THERMAL VENTILATION,

AND OTHER

SANITARY IMPROVEMENTS,

APPLICABLE TO PUBLIC BUILDINGS,

AND RECENTLY

ADOPTED AT THE NEW-YORK HOSPITAL:

A DISCOURSE,

Delivered at the Hospital, February 8th, 1851,

BY

JOHN WATSON, M. D.

New-York:
PRINTED BY WM. W. ROSE, 17 WALL STREET.
1851.

DISCOURSE.

Those of you, gentlemen, who have formerly been familiar with the plan of this edifice, must have observed, that it has recently undergone extensive alterations.

The measures which have resulted in these changes were adopted in the early part of last spring. The work was commenced in May, and has been in active progress ever since. The new arrangements being now so far complete as to allow the wards in every part of the house to be again open for the accommodation of the sick, it has been thought advisable to invite the attention of the public towards them in their present state of renovation, and to solicit a careful inspection of them from the members of the medical profession, from the guardians and directors of other public institutions in the city, and from such other enlightened individuals as may deem the condition and management of the New York Hospital worthy of a special examination.

With this view, gentlemen, the Executive Committee of the Board of Governors, who have been more immediately instrumental in bringing about the present changes, and the Physicians and Surgeons of the Institution, at whose advice and recommendation they were commenced, have solicited the favor of your attendance on the present occasion, and have instructed me to present to you a summary account of their improvements, and of the reasons and circumstances which have led to them.

The health and comfort of domestic life are intimately connected with the abundant and unfailing supply of

pure and genial air. To furnish this, as free as possible from accompanying annoyances, is a problem, which, of late, has excited much thought and ingenuity. The means hitherto employed for the purpose, or at least the most of them, have long been in requisition; but the necessity for the more constant employment of these, and for their unremitting and energetic action, is hardly yet sufficiently understood.

It would here be out of place to dwell upon the constituent elements of the atmosphere, its sensible and insensible changes, or the various sources from which it may become deteriorated, and dangerous to health and life. Among the members of the medical profession these points are under daily observation, and in every well-informed community of the present day, they are generally understood.

The great fact developed in the Hyienic relations of the atmosphere within the past few years, is, that the sources of in-door contamination are more abundant, more difficult of removal, and more deleterious in various ways than had been previously acknowledged or suspected.

The words of Count Rumford—until recently a name of great authority—are in proof of this: "As long," says he, "as any fire is kept up in the room, there is so considerable a current up the chimney, notwithstanding all the reduction that can be made in the size of its throat, that the continual change of air which this current occasions, will be found quite sufficient for keeping the room sweet and wholesome: and even in rooms in which there is no fire-place, and consequently no current of air open from the rooms setting up the chimney, as in those heated by German stoves, and when the windows and doors are double, and both are closed in the most exact

manner possible, by slips of paper pasted over the crevices, or by strips of list or fur; yet, when these rooms are tolerably large, and when they are not very much crowded with company, nor filled with a great many burning lamps and candles, the air in them is seldom so much injured as to become unwholesome." * It is but just to observe, as a palliation for some of the erroneous opinions embodied in these words of Count Rumford, that he probably never thought it possible to reduce a chimney throat to such a degree as is now common in grates for the combustion of anthracite coal. As a comment on the rest of his remarks, I cannot do better than to adopt the words of Mr. Bernan: "We instinctively shun approach to the dirty, the squalid and the diseased; nor use," says he, "a garment that may have been worn by another. We open sewers for matters offensive to the sight and smell; we carefully remove impurities from what we eat and drink; we filter turbid water, and fastidiously avoid drinking from a cup that may have been pressed to the lips of a friend: yet, on the other hand, we resort to places of assembly, and draw into our mouths, air loaded with effluvia from the lungs, and skin, and clothing of every individual in the promiscuous crowd—exhalations offensive, to a certain extent, from the healthy individual; but, when rising from a living mass of skin and lung, in all stages of evaporation, disease and putridity, and prevented by walls and ceiling from escaping, in the highest degree deleterious and loathsome." †

I need not dwell on the character and amount of these exhalations. From the lungs alone, it is estimated that

* Essays, vol. 1, p. 302.
† Warming and Ventilation, vol. 2, p 313.

about 16 feet of carbonic acid gas, and from 16 to 20 ounces of aqueous vapor, highly charged with animal matter, are eliminated every twenty-four hours. For the vast amount of combined exhalations from the lungs and skin, and for some of the evils resulting from them when allowed to accumulate, and to be reabsorbed into the circulation, I may refer to the able report of my friend and colleague, Dr. Joseph M. Smith, presented to the American Medical Association, at their last annual meeting, and published in the volume of their Transactions for the present year.

Estimating the pulmonary and cutaneous exhalations thrown off in the form of vapor, at 40 ounces daily for every healthy individual, and the monthly accumulations of a family of ten persons, in one of our close and ill-ventilated city houses, where the inmates are confined not more than half the time, at about five hundred pounds, no inconsiderable portion of which consists of animal matter, which cannot remain long suspended in the air, and which must, in consequence, be precipitated and allowed to decompose in the apartment, and we have sufficient materials, he conceives, to account for the frequent spontaneous generation of typhus fever. This, however, is an estimate for the badly ventilated abode of healthy individuals. Apply the same reasoning to the wards of an hospital, the inmates of which are confined to their apartments both night and day, with their exhalations at the time of evolution already approaching a state of putrefaction, and the quantity of animal matter contained in these out of all proportion greater than that in the exhalations of the healthy; remembering, also, that the lungs are organs of absorption as well as of exhalation, that the whole mass of the blood passes through them about once in every three

minutes, and while thus passing is continually exposed to vitiation from any deleterious agents that happen to be retained in them, and we have some data from which to estimate the agencies continually at work for the propagation of typhus, and scrobutus, and purulent cachexia, and dysentery, and gangrene—not to speak of other innumerable, nameless, but not unknown peculiarities of diseased action, which render the treatment of hospital patients so difficult, their vital force so languid, and their chances of recovery from disease, which, under more favorable circumstances, would be looked for as a matter of course, so deceptive and precarious.

Like breeds like, is a law in pathology as well as in animated nature—a law recognizable in all the vegetative processes taking place within the body, and at least sometimes also out of it: for, though the fact is often overlooked, it is, nevertheless, an important truth, that *all the changes occurring in what is usually called effete matter, are not in strict subservience to the simple laws of inorganic chemistry.*

The twin-bearing mother and twin-bearing daughter; the hereditary peculiarity of race and stock, down to the minutest family trait, idiosyncracy or propensity; the spread and propagation of diseased actions, universally acknowledged to be communicable from individual to individual, are, perhaps, not more in strict subservience to this law than certain changes continually taking place among the molecules of effete matter, as well while retained within the body as after their elimination.

The class of diseases to which this law of propagation is universally admitted to apply, is comparatively small. In the philosophical study of Pathology, tendencies in subservience to it in other classes of diseases,

perhaps in all diseases, may possibly be shown to be neither limited nor rare. In the simple process of what is called healthy inflammation, we see this tendency to propagation from surface to surface, in intertrigo: we see it in the contaminating touch of the herpetic lip; in the diffusion of furunculi; in the progress of carcinoma and of tubercle: we see it in the eroding ulcer, and in the multiplication of carbuncles, as well as in the extension of typhus, of erysipelas, of purulent cachexia, and of hospital gangrene.

We see the influences of this same law in changes occurring in animalized, and even in vegetable substances, to all appearances deprived of vitality, and detached from the living tissue, or free in the open air. The purulent deposit, now formed from the living blood in the midst of comparatively healthy tissues, and now as a free secretion, is also formed by the disintegration of the primitive tissues, and even by changes occurring among other secretions already thrown out of the body and resting upon its diseased surfaces. The effete matters ceasing to be eliminated from a healthy individual, excite diseases identical with those which these same materials give rise to, when reabsorbed with the breath, and imbibed from the open air. The fomites of filthy clothing and of foul rooms, propagate diseases in every way identical with such as originate from internal causes. It is not every case of scarlatina, of measles, or even small pox, in which we can trace the communication of virus from individual to individual, much less so of typhus, of cholera, of yellow fever, of puerperal fever, and erysipelas.

The study of this primary law of organic developements, is never to be overlooked by the inquirer into the hidden causes of disease. Applying it to the exha-

lations from the living body, he is, at least in part, prepared to resolve some of those questions which formerly confounded, and which still continue to baffle the judgment and sagacity of the most acute and assiduous observers. The Hygienist, above all, is called upon to remember it in all his provisions for the health and safety of his fellow men, collected together in large assemblages, whether in armies or in fleets, in prisons or in factories, in schools or crowded individual abodes, in asylums or in hospitals. Thus far directed by it, he has furnished most of the suggestions which, of late years, have led to so much improvement in the comforts and amenities of social life, and among the rest, to the creation of what has now become almost a new science —Thermal Ventilation.

The art of purifying the in-door air, as already remarked, has been greatly improved within the past few years—not so much by new inventions as by the judicious application of such as were formerly in use, and by the adaptation of these in accordance with the rules of health, and without regard to the purposes to which they were originally turned. There is hardly an application now in use for the heating and airing of dwellings, that had not been previously employed for other purposes, most of them, with little or no essential modification, for centuries, and some of them, since the earliest times.

I. The Hypocaust of the ancient Romans was evidently derived from the brick kiln. The primary construction of the one is essentially the same as that of the other—both alike consisting of an immense mass of mason work, underlaid with flues for the diffusion of heat, with no provision for the withdrawal of smoke or vapor.

The Hypocaust was first employed for heating bathing-rooms and sudatoria, but afterwards for warming private dwellings. It was without chimney, and without flues for the transmission of heat to the apartments above it—at least during the combustion of fuel. Its mouth or entrance was at the outer wall, and through this the smoke escaped, as from the mouth of an oven. The heat imparted to its mass of brick and stone, was transmitted by slow conduction through the tyle or marble pavement, to the room above. In some of its more complicated forms, there were concealed flues rising in the wall to the first or second story, but with no outlet at the top. In others, these flues, after the fire beneath them had ceased to glow, could be opened by the removal of a lid or cover, and thus they allowed the warm air issuing through them to enter the upper apartments.

These cumbrous furnaces were, of course, subject to frequent leakage. The Emperor Julian, by a defect in one of them, and the exhalation of vapor through the walls of his chamber, was completely overpowered, and his life was only saved by speedily removing him into the open air. His successor, Jovian, is said to have been suffocated by the fumes of a furnace while sleeping in a close apartment.

The Hypocaust, for the simple purpose of imparting heat, has for many centuries been laid aside. The focus and brazier, even in ancient times, were usually preferred to it. Yet it may have early served as the prototype of the German stove, as this latter has, in turn, served as the model upon which the air-chamber was engrafted in the original dry-air furnace. The Hypocaust, with the addition of a smoke-flue, is still retained in the malt kiln—a furnace with a low room above

it, used by brewers for the drying of grain, after this has undergone the requisite degree of saccharine fermentation.

The *focus* in the centre of the room, or instead of this, the *clibanum* or brazier, was the usual fire-place even in the most costly residences of the ancients. In the castles of the English Normans, and in other similar structures of the middle ages, the fire-place was moved to a deep recess against the wall, and the smoke, as in more ancient times, found vent at the loop-hole in the roof, or through the open turret, or the louvre window in the side of the dwelling. But on the invention of chimneys, by the Italians, in the early part of the fourteenth century, the open fire-place assumed the form which, under varying modifications, it has ever since retained.

The third essential form of heating apparatus is the *water stove*, now looked upon as one of the most recent and original, as it is certainly one of the most admirable. But this identical apparatus, or some contrivance like it, may have been used by the ancient Egyptians for the hatching of eggs; for it is well known that they used some artificial machine for this purpose. But whether used by them or not, in its present form it was first introduced into France as an apparatus for the hatching of eggs, under the name of Bonnemain's Chicken Stove, in the latter part of the past century. For the heating of dwellings, it was first employed in England by the Marquis of Chabannes, and claimed by him as an invention of his own, as early as 1816.

The *steam apparatus*, for the purpose of warming, was only a special adaptation of the ordinary boiler of the steam engine; and we find that Mr. Watt, the great improver of the engine, began to turn his attention to

the use of steam for the heating of houses, and, in fact, employed it in his own office for this purpose, as early as in the winter of 1784–5, allowing the steam to escape, and thus to evolve its latent heat. Mr. Boulton soon afterwards applied it successfully for the heating of baths, and other domestic purposes; and in the year 1795, introduced it, by means of metallic pipes, into the house of his friend, Dr. Withering, of Birmingham. Before this, however, viz. in 1791, Mr. Hoyle, of Halifax, (England,) obtained a patent for heating by steam-pipes passing to and from the boiler, and distributed throughout dwelling-apartments, in essentially the same manner as employed at the present day. We need not follow the various modifications and extensive applications of this apparatus in the hands of our ingenious countryman, the late Mr. Perkins, or the improvements upon his plans, especially in combining the apparatus with systems of ventilation, by other artizans and mechanics of England and this country.

II. Appliances for the tempering of summer heat are, in some countries, as necessary, and may have been as long in use as the heating apparatus of other places.

The Punkah, a horizontal fan, suspended from the ceiling, and made to vibrate over the heads of the company in some of the spacious abodes of India, belongs to this class of contrivances. It is usually worked by hand; but some of the Nabobs, we are told, have lately applied the steam engine to it.

The Tattie, a kind of mat, saturated with water, and suspended in the doors and window spaces, to favor rapid evaporation, and thus to cool the surrounding air, is another contrivance of the Southern Asiatics, for effecting the same object.

The underground tunnel, now in use as an equalizing

chamber, was long ago employed as a cooking apparatus. The palace of the Trenti, at Costosa, in Italy, being in the neighborhood of some deep stone quarries, the air in which had been noted for its coolness, one of these was fitted up at great expense, and connected with the various rooms of the building by means of a tunnel through the rock. When they would have cool air from this spacious Æolian Grotto, says an old traveller who visited the place in 1663, they shut a gate in the cave, and open a door at the end of the tunnel, which lets in the fresco, every room having a hole in the wall or pavement, to admit it.*

I need hardly allude to the plan of suspending a mass of ice near the ceiling, which is now in common use, during the warm weather, in our own country, for the cooling of milk rooms and other domestic purposes.

III. After the Louvre, the open turret, the latticed window, the chimney, and the windsail, the contrivances of most repute for producing a change of air, are the rotary centrifugal fan, the air pump, and the ventilating fire, for creating either an upward or downward current.

The influence of large fires in rarifying the air, and removing noxious vapors, was as well understood in ancient times as at present. Acron, the Pythagorian philosopher and physician, who lived nearly a century before Hippocrates, is said to have arrested the spread of an epidemic at Athens, by kindling numerous fires in different parts of the city.† Celsus alludes to the beneficial effects of fire, of the sun's heat, and of an airy and elevated exposure in purifying the air of sick rooms; and Agricola, in the sixteenth century, states, that in Germany it was customary to remove the foul air from

* Bernan, vol. 2, p. 187

† Littre, Œuvres d'Hippocrates, tom 1, p. 17.

mines, by suspending a fire in the middle of the shaft, to create an upward current. The creation of a downward current, by a fire in the basement, is, I believe, a comparatively recent invention. The attic fire-place and flue, for the removal of foul air from the dwelling apartments beneath, was first applied to the old English House of Commons, and with good effect, more than a century ago.

The rotary, or centrifugal fan working by a crank, and an air pump, in the form of an immense pair of bellows, also appear to have been in use for injecting pure air into mines, and thus forcing out the foul air, as early as the sixteenth century, and are still in use for the same, as well as for other purposes. A triple barreled air pump, working with a crank by hand power, was invented by Dr. Desaguliers, in 1727, for the removal of impure air from the mines of the Duke of Westmoreland, and was capable of discharging about ten cubic feet of air per minute. The same ingenious philosopher, from causes which he could not control, being obliged to remove his ventilating fire from the attic of the old House of Commons, placed in its stead, over the top of the building, the rotary centrifugal fan, which still goes by his name, for drawing up the foul air from beneath. This instrument was erected over the roof of the building in 1736, was worked by a hand crank, and continued in operation until the year 1820, or about 84 years—a sufficient proof of its usefulness. The fan is still employed for ventilating ships and factories, sometimes for increasing the draught of furnaces, worked either by hand, by water, or by steam power. It can be worked either as a forcing, or, by a reversed action, as a sucking pump. In a portable form it has occasionally been employed in the wards of this hospi-

tal. The apparatus called the ship's lungs, invented by Dr. Hale, of London, during the last century, worked by a double lever, and capable of discharging about a tun of air at a stroke, was somewhat in the form of an immense pair of bellows, acting also as an exhausting pump.

Mr. Sutton, a brewer, of London, during the last century, ventilated the holds of ships by means of the cooking fire on the deck, drawing up the air through tubes which were connected with the ash pit of the fire-place; and Sir George Paul, about 1820, ventilated, by the same means, the wards of an hospital, the foul air from near the ceiling of every lower ward being drawn upwards through a flue, and conducted through the fireplace of the room over head, and so carried off by the chimney. Mr. Green, as early as 1793, excited an upward ventilating current in a similar manner, substituting a wide metallic pipe for the foul air flue or chimney, and a smaller tube within this, instead of the fire.

By the Æolian apparatus of Mr. Deacon, invented in 1813, the air was forced from beneath, by means of a fan, through earthen or metallic tubes, the sides of which were kept immersed in boiling water; and when thus heated, it was allowed to rise upwards into the dwelling apartments. By using cold instead of hot water, he could temper the air also for summer use.

The gimlet-hole system of ventilating apertures, first devised by by Sir Humphrey Davy, for the equable diffusion of fresh air, and for preventing strong draughts in the removal of foul air, and originally introduced by him in the English House of Lords, has since been carried out by Dr. Reid and others, with the most favorable results. Davy, however, appears to have been but badly rewarded for his trouble, at least if the epigram

in which his experiments are recorded, speaks the truth.*

From these facts, (and innumerable others might be adduced,) it is clear, not only that the instruments and appliances now in use for Thermal Ventilation, are not of recent date, but that they had long ago been occasionally employed for this purpose. For mitigating the summer's heat and winter's cold, and removing from around him such noisome and offensive vapors as are recognizable by his senses, and even those more insidious exhalations which issue from his own body, as well as those others "which the sun sucks up from bog, fen, marsh," and even from the open field or mountain side, man must have, in all ages, exerted his ingenuity. All, then, that can be claimed by modern science, in its more efficient protection of health and life in this respect, is, in having demonstrated the importance of continual attention to the principles upon which the art of Thermal Ventilation is founded, and of carrying out its measures in accordance with these, to an extent never before admitted, and for reasons which, until within the past half century, could hardly have been understood.

Let us now return to our own institution.

The central or main building of this hospital was commenced nearly eighty years ago, and has been in constant use for hospital purposes, now, just sixty years. It was constructed after plans which had been prepared under the supervision of Dr. John Jones, a surgeon of great reputation in this city about the middle of the last century, and the author of the first surgical work ever published in this country. The original plan of the

---

* "For boring twenty thousand holes,
The Lords paid nothing: d—— their souls."

building, for its time, was probably the best that could have been devised. But to meet the growing exigencies of the city, to maintain efficient internal sanitary arrangements, and provide for the convenience and proper treatment of the sick, the house, within the past fifty years, has undergone several important changes.

As originally finished, it was in length, from north to south, about 124 feet. Of this length, 66 feet were included in the central portion, and 29 feet at either extremity were occupied by the wings. In width, from east to west, it measured rather less than 50 feet for the centre, and 86 feet for the wings. It was at first only two stories high: the third story was added in 1803, giving it an elevation of 52 feet, of which 10 feet above the ground were appropriated to the basement, and 14 feet to each of the three stories above this. In 1829, a quadrangular extension of 12 feet from north to south, and about 40 feet from east to west, was added to each of the end wings, making the whole length 148 feet.

A central hall, or corridor, eight feet wide, extended through the whole length of the building on every floor, terminating, for the basement and first story, in end doors,—for the two upper stories, in wide windows, since cut down to the floor. In the wings on either side of the corridor were the wards, or sick rooms; and in connection with each ward were provided, in the extension of 1829, two small rooms, the one for the nurse, the other for a bathing-room and water-closet. The wards could be approached only through the central corridor. They were lighted by numerous windows on three sides, and supplied with fire-places for the combustion of wood, in the wall immediately facing the hall doors. The central portion of the building was, as at

present, mostly taken up with the spacious vestibule leading from the front entrance, with transverse passages from front to rear, with two flights of stairs, and with the various offices and other smaller apartments.

Taking the original plan in connection with the elevated site of the building, on the brow of a hill overlooking the level space of 600 yards, lying between it and the banks of the Hudson River, and with its rural, or, at least, suburban exposure, it will be perceived that at the date of its erection, it must have been well provided with all the requisites for maintaining a thorough system of what is now technically called Spontaneous, or Natural Ventilation.

Its situation, I have said, was suburban. The five acre lot, near the centre of which this building stands, for some time after the commencement of the present century, was at considerable distance beyond the northern limits of the city, the ground to the south of it, as far as Murray street, still lying in open fields. A gentleman, now officiating among our Governors, looking from the rear of his own house in Murray street, remembers to have witnessed the attack of the populace upon the south wing of this building, during the memorable riot, known in the history of the city as the "Doctors' Mob."

In the year 1792, Dr. Tillary, after officiating about a month as one of our attending physicians, gave as an excuse for sending in his resignation, that the Institution was so far out of town, that he would be unable to continue his services without incurring the expenses of a horse and gig.*

*It may, perhaps, be worth while to remark, for the information of those who are not familiar with the topography of this city, that the Hospital is about three-fourths of a mile north of the Battery, or southern limit, and nearly three miles south of the point to which the thickly settled portion of the city now extends towards the north. Most of the heavy business is done in the elder portion of the city to the south of the Hospital, whilst the great mass of the population reside in the northern section.

For many years after the opening of this building, the ancient chimney-piece was still in vogue, and the blazing hearth adorned the rooms in most of our city dwellings. Stoves were yet unpopular, and anthracite unknown. Oak and hickory were still abundant, and no one contemplated the necessity of cheaper fuel, or of economising heat at the expense of fresh air. Under circumstances such as these, typhus, and typhoid erysipelas must have been but rarely witnessed. But with the open hearth and crackling fire of wood, come smoky rooms and troublesome currents of cold air. For these annoyances, our patience, if not our health, impels us to seek a remedy.

But these were days before the fame of Howard. Accidents like those at the Oxford Assizes in 1577, or at the Old Bailey in 1750, had not yet entirely ceased: the close air and unwholesome regimen which had decimated our own people in the British prison ship at Wallabout, were still among the scourges of the sea; and the favorite means of purifying prisons and asylums, was still, by the daily sprinkling of lime water, or of an acetous infusion of rue, wormwood, sage, lavender, mint, and rosemary. In short, the principles of ventilation, as a sanitary measure, were, as yet, habitually overlooked; and consequently, it could hardly have been expected, that the governors of this institution, in their earliest attempt to find a remedy for smoky rooms and draughts of cold air, should at first have fallen upon the best one. A Franklin, a Rumford fire-place, a chimney cowl, or turn-cap, might have remedied the smoke; but stoves might prove a cure for both annoyances; and stoves were introduced, one for each ward, with its pipe opening into the chimney, and the fire-place sealed up with a fire-board. The rooms,

as a matter of course, now became offensive from close air ; to relieve which, a four inch circular opening was next made through the walls of the building, near the ceiling, in each ward. But this defective method of tempering the winter atmosphere was endured only long enough to lead to a better, namely, to the downward system of thermal ventilation, which was devised about 1820, and which, among other improvements, was introduced here in 1829.

This system, said to have formerly been employed by Evelyn, was first applied to hospital use by Mr. Wm. Strutt, at the infirmary of Derby, in England. He introduced the fresh air through an underground culvert 4½ feet wide, and about 210 feet long, commencing in an upright shaft in the open ground near the building ; which shaft was mounted by a turn-cap, the mouth of which was constantly to the windward. The air entering through this tunnel, after being heated by a furnace, ascended upward to the sick rooms, which it reached at openings near the ceiling. Descending as it cooled, it was next conducted off, as foul air, by openings near the floor of the rooms, and thence ascending again through foul air flues, it was discharged through a second wide tunnel, which, with its turn-cap continually directed from the wind, rose to some considerable elevation above the roof. For some time after it was first made public, this plan of ventilation was in general favor, both in England and this country ; and it is still in use in many of our well regulated public institutions. As introduced into this building, the underground tunnel was omitted, and the air received into ordinary air chambers, from the windows of the basement. The foul air from the rooms, instead of rising by special flues, was conducted off through the throat

of a narrow anthracite grate near the level of the floor, passing to the top of the house through the chimneys, and thus, when necessary, admitting of a certain amount of forced ventilation, by the small coal fire in the grate at the point of the room most remote from that at which the air entered.

With the occasional aid of a fire in the grates, and of lateral ventilation through the windows, doors, and special openings over the doors, with frequent purification by whitewashing and scrubbing; and with strict attention to cleanliness in the furniture of the sick rooms, as well as in the personal habits of the patients; the new system of warming and airing continued for many years to be satisfactory. But within the past three or four years—owing partly to the failure of the furnaces, partly to essential defects in the downward ventilation under any circumstances; partly to the gradual increase in the number of severe surgical cases, partly, perhaps *mainly*, to the greater prevalence of ship fever, or the European typhus, which, since 1847, has always prevailed in the city, and given rise to a great share of the medical cases here; and, perhaps, owing also to other causes, which at present can neither be analyzed, nor detected,—it was observed, that the atmosphere of the house had a growing tendency to deterioration. The severer forms of erysipelas became more common here than formerly, the convalescence of patients after surgical operations was neither so rapid nor so certain as might have been expected under the favoring circumstances of pure and genial air; and at length, in 1849, hospital gangrene, one of the most serious pests of the old and crowded infirmaries of Europe, declared itself for the first time among the inmates of this hospital.

Under these circumstances, in the early part of February last, a committee from the Board of Governors was appointed to inquire into the causes of the existing evils; and in association with the physicians and surgeons of the institution, to submit some plan for the more efficient ventilation of the main and south buildings, with special reference to the arrest or prevention of the prevailing diseases. In compliance with the duties imposed upon them, the committee, on the 2d of March, replied, that mere ventilation, however well devised, independent of other measures, offered no sufficient remedy against the evils in question; and that, to put an effectual check upon them, would involve a thorough revision of the whole internal arrangement of the two buildings.

In allusion to the defects of a downward ventilation they remark, that this plan, though sufficiently effective for temperature merely, and perhaps the best for the heating of prisons and other institutions where economy in fuel is of primary importance, is, at the present day, condemned by the most competent authorities as being more specious than correct in its application to hospitals. The exhalations from the sick naturally seek the highest level; but by this mode of ventilation they are forced reluctantly to descend; and in so doing, they are drawn again and again into the lungs of the patients; and the more frequently by such of them as lie prostrate upon their backs near the level of the floor, than by the less feeble who are able to walk about. The experience of the past winter, they say, has sufficiently demonstrated that with the present system of drawing off the foul air, a healthy atmosphere cannot be maintained without the aid of collateral ventilation, and the admission of cold air through

the crevices of the windows. In the adoption of any new plan, it may perhaps still be inexpedient wholly to prevent the transit of cool air in this way. But the cooling effect of windows moderately tight, is owing mainly to another cause, namely, to the direct loss of heat through the glass by conduction. Most of the heat thrown into the rooms is lost in this way. The warm air impinging on the cool glass, is suddenly condensed near the top of the windows, and precipitated downwards to the floor, and in its descent it falls in strong currents upon the patients lying near the windows, with their heads towards the wall.

In regard to the actual accommodations of the house, they remark, that with the existing means of ventilation for the winter season, the number of patients admitted has been greater than a due regard to the welfare of the sick would sanction. The number of healthy individuals that may be accommodated during the night, within a given space, with impunity to themselves from confined air, is no criterion for determining hospital accommodations, where the sick are confined both night and day, and where unwholesome exhalations are continually rising from their bodies and mingling with the atmosphere of their apartments. The effluvia from the bodies of the sick, the animal matters from their breath, are in time condensed along the windows and around the cooler parts of the room, settling upon, and intimately combining with, the walls and fixtures, so as to be wholly incapable of removal by ventilation ; and when allowed to accumulate, although incapable of detection by sight or smell, they may, nevertheless, serve as a most prolific source of disease. The more crowded these apartments, the greater the number of offensive patients under treat-

ment, and the cooler and damper the weather, the more rapid will be the accumulation of these offensive deposits, and the greater need of attending to every conceivable expedient for their prevention or removal.

After an exposition of the general condition of the two houses, they proceed to recommend, that in the main house the dry air furnaces and downward ventilation be abandoned, and some more approved method of heating and ventilation be substituted, to apply to every part of the building as well as to the wards ; that all parts of the house be kept, as nearly as possible, at the same temperature ; and that the ventilation of the sick-rooms be so devised, as to withdraw the foul air at numerous points along the upper as well as lower parts of the rooms ; that the beds in the several wards be so arranged as to stand entirely free from the walls ; that the number of them, unless new accommodations can be provided, be diminished ; that every annoyance in connection with bathing-rooms be obviated ; that all cumbrous furniture and fixtures, not absolutely necessary, be removed from the wards ; that a proper eating room, and convalescent room, be provided in connection with each of the large wards ; and that every patient whose disease renders him an object of offence to others, or whose case requires seclusion, be provided with a small room in some portion of the building by himself.

After submitting these suggestions in their first report, the Committee, by order of the Board, were instructed to continue their investigations, and to prepare plans and estimates for carrying their various suggestions into effect.

In compliance with this order, three of the Committee, with some of the medical officers of the Institution, were deputed to inquire into the practical appli-

cation of such sanitary arrangements as had recently been introduced into the hospitals and lunatic asylums of Trenton, Philadelphia and Boston.

In this tour of observation much attention was given to the different systems of Thermal Ventilation, by dry air furnaces, by water furnaces, and by the steam apparatus; as well as to the different modes of ventilation, by the ascending and the descending current. With respect to these two movements, the result of a careful inquiry was, that other things being equal, the rooms in which the upward current was adopted were invariably better aired, and less offensive than those in which the downward current existed; and that among the latter, the more complicated the apparatus, and the more circuitous the movement, the less efficient it became for removing the foul smell from the apartments.

In a second report, presented on the 1st of May last, the Committe state, that their inquiries had furnished them with facts sufficient to enable them to appreciate the worth, and to decide upon the necessity of most of the measures of improvement which had already been submitted. Without entering into a minute account of the several institutions which they had visited, they remark that the new arrangements for the heating and ventilation of these institutions, and the alterations which they have undergone, are on a scale of enlightened liberality hitherto unknown in the charitable institutions of this country; and that in such of them as have been constructed or remodeled within the past few years, the old plan of heating by any air furnaces has been entirely abandoned, and the hot water or the steam apparatus introduced.

Discovering, in the course of their inquiries, that the new system of heating and ventilating by steam, had

been received with greater favor than that by simple hot water, even in the institutions in which this latter had already been partially adopted, the committee were induced to examine the steam apparatus with much attention. It is capable of being managed with perfect safety; it is more efficient in large buildings than the simple hot water apparatus, and it obviates the necessity of numerous furnaces in different parts of the basement. It can be brought into full operation with much greater speed than the hot water apparatus; it can be turned to a great variety of uses, as, in aid of ventilation, in the heating of water for baths, for cooking, and for the uses of the laundry. It can be worked with much less labor and expense, after the first outlay for fixtures; and with less risk of vitiating the air, by the escape of gases from the fires; and by having the furnaces beyond the walls of the building, it guards more effectually against the admission of dust and dirt than any other apparatus.

Convinced of the advantages of the steam apparatus, and satisfied that the suggestions for the general renovation of the hospital, as presented by the physicians and surgeons, and embodied in the first report, were practical and judicious; and that, if carried out, they could not fail to add greatly to the conveniences of the institution; and having consulted mechanics, and obtained the necessary drawings and estimates, the committee submitted to the Board of Governors their plan of improvements, which, as adopted by the Board, and since carried into effect, is essentially as follows :—

1. *For the Admission of Pure Air.*—For supplying the wards with pure air, independent of accessory aid from windows and doors, two perpendicular cool air

shafts, each about fifteen feet high, and four and a half wide internally, one in the open green at the north, the other in the corresponding green at the south of the building, and each at the distance of thirty feet from it, have been erected, and made to communicate beneath, with two underground air-ducts of the same capacity, each passing in a direct line from the bottom of the upright shaft, towards the centre of the basement hall, and beneath it, to within a few feet of the point at which the respective wings meet the central portion of the building. Each of these underground air-ducts, in its passage beneath the hall, gives off four laterally ascending branches, which open into a corresponding number of air-chambers in the basement of the wings. The united capacity of the ascending branches is still equal to that of the main air-duct, and each of them opens into its respective air-chamber through the floor.

For supplying pure air to the centre of the house, three apertures are provided near the basement windows, one on either side of the front entrance, and one at a corresponding point in the rear, and the air is introduced through these in such a way as to become somewhat tempered before reaching the three air-chambers under the central portion of the house, and into which it is received near the floor.

From the eleven air-chambers, four for each wing and three for the centre, the air is conducted upwards by flues, all terminating near the floor of the respective apartments to which they lead.

2. *For the Supply of Heat.*—The space to be heated within the building is estimated at three hundred and thirty thousand (330,000) cubic feet, and the temperature to be maintained throughout the house at 68° or

70° Fahrenheit, through the whole of the winter season. The heating apparatus consists of two tubular boilers, with their necessary fixtures and appliances, and an extensive series of steam pipes for the diffusion and radiation of heat in different parts of the building.

Each of the boilers is about twenty feet long. The shell in which its flues are enclosed is about three feet nine inches in diameter, and twelve feet long. The front is three feet eleven inches wide by six feet two inches in height, having a semi-circular top surmounted with a safety valve, and branches to connect the steam mains. The fire-box is three feet seven inches wide by four feet three inches long; and the smoke-flue is twenty-two inches in diameter. There are in each boiler one hundred narrow flues, each twelve feet long by two inches in outside diameter. These boilers are placed side by side within a large furnace-room, which has been provided for the purpose, in a building at the low ground in the west of the premises near Church street, a hundred feet and more west from the north wing of the main building. The boilers are connected together by pipes, and so arranged by valves as to work either conjointly or separately, as may be required by the state of the weather. They are supplied with water, when needed, from the Croton main, by a permanent connection; and there is also connected with them a water-pipe communicating with the sewer, for the discharge of water when the boilers are to be emptied. The fuel for the furnaces is deposited in a new vault in their vicinity. The branches for the transmission of steam from the united main at the boilers are three—one for supplying the small tubes in the air-chambers; one passing to the kitchen for culinary purposes, and to the attic for heating the bathing-water in the tanks, and for rarifying the

foul air in the belfreys—the third, going to the wash-house, and supplying the engine for working the forcing-pump in the furnace-room.

Leading from the furnace-room is an underground tunnel about a hundred feet long, following the ascent of the surface, and terminating at the bottom of the enlarged chimney, which rises about eighty-eight feet perpendicularly in the west wall of the north wing. This tunnel is about three feet six inches wide by six feet in height, and arched above, but narrows to about half this size before reaching the chimney. Through it the smoke and gases from the furnaces are conducted to make their escape by the chimney: through it, also, pass the several steam-pipes and water-pipes from and to the boilers, most of which are made to rest upon vertical supports secured in the floor, or so contrived as to move backwards and forwards, and to accommodate themselves to the contraction or expansion of the pipes.

The main steam-pipe for the heating of the house, after passing from the boilers and reaching the basement of the building, is conducted along the ceiling of the basement hall, giving off as it passes a lateral supply-pipe to each of the eleven air-chambers, and an ascending pipe to furnish radiating coil for heating three small rooms in the centre of the house which could not be readily reached from the air-chambers. This main pipe measures three and a half inches internally, and is about two hundred and ninety feet in length.

The lateral supply pipes distribute the steam to nests of radiating pipe which are arranged in horizontal shelves in the upper part of the chambers. These pipes are of three-quarter inch bore, and when in full operation, present a heating surface of wrought iron sufficient to raise the temperature of the air in every part of

the house to 68° or 70° Fahrenheit, during our severest winter weather. The temperature of the radiating surfaces is usually from 180° to 200° Fahrenheit, and never sufficiently high to scorch cloth or paper. The whole length of radiating pipe throughout the house does not exceed thirteen thousand nine hundred (13,900) feet.

The steam pipes for cooking, and those going to the attic, are of various lengths, and are from two inches to an inch and a quarter in bore. They form a separate circulation of their own, and can at any time be disconnected from those for heating the atmosphere, so as to be in operation while the others are not in use. The heating of water for culinary purposes in the kitchen, is effected by steam jets.

The length of iron pipe of every sort throughout the house, connected directly or indirectly with the boilers and heating circulations, is equal to about seventeen thousand two hundred and seventy-nine (17,279) feet; and if all were reduced to the standard of the radiating tubes in the air-chambers, they would measure about twenty-one thousand (21,000) feet in length, and furnish a superficial surface of five thousand two hundred and fifty (5,250) square feet, or about ten times the superficial measurement of the boilers.* The heating capacity of

---

* The actual measurement of the different kinds of iron pipe used in the different circulations for supplying the main house, are as follows:

⅜	inch pipe	78	feet	in length.
½	do	201	do	do
¾	do	13,771	do	do
1	do	516	do	do
1¼	do	516	do	do
2	do	375	do	do
2½	do	67	do	do
1¼	do	338	do	do
3½	do	290	do	do
		16,152		
Return bends,		1,127		
		17,279		

the whole apparatus is, of course, in proportion to the power in the boilers of converting water into steam, and of forcing the circulation of this through the pipes; but the relative heating capacity of the apparatus at any given point within the building, is in proportion to the extent of radiating surface there collected, and from which the heat is to be eliminated.

After the steam in circulation has become condensed and converted into hot water, this latter is returned through a lower range of tubes from the different circuits, and being collected at the main return-pipe, it is again conducted to the bottom of the boilers. Thus, without waste of steam, or of hot water, a continual series of circulations is kept up, and an equable distribution of heat maintained in every apartment.

The temperature, volume and velocity of the air for the different rooms, are regulated by stop-valves in the air-ducts, by wooden slides at the bottom of the hot air-flues in the air-chambers, by registers for controlling the too rapid escape of air from the rooms above, and by valves in the main steam-pipes as well as in the lateral pipes leading to the air-chambers, and at the junction of the different shelves of radiating pipe within these chambers. The force of the current and volume of air in the various wards are so arranged as to be wholly beyond the control of the inmates of these apartments; but the air-flues leading to the offices and small apartments in the centre of the house, can be regulated by registers which are of easy access.

It is estimated that, with the two boilers at present in operation, a sufficient heat can be produced, not only for the main building and the cooking and washing of the whole establishment, but also for warming one of the other two buildings belonging to the Hospital. But for

the heating of the whole of these by steam—a measure still in contemplation—an additional boiler will still be requisite.

The working pressure of steam in the boilers for all purposes to which they have, as yet, been employed, is about twenty-five pounds to the square inch. It is never allowed to exceed thirty pounds ; though a pressure four times as great as this, might be employed with safety.

At the first kindling of the fires in the furnace-room, on the 22d of October last, there were one hundred and ten tons of Lackawanna coal in the vault. After they had continued in operation up to the 1st of February, or one hundred and one days, there were still remaining about fifteen tons : showing an average consumption of fuel for keeping the house warm, for the heating of bathing-water, and assisting the process of cooking, at rather less than a ton a-day.

The skill requisite for managing the whole heating apparatus, may be acquired in a few days by any ordinary laboring man. The points chiefly calling for attention are, first, the height of the water in the boilers, especially before starting them anew in the morning ; secondly, the management of the fire to the best advantage; thirdly, in seeing that the air-cock is open when the steam is let into the main conducting-pipe, and that all the heating-tubes are exhausted of air—a circumstance essential to the ready circulation of steam and the return of hot water to the boilers. These points being observed, the waste of water need not exceed a few gallons daily, except so much as may be withdrawn for working the engine, and for cooking. An evaporating trough, supplied with water from the hydrants, is placed in the upper part of each air-chamber: from each of these troughs several gallons of water are absorbed daily by the heated air.

3. *Additional Accommodations.*—Where no artificial means are employed for assisting in ventilation, a space of from 700 to 800 cubic feet is usually considered sufficient for each individual. In the barracks assigned to the British soldiery in India, each soldier is allowed about 800 cubic feet of free space, while about 1,000 cubic feet are usually allowed to the inmates of well arranged prisons; the latter being in confinement both night and day, the former constantly exposed to the open atmosphere during the day time. It is estimated that every healthy individual, breathing about twenty times in a minute, and inhaling at each breath about twenty cubic inches of air, draws into his lungs about three hundred and thirty-three cubic feet of air every twenty-four hours; and that of the air respired at each breath about one-twentieth part, or what amounts the same thing, about one-fifth of the oxygen is absorbed, and an equal amount of carbonic acid gas eliminated from the lungs to replace it. With a knowledge of this continual process of vitiation, independent of others from the exhalation of watery vapor and the elimination of animal matter, it is clear that the same air should never be inhaled a second time. In the arrangement of hospital wards these facts are not to be overlooked. In the reconstruction of our present wards they have been carefully considered.

For increasing as far as possible the room devoted to the sick, and for rendering their apartments more airy and salubrious, the whole space within the walls of each wing on every floor, including every two of the former wards, and the intervening portion of the hall, has been thrown into one large ward, measuring about twenty-three and a half by eighty feet, independent of the additions of 1829, actually occupying not less than twenty-

nine thousand cubic feet of space, and, with the liberal allowance of twelve hundred cubic feet for each of the inmates, capable of accommodating not fewer than twenty-four patients. This important change applies to all the main wards above the basement, excepting on the third story of the north wing, which is still, as formerly, devoted in part to the surgical amphitheatre. Each of these enlarged wards communicates with the corridor only by a single door, and is well exposed to light and air on every side by numerous large windows.

In connection with this improvement, four spacious piazzas, with sides enclosed, each three stories high, now occupy the recesses formerly existing on either side of the extension of 1829, at the ends of the wings. In these new structures, and communicating with each of the wards, are now, first, refectories or eating-rooms, with the requisite fixtures for cupboards, closets, water jets and dumb waiters; and secondly, convalescent or sitting-rooms, with drawers and closets for the safe keeping of clothing, bedding, and furniture out of use: each of these new rooms measuring, internally, about twelve by twenty feet.

Between these, in the extension of 1829, one of the former nurse's rooms has been converted into a room for the seclusion of special patients, and the other has been so much enlarged by doing away with one of the former water-closets as to furnish sufficient accommodation for the two nurses now in charge of every ward. The remaining water-closet, with the washing and bathing apparatus, has also been wholly reconstructed and rendered in every way more commodious and appropriate than formerly. Each wing is now also furnished with a perpendicular discharge-shaft communicating between the several wards and the basement, for the

removal of soiled clothing and the dust and sweepings of the apartments; and with another corresponding shaft for the transit of food by the dumb waiters.

In connection with the improvements in the wings, the central portion of the house has also been renovated. The floors in nearly every part of the house have been relaid, the old plastering of the walls has been replaced by a new hard finish, the central flight of stairs has been remodeled and extended to the third story, the rear flight has been newly planked, the windows throughout have been repaired and furnished with new inside lattice shutters, and all the chimney-flues of the four central chimneys, not converted into hot-air flues, have been provided with registers, and made to serve as ventilating, or foul-air shafts. The offices in the basement and on the principal floor, have been remodeled, as also several of the small rooms in the second and third stories; and those of the third story arranged to serve as reserved wards, for special emergencies.

4. *For the Supply of Bathing-water.*—In consequence of the great elevation of the buildings, and the frequent failure in the supply of water from the hydrants, it has occasionally been necessary to employ a forcing-pump for supplying the baths of the upper stories. To render the supply of hot and cold water here more reliable, four large tanks, each holding about seven hundred gallons, two for hot and two for cold water, the former of iron, the latter of wood lined with lead, have been placed in the attic, immediately under the central cupola. The forcing-pump for supplying these with water is placed in the furnace-room, and worked, when necessary, by steam power. The water in the iron tanks is heated by radiating steam-pipes, arranged in coils at the bottom

of each tank. The water, hot and cold, is conveyed from the tanks, by metallic tubes, to every part of the building above the basement.

5. *Drainage and Sewerage.*—The drainage in different parts of the Hospital, having become somewhat defective, has been newly arranged throughout; and the underground drains leading from the three main buildings, as well as the main sewer as far west as Church-street, have been entirely rebuilt.

6. *Ventilation.*—The fresh-air shafts, and underground air-ducts, give each wing of the building an equalizing reservoir containing about sixteen hundred (1600) cubic feet, in which the air is tempered before reaching the hot-air chambers; and thus equalized, either for winter or summer use. Every ward receives fresh air by four distinct openings—one from each of the chambers beneath it. The average united measurement of these openings for each ward is about seven superficial feet. They are sufficiently large, with a current moving at the almost imperceptible velocity of half a mile an hour, to supply each ward with three hundred cubic feet of pure air in a minute, or more than twelve cubic feet per minute for every patient—a supply thought to be ample for sanitary purposes. But as the current, under ordinary circumstances, is probably more than four times that speed, it is believed that deficiency of pure air by the new arrangements, independent of any aid from doors or windows, has been entirely obviated.

The velocity with which the fresh air is supplied to the wards must, of course, vary with the force of the wind at the time, the difference between the out-door and in-door temperature, and the amount of resistance

from curves and valves, and from the friction of air-flues. With the heating apparatus in operation, the velocity is believed never to have fallen short of the highest estimate above given. In the only attempt as yet made to measure the actual velocity of the current, the wind at the time being rather fresh from the north-west, the out-door temperature at 34°, the in-door temperature at 70°, and the openings for the admission and discharge of air being about of equal dimensions, the velocity of the fresh air from the top of the air-shafts in the open ground, to the point at which it first reaches the air-chambers in the basement, was found to be 90 feet in four seconds of time, or about equal to fifteen miles an hour.

The foul air from the wards is drawn off, first, by two chimneys with open fire-place, sone at either extremity of each ward, by a small flue opening at a register near the ceiling in each of the nurses' rooms, and by another in each of the bathing-rooms, all of which rise perpendicularly to give vent to the foul air at the top of the house; and secondly, in addition to these, by nine new ly constructed ventilating shafts, measuring each about six by nine inches, arranged at short intervals along the sides of each ward, some with registers near the floor, and others near the ceiling, and all rising perpendicularly to the attic, and there terminating in larger trunks, which converge towards two upright turrets or belfreys, which in turn ascend through the roof of either wing, and give exit to the foul air through their open or louvre sides over the top of the house. The united capacity of these various ventilating channels is as nearly as possible equal to that of the inlets for fresh air, in every apartment and throughout their whole course.

Thus far the ventilation is in accordance with what

is technically called the natural method, and will probably at all seasons be sufficient. But in order to command a rapid change of air at seasons in which heat is not supplied to the wards, it is proposed to place coils of radiating steam pipe at the bottom of each of the four belfreys, so as to rarify the air rising into these, and thus facilitate its escape. An occasional fire of wood on the hearth at either end of the ward, will effect the same purpose. The smoke-flue from the furnaces, and from the kitchen ranges, rising in the chimneys at the west end of the wards, will also rarify the air in the contiguous foul-air shafts connected with these chimneys, and at all seasons of the year assist in ventilation.

From the velocity of the air as it enters, and from its distribution by numerous openings for exit and admission, it must be sufficiently apparent that while in transit through the apartments it can never lodge for a sufficient length of time to become deleterious to health.

But perhaps the best proof of the efficiency of the ventilating apparatus is, that to the senses of the observer the air within the wards, with every bed occupied both night and day, is always fresh and exhilarating. During the months of December and January last, there were in the Hospital several patients with profusely suppurating sores and foul discharges; but by placing these patients in the beds nearest to the fireplaces, the foul smell arising from them being obviated by the draught towards the chimney, was scarcely perceptible at the distance of three feet beyond their beds, and was wholly imperceptible in every other part of the ward.

The ventilating apparatus for the body of the house is essentially on the same plan as for the wings, the chimneys serving part of the way up for fresh air-flues,

and for the rest of the distance as foul-air flues, opening at the roof.

7. *Night Illumination.*—For the saving of labor and the promotion of cleanliness, and for affording sufficient light at night throughout the house, hitherto somewhat defective, especially in the surgical amphitheatre, it has been thought advisable to introduce gas illumination. Every ward and other apartment is at present lighted in this manner.

Alterations in the Marine or South Building.—In the Marine House the old plastering of the walls has been scraped and renovated; the old ventilating flues have been repaired; new ventilating registers have been opened near the ceiling, and at the level of the floor, between each of the larger wards and the adjoining corridor; and additional forced ventilation has been secured by means of two large hall stoves in the central corridor on every floor. These arrangements, however, are only temporary, and made in contemplation of other measures hereafter to be carried out, for the improvement of this edifice, or for its total reconstruction.

The Laundry.—In order to adapt the steam apparatus to the washing, drying, and smoothing of clothes, a one-story stone building, forty-five feet long and thirty-two feet wide, has been erected immediately over the furnace room, to be, when finished, divided into three apartments—a washing-room, a pressing-room, and a drying-closet. The latter is to be twelve feet square, and to be filled with wooden horses, about six inches apart; and these to be so suspended from the top as to be easily drawn outwards or inwards. The wet garments

spread upon them being brought into a current of dry and heated air from below, will readily impart their moisture to the air, to be carried off as vapor, through a ventilating turret in the roof. The washing machinery, and the apparatus for the mangling or smoothing and pressing of clothes, will also, as far as possible, be effected either by the use of steam heat, or by the action of the steam engine. Much attention has, within the past few years, been given to improvements in the washing machinery of our public institutions, with special reference to the saving of labor. Among the instruments now in use for this purpose, the rotary dash-wheel for cleansing, and the hydrostatic and the centrifugal press, for rinsing, may all be worked by steam, and have been received with much favor.

CONCLUSION.

In the adoption of the various measures of sanitary improvement now described, it has been a main object on the part of the Governors of the Hospital to introduce every available invention, shown by experience to be the best of its kind, for promoting the usefulness of the Institution, and facilitating the labors of those who have in their immediate charge the care and treatment of the sick. These measures were resolved upon only after much deliberation and full conviction of the benefits to be expected from them ; and it is gratifying to know that, so far as they have yet been tested, they have proved eminently successful.

In conclusion, it is proper to observe, that the gentlemen of the Executive Committee, under whose watchful and enlightened supervision the whole of these improvements have been effected, were Wm. M. Halsted,

Esq., John A. Stevens, Esq., Frederick Sheldon, Esq., Geo. F. Trimble, Esq., and Benjamin, L. Swan, Esq., with whom was also associated the President of the Hospital, Geo. Newbold, Esq. The mason-work, under the immediate care of Mr. Lorenzo Moses ; the carpenter-work under that of Mr. Thomas Gardner ; the plumbing under that of Messrs. J. and S. Philbin ; and the heating apparatus under that of Mr. Thos. T. Tasker, of the firm of Morris, Tasker & Morris, of Philadelphia. The actual expenditure on account of the heating apparatus, with all the necessary fixtures, has been $9319.15. The mason's and carpenter's work constitute the principal items of expense ; and it is estimated that the whole of the outlay for all the improvements effected, will not fall far short of fifty thousand dollars.