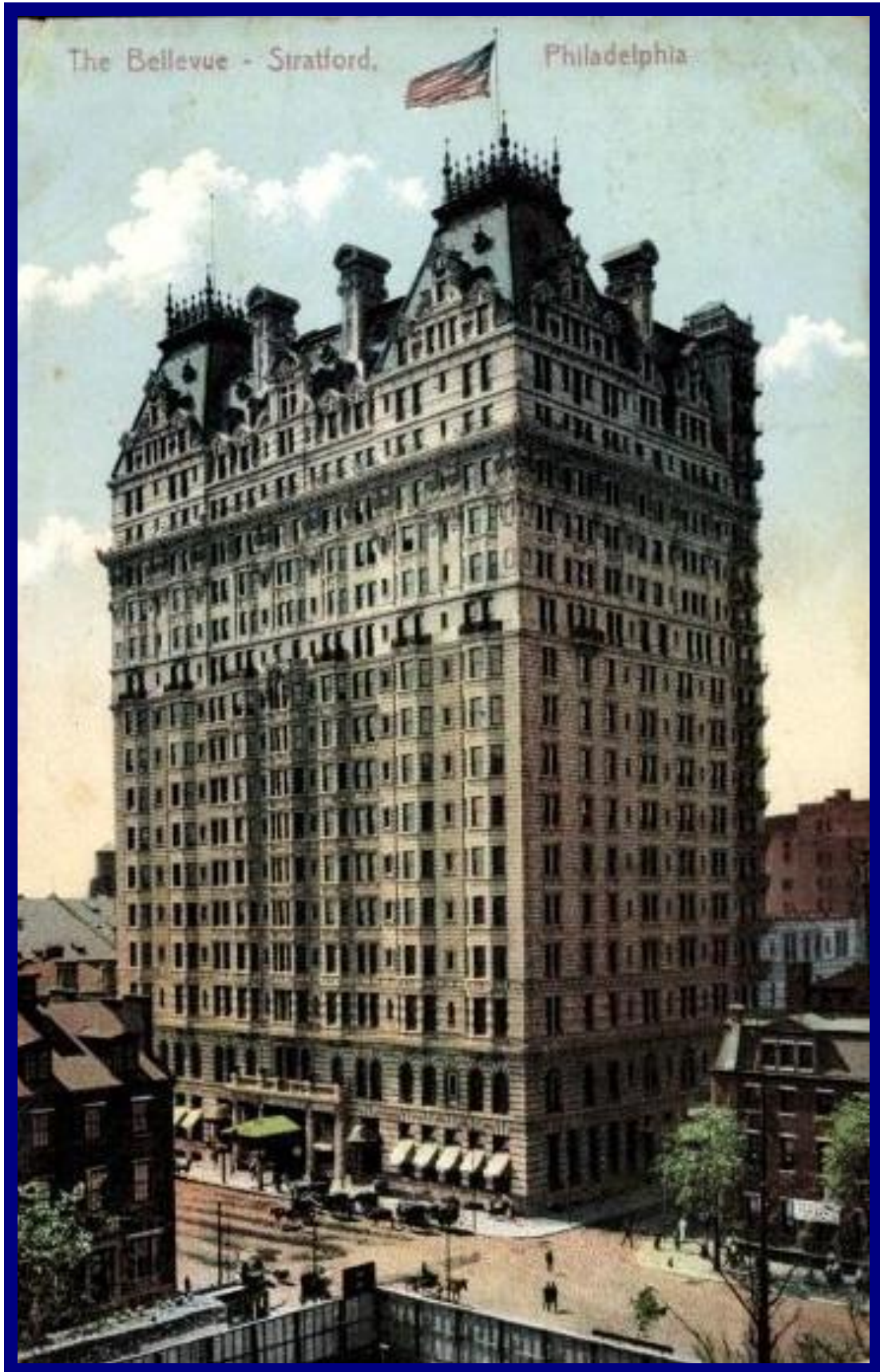


HVAC IN HISTORIC BUILDINGS OF USA PART TWO BOSTON, PHILADELPHIA, WASHINGTON, CHICAGO

BRIAN ROBERTS

BELLEVUE STRATFORD PHILADELPHIA



MAJESTIC THEATRE BOSTON



The Heritage Group has recorded details of the history and engineering services in a variety of early buildings in four United States cities (1859-1933): Boston, Philadelphia, Washington and Chicago.

CONTENTS: FEATURED BUILDINGS

COVER: US Capitol, Washington: *front*, PSFS Skyscraper, Philadelphia: *inside front*,
Wrigley & Tribune Towers, Chicago: *inside back*, Chicago Theatre, Chicago: *back*.

BOSTON: Majestic: 3,8,9, Symphony Hall: 4-7, Opera: 10-12, Theatre: 12,13

PHILADELPHIA: Bellvue Hotel: 2,26-28, US Mint: 14-17,

Dept Store: 18,19, Wanamakers Store: 20,25

WASHINGTON: US Capitol: 1,30-33

CHICAGO: National Bank: 34,35, Armour: 36, Congress Hotel: 37, Central Park Theatre: 38,

Tivoli: 39,40: McVickers: 41, Riviera: 42, Roosevelt: 44

OTHER: Unknown Hospital: 29, Carrier Patent: 41, References & Further Reading: 44

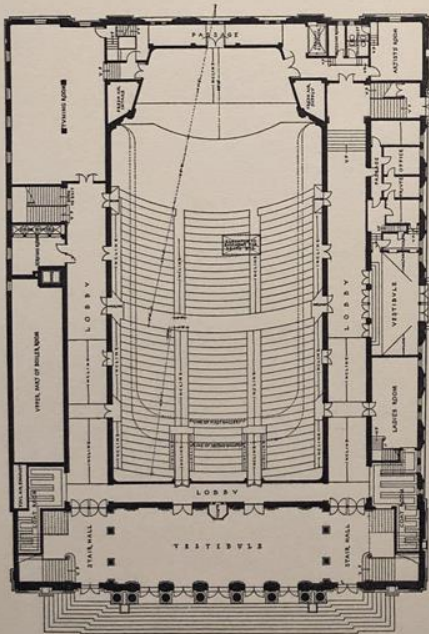
SYMPHONY HALL BOSTON

MCKIM, MEAD & WHITE

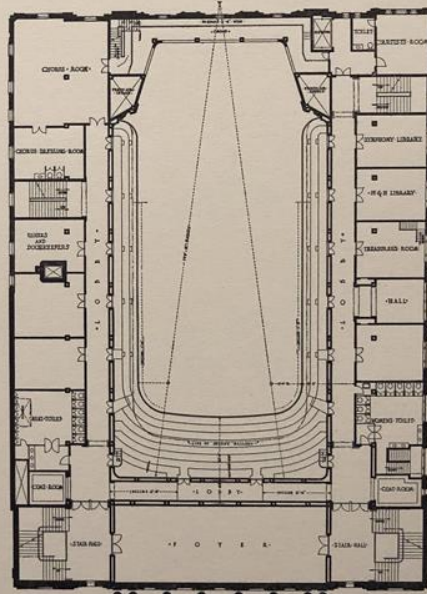
PLATE 142



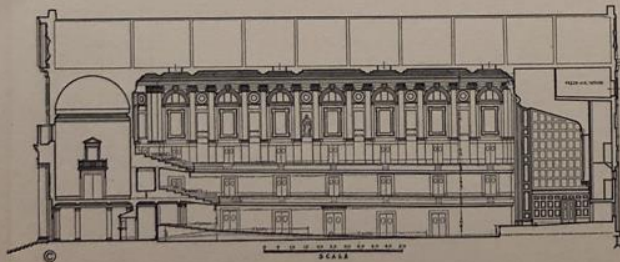
SCALE 0 5 10 20 30 FEET
FRONT ELEVATION



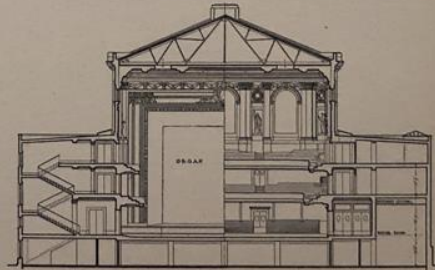
GROUND FLOOR PLAN



SECOND FLOOR PLAN



LONGITUDINAL SECTION

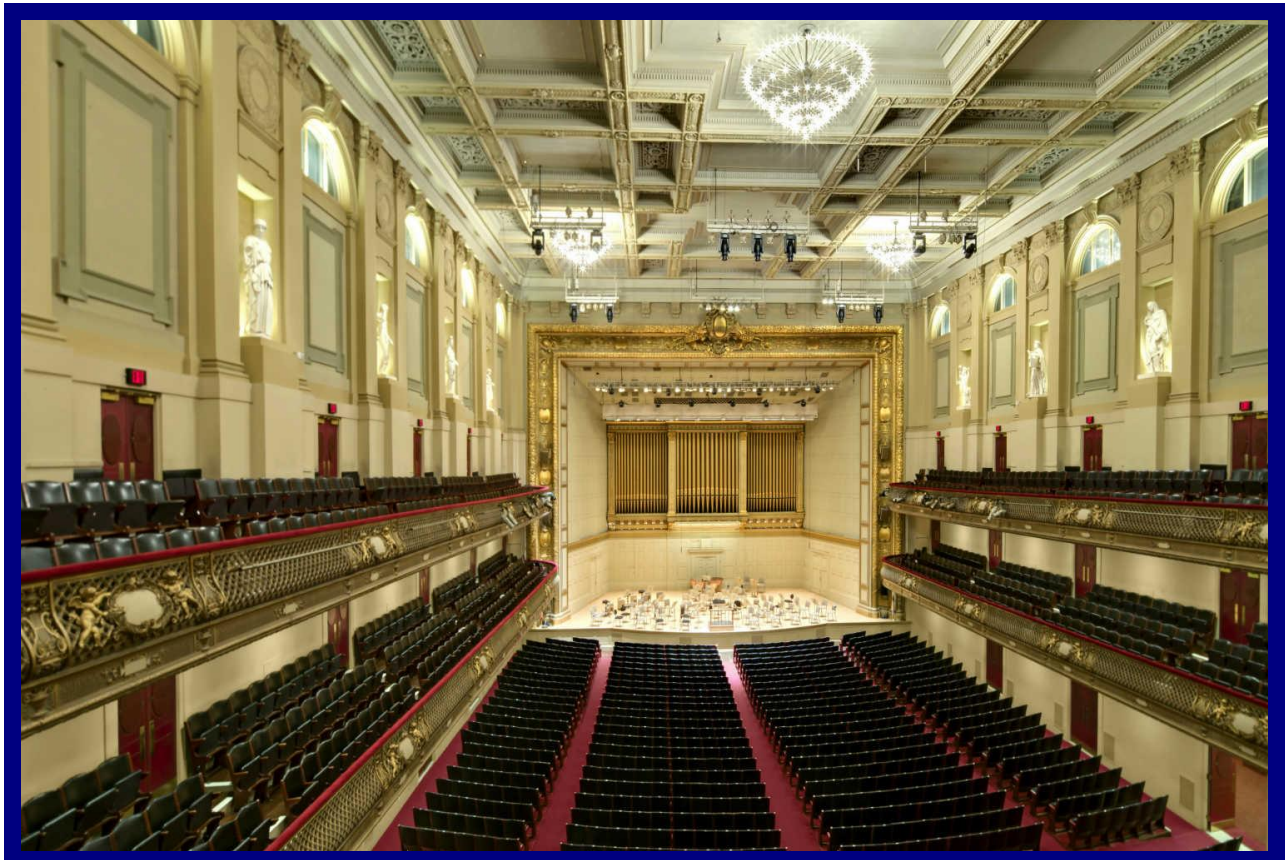


TRANSVERSE SECTIONS

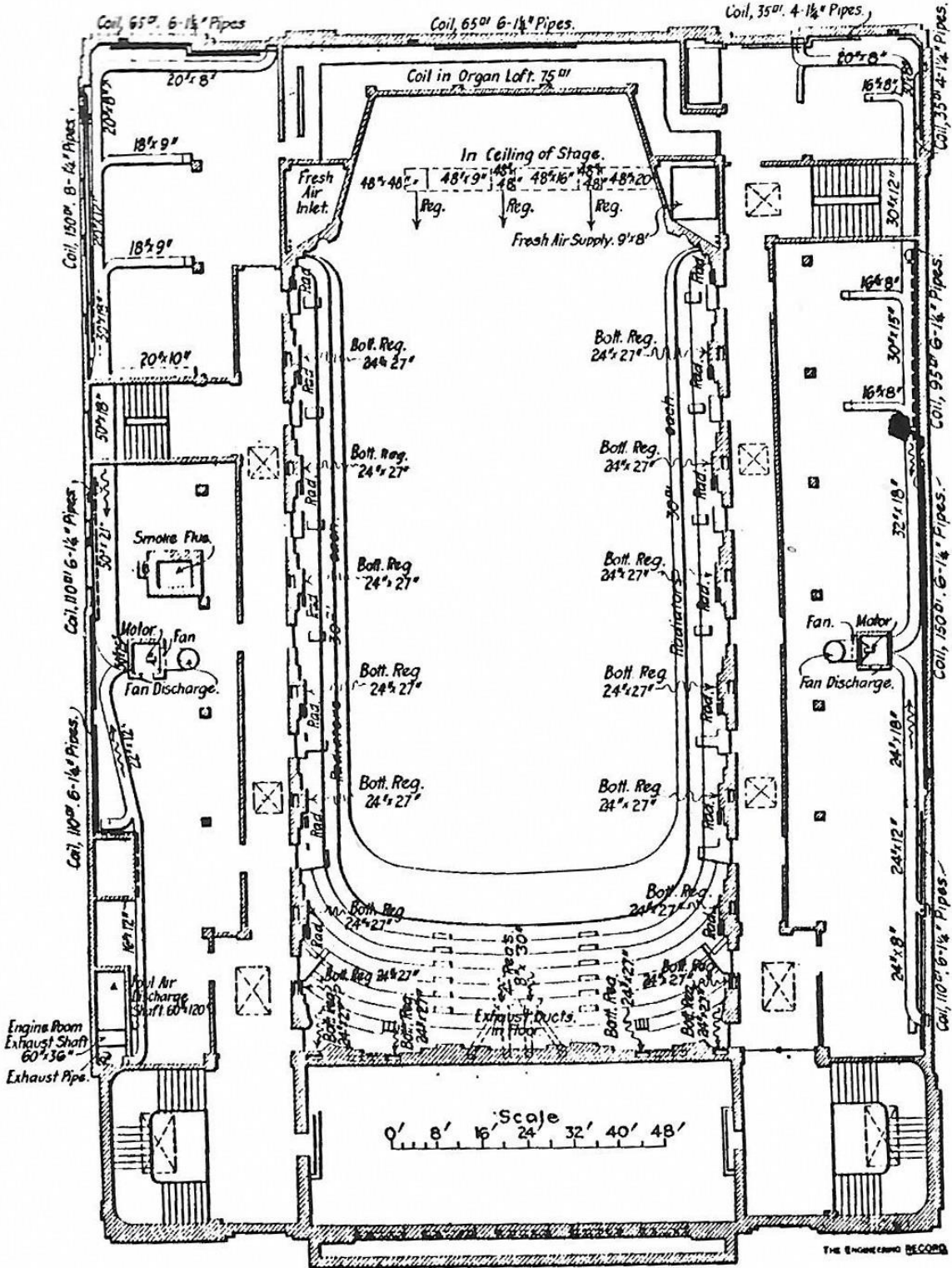
BOSTON SYMPHONY MUSIC HALL, BOSTON MASS.

1900

SYMPHONY HALL BOSTON

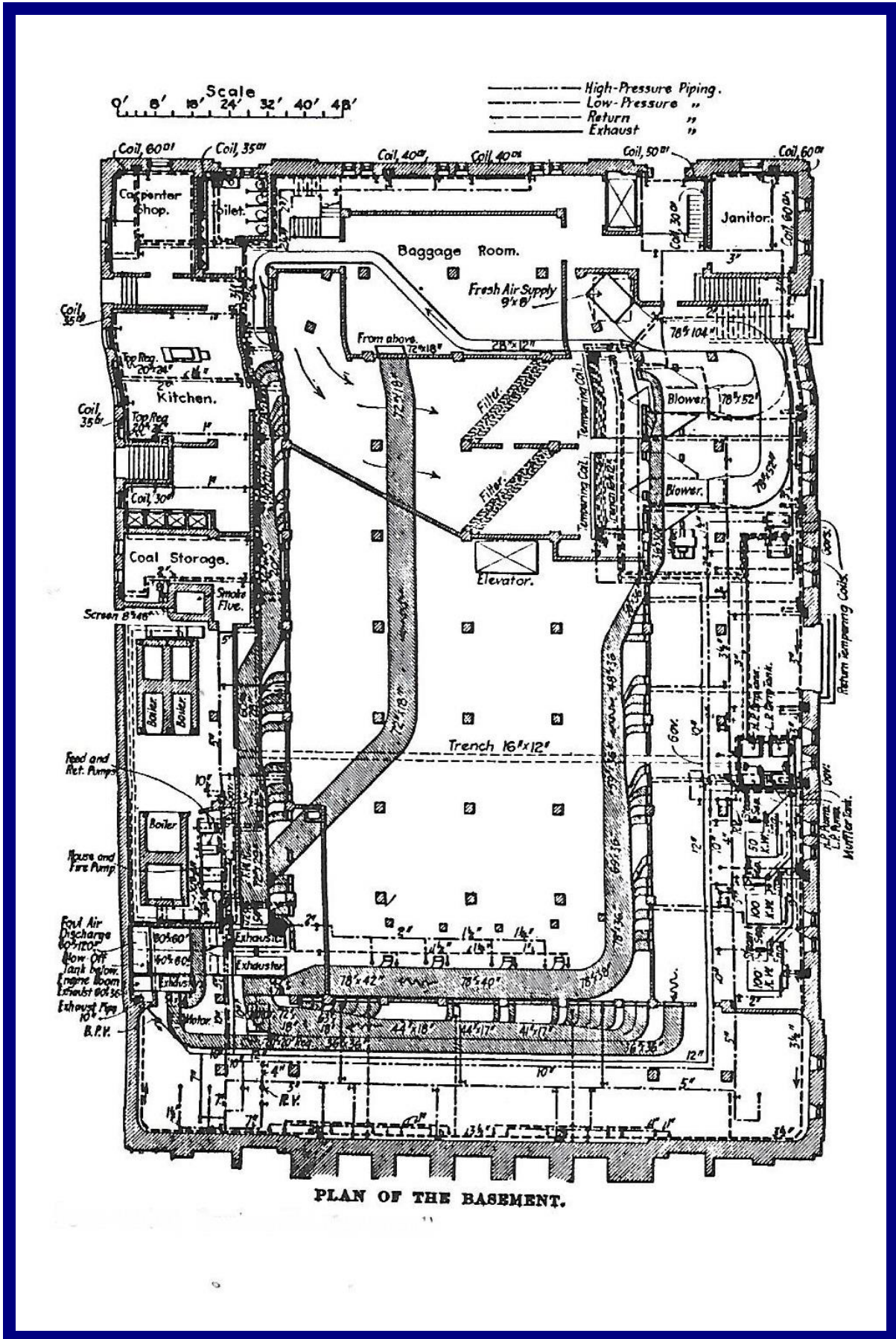


SYMPHONY HALL BOSTON



PLAN OF THE SECOND GALLERY.

SYMPHONY HALL BOSTON 1901

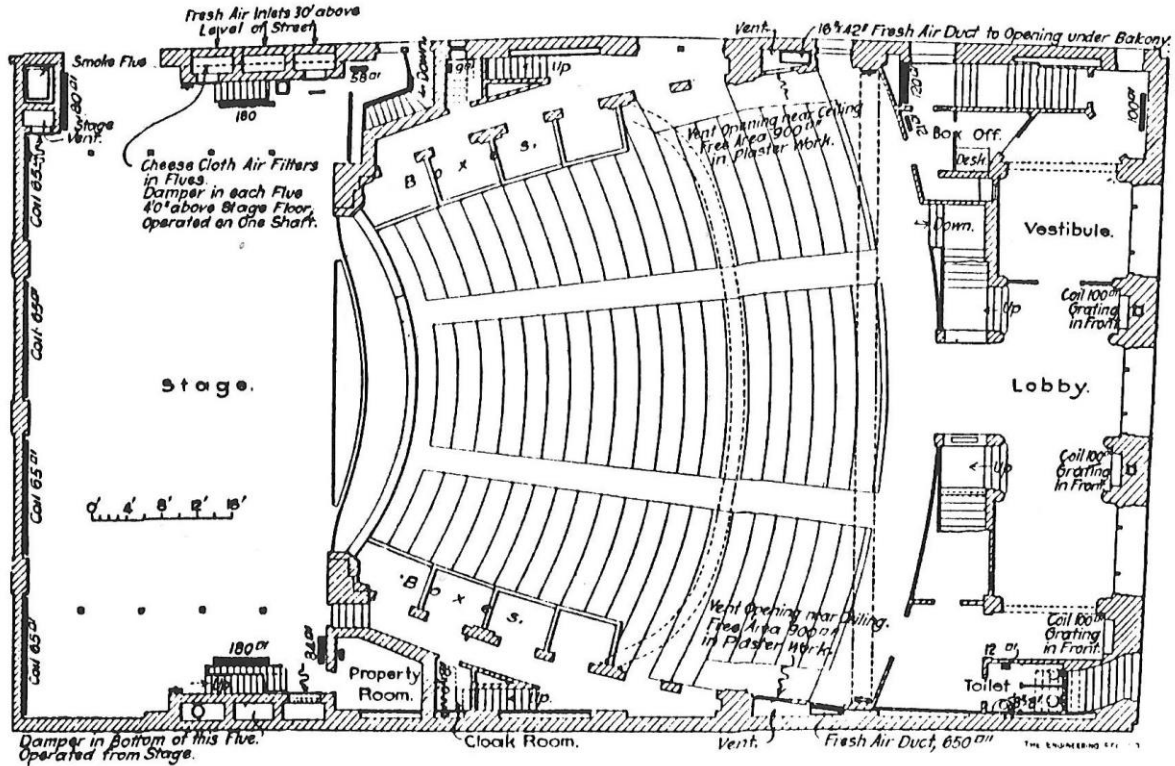


PLAN OF THE BASEMENT.

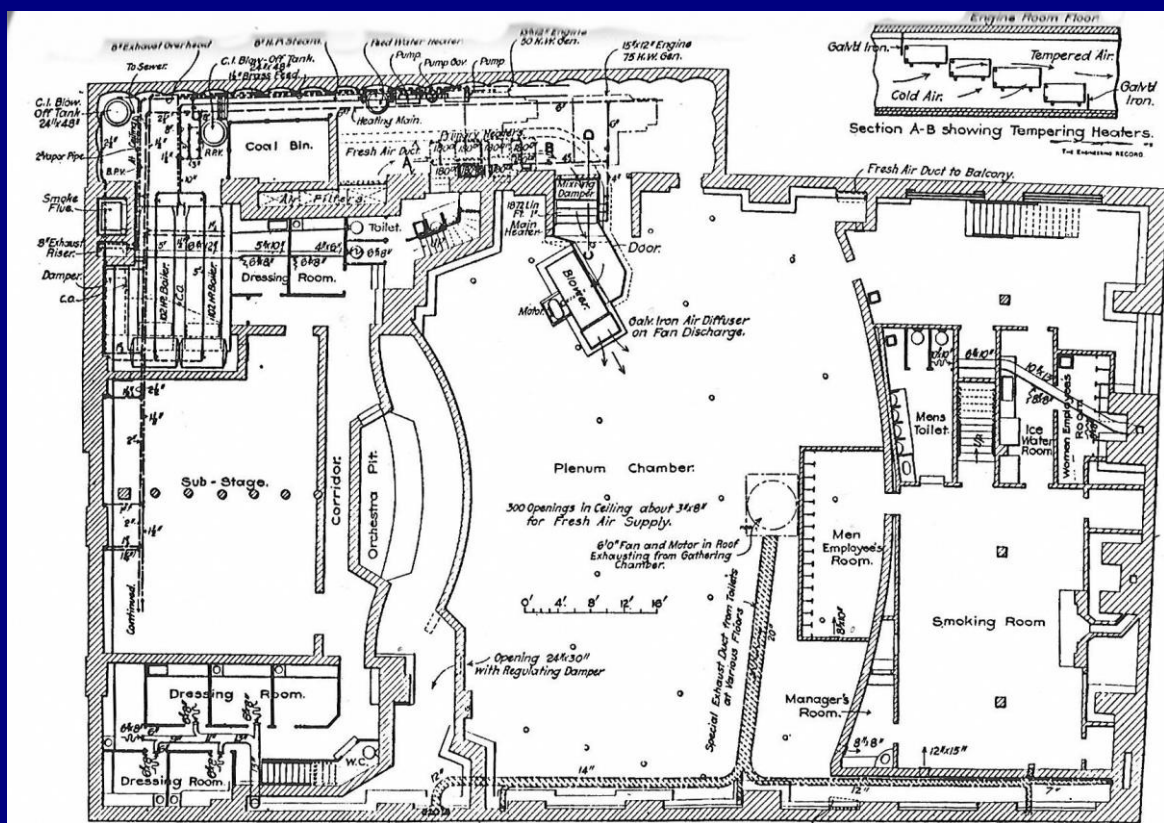
MAJESTIC THEATRE BOSTON



MAJESTIC THEATRE BOSTON

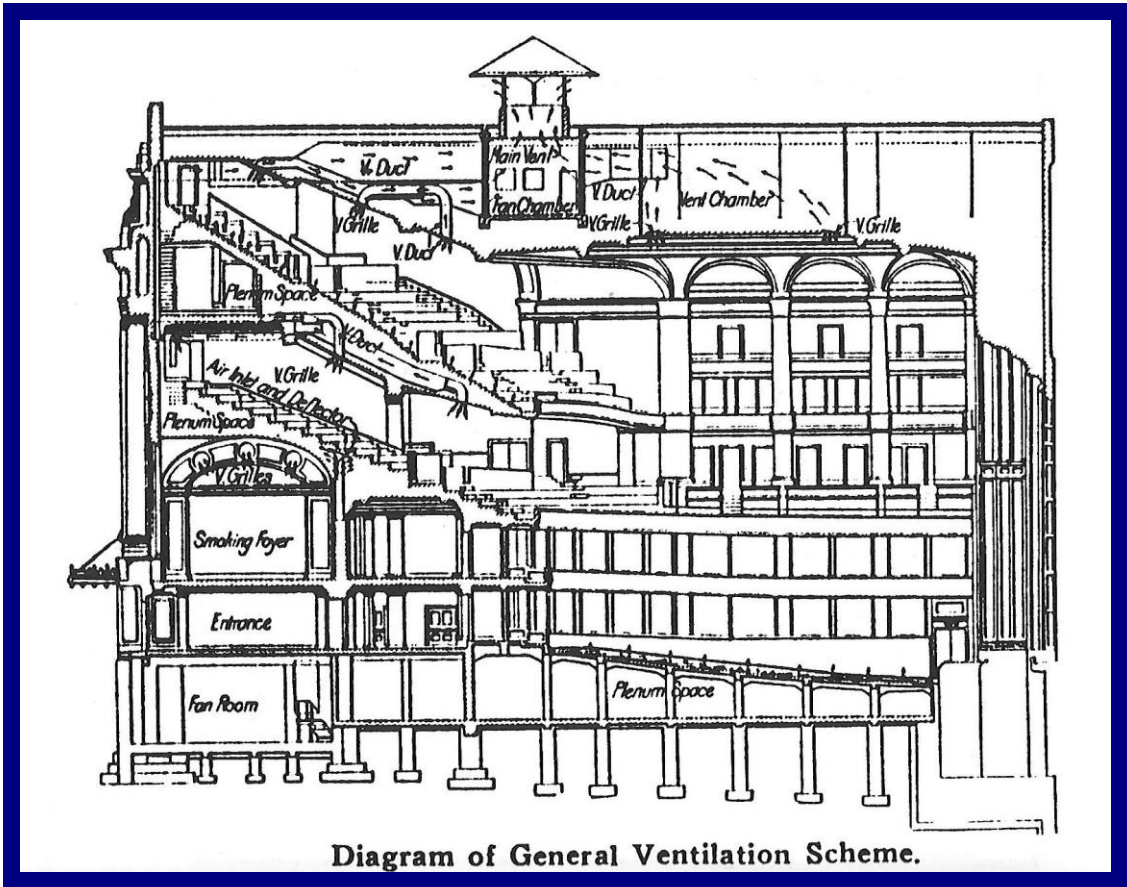


Main Floor Plan, Showing Arrangement of Fresh Air and Vent Flues.



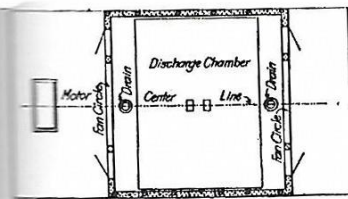
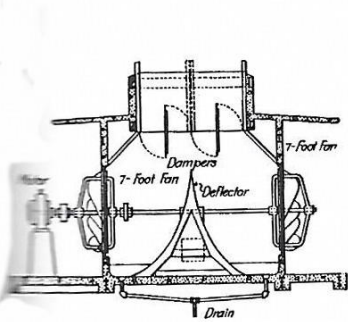
Basement Plan of the New Majestic Theatre at Boston, Mass., Showing Details of Mechanical Plant, Blower Apparatus, Etc.

BOSTON OPERA HOUSE

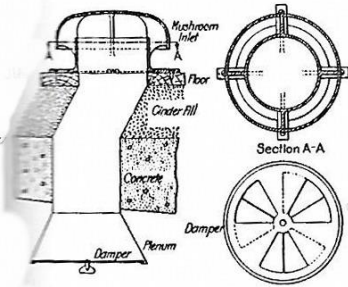


Ventilation system (top) 1911.

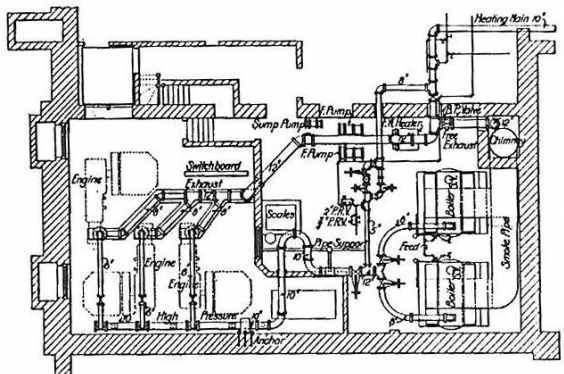
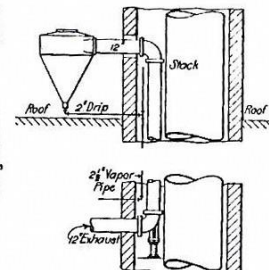
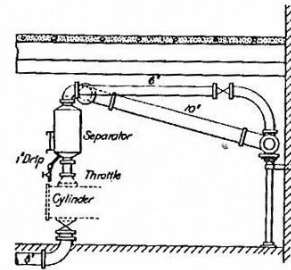
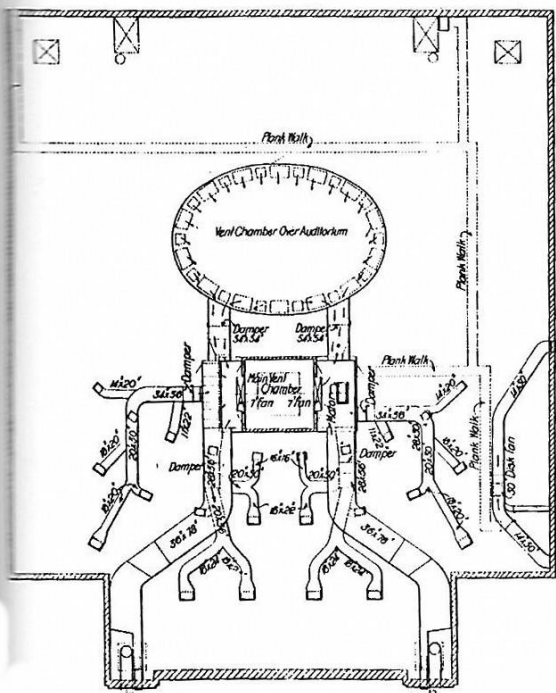
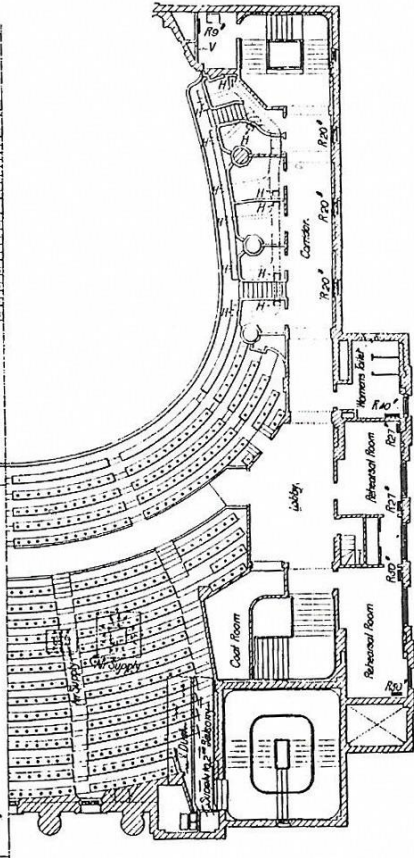
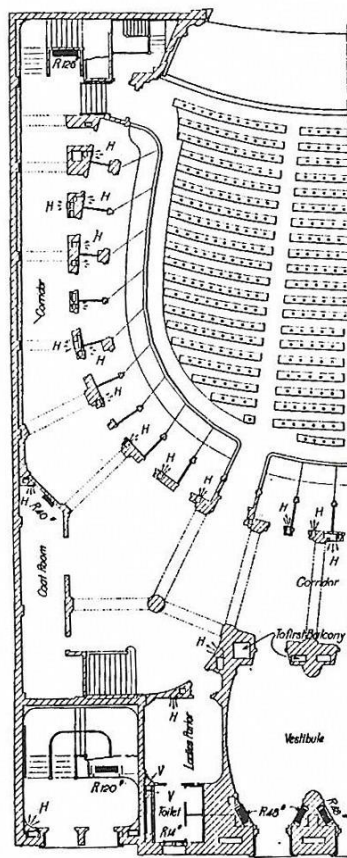
BOSTON OPERA HOUSE



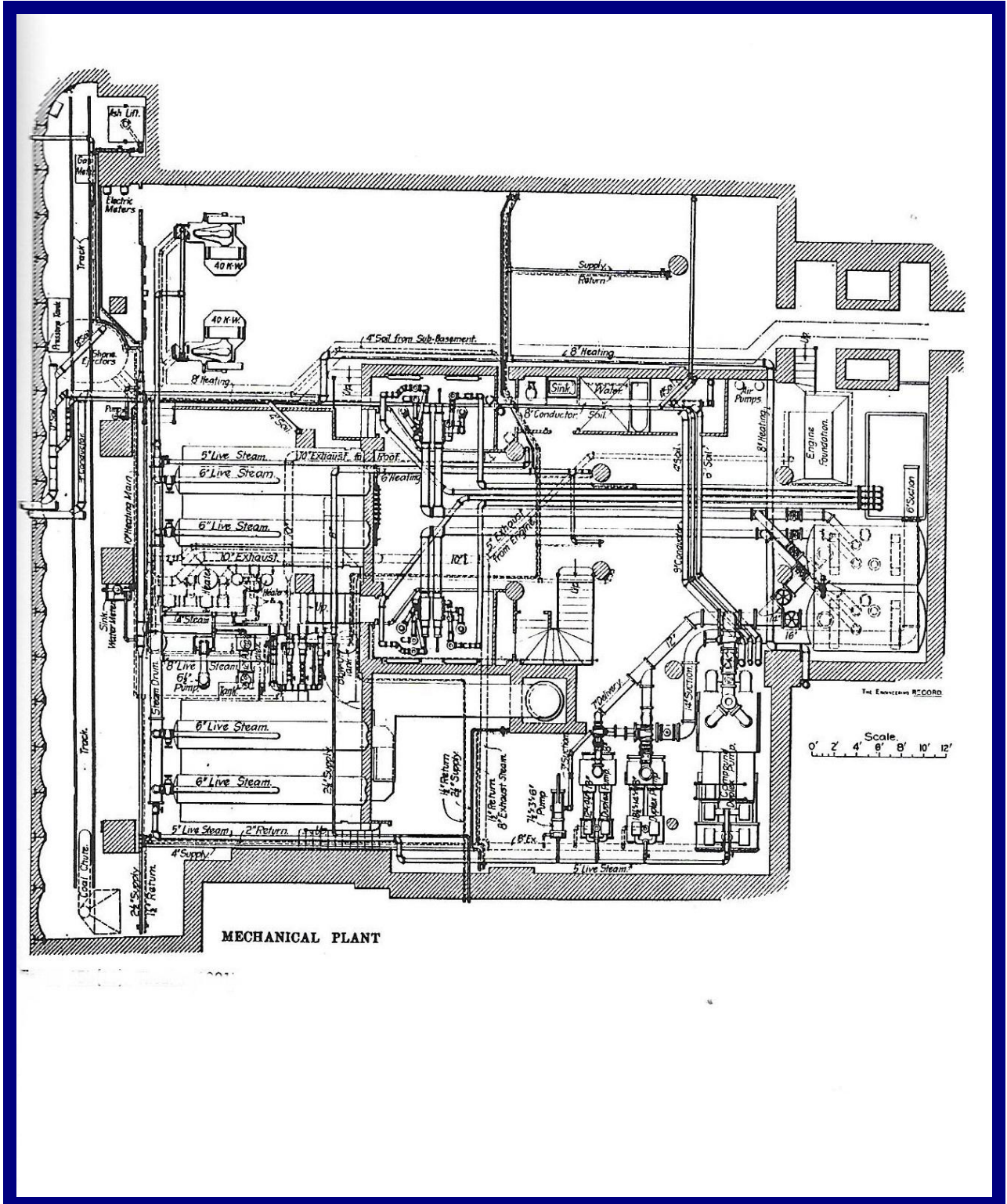
Attic Fan Chamber.



Mushroom Inlet.

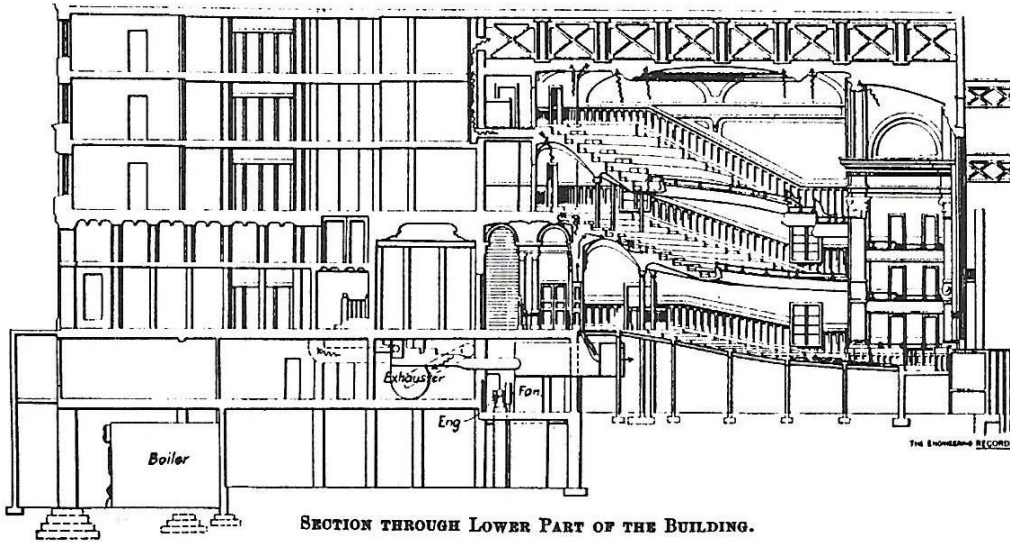


BOSTON THEATRE

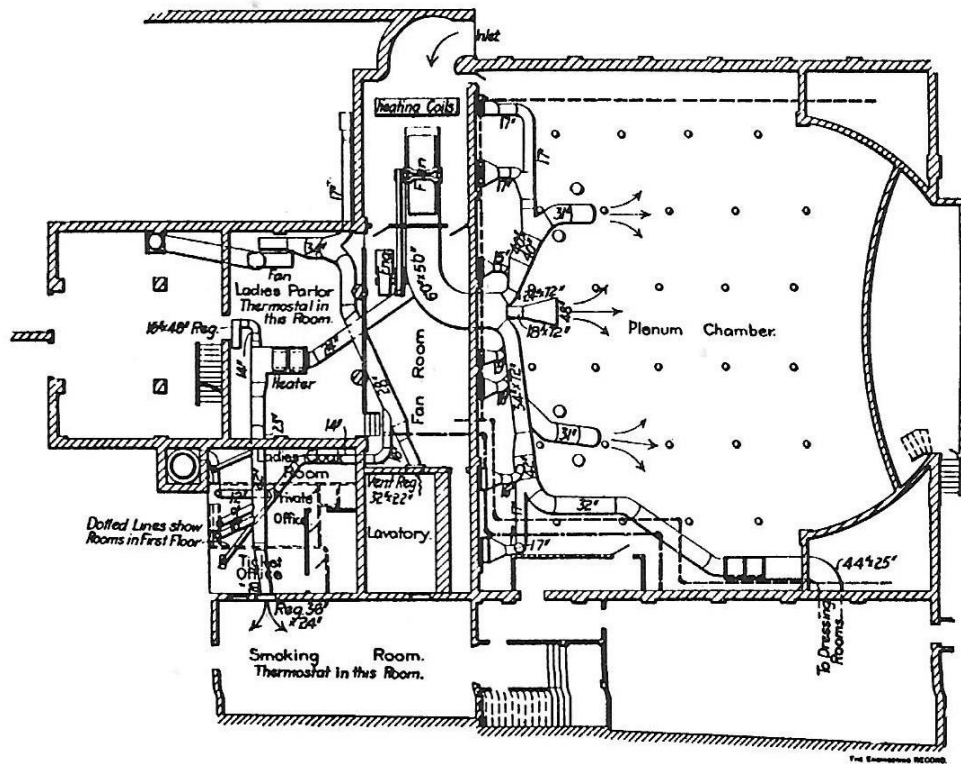


Steam systems and electrical plant 1901.

BOSTON THEATRE

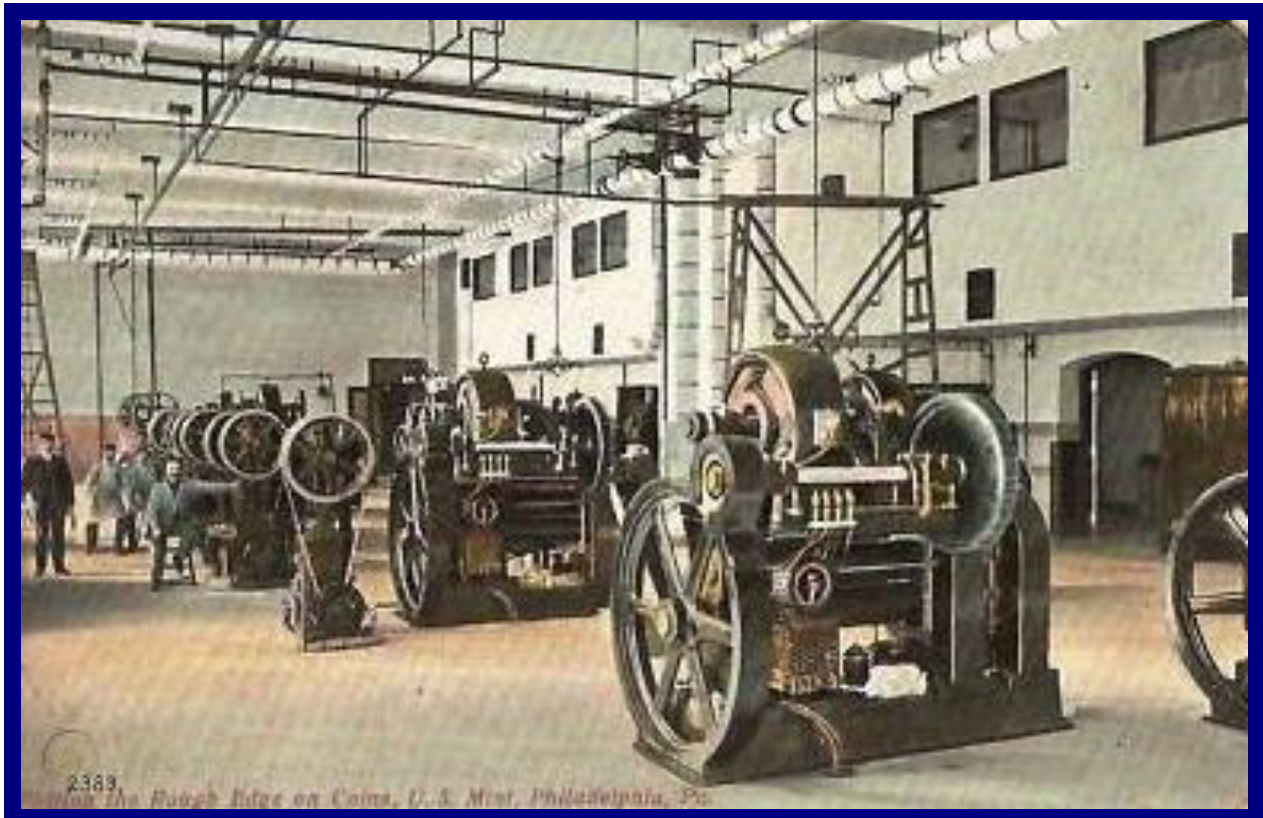


SECTION THROUGH LOWER PART OF THE BUILDING.

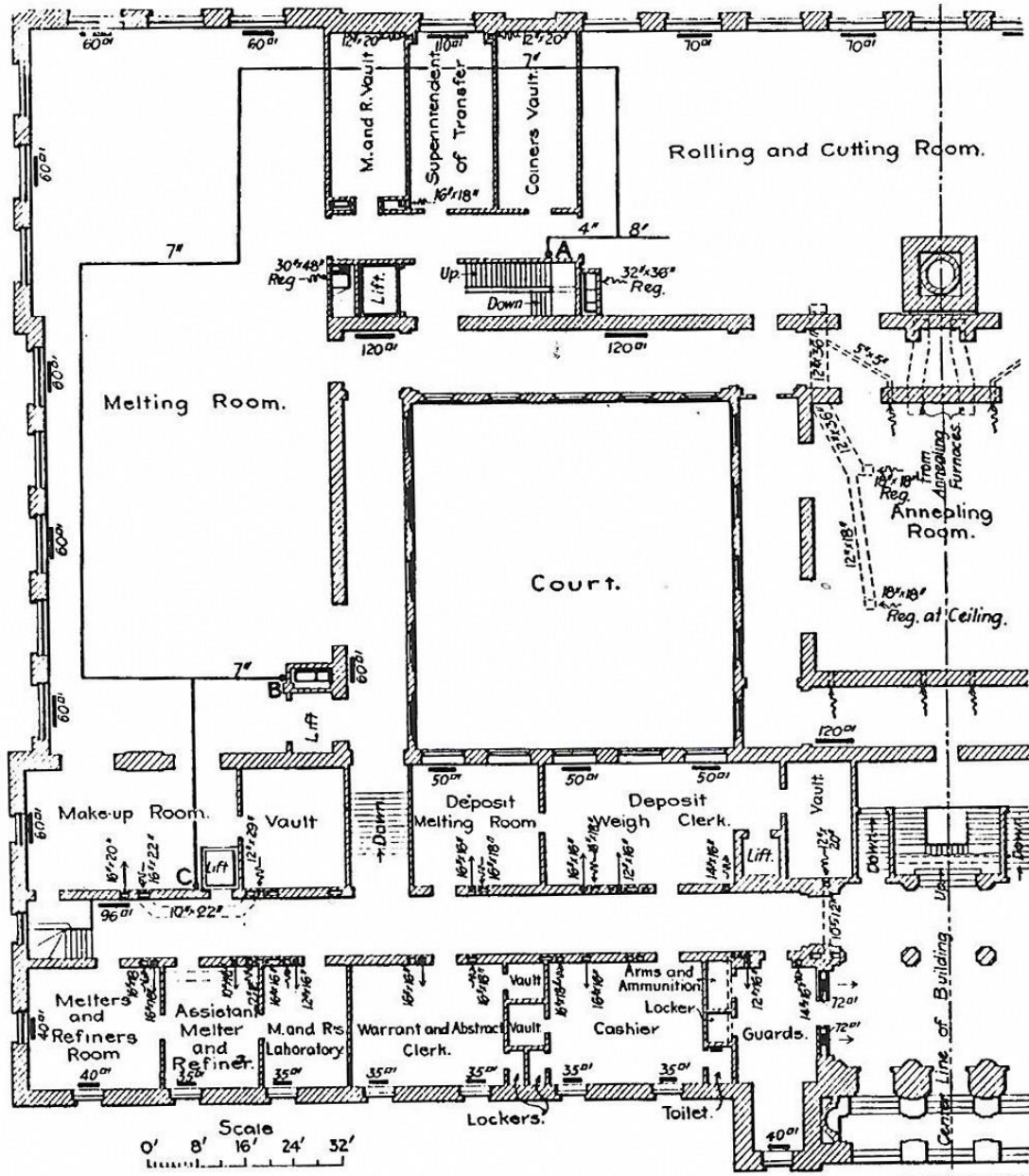


PLAN OF THE BASEMENT.

PHILADELPHIA U.S. MINT

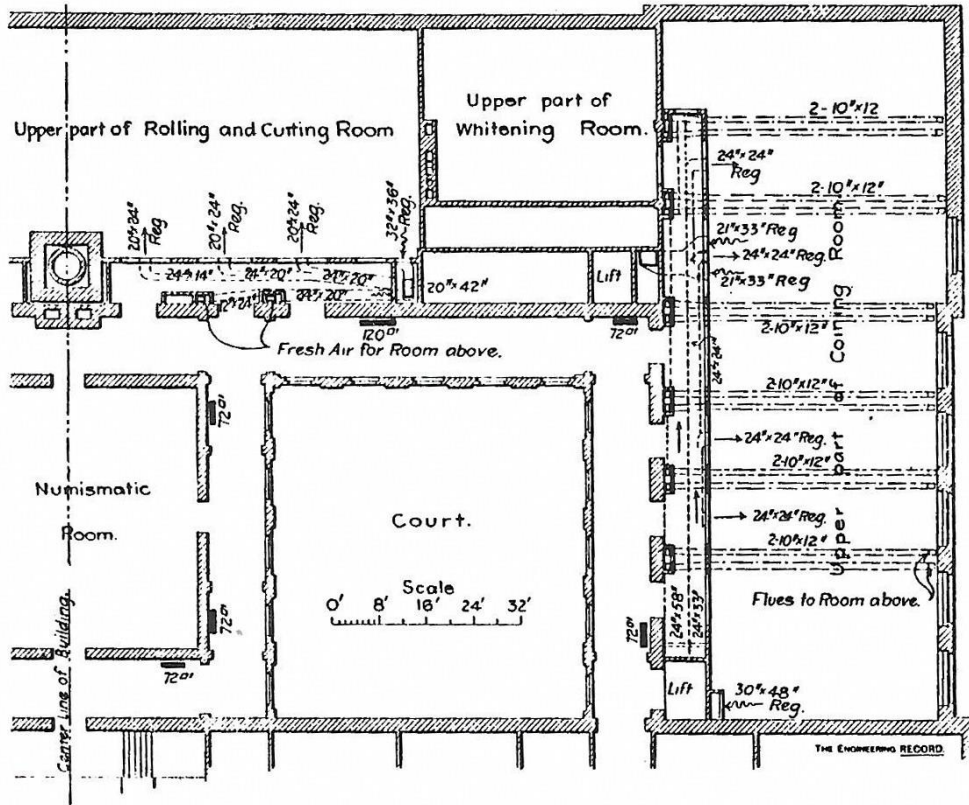


PHILADELPHIA U.S. MINT 1902

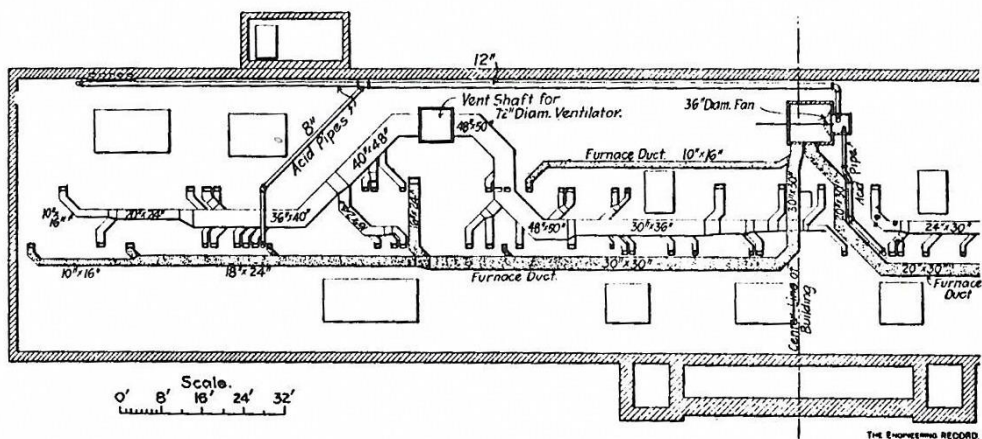


HALF PLAN OF FIRST FLOOR, SHOWING HEATING MAIN.

PHILADELPHIA U.S. MINT

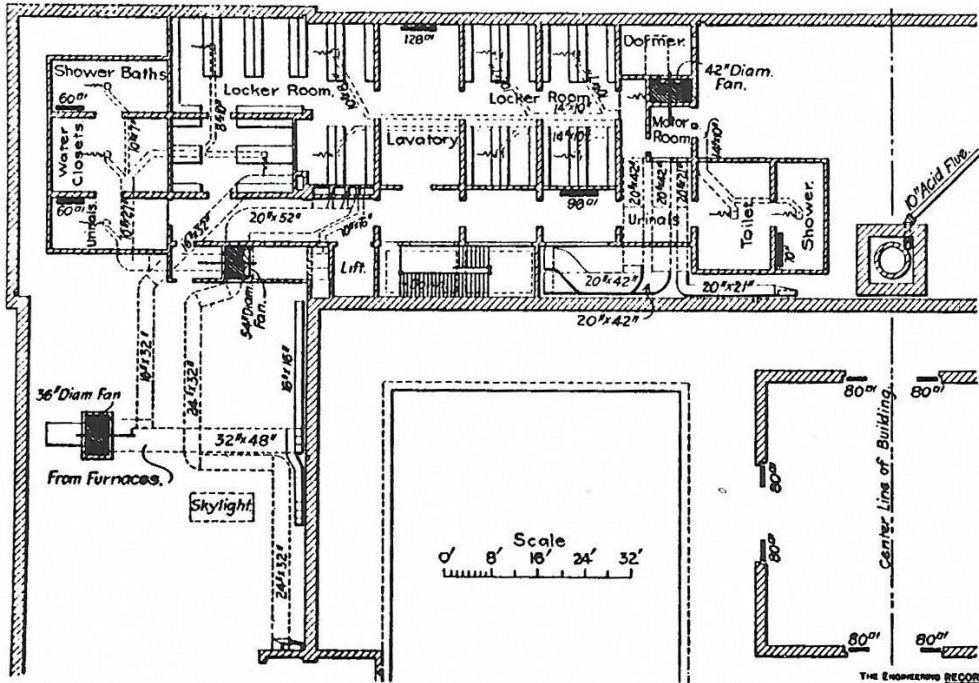


PART PLAN OF THE MEZZANINE STORY.

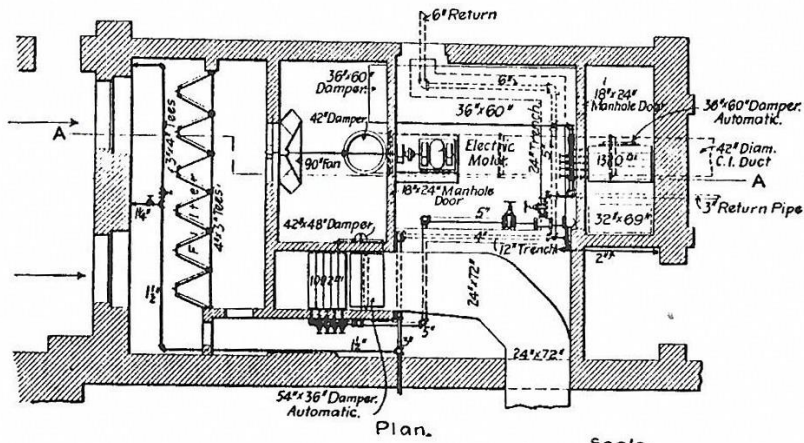


HALF PLAN OF THE FRONT ATTIC STORY.

PHILADELPHIA U.S. MINT

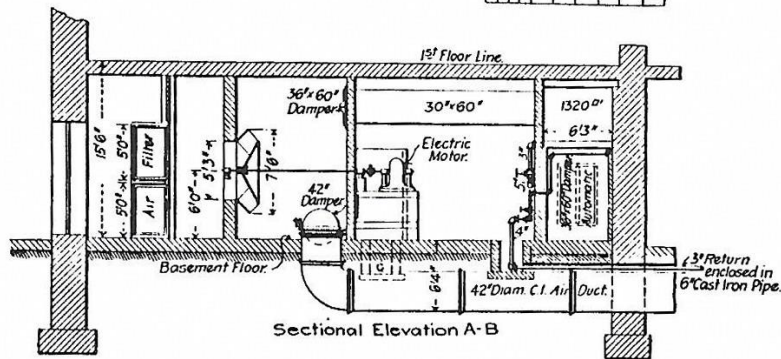


HALF PLAN OF THE REAR ATTIC STORY.



Plan.

Scale. 0' 4' 8' 12' 16'

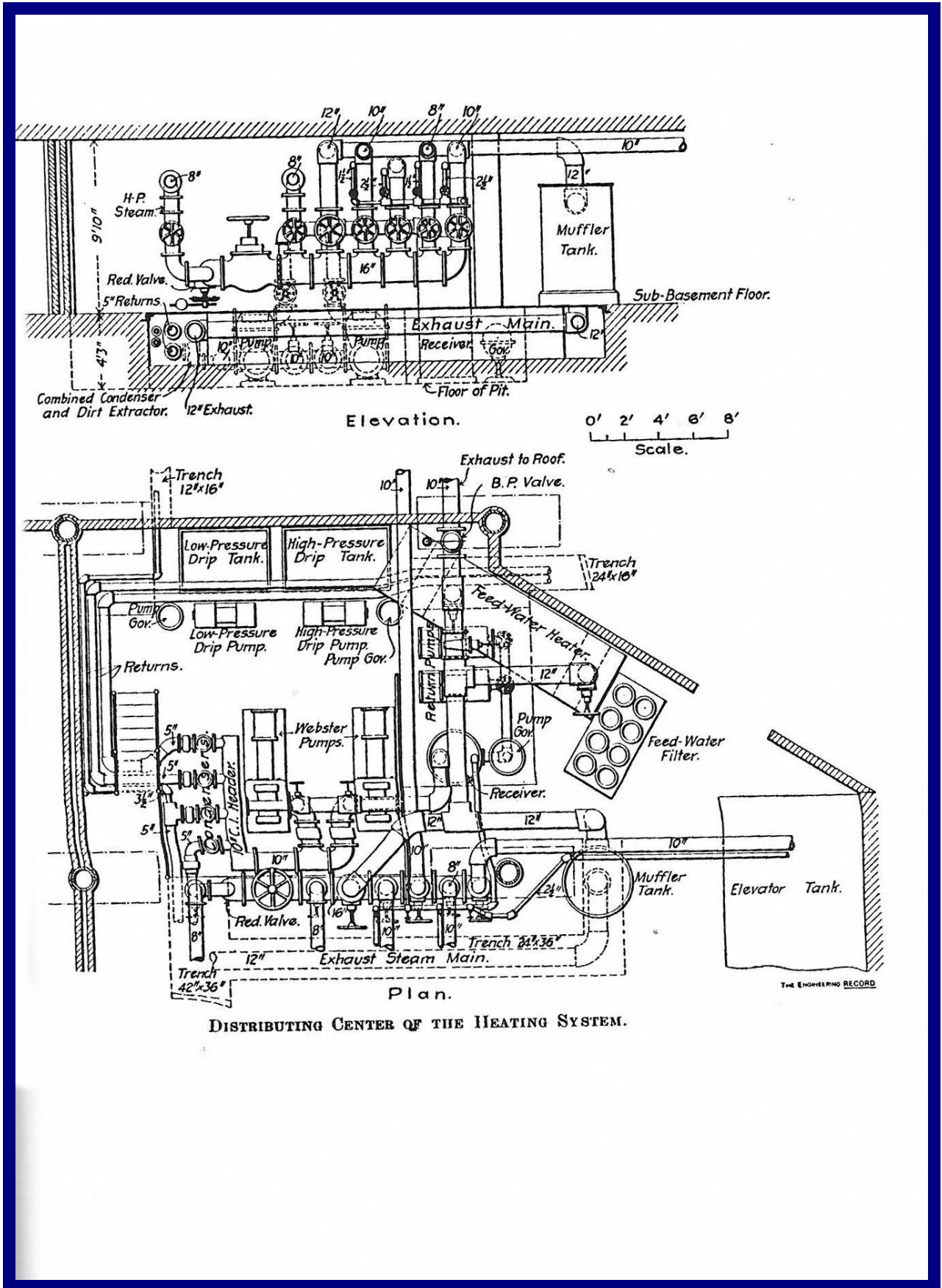


Sectional Elevation A-B

THE ENGINEERING RECORD

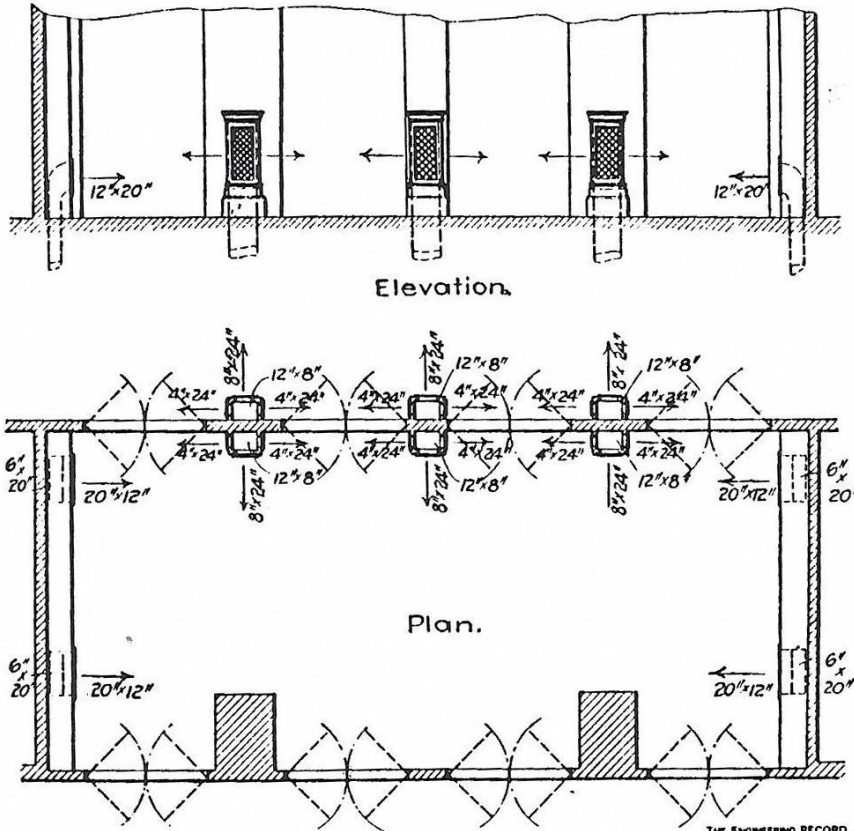
ONE OF THE FRESH AIR ROOMS.

PHILADELPHIA DEPARTMENT STORE

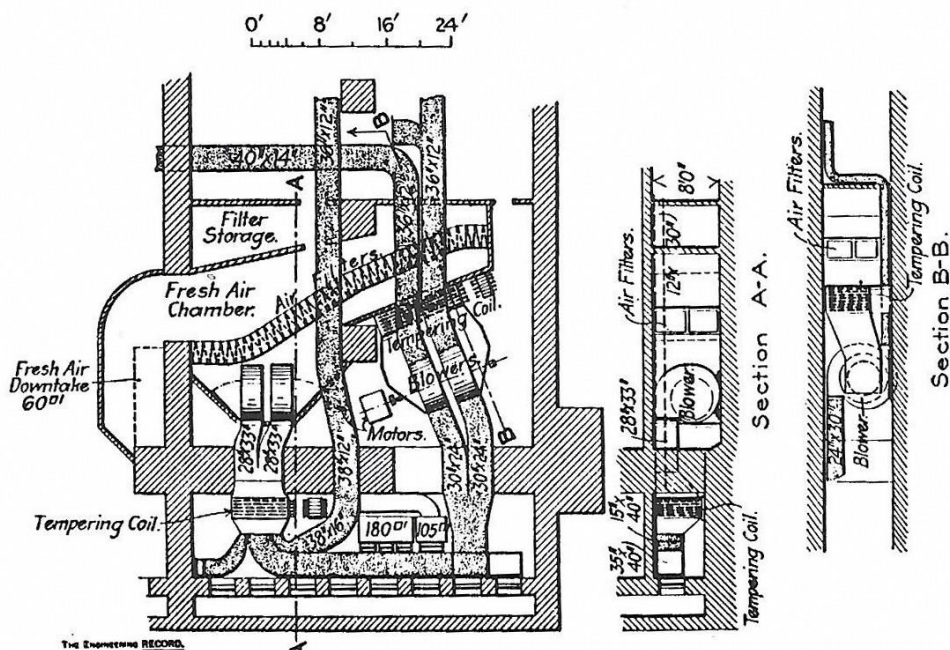


DISTRIBUTING CENTER OF THE HEATING SYSTEM.

PHILADELPHIA DEPARTMENT STORE 1902

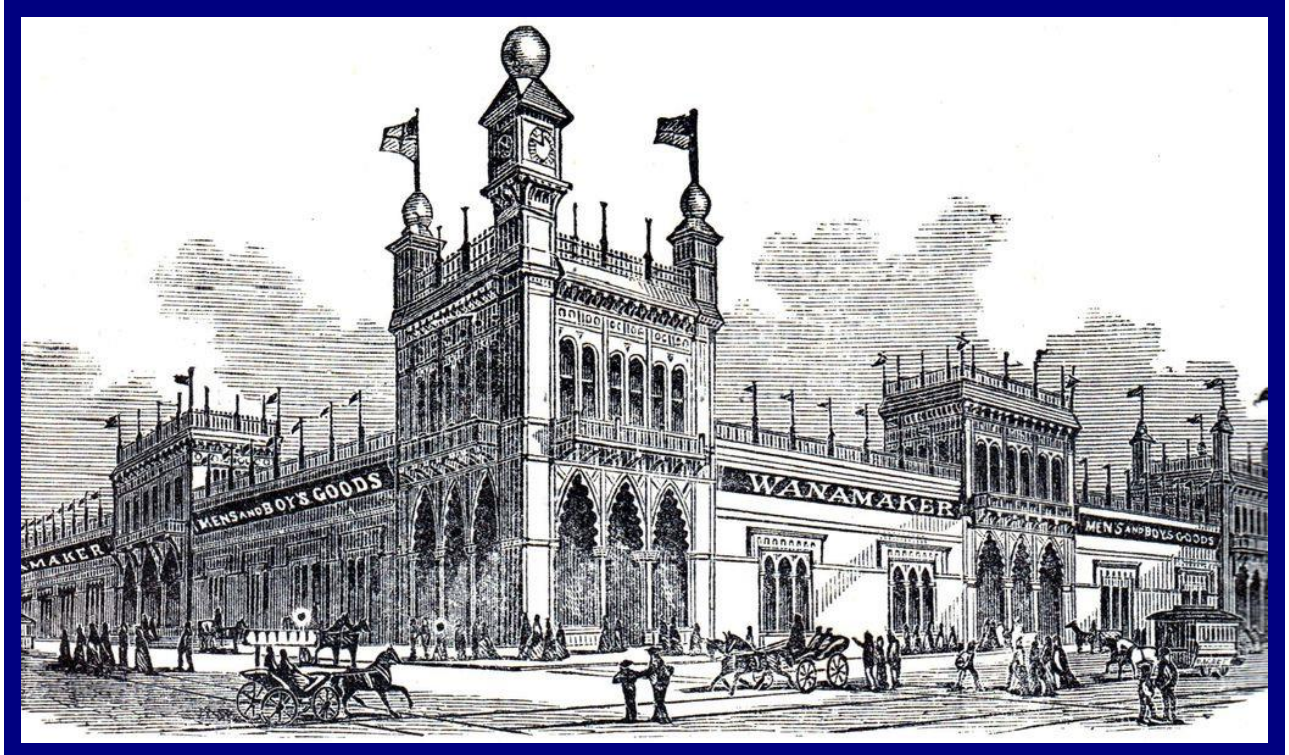


ARRANGEMENT OF REGISTERS IN A TYPICAL ENTRANCE.



DETAIL OF THE 5 AND 5½-FOOT BLOWERS.

PHILADELPHIA WANAMAKER STORE



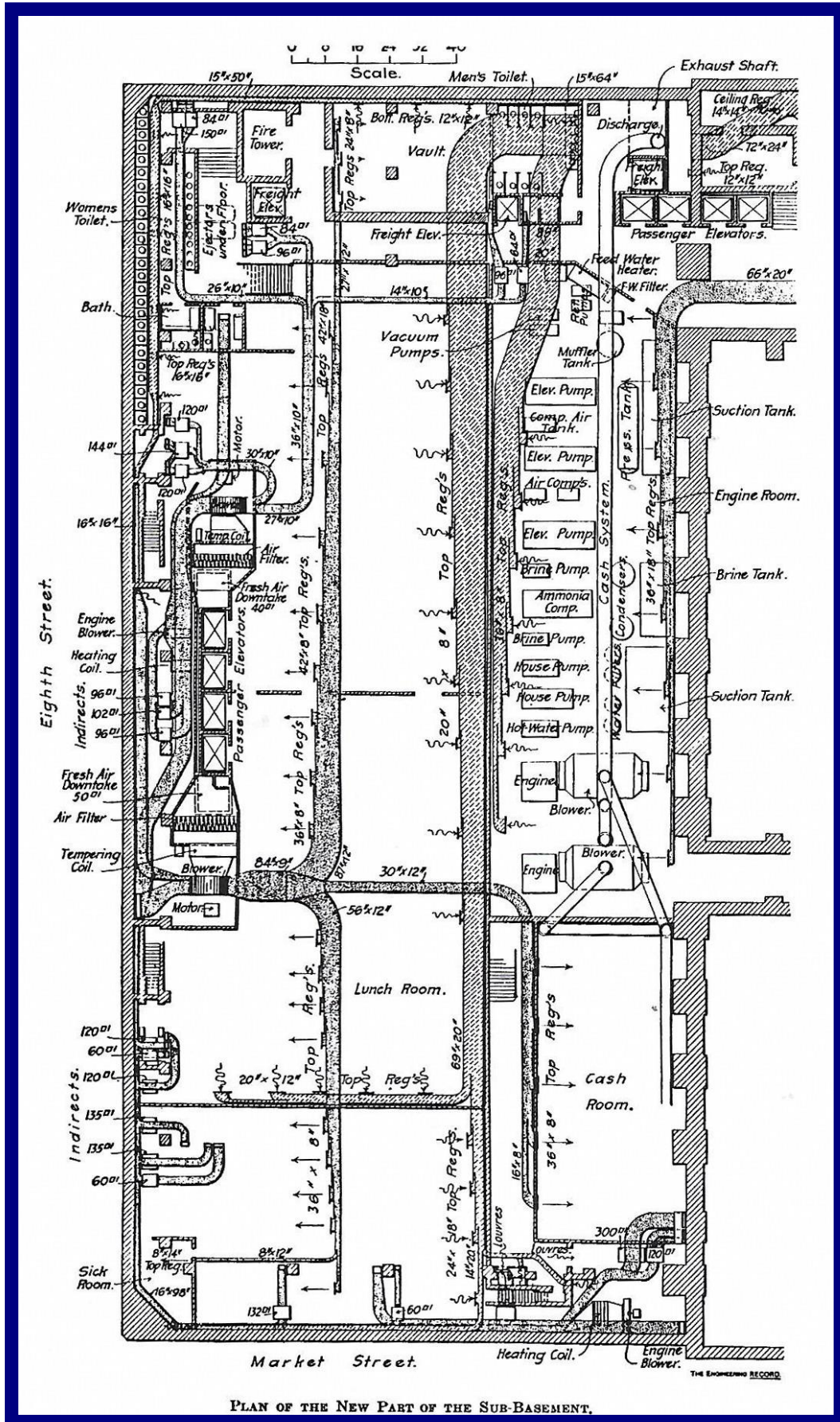
Old and new Department Store buildings.

PHILADELPHIA WANAMAKER STORE



Atrium entrance and trading floor.

PHILADELPHIA WANAMAKER STORE



PLAN OF THE NEW PART OF THE SUB-BASEMENT.

Mechanical services 1902.

PHILADELPHIA WANAMAKER STORE

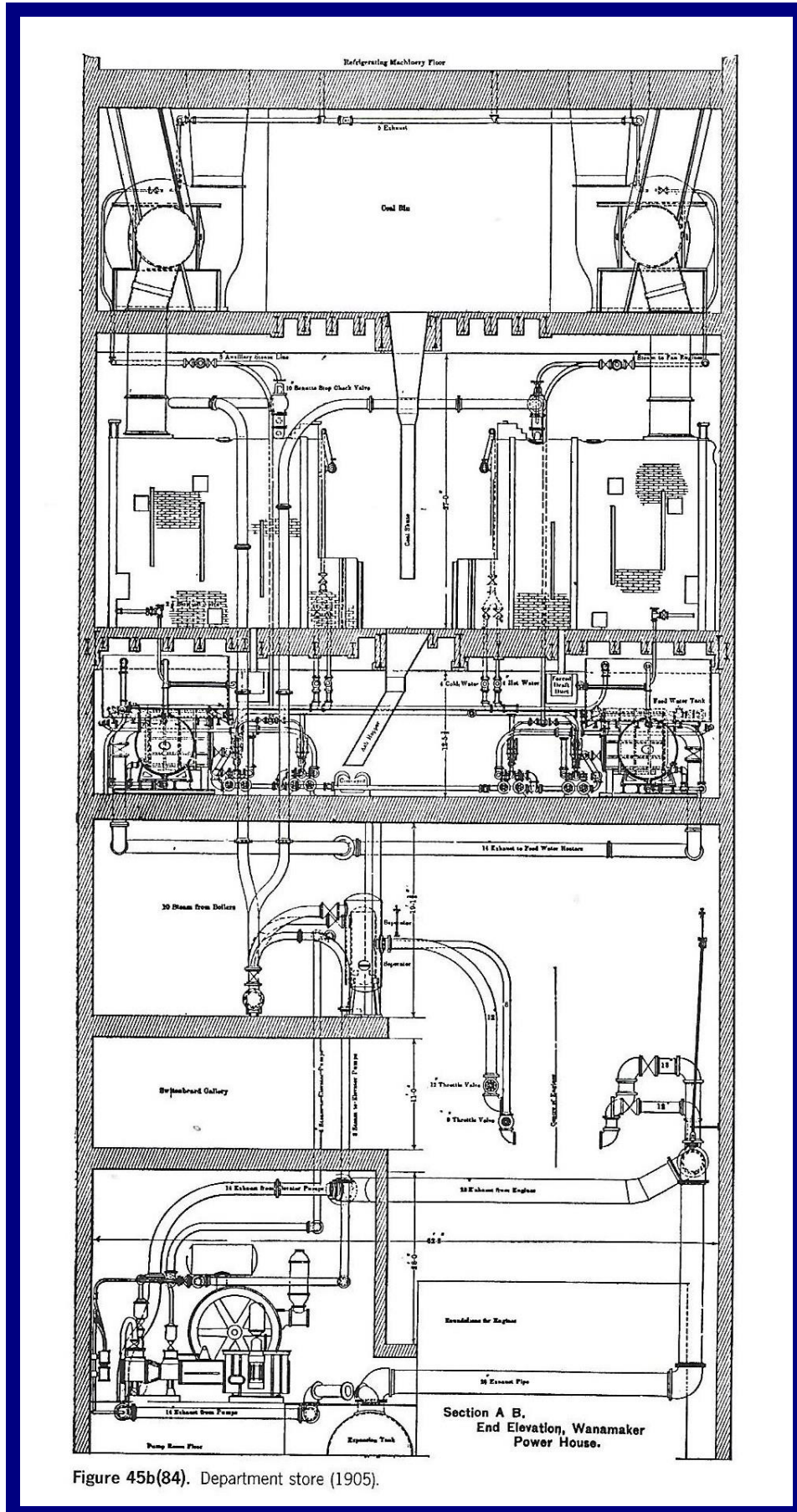
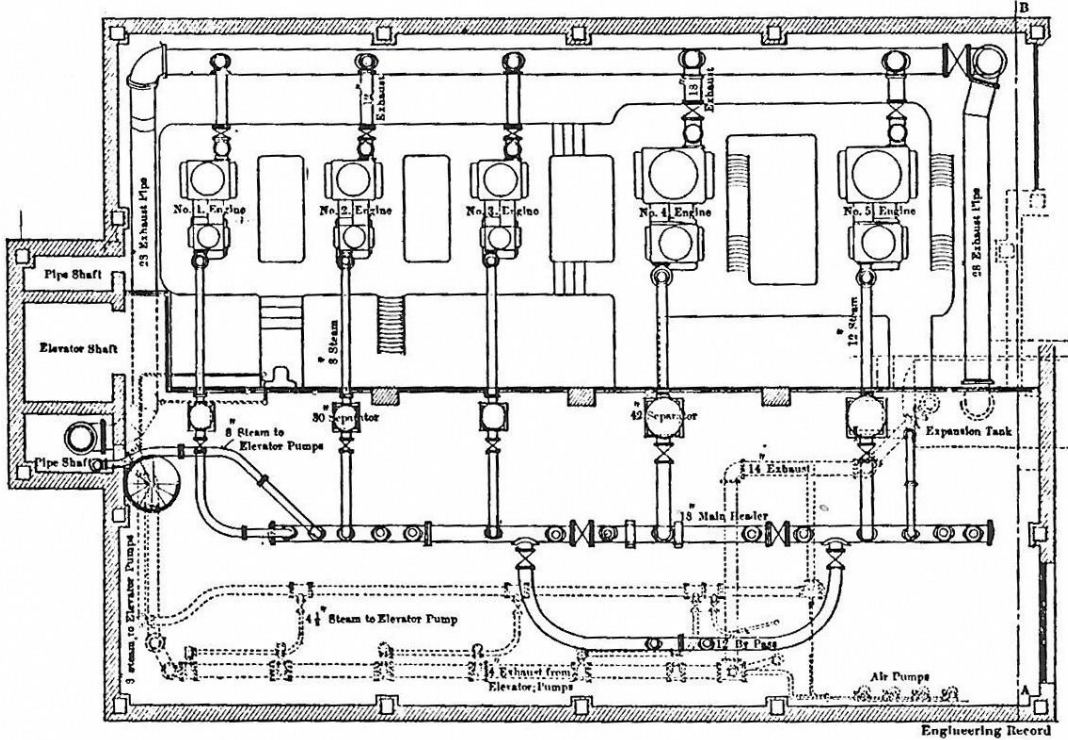
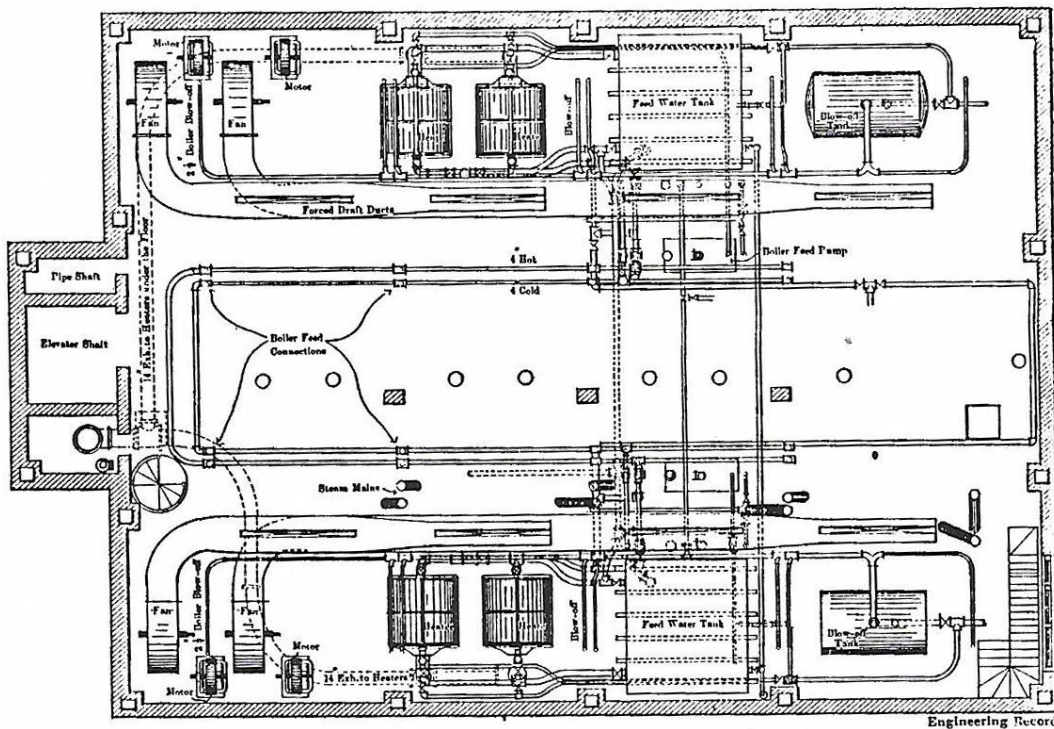


Figure 45b(84). Department store (1905).

PHILADELPHIA WANAMAKER STORE

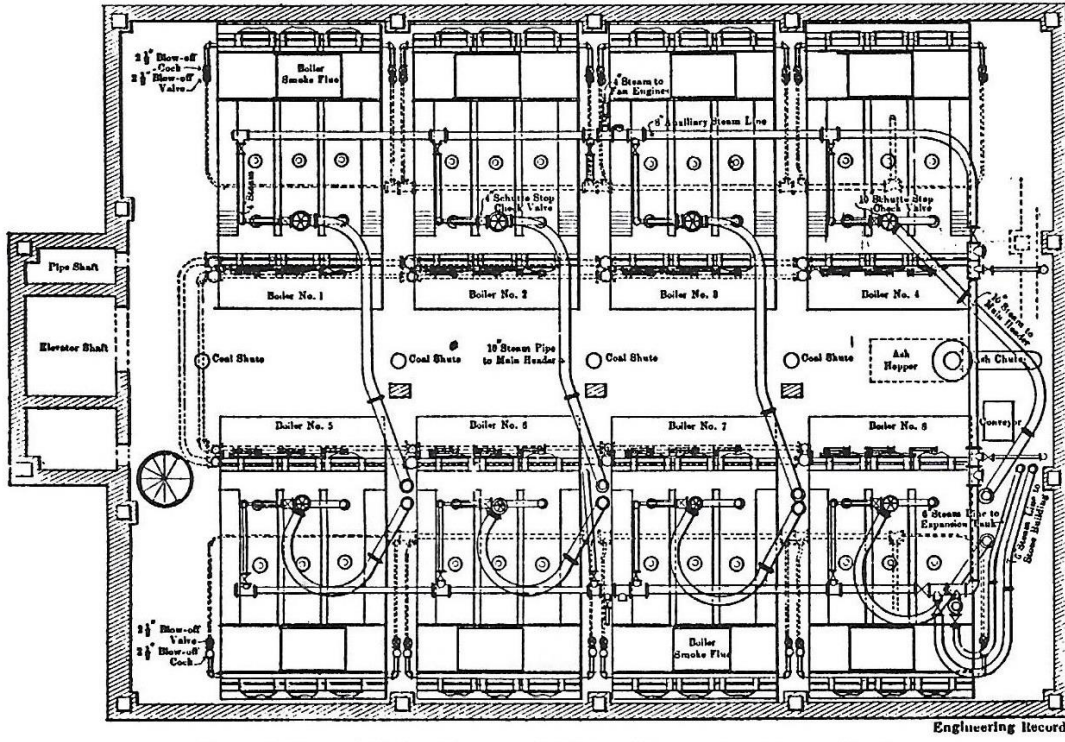


General Plan of Engine Room and Mezzanine Piping, Wanamaker Power House.

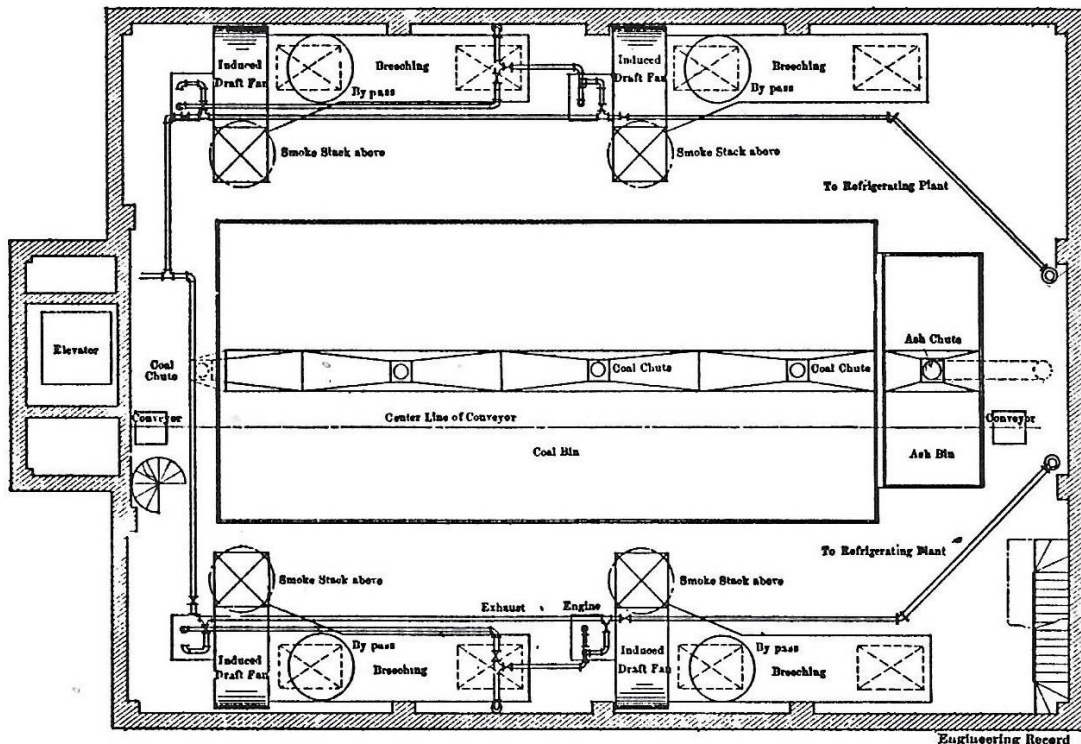


Steam Piping, Auxiliary Boiler Floor, Wanamaker Power House.

PHILADELPHIA WANAMAKER STORE



General Plan of Boiler Room and Piping, Wanamaker Power Plant.



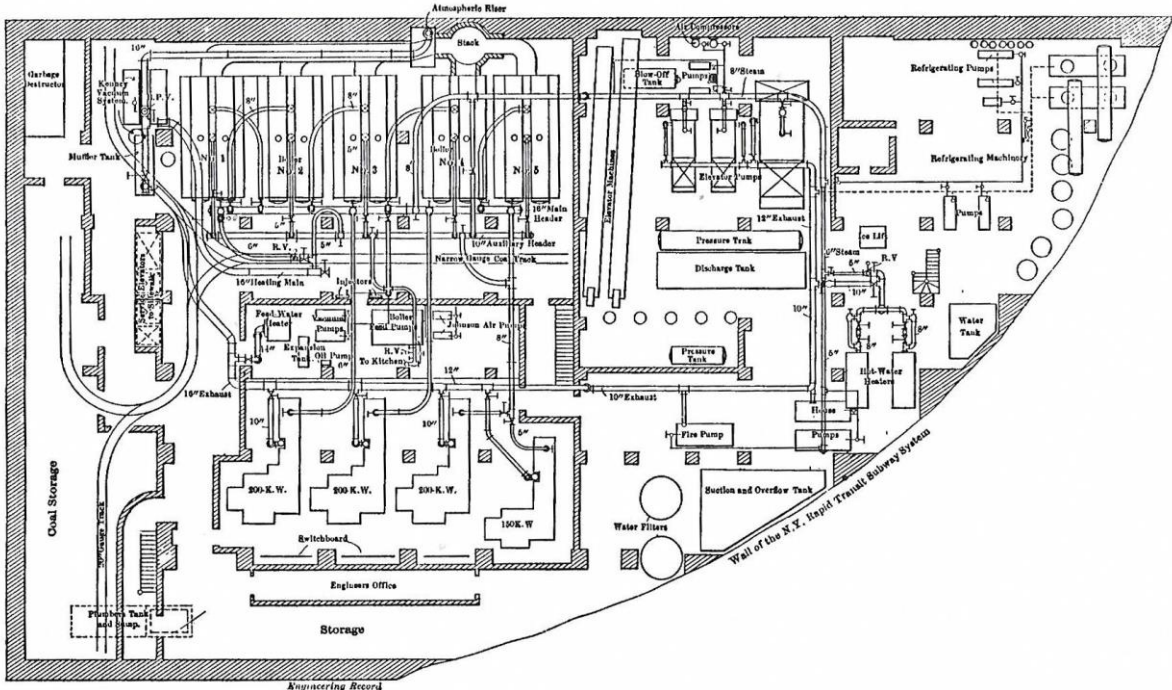
Coal Storage Room Plan, Wanamaker Power House, Philadelphia.

PHILADELPHIA BELLVUE STRATFORD

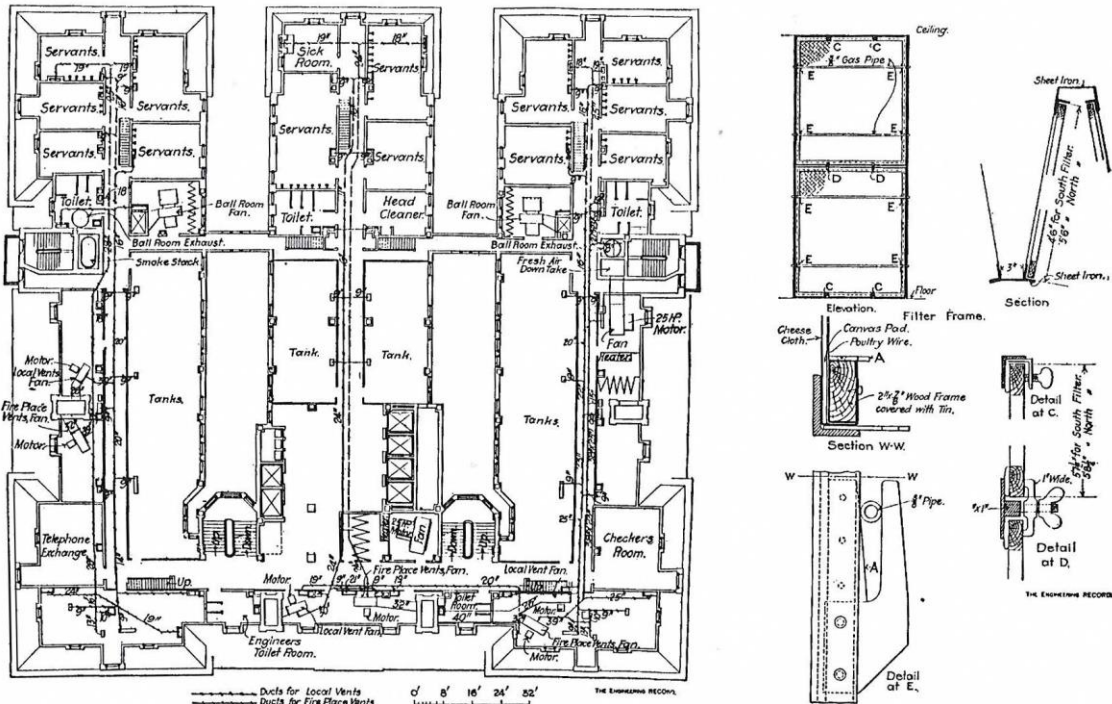


Historic Skyscraper Hotel.

PHILADELPHIA BELLVUE STRATFORD

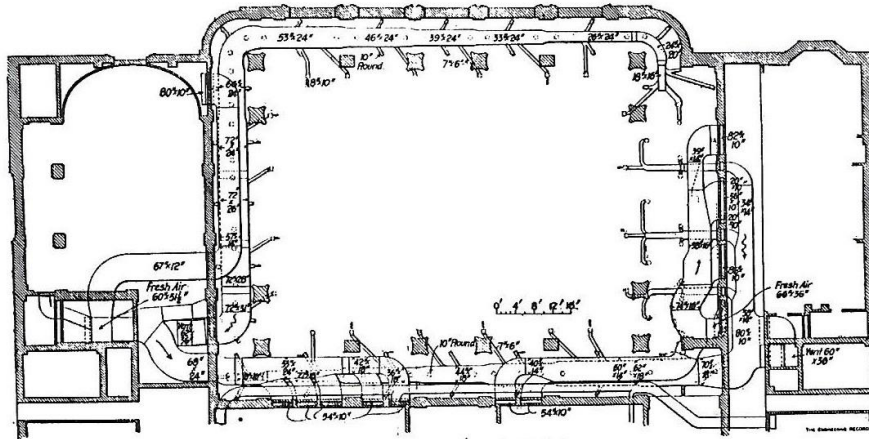


Plans of Fifth Basement, Hotel Belmont, Containing Power Plant, Refrigerating Machinery and Elevator Equipment. I

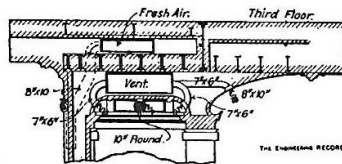


Air Supply and Exhaust Units in the Seventeenth Story; Details of Air Filters.

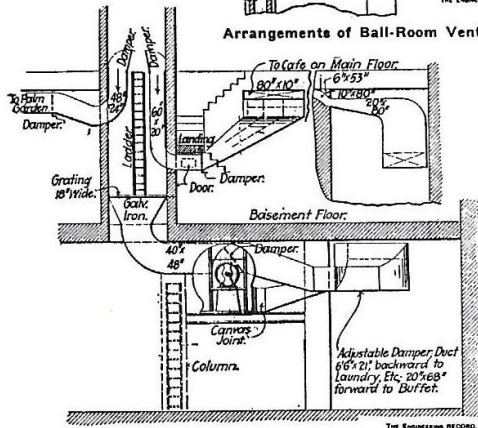
PHILADELPHIA BELLVUE STRATFORD



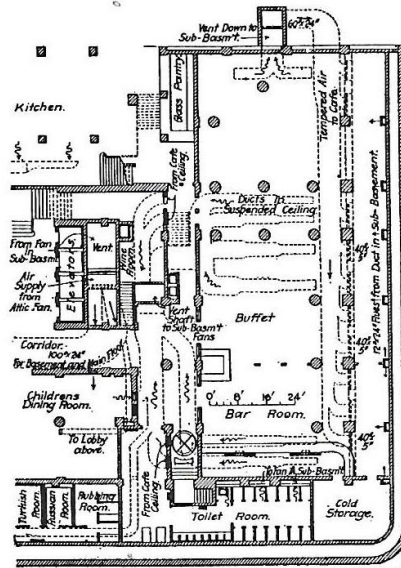
Scheme of Ventilation for the Ball Room.



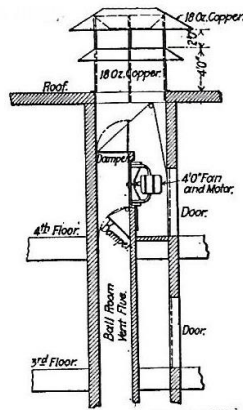
Arrangements of Ball-Room Vents.



Arrangement of Relay Fan for Laundry and Buffet.

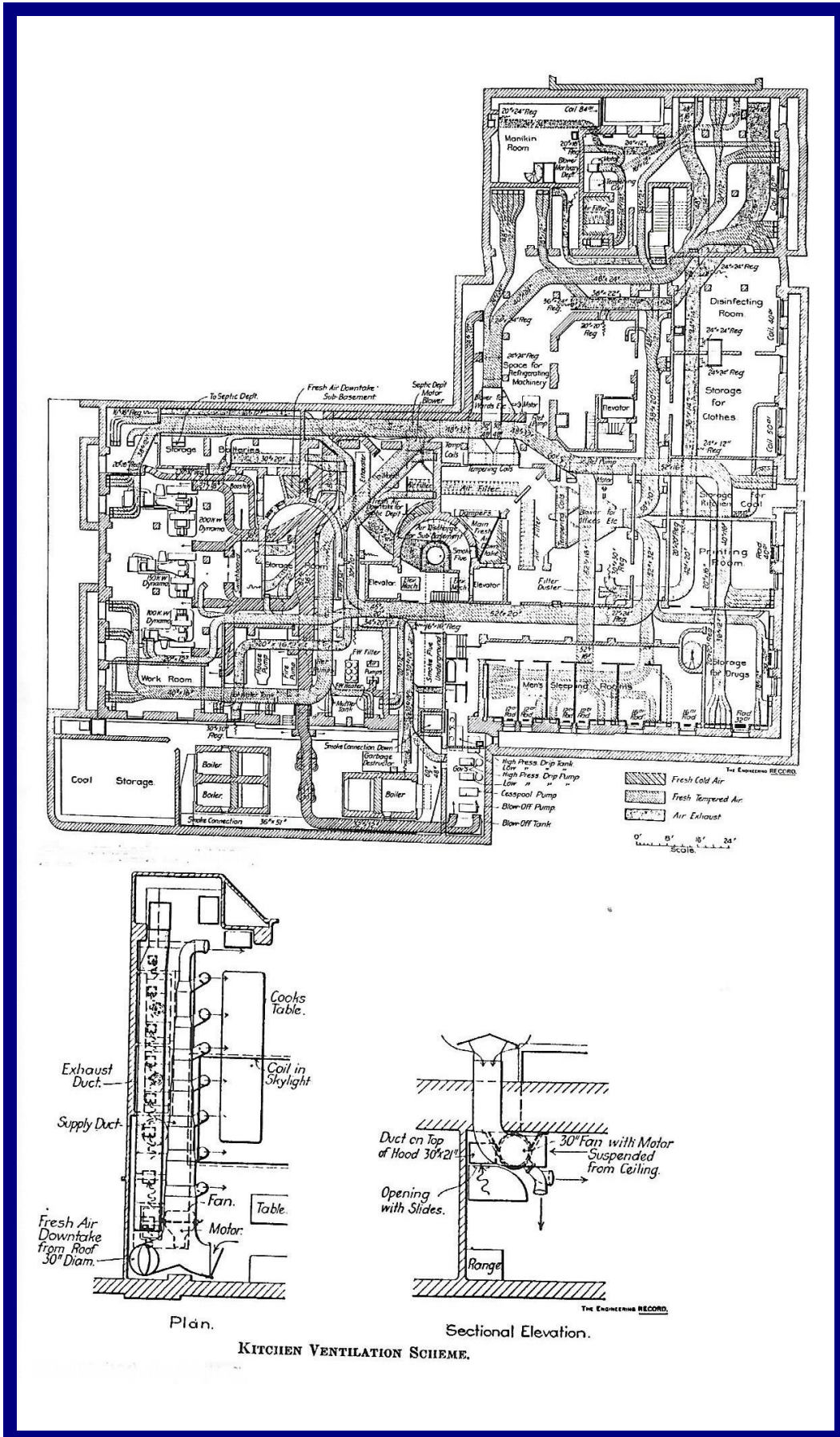


Exhaust Duct System for Buffet and Cafe.



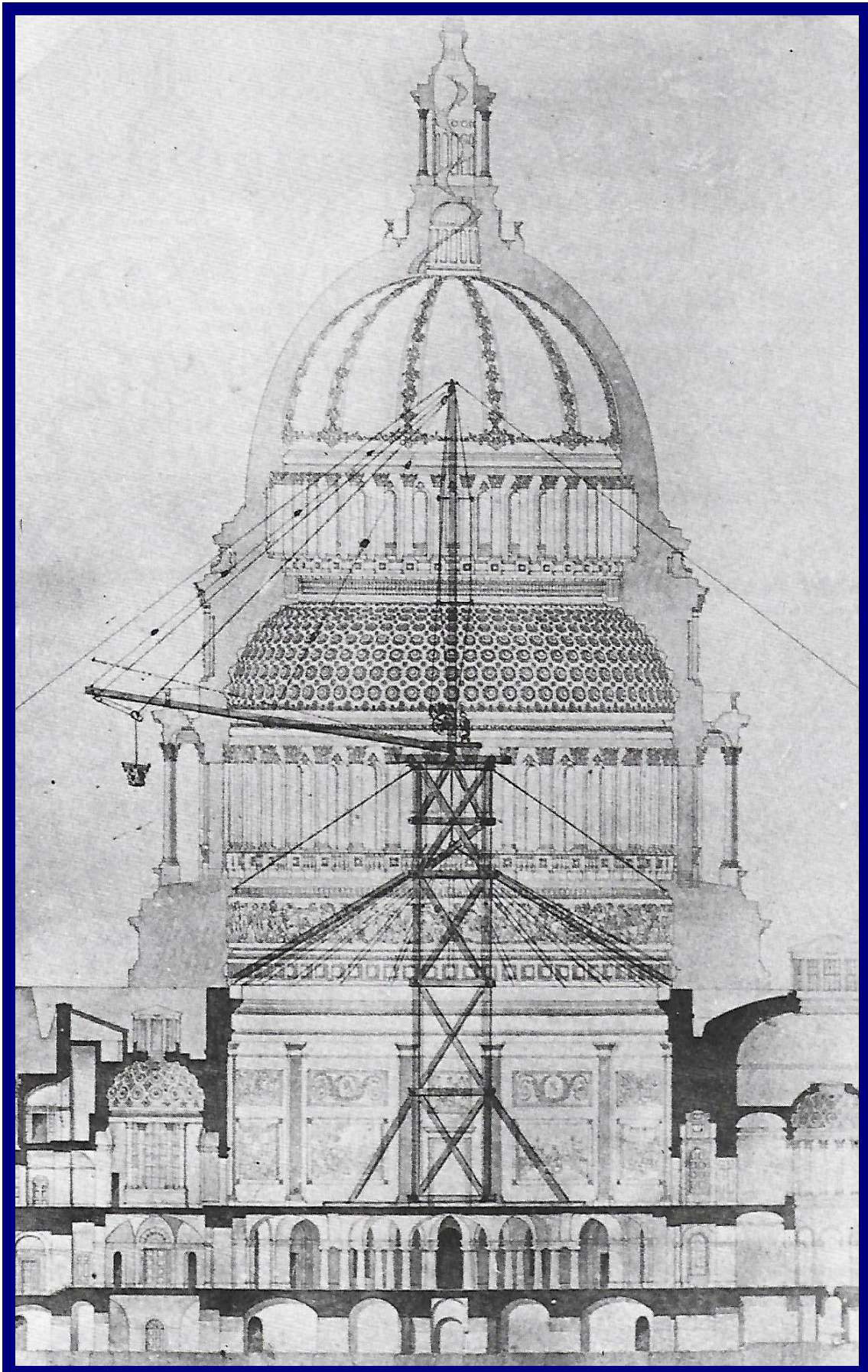
Ball-Room Vent Shaft.

UNKNOWN HOSPITAL H&V

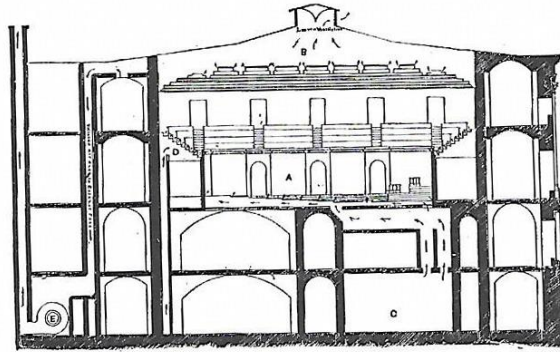


Fresh air, and warm air supply and extract ventilation 1903

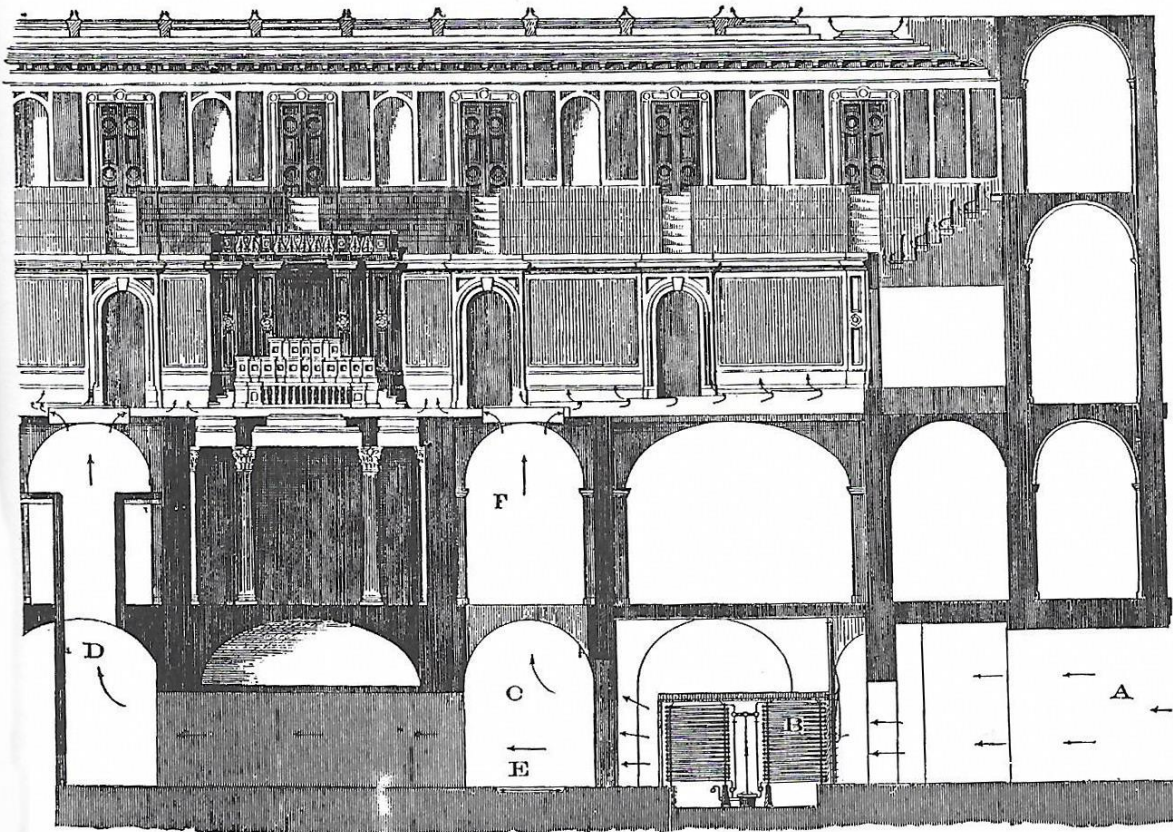
WASHINGTON D.C. CAPITOL



WASHINGTON D.C. CAPITOL



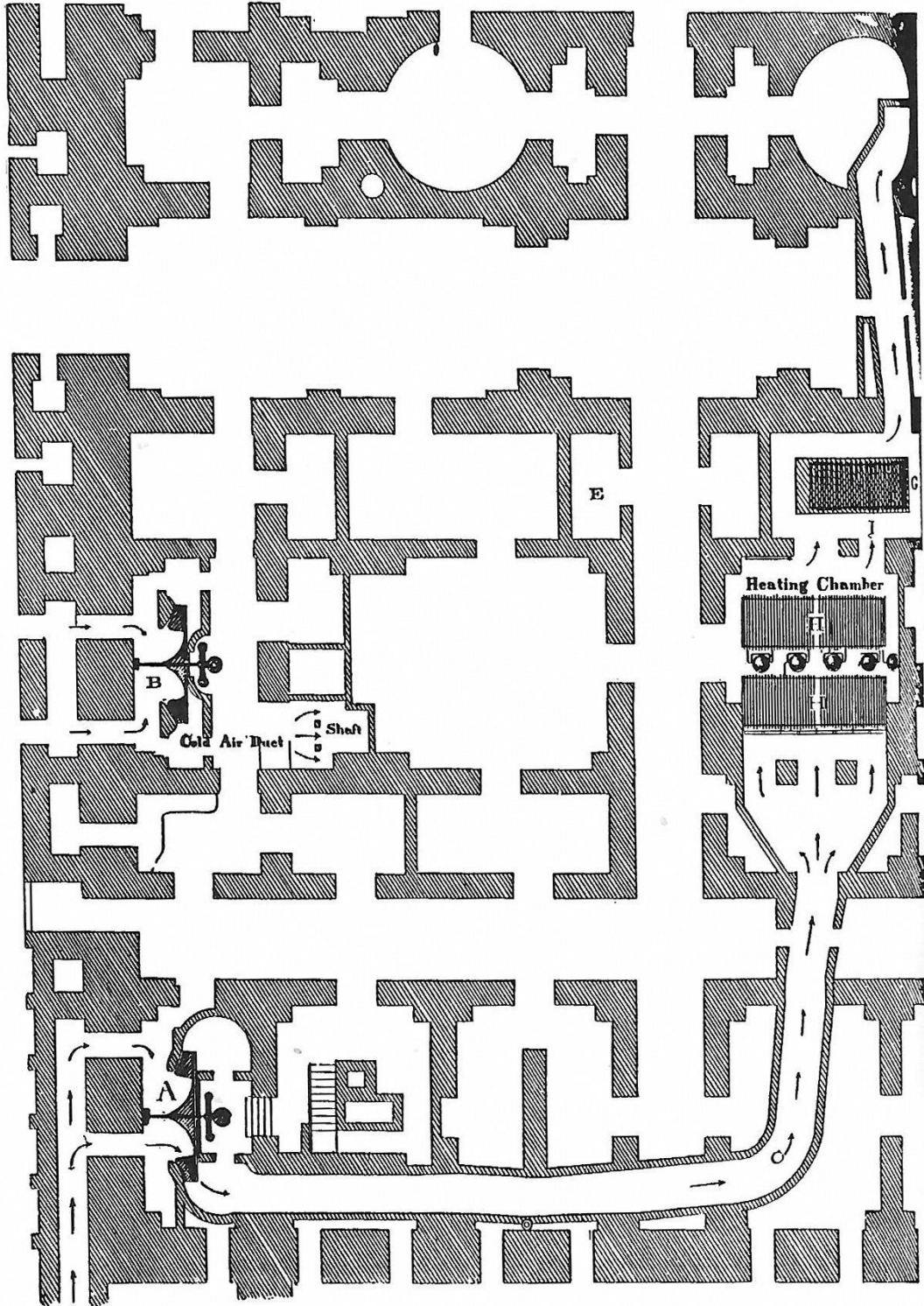
TRANSVERSE SECTION THROUGH SOUTH WING, U. S. CAPITOL.
A—Main Hall; B—Space over Hall; C—Main Fresh Air Duct; D—Fresh Air Supply to Galleries; E—Exhaust Fan.



SECTION THROUGH AIR DUCTS AND HEATING APPARATUS OF SOUTH WING, U. S. CAPITOL.
A—Cold Air Duct; B—Heating Coil; C—Mixing Chamber; D—Fresh Air Shaft; E—Evaporator; F—Fresh Air Shaft.

12
CH
Hea
Ver
Air-

WASHINGTON D.C. CAPITOL

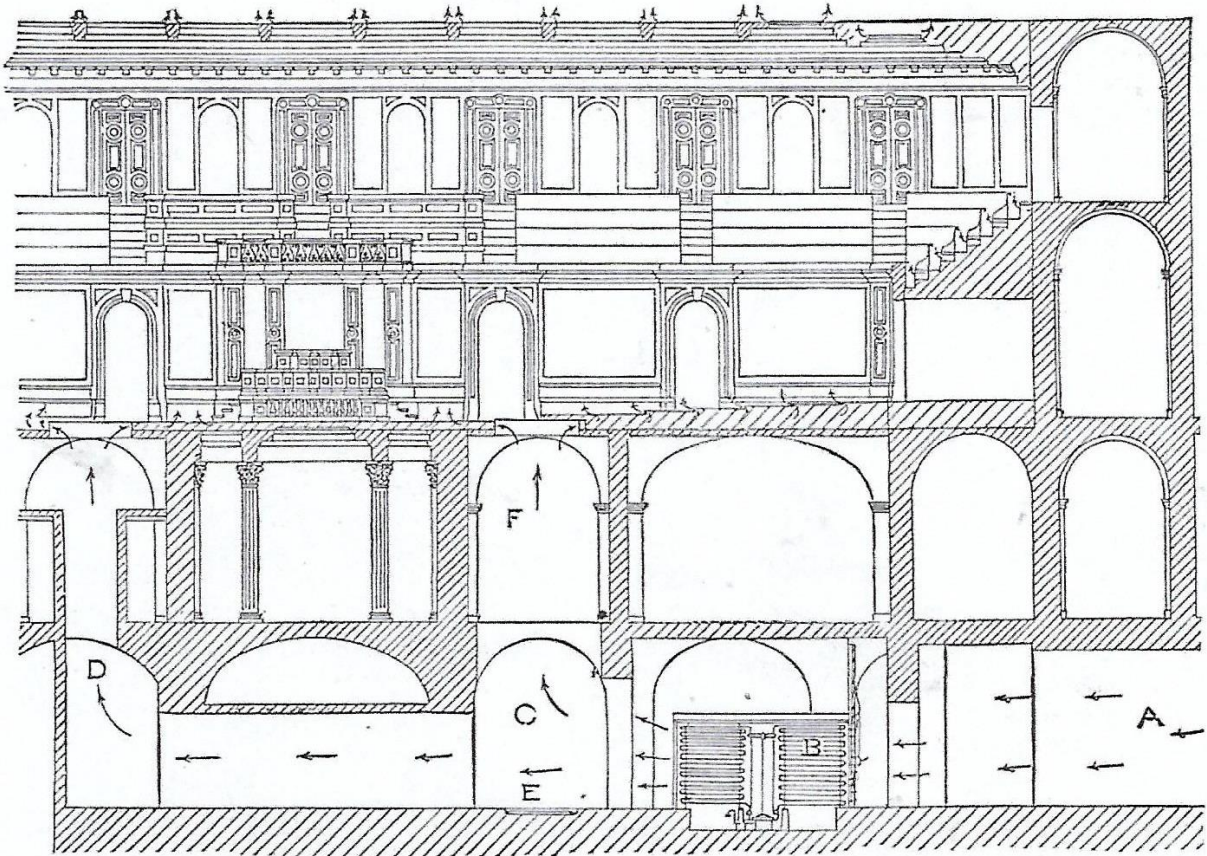


PLAN SHOWING AIR DUCTS, ETC., IN CONNECTION WITH HEATING APPARATUS,
SOUTH WING, U. S. CAPITOL.

A—Main Fan for Hall.
B—Small Fan for Committee Rooms.

G—Evaporator and Mixing Chamber.
H—Heating Coils.

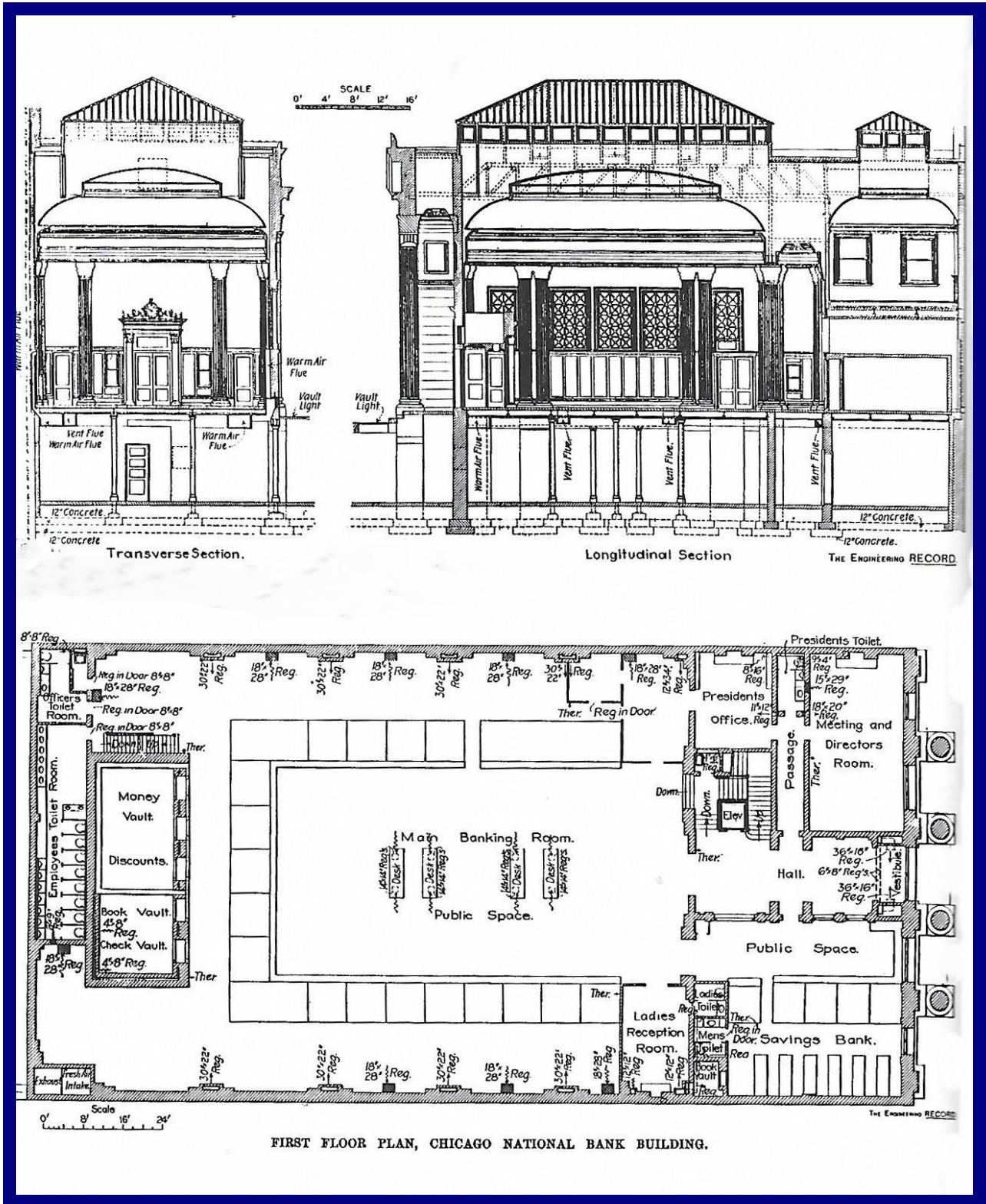
WASHINGTON D.C. CAPITOL



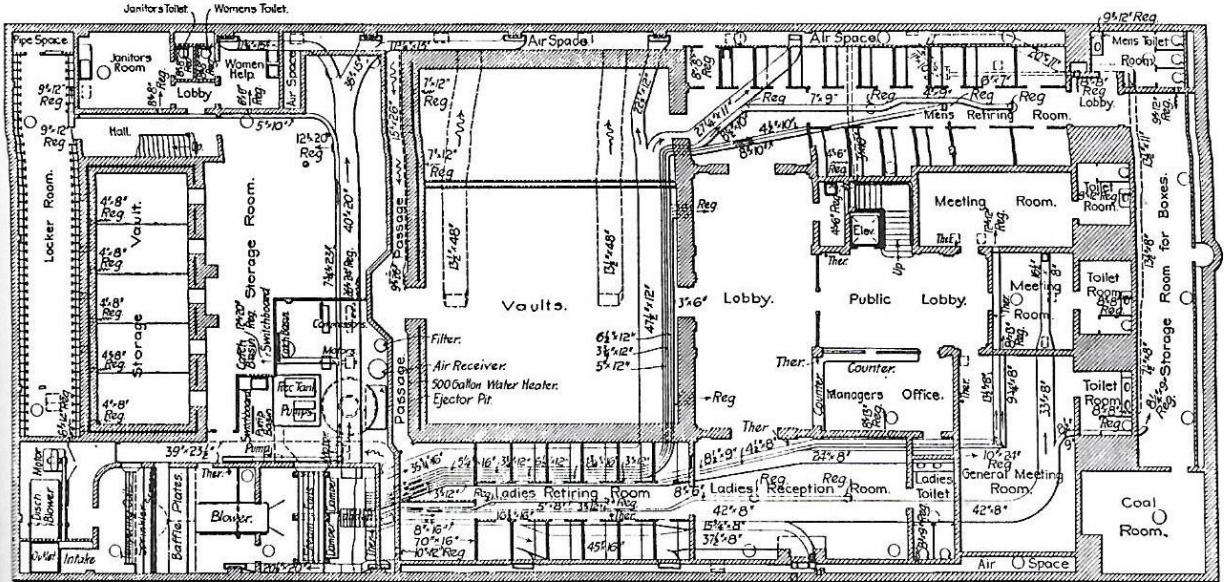
*P.11 Section through air ducts & heating apparatus, South Wing,
US Capitol, c.1880 [Ventilation & Heating, Billings, 1896].*

*A cold air duct B heating coil C Mixing chamber
D Fresh air shaft E Evaporator (sprays?) F Fresh air shaft*

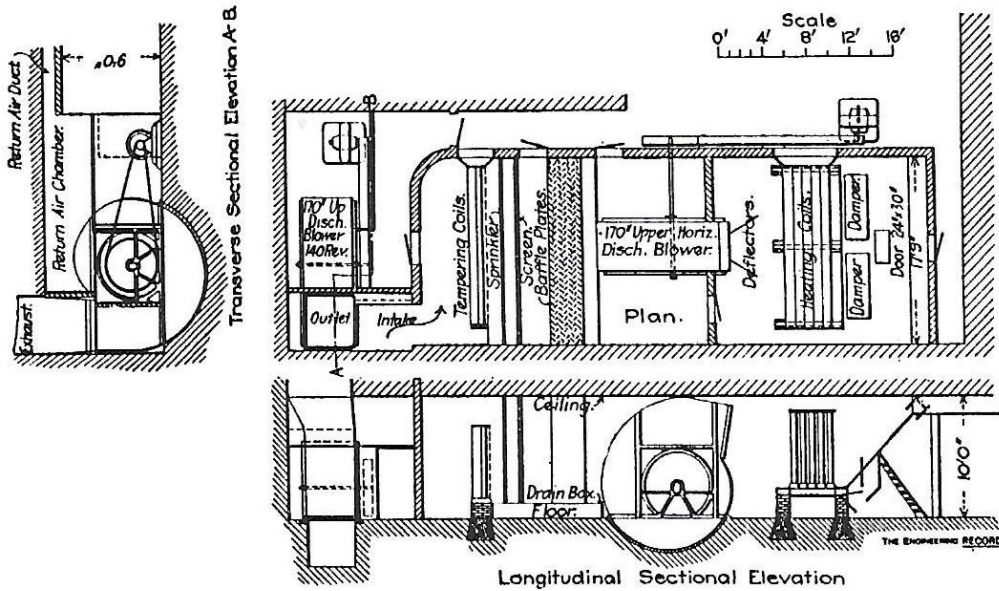
CHICAGO NATIONAL BANK



CHICAGO NATIONAL BANK

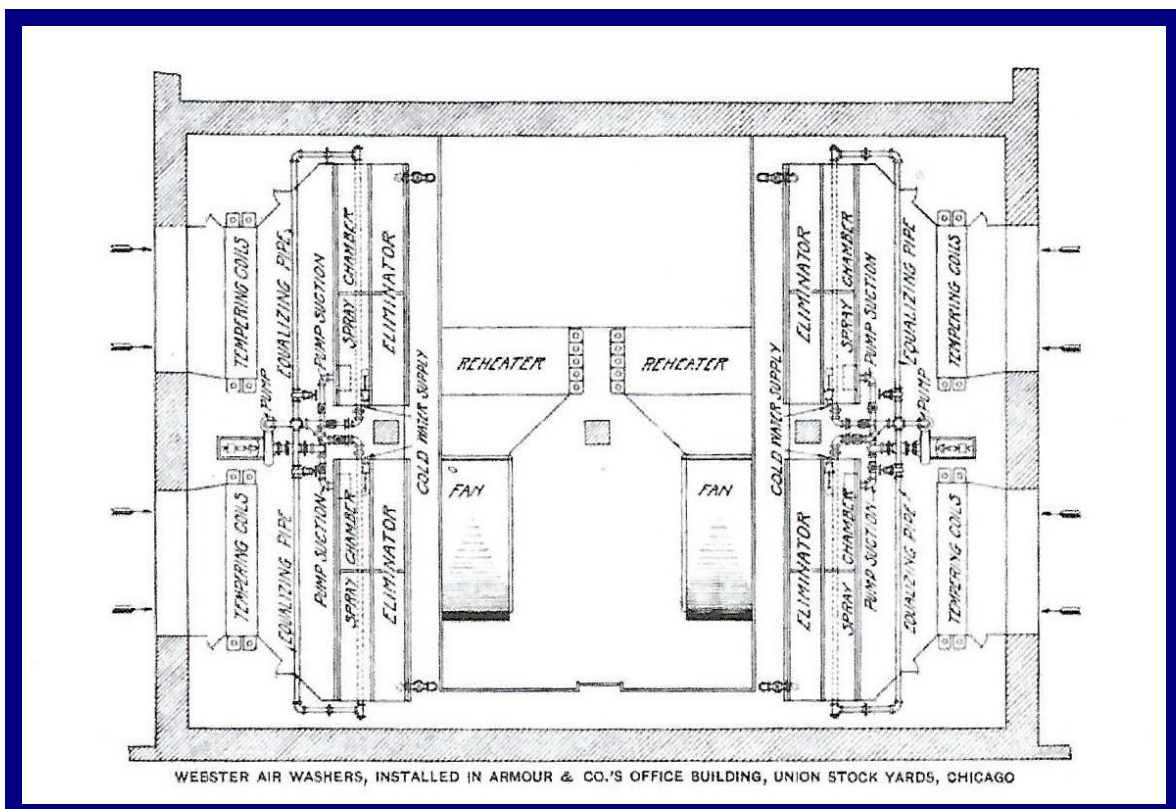
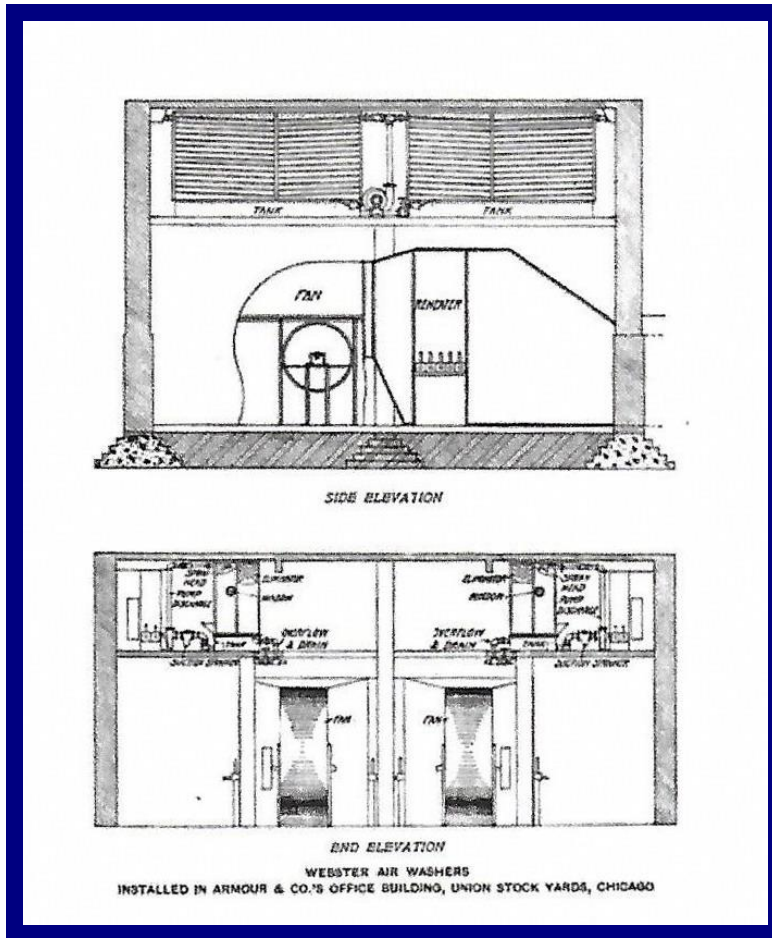


BASEMENT PLAN, CHICAGO NATIONAL BANK BUILDING.



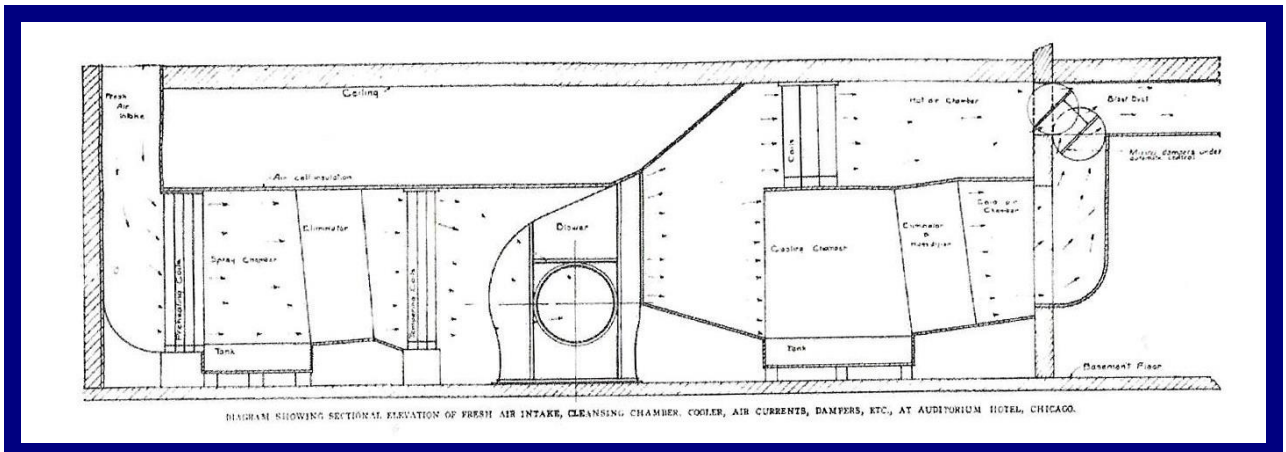
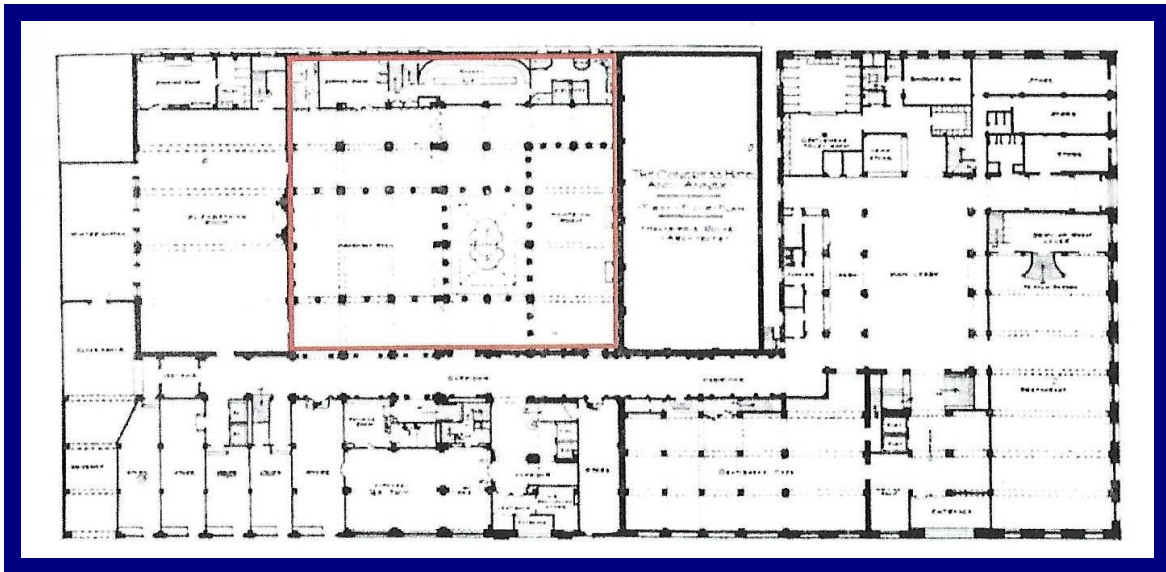
PLAN AND ELEVATIONS OF THE VENTILATING APPARATUS.

CHICAGO ARMOUR OFFICES

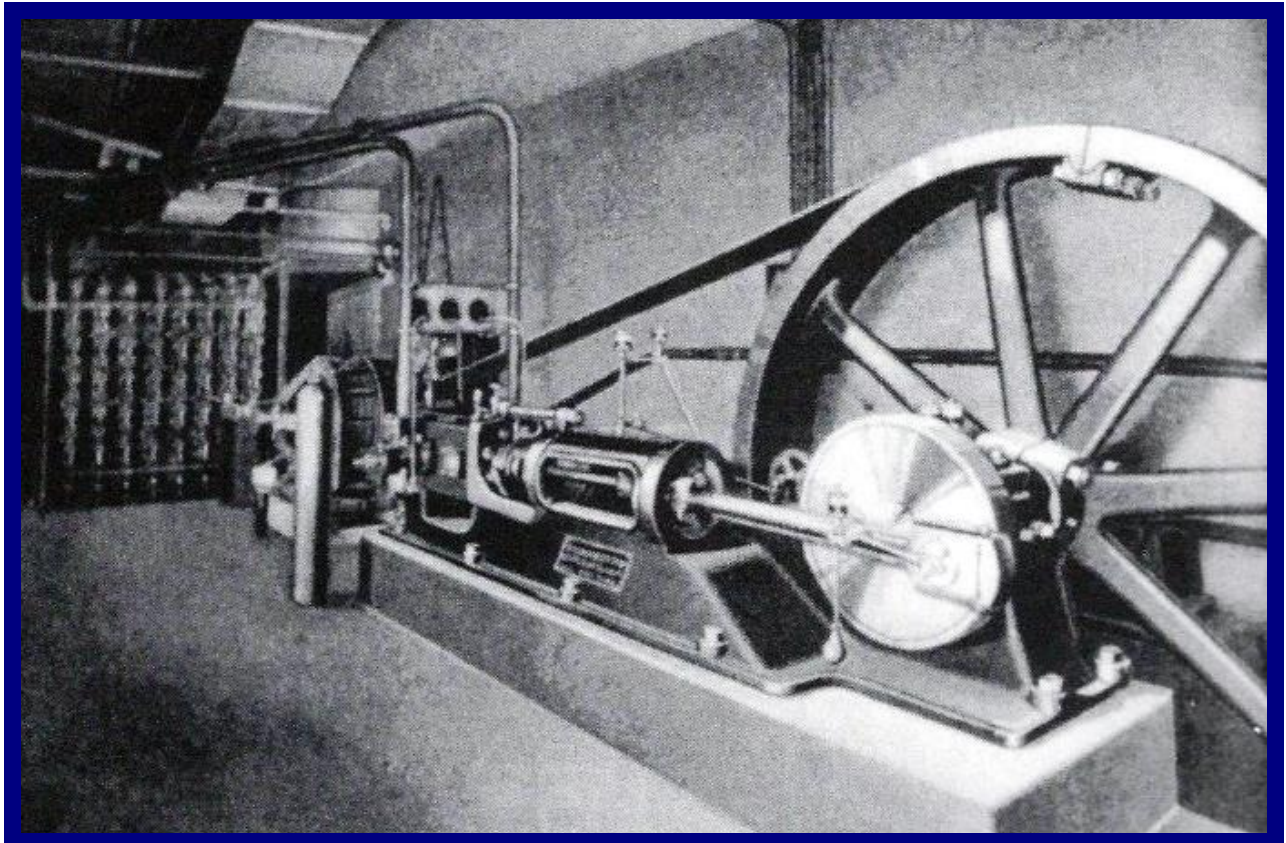


Heating and ventilation plant with Webster spray air washers 1908.

CHICAGO CONGRESS HOTEL

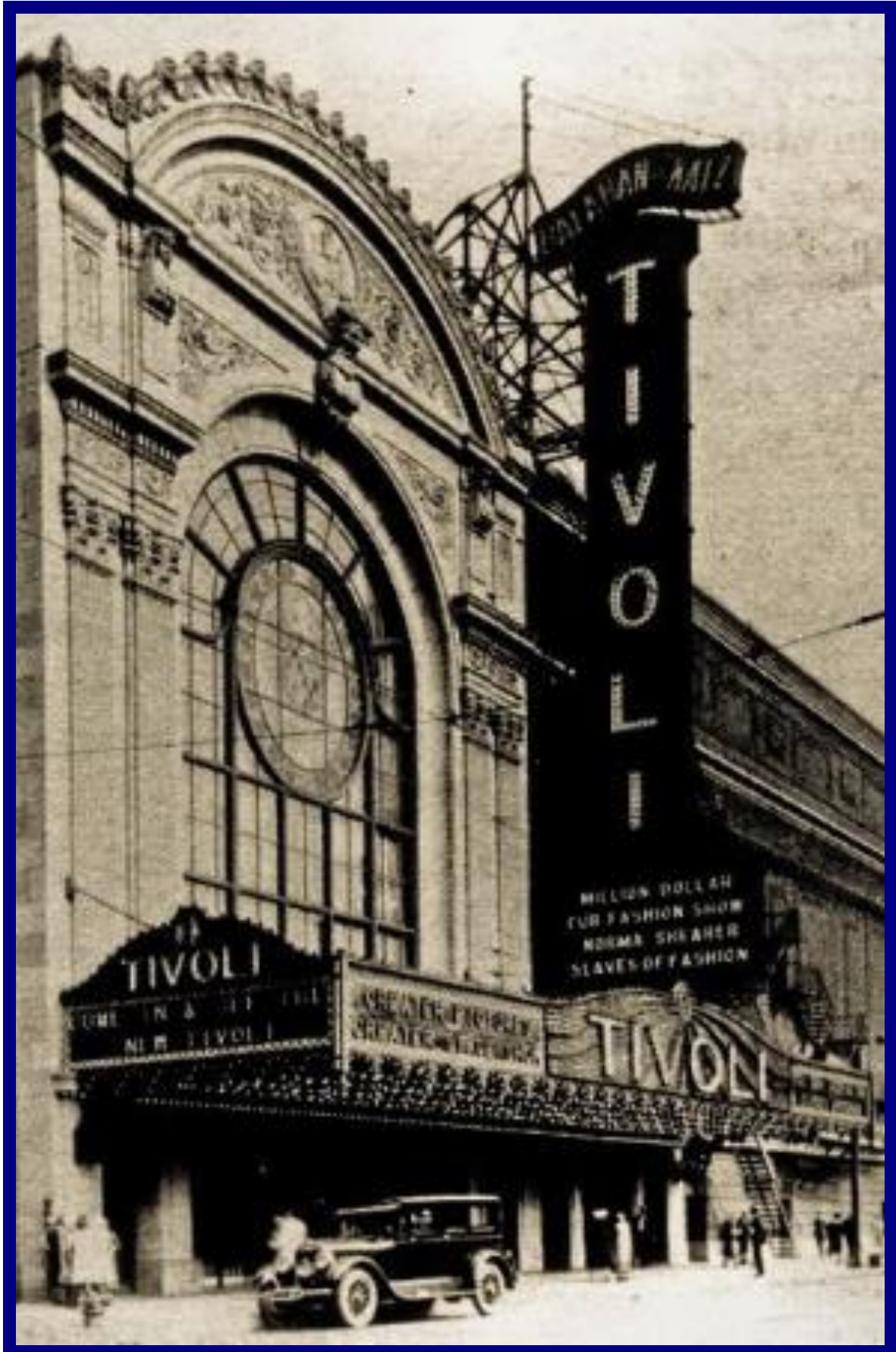


CHICAGO CENTRAL PARK THEATRE

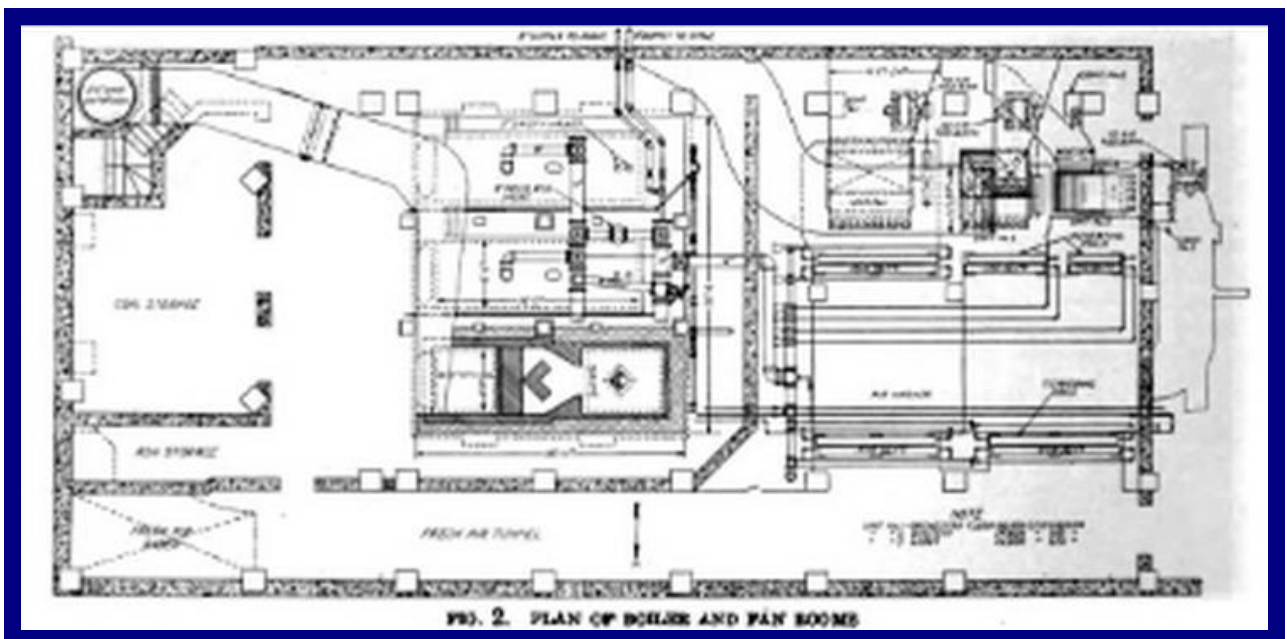
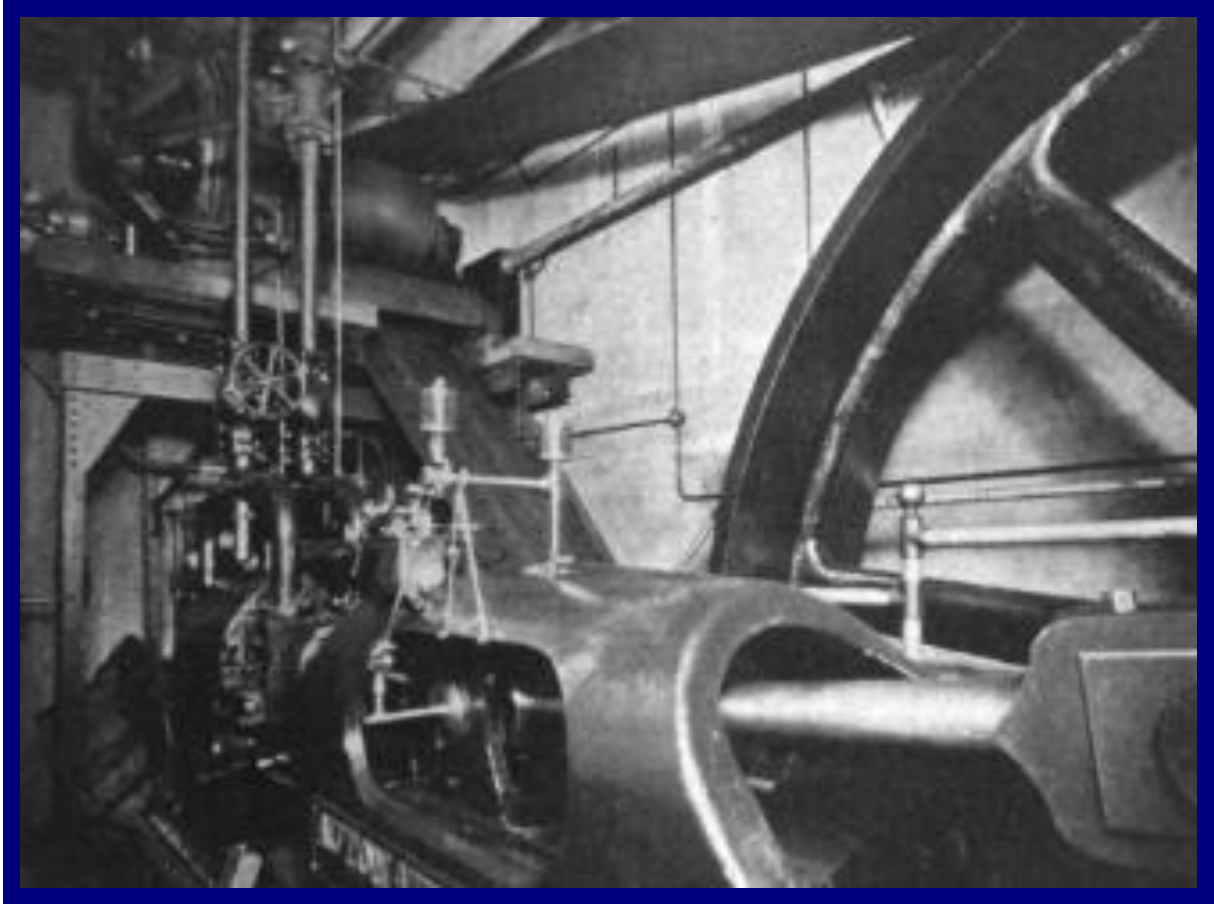


Wittenmeier air conditioning with Kroeschell CO₂ refrigeration 1917.

CHICAGO TIVOLI THEATRE



CHICAGO TIVOLI THEATRE



Air conditioned with CO₂ refrigeration by the Automatic Carbonic Machine 1921.
Refrigeration capacity 150 TR with brine storage.

CHICAGO McVICKERS THEATRE



Air conditioned in 1924, designed by Otto Armspach, with Kroeschell CO₂ refrigeration.

CHICAGO RIVIERA THEATRE

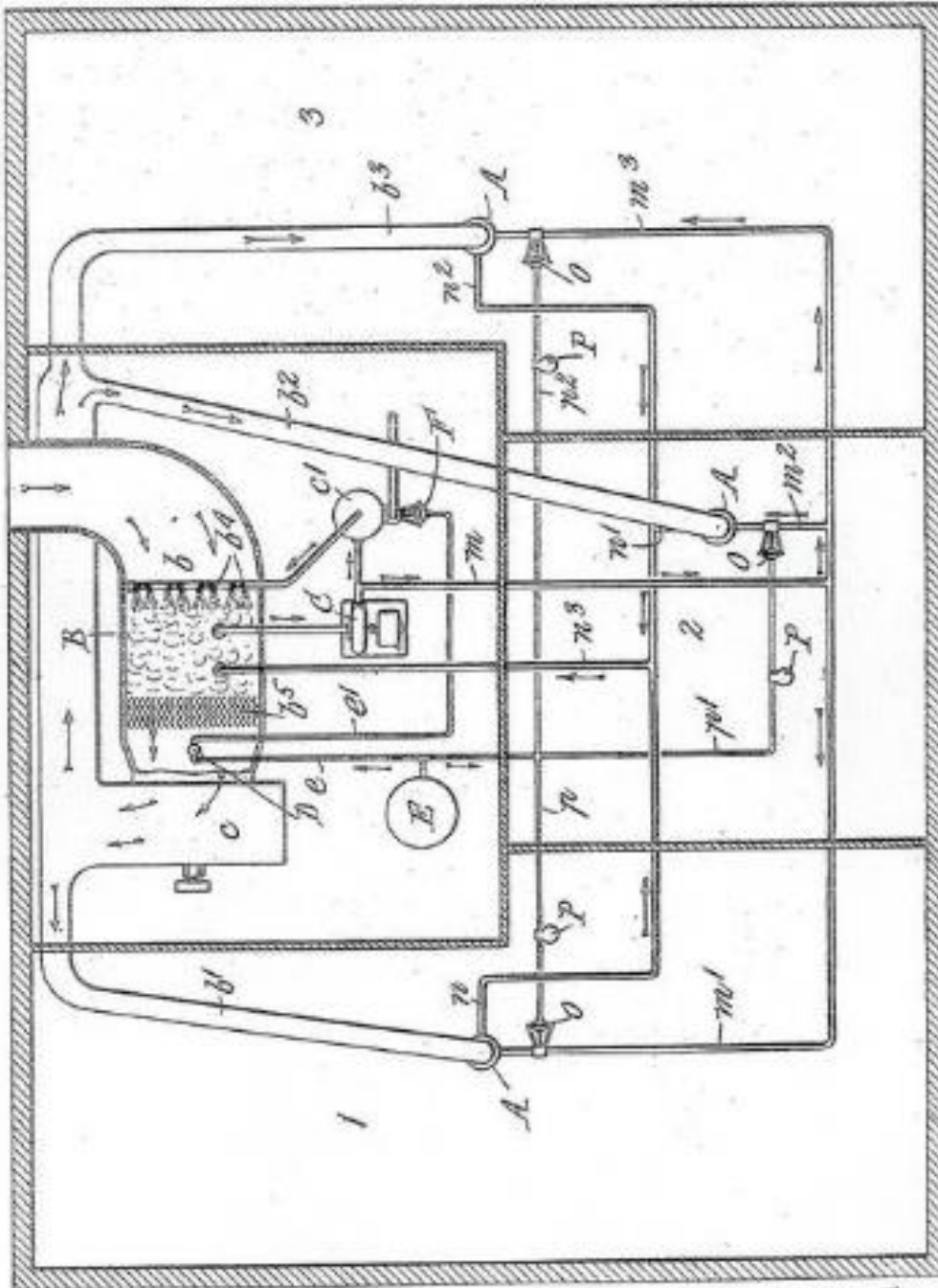


Wittenmeier's rule of thumb figures for theatre cooling were 2.5 tons of refrigeration for every 1000 cubic feet per minute of supply air in the northern states, increased by 25% for southern areas and appear to be based on 50% outside air. His evaporator design was based on using 1.25-inch iron pipe 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 CO₂ 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 CO₂ 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).

CARRIER HUMIDIFYING APPARATUS 1910

971,248. W. H. CARRIER.
HUMIDIFYING APPARATUS.
APPLICATION FILED DEC. 31, 1909. Patented Sept. 27, 1910.
2 SHEETS-SHEET 1.



Witnesses.
E. A. Volk
Chas. P. Diamond.

Fig. 1.

Inventor
W. H. Carrier
By W. H. Baker & Co.,
Attorneys

CHICAGO ROOSEVELT THEATRE



1922.

REFERENCES AND FURTHER READING

- 1976 Building Early America (Chapter 12), Charles E. Peterson (Ed), The Astragal Press, Mendham, New Jersey.
- 1989 Grand American Hotels, Catherine Donzel & Alexis Gregory, The Vendome Press, New York.
- 1992 Mechanical & Electrical Systems for Historic Buildings, Gersil Kay, McGraw-Hill, New York.
- 1995 Form Follows Function (Skyscrapers and Skylines inChicago), Carol Willis, Princeton Architectural Press, New York.
- 2006 The Chicago Movie Palaces of Balaban and Katz, David Balaban, Images of America, Arcadia Publishing, Charleston, South Carolina.
- 2007 Hotel: An American History, A, K. Sandoval-Strausz, Yale University Press, New Haven.
- 2014 Philadelphia, Then and Now, Edward Mauger and Bob Skiba, Pavilion Books.
- 2015 Chicago, Then and Now, Kathleen Maguire, Pavilion Books.
- 2016 Boston, Then and Now, Patrick L. Kennedy, Pavilion Books.
- 2016 Washington, D.C., Then and Now, Alexander D. Mitchell IV, Pavilion Books.
- 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 Heritage Group Archive and website.