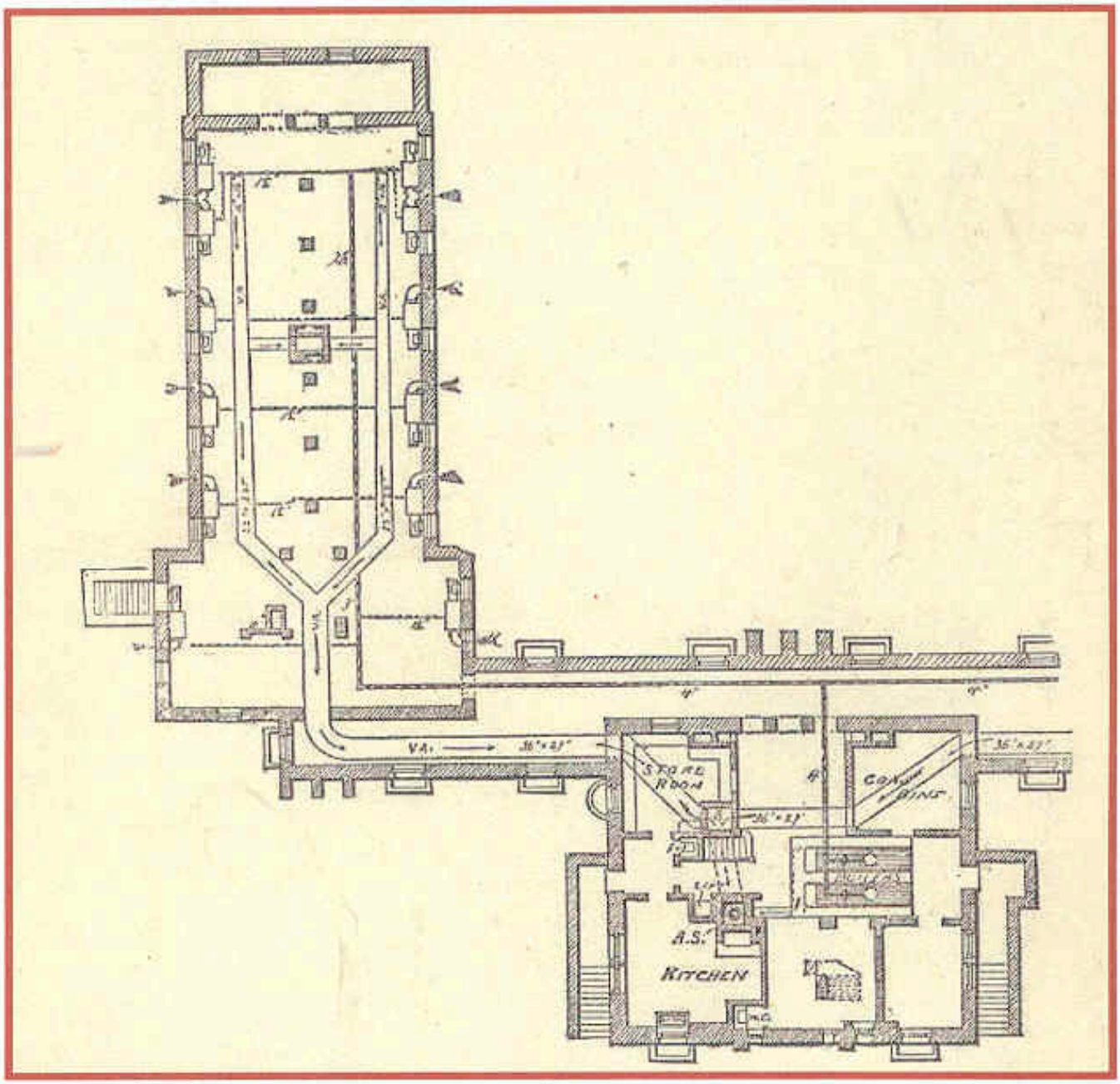
CAMBRIDGE HOSPITAL, CAMBRIDGE, MASS



Basement plan shows boiler, fresh air inlet ducts and risers to wards above, c.1890. Two boilers are arranged for either hot water or steam generation [VH, 315]

CAMBRIDGE HOSPITAL

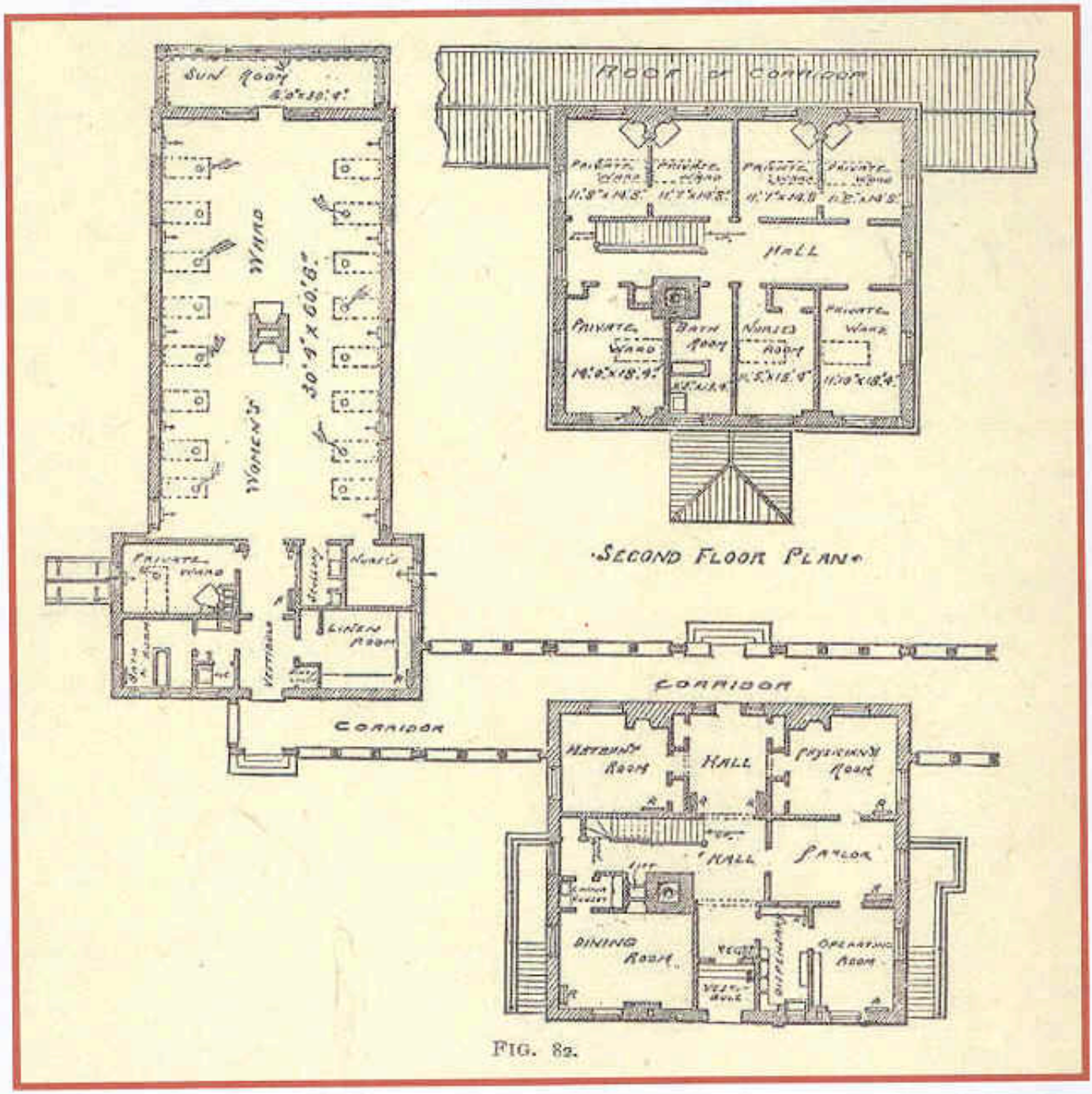


FIG. 82.

Part Plans of First & Second Floors showing heating and ventilation [VH, 316]

CAMBRIDGE HOSPITAL

The drawings show a plan of part of the basement and parts of the 1st and 2nd floors.

"The wards are connected with the administration building by roofed corridors. The sides of these are glazed, but in such a manner that the frames can be removed in fine weather. The upper stories of the administration building are to be used as private wards. The main room of each pavilion is 30 ft 4 ins x 60 ft 6 ins: the floor space to each bed being 115 square feet, and the cubical air space about 1840 feet.

The sun-rooms at the end of ths of the pavilions are 8 x 30 feet, with hammered glass roofs and clear glass sides extending almost to the floor. The level of the sun-room is very slightly below the floor of the principal ward, just enough to shed water outward, but not sufficient to interfere with the movements of an invalid's chair. The sun-room is on the south end of the wards, and the position of the pavilions being north and south, sunlight is available during the whole day.

The administration building is warmed by direct radiation, supplemented by indirect radiation to the main hall, and all sick rooms or chambers have an open fireplace. The pavilions are warmed by indirect radiation, supplemented by direct radiation in the sun-rooms, halls and bath-rooms.

The warming apparatus is arranged to be worked either as a low-pressure steam, or as a hot-water apparatus. Two boilers are used, located in the cellar of the administration building, 14 feet long by 42 inches in diameter, each containing 60 $2^1/_2$ inch tubes. These boilers are connected with a 21-inch vertical cast-iron smoke-pipe located within the aspirating shaft *A S*, cellar plan. Steam or hot water, as the case may be, is carried to the pavilions by the 4-inch pipes shown, where it is distributed to the indirect heaters, which are "pin" sections, centre connection, eight sections being used to each hot-air box.

Figure 83 is a section and Fig. 84 is a perspective elevation of one of these air boxes showing the arrangement of the air-inlet pipes *A*, mixing valve *D*, hot-air pipe *H*, and register box *R*, within the wards as well as a section of the vent ducts *V A*, with the vent under each bed *(A)*.

The coil casings or air boxes are made of No. 22 galvanised iron, with flanged corners, and the steam radiator is suspended midway in the case. The cold air enters through the 10-inch round pipe *A*, Fig. 84 and shown separated on cellar plan by the arrows, the mouth of which is protected by a register and frame. As the air enters through *A*, it can be made to pass either under and through or above the heating surfaces of the radiator by means of a sliding damper *D*, or the air current may be divided by placing the damper in a nearly central position, allowing some of the air to pass each way, thereby regulating its temperature without reducing its volume."

CAMBRIDGE HOSPITAL

"The upper end of this damper is connected by a chain with a pull-and-stop mechanism within the ward, so that the attendant can regulate the heat of the air without leaving the room. The registers are in every case underneath the windows between the piers.

The vent ducts shown on cellar plan are made of pine lined with zinc. They commence 16 inches square and increase to 22 inches square for each side of the ward and then connect into a main duct 36 x 27 inches, their position being against the ceiling At *S*, cellar plan, the main ducts from each pavilion enter a short down-shaft, that they may connect with the aspirating shaft below the floor to avoid destroying the head room at the stairs. From the points marked *D D* on the ducts near the middle of wards, the vent duct *(V A)* is divided by a midriff in a horizontal plane. The object of this is to increase the certainty of all the vent openings under the bed drawing alike. At *D D*, also, are shown branch ducts entering stacks in the middle of large wards. These stacks are to be used to exhaust the ducts in times when no heat is in the main aspirator or to be used as auxiliary to it.

Provision is made for a stove at the foot of each stack and fireplaces in the pavilion wards also open into it. The latter are intended for damp weather in summer, etc.

At *SS*, in the sun rooms, coils of pipe are run under the windows for extra warmth.

The ventilation of this hospital was designed by Dr Morrill Wyman, and has proved very satisfactory. Dr Wyman informs me that the heating is hardly sufficient in very cold weather, when hot water is used, the mains being too small, but steam has not been used for several years owing to the extra labour required in maintaining fires."

[VH, 316-319]

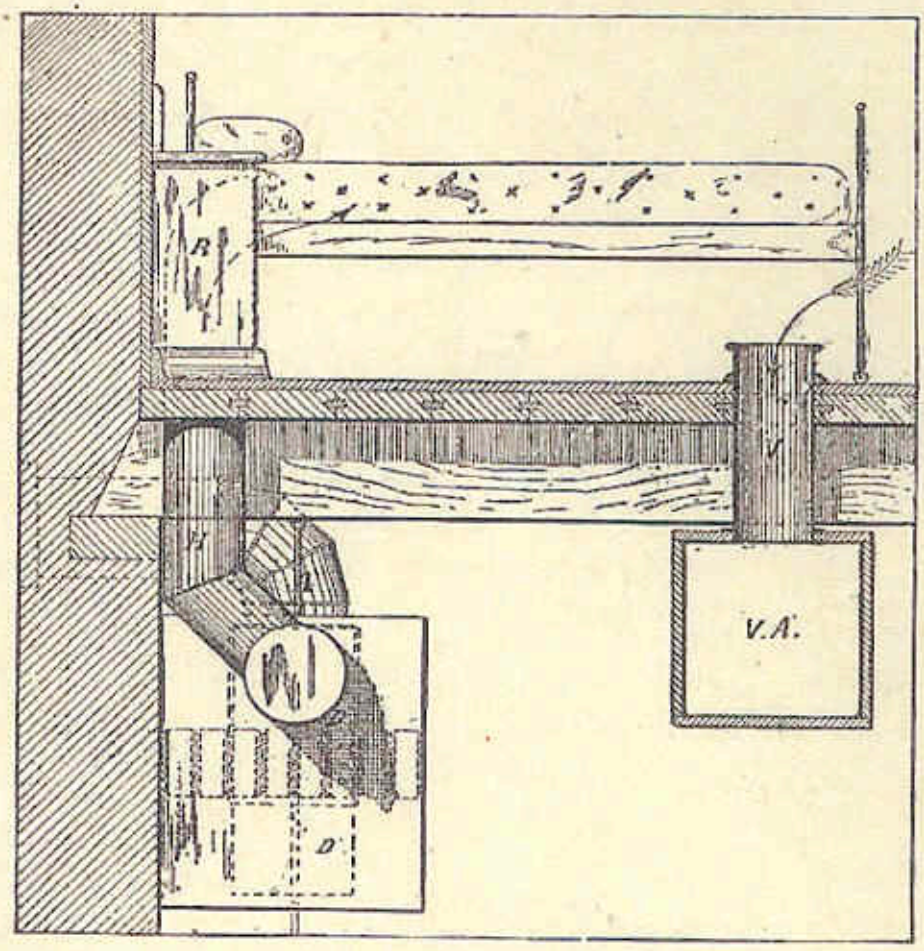


FIG. 83.

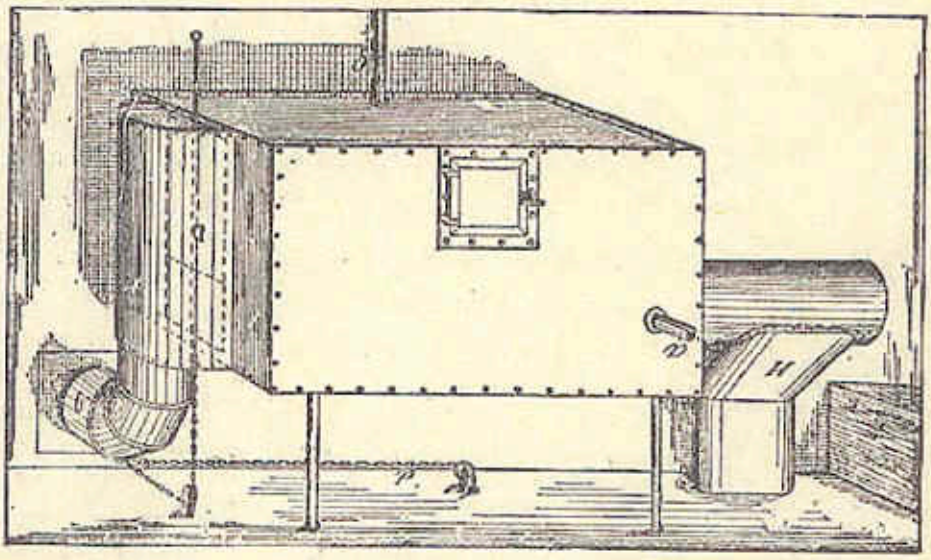
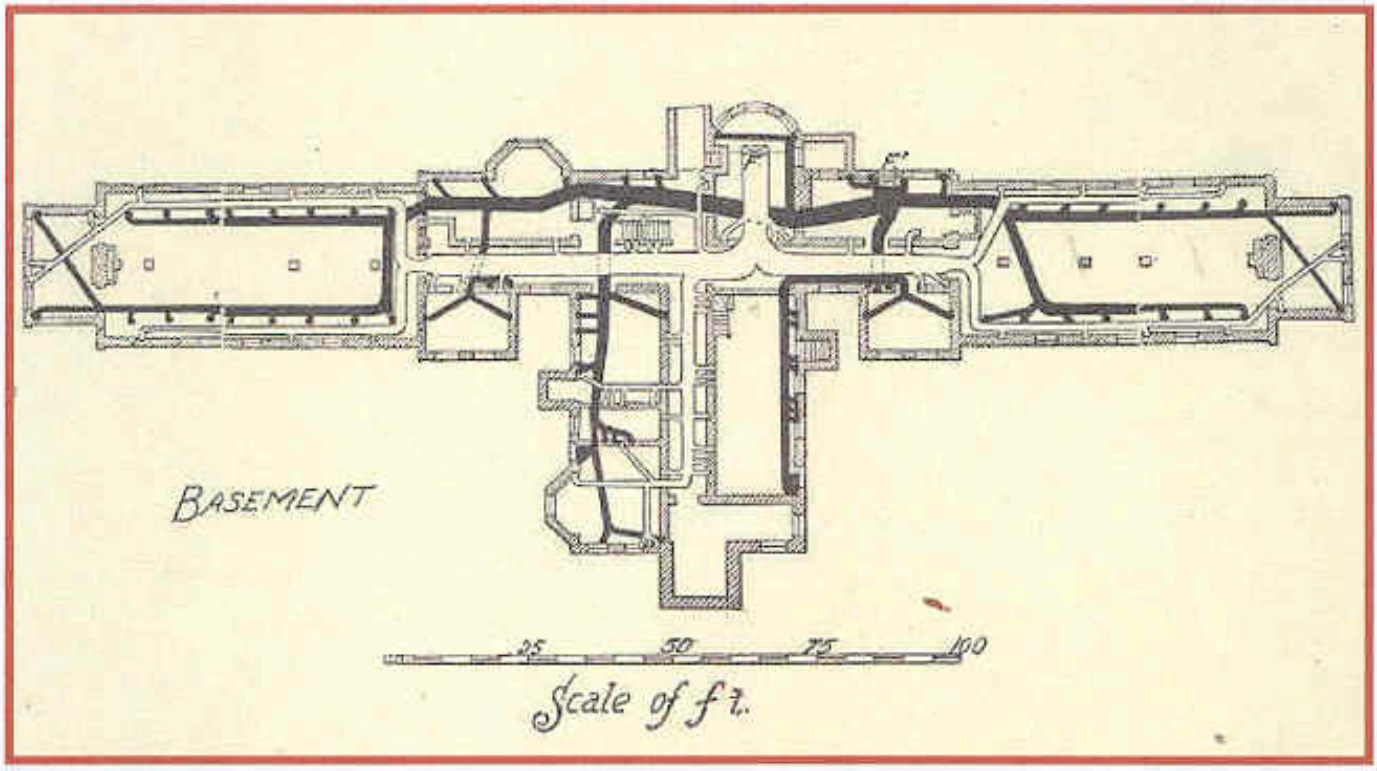
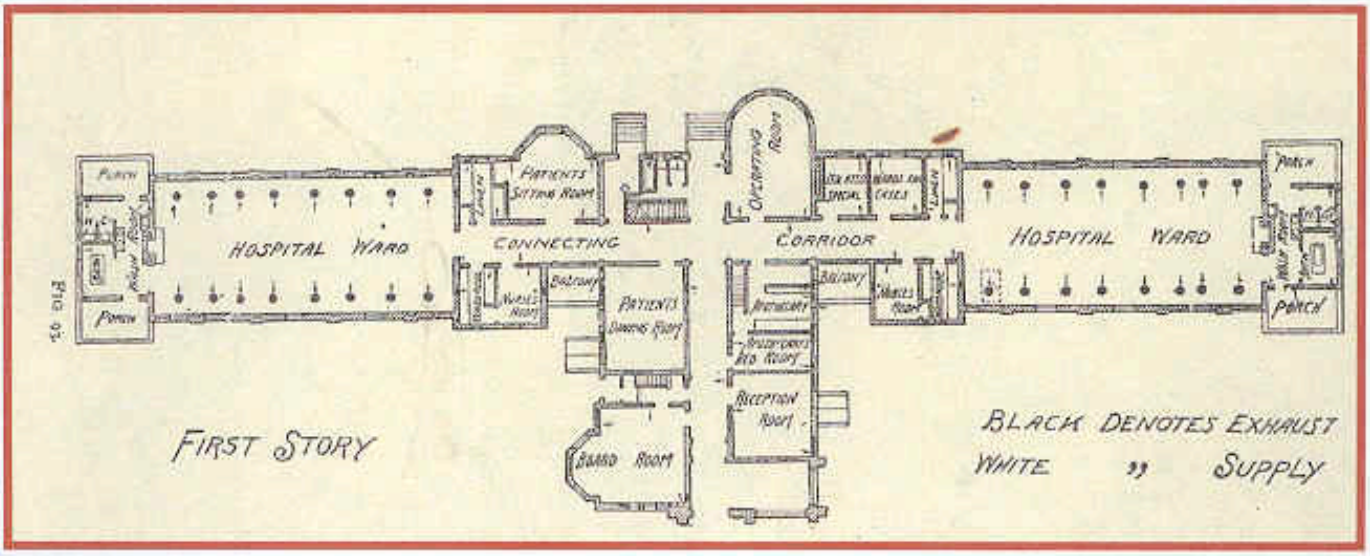


FIG. 84.

Detail of *Pin*-type radiators and air-boxes [VH, 318]

MINER'S HOSPITAL, HAZELTON, PENNSYLVANIA





Mechanical ventilation arrangements.
[VH, 325-26, *The Engineering Record*, 18 January 1890]

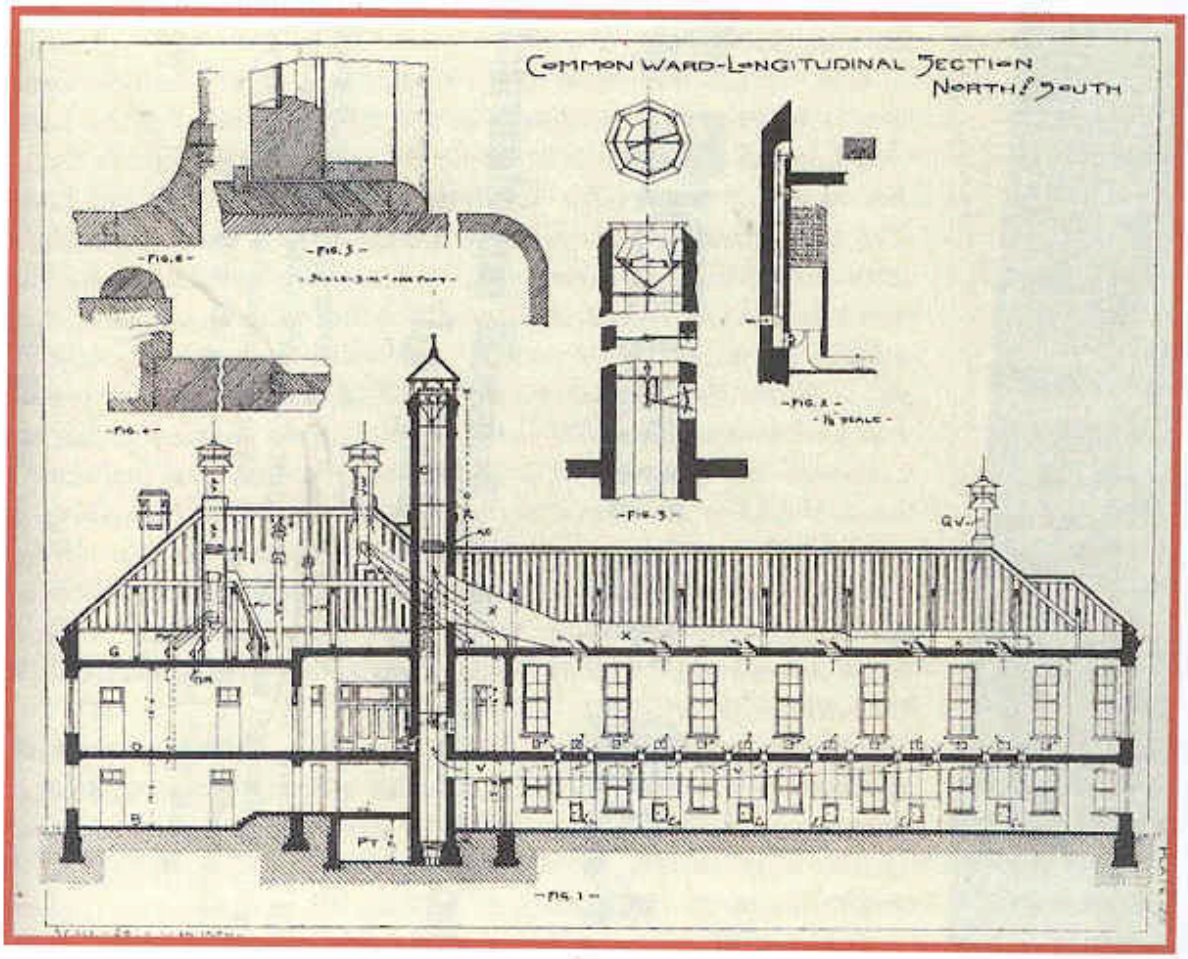
MINER'S HOSPITAL, HAZELTON, PENNSYLVANIA

The basement plan shows a "propelling fan" at F (top of drawing, centre) of 4 feet 6 inches diameter which forces fresh air through a radiator chamber and thence through the outlined ducts. The ducts indicated in solid black are for foul air and lead to an exhaust fan F' (top of drawing, just right of centre), also 4 feet 6 inches in diameter, discharging into a chimney.

The ward plan shows the position of the multiple foul air extraction points in the floor (one per bed?). The design is designed to provide an air change rate of 4 times per hour. The building is some 160,000 cubic feet in volume and the heat and power are furnished by two connected 30 horse power horizontal tubular boilers. (1 boiler horse power = 33,475 Btu/h).

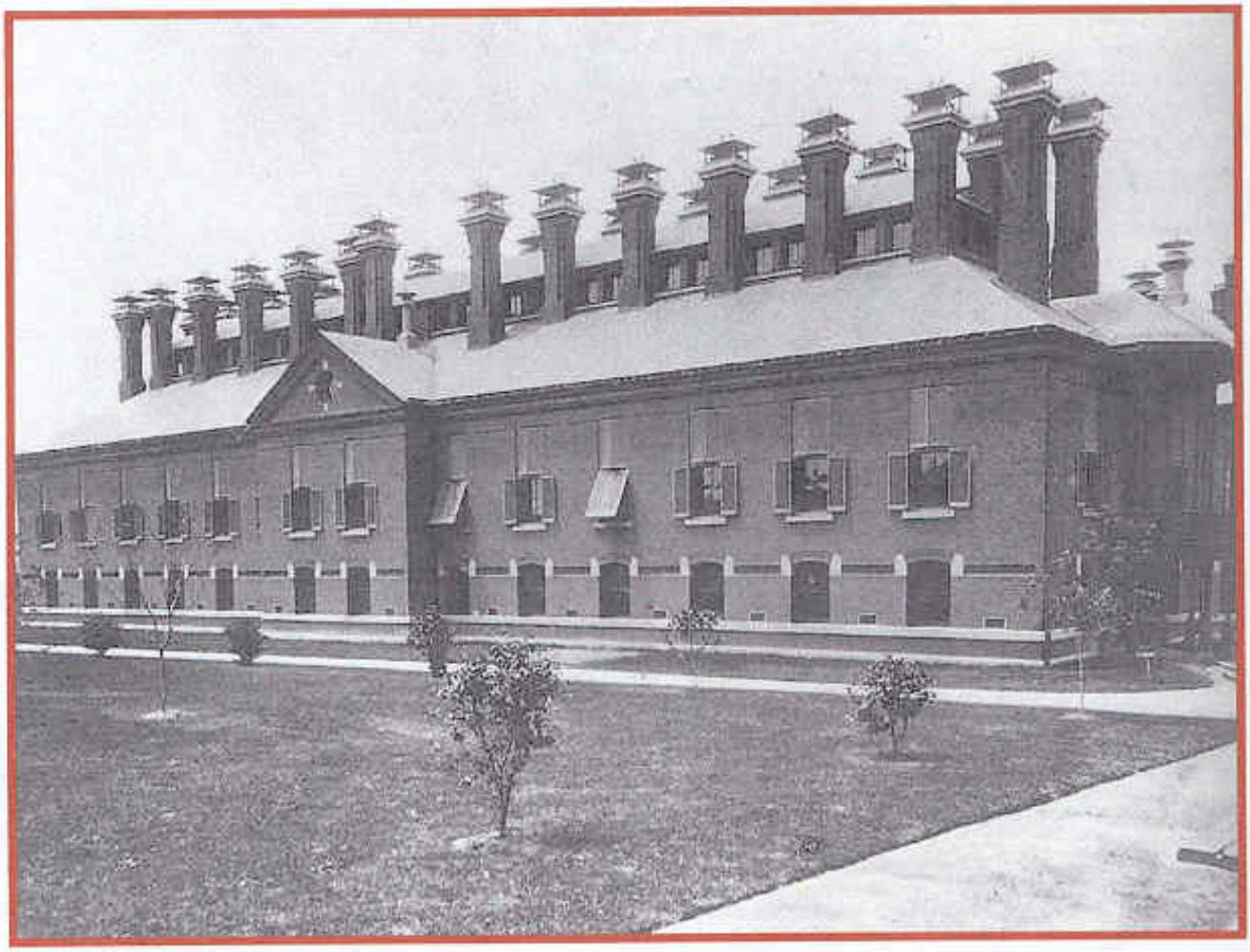
[VH, 324-26, from *The Engineering Record*, 18 January 1890]

JOHN HOPKINS HOSPITAL, BALTIMORE



[Top] A Common Ward equipped with iron *blacksmith beds* with ventilation supply air ducts located under each bed, c.1885 [AUS, plate 104]. [Bottom] Ventilation system for Common Ward, c.1880 [AUS, plate 106].

JOHN HOPKINS



The *Isolating* Ward block where each patient had a separate room with its own ventilating system, the foul air being exhausted through the ranks of *aspirating chimneys* (pictured) [AUS, plate 105]

JOHN HOPKINS

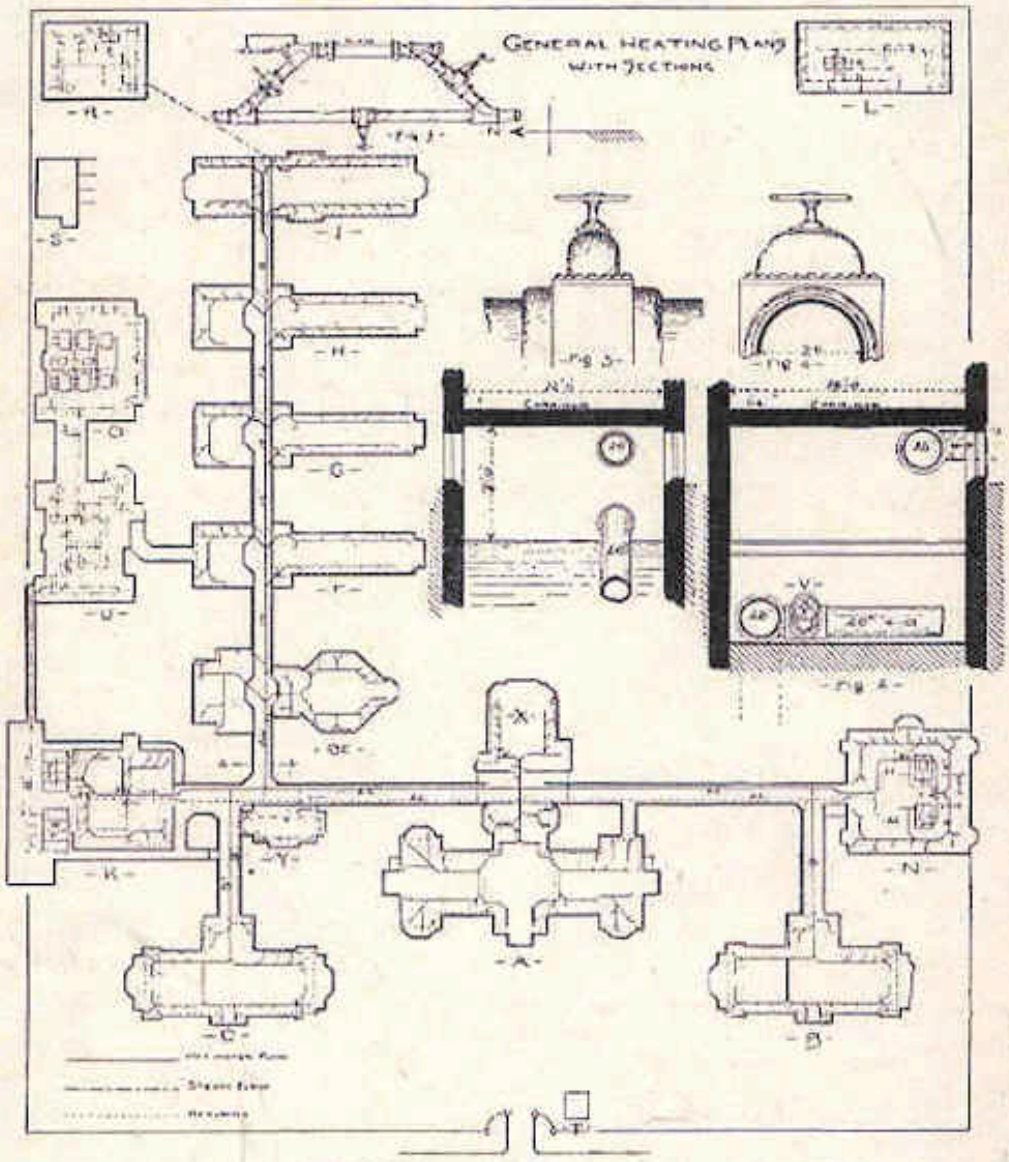


FIG. 99.—BLOCK PLAN OF JOHNS HOPKINS HOSPITAL.

A.—Administration building.
B C.—Pay wards.
D E.—Two-story octagon ward.
F G H.—Common wards.
I.—Isolation ward.
K.—Kitchen.
L.—Laundry.
N.—Nurses' home.
O.—Dispensary.
R.—Mortuary.
S.—Stable
T.—Janitor's lodge.
U.—Amphitheater.
X.—Apothecaries' building.
V.—Baths.
Fig. 2.—Cross-section of corridor and pipe tunnel beneath.
Figs. 3-4.—Cut-off valve on hot-water main.

Block Plan [VH, fig.99]

JOHN HOPKINS

In his book of 1893 Billings wrote, "One of the most satisfactory of existing hospitals as regards its heating and ventilation is the John Hopkin's Hospital in Baltimore (see the block plan). In this hospital the heating of all the wards and of the administration and apothecaries' buildings, the nurses' home and the kitchen is effected by hot water, the heat being furnished by four boilers in the vaults of the kitchen building and two in the cellar of the nurses' home, each boiler being 16 feet long, 5 feet in diameter and containing 106 $3^1/_2$ inch tubes. The outflow main is 26 inches in inside diameter and the entire system contains about 175,000 gallons (US) of water.

The heating of the amphitheatre and dispensary is effected by low-pressure steam from boilers in the kitchen building. Figure 100 shows the main floor plan, Fig. 101 the basement and attic plans, Fig.102 a longitudinal section and Fig.103 a cross-section of one of the common wards.

The common wards are each contained in a separate pavilion of one storey with a basement. The basement is devoted entirely to heating and ventilation purposes, forming practically a large, clean air chamber containing the hot-water coils for heating, and from which the air supply for theses coils can be taken when desired. Usually, however, the supply is taken directly from external air. Each of these wards is practically a separate small hospital, and it is impossible to pass from one ward to the other, or from the corridor which connects the basements to the wards, without going into the open air.

Each of the wards has a separate aspirating chimney, located as shown in the plans, in an octagonal hall or vestibule on the connecting corridor. Into this chimney empties a foul-air duct, which runs longitudinally beneath the centre of the floor of the ward, and which receives the air from lateral ducts opening beneath the foot of each bed. The main foul-air duct is made of wood, lined with galvanised iron, and cylindrical in shape.

A similar duct is placed above the ceiling and communicates with the ward by five openings in the ceiling, in the longitudinal central axis. Just above where this upper duct enters the chimney, there is placed in the shaft a coil to be heated by high-pressure steam when it is necessary to quicken the aspirating movement.

It will be seen, therefore, that the foul air can be taken either at the level of the floor beneath the beds or from the centre of the ceiling: the first method being employed in winter and the second in summer.

The main central aspirating chimney is devoted to the ventilation of the ward only. All the service rooms have separate and independent exit shafts of galvanised iron passing up through the roof, and capped with a modification of the Emerson ventilator.

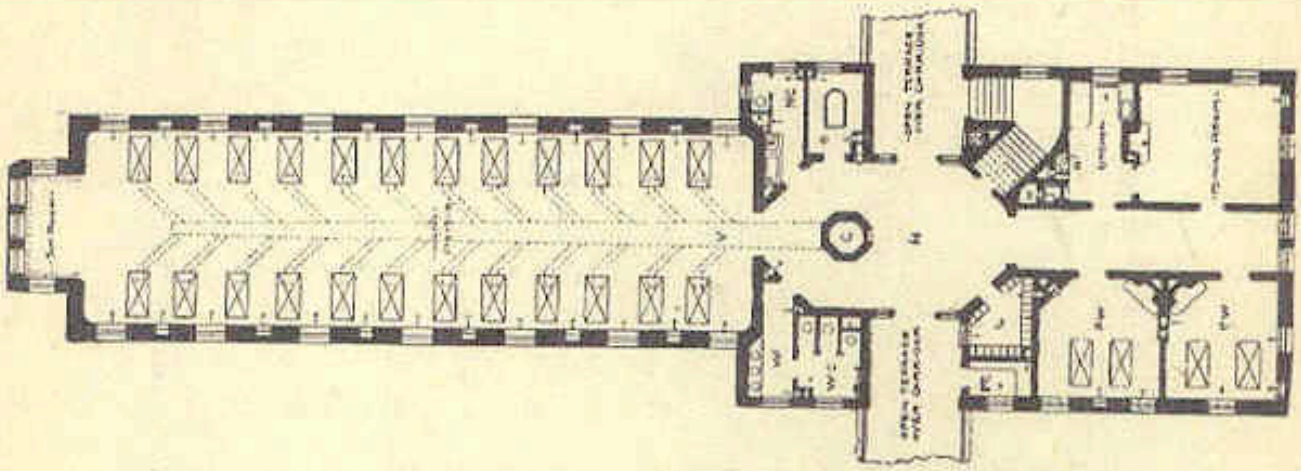


FIG. 100.—FLOOR PLAN OF COMMON WARD, JOHNS HOPKINS HOSPITAL.

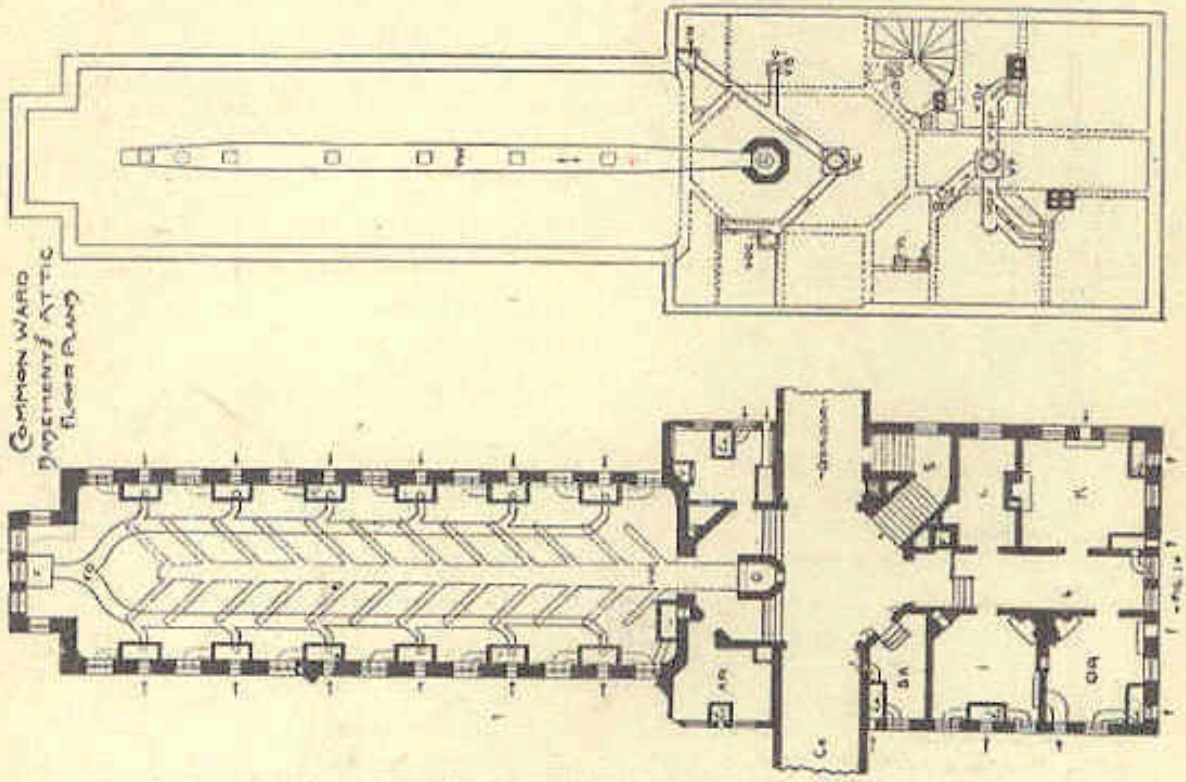
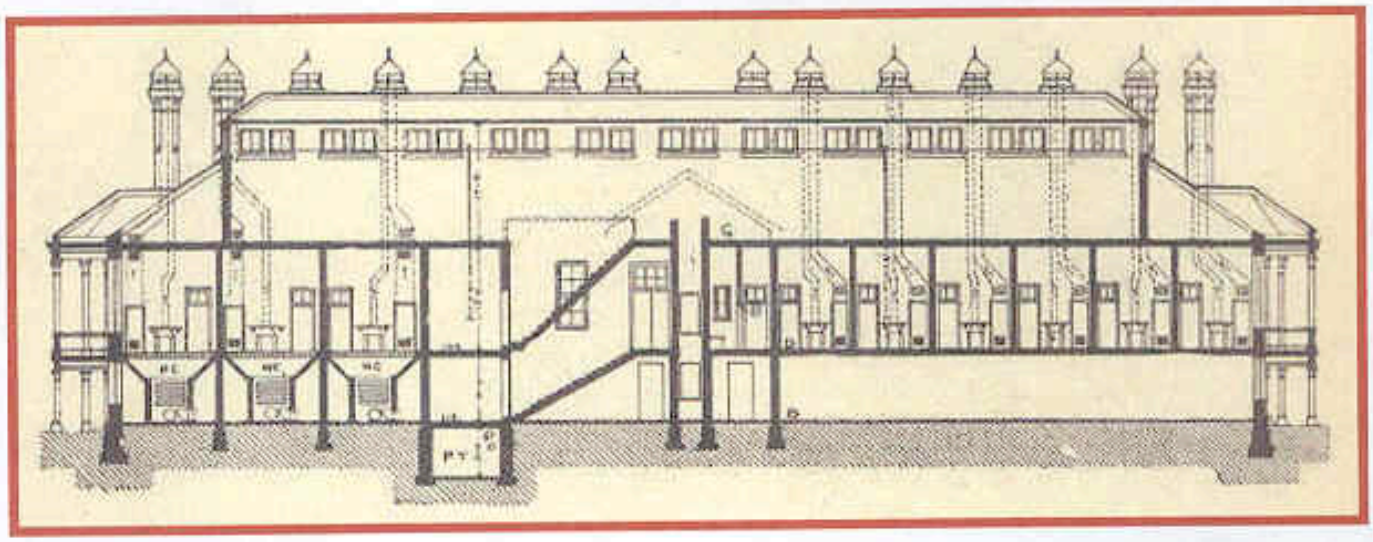


FIG. 101.—BASEMENT AND ATTIC PLANS OF COMMON WARD.

Plans of Common Ward showing ventilation ducts [VH, figs.100 & 101]



Ventilation arrangements in Isolating Ward [VH, fig.73]

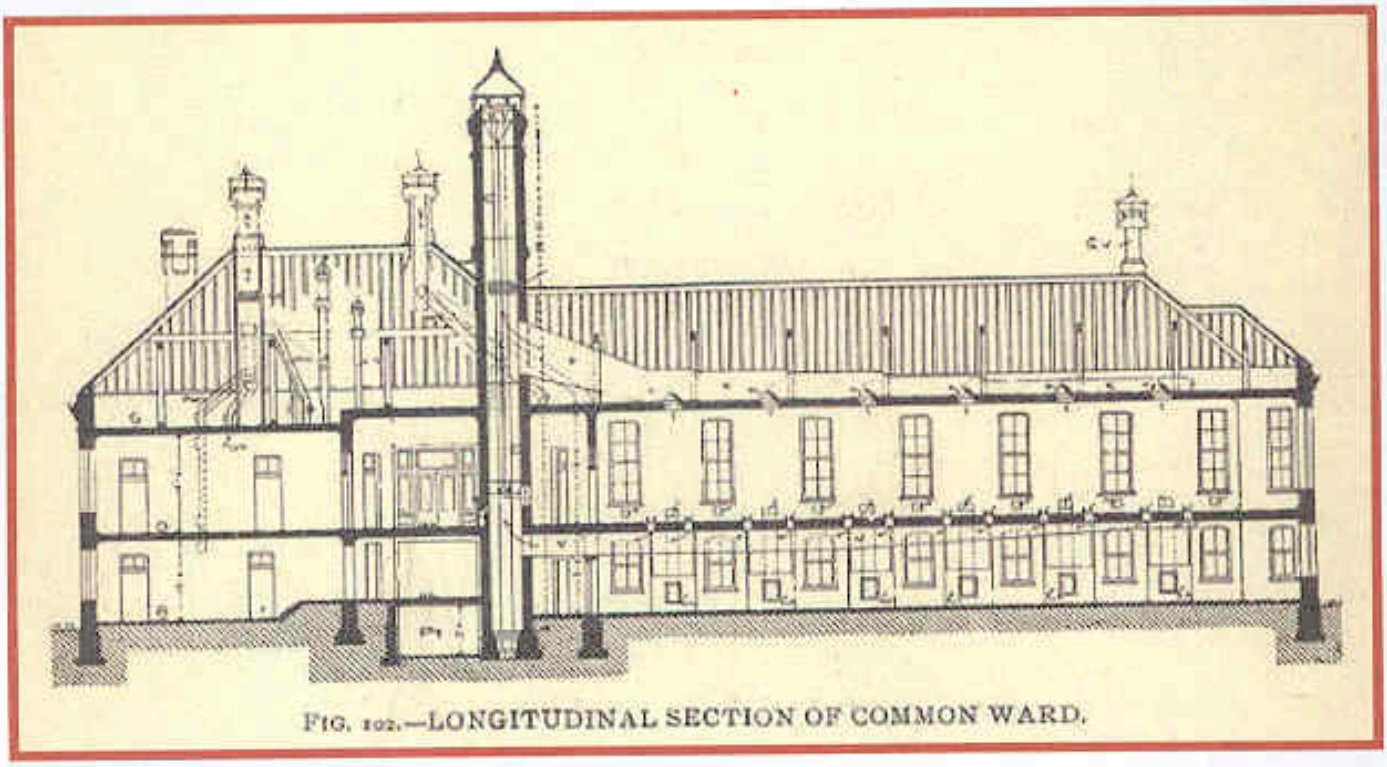


FIG. 102.—LONGITUDINAL SECTION OF COMMON WARD.

Ventilation arrangements in Common Ward [VH, fig.102]

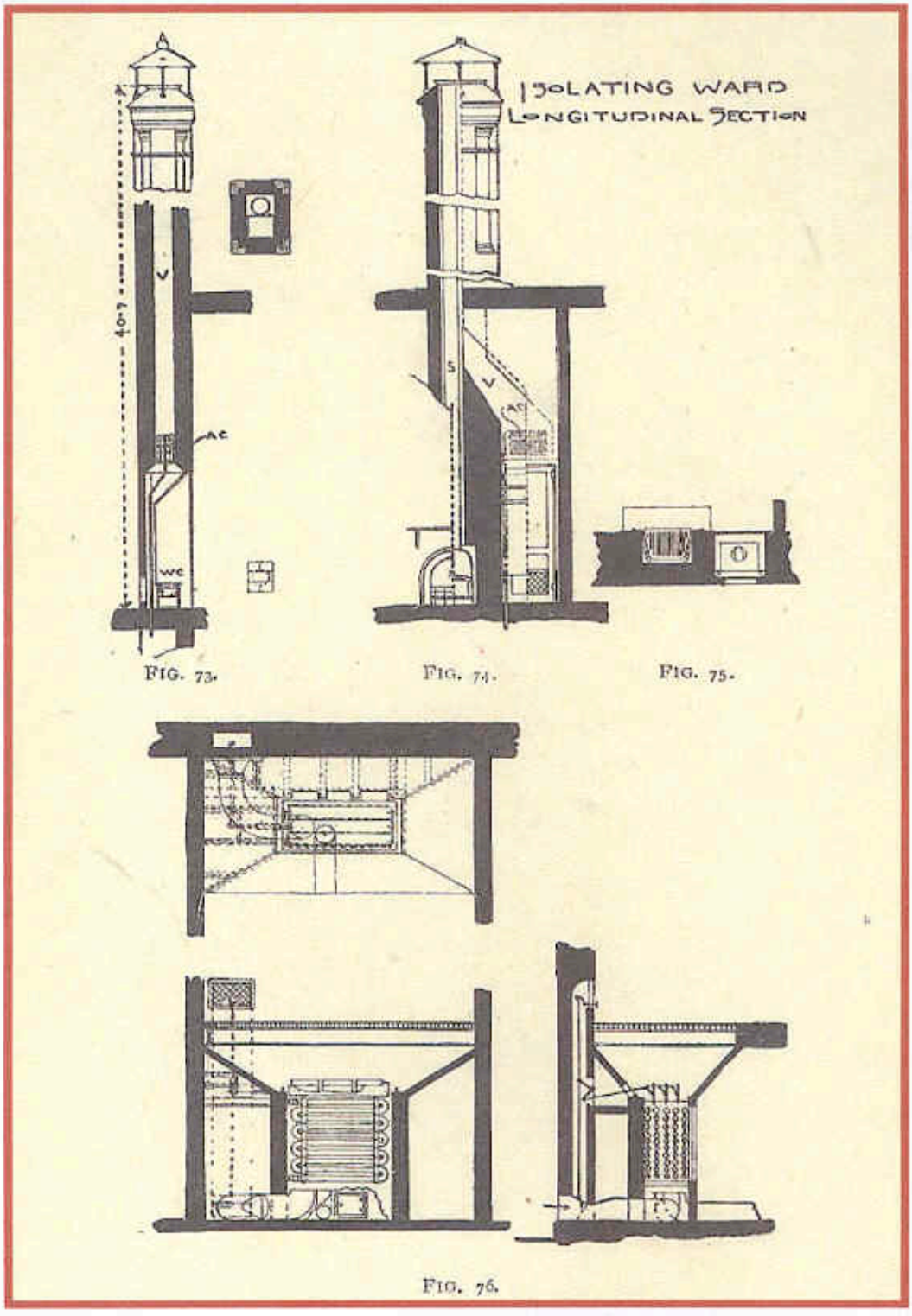
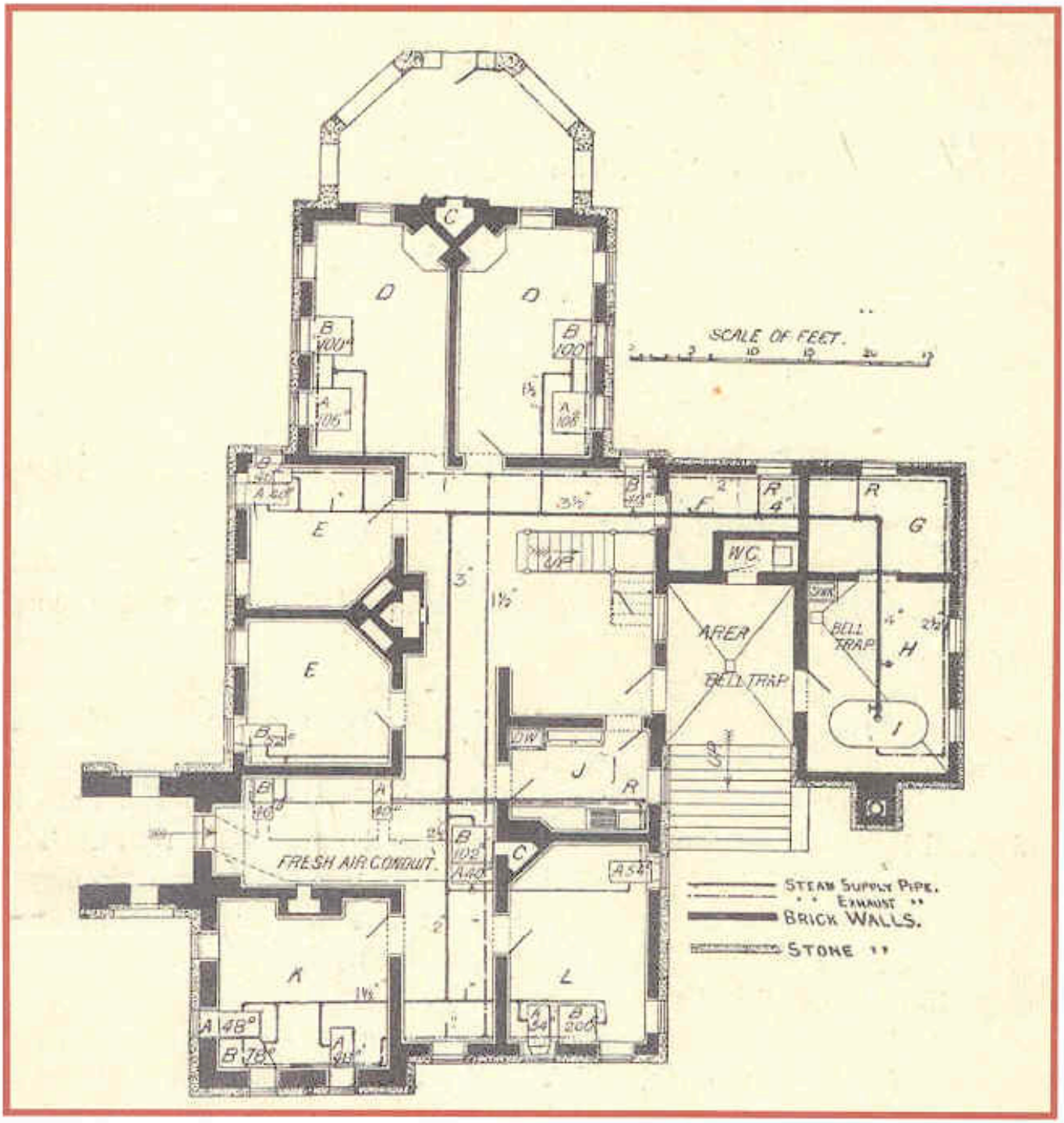


FIG. 73. FIG. 74. FIG. 75.

FIG. 76.

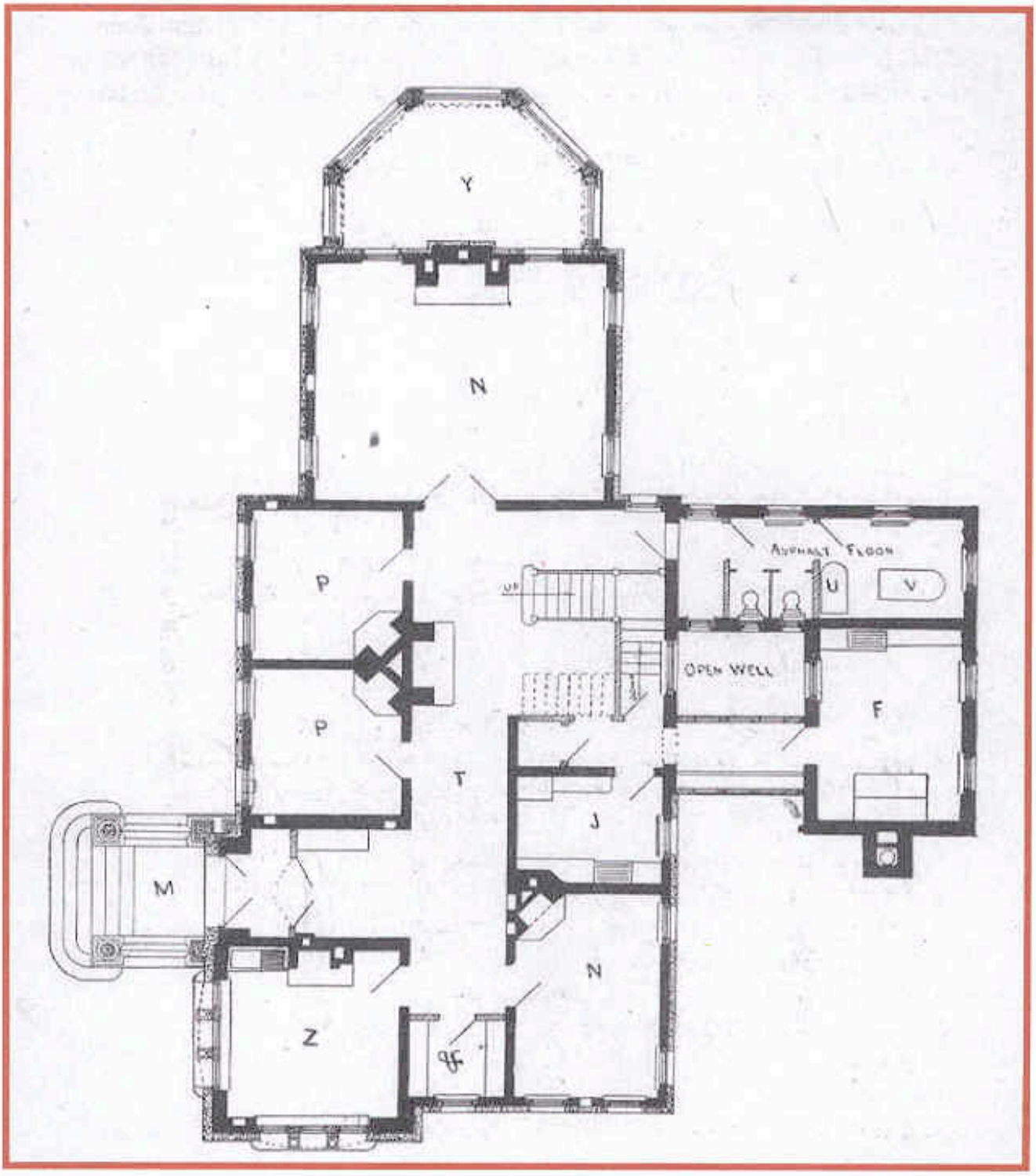
Details of heating & ventilation in Isolating Ward [VH, p.310]
Fig.74 ventilating closet: Fig.75 shows fireplace & commode
Fig.76 shows heaters in 3 larger rooms with 5000 ¼" holes for fresh air

McCOSH INFIRMARY, PRINCETON, NEW JERSEY



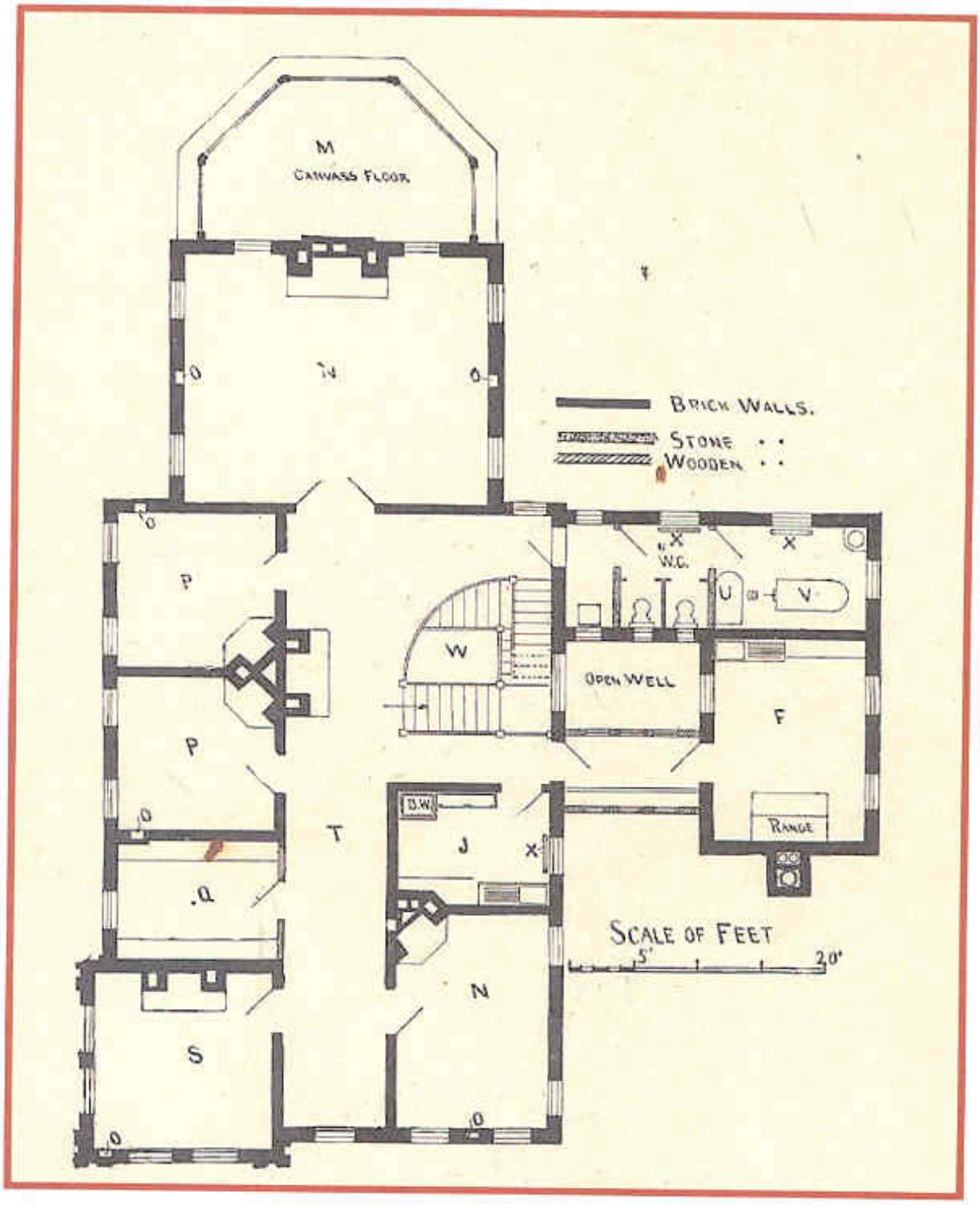
Basement Plan; Section shows fresh air ventilation ducts and steam heating mains, c.1890 [VH, 320]

McCOSH INFIRMARY



Typical Floor Plan. Steam heated by radiators with fresh air inlets behind, ventilation being assisted by open fireplaces [VH, 321]

McCOSH INFIRMARY



Another Floor Plan. Steam heated by radiators with fresh air inlets behind, ventilation being assisted by open fireplaces [VH, 322]

McCOSH INFIRMARY

The Isabella McCosh Infirmary at Princeton New Jersey was built as a small hospital for the benefit of sick students. Ventilation is by open fireplaces. Heating is by steam (the area of heating surface in square feet for each room is marked on the "radiator stacks" shown on the basement plan.) Each set of radiators receives fresh air from outside and by means of a mixing valve (damper) operated from each room. The temperature of the supply air is thus regulated without diminishing its flow. Every heat flue has its separate set of radiators, fresh air supply and mixing valve, and can be operated independently of any other heat flue.

The reference letters indicate the following: A & B = radiator stacks; C = ash pit; F = basement coal vault; G = coal vault; H = boiler room; I = a double "Florida" boiler No. 66; R = steam pipe riser; and X= direct radiator: other letters are a key to room names.

The detail drawing is a vertical section through a radiator case = A. External cold air enters through the copper wire screen C' over an aperture in the basement wall W, and when dampers are in a certain position, passes through cold-air chamber E and a perforated tin plate G to the radiator box F, which contains a Gold's pin radiator (not shown), rises to hot air chamber H and is delivered through the flue I and the register J to the room. K is a clean-out door while D =damper and L =regulating handle; also M = mixing valve (shown wide open for hot air), and operated by rod N and crank P and lever handle O which can be locked by the set screw Q.

[VH, 319-24]

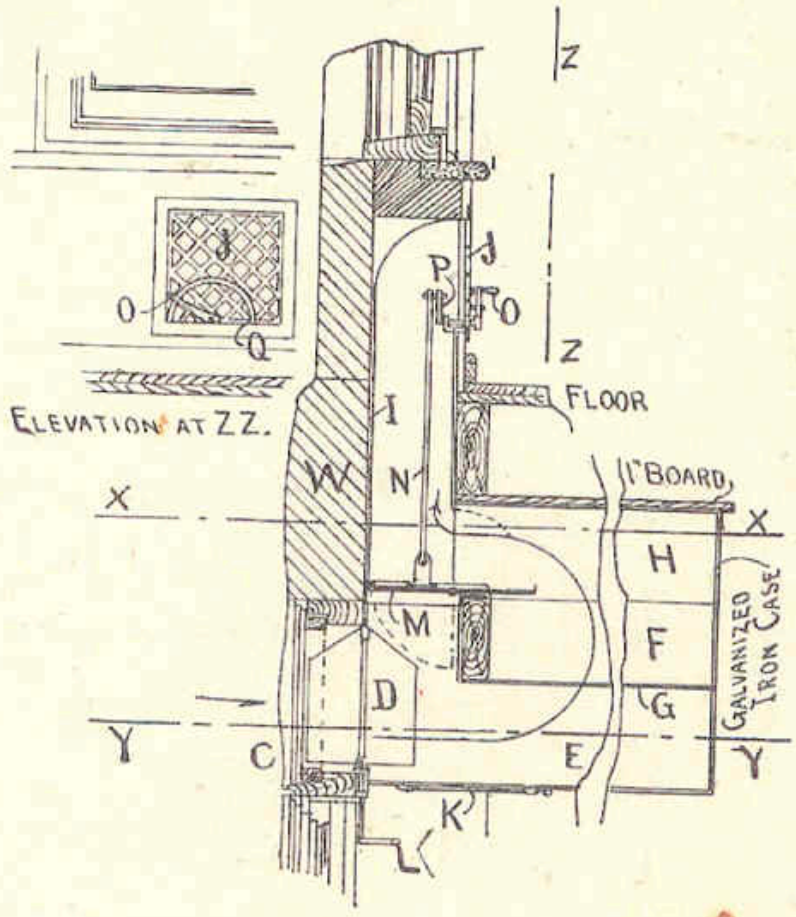


FIG. 88.

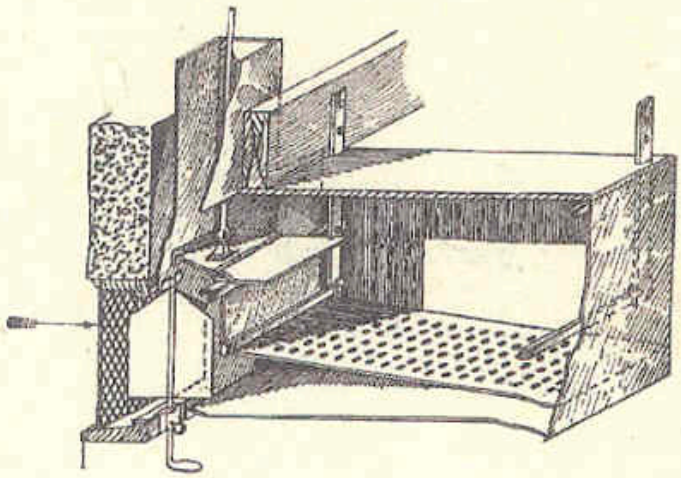
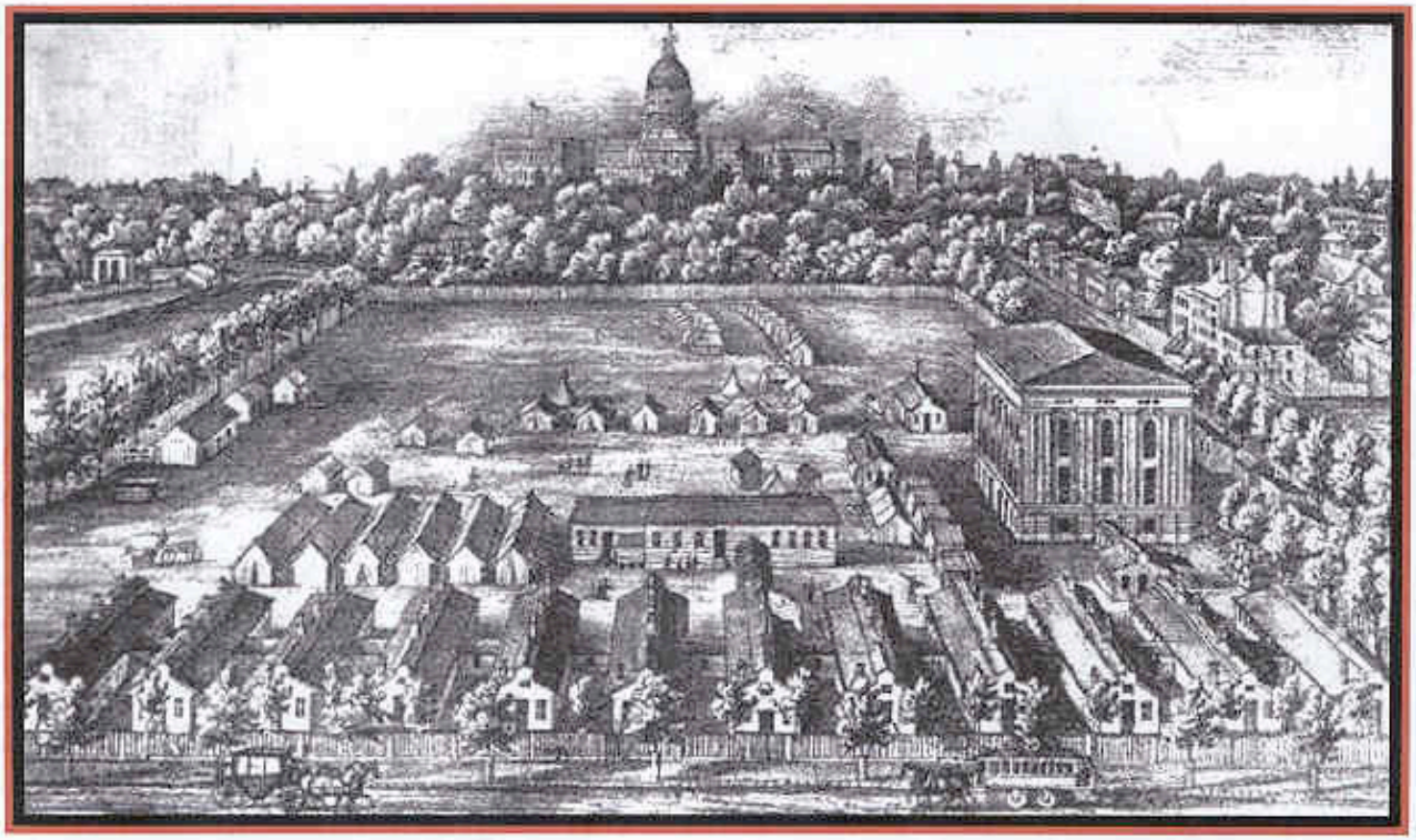


FIG. 89.

Radiator casing and fresh air damper arrangement
[VH, 323, from *The Engineering Record*, 11 June 1892]

ARMORY SQUARE HOSPITAL, WASHINGTON
AMERICAN CIVIL WAR

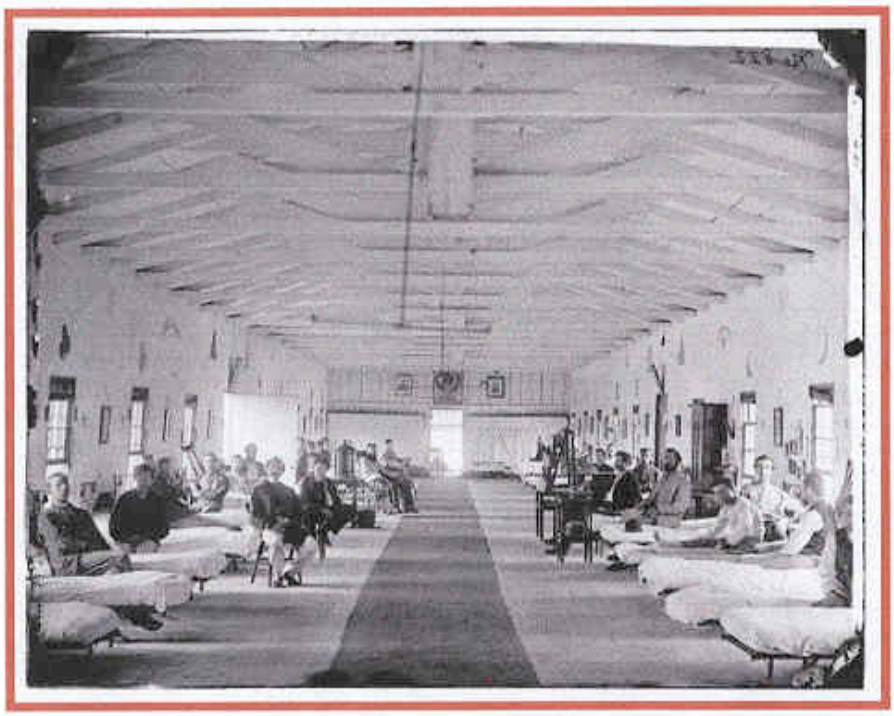


Armory Square Hospital, Washington DC, 1865 with newly built Capitol in background

ARMORY SQUARE

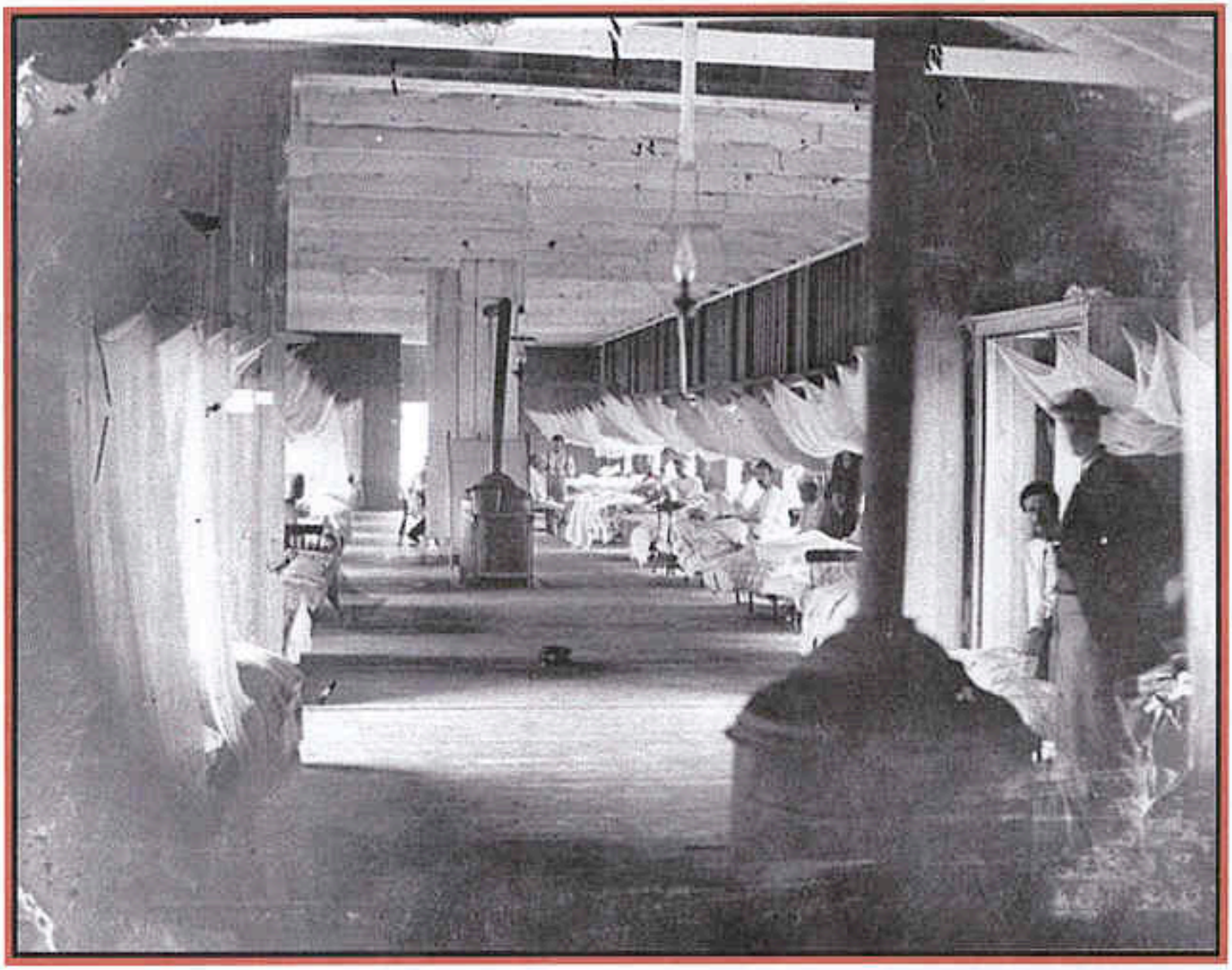
Armory Square Hospital, Washington DC, possibly decorated for the end of the war, 1865 [CW, 299].
There is a number of heating stoves behind the patient in a wheelchair (centre).

ARMORY SQUARE



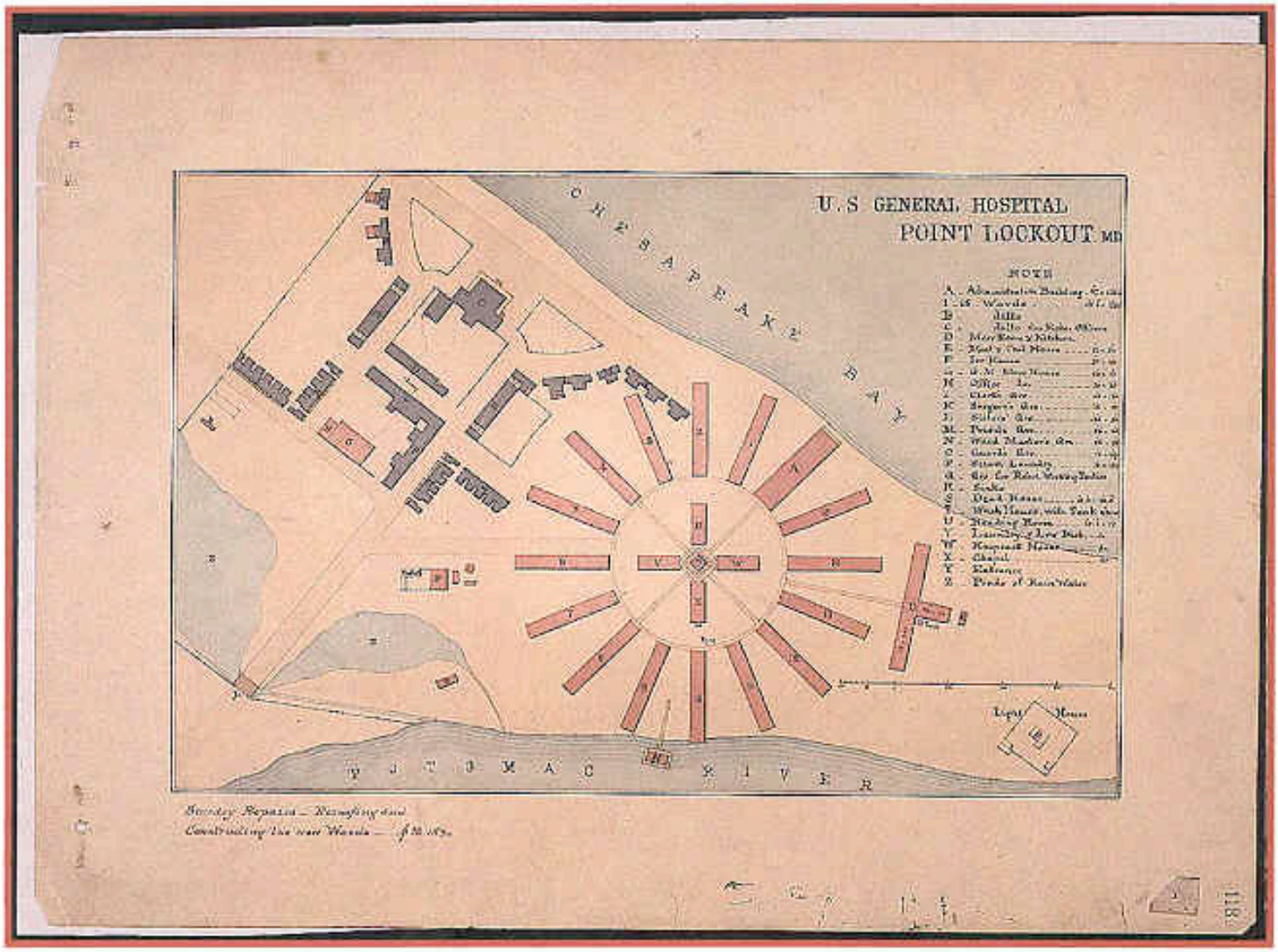
[Top] Armory Square [source unknown].
No means of heating is visible in this photograph, but gas lighting is provided.
[Bottom], Ward with four solid-fuel heating stoves visible [unknown]..

HAREWOOD HOSPITAL, WASHINGTON
AMERICAN CIVIL WAR



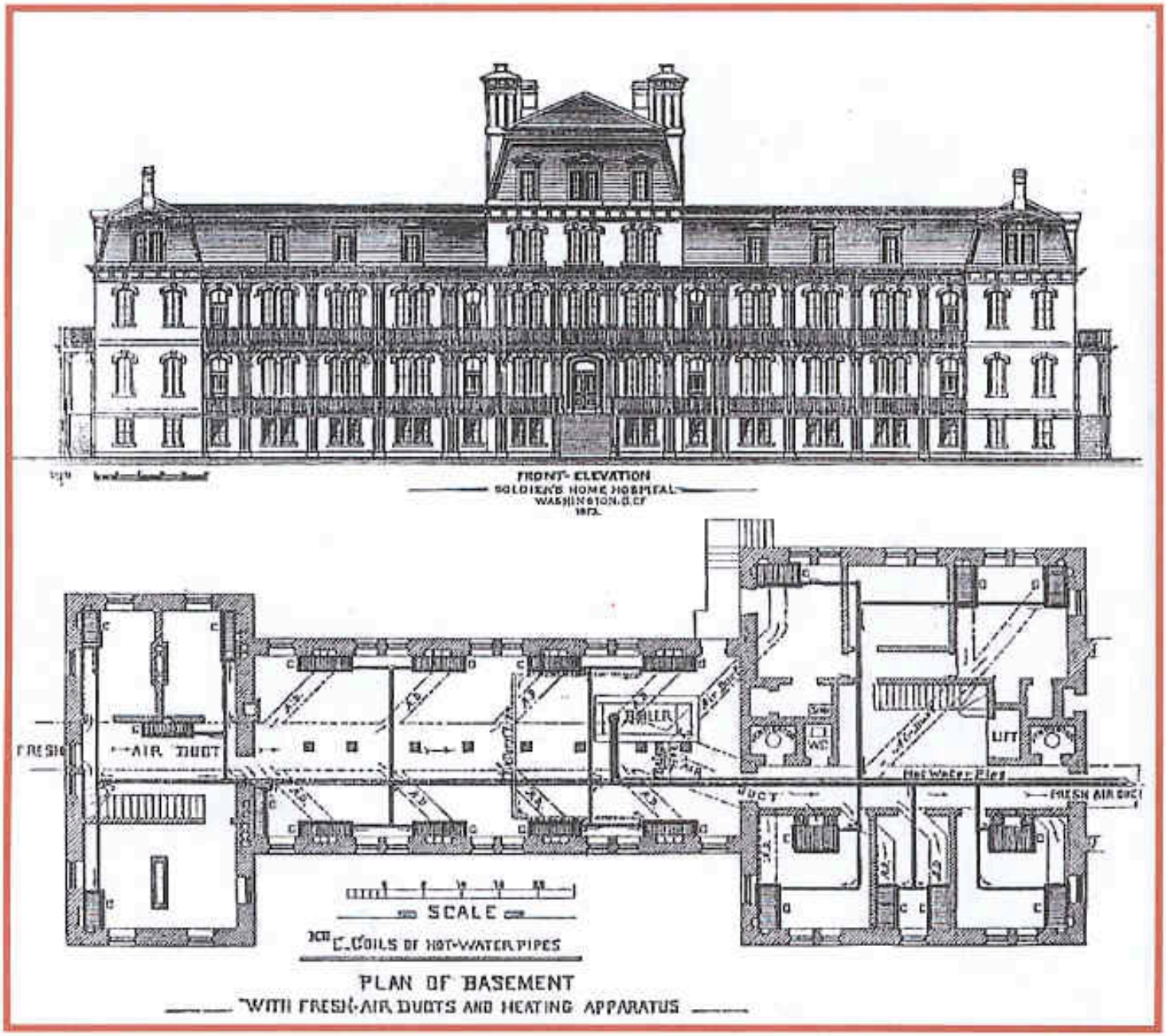
Harewood Army Hospital, Washington DC, 1860s [CW, 298]
The photograph shows heating by solid-fuel stoves and lighting by kerosene lamps.

POINT LOOKOUT HOSPITAL
AMERICAN CIVIL WAR



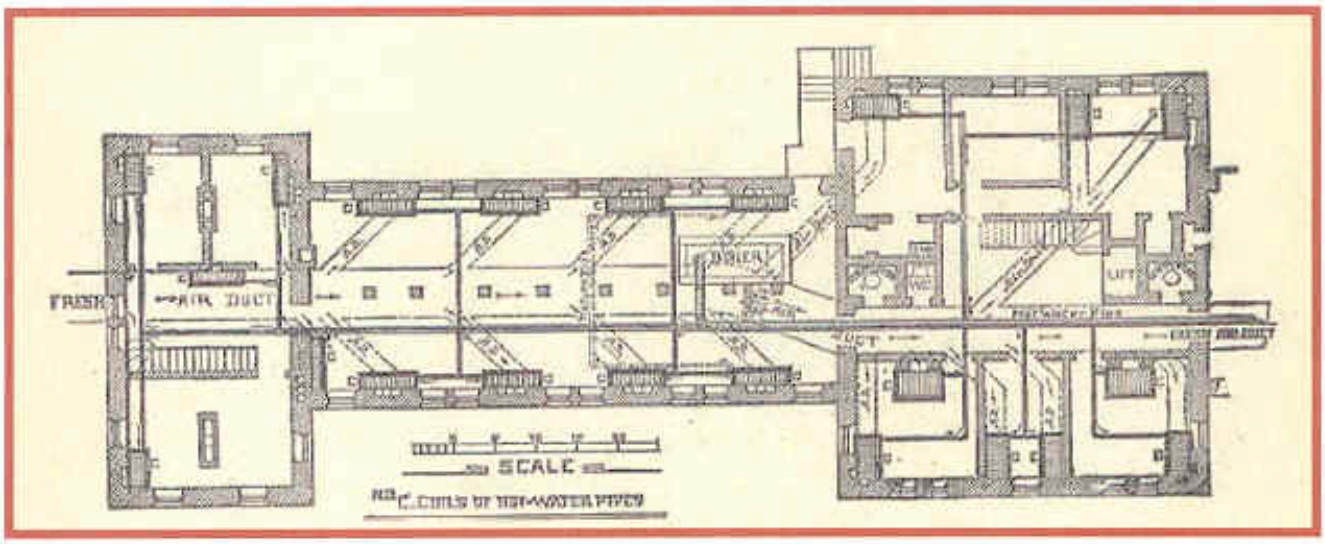
US General Hospital, Point Lookout on the Potomac River, Maryland [source unknown]
Buildings include Kitchen, Coal House, an Ice House, a steam Laundry, "Sinks,"
a Wash House, another Laundry, and Ponds of Rainwater.

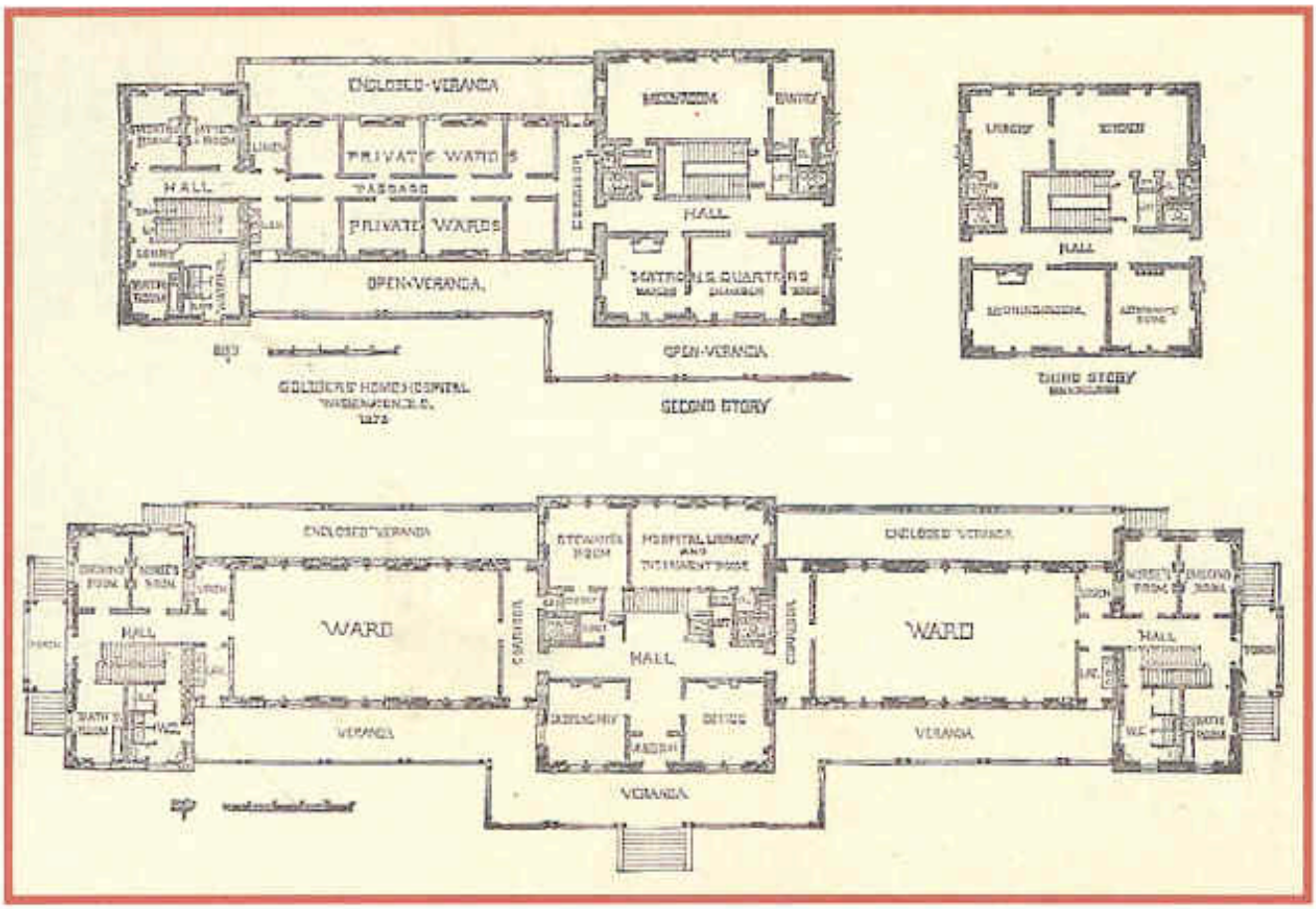
SOLDIER'S HOME HOSPITAL, WASHINGTON DC



Basement plan shows boiler, fresh air inlet ducts and risers to wards above, with air warmed by hot water pipe coils, 1883 [MES, 174]

SOLDIER'S HOME





Plans of Basement & Ward Floors showing mechanical ventilation system and hot water heating apparatus [VH, 327 & 329]

NEW YORK HOSPITAL

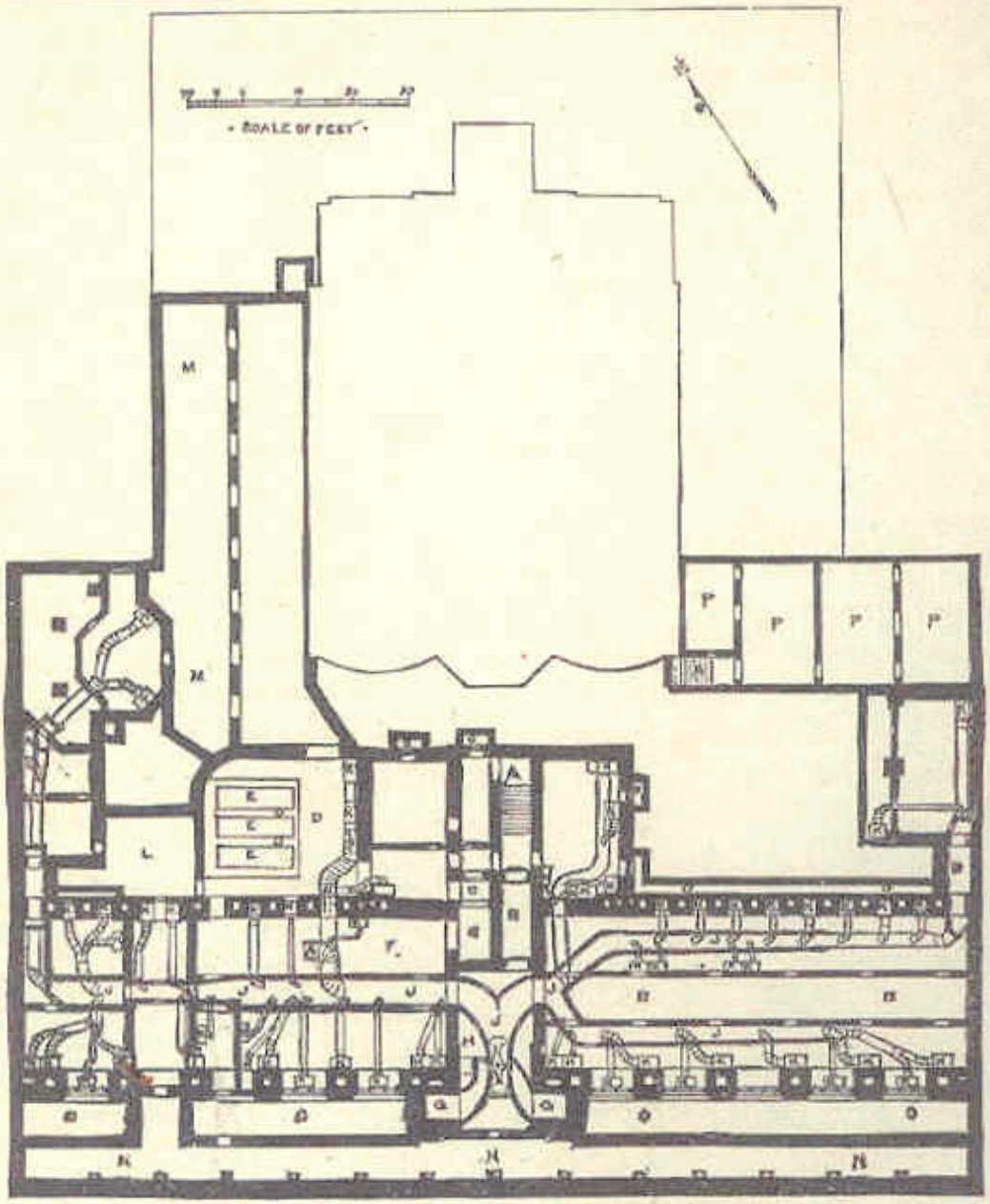


FIG. 96.—NEW YORK HOSPITAL BUILDINGS.—PLAN OF CELLAR.

A.—Stairs.
B.—Corridor.
C.—Elevator.
D.—Boiler room.
E.—Boiler.
F.—Engine room.
G.—Fresh-air duct.
H.—Engine.
I.—Fan blower.
J.—Cold-air duct.
K.—Steam coils.
L.—Ash vaults.
M.—Coal vaults.
N.—Vaults.
O.—Area.
P.—Vegetable vaults, etc.
Q.—Ice house.

Basement Plan of New York Hospital [VH, 332]
The drawing shows 3 boilers in the boiler room, the coal storage area, the ash disposal vaults, the fresh air and cold air ducting, steam heating coils and supply fan (blower).

NEW YORK HOSPITAL

The designs for the New York Hospital were prepared by the well-known architect G B Post in 1875. With limited ground area, a multi-storey option was decided upon.

The general arrangement is shown on the drawings. The building is brick-built with 163 beds. In the wards there is one window to each bed, each external pier of the building being an exhaust flue, lined with hollow bricks to minimise heat loss. Through the centre of these vertical flues run cast-iron pipes, intended to be fitted as airtight, through which fresh air is admitted to the building by a fan. The exhaust flues are connected to roof level extract fans.

Heating is by steam, with heating coils located at the bottom of the fresh air inlet pipes and being fitted with an air bypass damper arrangement. Fresh air is discharged into the wards through slits in the window sills, being likened to the jet of air on the principle of Tobin's tubes. Foul air extract is partly through the walls of the piers and partly from beneath the beds.

A review by Billings [VH, 333-34] notes there is uncertainty about air distribution due to the interconnection between staircase halls and elevator shafts but admits to a fair degree of success with the system. However, Billings notes that the average air supply is about 2400 cubic feet per bed per hour, which he considers insufficient. He is critical of the principle of placing fresh-air pipes inside the foul-air ducts, anticipating future leakage due to rusting of the iron pipes and due to alternate expansions and contractions. He also notes that the iron pipes are enclosed within the walls and that there is no way of checking their condition.

New York Hospital

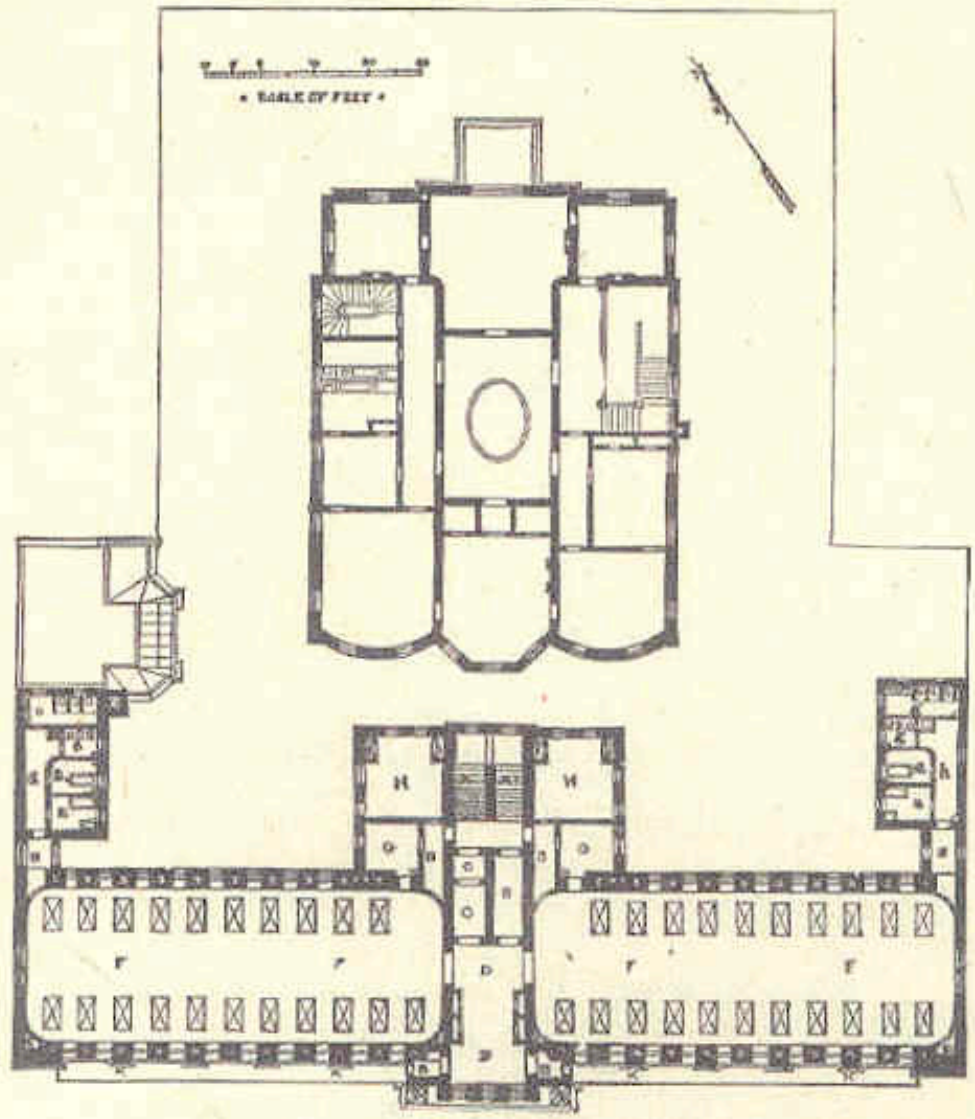


FIG. 97.—NEW YORK HOSPITAL BUILDINGS.—PLAN OF SECOND, THIRD AND FOURTH STORIES.

MAIN BUILDING.

A.—Stairs.
B.—Corridor.
C.—Elevator.
D.—Hall.
E.—Closet.
F.—Ward.
G.—Nurses' room.
H.—Dining room.
I.—Dumb waiter.
J.—Ventilating duct.
K.—Balcony.

WEST WING.

a.—Bath-room.
b.—Sink.
c.—Toilet room.
d.—Corridor.

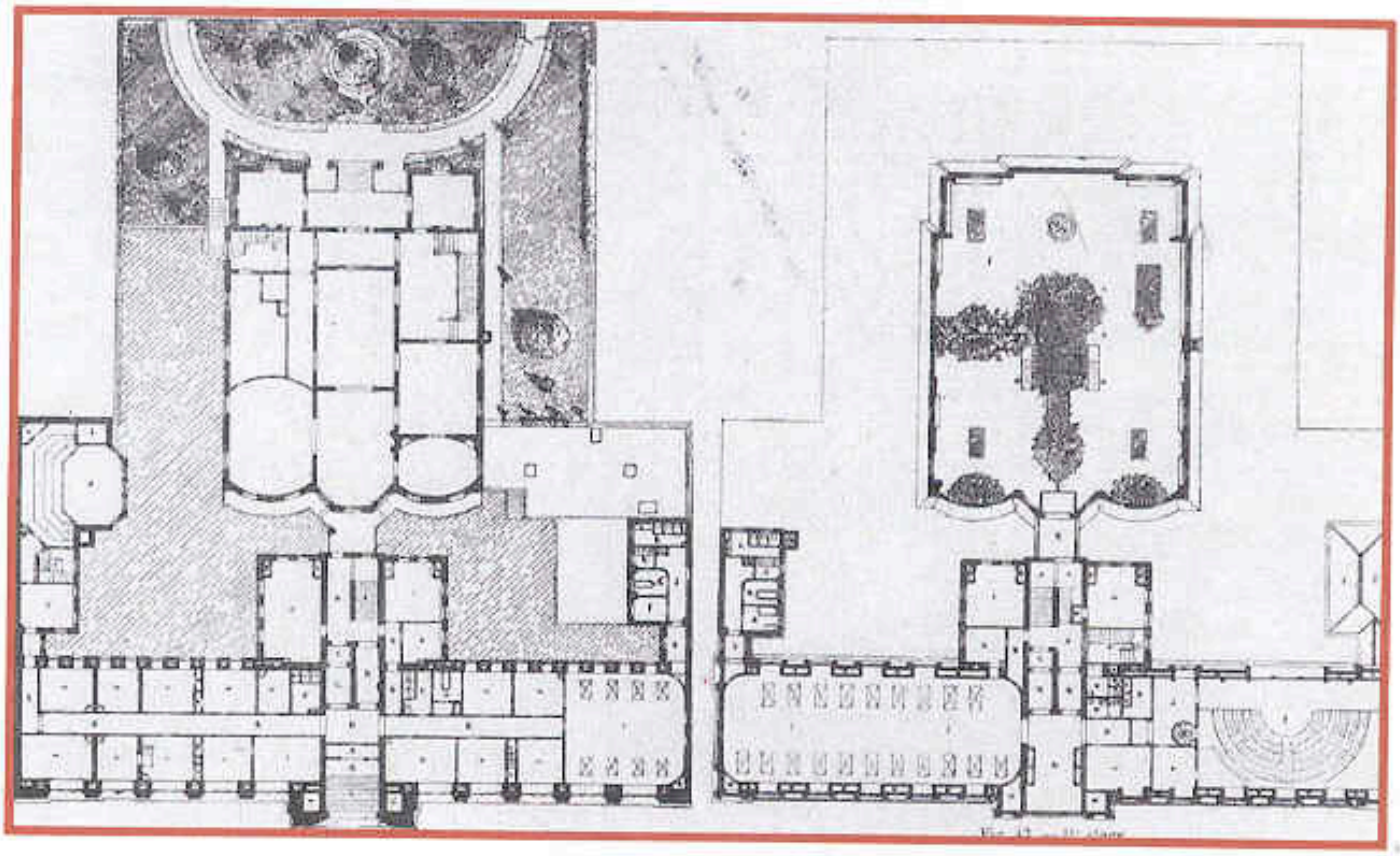
EAST WING.

e.—Bath-room.
f.—Sink.
g.—Toilet room.
h.—Corridor.

ADMINISTRATION BUILDING.
Library and Museum Floor.

Typical Floor Plan of New York Hospital [VH, 334]

NEW YORK HOSPITAL



Plan of Ground Floor & Upper Storey [ANC, fig.192]

NEW YORK HOSPITAL

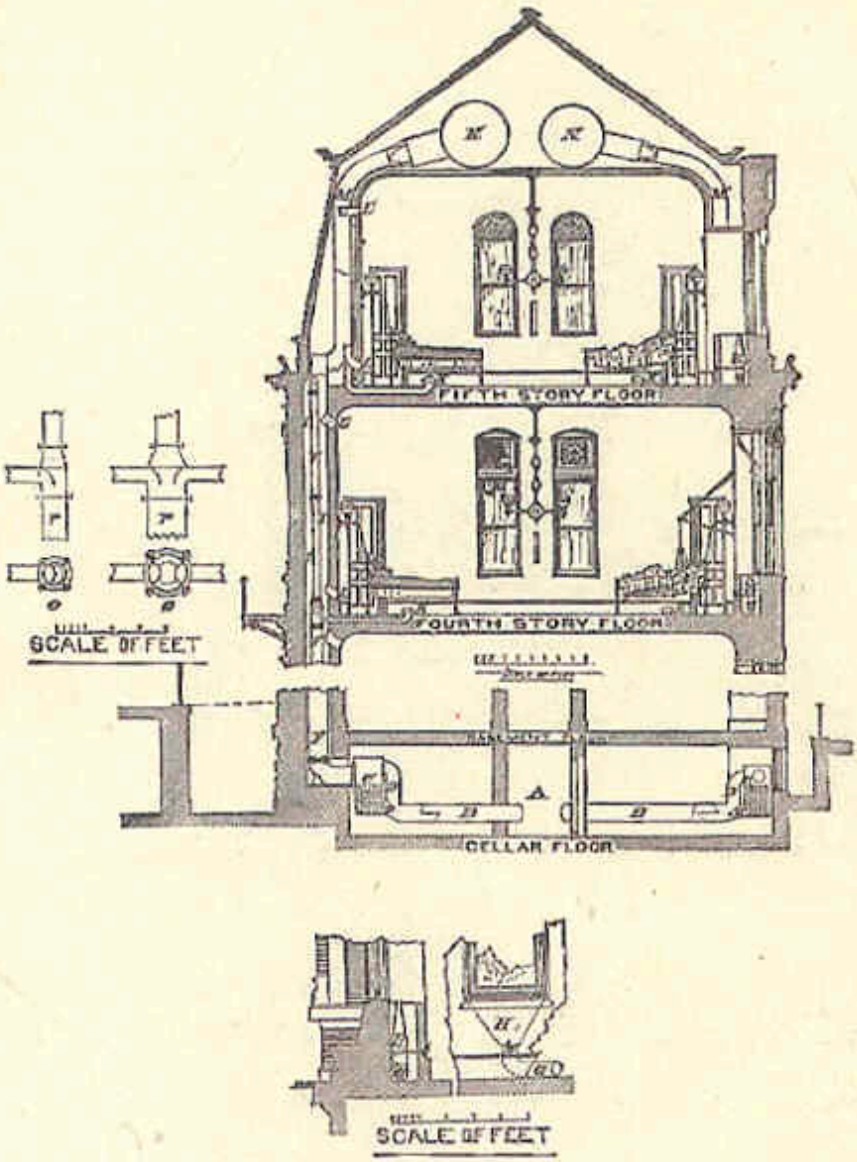


FIG. 98.—NEW YORK HOSPITAL BUILDINGS.—DIAGRAM OF VENTILATION AND HEATING.

A.—Main fresh-air shaft from blower.
B.—Connection to steam coil.
C.—Steam coil.
D.—Cold-air passage around steam coil.
E.—Valve to regulate temperature by passing any required portion of the air around the steam coils.
F.—Hot-air pipes.
G.—Connections to registers.
H.—Register box and opening.
I.—Ventilating flue containing hot-air pipes.
K.—Main orifices for ventilation.
L.—Orifices for ventilation for occasional use.
M.—Ventilating pipes.
N.—Trunk ventilating pipes leading to exhaust blower.
O.—Plans of connections of hot-air pipes.
P.—Sections through connections of hot-air pipes.

Diagram of system of heating & ventilation [VH, 335]

BLEGDAMS HOSPITAL, COPENHAGEN

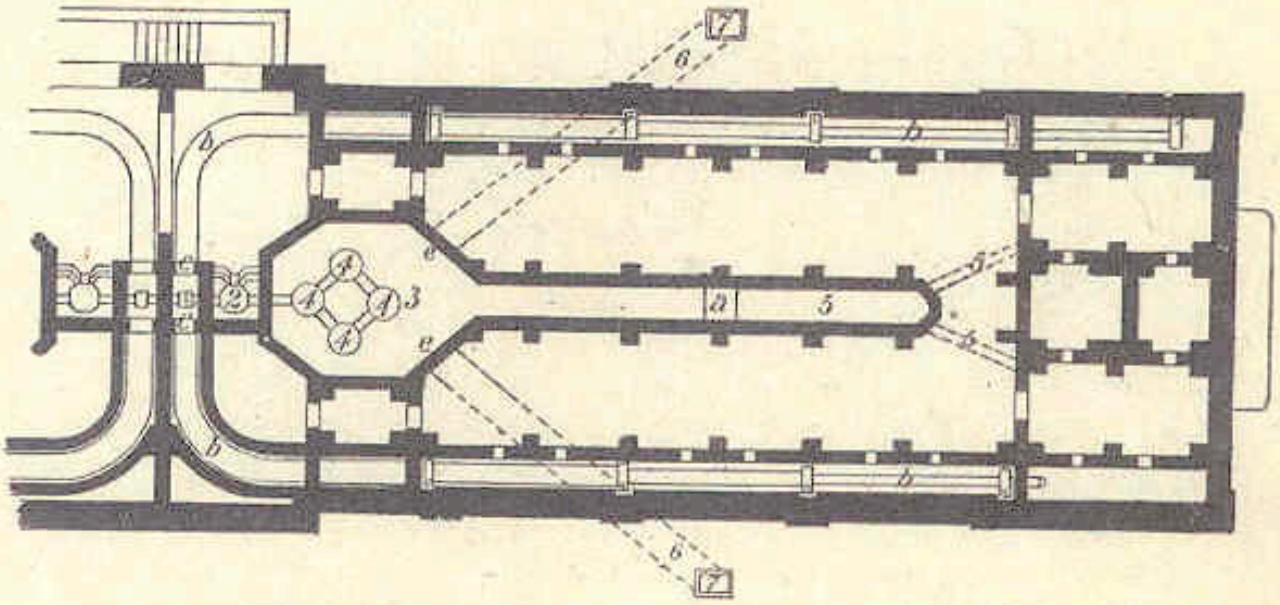


FIG. 69.

2.—Furnace.
3.—Fresh-air chamber.
4.—Heaters.
5.—Fresh-air duct from air chamber.
6.—Fresh-air duct to air chamber.
7.—Fresh air inlets.
a—Fresh-air inlet.
b—Foul-air duct.
c—Point of entrance of foul-air duct to aspirating chimney.

Heating and ventilation for infectious diseases ward, c.1890 [VH, 307]

BLEGDAMS HOSPITAL

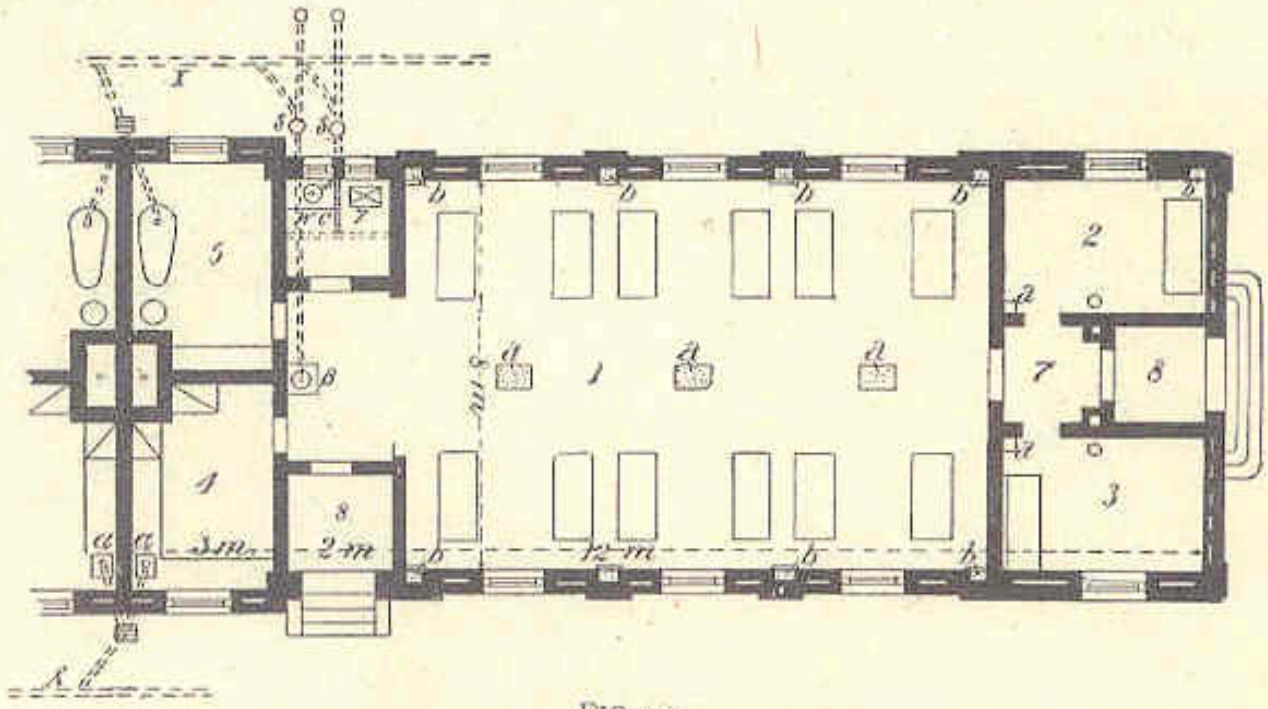


FIG. 70.

1.—Ward.
2.—Isolation ward.
3.—Nurse.
4.—Kitchen.
5.—Bath-room.
6.—Water-closet.
7.—Corridor.
8.—Lobby.

a—Inlet openings for fresh air.
b—Aspirating openings for vitiated air.
c—Chimney.
B—Wash-stand.
Y—Sink
S—Interceptor.
X—Sewer.

Heating and ventilation for infectious diseases ward, c.1890 [VH, 308]

BLOODAMS HOSPITAL

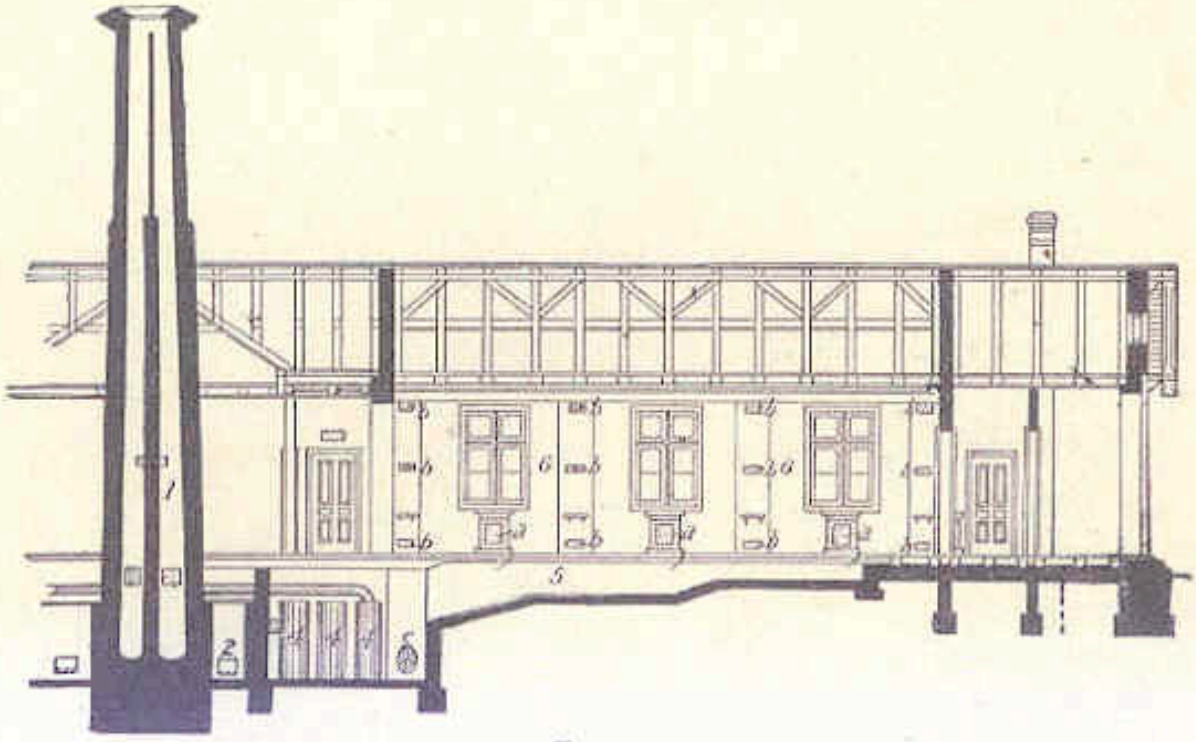


FIG. 71.

1.—Chimney.
2.—Furnace.
3.—Fresh-air chamber.
4.—Heater.
5.—Fresh-air duct
6.—Ward.

a—Inlet openings for fresh air.
b—Aspirating openings for vitiated air.
c—Inlet of aspirating duct in chimney.
d—Outlet opening in chimney for vitiated air from closets.
e—Inlet opening for fresh air in air chamber.

Heating and ventilation layout showing aspirating chimney (left) [VH, 309]

CITY HOSPITAL, HAMBURG, GERMANY

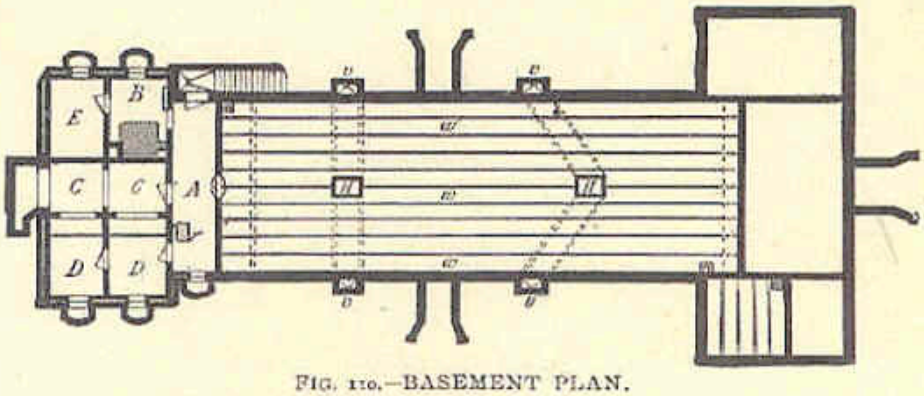


FIG. 110.—BASEMENT PLAN.

A.—Transverse corridor.
B.—Boiler room.
C.—Coal vaults.
D.—Store-rooms for utensils.
E.—Stoker's room.
H.—Radiators.
r.—Soiled-clothes chute.
v.—Air ducts.
w.—Separating walls in hot-air flues under floor.

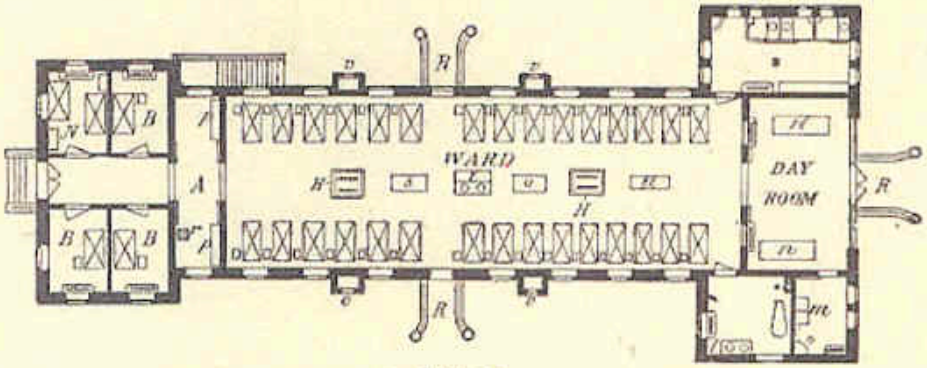


FIG. 111.

A.—Transverse corridor.
B.—Isolating rooms.
H.—Radiators.
N.—Attendant's room.
R.—Landings.
l.—Washstand.
m.—Rinsing basins.
n.—Tables.
o.—Glass table for utensils.
p.—Clothes presses.
r.—Soiled-clothes chute.
s.—Cabinet for bandages.
t.—Washstand and writing table.
u.—Bandaging table.
v.—Air ducts.

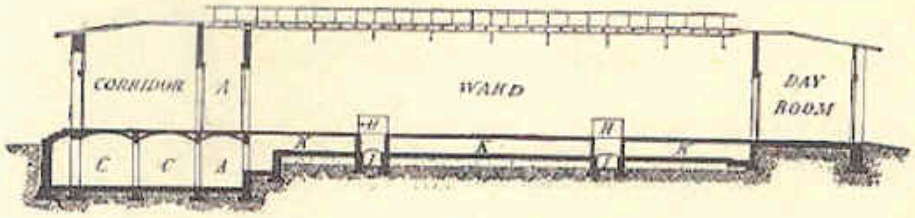
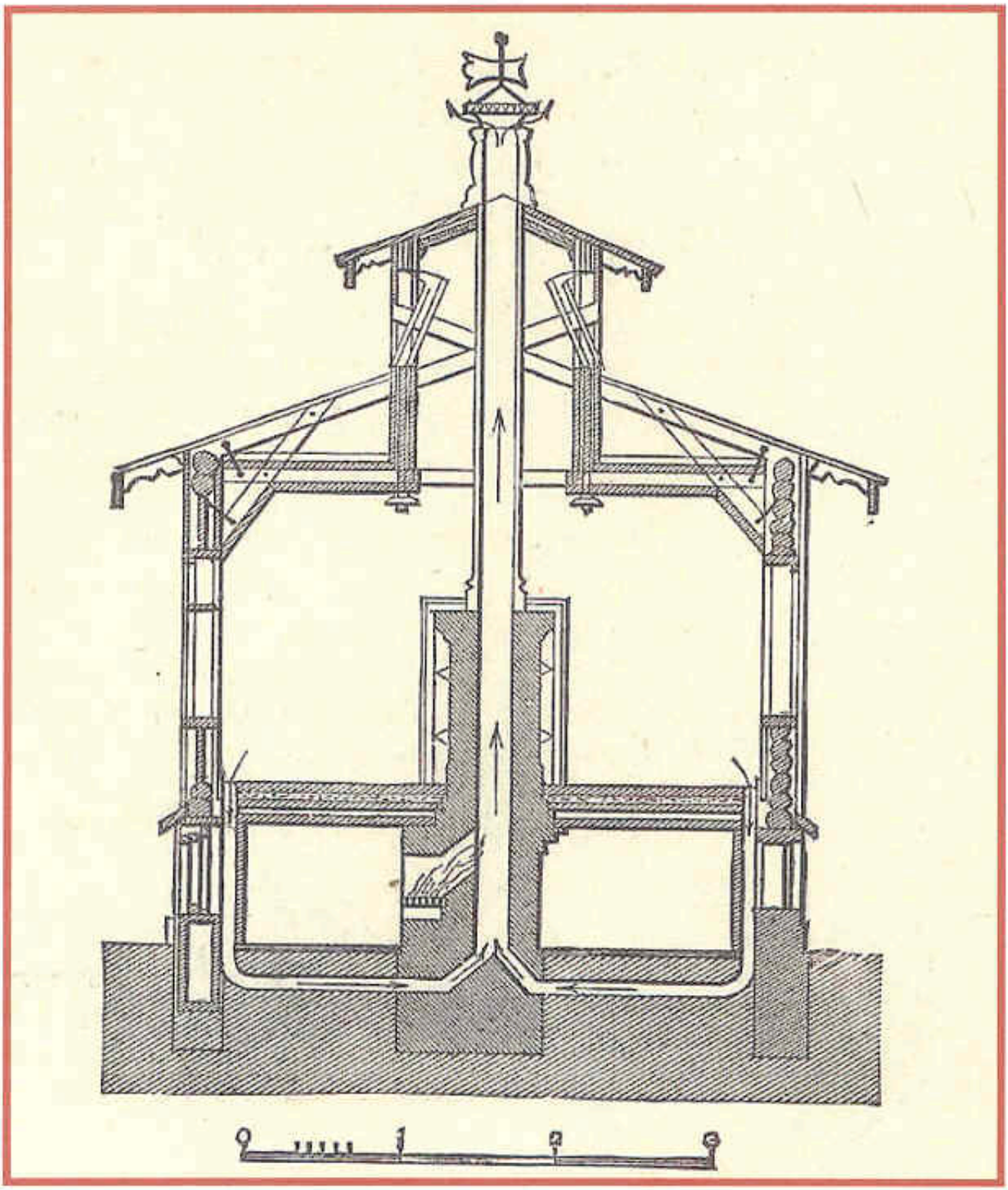


FIG. 112.

A.—Transverse corridor.
C.—Coal vaults.
H.—Radiators.
l.—Air chambers (Luftkanäle).
K.—Space or chamber for pipes for heating floor.

Underfloor (hypocaust) system of heating and ventilation, 1890 [VH, 345].

ST PETERSBURGH CITY HOSPITAL, RUSSIA



Fire-assisted Ventilation scheme, 1872 [VH, 302].
The heating furnace is a giant German porcelain stove.

ST PETERSBURGH

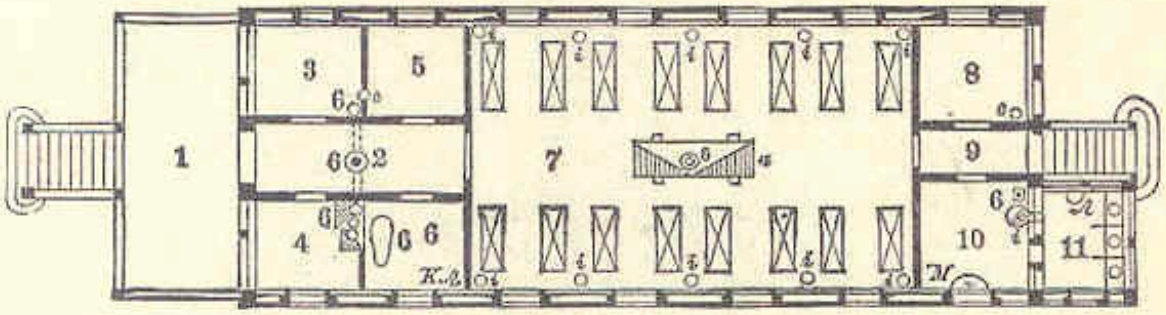


FIG. 62.—FLOOR PLAN OF ST. PETERSBURGH CITY HOSPITAL.

1.—Porch.
2.—Hall.
3.—Nurses' room.
4.—Ward kitchen.
5.—Room for two patients.
6.—Bath.
7.—Ward.
8.—Room for two patients.
9.—Hall.
10.—Wash-room.
11.—Water-closet.

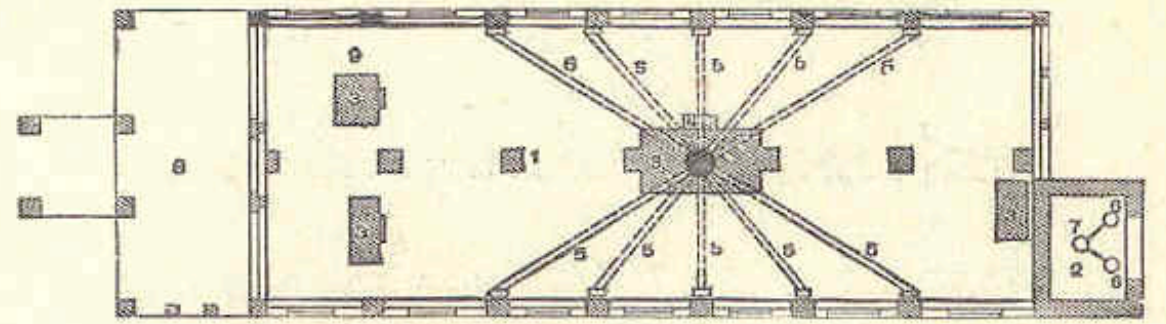


FIG. 63.—CELLAR PLAN OF ST. PETERSBURGH CITY HOSPITAL.

1.—Cellar.
2.—Soil pipes.
3.—Foundation of stone.
5.—Foul-air tubes beneath the floor.
6, 7.—Vessels for excreta.

Fire-assisted Ventilation scheme, 1872 [VH, 303].

ST PETERSBURGH

Reference is made by Billings [VH, 302-304] to the necessity of having suitable small hospitals for the emergency reception of contagious diseases (which he says are sometimes known as "pest houses"). He suggests these should be one-storey wooden buildings, with wards containing about 6 beds, heated by a stove in the centre. Through or around this stove the greater part of fresh air should be introduced in cold weather, while the foul air is removed by a shaft reaching nearly to the floor near the stove and containing the stove-pipe in its upper part. On a larger scale these are termed a "barrack hospital."

An example discussed is one of the barracks of the Roschdestwensky Hospital in St Petersburgh, Russia. Three such barracks were built in 1871-72 and "they have proved to be a great success, being comfortably warm in the extreme cold of the Russian winter, and giving excellent results in cases of typhus and also in surgical cases."

The barrack hospitals have triple walls enclosing two air spaces. Heat is provided by a massive German porcelain stove (actually a furnace), 14 feet long x 4 feet 8 inches wide x 6 feet high. The furnace is fired from below with eight openings for the admission of warm fresh air into the ward. The foul-air flues open into the central smoke flue (as shown in the cross-section drawing). Besides this central stove there are three others, providing in total about 103,000 cubic feet per hour of fresh air. When the external air temperature is above freezing point the stoves are fired once a day, Between zero and 32 F they are fired twice a day, and when below zero, three, and in extreme cold, four times a day.