Interpreting the Steam Fire Engine
by Ted Elder

Goals for Today

- Show a variety of ways to interpret the steam fire engine for different audiences.
- Review the steam fire engines impact on the fire service
- Discuss how the steam fire engine fits into the Industrial Revolution
- Look at the science and technology of the steam engine
- Provide key words for additional research.
How do we interpret That?

- Video is available. Check YouTube.com out.
- Select photographs showing operating steamers.
- Tools of the trade.
- A well educated docent!!!
Pivotal element in the History of the Fire Service

Manpower needs reduced from this

To This

From a 60 man volunteer crew to a 3 man steamer crew.
Motive power changes

- Steamers were drawn in all manners:
  - Hand-drawn
  - Horse-drawn
  - Motor-powered: Steam, gasoline, and electric.

Politics of the fire service

- Large volunteer organizations had political clout.
- Paid department replaced the volunteers.
- Rise of the Unions and their political clout.
The Industrial Revolution

The Glorious Era of Steam

American Industrial Revolution

- Begins in 1790, but great expansion takes place from 1870 to the early 1900s. (The steam fire engine era began in 1852 and ended in 1916.)
- Small home-based businesses are replaced by large factories with employees. (The local wagon maker and blacksmith are replaced by factories.)
- Craftsmen are replaced by machinery. (The steam pumper replaces the volunteers.)

Steam made it possible!
Technology made it work.

Locomotives, steam ships, steam power!

Inventors, engineers, and machinists!
Coal is our fuel, but where does the coal get its energy? Where does the energy come from in fossil fuels?

The principle of Conservation of Energy states energy cannot be created or destroyed. It can only change forms.

Follow the Energy!
Heat Transfer

- Combustion is our Heat source. It can be rich or lean. The draft of the boiler and design of the grate controls the air ratio.
- Heat is transferred by:
  - Conduction
  - Convection
  - Radiation
- Heat is lost out the stack. This is the efficiency of the boiler.

Heat Engines

- Potential energy vs. Kinetic energy.
- Heat engines use energy in the form of heat to do work.
- Work is applying force over a distance, \( W = F \times D \)
- Flywheels store rotational energy.

Thermodynamics

- Heat engines are constrained by the 1st and 2nd laws of thermodynamics
- The first law states the change in internal energy of a system is equal to the heat added to the system minus the work done by the system.
- The second law is a principle that says that no heat engine is perfect. All lose heat to the environment (the Cold Reservoir).
- The most efficient steam engines can only achieve 40% efficiency for the steam engine.
Steam

- Water must be heated to 212 degrees Fahrenheit to boil.
- A British Thermal Unit is the amount of energy (heat) needed to raise 1 lb of water 1 degree F.
- The Latent Heat of Vaporization of water is 970 BTU/lb.
- Water expands 1700 times when it turns to steam.
- This is why steam is so powerful and can be so dangerous (BLEVE).
- Steam is a gas and must follow the Ideal Gas Law, Boyle’s Law, and Charles Law.
- A pound of coal has 12,000 BTU. (A pound of gasoline has 19,800 BTU.)

Hydraulic Forces

- Most steamer’s operated at around 80 lbs of steam pressure. How did they pump high pressure to the water towers and deck guns??
- The Force on the steam piston is applied over the entire area of the piston and is multiplied.
- \[ F = \text{Pressure} \times \text{Area} \]
- This is transmitted to the pump and divided over the area of the water piston.

Questions?