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ESSENTIALS IN THE CONSTRUCTION OF HOSPITALS FOR LARGE CITIES.*

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CHICAGO.

Almost every large city in this country has under contemplation the construction of one or more hospitals at the present time, and during the next few years hundreds of these public institutions will be constructed in this country. This will involve the expenditure of many millions of dollars, and will produce good or bad facilities for the treatment of millions of patients in the future. If these institutions are properly planned, the amount of good which will accrue to the citizens of this country for the amount of money expended will be vastly greater than if they are badly planned. The good features of a well-planned hospital will have a permanently beneficial effect on the community supporting the institution, and in the same manner a badly planned hospital will be a constant source of inconvenience, if not a real menace. For these reasons it seems proper for this subject to be discussed by the representative surgeons and hospital men who compose, to a great extent, the Surgical Section of the American Medical Association.

THE COMMON BASIS OF HOSPITAL CONSTRUCTION.

Singularly enough, the work most extensively consulted by architects who are called on to provide the plans for hospitals, is "Hospital Construction and Organization." "The Johns Hopkins Hospital, 1875," is one which was based on observations made 27 years ago. The authors of these essays did their work so well that no one has seriously attempted to criticise them since, and the work has stood with authority for these many years. One can obtain a fair idea of how thoroughly the plans and theories laid down in these essays have been accepted by architects who have been called on to plan hospital buildings by studying the very comprehensive work of Henry C. Burdett, "Hospitals and Asylums of the World, J. A. Churchill, London, 1893." This work gives the plans of all the important hospitals which were constructed before the close of its publication, and virtually all of these contain the same essentials in their construction.

THE NEED OF NEW PRINCIPLES IN CONSTRUCTION.

When we bear in mind that during this time everything in our theories concerning infection, contagion and hygiene has changed, and that scientifically proven facts have taken the place of theories, does it not seem strange that we should still adhere to the same essentials in hospital construction? Could an architect build an office building to-day on essentially the lines of thirty years ago, or a hotel or a factory or a library or a brewery or a building utilized for any industry in which there has been progress?

This work was written before we were acquainted with the cause of infection; before we knew that infection means the planting by contact of definite micro-organisms; before we knew that these micro-organisms develop under definite conditions, and that their development can be prevented or inhibited at our will. It is true that Pasteur had opened the way to our present conception of infection before this time, but his theories had not yet taken a definite practical form. At that time observation had demonstrated the fact that if one patient in a given part of a hospital became infected, the other patients were likely to suffer in the same manner and that patients in another building at a distance might remain free from the infection, consequently it seemed wise to separate as much as possible the patients in separate pavilions. At the present time we know that the infection was carried from one patient to the other through the ignorance of the attendant who manipulated all the patients in the same pavilion, but could not contaminate those with whom he did not come in contact. This fact is so well understood now that it seems superfluous to mention it. Every one connected with hospital work is drilled on this fact so that in well-regulated hospitals infection of wounds in the same pavilion is no more likely than it would be if they were any given distance apart.

THE GENERAL PLAN.

A knowledge of this fact should eliminate the construction of hospitals extending over large areas, if there were no other reason except the fact that there is greater economy in construction, and maintenance of a compact building. A compact building can be heated at a smaller expense, the food can be supplied to the patients more easily and with less labor, hence more economically; the amount of cleaning and painting and repairing is decreased. There is less roof surface exposed, and the time of the visiting staff is economized because the attending physicians and surgeons are not compelled to travel great distances in visiting the patients in different wards.

Ever since Pasteur's observations determined the presence of micro-organisms in the ordinary air and their absence in the air on high mountains, it has become more and more apparent that the air near the surface of the earth contains more micro-organisms than that higher up. This is especially true in cities in which the street dust is laden with germs and is much thicker at the level of the first than at the level of the higher stories. Our own observations have again confirmed this well-established fact. This fact must condemn low hospital buildings, because in these the patients are forced to live in the most unfavorable conditions as regards the air they are compelled to breathe. This fact, although already discovered by the observations of Pasteur and his pupils, had not been generally considered when the Johns Hopkins essays were published, but now that we are familiar with this fact it seems unfortunate that it is not generally made use of in hospital construction. The same principle applies to the building of operating rooms. A number of palatial operating pavillions have been constructed on the ground floor in great cities, whereas they should have been placed in the garret of a tall building.

FIRE-PROOF CONSTRUCTION.

Twenty-five years ago it was not wise to build high hospital buildings because of the danger from fire. This danger no longer exists because absolutely fire-proof buildings can now be easily constructed out of stone, brick, tile, concrete and steel. It is true that some so-called fire-proof buildings have been burnt, but never those which were honestly constructed, in which there was no wood used except for floors and window frames and doors, and in which each story was separated from the one above by a ceiling of hollow tile or concrete in which the steel was imbedded. Of course all of the partitions, closets and air shafts must be constructed of hollow tile or cement, and in fact there must be no wood

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except in the floors, doors and windows, and even these parts can be made of fire-proof material.

A hospital not constructed absolutely fire-proof at the present time should be condemned, even though it be only one or two stories high. This is especially true because at the present time a hospital is likely to contain a very large proportion of patients, who have just undergone serious operations and could consequently not be moved with safety in case of fire. The use of the modern elevator is another important factor which makes high hospital buildings especially convenient.

LOCATION AND ARRANGEMENT OF DEPARTMENTS.

These are the main considerations and all these are relatively new and should be borne in mind in the construction of hospitals at the present time. The minor considerations will be treated later, not because they are unimportant, but because I wish to emphasize the greater importance of the adoption of high hospital buildings for large cities.

With a given area of land on which to build, it is plain at once that with a high building many favorable con-

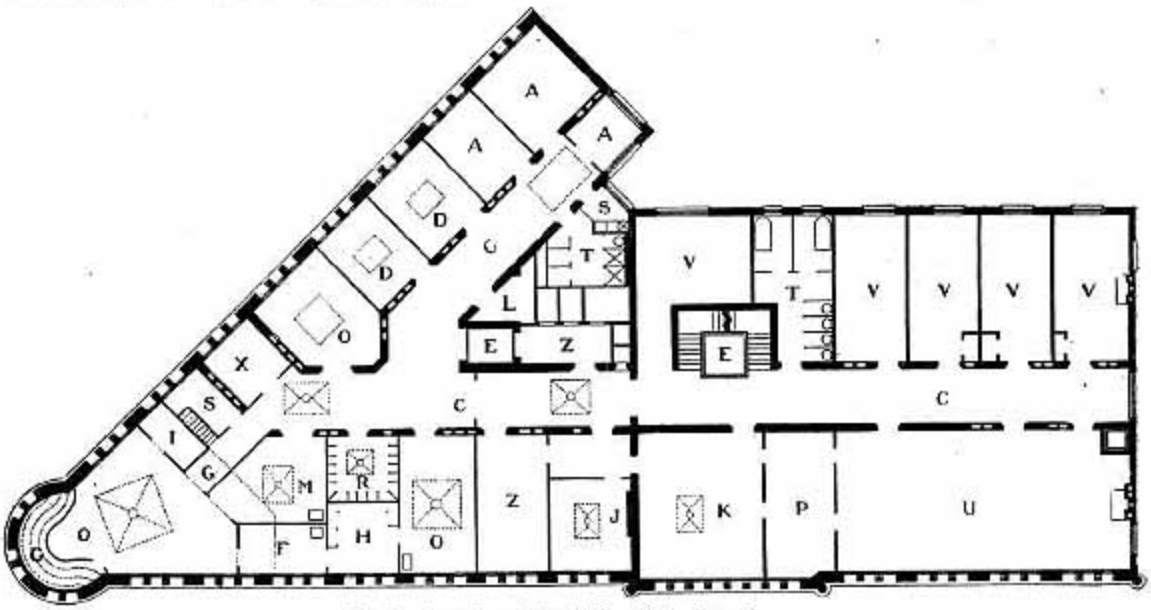


Fig. 1.—Augustana Hospital. Sixth floor plan.

KEY TO HOSPITAL PLANS.

A.—Recovery room.
B.—Bath room.
C.—Corridor.
D.—Dressing room.
E.—Elevator.
F.—Sterilizing room.
G.—Amphitheater and balcony.
H.—Supply room.
I.—Instrument room.
J.—Steam cooking room.
K.—Kitchen.
L.—Linen room.
M.—Anesthetizing room.
N.—Nurses' room.
O.—Operating room.
P.—Pantry.
R.—Recovery room.
S.—Sanitary.
T.—Toilet.
U.—Dining room.
V.—Private room.
W.—Ward.
X.—X-ray room.
Z.—Store room.

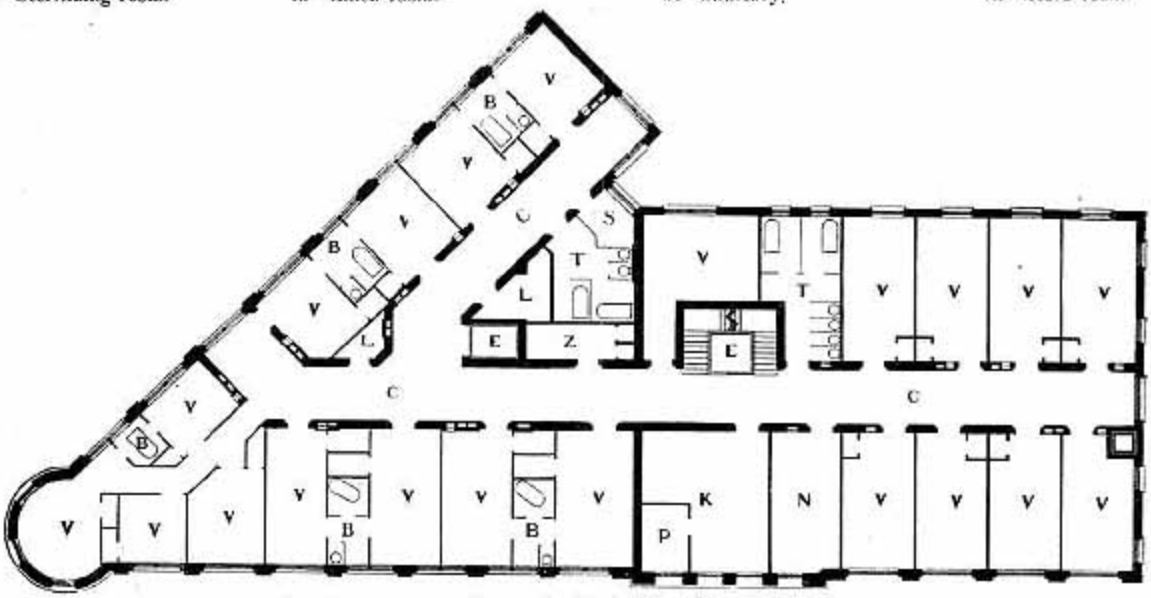


Fig. 2.—Augustana Hospital. Plan of fourth and fifth floors.

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ditions can be secured which will be impossible with low buildings of the same number of beds.

1. The building can be set back from the street, which will still further lessen the amount of street dust. It will also lessen the disturbance caused by the street noise.

2. If land can be secured overlooking a park or any other attractive landscape, the higher the building the more patients can obtain a view of this landscape.

3. The building can be more easily placed so that every room and every ward secures sunlight during some portion of the day. With the low buildings one is constantly compelled to infringe upon the sunlight in order to secure a sufficient amount of space for the number of beds required, while with the high buildings one simply adds another story which in no way interferes with the remaining portion of the building.

4. The hospital can be conveniently located for the patient as well as for desirable physicians and surgeons for its staff. Relatively speaking, the air above the second story in a well-chosen portion of the city in which the surrounding buildings are not high compares favorably with the air in the first story in the outskirts of a large city. And the air in the sixth story is nearly as pure as country air.

If a great physician or surgeon can be saved an hour's time each day which he would be compelled to spend in going to and from the hospital located a great distance from his residence, his services can more easily be obtained, and this time in itself given a hospital service will amount to a great deal during each year. There can also be no doubt that much harm is done to many very acute cases by being carried great distances to the hospital. I need but mention those suffering from severe pneumonia, typhoid fever or peritonitis.

Of course the same care should be exercised in selecting a location. It should be as high as possible, near a park, river or lake in as quiet a location as available, away from the street cars or railroad tracks and still easily accessible to patients and their friends. The larger the grounds the better it is for the institution.

VENTILATION.

In the climate of the United States the air supply of the hospital must come during the warmer portion of the year directly from the outside through open windows or through ventilating flues in the walls During the colder part of the year the fresh air should be forced into the upper portion of the wards and rooms by means of revolving fans. This air should be taken from a tower above the roof.

It should first be washed by passing through strands of oakum or other similar material suspended in the horizontal portion of the air-shaft, a small amount of water being permitted to trickle over these strands constantly; then it should pass through a long shaft, extending preferably through the entire length of the building. This shaft should contain coils heated with steam or water. The outside of this shaft should be covered with some material which prevents the radiation of heat, in order to economize fuel. Taking the air from a tower some distance above the roof of a high building, it is nearly free from micro-organisms; this can be freed from particles of soot and introduced into the hospital clean and heated to the desired temperature. The foul air should be carried out of the rooms and wards through flues opening near the floor.

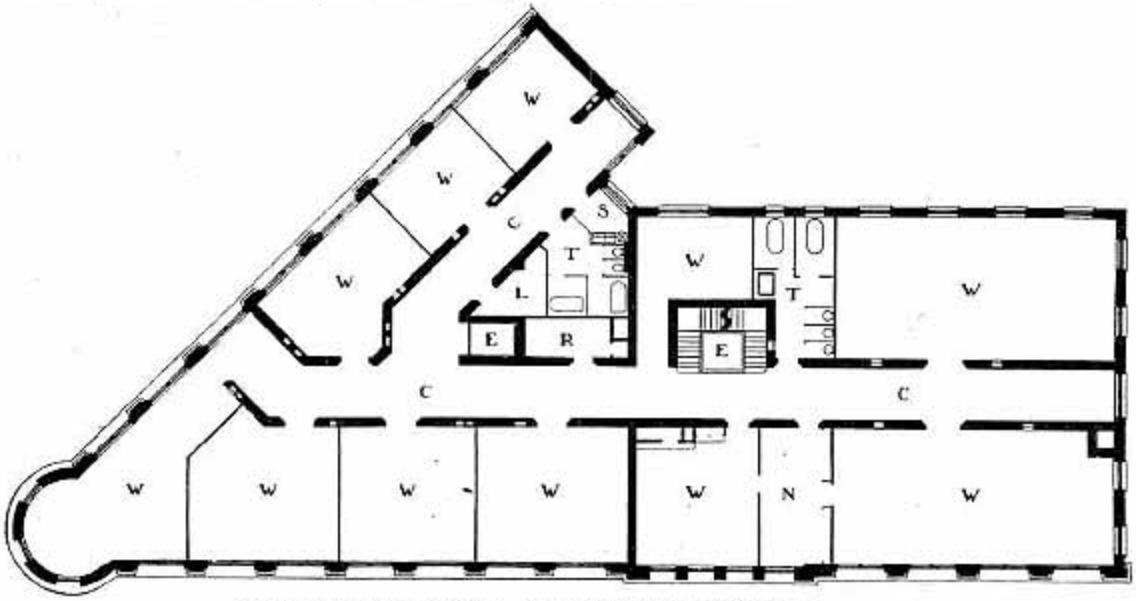


Fig. 3.—Augustana Hospital. Plan of second and third floors.

In portions of the country with especially severe winters this system of heating may be combined with direct radiation from steam or hot-water coils, only enough air being forced through the heated air-shaft for ventilation, the greater portion of the heat being supplied by the more economical direct radiation.

A very simple method devised for heating and ventilating is the direct, indirect method, one which has been used to some extent in hospitals. The heating is all direct, the air coming in through louvers, passing through a register which can be opened or closed at will, back of which is an extremely fine mesh screen which is removable, so that it can be readily cleaned. All the air goes into a duct, two screens made of cheese cloth and removable being interposed. These can be made damp and changed as required. At the bottom of the duct are two small doors into which can be placed a pan

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of water. This will serve the double purpose of taking up the particles which may get in and of giving humidity to the air. The air falls directly over the radiator through the duct, and this duct being back of the radiator, the chill is taken off the air primarily. It then rises and traverses the entire room to the duct at the floor which leads to a large air chamber in the attic space between ceiling and roof, giving room for a great volume and thus a regular circulation. This attic space is ventilated by a shaft thirty feet above the roof and may be made to work either naturally or mechanically, the first by means of a cowel facing the aperture from the wind and so creating a vacuum directly in front, and a plenum state directly behind the shaft. A simple mechanical process is the placing of a radiator of large capacity at the base of the shaft or duct and so creating a current of air by convexion. An ordinary gas jet at the bottom of each shaft will in many instances suffice. This method has many strong advocates.

LIGHTING ARRANGEMENTS.

If a hospital building is placed from north to south, being long and only wide enough for a row of wards or rooms on each side of a central hall, then all the

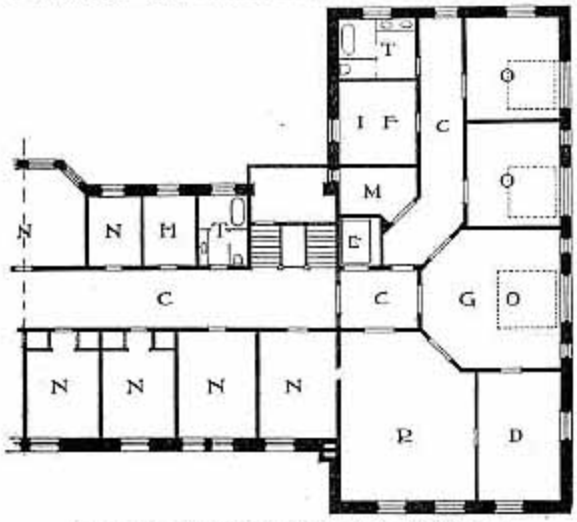


Fig. 4.—St. Mary's Hospital. Part of fifth floor.

rooms and wards on one side are exposed to sunlight during the entire forenoon and on the other side during the afternoon.

In visiting many hospitals I have found that only in a few instances care has been exercised to obtain sunlight for every room and ward in the institution, and the dark corners are very common.

Ordinary illuminating gas is the least desirable of all artificial lights. It gives rise to much soot, gives off much heat and consumes much oxygen, and in most institutions it does not give a clear, uniform light unless some form of asbestos mantle is used.

Incandescent electric light is clean and does not consume any oxygen and gives off but little heat, but the radial power is not good, compared with the cost of production. Acetylene gas consumes some oxygen, but compares well otherwise with incandescent electric light; it is possibly the most economical form of lighting. There is very little heat produced and no soot.

KITCHENS.

The kitchen is one of the most common sources of annoyance in hospitals because of the odors which are very offensive to the sick. This can be remedied by placing the kitchen in the garret. All the odors from cooking rise, hence the location of the kitchen in the garret will at once eliminate this source of trouble. The range should be placed in the center of the room and a good skylight and ventilator put over it. Another remedy lies in building a separate small building at some distance from the main hospital building for the housing of the boilers, engines, dynamos, if electric illuminating is employed, the kitchen and the laundries.

Each floor should, of course, have its own little diet kitchen, and these should be directly below the main kitchen or in such position that there will be direct communication by dumb waiter.

FLOORS.

In the halls, bathrooms, closets, kitchens, operating and dressing rooms, some form of flooring which is impermeable to moisture, such as tiling or glass, has now been generally adopted with great satisfaction, because it can be easily kept clean and is attractive in appearance. In the wards and rooms hardwood floors laid on the cement covering which isolates the floor from the lower story seems preferable. This should be covered by some dressing impermeable to moisture in order to prevent septic materials from penetrating the pores of the wood. A careful application of grain alcohol shellac closes the pores.

WALLS.

The walls should be covered with paint which prevents the plaster from becoming filled with germs. These walls can be washed and thus rendered aseptic after the rooms have been occupied by patients with suppurating wounds.

In the operating rooms and dressing rooms walls covered with tile, marble, glazed brick or glass are very attractive, but they are in no way superior to those which have been carefully covered with hard enamel paint which is impervious and acid proof.

PLUMBING.

There is no part of the construction of a hospital which requires greater care than the plumbing, but, fortunately, this branch has been so perfectly developed in house and hotel construction that any good architect whose attention has been directed toward the importance of this part of the construction will be enabled to furnish safe and satisfactory plans. One essential that should be introduced in all hospitals is a large slop sink or hopper with a water seal—in fact, an enlarged syphon-jet water closet with a large flushing tank. The utility of such a device can be seen at a glance. The aperture at the top should not be less than 24 inches square in order to prevent spilling in emptying bed pans and other utensils. The bathroom should be separated from the water closet and both should have large outside windows, and these should, if possible, reach to the ceiling, in order to light every part of these rooms from above, which will make it much more difficult for the servants to slight their work in keeping these departments clean. Storerooms should be well lighted, for often a dark storeroom serves to accumulate unclean material, because the dirt escapes detection by those in authority.

STERILIZING ROOMS FOR MATTRESSES, BEDDING, ETC.

There should be two sterilizing chambers, each sufficiently large to sterilize all the bedding and mattresses to be used for an entire week, so that while the material is being used from the chamber in which ster-

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ilization has been completed the other sterilizing chamber can serve for the accumulation of the next amount of material to be sterilized. There should also be a space left set aside for airing and sunning the bedding, which may be arranged on the roof.

Sterilization of instruments, utensils, dressings, towels and operating gowns is accomplished in a most perfect manner in the various sterilizers which can be purchased from the manufacturers of such appliances.

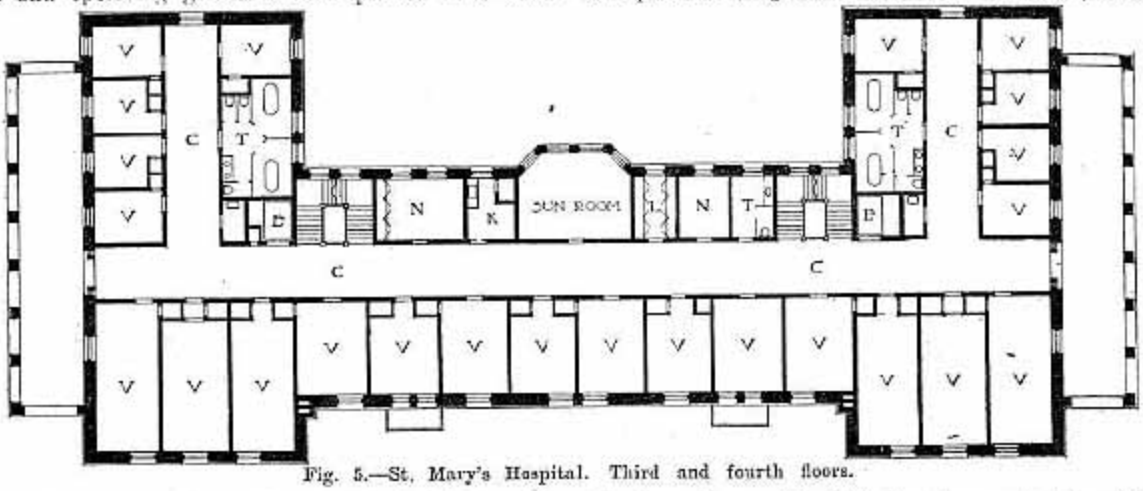


Fig. 5.—St. Mary's Hospital. Third and fourth floors.

SOME MODEL CHICAGO HOSPITALS.

I have been interested in the building of two of the larger hospitals of Chicago which have been under my surgical management for some years. The architects who planned these institutions incorporated the ideas brought out in this paper and the results have been most satisfactory. These institutions are six stories in height and extend from north to south, with a large corridor extending the entire length of the building. There are no dark corners and very few convenient places for the accumulation of dirt. These institutions furnish better air than do one or two-story buildings and still they can be conducted at a much slighter expense.

The accompanying drawings, kindly furnished me by Messrs. Hallberg & Sturm, architects of the Augustana Hospital, and Mr. Henry J. Schlacks, architect of St. Mary's Hospital, both of Chicago, illustrate the arrangement of two floors in each building, one for private patients and one for ward patients, the floors for private patients being the higher, those for ward patients the lower floors. The first floor is occupied by offices, waiting rooms, examining rooms, laboratories, etc., so that all the patients are above the first floor.

I also show the operating rooms, which are on the sixth floor in each institution, where their construction was possible at a much smaller expense than if placed in a separate pavilion, and still the conditions are much more favorable for an aseptic operating room than the

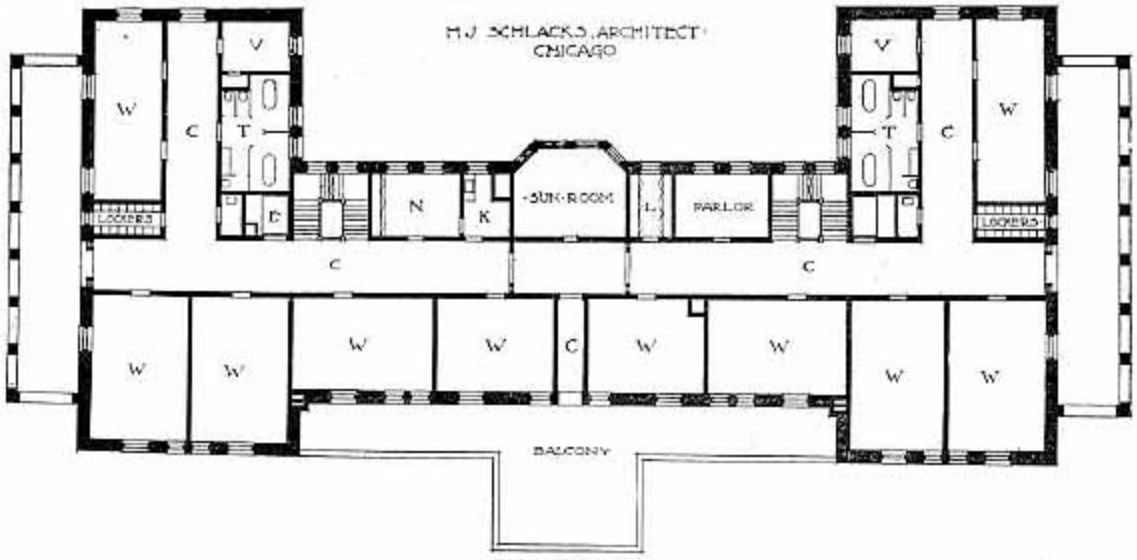


Fig. 6.—St. Mary's Hospital. Second floor.

would be on the first or second floor. Of course, it would be possible to add as many more stories as might be desired in order to increase the number of beds without in any way impairing the hygienic conditions present.

During the past sixteen years I have given a great amount of attention constantly to the study of hospital construction. I have visited most of the hospitals

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of the large cities in this country and Canada, as well as those in most of the large European cities, and have studied the plans of most of the other hospitals which I have not personally visited, and I am confident that the hospitals of the large city in the future must be a high building constructed on the essentials emphasized in this paper.

EXPLANATION OF ILLUSTRATIONS.

Figures 1, 2 and 3 are taken from the plans of Augustana Hospital, which is to be completed next year, only the south half being finished at the present time.

Figures 4, 5 and 6 are taken from the plans of St. Mary's Hospital, which was completed last spring.

Figure 1 shows the top floor, the greater portion of which is given up to a series of operating rooms, dressing rooms and recovery rooms, and to the kitchen and dining rooms. These departments, it will be seen, are practically isolated from each other and from the remaining portion of the hospital.

Figure 2 represents the fourth and fifth floors, which are occupied entirely by private rooms and are provided with every comfort and convenience that may be desired by private patients.

Figure 3 represents the second and third floors, which are occupied entirely by wards. The large wards at one end of the floor, I believe, are a mistake, especially in a hospital where bedside teaching is done, because of the unnecessary disturbance of a large number of patients; moreover, it is easier to obtain uniformly good nursing if each nurse has assigned to her a ward sufficiently large to occupy her time than if a large ward is under the joint care of a number of nurses. It is much better to have all the ward patients together on the same floor and all the private patients on another floor than to have them mixed, because it avoids jealousies and dissatisfaction. In this institution the second floor contains the wards for male and the third for female patients, which further simplifies the management of the institution.

Figure 4 represents the plan for the operating, sterilizing, anesthetizing, supply and dressing rooms in St. Mary's Hospital. Being placed in the top of a high building, the light and air are ideal and the expense of construction is exceedingly low.

Figure 5 represents the third and fourth floors, which are occupied by private rooms and small private wards. In this portion of the plan the large hall extending through the entire length of the building and ending in a broad veranda at each end is especially attractive.

Figure 6 represents the second floor, which is occupied by the larger general wards, with an isolation room at each end. The two central wards, with a veranda on the east side of the building, are occupied by children. The south end is occupied by women and has a large veranda, while the north end is arranged in precisely the same manner and is occupied by the men.

There are many details which are interesting but whose description would consume too much space.

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DISCUSSION.

DR. H. M. SHERMAN, San Francisco—Dr. Ochsner's statement that modern methods of constructing buildings should be applied to hospitals is one to which we will all agree, as, for example, a hospital constructed like the Manhattan Hotel in New York, where everything is of non-combustible material. The floors and windows could be made of even less combustible material, I am sure. Dr. Ochsner puts aside the pavilion hospital, but such a building as he describes is practically one of superimposed pavilions, each floor representing a pavilion. The gain which he makes in the way of sunlight and air by the elevation is manifest. It seems to me that there is a point which can be criticised and that is in the amount of plumbing. In one plan the bathrooms, etc., are in the two wings and the center of the building is quite free of any plumbing. In going through the hospital I was impressed with this same fact. I think if Dr. Ochsner is going to economize his nurses he must also economize his nurses' time. The amount of running to and from which a nurse would have to do in passing to and from the bathroom would be a considerable amount each day. In the construction of the children's hospital in San Francisco, I had to deal with an exceeding obstinate architect. I had to calculate the steps between the bed which is farthest from the bathroom and found that the nurses walked two or three miles which could have been eliminated. The walks, of course, were broken, which is the only way they could stand it. With modern plumbing, such as you see in a modern hospital, which is absolutely perfect in its theoretical and mechanical construction, it would be possible to put in another bathroom which would answer admirably for the nurse. Then, too, surgeons are always washing their hands, and a nurse has to go and get the water every time it is needed. In other words, she has to go to so much trouble which is not necessary. Hot and cold water should be in every ward even if it contained only two beds. Another practical point is the heating of hospitals. We are using petroleum for fuel and it is exceedingly economical, the escaping steam being used for heating the building. Dr. Ochsner has put his operating-room at the top of the hospital and his kitchens should be the same place. Such a hospital as this, which should be very near the hotel center of the city so that hotel people could be transferred to it, should also have an annex in the country to which could be transferred such patients as have a long convalescence. Such a hospital in the center of the city offers good opportunities for the people who have a long convalescence and can not be moved to the country. The pure air of the country, the weather outlook and the opportunity to get out of doors, which is denied in the center of the city, is to be thought of. Any one building such a hospital as this should have weather plans and also include the country annex.

DR. E. W. CUSHING, Boston—I think that the author of this paper has rendered a great service. The work of Burnett, in England, and the example of the Johns Hopkins Hospital, in this country, seem to have remained as absolute standards of authority with architects and constructors of hospitals, although the theories as to the nature of infection and the knowledge of means to prevent it have greatly progressed since these works were written. I am interested in the planning of one of the great new hospitals of Boston, and I have been surprised to find how little has been written on hospital construction in the last ten years, or since the time when it was understood that infection of wounds was caused by actual contact of a solid or liquid medium rather than through the air, and since it has become possible to construct thoroughly fire proof buildings. In large cities, where land is very valuable it is evident that it is cheaper to build hospitals with less superficial area and higher than has been customary. With modern methods of heating and cooling and ventilating and with modern sanitary plumbing there seems no reason why a hospital should not occupy several of the upper stories of a lofty building in the heart of a great city. It is also true that in a hospital thus centralized in one building there are economies in heating and in the smaller distances to be traveled by nurses and others. It is not usually considered that extra steps for nurses mean a larger number of them and extra expense. It is certainly a great convenience for the visiting staff to have the hospital in a convenient place, and the same may be said in regard to the friends and relatives of the patients.

Nevertheless, for large general hospitals there are greater advantages in having plenty of land, so that there can be grounds for the ambulant and convalescent patients, and although surgical infection may be usually carried by physical contact with an infected body, yet when the hospital gets crowded there are times in the best of hospitals when the wounds do not do well, even with all the refinements of moder

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technic. We can not deny that in medical diseases the atmosphere is sometimes a carrier of infection, and when it comes to a large hospital with all sorts of diseases, including offensive cases, and with provision to make for a pathologic department, an autopsy room, etc., there will always be great advantages in locating the hospital in a suburb and on a hill, with plenty of land to allow for separate buildings for various purposes and to permit of future growth of the institution.

Dr. Geo. W. Crile, Cleveland—Dr. Ochsner has opened an important field for discussion. So far as the principles he lays down are concerned there is little to be said. While his system is to my mind almost perfect there are one or two points that occurred to me might be open for discussion. If a hospital is a teaching hospital then I think it is better, for obvious reasons, to have the pathologic building isolated. It would seem difficult to secure satisfactory isolation by this plan of construction. The pathologic pavilion should also be of considerable size. It is desirable to have the storehouse, kitchens, etc., in a separate pavilion. The plan of construction outlined is probably the best available if economy must be practiced.

Dr. Ochsner, in closing—I gladly indorse all of Dr. Sherman's points. It is intended that this hospital should be located in the residence portion of the city, away from the noise and smoke. The idea of having a separate annex at some distance from the city is a good one for patients who have only to be seen by the attending physician once or twice a week. The matters of heating and ventilation are carefully discussed in the paper. The kitchen is on the top of the building, entirely separated from the rest of the house, and the cooling rooms are also on the top. There are two recovery wards for patients after anesthesia. A small isolation room for dying patients has been provided for on each floor, and isolation wards for scarlet fever, erysipelas, diphtheria and other contagious diseases are provided for at a distance in a separate building. I believe that when there is an epidemic of suppuration in cases which should heal primarily, a condition which Dr. Cushing has mentioned, it is not necessary to separate the cases because the cause of this is always found in some particular person, either a nurse or an assistant or the surgeon himself, who has been careless, and as soon as the error is corrected the suppuration ceases to occur in future cases. I believe a hospital of this size is very badly constructed unless it has a large garden, and we should not permit any one to build a hospital unless they provide such a garden. Dr. Crile's remarks concerning the location of pathologic laboratories are quite in accordance with my views on this subject.

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