed with facility to high pressure or whereby the feed-port of the low-pressure cylinder may be connected with the exhaust-port of the high-pressure cylinder when it is desired to compound the engine.

Further objects and advantages of this invention will appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims.

In the drawings, Figure 1 is a plan view of a motor constructed in accordance with my invention. Fig. 2 is a side view of the same, showing the cylinder and contiguous parts in section on the line 2 2 of Fig. 1. Fig. 3 is a longitudinal sectional view of the cylinder. Fig. 4 is a vertical sectional view of the generator and the contiguous valve mechanism, including the governor, and also showing in section the supply-pump and its connection with the generator. Fig. 5 is a detail view in perspective of the piston-follower, comprising the wings which form the moving abutments of the piston. Fig. 6 is a detail sectional view of the controlling-valve, showing it in the position which it occupies to admit high pressure to both cylinders.

Similar numerals of reference indicate corresponding parts in all the figures of the drawings.

1 and 1ª designate high and low pressure cylinders containing eccentrically-mounted pistons 2, said cylinders being provided with water-jackets 3, with the interiors of which communicate supply and exhaust pipes 4 and 5 for the admission and removal of a cooling agent, said jackets being connected by a suitable communicating-tube 6. The pistons are of hollow construction and are carried by a common tubular shaft 7, of which the bore 8 is in communication by ports 9 with the interior of the pistons, by which construction it is possible to admit a cooling agent at one end of the hollow shaft, exhaust it at the opposite end thereof, and cause it, between these points of supply and exhaust, to pass through the interiors of the pistons. A longitudinal diametrical wall 10 is arranged in each piston and is recessed to form guides 11, which are open at diametrically opposite points of the piston-shell to receive the piston-wings 12, and these piston-wings are connected by guide-rods 13, extending through diametrical openings in the shaft to form a follower, which is reciprocated in the piston-shell by the contact of the outer or exposed edges of the wings, and thus forms a moving abutment for the application of fluid-pressure. The piston-wings are provided with suitable packing-strips 14, preferably of angular construction, of which the short arms are held in contact with the heads of the cylinders by means of expansion-springs 15, while the long

arms, which are rabbeted and overlapped at their contiguous extremities, are held in contact with the walls of the cylinders by means of leaf-springs 16 or their equivalents. Spring-actuated packing-gibs 17 are also located in the terminal heads of the cylinders, the springs 18 thereof being held at the desired tension by means of tension-screws 19, and a central or dividing gib 20 is arranged longitudinally of each cylinder between the feed-ports 21 thereof and is held in yielding contact with the upper surface of the piston-shell by means of actuating-springs 22. This dividing-gib 20 is preferably of sectional construction, with the contiguous extremities of the sections halved and overlapped to form a sliding joint, (clearly shown in Fig. 3,) and disposed longitudinally in the contiguous extremities of the sections is arranged a guide-tube 23, in which is arranged an expansion-spring 24. This causes a longitudinal expansion of each dividing-gib to preserve steam-tight contact with the heads of the cylinders.

The feed-ports 21 communicate with a reversing-valve casing 25, in which is arranged an oscillatory reversing-valve 26, provided with an operating-handle 27, and also communicating with said reversing-valve casing is an exhaust-port 28, with which communicates a suitable pipe or conveyer 29, and 30 represents the supply-port of the reversing-valve casing for communication by means of a feed-port with the interior of the cylinder at one side of the dividing-gib 20.

Formed in the wall of each cylinder and extending in opposite directions, respectively, from the feed-ports to diametrically opposite points in the walls of the cylinders are counterbores 31, of which the function is to communicate pressure past a piston-wing during the time that the same occupies the position between the feed-port and the opposite extremity of the counterbore, and thereby apply said pressure to the preceding or other piston-wing, of which a greater area is exposed. For instance, when a piston-wing is in the position indicated at *a* in Fig. 2 pressure admitted through the supply-port 30 is communicated through the right-hand feed-port 21 to the interior of the cylinder, but is applied not only to the piston-wing located at *a*, but also and mainly to the opposite piston-wing located at *b*, said pressure being communicated through the counterbore at 31, and hence passing the contiguous piston-wing until the latter shall have reached a point where communication of the counterbore with the interior of the cylinder is cut off. Obviously as the piston advances the exposure of the wing which has passed the counterbore 31 is increased until a vertical position thereof is reached, and while after a vertical position has been passed the area of the lower or advance piston gradually decreases, while the exposed area of the upper wing correspondingly increases, the exposed area of the foremost or advance wing can never become less than the exposed area of the following wing. When said areas are practically equal, the advance wing has passed beyond the extremities of the counterbore at the opposite side of the cylinder from the inlet-port and thus has brought the space between the piston-wings into communication with the exhaust-port. Hence, inasmuch as the exposed area of the foremost or advance piston-wing is always greater than that of the following piston-wing, it will be seen that pressure admitted through the counterbore 31 will have an operative pressure upon said advance piston-wing and will assist in the operation of the piston. When that point in the rotation of the piston is reached in which the end of the counterbore is covered by one piston-wing, the preceding piston-wing is relieved of pressure, while the entire pressure is applied to the following or contiguous wing, and as the preceding wing exposes the contiguous end of the left-hand counterbore 31 simultaneously with the closure of the extremity of the right-hand counterbore it is obvious that at the moment of applying the entire fluid-pressure to the following piston-wing the space between said following and preceding piston-wings will be brought into communication with the left-hand counterbore 31 and hence with the left-hand feed-port 21, which communicates with the exhaust 28.

In the construction illustrated in the drawings the counterbore 31 is formed as a laterally-closed duct or channel in the thickened wall of the cylinder and exposed only terminally for communication, respectively, with the feed-port and the cylinder. In other words, it is closed laterally by a web or partition, as shown clearly in Fig. 2.

In the drawings I have shown the apparatus adapted for use as a gas or explosive engine, and hence the cylinders are provided at diametrically opposite points with contact-points 32, adapted to ignite the contained gases during the rotation of the piston in either direction. But when the engine is operated explosively the explosions occur just as a piston-wing passes one of the contact-points 32, and hence ignites the explosive mixture in that portion of the cylinder which is in rear of the piston-wing which has engaged the contact-point. The portion of gas or explosive mixture which is in the space between the piston-wings, and hence in advance of the following piston-wing, does not explode by the sparking mechanism described. The function of the counterbore 31, however, remains the same as when the machine is operated simply by an expansive motive agent, for the reason that when the explosive gas is admitted to the cylinder to start the engine it passes through the counterbore and is applied expansively to the foremost piston-wing and thus imparts an initial motion to the piston. When this motion has continued a sufficient time to bring the following piston-wing

into engagement with the contact-point, the volume of gas in rear of said following piston-wing is exploded, and thereafter the machine operates under the explosive action of the motive agent.

The exhaust-port of the high-pressure cylinder 1 is connected by means of the conveyer 29, above described, with the supply-port 30ª of the low-pressure cylinder, whereby exhaust-pressure from the high-pressure cylinder may be admitted to the low-pressure cylinder and from thence exhausted through the port 28ª and conveyer 29ª, which terminates in an outlet 33, controlled, for a purpose hereinafter explained, by a valve or cut-off 34. Let into the conveyer 29, and hence communicating at opposite sides, respectively, with the high-pressure exhaust and the low-pressure supply-ports, is a four-way controlling-valve casing 35, containing the controlling-valve 36. This controlling-valve casing is also in communication, preferably at opposite points, with the high-pressure supply-port 30 and the low-pressure exhaust-conveyer 29ª through connection 40, and the controlling-valve is provided with a plurality of ways, of which the diametrical way 37 is adapted to establish straight communication between the high-pressure exhaust and the low-pressure supply-ports, as shown in Fig. 3. It frequently happens, however, especially in starting an engine with a full load, that it is desirable to apply, at least for a short time, high pressure to both cylinders, and in order to accomplish this it is simply necessary to turn the controlling-valve through a one-eighth revolution to bring the ways 38 and 39 into such position as to connect the high-pressure exhaust-port with the low-pressure outlet-port through the low-pressure exhaust-conveyer 29ª and the connecting-tube 40, which extends from the controlling-valve casing to the said low-pressure exhaust-conveyer 29ª, and at the same time connect the high-pressure supply-conveyer 41, which communicates with the high-pressure supply-port 30, with the low-pressure supply-port 30ª, through the portion of the high-pressure exhaust-conveyer 29 which is arranged between the controlling-valve casing and said low-pressure supply-port, as shown clearly in Fig. 6. This arrangement of the valve causes high-pressure motive agent to be admitted to both cylinders simultaneously and causes both cylinders to exhaust into the common low-pressure exhaust-conveyer 29ª and thence through the common outlet 33. This arrangement of parts, especially including the connection of the high-pressure exhaust-port with the low-pressure exhaust-conveyer, whereby both high and low pressure cylinders exhaust through a common outlet-port, has the further advantage of muffling the exhaust from the high-pressure cylinder and thus making the exhaust approximately noiseless.

Communicating with the casing of the cut-off valve 34 is a compressor-port 42, leading into a reservoir 43, whereby the interior of the reservoir may be connected with the low-pressure exhaust-conveyer 29ª by turning the valve 34 to cut off the outlet-port 33. Also, in connection with the supply pipe or conveyer 41 I employ a supply-valve 44, with the casing of which communicate inlet-ports 45 and 46, the former being a motive-agent-inlet port in connection with a generator or suitable source of supply, while the other is an atmospheric-air inlet, which is opened by the valve 44 simultaneously with the closure of the motive-agent-inlet port. Hence when it is desired to retard the forward movement of the piston to secure a gradual checking of the vehicle to which the apparatus may be applied the supply-valve 44 may be turned to cut off the motive-agent-inlet port 45 and open the atmospheric-air-inlet port 46, whereupon the feed-port 21 of the engine will be supplied with atmospheric air at atmospheric pressure, the same being inducted through the port 46 by the suction incident to the revolution of the piston. Obviously the air thus inducted will be discharged in a manner similar to a pump through the exhaust-passages into the low-pressure exhaust-conveyer 29ª, and will thus form a cushion which acts to gradually stop the rotation of the piston if the outlet-port 33 has been closed by the cut-off 34. If, however, this outlet-port is allowed to remain open, it is obvious that the air inducted through the port 46 will simply be discharged through the outlet 33 without having any material effect upon the operation of the mechanism. In order to form a chamber whereby a sufficient quantity of atmospheric air may be placed under tension by this compressive action of the engine, I employ the above-described reservoir 43, which may be arranged in communication with the lower-pressure exhaust-conveyer and thus charged with compressed air. This charge of compressed air which has thus been stored in the reservoir may be utilized in a further way than as a cushion to effect the gradual retardation of the motion of the engine. It may be used as an initial motive power for starting the engine after the stop following the gradual checking movement of the engine which produced the charge in the reservoir. To effect this further object, an outlet-port 47 of the receiver is connected by a suitable conveyer, such as that shown at 48, with the motive agent in the port 45 of the supply-valve casing. Hence when the supply-valve 44 is turned to establish communication between the motive-agent-inlet port 45 and the supply-conveyer 41 the expansive force of the charge in the reservoir is admitted to the cylinders through the usual channels, including the supply-ports, reversing-valve casings, and feed-ports, as fully described hereinbefore. In order to facilitate the operation of the supply and cut-off valves 44 and 34, respectively, they are preferably connected for simultaneous movement, and

in the drawings I have illustrated a simple form of connection, consisting of an operating lever or handle 49, arms 50 and 51, fixed, respectively, to the spindles of the valves 44 and 34, and a link 52, connecting said arms.

By constructing the reservoir of a special shape it may also be adapted, without change of the connections, as above described, to perform the additional function of a vaporizer. In order to adapt it to operate in this capacity, it is preferably made of an inverted-pear shape, (shown in the drawings,) and axially therein is arranged a spray-nozzle 53, communicating with a supply-pipe 54, having a safety-valve 55 and a check-valve 56, the latter being designed to prevent back pressure. Below the reservoir is arranged a heating device 57, of any suitable construction, which, in common with the reservoir, is arranged in a suitable casing 58. In the construction illustrated said heating device preferably consists of a fluid-fuel burner adapted to burn gasolene or its equivalent, and it is obvious that a liquid—such as petroleum-oil, water, or any suitable substitute therefor—is introduced in the form of a spray into the reservoir and is converted into a vapor, which is then communicated, by the means hereinbefore described, to the feed-ports of the cylinders.

When petroleum-oil is used as the motive agent, it is preferable to introduce the same into the reservoir under pressure and at the same time provide mixing devices, whereby air is admitted therewith, particularly when the motive agent is intended to be utilized as an explosive, and in order to accomplish this operation I employ a pump mechanism 59, of which the cylinder 60 is provided at opposite sides of its plunger 61 with outlet-ports 62 and 63, communicating by branches 64 and 65 with the common supply-pipe 54, a coil 66 being preferably arranged in said supply-pipe over the heating device to accomplish the initial heating of the motive agent preparatory to admission into the reservoir. The branches 64 and 65 are provided with suitable check-valves 67 and 68, and preferably an auxiliary branch 69, controlled by a cut-off valve 70, connects the branch 64 with the interior of the fuel-receptacle of the heating device 57 in order to supply air to the interior of the latter for the purpose of promoting combustion and facilitating the feeding of the fuel in the heating device to the burner-tip, said auxiliary branch 69 being also provided with a check-valve 71. Also communicating with the cylinder 60, upon opposite sides of the plane of the plunger 61, are inlet-ports 72 and 73, with which communicate inlet-pipes 74 and 75, of which the inlet end of the former is preferably exposed to the atmosphere, while that of the latter is in communication with the source of supply of the motive agent, whether oil, water, or the equivalent thereof, (the reservoir constituting such source of supply not being illustrated in the drawings.) The inlet-pipes 74 and 75 are provided with check-valves 76 and 77 and with controlling-valves 78 and 79, the casings of the controlling-valves 78 and 79 being also provided with suction-ports 80 and 81, which are adapted to be opened when the communication through the inlet-pipes 74 and 75 is cut off by a readjustment of the controlling-valves. These controlling-valves are preferably provided with arms 82 and 83, which are connected to the link 52, thus providing for the adjustment of the controlling-valves 78 and 79 simultaneously with the supply-valve 44 and the cut-off valve 34.

This being the construction of the essential features of the apparatus, the operation thereof is as follows: The reciprocation of the pump-piston draws fluid through the inlet-pipes 74 and 75 (which may, if preferred, be in communication with a common source of supply, when it is unnecessary to produce a mixture of fluids, as of air and a volatile oil) and at the same time forces said agent into the supply-pipe 54, by which it is conducted to the reservoir. Becoming vaporized in the latter the pressure of motive agent is accumulated, (the amount of pressure being indicated by the gage 84 and being relieved in case of excess by the safety-valve 55,) from which it is discharged, when the supply-valve 44 is in its normal or operative position, (indicated in Fig. 4,) into the reversing-valve casings of the cylinders, either directly or successively, as will be understood from the foregoing description applying to the construction of the cylinders. The exhaust-pressure passes through the low-pressure exhaust-conveyer 29ª to the outlet 33. When it is desired to check the movement of the engine and at the same time produce an initial or starting pressure in the reservoir, (which is then adapted to perform its function as a receiver,) the lever 49 is operated to reverse the supply and cut-off valves 44 and 34, respectively, to open the inlet or suction port 46 and establish communication between the low-pressure exhaust-conveyer 29ª and the inlet-port 42. The momentum of the pistons, and, obviously, of the vehicle which is being operated by the mechanism, causes the engine to operate as a pump, thereby drawing atmospheric air through the suction-port 46 and forcing it into the reservoir, where it is stored for future use. Thus the reservoir performs alternately the functions of a dispenser and a reservoir. Simultaneously with the reversal of the valves 44 and 34 the inlet-pipes 74 and 75 are closed by the controlling-valves 78 and 79, and the suction-ports 80 and 81 are brought into communication with the pump-cylinder 60 at opposite sides of the plunger. Hence the continuance of motion of the pump-plunger is accompanied by no influx of motive agent, but, on the other hand, is relieved of pressure, and the check-valves 67 and 68 prevent pressure which is being accumulated in the reservoir from escaping through the pump-cylinder.

In practice, inasmuch as it is desirable to secure the greatest possible compactness of mechanism, I preferably operate the pump-plunger from the piston-shaft 7, and hence for this purpose employ an eccentric 85 in connection with the plunger-rod 86; but it is obvious that any equivalent system of connections may be employed to accomplish the same object.

In connection with the above-described mechanism I also preferably employ a governor, of which a convenient and at the same time simple form is illustrated in the drawings. This governor is designed to control the inlet of motive agent through the pipes 74 and 75, and, as illustrated, it includes governor-valves 87 and 88, arranged, respectively, in said inlet-pipes 74 and 75 and provided with arms 89 and 90, which are connected by links 91 and 92 with a cross-arm 93, carried by a yielding diaphragm 94 or its equivalent, exposed through a branch pipe 95 with the motive-agent-supply pipe, as at the supply-port 45 of the casing of the supply-valve 44. In the construction illustrated this diaphragm consists of a piston which is yieldingly held in its normal position by means of a spring 96, arranged in a suitable casing 97. It is obvious that when the pressure in the reservoir exceeds a certain amount the diaphragm will be raised in opposition to the resisting force supplied by the spring 96 or its equivalent, and hence will partially or wholly close the governing-valves 87 and 88.

When the apparatus embodying my invention is adapted to be actuated by an explosive fluid or mixture of fluids, in which case the opposite contact or sparking points 32 are employed, I preferably employ spaced terminals 98 and 98^a, connected, respectively, with said contact-points and arranged in such a position that the operating-lever 27 may be arranged in contact with either of them, according to the position which it assumes in order to open the several feed-ports. In other words, when the operating-lever is arranged to open the right-hand feed-port it is in contact with the right-hand terminal 98^a. Then by insulating the lever 27 and arranging it in the circuit with the source of electrical energy it is obvious that either contact-point may be arranged in circuit and thereby energized according to the feed-port which is employed. One arm of the electrical conductor is connected with the piston-shaft, as indicated in the drawings, whereby the piston-blade is arranged in the circuit and performs the function of an ordinary movable electrode in producing the igniting-spark. Any suitable source of electrical energy may be employed in connection with the circuit above traced, such as the battery which is indicated diagrammatically in Figs. 1, 2, and 3.

Various changes in the form, proportion, and the minor details of construction may be resorted to without departing from the spirit or sacrificing any of the advantages of this invention.

Having described my invention, what I claim is—

1. A motor having a piston-cylinder provided with inlet and exhaust ports, a reservoir, and valve mechanism, whereby either of said ports may be arranged in communication with the reservoir and the other exposed to the atmosphere, to adapt the reservoir to act alternately as a dispenser and a receiver, substantially as specified.

2. A motor having a piston-cylinder, a reservoir, supply and exhaust conveyers connecting the reservoir respectively with the inlet and exhaust ports of the cylinder, and valves controlling said conveyers and contiguous ports exposed to the atmosphere, whereby the reservoir is adapted to act alternately as a dispenser and a receiver, substantially as specified.

3. A motor having a piston-cylinder, a reservoir, supply and exhaust conveyers connecting the reservoir respectively with the inlet and exhaust ports of the cylinder, and supply and cut-off valves for controlling said conveyers and having their casings provided respectively with suction and outlet ports either of which is adapted to be arranged in communication with the conveyer when the contiguous valve is arranged to cut off communication between said conveyer and the reservoir, substantially as specified.

4. A motor having a piston-cylinder, a reservoir, supply and exhaust conveyers connecting the reservoir respectively with the inlet and exhaust ports of the cylinder, supply and cut-off valves controlling the conveyers and having their casings provided respectively with suction and outlet ports which are adapted to be arranged respectively in communication with said conveyers when the valves are arranged to cut off communication between the conveyers and the reservoir, and means for communicating simultaneous movement to said valves whereby when one is arranged to cut off communication between the conveyer and the reservoir, the other is adjusted to open communication with the reservoir, substantially as specified.

5. A motor having a piston-cylinder, a reservoir adapted to perform the function of a vaporizing-retort, a heating device, a sprayer arranged in the reservoir, pump mechanism in connection with the sprayer and provided with an inlet-pipe, supply and exhaust conveyers connecting the reservoir with the inlet and exhaust ports of the cylinder, supply and cut-off valves for controlling said conveyers and having their casings provided with suction and outlet ports, means for simultaneously operating said valves to open communication between the reservoir and one conveyer and cut off communication between the reservoir and the other conveyer, and a controlling-valve, arranged in said inlet-pipe

of the pump mechanism, operatively connected with the supply and cut-off valves, and having its casing provided with a suction-port, substantially as specified.

6. A motor having a piston-cylinder, a reservoir adapted to perform the function of a vaporizing-retort and having independent communication respectively with the inlet and exhaust ports of the cylinder, valve mechanism for controlling communication between the reservoir and said ports and also controlling suction and outlet ports adapted to be arranged in communication, respectively, with the inlet and exhaust ports of the cylinder, a heating device for the reservoir, a sprayer arranged in the reservoir, a pump mechanism having outlet-ports communicating with the supply-pipe which is connected with the sprayer and also having inlet-ports adapted to admit different fluids for discharge into said supply-pipe, and controlling-valves for the inlet-ports of the pump, operatively connected with the said valve mechanism for controlling communication between the reservoir and the ports of the cylinder, said controlling-valves having their casings provided with suction-ports, substantially as specified.

7. A motor having a piston-cylinder, a reservoir adapted to perform the function of a retort, means of communication between the reservoir and the inlet and exhaust ports of the cylinder, valve mechanism for controlling said communication, and also controlling suction and outlet ports adapted to be arranged in communication respectively with the inlet and exhaust ports of the cylinder, a heating device, a pump mechanism for supplying motive agent to the reservoir and having its cylinder in communication with inlet-pipes, controlling-valves in said inlet-pipes operatively connected with said valve mechanism for controlling communication between the reservoir and the ports of the cylinder, the controlling-valve casings having suction-ports, and governor-valves arranged in said inlet-pipes, and a diaphragm exposed to the pressure of the contents of the reservoir and operatively connected with the governor-valves, substantially as specified.

8. A motor having high and low pressure piston-cylinders, supply and exhaust conveyers respectively in communication with the inlet and exhaust ports of said cylinders, and a four-way controlling-valve having its casing in communication at diametrically opposite points with the high-pressure supply and the low-pressure exhaust ports, and also in communication at diametrically opposite points with the high-pressure exhaust and the low-pressure supply ports, substantially as specified.

9. A motor having an eccentric piston-cylinder, and a dividing-gib arranged between the feed-ports, said gib being longitudinally expansible and comprising sections having overlapping contiguous extremities, a tube connecting the sections longitudinally to form a guide therefor, and an expansion spring housed in the tube, and bearing terminally against the gib-sections, substantially as specified.

10. A motor having a cylinder, a controlling-valve for the ports of the cylinder, a rotary piston, opposite contact or sparking points, spaced terminals connected respectively with the contact-points, and an operating-lever for said valve adapted to perform the function of a switch to contact with either of said terminals, said lever being included in an electrical circuit which also includes the piston, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of witnesses.

FRANK M. MACKEY.

Witnesses:
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HARRY T. DE GROOT,
A. H. MCCORMICK, Jr.