

(No Model.)

2 Sheets—Sheet 1.

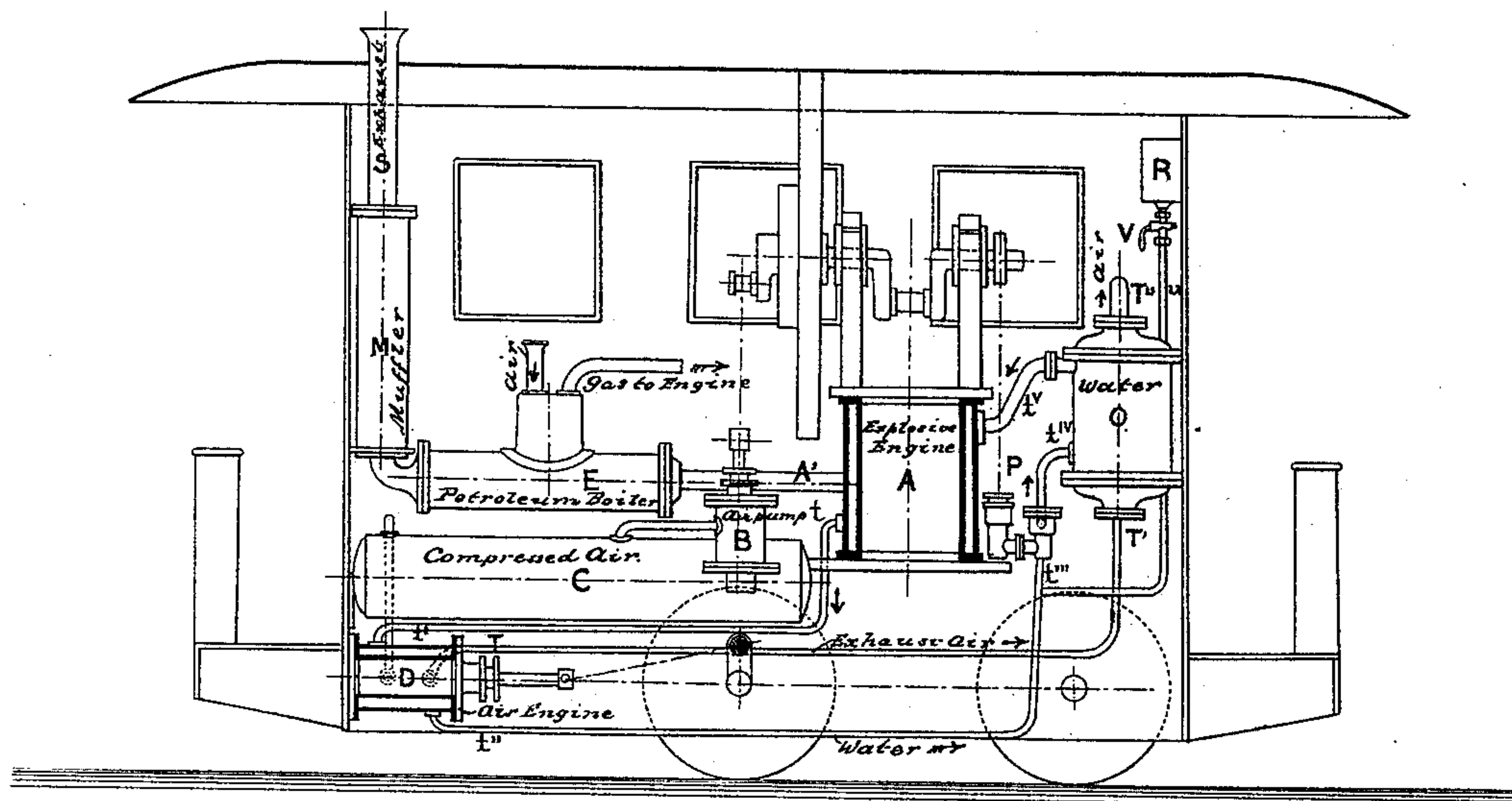
E. STEVENS.

COMBINED GAS AND COMPRESSED AIR ENGINE.

No. 414,173.

Patented Oct. 29, 1889.

FIG. 1



Witnesses:

E. J. Griswold
John Revell

Inventor:

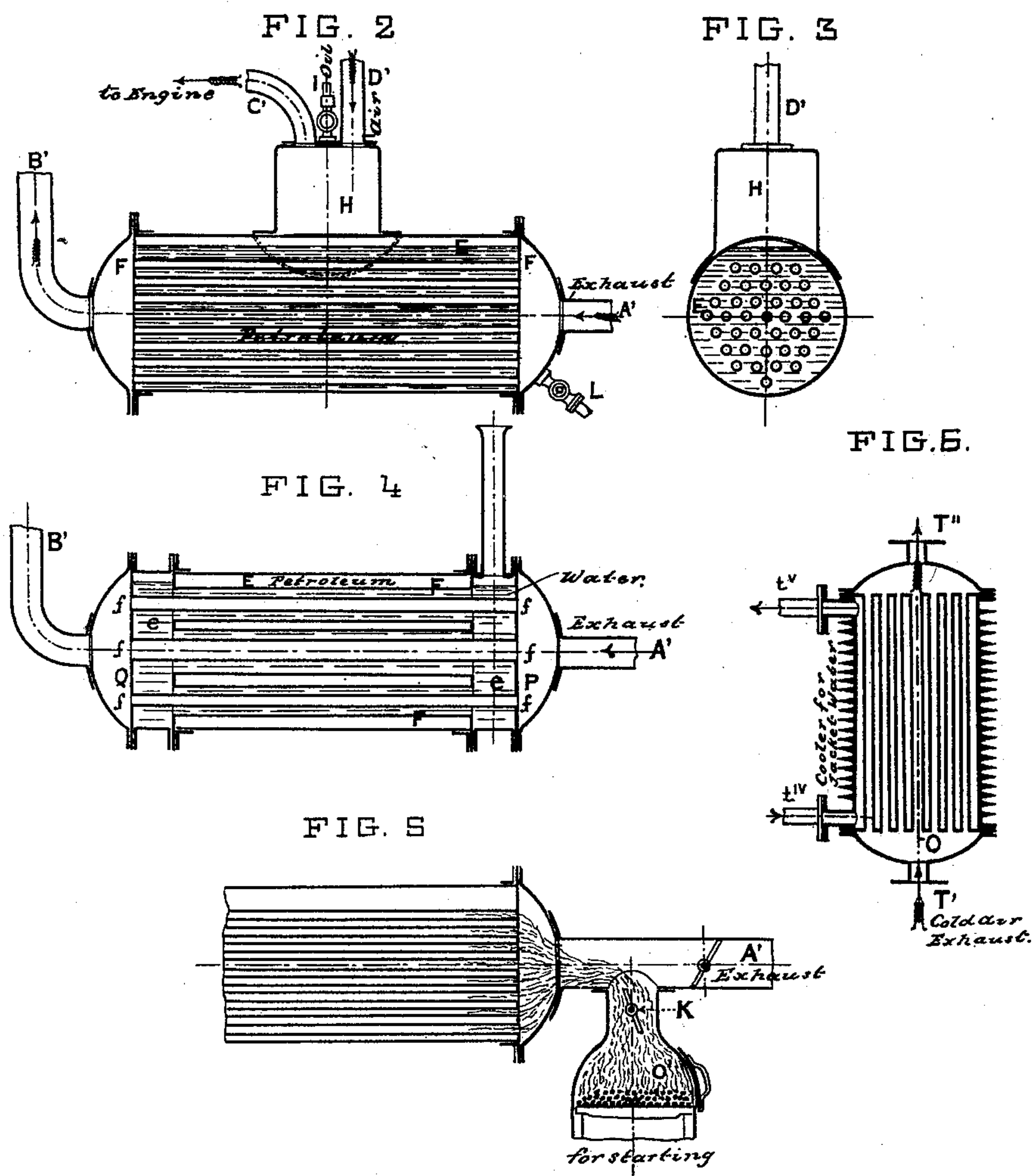
Emanuel Stevens
By his Attorneys
Howden and Howden

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Witnesses

John Revell
S. C. Connor

Inventor

Emanuel Stevens
By his Attorneys Howard and Howard

UNITED STATES PATENT OFFICE.

EMANUEL STEVENS, OF BRUSSELS, BELGIUM, ASSIGNOR OF ONE-HALF TO
JAMES MORISON BURNUP, OF LONDON, ENGLAND.

COMBINED GAS AND COMPRESSED-AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 414,173, dated October 29, 1889.

Application filed November 6, 1888. Serial No. 290,148. (No model.) Patented in Belgium March 16, 1887, No. 76,731; in England March 31, 1887, No. 4,843; in France September 15, 1887, No. 185,874, and in Germany October 7, 1887, No. 43,059.

To all whom it may concern:

Be it known that I, EMANUEL STEVENS, a subject of the King of Belgium, residing at Brussels, in the Kingdom of Belgium, have
5 invented certain Improvements in Combined Gas and Compressed-Air Engines, (for which I have obtained a Belgian patent, No. 76,731, dated March 16, 1887; a British patent, No. 4,843, dated March 31, 1887; a French patent,
10 No. 185,874, dated September 15, 1887, and a German patent, No. 43,059, dated October 7, 1887,) of which the following is a specification.

This invention consists in certain improvements in motors applicable to locomotive-engines for carriages, tramway-vehicles, and
15 other purposes.

The improvements consist, essentially, first, in the combination of a motor actuated by hydrocarbon vapors or gases and driving an
20 air-compressing pump with another motor actuated by this compressed air, all the cylinders of the motors being jacketed, and water is caused to circulate through these jackets, so as to cool the cylinder or cylinders of
25 the gas-motor and to warm the cylinder or cylinders of the air-motor, being kept at a proper temperature by passing through a refrigerator in this circuit; second, in a peculiar carbureting apparatus, in which a mixture
30 of air, compressed or otherwise, and naphtha, petroleum, or other hydrocarbon vapor is produced for actuating the gas-motor.

In the accompanying drawings, Figure 1 is an elevation, partly in section, of a locomotive
35 for trams according to this my invention. Figs. 2 and 3 are respectively longitudinal and transverse sections of the carbureting apparatus. Fig. 4 is a longitudinal section of an alternative form of the same. Fig. 5 shows
40 a method of heating the carbureting-liquid when the apparatus is to be started. Fig. 6 is a longitudinal section of the apparatus for cooling or refrigerating the circulating water.

The gas-motor A serves, first, to actuate
45 the air-compressing pump B, and, secondly, to actuate the pump P for setting the water in circulation. The pump B compresses air into the receptacle C, whence the compressed air passes into the air-motor D, and after having

done its duty escapes into and through the 50 refrigerator O. The gas-motor A and the air-motor D may be of any usual and suitable construction, and the gas-motor A can very conveniently be simplified by taking compressed air from the receptacle C to mix with 55 the gas, so that no compression of the air is effected in the motor itself, as is usually the case.

The gas-mixture that actuates the gas-motor A may be produced from compressed air and 60 the vapor of naphtha, petroleum, or other hydrocarbons by either of the carbureting apparatus shown in Figs. 2 and 3 or 4.

The apparatus shown in Figs. 2 and 3 is 65 suitable for use when less volatile and less inflammable carbureting-liquids are used. A tubular boiler E is formed with double ends, and the carbureting-liquid is contained in this boiler, through the tubes F whereof
70 pass the exploded gases which leave the gas-motor A, and enter the boiler E through the passage A' and leave the boiler E through the passage B'. The vapors arising from the carbureting-liquid so heated accumulate in
75 the chest H, where they are mixed with air, which is supplied through the pipe D', and the mixture passes away, as required, to the gas-motor A through the pipe C'. The carbureting-liquid enters the boiler E through
80 the pipe I. When the apparatus is to be started, the necessary heat must obviously be supplied from and by an extraneous source. This can be effected either by steam produced by means of a petroleum-boiler and entering through the pipe I, or, as shown in
85 Fig. 5, a furnace O', for wood, coal, or other fuel, may be connected with the passage A', the products of combustion being allowed to pass to the tubes F by opening a throttle-valve K, the passage A' being likewise provided with a throttle-valve to prevent these
90 products passing to the gas-motor A, and after the apparatus has started, to regulate the quantity of the gases to be allowed to enter the boiler E, before which valve a pipe
95 branches off from the passage A', leading direct to the exhaust.

The apparatus shown in Fig. 4 is more suit-

able for use when very volatile and very inflammable carbureting-liquids are used. The end or the tube plates P and Q of the boiler E are double, and through the tubes F, which
 5 extend only to the inner end or tube plates, are passed the smaller tubes *f*, which extend to the outer end or tube plates, and through these tubes *f* the exploded gases pass. The spaces *e*, between the end or tube plates and
 10 the spaces between the tubes F and *f* are filled with water, so that the gases in passing through the tubes *f* impart their heat primarily to the water and not directly to the carbureting-liquid, and as the water so heated
 15 can be drawn off and replaced by cold water, it is obvious that the degree of heat in this boiler can be exactly regulated and all danger of explosion prevented.

The cylinders both of the gas-motor A and
 20 of the air-motor D are jacketed, and these jackets are connected by the pipe *t t'*, and the jacket or jackets of the air-motor D is or are connected by the pipe *t'' t'''* with the pump P, the discharge-pipe *t^{IV}* of which is led to the
 25 cooling or refrigerating apparatus O. A longitudinal section of this cooling or refrigerating apparatus O is shown in Fig. 6, and it is essentially similar to a tubular boiler, the outer casing or jacket whereof may be pro-
 30 vided, as shown, with ribs to assist the radiation. The air leaves the air-motor through the pipe T, and entering this apparatus O through the passage T' passes through the tubes therein and escapes through the pas-
 35 sage T'', and in this passage the air must obviously expand, and thereby become capable of absorbing a considerable amount of heat. The water, as aforesaid, is drawn by the pump P from the jackets of the gas and air motors,
 40 and is forced through the pipe *t^{IV}* into the spaces surrounding the tubes in the apparatus O, through which tubes the air passes, whereby the water is cooled before it passes through the pipe *t^V* back to the jacket or jackets of
 45 the gas-motor A, and thus the desired circulation of the water at a proper temperature is maintained. The receptacle O for the compressed air may likewise be jacketed, as also may the pump B, in which case the water is

also in a similar manner circulated through
 these jackets. To compensate for the gradual
 loss of this water a cold-water reservoir R can
 be arranged, from which cold water can be led
 directly into the pipe *t'' t'''*, or otherwise,
 through the pipe *u*, by opening the cock V, as
 55 and when required.

In some cases it may be possible to dispense with the pump P and to produce sufficient circulation by the different densities of the water in the different parts of the circuit. 60

To prevent the resistance of the compressed air from being exercised when the gas-motor is set in action, a cock is preferably provided at the air-pump and opened, so that the air-pump runs free at first; or the pump may be
 65 entirely disengaged and afterward be set in action.

This motor as so combined may obviously be employed for any suitable purpose.

I claim as my invention and desire to se-
 70 cure by Letters Patent—

1. The combination of a gas-motor A, having one or more jacketed cylinders and driving an air-compressing pump B, an air-motor D, also having one or more jacketed cylinders,
 75 and a refrigerator O, also jacketed, wherein cold is produced by the expansion of the exhaust-air from the air-motor, the jackets of the cylinders aforesaid and of the refrigerator being in connection, whereby a current of
 80 water may be caused to flow through the said jackets, the whole combined and acting substantially as and for the purposes described and set forth.

2. The combination, with the motor comprising the apparatus A, B, D, and O, as set forth, of a carburetor consisting of a tubular boiler E, wherein the evaporation of the carbureting-liquid may be effected by the exhaust-gases from the gas-motor A, and comprising
 90 the tubes F or the tubes F and *f*, substantially as and for the purpose set forth.

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

EMANUEL STEVENS.

Witnesses:

GEORGE BEDE,
 ADOLF STEIN.