F. M. H. MOTARD.

Modes of Recovering and Regenerating Steam in Motive-Power Engines.

No. 142,038. Patented August 19, 1873.

Fig. 1.

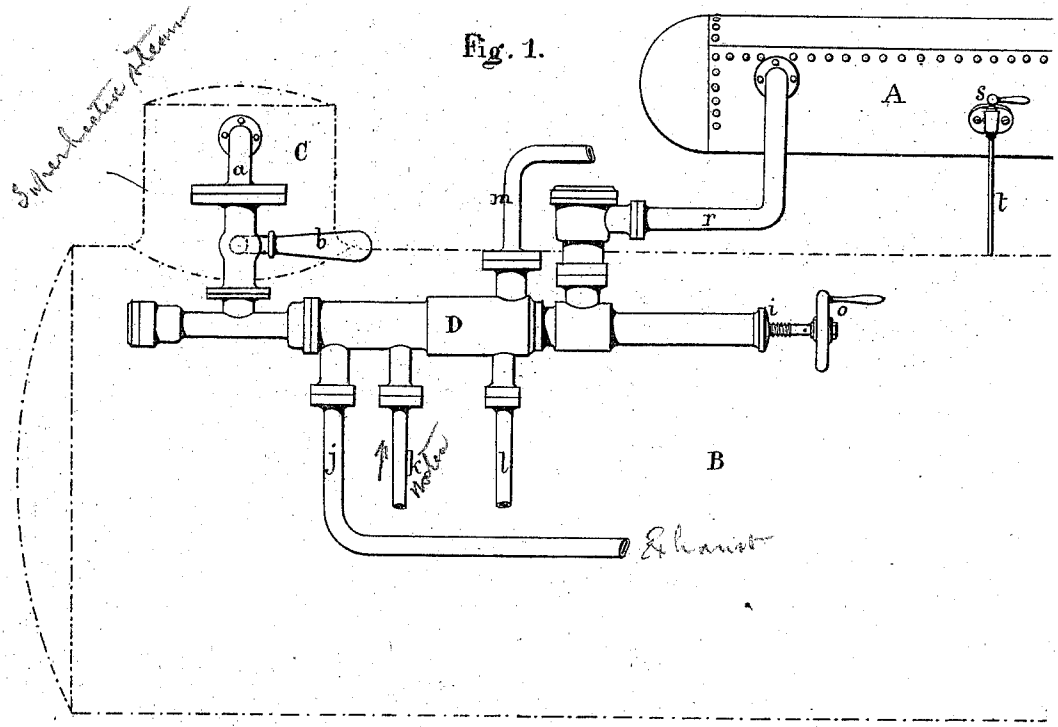
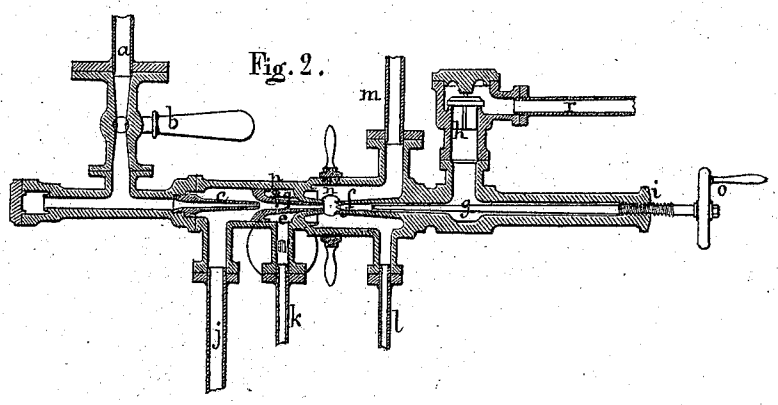


Fig. 2.



Witnesses.

J. H. Shumway

A. J. Roberts

François M. H. Motard

Inventor

By Atty.

John P. Earle

UNITED STATES PATENT OFFICE.

FRANÇOIS MAURICE HIPPOLYTE MOTARD, OF PARIS, FRANCE.

IMPROVEMENT IN THE MODES OF RECOVERING AND REGENERATING STEAM IN MOTIVE-POWER ENGINES.

Specification forming part of Letters Patent No. **142,038**, dated August 19, 1873; application filed November 16, 1872.

To all whom it may concern:

Be it known that I, FRANÇOIS MAURICE HIPPOLYTE MOTARD, of Paris, France, engineer, have invented an Improved Mode of Recovering and Regenerating Steam in Motive-Power Engines, of which the following is a specification:

It is known that in employing steam in engines the latent heat communicated to it in the boiler when the water is converted into vapor is totally lost when the steam escapes into the atmosphere, and that it is lost to a great extent when the steam is condensed. Hence results an excessive consumption of fuel, which is the more objectionable as fuel becomes daily more rare and expensive. To remedy this defect many plans have been proposed, which, though ingenious, have hitherto failed in practice. I hope to be more successful with the system which I have devised for this purpose and which forms the subject of my present invention.

The problem which I have solved may be thus stated: First, to collect in whole or in part the steam remaining on the side of the piston toward which it is moving in the condition of dilatation to which it has been brought by expansion in the cylinder; second, to regenerate or recover this steam—that is to say, while retaining it in the gaseous condition to restore to it the normal tension which it had before reaching the cylinder—in such a manner that on admitting it again to the cylinder it shall there perform the same mechanical work as it had done before.

In order to fulfil these conditions, I have had recourse to a physical principle of which the application made by me is marked at once by the novelty of the object to be attained, and by the originality of the arrangements and apparatus employed for this purpose. This principle consists in the well-known property which a fluid mass in movement possesses of sucking or drawing with it in its passage a surrounding fluid mass relatively in a state of rest, the two masses forming by their mixture a single resultant, the uniform physical nature of which partakes of those of the two constituent masses. Indeed, my system consists essentially in the introduction of a jet of steam from a generator at higher pressure than that of the steam admitted to the cylinder, which jet is directed through the mass of steam expanded after performing work in a medium selected outside the cylinder in the course of the admission-pipe. This jet, in its rapid passage, encountering the expanded steam forms a new current, which acts according to the special conditions resulting from the new elements introduced, a pressure and temperature exceeding those of the expanded steam.

The second point characteristic of my system is the arrangement of a reservoir for receiving the current produced and for delivering successive charges to the cylinder, which is thus supplied with steam from this reservoir and not from the boiler to which the fire is applied.

It will be seen that the economy of fuel attained depends on the quantity of steam expended in producing the jet. That this quantity may be the smallest possible I have found that it must be in a superheated state — that is to say, heated to a temperature considerably exceeding that which is due to saturated steam of equivalent pressure. In fact the complex and intermediate phenomena which manifest themselves on the mixture of the two masses of steam, result finally in a mutual exchange of their quantities of heat. Thus, when the equilibrum of temperature is attained, the weight of steam to be introduced as jet may be estimated by the simple formula of mixture, so that it can readily be determined that the higher the temperature of the steam forming the jet the less weight of it is required. In this formula it is to be remarked that pressure forms no element, but it necessarily must exceed that of the regenerated steam in order to give the current which it forms sufficient energy to overcome the resistance of the medium formed in the admission-chamber. Thus, high temperature and pressure, exceeding that in the chamber, are the two elements which should be brought by the steam of the jet in order to constitute afresh the expended steam and to add to the heat which it retains the quantity of heat which it had lost in doing work. It

cannot fail to be remarked that the chamber, in receiving the resulting current, will necessarily be charged with an excess of fluid from the jet which exceeds what is not required to be expended in the cylinder. To avoid surcharge, I can discharge the excess of steam, either by the chimney to assist the draft or by employing it to work a small engine. I prefer, however, the following mode of utilizing it. It is founded on this observation—that it is better to promote the condensation of the jet-steam in the chamber, in order to get full advantage of all its latent heat, than to let it escape and make use of it in the gaseous condition. Consequently, in order to force this steam to condense, I bring the current, immediately after its formation, in the selected medium, in contact with a thin stream of water (sucked in) in such a manner that the regenerated steam shall alone retain the qualities of an elastic fluid when it reaches the interior of the chamber. This chamber will, therefore, always contain a certain quantity of water of condensation, which will be retained at a constant level, and which will be returned as heated feed-water to the boiler, restoring to it, to a great extent, the heat brought in excess to the current. It may, therefore, be said of the chamber, that it will perform the office of regenerator of the second order and of feed-heater.

Having thus explained, generally, the physical conditions on which my system of operat- is founded, I will now describe the combination and arrangement of apparatus by which it is carried into practical effect, referring to the accompanying sheet of drawing and to the figures and letters marked thereon.

Figure 1 represents a side view of a part of a steam-boiler with my system applied to it, and Fig. 2 represents a longitudinal section of the apparatus for producing the fluid current.

A is the steam or admission chamber, placed above the boiler B, with which it has no communication. The boiler is provided with a superheater, which superheats the steam before it is collected in the dome C. The apparatus D, for producing the current, is arranged between the chamber A and the boiler-dome C at a little distance from the working steam-cylinder. The steam for forming the jet flows from the dome by the pipe *a*, which is provided with a cock, *b*, and has a nozzle, *c*, above the sucking-tube *j*, which is an extension of the waste-steam pipe, and brings the expanded steam from the cylinder. The current formed passes through a taper-tube, *e*, the position of which can be ascertained by inspection through a hole, *n*, and can be altered by means of a pinion, *p*, gearing with a rack, *q*, on the tube, so as to adjust the areas of entrance into, and issue from, the tube *e*. A pipe, *k*, brings the water for condensing the steam of the jet after it has effected its purpose. This water, passing through lateral holes in the tube *e*, mixes with the current in the tube, and the mingled current enters the expanding tube *f*, the area of the mouth of which can be regulated by a taper spindle, *g*. For this purpose the spindle *g* has on it a screw-thread, working in the body of the apparatus D, and is provided with a wheel and handle, *o*, by turning which the spindle can be made to advance or recede. A stuffing-box, *i*, prevents escape of steam or water round the spindle. The pipe *m*, branching upward over the expanding tube *f*, serves to prime the apparatus and to permit free discharge of the steam in case the current should by any circumstance be arrested. The excess of water can issue by the pipe *l* branching downward. The current, after raising a check-valve at *h*, flows by the pipe *r* into the admission-chamber or second generator A. In the chamber the current on arriving proceeds to separate itself into its two constituent parts, steam and water. Of the one part the quantity of expanded steam which has been regenerated diffuses itself through the chamber, putting itself in equilibrium with the existing medium which has the initial pressure of the admission steam. Of the other part the water resulting from the condensation of the jet mingled with the water introduced for the condensation falls to the bottom of the chamber, and constitutes the reserve of liquid for maintaining the steam in a saturated condition. A pump or other feed apparatus draws the hot water for feeding the boiler. In order to maintain its level constant a cock, acted on by a float, may be employed to discharge automatically the excess of water.

In starting the apparatus the chamber A must be filled, which can be done by opening for a short time a cock, *s*, on a small pipe, *t*, which takes steam directly from the boiler.

In carrying out these improvements it will be understood that the proportions and details of the apparatus may be varied without departing from the essential features of the invention, which may be classed as follows:

In combination with the chamber A, above the boiler and the dome C, the herein-described apparatus for producing the fluid current arranged between the said dome and chamber, the said apparatus consisting of the pipe *a*, nozzle *c*, sucking-tube *j*, taper tube *e*, pipe *k*, expanding tube *f*, pipe *l*, and check-valve *h*.

In testimony whereof I have signed my name to this specification before two subscribing witnesses.

F. M. H. MOTARD.

Witnesses:
J. ARMEGAUD, *Fils*.
L. DARNANVILLE.