Kent & East Sussex Railway

Operating Department Mutual Improvement Class

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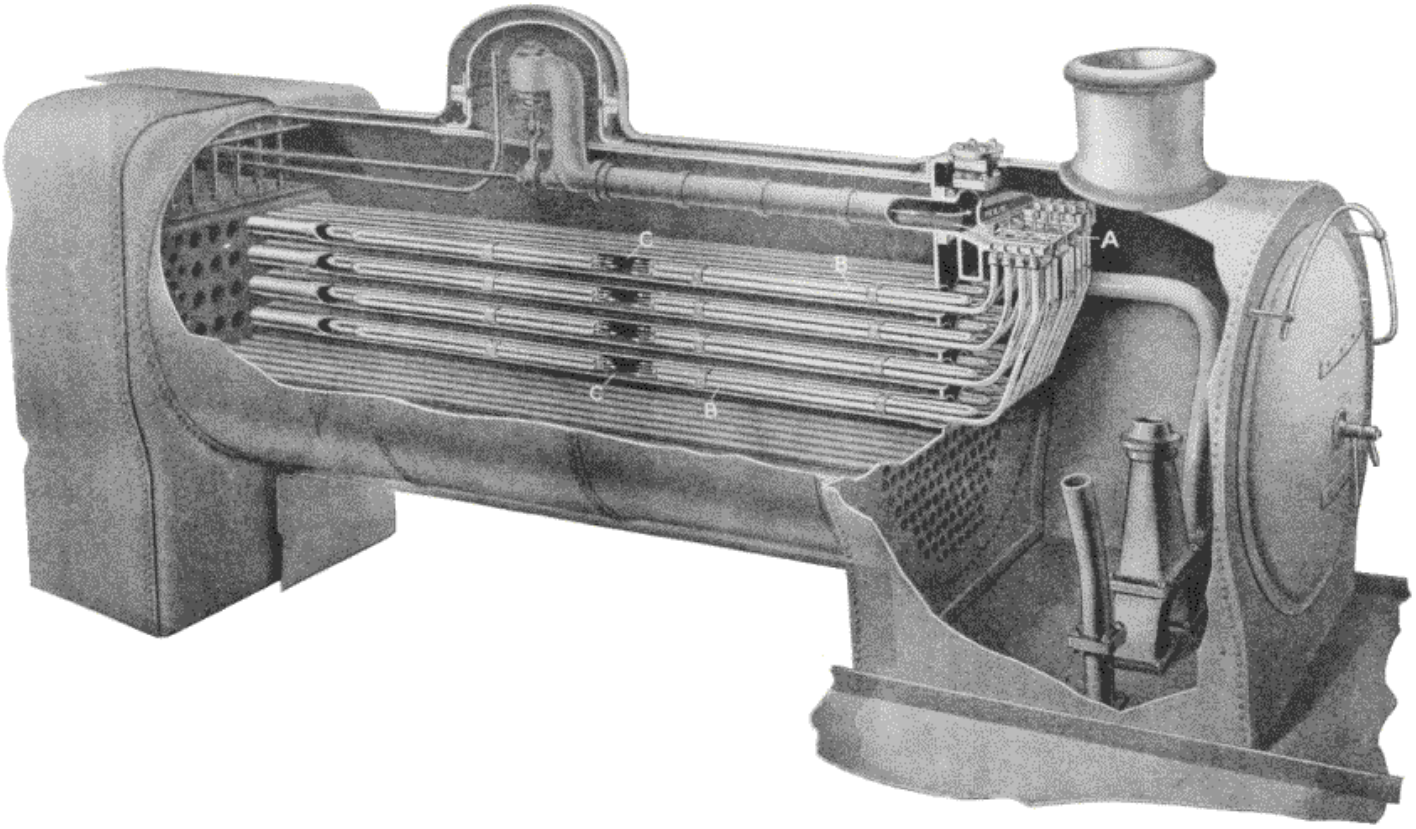
Superheaters



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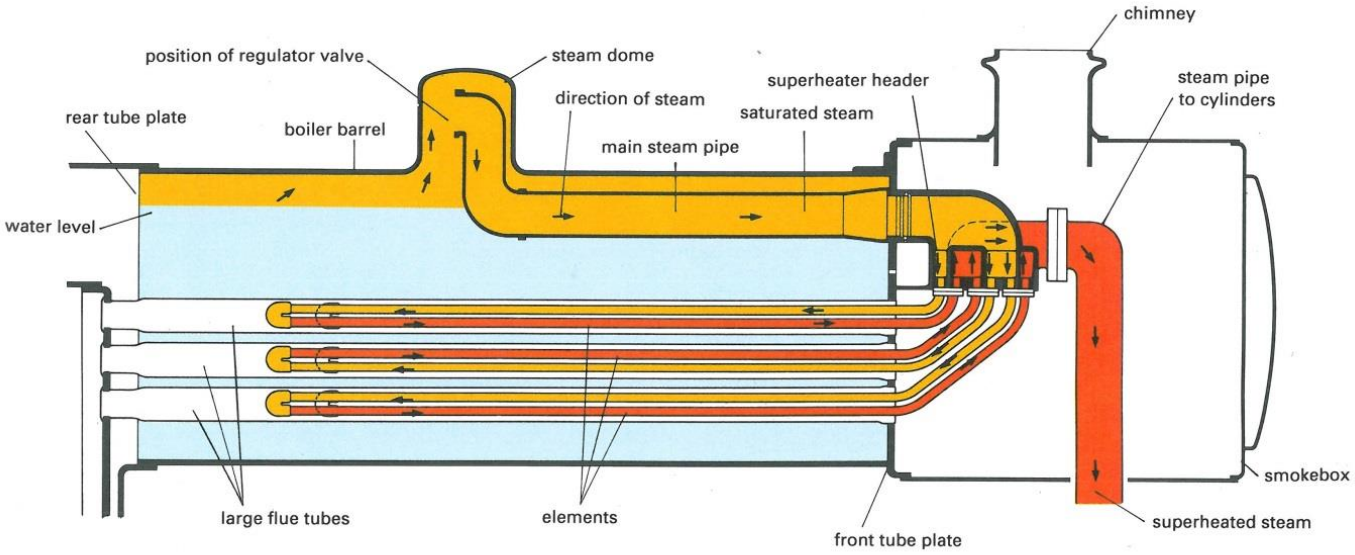
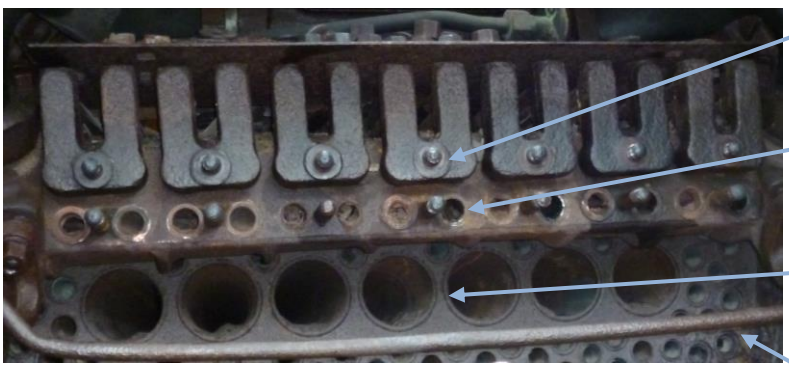
Steam collected above the water level in the boiler is known as ‘saturated’ or ‘wet’ steam. Many locomotives use steam in this form. However, later developments resulted in a method that refined the steam generating process through a method known as superheating creating ‘superheated’ or ‘dry’. This refined method is used to further increase the volume of steam generated in the boiler, accentuating its expansive properties and resulting in improved efficiency.

Saturated steam has high water content. Superheating allows it to be dried further, converting more of its water content into more steam, thus improving the efficiency of steam generation. To be able to dry the saturated steam, it must first be separated from the boiler. Instead of directing the saturated steam for use in the cylinders, it is passed to a ‘wet header’ in the smoke box. From here it is passed through a series of tubes, known as superheater elements. These elements pass back through the boiler inside large flu tubes almost as far as the firebox, but far enough away to avoid contact with the flames.



Some of the otherwise wasted gases escaping from the firebox to the chimney are put to good use, passing through the space in-between the flus and the elements, further heating the steam passing through them. As it does not have to boil the water in the boiler as well, the heat energy is concentrated into drying the moisture in the saturated steam, which then becomes superheated as the pressure builds.



Top half of superheater header, complete with elements.

Bottom half of superheater header, minus elements.

Bottom row of flu tubes, minus superheater elements.

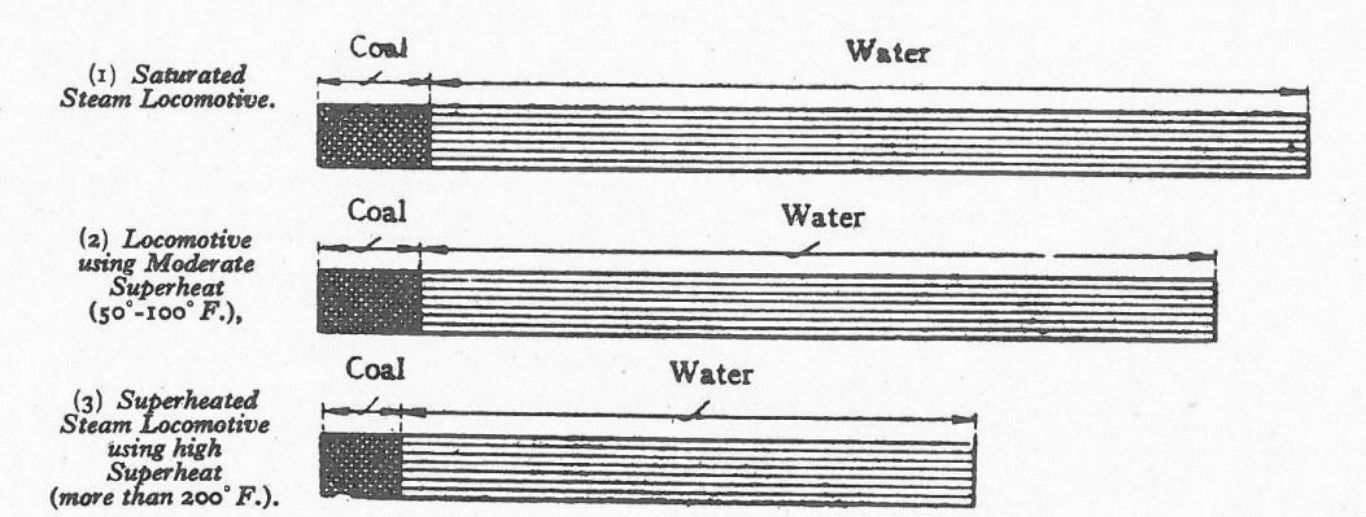
Smoke tubes

By further heating the steam away from the boiler, the pressure in the superheater can exceed the maximum pressure set by the safety valves. In addition, as the pressure builds, the temperature of the steam can increase by around an additional 300°F.

STEAM PRESSURE-TEMPERATURE TABLE

Gauge Pressure lb. per sq. in.	Temperature °F.	Gauge Pressure lb. per sq. in.	Temperature °F.
0	212·0	170	375·2
50	297·9	175	377·4
100	337·8	180	379·6
120	350·0	185	381·7
130	355·5	190	383·8
140	360·8	195	385·9
150	365·8	200	387·9
160	370·6	220	395·6
165	372·9	250	406·3

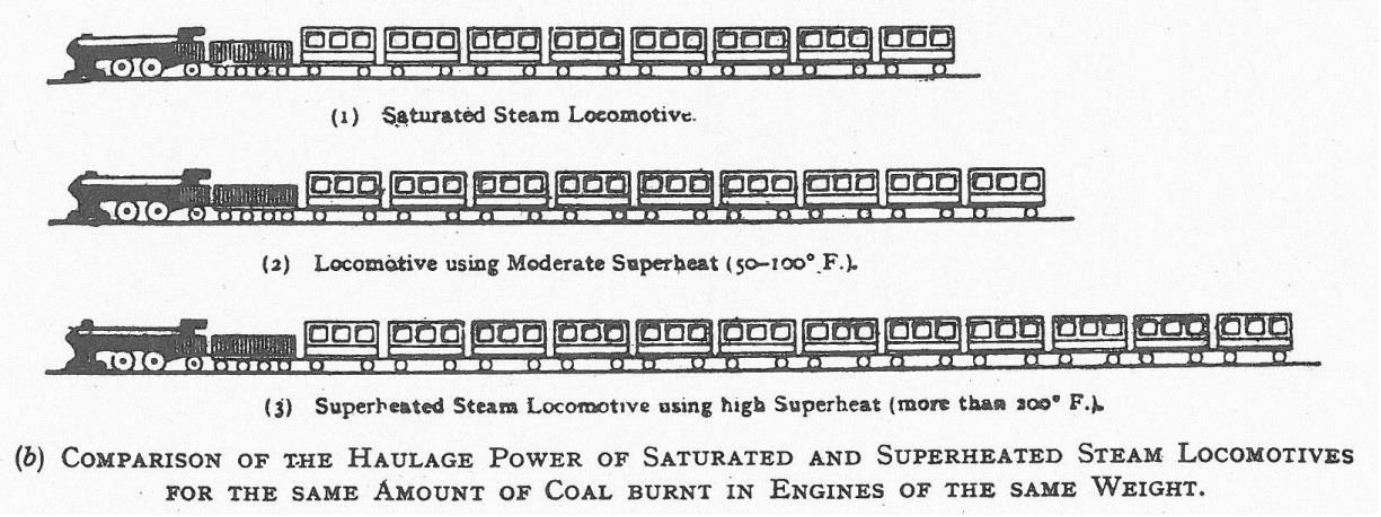
As an example, the increase in the volume of steam for an engine with a working pressure of 225lb is approximately 30%. By generating more steam in the superheating elements, the demand on the boiler to generate steam is reduced which saves on water and coal.



(*a*) Comparison of Coal and Water Consumption of Saturated and Superheated Steam Locomotives for the same Tractive Effort.

Having passed through the elements, the now superheated steam is collected again by the superheater header and passed into the steam chest where it is distributed via the valves to the cylinders. Using superheated steam in the cylinders helps to prevent the build-up of water through condensation, but is more abrasive and requires the cylinders to have good lubrication.

By increasing the steaming capacity of the boiler, it also has the effect of increasing the haulage power of the locomotive. This is due to the increased expansive properties of the steam, allowed by the increased pressure.



(b) COMPARISON OF THE HAULAGE POWER OF SATURATED AND SUPERHEATED STEAM LOCOMOTIVES FOR THE SAME AMOUNT OF COAL BURNT IN ENGINES OF THE SAME WEIGHT.

While superheated locomotives are superior in their steaming efficiency, the process does bring drawbacks. Extreme care must be exercised to fire and drive superheated locomotives in a manner that will not allow water to be carried out of the boiler. Along with the dangers of priming, due to the superheating process any water carried into the super heaters would cause a sudden and violent increase in steam production. Even after the regulator has been closed to stop the water being carried over, the superheating cycle would result in a period of uncontrolled steam admission to the cylinders. This can cause a locomotive to leap ahead or go into an uncontrolled slip and has been known to result in collisions when approaching stabled rolling stock or even cause severe damage to locomotive motion. In extreme cases the water carry over can prevent the regulator from being shut, as occurred with A2 ‘Blue Peter’ in 1994. Videos depicting issues with superheated locomotives can be found in the historical information section of the MIC website.