CHARLES TELLIER.

Improvement in Ammonical Engines.

No. 121,909. Patented Dec. 12, 1871.

Fig: 1.

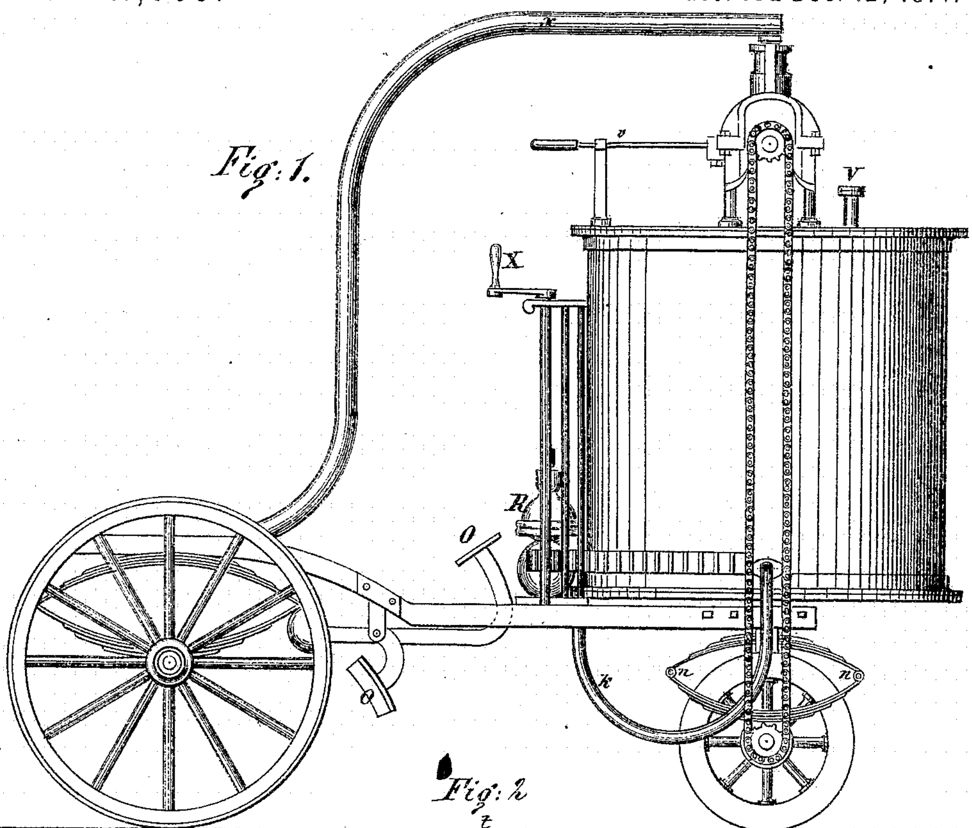
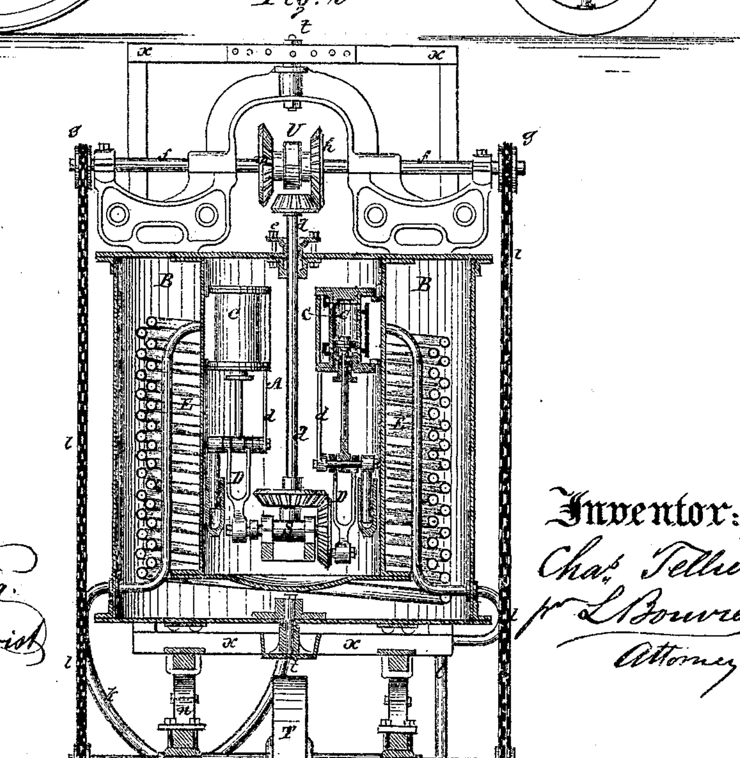


Fig: 2



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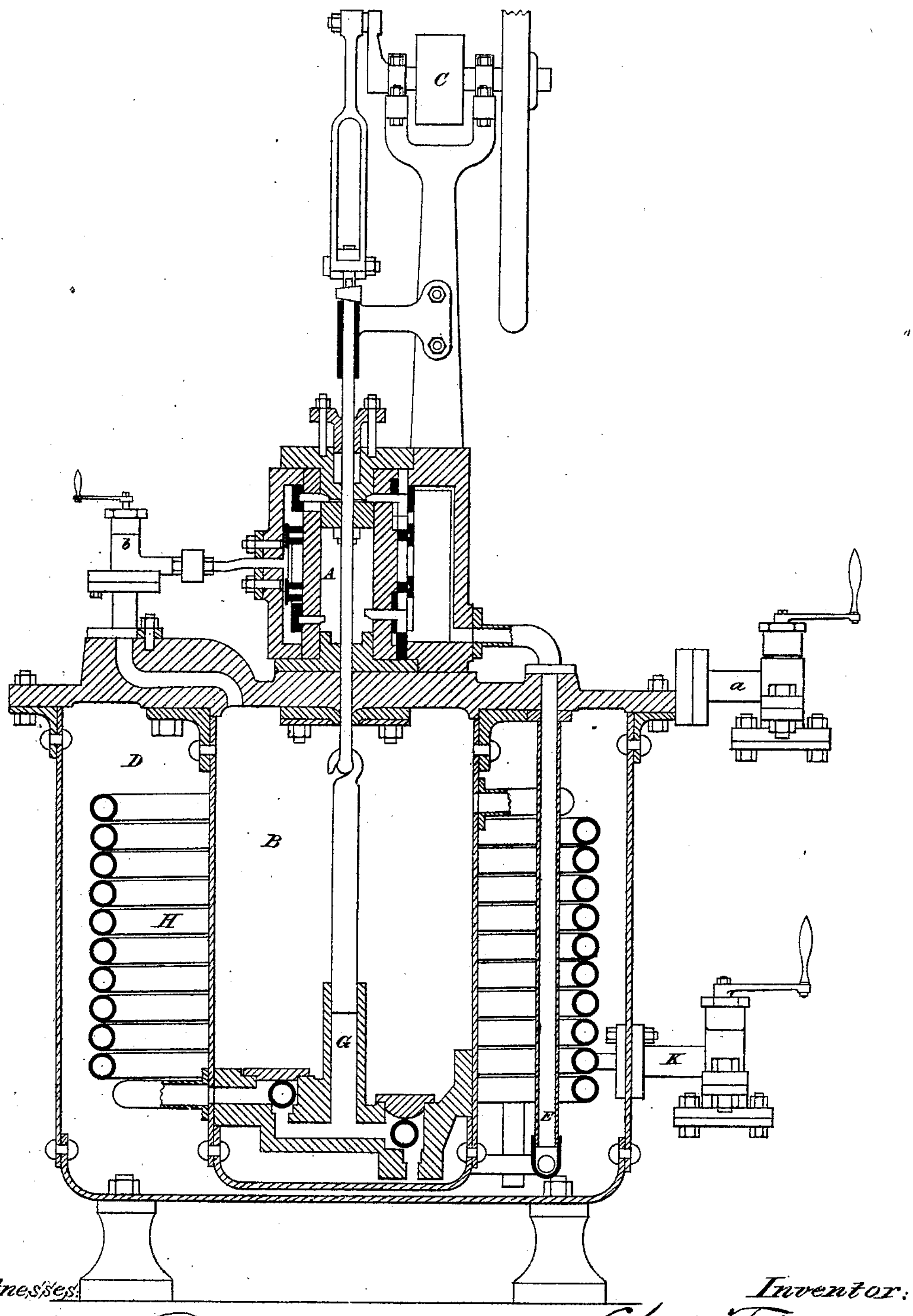

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UNITED STATES PATENT OFFICE.

CHARLES TELLIER, OF PARIS, FRANCE, ASSIGNOR TO LEOPOLD BOUVIER, OF NEW YORK CITY.

IMPROVEMENT IN AMMONIA-ENGINES.

Specification forming part of Letters Patent No. 121,909, dated December 12, 1871.

To all whom it may concern:

Be it known that I, CHARLES TELLIER, of Paris, France, have invented a certain Improved Apparatus for the purpose of Utilizing the various properties of Ammoniacal Gas as a motive-power, and the following is a full and complete description of the nature and objects of the invention and of the machine itself.

Ammonia maintains itself in the gaseous state under the atmospheric pressure and at the ordinary temperature. Under that pressure it requires a cold of 35° centigrade(—31° Fahrenheit) below zero to liquefy, and of 75° centigrade(—103° Fahrenheit) to solidify.

Ammoniacal gas dissolves in considerable quantities in cold water; at the temperature of +15° centigrade (+59° Fahrenheit) that liquid absorbs seven hundred and twenty-seven times its own volume of the gas. Heat drives it from the solution. It has no action upon either cast or wrought iron; in presence of these metals it is indecomposible below the red heat. It may, therefore, be superheated without danger, and the advantages of that operation availed of without having to fear excessive temperatures as with steam. This result is the more easily reached that, even at the ordinary temperature, its pressures are sufficient for industrial purposes. The following is a table of their power at various degrees of the thermometric scale:

Degrees centigrade.	Degrees Fahrenheit.	Atmospheres.
0	+32	4.10
+5	41	5.10
10	50	6.10
15	59	7.20
20	68	8.50
25	77	10.00
30	86	11.60
35	95	13.40
40	104	15.50

Finally, it is specifically lighter than steam, while having at the same time a latent caloric somewhat less than that of the latter. In every respect, therefore, this body presents itself in excellent conditions for the purposes of practical industry. We will now see what use can be made of its application. Before all, I must call particular attention to the result obtained by the use of some of the properties we have just mentioned, viz.: That it is possible to collect, by dissolving them in water, the vapors which have been used; consequently, to render sensible the latent caloric which they carry off, and finally to restore this caloric to new vapors, which may be formed and used—a triple phenomenon produced simultaneously by a single fact, the dissolution of ammoniacal gas in water. From the working of these combinations the following result may then be obtained, viz.: That if there be stored in some vessel a certain quantity of liquefied ammoniacal gas, and at the same time in some other vessel a quantity of water about three times greater, the whole of this gas may be vaporized and made useful as a motive power at a pressure of about eight to ten atmospheres. The action of this effect will remain constant, since, as I have just explained, the latent caloric necessary for the gasification will be constantly furnished by the caloric of condensation disengaged in the aqueous solution. Consequently, if in an establishment disposing of the proper means of action ammoniacal gas be collected and liquefied, that body, transported thus liquid to the spot where it is to be used, will furnish instantaneously and without preparation a motive vapor which may be used advantageously and economically. The solution formed by the absorption of the ammoniacal vapors in water being taken back to the works will be regenerated, and the ammonia thus produced will be again liquefied to be used again, and so on indefinitely.

The application which I now propose may therefore be resumed thus: First, produce in a special establishment liquefied ammonia by first extracting the gas from its solution. Second, store this liquefied ammonia in a movable reservoir which is itself plunged in another reservoir containing water. Third, utilize the vapor which liquefied ammonia constantly tends to form instantaneously. Finally, return this vapor to the water which surrounds the reservoir of liquefied ammonia. The ammoniacal vapor, upon coming in contact with the water, will immediately dissolve. In condensing, it will render sensible the caloric which it held latent, and this caloric, passing through the shell of the reservoir of liquefied ammonia, will cause the production of new vapors. It will be seen by this that one essential condition of the operation consists in a suitable combination of the surfaces by means of which the exchange between the caloric of vaporization and the caloric of condensation is to be effected, and in order that the mechanism of this operation be well understood I will now proceed to the description of the accompanying drawing, Plate 1. This drawing presents the simplest application which may be made of ammonia and its properties for the production of power. The apparatus it represents is a stationary motor; its transformation into a tracting motor is a mere matter of adaptation which can be readily understood.

B is an inner reservoir filled with liquefied ammonia, which is introduced into it through the valve *d*, the operation of liquefaction having been previously effected in a special establishment, as already stated. At the temperature of +25° centigrade (+77° Fahrenheit) this gas is maintained liquid by its own pressure, which is of ten atmospheres; its vapors naturally have the same tension. By reason of their specific density, lighter than that of the liquefied gas, they will occupy the upper part of B. If, now, the valve C is opened it is evident that these vapors will escape and will pass into and act upon the motive-cylinder A, which may be of any known system or model, and this effect will remain constant if, by some artifice, the latent caloric carried off by the vapors is restored as fast as removed. With steam the escape might take place directly into the atmosphere; but two circumstances compel us to save the ammoniacal vapors: first, they have a value which does not allow of their being wasted; and again, it is necessary to recover the latent caloric which they carry off. These two actions will be the consequence of the following disposition: The 'scape-pipe is bent in E, and plunges in the interior of the tank D, at the bottom of which it opens freely. This tank is two-thirds full of water at the ordinary temperature.

Now, in virtue of the extraordinary affinity of ammonia for water, as soon as the vapors of the first body come in contact with the second, combination will at once take place. But this combination can only take place upon an inevitable condition—that is, that the latent caloric of the vapors shall be disengaged, as well as the caloric of combination. If, then, this were the only action taking place it would inevitably result that at every stroke of the piston, and, consequently, at every fresh absorption of vapor, the temperature of the tank D would go on increasing gradually. But there is another fact which must not be forgotten: it is, that at the same time that vapors are arriving into D, which are dissolved and produce heat, other vapors are formed in B which carry off caloric. If there were as many vapors formed as there are condensed it is evident that the quantity of heat in motion would be the same, and that to restore the equilibrium it would be sufficient to bring back into B the caloric which is disengaged in D. Now such is precisely the fact which takes place; for, as we operate in one and the same chamber the cylinder A, the quantity of vapor arriving into it must necessarily be equal to that which escapes and goes to be condensed. Consequently the whole problem is reduced to finding a suitable means of facilitating the exchange of the caloric—that is, to cause the caloric which arrives in D to pass into B. To accomplish this the sides of B would not be sufficient, for, besides the fact that the surfaces they develop are not large enough, it is evident that as the reservoir B is getting empty the effect of the surfaces and, consequently, the power of the machine, would diminish. I supply this deficiency by means of the coil H, which communicates freely above and below with the reservoir B. A pump, G, perfectly simple, without stuffing-box, as it has no opposition to its play save the liquid column in the coil, is worked by a simple extension of the piston-rod. At every stroke of this piston the pump sends a certain quantity of liquefied ammonia through the coil H, which is itself plunged in the water which receives the vapors to be condensed. During the passage of the liquefied ammonia through the coil ammoniacal vapor is formed; the mixture of this vapor and of non-vaporized ammonia returns to fall into B; the liquid parts drop to the bottom of B to begin again the circuit just described, while the vapors produced go to give motion to the cylinder, and then pass into the tank D to surrender their latent heat, a simple combination by means of which the surfaces are increased while their effect is made constant. A moment will come when the liquefied ammonia in B shall be wholly exhausted. This reservoir will then be empty, while on the contrary the tank D will be filled with ammoniacal solution. This solution can be drawn off through the cock K to be taken back to the regenerating works. The apparatus being then charged anew with liquefied ammonia in B and water in D is again ready for work.

The affinity of ammonia for water is so great that in the ordinary process of regeneration it will be found almost impossible to extract the entire quantity of gas contained in the solution. The gas remaining in the water can be wholly saved by using this weak solution instead of pure water for the purpose of absorbing the vapors produced by the running of the machine. It may be feared that the entire amount of caloric carried off by the vaporization would not be yielded again in the condensation; such a fact could only result from some loss of caloric. Now, this loss could only arise from two causes: First, the undue elevation of the interior temperature, which would lead to the caloric being conveyed outward, thus causing a loss. Second, the lowering of the exterior temperature, which would lead to the same result. In the first case it must be remembered that there is, in practice, no actual heating of the water; the same quantities of caloric circulate from the tank containing the solution to the reservoir containing the liquefied ammonia, and, reciprocally, the temperature of the mass does not change, and there is, therefore, no loss to fear on that score. The second has reference to atmospheric fluctuations.

I have spoken of +25° centigrade (+77° Fahrenheit) and ten atmospheres corresponding pressure; it may be asked how can such a temperature be reached and maintained when that of the atmosphere shall be lower. In mentioning these figures it has not been my intention to say that they were indispensable to the successful working of the machine. I have only intended to show that at an average summer temperature there are no excessive pressures to fear from the use of ammonia, as in the case of other liquefied gases, such as carbonic acid, protoxide of azote, &c., which, at 25° centigrade, are extremely dangerous to handle. It is, on the contrary, perfectly easy to work at the ordinary temperature, for even at the freezing-point ammoniacal gas still has a pressure of four atmospheres, which is amply sufficient for all practical purposes. Below 0° centigrade (+32° Fahrenheit) it is evident that some special precautions must be taken for the insulation of the apparatus. The fact that the vapors of ammonia may be superheated to 180° to 200° centigrade (356° to 392° Fahrenheit) with perfect safety can be advantageously used to obviate any difficulty on that score.

I need hardly state that the apparatus above described is essentially variable. The cylinder may be vertical or horizontal. The main point is to arrange a generator of vapor, so as to constantly utilize the surfaces necessary to the required vaporizing action. The latter organ itself may vary in many ways. It may be simple or composed of numerous pieces, through which the action of the vapor itself would cause the liquid to be vaporized, to circulate upon the vaporizing surfaces, &c. Among the most important applications of this apparatus is its application to mechanical traction, and I now propose to enter upon some details on this point.

Plate 2 presents an arrangement by means of which ammonia may be applied to mechanical traction upon common roads. The drawing shows an exterior view of the apparatus, and also a transverse section. Its principle is this: Cause the entire weight of the motor proper to rest upon a single wheel, T, then, by means of the adherence given to the wheel by this weight, and of the action which it receives from the motor, draw a load in good traveling conditions. This principle is, of course, not absolute, and may be varied in many ways.

The advantages of the present arrangement are as follows: First, the apparatus thus combined may be attached to any vehicle by simply removing the fore wheels of the latter and fastening them to the after wheels of the apparatus, and thus at once ammonia is substituted for horse-flesh. Second, when the driving action is exercised simultaneously upon two wheels, it is necessary when turning that one should be made free upon its axle. This necessitates rather complicated maneuvres, shocks which are very inconvenient in practice, besides the mechanical difficulty of obtaining a certain result. With a single driving-wheel, we enter the category of tricycles, a well-known species of vehicles, the handling of which is perfectly easy even for a very feeble hand. Third, the faculty of detaching at any time the driving apparatus from the vehicle facilitates any necessary repairs without interrupting the service of the vehicle itself, as another engine may always be substituted for the one undergoing repairs. Fourth, finally, because all the mechanical organs are united under the hand of the driver under the most favorable conditions for their best preservation.

Two objections occur here—the first relating to the waste of ammonia, the other to the possible introduction in the organs of the machine of sand, dust, &c., and its consequent rapid deterioration. I obviate both by inclosing the entire motor within one of the liquefied gas-reservoirs, and thu I obtain the double result desired, for the same reason which prevents the escape of the ammonia necessarily prevents the dust from entering. I now proceed to the description. A is an iron reservoir, perfectly tight and of sufficient strength, in which is stored the liquified gas, which is introduced through a packed cock, V. This reservoir is completely lodged within another, B B, which contains the water of absorption. The ordinary pressure of the atmosphere being always maintained in the latter, it need not be constructed of any special strength. Owing to this arrangement any gas escaping from A must necessarily be stopped and dissolved by the water in B, and, consequently, impossible loss of ammonia. In the reservoir A I place directly the driving-pistons, of which there are two, G G. The advantage of this arrangement is that nothing comes out from the reservoirs except a revolving rod, *a b*, which may be packed very tight. The cylinders have already been described when speaking of the ammonia motor. I must mention, however, that the cut-off is invariable at the one-fifth; that the drawer of introduction is put in motion directly by the piston by means of a rod, *d*, and that the escape-chest is formed by the wall itself of the vertical cylinder A, which bears externally the escape-tube *e*, which latter extends to the wall of the reservoir B B. The pump D is connected directly with the axis of the piston; it causes the ammonia to circulate through the coils E E, which open into the upper part of A, as already described in the stationary motor. The motion is transmitted outward by the shaft S, which, by means of a pinion, works in the vertical shaft *a b*.

In order that the apparatus may be entirely homogeneous and strong it is important that the whole of this work be put up against the wall of the cylinder A, so as to be adjusted easily before the top and bottom are put on. The vertical shaft *a b* is provided at its upper end with a pinion, which communicates the motion to the horizontal shaft *f f*, from which it is transmitted, by means of the cogged wheels *g g* and the chains *l l*, to the axle J of the propelling-wheel T. It is now evident that, as long as the motor is kept working, the forward movement must take place. But it is also necessary to be able to move backward: two pinions, *m h*, may be seen upon the shaft *f f*. They are adjusted in such way that when one is connected to the wheel C the other is not, and vice versa. Moreover, a lateral sliding motion may easily be given them by means of the guide U. Thus the wheel C may be connected, at the will of the conductor, either with the pinion *m* or the pinion *h*. Now, each of these communicates an opposite motion to the shaft *f f*, and, consequently, to the propelling-wheel. It is evident, therefore, that according as one or the other of these pinions is connected the machine will work backward or forward. The apparatus is suspended upon two springs, *n n*. In order that it may remain in a vertical position a double shaft of wood, covered with iron, holds it above and below. This shaft is shown at *x x x x*. It is strongly fastened at its lower extremity to the crown of the fore wheels. It extends, by means of two double cross pieces, which unite at the collars *t t*, and maintains the whole apparatus in a perpendicular position. The stability, the forward-and-backward motion being obtained, there are still two essential points to look after: first, the direction, which consists in motions to the right or to the left; second, the regulation of the speed. These two actions are obtained simultaneously, and at will, by means of two cranks, of which one only, X, may be seen. It is the one that gives the direction. It works a cogged wheel which, by means of an intermediary-pinion acting upon a dentated segment fixed to the apparatus, causes it to turn one way or the other. The propelling-wheel T obeys, necessarily, this action, and as it is this wheel which drives the apparatus it gives, necessarily, to the whole the same direction which it receives. The second crank, concealed behind the first, serves to regulate the speed. Usually in steam-engines the regulating-cock is placed upon the receiving-pipe. Here I reverse the facts, and I place this cock upon the escape. Having no condensation to fear, it matters little whether the cylinders contain any gas or not when not working. It is clear, however, that the more the escape will be facilitated the faster we will go, and if, on the contrary, the escape is obstructed we will check, and, if need be, wholly stop the motion. To obtain this result the second crank is merely an extension of the packed valve R. The ammoniacal gas escaping from the two cylinders is brought to this valve by two flexible tubes, K. From this valve it is taken, by means of a third flexible tube, L, to the cylinder B B, which is filled with water, and where the absorption naturally takes place. Finally, it may become necessary to stop short, and, consequently, not only to stop the action of the motor, but also to neutralize the impetus of the machine. To do this I use the brake *o o*, which is worked by simply putting the foot upon the foot-piece *o*, which, forcing the clogs against the periphery of the fore wheels, stops them almost immediately.

As already stated, this apparatus is essentially modifiable. It has been devised for the special purpose of being applied to ordinary vehicles, or to be used by itself. Now, according to various countries, usages, or roads; according as old carriages are to be used or new ones built expressly; according as public or private transportation is required, the apparatus must necessarily vary in many ways. Thus, for instance, it would be possible to lower materially its center of gravity by substituting for the cylinder shown in Plate 1 two horizontal cylinders, the axis of which would coincide with the axis of the wheels.

In new carriages constructed especially for this mode of traction, the reservoirs themselves may be located under the body of the carriage, and thus the vehicle be concentrated so as to occupy less room on the street, or allow the construction of larger vehicles.

Again, if it is desired to apply the traction to railroads, the arrangement must change. I propose, in this case, to suppress the locomotive, and to substitute for it a double reservoir of water and of ammonia, combined as already indicated in the description of the above two plates. Then, under each car may be placed a pair of small motive-cylinders, working one or two pairs of wheels, and communicating by means of valves with the reservoirs of liquefied ammonia. By opening or closing these valves it is evident that the motion will be given or withdrawn from the cylinders. There need not be any special reservoir when each car is expected to travel by itself, as, for instance, on tramways or street railroads. In this case each car will bear its own double-reservoir and motive-system.

I have spoken of the necessity of preventing any leaks. In Plate 2 I have shown that this may be obviated by lodging the whole apparatus inside the reservoirs, so as to leave absolutely nothing but one stuffing-box outside. But this is not always practicable, and when applied to railroads would be simply impossible, since the cylinders are located under each car. In this case the escape may be arranged with a metallic jacket surrounding hermetically the cylinder. All leaks would then become, if not impossible, at least without inconvenience, since the vapors escaping thus would naturally return to the water for absorption. The stuffing-box alone would then remain to be watched, and by making it double so as to leave a small chamber between the first and second, and connecting this chamber by a tube either with the metal jacket just referred to, or directly with the water of absorption, the second stuffing-box would have no chance of leaking, as everything that would pass through the first would inevitably be collected in the water of absorption, and there would be no pressure upon the second.

Having now fully described the nature and objects of my invention, I wish again to repeat that I do not mean to confine myself to either of the mechanical arrangements above described; but

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

1. The application of ammoniacal gas as a means of producing motive-power by means of its liquefaction and subsequent absorption in water, substantially as described.

2. The combination of surfaces by means of the

inner reservoir A, (Plate 1,) the outer reservoir D, the coil H, and pumps G, or any other similar arrangement for the purpose of securing a perfect and complete exchange between the caloric of condensation and the caloric of vaporization, and thus insure the constant working of the machine, substantially as above described.

3. The general features of the apparatus shown in Plate 2, including the single driving-wheel, the mode of direction, &c., forming a practical application of the ammonia motor as a locomotive for common roads, substantially as above described.

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Witnesses:
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(2)