Description of the Laboratory of the Marine Biological Association at Plymouth.

By

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The Laboratory which is now in the course of erection at Plymouth for the Marine Biological Association, is situated between the south wall of the "Citadel" and the Sound, at a height of 95 feet above the level of the sea. The site, which has been granted to the Association by the War Office, occupies the whole length of King Charles's Curtain, 265 feet, and extends southwards from the Citadel wall 240 ft., giving a surface of, say, 63,600 feet.

A road lies between this plot of land and the sea, and private access to a small section of the seaboard is provided for by means of a tunnel 7 ft. 6 in. high and 6 ft. 6 in. wide, which leads from the area surrounding the cellars, beneath the road, to the rocks below.

The building (*vide* Frontispiece) is placed 90 feet from the wall of the Citadel, and is about 60 yards from high-water mark. It is in the form of two blocks, which are each 34 ft. 6 in. long by 42 ft. wide and three stories high (40 ft.), and a central connecting portion 70 ft. long by 34 ft. 6 in. broad and two stories high (30 ft.). The east, south, and west fronts are built entirely of dressed limestone, which has been excavated on the spot; but on the north front the window- and door-dressings are of brick.

The roof of the central portion is peaked and covered with slate; that of the two blocks is flat and covered with lead.

Below the western block cellars have been excavated (Plate III) 14 ft. deep, surrounded by an area 6 ft. 6 in. wide

on the north and 4 ft. wide on the west and south sides; further the excavation has been extended between the cellars and the Citadel wall to form two reservoirs for salt water, each 37 ft. 6 in. long, 21 ft. 6 in. wide, and 13 ft. deep, and each capable of holding 50,000 gallons. The roof of a portion of each of the reservoirs (Plate I, *r*) is 6 ft. higher than the remainder and is fitted with a gangway (*t*) to enable a man to walk inside. These reservoirs are built of concrete and coated with a special asphalte supplied by Messrs. Leete, Edwards, and Norman, of London; they are arched in with brick and completely covered over.

The arrangement of rooms in the building is as follows:

Cellars.—The cellars (Plate III) are 13 ft. high, and consist of an engine room, 20 ft. by 16 ft.; a boiler room, 20 ft. by 11 ft.; an engineer's room, 13 ft. by 11 ft.; a coal cellar, store room, and w. c. Access to the cellars is provided for by means of steps down into the area on the north side.

Ground Floor, West Block.—The rooms on the ground floor (Plate I) are 12 ft. high. The main entrance to the building is in the centre of the west face of this block, and leads, on the one hand, by means of a straight passage 6 ft. wide direct into the aquarium, and, on the other hand, by means of a staircase 9 ft. wide to the first floor. A urinal is placed leading from the landing of this staircase. On the south side of the entrance are two rooms to serve as kitchen and bedroom for the caretaker of the building; these rooms are each 14 ft. by 12 ft., and between them is a pantry 9 ft. by 6 ft. On the north side of the entrance the scullery and offices for the caretaker, the staircase leading to the first floor, and a "Receiving Room" 20 ft. 6 in. by 16 ft. are placed.

Centre.—The central part is occupied by the aquarium from the east end of which a door leads into the

East Block.—On the north side of this block is Laboratory II, 17 ft. 6 in. by 16 ft.; on the south side Laboratory III, 15 ft. by 9 ft. The remainder of this floor of the block is occupied by the kitchen and offices of the Superintendent's residence. The main entrance to the residence

is in the centre of the east face of the block, it leads into a passage from which direct communication with the aquarium is provided. A staircase 7 feet wide leads to the first floor. A back door is placed on the north side.

First Floor, West Block.—The rooms on this floor (Plate II) are 11 ft. high. The staircase opens onto a landing above the entrance hall, and from this point a staircase communicates with the second floor, and a passage 6 ft. wide leads into the main laboratory. On the north side of this passage is the Physiological Laboratory, 20 ft. 6 in. by 16 ft.; on the south side the Chemical Laboratory, 22 ft. by 14 ft., and a small room communicating with the latter, 8 ft. by 14 ft., which is designed to serve as a photographic room. These two laboratories are entered through doors which open into the passage. At the end of the passage a door leads into the

Centre.—The main laboratory occupies the whole of the first floor of this portion of the building. It is provided with seven large windows on each side, which reach from a point 2 ft. 6 in. from the floor to a height of 10 ft. from the floor. The roof is a collar-beam roof with tie-rods leading down to the feet of the principals. It is 16 ft. from the floor to the ceiling along the centre of the room. The floor is especially constructed of Dennett's arching to ensure freedom from vibration as much as possible.

East Block.—The rooms on this floor are a dining room, pantry, and study for the Superintendent, and an office from which a door leads directly into the main laboratory.

Second Floor, West Block.—The rooms on this floor (Plate IV) are 10 ft. high. The staircase and passage are the same as on the first floor. On the north side of the passage is a lavatory, 16 ft. by 8 ft., for the convenience of workers in the laboratory, and a private workroom, 16 ft. by 12 ft., while the whole of the south side is occupied by the library, a room 30 ft. 6 in. long and 16 ft. wide.

East Block.—This floor is occupied by bedroom accommodation, &c., for the Superintendent and his servant. A small staircase 2 ft. wide will lead from the second floor on to the flat roofs of each block.

Fittings.

The Tank-room.—The tank-room is fitted with tanks of slate and of glass fitted in cast-iron frames, and water is supplied to these tanks through vulcanite piping. The system it is proposed to use for keeping the sea-water in good condition is known as the "circulating system." It was introduced into England by Mr. Lloyd, and is in use at the Crystal Palace and, I believe, all the inland aquariums. The Naples Zoological Station and various continental aquariums have also adopted this method of keeping the water continually in a satisfactory condition.

The system is briefly as follows:—By means of pumps the water is forced from the reservoirs through vulcanite pipes into the tanks. The pipes are placed about 2 feet above the level of the water in the tanks, and the water is forced through nozzles, the bore of which is from, say, one eighth to one quarter inch diameter, and regulated with a tap. Jets of water are thus forced into the tanks from some little distance above, and air in a state of very fine division is carried by the jet deep into the water of the tank, and distributed through it. By this means all decomposing organic matter is oxidised and the water constantly kept in a condition satisfactory for maintaining life. The force of the jet of water is regulated by the speed of the pumps and by valves placed in the main pipes, according to the amount of aeration required. The water overflows from the tanks into so-called "circulating reservoirs," which are placed below them but above the level of the water in the main reservoirs, and through these it is conducted to a culvert (Plate I, *p*) which conveys it back again to the main reservoirs, to be again pumped up into the tanks.

This is not the place to enter into a discussion of the relative value of the various methods now in use for keeping aquaria in good condition, but I would point out that the advantage of the method adopted by the Association is that the water is kept *constantly* in good condition.

A series of nine tanks are placed along the whole length

of the south wall of the aquarium. They are all 4 ft. wide and 4 ft. deep. One of them (*k*) is 15 ft. long, two (*l l*) are 10 ft. long, and the remaining six (*j*) are 5 ft. long. The circulating reservoir below this row of tanks is 2 ft. 6 in. wide and 3 ft. 6 in. deep. The circulating reservoirs are built of concrete and brickwork, and the internal surface covered with a special asphalte. The tanks are supported on the walls of the circulating reservoirs; each tank is provided with an overflow into the circulating reservoir and an overflow into the tank next to it, the level of the tanks being so arranged that the water flows from east to west. These overflows are so arranged that they can be used or not as desired, and thus any tank can be isolated.

A second series of three tanks is placed along the north wall. Two of them are 5 ft. deep and 9 ft. wide, one of these (*f*) being 15 ft. 6 in. long, the other (*g*) 30 ft. 6 in. long, while the third (*h*) is 5 ft. deep, 5 ft. wide, and 15 ft. long. The circulating reservoirs below are 3 ft. 6 in. deep and 7 ft. wide. The overflows are arranged like those on the south side. The height of the top of these tanks from the floor is 7 ft., while on the south side the top of the tanks is 6 ft. 6 in. above the floor level.

A third series (*e*) of five "table tanks," each 9 ft. 9 in. long, 2 ft. 3 in. wide, and 1 ft. 9 in. deep, is placed down the centre of the room. They are supported upon the walls of a circulating reservoir 1 ft. wide and 3 ft. deep, and being only 4 ft. above the floor level their contents can be examined from above.

The water in each of the circulating reservoirs flows at the west end into a culvert (*p*) which conducts it back to the main reservoir; the culvert is of concrete, lined with asphalte, and covered over with slate.

It will be convenient to include in this description of the aquarium a series of twelve small tanks, which are placed in a double row in the main laboratory (Plate II, *k*). They are supplied by the pumps with water, which flows again into the main reservoir. Each of these tanks is 1 ft. 6 in. deep, 2 ft. 3 in. wide, and 5 ft. long. The pipes are of vulcanite. A supply of water is also conducted through pipes

of the same material to Laboratories II and III, to the Physiological (Plate II), Laboratory, and to the "Receiving Room (Plate I)."

The Engine Room.—The engine room (Plate III) contains two patent "Otto" gas engines, one of two horse power (*b*), and the other of four horse power (*a*); two patent rotary pumps ("Forbes and Edward") in duplicate, each capable of circulating 7500 gallons an hour (*d*), and two similar pumps capable of circulating 2000 gallons per hour (*e*). These pumps are of vulcanite, and all the pipes, cocks, taps, &c., concerned with the circulation of the sea water are also of vulcanite. Vulcanite and rubber hose is used to convey the water from the reservoirs to the pumps. The two large pumps supply the tanks in the aquarium, the two smaller pumps the tanks in the Laboratory. In consequence of the necessity to circulate the water continuously, the engines and pumps have been supplied in duplicate.

For the renewal of water in the reservoirs a Shone's ejector placed at low-water mark has been provided. This ejector is supplied with compressed air from a receiver in connection with a compressor attached to the four-horse power engine in the basement of the building. This engine will thus perform as required the double function of circulating the water through the pipes and tanks of the aquarium and laboratory, or renewing the supply of salt water in the main reservoir from the sea. By this arrangement the necessity for a distinct pumping engine and house on the rocks, here exposed to the waves, is avoided.

The engine room also contains a special receiver for compressed air (*c*), which is distributed to the main laboratory in pipes for the purpose of aerating small aquaria containing minute organisms.

Receiving Room.—Materials for workers in the laboratory and to stock the aquarium will be brought by the fishermen into the "Receiving Room" (Plate I). This room is on the ground floor in the western block above the engine room, and communicates directly by means of doors with the yard outside and with the aquarium, and, by means of a lift, with the floors above it. The room is fitted with a

large sink (*a*), with tables upon which the sorting of material and the dissection of large animals can be carried on (*b*, *b*, *c*) —one of these tables (*c*) is supplied with a slate top—and with sufficient shelves (*d*). A supply of fresh and salt water, and a coil for heating water, is placed over the sink.

The room is lighted with a pendant in the centre, having two burners, and with brackets on the walls.

Main Laboratory.—Along each side of the main laboratory are seven compartments (*m*)—each 10 ft. long and 8 ft. wide—formed of wooden partitions on either side, 7 ft. high, and by a curtain suspended on a rod behind. Each of these compartments is fitted along the window with a bench (*o*) 9 ft. long, 4ft. 3 in. wide, and 2 ft. 6 in. high, and an earthenware sink (*n*) 1 ft. square and 8 inches deep. On the one side is placed a chest of drawers and cupboards (*r*), 4 ft. 6 in. long, 3 ft. high, and 1 ft. 8 in. deep, and the whole of the other side is occupied with a set of shelves (*p*) conveniently arranged to hold small and large bottles. The sink is supplied with fresh water; gas nozzles are conveniently placed on the bench, and a gas bracket on the central pier of the window-frame. Between these compartments on either side of the laboratory is a space 14 ft. wide. The eastern portion of this space is occupied with the series of twelve small tanks (*k*) already mentioned in the description of the aquarium fittings. They occupy a space 4 ft. 6 in. wide and about 30 ft. long. In a line with these tanks is a slate-topped table (*j*), 14 ft. long and 5 ft. 8 in. wide, along the centre of which is a partition 2 ft. high supporting a shelf. Water and gas taps are placed at intervals along the table. A large sink, 5 ft. long and 2 ft. wide is placed at one end of this table, and another sink, supplied with drying board, hot-water coil, &c., is fixed along the western wall of the room (*l*, *l*). A cupboard 3 ft. high is placed beside this latter sink and shelves above the cupboard.

Besides the gas brackets in each compartment, and one above the sink just mentioned, the room is lighted by three double-burner pendants hanging at intervals down the centre of the room.

The Chemical Laboratory.—A bench runs along the windows 3 ft. 3 in. above the floor and 3 ft. wide (Plate II, *e*). Four stoneware basins are let into the bench at intervals, and fresh water conducted to each. Shelves are placed against the window-piers above the bench, and cupboards and drawers along its whole length beneath.

A slate-topped table, 8 ft. long, 3 ft. wide, and 3 ft. 6 in. high, is placed in the middle of the room (*d*), and contains four rows of drawers of different sizes, each row consisting of five drawers. A sink, 6 ft. long, with drying-board, table, and shelves, occupies the east wall of the room (*c*); shelves are placed along the north wall (*h*), and a stink-cupboard (*g*) and blow-pipe table (*f*) alone the west wall.

The room is lighted by a central pendant and by brackets on the window-piers, and gas nozzles for india-rubber tubing occur at intervals along the main bench, on the pendant above the central table, in the stink cupboard, &c.

The Physiological Laboratory.—There are two sinks in this room, each 3 ft. by 1 ft. 6 in.; one of these is of glazed earthenware, and is supplied with salt as well as with fresh water, the other is of wood lined with lead (*a*, *a*). A large cupboard, 8 ft. 8 in. long, 6 ft. high, and 15 in. deep, with air-tight glass doors, is fitted against the south wall (*b*) and shelves on the east wall. Two substantial tables, 6 ft. by 3 ft. and 3 ft. high, and one table, 6 ft. by 4 ft. and 3 ft. 3 in. high, are also supplied; these tables are not fixtures, but can be moved about as desired.

The gas supply is similar to the chemical room.

The Library.—The library, on the second floor of the west block, is fitted with shelves along the east, west, and north walls (Plate IV, *a*), and supplied with writing-tables and chairs.

Laboratories II and III.—Gas and salt-water and fresh-water pipes are carried into these rooms, but the fittings have been deferred for the present (Plate I).

Heating.—The greater part of the building is heated by means of air, which is passed over pipes through which hot water circulates at a low pressure. A boiler is fixed in the cellars and pipes are carried from it into the Receiving Room, along the north and south walls of the laboratory,

into the Chemical and Physiological Laboratories, the library and the Superintendent's office and living rooms. These pipes are cased in, fresh air is admitted within the casing through perforated bricks, and is distributed into the rooms through short vertical shafts placed against the wall at intervals. The top of each shaft is provided with a valve which can be regulated as desired and through it the warm air enters the room. The aquarium is warmed by means of hot-water pipes lying in a trench covered with iron grating along the passages between the three rows of tanks (Plate I, *a*).

Ventilation is provided for by means of shafts in the walls dividing the central portion from the two end blocks, into which the foul air from the top of the rooms is conducted through grids. The up-draught in these shafts may be assisted by means of gas burners placed within them. Ventilation in the main laboratory is assisted by means of revolving ventilators (Plate IV, *e*) placed in the roof.

CORRESPONDENCE AND SHORT NOTES.

Communications addressed to the Honorary Secretary of the Association will, if suitable, in future numbers of the Journal be published under this heading.

OFFICIAL NOTICES.

The Council has appointed Mr. J. T. Cunningham, M.A., F.R.S.E., Fellow of University College, Oxford, to the post of Naturalist at the Plymouth Laboratory. There were four applications for the post. Mr. Cunningham has for several years acted as Superintendent of the Scottish Marine Station on the Firth of Forth, under the direction of Mr. John Murray, of the "Challenger" Expedition.

DESCRIPTION OF PLATES I, II, III, IV.

Plate I.—Ground Plan.

a. Sink in Receiving Room.
b b. Tables.
c. Slate-topped table.
d. Shelves.
e. Five table tanks, each 9 ft. 9 in. long, 2 ft. 3 in. wide, 1 ft. 9 in. deep.
f. Tank, 15 ft. 6 in. long, 9 ft. wide, 5 ft. deep.
g. Tank, 30 ft. 6 in. long, 9 ft. wide, 5 ft. deep.
h. Tank, 15 ft. long, 5 ft. wide, 5 ft. deep.
j. Six tanks, each 5 ft. long, 4 ft. wide, 4 ft. deep.
k. Tank, 15 ft. long, 4 ft. wide, 4 feet deep.
l. Two tanks, each 10 ft. long, 4 ft. wide, 4 ft. deep.
m. Pillars to support Dennett's arching.
n. Manhole into circulating reservoirs along north side.
o. Trench covered with grating containing hot-water pipes.
p. Culvert conveying salt water from circulating to main reservoirs.
r. Raised portion of reservoirs.

Plate II.—First Floor Plan.

a a. Two sinks in Physiological Laboratory.
b. Cupboard with air-tight glass doors.
c. Sink in Chemical Laboratory.
d. Slate-topped table.
e. Bench.
f. Blowpipe table.
g. Stink cupboard.
h. Shelves.
j. Slate-topped table in main Laboratory.
k. Twelve tanks, each 1 ft. 6 in. deep, 2 ft. 3 in. wide, 5 ft. long.
l l. Two sinks.
m. A "compartment."
n. Sink.
o. Bench.
p. Shelves.
r. Table with drawers and cupboards.

PLATE III.—PLAN OF CELLARS AND FOUNDATIONS.

a. Four-horse power gas-engine.
b. Two-horse power gas-engine.
c. Compressed-air receiver.
d. Duplicate pumps to throw 7500 gallons an hour.
e. Duplicate pumps to throw 2000 gallons an hour.
f. Arching, in plan.
g. Drains.
h. Foundation for pillars to support Dennett's arching.

PLATE IV.—SECOND FLOOR PLAN.

aaaa. Shelves in Library.
b. Washhand basins in Lavatory.
c. W.C.
d. Urinals.
eee. Revolving ventilators.

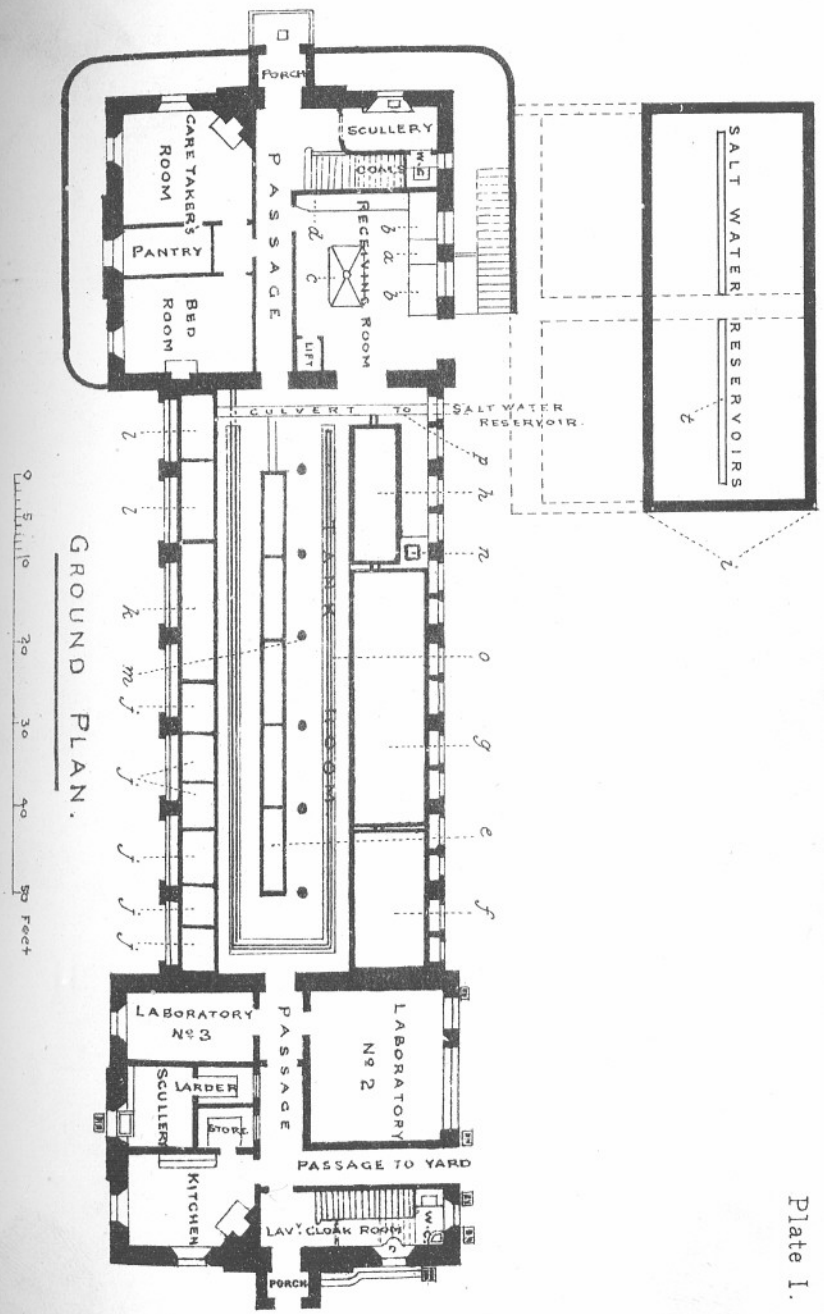
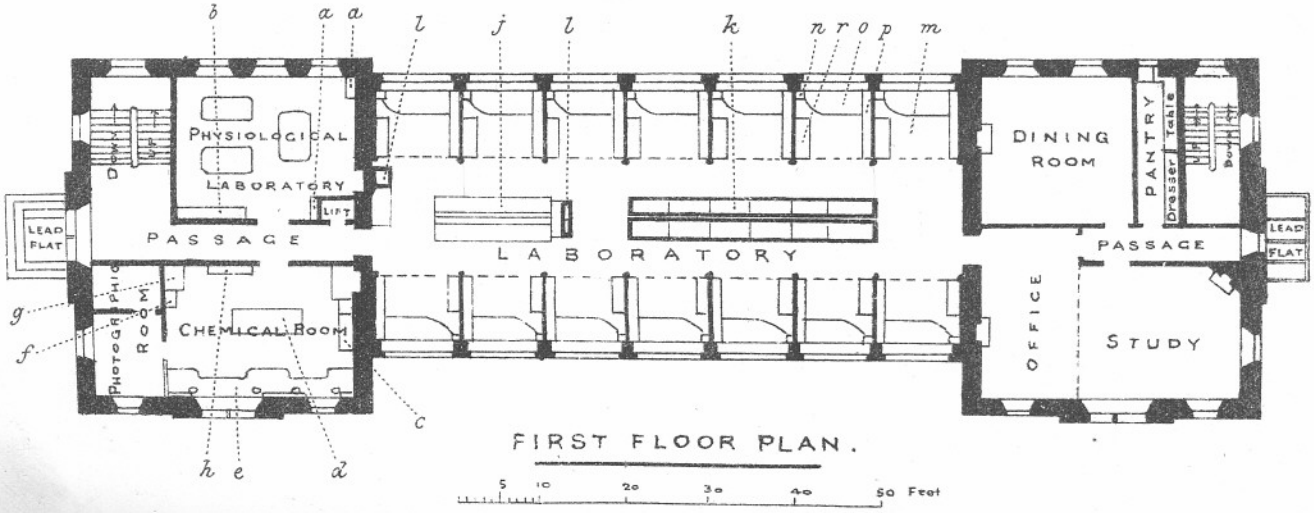
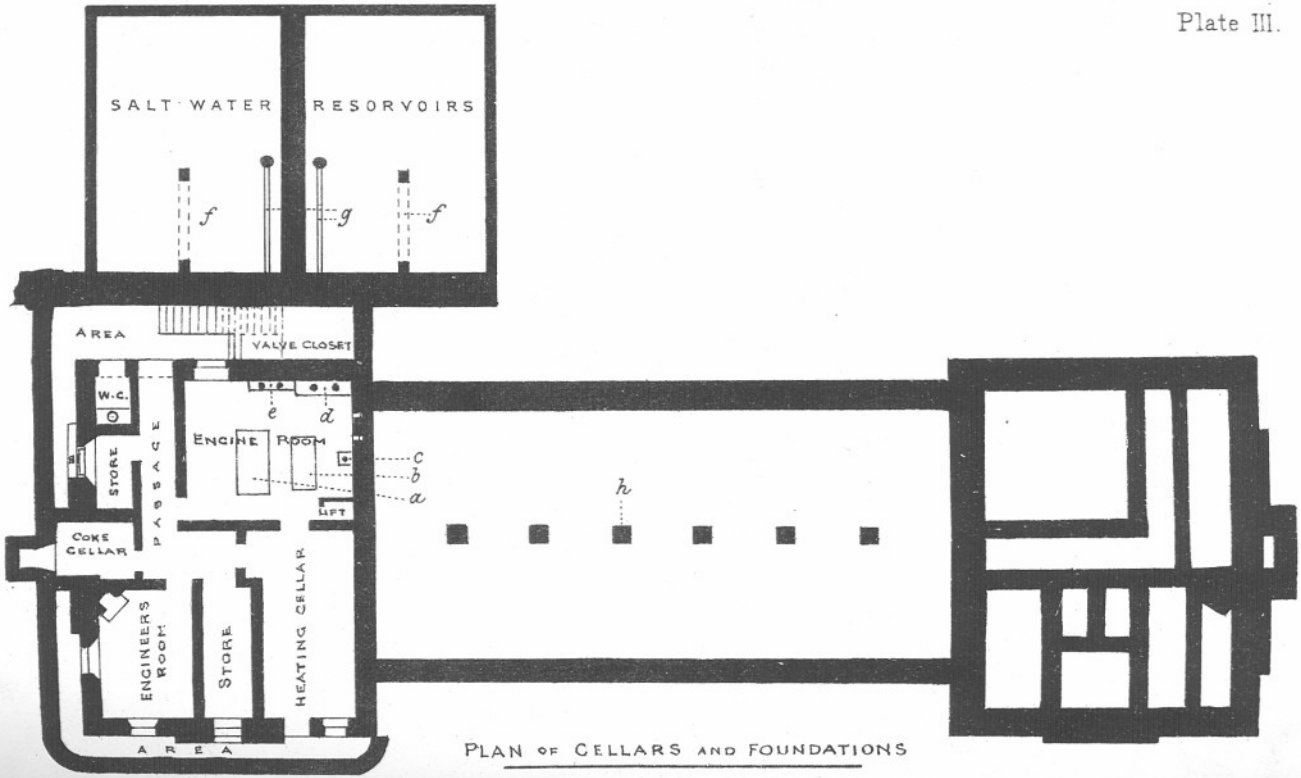


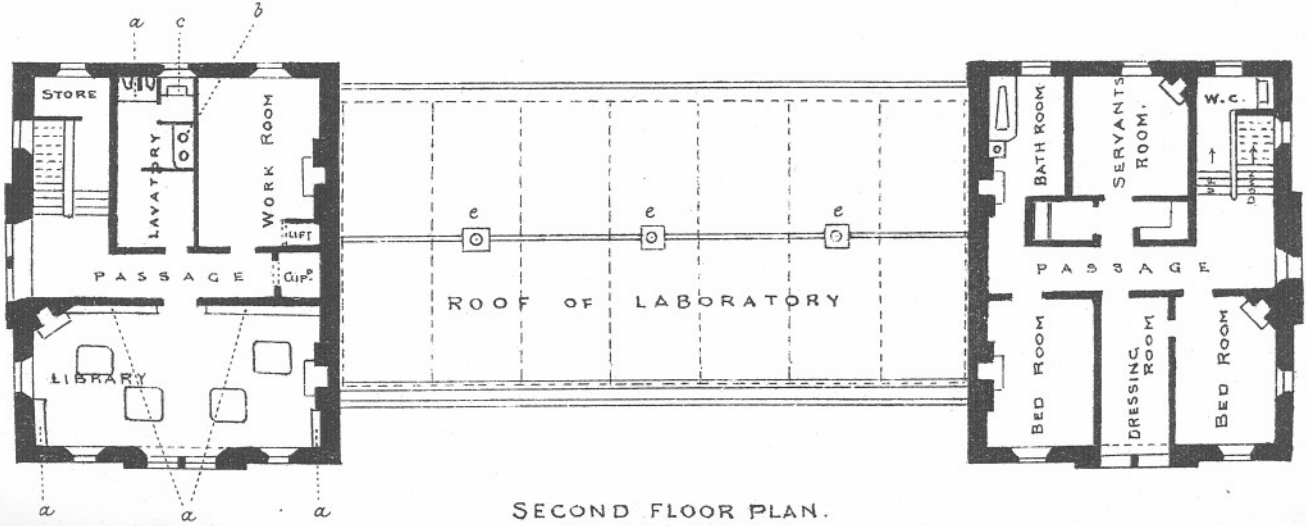
Plate I.



FIRST FLOOR PLAN.



PLAN OF CELLARS AND FOUNDATIONS



SECOND FLOOR PLAN.

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