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SEWER-GAS AND ITS DANGERS.

Sewer-gases

SEWER-GAS

AND

ITS DANGERS;

WITH

AN EXPOSITION OF COMMON DEFECTS IN HOUSE DRAINAGE, AND PRACTICAL INFORMATION RELATING TO THEIR REMEDY.

BY

GEORGE PRESTON BROWN.

CHICAGO:
JANSEN, McCLURG & COMPANY.
1881

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PREFACE.

This is not a scientific treatise on sewer-gas, nor does it undertake to impart technical information on plumbing and the construction of house drains. It is the result of investigations made by an impartial inquirer in this city for the purpose of ascertaining to what extent that bane of city life, sewer-gas, is responsible for sickness and discomfort. An inquiry into the effects of the poisonous gas in a single instance in the month of July, 1879, suggested a possibility of similar results in other houses than the one examined. Investigations from that time were systematically pursued, and the astonishing prevalence of sewer-gas poisoning, and consequent illness and death in every part of the city, among all classes and in houses of the best as well as the poorest construction, gradually developed. These continued through the remainder of the Summer and Fall of that year, and were again taken up and pursued during the Winter just passed. Faithful

records of the sorrow and suffering encountered, so far as they were the result of sewer-gas poisoning, were kept. The presence of the invisible and insidious enemy in the houses of those afflicted was found to be seldom realized. It was natural that inquiries should be made as to the means which sewer-gas had of entering a house, and whether it might not be shut out, or induced to go into the open air. Defects in house drains were noted as they were found, and means for remedying defects were sought out. In the search a system of drainage was discovered which seemed to promise relief. All these facts are presented in as plain and comprehensive a manner as possible, that those most in need of the benefits to be derived from their presentation may readily understand the subject. If there has been any doubt that sewer-gas is a dangerous enemy to health and happiness, it must be dispelled by the stern facts presented in this book. To breathe sewer-gas, much or little, in his own house or office, day after day, is a risk which no man can afford to take for himself or his family. It is to emphasize this point that so many cases of actual, deadly poisoning by sewer-gas are given. If they

do not convince they certainly must set people to thinking and investigating, the result of which will inevitably be better house drainage and better health.

Thanks are due to Mr. W. F. Storey for permission to use much of this matter, which, in another form, has appeared in *The Times* in daily reports made by the writer during the past two years; to Dr. Oscar C. DeWolf, Commissioner of Health, for encouragement and advice in this work; to Prof. Walter S. Haines, of Rush Medical College, and to others who have furnished information relating to the subject in hand.

G. P. B.

Chicago, March 31, 1881.

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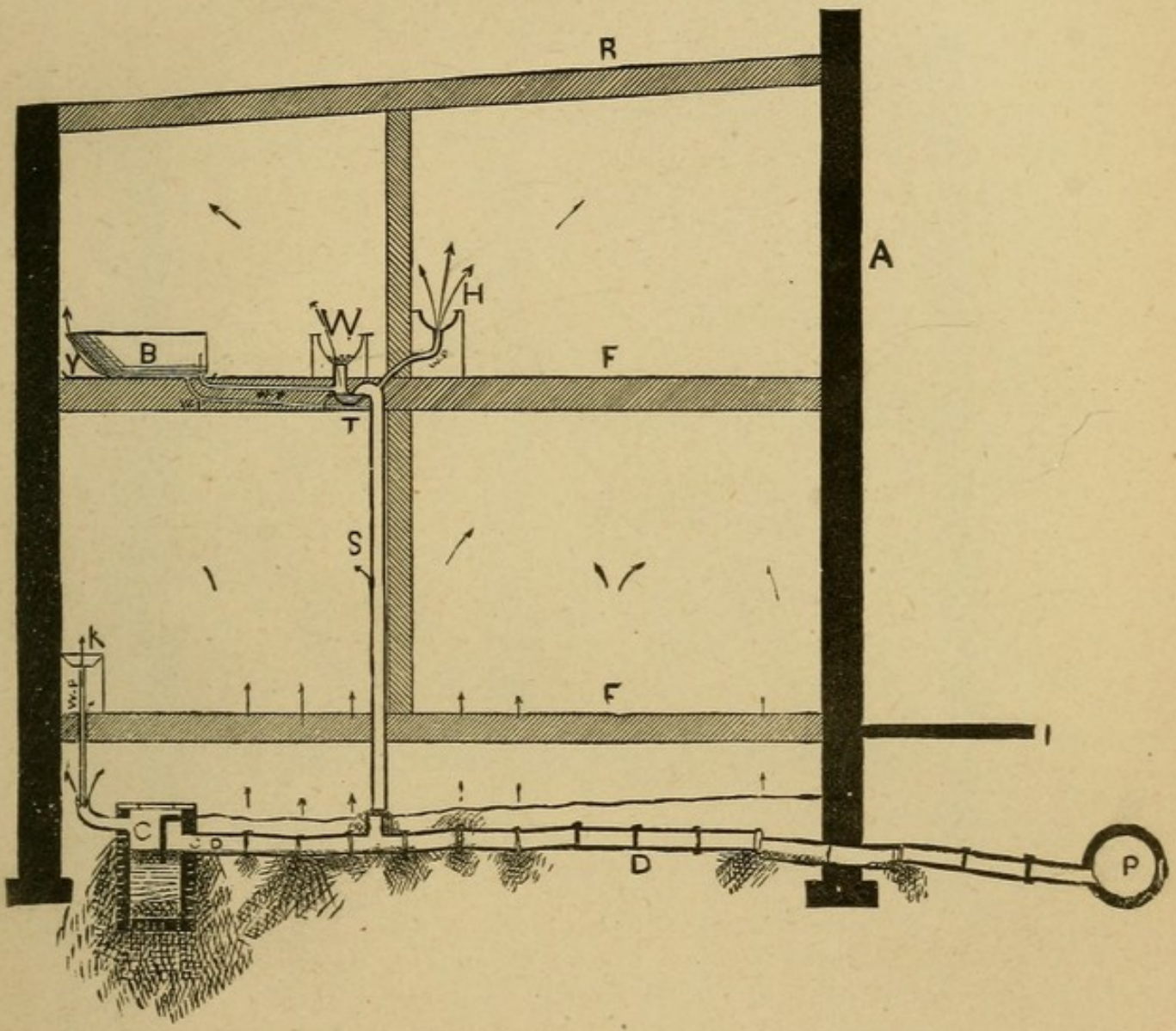
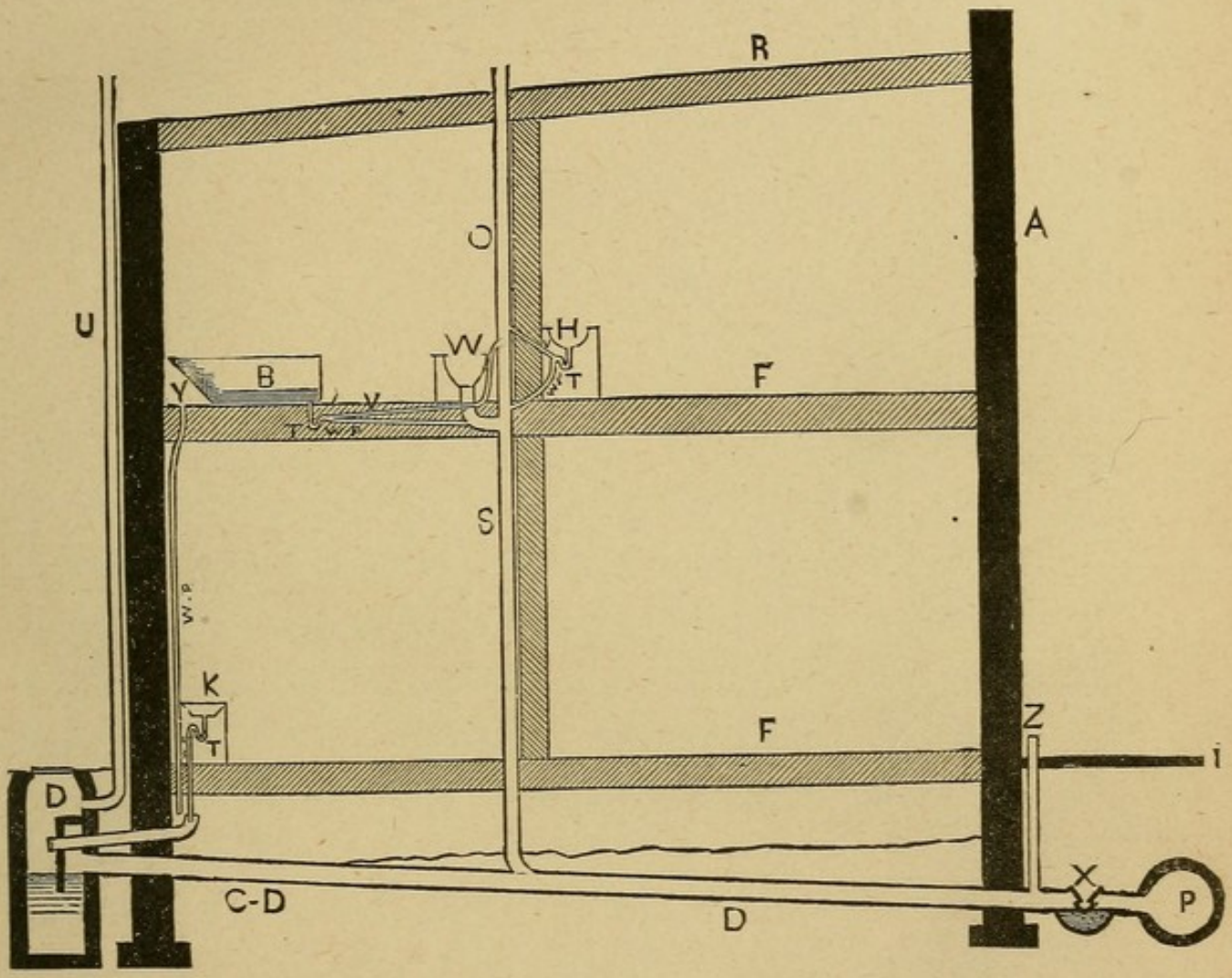
NOTE.—The illustrations in this book represent exactly what was found in houses having the appearance externally of being desirable residences, some having been prepared from photographs. The author is indebted for a few of them, in part, to a most excellent work, entitled "Dangers to Health," by Dr. T. Pridgin Teale, of Leeds, England. They are given a place here because of the evidence they bear with them that defects in house drainage are universal.

PLATE I.



HOUSE DRAINAGE AS IT IS.

Plate II.



House Drainage as It Should Be.

SEWER-GAS AND ITS DANGERS.

CHAPTER I.

A CITY'S CURSE.

The greatest blessing of this life is good health; the greatest misfortune, ill health. Without health, a man can not be happy, and hardly prosperous; with a diseased organism, he is his own greatest enemy, and a promoter of unhappiness in others. A man's health is largely in his own hands, subject to the air he breathes and the food he eats. Of course, men and women must die sooner or later, but the number who live their allotted years, and finally yield to the exhaustion of old age, is surprisingly small. Of the 803 persons who died in Chicago during the month of September, 1880 — a month selected at random from the records of the health department — only thirty-six had reached the age of seventy years. Of the entire number, 328 — more than forty per cent. — died of diseases which might have been prevented. Parents mourn the loss of children,

and young and old the death of friends, and, somehow, can not get rid of the idea that there is a kind of fatality in death, or that a cruelly-kind Providence has cut short the life of this one or that one "for the best." Some people look upon sickness as a scourge for their sins, and others affect to believe that it is often "constitutional," by which they are supposed to mean that incurable afflictions are inherited, or fastened upon themselves in some other doubtful way; while, in fact, they may have simply tainted their blood and devitalized the tissues of their bodies by breathing foul air, or taken food or drink which disorganizes rather than builds up the system. If it is alarming that nearly half of the people of a great city die of diseases which might have been warded off, it is a more startling fact that 445, or more than half, of the 803 people who died in the month named above, in Chicago, were children under five years of age.

There is a popular belief that physicians have the power to cure most, if not all, diseases, and when a man is taken sick, his first impulse is to send for a doctor. If he recovers, the physician is given credit; if he dies, the friends say that it was due to improper medical treatment. If people would only learn, and then profit by the knowledge acquired, that it is better and easier to pre-

vent disease and physical disorganization than to cure and reorganize after the affliction, life would be prolonged, and death made easy and natural. The physician might then dispense with his drugs, and devote himself to the preservation of health, instead of its restoration.

A great many elements enter into the causes of preventable diseases. In a city there is apt to be tainted or adulterated food, especially for the poorer classes, who are compelled to live cheaply, and whose houses, too often, lack comfort and convenience. In some cities there is apt to be poor water, which, happily, is not the case in Chicago. Filthy streets give off exhalations which are nothing less than the breath of disease. Improper ventilation of houses, and especially of sleeping-rooms, in which people breathe an atmosphere soon saturated with poison, is a more direct and potent cause of disease and diminished vitality than most people imagine. Finally, and most important of all, is the influence and effect of the poisonous air which escapes from sewers. There is reason to believe that in great cities like Chicago sewer air, or, as it is commonly known, sewer-gas, is the source of more physical suffering, and the cause of more diseases, than any other one thing. If this is true, the contamination by sewer-gas of the air which people

breathe, is a calamity indeed, and that the statement is true there is no doubt.

Wherever there are sewers, it is certain that there will be sewer-gas. If confined within the sewer, or permitted to escape into the open air, it can do no harm. In the first instance, it is imprisoned and helpless; in the second, it is robbed of its power by the oxygen of the atmosphere. It is only when it finds its way into houses, drives out pure air, and is unconsciously taken into the lungs, that it becomes the enemy of the human race. Sewer-gas is not often instantaneous in its effects, but it is none the less certain. It may be the source, or promoter, of all the so-called zymotic diseases. A zymotic disease is defined as "any epidemic, endemic, contagious, or sporadic affection which is produced by some morbific influence acting on the system like a ferment." This technical definition is not so comprehensible as the plain statement that zymotic diseases include typhoid, typhus, scarlet, cerebro-spinal and malarial fevers, small-pox, measles, diarrhœa, dysentery, cholera, cholera morbus, cholera infantum, croup, diphtheria, whooping-cough, puerperal diseases, and some others. A prominent writer says: "If we look for the cause of the large mortality from zymotic diseases in our cities, we find it principally in sewer-gas poisoning. Other causes operate to

swell the total, but to bad plumbing we may attribute the prevalence of pythogenic pneumonia, peritonitis, inflammatory rheumatism, typhoid and malarial fevers, croup, diphtheria, and many kindred diseases, which are almost epidemic in all our large cities."

Sewer-gas does not always kill. It poisons the blood of once healthy men and women, and destroys, or cripples, their capacity for business or enjoyment. It robs men of ambition, and women of beauty. It paves the way for specific diseases which would otherwise never have sent strong men to bed for months. There are those in this city whose lives were imperiled by it, but who fled from its presence; years have passed and the poison has not yet been driven out of their veins.

There is said to be a distinct, odorless and non-analyzable element which has been denominated sewer-gas, and which is as deadly in its effects as sulphureted hydrogen. If this is true, it is seldom met with. The term sewer-gas is more commonly and properly applied to the pent-up foul odor which may be found in any sewer or its connections. It is easy to understand that this gas is laden or saturated with particles of decaying animal, vegetable and excrementitious matter, which finds its way into the sewer. If this gas is breathed into the lungs, thus laden with poison, the blood

must of necessity be contaminated. Further than this, the air which escapes from the sewer may bear with it the germs of contagious diseases, and deposit them where least expected. It is possible — it is probable — that the blood-poisoning resulting from the breathing of sewer-gas is due to chemical changes in organic matter which has been taken into the lungs. This may come from the sewer, catch-basins, drains, privy-vaults, or waste-pipes. Sewer-gas, or its equivalent, is generated in an out-door privy vault, but it comes so soon in contact with the surrounding atmosphere, that it is rendered comparatively harmless. The air which escapes from sewers into houses is dangerous because it is not diluted, nor disinfected, by pure air, and because its confinement increases its potency. If all sewers were open at the top throughout their entire length, there might be no danger from the exhalations, except possibly from the germs of contagion which may have been carried into the sewers by water used in bathing the bodies of the sick. But this danger could not be so great as that which to a limited extent attends the breathing of the atmosphere which has swept through a sick room, and which many people do unavoidably and with apparent impunity breathe. In some cities of Europe, sewage is conveyed away in open gutters, without serious dis-

comfort or danger. In other cities there are open man-holes leading to the sewers, and the gases generated are allowed to pass off freely and without danger. Sewer-gas is to be feared when it insidiously and persistently finds entrance to houses, offices, or buildings of any description in which people live or work. There are some people who believe it can do no harm; others know by sad experience that it is destructive of health and robs life of enjoyment, but they imagine that they are helpless against it. Again, there are many thousands suffering from its effects, and they are entirely ignorant of the fact. In mercy to this third class the warning note should be sounded, and for their especial benefit, as well as for those who know no remedy, the means for shutting sewer-gas out of houses, if there are any, ought to be made known in the fullest and widest possible sense.

No man would build his house over an open cesspool; and yet, in a city where there are public sewers, houses are built over a hidden cesspool a thousand times more dangerous than one above ground could be. Into it empty ten thousand drains, which in turn are connected by waste-pipes and soil-pipes with wash-basins, kitchen sinks, and water-closets. Into these are deposited the waste of human bodies and the liquid waste of kitchens,

laundries, and lavatories. Through the waste-pipes of the house this liquid filth is conveyed directly to the street sewer, into which are also poured other liquid abominations, which often hold in solution matter still more objectionable. Does any one need to be told that this must be the source of a gaseous exhalation, poisonous as well as foul? The pipes which connect a house with the sewer may perform their duty well enough as drains, but they are practically serviceable as ventilating shafts for the hidden cesspool, the sewer. A man may pity an unfortunate victim of small-pox, diphtheria, or contagious fever, but he would not consent to receive the one afflicted into his home at the risk of the lives of his own family; but if there is danger from contagion by personal contact, there is also reason for alarm lest the germs, or specific poison, of disease drawn into the public sewer, and carried from one end of the city to another, may be borne into houses of distant neighborhoods through drains and waste-pipes on the wings of an invisible sewer-gas. Before and since the time of Martin Chuzzlewit men have undertaken to live in swamps and marshes in obedience to the demands of an apparent necessity. The swamp malaria prostrated the imaginary Chuzzlewit and his faithful companion as it has many others similarly situated. The sewer cesspool is not essentially different from the

swamp, but ordinarily that for which the former is responsible is slower in action, though oftener fatal or more lasting in its effects.

There is nothing about which the people of a city seem to know so little as its sewerage. There is nothing relating to the comfort and healthy condition of a habitation with which any one of mature years should and might be more familiar. House drainage, an adjunct of sewerage, is next in importance to the construction of the four walls of a house. It is the last thing which an occupant considers. If waste water "runs off," he is satisfied. But it is not sufficient to know that the waste will be carried out of sight; there should be no doubt that it reaches the sewer, and that there is no leaking or spilling along the way. There should be such appliances in and about the pipes as would prevent the return of sewer-gas to the rooms of a house, and this fact should be positively known. A gentleman who knows more about the effects of sewer-gas than the rules of grammar, wrote, recently, "Every precaution should be taken to keep it out, as we would a thief, and much more so, because he takes what we can replace, while sewer air robs us of that which nothing can restore."

It is an easy matter to shut sewer-gas out of a house, especially if some intelligent attention be

given to the matter when the house is constructed. The trouble is, that houses are built over sewers, and connected with them with as much unconcern as though they were streams of pure water. Unfortunately, sewers and house-drains are out of sight. A man may easily settle the question whether decaying garbage in or about his premises is responsible for obnoxious smells, but he can not of his own knowledge say that they come from a defective drain or sewer. He can learn something of the architecture and mechanical construction of a house by observation, and say that his shall be built thus and so, but he can not so readily learn how a house should be drained, even if the thought ever occurred to him that house-drainage consisted of anything further than getting waste matter out of sight. He has, possibly, heard something about traps in pipes and drains, but does not know where to look for them, and very likely would not know their use when found. A plumber's advice and services are paid for, but often to no good end. At the close of the year the occupant foots up his medical and funeral expenses, and wonders why fate has dealt so hardly with him. There is a repetition of these experiences during the following year; at length the house is sold, or bartered away for another, which may prove to be a better or a worse habitation.

The man who lives in rented houses has the advantage of a privilege to change his residence once a year, but he is continually getting into houses that were built to make money out of, and not to live in. These are apt to be deficient in everything except outside appearance; it is merely an incidental circumstance that somebody is to occupy them. There is no part of a house in which imperfect work may so effectually escape detection as the drainage; hence there is little good work in the construction of the drains. So long as the man who builds his own house does not know how sewage should be properly disposed of, it will have defective drainage, and he will be troubled by sewer-gas. So long as the tenant of a house is not as able, when he rents, to determine whether the drainage is properly constructed, as he is that the house itself is secure, commodious, and warm, those who have money to invest will continue to construct houses better adapted to ventilating the street sewers, than for occupation. A man might better put his family into a shed in which they would suffer from cold in Winter and heat in Summer, than into a marble-front mansion, the waste-pipe of whose kitchen sink is not securely trapped and ventilated; better for a family to live on a house-top where poisonous gases are sure to be disinfected by pure air, than within the

house, although it have all the conveniences which human ingenuity can devise, and yet have defective drains beneath it.

It is important that municipal authority should be exercised over the construction of house drains. A pretense is made of doing this in Chicago, but it is a hollow one. The supervision which many are led to believe is given is confined to a dingy office in the old rookery at the corner of Adams and La Salle streets, where so-called drain-layers and plumbers are licensed to ventilate street sewers into dwelling-houses and public-buildings. The city pays a number of "inspectors" to watch the construction of house drains, and report defects; but their "inspection" goes no farther than to make a very "free hand" sketch of the plan of drainage prepared by the architect, or builder, which is filed away in a vault of the aforesaid rookery. The little that has been done in securing better house drainage must be credited to the Health Commissioner, Dr. DeWolf, whose special inspectors, charged with the duty of ferreting out the causes of preventable diseases, have found sewer-gas to be mainly responsible, and have, by their advice and directions, and sometimes by suits in court, secured the improvements necessary. This little is as "a drop in the bucket;" it should be supplemented by the coöperation of the De-

partment of Public Works, or, better still, the superintendence of the construction of house drains should be given to the Health Commissioner, and means placed at his disposal to cause all existing defective drains to be repaired.

The construction of house drains is now left almost exclusively to drain-layers and plumbers, who are permitted to do work to suit themselves alone. When completed, the work is so effectually concealed that no one could find out, if he desired to, whether it was well done or not. The result is, that competition has reduced the work to a sham, and those houses which do not have defective drainage are an exception. The worst of it is, that the people themselves, who must suffer in consequence, do not realize this, and are so slow to learn the facts that the penalty of death, even, has been, and must be, paid, over and over again, for the ignorance.

All this finds confirmation in what Prof. C. A. Lindsley, of the Medical department of Yale College, has recently written. He says: "By the commingling in the sewer of such immense quantities of matter in ever changing proportions and kinds, and in all stages of putrefaction, the sewer may be considered, in the language of the chemist, as a vast test tube of prodigious proportions, stretching its stupendous length beneath the sur-

face of the highways and ramifying its branches into all our houses. The activities of the liquid filth poured into it are not merely those of motion passing down a declivity, but they are activities of a widely different nature. Silently, persistently, yet energetically and inevitably, the laws of chemical action are set in operation, and among the products of the changes resulting from the contact with each other of such various matters are the formation of noxious vapors, recognized under the general term of sewer-gas. Now as sewer-gas is lighter than common air it flows upward as naturally as water flows downwards. The immediate consequence is that the pipes leading from the several apartments of the house described become the conduits by which the sewer-gas is conducted directly into those apartments, and sewer-gas is filth — often in the most dangerous form. And so our fellow citizen has failed of doing what he proposed, but instead has really provided admission for a far more dangerous form of filth than he had before, viz., the gaseous products of sewage putrefaction. * * * Thus it is quite evident that the sewers constructed for public use to afford to our citizens the means of removing out of and away from their houses the filth of housekeeping, may ignorantly be so used that, while they do

secure a prompt and convenient removal of such filth, they do also inject, as it were, into the very midst of our homes a form of filth more dangerous than that removed, and so subtle and intangible that its presence is not even detected, and yet often so laden with the germs of disease that diphtheria, scarlet fever, typhoid fever, and other fatal maladies are the sure event to those who dwell in such air-poisoned houses.

"Does not consistency demand that the authorities which have provided sewers to protect the people's health should also provide that said sewers shall not be a cause of danger to the people's health? And yet there is no law in Connecticut forbidding our fellow citizens to commit suicide, and take the lives of their families, or prohibiting landlords from jeopardizing the lives of their tenants through exposure to the fatal influence of the public sewers.

"It is a reproach to the intelligence of the civilization amidst which we live that some guard against this peril does not stand prominently upon the pages of our sanitary laws. If nothing be done by the authorized powers for the safety of those who are already in peril from their exposure to sewer-gases, surely it is a species of crime to permit property-owners through ignorance, or for

any other reason, to go on unrestrainedly putting additional numbers of our fellow citizens in danger by any further connections of houses with the sewers without adopting the safeguards necessary for their protection."

CHAPTER II.

AN APPARENT CAUSE OF DIPHTHERIA.

An essential element of sewer-gas is sulphureted hydrogen, a deadly poison. This is in itself a sufficient argument that there is danger in breathing sewer-gas; but, as a man knows that what fire destroys can not be restored and will not insure his house until his neighbor's has been burned, argument heaped upon argument will not convince many people that sewer-gas is as destructive of life as fire of buildings, until the actual results are placed before them.

Diphtheria is one of the diseases which result from the breathing of sewer-gas; it is a disease of the country, but it is making such ravages in cities as would cause excessive terror if due to yellow fever or cholera. According to the latest report of the National Board of Health, for the week ending March 19, diphtheria was the cause of more deaths in the United States — consumption and pneumonia alone excepted — than any other disease; and the fatality was greatest in cities with underground drainage. Diphtheria has been classed

as one of the filth diseases, that is, filth is regarded as an important factor in its propagation and spread. This disease may be imparted to an apparently healthy person by contagion, but undoubtedly with no serious results unless the blood has been already robbed of a portion of its vitality by some such agent as sewer-gas.

During the Summer of 1879 and the Winter of 1880, the writer visited a large number of dwelling-houses in Chicago — taken without any previous knowledge of their character or condition — and made careful examinations of their drainage. These inspections were confined to dwellings in which there had been recent sickness, or deaths, from certain zymotic diseases, especially diphtheria. The object was to determine definitely the relation, if any existed, between such diseases and sewer-gas. The plan was first conceived of visiting all houses in which there had been deaths from the causes named in a certain month. This was pursued for a few days, but as the number of cases was so large the territory was restricted to a single ward. Considerable difficulty was encountered at first, because many people did not like to admit a stranger into their houses unless he had the authority of the law, and, besides, they did not like the implied imputation that filth could be found on their premises; it was difficult to make

them believe that they were not necessarily responsible for defects in the drainage of their houses, and that it would be for their interest to have such defects, if they existed, brought to light. The assistance of Inspector Genung, of the Health department, whose official authority secured unrestricted privileges, was afterward offered by Dr. DeWolf, and the inspector assisted in nearly all the investigations here reported. Almost invariably it was insisted by people that there was no sewer-gas in their houses, and never had been, and yet when the doors were thrown open, the atmosphere within was often found to be tainted unmistakably with odors from the sewer. The occupants had become so accustomed to the sewer air that they could not distinguish it. In answer to questions they usually acknowledged that there were no traps in the waste-pipes leading from their kitchen sinks, or they failed to know what traps were or to understand their use. A woman who responded to a rap at the door of a frame house on South Jefferson street, in which there had been a recent death from diphtheria, said that the house was in a perfect condition so far as its drainage was concerned. She laughed at the idea that sewer-gas had ever found its way into her rooms; but the warm air which sought relief through the open door brought with it a very perceptible odor

of sewer-gas. The woman, who politely refused to permit an examination of the drains, had a sallow complexion; there were dark rings under her eyes, a vacant look in the eyes themselves, and a listless expression in her face. She was plainly enough not well. There was good evidence that she was suffering from blood-poisoning. The same tell-tale symptoms were seen in the faces of other women in the house. The building was one of a class erected years ago, when they were needed in a hurry, and when plumbers and drain-layers had even fewer conscientious scruples than they have at the present time.

A two-story frame house at No. 681 South May street was found to be occupied by three families, one of which belonged to the landlady. The first floor front was the home of a Bohemian family named Wille. A few days before the visit to the house, Mr. and Mrs. Wille had lost a little girl two years old. A year previous, a little boy of five had been taken from them. This was soon after they moved into the house. Both of the children died of diphtheria. The boy was sick only three days; the girl, nine. Two children were left — one a babe in the mother's arms. This child was far from being healthy, as eruptions on its face and a rattle in its throat indicated. The mother's countenance was not only expressive of

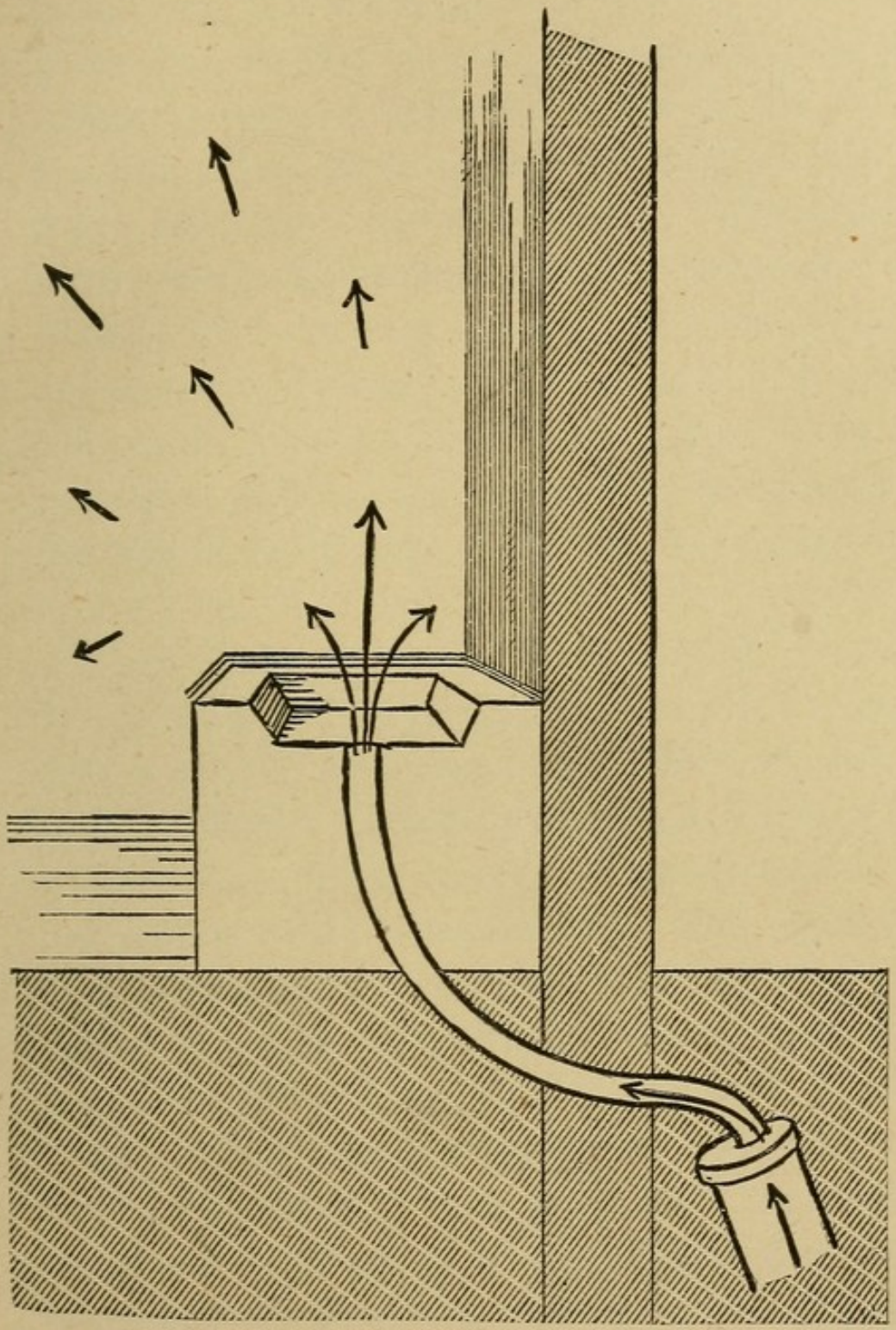
deep despair, but colorless, except that there were the tell-tale dark rings under her eyes. She did not object to having an examination of the premises made. There were three rooms occupied by her family, and they were quite clean and neat. In the kitchen was a sink. This connected with the sewer through an intervening catch-basin. Into this basin two other kitchen sinks emptied. Mrs. Wille's kitchen was small, and the only bed-room the family had opened out of the kitchen. The bed was not more than twelve feet from the sink. If foul odors came from the waste-pipe, they would first fill the kitchen and then the bed-room. It would be possible and very probable that they should escape constantly during the night and find their way to the lungs of the family and be breathed over and over again without being detected. Mrs. Wille was questioned upon this point and replied: "Oh, sir, those awful smells! They bother us terribly, and especially in the morning, or after a storm." The question was unnecessary. The outlet of the sink was covered by an inverted bowl, the only defense the poor woman had against odors whose source she had discovered, and which were to her exceedingly obnoxious.

Was this odor sewer-gas? As usual in houses of that class, there was found to be no trap in the pipe which connected the sink with the catch-basin

— the latter, an intercepting cess-pool between the house and the sewer, usually built directly under the house. (See plate IV.) The waste-pipe was no less than twenty-five feet in length, and the greater portion of it ran horizontally. Its inner surface was undoubtedly coated with the festering sediment of the waste which had been flowing through it for years. Not only was this constantly generating and giving off a poisonous gas — nothing more and nothing less than sewer-gas — but also the waste-pipe afforded a means of ventilation for the foul catch-basin, which had no other ventilation, directly into the kitchen. The condition of things is exactly represented in Plate III., the arrows indicating the course of the poisonous and offensive exhalation.

Two weeks previous to the death of Maria Wille, a child of about the same age died of diphtheria in the adjoining house, or at No. 679 South May street. The construction of this house was found to be similar in every respect to the one described. It is unnecessary to go into further details. All the houses in that neighborhood were built at about the same time, and the defects of one were duplicated in another. The street was unpaved, and stagnant water might sometimes be seen in the gutters. The buildings were crowded together, and the yards small. The privies were

PLATE III.



UNTRAPPED WASTE-PIPE.

in the rear, and not cleaned as often and thoroughly as they should have been. Occasionally these adjuncts were unpleasantly close to the houses, and the odors from them were carried into windows and doors on every breeze. The residents were mostly Bohemians and Germans, who occasionally owned a cow. In such case the stable was apt to become as great a nuisance as the privies. The result was that the women and children, who were kept at home night and day, could not enjoy the blessings of pure and sweet air within doors or out.

A child two years old died of diphtheria, at No. 243 South Jefferson street, a house which provided "homes" for four families. Each kitchen, or room used as a kitchen, was supplied with a sink, whose waste-pipe furnished an uninterrupted communication with the catch-basin. The liquid waste of the four kitchens emptied into the same catch-basin. This was not cleaned oftener than once a year; but had it been cleaned once a week, its contents would send up sewer-gas to the kitchens in quantities which would have been exceedingly dangerous. At the time of the visit, the odor of sewer-gas was plainly noticeable in the rooms, and very offensive at the outlet of the sinks. The mother of the babe that died pointed out the family bed-room. It opened into the kitchen; the

beds were not more than ten feet from the sink. A baby in the mother's arms was a puny thing; it did not seem that its lamp of life could burn much longer. Ten days later there was crape on the door.

No one mourned more deeply, and none deserved greater sympathy, than Mr. and Mrs. Edward Weissart, who lived at No. 103 Clybourn avenue. They had five as healthy and promising children as any in the city. In two weeks, four were taken from them, and the one left was barely rescued from death. The case was the more pitiable in that the deaths seemed to have been entirely unnecessary. The four died of diphtheria, or diphtheritic croup, as the attending physician denominated it, and the cause for it was as evident as that flowers are cut down by frost in the chill nights of Autumn. Without any warning, Clara, six years old, and Eda, two years younger, were taken down with sore throats, on Wednesday, September 8, and were put to bed. On Friday, two days later, Clara died, and on Sunday morning Eda met the same fate. Both were buried together on that Sunday afternoon. On the day that Clara died, Adolph, the baby, sixteen months old, was put in bed with his little throat inflamed and swelling. He lived only till the Wednesday following, the physician's skill availing nothing.

In the meantime, little Albert, two years old, was afflicted in the same manner. He was placed under the care of physicians on the day after Clara died, Saturday, and he, too, was a corpse in eight days. The remaining child, who was finally afflicted, was hurried out of the house. The bodies of the four whose spirits were taken are now resting in Waldheim cemetery.

It is stated above that the cause for these deaths was apparent. It might have been removed, and the lives saved. The privy, used in common by the eight families occupying the house, was a two-story brick structure, and stood in a small court between front and rear divisions of the building. The contents of this were supposed to run through a drain to a catch-basin, and thence to the street sewer. This drain was found to be clogged, and the filth in the privy vault could not escape. As the vault filled, the contents worked back into a drain which connected with the down-spout, from the roof — a pipe which carries off the roof-water. This did not have close joints, and the result was, that it permitted the filth to ooze out upon the ground. It is not known how long this was going on, but the earth in the court into which it soaked was saturated with the waste to a depth of more than two feet. More than two tons of filth, which had been giving off its foul and destructive odors,

to rise and enter the windows and doors above, were finally removed. The people had suffered exceedingly, at times, from the annoyance, and yet the privy waste had so soaked away in the soil that they did not suspect the source of the trouble.

It is doubtful that the offensive emanations from this filth can be connected with the disease which invaded Mr. Weissart's family, so much as the sewer-gas which escaped into their living rooms through the kitchen sink. The waste-pipe which extended from the sink to the main drain under the house, had no trap in it, nor was there any trap in the drain itself; both were, also, unventilated. The gas generated by the decaying sediment adhering to the inner surface of the waste-pipe and drain, was nothing else than sewer-gas, incorrectly, perhaps, so called. The family said that they had suffered greatly from the foul odors which came from the sink. The children first attacked slept in a bed-room adjoining the kitchen, and a small open window afforded communication between the two rooms.

Sickness from various causes was said to have prevailed almost continuously among children in the neighborhood of No. 52 West Thirteenth place. The street was not graded, though a sewer had been laid in it. The houses were for the most part

early-built frames, and the drainage in them was of the kind put into houses ten years ago — adapted only to carrying waste out of buildings. There was nothing in it to keep out the gases of decomposition. The house at No. 52 was occupied on the second floor by a cigar manufacturer named Rees. One of his children came home from school one day feeling "very tired," as the little one explained. She had not been strong for many months, and had often complained of being "tired." She had not been apparently sick, and consequently had not had medical attendance; but she had lost flesh, was without appetite, and had become quite thin. A sister two years younger was similarly affected. The parents could not account for this, and certainly had no idea that the stenches proceeding from the kitchen sink had anything to do with the evident ill-health of their children. The mother maintained that she always kept her house as clean and neat as possible, and assuredly it was a model of neatness and cleanliness when visited. She said that the children were always warmly clothed and otherwise provided with everything that ought to secure health and comfort. Like many another fond mother she had watched over and cared for them as tenderly as though they were two delicate flowers. On the day after the elder child came home unusually

"tired," her throat became sore with diphtheria. A physician was promptly summoned and she was carried safely through the attack. The disease came again and again until she had been sick four times. In the meantime her sister was prostrated and died after an illness of ten days. The parents claimed that there had been a most disagreeable odor escaping from the outlet of the sink. In the Summer the privy had overflowed, and its foul contents spread out over the yard. The waste-pipe of the sink was found to run directly into the privy vault, which in turn was supposed to empty into the sewer. The outlet of this had plainly become choked. There was no trap in the waste-pipe, nor had it any ventilation,—nothing to prevent the gases generated in the vault from entering the house.

At No. 138 West Ohio street, a woman was found sick in bed with erysipelas, and a little boy lay by her side, not yet recovered from an attack of diphtheria, breathing the poisonous atmosphere of the sick-room, so offensive that the writer was compelled at once to quit the house. A child four years of age died there on December 30, after an illness of five days. This child belonged to a family named Murray, who were occupying two lower front rooms and boarding in the house. They had been there about two months. During that time it

was discovered that the catch-basin had become clogged, the result of neglect in cleaning it, and that its contents had oozed out and run under the house until there was finally no room for more filth and it came up through the floor. The catch-basin received not only the waste from the kitchen, but also the contents of the privy vault. The basin was cleaned out, and a communication again established with the sewer; but as the water ran off, a mass of festering filth was left on the ground to continue to breed disease. One of the occupants said there had been seven deaths in the house to her personal knowledge. Some one was constantly sick in it.

At No. 159 Bremer street, a girl five years of age died of diphtheria after a sickness of four days. So far as known the disease was not the result of direct contagion. There were other cases of diphtheria in the house a little later, but these were cured. The house was found to be a two-story and basement structure, and was built five years ago. The privies were in the rear, but within the house there were the usual kitchen sinks whose waste-pipes were without traps and ventilation. The mother of the child that died said she was annoyed by the "smells" from the sink in her kitchen at times. She herself was not well, and a small child which she carried in her arms would have been

under the care of a physician had its mother been able to pay for medical attendance.

At No. 17 Will street, Jane A. Craty, twelve years old, died of diphtheria on December 21, after a sickness of ten days. She had been at school, but, so far as known, the disease was not transmitted to her by contagion. She had been complaining of exhaustion for several days, and could not eat a proper amount of food. She had received permission to stay at home and rest, when when she came from school on Friday night, but on the following morning her throat was sore. The same day an older brother was taken with the diphtheria, and compelled to quit his work. The boy lived; the girl died. Another girl was sick in bed with the disease when the house was visited, but she was expected to recover. A fourth child, a girl, was not afflicted at all. The house in which the family lived was an old one, two stories high, and not connected with the street sewer until about two weeks before the sickness occurred. Mrs. Craty said that there had never been any sickness previously in her family.

Jeannette M. Hill, nine years old, died at No. 262 Hubbard street, on December 19. A boy about two years younger, the only remaining child in the family, was first attacked, but he recovered. The little girl was sick just a week. The mother

did not know that her children had come in contact with others afflicted with diphtheria. The sink was in a summer kitchen, "a sort of shanty," as the woman called it, but a substantial one, built against the house, in the rear. Not only was there no trap in the waste-pipe, but the small lead pipe which served as an immediate outlet for the sink, emptied into a large pipe of tin, and no attempt had been made to unite the two closely. There was nothing to prevent the ventilation of the catch-basin into the kitchen. During the cold weather, the heat of the house tended to draw the gases through the crevices at the sides of the door and in the wall into sleeping-rooms.

At No. 747 South Jefferson street, Paul F. Brœcker, three years old, died on December 30, of diphtheria, after an illness of ten days. The main drain under the house extended back to a catch-basin in the yard, into which all the liquid waste of a barn was conducted. Directly under the kitchen floor this waste, augmented by the contents of the house water-closets, which were in the basement, was poured into a second catch-basin. Before it reached the street sewer, it was compelled to pass through another catch-basin — the third of a series of cesspools under and about the house, unventilated, except by the pipes which led up into the rooms of the house. The whole

family, including the father, had been troubled with sore throats more or less during the Fall and Winter.

At No. 52 South Union street, a boy, eight years old, died of diphtheria on December 31. His parents occupied the rear rooms on the first floor, and their kitchen sink emptied into a wooden drain leading to a catch-basin. The waste-pipe was without a trap.

At No. 40 Fry street, Mary Walpool, four years old, died of diphtheria on December 27. The room occupied by the Walpool family as sitting-room, eating-room, and kitchen, had the usual sink in it, connected with the sewer, without any trap in the waste-pipe.

The house at No. 31 Snell street, was a tenement. A family named Nelson had occupied three small, rear rooms on the first floor, for eight or ten months. On December 29, they lost their only child, one year old, from diphtheria. The father and mother immediately moved out. An untrapped sink, communicating with the privy vault was found in their abandoned kitchen. Other occupants of the house said that the privy odors working back through their sinks were so offensive that they had been often compelled to thrust rags into the sink outlets.

Sewer-gas was found in all these houses, but it

will be noticed that this gas did not, in all cases, come directly from the sewer. As corroborative of what has been already said about the formation of sewer-gas in drains and waste-pipes, the following may be quoted from Colonel George E. Waring, Jr., an experienced sanitary engineer. He says: "We have heard so much of sewer-gas that we were in danger of ascribing the production of this foul air only to the sewer and cesspool. Indeed, the majority of sanitarians to this day seem to believe that if they can effect a thorough disconnection between the sewer, or drain, and the waste-pipes of the house, they have gained a sufficient protection against sewer-gas. The fact is, that that combination of the gaseous products of organic decomposition, which is known by the generic name of sewer-gas, is very largely produced by the contents of the house-pipes themselves. Not only in the traps, where the coarser matters accumulate, but all along the walls of the inclosed pipes, where filth has attached itself in its passage, there is a constant decomposition going on which is producing its constant results." Since the above was put in type, Colonel Waring has more fully elaborated this idea in the May number of Scribners' Monthly.

Dr. Lindsley, already quoted from, also says:

"But the gases of putrefaction may be produced elsewhere than in the street sewers — aye, even within the walls of our own houses. The drain-pipes from our kitchen sinks and the bed-room basins are little sewers, and in a modern city house of average size, these, with the soil-pipes from the water-closet and the larger drain-pipe into which they all enter in the cellar, present an aggregate superficial surface of many square feet. This surface is thickly and completely besmeared with deposits from the filthy fluids constantly passing over it. The gases generated here differ from those in the larger sewers of the street only in being more virulent from their greater concentration, because of less admixture with the common air. And these gases, made within the very walls of our houses, literally within the walls, are not stagnant, not motionless — they must move on to give place to constant new supplies; no trap can stop them. Unless special provision is made for their free passage to the open air without, more or less of them will surely find their way to the air within the house. This is emphatically true of those drains connecting kitchen sinks, water-closets, etc., with unventilated cesspools. As well might one try to trap the neck of a bottle, and then fill it with wine without displacing the air in the bottle. There is

evidence enough that cesspools, as usually constructed, are always sources of great danger, and even under the most favorable conditions of construction, are worse than the sewers."

The Chicago catch-basin is a cesspool.

CHAPTER III.

THE POOR MAN'S AFFLICTIONS.

A poor man's treasures are his children. Fire may sweep away his house and all that he has accumulated in years of hard labor, and the affliction is greater than those in easy circumstances can appreciate. A poor man's solace and source of inspiration are the affection of his children. When death comes in and takes them, the affliction is not to be compared to that which fire can bring. The poor man is compelled to purchase property that is low in price, or rent that which comes within slender means. The consequence is that he must often take his family into quarters of the city where the streets are unpaved, the drainage defective, and the houses otherwise unfit for habitation. Hence it is that the zymotic diseases, and especially diphtheria and scarlet fever, prevail to so large an extent among the families of the poorer classes. Once in a house, they seldom leave it until they have secured more than one victim.

While the cases here reported relate almost exclusively to deaths from diphtheria in families who

were not able to improve their sanitary surroundings, if they would, it should not be forgotten that there are a dozen other diseases which might be traced to sewer-gas poisoning, and which constantly prevail, though perhaps not to so great an extent as diphtheria.

Mr. and Mrs. Green, of No. 3,009 Dearborn street, saw, within five days, their three children taken from them. The first, a boy of seven, died on December 24, and two girls followed him on December 28 and 29, respectively. The sickness ranged in duration from five to seven days. Previously, the children were said to have been types of health and vigor. The boy's throat became sore and pains in his chest followed, indicating pneumonia. At no time did any of the three appear to be seriously sick until a very few hours before their death. To the casual observer there was no cause for this diphtheria. So far as known, the children had not come in contact with any other child that was sick with it. To the careful inquirer, there was sufficient cause in the defective drainage of the house. The building stood on the rear part of a lot and very close to a double privy, used by the members of several families. Its vault was connected with the street sewer, and into it emptied the waste from the kitchen sink. The waste-pipe from this sink was without a trap, but

Mr. Green had taken what he believed to be precautions against the introduction of deleterious gases from the privy vault. The waste-pipe emptied loosely into a wooden drain under the house. This drain lay upon the surface of the ground. Several holes were bored through its top to permit the escape of gas, which Mr. Green thought had better be under the house than within it. But he simply promoted a circulation which he had hoped to check. The concentrated gases of the privy vault, generated during the night, found ready means of ingress to all parts of the house, aided, as they were, by the drains and the heat of the rooms during the cold weather of December. Mr. and Mrs. Green did not notice offensive odors in their house because they had used a great deal of carbolic acid, chloride of lime, and other "disinfectants," to ward off danger, as Mr. Green said. The odor of these simply counteracted foul smells, but did not destroy the poison in the gases. The fact that he had used disinfectants at all implies that at some time there was a perceptible odor from the sewer or privy, and that he was fighting an actual and not a possible danger. It is often that a man dreads to acknowledge, even to himself, that his house drainage is defective, or that he has not taken every reasonable precaution to shut out sewer-gas. His method may be an original one,

but his confidence in its efficacy is apt to be greater than in the "new-fangled" notions of experts. Hence it is that a system of drainage so plainly deficient as that in the house of Mr. Green is often believed to be all-sufficient. It is exceedingly doubtful if his home can be made as healthy as his own and his wife's efforts would warrant, until the privy is removed farther away, and all drainage communication between it and the house shall be cut off by proper traps and ventilation.

A very pleasant and apparently comfortable house at No. 382 Clybourn avenue was turned into a scene of mourning by the death of a little girl, four years of age. The mother said her child had been unusually strong and active until taken down suddenly with sore throat. In four days she died of diphtheria. No sewer was built in Clybourn avenue in the neighborhood of the house named until the Summer previous to this death. Before that time the waste of the kitchen had run into the gutter. This practice was certainly bad enough, but when the sewer was completed the kitchen sink was connected through an intervening catch-basin with the sewer. The family looked upon the improvement as a blessing, for there was no longer stagnant water in front of the house and in the yard. The mother was asked if she had

been annoyed by "bad smells" issuing from the outlet of the sink. She replied in the affirmative, and said that her husband managed to keep them out at night by placing a bowl over the orifice. The woman had never thought that the foul odors were at all dangerous. To be rid of their annoyance was all that she had ever hoped for. Before the house was connected with the sewer there was sickness in the family, but the cases were not fatal, and hardly serious; the first case of sickness afterward was from a disease which is known to be affected, if not caused, by sewer-gas, and it ended fatally within a very short time.

A boy, five years old, died at No. 263 North Clark street, of diphtheria. His parents occupied a flat in a business block at that number. Their front room was devoted to the uses of a barber-shop, and the living rooms were in the rear. The basement was unoccupied, except by a collection of odds and ends and a great deal of dirt. There was a catch-basin under the basement floor which had not been cleaned for years, apparently. When opened the stench from it was almost unbearable. There were traps under the sinks, but the rooms were full of sewer-gas at the time of the visit. Two water-closets, one on the first floor and one in the basement, were exceedingly foul, and were without

ventilation. The place was a most undesirable habitation.

A family of respectable and cleanly German people were found living in a restaurant which they owned and conducted on South Water street. Less than two weeks before the visit made to the premises, the proprietor had three promising children; one only was then living, and his recovery from a severe attack of diphtheria was not yet assured. The two others, girls, aged two and nine years each, died of diphtheria on January 8 and 14 respectively. Those who do not believe that sewer-gas was wholly or largely responsible for these deaths should have the privilege of visiting the premises and examining the drainage for themselves. A plainer case could not be asked for, and yet the parents of the children did not believe that sewer-gas had anything to do with the disease. Because there was nothing on the outside of the waste-pipes and drains to produce sewer-gas, they could not believe that it would come from anything within the drains. Besides, they used "disinfectants" to overcome the bad smells, and wondered why any one should suggest the presence and poison of sewer-gas. When the gentleman bought the restaurant, which, by the way, was a cheap building erected on the site of a structure swept away by the great fire, he made the necessary additions in the

rear to provide his family with a comfortable home. Among the "improvements" added was a water-closet. The soil-pipe connecting the closet with the drain below was made of tin, and resembled a cheap down-spout from the roof, through which rain-water runs off. Just above its junction with the drain it was bent into the shape of an ordinary water-closet trap. The trouble with it was that none of the joints made by the soldering of the sections was properly made. The drain into which the soil-pipe emptied was simply a long wooden box running under the building and resting upon the surface of the ground. It extended to a catch-basin in the rear. A sink waste-pipe, also made of tin, emptied into the wooden drain, and was not trapped.

A tenement house, at No. 10 West Thirteenth street, furnished "homes" for six families. One of these was that of Mrs. Miller, who lived on the second floor. Her little girl, Maria, five years old, died on December 23, after a sickness from malignant diphtheria of two days only. The poor woman, overcome with grief at her loss, said that she should get out of the building at the earliest possible moment. She had been there five years, and her children had been sick more or less during the entire time. She had one child left, which she would try to save, but she was convinced that

health could not be had in that building. She complained bitterly of the odors — the "awful smells," as she characterized them — which seemed constantly to escape from the sink. This sink was not in the kitchen, but in a narrow hall, and used as all sinks are supposed to be. Its waste-pipe was without the needed trap. The doors could not shut out the escaping gas, and the air in all her rooms was tainted by it.

At No. 3,739 Emerald avenue was a two-story frame house, occupied by three families. Two of them lived on the second floor, and in rather contracted quarters. Mary Ann Griffin, a two-year-old child, died of diphtheria, on December 9, after an illness of five days. The mother spoke of the child as having been somewhat feeble, though never before sick. One day the latter complained that her throat was sore, and she could not drink her accustomed cup of tea. A doctor was summoned, and he said at once that he thought his services would be useless. A fat baby, with colorless face, which had thus far escaped the disease, sat on the floor at the time of the visit to the house. The little girl had not been exposed to contagion, and, as the same apparent cause of the disease which fastened itself upon her remained, it seemed probable that the babe would suffer a like fate. This house was connected with the

street sewer the Spring previous. In reply to the question whether she had ever detected any odors escaping from the sink, Mrs. Griffin replied that she had, and that they were very offensive. To prevent their escape, she had put a cloth in and over the outlet, and on this a twenty-two pound cannon-ball! She found this treatment as effectual as a trap. The woman did not seem to think that the sewer-gas was responsible for her child's sickness. Her physician had told her that the diphtheria "was in the air"; he made no inquiries about the drainage. The family had lived in the house for three years, and there had been no sickness in it, except a light case of the measles, until the house was connected with the sewer. Even then there was no sickness so long as warm weather continued and the house was well ventilated. For two or three weeks before the diphtheria appeared, the children had been shut close within the house.

A child three years old died of diphtheria in the low and very filthy restaurant at No. 16 Lake street, on December 20. She was the daughter of the proprietor of that establishment, who lived with his family in the rear rooms of his shanty. Two children, a boy and a girl, were left, and when seen by the writer they had their throats wrapped about with flannel. The one that died

had been sick nearly all the time the family had lived in the place — a year and three months. "Oh, no; dem sewers ish all right," replied the father, when questioned on the subject of sewer-gas; "ve have no got him here; dem sewers ish all right." He consented willingly, though, to have an examination made, and the basement, or cellar, of his establishment, was explored. The coffee-shop was built over the ruins of some pretentious structure destroyed by fire. Two-by-four scantlings were placed on end for a foundation, and on them rested the superstructure, very shabbily built. A few boards nailed to the scantlings inclosed the basement, which was used as a store-room for old boxes and garbage, and a dog-kennel. The waste-pipes from the kitchen led through the floor only, and emptied their contents unceremoniously on the ground. A great cesspool was found there, and this the proprietor of the place called his "all right" sewer. This waste was partially frozen over, but was, nevertheless, offensive beyond endurance.

"How about your water-closet?" was asked; "where is that?"

"Ve don't have none at all," said the honest Dutchman; "ve takes a pail and use him in de morning, and den I dump him in de yard."

A cottage at No. 560 North Franklin street was

visited. This was in response to a request, by a physician, that an examination for sewer-gas be made, since to nothing else could he attribute the sickness of his patients — the mother of the family and her children. She and they had been afflicted for weeks with diarrhœa and general derangement of the stomach, she said. Her face gave indications of impure blood in a number of boils. The family had come from England a year previous, and all were then, and had been previously, healthy and strong. An exploration showed that the perfidious plumber had allowed the waste-pipe to empty into the drain-tile, five inches larger in diameter, without any attempt at closing the exposed space between them. As usual, there was nothing to prevent the return of the sewer-gas to the kitchen, and consequently to all parts of the house. The woman said she kept her children out doors as much as possible, but they were not so rosy-cheeked and sprightly as they once were.

"Why, my dear sir, we never had any trouble in this house; the water always runs off." This was the reply given to inquiries as to the condition of the house at No. 186 West Seventeenth street. That was a two-story frame building, and might have been a convenient house for one medium-sized family. In it were found four families, with a total membership of thirty-one. Four deaths

from diphtheria had occurred in the house within the twelve days previous to the visit. One was that of a child nineteen months old, which had been sick eight days; another victim was five years old, and had been sick for six days only. The apartments of all of the families were very small, and consisted in one instance of a living-room about fifteen feet square; a bed-room 7x10 feet in size, and a kitchen about the size of the living-room. In each kitchen was a sink, whose waste-pipe led directly into the basement, with no intervening trap. The waste-pipes of the entire building emptied in the basement into a wooden trough, with no attempt at a close connection. This wooden trough conducted the waste into a privy, itself in the basement. The contents of the privy were emptied through an underground drain into a catch-basin, which in turn emptied into the sewer. No one on the premises remembered that the catch-basin had ever been cleaned. It was not necessary to go further than the privy cesspool to locate the source of the blood diseases which had made their ravages in the house. This most abominable of abominations was open to admit of the free escape of the noxious gases generated in its filth, a large quantity of which was constantly held in the vault. The waste-pipes leading into each of the four kitchens were simply

ventilating flues for the privy vault. That there was but little sickness in Summer may be accounted for by the fact that the basement, as well as the rooms of the house, were always well ventilated. In the Winter this was closed, and the heat of the house sucked up the dangerous gas.

At No. 565 North Paulina street, little Adolph Hubner, four years old, died of diphtheria on December 28. Four days before, a baby, one year old, died, after a sickness of eight days. The mother was positive that her children were not out of the house and in contact with other children who might have had the disease. The last previous case of sickness from diphtheria in the neighborhood occurred in October, and that was several blocks distant. The attending physician seemed to have reported the first case as scarlet fever, although the mother said she was given to understand that both cases were the same; at any rate, both children had some fever, and neither was considered dangerous until a few hours before death. There were not the usual marked symptoms of diphtheria. There were six children remaining in the family, none of whom was more than twelve years of age; all of these had escaped the contagion, either of scarlet fever or diphtheria. As usual, the victims were the youngest and the

most frail. It did not seem at all unlikely that some of the others might yet meet the same fate, as their pallid countenances and thin bodies seemed to indicate poisoned blood. The family lived in the basement, or, as they would prefer to call it, the first floor, of a cottage. They had occupied the house for five years, but on the upper floor until two months previous. That floor was eight feet, at least, above the ground. The first floor had been used as a tailor-shop, until within the time named. Mr. Hubner seems then to have adopted the "penny wise and pound foolish" policy of moving into the basement, and renting the upper and better floor. The house was connected with the sewer only through sinks, whose waste-pipes, as might be expected, were without traps. The privy vault emptied into a catch-basin, whose contents, in turn, were conveyed to the street sewer through a drain which was under the house. The floor of the basement was very near to the ground, almost resting upon it. The polluted air in the house at the time of the inspection would have been death to any child not accustomed to it.

At No. 696 South May street, in the neighborhood in which other deaths from diphtheria occurred, a child twelve years old died of this disease. The house was the ordinary two-story

frame cottage, and served as a residence for two families. The child was sick five days. The "modern improvements" consisted of a kitchen sink only, which was connected with the catch-basin by a long stretch of lead pipe, untrapped and not ventilated.

At No. 38 Sigel street, a girl four years of age succumbed to diphtheria, on December 29. The family occupied rear rooms on the first floor. The house was a two-story frame. The water-closet was conveniently disposed by being placed under the front steps. It had a vault, three feet deep, the outlet of which, communicating with the street sewer, was, according to the prescribed regulations, "high enough above its bottom, effectually, to prevent anything but the liquid contents of the vault from passing into the drain." The solid contents of the vault, of course, remained in the bottom until they could be converted into a liquid, or a gas. Communicating with this vault was a wooden drain, extending back under the house, and into this emptied the waste from the kitchen belonging to the family living in the rear, through a sink waste-pipe, which was found to be untrapped. The parents of the deceased child complained bitterly of the stenches, extremely nauseating in warm weather, which pervaded their premises, which came from the water-closet through

the sink waste-pipe, and which were undoubtedly the source of the fatal diphtheria.

A child five months old died of diphtheria at No. 295 South Jefferson street, after a sickness of two days. The kitchen was supplied with a sink, whose waste-pipe was untrapped and not ventilated. There was no other apparent cause for the disease than the sewer-gas, which might have escaped from the catch-basin, or been generated by the deposit on the inner surface of the waste-pipe itself.

At 399 Larrabee street, two children died of diphtheria on January 1. This house was a tenement, and the four or five families living in it had few and small rooms. The family that lost the two children lived in the rear part of the house, and on the second floor. The water-closets were in the yard, but a sink was found in the kitchen, with an untrapped waste-pipe. The mother stated that she had been seriously annoyed by the obnoxious odors coming from the sink, especially in warm weather. The sorrowing woman was jealously guarding the only child she had left.

A previously healthy boy, of four years of age, became sick from some unknown cause, at No. 597 South Union street. A physician was summoned, and, according to the people in the house, he said the boy had the measles. He never told the parents

differently, and they claimed not to have been aware that the child was very sick until, at the end of ten days from the time of the first attack, he died. In his report to the health department, the physician ascribed the death to diphtheria. The disease was generated *de novo*, the child not having come in contact with any person similarly afflicted, so far as could be learned. The house was a two-story frame structure, providing comfortable and apparently healthy homes for the three families in it, except so far as the drainage was concerned. In the previous Spring, the house was connected with the street sewer, and the sink waste-pipes were not provided with traps. There must of necessity have been sewer-gas in the house at times. The family whose child died were neat and the yard about the premises was clean.

CHAPTER IV.

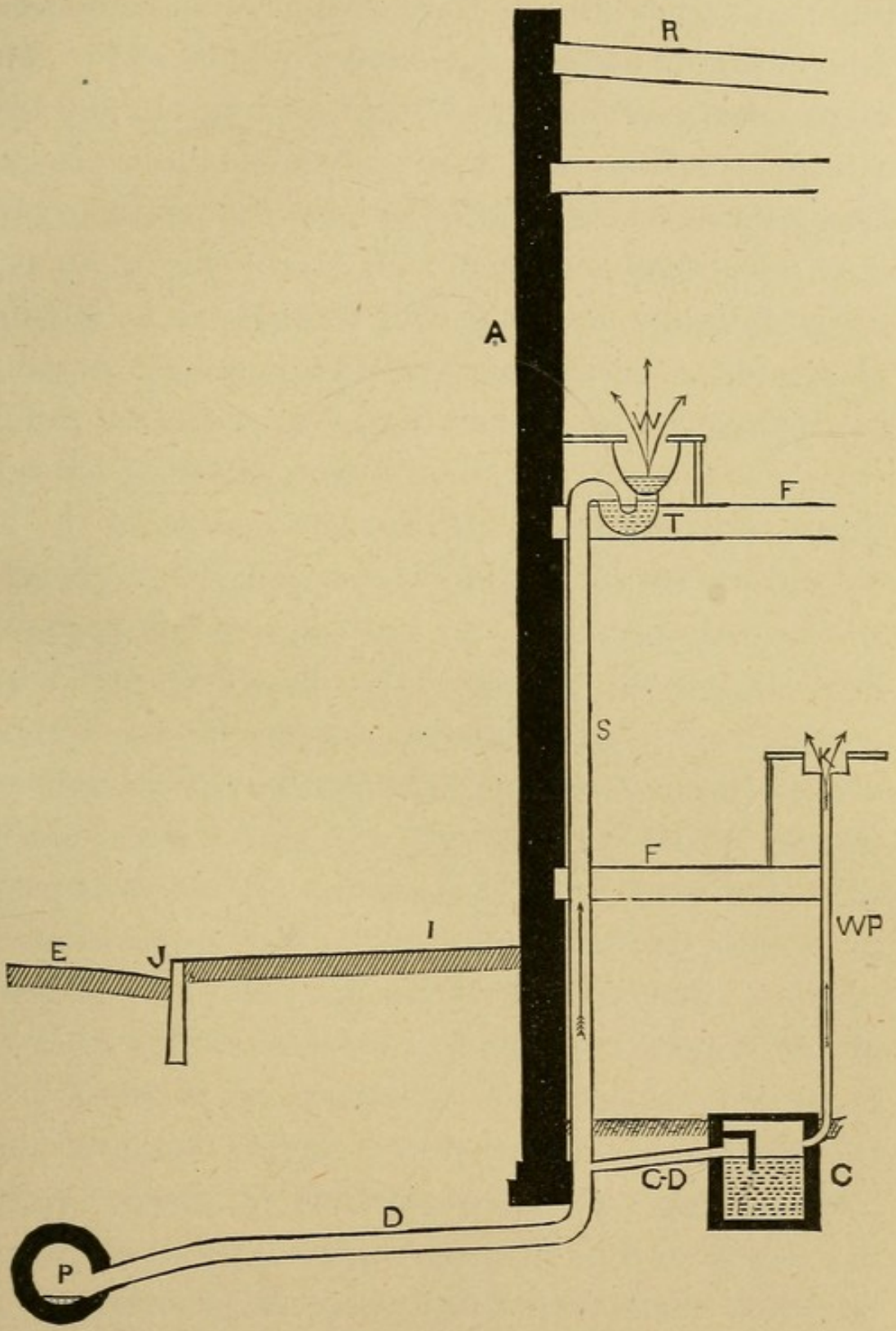
THE PEST IN MARBLE FRONTS.

The sanitary surroundings of the poor are so often the theme of pencil and tongue that it has come to be believed that death and disease do their work mainly among the middle and lower classes. Decaying garbage, cesspools and miscellaneous filth, in gutter, yard and house, are known to be hot-beds of malaria. Children, in overcrowded tenement houses and old rookeries, standing on an island in some sea of stagnant water, die by the dozens every week, and people allude to the circumstance as a natural consequence. But an emissary of death is lurking in the homes that are known as marble fronts, and he performs his duty with relentless certainty. There may not be so many deaths among the young on paved streets and in well-ordered houses, but there are delicate children and feeble men and women. The physician's skill goes far toward prolonging life, and so cheats death of immediate victims, bnt there is lack of ruddy health and vigor in brick mansions as well as in frame hovels, even though the former are

supplied with all of the auxiliary conveniences which ingenuity can invent. The man who can control his circumstances supplies himself and his family with the best food; secures ample recreation for the relaxation of his strained powers; enjoys the advantages of society, and, in short, avails himself of, and provides for those under his charge, all that is supposed to promote health. And yet, he often rises from bed in the morning with a headache, and suffers from general depression; feels more weary than when he retired; is afflicted with a disordered stomach — due to dyspepsia, according to his physician; contracts catarrh and diphtheria, and often falls into the hands of a fatal fever. He seems exceedingly susceptible to changes in the weather, and his blood is always ready to absorb every poison that comes near him. The reason of all this is, in very many instances, that the houses in which these people live have defective drainage, and the street sewers are thus ventilated into them. Sewer-gas is a curse to marble fronts as well as cheap houses.

The water-closet is not usually found in the class of houses to which reference has been made in the preceding chapters. It is put into the better class of residences, and through it additional means are provided for the introduction of sewer-gas. An entire system of house drainage in its simplicity—

Plate IV.



Simplicity and Sewer-gas.

and it is the prevailing system — is shown in Plate IV. The liquid waste of a kitchen is intercepted by the catch-basin, but the water-closet has a more direct communication with the sewer. Usually there is an "S" trap under the water-closet, as indicated by the letter T. This is a bent pipe, supposed to be always full of water, which is again supposed to keep back gas generated in the sewer. That both of these suppositions are ill-founded will be shown further on.

A house on Twentieth street, not far from Michigan avenue, was among the number visited. Outwardly it indicated an enviable home. It was the residence of a family of wealth, and every possible means seemed to have been taken, so far as the occupants knew, to secure health. They moved into the house about three months previous to the inspection here reported. In two or three weeks the wife began to decline in health. She was constantly afflicted with a disordered stomach, and was oppressed with a lassitude which she could not shake off. She complained to her husband, but he undertook to laugh away her fears. Soon, he was affected in the same manner, and poisoning through their food was suspected. They became extremely cautious in their diet, and began to take medicine for dyspepsia. They doctored and dieted, and continued to grow worse.

The woman had the appearance of one who had just risen from a sick-bed, and then under protest. She said that her throat was continuously sore. It was a symptom for which she could not account. The gentleman's brother chanced to visit the place and suggested that the drainage might be out of order. It was then recollected that the lower part of the house was at times permeated with a disgusting odor, and, particularly, when it rained. It was decided to ask the Health department to investigate. The investigation brought to light a mass of corrupting filth in the catch-basin in the basement, that was generating poisonous gas enough to obliterate a whole city full of men and women. Diluted by the atmosphere, it had been carried upward in currents of air, or forced up by pressure, until the whole house had been infected with the poison. The woman had been confined to the house more than her husband, and became affected first. It slowly but surely poisoned his blood as well, and dragged him down to the verge of a dangerous sickness. The intolerable condition of the catch-basin was not the only objectionable thing brought to light. A two-inch waste-pipe from a sink in the kitchen led to a drain in the cellar, which communicated with the catch-basin. The drain itself was six inches in diameter. No proper connection seemed ever to have been

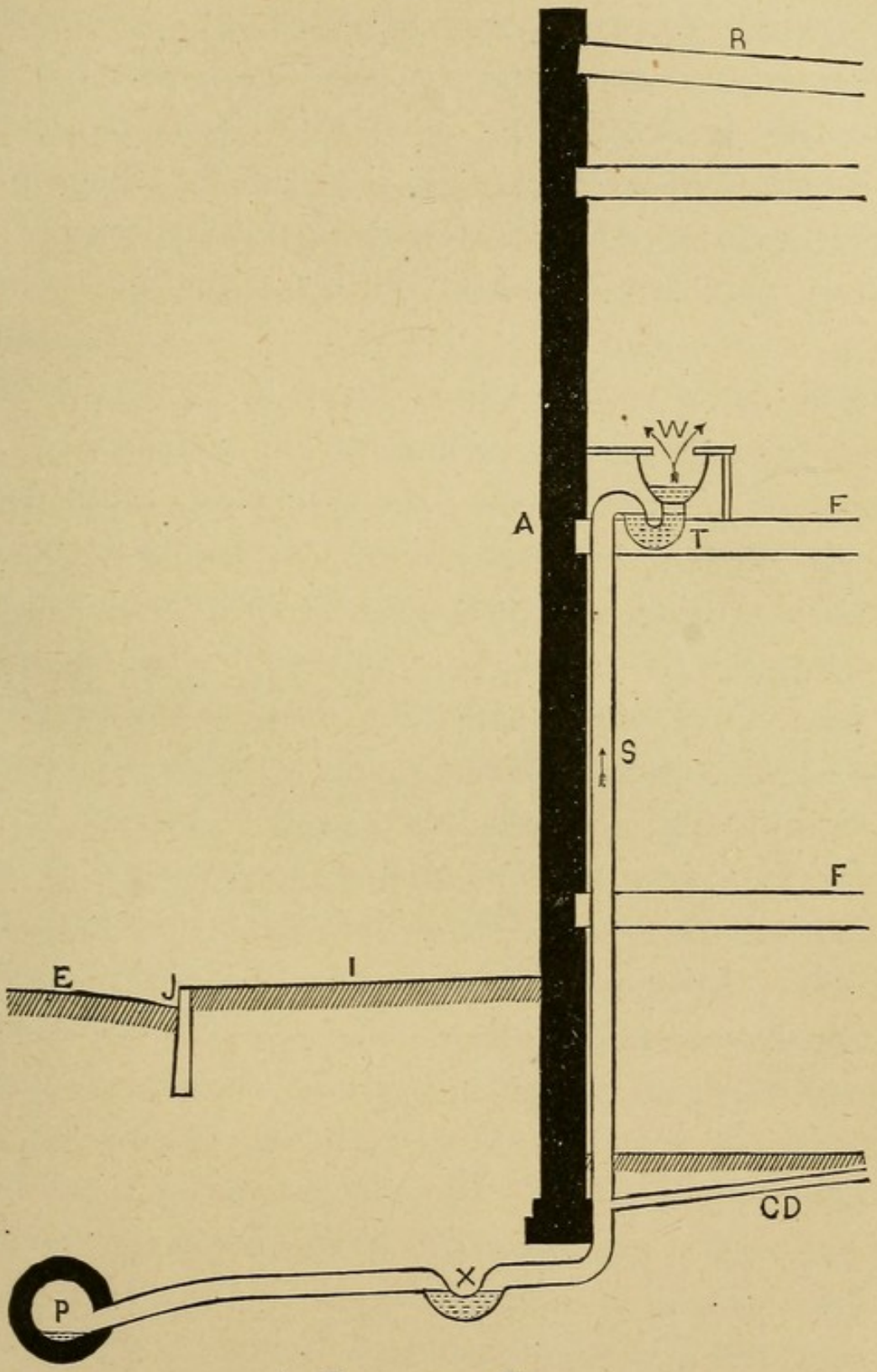
made between the small pipe and the large drain. The former simply emptied into the latter at its end, and the space which the small pipe did not fill was left entirely uncovered. The drain became simply a ventilating tube for the catch-basin. The family were breathing surplus gas from the sewer in the street, which was forced back into their house whenever there was not an equilibrium between the external air and the gas in the sewer; not only were they breathing it, but it saturated their food, and was taken into their stomachs at every meal. So much of it did they breathe, that it caused sore tonsils. It did not prostrate them with sickness, but it rendered them susceptible to disease.

The exhalations from the sewer might have been checked by a "running" trap in the main drain outside the walls of the building. This is of some consequence, inasmuch as it is generally heavier than other traps. When properly ventilated, it is an effectual check to the passage of sewer-gas from the sewer into the house drains. Unfortunately, it has not, as a rule, been placed in drains already constructed. Of course, it has nothing to do with the control of sewer-gas generated in the drains themselves. Its position and use are indicated in plate V, by the letter X. The drain C-D empties the catch-basin, which may be

conceived as placed outside the building, where it properly belongs.

During the Spring of 1879, there was an unusual and unaccountable amount of sickness in one of the most elegant houses on West Washington street. The house was built eleven years previous, at a cost of $30,000, and nothing was omitted, so far as the builder knew, to secure comfort and health. It had all the most useful of the accepted improvements in the way of drainage and ventilation, and some specifications made below will indicate the care that had been taken. The family occupying the house came into it not many months before, and found everything, as they supposed, in the best possible condition. There were four children in the family, who were intrusted to the care of a woman of good judgment. The nursery was on the first floor, and consisted of a suite of rooms, three of which were occupied by the governess and the children as sleeping-rooms. The family had not been long in their new home when the children became very irritable, and some one of them was continually in bed sick. A skillful physician was employed, and he "doctored" for this thing and that, and kept his little patients from dying, though to restore them to sound health seemed impossible. At length, the lady who had charge of the children became sick with

Plate V.



A Running Trap.

pneumonia. She was carried through the sickness, but not two weeks elapsed before she was again prostrated, and this time with typhoid fever. With great difficulty the disease was driven out of her system sufficiently to permit her to resume her duties, but not until she had suffered long and severely.

The Health Commissioner, Dr. DeWolf, was an acquaintance in the family, and he chanced to make them a friendly visit one evening. He no sooner entered the house than he noticed the peculiar odor of sewer-gas, which he surmised was being let loose by a defective drain. He bluntly called attention to it, but was told that it was nothing uncommon, and, in fact, was not noticed by the family to any great extent. He replied that it was a very serious matter, and that he would send an inspector to the house on the following morning to make an investigation. The inspector found the catch-basin, which was built within the walls of the house, filled to overflowing, and the emptying drain so choked that the contents could no longer run off. A ton of filth was afterward removed from the sub-cellar. The gas generated by it had been the cause of all the sickness. "Precautions" had been taken in the construction of the basin to prevent any of the evils which were known sometimes to result. It had

been placed a little lower than usual, and a gradual descent had been made in the ground, on all sides, and a heavy coating of cement applied. This formed an extensive outer basin, which was intended to catch any possible overflow, and ultimately to return the water and filth to the catch-basin and the sewer, instead of allowing it to be absorbed by the earth, or to form cesspools under the house. This large reservoir was completely filled and running over with the waste which should have passed into the sewer. The earth beyond the edges of the huge bowl was receiving the liquid filth, and was soaked with it. The cause of this was a choked drain. There had been neglect in cleaning the catch-basin, and at length the solid contents dropped to the bottom and wholly or partially choked the outlet.

A lady living in one of the houses on the west side of North LaSalle street, between Elm and Division streets, related her experience and that of her family, with sewer-gas, as follows: "We came into this house last Spring, and you can see that it is apparently a very desirable home. We had not been here long when I detected most abominable odors, but it was impossible to locate them. One day I was confident they came from the outside, and then I believed that their source was within my own house. I exacted the most scrupulous

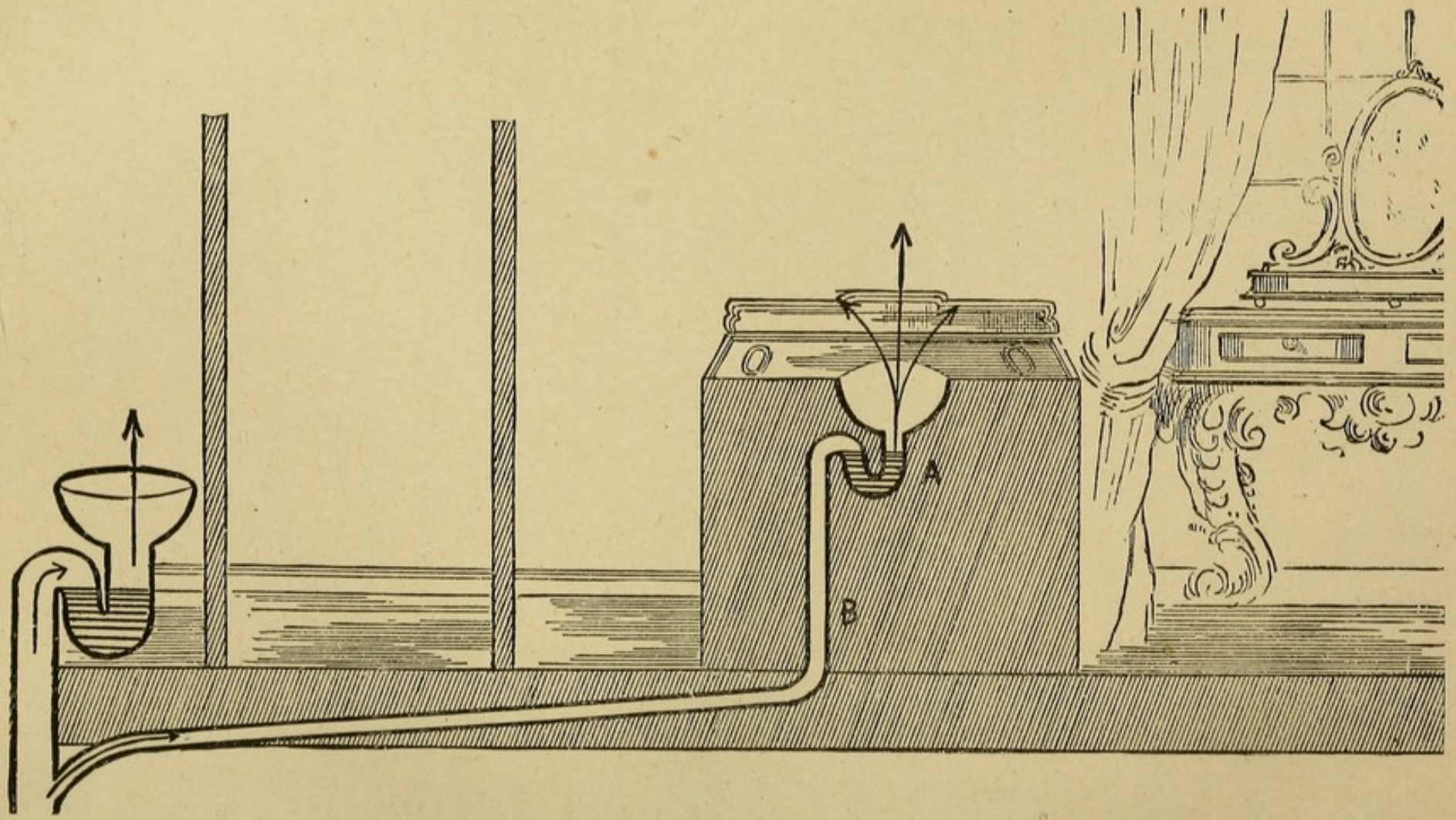
neatness on the part of my servants, requiring them to leave no vegetables of any kind within the house. The members of my family were as devoted to cleanliness as myself, and yet there was the stifling, horrible smell which aggravated my senses. I summoned the health officer of the ward, and asked him to see if there were not nuisances in the neighboring yards, and particularly, in the stables which are built across the alley yonder. As he never made any report to me, I concluded that he found nothing objectionable. I noticed the strange odor at the time of rain storms, and when the wind was high especially. On that account I thought it must proceed from neighboring out-houses and stables. Presently there was a noticeable decline in the health and spirits of my family. My daughter's children were constantly sick, and she was brought to the verge of prostration. A gentleman who, with his family, occupies rooms in my house, and who is a builder himself, examined the plumbing work, and was unable to find any fault in it. We were less and less impressed with the belief that sewer-gas had anything to do with our afflictions. Notwithstanding this, we all continued to decline, and at last my daughter started for the sea-shore with her children. She secured the attention of one of the best physicians in New York, and he at once said that they were

suffering from malaria. This was the first professional indication of the truth that we had. He prescribed a change of atmosphere and an escape from sewer-gas. At Narragansett Pier, my daughter and her children are now well. It is only by artificial means that I am able to keep up, strong as you see I am, and a stranger to sickness. For weeks I have been taking arsenic and quinine three times a day. I am beginning to feel their influence in undermining my constitution, and I have arranged for a prolonged trip to Colorado. I occupy a room on the second floor, and in that the sewer-gas, which is so annoying me, is most noticed. I believe it escapes from that wash-basin, and I want to know, sir, if something can not be done to keep it back."

The waste-pipes were properly trapped. Here were indications that traps might be ineffective. Sewer-gas was absorbed by the water in them, and given off above, or, as frequently occurs, the water was displaced or syphoned out. Plate VI indicates the condition of things in this house.

Mr. L. J. Clawson, Jr., occupied with his family a house at No. 3,643 Indiana avenue, one of a block of ten stone-front houses. Outwardly, these were very desirable residences, and were the houses of those well-to-do in the world. The occupants understood the value and comfort of good health,

Plate VI.



Inefficiency of Traps.

and the way in which their houses were furnished and kept showed that they had not omitted anything which, so far as they had control, could secure health. Mr. Clawson's little girl, twenty-six months old, was taken sick on November 10. She had been a strong and healthy child. She was attacked with a sore throat. A physician was summoned, and he said it was membranous croup, believed by some physicians to be essentially diphtheria. She grew worse very rapidly, and it did not seem possible that her life could be saved. More fortunate than hundreds of fathers in a city whose children are prostrated similarly, Mr. Clawson was able to secure the best medical skill, and a half dozen physicians answered his summons to come and save his child at any cost. In eight days, she was pronounced out of danger. Mr. Clawson was told that the cause of the disease was sewer-gas. He went to the agent of the property, and was laughed at for his trouble. It finally came to light that the house drains emptied into a wooden sewer in the street, and that the drains were so defective that sewer-gas had abundant opportunity to get into the house. Mr. Clawson had the proper remedies made, and then brought suit against his landlord, claiming damages in the sum of $5,000. The case is now pending. The outcome is awaited with interest, on account of its bearing upon the

relation between landlord and tenant in sanitary matters.

In the third house from that of Mr. Clawson's, and in the same block, there was crape on the door at the time of the visit to the former house. A child had died, and the mother and two other children were prostrated with diphtheria. This was in the family of Mr. Joseph K. C. Forrest. Mr. Forrest stated that he had noticed sewer-gas in the house at times, and particularly during the Summer. At any rate, there was nothing to prevent its entering the building.

A lady, living on Thirty-ninth street, near Vincennes avenue, was found almost ready to believe herself a victim of fate. Five years ago, her husband died of throat disease, after a sickness lasting only a few days. Their home was then on Wabash avenue, near Thirty-second street. She and her friends attributed his death to the defective drainage, and, in the Spring of 1880, she secured a house on the south side of Thirty-ninth street. This is just outside the city limits, in the town of Hyde Park. The house was not connected with any sewer, and had none of the "modern improvements." There was only a sink in the kitchen, which was the nearest approach to the so-called "improvements." On this account the lady believed that she would effectually escape her per-

sistent enemy, sewer-gas. She had not been in the latter house long, when the eldest boy, eight years old, began to fail in health. He became so nearly sick that she sent him into the country. He was brought back in the Fall, strong and full of a boy's spirits. Almost immediately he began to lose his health again, and, on November 14, was suddenly prostrated with malignant diphtheria. On the same day, a domestic, and another child, three years younger than the boy, went to bed with the same affliction. The attending physician was puzzled when he learned that the house was not connected with the street sewer, since he was certain that he had detected the odor of sewer-gas. The writer was informed of the circumstances, and immediately made an examination of the premises. It was found that the kitchen waste was conveyed to an underground cesspool in the rear of the house. The waste-pipe communicated with it through a wooden drain, both untrapped. The cesspool had been in use for years ; it was without ventilation, except through the waste-pipe into the house. One of the children died. The mother hastened to the country with the other, where she has managed to keep it alive, but, even now, after nearly six months have passed, its throat, internally relieved, is covered externally with running sores. The physician has wavering hopes that a

permanent cure may be effected if the child can be protected from further sewer-gas poisoning. The children of the family who have taken this lady's place, in the Thirty-ninth street house, have been constantly sick with scarlet fever, or diphtheria, since moving into it.

Among the houses visited was a pretentious one of brick, on a prominent North-side thoroughfare, in which a child, a boy of four, died of diphtheria. If sewer-gas was ever responsible for a death, it was for this one. From the first, the family were troubled by abominable odors. They endeavored to ignore their fears, but when members of the family began, one after another, to fall sick, and the stench became quite unendurable, an investigation was made. Then it came to light that there were no traps in any of the waste-pipes, and that the soil-pipes from the water-closet on the second floor had been leaking. The drippings had soaked through the wall in many places, and the wall-paper in a bed-room nearest the soil-pipe was found covered with a fungus growth. The ceiling of the same room, as well as of one in the basement, was discolored by the sewage. When the box covering of the soil-pipe was torn away, a disgusting stench escaped, and the wall on the interior was found to be literally soaked with the waste from the water-closet. Of course, the gentleman of the

house notified his landlord, and, after much urging and begging, succeeded in getting traps put in, and the soil-pipe mended with rags and putty! Even these inefficient repairs were made too late, for one of the children became a victim of diphtheria. The lives of the other children were saved by prompt removal to another house. The catch-basin was found to be in a very unclean condition, and as there was nothing to prevent its gases from entering the kitchen, they had permeated the entire house. It is said that the house had been previously unhealthy to a notable extent.

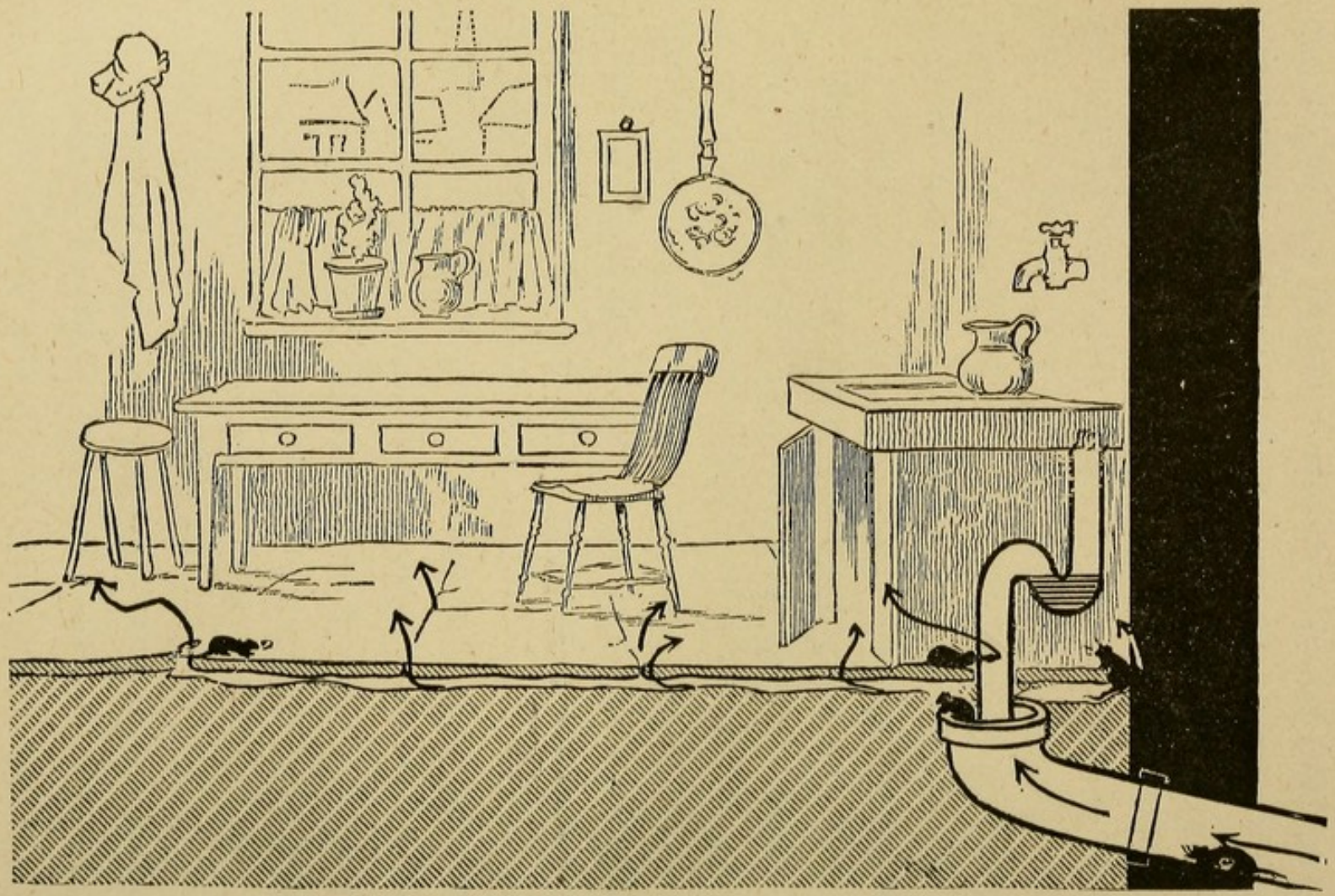
One of the children of Mr. C. H. Rowe, of No. 3,212 Michigan avenue, died, on December 31, of diphtheria. A short lead pipe connected the hot water tank in the kitchen with the waste-pipe *below* a trap. When the water was allowed to run off at night, to prevent freezing, the gases of the catch-basin had free access to the tank, and to the room, through a defective stop-cock which was found in the outlet pipe. No part of the drainage was ventilated into the open air, and the traps were of little consequence.

The following is a copy of a communication which was received at the Health department. The gentleman who wrote it is a prominent employé in the office of the Chicago and Northwestern Railway company: "I have just got up from a

sick-bed, where I have been for the past two weeks with intermittent and bilious fever and chills. My little boy, seven years of age, suffered from the same, last month, and now my wife is down and very sick with the same complaint. In May I moved into a block of six brick houses, No. — Chestnut street, and I can truthfully say that I and my family have been miserable ever since. My doctor says the trouble is with the sewerage, and bad air throughout the house, and that we must have the matter attended to, or we will all die. I have understood from one of my neighbors that his dining-room *stunk* so that they could not eat there for months. Will you kindly give this matter your early attention, and send some of your competent men to investigate and see what can be done. My wife is very sick, and I have still a little fellow, four years old, that used to be as fat and as jolly as could be, but for the past month he has become very poor and lifeless. Be good enough to see to it that this sewerage is thoroughly investigated."

The writer accompanied the inspector in his visit to these premises, and found the family suffering with sickness, as the gentleman had described. It did not take long to find the cause. In the rear of the house, close to the wall, and directly under the window where the sick woman lay, was a slop-

PLATE VII.



DEFECTIVE CONNECTION.

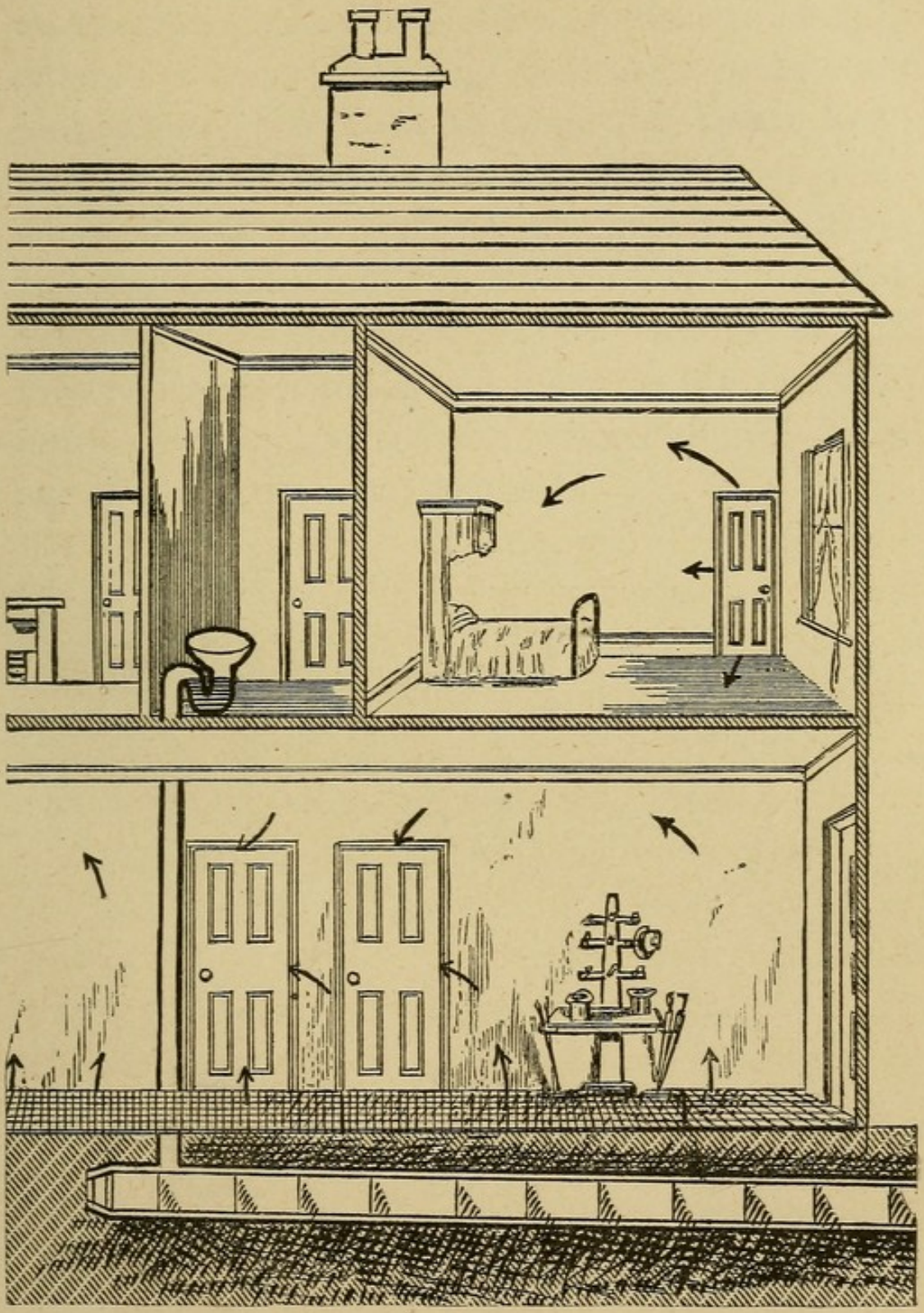
basin connected with the sewer and imperfectly trapped. It was constantly emitting sewer-gas. Further investigation was made, and it was found that there had been an imperfect connection of the soil-pipe and the main drain. The cement used to close the space between the pipe and drain, of unequal size, was of poor quality and had cracked, and pieces of it had fallen away. Sewer-gas had an uninterrupted communication between sewer and house. The connection between the kitchen-sink waste-pipe and drain was also defective. These faults, almost universal, are more fully explained in a succeeding chapter. An indication that such defective connection is a very serious matter is given in Plate VII, which also shows how rats may assist sewer-gas in finding its way through stone, or cemented, floors.

Prof. Chandler, President of the New York City Board of Health, said, in an interview: "Intelligent people are often amazed at being told that their houses are a constant invitation to disease. Some time ago one of my pupils died in circumstances that indicated poisonous air. The house was a handsome one in Madison avenue, but I found that the sewer-pipe beneath the cellar was defective, and belched forth its gases into the house straight from the main sewer, between which and the house sewer there was actually no trap. The

traps underneath the water-closets and basins were not ventilated, and such was the condition of the house that I was quite prepared for Dr. Fordyce Barker's diagnosis of sewer-gas poisoning. I know of four other handsome houses from which the families have recently been ordered out by Dr. Barker until the proper changes can be made. * * Men who will spend thousands of dollars on painting and gilding and carving their houses, will not spend one cent to make sure that the air they and their families breathe is not reeking with dangerous impurities which would make their hair stand on end with horror could they see them magnified a few hundred times. Doctors know something about these dangers, although not half what they ought to know; but they contend that their business is to cure, and not to prevent. Sewer-gas gives them work all the year round. When the disease appears, the doctor is called in at the expense of hundreds of dollars, whereas a few dollars spent in making sure of one's drains every year would obviate the necessity of doctors. It should be thought of far more importance to examine one's cellar and one's drains and traps every year than to shake one's carpet and paint one's house."

An illustration of what Prof. Chandler found on Madison avenue is given in Plate VIII. This

Plate VIII.



A Leaking Drain.

represents a common stone drain under a tiled hall, leaking at every joint, and forming a large cesspool under the house. In a house in Leeds, England, with such defective drainage, Dr. Teale says, in his "Dangers to Health," that enteric (typhoid) fever broke out, and from the initial case it spread to the neighboring village. "The drain was almost without fall, so much so that it had become blocked, and the sewage had found its way under the flooring of the passage and rooms."

CHAPTER V.

CUMULATIVE EVIDENCE.

Sewer-gas is no mere bugbear. It is man's mortal enemy. "Our ancestors, a century or more ago, had a superstition which had come down from earlier times that every sewer or cesspool had within it a resident evil spirit. Like many another superstition which people forget when they grow wiser, the idea rested upon a truth which is every day becoming more evident to intelligent people of all classes. The evil spirit of the sewer and cesspool is that nameless something which we call organic-vapor. Analysis can not determine its composition, nor can the microscope find its poisonous fangs. There is no means of finding out anything which will account for its subtle power of mischief. It is known that in sewer-gas, beyond the range of chemical test or microscopic investigation, there are innumerable intangible germs, which are the seeds of disease, and which bear within themselves the power and potency of death. There is as much use in trying to hold this invisible enemy in suppression as in trying to chain a

ghost. The only chance of conquering it is to let it loose to the pure air, when it will be quickly destroyed or rendered harmless by the oxidation of the organic cells, which show such malignant activity when mingled with the confined air of living and sleeping apartments. The poorest kind of economy is that of putting bad plumbing work into a house, and then having to pay large interest in the shape of doctors' and undertakers' bills."

A distressing case of sewer-gas poisoning was reported from the house at No. 696 West Jackson street. This building proved to have been little else than a pest-house from the time of its construction — a period of about seven years. During most of this time, there was sickness in it, and a number of deaths occurred. The last were those of Mr. Frank Culver, of the firm of Culver & Marsh, doing business at No. 637 West VanBuren street, and his infant child. Mr. Culver died of diphtheria, after a sickness of ten days. The building in which he lived was a two-story and basement structure, the basement of brick and the other portion of wood. Mr. Culver's father and mother and Mr. Marsh, his partner, with his family, also took up their residence in the same house. There were fourteen persons in all — not too many for the building, a commodious one. They had not been in it a day before they noticed unpleasant

odors, but these were attributed to the former unclean condition of the premises, and it was argued that the house would be all right as soon as it was thoroughly aired. The women became accustomed to the smells, and were not annoyed, after a few weeks, but the men invariably remarked, when coming in from the fresh air at night, that there was something wrong. Within two weeks the symptoms of sewer-gas poisoning began to show themselves, and in time not one in the house could climb the stairs without clinging to the banisters. All were sleepless, and without appetite or ambition. The landlord was asked to have the cause of the trouble ferreted out, and remedied, but he repeatedly refused to give the matter his attention. He said that other tenants had lived in the house without complaining; why shouldn't they? At length Mr. Culver was prostrated. Diphtheria of a malignant type attacked him, and his death was expected on the first night. A physician was summoned, and he at once declared that the cause was sewer-gas, which he distinctly detected on entering the house. A messenger was again dispatched to the landlord, with the opinion of the physician and the urgent request that he send a competent person to locate the trouble. All the waste-pipes within the building were found to be in good condition. The

catch-basin was next examined, and the strange revelation was made that it was as clean as when built. During the seven years of the occupancy of the house, not a pint of sewage had been deposited in it. This suggested the true state of affairs, and a hole was cut through the kitchen floor, that access might be gained to the low cellar. Like so many houses in the city — rather, unlike a very few — this low cellar was simply a huge box, the size of the house, and about three feet deep. It was without ventilation on the sides, although there was abundant room above the surface of the ground for ventilating flues. In fact, grated flues were constructed in the outer layer of bricks in the wall, but the inner layer was built up without any regard to these openings.

This house was well built. The floors were as tight as they could be made without cement. It was only when the pestilential gases beneath became dense that they were forced up through the invisible cracks and crevices; when the hole was opened through the kitchen floor, a horrid and sickening smell arose that staggered those bending over it. The cellar was found to be almost level full of liquid filth. Many have seen that portion of the south fork of the South Branch of the river nearest the stock-yards, into which the filth of the yards is poured by one of the large

sewers. The surface of the water is covered with a thick layer of a greasy substance, which looks so much like the soil of the banks that men have mistaken it for solid earth, and stepped upon it only to be plunged into the mire. This is simply the solid matter which finds its way from the slaughter-houses in particles too fine to be intercepted for transformation into fertilizing material. When this clay-colored crust on the surface of the water is at rest, it is not so offensive, by the one-hundredth part, as when it is stirred, and yet, at no time, will any one with untrained nostrils care to linger near it for any length of time. The water under Mr. Culver's house was covered with a substance which resembled that on the south fork of the South Branch of the river, and the gases which it set free were like those of that portion of the river, although more intensely offensive. The landlord no longer refused to believe that there was cause for complaint about the sanitary condition of the premises, and he ordered the cellar cleaned with no delay. The earth was dug out for several inches below the original bottom of the cellar, which had become saturated. Quantities of lime were thrown in, under the delusion that the cellar would be disinfected, and a patent alleged liquid disinfectant was also sprinkled freely about the house under delusion No. 2, that a

stronger smell than that of sewer-gas was indicative of disinfection. What little good this might have done came too late. Mr. Culver died, and ten days later his little child joined him in spirit.

The defects in the drainage, by which sickness and deaths were occasioned, are, by no means, the least worthy of consideration. The house had been built well enough; it had been considered a choice residence, and had never wanted for occupants, notwithstanding no family, so far as could be learned, ever lived in it without almost constant sickness. The underground drains appeared to have been well laid, but the drain which connected with the catch-basin was directly under the chimney. The chimney settled, evidently, very soon after it had been built, and simply crushed the drain. The latter became clogged with dirt and refuse, and from that time on the waste from the kitchen poured down into the cellar and gradually filled it. This accounted for the fact that the catch-basin was like a new one, when uncovered seven years afterward. It very frequently occurs that a drain is broken, or displaced, by a wall under, or through, which it has been placed, (see Plate I,) but this is the first known instance in which a chimney has been built to do damage of that kind.

The family of George Kretsinger occupied the

house the previous year, and they suffered from the emanations of the foul sewage in the cellar. The family contained four persons; three of them were prostrated with typhoid dysentery, and one died. It is important to note that Mr. Culver was an exceptionally vigorous and healthy man when he moved into his Jackson street home. Because he was strong and healthy, he was not proof against the poison of sewer-gas.

At No. 897 West Washington street, the waste-pipes emptied into an open "slop-hopper" in the basement. This in turn communicated with the catch-basin by an untrapped drain. The lady of the house said: "We came to this house in May. Up to that time, we all were perfectly healthy, so far as we knew. My little girl, whom you see there, was the picture of health. She had never been sick, excepting, perhaps, some temporary ailment, to which all babies are doomed. From the time we came into this house until the present day, we have been annoyed by these horrible smells, and half of the time sick. I and my little girl have had diarrhœa and sore throats, and none of us have enjoyed a good night's rest. We get up in the morning more exhausted than when we retired. Our joints are stiff, and we are almost without animation. Our blood is very much out of order. We have been attended by a physician,

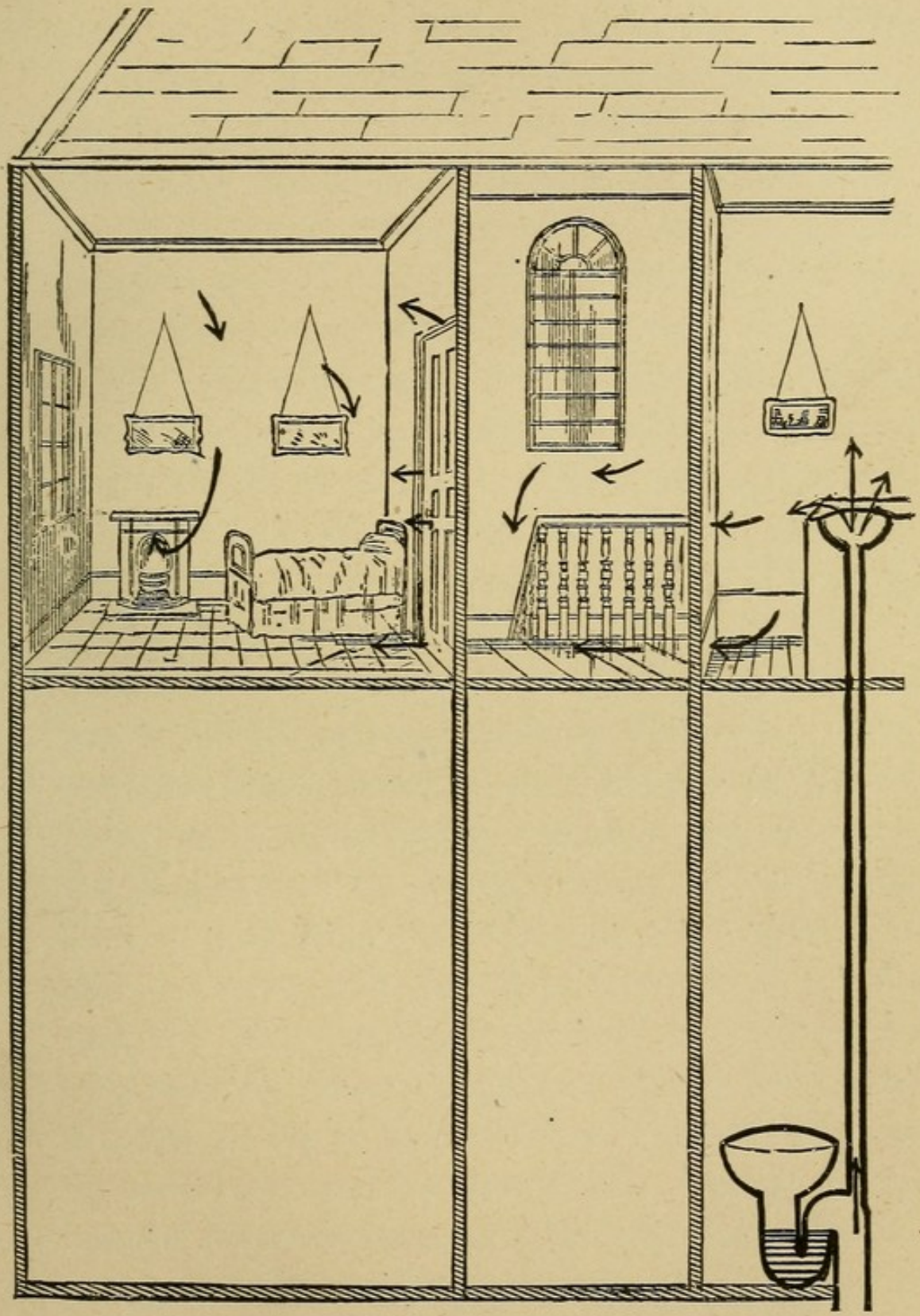
and he has prescribed for indigestion! He has never suggested that our troubles arose from the poisonous sewer-gas, nor has he ever asked about it. The thought never occurred to him, evidently, that this was the case. We began to get alarmed at last. We have complained to our landlord, but he turns a deaf ear and only says that there can't be any danger. We have asked him if the catch-basin didn't need cleaning, and he said it was of a kind that never needed cleaning! Here we are in this predicament. What shall we do?"

A child, eight years of age, died of diphtheria, on January 1, at No. 606 North Clark street. This house is one of a block of four or five two-story brick houses, built a good many years ago. There was a perceptible odor of sewer air about the premises, although the waste-pipes were well trapped, with one exception. In the room in which the child had slept, was found a wash-basin whose waste-pipe was traced to the soil-pipe in the water-closet on the floor below. The plumber, who should have been held criminally responsible for the child's death, connected the waste-pipe with the crown of the trap in the soil-pipe, thus establishing a direct communication with the street sewer. A trap in the waste-pipe under the wash-basin would have been of no account, since it would have been repeatedly syphoned. Two other chil-

dren in the family had been afflicted with diphtheria, but they were recovering. They were kept in another room, and had not been so seriously poisoned. The construction of this waste-pipe is illustrated in Plate IX. This is by no means an uncommon defect.

Malignant diphtheria made its appearance at No. 423 North Clark street, and Mr. Englehardt Peters lost a once bright and robust boy, eight years of age. The lad had been afflicted with sore throat for some time, but no danger was apprehended until the day before the death. Another son, three years older was afflicted in the same manner, and lay at the point of death when the writer called at the house. Later, this lad improved, but the physician said he might decline at any moment and die. Mr. and Mrs. Peters moved into their rooms nearly two years previous. They then had four children. Very soon it was noticed that they all became thin and pale, and grew languid and listless in their movements. In less than a year the youngest, a babe, died. Three months afterward, the next oldest, Katie, fell a victim and was put to rest in the cemetery. Neither the family nor the physician suspected any unusual cause for the sickness and deaths. The family were all strong and healthy before moving to their present quarters, and had taken the utmost pains to pre-

Plate IX.



Criminal Construction.

serve their health. When, finally, the attending physician, who could not account for the speedy and fatal action of the disease, said there must be something wrong about the drainage of the house, the family remembered that they had been greatly annoyed by the "most horrid smells," at times, which came from their sinks and water-closet. A health officer was sent to the place then, and he found the odors complained of to be from sewer-gas. Mr. Peters stated that the odors had become so obnoxious on the first floor that he was compelled to stop the pipes leading from a sink in the rear part of the room, and discontinue its use.

A Frenchman, named Ducharme, had been living in the Beaurivage flats, on Michigan avenue, but moved into rooms on the third floor of No. 433 State street, temporarily, pending a removal to better quarters. Soon after getting settled, his son, twelve years old, was attacked with diphtheria, and on December 19, six days later, he died. The boy had been employed as clerk in a store, and only slept at home. So far as known, the attack did not result from contagion. The water-closet on each floor, used by two families, was in an unventilated room opening into the hall, and the soil-pipe itself was unventilated. The one on the third floor was found to be in a very filthy condition. Mr. Ducharme said that the house was

constantly full of bad odors. The catch-basins of the block were in the basement, and two of them were cleaned about the time that the boy was taken sick. They were in an exceedingly foul condition. The attending physician attributed the diphtheria to the sewer-gas in the building.

The people living at No. 1,022 West Madison street, were called upon to pay the penalty of lack of knowledge about house-drainage. A youth, sixteen years of age, died of diphtheria on December 20, after a sickness of seven days. His mother believed that the disease was the result of a little indiscretion and a superabundance of youthful spirits. He was engaged in a down-town establishment. His hour of rest at noon was often spent in out-door recreation, rather than in taking such food as he needed. The mother thought that he took cold and that diphtheria was the result. A far more potent cause was found in an untrapped and unventilated kitchen sink waste-pipe. The construction of this pipe was otherwise faulty. The family knew nothing about any catch-basin, and they had been in the house since the March previous. It certainly had not been cleaned in that length of time, and probably not for years before, if ever.

Edgar H. Kent, twenty years old, died on December 28, at No. 581 State street. He had been

sick for nearly four weeks with quinsy, as was supposed, but when he became suddenly worse, two days before his death, the doctor said it was diphtheria. There were found two water-closets and two wash-bowls on each floor, the latter without traps in the waste-pipes, and neither soil-pipes nor waste-pipes were ventilated. The water-closets were extremely filthy, and the soil-pipes leaking. Kent had been in the house only a few months. In one of the basements, devoted to Chinese laundrying, one of the kitchen waste-pipes was found emptying its contents upon the ground, and a large cesspool had been created. No one knew where the catch-basins were, nor whether they had ever been cleaned.

Health Commissioner DeWolf said, in an interview with the writer: "It will be a blessed thing for Chicago, and other cities, when every man and every woman asks, first of all things, about the drainage of the house into which he or she is to move, and then will not go into the building until it is certain that sewer-gas will be effectually shut out. People by the scores have come to me to ask, with considerable anxiety, if there could be so much danger attending defective house-drainage as reported. I have made but the one answer only: 'The reports you have read contain not only facts, but not even half the truth has been

told! It is a subject over which you may be alarmed with reason. There are many sources of deadly suffering, but none so terrible and so relentless as sewer-gas. It is a poison as sure as you are living, and no atom of it gets into your system that does not weaken it, and hasten the day of disruption in your mental and physical structure.'"

The doctor said that he had tried many times to bring these facts before the public, but his efforts had been ridiculed. A portion of the press exerted itself to throw suspicion upon his purposes, and hindered him all it could. He referred to a report which he made in 1877, which indicated not only what he undertook to accomplish, but so exactly a condition of things corresponding to what is now revealed, that the following extracts are made:

"For the five months ending February 28 last, there have died 1,088 persons from the so-called zymotic diseases, which, in popular language, would be understood by the expression, diseases induced by poisons taken into or acting upon the organisms in various ways. From the best data within my reach, I infer that not less than 5,500 persons have been sick from these diseases to have produced this mortality. They are a class of ailments which are regarded by all educated medical

men as largely preventable — not that they can be entirely blotted out from the ills which afflict men, but that, whenever or wherever epidemics of typhoid fever, scarlet fever, small-pox, erysipelas, the puerperal diseases, or cerebro-spinal meningitis, occur, these unsanitary conditions and surroundings must certainly exist, and which can, and ought to, be removed by human agencies.

"I prepared a list, as they stood on the death record, of 400 dwelling-houses, and detailed an educated and intelligent plumber and sewer-builder to continue the search. He has put into my hand, to-day, a report of the first seventy-five examinations, and to this report I respectfully call your attention. It has brought to light many domestic nuisances which would never have been discovered by the ordinary methods of answering complaints, and is full of instruction and warning to every citizen. Of the seventy-five houses examined, forty-one were defective in their sewerage connections or arrangements, with more or less sewer-gas in every room. Of the forty-one, twenty-eight contained sinks which connected directly with the main sewer by a pipe, without a trap or obstruction of any kind to the direct return of a stream of gas from the sewer. Seven were unfit for human habitation, for the following reasons:

"No. —; new marble-front, three-story house;

sewer-gas very offensive, coming from southeast corner of dining-room, under floor, at connection of soil-pipe with sewer.

"No. — ; bad leak from escape-pipe to lower water-closet ; candle extinguished if held near it. Upper water-closet in bad order ; basin is not flushed with water.

"Nos. — and — ; new houses, occupied six months. The sewer-pipe passing under the houses is six-inch, while the soil-pipe which joins it at right-angle is only four-inch. The smaller is passed into the larger, and the cement connecting the two is worthless and crumbling out ; houses more or less offensive.

"No. — ; one person died in this house, two months since, with typhoid fever, and another is now dangerously ill with the same disease, attended by Dr. Roler. I find the earth under the basement, or cellar, floor completely saturated with all the liquids usually discharged from waste or soil-pipes of an ordinary dwelling or boarding-house. I also find a waste-pipe to sink in room above discharging on the ground under the cellar floor, without any connection whatever with any sewer, drain, or catch-basin.

"Nos. — and — ; new marble-front house. The families are alarmed, and are thankful for the

examination ; have been more or less sick for some time ; gas not always observed. Houses have settled and disconnected pipes, which discharge under concrete floor of cellar. The catch-basins are everywhere generally filthy.

"I do not know," he added, "that this record would be more emphatic were the contemplated work completed, and the history of the four hundred houses given, rather than that of seventy-five. Whether long or brief, it is a record which does not point to faulty public work as the cause of the disease, nor to that *bete noir* of every Chicagoan, the Bridgeport odors, among which children thrive and mothers are merry and stout ; nor to the necessary omission of scavenger duty and street-cleaning for the past four months, when every thing offensive thrown on to the ground or in street or alley has been rendered entirely inoperative by the frost and snow, but it does point to sham and fraud in private construction of dwellings and local sewers, and to the most unaccountable indifference of the citizens to the plainest sanitary requirements of their domiciles and property. The exhalations from foul privies, sewers and catch-basins are evils not largely within the control of the health officers ; the warfare against them must be waged, and this preventable invasion of disease turned back, by every mechanic who plans a sewer or builds a

house, and by constant attention of every owner or occupant."

At a meeting of the Sanitary Institute of Great Britain, lately held at Exeter, Mr. Henry C. Burdett drew attention to the cases of three new public buildings with which he was familiar, namely, a hospital, a convalescent institution, and a county lunatic asylum, in which serious ignorance of sanitary requirements by the architects had been exhibited. In the case of the hospital, it had not been occupied eighteen months when the health of the inmates pointed to defective drainage, and a thorough investigation was called for. At the outset, it was found that there were no plans of the drains to be relied on. Its drains were without man-holes or means of inspection, and were choked, owing to the cisterns for flushing them never getting filled, as they had been placed too high for the pressure in the water-mains to command them. There were other defects throughout the building, and sewer-gas had free access at all points. The hospital was eventually closed for the sanitary defects to be remedied. In the case of the convalescent institution, which was beautifully situated in extensive grounds and gardens, within a year of its being opened there was a sharp outbreak of erysipelas, and the institution had to be closed. An examination showed that the baths, lavatories,

and sinks opened directly into the sewers, and that many were untrapped. The ventilation of the drains was so defective that in certain winds the sewer-gas was driven by the ventilators into the building; the drains themselves were laid up hill, and were full of leaks and defects. Mr. Burdett stated that the result of all this was that the convalescents returned, not to their homes, but to the hospitals from which they came. In the case of the county lunatic asylum, which was built regardless of expense, there were outbreaks of dysentery and erysipelas almost from its first occupation. Suspicion falling on the sanitary arrangements, a competent engineer was called in, and numerous faulty matters were discovered, which, being put right, resulted in the establishment's becoming healthy.

CHAPTER VI.

THE VOICE OF EXPERIENCE.

Among those who have suffered from the effects of sewer-gas poisoning, is a gentleman of this city, who was prostrate the greater portion of the Summer of 1879, and only through skillful treatment was restored to a comparative degree of health. He was asked for a faithful account of his sickness, its cause and treatment. It was given by his wife, whose constant attendance at his bedside enabled her to know its truth as well as, or better than, he; she wrote as follows:

"How long we lived in a foul, unhealthy atmosphere, it is impossible to tell, but when it made itself known, the symptoms of different members of the family were so unlike that it would have seemed absurd to attribute them to a common cause. One suffered from headache; another, from the return of an old trouble of which there had been no sign for years; still another, from continual soreness and irritation of the throat, while those who were not so seriously affected grew heavy and stupid, and found that even a slight ex-

ertion became a weariness to the flesh. They waked in the morning faint and unrefreshed and without appetite; if a rainy day kept the ladies of the family in-doors with windows closed, headache followed, as a matter of course. One member of the family slept later than the others, and occupied a room adjoining the bath-room, the waste from the wash-bowl in the chamber and that from the water-closet having a common outlet. Although the wash-bowl was always kept closed, or filled with water, much gas must have escaped through it. For months the occupant of that room had complained of feeling 'tired,' and had waked in the morning with a dull headache. When the suspicion which had forced itself upon us of the cause of the general discomfort became a certainty, proved beyond question by the odor which came to us through the register, and surged back into our faces from the waste-pipes in the sleeping-rooms, we made desperate efforts to have the evil remedied. On all sides we were met with the cry: 'A woman's notion; women are always fancying something.' Landlord and agent visited the premises, inspected and sniffed, and declared the air as sweet as the breath of June roses. Then followed an official, who peeped daintily into the cellar, sniffed gently as he hurried through the chamber, and, having just come from an interview with the

landlord, could find nothing out of order, except the feminine sense of smell, which ought not to be encouraged in such irregularities. At last, after repeated entreaties, a few traps were put into the waste-pipes, and one or two broken pieces of drain-pipe in the cellar were replaced — under protest, and as a sort of generous concession to unreasonable feminine fancy. But the sufferers were not all women; indeed, they were more fortunate than the masculine members of the household.

"At last, the dull headache and the constant weariness, to which were added frequent attacks of indigestion, made a vacation imperative, and the most seriously affected victim went into the country, where it was a delight to breathe, and where there were no 'modern conveniences' to encourage and assist the spread of various forms of malaria. His appetite returned, and he soon gave up tea and coffee, drinking nothing but milk. He had promised himself about two weeks of this country life. But before the end of that time the dormant poison in his system, made active in some degree, no doubt, by the milk he had taken so freely, began to show itself in the form of a humor. From head to feet he was covered with a fine rash, whose itching and smarting were by no means agreeable. This passed off after a few days, but a new form

of the disease appeared, attacking his eyes, which became so inflamed and swollen that he could scarcely see. During all this time he had suffered from pain in the bowels, which, he thought, proceeded from indigestion; but before the eyes were well, a third trouble was discovered, more serious than either of the others. The doctors said, gravely: 'If this proves to be an abscess which discharges internally, it must result fatally.' Every effort was made to draw the disease to the outside, and produce an external discharge. The means used were few and simple, but effective. There were daily draughts of citrate of magnesia to regulate the bowels, and outward applications of hot spirits of turpentine and water applied by flannel cloths. For several days this treatment was continued without any perceptible improvement on the part of the patient; then a blister was substituted for the hot applications. After this had done its work, poultices of warm bread and milk were applied, which were renewed every three or four hours, as the turpentine had been. As the plastered part healed, the pain subsided, and the swelling, that had seemed like a ridge lying diagonally across the left side of the bowels, gradually disappeared. The sick man slowly regained his strength, and, on his return to the city, put himself out of further danger by renting a

house so destitute of 'modern improvements' that it has neither gas nor furnace, and waste-pipes in no room except the kitchen. Pure air and wholesome food are his medicines, yet after a year in which it has been the chief aim of the 'loaf-giver' of the family to provide them for the household, the blood poison is not wholly eradicated from the system of this victim of sewer-gas. Had he returned to a house in which there was the least taint of the poison, he would, undoubtedly, have fallen an easy prey to the merciless destroyer.

"A few days ago, a gentleman left the city to seek health and strength among the mountains of Colorado. For two years he had been fighting against weakness and weariness, for which there seemed to be no good reason. He had no organic disease, and in his 'holidays,' spent away from home, he always improved; but, so soon as he crossed his own threshold, the heavy; dull feeling took possession of him, and life became again a heavy burden. His bed-room, which was on the first floor, opened into the bath-room, and although both rooms were kept perfectly clean, and there was never any disagreeable odor, the air seemed often to have lost all its freshness. To one who understands the effects of sewer-gas, the reason for the man's ill-health is clear."

The Commissioner of Health, in Chicago,

recently addressed a series of questions to leading physicians in the city, on the nature and cause of diphtheria. Among these was the following: "Is it your opinion that sewer-gas, or surface filth, can create the special exciting cause of diphtheria?" The responses were not unanimous, but the majority of those addressed held that sewer-gas is either the "special exciting cause," or, at least, promotes the disease. Twenty-eight said, emphatically, "Yes"; seventeen others believed that it assisted in the development of diphtheria; nineteen answered in the negative, three had no opinion, and one thought that it is a probable cause, but that there is lack of proof, while the balance failed to state with clearness what they believed. Of the responses, the following are quoted as explanatory of the positions taken:

"It is my opinion that sewer-gas and surface filth can, and do, create the cause of diphtheria."

"Diphtheria is a zymotic disease, the blood being affected by separate germs and sewer-gas."

"I think they can, though not often the cause."

"Not without coöperation of atmospheric influences of some special kind. I think sewer-gas is charged with a good many things it is not guilty of."

"Medical history forces us to believe that these or similar agents can create it. When the terrible

epidemic of diphtheria broke out at Kingston, N. H., in May, 1735, the disease had not been seen for over twenty-five years, neither in America nor Europe; if these agents could not create it, they supplied the durance and vehemence."

"Diphtheria must have an atmospheric, local filth and individual condition to develop it, in my opinion."

"Only as all poisons which depress vitality tend to a preponderence of diphtheritic, over ordinary, anginas."

"I can not regard them as the cause, but as potent factors in its development."

"Yes; but it may come without either."

"Yes; this is the undoubted cause of our great mortality in the Fourteenth Ward, and any relief would be desirable."

"Does not create it, but will promote the spreading, as I suppose."

"Sewer-gas and surface filth may reduce vital resistance and render infection possible, but neither the one nor the other can produce the contagion."

"No; they no doubt aggravate, but do not create, else it would prevail all the time in cities."

"I regard the latter as creating the special exciting cause, and the former as a facile means for its diffusion and introduction into houses."

"To the decomposition of any organic matter, whether from sewer or slop-pail."

'I think the cause may come from animal matter undergoing decomposition ; when once produced it may be propagated by contagion."

"It is my opinion that neither sewer-gas nor surface filth can create the special exciting cause of diphtheria."

"Yes, under favorable circumstances."

"Yes ; but more commonly a predisposing cause, poisoning the blood and rendering the system especially susceptible to the development of the disease from slight, exciting causes, as colds, etc."

"No ; but may be the means of communicating the infection, or contagious principle."

"No ; emphatically, no ! It has not been proved as yet. Still, I would like the sewers cleaned. It is a bad wind that does not blow good for somebody."

"It is a specific poison, distilled from something in nature's laboratory — let us say filth."

"Not exactly create, but promote the exciting cause."

"I regard diphtheria as a filth disease, and generated wherever this exists, in sewers, or elsewhere, sewer-gas thus conveying the poison."

"They can not create ; they predispose by

depressing the resisting powers of the system."

"They aggravate it, but do not create it."

"Sewer-gas has nothing to do with diphtheria (and scarlatina), as I have seen plenty of it where no sewers exist. Surface filth offers a good breeding place for bacteria, and favors the invasion and spread of diphtheria."

"I think it very doubtful about creating the disease from sewage, but the sewer-gas renders diphtheria much more dangerous."

"No, not of themselves. We find in places of very high altitude, such as Leadville, Col., diphtheria appearing in epidemic form, although vegetable decomposition seldom occurs."

"No. But I think they may create profound enough constitutional impression to make the system more easily infected by the diphtheritic poison, whatever this poison may be."

"No. I believe it may render the system unresisting to the special poison."

"I do not. But they most certainly add malignancy and virulence to the disease when once started, hence cause its spread. My worst cases have been on the open prairies, free from any surface filth or sewer-gas, for two years past."

"Possibly it may. We lack proof that it does."

"No, not to create the special exciting cause,

but to lower the vitality, so that the exciting cause finds a more congenial soil."

"No, but I think they prepare the system for the development of the disease when the poison has been absorbed."

"No, but they are powerful predisposing causes."

"No. If it were so there would be much more diphtheria than there is. Sewer-gas and surface filth are always with us; diphtheria but seldom."

"I do not think sewer-gas and surface filth produce the specific disease germ of diphtheria, but that they greatly favor the attack and growth of this especial germ and increase its deleterious influence."

"It is my opinion that sewer-gas or surface filth can not create the special exciting cause, but often appears to favor the development, of diphtheria."

"Nobody knows."

"No. It can only aggravate the disease."

"No. Given a quantity of sewer-gas, or surface filth, diphtheria only arises when the special exciting cause of diphtheria has been superadded."

"Not alone. They act as predisposing causes only."

"I ought to say to you that I also believe in the contagiousness of all matter, or, in other

words, that all products of the inflammatory process are capable of awaking a like inflammatory process when conveyed to the proper soil, under circumstances favorable to such propagation, and that the resulting process will, within certain limits, be proportioned to the intensity of the process which gives rise to the inflammatory product. This is my view in brief, and it follows from it that the agencies which are capable of powerfully modifying the original process are those you mention, viz., surface filth and sewer-gas, though I would be unwilling to name these as the sole cause of diphtheria, nor always as its necessary causes. Thus, I am of opinion that a man might have a malignant form of diphtheria in a hospital ward, where there was an epidemic, or erysipelas of a severe grade, or where hospital gangrene was in progress, these two disorders being frequently due to the causes named. And I am also of opinion that a man might be exposed for a long time to sewer-gas and surface filth, and enjoy a reasonable degree of health, though I certainly should not expect it."

"The disease I have mentioned is, in my opinion, caused by some poison, sewer-gas maybe, our surface filth another, but not all filth."

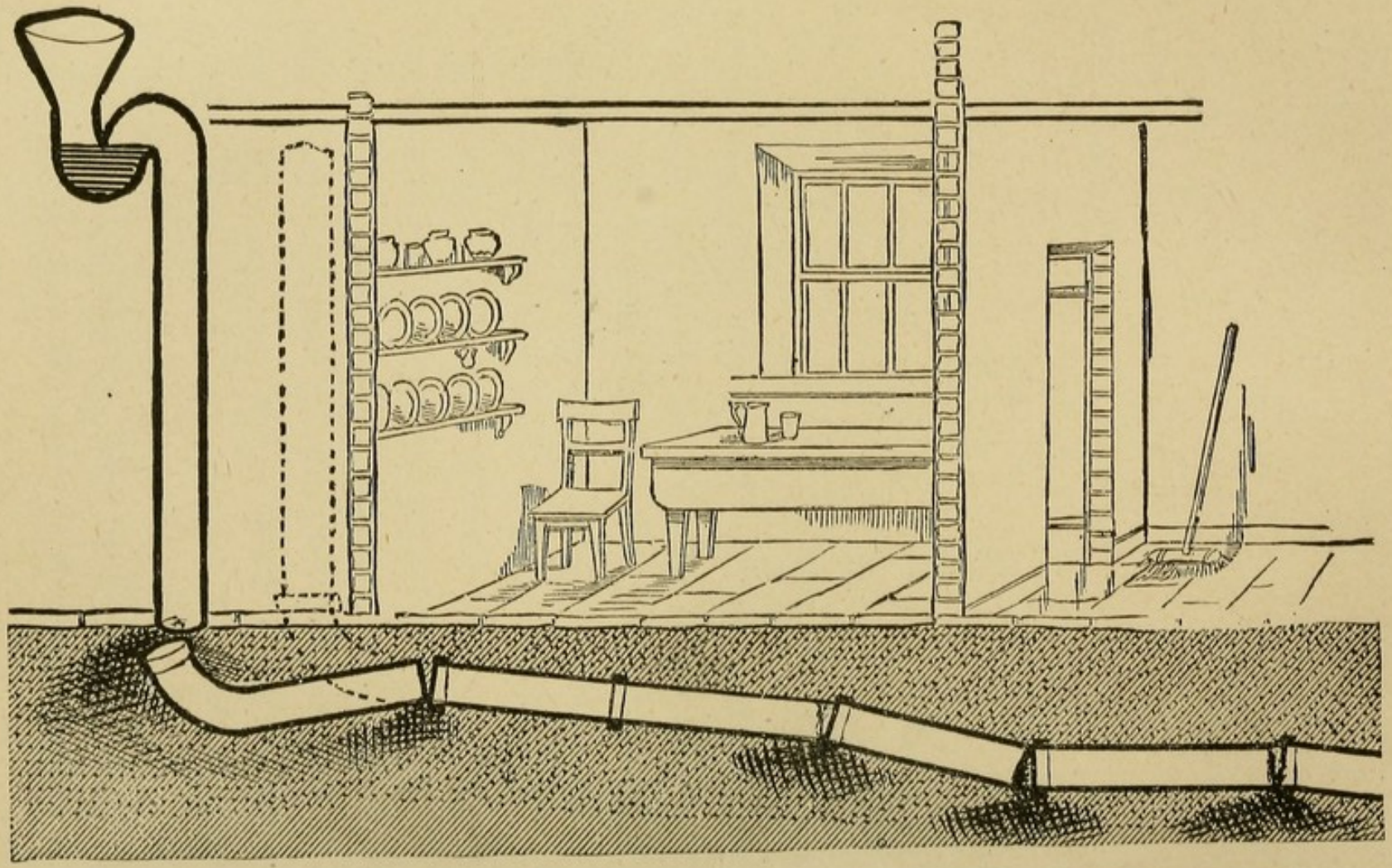
Dr. D. McVickar, a physician of many years' practice in this city, said that only half of the

truth in exposing the terrible condition of houses with broken sewer drains and disjointed connections in waste-pipes, had been told. The worst half would probably never come to light, as families who have been sorely afflicted with sewer-gas dislike to make it known publicly that there has been such neglect in their houses and that they never had found out the leaks and stopped them ; it is felt to be a reproach on their habits of cleanliness, and they prefer to keep the truth to themselves. The doctor said he might spend a day in relating the circumstances attending sewer-gas poisoning among his patients. In truth, the majority of them were sick from no other cause than sewer-gas. Nothing was, on the whole, so destructive of all the powers and faculties of the human body and mind. It not only brought weak and disordered systems to the sick bed, but it transformed the blood into a dark stream of poison. Recently, he was called to the house of a wealthy family, and found the mother and children prostrated with sickness. Their home was in one of the finest houses of the South Side. He told them plainly that sewer-gas was at the foundation of their ailings. An examination of the sewer-pipes was made, and the usual cracks in cemented joints were found. The family were hurriedly conveyed to other quarters, and soon began to recover. He

was once summoned by a breathless messenger to the house of a friend on Ashland avenue, where a young man was said to be dying in great agony. He found what seemed to be at first sight a clear case of sporadic cholera. The patient was sinking rapidly, and writhing under terrible pains. In a short time the doctor was convinced that sewer-gas was the cause of the suffering. He administered sedatives ; it became possible to remove the patient to another house, and in a day or two to the country. The young man was soon out of danger. An examination of the drains in the house from which he was removed, revealed broken joints and escaping sewer-gas.

Prof. Walter S. Haines, of Rush Medical College, related an instance which would seem beyond belief, if not from so reliable authority. During a recent Spring, a family on the West Side, consisting of five members, were afflicted by sewer-gas, which filled their whole house. The oldest of the children was a young man, eighteen years of age. The other two were young girls. The three were brought to their beds. Two physicians spent nearly two months over them, absolutely ignorant of the cause of their prostration. The two girls became deaf, dumb, and blind. One side of their bodies was paralyzed, and the unfortunate victims were barely kept alive. Besides

PLATE X.



BROKEN JOINTS.

being without sight and hearing, their sensibilities were so deadened that they did not seem to care to live. The cases became alarming, and a third physician was summoned. He said that sewer-gas was responsible for the whole trouble. He transferred the helpless patients to another house, and soon they began to recover, and were ultimately restored to their normal health. An examination of the house drain showed that it was broken in a half-dozen places, and the gas escaping.

Plate X shows how the main drain, invariably placed under the house, is often broken by the unequal settling of the ground, by the weight of walls, or because the joints are imperfect when made.

CHAPTER VII.

THE CHEMISTRY AND POTENCY OF SEWER-GAS.

Dr. Letheby, of London, found, by analysis, that the elements of sewer-gas are sulphureted hydrogen, sulphide of ammonium, carbureted hydrogen, oxygen, nitrogen and carbonic acid gas. It contains, also, organic matter. The constituents are not always the same, nor do they always exist in the same proportion. The noxious effects of the gas are due to the sulphureted hydrogen, sulphide of ammonium, and the organic matter. These are always found in sewer-gas, in varying quantities, and it is an important fact for every one to know that the two gases named are among the most dangerous known to chemistry, at least of those about which anything is popularly known. Even when greatly diluted, the first is deadly poisonous to man and animals. Air, otherwise pure, containing one part in two thousand of sulphureted hydrogen will instantly kill birds. Air, one two-hundredth part of which is sulphureted hydrogen, will kill dogs, and a mixture of one part in two hundred and fifty, will end the life of a horse.

Although it has never been practically tested, it is believed that air containing one per cent. of this dangerous gas will cause the immediate death of man. The danger which it brings to man's life in the company of those other elements with which it forms sewer-gas, is apparent.

Advantage was taken of the destructive power of sulphureted hydrogen, some years ago, to rid the garden of the Luxembourg, in Paris, of the crows which infested it. These annoying birds had become so numerous that they were actually a terror, and were driving people from the garden. It was not safe to attempt to shoot them, since there was a possibility of doing injury to the people themselves. The device was adopted of placing in the hands of the gardeners a small bag containing sulphureted hydrogen, to which was attached a tube that could be thrust into the foliage of a tree, and into the midst of a flock of the birds, without disturbing them. The gas was then allowed to escape, when the crows immediately fell to the ground lifeless. The proceeding was so noiseless a one, that it was easily carried on till all were killed and the garden freed.

This extremely poisonous gas may be produced by acid-liquids turned into drains. It frequently seems to become concentrated, and causes death quite unexpectedly. Men have dropped

dead while at work in the sewers of London, apparently from breathing it, and in some instances it has found its way into bed-rooms through waste-pipes, not sufficiently diluted, and has caused instant death. If in a comparatively pure state, its effects are so exceedingly dangerous, in small quantities, it must, under other circumstances, be considered capable of doing much harm. Its known effects are, when present in air which is breathed, headache, vomiting, drowsiness, etc. This is observable in the rooms of the chemist where, for experiment or otherwise, the noxious gas is generated. A simple trace of it in the air will often produce a debilitated condition resembling typhoid fever. In chemical analysis the operator and those around him suffer frequently from chronic poisoning of the blood by it; it is, also, the cause of typhoid or malarial fevers.

The effects of sulphide of ammonium on the system are similar to those of the first-named gas. A good many experiments have been made to determine the manner in which sulphureted hydrogen and sulphide of ammonium produce their noxious influences. The results have been interesting, and throw much light on sewer-gas poisoning. It is a well-known fact that the red corpuscles of the blood are its most important constituents. Their chief office is to take up oxygen in the

lungs, and convey it to all parts of the body. The most important function of the body, probably, is the carrying power of these corpuscles. The body will do without food or drink for a number of days, but if this function is interfered with, even for a few minutes, death ensues. This is illustrated in suffocation by drowning, or otherwise. No person is in a condition of health unless the red corpuscles perform their duty properly and efficiently. Chemical research has shown that the active principle of the red corpuscles is a very interesting compound to which the name of hemoglobin has been given. In plainer terms, this compound is a portion of the substance of the red corpuscles, and upon this the oxygen-carrying power of the corpuscles depends. Hence, anything which interferes with this hemoglobin interferes with the oxygenation of the system.

Experiments on the blood of animals have shown that sulphureted hydrogen and sulphide of ammonium have a very destructive influence on the hemoglobin of the red corpuscles. Whenever they are brought into contact with these corpuscles each is robbed of its oxygen, and if the action continues the gases will utterly destroy the hemoglobin and reduce the corpuscles to a condition which renders them worse than worthless. The hemoglobin is not only deprived of its oxygen-

carrying power, but it is deadened, and becomes extraneous and effete matter in the blood. The result is apparent. The body can not live for an instant without oxygen. It is the stimulus which supports vitality. Shut off the oxygen, and death follows at once; cut off a portion of the supply, and some derangement, even though not immediately fatal, must ensue. The condition of the blood of animals which have been poisoned by these gases, shows the action to be that given above. The blood is black and thick like the dead blood which has flowed from a wound.

From this destructive influence upon the red corpuscles, it may be easily understood what the nature of the danger is which persons, who are exposed to sewer-gas, must encounter; and how they may be injured by it. The peculiar, marked anemia, or blood-poisoning, of those who have suffered from sewer-gas poisoning, is explained by these facts. There still seems to be an influence in sewer-gas derived from the organic constituents, which, also, not infrequently, modifies the action of the other two gases. There is no doubt that the organic elements are as poisonous, or deleterious, as the decaying particles of animal or vegetable matter wherever found, for that is all that they are.

In many diseases the poison of the malady

seems to be eliminated largely by the bowels, and the fecal discharges evolve gases, which are capable of propagating disease. This is particularly true of typhoid fever, and does not fail in the case of cholera, and possibly of cholera morbus, which is held by many to be cholera in an incipient stage, though there is reason to doubt it. Many leading scientists discredit the germ theory of the spread of disease. They believe that chemical gases generated by disease in one organism may produce a ferment, so to speak, in another, and the result is the reproduction of the same disease. It is known that strychnine produces a certain effect on the blood, as the woorara used by the South American Indians in poisoning their arrows does, and which results in death. There are no germs of disease in either case. There are no specific disease germs in the decomposing flesh of a corpse, and yet a few particles of the putrid flesh, introduced by accident into the blood, as a student works in the dissecting-room, will poison the system, and may produce death. So the poisonous particles which are given off by a diseased person may float through the sewer and on the wings of its gas be transmitted to the living and sleeping apartments of any family whose house has defective drainage, and when in contact with blood already deteriorated by sewer-gas, cause a ferment, or disease, in the sys-

tem, the whole action being precisely analogous to that of yeast. Small-pox may be transmitted in this manner from the discharge of the pustules. Yellow fever may be propagated by fecal, vomital and urinal discharges; but in this case, it seems that the poison itself must come in direct contact with the person. The noxious gases of the sewer may be oxydized, and consequently destroyed. All that is necessary is to give them the benefit of plenty of pure air.

To summarize: The poisonous elements of sewer-gas are sulphureted hydrogen, sulphide of ammonium and organic matter. The first is a deadly poison, and in a sufficient quantity its fatal effects are immediate. In small quantities it weakens the vitality of the system, by counteracting the oxygen-carrying power of the blood. It is always present in sewer-gas, and a very small amount will produce, or pave the way to, disease. The noxious gases which by fermentation reproduce the disease from which they originated, are borne hither and thither by sewer-gas through defective drains and into houses in distant parts of a city.

The writer had an interview with a leading physician of Chicago, who has given the subject of house-drainage and sewer-gas poisoning careful and prolonged study. This gentleman had seen his family afflicted with some strange malady. In

spite of his utmost exertions, each member grew paler and weaker, and he soon realized that they were dying, inch by inch, before his eyes. His own health was seriously impaired, and the day seemed near at hand when the family circle would be broken by the snapping of some link. Investigation satisfied him that they all were being poisoned by sewer-gas. He was the first to introduce a system of drainage which has since proved to be an enemy to sewer-gas. His family were soon well and they have remained so. "One very serious danger," the doctor said, "is in the means which sewers afford for the spread of contagious diseases. The germs, or poison, of scarlet fever appear time and again where the disease is not expected. I believe they are often carried down the drains of houses to the sewers, in water which has bathed the bodies of the sick, or washed their clothes, and are conveyed to a distant part of the city to be again forced back by the gas which is generated in the sewers into other houses. I have no doubt that many a contagious disease is spread over the city in just that way. But that is only one of the necessary evils attending the presence of sewers in a city. The house drains are more to be feared than the sewers themselves. They are laid loosely on sand, and are easily broken; ordinarily, in fact almost universally, they are noth-

ing but tiles badly jointed, and often broken when put into position, or broken by the settling of the house. With these defects, not only are the contents of the waste-pipes let loose to be absorbed by the earth, but also the poisonous gas may escape to penetrate through the house in all its rooms. There is this difference, too, between the drain and the sewer: In the latter the gas is oxydized to a great extent by its contact with pure air, and rendered harmless. The gas in the drain is by far the most dangerous, and its most natural escape is through a house. The pipes in the house are always warm and sometimes heated; the drains are cold, and whenever there is opportunity for a current, it will be up and backward, carrying the poison with it.

"Sewer-malaria — for that is what it should be termed — does not kill people outright, but it is the source of many diseases which themselves destroy life. I have no doubt that tens of thousands have lost their lives by it, and ten times as many have been robbed of their usefulness. Among the acute diseases which it will generate is typho-malarial fever. The chills and fever of the Eastern States are precisely like this. I do not know of any symptoms which marsh and swamp malaria will produce, which may not be as well produced by sewer-malaria. I have had a patient direct from

Texas, chattering, shivering and burning with chills and fever, whose case has been duplicated in Chicago.

"Sewer-malaria has the singular property of increasing the friction of the blood in the blood-vessels; hence it may give rise to any disease of a congestive nature. It will cause a rush of blood to and a continued pressure in the head. It gives a sense of weariness and drowsiness which causes people to feel more tired when they rise in the morning, than when they retired at night. It debilitates the system, and hastens men and women to premature graves. Business men go home from their labors tired out with hard work, as they believe, when in reality they are the victims of sewer-malaria. Men of business break down early in life, and it is said that excessive application has killed them; but the truth is that sewer-malaria is responsible.

"Congestion of any organ may arise from the breathing of so-called sewer-gas. It will cause diseases of the heart, and particularly palpitation. I know of very many in this city who are suffering from heart disease, because they have breathed so much sewer-gas. It exhibits its power in causing eruptions of the skin. It is responsible for the bad complexions which women in this city have. Who has not noticed the difference between the sallow

and faded complexions of young and middle-aged women and the comparatively ruddy and healthy look which the faces of men have, as they walk along the street or ride in the cars? The reason is, that the women are shut up in houses, and they feed upon the malaria which is almost continually about them, while their husbands and brothers are out in the fresh and purer air.

"The high arterial pressure which is constantly exerted by reason of this deadly element may produce Bright's disease of the kidneys. It affects children most in causing congestion of the brain, and palpitation of the heart, by its absorption into the blood. It makes children puny and dull; it renders them susceptible to any disease. It is a direct cause of diarrhœa and other disarrangements of the stomach. Sewer-gas has a peculiar effect upon the kidneys. It possesses an unexplainable property of changing the urine from day to day, not only in color, but consistency. I have noticed this in patients who have come to me for treatment, and traced the disorders to the breathing of sewer-gas. The blood becomes charged with the poison, and the effort of nature to carry it away is indicated by the overstrained action of the kidneys and the substance which is thrown out of them."

In addition to this alarming category of the

diseases which are traced to sewer-gas as their cause, the doctor said that its effects were not temporary, but rather permanent. A man's system would carry the malaria about with him for years, and in some cases it would fairly defy all efforts to drive it out. He had known instances of this kind, even when the victim had fled from the presence of the poison, and used every means to eliminate it from his system.

The system acquires a tolerance of the poison and will not notice it in time. It will affect those most who have been accustomed to breathe the pure air of the country, or who live in houses that have no sewer connections. When strangers come to the city and suffer a temporary sickness, or are afflicted with indisposition, it is usually attributed to a change of diet, or to the water drank. The real cause is the sewer-gas which they breathe. To it should be charged the prevalence of catarrh in this city. It was simply absurd for people to talk about being unable to live on the lake shore because the winds aggravate their catarrhal difficulties. Rather, this was the reason why they can not live on the lake shore: Near the mouths of the sewers any undue pressure from the lake, or by strong winds, is first felt. The gas rushes out into these houses first, and in greater quantities than into any two miles west of the lake.

"Set that down, then," he said, "as an important fact that the lake breezes have no influence on catarrh except to benefit it.

"I believe, and know," the doctor continued, "that a system of drainage can be provided which will reduce the dangers spoken of to a minimum. Remember that the evil is confined mainly, almost wholly, to the drainage which is located under the house, and to the plumbing within it. As things are now, every house, or block of houses, which is supplied with tile drainage, stands over an elongated cesspool. I hold that it is an impossibility for tiles to be so united that a safe joint can be made. They will spread more filth under a house than they will conduct into the sewer. A drain should be, in every respect, as well constructed, and of as lasting material, as a gas-pipe. There should be no possibility of breakage, or leaking, and the air-tight joints should allow no poisonous gas to escape. A system of drainage can never be perfect until it provides ventilation as well. Such a system can be constructed and used. I know it, for I have one now in my house. While myself and my family were previously poisoned by, and sick with, sewer-gas, we are now well.

"I most firmly believe that sewer-gas is far more reaching in its deadly influences and effects than to kill individuals and households. I believe

that it has, and will, conquer cities. So sure as there is a future, this city is doomed to perish at the breath of this relentless enemy, sewer-malaria. It will be centuries hence, possibly, but the time is indefinitely long or short, as means are provided to control sewer-gas. As things are to-day, the soil on which Chicago rests is becoming very rapidly impregnated with it. Through poor and defective drains it is forced into the earth, and it will stay there for ages. A house will draw upon the stock thus stored away, for a distance of twenty feet. Let the soil be full of it, and imagine what must result! Many reasons have been advanced for the decay of ancient cities. I believe it will yet be shown that they perished of sewer-malaria, the very same that is so troubling us to-day. Isn't it strange that cities surrounded with all that man can acquire and invent to continue their prosperity, should suddenly cease to advance, and then begin to go backward? Is it not plausible, is it not likely, that the decay dated from the time when the earth on which they stood became stagnant with sewage? I believe that this is true, else why is it that a curse has seemed to hang over the sites of once prosperous cities, and it has been impossible to restore them even to a shadow of their greatness?"

Dr. A. De Verona, of Brooklyn, N. Y., says:

"It is not my aim to give any exact statement of the total influence which sewer emanations exert upon health, for, as a general thing, it is only so far as diseases kill that their effect can be represented in numbers. Of the incalculable amount of physical suffering, the disablement which they occasion, the sorrows, the anxieties, the darkening of life, the strained means of subsistance, the destitution and pauperism which often attend, or follow, suffering, death statistics and health-board reports, to which alone I can refer, testify only by suggestion. However, what we have said is sufficient to show that, of the death-rates which we register each year, fully one-half are of the zymotic order, and of these the great majority are due to the effects of bad drainage. * * * Very small amounts of sewer-gas may develop fatal ailments on the one hand, and, on the other, large amounts may produce but slight derangements; and, above all, the poison once implanted in a human being is capable of reproducing itself *ad infinitum*. * * * Note, now, the diseases produced by the so-called sewer-gases. They are always of the infectious kind. One case may be the parent of a thousand. The first victim has taken the disease from the sewage vapor through the mouth, nose or eyes, or the blood-vessels may absorb it from the surface of any open wound or

ulcer; but the second victim need have nothing to do with the sewage vapor; he may never have been near it; he may take it directly from the first victim — from his breath, or his secretions. Does it not seem as though something had passed with the sewage vapor into the first victim, which had there multiplied and propagated its kind, and that its offspring had passed from the first to the second, where the same phenomena had been developed, with the same capability of reproduction?

"We noted that sewage, in addition to its organic matter and its living things, is largely composed of water; that water is constantly passing into a state of vapor. We see, therefore, that, as it liberates its one and a half cubic inches of putrid gases per gallon per hour, it gives to the air around it the living germs, the humidity they need to live in, and the food they need to thrive upon."

CHAPTER VIII.

THE DELUSION OF DISINFECTION.

Health Commissioner DeWolf was asked if the public could not be given some practical information about the use of disinfectants. If people would not, or could not, keep their surroundings clean, might they not partially counteract the malarial and contagious influences of the filth about them, especially of that in drains and sewers? The Commissioner thought this practicable; but he wished that they could be divested of the idea that it was the duty of the health department to be at hand whenever sickness in the neighborhood occurred, and throw a mantle of undefined protection about their homes. A health department could not be expected to disinfect every house in the city, and then keep up the disinfection every time a contagious fever was reported. The people themselves could do this work as well, ordinarily, but they might call upon the department in case of extremity.

"But the people generally do not know what disinfection is or how and when to make use of it."

"Very well, then let me make the assertion easily understood, that disinfection is necessary at all times, and that the disinfectant most easily obtained and applied is fresh air. With this best of all remedial and hygienic agencies, I would keep all houses and rooms constantly supplied. The germs of disease are floated hither and thither and fed by an impure atmosphere. In pure air they are destroyed, or, at least, lie dormant. If people were surrounded always by pure air, sickness would be reduced to a minimum. To be sure, this involves a constant watchfulness over surroundings and a determined effort to remove the causes of impurities in the atmosphere. Since this duty is not observed, artificial means for destroying the germs of disease must be substituted. It is a very common error on the part of people, to suppose that the production of an odor is securing disinfection;" and the doctor proceeded to relate a circumstance which came to his notice unsolicited, and which illustrates how widespread such a belief is even among intelligent medical men. A physician of good standing, and who had "practiced medicine" for twenty-five years in Chicago, asked the Commissioner's permission to remove a card from a certain house, which indicated scarlet fever within. Said the medicine man: "I consider the case practically cured, and I have

seen to it that the house has been thoroughly disinfected."

"What have you done to disinfect?" asked the Health Commissioner.

"Why, I have used the same means that I have for the past twenty years — burned coffee and vinegar in all of the rooms?"

The Commissioner had an indistinct impression that men sometimes chewed coffee after imbibing pretty freely of whisky; but he had no information that they were kept sober thereby; so the smoke of burnt coffee would be about as effectual in keeping women and children healthy.

"Aerial disinfection, as generally practiced," said the Commissioner, "is a delusion. To expose a little chloride of lime in a saucer, is not disinfecting a room. Sprinkling a little carbolic acid on clothing, is not effectually destroying the germs of contagion. The germ theory of the spread of disease brings us face to face with the fact that all danger from contagion is removed only when a house, a room, bedding, clothes, and the air itself are subjected to a treatment which would destroy any form of life, animal or vegetable, in human or parasitic form. The breath of a sick person may escape through an open window and be the means of conveying the seeds of a contagious disease to some neighbor or passer-by. Every scrap

of clothing in a sick-room, and the walls themselves, are impregnated with the death-dealing germs, and nothing but a treatment powerful enough to destroy all life is sufficient to remove the danger.

"Very much can be done to check the spread of these germs, if not to destroy them. The Health department uses three kinds of disinfectants, and all of these are within the reach of every citizen. One consists of a solution of iron and carbolic acid, in water, in the proportions of five parts of carbolic acid, twenty parts of sulphate of iron, and seventy-five parts of water. The carbolic acid should be ninety-five per cent. purity. This is good for use in privies, gutters, and where there is likely to be collected decaying garbage. Another kind is a solution of mineral salts and contains, principally, chloride of zinc and nitrate of lead. This is manufactured in this city, and is used by the United States Government for disinfecting purposes in the yellow fever districts of the South. It is very cheap, costing not more than $2.50 or $3.00 a barrel. It is stronger than the first article, and is to be used in more extreme cases. Still again, the Health department uses what is known as Crane's chloridium. It is a solution of mineral salts, and is very good. Complete disinfection is accomplished by the use of sulphur-

ous acid gas. It is best applied in the following manner: Infected clothing, carpets, etc., are hung on lines stretched across the room. The room is then very carefully sealed up by pasting strips of paper over all the cracks which can be found about the windows and doors. The last door is, of course, sealed on the outside after the final exit is made from the room. In the center of the floor is placed a kettle containing brimstone, which is moistened with alcohol and set on fire. The fumes from the sulphur penetrate every crack in the room, and even the brick or stone walls. The room is left closed for about eight hours. No germs of disease will remain. This last process should always be applied in extreme cases, and then the Health department stands ready to conduct it."

"When and how shall the more available disinfectants be employed? Please give some directions that any person can follow."

"I would advise every householder to keep stored in his basement or cellar a barrel, small or large, of the first solution I mentioned — carbolic acid, sulphate of iron and water, in the proportions of five, twenty and seventy-five parts. Let him from time to time, as the unpleasant odors may demand, fill an ordinary sprinkling-pot and sprinkle yards, gutters and privies freely with it, and pour

it into drains. He may use carbolic acid and water in the proportion of one to ten respectively, which will be efficient. Here I might advise caution against the use of coal tar. It ordinarily contains but five to fifteen per cent. of carbolic acid, and often but a half of one per cent. Its disinfecting properties are thus seen to be very slight.

"Pulverized charcoal is an excellent absorbent of unpleasant odors, and will do much good service if kept sprinkled in gutters and back yards. It is inexpensive, costing but twenty or thirty cents a barrel. Freshly slacked lime is also very good for use in the same way. It should not be forgotten that the destruction of an unpleasant smell is not disinfection in the correct sense of the term. If scarlet fever, diphtheria, or kindred diseases, breaks out in a neighborhood, let the people see to it, first, that they supply themselves with as much fresh air as possible, and then disinfect their premises thoroughly. On every-day occasions, let them use lime and charcoal freely. It may strengthen their confidence in these articles to know that the Health department will use six hundred tons during the present season."

A leading chemist was asked as to the effect of disinfectants on sewer-gas. He said: "If supplied in sufficient quantity they will destroy sulphureted hydrogen and sulphide of ammonium,

but the amount must be enormous. All that a single family can do toward destroying the power of these gases is like emptying a cup of water into Lake Michigan. Practically, there is little use in the attempt to disinfect a single house. If every family in the city would agree to do the same thing, disinfecting might amount to something. As it is, disinfectants have only an effect upon the drains of a particular house, and end there, and then the amount applied must be very great." The gentleman added that the best disinfectants were chloride of lime, sulphate of iron, and sulphate of copper. He had little faith in carbolic acid. It was little more than a deodorizer.

Prof. Chandler, President of the New York Board of Health, says: "Some persons have great faith in disinfectants; they buy copperas, kill the odor, and think they have done all that is required. Disinfectants are useful only to prevent the spread of diseased air or matter; for this purpose they should be used freely in sick-rooms, but for counteracting the effects of sewer-gas they are useless. The use of these modern abominations, which pretend to kill the germs of disease, patent disinfecting machines, water-closet purifiers, and so forth, is pernicious. The man who uses them virtually confesses that his house is unclean, and that the bad odors need to be hidden or perfumed."

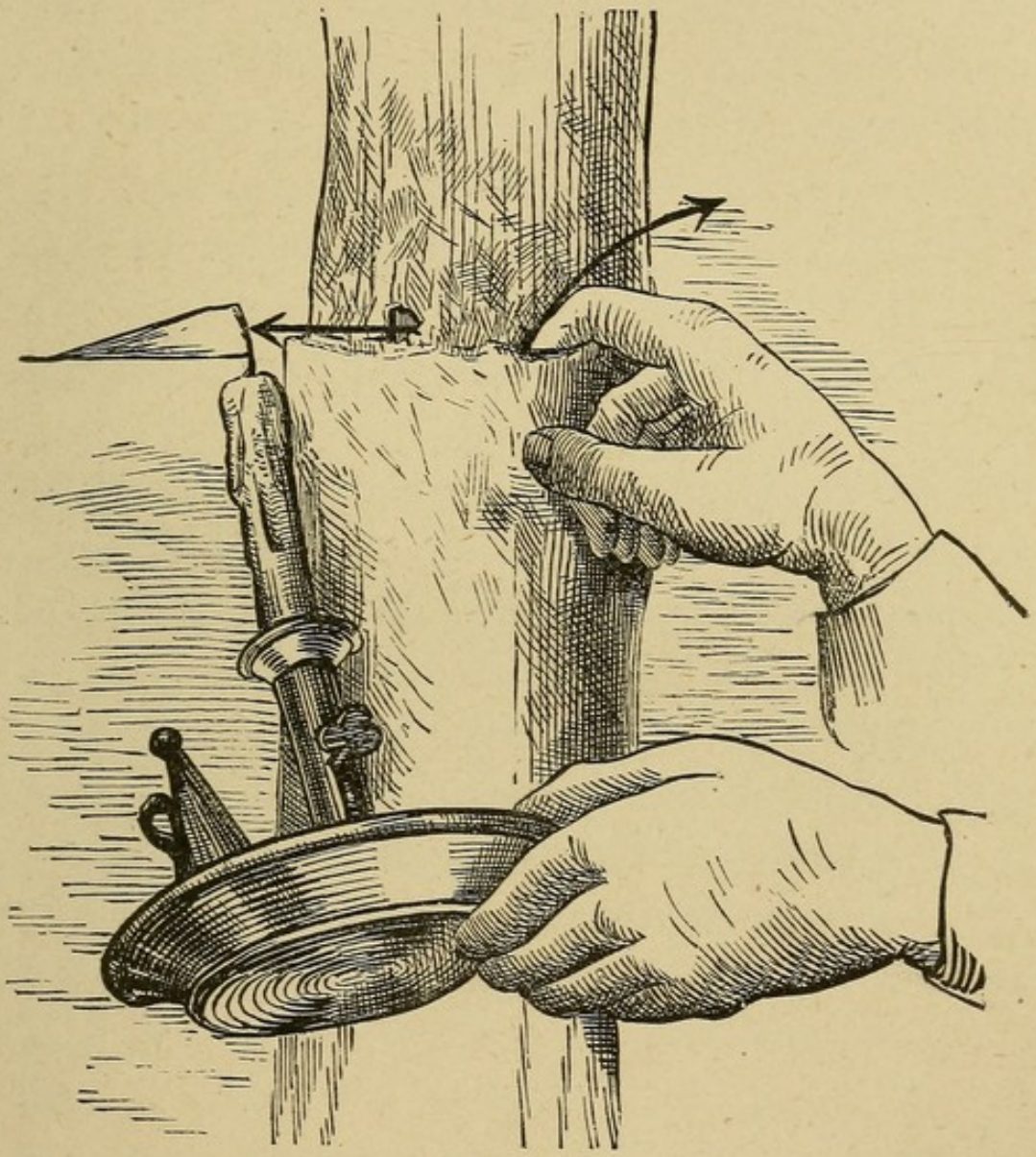
The conclusion is, that disinfection, as ordinarily practiced, can not be relied on to rob sewer-gas of its danger. While there is a possibility, and even a probability, that the germs, or poison, of disease may be destroyed by chloride of zinc, there still remains a reasonable and important objection to relying upon such a method of dealing with sewer-gas. It is like leaving the doors and windows of one's house open at night and depending upon the possibility of shooting a burglar who may enter to steal. It is like swallowing a poison and following it with an antidote. If a man sleeps with one eye open, and is a good shot, in the one case, and knows positively what will neutralize his poison in the other, he may snap his fingers at burglars and take poison with impunity. It is likely, however, that most people would not care to incur risks in either case. "Shut out the burglar," and "keep the poison at arm's length," would strike most people as being the safer advice to follow. Sewer-gas may and should be let loose in the out-door air, and not allowed to generate in the house, nor come back to the rooms through soil, or sewer, pipes. To bring a sweet-smelling disinfectant, or antiseptic, into a water-closet, or sick-room, gives a sense of security which so long as sewer-gas may enter, is often false.

CHAPTER IX.

DEFECTS IN HOUSE DRAINAGE.

It would require a long chapter in which to enumerate all the defects in house drainage. As drains exist to-day, there is no section, no joint, no connection, no trap, no pipe, no part, which is not defective. Not all the defects may be found in the drains of a single house, but what one lacks another will supply. It is no exaggeration to say that nine-tenths of the houses of this city, which are connected with the sewers, are unfit to live in because of defects in their drainage. A sanitary engineer, whose investigations were made in Eastern cities, says: "I have never completed any examination without discovering serious sanitary defects — not merely such errors of arrangement as were universal until a short time ago, but actual, palpable bad condition, which the owner and his plumber at once acknowledged as of a grave character. Leaks in drains under the cellar floor, or in or near the foundation; lead waste-pipes eaten through by rats, and spilling their flow under the house; lead pipes perforated by corro-

Plate XI.



Putty Joints.


STATE BOARD OF HEALTH
MASSACHUSETTS

sion; imperfect joints, leaking drain air within the partitions; the accumulation of dirty sloppings under the bench of the water-closets, and even untrapped connection between some room and the soil-pipe, or the direct pollution of the air over the tank through its overflow pipe — these are most common faults, and some one of them I have found to exist wherever I have looked for them in a first-class house, where it was naturally supposed that the most perfect conditions prevailed."

There is nothing unusual in this; the same thing may be said of any city in which there are public sewers. The condition of house drainage as it is may be appreciated by studying Plate I, which represents no defects that the author of this book has not seen in houses of Chicago. Many of them have been referred to separately, in previous chapters, but it is well to take a comprehensive look at them again. It matters not that a man may have secured the best material and the most skillful workmanship, and given the construction of the drainage in his house his personal supervision; he may have selected the best-known appliances for shutting out sewer-gas, and yet, if he has used tile drains, cement, lead-calked, or putty-jointed, iron soil-pipes, or lead soil-pipes, the best-known traps, pan, or hopper, water-closets,

and unventilated catch-basins, he is as certain to have a house contaminated by sewer-gas as that he has a house. Drains and house walls will not settle equally, and there may be breaks or disconnections in the former in consequence. Clay tile drains are more or less porous, and will certainly leak in time. It makes no difference if they are laid in cement; cement itself will yield to the corrosion of the sewage, or be cracked by the action of the atmosphere if above ground, and by the ground-air if below it. Cemented joints, then, can not be made permanently secure. The unequal settling of house walls and drains will affect the connections of soil-pipes and drains, however well these connections may have been made. Traps are only a pretense of protection, and often there are no traps at all. It matters not that the street sewer may be ventilated; sewer-gas will be generated from the deposits in the drains themselves. The catch-basin, as heretofore constructed, will leak, become foul and over-run, and generate a gas a thousand times more dangerous than that from the sewer, because more concentrated. There are other serious faults, but certainly these are enough to startle the most conservative. The arrows in the illustration indicate the presence and course of sewer-gas. A soil under the house, soaked with sewage leaking from broken or disconnected

drains, or from a poorly constructed catch-basin, is also shown. The "save-all" tray is frequently placed under bath-tubs, wash-basins, and water-closets to catch all water which may overflow. Too often the plumber conducts the outlet of this tray to a soil-pipe, and thus establishes an open communication with the interior of the drains, or the sewer itself.

The following note, received by the writer, led to some interesting revelations: "I can refer you to a job at the corner of Thirty-first street and Cottage Grove avenue where there are ten stores with tenements above, where you will find the worst job of sewer-work that was ever done in this town. I have a brother living in the house, and he tells me the sewer men are there now overhauling the whole job."

The place was immediately visited. The block referred to presented a very attractive exterior. It was of brick, three stories high, and had been built four years. The locality was a good one, both for business purposes and for homes, so that during most of the time the owner had not lacked tenants; yet their stay with him was not of a permanent nature by any means, as the stench which was always in the house had kept them continually coming and going. When the building was constructed, the drain-layer completed his work under

one house, by "turning up" the last section of the main drain at a point where he believed a soil-pipe would connect with it. Then came the plumber. He thrust the soil-pipe through the floor about two inches, and departed. Later, some one seemed to have thought it desirable that the drain and soil-pipe, which were at least two feet apart, should be connected. But the two were not so situated with reference to one another that a single section of drain tile could be used to join them. What did the workman of an inventive turn of mind do? He pecked an irregular hole in the drain (see Plate XII), thrust into it his connecting pipe, spread a little plaster — not cement — over the hole, braced his pipe up with a stick, covered the top of the unused, upturned drain with an oyster can, and walked off. For four succeeding years sewer-gas was drawn out of these openings by the heat of the house.

The houses in the block extended from Nos. 387 to 405, inclusive, on Cottage Grove avenue. Each one was examined, and the defects in the work noted. None of the so-called joints between soil-pipes and drains seemed to have been properly made. At one number the soil and waste from some upper closet was dripping from a broken soil-pipe; a portion went the proper way into the drain, while the rest dropped outside and ran off on the ground.

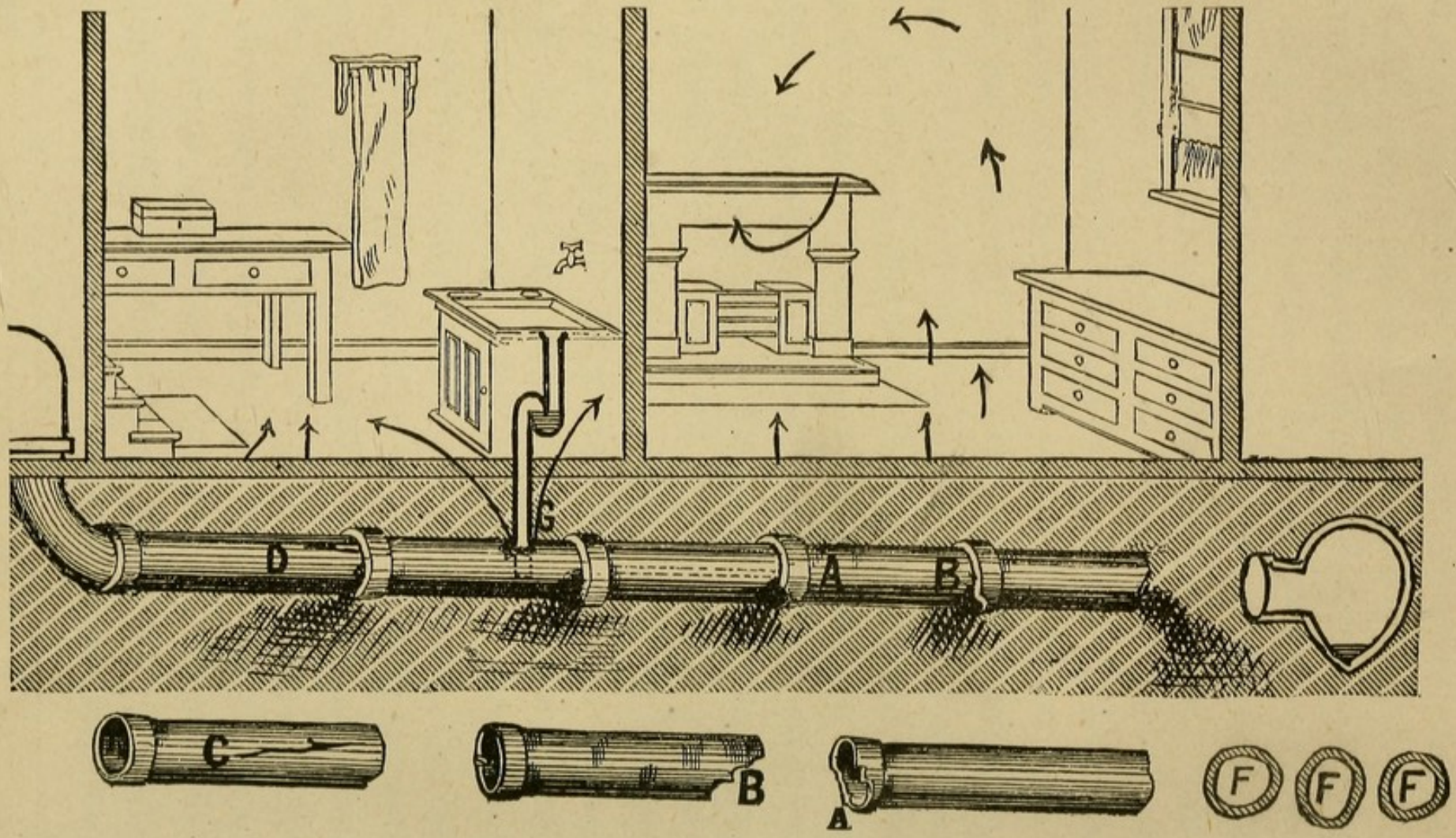
(See Plates I and X.) The last section of the drain tile had been leaned against the wall of the cellar at an angle of about forty-five degrees, and projected a few inches above the ground. In this position the plumber found it. His own pipe was not long enough to reach into the drain. He used a little plaster in attempting to make a connection, and that was all. There was no trap between any house and the street sewer, and none of the defective joints had been repaired during the four years that the block had been occupied. The first floor at No. 387 was used as a furniture store. When there was a high wind from the lake, and the pressure in the sewer became great, the proprietor said that he was unable to endure the smells. His customers had been driven away, one by one, until he was afraid he would lose them all. At one number, a druggist said that he had tried to "get ahead" of the obnoxious odors, by the use of chemicals, but all the compounds that he could set to vaporizing were of no avail. Plaster had been used to connect soil-pipe and drain there, but it had cracked and fallen away.

Plate XII illustrates the practice of breaking a hole into a drain to insert a soil-pipe or waste-pipe; it also shows how drains are made of defective tile—"seconds," as they are called in England. The sections A, A, are broken at the flange, and B, B, at the

smaller end. F, F, F, show how pipes, which are misshapen, spoiled in the baking, look. They are irregularly oval instead of round. The difficulty of making good connections between the ends of such pipes is apparent. C has a fissured surface, and D has been broken and pieced together. "Seconds" are used when a drain-layer has taken a job at such low figures that he can not afford to put in new tile. The illustration also shows that the drain does not connect with the sewer, a section of pipe having been left entirely out, either to save expense, or because the work of laying it was inconvenient.

In nearly every modern-improved residence may be found a bath-room located on the second floor, directly over the parlor. In this there are a pan water-closet, a bath-tub, and usually a wash-bowl. Adjoining this room are the front and rear chambers and in them are located wash-bowls placed in niches. The waste-pipe from this system of plumbing work is branched into the water-closet trap, and in hundreds of cases these branches are run into traps above the water line. (See Plate I.) When the water-closet is being used, the odor from the soil passes up into the bath-room and adjoining chambers. In many instances the soil is allowed to remain in the trap for hours, giving forth the most unwholesome gases. The soil-pipe

PLATE XII.



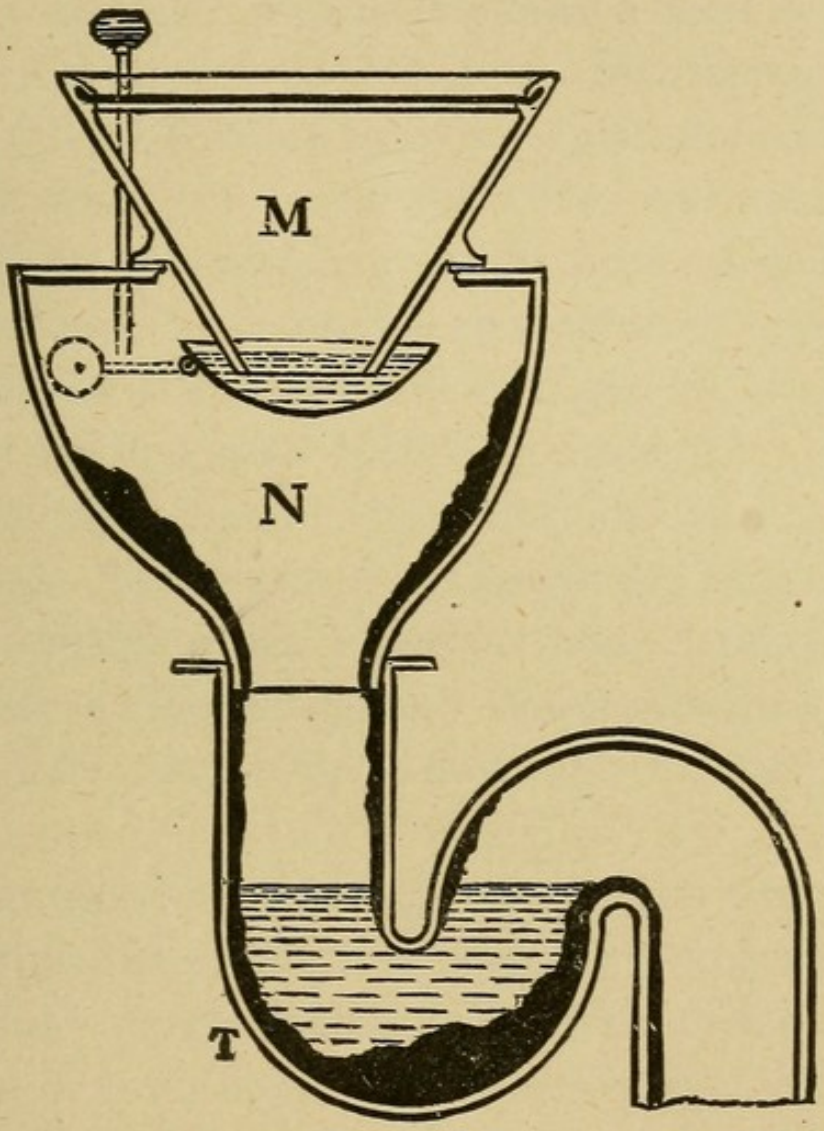
BROKEN DRAINS.

from the water-closet trap runs down to the sewer either in the hall or folding-door partition, and is supposed to be properly fastened to studding. "Often I have found soil-pipes not secured at all," said a plumber; "and, as a result, the pipe sags down from its own weight, loosening the joints and breaking the sewer elbow at the bottom, thus leaving openings in the soil-pipe large enough to allow a current of sewer-gas to escape sufficiently strong to extinguish a lighted candle. These are instances where buildings settle to such an extent that soil-pipes get loosened where they enter the sewer, leaving an air opening. I often notice in bath-rooms that no lining of lead (Save-all tray — see Plates I and II) is placed beneath the water-closet, so when a leak or an overflow takes place the parlor ceiling and surrounding woodwork get saturated with soil and urinal matter. I frequently find what might be called, at a glance, a good job of plumbing: the closets are lined underneath, and from this lead lining there is supposed to be a waste-pipe running down beneath the basement floor; but, upon examination, these waste-pipes abruptly end about four inches below the lining, and there are stopped up. After a little time a leak may take place, but not enough to fill the lead lining which is turned up sink-like. This matter remains stagnant for weeks, and finally it over-

flows. The bath-tubs and water-closets are ceiled around with matched boards, and are nailed and screwed together so firmly that the occupant, or owner, rarely sees the inside of these death-breeding apartments."

The water-closet in common use is the crowning nuisance. Looked at from the outside it seems harmless enough, and, when used by people who have some respect for cleanliness, it need show no signs of filth. But, like the soil-pipe and the waste-pipes, it is the source of hidden dangers, of which there is universal ignorance. A sectional view of the pan-closet — more used than any other — given in Plate XIII, will assist in understanding its construction. All that can be seen from above is the pan, which holds a cup of water, supposed to form a seal at the bottom of the earthen bowl, thus preventing the return of any offensive gas. When the closet is used, and the pan is tipped one side by the handle which extends up above the seat, its contents are dropped — where? Not into the sewer, as many undoubtedly fondly imagine, but into a cesspool just under the closet and out of sight — the trap. The pan flies back to its original position, and fills with water. What follows? The excrementitious matter in the trap cesspool evolves an offensive and dangerous gas, which is held in the container until some one pro-

PLATE XIII.



THE PAN CLOSET.

vides it with a means of escape when the closet is next used and the pan lowered. The puff of foul gas which offends all who use water-closets is familiar enough. In the illustration there is an attempt, also, to show how the filth which is suddenly dropped from the pan splashes against and clings to the sides of the container. This will remain to give off its exhalations long after the cesspool has become clear. The container is made of cast-iron, and with its rough sides is well adapted to catching and holding what is thrown against it. Its interior is beyond reach, thus defying all attempts to clean it. It is joined to the earthen bowl above it with putty, which often becomes cracked, and the joint is then defective. A hopper-closet is no better than this, even if it is not a greater nuisance.

Existing house drainage consists of two parts, waste-pipes and soil-pipes above ground, and tile drains laid under ground. The former are made of iron, or lead, and the latter of clay. For the construction of each part, there is a separate profession — that of the plumber, and that of the drain-layer. The two halves of the system are united, at one time by the former, and at another by the latter. The attempt to connect clay tile and iron pipe, incongruous as they are, would seem to justify a third profession. As it is, the

last man on the job is supposed to make the connection. Sometimes he does, and sometimes not; but rarely satisfactorily. There are two reasons for this: it is a difficult thing to do, and it can be left undone with but little risk of exposure. With this imperfect work, sewer-gas has ready means of escape from the drains, notwithstanding each "specialist" may have executed his own work well enough. In many instances, it was found that no cement — nor plaster, even — had ever been used in making this connection. The vertical pipes range in size from one to three inches in diameter, while the horizontal drain is not less than four, and often six, inches. Nothing but the very best cement will make a joint approaching perfection, and such a joint will not long remain absolutely tight, by reason of the cracking of the cement when exposed to the air; or, because there will be unequal settling of the drains, which rest on or in the ground, and the vertical pipes, which are attached to the walls of the house; or, again, by reason of the unequal expansion of the two materials — iron, or lead, and clay. The horizontal drain is in sections, about two feet in length, which are themselves united with a so-called cement. If the drain happens to be exposed to the air, the cement cracks and drops off; if laid under ground, inconvenience almost invariably induces the work-

man to slight his work, and the bottom parts of the joints get no cement. The result is, that sewage constantly oozes out and soaks into the ground under the house. (See Plate I).

In a residence on South Wood street, the soil-pipe, which a plumber desired to use, was found to be too short; he simply wrapped a piece of tin about the lower end of it to extend it to the drain. In a house on Twentieth street, the waste-pipe was conducted into the end of the drain without any surrounding cement; and in a house on West Washington street, the waste-pipes emptied into a wooden trough, which conducted the contents directly into an upright wooden spout, which, itself, led to the catch-basin. As a plumber often pecks a hole into a drain for the insertion of a pipe, when he finds that the drain-layer has left no opening, as the latter is supposed, but not required, to do, the result is that the drain-tile is very frequently cracked throughout its entire length, or broken into pieces. The plumber doesn't stop to insert a new section, because he is not "allowed to lay drains," and he doesn't care to inform the drain-layer of what has occurred, and get a cursing. He covers the whole with earth, and nobody ever knows what caused a six-months' sickness in the house, till the drain is uncovered and sewer-gas found to be escaping.

The very insecure method of laying drains on an uneven bed results in their being easily misplaced. They were found to have settled in places so that the joints were broken (see Plate X), or they were thrown out of grade and the waste would not run into the sewer, but, instead, percolated slowly through the porous tile and imperfect joints.

Drains are usually laid while building is in progress, and very often the heavy stones which are at that time rolled about fall upon and break or displace them. The drain-layer can not afford to remove a broken tile and insert a new one, for he has taken the job at starvation prices. He sticks the pieces together as well as he can, with or without cement.

The drain-layer has also been found guilty of putting in less pipe than his plans called for, and charging the owner for all that the contract specified. The drain-layer himself stamps upon the sections of the tile while engaged in laying them, or crowds them from side to side of the narrow trench in which they are placed, thus breaking joints which may have been well made at first.

When the soil- and waste-pipes are of lead, the lead is very easily penetrated, and a hole thus made for the escape of sewer-gas. In one case, it was found that a nail had been driven into the soil-

pipe, either by accident or design, while the house was in process of construction. The lead had gradually corroded, and the hole became so large that the nail dropped out. In the course of a year or two, sewer-gas was noticed. A thorough examination of all the joints revealed no fault, and it was not until the partitions of the house were torn away that the discovery of the nail-hole was made.

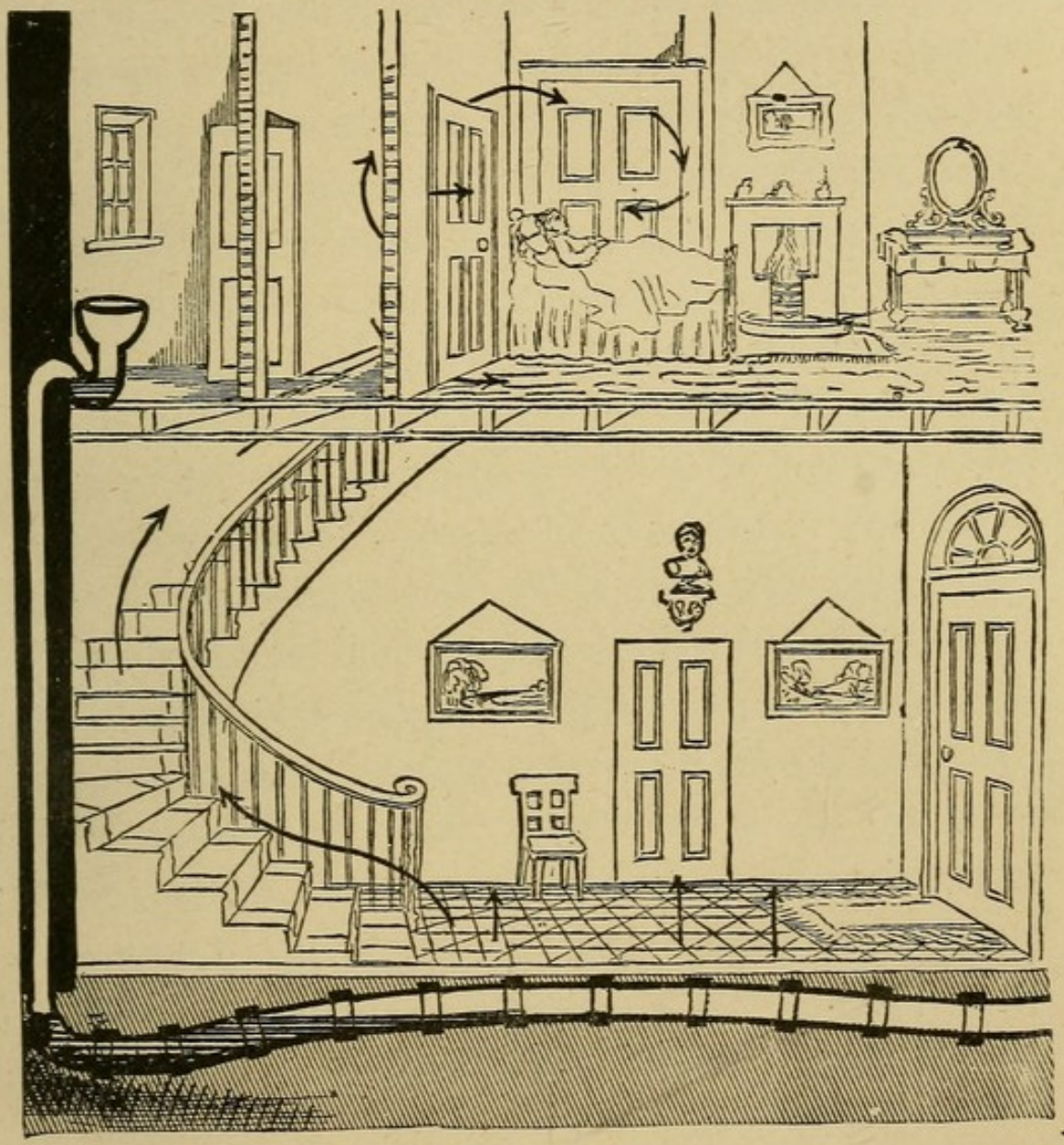
The joints between sections of iron-pipe, when iron is used, are calked with lead, unless the plumber sees fit to use putty instead, as he often does. The result in the latter case is illustrated in Plate XI, at the head of this chapter.

A gentleman, living in a marble-front house on the North Side, became convinced that sickness in his family was due to sewer-gas. He had the entire drainage torn out, and a new and safe system put in its place. The main drain was found to be lower at the foot of the soil-pipe, than it was thirty feet away in the direction of the sewer. This is illustrated in Plate XIV. The result is apparent.

The catch-basin (see Plate IV) plays a very important part in the drainage of a house. If it is neglected, it becomes a source of great danger. If every man was the owner of the house in which he lived, there would be more likelihood of its being kept clean ; but in a community where a majority of the people change residences every year,

this is not the case. This attachment to the drainage of a house is nothing more nor less than an underground cesspool into which the liquid waste of a kitchen or laundry empties, on its way to the sewer. The object is to prevent certain substances which find their way into waste-pipes from going into sewers. Principal among these is the grease which becomes unavoidably mingled with dish-water in the kitchen. This will separate from the water while cooling, and cling with such tenacity to the sides of pipes and sewers that it would ultimately clog them. It will unite so firmly with the sides of drains, if it comes in contact with them in a slow current, that it will defy all attempts at removal. It will become harder than a drain tile itself. Of course, anything which will check grease will also keep back all the sediment which finds its way through a kitchen sink. In the catch-basin, the grease will float on the top of the water, and retain with it coffee-grounds, soap, bits of meat, pieces of potato, bread, etc. Every time there is a discharge from the kitchen sink, the mass is increased in quantity and thrown into commotion. It needs not the oft-repeated statement that this filthy and most abominably obnoxious and poisonous mess is continually manufacturing a deadly gas. This gas can not reach the sewer because of the heavy trap in the basin; but it is induced to

Plate XIV.



Drain Sloping the Wrong Way.

come back into the house by the heat of a kitchen, and there is usually nothing in the waste-pipe to prevent its return. Often the solid matter becomes so abundant that it suddenly drops in a mass to the bottom of the basin. Immediately the outlet is clogged, and not even the water will any longer escape. The basin fills to the brim and then overflows. The filth, now in a semi-liquid form, spreads out over the ground, and, when the basin is under the house, the whole of the basement or sub-cellar is converted into a cesspool. Most of the water soaks into the earth, but the solid matter stays heaped up to rot and exhale its stench. The lower part of the house will not contain the gases, and they are forced upward through the whole building.

Catch-basins should be cleaned twice every year —once in early Spring, and again late in the Fall. This should be done oftener when the basin is receiving an unusual amount of waste, or when it is doing work for two houses, or for a single large house. It is almost invariably the case that the catch-basin is hidden away under the house or buried two or three feet below the surface of the ground when placed outside. This renders it next to impossible to find out the condition of the thing until it has become so obnoxious that health and life have long been endangered by it.

When it was discovered that sewer-gas was

working back from the sewer into houses, devices were resorted to for shutting it out, and traps were invented. Although they are of many kinds, and have come to be most complicated, and often quite useless, contrivances, the principle on which they work is well enough illustrated in the S trap, most commonly in use in kitchen-sink waste-pipes, and in soil-pipes. It will be readily understood that all gases back of and below the trap can not escape unless the pressure becomes so great that the water is forced aside, or, as may be the case, gas is absorbed by the water on one side and given off on the other. Dr. Fergus, of Glasgow, found, by experiment, that ammonia would pass through a quantity of water in fifteen minutes; sulphurous acid in one hour, and sulphureted hydrogen in three to four hours. A learned German, Dr. F. Erismann, has computed that cesspool, or sewer, matter gives off in every twenty-four hours its own volume of sewer-gas, which enables one to form some notion of the volume of gas sent out daily from sewers and forcing its way up into the closets and basins of houses, unless some other egress is provided. According to Dr. Erismann, eighteen cubic metres of cesspool matter give out daily 11.144 kilograms of carbonic acid, 2.040 of ammonia, 0.033 of sulphureted hydrogen, and 7.464 of carbureted hydrogen, or marsh-gas.

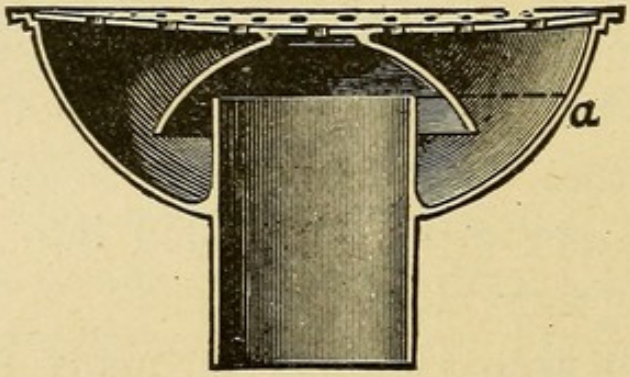
A series of scientific experiments has just been completed by Prof. Paton, Chemist of the Chicago Health department. In his elaborate report, he says: "The gases are absorbed, or dissolved, as the case may be, at the lower end of the trap, and pass, by absorption or diffusion, to the inner end, where they may break away in the same manner as they first started from the sewage below, and pass into the air of the room. Their motion may also be expedited by evaporation from the surface of the water in the trap, or by the splashing of the water in opening the valve, as particles of salt are thrown into the air by the action of sea spray. If these gases are carrying germs of any kind with them, they will be liberated into the atmosphere at the same time."

The bell trap is found in many waste-pipes which are emitting sewer-gas. It is so useless that in no instance is it likely to be of any use at all. It occupies a place, most frequently, under kitchen sinks, and since people who are ignorant of drainage are never more easily made to believe a lie by landlords who want their tenants to have all the improvements than in the case of this particular trap, its shortcomings are herewith presented. In every instance where found, the trap was broken, and absolutely of no use. A cross section of this trap is shown in Plate XV. The height at which

water stands in it is indicated by the dotted line "a."

Even when unbroken, this trap is deficient, since it holds but a very small amount of water, and is, consequently, but an insecure protection against the escape of gas. It is attached to the bottom of the sink, and its presence can readily be determined by any one. It suffers the calamity,

PLATE XV.



THE BELL TRAP.

ninety-nine times out of a hundred, of having the "bell," which is seen to overhang the end of the waste-pipe, and which is dependent from the perforated covering above it, broken off. It is so insecurely joined at this point that the separation frequently occurs before the trap is put in place. It is also the case that servants and housewives become wroth at the slow escape of water from the sink, and, imagining that the "bell," which they

can see, is an obstruction, they peck away at it till it is broken into fragments.

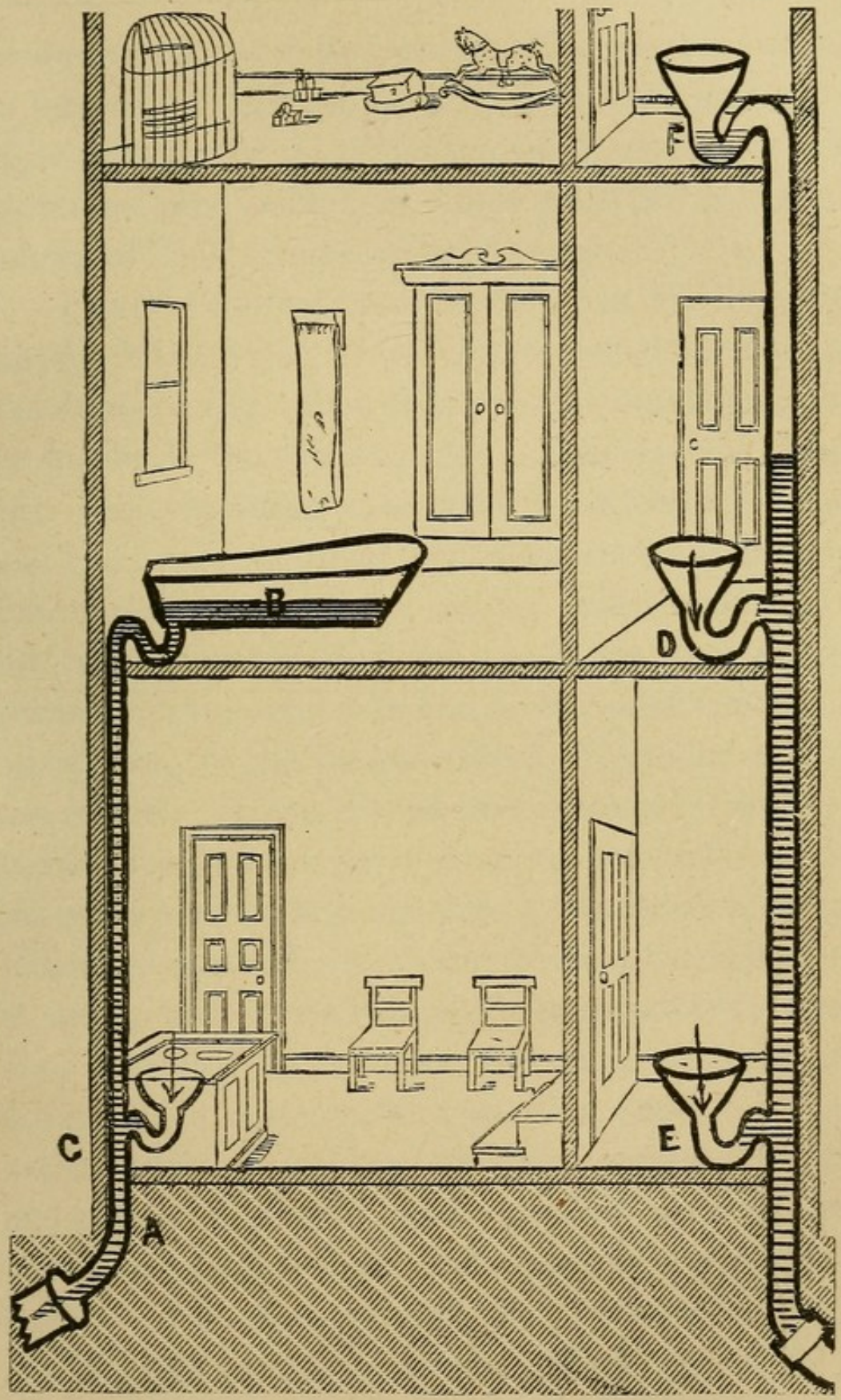
Dr. T. Pridgin Teale tells of a case of typhoid fever, at Keighley, England, "due to the magnificent completeness of the whole drainage, done at great cost, including an equally magnificent cesspool, three hundred yards away, and all absolutely tight, and so unventilated anywhere, except into the house through the water traps."

The greatest danger attending the use of the "S" trap is in the complete removal of the water by syphoning. If two or more water-closets, wash-basins, or kitchen-sinks, are connected with the same perpendicular pipe, water discharged from any one of them tends to produce a vacuum in the pipe, and the water is drawn out of the traps. This is illustrated in Plate XVI. As the water descends from the closet F, the traps at D and E will be syphoned. The same is true of the trap under the lavatory at A. If the waste-pipe, C, has about the same size as the outlet of the bath-tub, the trap under the bath-tub is certain to be syphoned every time water is discharged through it. The result is, that sewer-gas then has free access to the rooms. The alternate filling and syphoning of traps is very neatly exhibited in glass traps, which are found in some plumbers' offices. There is the additional danger of evap-

oration of the water if the pipes are not in constant use. Syphoning is prevented by extending the pipe from the crown of the trap up through the roof of the building, or by connecting it, above all water-closets, with some other pipe which extends to the roof.

The glazed drain-pipe so largely used is often a fraud; while it is covered, originally, with a coating which is intended to make it impervious to gases and liquids, the drain very soon loses this glazing, and becomes as porous as a brick. The following is from Eliot C. Clarke, a civil engineer of Boston, who made investigations in that city: "What has been said about bricks applies to the clay drain-pipe (now so commonly used) to a degree not usually recognized. Too frequently one hears Akron pipe spoken of as though it possessed unvarying qualities. It should be remembered that such pipes are burnt in a kiln very much as bricks. Before burning, they may be air-checked; like bricks, the pipes nearest the fire may be warped, or fire-cracked; those higher up may be less thoroughly burnt, corresponding to 'light-colored bricks.' Others may be quite soft and imperfectly glazed, or the glazing may scale off by 'popping.' Slip-glazed pottery pipes are still more liable to defects. They are made of a different kind of clay, and, being burnt at a lower temperature, are usually

Plate XVI.



Syphoned Traps.

more porous and less hard. The glazing, which is formed by dipping them, before burning, into a thin mixture of argillaceous earth, forms a skin over the pipe, which at times peels off under the action of frost, acids, or hard usage."

A gentleman was about to build an $8,000 house on the West Side. The architect asked for bids on the drain-laying. One of the professionals said that he would do the work for $46. This was the lowest bid. The building was to be 25x61 feet in size, and required 139 lineal feet of six-inch tile-drains; twelve feet of four-inch drains, and eight feet of fifteen-inch sewer-pipe, for a cold air duct to the furnace. A catch-basin had to be constructed, and an opening to the street made for connection with the sewer. It would cost the drain-layer $5 for a permit to open the street, leaving him just $41 for his work and the material used. The kind of a job which he would do is apparent when the following is taken into consideration: A responsible man, who is known to do none but good work, would not take the contract for less than $460. A good catch-basin, extending to the surface of the ground, as it should, and supplied with an iron cover, alone costs $15. The condition of existing drains shows conclusively that drain-layer No. 1 might keep within the price. With such facts as these at hand, it is easy to account for disjointed

tiles, plaster "cement," broken drains, improper connections, and escaping sewer-gas.

It has been found to be a matter of serious objection that the waste-pipes and drains are so inaccessible. It is frequently impossible, and always difficult, to locate defects, and, hence, to secure any repairs. The drains are hidden away under the cemented floor of a basement, or in a low and inaccessible cellar, and the pipes are shut up in the walls. If they were absolutely perfect in construction, this would be no objection; but a system of tile drains and putty-jointed, iron soil-pipes can hardly exist for three months without becoming defective.

Ordinarily, drains and pipes have no means of ventilation, except through water-closets and sinks, directly into the apartments of a house, or through defective joints. Sewer-gas is generated in drains themselves, and is prevented by traps from passing into the sewer. It is compelled, then, to escape in the opposite direction.

The defects found in house drains, as they have been heretofore constructed, may be enumerated as follows (see Plate I):

1. Much of the drain-tile in use soon loses its glazed coating, and admits of the passage of water and gas through its substance.

2. The joints in drains and waste-pipes, and the

connections between these, which are made with cement and plaster, are defective, both because of the nature of the material used and of the workmanship.

3. Drains are often broken, or joints disconnected, by the unequal settling of the drains and the building.

4. Traps are either inefficient, or a nuisance in themselves.

5. The catch-basin is either wrongly put under a house, or not located where it can be readily examined and cleaned.

6. No adequate ventilation is provided, by means of which the excess of poisonous gases in the drains may pass into the outside air.

7. Pipes are thrust loosely into drains, and no attempt made to close the space between a small pipe and a large drain.

8. Holes are pecked into the side or top of drains to admit a soil-pipe, and whole sections are so cracked, or broken, that they are no longer air-tight, or gas-tight, drains.

9. The soil-pipe is not long enough to reach the drain, and a piece of tin, or something similar, is wrapped about the lower end and extended into the drain; the cement, if used, soon cracks, and the damp atmosphere causes a corrosion of the tin until there is an opening through it.

10. Holes and cracks are found in lead waste-pipes, and iron soil-pipes, which have been hidden away in partitions.

11. Inferior drains, those spoiled in the baking, or "seconds," discarded drains, are used.

12. Drains are laid without reference to grade, and their contents thus turned back under the house.

13. The waste-pipe of a kitchen-sink is carried into a soil-pipe conveniently near, and connected with it below the trap.

14. The overflow, or the save-all tray, of wash-basins and bath-tubs, connects with the waste-pipe below the trap.

15. The pan closet, commonly in use, is objectionable, because of the unventilated chamber between the pan and the trap. This fills with gases which pass through the water-seal by absorption, or are set free when the closet is used.

CHAPTER X.

WHERE THE BLAME BELONGS.

"It is not just," said a drain-layer, "to charge up all the evil results of bad drain-laying to those who do the work. I will admit that there are very many dishonest and incapable men in the profession, but there is very often somebody back of them who is primarily responsible for defective work. I might point out block after block of houses that, I 'll warrant you, are unsafe to live in. I have never entered them. I simply know what the system is under which they were put together, and consequently that good work could not have been done without a loss. You know that no workman is going to lose any thing on a job if he can help it, and there is abundant opportunity to keep inside the figures in drain-laying and plumbing. This is the system to which I refer: A man with money proposes to speculate. He purchases a number of lots in a favorable residence locality, and undertakes to erect thereon a row of houses which shall present an attractive exterior, and so find ready sale, or be easily rented.

He gets an architect to draw plans, and, when they are satisfactory, buys them. He goes next to a builder, lays the plans before him, and opens negotiations for letting the job in a lump. The builder, who has on hand estimates for similar work from plumbers, drain-layers, painters, etc., selects the lowest and commences to figure on them as a basis. The bargain is struck after the builder has gone down to the very lowest figures, and after he has spent a week or more listening to what Mr. So-and-so will do the work for. To get the contract, he is obliged to omit any rated profit, trusting to his success in squeezing contractors under him down to lower estimates.

"With the contract on his hands, the builder proceeds to let out the work in sub-contracts. Carpenters, plumbers, drain-layers, glaziers and others are summoned to his office to bid. He has at hand the estimates on which he has based his own contract, and as it makes but little difference to him whether the building is well-constructed or not, if it only looks well on the outside, he lets the jobs, particularly of plumbing and drain-laying, to irresponsible men, simply because their bids are low. The result is inferior work. When the owner of the property steps into the houses after they are completed, he can not discover any faults, since he rarely knows what faults are even in ordi-

nary carpentry. The houses are rented low, because built cheap, and families come into them, who, when once domiciled, can not afford to move, or, perhaps, something in their leases works a forfeiture of all their goods, if they leave before the year is up. Sewer-gas inevitably finds its way out of the poor joints and broken drains, and sickness and death are constant guests at the homes of these unfortunate people. It is not only in the ordinary brick houses that this is an actual experience, but in houses with stone and marble fronts.

"I do not believe that our best drain-layers will stoop to such dishonesty; but you must know—and yet, perhaps, you do not know—that there are men in this city, pretending to lay drains, who never served an apprenticeship in their lives. It is nothing but the truth that men have obtained licenses from the city government to lay drains, who never did anything more in the business than to drive a team in hauling drains for some other man, or dig trenches in which drains were to be laid! After such an apprenticeship of a few weeks many an ordinary day laborer has concluded that he can lay drains as well as his employer. He suddenly quits work and turns up at the Department of Public Works, with a friend or two to sign a bond, and gets a license for the new business. It is by such men, who are not capable of

doing a good job, and consequently can work cheaply, that poor and faulty drains are laid You must understand that such as these are an injury to our business, since it has been, and even is now, so hard to make people believe that drain-laying is a profession; that it requires skill and education to follow it — a technical education, I mean. A drain-layer is required to give a bond in the sum of $5,000 that his work will be well performed. It is a pity that it can not be a protection to us who know how to lay drains properly. A competition with irresponsible and ignorant men is inducing reliable drain-layers to slight their work. It becomes a necessity with them, since the only alternative is to quit the business."

"What can be done to secure the proper construction of drains?" was asked.

"In the first place, educate the people until they shall see the necessity of hiring none but good and reliable drain-layers. So long as the people themselves will accept defective drains, so long will they be laid. I understand that the mass of the people are in the predicament of being compelled to live in the houses that have already been built by speculators, but a system of house inspection by the Department of Public Works, or by the Health department, could readily bring these defects to light, and lead to their being remedied. It

certainly could prevent their recurrence. There are now inspectors whose duty it is to look after the drain-laying and plumbing while houses are being constructed, but they are simply present when the drain-layer locates his drains, catch-basin, etc., and that is the last seen of them. The inspector actually never knows whether a job is well done or not. These inspectors again misdo their duty in recommending that licenses be given to the upstarts of whom I spoke a little while ago."

"What are the qualifications of a good drain-layer?"

"He should be a mason, or bricklayer, in the first place, so that he may know how to construct a catch-basin properly. Here let me point out another fault that must be charged up to the city. Formerly, it was required that the bricks used in building the catch-basin should be placed on end, with the edge forming the inner surface. The bricks were set in the best cement, and pointed. Then the basins were solid and tight. Now, the custom is to break the bricks in two and lay them on their side. The work is much easier and less expensive, and the basin is only half as good as one of the former kind. So far as the Department of Public Works is concerned, it doesn't make much difference how a catch-basin is made, and we may soon expect to see one simply boarded up."

The gentleman's attention was called to the job referred to in a previous chapter, which a drain-layer offered to perform for $46, and he was asked to make an estimate. He figured for a moment, and exhibited the following table, which he said indicated the exact first cost of everything:

Drains, 139 feet, at 15 cents a foot	$20 85
Top and bottom for catch-basin	80
Cement	1 25
Knuckles for branches	3 00
Brick	2 40
Cold-air ducts for furnace	7 50
Permit for opening sewer	5 00
Hauling drains	1 00
Work	10 00
Total	$51 80

In this there was no allowance for profit, which every man must have, or discontinue business. If the "professional" drain-layer, who offered to build the basin for $5.80 less than first cost, got the contract, he must of necessity have slighted the work. The result in such case would be a catch-basin like that shown in Plate I.

A diabolical plan for introducing sewer-gas into houses was discovered on the North Side. It is enough to startle the most indifferent to know that their lives may be so imperiled by the rascality or thoughtlessness of architects and drain-layers. Six brown-stone-front houses were in process of erec-

tion on Erie and Ontario streets, between State and Cass streets. They stood on a double lot extending from one street to the other, three foundations on Ontario and three on Erie. They were three stories high besides the basement, and appeared to be well constructed. They were among the most attractive houses on those streets. The work had proceeded so far that the walls were up, a portion of the plastering done, the plumbing partially completed, and the inside carpentry begun. A gentleman examined the houses, with a view to leasing one of them. That gentleman was a sanitary engineer, and had given the subject of drainage and ventilation considerable study for his own personal satisfaction. It thus happened that he made a careful examination of the drainage, means of heating, etc. To his surprise and horror, he found a drain-pipe immediately connecting the air-chamber under the furnace with the sewer in the public street! He saw at a glance that the result would be to warm every room in the house with heated sewer-gas, drawn directly from the sewer, and that the occupants would breathe it instead of even a diluted atmosphere! It took him but a moment to reach the street, and offer up a silent prayer that the discovery had been made before it was too late, and he had taken his family into the house only to see them perish. He informed the

writer of his discovery, and the latter made a personal investigation, together with Inspector Genung, of the Health department, who was asked to lend his official confirmation to whatever facts might be disclosed.

The air-chamber under the furnace in each of the houses was found to be about three feet deep and four feet in diameter. Connected with this was an eighteen-inch duct, leading to the rear of the house, through which fresh air could be drawn. This would ordinarily pass upward through the furnace, become heated, and be conducted through flues to the various rooms. By the light of a lamp, a small grate was discovered in the bottom of this chamber, and a workman explained that it covered the entrance to the drain which led to the sewer. The drain was four inches in diameter, and as it ran along under the ground, it was to receive the contents of the water-closets of the house. A running trap had been placed in this drain, which, it was expected, would shut off the gases in the sewer from the house. No one needs to be informed that the water in the trap would very soon evaporate, when there would be an uninterrupted communication between the furnace and the street sewer. The foul and poisonous gases from the sewer would feed the air-flues of the furnace, and be distributed over the entire house. The pressure

in the sewer would drive these gases back into the furnace to the exclusion of fresh air through the legitimate flue, and the suction of the furnace would even draw the gases through the trap by displacing the water; but, worst of all, the gases generated in the soil- and waste-pipes would be drawn directly into the furnace.

The man primarily guilty of such construction was the architect. The architect drew the plans of the houses, and made the specifications in detail. Under his direction the work was performed. He ordered the drain from the air-chamber under the furnace to the sewer to be put in To be sure that there was no mistake about the matter, he was seen at his office. He was a leading architect of the city. He acknowledged his responsibility, and said that the drain had been laid to draw off the water which might accumulate under the furnace. It had been an afterthought, but, when he found that water collected there, some way had to be provided for its escape.

"But," said the Inspector, "don't you consider that a violation of the sanitary principles which should govern in the construction of a house?"

"Well, what of it?" was the short and sweet reply.

"Simply this, that the Health department will not allow——"

"The Health department be —. I'm building those houses, and I presume that I'll do as I'm a-mind to."

"But you are conducting into the house the most dangerous of all gases, and the result will be that no person can live there."

"What's that to you? What business is it of yours if it does stink? I'll put a —— into each house if I want to."

He afterward apologized, and confessed that he had feared at the beginning that sewer-gas would feed the furnace, but he thought the trap would overcome the danger. He acknowledged, too, that there was a likelihood of the evaporation of the water in the trap, but he had tried to make himself believe, evidently, that enough water would rise up out of the ground mysteriously, and flow into the drain from the air-chamber, to keep the trap filled.

The man who laid the drains was present during the interview. He was asked what he thought of such a diabolical undertaking. He shrugged his shoulders, and said, in a whisper: "You see, I'm not to blame; I was hired to put in the drains, and I did the job without asking any questions. You see, when a fellow has to figure down so close to get a job, we don't make any suggestions, for we can't afford to put in any improvements, or to lose

the work, as we certainly would if we didn't keep our mouths shut. I think it's a pretty bad piece of business, on the sly, you know."

He was finally ordered, by the architect, to go up at once and examine the drain, and, if he thought best, close it up. The very evident reason for the construction of the drain was, that if water should, by any means, get into the air-chamber and have no means of escape, the owner of the building would discover it and complain. The drain would never be revealed until the furnace itself should be torn away. No one knows how many houses are cursed with the same hidden danger, and are saturated with sewer-gas whose escape from the sewer can not be accounted for.

CHAPTER XI.

HOW TO FIND AND REMEDY DEFECTS.

It must be conceded by every intelligent and honest person, who has given the subject attention, that it is dangerous to live in a house which has defective drainage. But a man's opinion should be respected when he affirms a belief in the security of his house against sewer-gas. An expert might detect it by the sense of smell, while another person could not, or be satisfied, from the faulty construction of the drains, that it would enter the house under certain circumstances, a fact which the occupant could not appreciate without proof. It has been stated that nine-tenths of the houses in this city are unfit to live in, by reason of defects in their drainage. This is undoubtedly true of all cities. In Chicago, it would probably be nearer the truth to say that not one house in a thousand has a perfect drainage, and, consequently, is a healthy habitation. If the advice were practical, it might be urged upon nine hundred and ninety-nine families in a thousand to move out of their houses at once; but, unfortunately, they

would have to stay out, as there could not be found other houses better than those abandoned. Dr. Teale says "that having discovered and rectified, one by one, numerous defects of drainage in my own house (in Leeds, England,) and in property under my charge, and having, further, traced illness among my patients to scandalous carelessness and gross dishonesty in drain work, I became indignantly alive to the fact that very few houses are safe to live in. The conviction struck deeply into my mind, that probably one-third, at least, of the incidental illness of the kingdom, including, perhaps, much of child-bed illness, and some of the fatal results in surgical operations in hospitals and private houses ('surgical calamities,' Sir James Paget would call them), are the direct result of drainage defects, and, therefore, can be, and ought to be, prevented. 'Preventive medicine' has long been proclaiming such facts, and long have we turned a deaf ear, and we of the medical profession in general are only just beginning to see the great reality of her teaching. If any one challenges this assertion in reference to my own profession, I will reply by the inquiry: How many medical men can he tell me of who understand the sanitary condition of their own houses, or have adequately ascertained that those conditions are, so far as our knowledge at present

goes, free from dangers to health? If, by any possibility, it could be brought about that every medical man in the kingdom should realize the necessity for looking into the state of his own house, and act upon that conviction, I feel certain that the discovery would be made in so great a proportion of instances that they were living over a pent-up pestilence, that we should at once have an army of sanitarians, earnest and keen to ferret out unsuspected sources of illness."

The doctor says that he has been taught by observation and experience "that if we are ever to have sound sanitary legislation — if we are ever to have our sanitary arrangements carried out in first-rate workmanship—it must be by the education of the public in the details of domestic sanitary matters, so that, realizing their vital importance, knowing what ought to be avoided, and able to judge of the correctness and quality of work done, they may demand and so obtain first-rate workmanship. When disease arises which we call 'preventable,' depend upon it, some one ought to have prevented it."

After declaring that defective work is due both to ignorance and dishonesty on the part of workmen, he presents the matter of responsibility for defective drains as follows: "Probably no work done throughout the kingdom is so badly done as

work in houses, drains and pipes, which is out of sight. Probably no better work is better done in the kingdom than on the locomotives turned out for our railways, or the machinery which we send to all parts of the world. Are the workingmen less honest in the one case than in the other? I trow not. The difference is this: Necessity in the one case compels good work; indifference and ignorance in the other case allow bad work to pass unchallenged. If the plate-layer were so to fix his rails that they would not correspond, and the next engine were thrown off the line, and death were the result, an inquest would be held, and that plate-layer would be held for manslaughter. Is there any great difference in the case where one drain pipe, by missing another, ends in nothing, and in a few weeks is the cause of death from typhoid fever? The excuse at present is that the drain-layer does not know how certainly he is laying the foundation of illness and death. Disperse that ignorance, and the excuse will be gone. If the tire of the locomotive breaks and throws a train off the line, the railway company goes to the maker of the engine, the maker of the engine to the maker of the tire, the maker of the tire to his books, and there learns the name of each foreman and, I believe, of each workman, through whose hand the tire passed. Why can we not achieve

the same connected responsibility about our drains?"

The subject of house-drainage has been given much closer attention in England than in this country. Sanitarians across the sea long ago found out the danger attending the breathing of sewer-gas, and for years they have been studying how it might be shut out of houses. But they have not aimed at the root of the evil by tearing out the old system and substituting one which has no defects, and can have none of those now so common. These men have learned well how to discover breaks and leaks, but they have not met with so good success in their endeavors to apply remedies. No better method of examination, so far as it goes, can be given than that of Mr. Rogers Field, an eminent English sanitary engineer.

"The first point is to ascertain whether the drains pass underneath the house or outside it. [They are invariably under the house, in Chicago.] If they pass underneath the house, I test them carefully for soundness—to ascertain whether they are water-tight—as well as test them for freedom from deposit and velocity of flow. If they pass outside, I merely apply the two latter tests. The test for soundness is managed as follows: The drain is opened down to at its lower end, generally in the area between the house and the street, and

carefully stopped with a plug of clay. Another opening is made in the drain, and the drain is then gradually filled with water. As soon as the drain is full, the water is turned off, and carefully watched at the upper opening. If the water remains in the drain, the drain is sound, but if not, the drain is leaky, and the rapidity with which the water sinks indicates the amount of the leakage of the drain. It is not at all unusual for the water to run away so rapidly that it is impossible even to fill the drain so as to make the water show at the upper opening at all. The test for deposit is by flushing from the closets, sinks, etc., and pouring down a large quantity of water, and watching the drain at the opening at the lower end (of course, without any plug in it). If the water comes down thick, or with a bad smell, it shows that there is a deposit; if it runs clear and sweet, it shows that the drain is clear. The test for velocity of flow is by noticing the time that water takes to run a given distance. Whether there are any old drains or cesspools, etc., can only be ascertained by opening up and searching for them, and this must be done whenever there is any reason to suspect their existence.

"The next point is to ascertain whether there is any trap between the house drains and the sewer. A strong draft up the drain from the sewer is gen-

erally unmistakable evidence of the absence of the trap. Should there be a trap, it must be opened down to, as the chances are that it is so constructed as to be more or less full of deposit. It must, of course, also be ascertained whether the drains are ventilated. It is generally evident they are not.

"The next proceeding is to examine and test all the details of the sanitary arrangements, water-closets, sinks, baths, etc. The soil-pipes must be carefully examined, and if they are inside the house they must be specially tested. If of iron, with putty joints, as is often the case, they may, without much risk of error, be assumed to be unsound; but if it is wished to test them, this could be done by the smoke test. If they are of lead, they should be tested by being plugged and filled with water. A glance at the water-closet apparatus is enough for an experienced man; but it is necessary to take down the seats to see whether the overflow of the 'safes,' or lead trays, underneath, are connected with the soil-pipes, as is often improperly the case. The condition of the traps can be tested by lifting the handle of the closets, and noticing whether any smell comes up. In a good closet no smell is perceptible. If, however, the apparatus is of a faulty description, the closet is sure to smell sooner or later. It must be carefully ascertained what cisterns supply the closets, and,

if there is the least uncertainty, the cisterns must all be tested by drawing off water from them, and in some cases by coloring the water. The waste-pipes of sinks, baths, etc., often give a good deal of trouble. A good way to trace them is by pouring down hot water, and feeling which pipes become heated. If hot water poured down the waste of a bath, for instance, heats a soil-pipe, it shows that the waste of the bath goes into the soil-pipe.

"It is never safe to trust to appearances, as the following curious instance will show: In a house I recently examined, I saw an open end of a pipe projecting through a wall, and was informed that it was the overflow of the cistern. I tested this overflow by pouring water down it, but no water came out of the projecting pipe. I was then told that it was the waste from the 'safe,' or tray, under the water-closet. I tested this in the same way, but no water came out of the projecting pipe. I was then told it was the waste from the safe of a bath, and on closer examination I found that the pipe evidently did come from the bath, when to my surprise no water came out of the pipe. I then had the casing of the bath taken down, when it was found that the pipe had surely been connected with the safe of the bath, but at its highest point, so that no water would run out of it, and that the real outlet from the safe of the bath was into the

soil-pipe. The explanation was, no doubt, as follows: The outlet of the safe had always gone into the soil-pipe, but some former tenant had insisted on its being altered. To do this properly, the fall of the safe must have been altered, which would have involved some expense, and the projecting pipe had therefore been run through the wall as a sham to deceive him. The bath in question was in a dressing-room opening into a bed-room, so that the connection of the outlet with the soil-pipe was a very serious matter.

"In an ordinary London house of moderate size, such an examination would probably take from three to four hours, if the house had been previously prepared by having the concealed parts exposed, and if no great amount of testing is required. In very many cases, after opening drains I consider it unnecessary to test them, as I am certain that they are leaky, from past experience.

"The drains are tested to see that they are water-tight when they are laid, but this test (by blocking and filling them with water) can be applied at any time. The accuracy of the laying of drains, and their self-cleansing capacity, can be immediately tested by trying the velocity of flow, as already explained. The traps on the drains can be tested by examining whether any solid matter rests in them, and also by trying whether paper,

etc., flushed down the drains, passes through them. The sufficiency of the flush of the water-closets can be tested by seeing whether it drives paper through the traps. The test of smell is also valuable, as in well-laid drains any other smell than that of fresh sewage is an indication that something is wrong."

Leaks in drains may be discovered by the use of peppermint. An ounce of the oil of peppermint turned into a water-closet on an upper floor, followed by two or three pailfuls of hot water, will indicate any openings in the pipes below by its odor. It is necessary that great care be exercised in making this test, lest the peppermint get on the clothes or hands and follow the person conducting the examination wherever he goes; it would then be impossible to tell whether the odor escapes from defects in the pipes or not. When drains are laid on the surface of the ground under a house, it is easy to find defects in joints, by observation merely. Commonly, the most glaring defect will be found in the imperfect connection of soil-pipe and drain. The syphoning of traps in waste-pipes, showing imperfect construction, is indicated by a gurgling sound as water is discharged from a sink or wash-basin. The safest way to determine whether a waste-pipe, emptying a bath-tub or wash-basin, connects properly with

the soil-pipe, is to remove a portion of the floor, but if a quantity of water is discharged from a bath-tub or wash-basin after the water has been shut off from the water-closet, and the pan under the closet be lowered so that the water in the trap is visible, a bubbling will indicate that the waste-pipe discharges into the trap — the best thing that can be recommended under the circumstances. It certainly should not discharge above nor below the water in the trap. The location of the catch-basin may be determined by following the course of the kitchen sink waste-pipe. It may be found in the cellar, or in the back yard.

As to remedying defects, the best and safest way is to tear out old drains and put in a system which can have no defects, such as that described in the next chapter. But there are thousands of people who are satisfied with the "next best thing," and other thousands who can not afford to tear down and build anew. It is well, then, to know that there is a partial remedy, and that for a small amount of money much can be done toward shutting out sewer-gas. Partial relief is better than none. A reference to Plate II will assist in understanding what follows.

In the first place, let a running trap be put into the drain leading from the house to the street sewer. A section of the old pipe can be removed

and the trap inserted in its place. Any section may be selected outside the house and within the yard. The diameter of the trap should be the same as that of the drain, and it should be provided with a hand-hole for the convenience of cleaning it out. It frequently occurs that rags, sticks, and similar articles, find their way into the drain, which would very likely clog the trap if left in it. The hand-hole makes it possible to remove such obstructions. Just above the trap, and in the same section — that is, in the end toward the house — an opening should be left on the upper side, to which a pipe could be attached to extend to the surface of the ground. This is to assist in the ventilation of the drains, which will be explained further on. This pipe should be four inches in size, for a six-inch drain ; six, for a nine-inch, and nine, for a twelve-inch drain. At the upper end, it should be covered with an iron grate, to prevent the entrance of any solid substance. The trap should be surrounded by a man-hole, built of brick, and reaching to the top of the ground. It may be covered with an iron plate, and thus not disturb, materially, the appearance of the lawn ; or, it may come near to the surface, and be covered with a sod.

The second important thing is to provide ventilation for the entire system of drains. If the soil-

pipe be extended to and above the roof, there will then be two pipes reaching from the main, underground, drain up to the open air. The one inside the building will always be warmer than the one outside, hence there will be a current upward in the former, and another downward in the latter. Any sewer-gas which is generated in the drains will thus be carried out into the open air by the induced current. Should the pressure in the sewer be so great as to displace the water in the running trap, or gas from the sewer pass the trap in any other way, it will be drawn out of the top of the ventilated soil-pipe, rather than into the house. To insure ventilation, the drains should be connected with a flue adjoining, or within, a chimney, and extend several feet above it. The mistake should not be made of attempting to ventilate the drains by a direct communication with the chimney. This was found to have been done in several instances. The result was that, when fires were not burning, the foul air of the drains was drawn into the rooms of the house.

If the catch-basin is under the house, it should be removed at once to some point in the yard, and kept periodically cleaned. The down-spout from the roof — the pipe which carries off the rain-water — may empty into the catch-basin, to serve as a ventilating pipe. The catch-basin should be placed

as near as possible to the sink and laundry tubs.

Exposed drains should be covered with earth after every joint has been looked to, and re-cemented, if defective. Putty joints in iron soil-pipes should be re-calked with lead, care being exercised in the examination of every joint.

The seats of water-closets should be constructed in such a manner as to allow a current of air to pass under them. The bath-tub should be raised from the floor at least four inches, and a small door-like arrangement run along in front of it and hung on hinges. There should be a proper lead lining — save-all tray — underneath them, with a waste-pipe leading to the basement. Soil-pipes and waste-pipes should not be hidden away in partitions, but put where they are accessible.

Unfortunately, too many are satisfied with the tinkering which the nearest plumber will do, and their house drains and waste-pipes are but little improved. It should be borne in mind that the plumber gets his living by putting lead pipes into houses, some of which bring water in, while others carry waste out. It is a very simple matter to put supply pipes in place, and they can never get out of order without that fact is known at once. The plumber likes a job of mending a supply pipe; it gives him occupation. A child may know what to

do when a supply-pipe needs repairing. It is when a plumber is needed to repair, or alter, a waste-pipe that the best of judgment and experience is required. The agitation of the danger lurking in defective drains will be hailed with joy by plumbers. When they see the people trembling with fear of being poisoned by sewer-gas, they rejoice, for their harvest has come. It is not because the plumber is a worse man at heart than other men that he is willing to earn something at somebody else's expense, but the fact is, that the majority of plumbers are ignorant of their business, or that particular part of it which relates to shutting out of houses the poisonous gases generated by the waste, for whose removal they, in part, provide. If a plumber's patron suggests a trap here, and a new pipe there, he is perfectly willing to put in the "safeguard," but he would be just as willing to take it out on the next day, if paid for the labor. Traps furnish him a good profit, and he would insert them in every five feet of waste-pipe if he had the privilege.

All this is given by way of warning. There are honest and capable plumbers, but when a man becomes satisfied that his house is polluted, and the lives and health of his family endangered, by sewer-gas, he should first seek the advice of a com-

petent sanitary engineer. Plumbers and drain-layers should be directed to follow his instructions. Common sense is a reliable guide; it may serve a man well in case he is compelled to act as his own sanitary engineer.

CHAPTER XII.

A PERFECT SYSTEM OF HOUSE DRAINAGE.

It is plain that a system of house-drainage, which will provide security against sewer-gas, must be perfect, both in construction and adaptation. The best possible material may be used, and the greatest care taken in the work, with the single exception of a defective joint; there is as much danger as though the whole system were deficient. The material may be above criticism, but it may as well have been worthless if the means to an end is lost sight of in the construction. House drains should never become ventilating pipes for the street sewer, nor should they bring cesspools into and under a house in useless traps and catch-basins. House drains should carry waste out of a house — not much, nor little, but all — and do it promptly. When that which is intended for the street sewer is started on its journey from kitchen-sink, wash-basin, or water-closet, it should be afforded a means of reaching its destination at once, and without interruption. Not an atom of filth should be allowed to cling to the sides of

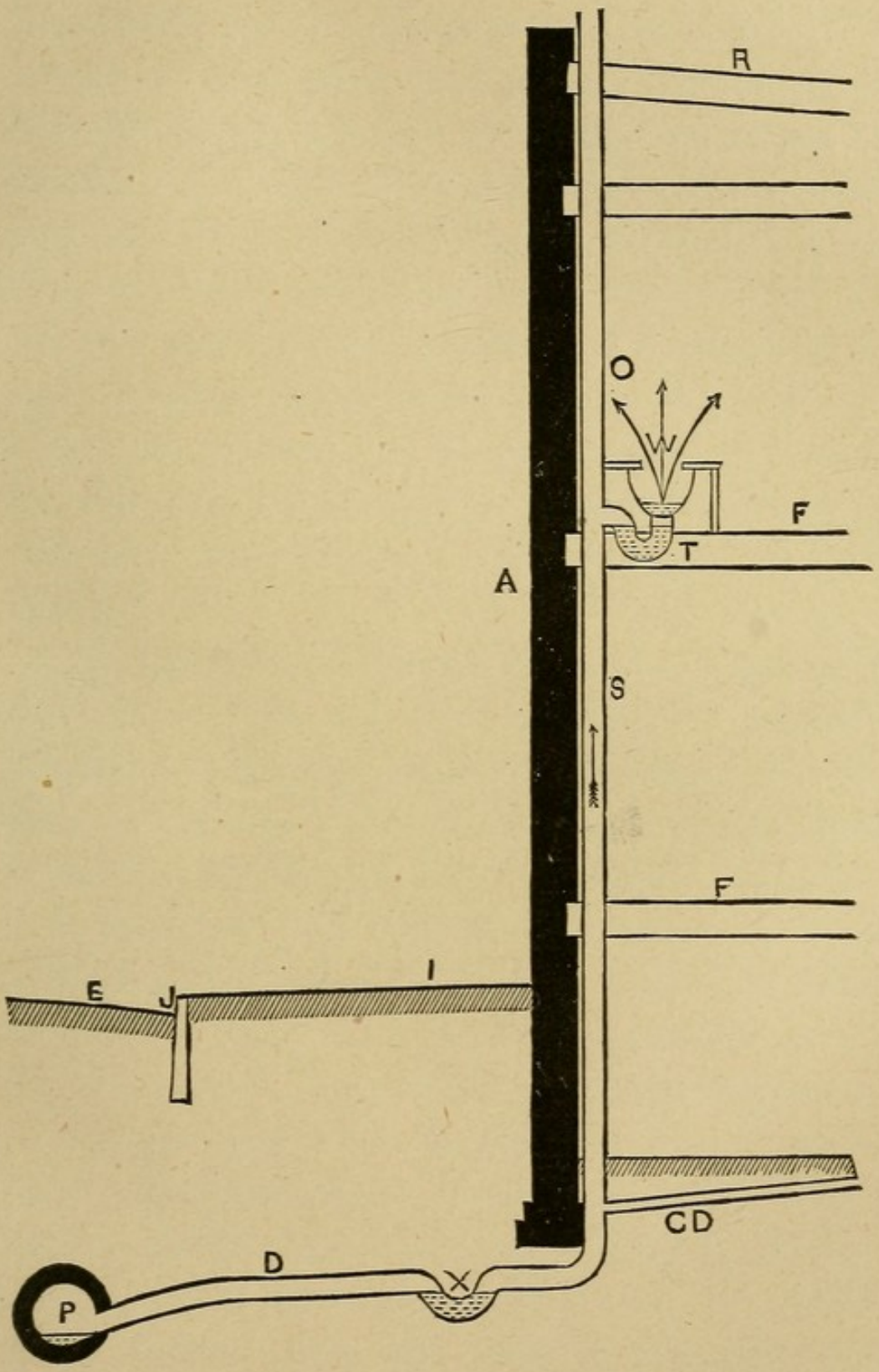
waste-pipes, nor be held in solution in some trap, until it begins to decompose and give off its dangerous gases. A perfect system of house-drainage will not leak, nor ever contain any foul odors. It will not get out of repair at some unexpected moment, nor will it wear out. There is no more reason why there should be perishable material used, and defective joints made, in house drains, than in the pipes which conduct illuminating gas into a house. The latter are air-tight, and gas-tight; so should the former be. House drains should be recognized as a part of a house, not an obnoxious adjunct, and be as accessible as any other part of the building. It is not extravagant to talk about a perfect system of drainage, as it might be of a house itself, since lasting material can be used, secure joints made, and ventilation for pipes provided, which will absolutely relieve a building of sewer-gas. To this end, good workmanship is essential. The supervision of the construction of house drainage should be entrusted to a sanitary engineer, no less than the construction of a house itself to an architect.

It is interesting, as well as a matter of importance, to notice briefly the growth of house drainage, as a system, which has at length culminated, apparently, in the perfection so much desired. The first crude idea of getting rid of house

waste, when sewers came into use, would be correctly illustrated in Plate IV if the catch-basin and the trap under the water-closet were not shown. When the uninterrupted communication with the sewer was found to admit offensive gases into the house — their danger was probably not realized — a trap was called into use, as represented. This was found to be only a partial safeguard, and a second trap, such as the one in the main drain — represented in Plate V — was put in. Again, it was discovered that a heavy pressure in the sewer would "force" the traps; that the water in them was syphoned out, would evaporate, etc. Furthermore, it was discovered that gases were generated in the drains themselves. Then the vertical pipes were extended to and above the roof, as shown in Plate XVII, to ventilate them. To relieve the main drain of the pressure from the sewer, a ventilating pipe was extended upward along the wall of the house to the roof; or, what was practically the same thing, the drain was connected with the down-spout. This has been supplemented by the open man-holes over the street sewer. Often this ventilating pipe ended near an upper bed-room window, and the gases it discharged were drawn into the house.

Some of these appliances, or all of them combined, are in use. They afford only partial relief.

Plate XVII.



Imperfect Ventilation of Soil-pipe.

The ventilation of the drains was not positive, but rather of a negative character. An established current in the drains was finally settled by connecting them with a flue in the chimney, as shown in Plate XVIII. With the house drains cut off from the street sewer, by the running trap; with the soil- and waste-pipes extended to the roof, full size, or with a fresh-air inlet to the main drain between the running trap and the house, and heat in the chimney, there must of necessity always be a current of pure air moving through the pipes and drains.

The catch-basin — more correctly, a grease basin — came into use to intercept the grease in kitchen and laundry waste. This would adhere to the sides of the street sewer, and ultimately obstruct it. The city authorities require its construction and use. At best, it is a nuisance of the worst kind; but until something is devised to take its place, it must be regarded as a necessary evil. Relief is promised by Mr. Benezette Williams, a civil engineer of Chicago, formerly City Engineer, in a self-acting flushing arrangement, to be attached to the catch-basin and empty it of all its contents once in twenty-four hours, or at other stated times. This will soon be put into active operation by Mr. Williams, but until fairly tested its success can not be assured.

The materials out of which house drains have been constructed have remained the same while other improvements were being made, and it was not until recently that it was thought that any thing else than clay drain tile, with cemented joints, and iron or lead pipes, loosely jointed, could be substituted.

Before explaining in detail a system in which better material is used and the construction satisfactory, the following requirements of a perfect system may be enumerated :

1. There must be an unobstructed and positive ventilation of all the pipes and drains within and beneath the house.

2. The ordinary earthenware drains must be discarded, since they can not be secured against breaking and defective joints.

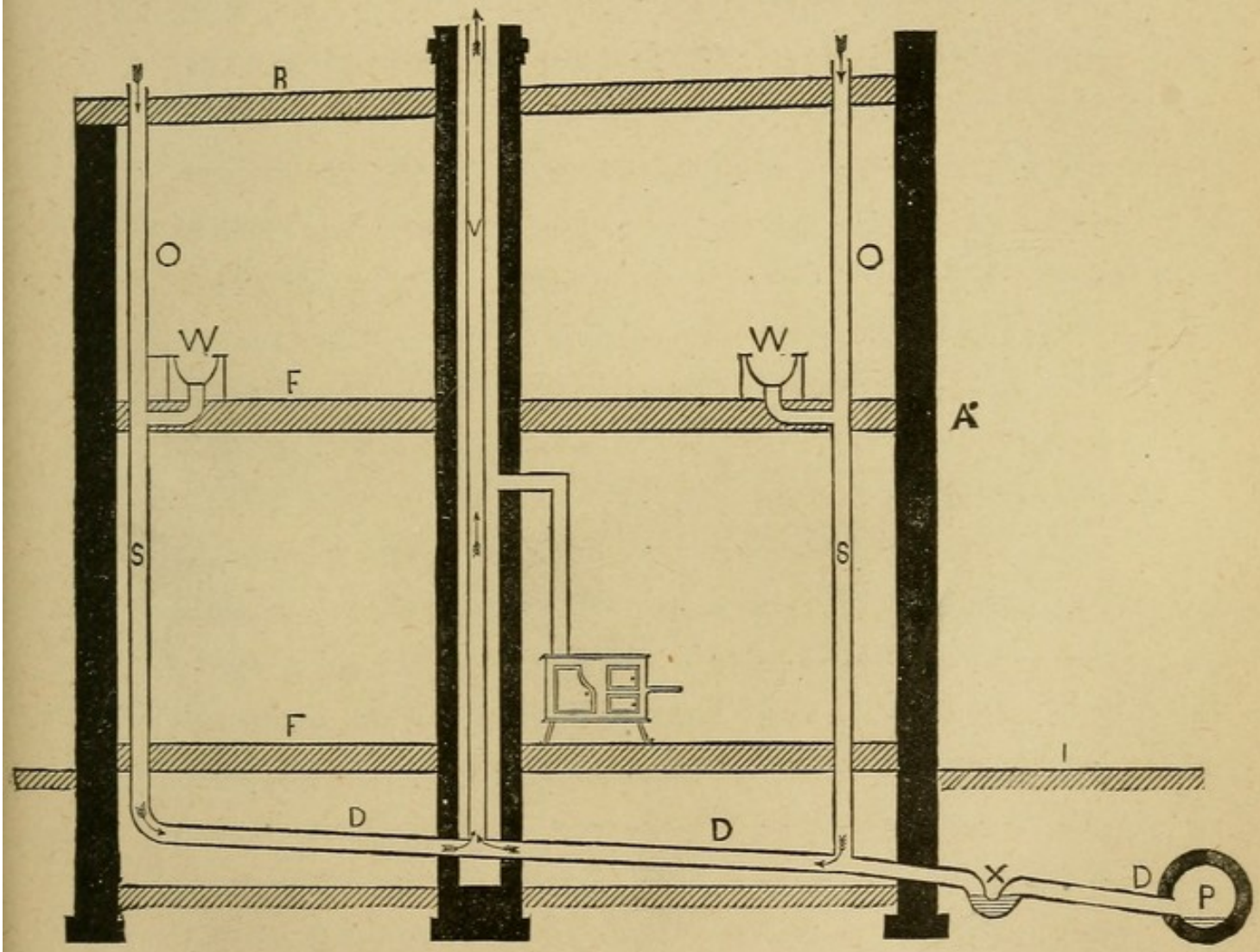
3. Perfect joints, and not mere connections, must be made between sections of drains and pipes.

4. The waste-pipes and drains must be one continuous system, and made of material that will not break, leak, corrode nor obstruct the free passage of the miuutest particles which enter them.

5. Traps must be used that will not permit the escape of gas by defect in construction or use ; or, better still, they should be entirely discarded.

A system which seems to meet these demands has lately come into use, and fortunately for

Plate XVIII.



Complete Ventilation of All Drains.

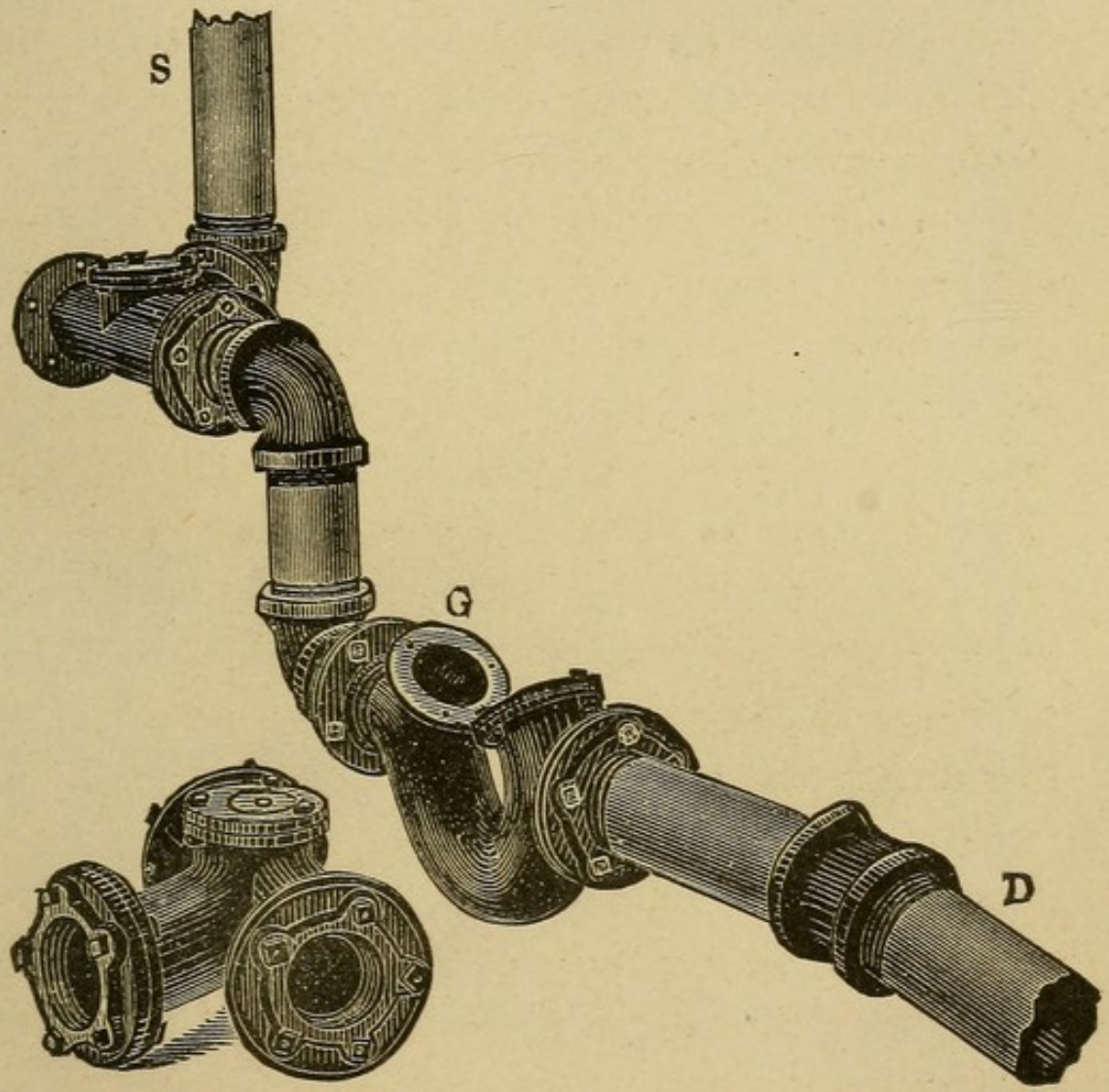
the future health and prosperity of the people, is finding its way into houses just about as rapidly as it can be put in. The system was devised by Mr. C. W. Durham, a civil and sanitary engineer of Chicago, who spent years of study and experiment in perfecting it. Where introduced, houses are absolutely free from sewer-gas, and are likely to be so as long as the houses themselves shall stand. Mr. Durham's system has been adopted for the entire Town of Pullman, now springing into existence a few miles south of Chicago, in which two thousand houses will be constructed this Summer.

An important feature of the system is one which satisfies the first requirement. A suction pipe is built inside the chimney, and extending some feet above its top. This is connected with the main drain at the bottom, as indicated in Plate XVIII. Actual tests, made by the writer, proved that in every instance there was a strong downward current in every water-closet when opened, rather than a puff of foul air into the room, as there commonly is.

No earthenware drains are used, and consequently there are no cemented joints, in both of which there has been found so much objection. The system is complete in itself — soil-pipes being made of wrought iron, and the horizontal drains, usually

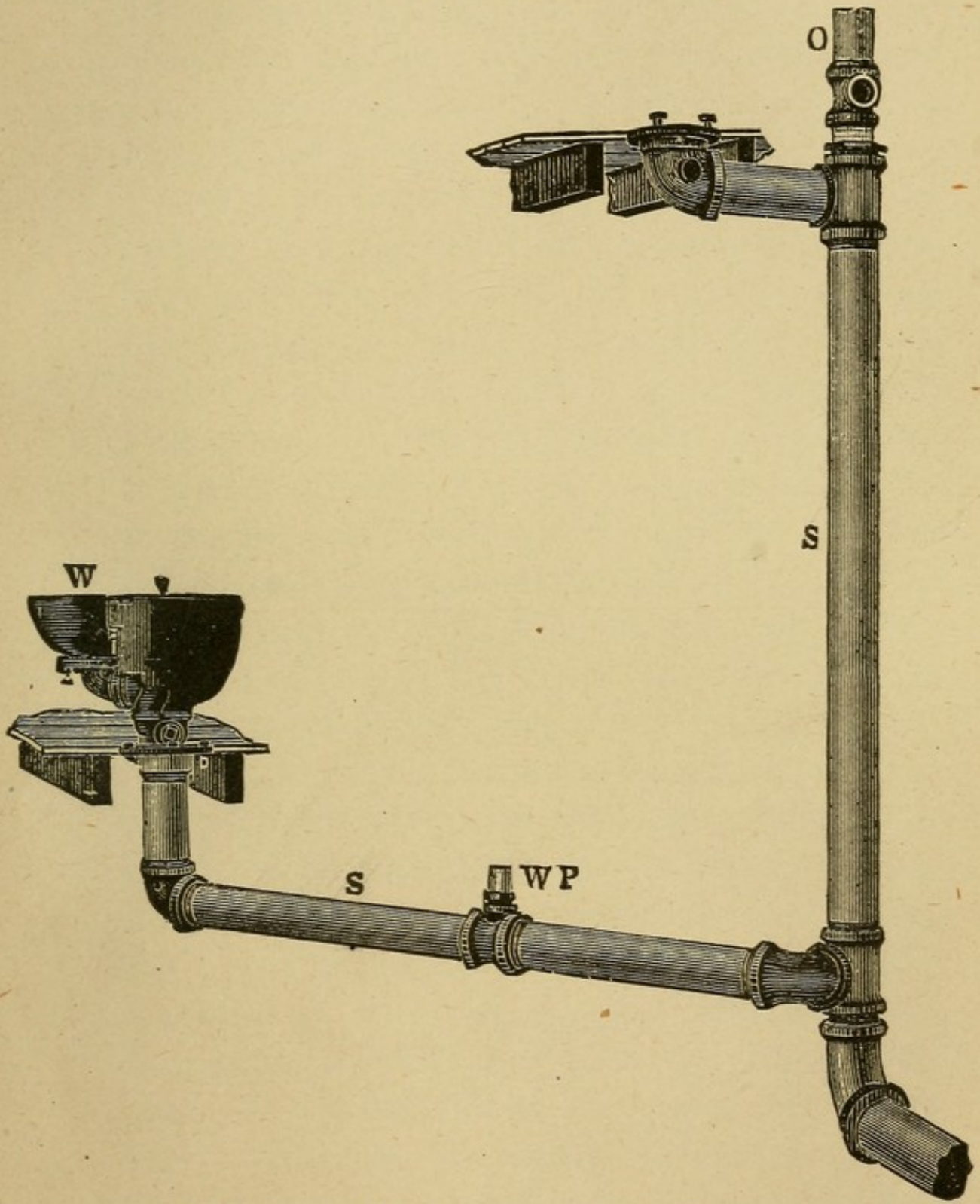
put under ground, of cast iron. The former have screw, steam-fitting, joints, and the joints of the latter are most securely calked with lead. The iron pipes are coated internally and externally with a rust-proof preparation. They are so strong that no ordinary weight can break, injure or displace them. They are not injured by exposure to the air, as tile drains or their cemented joints are, and consequently they need not be hidden away under the ground. Ordinarily, house drains consist of two parts; one rests upon the ground, and the other is attached to the walls of the house. Unequal settling is sure to cause a break. With all the drains of iron, firmly united, and dependent as one piece from the walls of the building, or resting upon supports free from the building, there can be no breaking. Plate XIX illustrates the main drain. The firm and lasting character of the pipe and the manner of making the connections are indicated. That portion of it within the outside wall of the building may be laid above ground, where it is always accessible. An open man-hole is built over the running trap, and the openings seen in it afford access to the drain in either direction, should it ever become necessary to remove obstructions. The trap holds so large an amount of water, it is improbable that any pressure from the sewer would "force" it.

Plate XIX.



Iron Drain with Steam-fitting Joints.

PLATE XX.



DRAINAGE UNOBSTRUCTED BY TRAPS

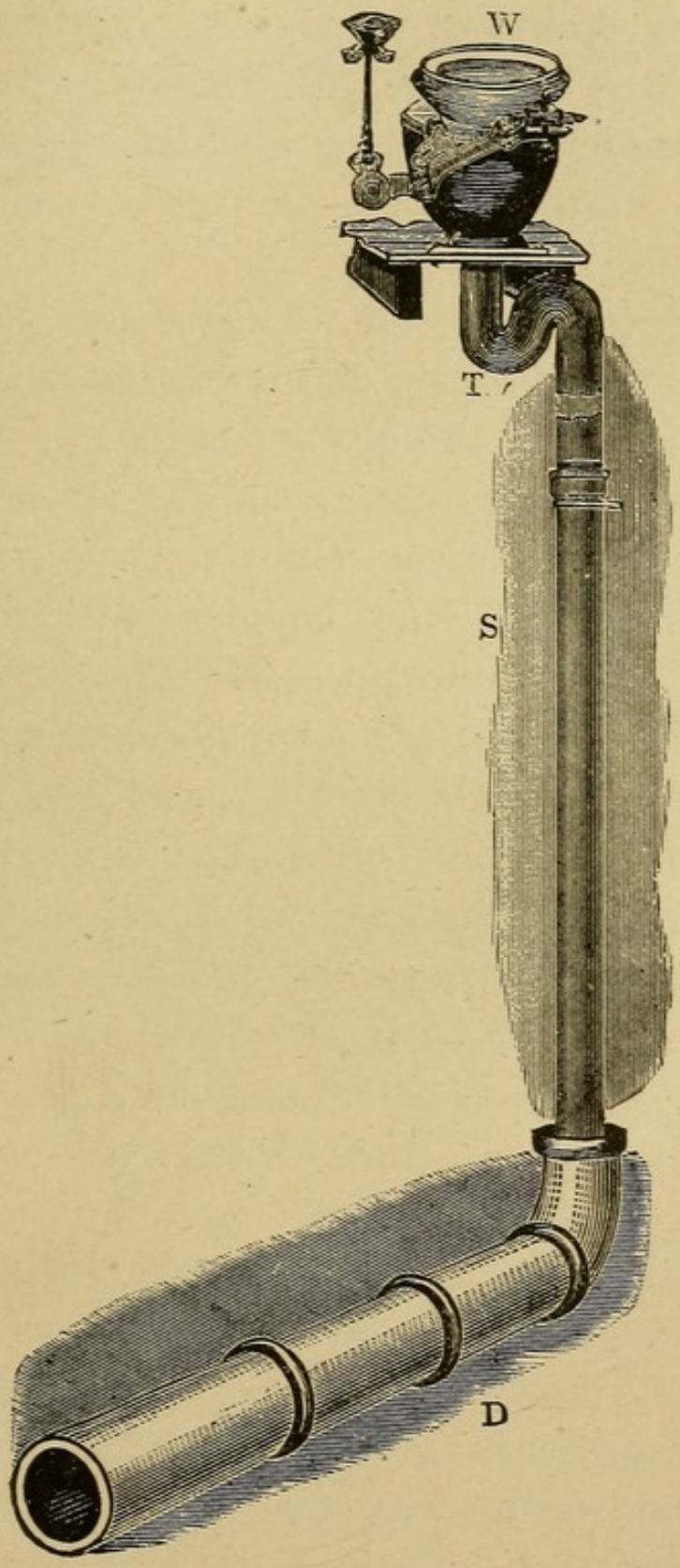
This is the only trap in the whole system, except under the kitchen sink, wash-basins, and bath-tub. These are always ventilated as shown in Plate II, and are so small that they can not become annoying cesspools. The two openings in the running trap are closed with screw plugs, or rubber-packed flanges, which can be easily removed when occasion demands. The screw joint between soil-pipe and drain should not be overlooked. There is no such thing as separation at this point. It is to be understood that this plate, as well as the succeeding one, is intended to represent construction and not actual proportions. While the sections of pipe may be of any length, they are usually twelve feet long. The sections of ordinary drain tile are about two feet long.

Plate XX shows the upper portion of the system. This is not to be considered as a separate half to be attached to the other in some uncertain way, but as a part of it. The soil-pipe is extended to the roof in all cases. A brass solder nipple is shown at W-P, where the lead waste-pipe of a wash-basin or bath-tub is connected with the soil-pipe. The opening near the upper end of the vertical soil-pipe is to receive the ventilating pipe from a trap in a waste-pipe, which would be syphoned, without such ventilation, by the water discharged from the water-closet. The soil-pipes

are screwed into the drain-pipes, and stand erect and rigid without lateral support. The water-closets are fastened to special fittings by set screws, and are supported directly from the soil-pipe, as readily seen, instead of resting on the floor. A water-closet some distance away from the vertical pipe might rest upon the floor, but the flexible joint where the branch unites with the main soil-pipe admits of settling, without in any way affecting the security of the connection.

It is an exceedingly important feature of this system that it will admit of the discarding of that abomination, the trap, under a water-closet. The pipes and drains are so thoroughly ventilated that no sewer-gas can remain in them, even supposing that they ever contained anything to generate a gas. The closet generally used is the Zane, or Jennings. Closets of this class are open only when the handle is pulled up. They hold a large amount of water — three or four gallons. When the handle is raised, this water descends in full volume through an opening as large as the soil-pipe, and with such force that all filth is swept along with it to the sewer at once, or, at least, to the running trap in the main drain, which, it should be remembered, is outside the house. If care is exercised in discharging the closet once or twice after using, this trap may be completely

Plate XXI.



"Lead, Iron and Clay."

flushed. Such suction is created by the water as it descends from the closet, that the unpleasant odors which invariably arise when using the ordinary closet are drawn at once into the soil-pipe.

The principle of the Durham system is shown in Plates II and XVIII; its construction, in Plates XIX and XX. To appreciate its superiority, and the security which it affords, a representation of the ordinary "lead, iron and clay" system is given in Plate XXI. This plate is made from a photograph of what it represents, taken for this work; hence, there is no exaggeration, nor misrepresentation, in it. As Plate XXI shows exactly the construction of house drainage as it is, so its principle and results are correctly shown in Plate I, which was prepared under the immediate supervision of the writer, and represents, faithfully, as already stated, what was brought to light in the investigations reported in this book.

The proper location and construction of the catch-basin, or kitchen grease-basin, should not pass unnoticed. It is placed outside the house walls, but as near to the kitchen sink and laundry tubs as possible, that there may not be a long stretch of waste-pipe to become coated internally with grease and other waste. It is built up to the surface of the ground, and ventilated. The traps

in the waste-pipes leading to it are also ventilated, etc. All these things are properly shown in Plate II.

Mr. Durham began his scientific investigations, which have resulted in this perfected invention, in 1873, and claims to have expended no less than $70,000 in experimenting and improving. Mr. Durham received his preliminary education at Michigan University, under the best scientific instructors. It is thus seen that he was prepared to investigate upon a scientific basis, and that he is not likely to have devised some mere make-shift, by which people realizing the dangers of sewer-gas may be humbugged. There is no doubt that his claim for his system is well founded. He says of it: "It may be broadly described as a combination of scientific design, proper mechanical construction, thorough ventilation, and rigid supervision by expert engineers. In it is substituted for the impracticable, and often dangerous, fancies of amateurs, a standard design of extreme simplicity. This design is constructed with the only proper materials for the purpose, viz.: heavy cast and wrought iron pipe. They are protected from rust, and put together in such a manner that very few buildings will outlive the drainage system. There are used the mechan-

ical refinements of the machine-shop, and the highest class of skilled labor, in place of the 'navvy' and the half-taught plumber. The methods of ventilation really create a circulation of air, and are not miserable counterfeits. The control of the work, in all its stages, is in the hands of civil engineers, where it properly belongs. Work is executed only in one way — the best way. The quality of the work in a tenement house is, in all respects, the same as that put in a State capitol."

Notwithstanding the superiority of this system, and the increased cost of skilled labor required in constructing it, its expense is not much greater than that of the old system. In Chicago, the cost, complete, for the drainage within the building, including kitchen drainage and grease-trap, ranges from $150, for an ordinary building, 25x40 feet in size, to $1,000, or $1,500, for a first-class double residence, the difference in cost being due to the varying amount of pipe required, as well as of labor. It can be put into houses already built, as well as in those which are new.

The time is coming when the condition of the drainage will determine the character and status — in a commercial sense — of every building. With the introduction of such a system of house drain-

age as the one here unhesitatingly commended, the long train of diseases occasioned by blood poisoning, for which sewer-gas is so largely responsible, will disappear, and humanity will be delivered from a great peril.

THE END.

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