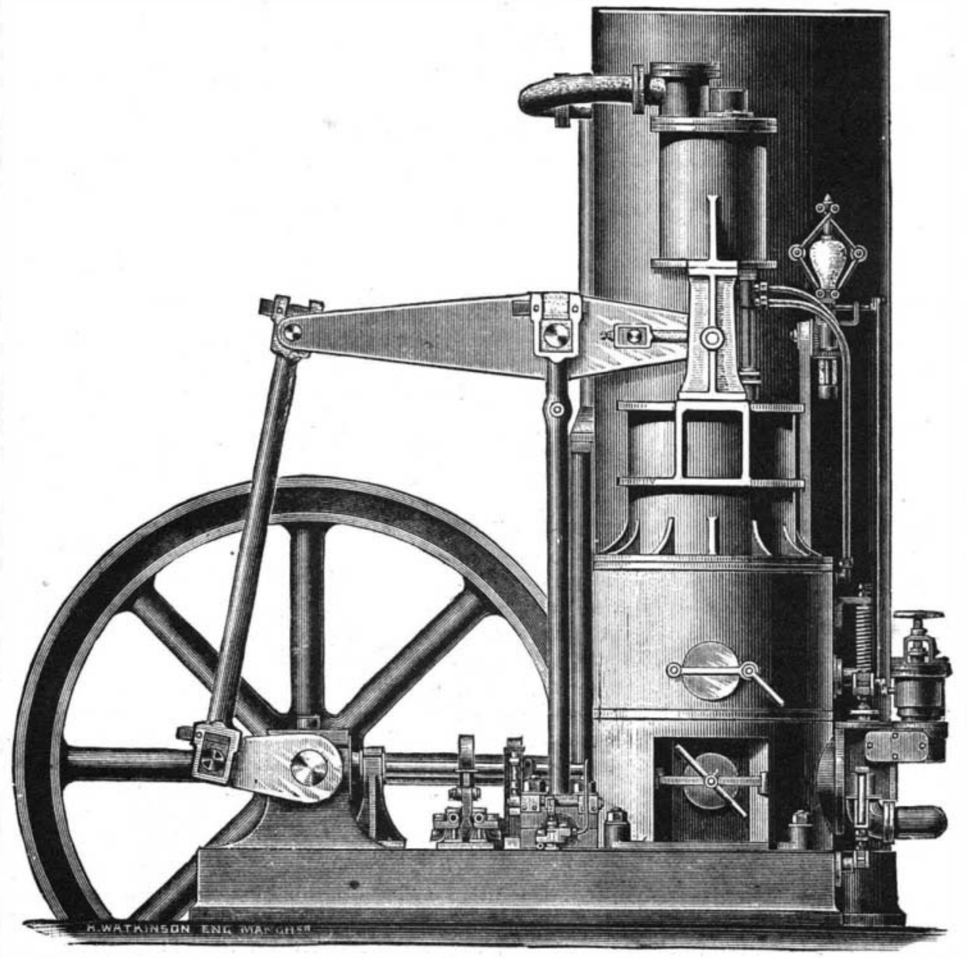
THE HARGREAVES THERMO-MOTOR.

This remarkable engine, the invention of Mr. James Hargreaves, of the firm of Hargreaves & Robinson, Widnes, is the result of a series of laborious and costly experiments, extending over a period of six years. The difficulties and discouragements encountered were both serious and numerous, but have at length been overcome by the determined perseverance of the inventor. The present engine is the third constructed under these patents, the two previous engines being entirely for experimental purposes. At 100 revolutions per minute it indicates 40 horse power, and consumes two gallons of coal tar per hour, or about 20·5 lb., or 0·512 lb. per indicated horse power per hour, the cost of two gallons of coal tar being less than 3d.



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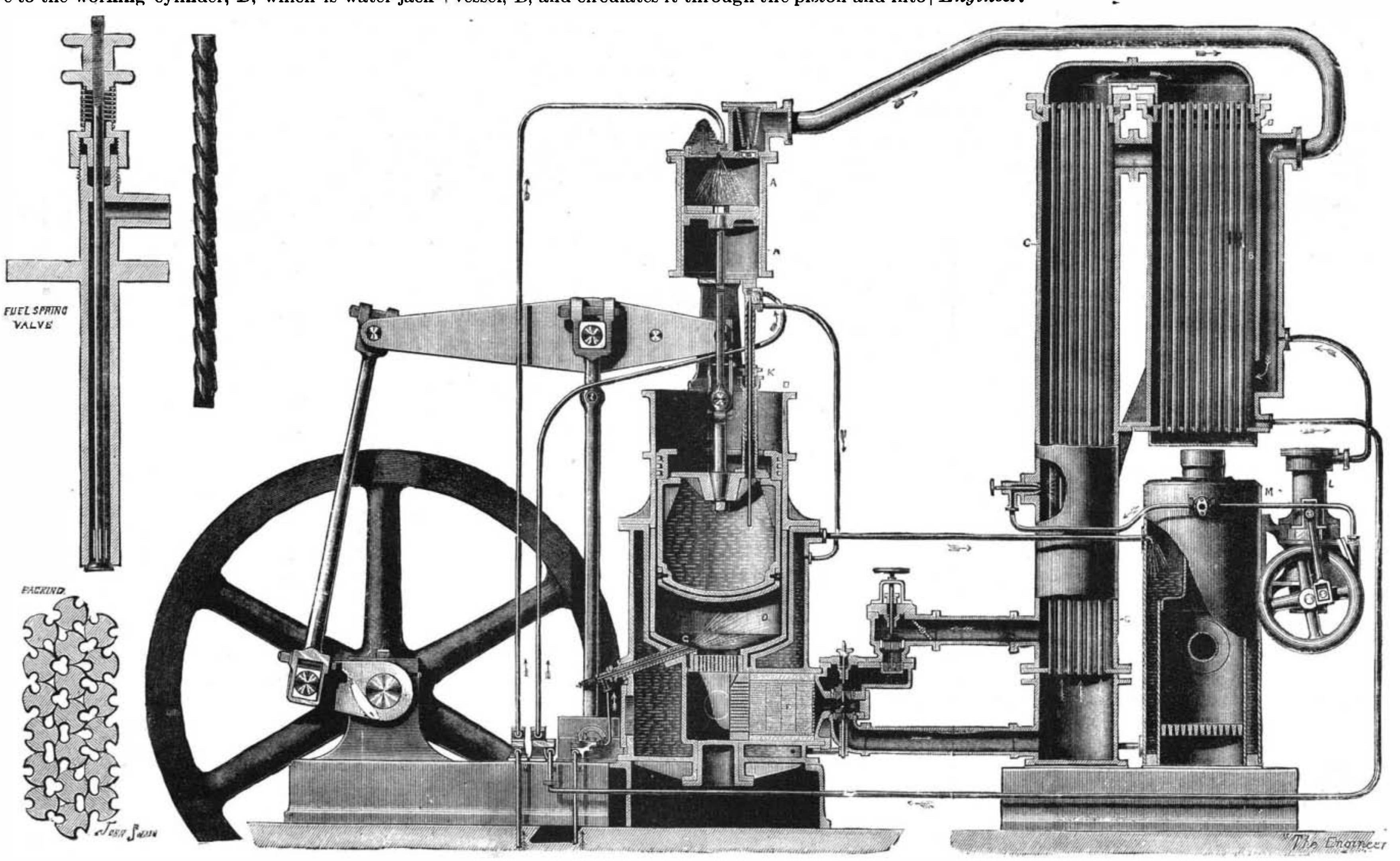
If we now examine the principle of the engine, we shall see how this extremely low consumption of fuel is attained. In 1824 Sadi Carnot propounded the great principle that the efficiency of any heat engine depended on the difference between the highest and the lowest limit of temperature in the working fluid, and that this difference must be as great as possible in order to secure a high efficiency. In the Hargreaves engine the highest temperature is probably over 2,461 deg. absolute, and the lowest 661 deg. absolute, or 2,000 deg., and 200 deg. Fah. on the ordinary scale, giving $\frac{2,461 - 661}{2,461} = 0·73$ as the highest theoretical available efficiency of the working fluid. If we compare this with a steam engine working with a boiler pressure of 170 lb. absolute and a terminal pressure of 6 lb. absolute, we have 830 deg. and 631 deg. as the highest and lowest absolute temperature, giving $\frac{830 - 631}{830} = 0·24$ as the highest theoretical efficiency of the working fluid in the cylinders. The efficiency of the boiler not being more than 0·7, we have $0·24 \times 0·7 = 0·168$ as the theoretical efficiency of the whole machine. In practice, the Hargreaves engine burns 0·512 lb. of coal tar per indicated horse power, and this may be still further reduced, while there are few steam engines even of large size which burn less than 1·6 lb. of coal per indicated horse power per hour.

Referring to the sectional elevation of the engine, below, it will be seen that it is of the internal combustion type, with regenerator and hot liners in the working cylinder. An air pump, A, draws air from the atmosphere and compresses it into the multitubular vessels, B and C, from which it passes through the inlet valve to the working cylinder, D, which is water-jacketed at the lower end, and fitted with cast iron liners where exposed to the hot gases. A thin layer of non-conducting material is interposed between the hot liners and the surface of the water jacketed parts. The piston is also water-jacketed, and the bottom is fitted with a liner in the same way as the cylinder. The packing rings are at the top of the piston, and work in a part of the cylinder which is comparatively cool. The regenerator, E, is filled with thin rods of hard porcelain, having three deep spiral grooves in each, something like a twist drill. This arrangement gives a large heating surface, and does not obstruct the passage of the inlet air and exhaust gases.

The fuel, which may be petroleum, coal tar, creosote, or any cheap oil fluid enough to pump, is forced into the cylinder by the small pump, F, through the spray valve, G. H and I are two small pumps, one of which forces water into the air pump, A, so as to saturate the air with water vapor, and keep down the temperature due to compression. The other draws the water not held in suspension by the air from the bottom of the vessel, B, and circulates it through the piston and into the cylinder water jacket by the telescopic pipe, K. L is a small pumping engine used to pump up the air pressure in the vessels, B and C, before starting the engine, steam being supplied by the small boiler, M, which also serves as a separator for the steam produced in the water jackets, which steam is passed into the vessel, C, and mixed with the air. Before starting the engine the end of the regenerator and the passage leading into the cylinder (the passage being formed of hard fire brick) is raised to a full red heat by a small portable furnace, an opening with a suitable cover being provided for this purpose in the bottom of the cylinder.

The action of the engine is as follows: The piston being at the end of its upward stroke, the exhaust valve opens, the gases then in the cylinder at a very high temperature pass through the regenerator as the piston descends, and communicate heat to the material with which it is filled, the end of the regenerator next the cylinder being kept at a bright red heat, while the gases escape through the exhaust valve at 360 deg. Fah. The exhaust gases then traverse the tubes of the vessels, C and B, communicating heat to the air from the air pump, A, and escape to the atmosphere at about 180 deg. to 200 deg. Fah. The air from the pump, A, enters the bottom of the vessel, B, at 140 deg. Fah., being saturated with water vapor. As the piston approaches the end of the down stroke, the exhaust valve closes. At this moment the fuel pump, F, makes its stroke, being worked by a cam, injecting the oil through the spray valve, the oil falling on the hot fire brick, and the hot liners of the cylinder and piston bottom is evaporated and heated sufficiently to take fire as soon as air is admitted by the inlet valve. The air leaves the vessel, C, at 240 deg. Fah., and in passing through the regenerator it absorbs the heat left there by the exhaust from the previous stroke. It arrives in the cylinder at a very high temperature. The combustion is consequently remarkably perfect and intense. The inlet valve closes at an early period of the stroke, the gases expanding during the remainder. At the end of the up stroke the exhaust valve again opens, and the cycle is repeated.

The action of the valves can best be understood on reference to indicator diagrams which were taken. The steam produced in the water jackets is mixed with the air, but in passing through the regenerator it is superheated to such an extent as to produce no bad effect on the combustion.—*London Engineer.*



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