

## The Steam Engine

- ◆ Pre-Steam
- ◆ Boilers
- ◆ Atmospheric Engine
- ◆ Condensing Engine
- ◆ Double-Acting Engine

## Pre-Steam

- ◆ Hero of Alexandria
  - ◆ 1st Century AD
  - ◆ Described Boiler and Reaction Turbine
  - ◆ No Suggestion for Useful Application of Device
- ◆ 16th Century - Descriptive Publications
- ◆ 17th Century - Beginning of Steam's Practical Usage

## Hero's Engine



## Boilers - Types

- ◆ Shell (1720s)
  - ◆ Kettle on Stove
  - ◆ Inefficient - Loss of Heat
- ◆ Heat Tube (1750s)
  - ◆ Tredgold - London
- ◆ Fire Tube (1750s)
  - ◆ Limited in Capacity and Pressure
  - ◆ Susceptible to Explosions
  - ◆ Smeaton
  - ◆ Trevithick (1804) - 65 psi, 25 inch bore, 10 ft stroke

## Boilers - Types (continued)

- ◆ Water Tube (1770s)
  - ◆ Blakey (1766) - First Built
  - ◆ Rumsey (1788) - First Successful
  - ◆ John Stevens - Lawyer (1800s)
    - ◆ **First Patents in 1790**
- ◆ Improved Water Tube (1850s)
  - ◆ Wilcox (1856)
    - ◆ **Multiple, Inclined, Water Tubes**
    - ◆ **Better Water Circulation**
    - ◆ **More Heating Surface**
  - ◆ Babcock & Wilcox (1866)

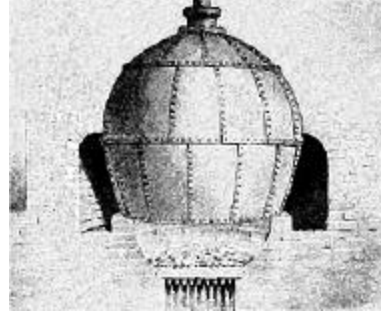
## Boilers - Construction

- ◆ Materials
  - ◆ Copper
  - ◆ Cast Iron
  - ◆ Rolled Iron Plates - 5/16" (1795)
  - ◆ Steel
- ◆ Fabrication
  - ◆ Bolts & Rivets
  - ◆ Welding

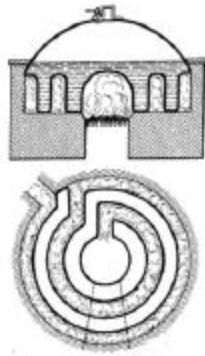
## Boilers - Explosions

- ◆ Poor Materials
- ◆ High Pressure
- ◆ Pressure Release
- ◆ Theoretical Considerations
- ◆ Fabrication Techniques - Rivets
- ◆ High Heat Input
- ◆ Poor Distribution of Heat
- ◆ Direct Heating
- ◆ Poor Circulation

## Haycock's Shell Boiler (1720)



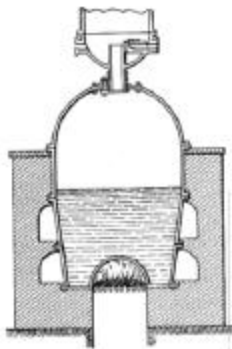
## Tredgold's Heat Tube (1750)



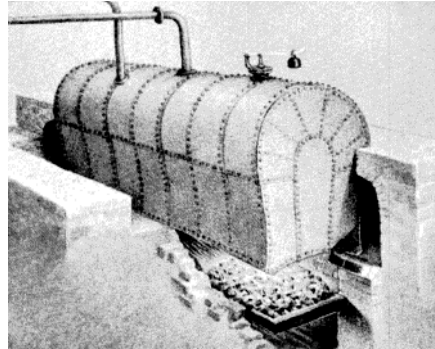
## Blakey's Water Tube Boiler (1766)



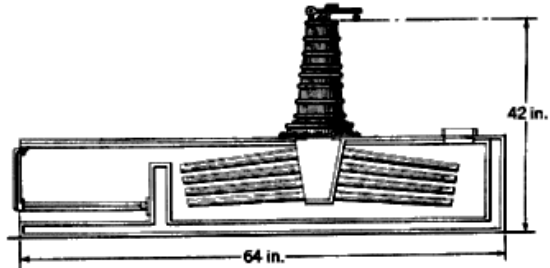
## Smeaton's Fire Tube Boiler (1770)



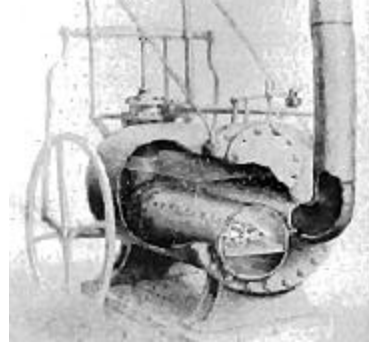
## Wagon - Shell Boiler (1769)



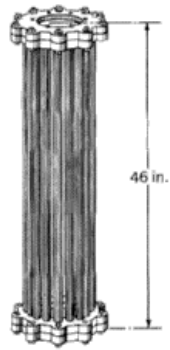
Steven's Water Tube Boiler (1803)



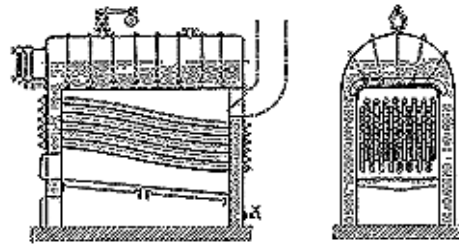
Trevithick's Fire Tube Boiler (1804)



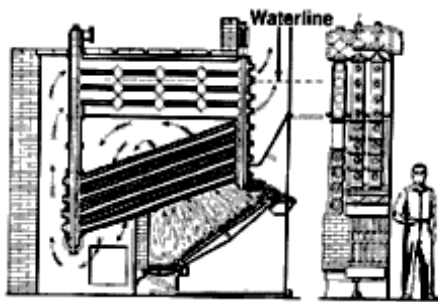
Stevens - Water Tube Boiler (1805)



Stephen Wilcox (1856)



Babcock & Wilcox (1867)



Babcock & Wilcox (1887)

