

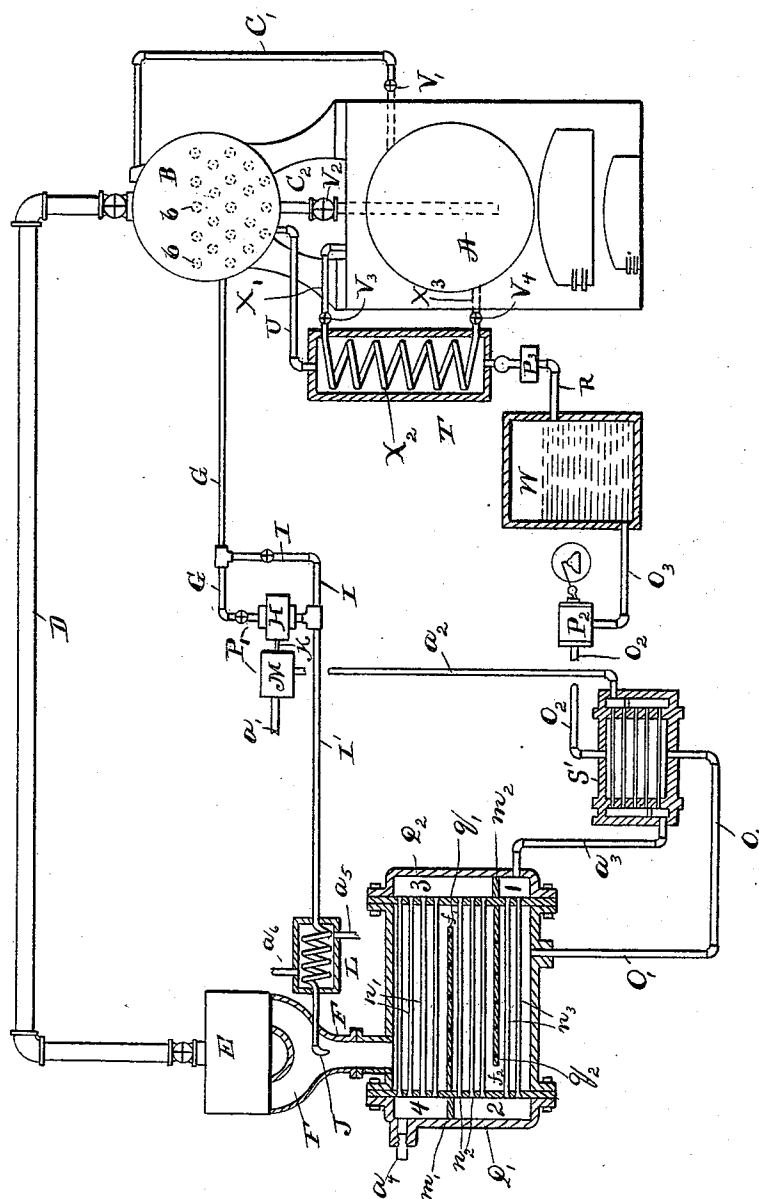
(No Model.)

J. H. CAMPBELL.

METHOD OF OPERATING VAPOR OR AMMONIA ENGINES.

No. 427,399.

Patented May 6, 1890.



Witnesses

W. E. Bower
C. L. Horack

Inventor

Joseph H Campbell
S W Ginsburgh
att'y

UNITED STATES PATENT OFFICE.

JOSEPH H. CAMPBELL, OF NEW YORK, N. Y.

METHOD OF OPERATING VAPOR OR AMMONIA ENGINES.

SPECIFICATION forming part of Letters Patent No. 427,399, dated May 6, 1890.

Application filed February 4, 1889. Renewed December 16, 1889. Serial No. 333,843. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH H. CAMPBELL, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented new and useful Improvements in Method of Operating Vapor and Ammonia Engines; and I do hereby declare the following to be a full, clear, and exact description of said invention, reference being had to the accompanying drawings, and to the letters or figures of reference marked thereon, which form a part of this specification.

My improvement relates to the operation of that class of vapor-engines in which the elastic medium employed is a gas held in solution by physical absorption in a liquid from which the gas is liberated when the solution is heated, and by which it is readily reabsorbed when the liquid is cooled.

The liquid which I employ is aqua-ammonia or ammonia-gas held in aqueous solution, and in the specification and claims I denominate the class of engines to which my invention applies as "ammonia-engines."

My invention also relates to the apparatus hereinafter described as used in the operations of such engines; but that portion of my invention forms the subject-matter of a separate application, Serial No. 298,632, filed February 4, 1889, and therefore is not claimed herein.

The accompanying drawing represents a vertical side elevation of my apparatus, partly in section.

A general description of the principal parts of the apparatus and its operation is as follows: A is a steam-boiler of any desired construction, in which steam is generated for the purpose of heating the aqua-ammonia, and from which steam is supplied for heating the aqua-ammonia on its return to the generator B. The generator B may be similar in construction to a tubular boiler, and is placed above the steam-boiler A, the tubes *b b* in the generator being connected with the steam-space of the boiler A by pipes *C'* and *C²*, so that steam entering the tubes *b b* from the pipe *C'* traverses the tubes and is returned with the water of condensation through pipe *C²* to the boiler at a point below the water-line, as shown in dotted lines. The valves *V'* and *V²* regulate the supply and return of

steam between the boiler and generator, and thereby, by regulating the heat applied to the contents of the generator B, correspondingly regulate the gas-pressure supplied to the ammonia-engine. The generator B is supplied with aqua-ammonia, the water-level being situate between the points where the pipes D and G enter the generator. D is the vapor-pipe which conducts the gas generated in the generator B (liberated from the aqua-ammonia by the steam traversing the tubes *b b*) to the ammonia-engine E, the piston of which is driven by the expansive force of the ammonia-gas. The vapor from engine E after doing its work is exhausted through the pipe F into the absorber S. The exhaust-gas is absorbed in the pipe F and absorber S by means of absorbing-liquid from the generator injected or sprayed into the pipe F by a spray-jet J.

It is one of the important features of my engines, described and claimed in a former patent, No. 337,371, that, to avoid the introduction into the circulation of my apparatus of additional water from without, the liquid used to absorb the exhaust is weak aqua-ammonia drawn from the generator B and cooled, in order to restore its power of absorbing ammonia before bringing it into contact with the exhaust-gas. For this purpose a pipe G from below the water-level of the generator B is led through a cooling-box L, whence it enters the exhaust-pipe F at J. This liquid, as it leaves the generator B, is a weak aqueous solution of ammonia, the ammonia being constantly liberated from the water by the steam-heat of the generator, the gas passing off to the engine, while the water remains behind. This cooled weak solution passes into the exhaust-pipe F, where it is sprayed into and over the exhaust-gas, passing with it into the absorber S, which is cooled by cold water or otherwise, and whereby the gas is absorbed by the weak solution, forming a strong solution, which, passing out of the absorber, is drained by gravity into the bottom of the secondary absorber *S'*, and from there is forced by a vacuum-pump *P²*, of ordinary construction, adapted to draw the solution and any free gas carried therewith from the absorber *S'* and force it into a well W. The well W is a close vessel for the purpose of

holding the liquid forced therein under pressure, so that any free gas which may have escaped absorption may now be forced by the pressure in the well to enter into solution with the liquid therein, whence the strong solution is forced back into the generator to keep up the supply for continuous operation.

I will now proceed to describe those parts of the apparatus which have special reference to the improvements claimed herein as my invention. There are certain parts of the apparatus which require the use of power for their operation—such, for instance, as the pumps P' , P^2 , and P^3 —which in such apparatus it is usual to operate by means of the power of the main engine or, at any rate, by means of the expansive force of the gas drawn from the generator. In my engine, however, the power employed to drive the main engine is that of the gas liberated from the aqua-ammonia by the heat of the steam circulating in tubes from the steam-boiler, and I propose to drive the pumps P' , P^2 , P^3 referred to, or either of them, and any other parts of the machinery, by means of the liquid contained in the generator under generator-pressure—that is to say, under the pressure exerted on the surface of the weak solution by the gas generated therefrom and contained in the vapor-space of the generator. To accomplish this I attach the piston of the water-cylinder M , of the force-pump P' , to the piston-rod of a small engine H of ordinary construction, so that the same piston-rod K , operated by the engine H , operates the piston of the pump P' . I connect the slide-valve of the engine H , by a pipe G , with the generator B at a point below the water-level, and the pressure of the liquid or weak solution from the generator operates the engine. The exhaust from the engine H connects with the pipes I and I' , which, with the pipe G , form a line of pipe from the generator B to the exhaust-pipe F of the main engine E . By passing through and operating the auxiliary water-engine H , the weak solution from the generator is somewhat cooled. It thence passes through pipe I' , a part of which forms a worm inclosed in a cooling-box L , where it is surrounded by cold water, which is constantly running in and out of the cooling-box. The weak solution is thus cooled, and passes in that condition, by the pipe I' , into the exhaust-pipe F of the main engine, where it is discharged through a jet J in a downward direction into and among the exhaust ammonia-vapor from the main engine. It is important to have the weak solution when it enters the exhaust-pipe F as cool as possible, because the power of water to absorb ammonia-gas diminishes very rapidly as the heat of the water increases, and vice versa.

The pump P' is used to force cold water into the absorbers S and S' . M is the water-cylinder of such pump, having a suction-pipe a' and discharge-pipe a^2 . The by-pass pipe I , with a valve, may be used to connect the

pipes G and I' , so as to permit more or less of the weak solution from the generator to pass through the cooling-box L and into the exhaust-pipe F without passing through the water-pump H . A similar arrangement may be made for the operation of the pumps P^2 and P^3 or other water-motors connected with the apparatus, the exhaust-liquid from the engine being in such cases returned to the pipe I' or directly into the absorber S .

Another feature of my improvement consists in first cooling the weak solution of ammonia to impart to it the requisite capacity of absorbing the exhaust ammonia-gas from the engine, then after the absorption is complete and the ammonia solution becomes more nearly saturated, forcing it into a close vessel heated internally by live steam from the boiler, and then passing it in a heated condition back into the generator. The advantages of this operation are obvious. The ammonia solution having been cooled as much as possible, in order to promote absorption in the absorber S , would, if passed in this condition into the generator B , tend to chill the contents and seriously interfere with the generation of gas; but by heating the strong ammonia solution just before returning it into the generator it is in a condition to generate gas as soon as it enters a vessel such as the generator, having a vapor-space to receive it. As the heat of the steam in the boiler and not its pressure is used in my apparatus, I am enabled by this method of utilizing the steam to effect a considerable increase of economy and efficiency. In accomplishing this object I interpose between the well W on one side and the boiler A and generator B on the other side, a close reservoir T , which communicates with the liquid space of the well W by a pipe R , in the line of which is placed a small force-pump P^3 to force the aqua-ammonia from the well W to the reservoir T . This pump may be operated, as before described, in relation to pump P , or otherwise. From the upper part of the reservoir T a pipe U leads to and communicates with the liquid-space of the generator B . Inside of the reservoir T is a steam-coil X^2 , the upper end of which is connected, by a pipe X (furnished with a valve V^3), with the steam-space of the water-boiler A , and the lower part of the coil X^2 is connected by a pipe X^3 (also furnished with a valve V^4) with the water-space of the boiler. By this means live steam from the boiler A in such quantity as may be desired and determined by the valves passes downward through the coil X^2 and returns with the water of condensation to the boiler. It is obvious that the strong aqua-ammonia forced into the reservoir T from the well W , by the pump P^3 , will thus be considerably heated before it enters the liquid-space of the generator.

Another feature of my improvement in the operation of ammonia-engines consists in bringing together the yet uncombined ex-

haust-ammonia gas and weak ammonia-absorbing solution in a vessel around the exterior of a series of pipes traversed by a cooling-liquid, the passage of the gas and absorbing-liquid through the vessel and around the pipes being retarded by mechanical means, so as to increase the efficiency of the absorber by furnishing a more extended cooling-surface without a corresponding increase of the dimensions of the absorber.

I use absorbers of peculiar construction, which I will proceed to describe.

S is an absorber of plate-iron of any desired shape and outward conformation, preferably of oblong and substantially rectangular form, as shown in longitudinal section. The absorber has a double head at each end, formed by caps Q^1 and Q^2 , bolted onto the main body of the absorber. It is furnished throughout with a series of longitudinal tubes $n' n' n^2 n^2 n^3 n^3$, which at each end open into the water-ways formed by the double heads. The space at each end of the absorber formed by the caps Q^1 and Q^2 is divided into two water-ways, marked 1, 2, 3, and 4, by partitions m' and m^2 . These partitions m' and m^2 correspond in location and height with perforated diaphragms or division-plates q' and q^2 , each of which extends entirely across the interior of the absorber, and extends lengthwise from one end nearly to the other, the top diaphragm q' being attached to the tube-head at the left end where partition m' is located, and diaphragm q^2 to the tube-head on the right end where partition m^2 is located. By this arrangement the interior of the absorber is divided into three communicating-chambers, and spaces f' and f^2 are left at the ends of the diaphragms for the free passage of any liquid or gas which has not found its way from one chamber of the absorber to the other through the perforations of the diaphragm.

As before stated, the exhaust-pipe F of the engine communicates with the absorber S entering the upper chamber of that portion traversed by the tubes $n' n'$. The weak solution from the generator B, after operating the pump-engine or motor H and having been cooled in the cooling-box L, enters the exhaust-pipe F by the spray-jet J, and, together with the exhaust-gas from the main engine, (which has been to some extent absorbed by the solution) is carried downward into the absorber partly by the pressure of the gas in the generator and partly by action of the vacuum-pump P^2 , before mentioned, which communicates with the secondary absorber S' . The liquid entering at the jet J takes up a part of the vapor in the exhaust-pipe by absorption and carries the unabsorbed gas by adhesion through the pipe F into the upper chamber of the absorber. Here the gas and liquid pass around the tubes $n' n'$, which are cooled, as hereinafter described, the gas being more and more absorbed by the liquid as they become cooler. A portion of the liquid and gas passes

through the perforations in the diaphragm q' and the remainder passes through the space at the end of the diaphragm into the next division, and so on down to the lowest division of the absorber, and thence the liquid, having become cooled and having absorbed nearly if not quite all of the gas, and having thus been restored to the condition of a strong solution of ammonia, is drained by gravity through pipe O' into absorber S' , constructed similar to absorber S, entering the same at the bottom or below its liquid-line, and, after passing around the tubes, leaves it at the top, thus maintaining within it a body of solution for the purpose of entrapping and absorbing such free gas as may have been carried along by adhesion. The pump P^2 withdraws the solution from absorber S' and forces it, as before described, into the well W.

The absorber is cooled by means of water or other refrigerating-liquid passed through the tubes $n' n' n^2 n^2 n^3 n^3$ as follows: The cooling-liquid is pumped by the water-cylinder M of pump P' through pipe a^2 through the chambers and tubes of the absorber S' , from where it passes through pipe a^3 into water-way 1 in the head of the absorber S, whence it passes through tubes $n^3 n^3$ to water-way 2 on the other side, and through the tubes $n^2 n^2$ to the water-way 3 on the right-hand side, and thence through tubes $n' n'$ into water-way 4 on the left-hand side, and thence out through the pipe a^4 . The advantages of this method of operation over that heretofore employed of passing the gas and absorbing-liquid through the pipes of the absorber are that it gives a larger relative space for the gas and that less obstruction is offered to the gas before it reaches the cooling-surfaces, and it increases the cooling-space of the absorber without increasing its size, inasmuch as the cooling-surface presented to the absorbing-liquid is greater when the liquid to be cooled surrounds the pipes than when the cooling medium is outside and the liquid to be cooled passes through the pipes.

What I claim as new, and desire to secure by Letters Patent, is—

1. The method hereinbefore described of working ammonia-engine apparatus, consisting of operating the main engine with gas extracted by heat from the ammonia solution in a generator, and operating the auxiliary engine or engines from the same generator by means of the weak ammonia solution from which the gas has been partially extracted under the gas-pressure of the generator, substantially as described.

2. The method of operating a main vapor-engine and an auxiliary water engine or motor simultaneously by power generated in the same generator, the same consisting in subjecting aqua-ammonia or similar solution to heat in a generator, thereby causing the separation of the gas from the water, passing the gas produced from the vapor-space of the generator to the gas-engine to operate the

same, and the remaining weak solution from the liquid-space of the same generator to operate the water-engine, using the exhaust-water or weak solution from the water-engine to absorb the exhaust-gas from the gas-engine, and returning the solution with the gas absorbed thereby as aqua-ammonia to the generator, substantially as described.

3. The method hereinbefore described of operating an ammonia (or similar vapor) engine, consisting in subjecting aqua-ammonia or similar solution to heat in a generator, passing the gas thus evolved or separated from the solution to a vapor-engine to operate the same, commingling the exhaust-vapor from the engine with weak solution drawn from the generator, cooling such solution to increase its capacity for gas-absorption, effecting the absorption of the exhaust-gas by the weak solution in a refrigerated absorbing-vessel, then heating the strong solution thus obtained by means of live steam from the steam-boiler, and returning the same in a heated condition to the generator to keep up the supply of aqua-ammonia, substantially as described.

4. The method herein described of operating an ammonia (or similar vapor) engine, consisting in subjecting aqua-ammonia or similar solution to heat in a generator to separate the gas therefrom, passing the gas thus generated to a vapor-engine to operate the same, and passing some of the weak solution remaining in the generator (which is preferably partially cooled on its passage) to the exhaust-pipe of the engine, causing the mingled gas and weak solution to traverse the exterior surfaces of a series of pipes or tubes cooled by the passage through them of cold water

or other refrigerating-liquid, such pipes being arranged in a series of communicating chambers, partially separated by diaphragms, to effect a more perfect cooling of the absorbing-liquid and a more complete absorption of the gas, and returning the strong solution thus obtained to the generator to maintain the supply of aqua-ammonia, substantially as described.

5. The method herein described of operating an ammonia (or similar vapor) engine, consisting in subjecting aqua-ammonia or similar solution to heat in a generator to separate the gas therefrom, passing the gas thus generated to a vapor-engine to operate the same, and passing some of the weak solution remaining in the generator (which is preferably partially cooled on its passage) to the exhaust-pipe of the engine, causing the mingled gas and weak solution to traverse the exterior surfaces of a series of pipes or tubes cooled by the passage through them of cold water or other refrigerating-liquid, such pipes being arranged in a series of communicating chambers, partially separated by diaphragms, to effect a more perfect cooling of the absorbing-liquid and a more complete absorption of the gas, and introducing it into a second absorber below the liquid-line prior to returning the strong solution thus obtained to the generator to maintain the supply of aqua-ammonia, substantially as described.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

JOSEPH H. CAMPBELL.

Witnesses:

C. L. HORACK,
JAMES McLAIN.