

Lowell, Francis and America's First Industry

Integrated Factory and Water Turbine

CEE 102: Prof. Michael G. Littman

Course Administrator: Catherine Eiben ceiben@princeton.edu

Computers for NOTETAKING ONLY

Please - NO Cell Phones, Texting, Internet use

Independence, Iron, and Early Industry

1776 – 1855



Independence, Iron, and Early Industry

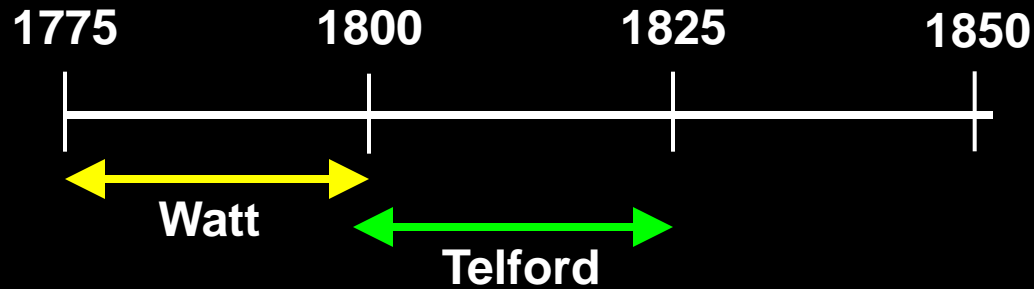
1776 – 1855



Engine

Independence, Iron, and Early Industry

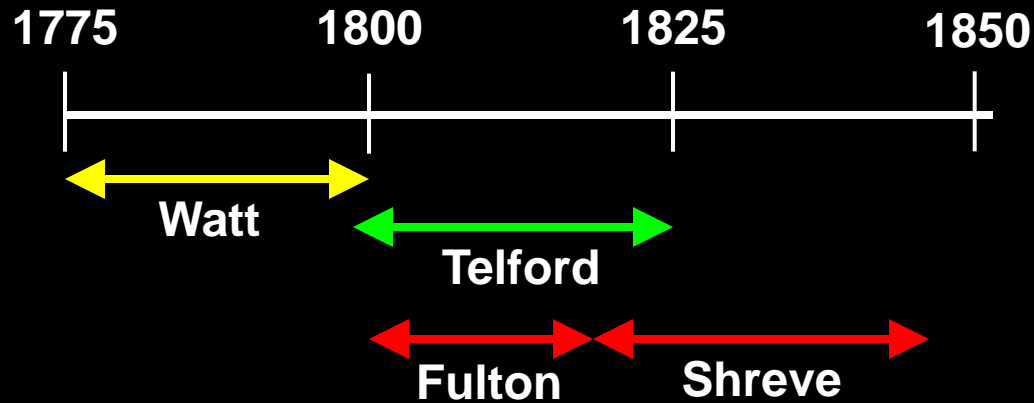
1776 – 1855



Engine – Bridge

Independence, Iron, and Early Industry

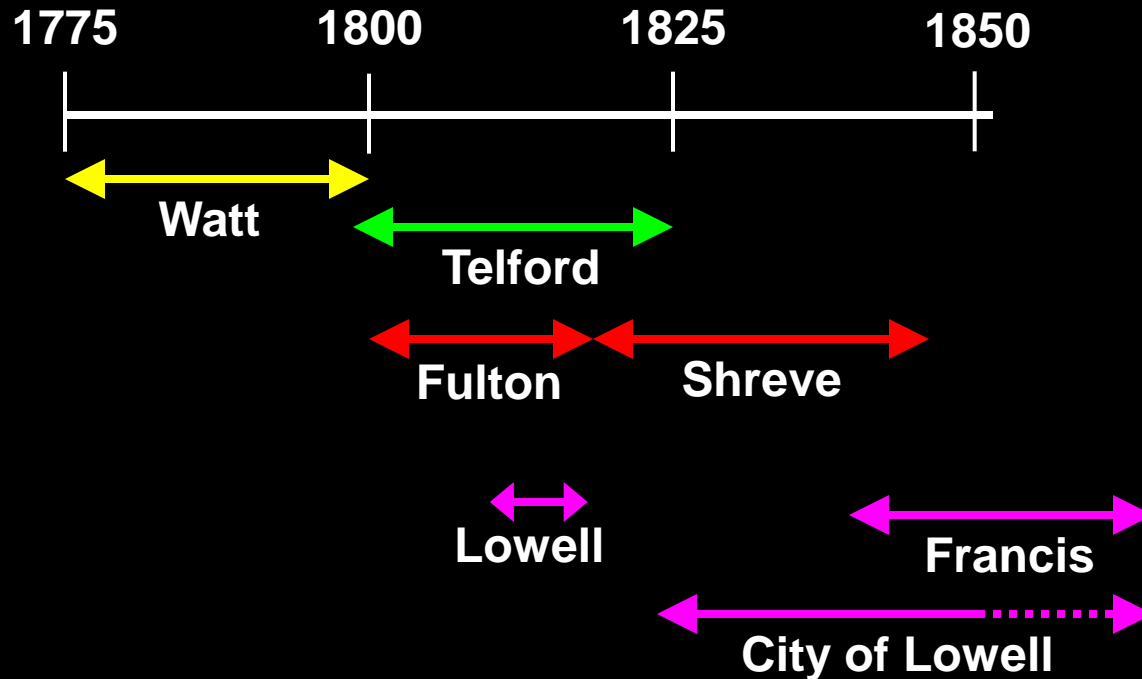
1776 – 1855



Engine – **Bridge** – **Boat**

Independence, Iron, and Early Industry

1776 – 1855



Engine – **Bridge** – **Boat** – **Textiles**

Textiles in America

Mechanization and Water Power

Planned Factory Town

Wealth and Education



Textiles in America

Mechanization and Water Power

Planned Factory Town

Wealth and Education



Textiles in America

Mechanization and Water Power

Planned Factory Town

Wealth and Education

**And this is good old Boston
The home of the bean and the cod,
Where the Lowells talk to the Cabots,
And the Cabots talk only to God**



Francis Cabot Lowell

entrepreneur

Mathematical mind

Business acumen

Ideal for industry



Francis Cabot Lowell

entrepreneur

Mathematical mind

Business acumen

Ideal for industry



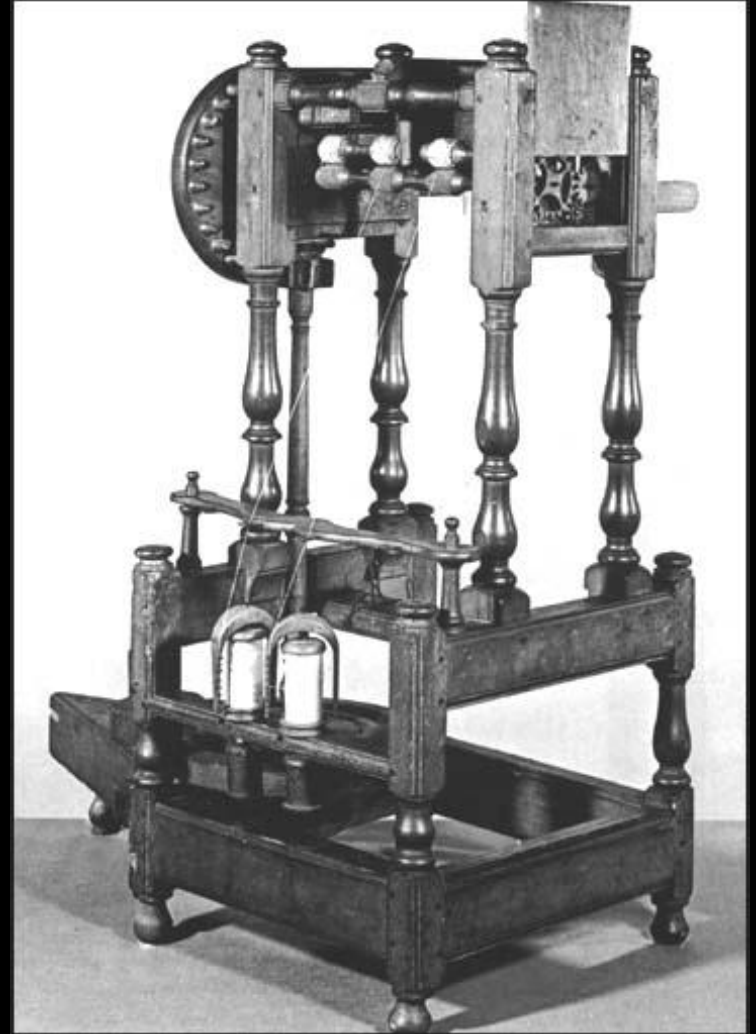
Francis Cabot Lowell

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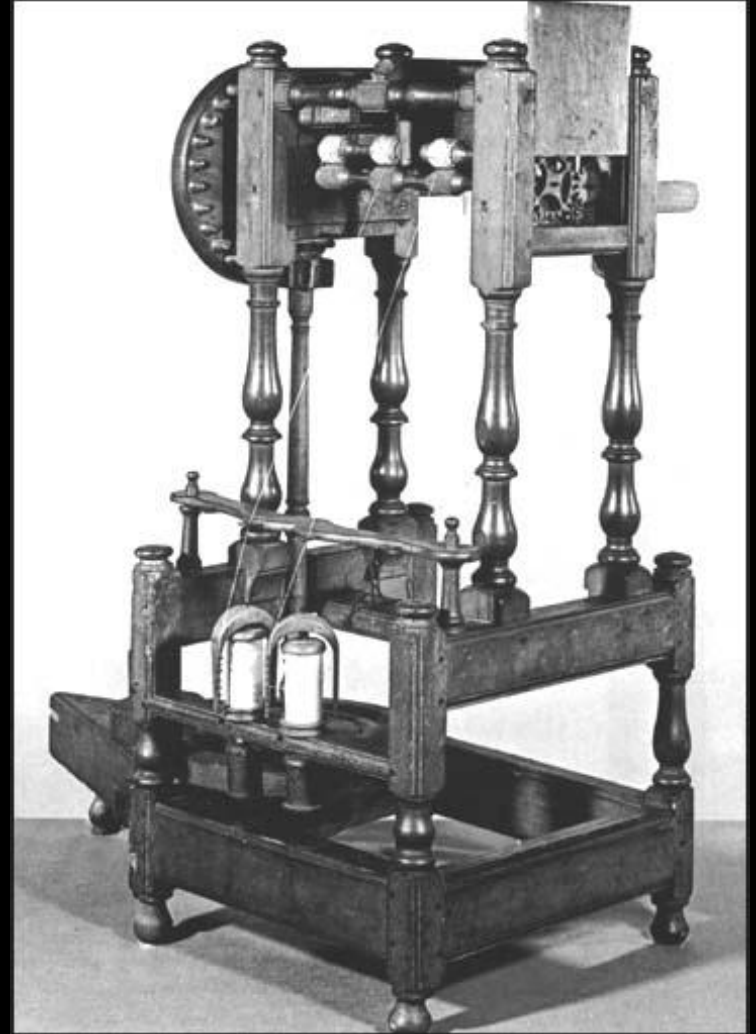
Waltham to Lowell

Francis C. Lowell

entrepreneur and innovator

Paul Moody

engineer and manager



Waltham to Lowell

Francis C. Lowell

entrepreneur and innovator

Paul Moody

engineer and manager



The Integrated Factory Bale to Bolt

**Boston Associates - First corporation.
Investors responsible up to investment
amount – not personal fortune.**

Waltham to Lowell

Francis C. Lowell

entrepreneur and innovator

Paul Moody

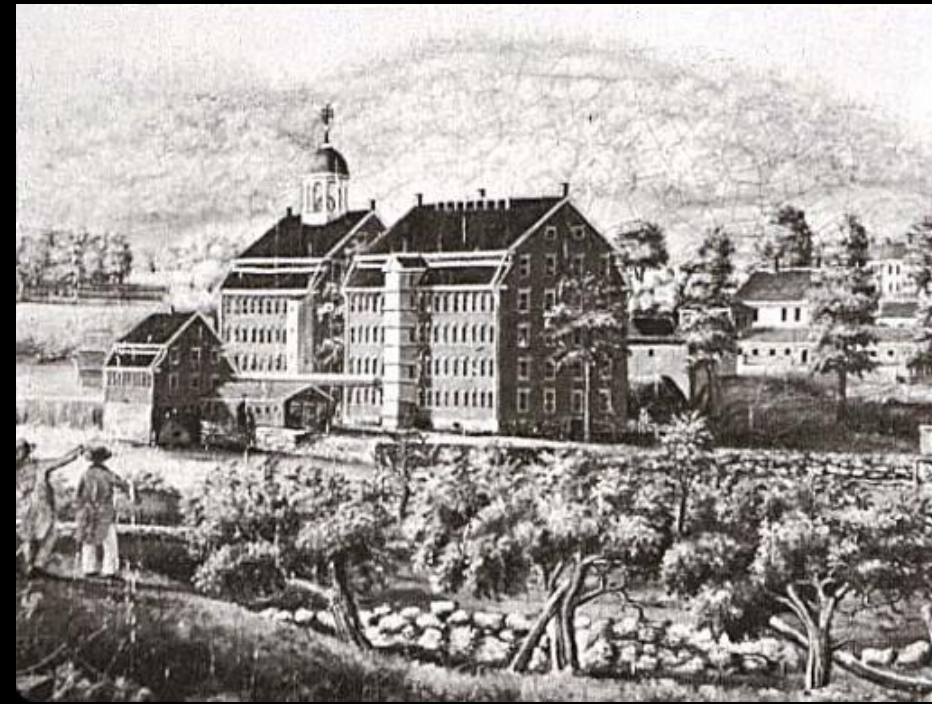
engineer and manager



The Integrated Factory Bale to Bolt

This indenture made this first day of November Eighteen Hundred & Thirteen, between the Boston Manufacturing Company on the one part & Paul Moody on the other, Witnesseth, that whereas said Company are about establishing the Manufacture of Linen, Woollen & Cotton Goods at their Mills in Waltham, & said Moody has agreed to superintend the same ...

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Pawtucket Falls



Pawtucket Falls

$$H_p = \frac{Q \gamma H}{33,000}$$

Transforming Nature
 FORMULAS: machines

$$\gamma H \times Q \longrightarrow H_p$$

water
pressure

flow

power



$$H_p = \frac{Q \gamma H}{33,000}$$

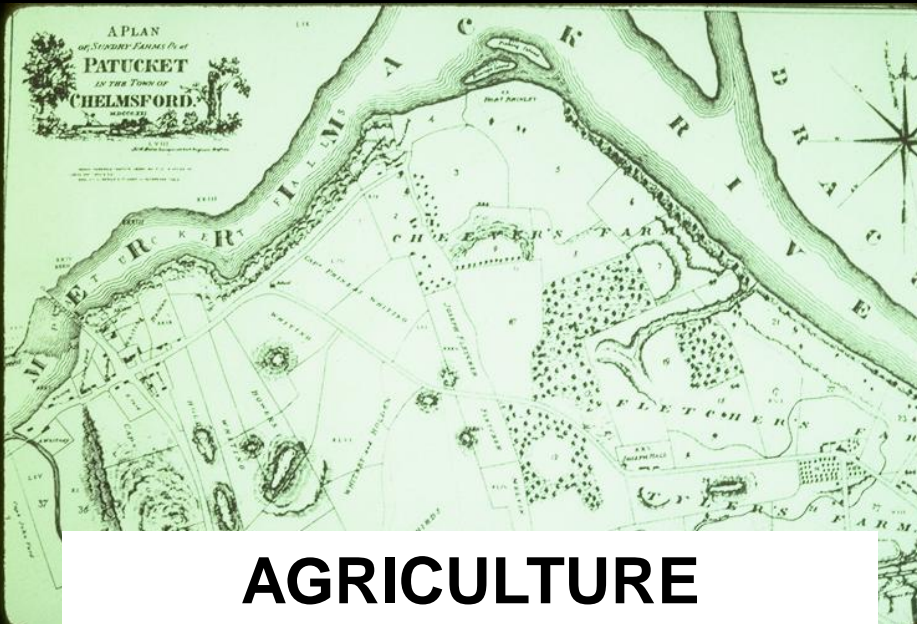
Transforming Nature
 FORMULAS: machines

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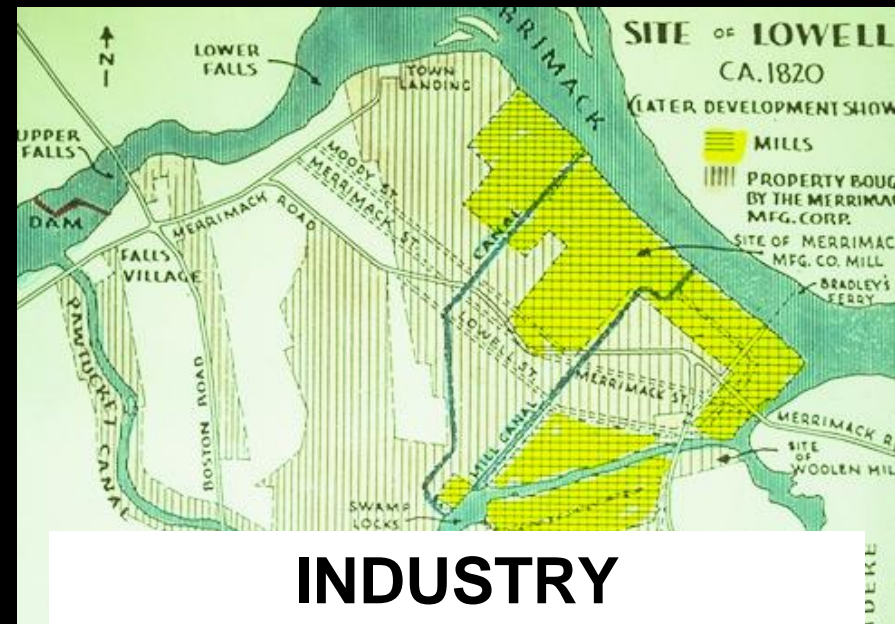
water
pressure

flow

power



AGRICULTURE



INDUSTRY

$$H_p = \frac{Q \gamma H}{33,000}$$

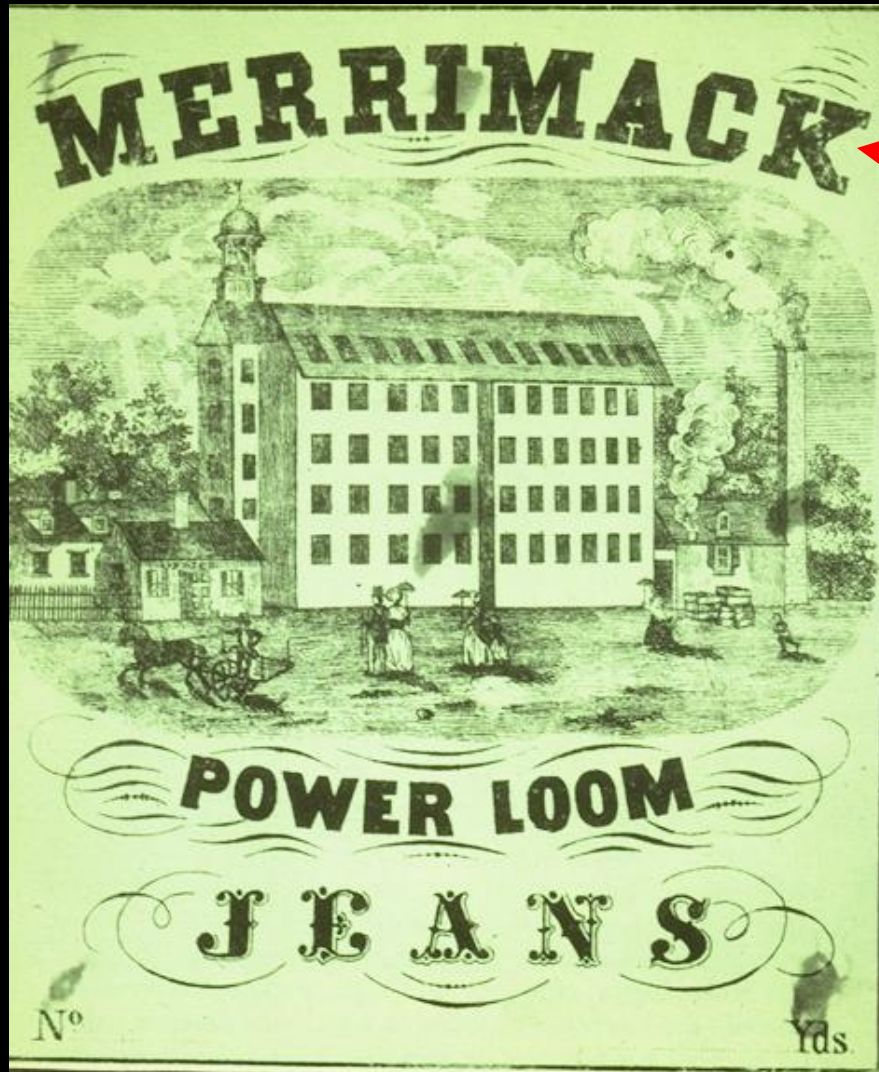
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water
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Transforming Nature
 FORMULAS: machines

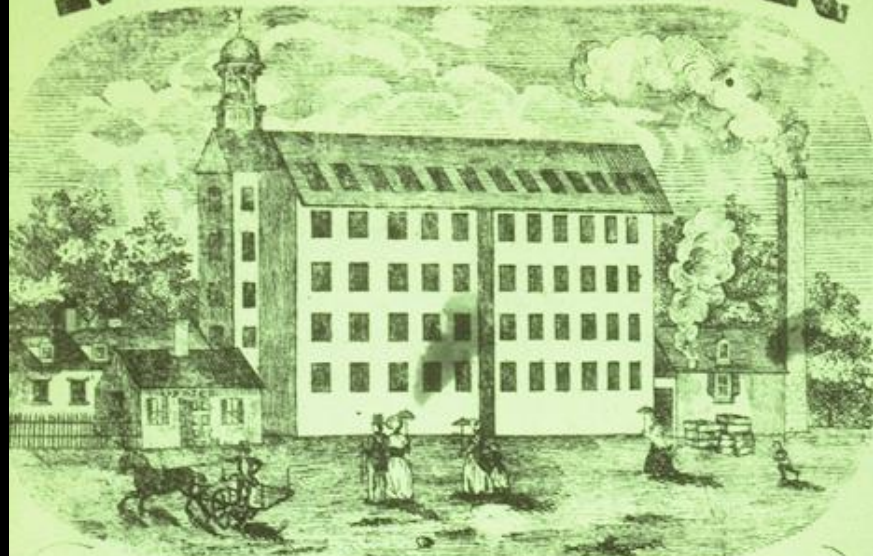
$$\gamma_H \times Q \rightarrow H_p$$

water
pressure

flow

power

MERRIMACK



POWER LOOM

JEANS

No

Yds

75 Young Women

From 15 to 35 Years of Age,

WANTED TO WORK IN THE

COTTON MILLS!

IN LOWELL AND CHICOPEE, MASS.

I am authorized by the Agents of said Mills to make the following proposition to persons suitable for their work, viz:—They will be paid \$1.00 per week, and board, for the first month. It is presumed they will then be able to go to work at job prices. They will be considered as engaged for one year, cases of sickness excepted. I will pay the expenses of those who have not the means to pay for themselves, and the girls will pay it to the Company by their first labor. All that remain in the employ of the Company eighteen months will have the amount of their expenses to the Mills refunded to them. They will be properly cared for in sickness. It is hoped that none will go except those whose circumstances will admit of their staying at least one year. None but active and healthy girls will be engaged for this work as it would not be advisable for either the girls or the Company.

I shall be at the Howard Hotel, Burlington, on Monday, July 25th; at Farnham's, St. Albans, Tuesday forenoon, 26th, at Keyse's, Swanton, in the afternoon; at the Massachusetts' House, Rouses Point, on Wednesday, the 27th, to engage girls,—such as would like a place in the Mills would do well to improve the present opportunity, as new hands will not be wanted late in the season. I shall start with my Company, for the Mills, on Friday morning, the 29th inst., from Rouses Point, at 6 o'clock. Such as do not have an opportunity to see me at the above places, can take the cars and go with me the same as though I had engaged them.

I will be responsible for the safety of all baggage that is marked in care of I. M. BOYNTON, and delivered to my charge.

I. M. BOYNTON,

Agent for Procuring Help for the Mills.



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From 15 to 35 Years of Age,

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Lowell- Factories and Cities

from **FARM** to **FACTORY**

from **COUNTRY** to **CITY**

from **CRAFT** to **ENGINEERING**

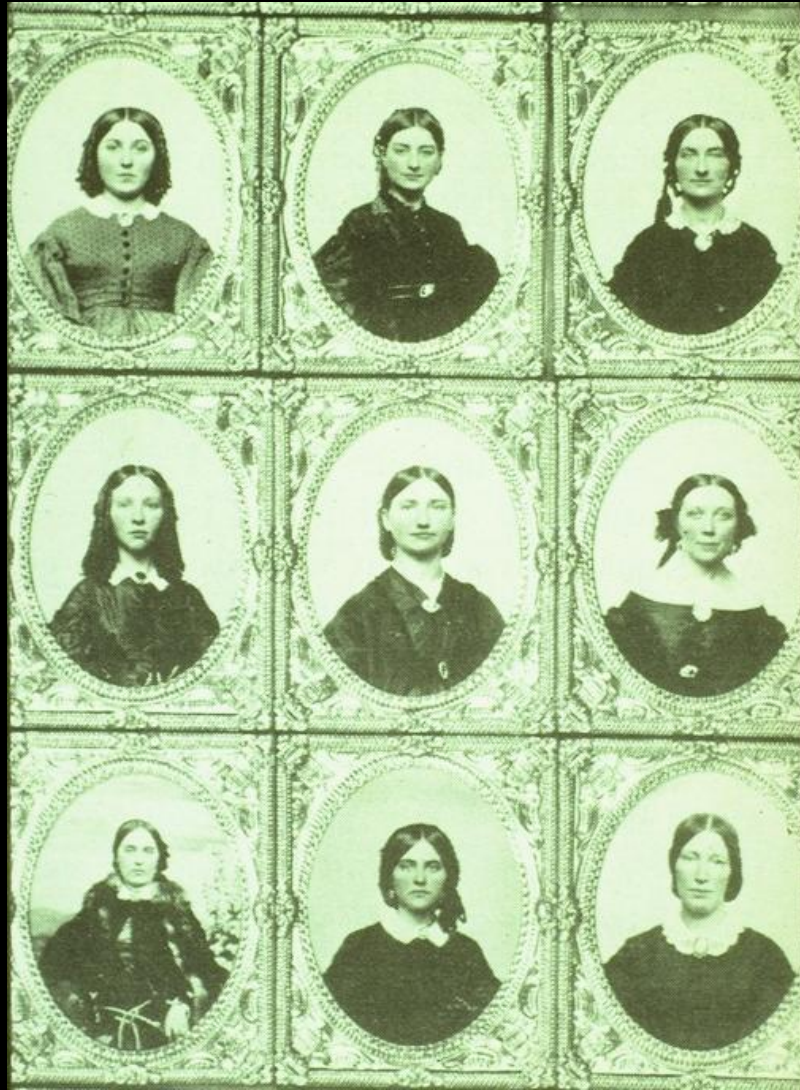


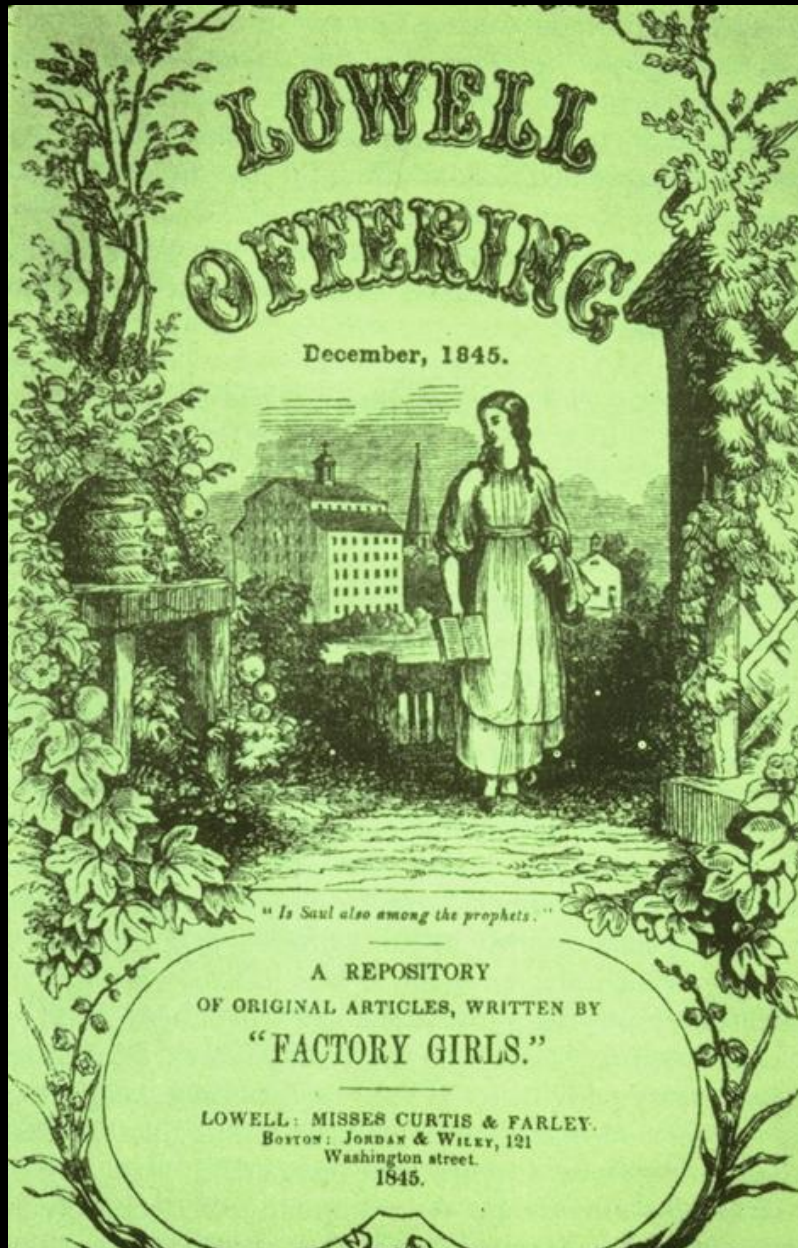
Lowell- Factories and Cities

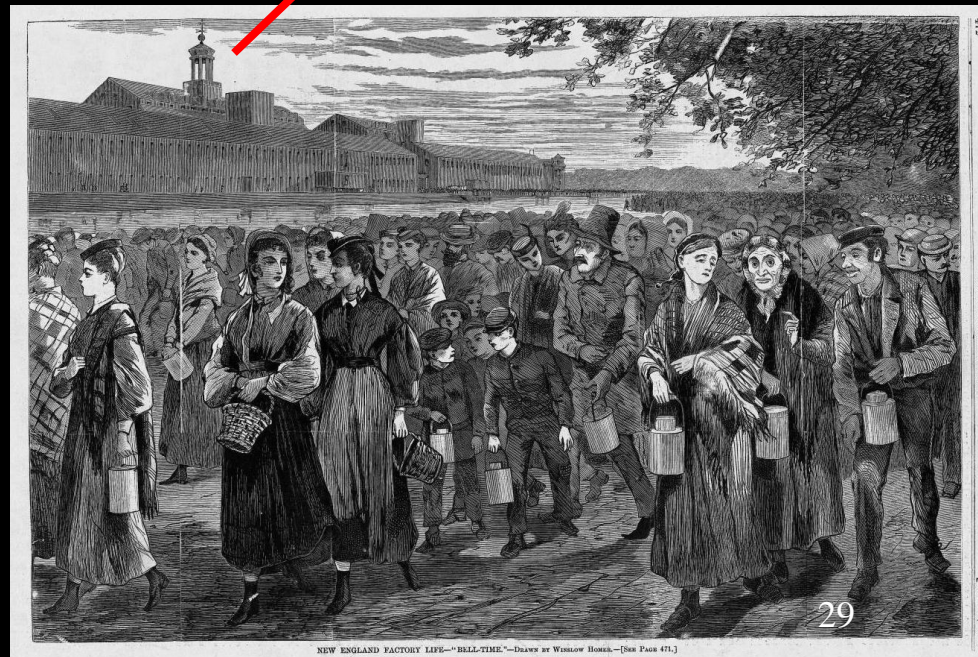
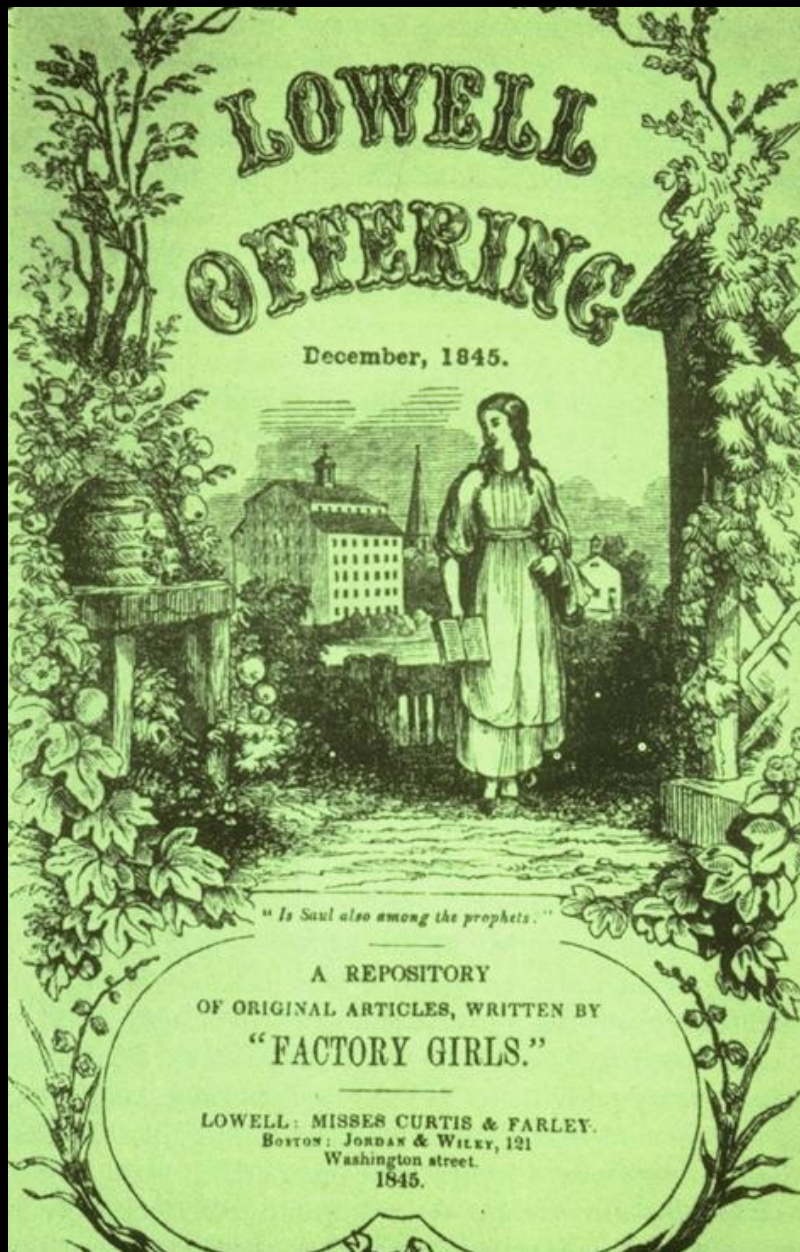
from **FARM** to **FACTORY**

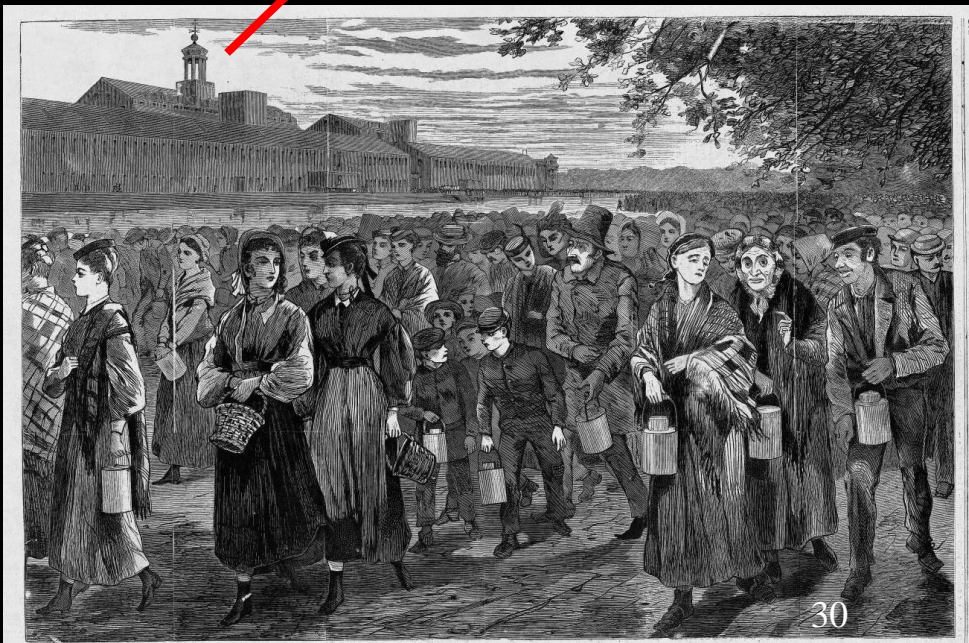
from **COUNTRY** to **CITY**

from **CRAFT** to **ENGINEERING**









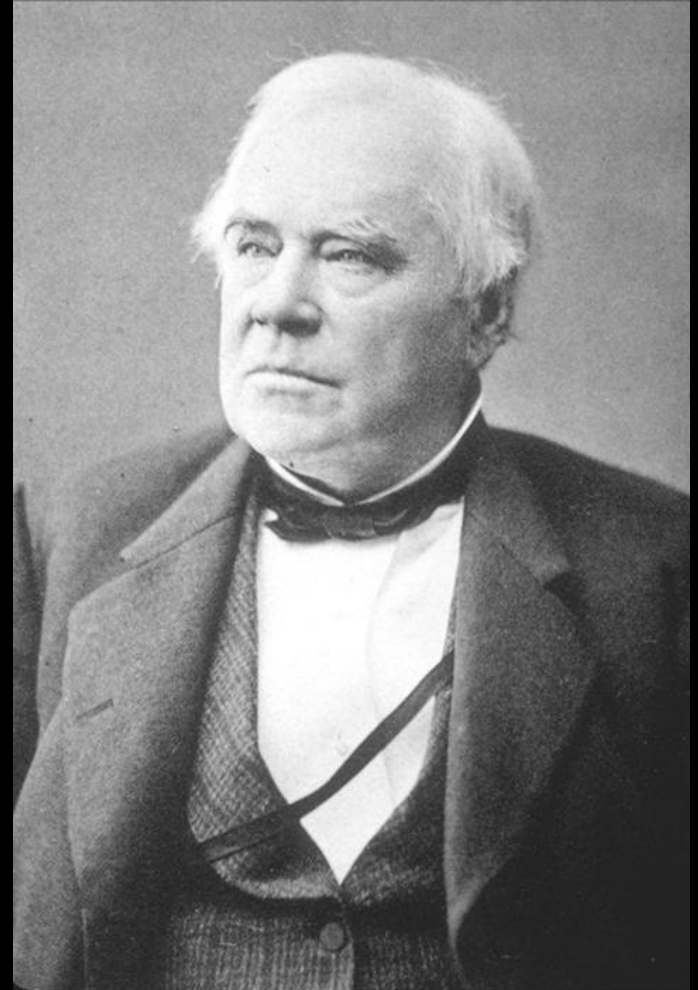
NEW ENGLAND FACTORY LIFE.—"BELL-TIME."—DRAWN BY WISLAW HOMER.—[SEE PAGE 471.]



VIDEO





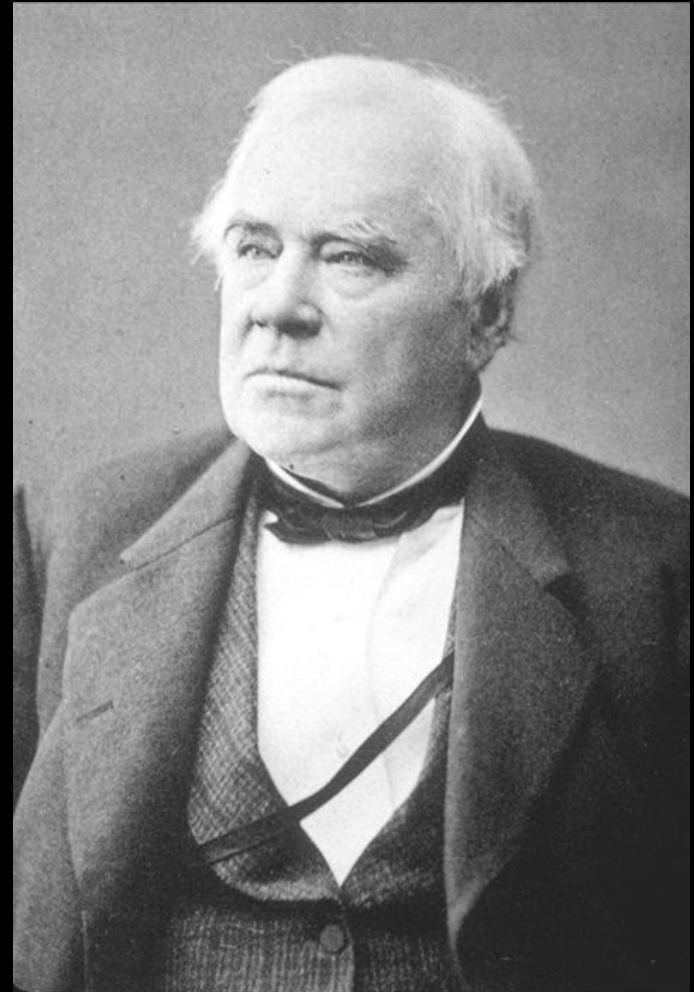


James B. Francis
engineer

Efficient Water Motor

“Water Policeman” – the Weir

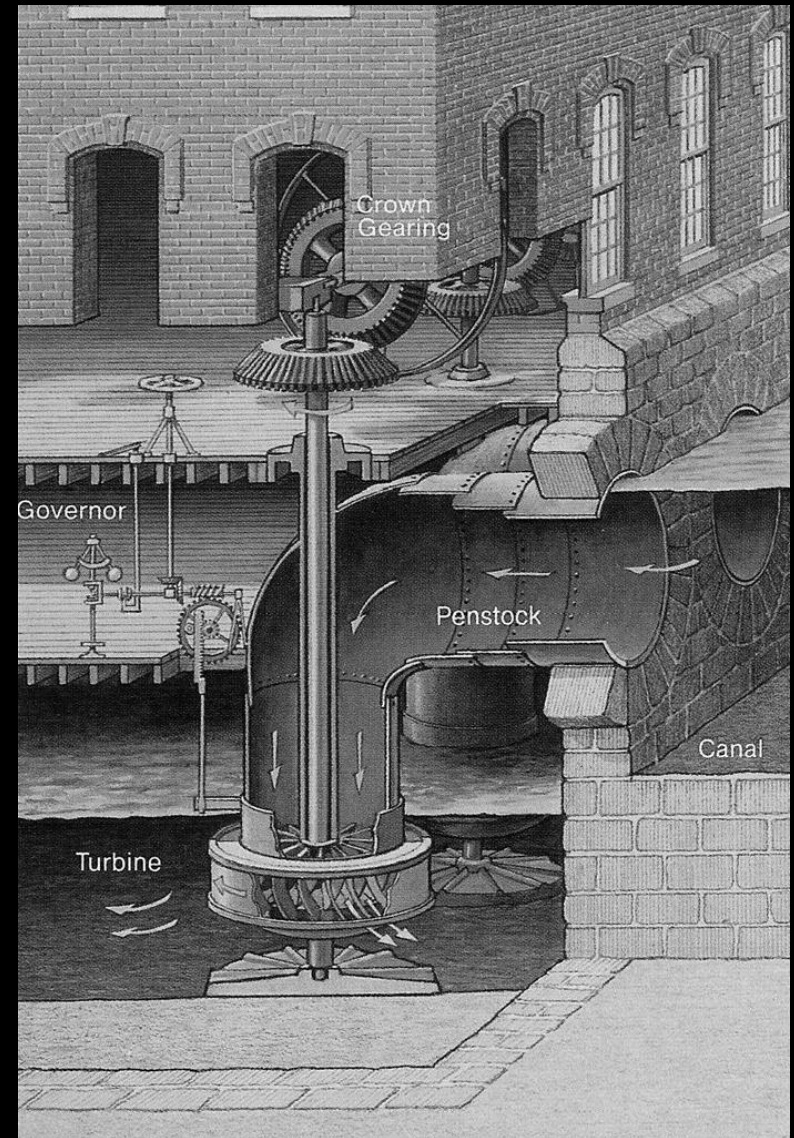
Canal Walk and Lock Gate



James B. Francis engineer

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“Water Policeman” – the Weir
Canal Walk and Lock Gate

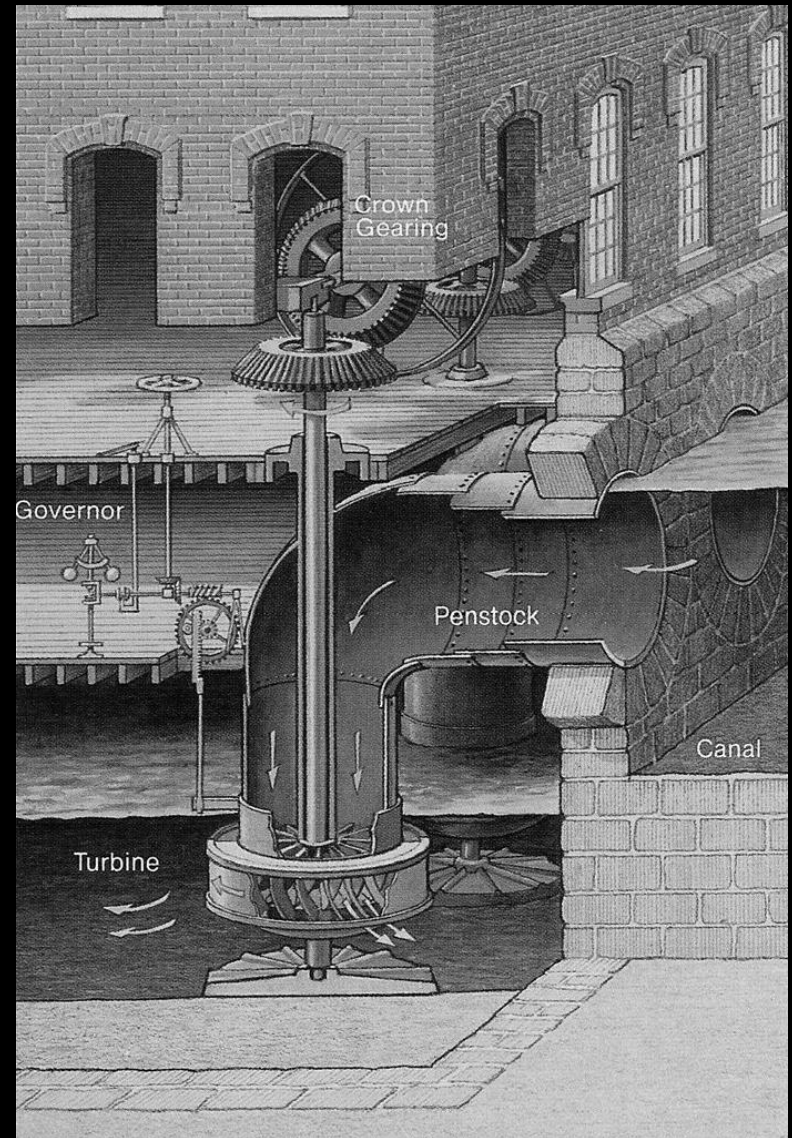


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Canal Walk and Lock Gate**

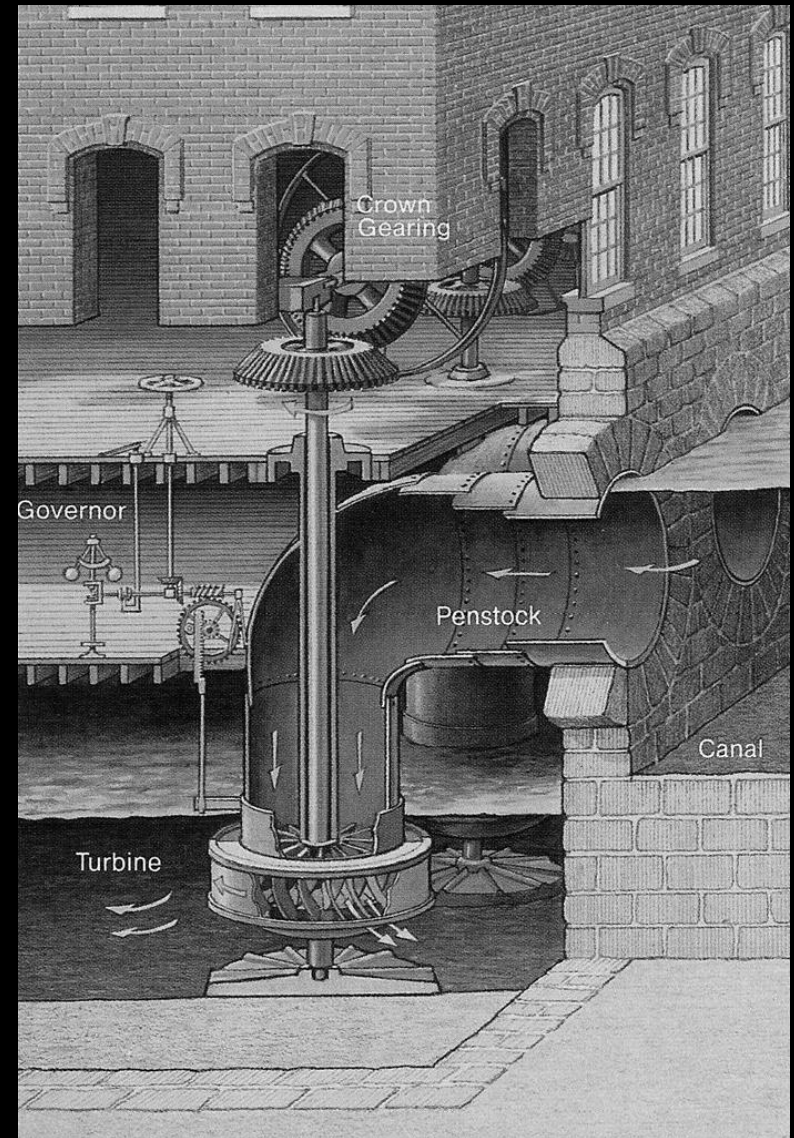
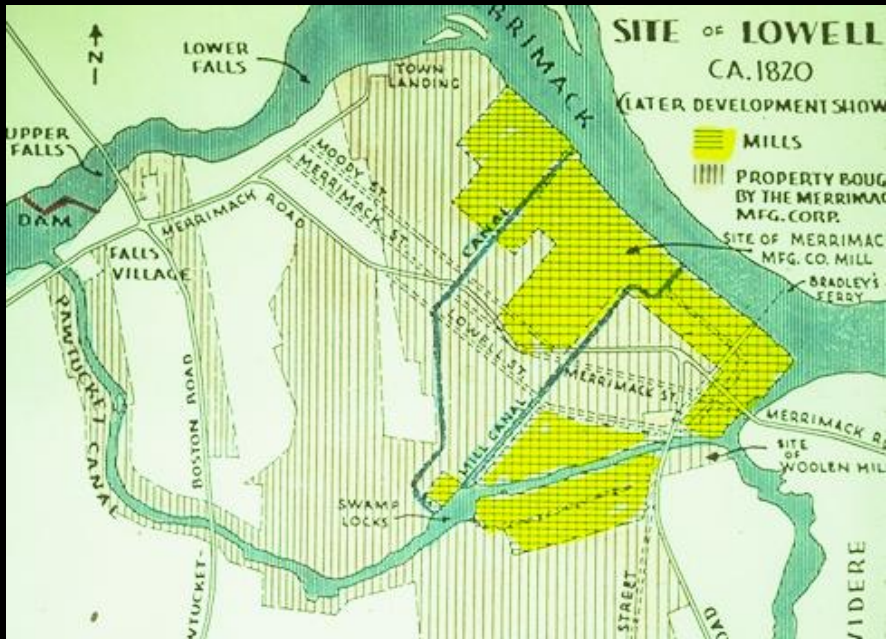
VIDEO

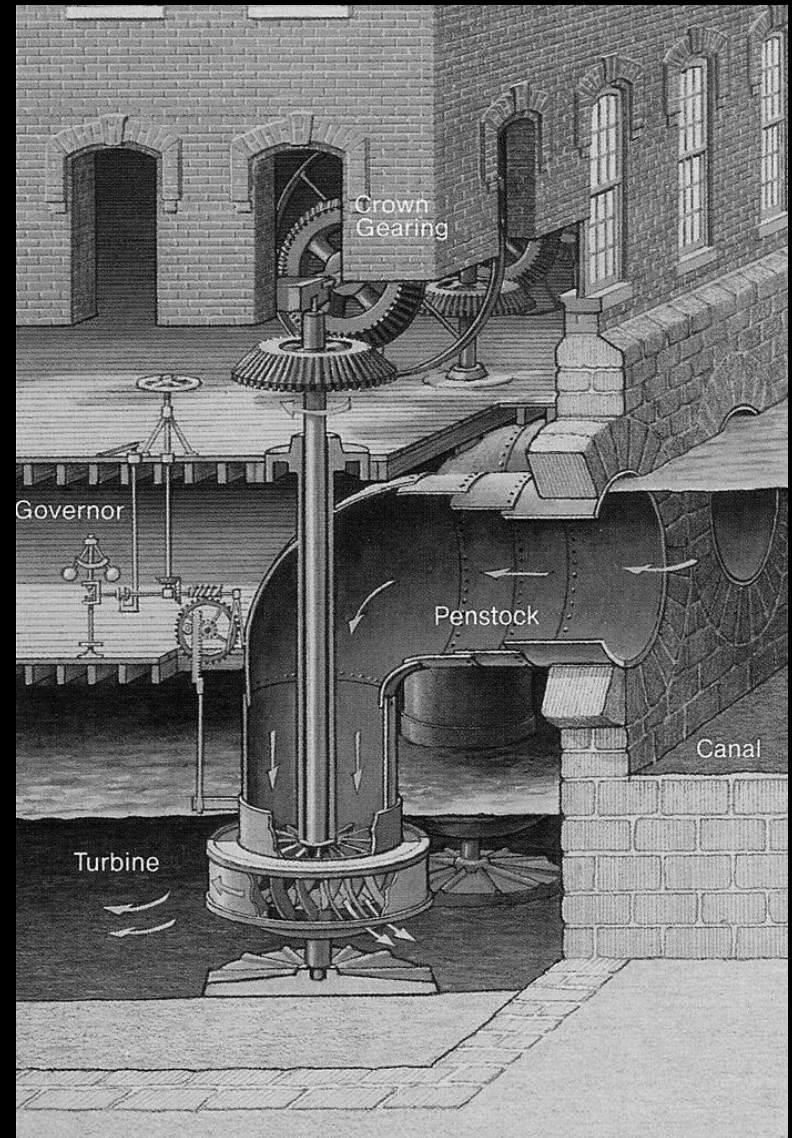
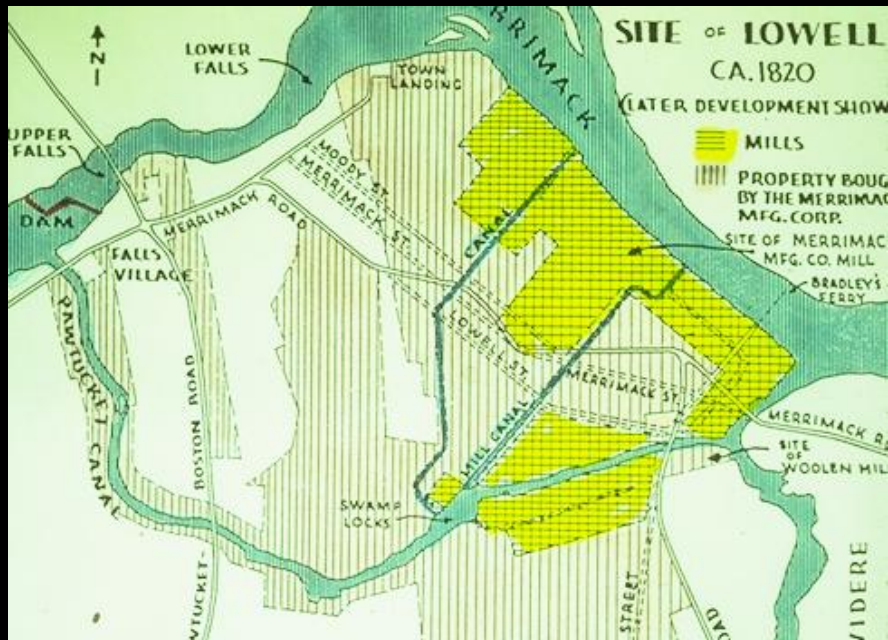


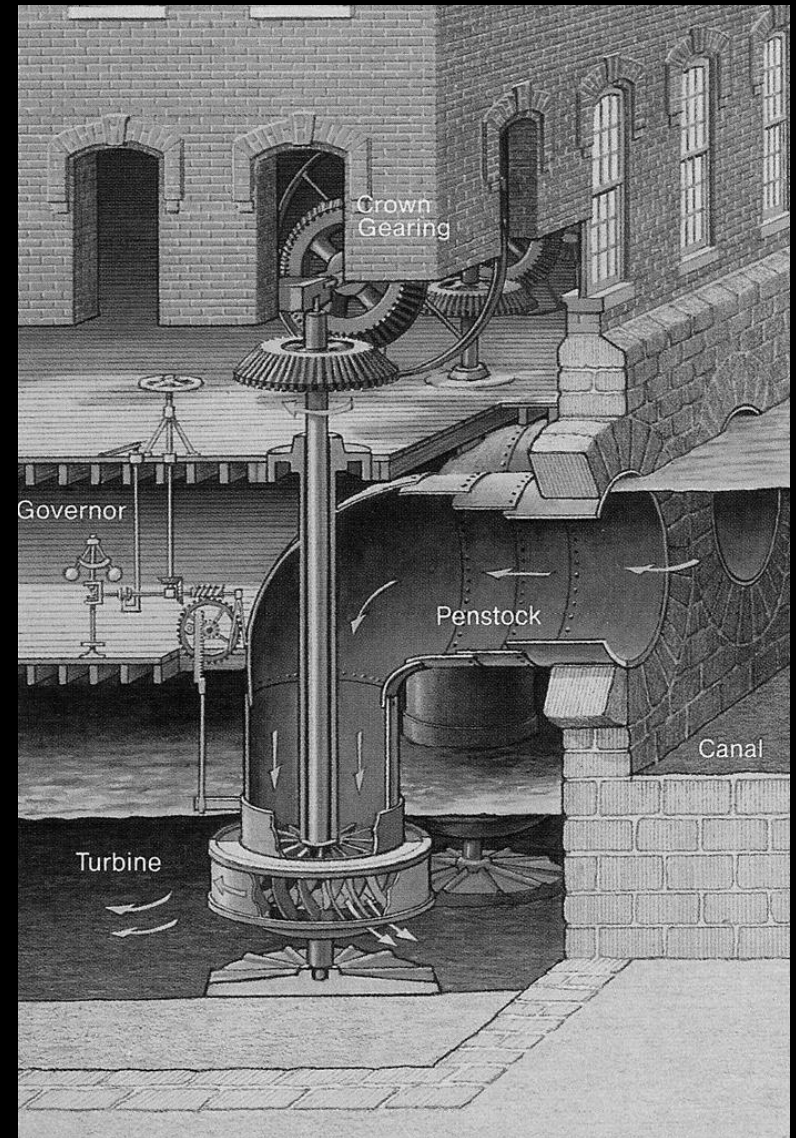
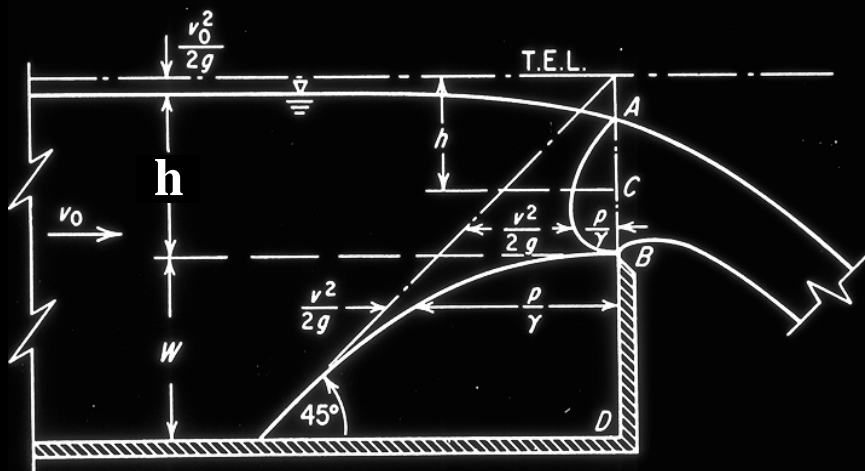
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Canal Walk and Lock Gate

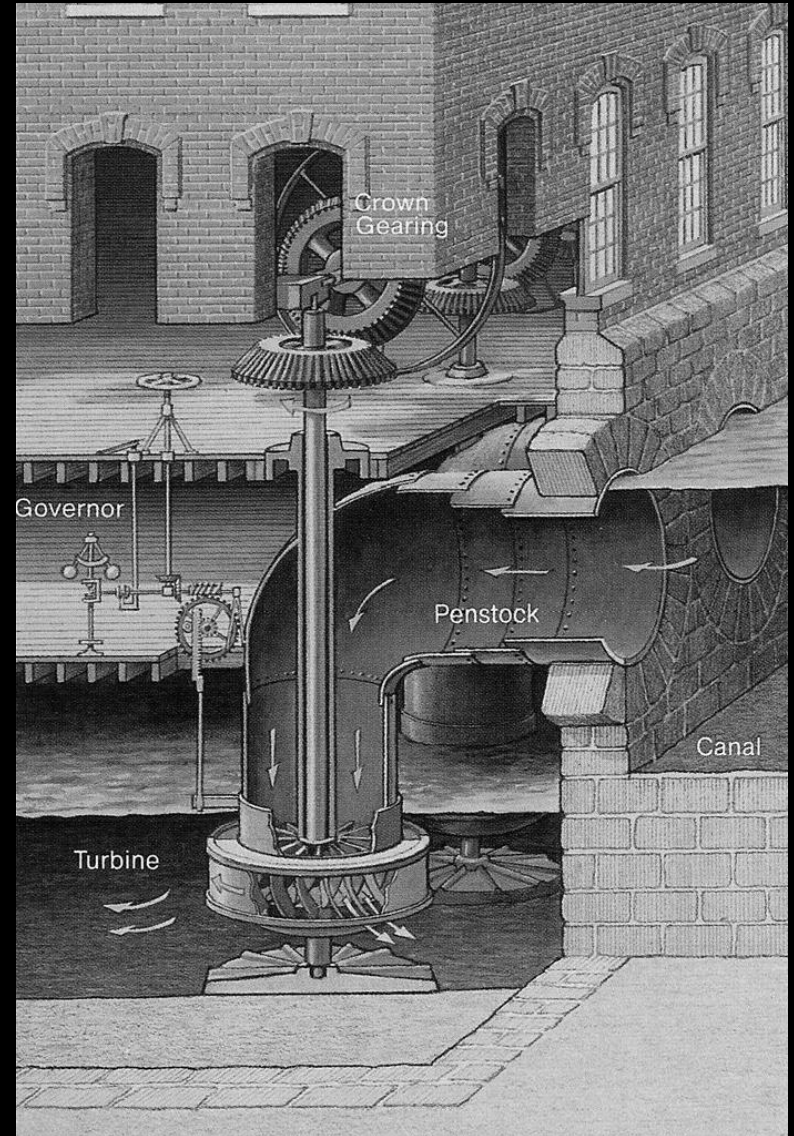
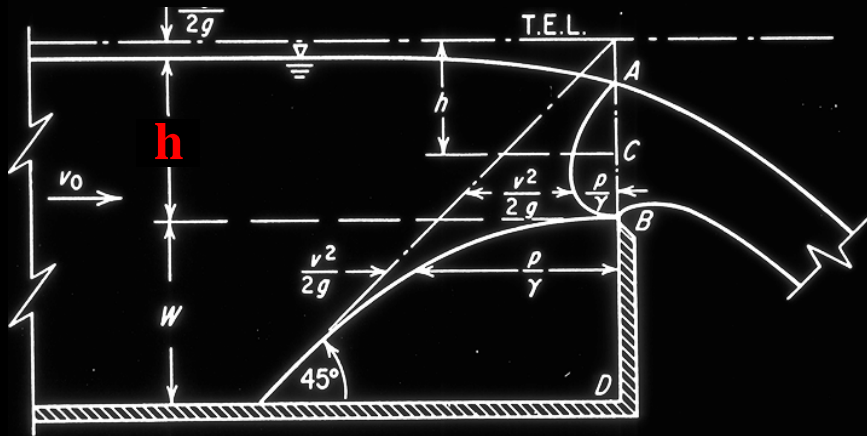








$$Q = 3.33 (L - 0.1n h) h^{3/2}$$





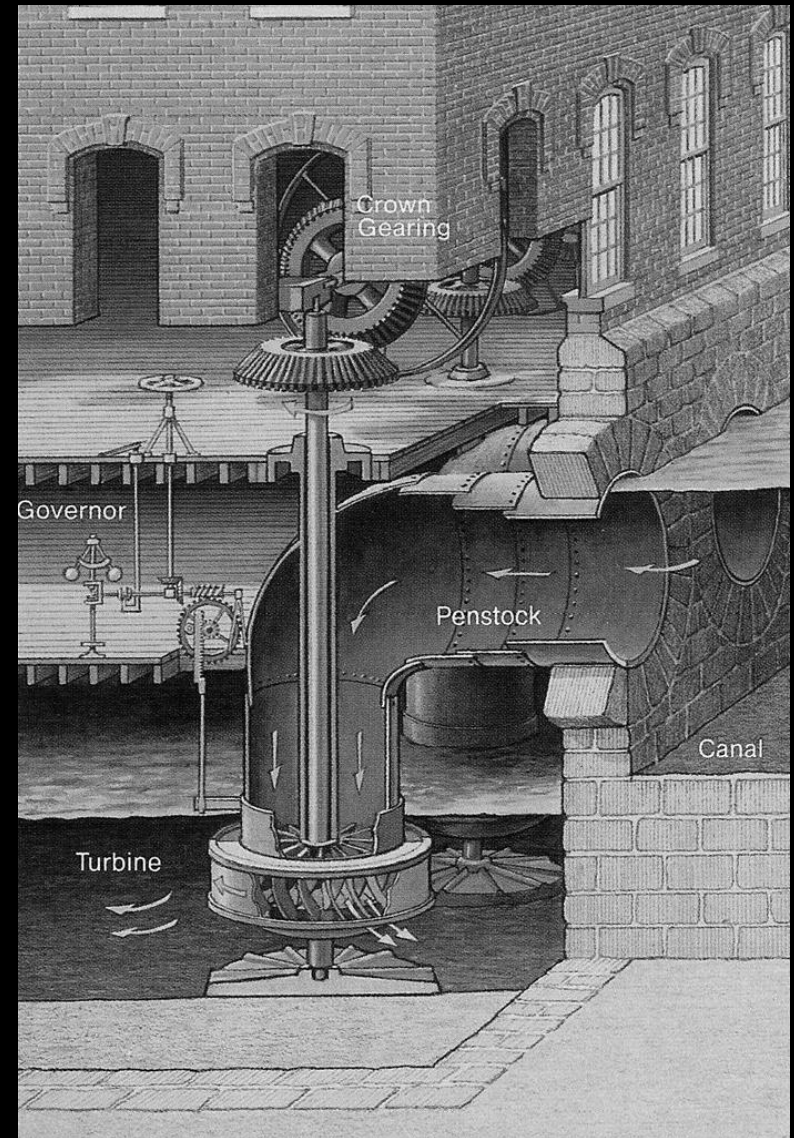
$$Q = 3.33 (L - 0.1n h) h^{3/2}$$

Economics vs. Politics

WATER TURBINE

$$\gamma_H \times Q \rightarrow H_p$$

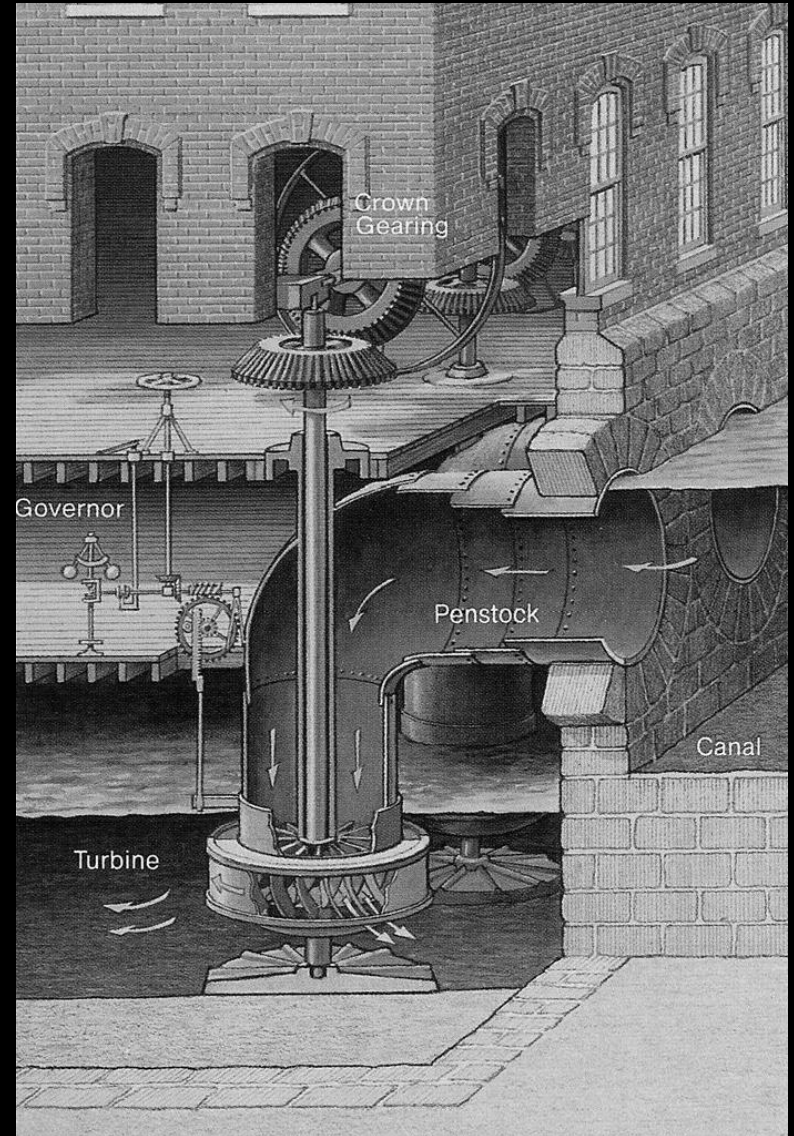
free resource	contested supply	power for profit
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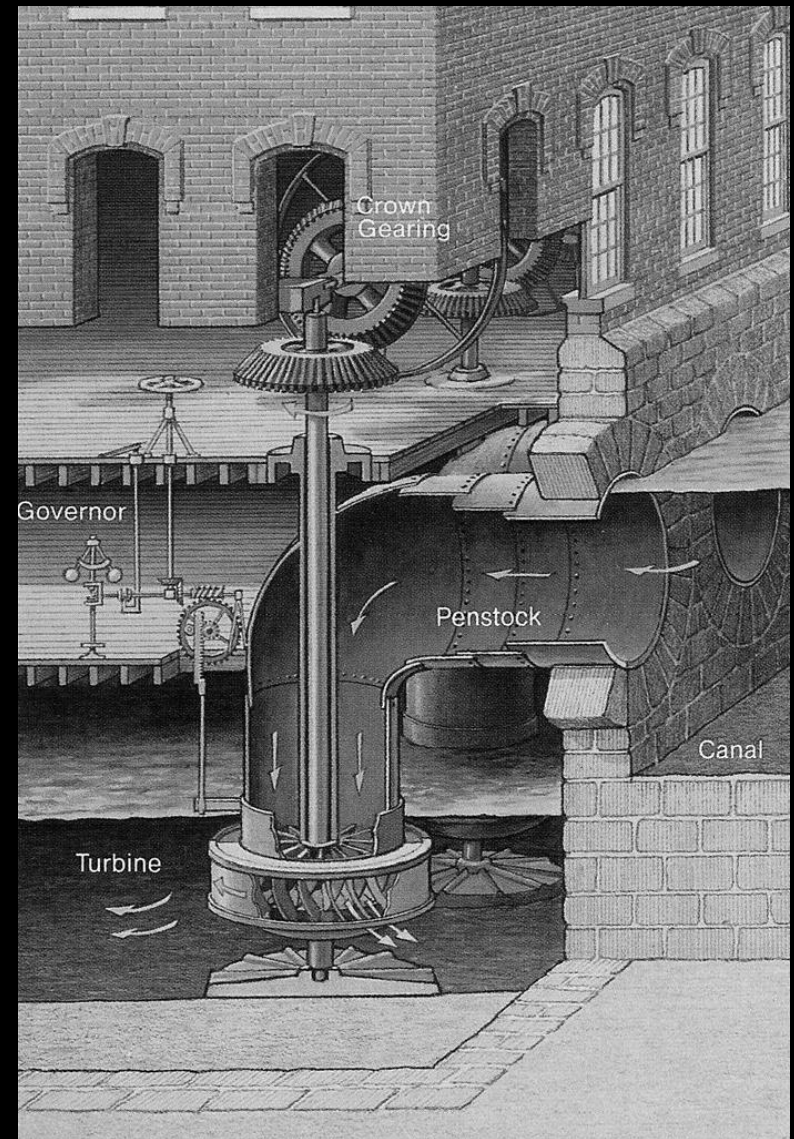
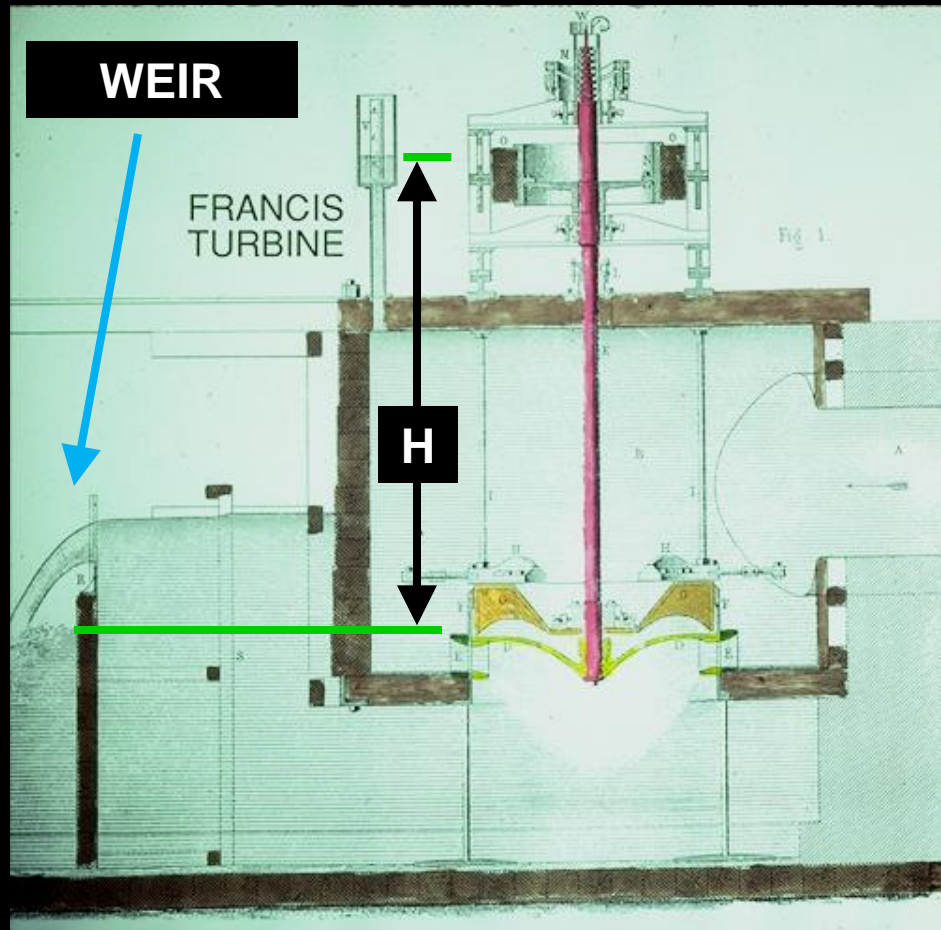




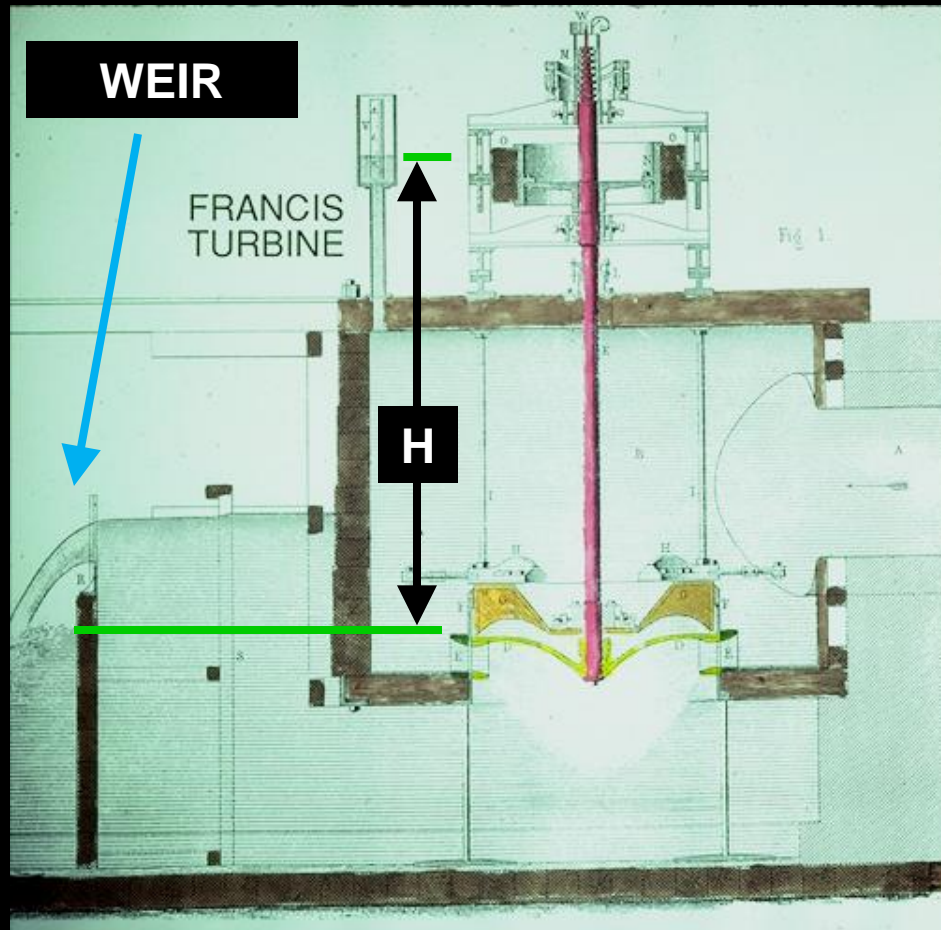
$$Q = 3.33 (L - 0.1n h) h^{3/2}$$

$$H_p = \frac{Q \gamma H}{33,000}$$





$$H_p = \frac{Q \gamma H}{33,000}$$



$$H_p = \frac{Q \gamma H}{33,000}$$

LOWELL HYDRAULIC EXPERIMENTS.

BEING A SELECTION FROM

EXPERIMENTS ON HYDRAULIC MOTORS,

ON THE

FLOW OF WATER OVER WEIRS, IN OPEN CANALS OF UNIFORM RECTANGULAR
SECTION, AND THROUGH SUBMERGED ORIFICES AND DIVERGING TUBES.

MADE AT LOWELL, MASSACHUSETTS.

BY

JAMES B. FRANCIS,

CIVIL ENGINEER, MEMBER OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS AND ARCHITECTS,
FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, MEMBER
OF THE AMERICAN PHILOSOPHICAL SOCIETY, ETC.

THIRD EDITION.

REVISED AND ENLARGED, WITH MANY NEW EXPERIMENTS,

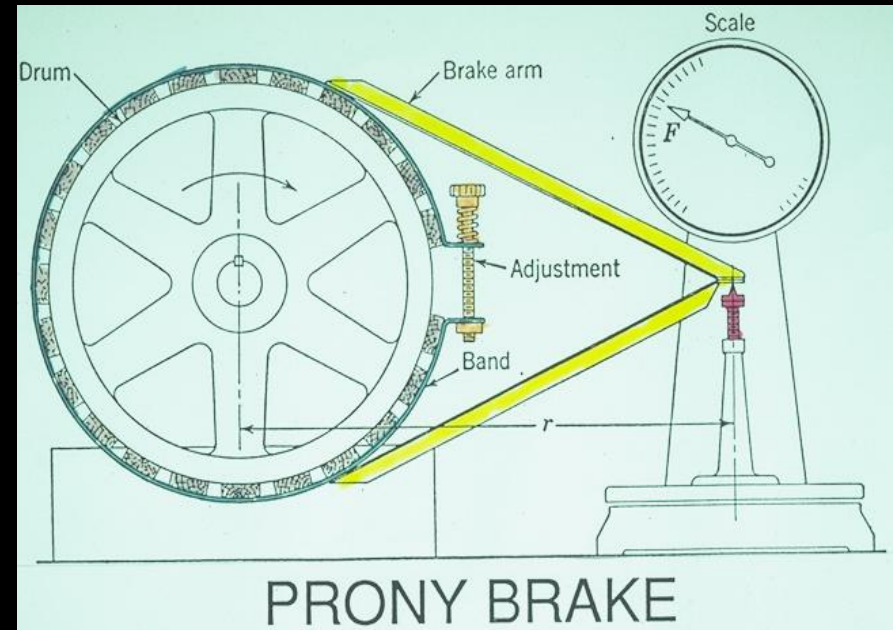
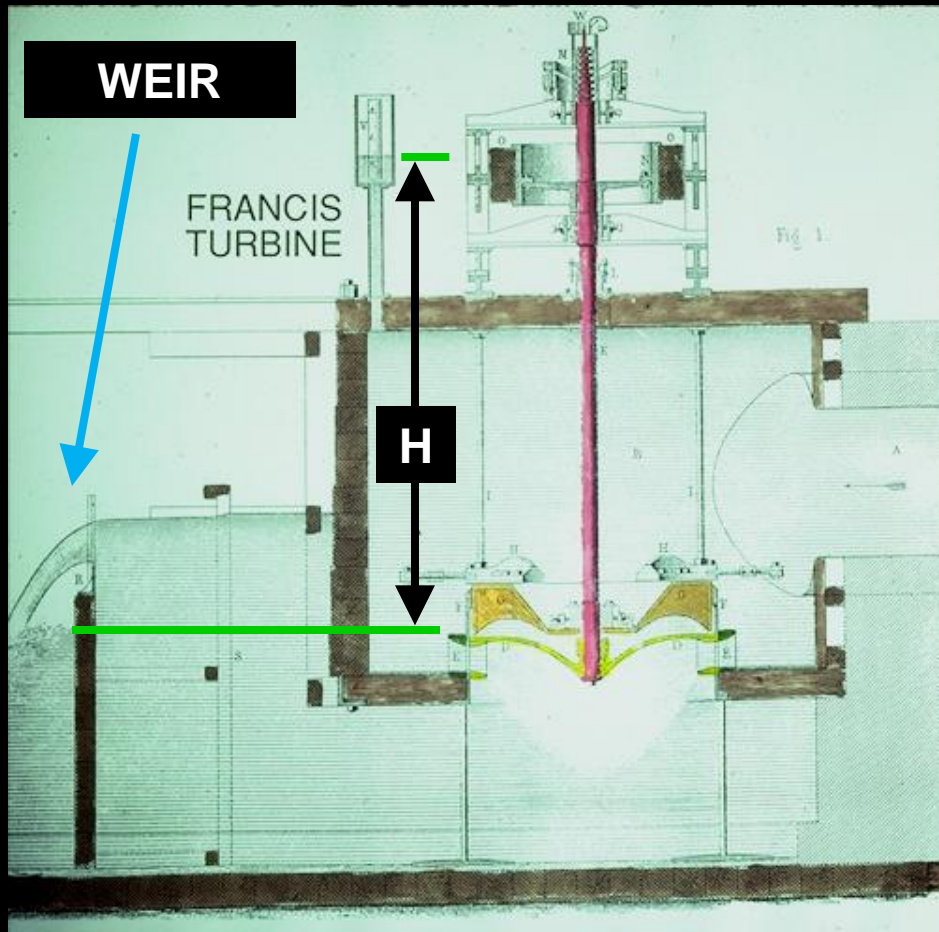
3rd Illustrated

WITH TWENTY-THREE COPPER-PLATE ENGRAVINGS.

NEW YORK:

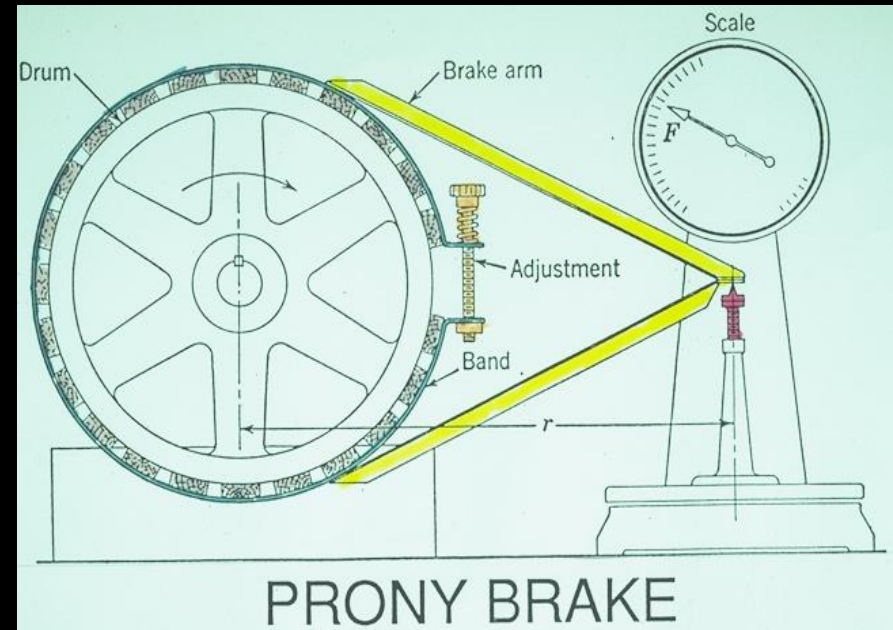
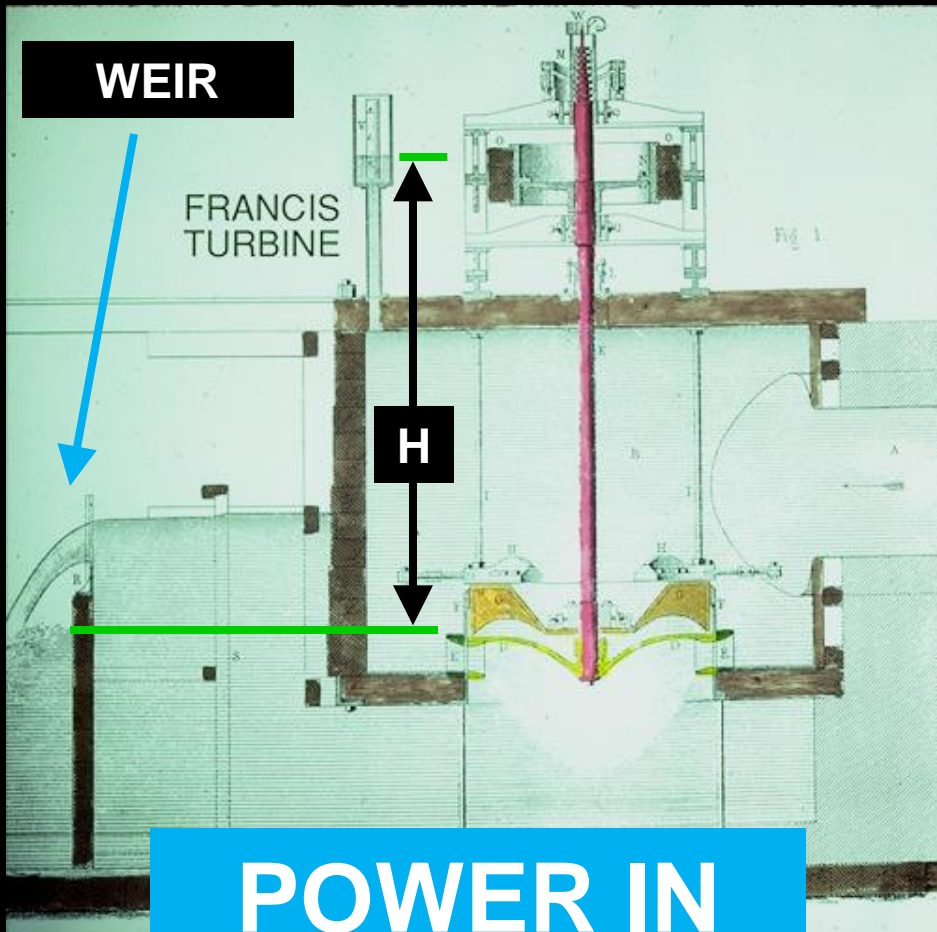
D. VAN NOSTRAND, PUBLISHER, 23 MURRAY STREET AND 27 WARREN STREET.

1871.



$$H_p = \frac{Q \gamma H}{33,000}$$

$$H_p = \frac{T V}{33,000}$$

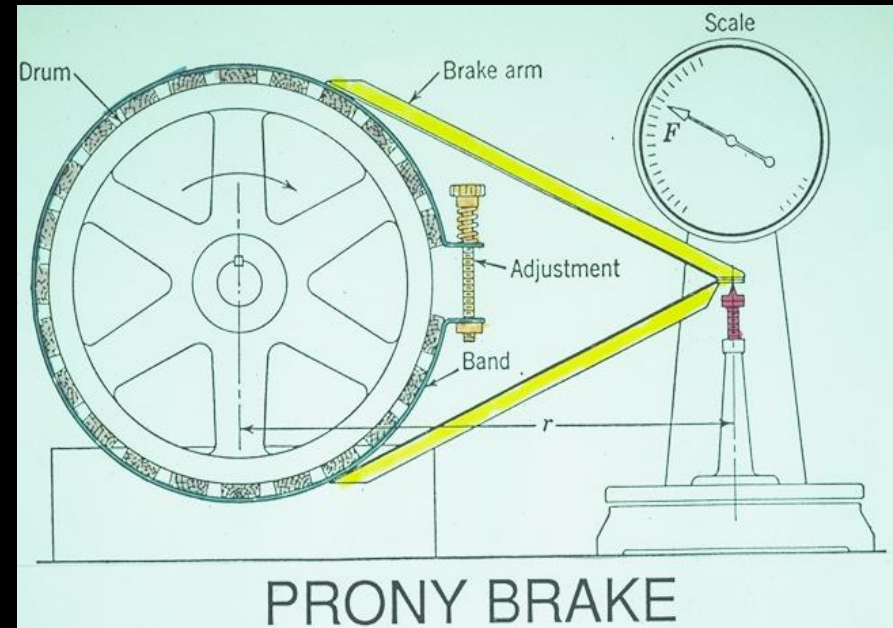


$$H_p = \frac{Q \gamma H}{33,000}$$

$$H_p = \frac{T V}{33,000}$$

Wheel slides against tight drum. Friction causes it to heat up.

Slide hands back and forth while pressing them together. Palms get hot.

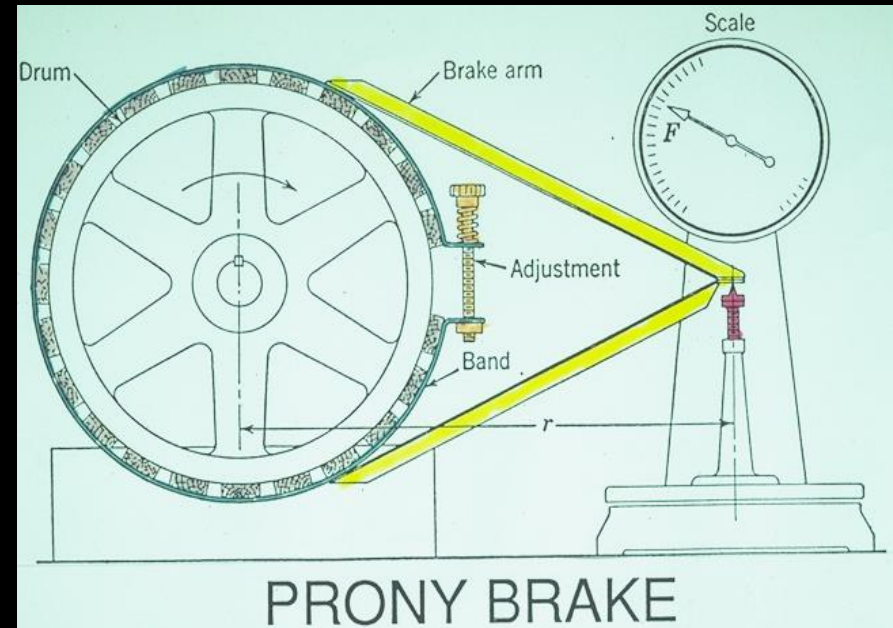


POWER OUT

$$H_p = \frac{T V}{33,000}$$

Wheel slides against tight drum. Friction causes it to heat up.

Slide hands back and forth while pressing them together. Palms get hot.



T is force needed to keep wheel sliding at speed V.

Hp is power dumped into drum causing it to get hot.

POWER OUT

$$Hp = \frac{TV}{33,000}$$

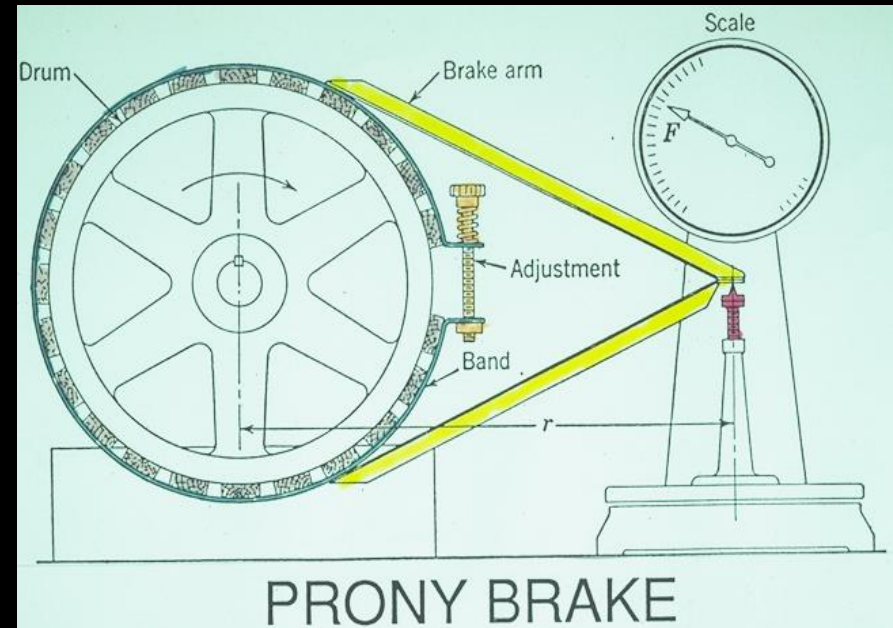
Wheel slides against tight drum. Friction causes it to heat up.

Slide hands back and forth while pressing them together. Palms get hot.

DEMONSTRATION

T is force needed to keep wheel sliding at speed V.

Hp is power dumped into drum causing it to get hot.



POWER OUT

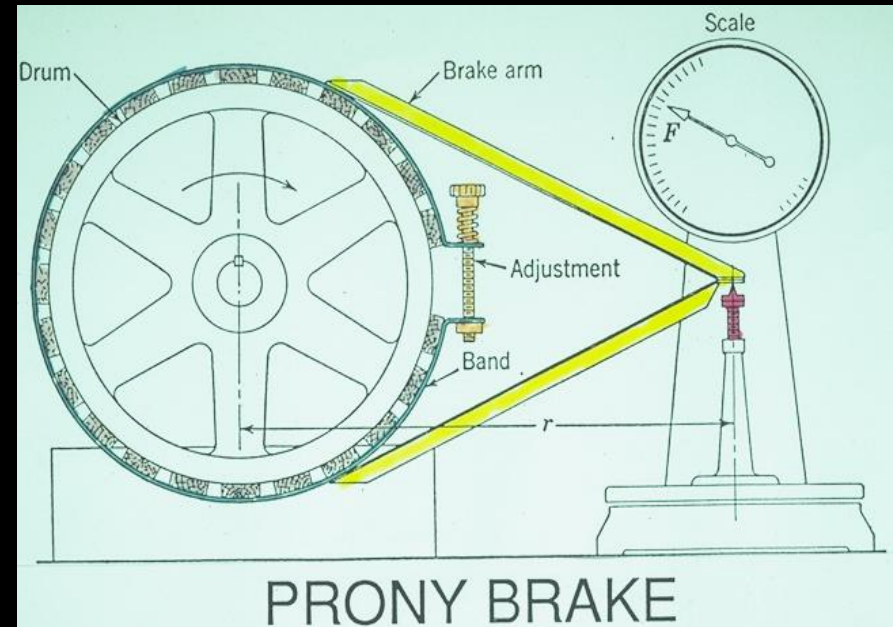
$$Hp = \frac{TV}{33,000}$$

James B. Francis engineer

Efficient Water Motor

“Water Policeman” – the Weir

Canal Walk and Lock Gate



$$H_p = \frac{T V}{33,000}$$

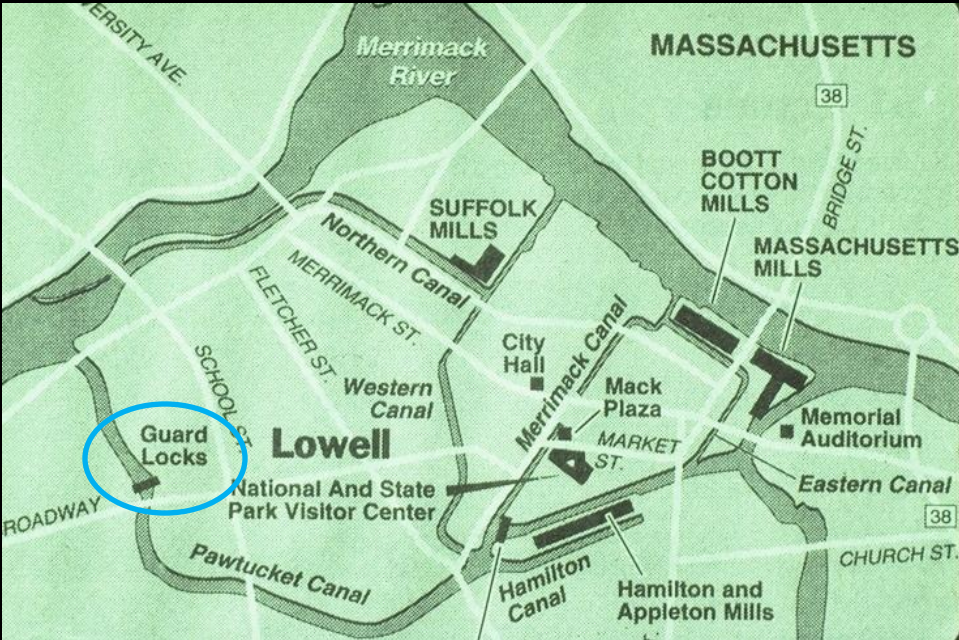
James B. Francis engineer

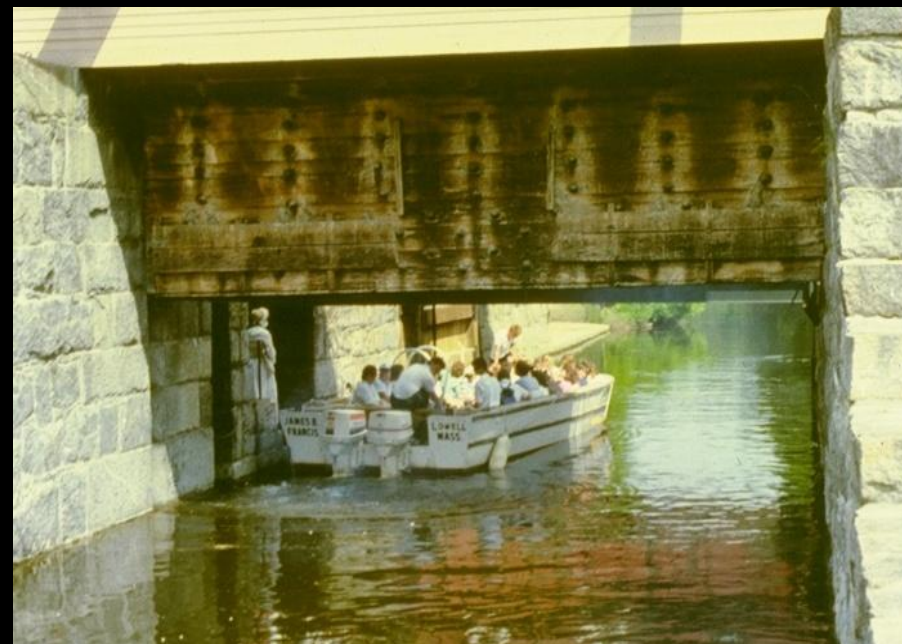
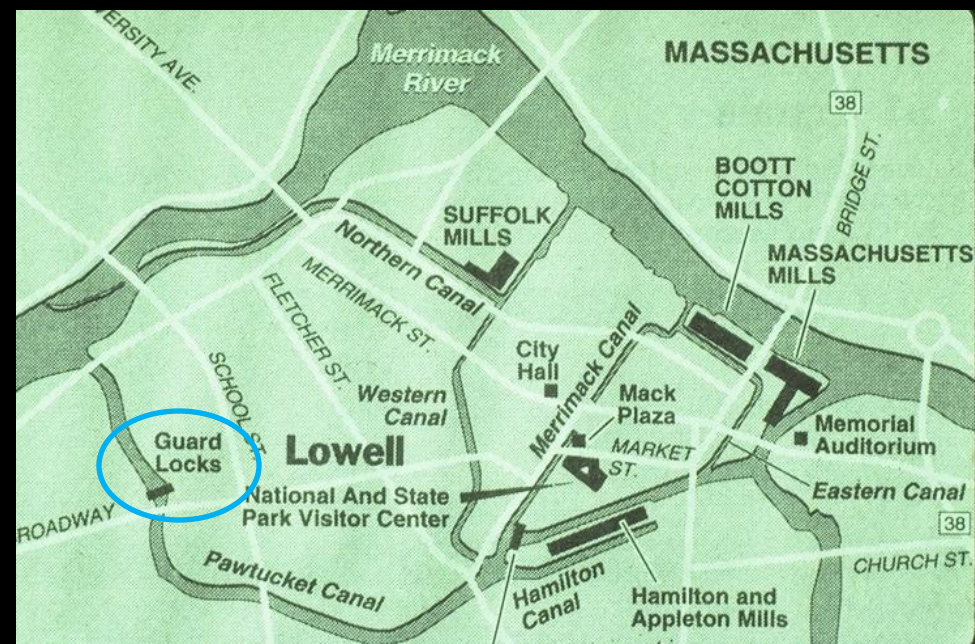
Efficient Water Motor

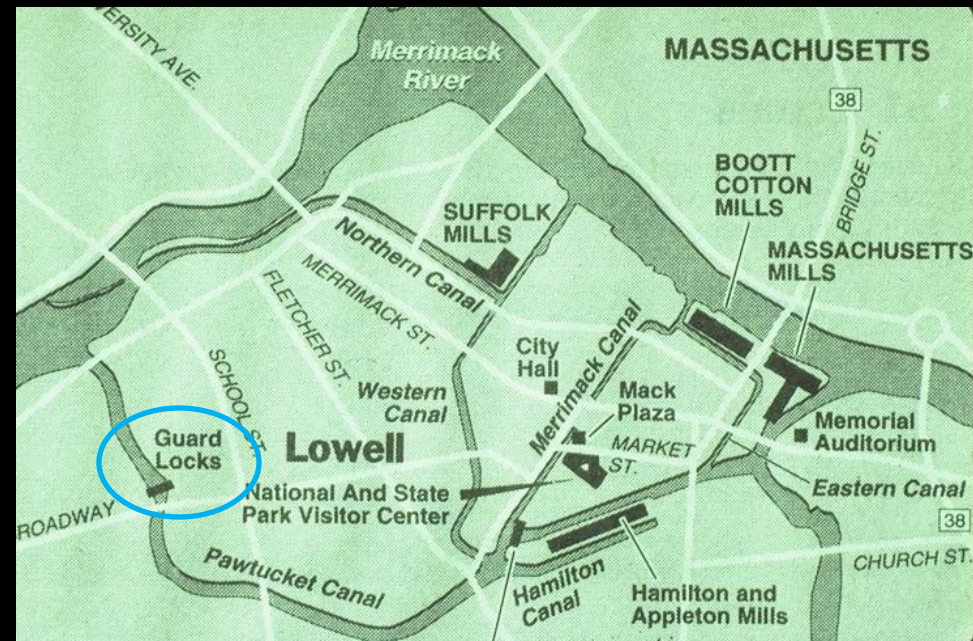
“Water Policeman” – the Weir

Canal Walk and Lock Gate









Lowell - Engineering Works

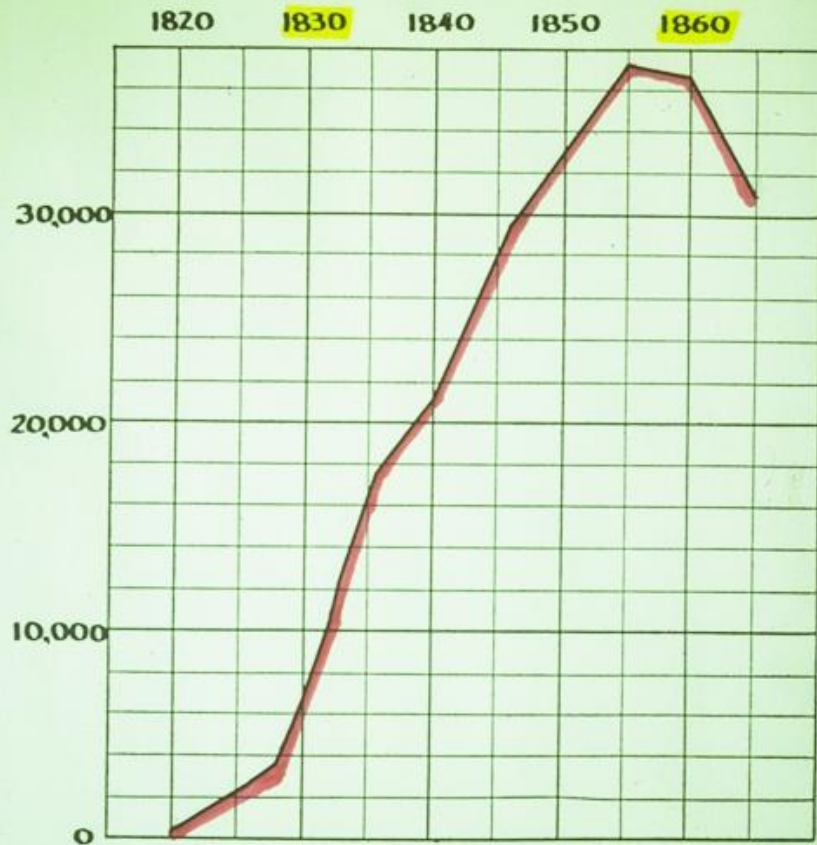
structures: the river dam

machines: the water turbine

networks: interconnected
power canals

processes: cloth making

LOWELL - INCREASE IN POPULATION



Lowell - Engineering Works

structures: the river dam

machines: the water turbine

networks: interconnected
power canals

processes: cloth making



Pawtucket Dam

Lowell - Engineering Works

structures: the river dam

machines: the water turbine

networks: interconnected
power canals

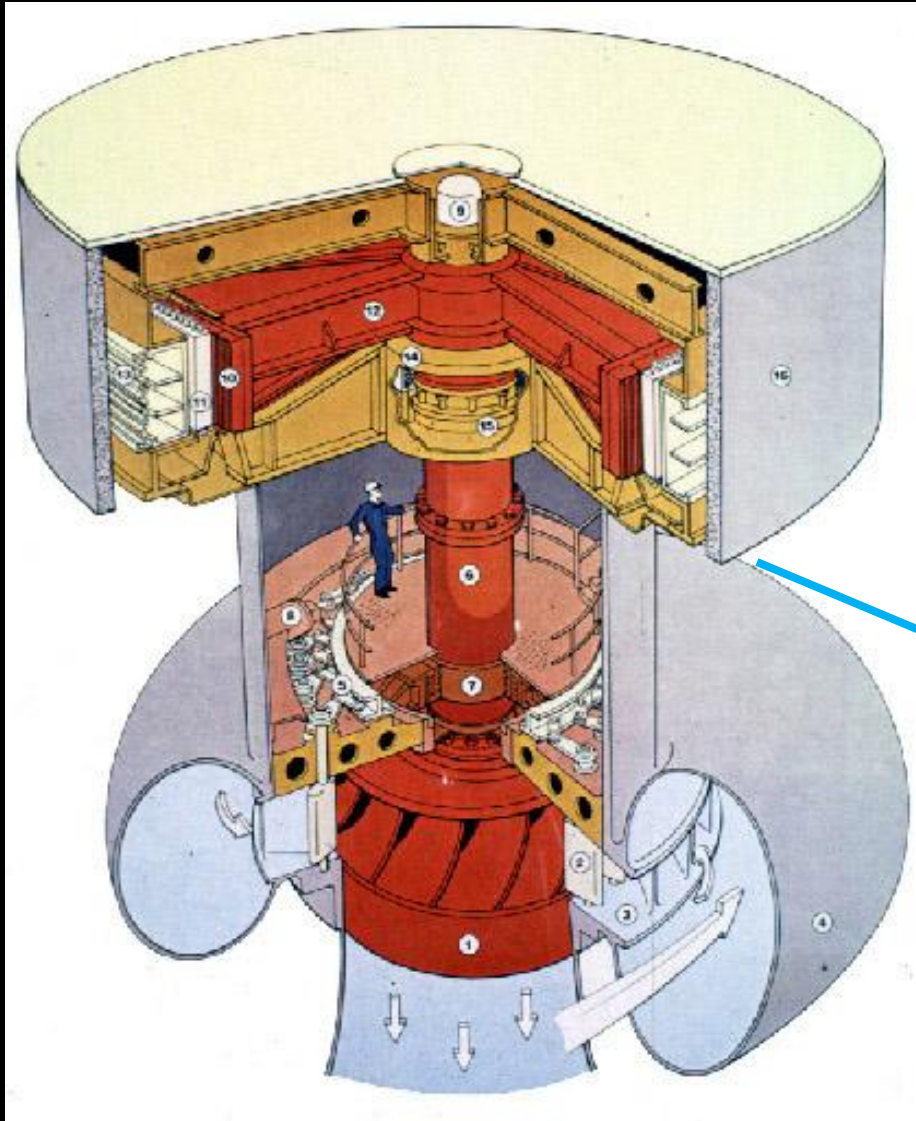
processes: cloth making



Pawtucket Dam

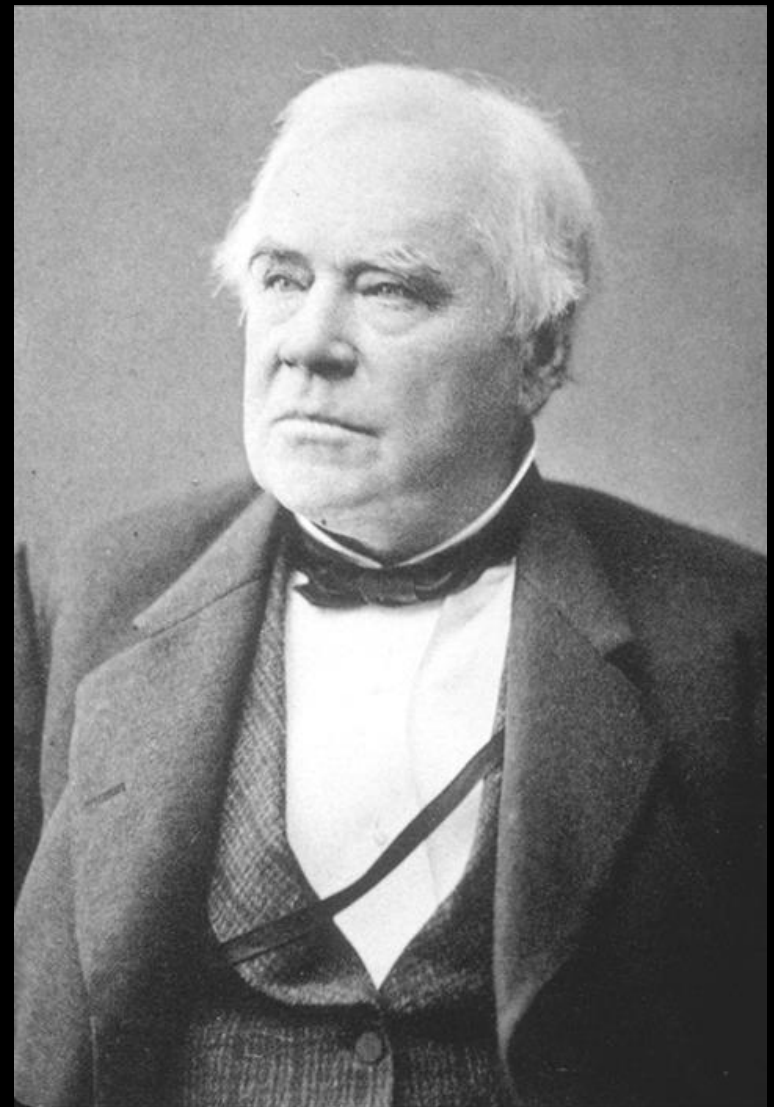
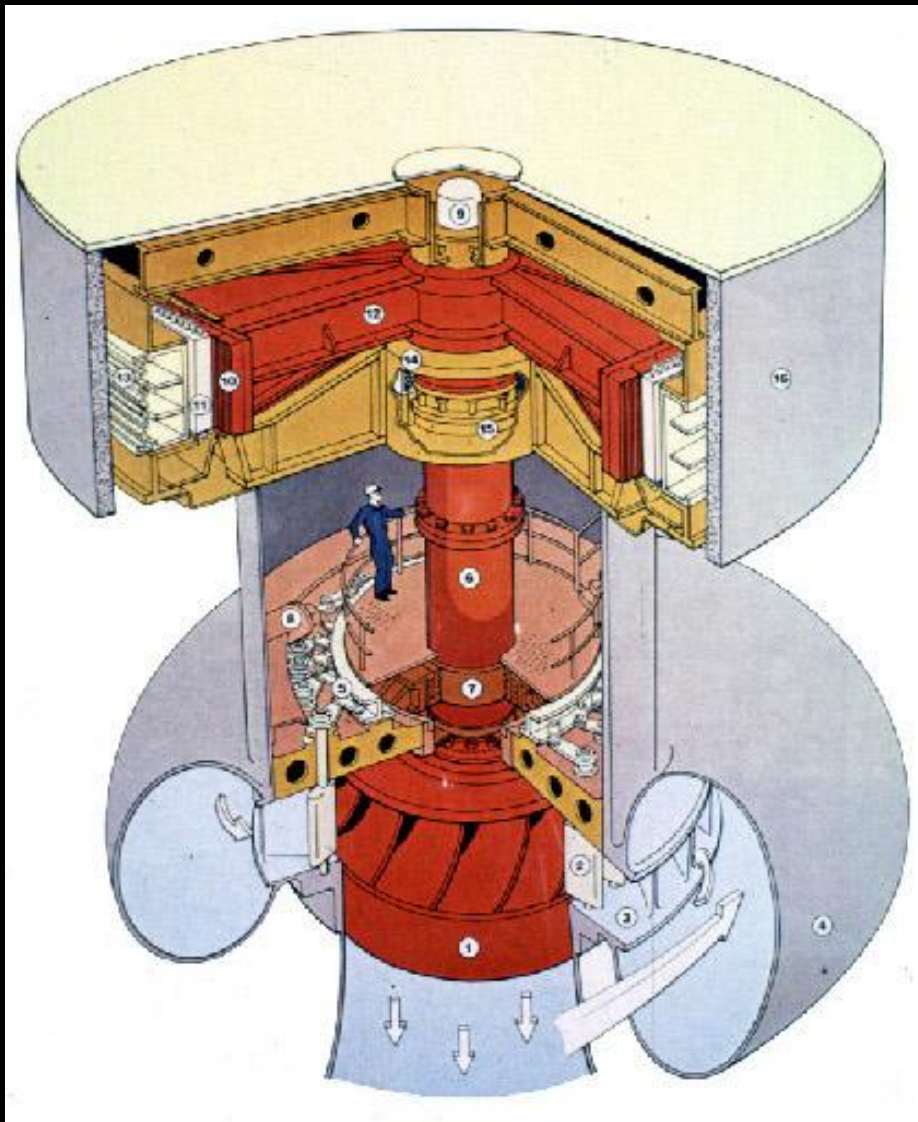


Hoover Dam



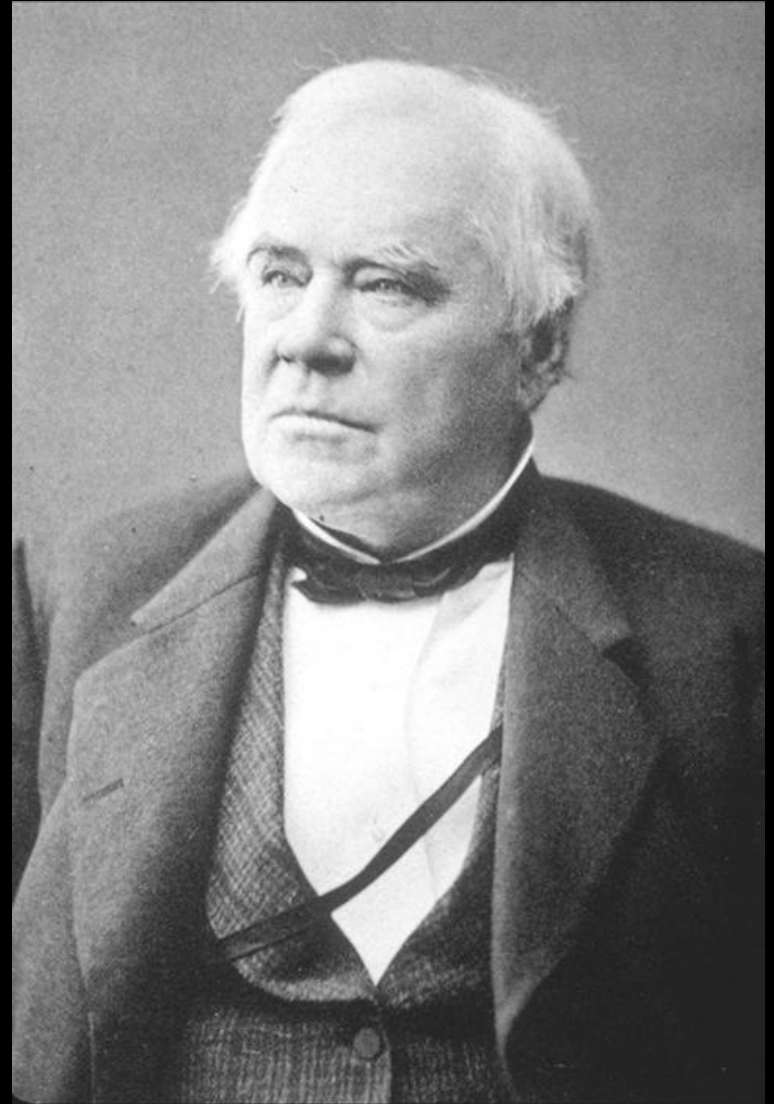
Hoover Dam

1 of 19 Francis Turbines and Generators





Massachusetts Institute of Technology





Massachusetts Institute of Technology

The Lowell Family

Percival Lowell

– **Harvard Astronomer**

Abbott Lawrence Lowell

– **Harvard President**

James Russell Lowell

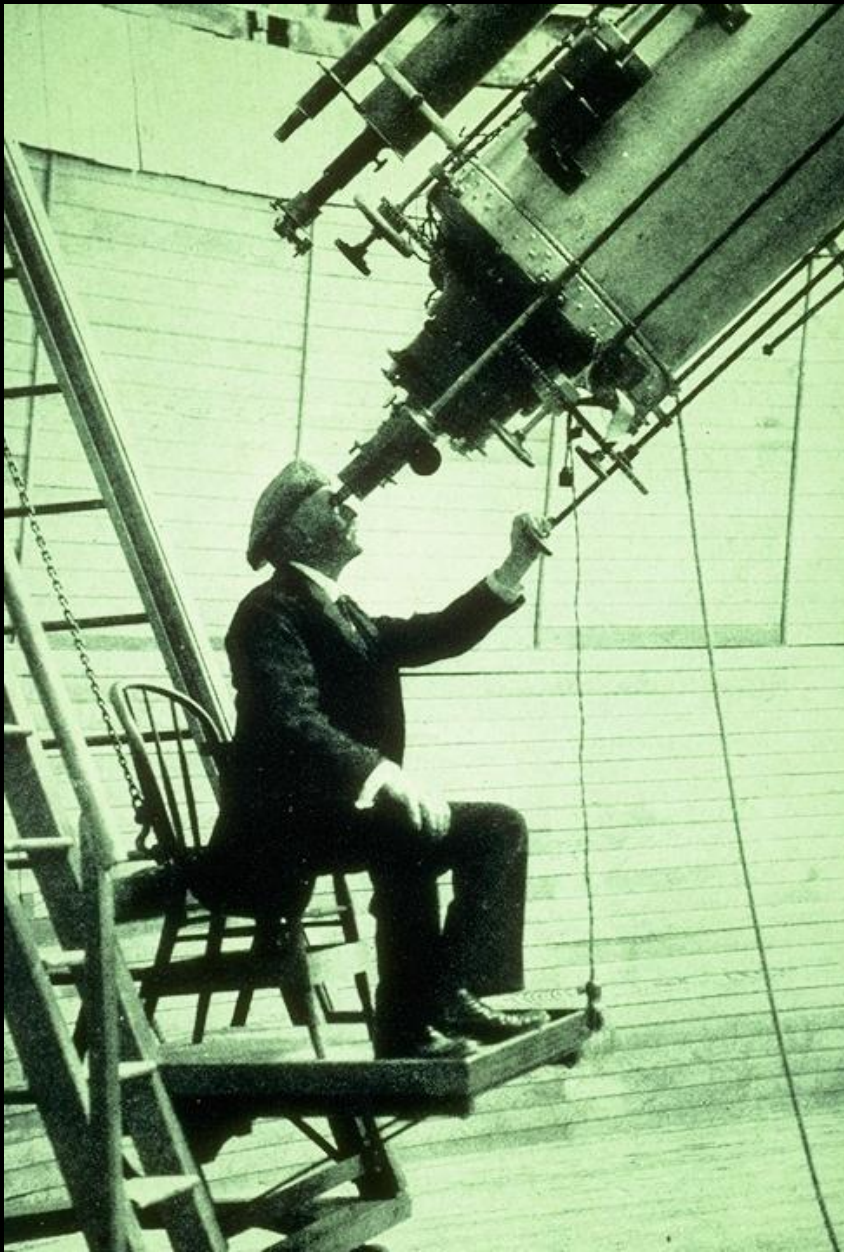
– **Harvard Prof and Poet**

Amy Lowell

– **Poet**

Robert Lowell

– **Poet**



The Lowell Family

Percival Lowell

– Harvard Astronomer

Abbott Lawrence Lowell

– Harvard President

James Russell Lowell

– Harvard Prof and Poet

Amy Lowell

– Poet

Robert Lowell

– Poet



The Lowell Family

Percival Lowell

– Harvard Astronomer

Abbott Lawrence Lowell

– Harvard President

James Russell Lowell

– Harvard Prof and Poet

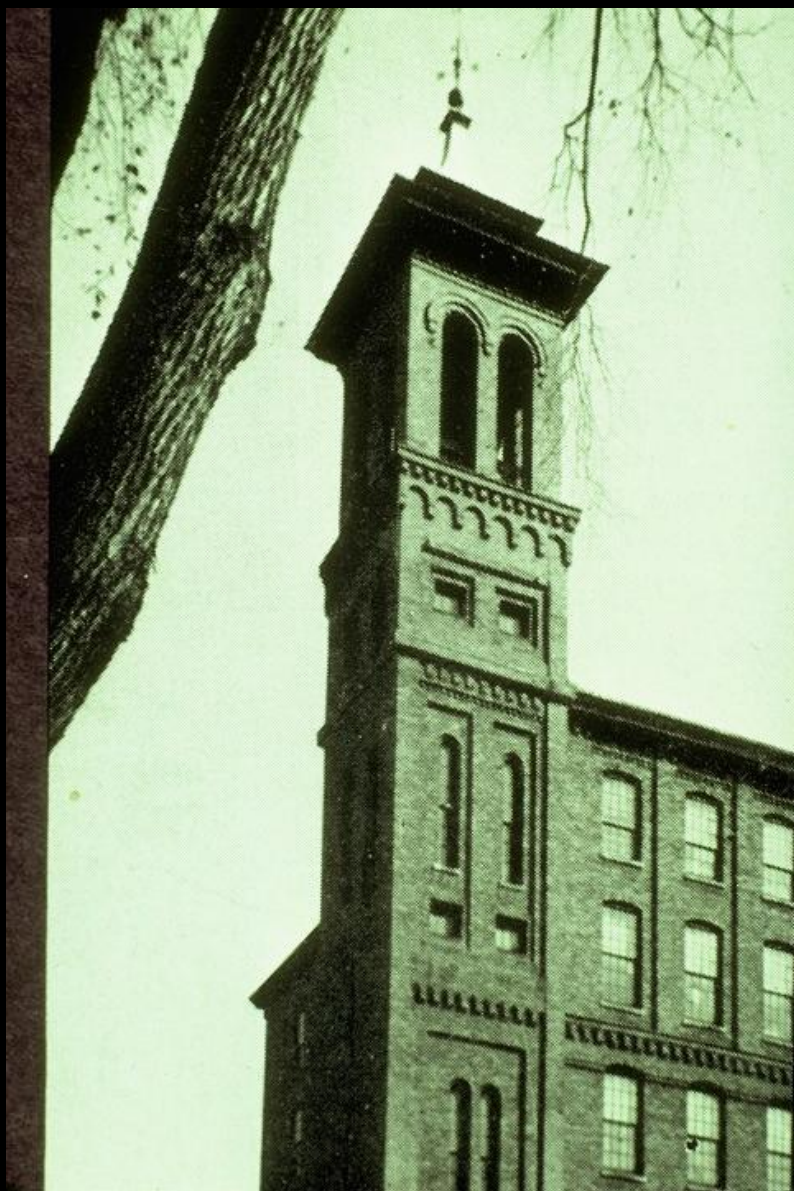
Amy Lowell

– Poet

Robert Lowell

– Poet





Key Ideas

Mechanization and Water Power
Planned Factory Town
Wealth and Education

