No. 722,116. PATENTED MAR. 3, 1903.

F. W. LANCHESTER.

MOTOR PROPELLED VEHICLE.

APPLICATION FILED JULY 12, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

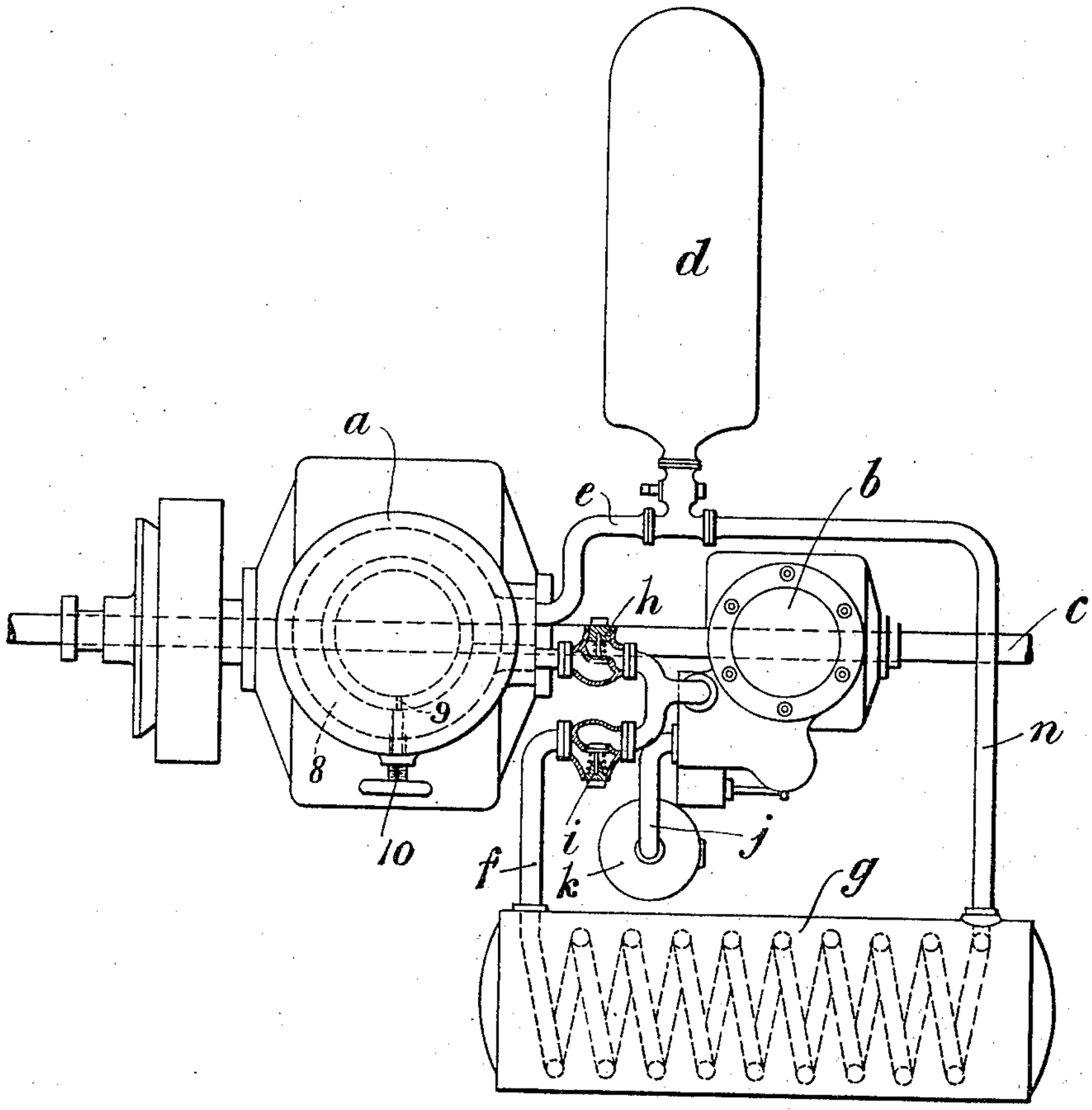

Fig. 1.

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NO MODEL. 2 SHEETS—SHEET 2.

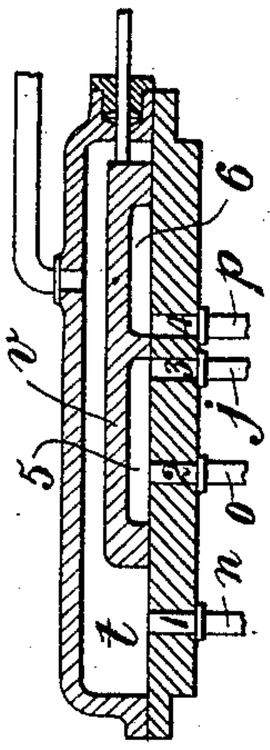

Fig. 3.

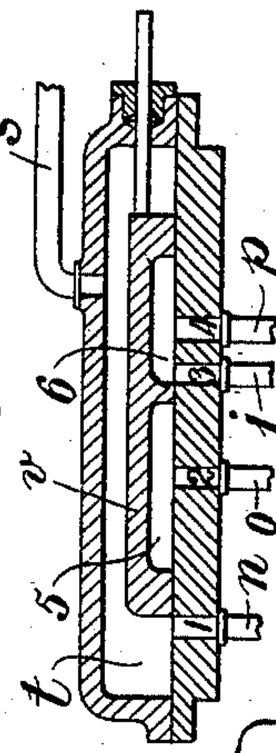

Fig. 4.

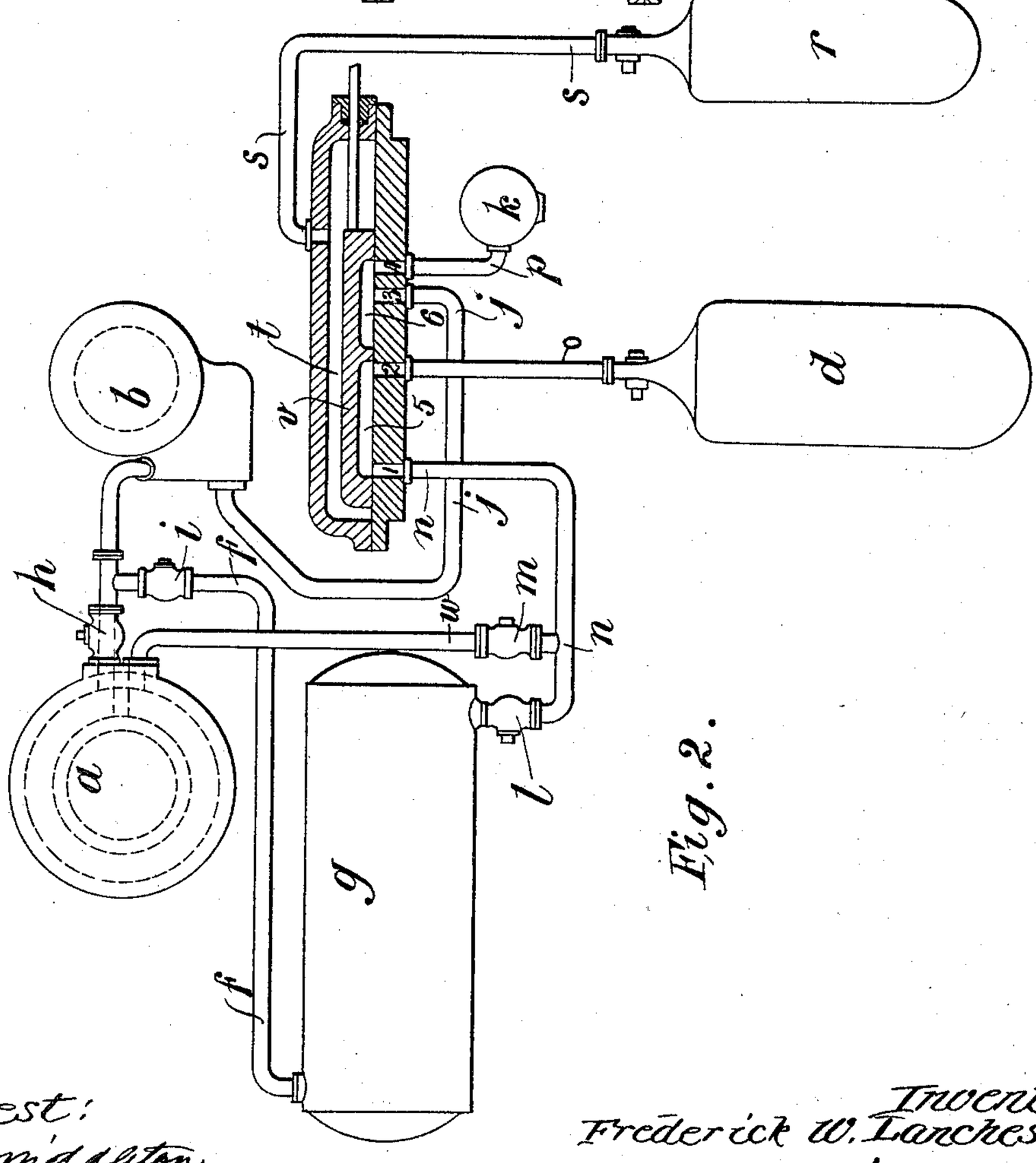

Fig. 2.

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UNITED STATES PATENT OFFICE.

FREDERICK WILLIAM LANCHESTER, OF BIRMINGHAM, ENGLAND.

MOTOR-PROPELLED VEHICLE.

SPECIFICATION forming part of Letters Patent No. 722,116, dated March 3, 1903.

Application filed July 12, 1902. Serial No. 115,357. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK WILLIAM LANCHESTER, engineer, a subject of the King of Great Britain and Ireland, residing at 53 Hagley road, Edgbaston, Birmingham, England, have invented certain new and useful Improvements Relating to the Propulsion of Motor-Propelled Vehicles, (for which I have made application for Letters Patent in Great Britain, No. 19,070, dated September 24, 1901,) of which the following is a specification.

The invention consists in the features and combination and arrangement of parts hereinafter described, and particulary pointed out in the claims.

The object of the invention is to provide means whereby the motor may be started automatically, reversed, or aided when required by reserve power, which is always at the disposal of the driver in case of emergency.

A further object of the invention is to provide for a storage of power from the prime mover in a volume of elastic fluid under pressure, such storage being effected either by the surplus power available from the prime mover on the vehicle when running on less than full load or when the vehicle is stopped.

This invention also provides for effecting multiple stage compression with a single-cylinder compressor and the utilization of the stored energy in a manner analogous to that effected in a compound engine, but in stages in a single cylinder.

The invention comprises a compressed elastic-fluid motor in conjunction with an internal-combustion engine or other prime mover in such a manner as to insure efficient working, which is attained by adapting the auxiliary motor to be used as a pump or motor, as desired, and by its means storing compressed elastic fluid in a reservoir during the easy running of the vehicle and utilizing such elastic fluid as an additional source of power when starting or for reversing or when great power is required, the transmission of the air from pump to reservoir being made through a cooler and from reservoir to air-motor through a heater in thermal connection with the cylinder or exhaust of the prime mover.

The invention further comprises two or more reservoirs in conjunction with a distribution-valve, whereby the elastic fluid may be compressed to and stored at different pressures and utilized in such manner to drive the air-motor that the principal advantages of a compound engine can be obtained with a single cylinder.

In the accompanying drawings, Figure 1 is a diagrammatic plan illustrating one manner of carrying out the invention wherein only one compressed-air reservoir is employed. Fig. 2 is a diagrammatic plan illustrating the manner of carrying out the invention wherein stage compression is employed. Figs. 3 and 4 are detail views showing the distribution-valve in two successive positions.

In carrying out the invention in one manner, as illustrated in Fig. 1, an internal-combustion motor *a* and an auxiliary air-motor *b* are both arranged to drive onto the same shaft *c*. The air-motor is of the double-acting steam-engine type and arranged so that it may be alternatively used as a pump or a motor, as circumstances may require. The construction of this motor forms no part of the present invention; but a suitable form of motor is described in the specification of an application filed simultaneously with the present application, Serial No. 115,358. A storage chamber or reservoir *d* is provided into which air is compressed when the air-motor *b* is used as a pump and from which air is drawn when it is desired to start, reverse, or assist the prime mover *a*. In order to prevent difficulties due to the formation of ice in and around the air-motor cylinder, the air in passing from the reservoir to the air-motor is caused to pass by way of a pipe *e* through a heater connected with the exhaust or combustion chamber of the internal-combustion engine or prime mover *a*, and in order to avoid the waste of power when the reservoir is being charged the air on leaving the compressor by way of a pipe *f* is cooled by passing it through a coil within a cooling water-tank *g* or tank containing the supply of combustible fluid. It will be understood that the valve-gear of the air-motor is under the control of the driver, who is therefore able to cause the said motor to act either as an air-compressor or motive-power engine or to put it out of action altogether, as he may deem advisable. When, however, the air-motor is so changed, the com-

pressed air will automatically take its proper course, owing to the arrangement of piping and employment of automatic non-return valves *h* and *i* thereon. For instance, when the air-motor *b* is acting as a pump air from the atmosphere is drawn through the pipe *j* (preferably through a casing *k*, filled with a drying material, such as calcium chlorid) and delivered through a non-return valve *i*, pipe *f*, cooler *g*, and pipe *n* to the reservoir *d*. When the air-motor *b* is working as a motive-power engine, the compressed air passes from the reservoir *d* by pipe *e* through the heater in connection with the internal-combustion engine or prime mover *a*, past non-return valve *h* into the motor *b*, and thence through exhaust-pipe *j* into the atmosphere. The automatic valves *h* and *i* may, if desired, be replaced by hand-operated valves.

In order to enable stage compression to be adopted, and thereby to obtain the principal advantages of a compound engine without the necessity of employing multiple cylinders, the arrangement diagrammatically illustrated in Figs. 2 to 4 is employed, in which figures parts which are similar to the parts shown in Fig. 1 are similarly lettered. In this case two reservoirs are shown—a high-pressure reservoir *r* and a low-pressure reservoir *d*. The air-motor *b* is arranged to first pump air from atmosphere into the low-pressure reservoir and then to pump from the latter into the high-pressure reservoir. The air-motor may then be used as a motive-power engine working either by high-pressure air to atmosphere, high-pressure air to low pressure, or low pressure to atmosphere. To enable these functions to take place, a distribution-valve *v* is employed, to which the pipes from the different elements are led. The pipes are led into ports 1 2 3 4, over which the slide-valve *v* is adapted to work, being provided with two ports or pockets 5 and 6. Thus by suitably arranging the valve *v*, as shown in Fig. 2, the air-motor *a* is thrown into connection with the low-pressure reservoir *d*, in which position of the valve the air-motor may be used as a pump or as a motive-power engine. When used as a pump, air is drawn from the atmosphere through the drier *k*, pipe *p*, ports 4, 6, and 3, pipe *j*, motor *b*, and then forced past non-return valve *i*, along pipe *f*, through cooler *g*, past non-return valve *l*, along pipe *n*, ports 1, 5, and 2, and by pipe *o* to the low-pressure reservoir *d*. When the air-motor is acting as a motive-power engine, with the valve *v* in the same position as above, the compressed air passes from the reservoir *d* by pipe *o*, ports 2, 5, and 1, pipe *n*, non-return valve *m*, heater of engine *a*, past non-return valve *h* to air-engine *b*, from which it is exhausted to atmosphere. In the position of the valve *v* indicated in Fig. 3 the air-motor *b* may still be used as either a pump or motive-power engine. In the former case it pumps the compressed air from the low-pressure reservoir *d* into the high-pressure reservoir *r*, and in the latter case it is worked by the high-pressure air from the reservoir *d*. When the air-motor *b* is pumping from the reservoir *d* into reservoir *r*, the air passes via pipe *o*, ports 2, 5, and 3, pipe *j*, motor *b*, non-return valve *i*, pipe *f*, cooler *g*, non-return valve *l*, pipe *n*, port 1, casing *t*, pipe *s* into high-pressure reservoir *r*. When the air-motor *b* is working as a motive-power engine off the high-pressure reservoir into the low-pressure reservoir, the compressed air passes via pipe *s*, casing *t*, port 1, pipe *n*, non-return valve *m*, pipe *w*, heater, non-return valve *h* into the motor *b*, from which it is exhausted via pipe *j*, ports 3, 5, and 2, pipe *o* into low-pressure reservoir *d*. In case of emergency or in cases where considerable power is required the air-motor may be worked directly from the high-pressure reservoir to atmosphere. In such a case the valve *v* is brought to the position shown in Fig. 4. When the air-motor is working directly from the high-pressure reservoir to atmosphere, as above suggested, the air passes via pipe *s*, valve-casing *t*, port 1, pipe *n*, valve *m*, heater, valve *h* to air-motor *b*, from which it exhausts via pipe *j*, ports 3, 6, and 4, and pipe *p* to atmosphere. It will thus be understood that the advantages of a compound engine may be obtained without the necessity of employing multiple cylinders. In order to heat effectively the compressed air on its way to the air-motor, it is passed, as before stated, through a heater which is in thermal connection with the exhaust or the combustion-chamber of the prime mover. In one convenient form of heater the pipe leading the air is contained as a coil within a passage 8, surrounding the combustion-chamber of the prime mover, which in the case illustrated is an oil-engine. The passage may be placed in direct communication with the combustion-chamber by a small by-pass 9, controlled by a screwed plug 10.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a motor-propelled vehicle, the combination with a prime mover, of an engine capable of acting either as an elastic-fluid compressor or a motor, a reservoir for the fluid, and changeable connections whereby said engine may be caused to store fluid in said reservoir, or the stored fluid may be used to drive said engine, a cooler for cooling the air delivered to the reservoir, and a heater for heating the air delivered from the reservoir to the engine, substantially as described.

2. In a motor-propelled vehicle the combination with the prime mover of an engine capable of acting either as an elastic-fluid compressor or a motor, a reservoir for compressed fluid in connection with said engine, a heater for the same in thermal connection with the cylinder or exhaust of the prime mover and means for rendering automatic the passage of fluid from the compressor through the

cooler to the reservoir or from the reservoir through the heater to the air-motor.

3. In a motor-propelled vehicle the combination with the prime mover of an engine capable of acting either as an elastic-fluid compressor or a motive-power engine, a reservoir, a cooler for cooling the fluid delivered to said reservoir, a heater for heating the fluid delivered from said reservoir, such heater being in thermal connection with the cylinder or exhaust of the prime mover, means for reversing the flow of fluid through the system, and means for rendering automatic the passage of fluid from the compressor through the cooler to the reservoir or from the reservoir through the heater to the air-motor, comprising pipe connections between the compressor and the cooler and between the heater and the air-motor each fitted with an automatic non-return valve, substantially as hereinbefore described.

4. In a motor-propelled vehicle the combination with the prime mover of an engine capable of acting either as an elastic-fluid compressor or a motor, a high-pressure and a low-pressure reservoir, a cooler for cooling the fluid delivered to either reservoir, a heater for heating the air delivered from either reservoir to the elastic-fluid motor, such heater being in thermal connection with the cylinder or exhaust of the prime mover, a valve-chamber having distributing connections with the said high and low pressure reservoirs, the motor and the atmosphere, and a distribution-valve controlling said connections for enabling the elastic fluid to be delivered from compressor to low-pressure reservoir, from low-pressure reservoir through compressor to high-pressure reservoir, from high-pressure reservoir through fluid-motor to low-pressure reservoir, from low-pressure reservoir through fluid-motor to the atmosphere or from high-pressure reservoir through fluid-motor to atmosphere, substantially as hereinbefore described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

FREDERICK WILLIAM LANCHESTER.

Witnesses:

FRANCIS JAMES BIGNELL,

BERTRAM HARRY T. MATTHEWS.