(No Model.)

F. A. T. DE BEAUREGARD.

Thermo-Dynamic Engine.

No. 237,828. **Patented Feb. 15, 1881.**

Fig. 1

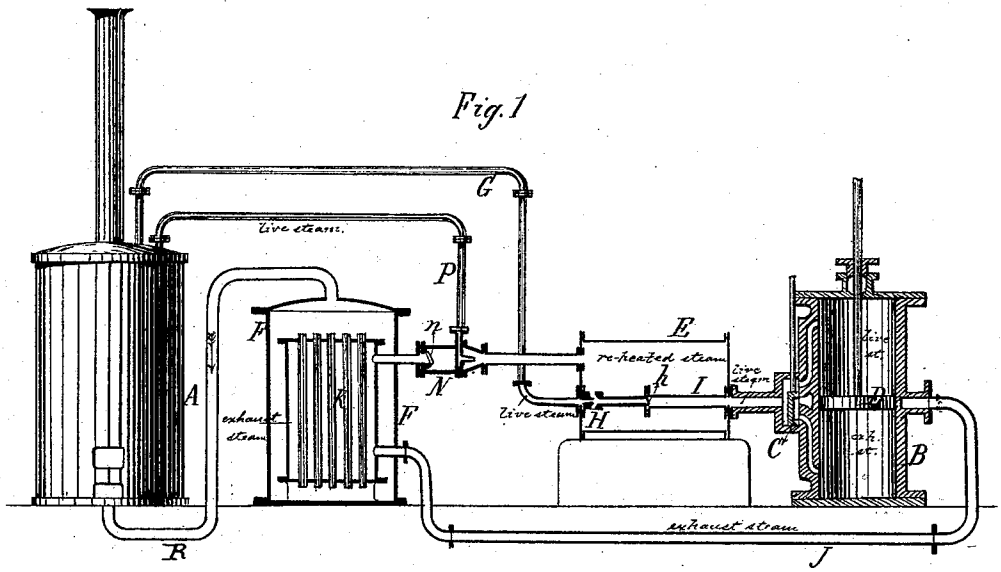


Fig. 3

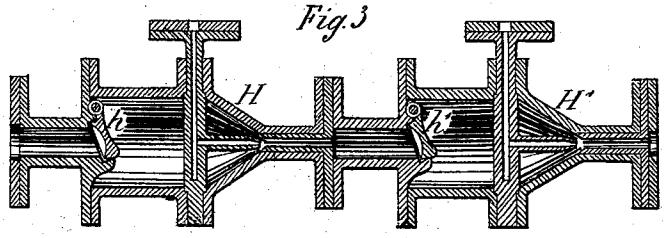
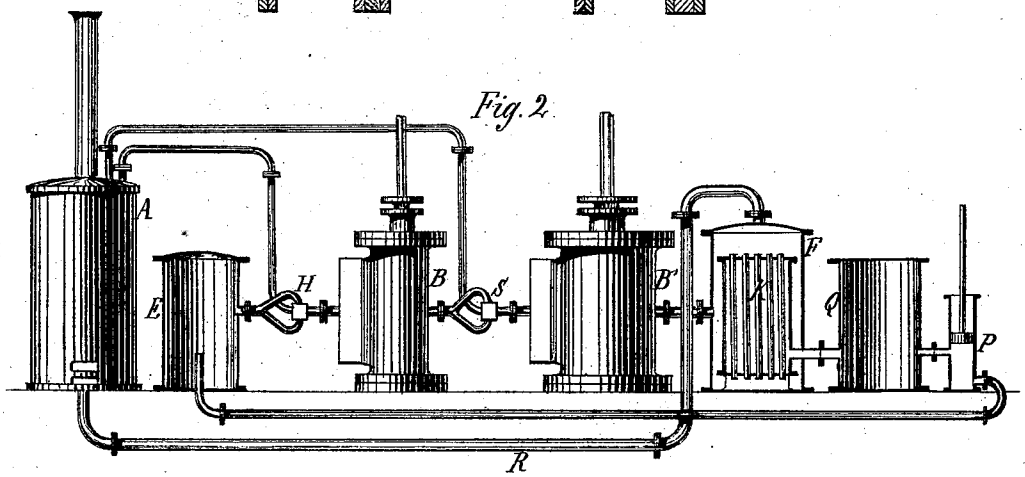


Fig. 2



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UNITED STATES PATENT OFFICE.

FELIX A. T. DE BEAUREGARD, OF PARIS, FRANCE.

THERMO-DYNAMIC ENGINE.

SPECIFICATION forming part of Letters Patent No. 237,828, dated February 15, 1881.

Application filed November 5, 1880. (No model.) Patented in France February 16, 1880.

To all whom it may concern:

Be it known that I, FELIX ALEXANDRE TESTUD DE BEAUREGARD, of Paris, in the Republic of France, have invented certain new and useful Improvements in Thermo-Dynamic Steam and other Engines, using gas or vapor as the motive agent, of which improvements the following is a specification.

I have heretofore demonstrated in former inventions the possibility and useful capacity of a continuous dynamic cycle with liquids—that is to say, a system of circulation which permits a liquid to obtain continuously from a suitable source the quantity of heat to be converted into mechanical work. In prosecuting my researches and experiments I have been led to devise a similar cycle with expansive fluids, vapors, or gases, and to such a closed and continuous cycle the present invention has reference.

In the following description the application of the improved system to steam-engines will be more particularly described. In these it is destined to modify the operation radically with respect to the amount of work obtained from the heat expended.

It is well known that in the engines in use the larger part of the heat supplied in the boiler is wasted, either by escape into the air or by means of the water used in condensation. The quantity of heat thus lost is none other than the latent heat of vaporization, and is measured by five hundred and forty calorics. From the formula of Regnault, $l=606.50+0.305t$, it will be seen that this is about four-fifths of all the heat employed to produce steam at the customary tension. To avoid this great loss, which corresponds to a veritable waste of fuel, the primary source of the motive power, is an object of the present invention; and to this end the steam is prevented from escaping from the circulation in the motor, and is maintained, as much as possible, in the aeriform state, by adding to it at each round the amount of heat usefully expended—that is to say, the amount which is converted into mechanical force during its operation and detention in the cylinder. In this way the new thermo-dynamic cycle is obtained. It should, however, be observed that heretofore various plans have been devised for reusing the exhaust by forcing it, by the aid of an aspirator furnished with fresh steam, from a boiler.

The present invention consists in the new combinations and dispositions of apparatus hereinafter explained, whereby certain difficulties in the practical and industrial application of a dynamic cycle, or system of employing again and again the same steam or vapor, are overcome.

In the accompanying drawings, which form a part of this specification, the application of the new system to an ordinary simple engine is illustrated in Figure 1, and to a compound engine in Fig. 2. Fig. 1 is a view, in section, of the apparatus employed with a simple engine; Fig. 2, a view, partly in section, of the apparatus used with a compound engine; and Fig. 3, a sectional view, on a large scale, of two connected aspirators.

The boiler A and motor-cylinder B, with its slide-valve C and piston D, are of ordinary or suitable construction, and need not be here described. Between them are placed the reservoir E and the equilibrium apparatus or partial condenser F.

A pipe, G, from the boiler is provided with an aspirator, H, within the reservoir. The pipe I forms a continuation of said pipe G, and is in communication at its farther end with the interior of the valve-chest. The pipe J is connected at one end with the outlet-port and at the other with the vessel K, having tubular passages extending through it. This vessel is surrounded with water in the receptacle F, and operates as a partial condenser. From the upper part of said vessel the uncondensed steam enters a second aspirator, N, which, by the aid of a jet of steam from the boiler by the pipe P, forces it into the reservoir E. The aspirators H and N are both provided with self-closing valves *h* and *n*, which prevent the passage of the steam backward. The steam, after operating in the cylinder, in place of being conveyed directly to the reservoir, as in the theoretical system first explained, passes into the vessel K, placed in the receptacle F and surrounded by boiling water, and thence through the aspirator N into the reservoir. The water in receptacle F absorbs the heat left free, and permits it to be returned in the form of steam to the fire, the upper part of the

receptacle being connected with the fire-chamber. The aspirator N, in forcing the steam into the receiver reheats it, and thus enables it to be more readily drawn in by the aspirator H. It will be seen, therefore, that the small quantity of high-temperature steam taken from the boiler is utilized in two ways: first, for the preliminary heating of the steam by the aspirator N, and, second, for its regeneration by the aspirator H, which forces into the cylinder C the mixture constituting "positive" steam. It will be readily understood that this mixture is with saturated steam, for at the slightly elevated temperature (140° centigrade, for example) which is maintained in the receiver, if the steam were dry, it would act as a gas, and would have only a feeble expansive force.

The explanation already given will serve to elucidate the application, which is based on the same principles as the preceding, to a compound engine, Fig. 2. The important differences to be noted are as follows:

First, an aspirator, S, is placed between the cylinders B B′ of the engine, and serves to give increased heat and pressure to the steam as it escapes from the small cylinder B, after having operated therein, so that it acts with greater force in the large cylinder B′. The aspirator H, as before, takes its steam from the reservoir E.

Secondly, the steam which escapes from the receptacle of equilibrium F is returned to the reservoir, not by an aspirator, but by a pump, P, which is supplied from a secondary receptacle, Q.

A pipe, R, is also shown connecting the top of the receptacle F with the fire-chamber of the boiler, so as to convey the steam from the water in said receptacle to the fire in order to thus utilize the same.

The aspirators shown in Fig. 2 are provided with self-closing valves, but the steam passes by two branch pipes to unite with the jet.

In the different applications of the cycle, aspirators can be connected in series, one following the other, so as to constitute an aspirator of multiple effect.

In Fig. 3 H H′ are aspirators so connected, each being provided with its valve *h h′*.

The present invention covers the thermo-dynamic cycle with expansive fluids in its various applications. It is applicable to steam-engines of all kinds and for all purposes—fixed, semi-stationary, movable, locomotive, marine, tramway, &c. It can be applied, also, with suitable changes in the disposition of the apparatus, to various industrial uses requiring the employment and transfer of heat.

The forms, dimensions, and materials of the apparatus composing the cycle can be changed in accordance with the nature of the application without departing from the spirit of the invention.

Having now fully explained the said invention and the manner of carrying the same into effect, what I claim is—

1. In combination with an engine-cylinder or other vessel in which the temperature and pressure of an expansive fluid are usefully diminished, the reservoir and two aspirators or forcing apparatus, one serving to force the fluid, after it has acted on the cylinder or vessel, into the reservoir, and the other to force the same thence into the said cylinder or vessel, substantially as described.

2. In a thermo-dynamic cycle, as described, the receptacle or equilibrium apparatus, in combination with the reservoir and other parts of said cycle, substantially as set forth.

3. In a compound engine, an aspirator located between the small and large cylinders and operating substantially as described.

4. In a steam-engine, a receptacle for effecting a partial condensation of the steam from the cylinders by means of liquid therein contained, so arranged and connected with the fire-chamber of the boiler-furnace, by a suitable pipe or conduit, that the steam generated from said liquid is conveyed to the fire-chamber, substantially as described.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FELIX ALEXANDRE TESTUD DE BEAUREGARD.

Witnesses:
GEO. H. SCIDMORE,
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