



# **HVAC IN HISTORIC BUILDINGS OF USA PART THREE FROM THE EASTERN SEABOARD TO THE WEST COAST**

**BRIAN ROBERTS**



# CHICAGO THEATRE CHICAGO





# NASHVILLE UNION RAIL STATION



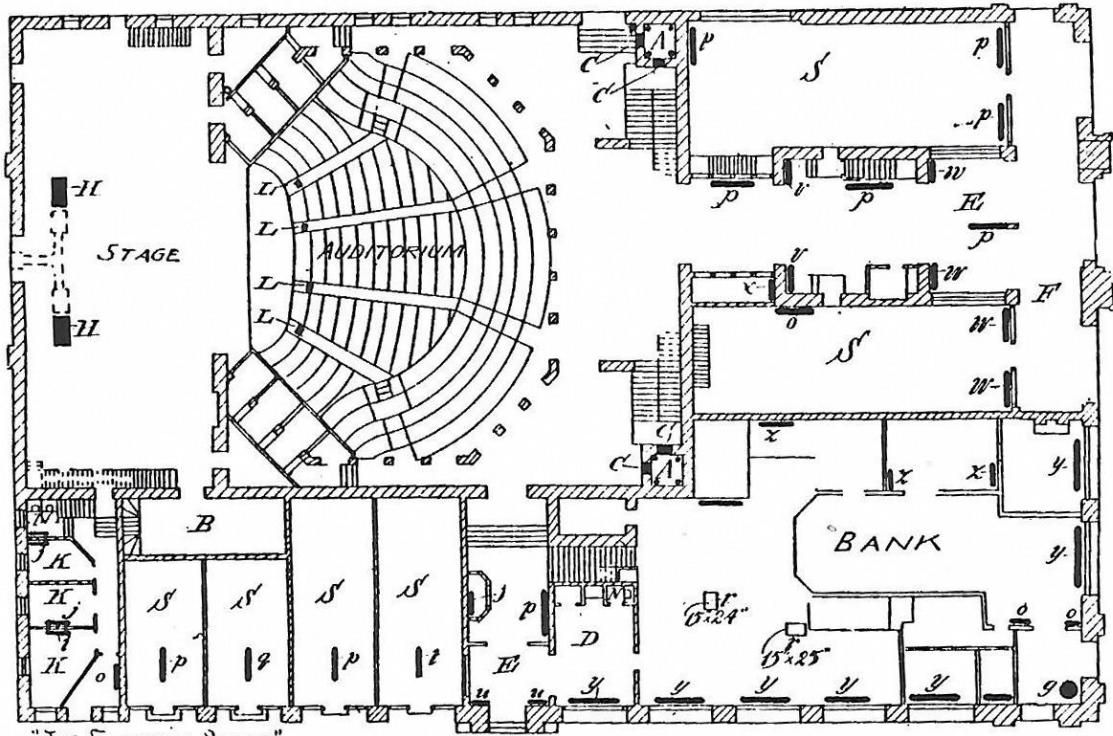
## CONTENTS: FEATURED BUILDINGS

COVER: Larkin Building: Astor Hotel: *front*, Library of Congress, Washington: *inside front*,  
Oriental Theatre, Chicago: *inside back*, Minnesota State Capitol: *back*.

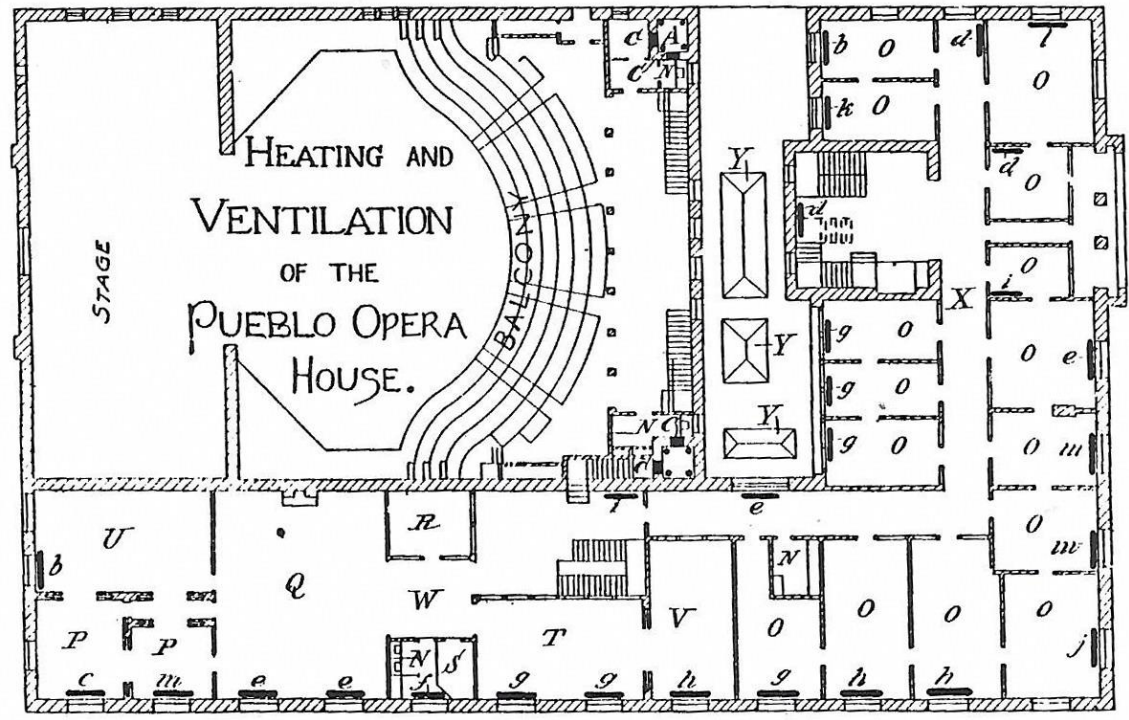
LIBRARIES: 1,22-25, THEATRES: 2,4-7,12,42-43  
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US PATENTS: 40,41  
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# PUEBLO OPERA HOUSE COLORADO

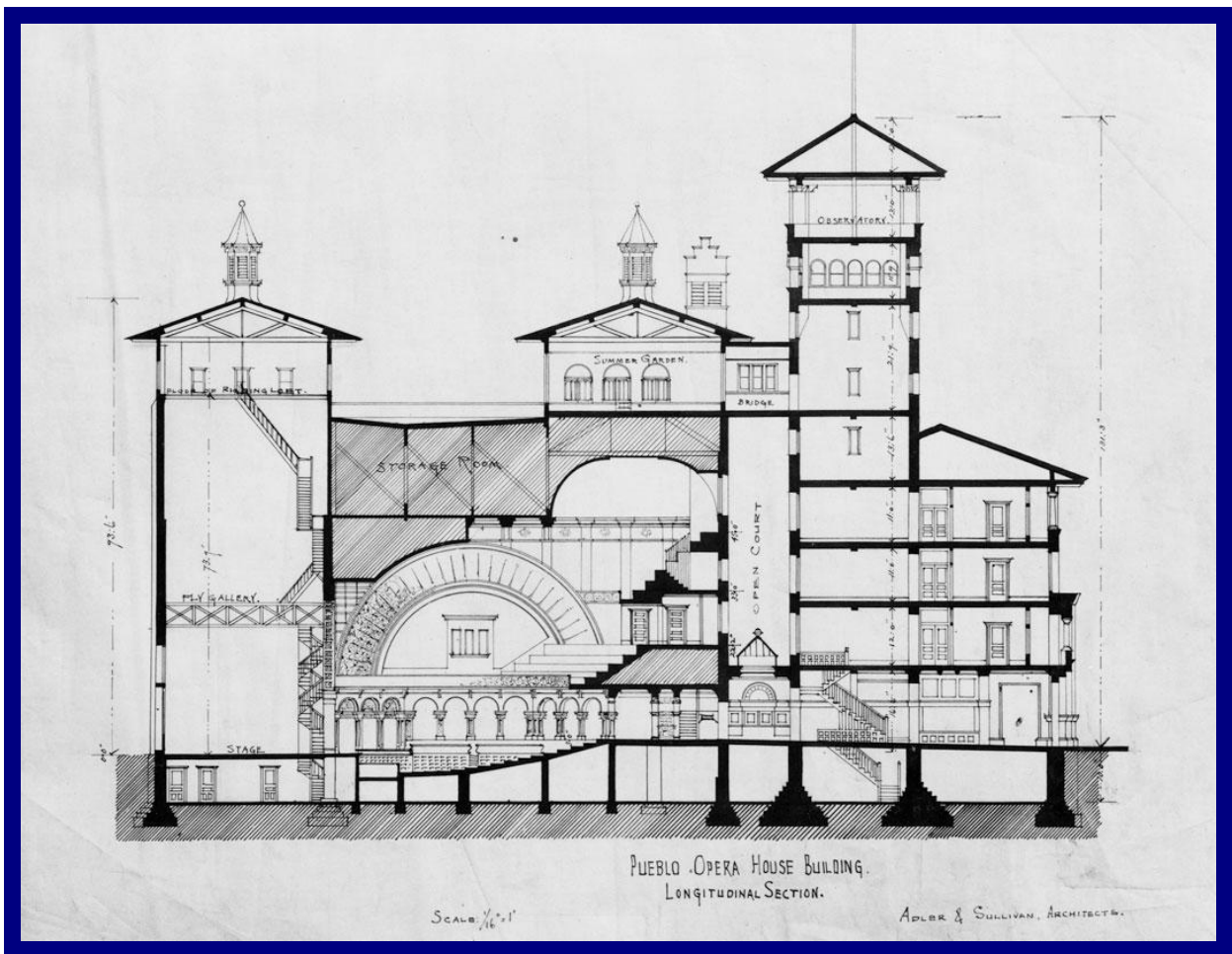


"THE ENGINEERING RECORD"



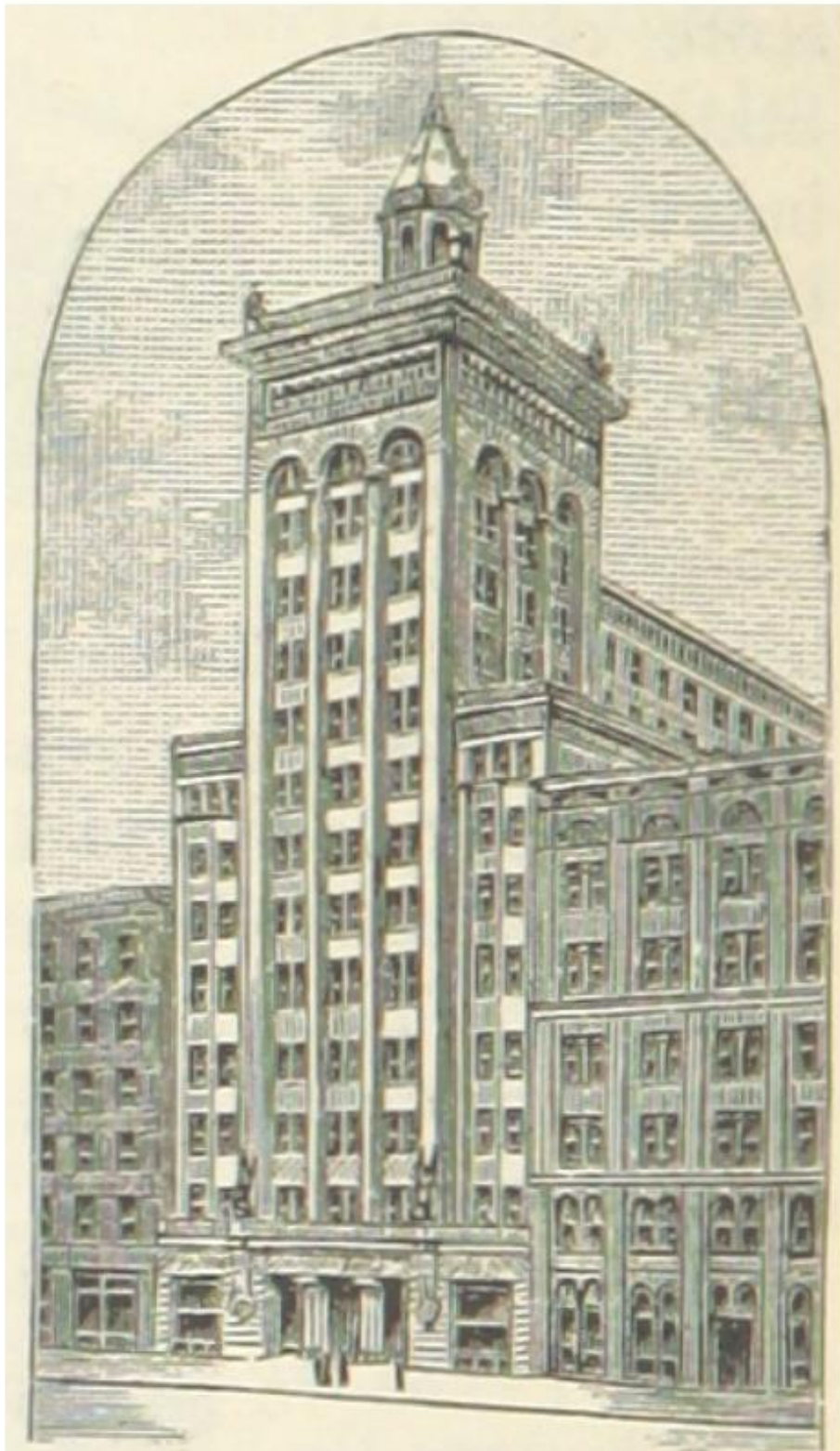


# PUEBLO OPERA HOUSE COLORADO





# GERMAN THEATRE CHICAGO

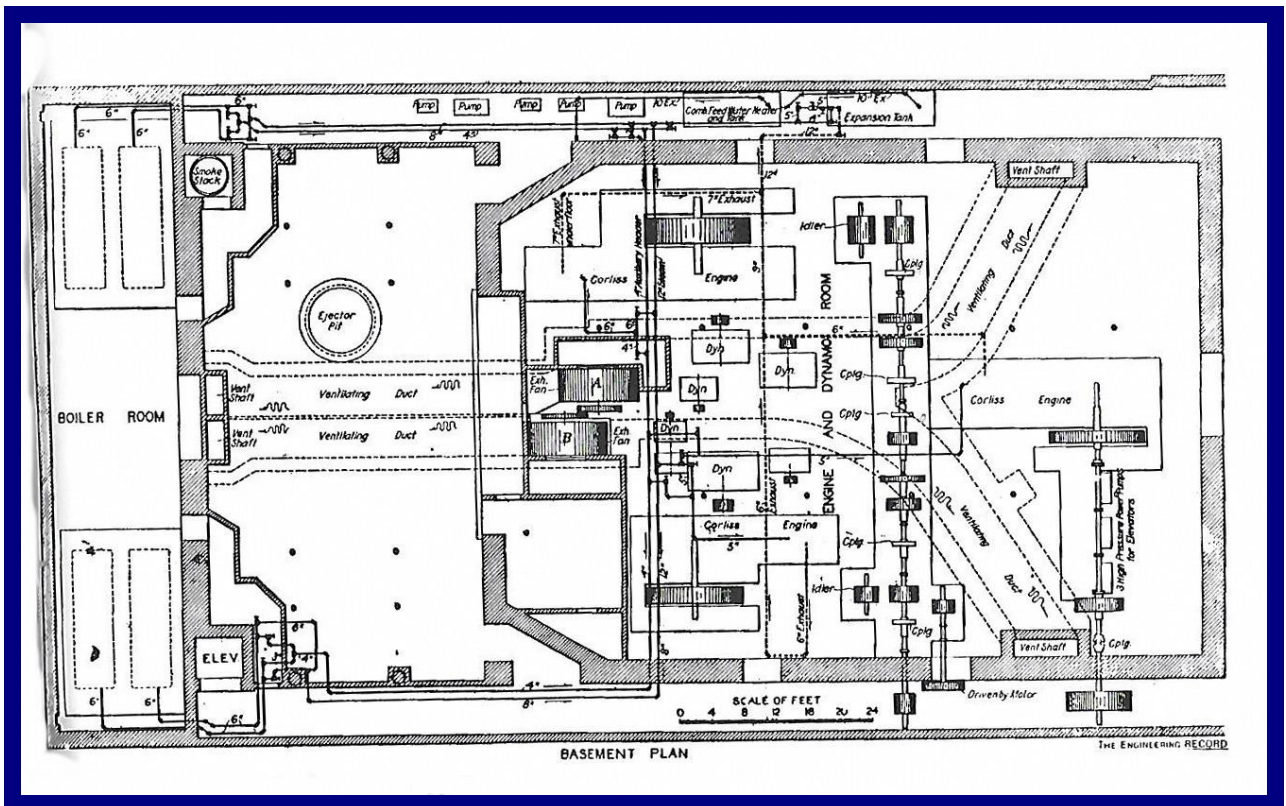
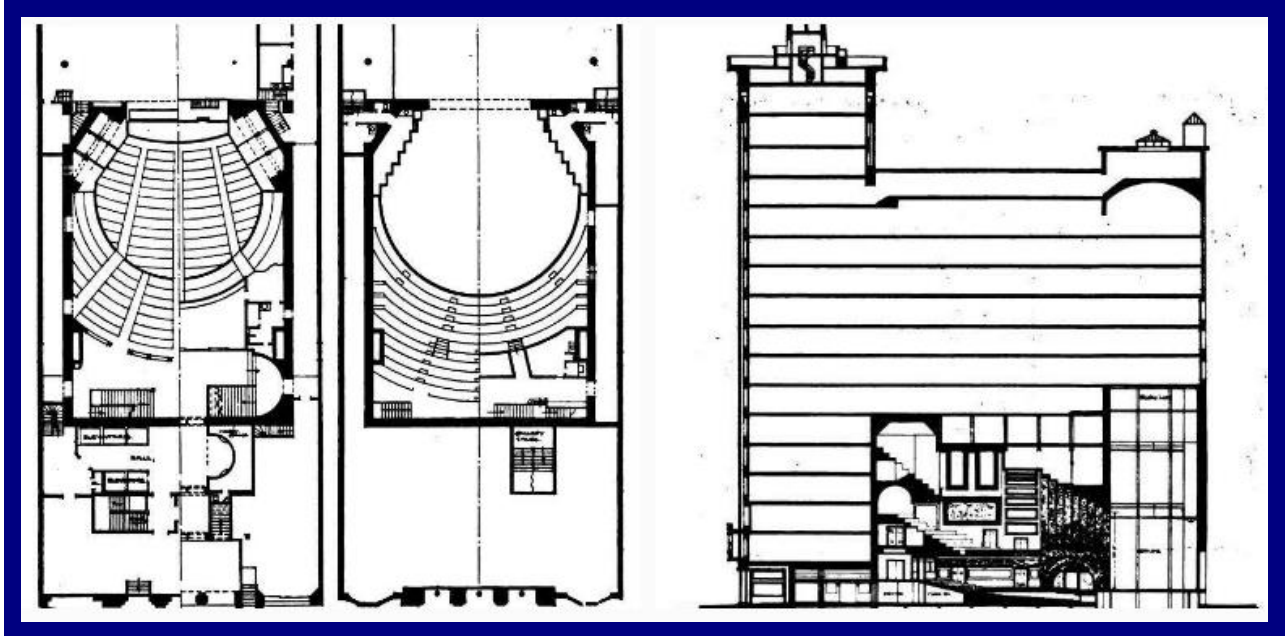


*Adler & Sullivan, Architects.*

CHICAGO: GERMAN OPERA HOUSE.



# GERMAN THEATRE CHICAGO

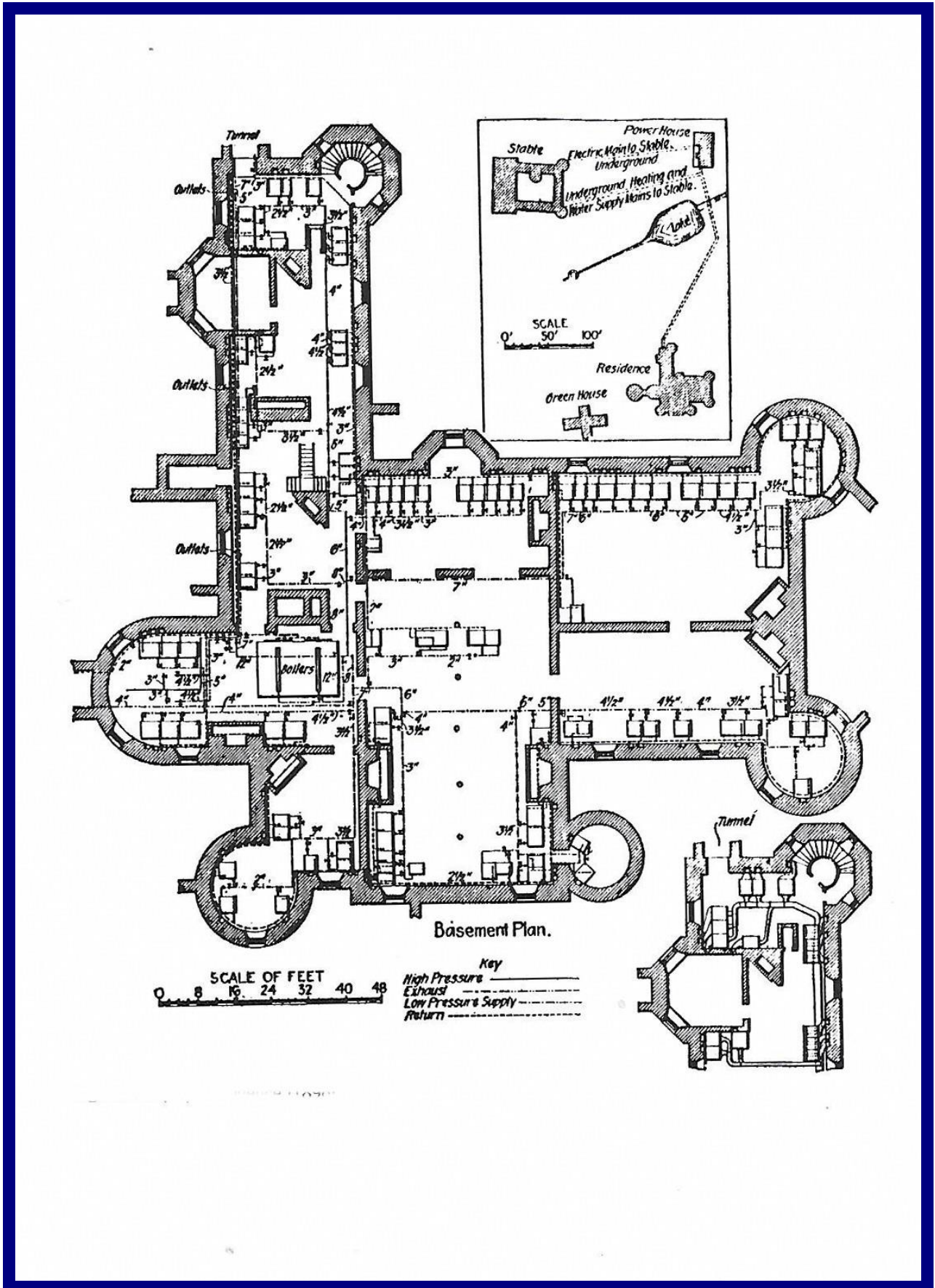


Plans of 1895 showing boilers, Corliss engines, electric dynamos & ventilation plant.





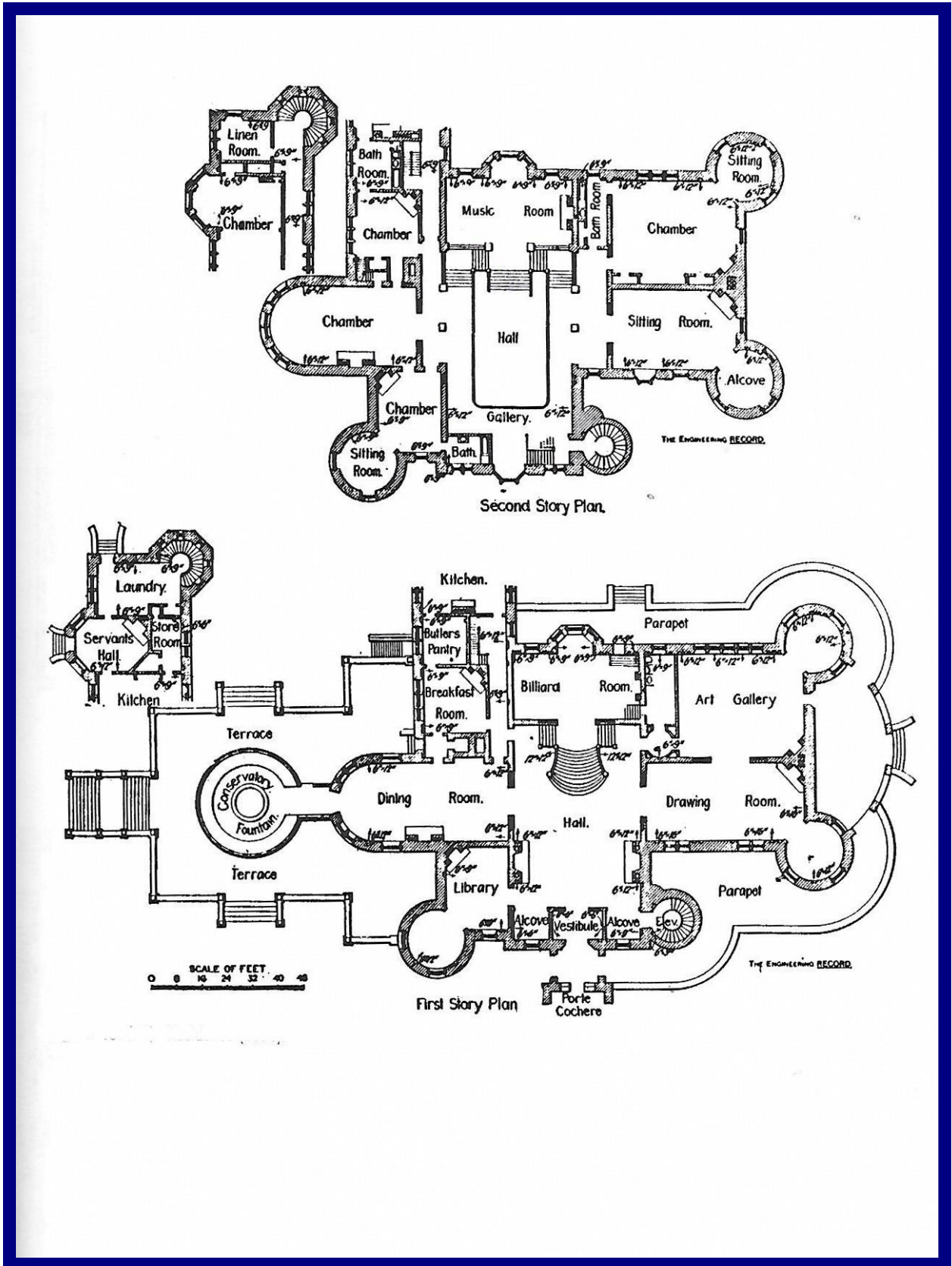
# RESIDENCE TWO



Plan showing boilers and steam distribution 1896.

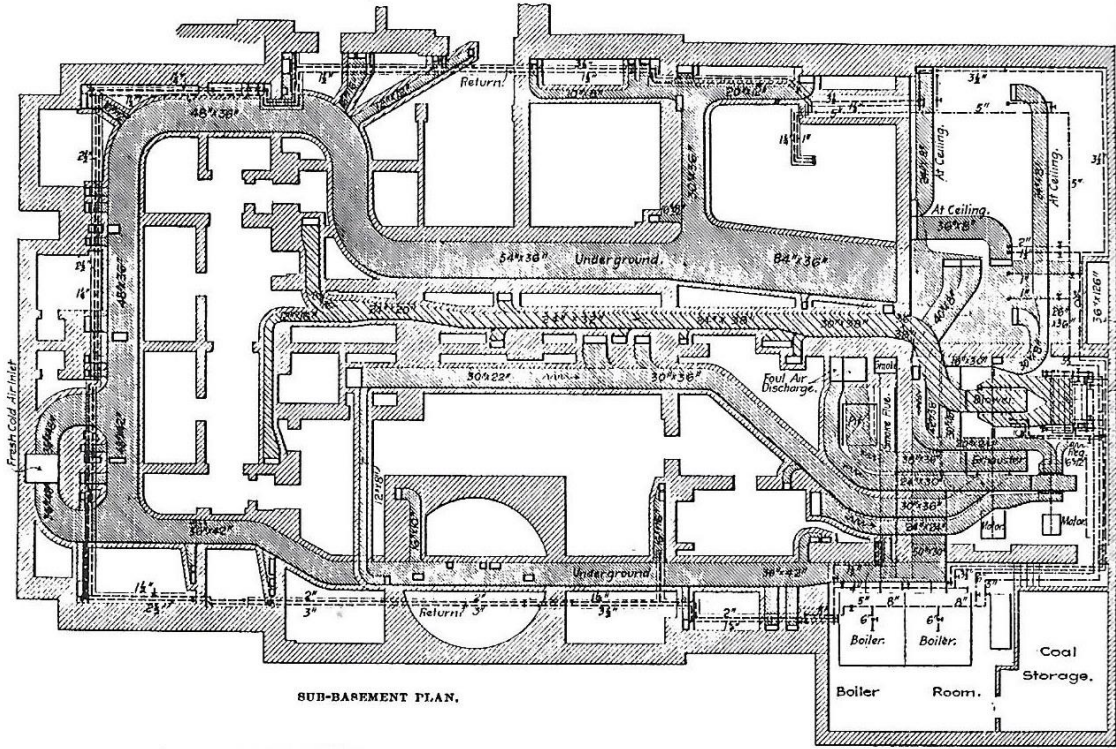


# RESIDENCE TWO

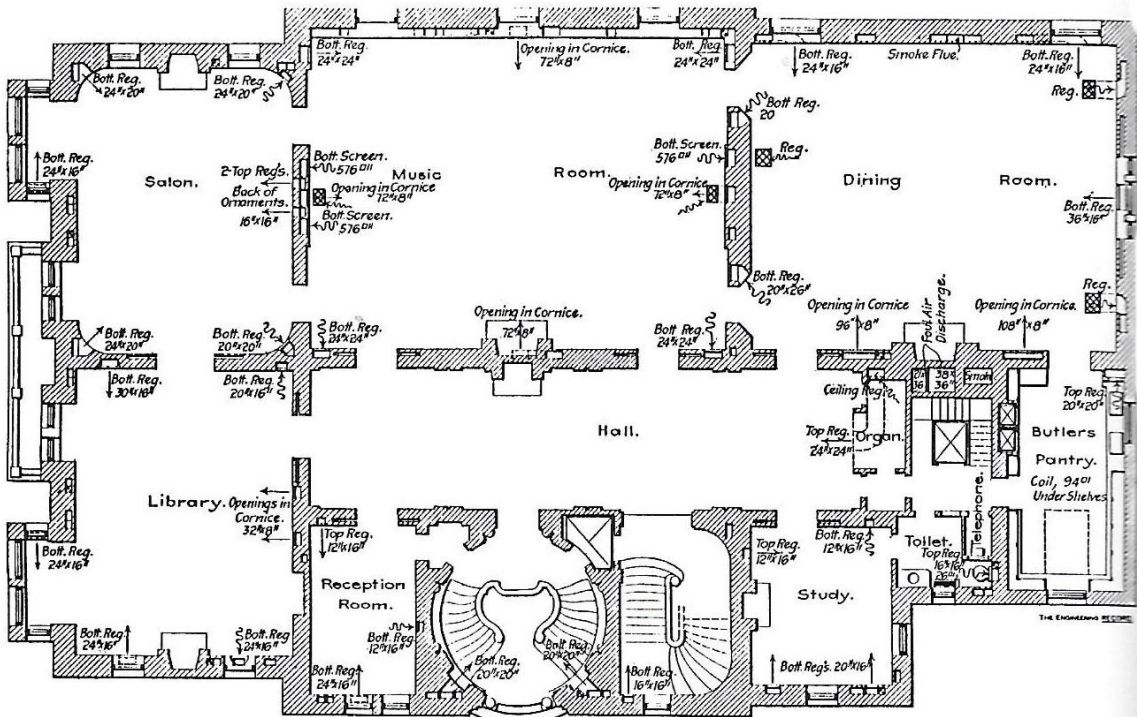


Plans of 1896.

# RESIDENCE THREE



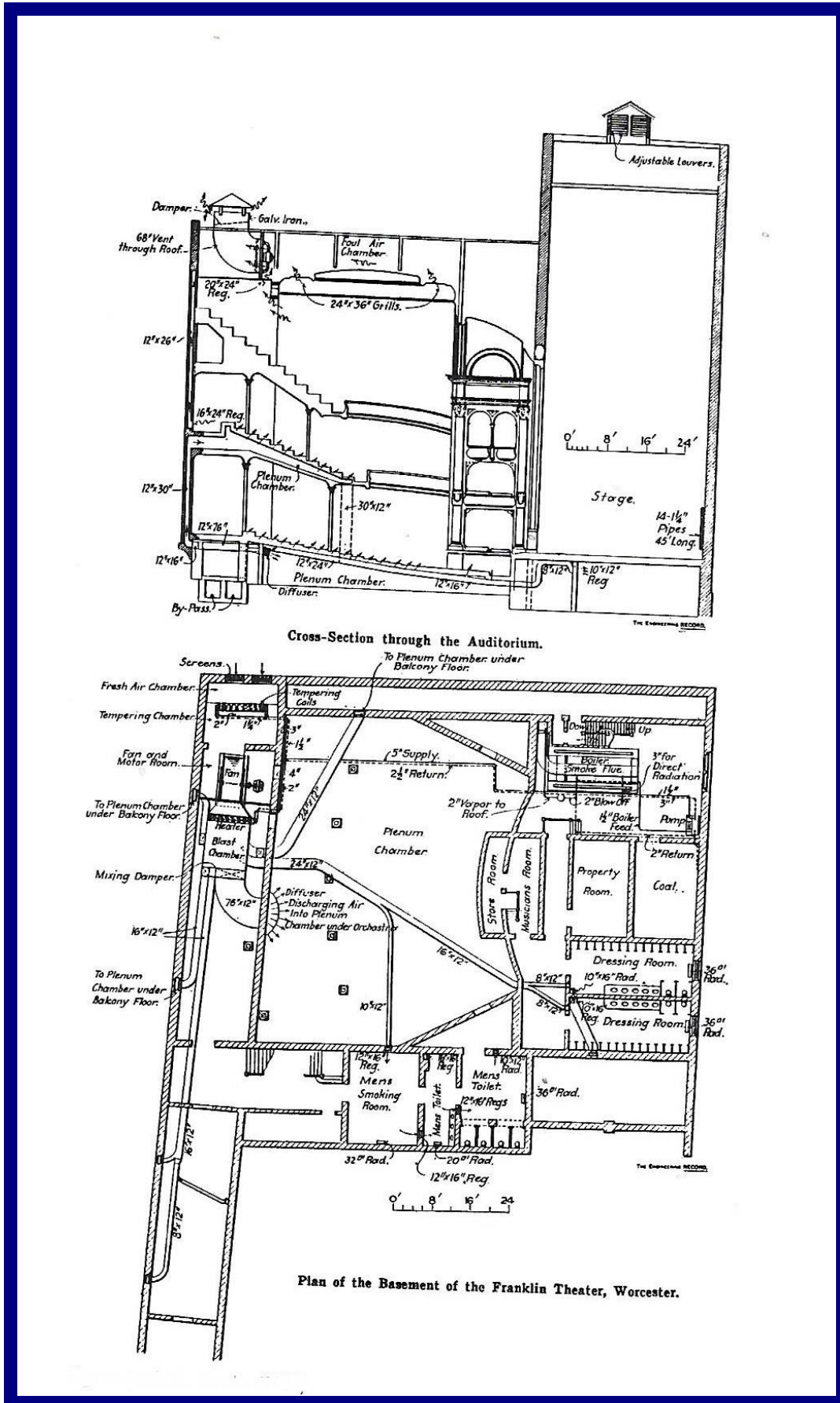
SUB-BASEMENT PLAN.



FIRST-FLOOR PLAN.

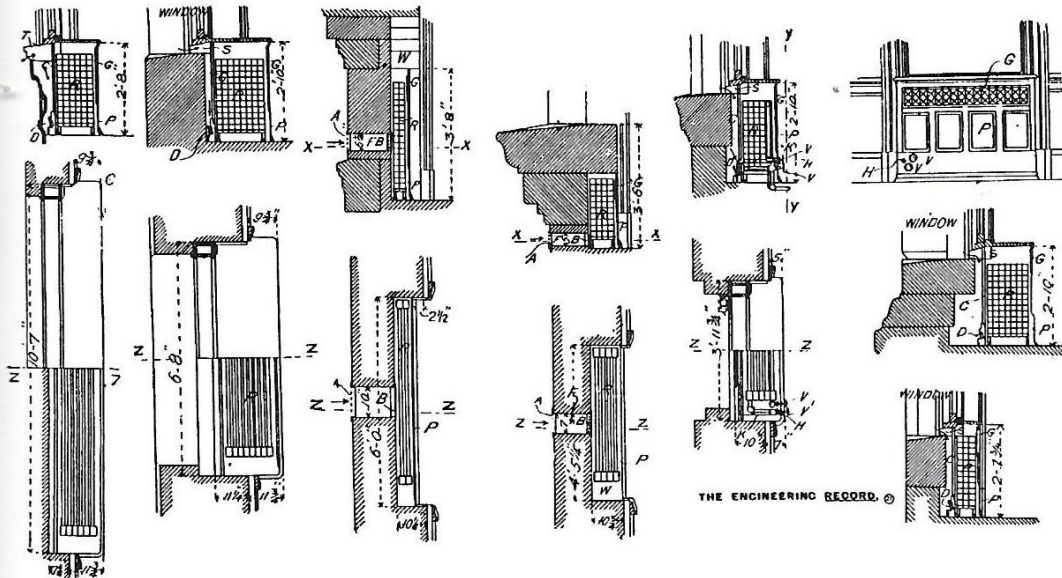
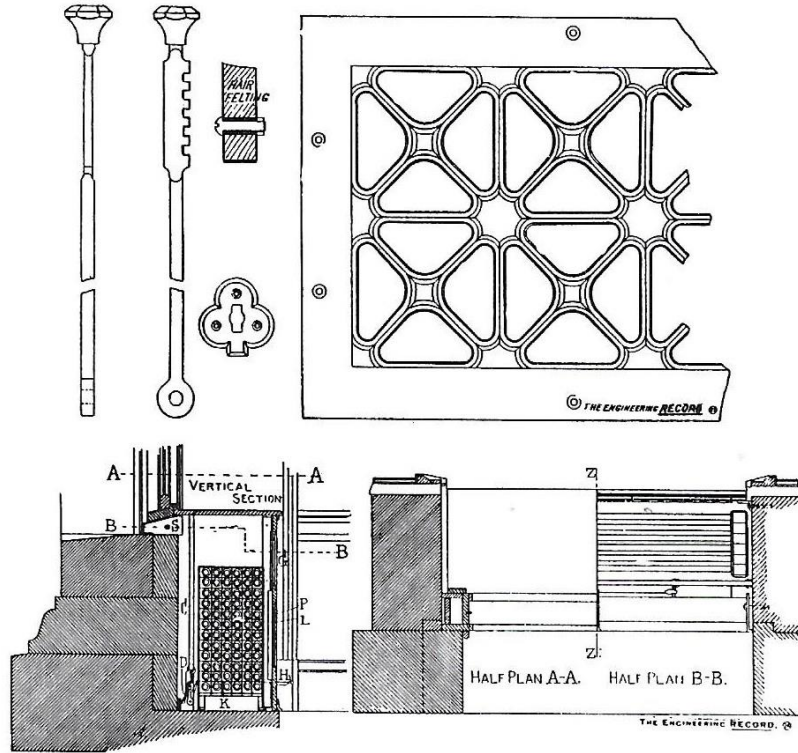


# FRANKLIN THEATRE WORCESTER



Warm air supply with basement plenum chamber and high level foul air extract 1904.

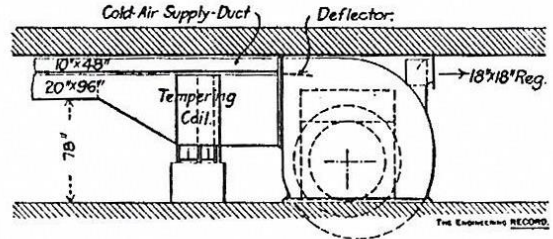
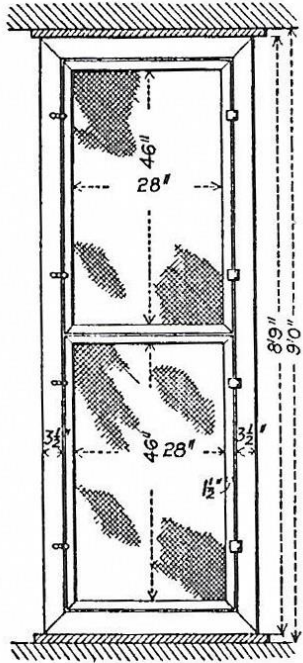
# SUFFOLK COUNTY COURT HOUSE



HEATING AND VENTILATION OF THE SUFFOLK COUNTY COURT-HOUSE.

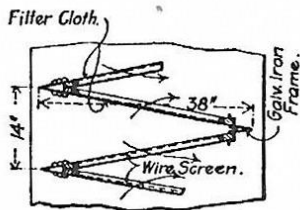


# APPELLATE COURT HOUSE NEW YORK



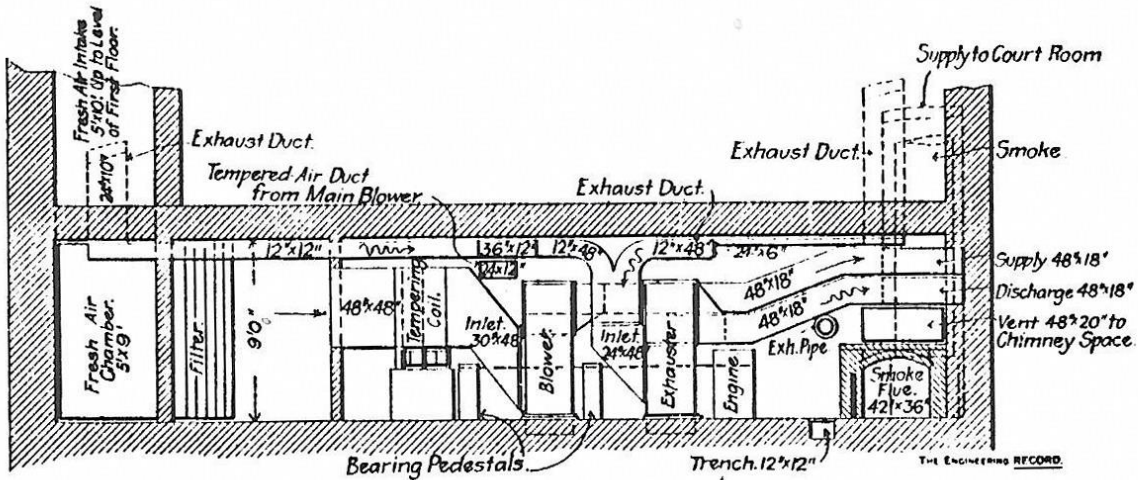
ELEVATION OF MAIN BLOWER.

Figure 45b(51). Appellate Court House, New York (1900).



THE ENGINEERING RECORD.

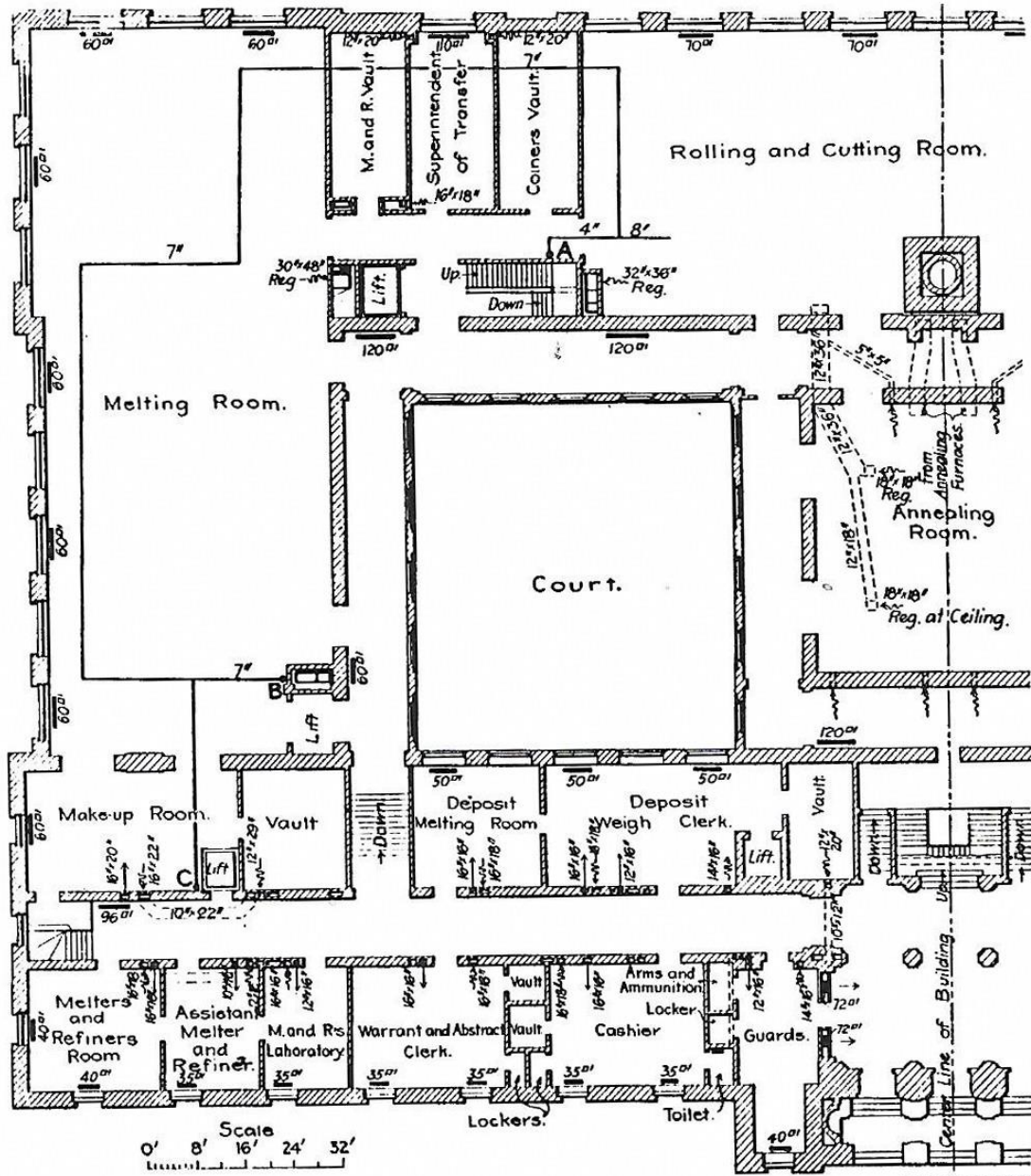
FILTER SCREEN.



THE ENGINEERING RECORD.

ELEVATION OF COURT-ROOM VENTILATION APPARATUS.

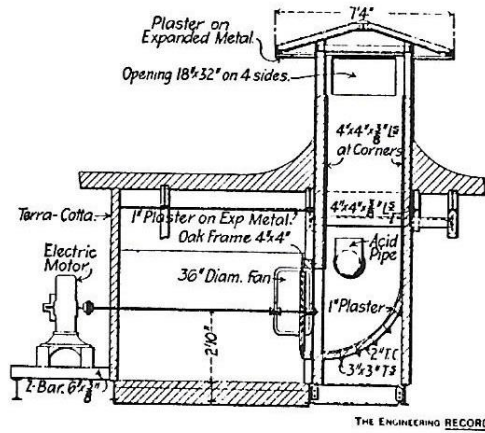
# PHILADELPHIA U.S. MINT



HALF PLAN OF FIRST FLOOR, SHOWING HEATING MAIN.

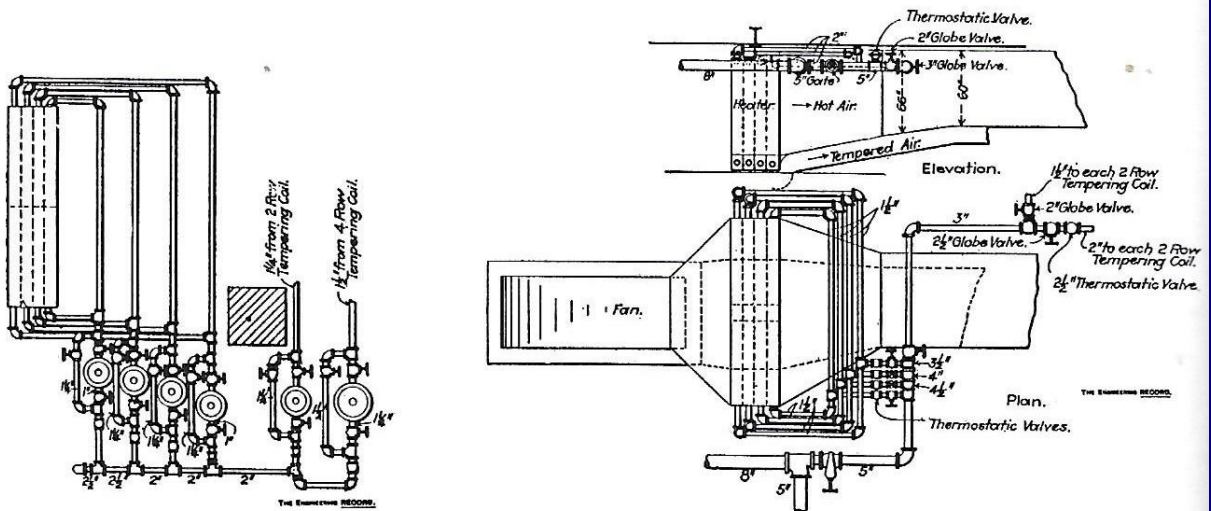


# US MINT & MINNESOTA STATE CAPITOL



EXHAUST CHAMBER AND FAN.

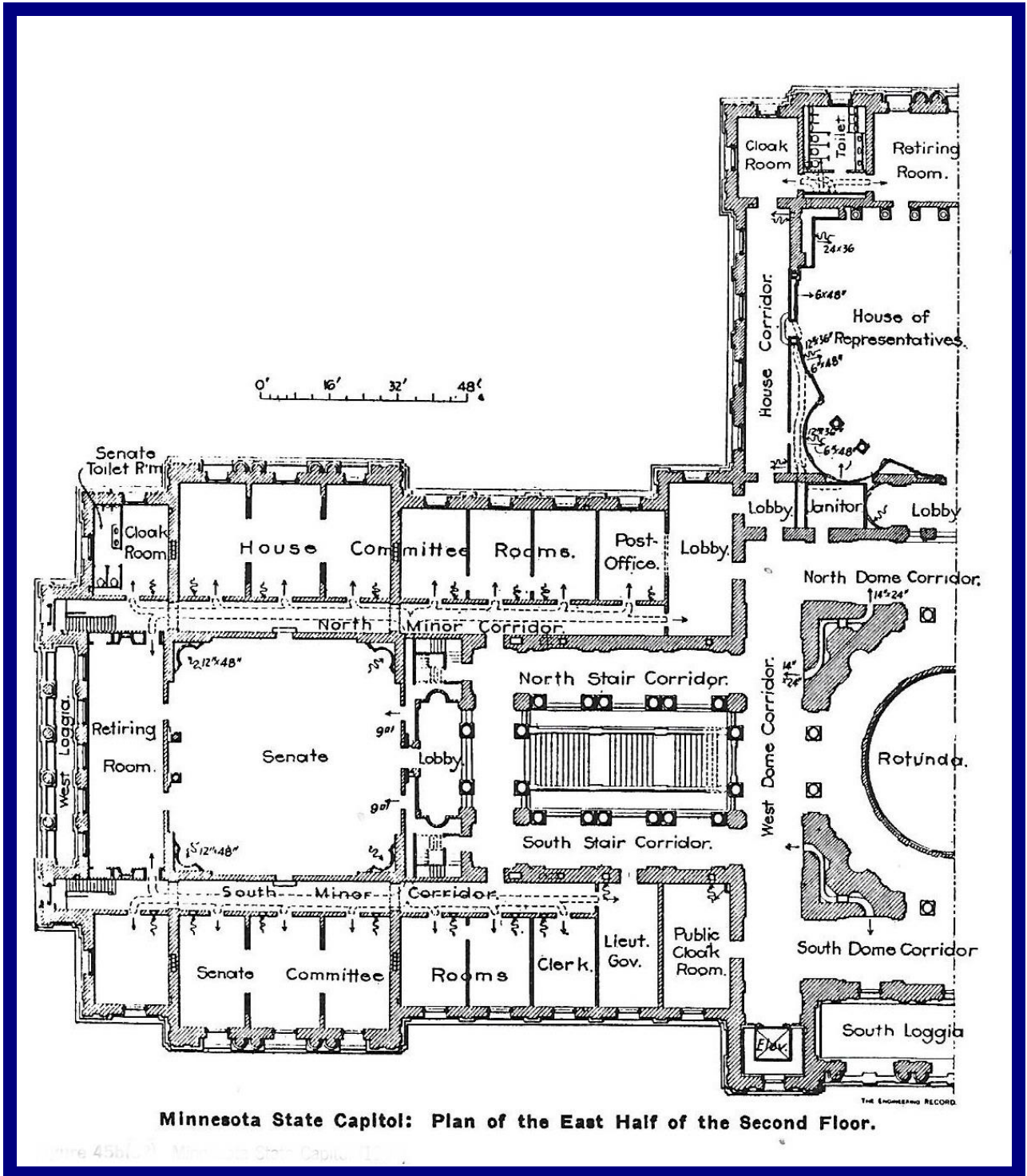
Figure 45b(60). United States Mint, Philadelphia (1902).



Typical Arrangement of Steam and Return Connections to Indirect Radiation.

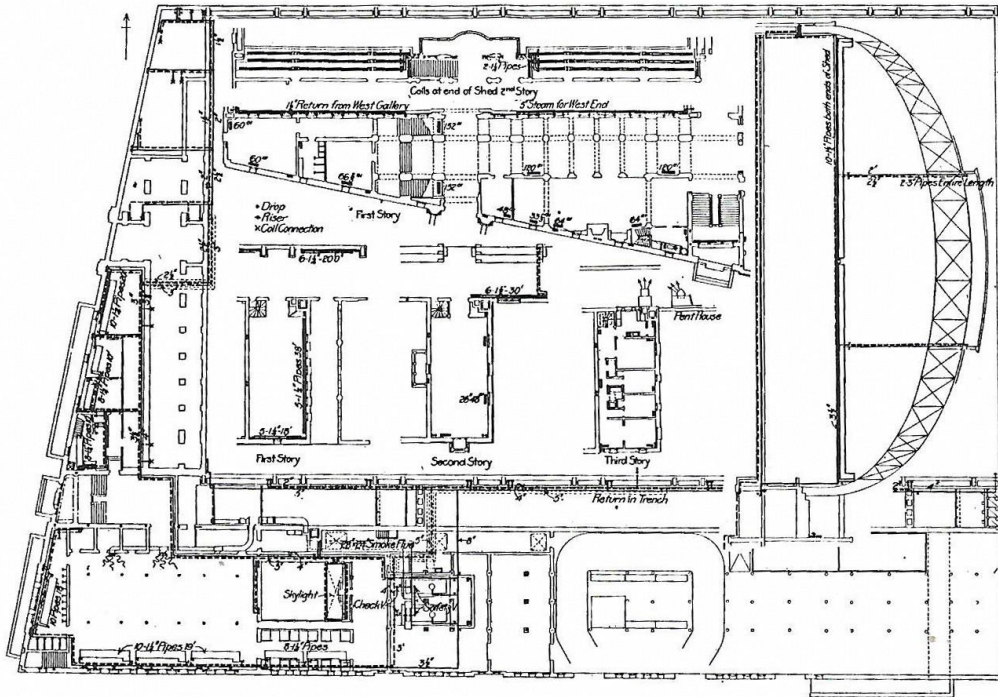
US Mint, Philadelphia, 1902: Minnesota State Capitol 1904.

# MINNESOTA STATE CAPITOL

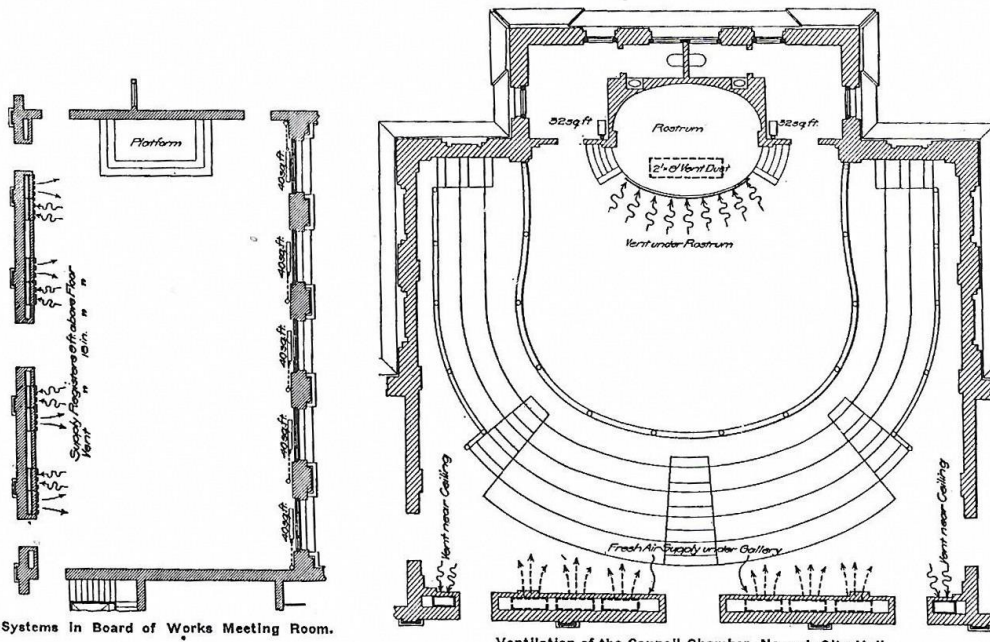




# CAVALRY ARMORY BROOKLYN 1905 CITY HALL NEWARK NEW JERSEY 1907



Diagrams Showing Heating Installation in a Cavalry Armory in Brooklyn.



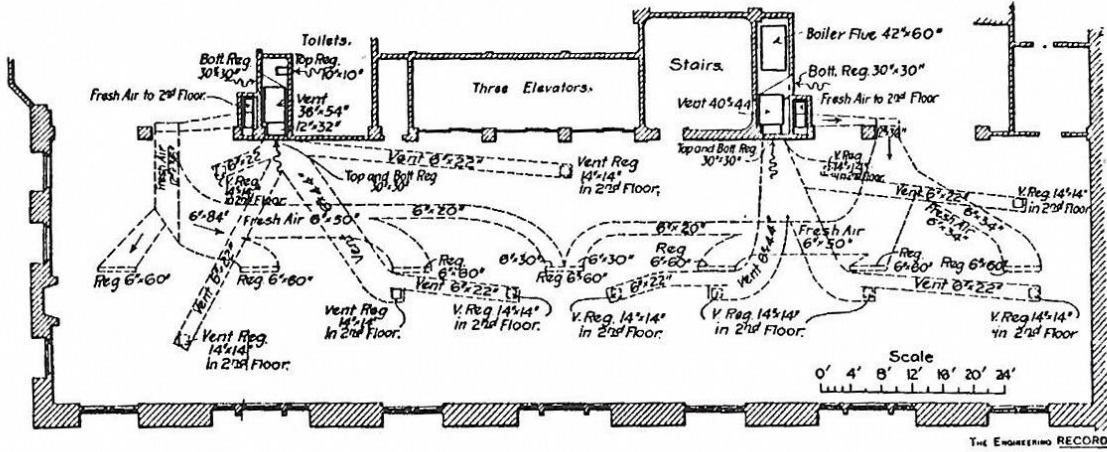
Systems in Board of Works Meeting Room.

Ventilation of the Council Chamber, Newark City Hall.

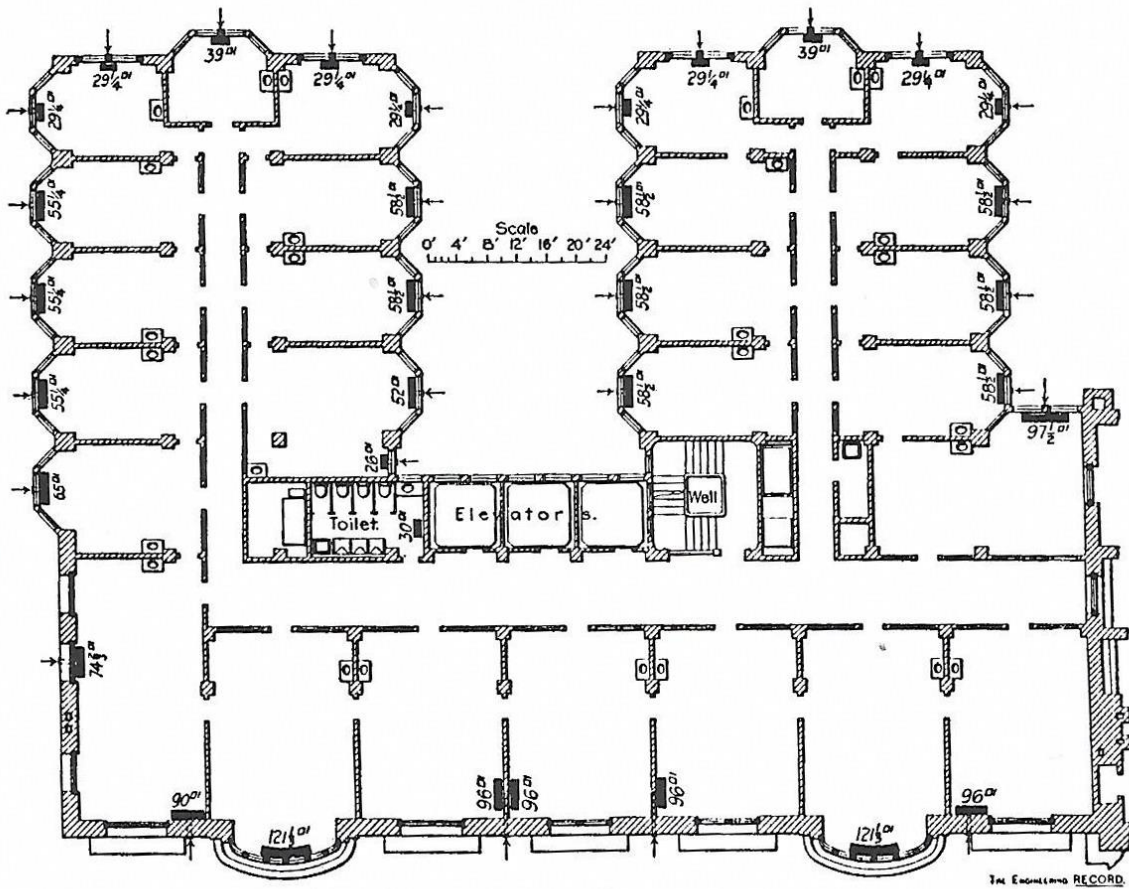




# OFFICE

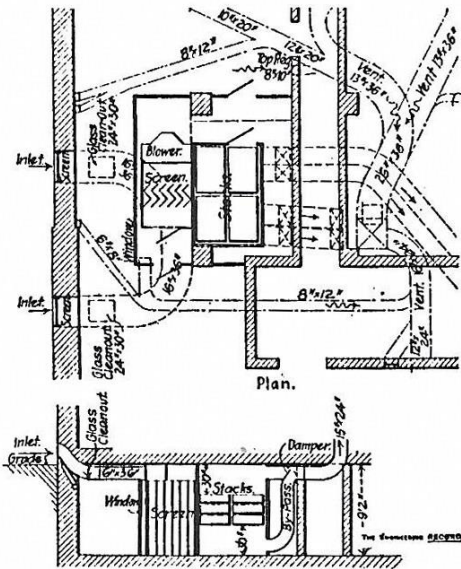


SUSPENDED CEILING OVER FRONT PART OF FIRST STORY.

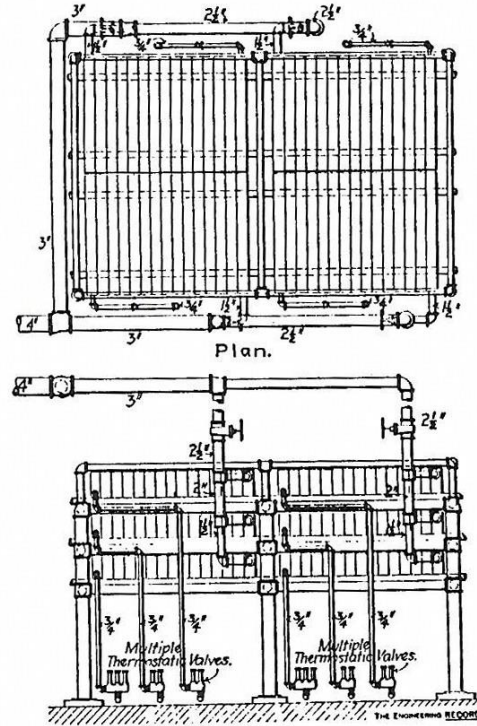


PLAN OF THIRD FLOOR, DUCTS OVER CORRIDOR CEILINGS NOT SHOWN.

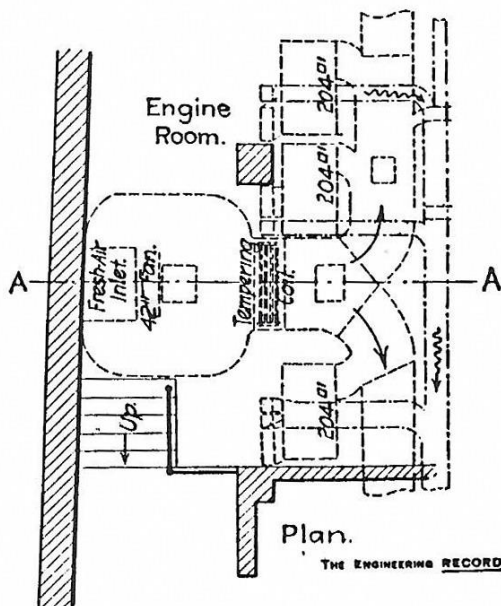
# OFFICE



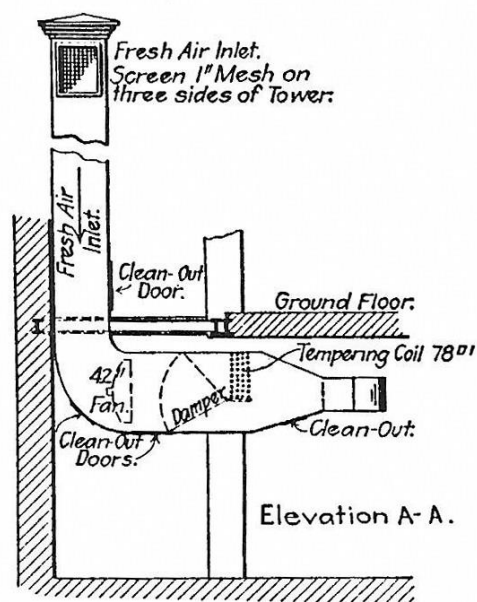
GENERAL ARRANGEMENT.  
AIR TEMPERING APPARATUS FOR THE MAIN FLOORS FRONT.



THE TEMPERING STACKS.



APPARATUS FOR MAIN FLOORS REAR.





# LIBRARY OF CONGRESS

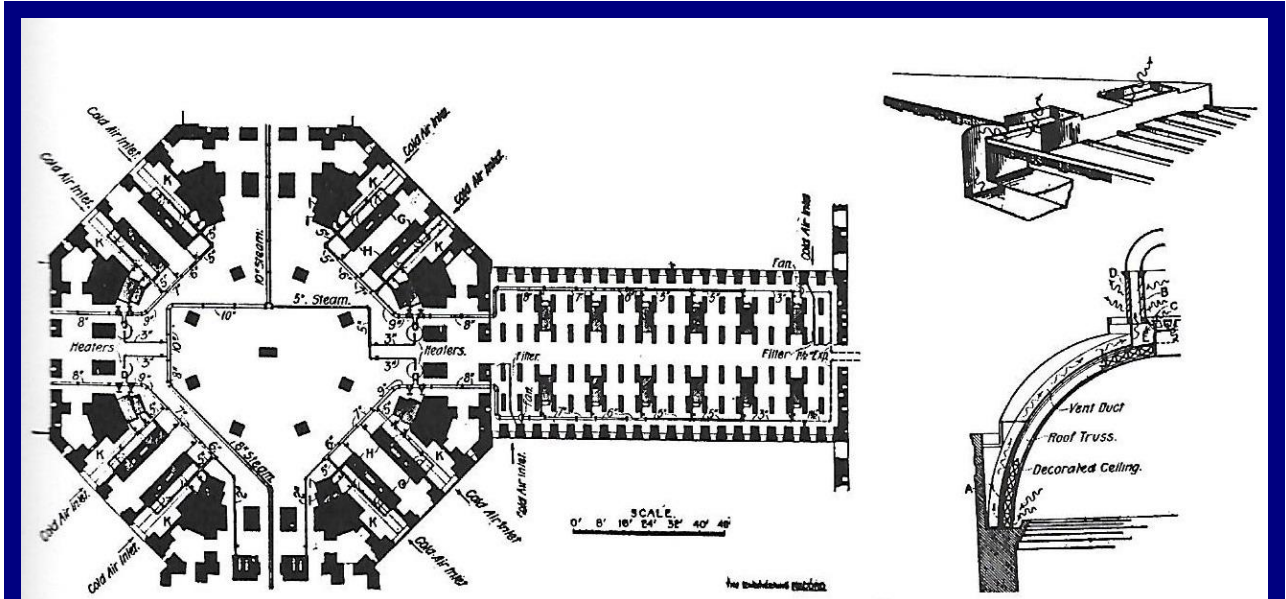
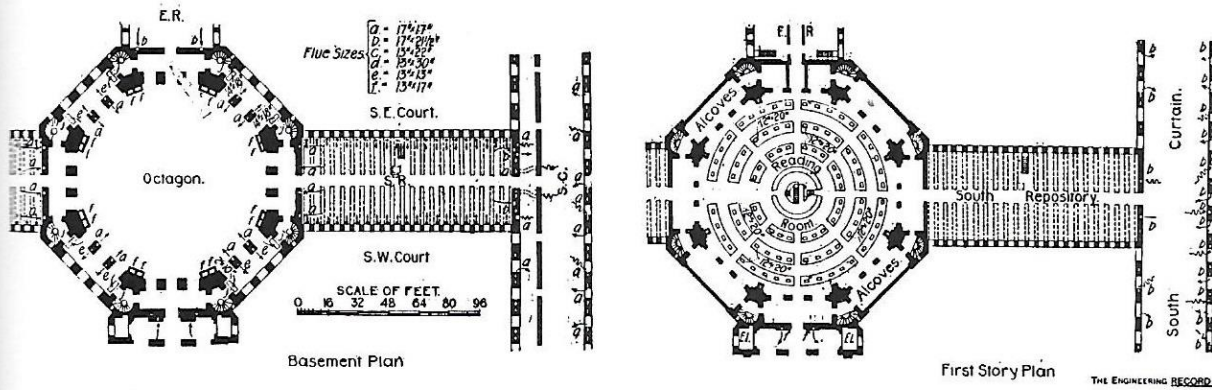
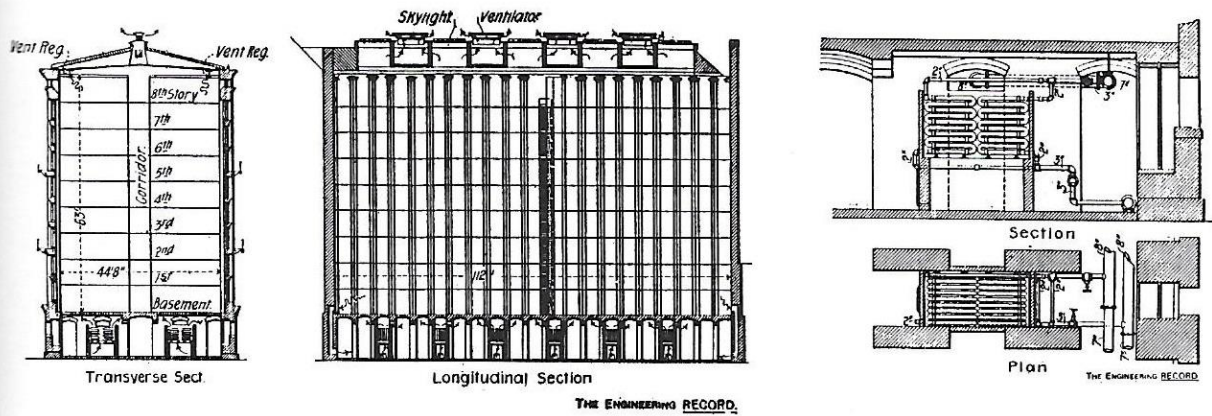
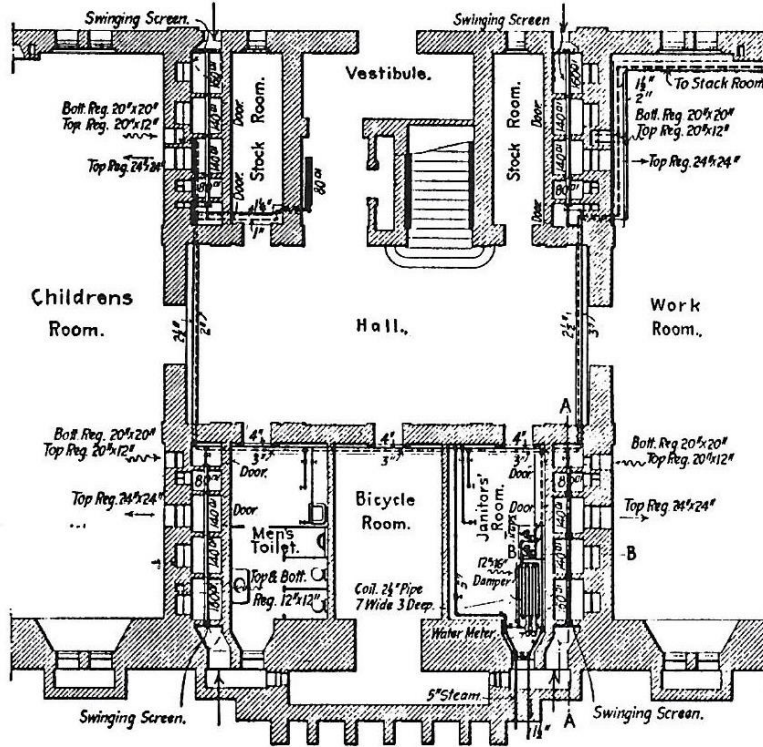


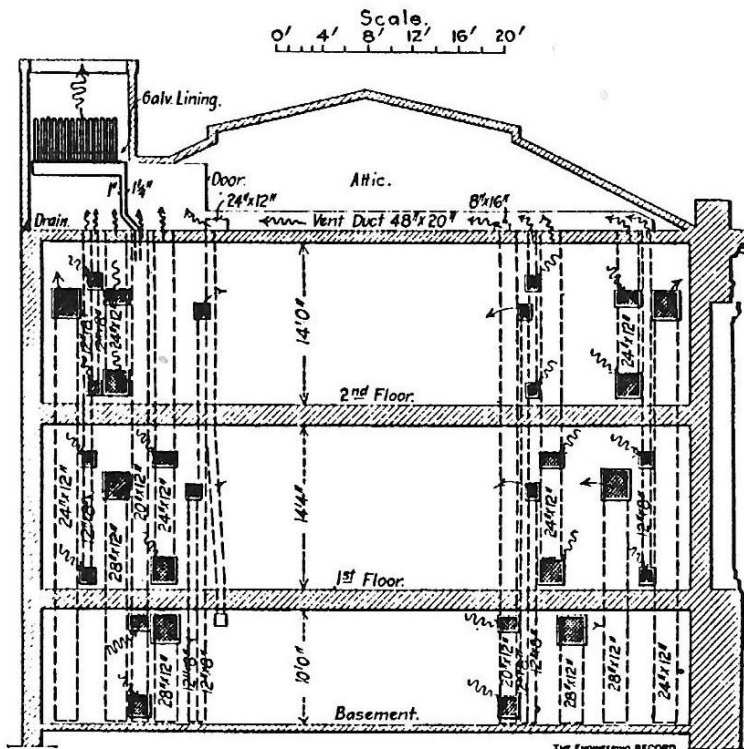
Figure 45b(97). Library of Congress (1897).



# ATLANTA PUBLIC LIBRARY



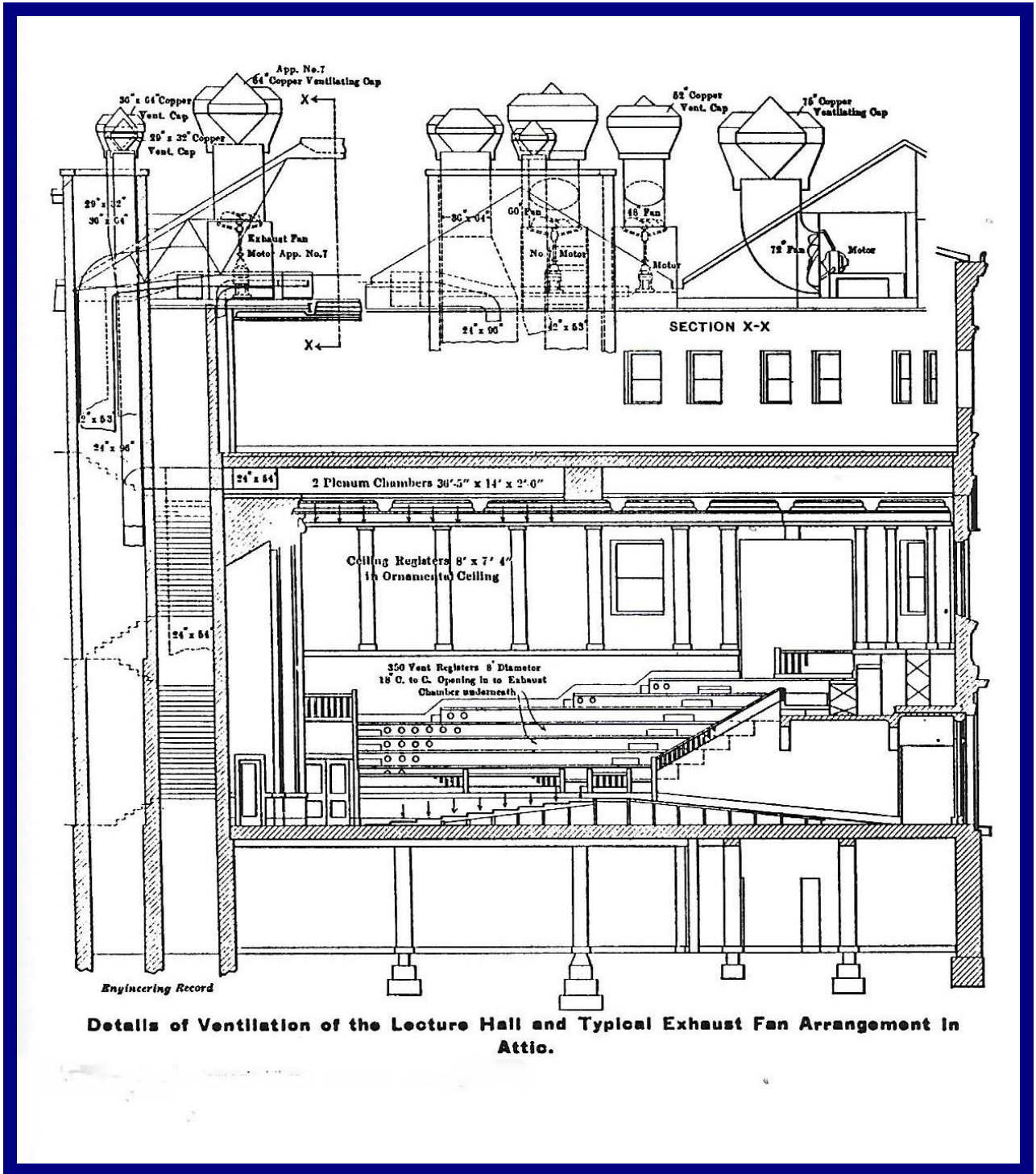
BASEMENT PLAN, SHOWING HEATING SYSTEM.



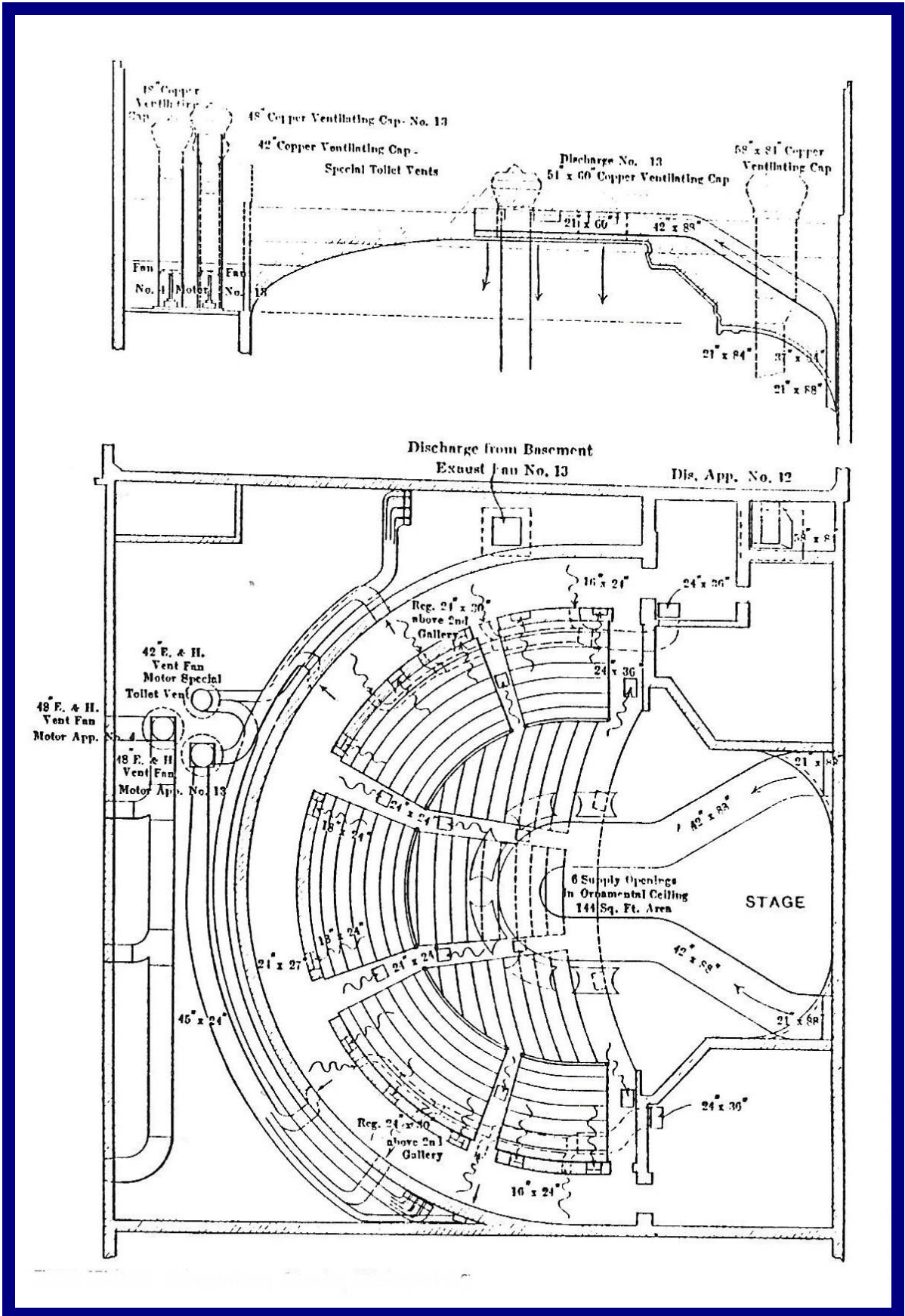
TRANSVERSE SECTION THROUGH THE BUILDING.



# CARNEGIE LIBRARY PITTSBURGH

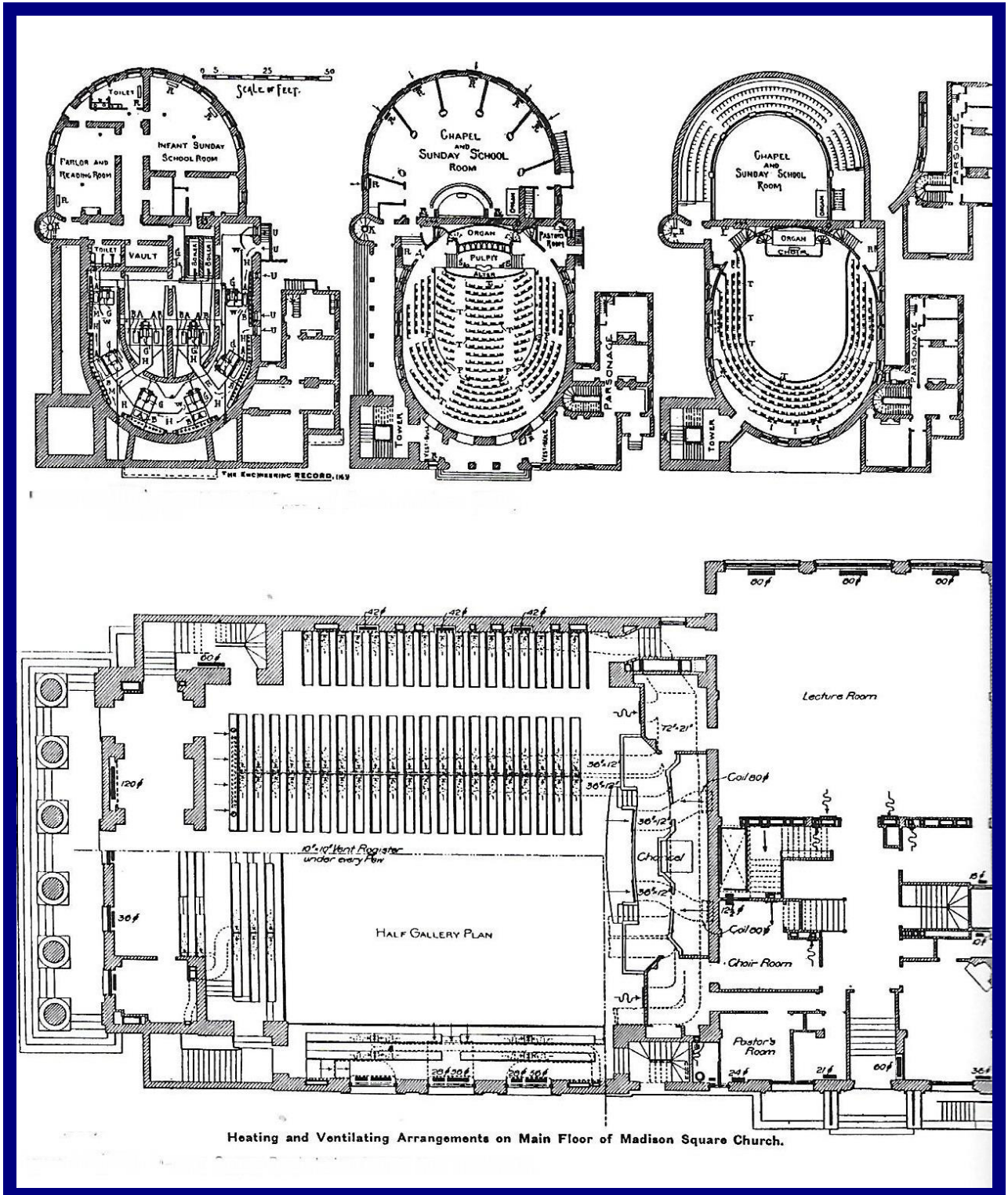


# CARNEGIE LIBRARY PITTSBURGH

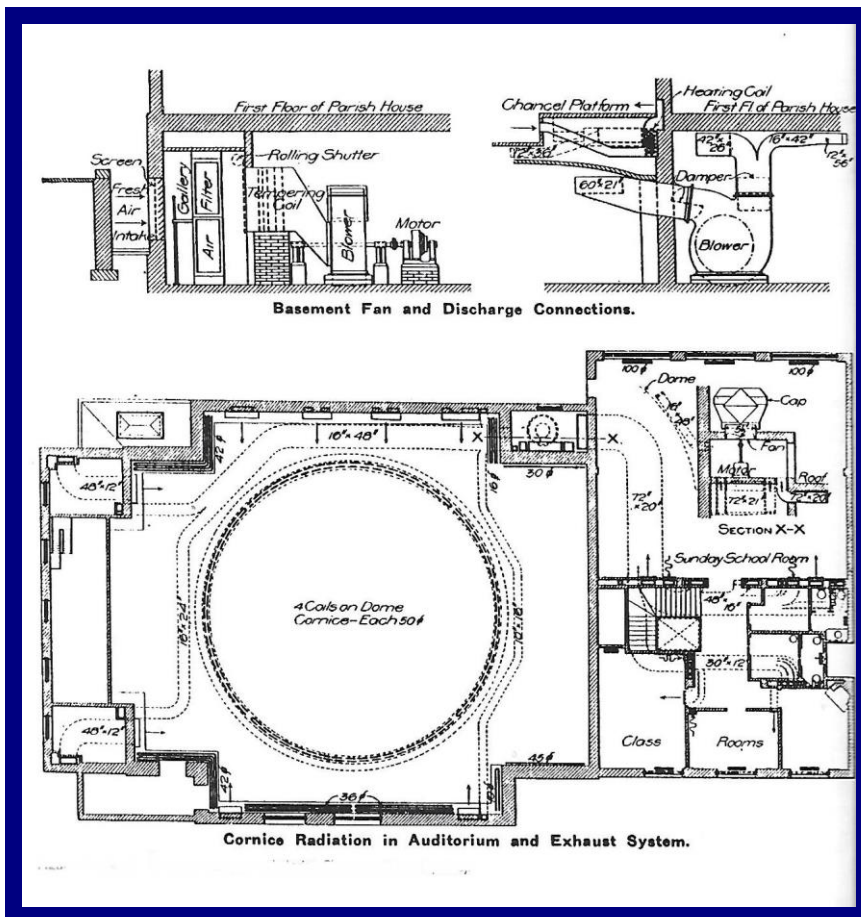
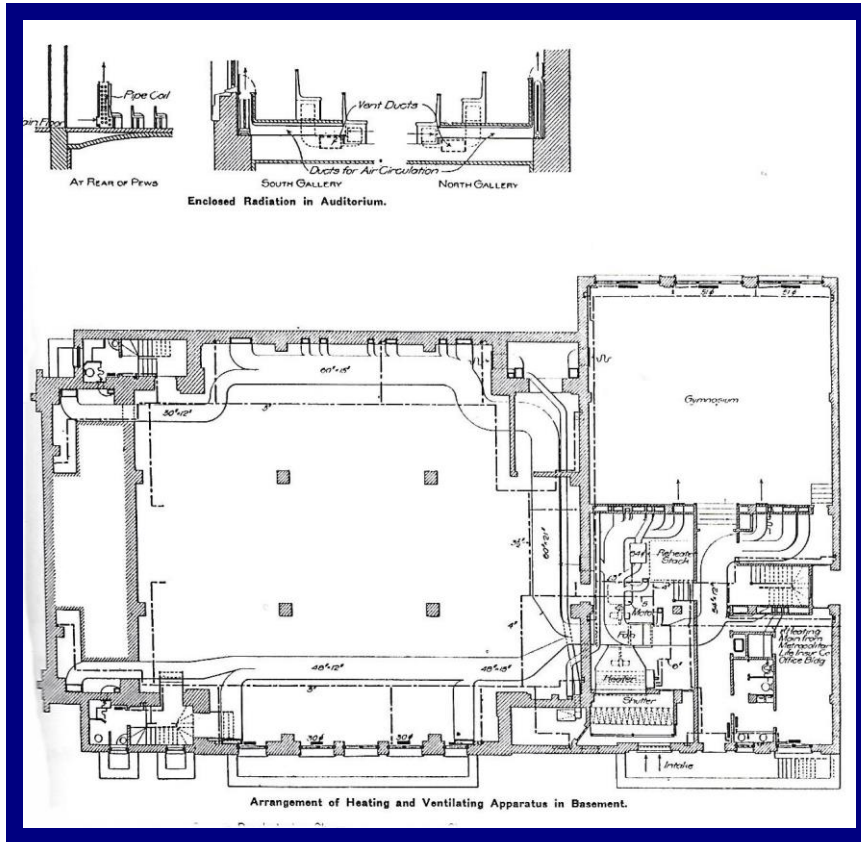




# MADISON SQ. CHURCH NEW YORK

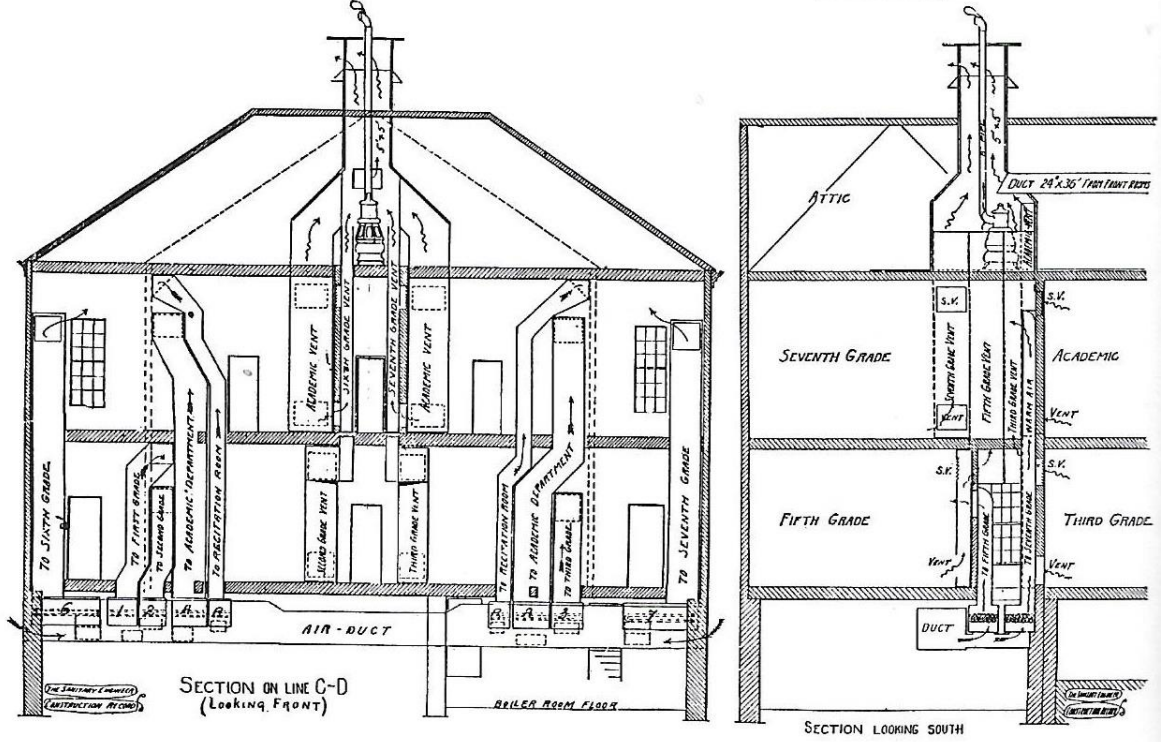
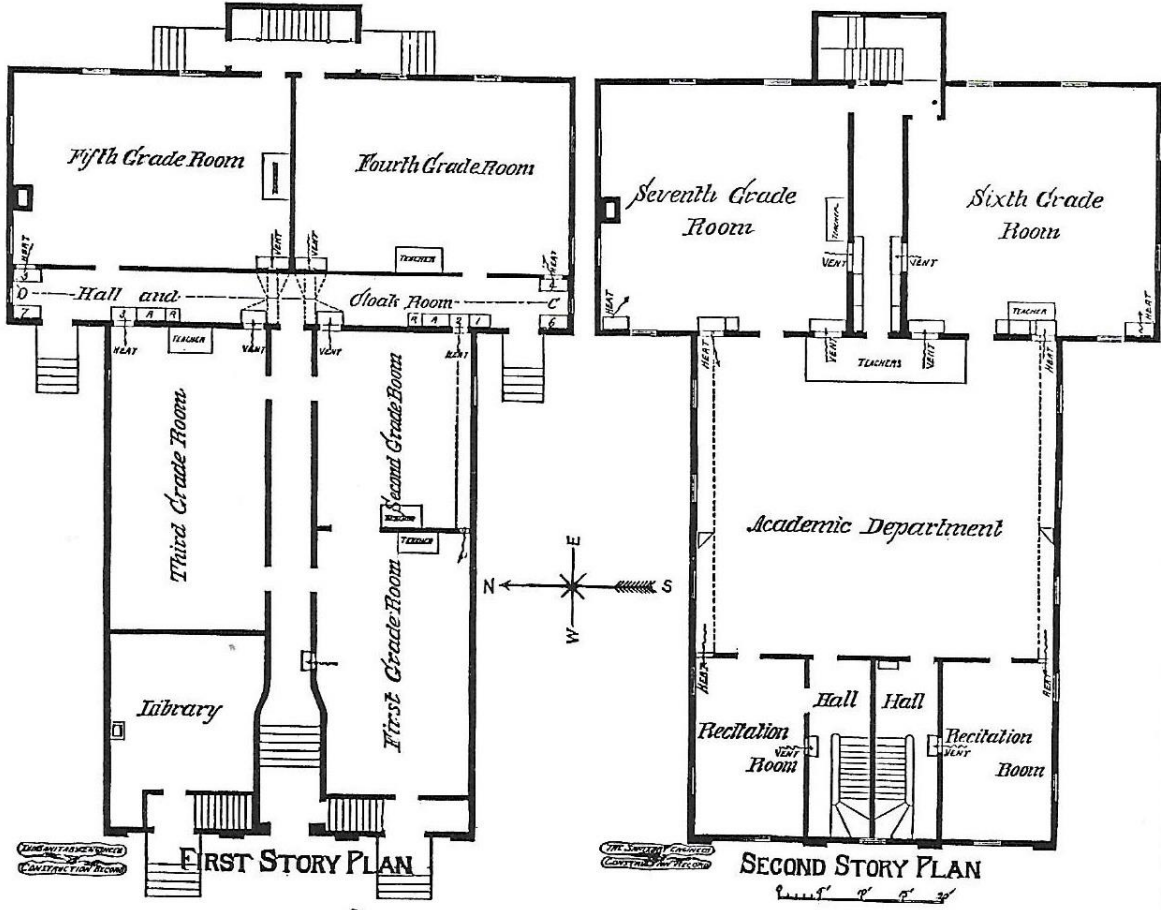


# MADISON SQ. CHURCH NEW YORK

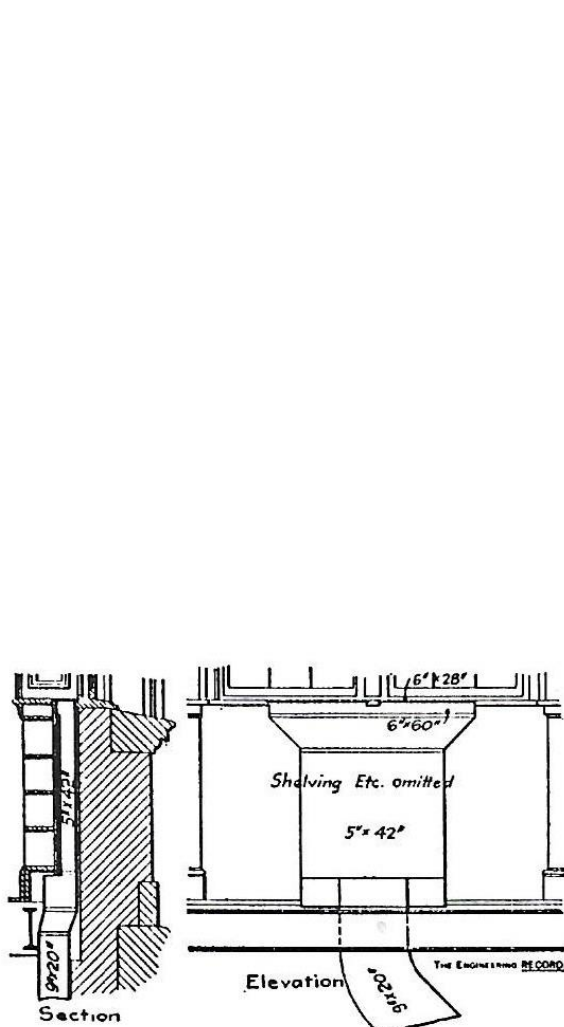




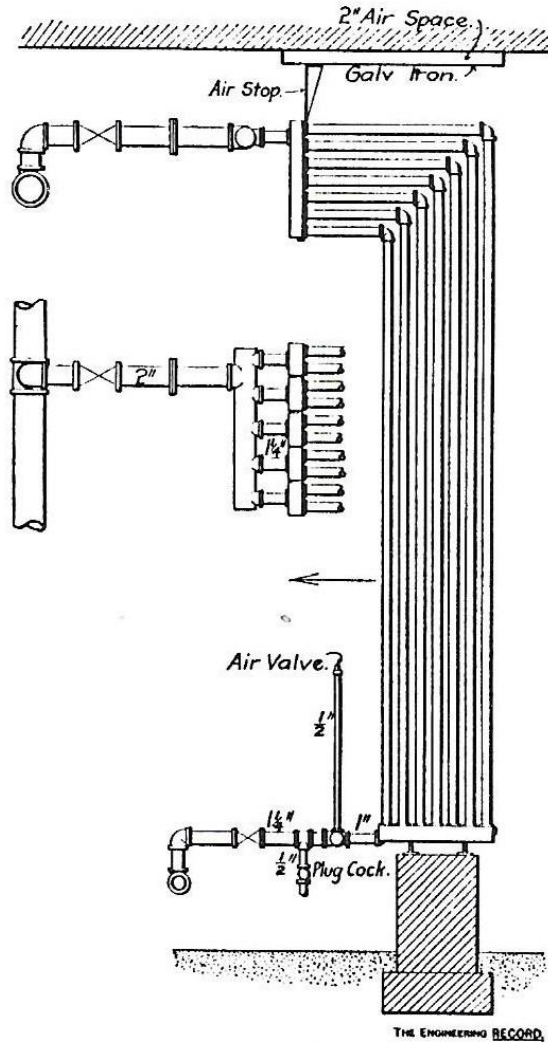
# SCHOOL ONE



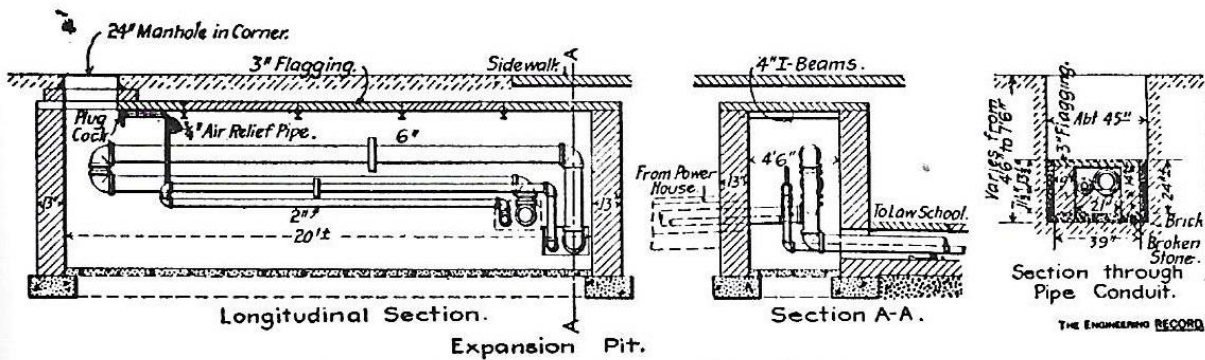
# SCHOOL ONE



WINDOW-SILL AIR INLET.



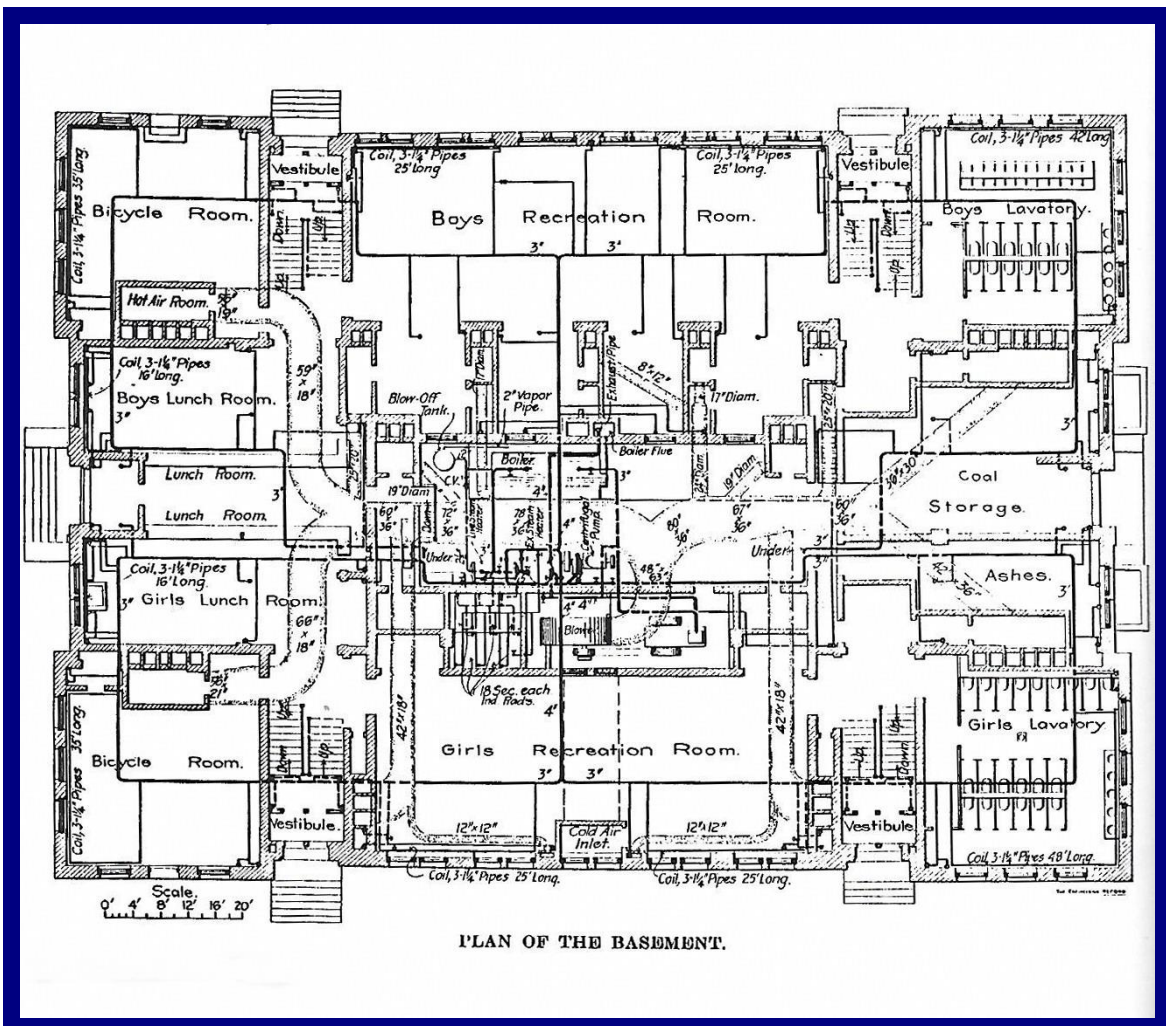
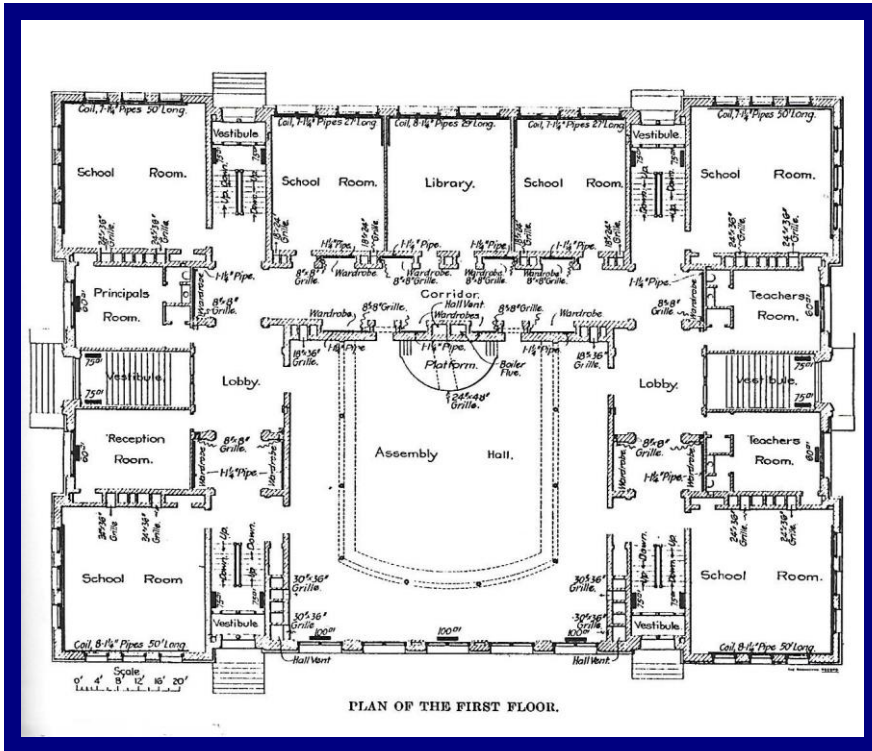
CROSS-SECTION OF TEMPERING COIL.



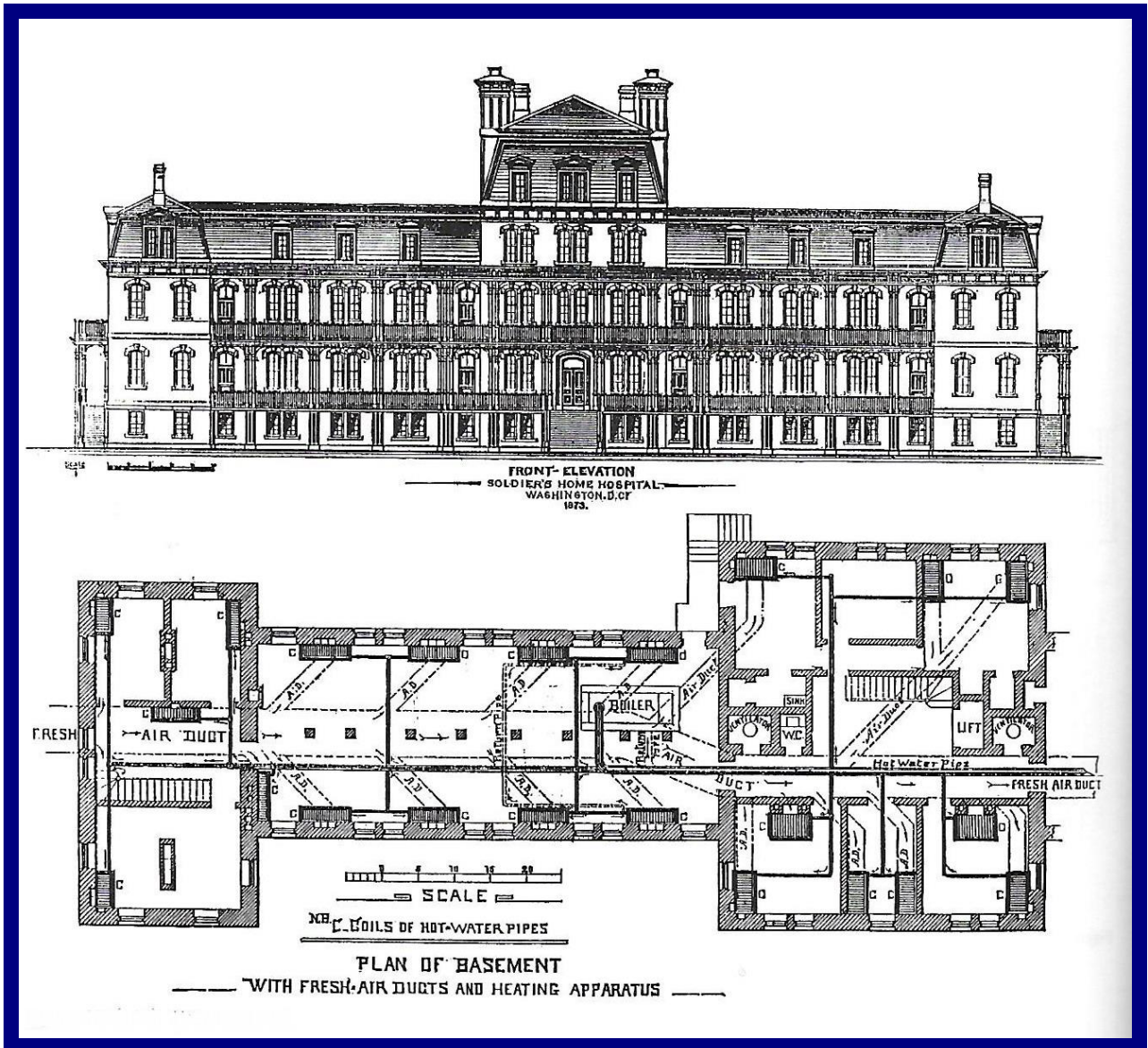
DETAILS OF THE UNDERGROUND PIPE CONDUIT.



# SCHOOL TWO



# SOLDIERS HOSPITAL WASHINGTON DC

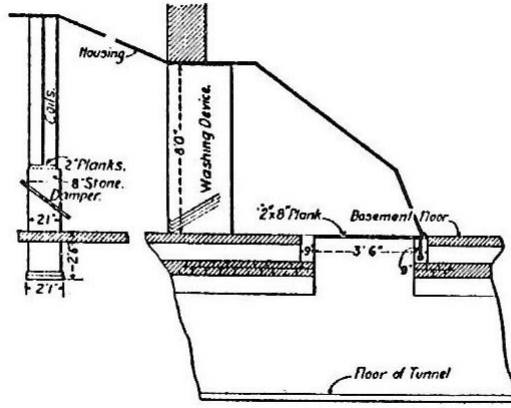


1883.

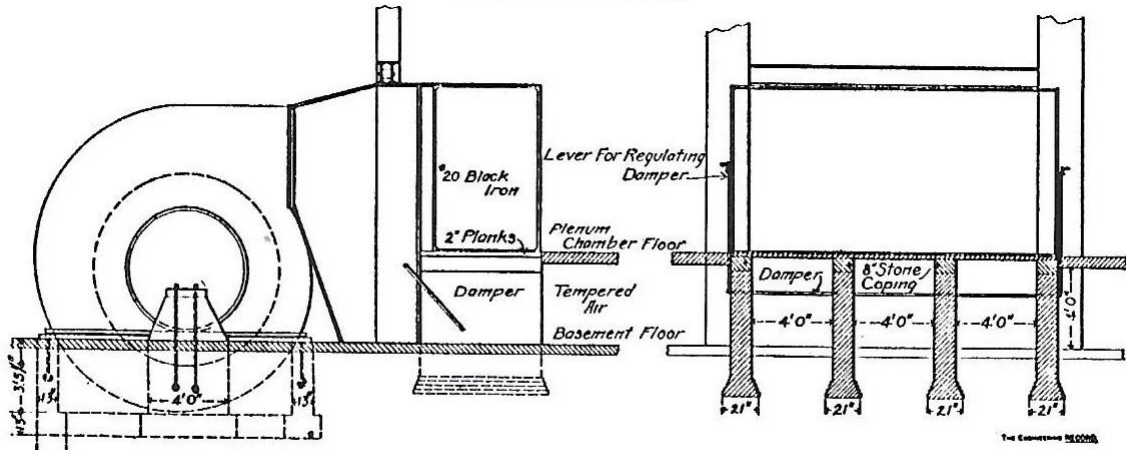




# NASHVILLE UNION STATION



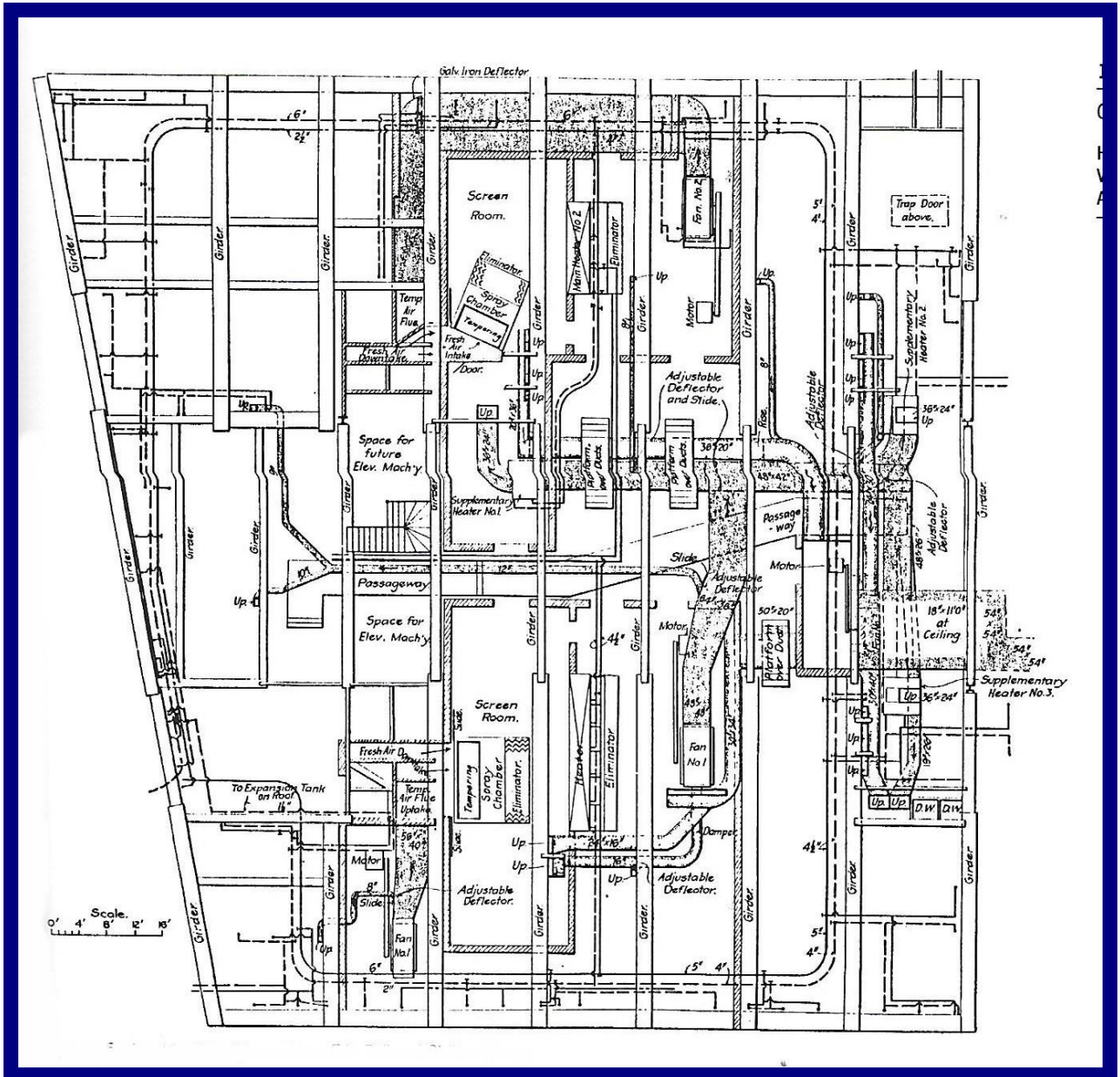
PART OF MAIN DUCT.



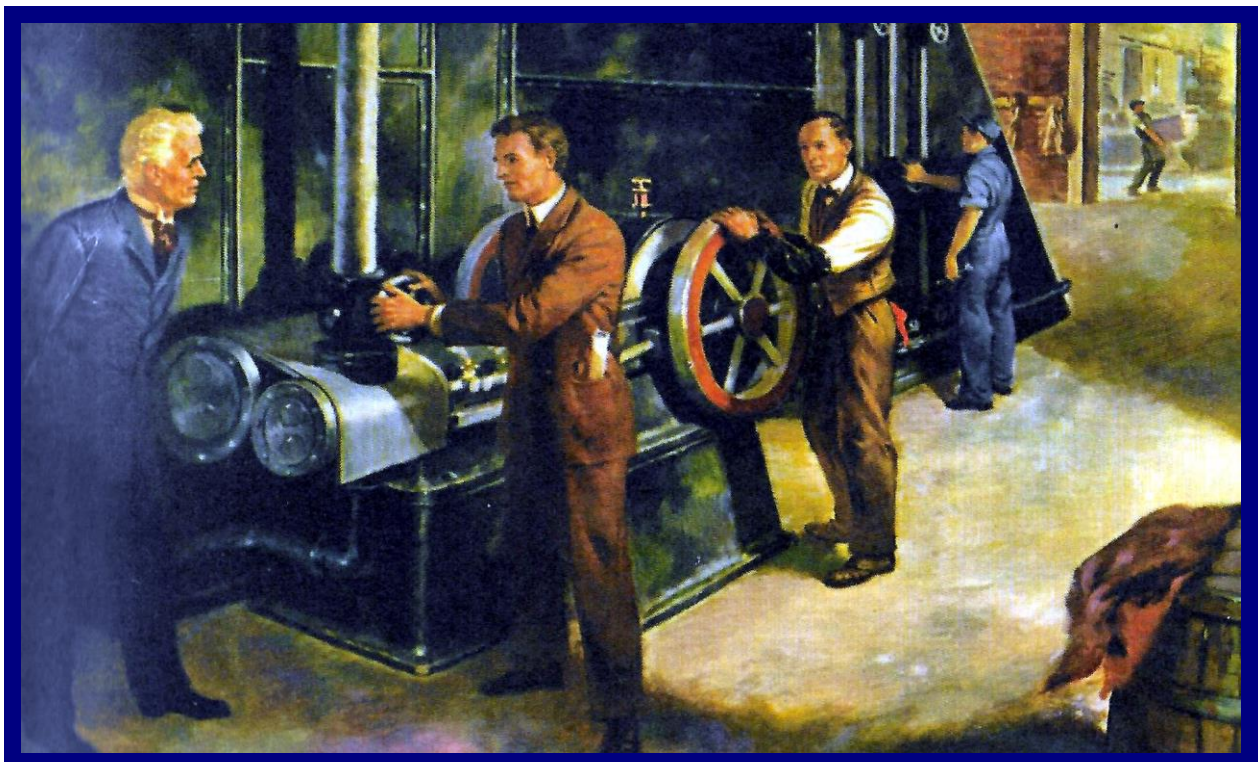
FOUNDATIONS OF BLOWER AND HEATING STACK.



# PITTSBURGH & LAKE ERIE STATION



## SACKETT & WILHEMS BROOKLYN

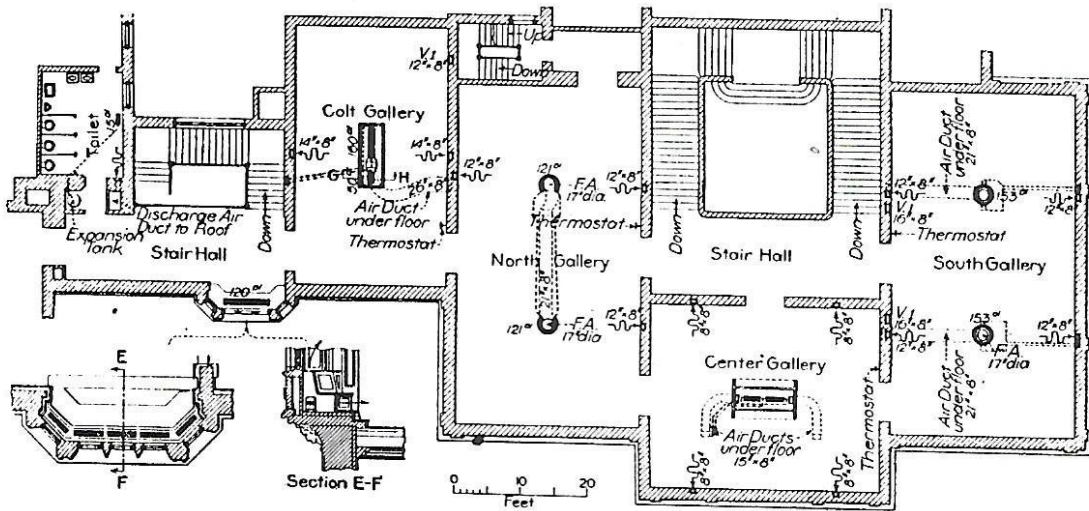
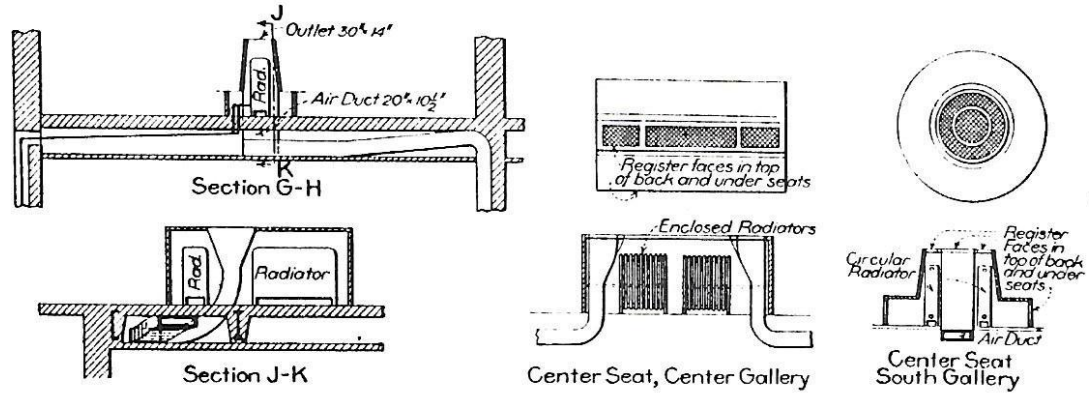


The humidifying/ventilation plant was installed by Carrier in 1902. The title to the illustration shows Willis Carrier starting the refrigeration compressor in 1902, but according Margaret Ingels (his biographer, page 19), the refrigeration was not installed until 1903.

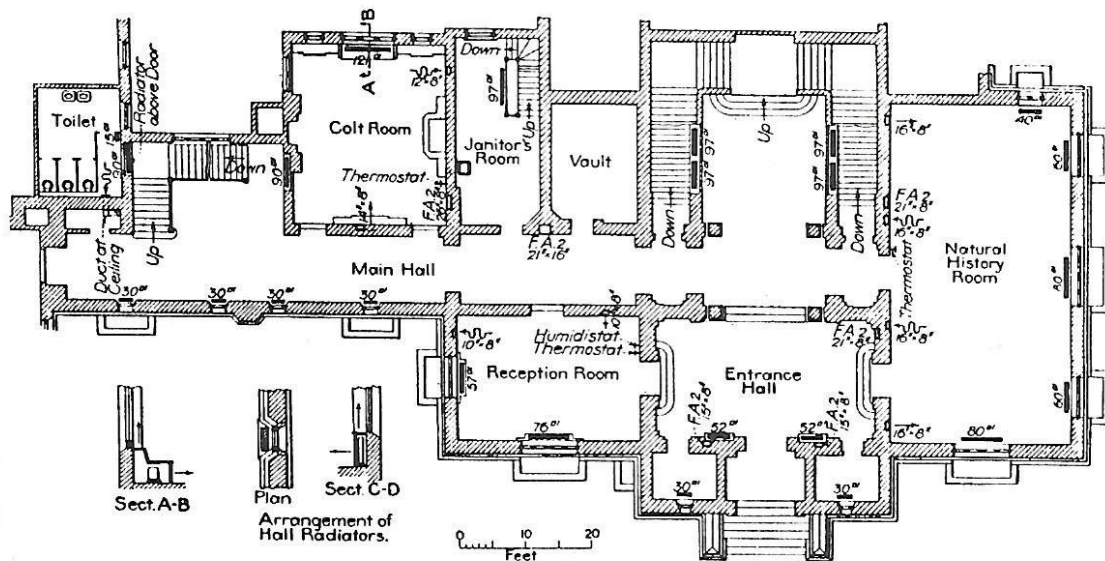




# MORGAN BUILDING HARTFORD



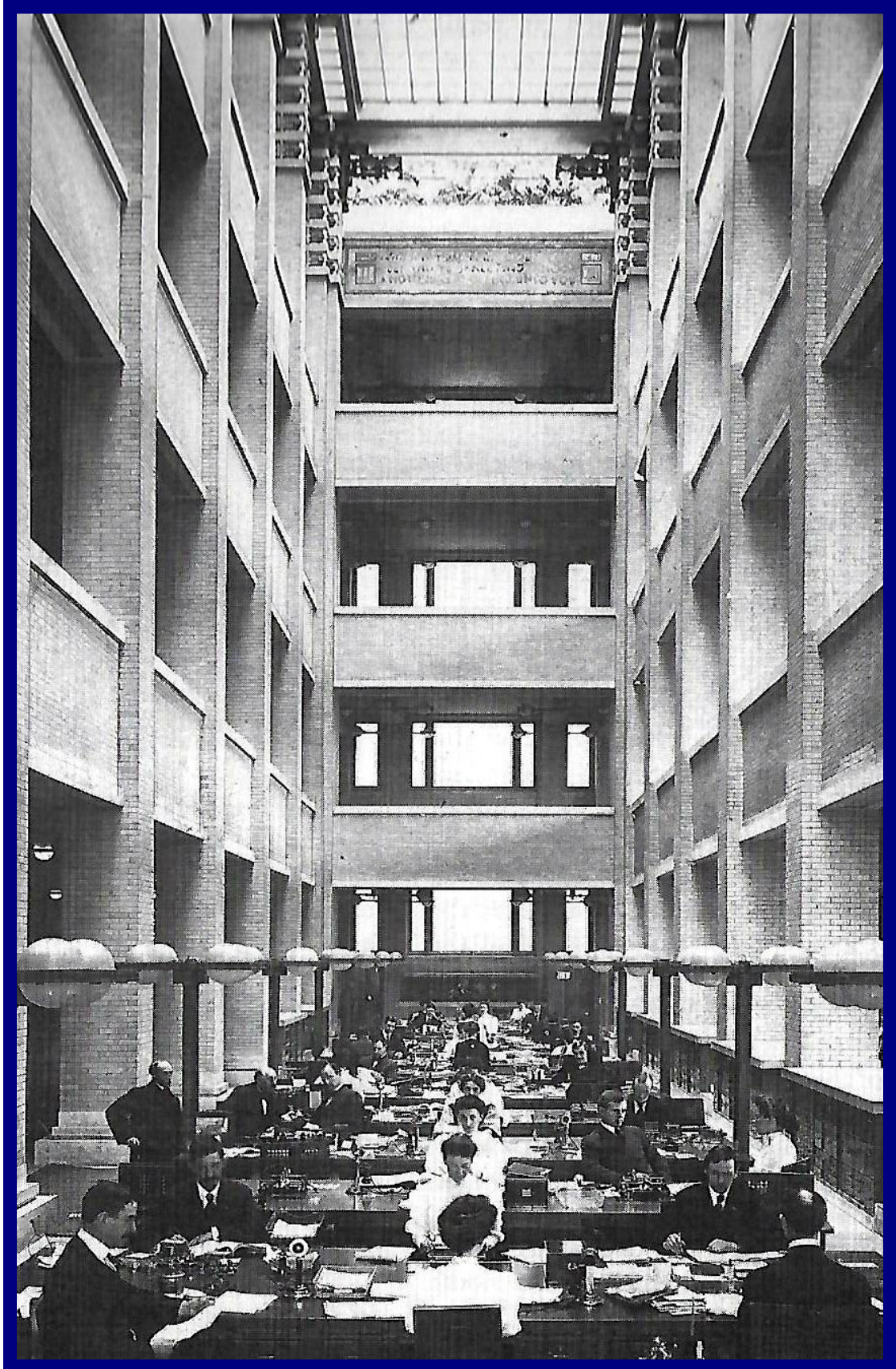
Second-Floor Plan, Morgan Memorial Building.



First-Floor Plan, Morgan Memorial Building.



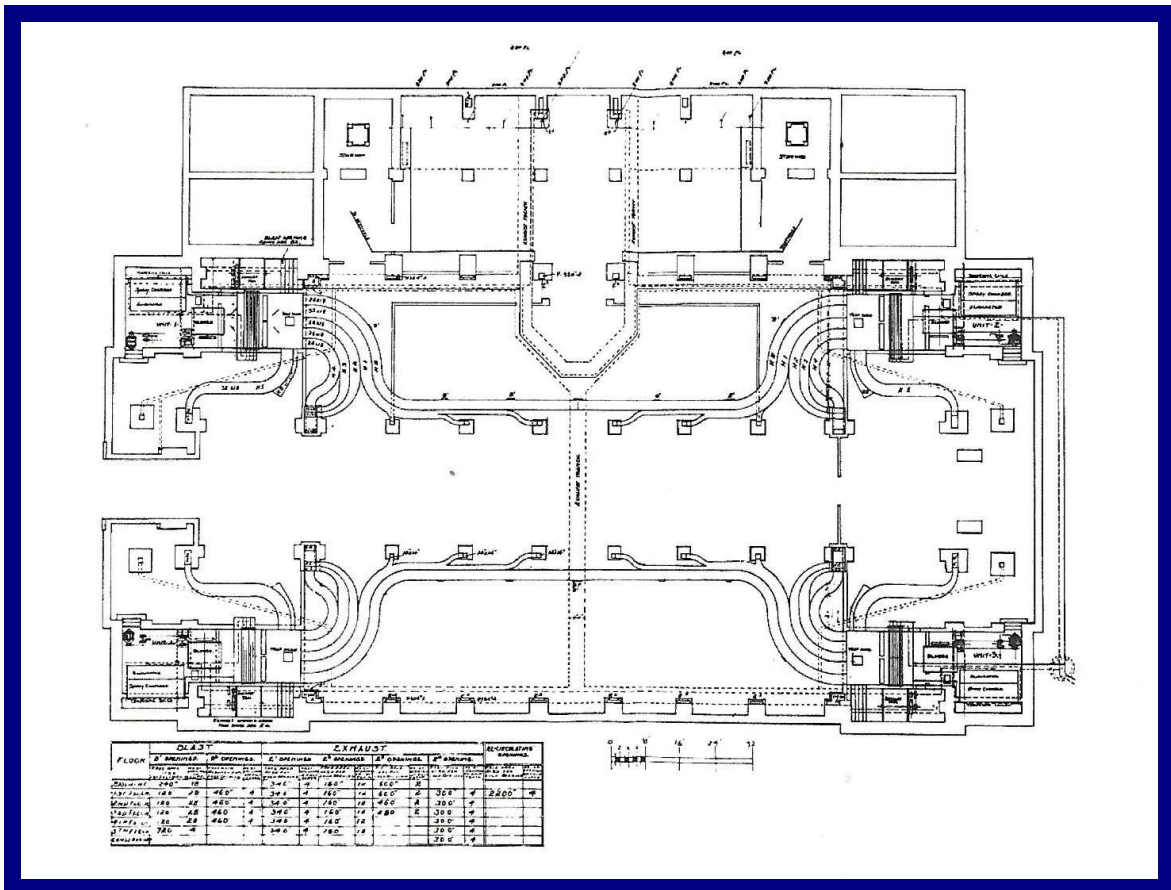
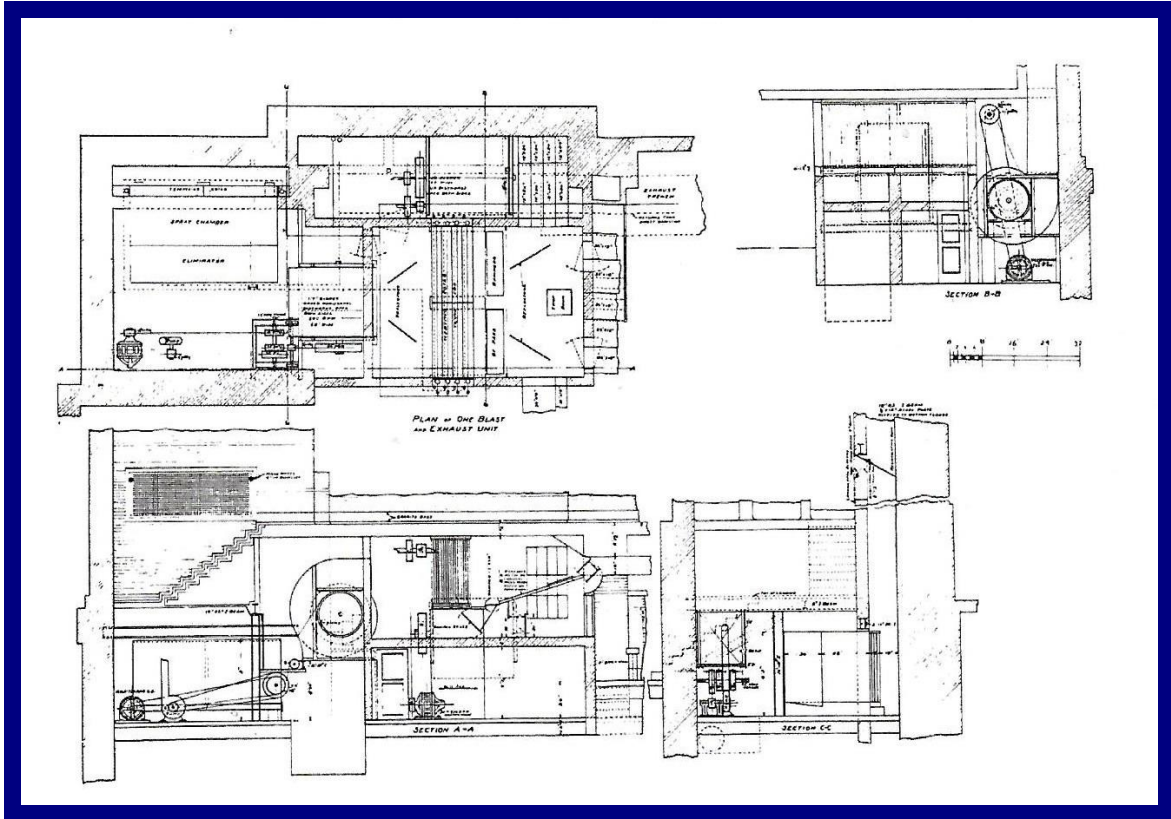
## LARKIN BUILDING BUFFALO



1904. Architect Frank Lloyd Wright.



# LARKIN BUILDING BUFFALO



Refrigeration added by Kroeschell of Chicago around 1909.



# CARRIER AIR COOLING APPARATUS 1913

1,078,608.

W. H. CARRIER.  
AIR COOLING APPARATUS.  
APPLICATION FILED JAN. 19, 1912.

Patented Nov. 18, 1913.  
2 SHEETS-SHEET 1.

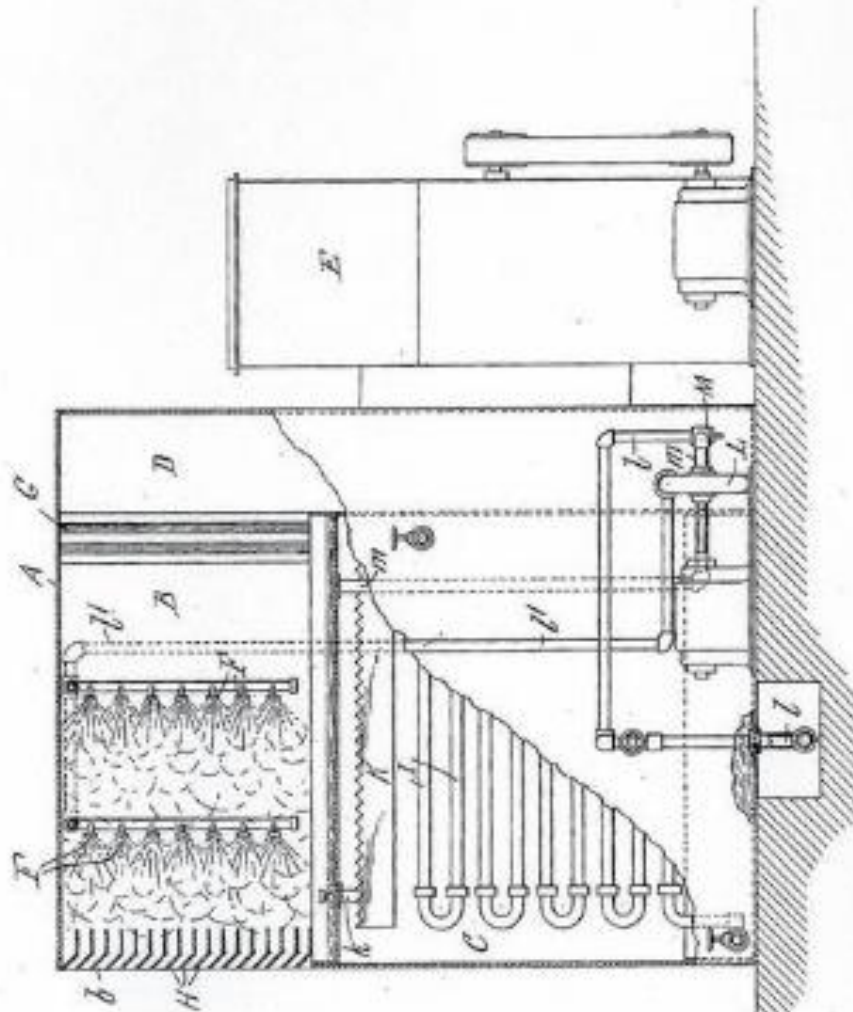
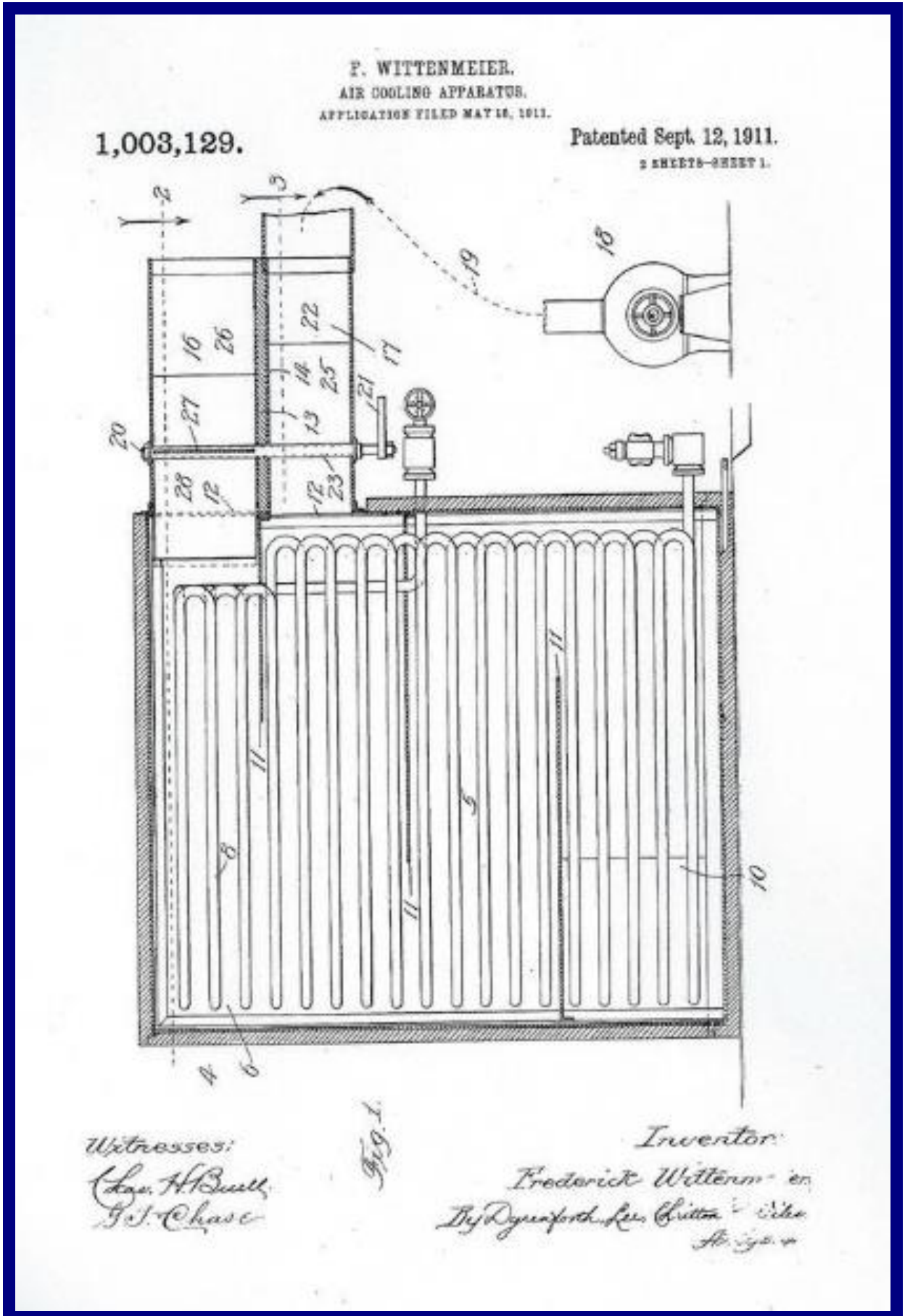


Fig. 1.

Witnesses  
A. F. Dimond.  
A. Bodenbagen

Inventor,  
Willis H. Carrier.  
By Wilhelm, Parker & Hardy  
Attorneys.

# WITTENMEIER COOLING APPARATUS 1911





## RIVIERA THEATRE CHICAGO



Opened 1918, 1943 seats. Air conditioned by Wittenmeier, CO<sub>2</sub> refrigeration.

Wittenmeier's rule of thumb figures for theatre cooling were 2.5 tons of refrigeration for every 1000 cubic feet per minute of supply air in the northern states, increased by 25% for southern areas and appear to be based on 50% outside air. His evaporator design was based on using 1.25-inch iron pipe coils calculated at 35 feet per ton of refrigeration (finned coils were not then in use). Recirculated washer spray water was installed before and after the face of the coils at the rate of 3.5 US gallons per square foot with the air face velocity at 500 feet per minute and a spray water temperature of 58 deg F (to prevent build up of ice). The evaporating temperature of the CO<sub>2</sub> was suggested as 22 degF. The condensing temperature using cooling tower water, often as high as 85 degF, resulted in a gauge pressure of 1240 pounds per square inch necessitating heavy-duty construction of compressor parts and heavy steel pipe and fittings. (Pressure gauges were often scaled in atmospheres to "avoid scaring the operators," for example a pressure of 1240 psig would read 83 atmospheres).

The air conditioned Riviera opened in 1919 with a CO<sub>2</sub> refrigerating plant by the Wittenmeier Machine Company. It has been recorded that the Wittenmeier system "provided for humidification but lacked an effective method for adjusting the humidity level. Air left the air conditioner nearly 100 percent saturated, and the body heat of the audience raised it by about 8 degrees. In the Riviera, that produced a relative humidity of approximately 70 percent. Wittenmeier routinely furnished a temperature of 76-78 (degF) and a relative humidity of 75 percent. I assure you that you will feel comfortable in such a house, he maintained." Later, other air conditioning engineers and researchers would not agree with Wittenmeier's statement and the audience complained about cold draughts due to the discharge of cold supply air through floor-mounted mushroom outlets by their feet. (In the past, these outlets had been satisfactory when supplying warm air for heating purposes).



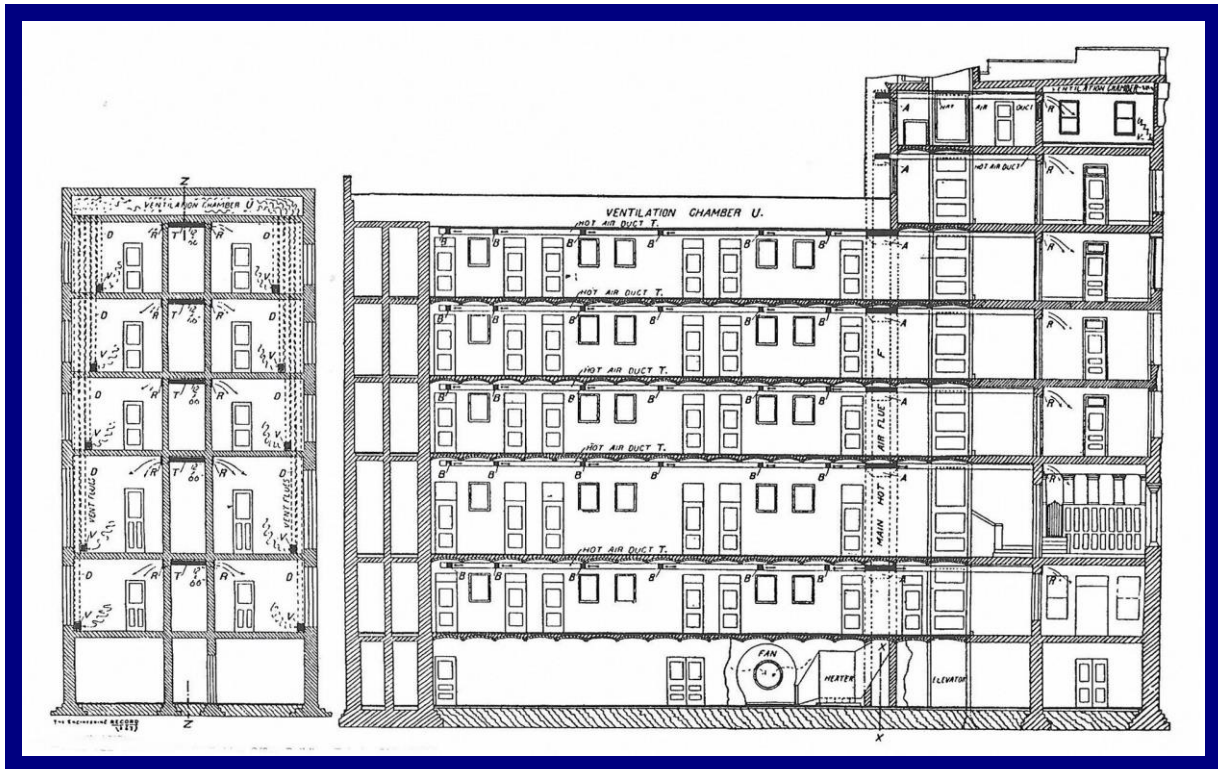
# ORIENTAL THEATRE CHICAGO



Opened 1926, 3217 seats. Air conditioned by Wittenmeier, CO2 refrigeration.



# WALBRIDGE OFFICE TOLEDO OHIO



1893.

## REFERENCES AND FURTHER READING

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- 1992 Mechanical & Electrical Systems for Historic Buildings, Gersil Kay, McGraw-Hill, New York.
- 2000 The Chicago Movie Palaces of Balaban and Katz, David Balaban, Images of America, Arcadia Publishing, Charleston, South Carolina.
- 2006 Frank Lloyd Wright's Larkin Building, Jack Quinan, University of Chicago Press.
- 2008 Theatres in Los Angeles, A.R. Hall and M. Wanamaker, Images of America, Arcadia Publishing, Charleston, South Carolina.
- 2011 Historic Movie Theatres in Illinois 1883-1960, Konrad Schiecke, McFarland, Jefferson, North Carolina.
- 2012 Weathermakers to the World, Carrier Corporation, USA.
- 2014 Rapp & Rapp: Architects, Charles Ward Rapp, Viburnham Press.
- 2021 20th Century Air Conditioning, David Arnold, ASHRAE.

**HVAC System and Equipment Plans, Sections and Drawings are from *The Engineering Record* magazine of New York. Other information from the US Patent Office, Heritage Group Archive and website.**