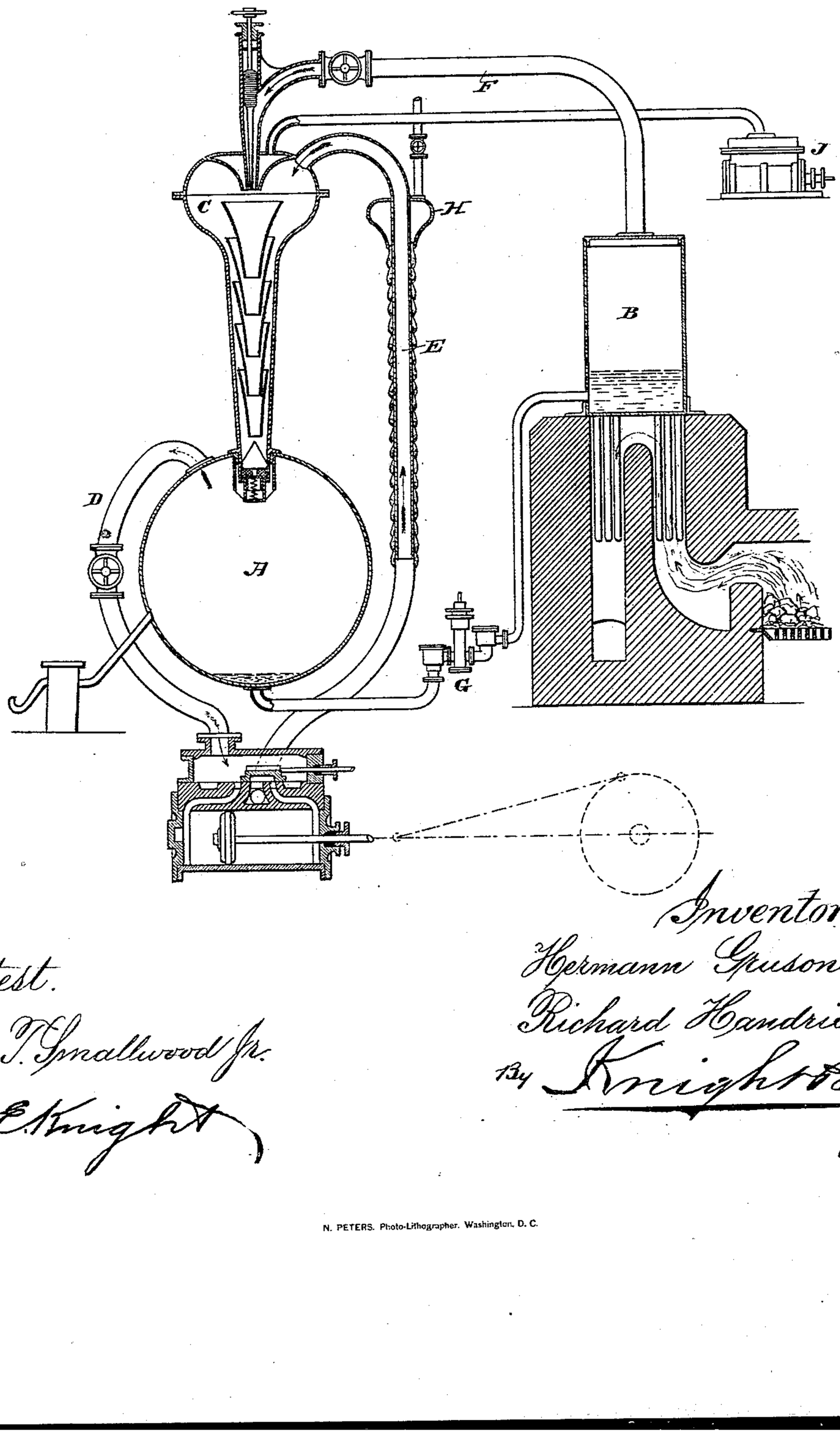
(No Model.) 2 Sheets—Sheet 1.

H. GRUSON & R. HANDRICK.

REGENERATING EXHAUST.

No. 277,271. Patented May 8, 1883.

Fig 1.



Attest.

Geo. T. Snallwood Jr.

H. E. Knight

Inventors:

Hermann Gruson and

Richard Handrick.

By Knight Bros

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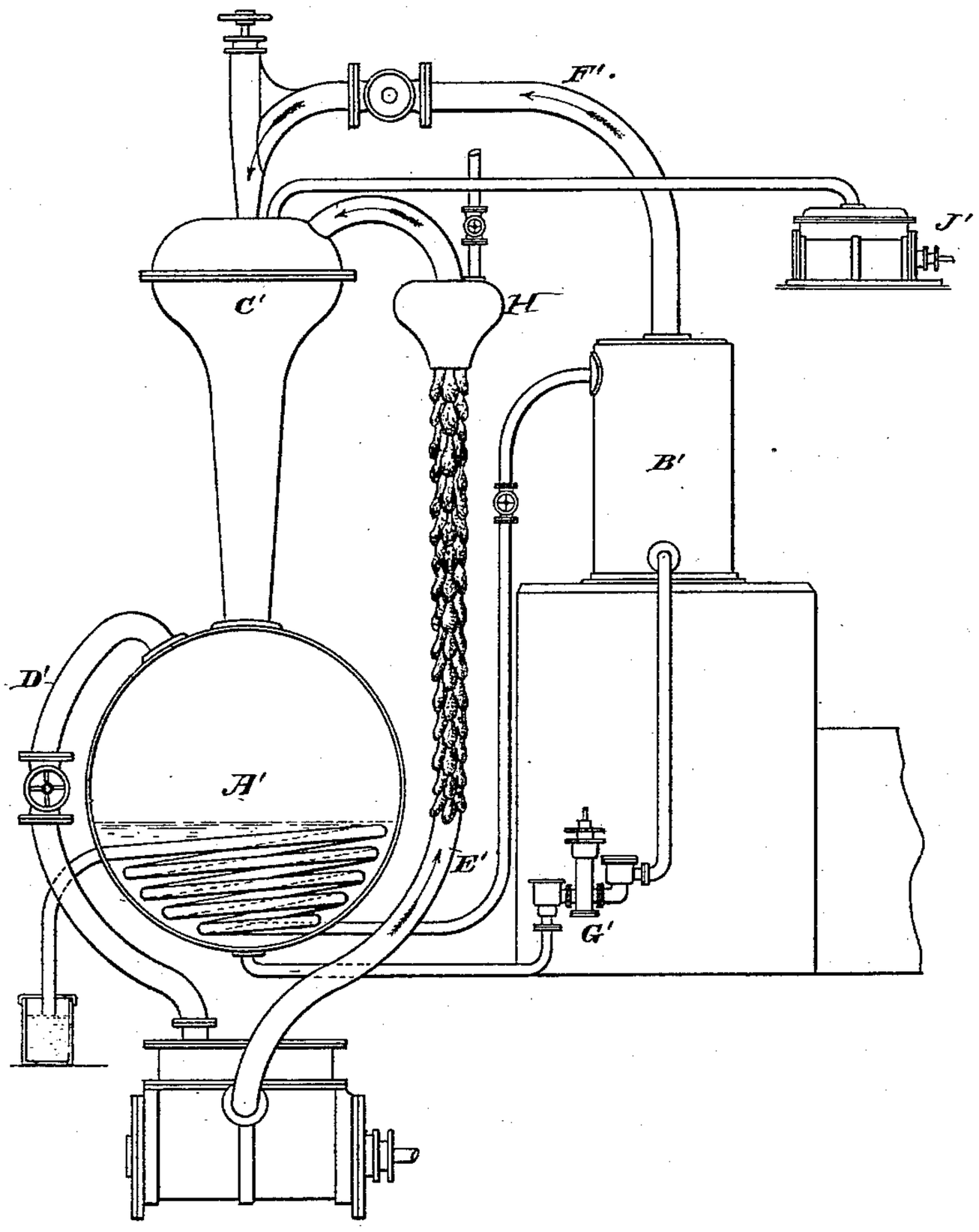
Fig 2.



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UNITED STATES PATENT OFFICE.

HERMANN GRUSON AND RICHARD HANDRICK, OF BUCKAU, NEAR MAGDEBURG, PRUSSIA, GERMANY.

REGENERATING EXHAUST.

SPECIFICATION forming part of Letters Patent No. 277,271, dated May 8, 1883.

Application filed December 9, 1882. (No model.) Patented in France September 7, 1882, No. 151,000; in Belgium September 14, 1882, No. 59,020; in England September 27, 1882, No. 4,598; in Austria-Hungary December 12, 1882, No. 30,007 and No. 49,001; in Sweden December 20, 1882; in Portugal December 28, 1882, No. 810, and in Italy December 31, 1882, XVI, 14,709, XXIX, 239.

To all whom it may concern:

Be it known that we, HERMANN GRUSON and RICHARD HANDRICK, both of Buckau, near Magdeburg, in the Kingdom of Prussia, Germany, have invented a certain new and useful Improvement in Regenerating Exhaust, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same.

This invention relates to an improved method of utilizing heat, which hitherto has been wasted, for driving engines or the like, whereby the heat is so completely converted into mechanical power that only the amount incidental to the construction of such engines is lost.

According to this invention we employ an injector for forcing again into a receiver the vapor, (after it has spent itself in driving an engine or motor,) not in a condensed state, but in an elastic or gaseous form, and thus render again useful the heat, which hitherto escaped unused from the engine, for the continuous maintenance of the same. It will thus be seen that this invention is constructed upon the mechanical principle which forms the basis of the Giffard injector—that is to say, the application of this injector for the suction and forcing of vapors and gases.

In the Giffard injector vapor (generally steam) at a greater or less pressure flows over a vessel in which there is a liquid (generally water) whose temperature is so regulated that the said vapor is condensed on coming into contact with the liquid. In consequence of this condensation the volume of the vapor is diminished, while its innate living force remains unaltered, and thereby the fluid particles, formerly gaseous, are able not only to force themselves into a vessel or boiler in which there is steam at a high pressure, but also to carry with them into the same other fluid particles. In Giffard injectors as hitherto constructed this principle was made use of generally for the suction of a liquid for the purpose of feeding a boiler; but theoretically it may be seen that an elastic or gaseous fluid, under certain conditions, will follow the given impulse and be driven into a receiver or vessel under pressure when the main condition—*i. e.*, the diminution of volume of the gaseous fluid—is fulfilled. This is the case when the vapor working the injector is of such a temperature that it condenses on coming into contact with the vapor used for the working of the engine. An apparatus constructed upon this principle works upon the condition that two sorts of vapors condensing at different temperatures are made use of for the injector and the motor, such that the vapor of the injector condenses on contact with the vapor of the motor. It is thus clear that under such conditions the vapor emerging from the engine, without being condensed, can be forced into the receiver and again used for driving an engine or the like. The correctness of the conclusions before mentioned is ascertained by analytic searches, as well as by sufficient practical trials made on a steam-engine by the inventors.

Suitable apparatus for carrying our invention into effect is illustrated in the accompanying drawings, in which Figures 1 and 2 are both vertical longitudinal sections.

In Fig. 1, A represents the receiver for holding vapor for working the motor; B, the boiler for generating vapor for working the injector, and C the injector. The vapor for working the engine is conveyed to the cylinder through the pipe D. Through the pipe E the exhaust-vapor is conveyed to the injector, and thence again to the receiver A.

The construction of the apparatus will vary according to the nature of the two kinds of vapors which are used; but the main principle remains the same in all cases. Should, for instance, the regenerating-injector be required to conduct the exhaust-steam of a common steam-engine back to the receiver, the injector would have to be worked by means of a vapor which condenses on contact with steam—for instance, with mercury or some other vapors that condense at a high temperature. Practically the invention would be of little use under these circumstances on account of the high temperature of condensation and the

disadvantages attendant upon the production of such temperature. It is much more preferable to work the engine with vapors condensing at a lower temperature than steam and to use steam or vapors of similar nature to work the injector. For instance, for working the motor or engine either alcohol, acetone, chloroform, chloride of carbon, sulphuret of carbon, ammonia, sulphuric acid, and the like can be employed, because on contact with the vapor of these steam condenses.

The source of actual heat and work is the injector-boiler B, inasmuch as the injector restores the amount of expended heat, which is thus again converted into work in the engine or motor, and also restores that which is lost through radiation, and this theoretically keeps up the vapor in the receiver A to its proper pressure, without its being necessary to conduct more heat to the said receiver. The working of the apparatus is regulated by the pressure and low temperature of the receiver vapors, which latter must be of such a temperature as to allow the injector vapors to condense on coming into contact with it. It follows that instead of the receiver vapor an incondensable gas can be taken, if it be mechanically compressed at a low temperature, into the receiver A.

In Fig. 1 of the accompanying drawings atmospheric air is to be used. The receiver A of an engine of any construction is filled, by hand-pumps or other suitable means, with compressed air which has a pressure equal to the steam-pressure before used. In the boiler B steam is generated. Through the pipe D the compressed air is conveyed to the cylinder of the engine, and through the pipe E the exhaust air reaches the injector, where it condenses the steam passing through the pipe F and is again compressed by the said injector into the receiver A. The condensed vapor that enters the receiver A at the same time gathers at the bottom of the vessel and is pumped out by means of the pump G into the boiler B.

As the injector, in consequence of its not being perfect in its action, requires more steam than should theoretically be conducted to it during its operation to insure permanency, it is necessary to get rid of the superfluous heat which it generates. This is accomplished by means of a cooling apparatus, H, from which the pipe E is constantly watered.

Another modification of the apparatus is advantageous under certain circumstances. It consists in assisting the cooling capacity of the air in the receiver by injecting water. In this case a more rapid condensation of the steam and a quicker development of pressure in the receiver A results, while, on the other hand, there is a larger quantity of water to pump out of the said receiver. A certain loss of pressure on account of imperfect construction is unavoidable. This can be restored by means of a small force-pump, J, to be driven from the crank-shaft of the engine.

In Fig. 2 ammoniacal gas is supposed to be the driving-vapor of the engine or motor. The receiver A′ is connected with the boiler B′, and these are similar in construction to the receiver and boiler A and B, Fig. 1. The receiver A′ is filled with a solution of sal-ammoniac, which latter is heated, by means of a steam-pipe from the boiler B′, to such a temperature that ammoniacal gas is formed. The water formed is taken away by means of a pump, G′. The compressed gas reaches the cylinder of the engine through a pipe, D′, and the exhaust gas is conveyed through the pipe E′ to the injector, which returns it to the receiver A′. The small unavoidable loss of gas is replaced by the pump J′ forcing some sal-ammoniac into the receiver. Instead of the ammoniacal gas, as already stated, any other gas of similar properties can be made use of.

We claim—

1. The process of regenerating the driving-fluid of a vapor-engine, which consists in injecting into the exhaust a different gas of greater specific density, and by this means regenerating the vapor and forcing it back into the receiver, substantially as described.

2. In combination with the apparatus for driving a vapor-engine, substantially as described, by the use of two different elastic fluids of different specific density, the apparatus for cooling and condensing the exhaust vapor before it enters the injector, substantially as set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HERMANN GRUSON.
RICHARD HANDRICK.

Witnesses:
EDWARD SCHLOIFA,
B. ROI.