

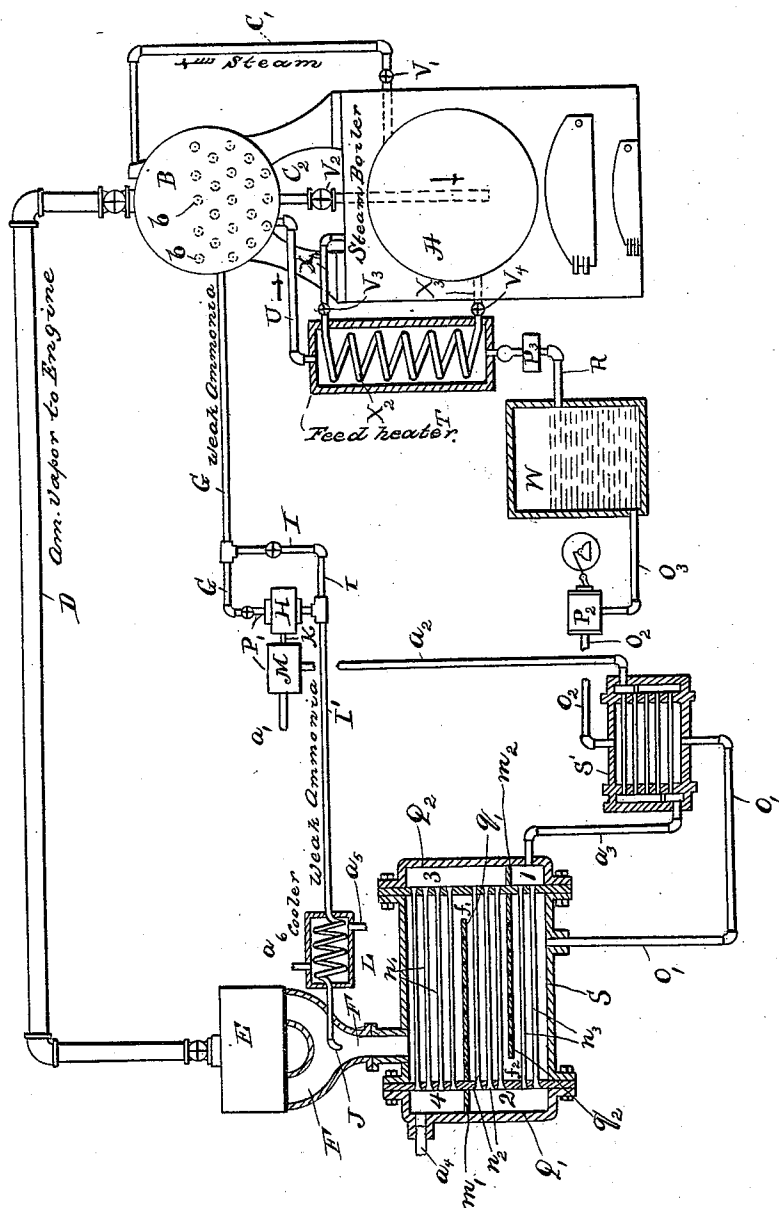
(No Model.)

J. H. CAMPBELL.

APPARATUS FOR OPERATING VAPOR OR AMMONIA ENGINES.

No. 427,400.

Patented May 6, 1890.



Witnesses

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APPARATUS FOR OPERATING VAPOR OR AMMONIA ENGINES.

SPECIFICATION forming part of Letters Patent No. 427,400, dated May 6, 1890.

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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 Apparatus for Operating Vapor or 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 drawing, and to the letters or figures of reference marked thereon, which forms a part of this specification.

My improvement relates to 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 consists in certain new and improved apparatus, hereinafter described, to be used in the operations of such engines; but the method of operation involved in its use forms the subject-matter of a separate application, Serial No. 298,631, 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 V¹ 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 situated 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 the 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 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 the 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 construc-

tion, 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.

There are certain parts of the apparatus which require the use of power for their operation—such, for instance, as the pumps P', P², and P³—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' P² P³ 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 the 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 α'

and discharge-pipe α^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 P² and P³, 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. As the ammonia solution used to absorb the exhaust-gas from the engine has been cooled to a considerable degree in order to cause it to absorb as much of the gas as possible, it is desirable before returning the strong ammonia solution thus obtained to the generator to heat it in order to prevent the chilling of the contents of the generator. For this purpose 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 P³ to force the aqua-ammonia from the well W to the reservoir T. This pump may be operated as before described with 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 X², the upper end of which is connected by a pipe X, furnished with a valve V³, with the steam-space of the water-boiler A, and the lower part of the coil X² is connected by a pipe X³, also furnished with a valve V⁴, 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 X² 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 P³ will thus be considerably heated before it enters the liquid-space of the generator.

As one of the chief difficulties in the construction of ammonia-engine apparatus is to effect the complete absorption of the exhaust-gas from the engine by the weak ammonia solution from the boiler, and as this result must be secured not only by cooling the solution before mingling the gas with it, but also and largely by so constructing the apparatus that the gas and liquid will be intimately mixed while the solution is being cooled, 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' and Q², bolted onto the main body of the absorber. It is furnished

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' and Q^3 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 end, 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, or 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, communicating 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 absorbed by the liquid as they become more intimately mixed and the liquid becomes 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 carries 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^1 .

The advantages of the construction just described over that heretofore used, in which the cooling-liquid surrounds the pipes and the gas and the absorbing-liquid pass through the tubes 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. In ammonia-engine apparatus, the combination of a generator arranged to be heated by steam or otherwise, an ammonia-engine to be operated by gas from the generator, a water motor or engine to be operated by liquid from the generator, suitable pipes connecting said engines with the generator, an exhaust-pipe from each engine arranged to bring the liquid-exhaust and gaseous-exhaust together on their way to the absorber, a refrigerating absorbing apparatus for cooling the liquid-exhaust from the auxiliary engine and causing it to absorb the gaseous-exhaust from the main engine, and a pump or other device for withdrawing the ammonia solution produced by such absorption from the absorber and returning it to the generator, substantially as described.

2. The combination of an ammonia-gas generator and its heating device, a gas-engine connected with the vapor-space of the generator, and a water engine or motor connected with the liquid-space of the generator for the purpose of operating both engines from the same generator, substantially as described.

3. The combination, in an ammonia-engine apparatus, of a gas-generator, a steam-boiler connected therewith, a gas-engine having connection with the generator, and an exhaust from the engine connecting with a refrigerating-absorber, a pipe connecting the liquid-space of the generator with the exhaust-pipe of the engine, a refrigerating-absorber, a pump for drawing the concentrated solution from the absorber and returning the same to the generator, and a reservoir heated by a steam-

coil from the boiler intermediate between the absorber and the generator, substantially as described.

4. In an ammonia-engine apparatus, the combination, with a gas-generator, a vapor-engine, and an exhaust-gas absorber, each connected with the other by suitable pipes, of a water-cooled or refrigerated vessel intermediate between the generator and the exhaust for cooling the weak solution on its passage from the generator to the absorbing apparatus, and a steam-heated vessel intermediate between the absorber and the generator for heating the strong solution before its return to the generator, substantially as described.

5. In an ammonia-engine apparatus having a pipe for conveying weak solution to the absorber, the absorber connected at its inlet with the exhaust-pipe of the engine and at its outlet with the generator through the intermediary of suitable pipes, such absorber consisting of a vessel having a chamber traversed by a series of substantially horizontal pipes opening at each end into a water-way for the flow of cold water through such pipes, said absorbing-chamber being divided into chambers by horizontal diaphragms traversing said chamber, and connected alternately with

the opposite end thereof, so as to leave a passage-way for the vapor and weak solution, whereby the weak solution and gas are caused to flow around the outside of a series of water-cooled tubes, substantially as described.

6. In an ammonia-engine apparatus having a pipe for conveying weak solution to the absorber, the absorber for effecting the absorption of the exhaust ammonia-gas by the weak solution from the generator, consisting of a vessel or chamber having an inlet-pipe at the upper end and an outlet-pipe at the lower end entering a secondary absorber below the liquid-line for the passage of the gas and ammonia solution, traversed by a series of substantially horizontal pipes communicating at each end with an inclosed water-way for the passage of cold water through the pipes without entering the absorbing-chamber, the absorbing-chamber being divided into connecting-chambers by perforated diaphragms, and the water-way at each end being divided by partitions, 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.