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Launching of the Great Caisson for the Brooklyn Terminus of the East River Bridge.

The launching of this caisson, which was quickly and easily accomplished on the 19th March of the present year, was justly considered a noteworthy feat of engineering. Our readers may get some notion of the magnitude of this immense mass of wood and iron when we recall the statement of the Chief Engineer, contained in his report, published in our last issue, to which the reader is referred.

Fig. 1

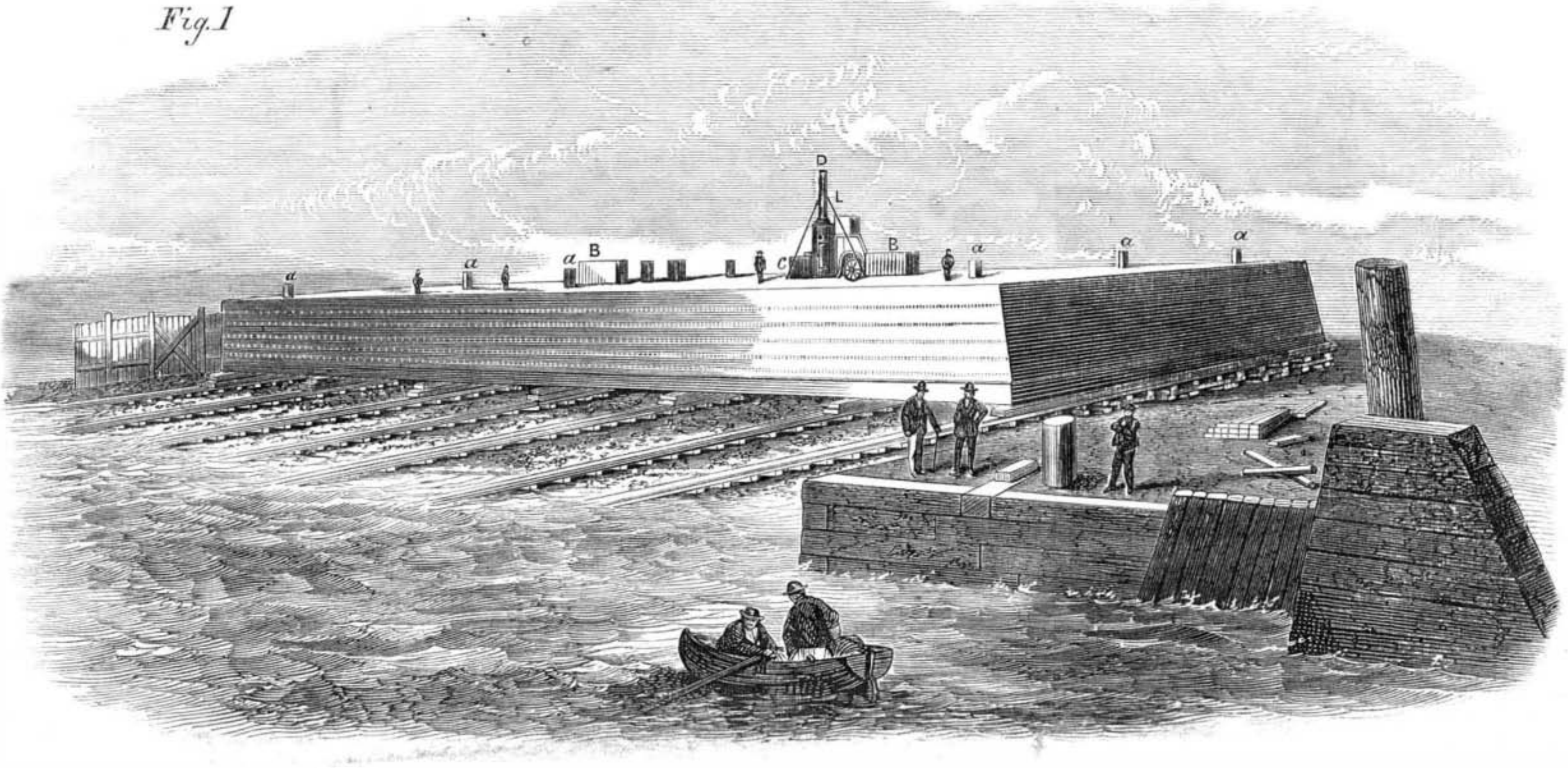


Fig. 2

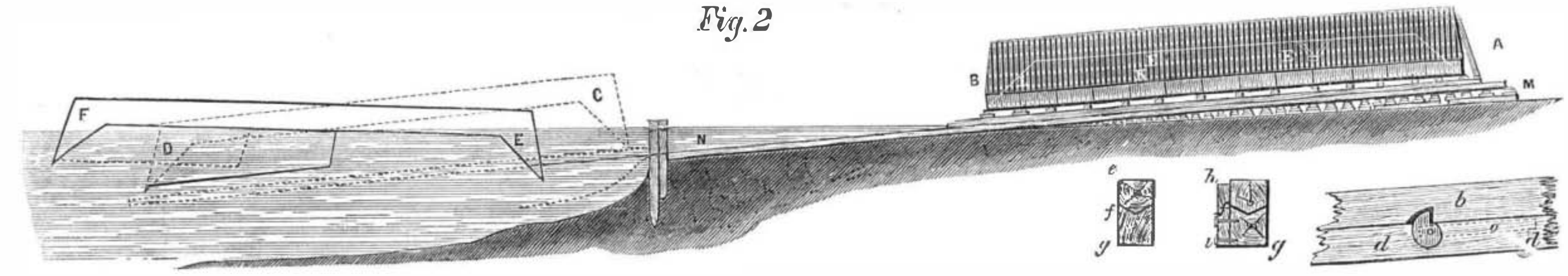


Fig. 3

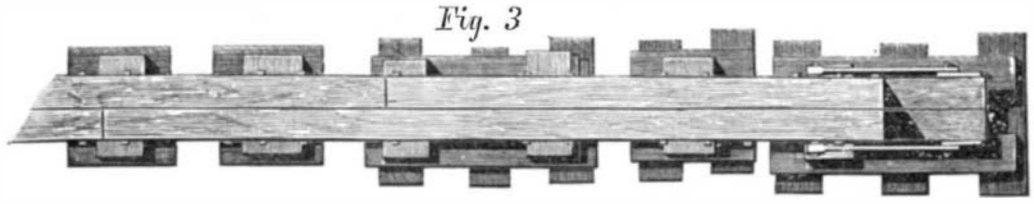
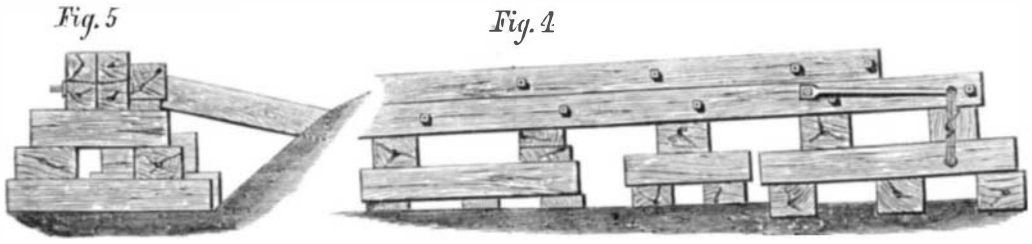


Fig. 5 *Fig. 4*



LAUNCHING OF THE CAISSON OF THE EAST RIVER BRIDGE

Our engravings show the caisson on the ways, as it appeared when ready to be launched, and also some details by which the construction of the ways and the plan of procedure in making the launch may be comprehended.

The structure was put together with its longer side parallel to the river bank, and about 100 feet distant from it, and the ways upon which it rested were seven in number, and each about 180 feet in length. These ways were laid in such a manner that their upper faces were curved to a radius of about 312 feet, and at a slope which made the chord of this arc form an angle of about 5°, the curved sine of the arc being some 13 inches, and the upper ends of the ways 15·6 feet higher than the lower ends. By this means an accelerated motion was given to the caisson in the latter part of its transit, the increased velocity it thus obtained enabled it to overcome the great resistance it encountered from the water when it struck the river broadside on. The details show the form given to these ways, and it will be observed that they rest upon cross and longitudinal timbers; the letters, *f g*, refer to the bearing pieces of the fixed ways, and *e f*, to the sliding ways attached to the underside of the caisson. The surfaces of the former of these were cut to an angle, as shown, that of the corresponding slide being made to fit, in order to insure a perfectly true motion of the caisson in the process of launching. Besides this, timbers, *h l*, were bolted to the inside of the two outer ways, which projected above the sliding surface, in order to check any swerving tendency. To insure a means of casting loose the caisson from every point at the same moment, a check cam, shown in the detail, was fixed into each of the ways near the upper end. The cam at the point where it took the bearing of the sliding way was provided with a projection which held it fast against the timber, and it was kept immovable by means of a lever secured by ropes at its extremity. These ropes being cast off simultaneously the cams were thrown over, and the caisson was free to move equally throughout its length. The position of the caisson upon the ways when ready for launching is clearly shown in the figures. The position of the air chamber is indicated by the dotted lines, H, K, L, and at E is shown a partition, which was constructed to divide the air chamber, and prevent the air from any sudden movement from one part of the caisson to another, which would have affected its stability. The dotted lines, C D, show the position assumed by the structure just as it left the ways, and E F represents it after it had been launched and had come to rest in the water.

In connection with this subject, a description of a visit to and

A DESCENT INTO THE CAISSON.

furnished us by one of two gentlemen, whose curiosity recently rose superior to all fears of the inconveniences and discomforts which—to novices—attend the descent, will be read with interest. It is as follows:

Save the employment of one gang of men above and one below for the completion of some extra service, the day's work on the caisson had ceased, when we two busy *bees* (or busy-bodies, if you prefer that term) presented ourselves at the entrance gate adjoining Fulton Ferry. We were neither engineers nor experts, nor did we propose an examination on which a scientific report might be based. The gratification of a great curiosity, to see with our own eyes the condition and mode of conducting one of the grandest engineering projects of the age, was the sole impelling motive.

We were made the more cheerfully welcome because we had chosen an off-hour for our visit; and that circumstance contributed to our own gratification, because it afforded better than usual opportunity for an undisturbed inspection of the work in all its parts.

The caisson inclosure extends some 250 feet along the river front, and thence back about 300 feet. The caisson itself has a frontage on the river of 168 feet, and a depth of 102 feet, the basin in which it is being sunk extending a few feet more in each direction. The caisson is, in effect, a box made of heavy timbers, sixteen feet in depth, and divided by like heavy timbers into six compartments. This great compartmented box, without a cover, was turned bottom upward and floated over the spot which it now occupies. Several layers of timber were then securely bolted over the entire upper surface, increasing its already immense strength, and sinking the structure until its sharp edges—protected by heavy iron plates—rested upon the bottom of the basin.

The problem was, and is, to sink this enormous caisson through mud and earth and boulders forty or more feet, until a firm ground is reached, there to leave it as the foundation for the immense towers of the bridge that is to be constructed. This is effected by maintaining and constantly changing an atmosphere, and at the same time excluding the water from each of the compartments of the caisson; thus furnishing means for carrying on the work of excavation to the best advantage. The means to this end are a supply of air forced by steam-driven pumps through pipes and hose into the caisson chambers, and a sufficiency of weight on the upper surface of the caisson to counteract the buoyancy alike of timber and air, and maintain the caisson at all times, firmly, on the bed of the excavation. This weight is provided by commencing at once the erection of the towers. For this purpose the entire surface of the caisson is covered with blocks of heavy stone, the interstices of which are filled with the best cement. As the caisson sinks other tiers of stone will be added, and when it rests upon its final bed the towers will be carried up their full hight.

The method whereby the workmen enter and leave their workrooms at the bottom of the caisson—already fifteen or twenty feet below the surface of the water and growing deeper day by day—and the method of removing the earth and rocks which they dig out are matters of greatest interest. To drive the water out of the caisson requires a pressure of air inside equal to six pounds to the inch. The workmen must therefore go in and out and take out the material excavated without leaving any open space through which the air could escape. And how is this done?

Down through these tiers of stone and timber—from the outer air to the inside of the caisson—is placed a tube of boiler iron some six feet in diameter. The upper end of this tube is closed, save a man-hole of perhaps 18 inches diameter. About seven feet below this upper end the tube is again closed by an iron division, save another man-hole of the same size as the first. On one side of the tube, from top to bottom—the seven feet space between the man-holes included—is fixed an iron ladder. The two man-holes are fitted with covers which are closed or opened at pleasure by means of suitable appliances in the seven feet chamber between them. These covers are operated by an attendant, who remains in the little chamber, at all hours, for the purpose.

And now we busy-bodied-bees present ourselves for admission. The upper man-hole is open, and the attendant below directs us to descend into his little room by means of the iron ladder. The man-hole below is tight closed. The little room is abundantly lighted by heavy glass set in the iron-work overhead. The cover to the man-hole by which we entered is now closed by a few turns of the windlass, and we three are cased in the strongest of iron prisons. Before we can feel the effects of our confinement the attendant opens a small valve which communicates by means of a pipe, with the space below the iron floor on which we stand. An unearthly and deafening screech, as from a steam whistle, is the immediate result, and we instinctively stop our ears with our fingers to defend them from the terrible sound. As the sound diminishes we are sensible of an oppressive fullness about the head, not unaccompanied with pain, somewhat such as might be expected were our heads about to explode. Meanwhile the sound stops entirely; the lower man-hole is opened, and the attendant directs our attention to the iron ladder below as the means of descent. The first determination to draw back and gain the pure air above, regardless of failure to accomplish the object of our visit, is succeeded by a sober second-thought, and in spite of present pain we drop through the man-hole and down the ladder as though life depended upon the celerity of our movements and the brevity of our explorations. But as the seconds fly we become accustomed to the "situation." The pressure on the head is relieved so that in three or four minutes we feel quite at ease. We place ourselves under the care of the superintendent in charge, Mr. Charles Young, foreman of the caisson, and are conducted from point to point until we have obtained a very satisfactory idea of the principles on which the work is conducted. The compartments, which are each some forty-five feet square, appear very much like the cellars of houses which have for months been submerged by the overflow of an adjacent river, and are now newly freed from water. A slimy mud covers everything. Planks are laid from point to point, serving alike as ways for feet and barrow-wheels, and doorways are cut through the different compartment partition walls to facilitate the passage between them.

In one of the compartments, as already intimated, we find the work going on, while the other five are dark and dank; slimy and silent. A single great boulder obstructs the progress downward of the caisson, and these men are engaged in its removal. They have dug around the inner side of it, but the excavation is filled with water. Indeed the boulder is concealed in the water, and they work at it, thigh deep, in the muddy liquid. They have drilled a hole and inserted an eye-bolt, such as is used in raising a large stone to its place on the walls of some great building. The boulder weighs ten, or it may be twenty tuns, and besides that is so bedded in mud that a power equal to twice its weight is required to loosen its hold. That power is obtained by means of an hydraulic jack. Unlike the usual lifting jack, in use for raising great weights, this one is so contrived as to exert the same power in pulling the weight. The water chamber of the jack is above and not below the piston, and the piston rod terminates in a hook instead of a lifting shoulder. This hook being first attached to the eye keyed into the boulder, and the opposite end of the jack chained fast to the nearest inner timber partition, the pump which forms part of the jack is put in motion. When the strain is fairly made the boulder yields and is drawn into the compartment. Here it is speedily drilled through and broken into manageable pieces. Let us follow them.

Down through the layers of stone and timber there reaches from the upper air to the level of the bottom edges of the caisson a huge square box, some eight or ten feet on either side, open at both ends. The water which is driven out of compartments where the work goes on, by the great air pumps, rises freely in this box to the level of the river beyond. As the caisson sinks the workmen dig around and under the lower edges of the box, keeping a space under it free from earth. Inside the box is a steam-operated lifter, so constructed as to dip great buckets full of whatever of earth or stones may be found at the bottom. It is, in short, a dredging machine, and is operated as such. It dredges out the earth below the box to a depth greater than that reached by the caisson, and thus forms, as it were, a cistern or space filled with water below the box. This cavity or cistern extends beyond the box itself into the working compartments on either side.

Hither the workmen bring the broken pieces of rock, the mud and earth, or such material as may have been excavated. It is thrown into the cistern, is dipped up by the dredger buckets, and lifted *through the water* into the upper air, there to be finally removed. The process is simple enough, and yet one almost wonders to stand at ease near the bottom of such a box—two of them are in use—and consider it as without either cover or bottom and yet full of water to a hight of a dozen feet above the head. The way is open, apparently, for the water to run out, and yet the flood is stayed! But that we have become accustomed to the condensed air in which we stand, and have forgotten that it exerts a pressure of six pounds to the square inch upon that water, and thus presses it up into the box and holds it up there to a hight of nearly twenty feet, we should not thus wonder. The process *is* indeed simple, but it is not the less difficult to realize. All around the caisson is the same wall of water, high above our heads, kept from overflowing us by the compression of the air in which we stand.

And thus the workmen are enabled to undermine the entire caisson—to sink it slowly and surely to its final rest. When that point has been determined, the entire inner space will be packed full of cement, and the whole will became substantially a vast rock, never more to be disturbed.

B. & B.

[For the Scientific American.]

THE DISPOSAL OF SEWAGE.

BY PROF. JOHN DARBY.

From the time men gathered into communities, some sanitary regulations have been adopted. It required no long experience, on the part of the members of a thickly peopled locality, to teach them that aggregation, alone, was a cause of disease. The reason of this result was not apparent; but the existence of the fact led to the establishment of hygienic regulations, which were supposed to have a bearing on the subject. The accumulation of filth, in a crowded population, was considered a prolific cause of disease. To get rid of this was the problem. Moses purified his camps by fire, or by regulations that carried the offensive materials off too far for them to exert any deleterious influence. To remove these morbific elements from cities, sewers were an early means. It was presumed that, by running water in sewers, all the decaying matter could be transported to a river or the ocean, and be lost or consumed in the abundant waters. Rome stood upon a net-work of sewers (*cloacæ*), and its vast population, in ancient times, owed, undoubtedly, their exemption from desolating diseases to the perfection of its sewage.

The subject of sewage has received the profoundest attention of the most learned and practical men in all the great cities of Europe. The best engineers and the most learned hygienists of Paris and London have spent their best energies on this subject; and the effect of their labors has been, undoubtedly, of great good. In the city of New York, similar labor has been expended, and similar happy results have followed. But all that is desirable has not been accomplished. Efforts are unabated to accomplish still greater results. No less than 7,455 deaths occurred in this city, in 1868, by diseases, in a great measure, due to impure air. There are two questions which present themselves in regard to this subject, which require consideration.

1st. What is it in the air that is so fatal to human life?

2d. How is the material to be destroyed?

There has never been any doubt in the minds of observers, that there was present in the air a material, which they called malaria, or miasm, the generator, in a great measure, of what they call zymotic diseases. One reason, for the want of success in removing entirely this destructive agent, is due to the fact, that its true properties have not been discovered or acted upon. Importance, also, has been given to agents that exerted no influence in the case. Carbonic acid has been sought for, found, and estimated in unhealthy localities. Carbonic acid exerts no influence in producing disease. It is a comparatively harmless gas. Le Blanc says carbonic oxide is twenty-five times more poisonous than carbonic acid, which is equivalent to saying that carbonic acid is not poisonous at all, which we have good reasons for believing. The amount of carbonic acid is always too small to exert any deleterious influence in the most malarious localities. It never amounts to more than one third of one per cent, which is too small a quantity to produce any injurious effect.

It is true that carbonic acid may accumulate in wells, cisterns, sewers, or caves, and suffocate any one descending into them. It is a heavy gas, and has slight diffusive power, and hence, will remain for some time in a close place, where it is generated. It suffocates, in these cases, as any other gas would do with like diffusive power.

It produces no zymotic diseases. The workmen in soda-water works breath an atmosphere often much more highly charged with carbonic acid than in any natural localities, and yet are perfectly healthy.

Angus Smith says, that a deficiency of oxygen, or the accumulation of carbonic acid is not the cause of the injury, but the discharging into the air some organic substance. Whatever this substance may be, as to its real nature, whether germs, puterine, organic nitrogen, or albuminoid ammonia, is of little or no consequence; its properties and effects are beyond dispute. That it is a producer of disease there is no question. In sixty-eight places, in England, the death rate was in direct relation to the quantities of this material in the air. It is to this organic substance that attention is directed.

To detect this material, we devised a means more than ten years ago. We attached to an aspirator one of Liebig's potash bulbs, containing a dilute solution of permanganate of potash; and as the water passes out of the vessel, a like quantity of air passed through the bulb, and any organic matter was indicated by the change of color of the permanganate from a deep reddish purple to a colorless solution. Care must, however, be taken to previously deprive the air of any sulphureted or phosphureted hydrogen; which is easily done. By this means the air can be tested from any locality or place wherein an india-rubber tube can be inserted—from cellars, bed rooms, or in the beds, from drains, from the tops of houses, or above them, sewers, etc.

By the same arrangement of apparatus, ozone may be tested, by putting into the bulb a solution of iodide of potassium and starch, prepared in the same manner as for ozone papers, only more diluted.

The following facts are established in regard to malaria by experiments:

1st. It is not generated at a temperature below 50° Fah.

2d. With due moisture and a temperature in the neighborhood of 80°, it is generated wherever organic matter is undergoing decay. The emanations of the human body afford it promptly under like conditions.

3d. It is heavier than the air—never rising but a few feet above the earth unless borne by upward currents.

4th. It is in very minute quantities. If a bottle of air be taken from the most malarious locality and submitted to an expert chemist, he would give the exact percentage of nitrogen, oxygen, water, carbonic acid, sulphureted hydrogen, etc., and make up 100 parts, but would take no notice of this organic substance. The deficiency, if any, he would—and might justly—attribute to error in observation. The permanganate is specially fitted for its detection, from its deep color and excessive sensitiveness to the presence of organic matter, especially if undergoing change.

In the months of July and August, especially, the temperature of every part of the city is raised to a point favorable for miasmatic production. The sewers, filthy streets, inclosed yards, and all filthy places, whether indoors or out of doors, become foci for the discharge of active malaria. Here it is, entering our homes, invading the sleeping rooms, and, perhaps, generated there, unless scrupulous neatness and thorough ventilation is observed.

Our second question comes to us, "How is this organic substance to be got rid of?" We are persuaded that chemical disinfectants are nearly or quite powerless. They are mere partial and temporary expedients for the purification of a great city, however applicable they may be for a single dwelling. We can conceive of but two ways of accomplishing this result,—one by the agency of ozone, the other by fire. There is an abundance of ozone floating above our city, which, if it could be brought down, would soon cleanse our atmosphere. How is this to be accomplished? We see no practical means, and we know of no practical way in which ozone can be artificially produced, to accomplish the same end.

Can we apply fire?

In the city of New York there are twenty-nine sugar refineries, eighteen saw mills, 324 establishments for printing, nine flouring mills, sixty-five iron founderies, sixteen planing mills, ninety-five distilleries. From much inquiry that we have made, and the average we have been able to make, the above establishments consume 2,000 tuns of coal per day, or its equivalent. We will suppose they use but 1,000 tuns. This is 2,000,000 lbs. To burn this coal—supposing it to be pure carbon—would require 5,333,333 1-3 lbs. of oxygen. The amount of air required to afford this amount of oxygen, supposing it all to be consumed, would be 26,666,666 2-3 lbs. Converting this into cubic feet, on the fact that 100 cubic inches of air weigh 31 grains, we should get about 36,000,000 cubic feet, which would fill a sewer 4-ft. by 3, and 568 miles long. The sewers of this city make 260 miles in length, and they will not average 3x4-ft. A great part of the length of the sewers is tubes, from 1-ft. to 1 1-2-ft. in diameter. We may safely calculate that, with the burning of 1,000 tuns of coal, all the sewers of the city would be emptied three times a day, if the furnaces in which the coal is burned drew their air from the sewers.

The proposition is, to connect the furnaces or bellows with the adjacent sewers. No one will deny the feasibility of this adjustment. It is no new thing to draw air for a blast from below. The air furnaces in New England, fifty years ago, drew the air by a subterranean trench, from outside the furnaces. Many farmers' fireplaces were furnished with a hole between the andirons, covered, when not needed, with an iron plate. It fulfilled two purposes—to let the ashes into a brick bin, below, and to blow the fire from a current of air from the cellar. The feasibility we consider settled.

Some objections may be raised on other grounds. It may be said, that the air of sewers is not fitted to support combustion, as well as external air. The amount of oxygen will not vary one third of one per cent, as analysis shows. Moreover, the air in the sewer will be from ten to twenty degrees colder than that of the furnace room, whence the air is now drawn. For the condensation of the air by this lower temperature will make a cubic foot of air in the sewer contain more oxygen than a cubic foot of external air, allowing for all impurities.

But it may be said, the foul gases may interfere with com