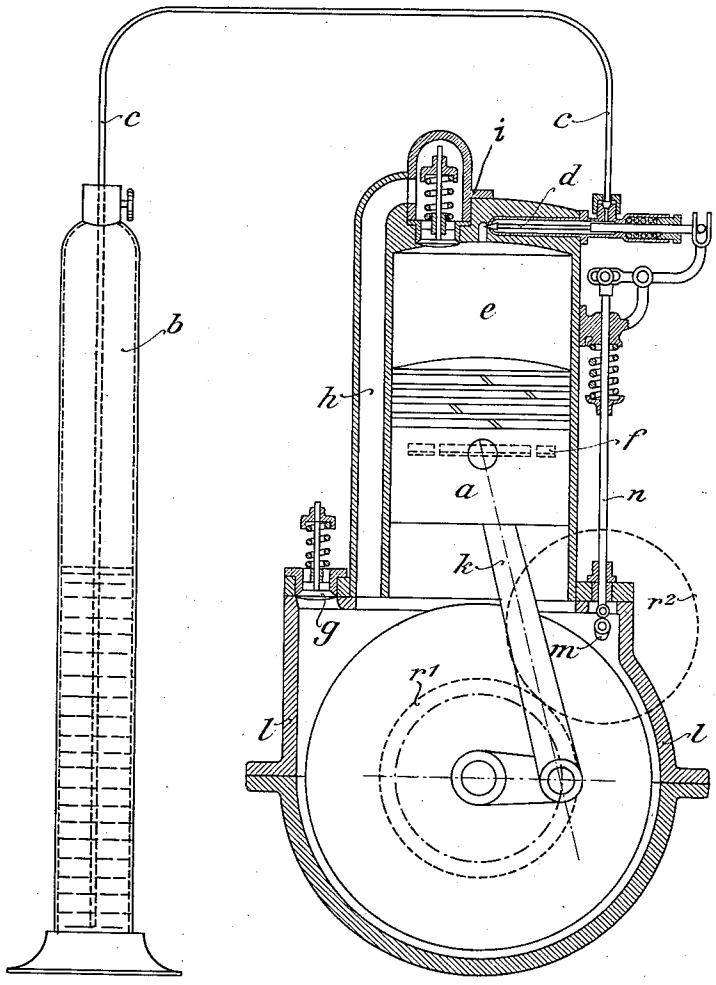
No. 886,054. PATENTED APR. 28, 1908.

F. HILDEBRAND.

METHOD OF WORKING EXPANSION ENGINES.

APPLICATION FILED FEB. 19, 1907.



Witnesses:

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FRITZ HILDEBRAND, OF DEUTSCH WILMERSDORF, GERMANY.

METHOD OF WORKING EXPANSION-ENGINES.

No. 886,054. Specification of Letters Patent. Patented April 28, 1908.

Application filed February 19, 1907. Serial No. 358,197.

To all whom it may concern:

Be it known that I, FRITZ HILDEBRAND, a subject of the German Emperor, residing at Deutsch Wilmersdorf, near Berlin, in the Kingdom of Prussia, Germany, have invented certain new and useful Improvements in Methods of Working Expansion-Engines, of which the following is a specification.

The subject of my invention is a method or process of working expansion engines by means of liquefied gases, and in particular of liquid carbonic acid and liquid air, the liquefied gas, being for this purpose brought together with compressed air.

After mingling of the hot compressed air with the vapors which arise from the liquefied gas, a high degree of expansion occurs. On expansion of the mixture the exhaust temperature will not fall below zero thus causing ice to form in the engine, provided the proportions of the two agents employed are suitably selected and their pressure, or the temperature, before mixing taken into account.

The expansive mixture may with advantage be allowed to act directly upon the piston of the expansion engine, only so much of the mixture being produced each time as is necessary for a working stroke.

In carrying my new method into effect in practice, the necessary compressed air may, if desired, be generated in well-known manner by the expansion engine itself, atmospheric air which enters into the working cylinder being compressed by the piston, whereupon, say at the moment of greatest compression, the liquefied gas is admitted to the working cylinder where it is converted into vapor. The expanding mixture drives the piston forward. The expansion engine may work either as a two or four stroke cycle engine.

The accompanying drawing by way of example shows one form of engine (for instance working on the two stroke cycle) to which the invention has been applied, the figure being a vertical section.

At the first stroke the piston *a* draws atmospheric air into the working cylinder *e* through the valve *i* and compresses it on the return stroke. About at the moment of reversal, that is of maximum compression of the air, the liquefied gas under considerable pressure flows from the reservoir *b* (constructed in the manner of a siphon bottle) and passes through the pipe *c* and positively controlled nozzle *d* into the cylinder *e*, where it is vaporized on contact with the hot compressed air and mingles with the latter. The mixture in a state of high tension expands and drives forward the piston until the latter exposes the exhaust port *f*.

On ascent of the piston *a*, its lower face will have drawn atmospheric air into the crank chamber *l* through the automatic valve *g*, which air on descent of the piston is forced into the passage *h*. As long as the pressure in the cylinder *e* is higher than that in the passage *h*, the automatic valve *i* remains closed. On opening of the exhaust port *f* and exit of the expansive mixture, the conditions of pressure are reversed, and the under-pressure in the cylinder *e*, even although by employment of a silencer it will be but small, is sufficient to permit atmospheric air to enter the cylinder, whereby the latter will be swept perfectly clean and charged anew. The piston *a* now ascends again, on the one hand compressing the air which has just entered, and on the other hand with its lower face drawing fresh air into the chamber *l;* while at the moment of its reversal liquefied gas enters through the positively controlled nozzle *d* into the cylinder space *e*, and the procedure is repeated.

The nozzle *d* is regulable during running of the engine, in order by the supply to regulate the number of revolutions of the latter. The automatic valves *g*, *i* can naturally also be positively actuated in well-known manner if circumstances render this desirable.

In the drawing, *k* is the connecting-rod, *m* the cam actuating the nozzle gear rod *n*, and r^1, r^2 the transmission gearing for the same.

The provision of a siphon bottle *b* would appear practical only for stationary plants. For vehicles and boats, where ordinary receptacles have to be relied on, it would be simplest to overturn the bottle, so that the gases forming above the liquid force the latter out.

It may, in some cases, prove advantageous to heat the atmospheric air prior to its entrance into the working cylinder, firstly, in order to keep the latter hot, if necessary, and secondly, to alter the compression of the air or the proportions of the mixture or its exhaust temperature. It is especially practical for this purpose to draw in the previously heated air through a jacket surrounding the

working cylinder. Or if fresh air is drawn in through the jacket, it is heated by the walls of the working cylinder rendered hot by the heat of compression, whereby needless cooling of the cylinder is prevented.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:—

1. The method of working an expansion engine, consisting in supplying the working cylinder with liquefied gas and compressed air, and allowing the mixture to expand, substantially as described.

2. The method of working an expansion engine, consisting in supplying atmospheric air to the working cylinder, and compressing it by means of the piston, and thereupon admitting liquefied gas into the said cylinder, and allowing the mixture to expand, substantially as described.

3. The method of working an expansion engine, consisting in supplying atmospheric air to the working cylinder and compressing it by means of the piston, and at the moment of maximum compression admitting liquefied gas into the said cylinder, and allowing the mixture to expand, substantially as described.

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

FRITZ HILDEBRAND.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.