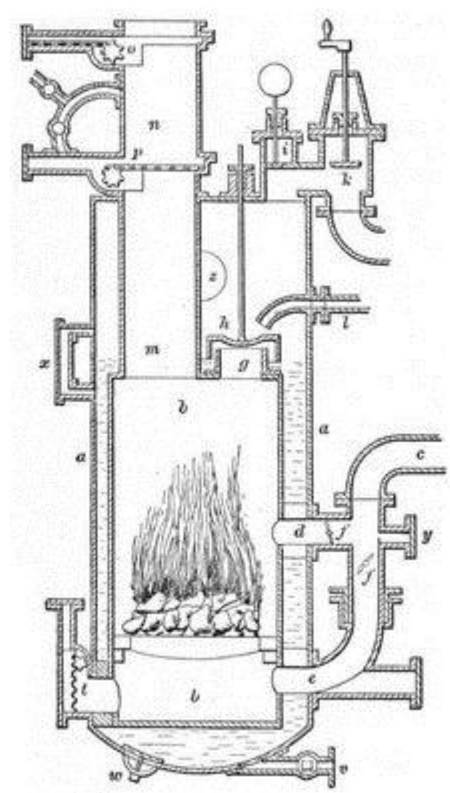
STEAM ENGINE USE AND DEVELOPMENT



A diagram of Cameron's aero-steam engine, from an 1876 dictionary

The first industrial applications of the vacuum engines were in the pumping of water from deep mineshafts. The Newcomen steam engine [[12]] operated by admitting steam to the operating chamber, closing the valve, and then admitting a spray of cold water. The water vapor condenses to a much smaller volume of water, creating a vacuum in the chamber. Atmospheric pressure, operating on the opposite side of a piston, pushes the piston to the bottom of the chamber.

In mineshaft pumps, the piston was connected to an operating rod that descended the shaft to a pump chamber. The oscillations of the operating rod are transferred to a pump piston that moves the water, through check valves, to the top of the shaft.

The first significant improvement, 60 years later, was creation of a separate condensing chamber with a valve between the operating chamber and the condensing chamber. This improvement was invented on Glasgow Green, Scotland by James Watt[[13]] and subsequently developed by him in Birmingham, England, to produce the Watt steam engine [[14]] with greatly increased efficiency. The next improvement was the replacement of manually operated valves with valves operated by the engine itself.

In 1802 William Symington built the "first practical steamboat", and in 1807 Robert Fulton used the Watt steam engine to power the first commercially successful steamboat.

Such early vacuum, or condensing, engines are severely limited in their efficiency but are relatively safe since the steam is at very low pressure and structural failure of the engine will be by inward collapse rather than an outward explosion. Their power is limited by the ambient air pressure, the displacement of the working chamber, the combustion and evaporation rates, and the condenser capacity.

The maximum theoretical efficiency is limited by the relatively low boiling point of water at near atmospheric pressure (100 °C, 212 °F).

The next big improvement in efficiency came with Richard Trevithick's [[15]] use of pressurized steam, which used a far greater pressure, but more importantly (from a thermodynamic standpoint) operates at a higher temperature differential. But with this added pressure came much danger and many disasters due to exploding boilers and machinery. The most important refinement at this point was the safety valve, which releases excess pressure. Reliable and safe operation came only with a great deal of experience and codification of construction, operating, and maintenance procedures.

Boilers

Boilers from Scientific American Supplement, Vol. XIX, No. 470, Jan. 3, are displayed in the National Museum of Science and Industry (The Science Museum), London. Boilers are of two main types:

- Fire tube construction is typical of early maritime installations for boats and ships and the boilers of steam locomotives. In a fire tube boiler, the hot gases from the firebox (a combustion chamber) are passed through tubes connecting perforated end plates. The gases then enter a smokebox orsmoke chest and pass on to a smokestack. The boiler may be vertical or horizontal.

For an example of a vertical boiler of this type observe the boiler in the small riverboat used in the movie The African Queen. This type is also used in some boilers that provide steam for steam heating of a building and was also used in the steam shovel. Locomotives and early ships used a horizontal orientation and early ships would usually require a tall smokestack to provide draft, not having a fan to provide a forced draft. In a steam locomotive the draft is generally augmented at startup by directing the steam exhaust through the smokestack, which provides a partial vacuum.

- In a Water-tube_boiler the water is heated in multiple tubes exposed to the hot gases. The tubes are joined to a steam collector chamber at the top. A significant advantage of this type is that there is less chance of catastrophic failure, as there is not a great amount of water in the boiler, nor are there large mechanical elements subject to failure. There may be additional tubes above the collector in the upper portion of the hot gas exhaust - this device, called a superheater, provides additional temperature (the pressure being unchanged) and increases the thermal efficiency of the entire mechanism. Superheaters were also used in some of the later versions of the steam locomotive.

There are also rarer variants, for example the drum boiler used in some steam cars.

There is also another division between boilers: natural aspiration, which is nearly all of them, and forced-draft, or "pressure-fired" boilers. This technology, equivalent to supercharging for an internal combustion engine, was developed by the Germans and acquired by the US Navy to be used in some frigates built after the Second World War. In it, a fan is used to increase the rate of burning; the boiler must be constructed to get that extra heat to the water. An engine using this kind of boiler has the greatest acceleration from a standing start of any marine powerplant.

Source: http://engineering.wikia.com/wiki/Steam_engine