(No Model.) 3 Sheets—Sheet 1.

F. M. MERRILL.

COMPRESSED AIR STREET CAR MOTOR.

No. 435,020. Patented Aug. 26, 1890.

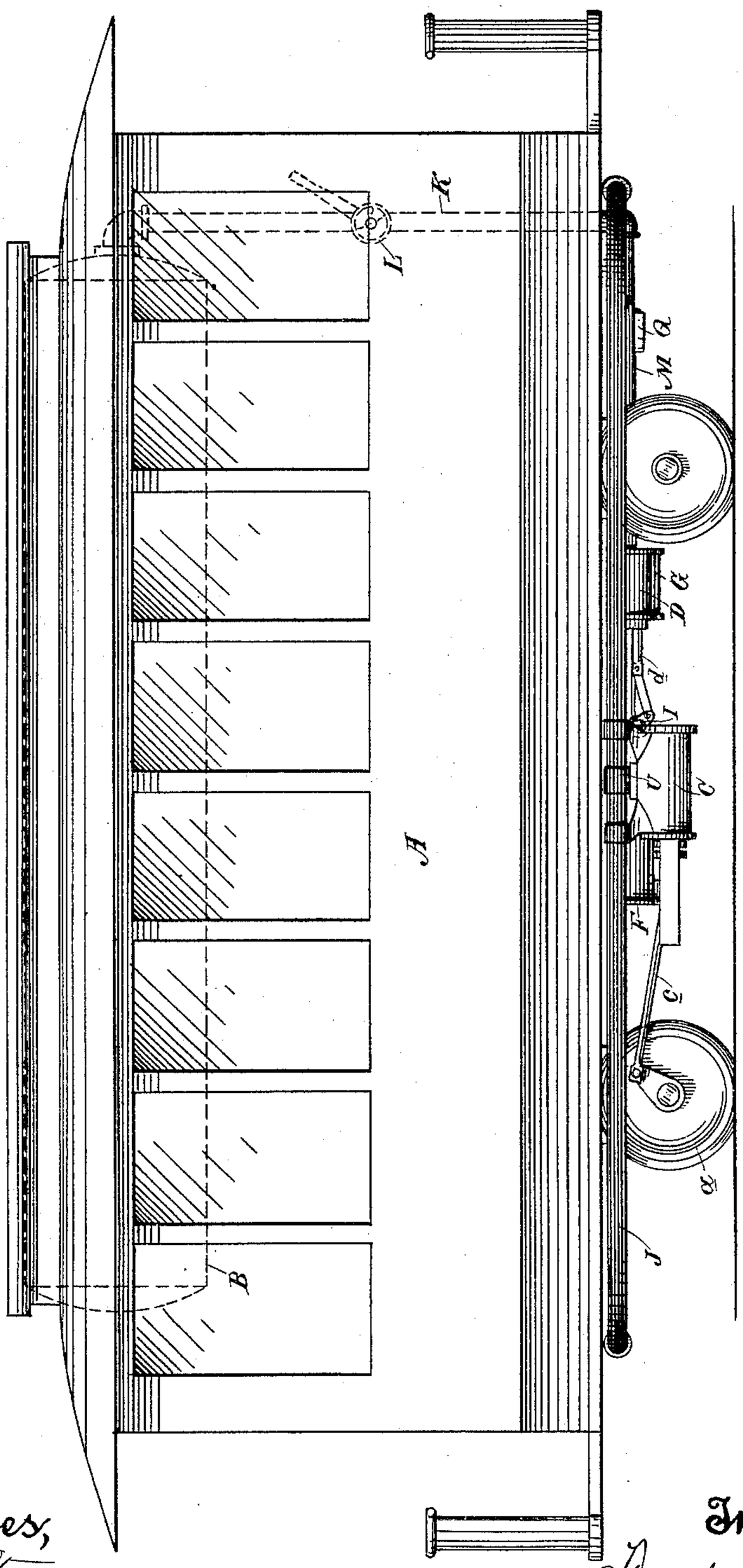

Fig. 1.

Witnesses,
Geo. H. Strong.
J. L. Ernest

Inventor,
Frank M. Merrill
by Dewey & Co. attys

(No Model.) 3 Sheets—Sheet 2.

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COMPRESSED AIR STREET CAR MOTOR.

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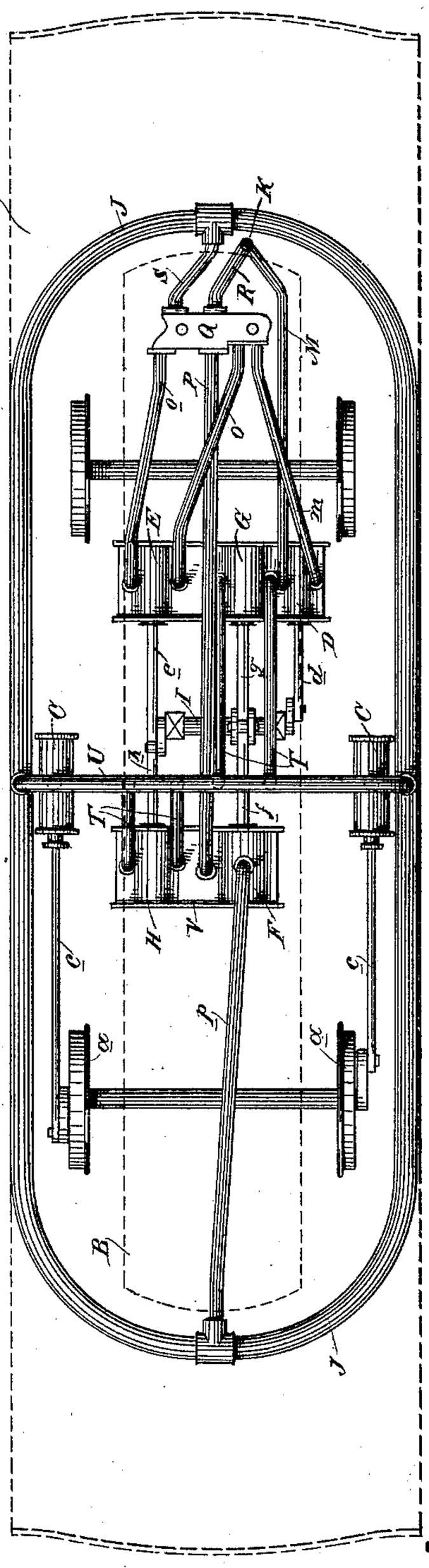

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

F. M. MERRILL.

COMPRESSED AIR STREET CAR MOTOR.

No. 435,020. Patented Aug. 26, 1890.

Fig. 3.

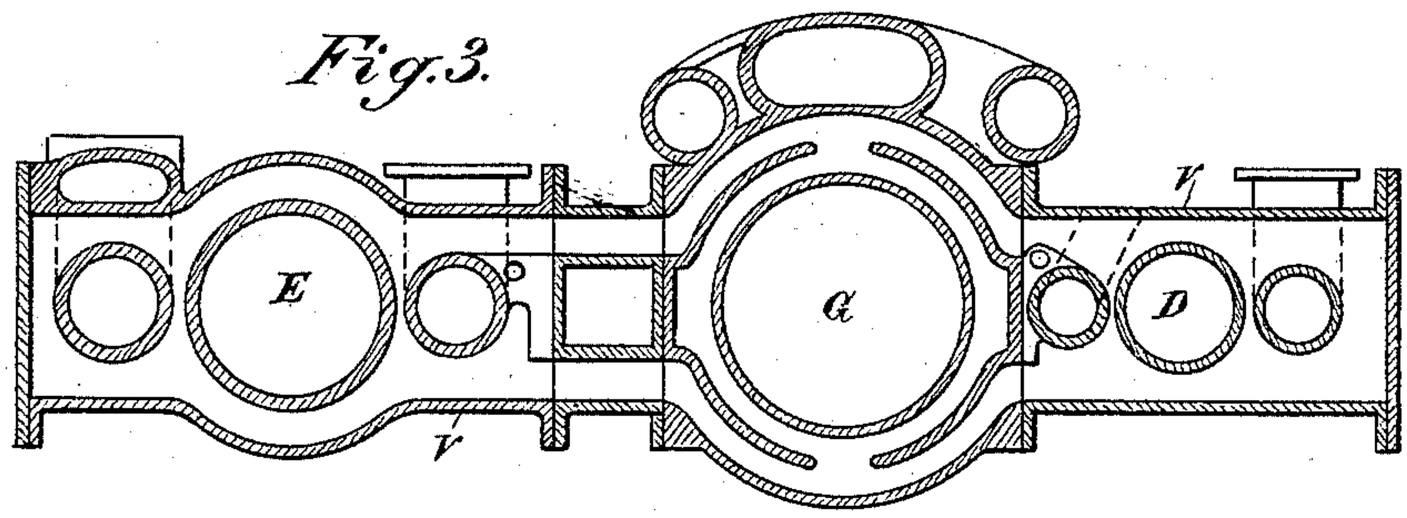


Fig. 4.

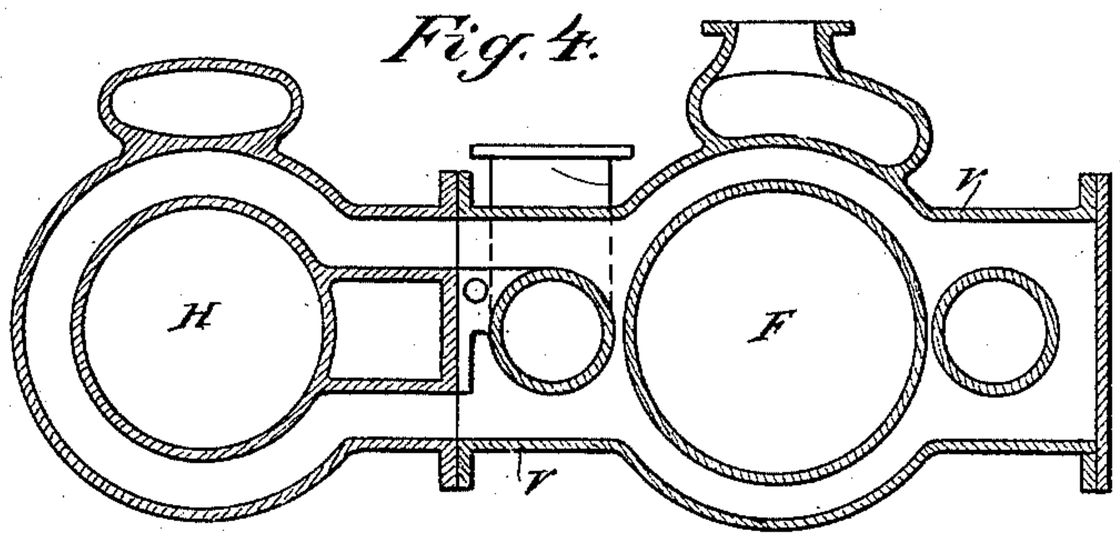


Fig. 5.

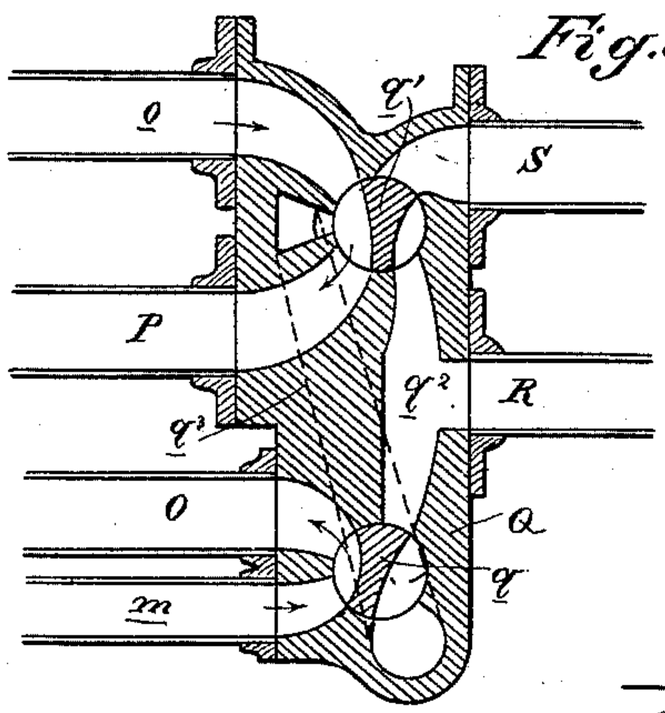


Fig. 6.

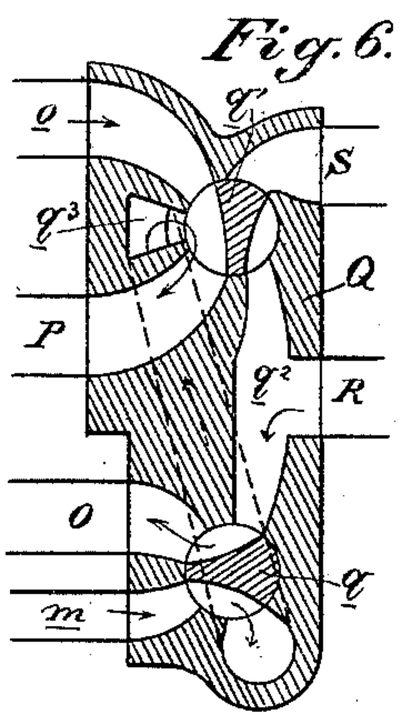
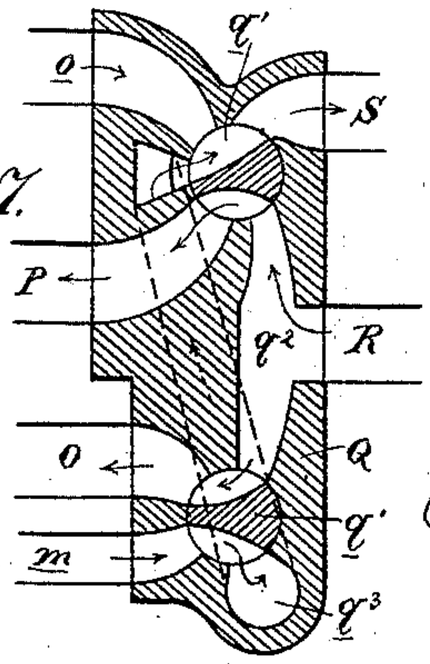


Fig. 7.



Witnesses,
Geo. H. Strong.
J. B. Hunsle

Inventor,
Frank M. Merrill
By Dewey & Co.
Attys.

UNITED STATES PATENT OFFICE.

FRANK M. MERRILL, OF OAKLAND, CALIFORNIA.

COMPRESSED-AIR STREET-CAR MOTOR.

SPECIFICATION forming part of Letters Patent No. 435,020, dated August 26, 1890.

Application filed January 2, 1890. Serial No. 335,639. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. MERRILL, a citizen of the United States, residing at Oakland, Alameda county, State of California, have invented an Improvement in Compressed-Air Street-Car Motors; and I hereby declare the following to be a full, clear, and exact description of the same.

My invention relates to that class of street-car motors in which the car-frame carries a suitable tank or reservoir as a receiver and holder of compressed air, and from which said air is drawn by means of suitable connecting and properly-controlled communications and admitted to the drive-cylinders.

My invention consists, essentially, in the provision of a series of communicating-cylinders intermediate between the drive-cylinders and the compressed-air receiver, in which the air is allowed to expand from the excessive degree of compression which it has in the receiver down to the necessary compression for use in the drive-cylinders; and, in connection with said expansion-cylinders, one or more air-compression-cylinders, the pistons of which are operated by power derived from the expansion-cylinders, said air-compressing-cylinders being peculiarly arranged with respect to the expansion-cylinders, and adapted to direct what air they compress into the drive-cylinders to act in conjunction with the expanded air, all of which, together with details of arrangement, I shall hereinafter fully describe, and specifically point out in the claims.

The essential object of my invention is to utilize the expansive force of the compressed air, which is being necessarily reduced from the high degree of compression in the receiver to the compression adapted for use in the drive-cylinders, by making said air during this course of operation useful in compressing more air; and another object is to provide against the excessive refrigeration of the parts due to the tremendous expansion which takes place as the air is being reduced from its original compressed state to a state necessary to work in the cylinders.

Referring to the accompanying drawings for a more complete explanation of my invention, Figure 1 is an elevation of my car. Fig. 2 is a plan view, the bottom of car taken off. Figs. 3 and 4 are vertical sections through the series of cylinders. Figs. 5, 6, and 7 are diagrams of the valve Q, showing its different positions.

A is a car of any suitable construction. In the top of this car, or in any other suitable part, is located and carried the receiver B, which contains compressed air, and which is to hold it for use during the entire trip of the car.

C are the driving-cylinders, one on each side of the car below, and having their pistons *c* connected with the cranks of the drive-wheels *a* of the car, whereby motion is imparted to the car.

Under the car is located the first and smallest of the series of expansion-cylinders, represented by D. E is the second expansion-cylinder, larger than the first, and located in the same transverse line as the cylinder D, but separated therefrom. F is the third expansion-cylinder, larger than the second. Between the expansion-cylinders D and E is a compressing-cylinder G, and on one side of the expansion-cylinder F is a compressing-cylinder H. The several piston-rods *d*, *e*, and *f* of the expansion-cylinders are connected with the crank-shaft I, with which the piston-rods *g* and *h* of the compressing-cylinders are likewise connected, so that the power of the three expansion-cylinders is directed to said shaft, effecting its rotation, and through it operating the pistons of the compressing-cylinders, which take their air directly from the atmosphere.

J is a pipe into which the third expansion-cylinder F exhausts through a pipe *p*, said pipe communicating with the drive-cylinders, whereby the expanded air is admitted to them.

K is the pipe by which the air is taken from the receiver B above, and L is a valve of suitable construction controlling said pipe. From the pipe K extends the admission-pipe M to the first expansion-cylinder, and *m* is the exhaust from said cylinder.

O is the admission-pipe of the second expansion-cylinder, and *o* is the exhaust-pipe therefrom.

P is the admission-pipe of the third expansion-cylinder, and *p* is its exhaust-pipe. These several admission and exhaust pipes

I have arranged to accomplish the following objects: When the air in the receiver is at its highest pressure, I find it necessary to expand it down to the pressure for use in the driving-cylinders by passing it successively through the three expansion-cylinders—that is to say, admitting it first to the first cylinder, exhausting it thence into the second cylinder, exhausting it thence into the third cylinder, and thence into pipe J. This mode of operation may be termed working the cylinders "tandem;" but as the pressure in the receiver B diminishes it will be found necessary to work two of the expansion-cylinders by direct admission from receiver B to each, and this may be termed working them "two abreast." Likewise when the pressure in receiver B is still further reduced it will be necessary to work the three cylinders abreast.

Now, to effect these several modes of operation, I arrange the pipes as follows: Q is a ported casting. In one end is a valve q of the rotary pattern, with a groove forming a port on each side, and in the other end is a similar valve q'. The exhaust-pipe m from the first expansion-cylinder communicates with the casting at the valve q, as does also the admission-pipe to the second cylinder. The exhaust-pipe from the second cylinder communicates with the casting at the valve q', as does also the admission-pipe to the third cylinder. In the back of the casting is a port q^2, which extends to each valve, and with this port communicates the pipe R, which extends from the supply-pipe K, and may be called the common "admission-pipe." With the valve q' also communicates a pipe S, which communicates also with the pipe J of the driving-cylinders, and may be termed the common "exhaust-pipe." Finally, in the casting Q is made a passage q^3, connecting the two valves. Now, in operation, if it be desired to work the cylinders tandem, the valves q and q' are turned to connect the pipes m, O, o, and P, and the course of the air then is through pipe M, first cylinder, pipe m, valve q, pipe O, second cylinder, pipe o, valve q', pipe P, third cylinder, pipe p, pipe J, to the driving-cylinders. The valves are shown in this position in Fig. 5. When it is desired to work the first and second cylinders abreast, I turn the valve q to the position shown in Fig. 6, leaving the valve q', as shown in Fig. 5, for working tandem. The course then is from K through M, first cylinder, pipe m, valve q, passage q^3, valve q', into pipe P of third cylinder; also, from K through pipe R, port q^2, valve q, pipe O, second cylinder, pipe o, valve q', into pipe P of the third cylinder. When it is desired to work all three cylinders abreast, I turn the valves to the positions shown in Fig. 7. Then the course is from K through pipe M, first cylinder, pipe m, valve q, passage q^3, valve q', and common exhaust-pipe S, and thence into pipe J; also, from K through common admission-pipe R, port q^2, valve q, pipe O, second cylinder, pipe o, valve q', common exhaust-pipe S, and thence into pipe J; also, from K through pipe R, port q^2, valve q', pipe P, third cylinder, pipe p, and pipe J. The air in any of the courses described operates by expansion. The pistons of the expansion-cylinders, and the power which would ordinarily be wasted, is thus utilized in driving the compressing-cylinders, thereby compressing more air. These compressing-cylinders are connected by pipes T with a cross-pipe U, which admits the compressed air to the driving-cylinders, in conjunction with the air which is passed through the expansion-cylinders.

This is the first and main object of the invention—namely, to utilize what power would otherwise be lost in the reduction of the compression of the air to the necessary point by making it subserve the further purpose of compressing more air derived directly from the atmosphere.

There is another object in this construction—namely, to utilize the heat generated by the compressing-cylinders in ameliorating the intense refrigeration of the expansion-cylinders. This I do by locating the compression-cylinders beside the expansion-cylinders and surrounding all of them by means of a jacket V for containing water or other heat-conveyer, and thereby utilizing the heat of the compression-cylinders to somewhat raise the temperature of the expansion-cylinders.

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

1. In a compressed-air street-motor, the combination of expansion and compressing cylinders for the purpose of utilizing the expansive force of the air while it is being reduced from the initial compression to the final compression necessary for use, substantially as herein described.

2. In a compressed-air street-motor, a cylinder and operative parts intervening between and communicating with the compressed-air receiver and the driving-cylinders, whereby the compressed air is reduced by expansion from its initial compression to the compression necessary for use in the driving-cylinders, and an air-compressing cylinder and operative parts operated by the expansion-cylinder, whereby more air is compressed and delivered to the driving-cylinders, substantially as herein described.

3. In a compressed-air street-motor, a series of communicating-cylinders and operative parts intervening between and communicating with the compressed-air receiver and the driving-cylinders of the motor, whereby the compressed air is successively reduced by expansion to the compression necessary for use in the driving-cylinders, and air-compressing cylinders and operative parts operated by the expansion-cylinders, and adapted to compress the external air and direct it to the driving-cylinders, substantially as herein described.

4. In a compressed-air street-motor, the compressed-air receiver and the driving-cylinders, in combination with the graduated series of communicating expansion-cylinders, said series communicating with the compressed-air receiver and with the driving-cylinders, and the air-compressing cylinders operated by the expansion-cylinders and communicating with the drive-cylinders, substantially as herein described.

5. In a compressed-air street-motor, the series of communicating expansion-cylinders, by which the air is reduced to the compression necessary for use in the driving-cylinders of the motor, the pipes by which said cylinders communicate with the air-receiver and with each other, and the valves by which these communications are controlled, whereby the cylinders may be operated by air passed from one to the other or by air direct from the receiver, substantially as herein described.

6. In a compressed-air street-car motor, the compressed-air receiver and the driving-cylinders, in combination with the series of communicating expansion-cylinders communicating with the air-receiver and with the driving-cylinders, the air-compressing cylinders operated by the expansion-cylinders and communicating with the driving-cylinders, the valve-controlled supply-pipe from the air-receiver, the pipes by which the expansion-cylinders communicate with the air-receiver and with each other, and the valves by which these communications are controlled, whereby the cylinders may be operated by air passed from one to the other or by air direct from the receiver, substantially as herein described.

7. In a compressed-air street-car motor, the expansion-cylinders intervening between the air-receiver and the driving-cylinders, whereby the air is reduced to the degree of compression necessary for use in the driving-cylinders, the air-compressing cylinders operated by the expansion-cylinders, and a jacket for water or other heat-conveyer common to the compressing and expansion cylinders, whereby the temperature of the latter cylinders is raised, substantially as herein described.

In witness whereof I have hereunto set my hand.

FRANK M. MERRILL.

Witnesses:
S. H. NOURSE,
H. C. LEE.