# HANDBOOK ON SANITATION.

## A MANUAL OF THEORETICAL AND PRACTICAL SANITATION.

*FOR STUDENTS AND PHYSICIANS; FOR HEALTH, SANITARY, TENEMENT-HOUSE, PLUMBING, FACTORY, FOOD, AND OTHER INSPECTORS; AS WELL AS FOR CANDIDATES FOR ALL MUNICIPAL SANITARY POSITIONS.*

BY

GEORGE M. PRICE, M.D.,

*Medical Sanitary Inspector, Department of Health, New York City; Inspector New York Sanitary Aid Society of the 10th Ward, 1885; Manager Model Tenement-houses of the New York Tenement-house Building Company. 1888; Inspector New York State Tenement-house Commission, 1895.*

*SECOND EDITION, REVISED AND PARTLY REWRITTEN.*

SECOND THOUSAND.

NEW YORK:

JOHN WILEY & SONS.

LONDON: CHAPMAN & HALL, LIMITED

1908.

The Scientific Press
Robert Drummond and Company
New York

TO

JACOB A. RIIS,

*To whose profound knowledge of "How the Other Half Lives," deep feeling for the "Children of the Poor," and strenuous efforts in behalf of the tenement-house population of New York, a great many sanitary improvements and progress in tenement-house reform are due,*

THIS BOOK IS DEDICATED IN APPRECIATION AND RESPECT

BY THE AUTHOR.

# PREFACE TO SECOND EDITION.

WITH the object of increasing the usefulness of this "Manual" for sanitary inspectors in Health Departments, as well as for those in other municipal positions, the author has brought the text up to date and omitted all material of merely local application. This plan has required considerable revision of the text of the first part of the book, the entire elimination of the fourth part of the book, on Sanitary Law, and a considerable enlargement of the part on Sanitary Inspection. The principal change, however, is made in Part II, on Sanitary Practice, which has been entirely rewritten and rearranged. The subject-matter is treated in four sections, entitled "Habitation"; "Occupation and Trades"; "Food"; and "Disinfection." The treatment, although condensed, is nevertheless comprehensive, and will give to inspectors in all departments of sanitation very valuable aid in their work.

The author takes this opportunity of acknowledging the kind criticism of the medical press and of the general press, which has enabled him to make the second edition much more suited to the needs of those for whom the book was written.

# PREFACE.

In this era of intense interest in all matters relating to public health and practical sanitation, no defence is needed for the presentation of a new book on the subject, especially as the book presents the matter in a form hitherto unexploited.

Municipal Sanitation has made giant strides within the last decade; and the circle of those whose duties compel them to make a special study of sanitary questions has been considerably widened within the last few years.

The number of inspectors in the various municipal health, building, sanitary, and other similar departments, is already quite large, and the tendency is to a further augmentation of their number.

Moreover, the time when inexperienced men could be appointed as Sanitary and Health Inspectors has passed, and certain quite important and strict qualifications are required of the candidates for one of these municipal positions. These requirements and qualifications for sanitary positions are constantly being made more strict and thorough; and there is no doubt that Surgeon-General W. Wyman is right in saying: "In the sanitary progress of the new century, it has occurred to me, there must be developed a new class of individuals in sanitary affairs." (Journal Am. Med. Asso., March, 1901.)

There are several thousand inspectors in the various sanitary municipal departments throughout the United States, and this number is being increased every year. New York City alone has added over 200 inspectors in its newly-established Tenement-house Department, which is to begin its existence January, 1902.

In spite, however, of the growing number of sanitary inspectors, the still greater number of candidates for inspectorships, and the general interest in sanitary questions, there are as yet very few sources where the desired and necessary knowledge may be gained. In England there is an extensive literature on the subject; there are dozens of special books on Sanitation, a large number of practical manuals, and a number of aids, helps, and handbooks on all sanitary subjects. Here in the United States one has to consult the several bulky text-books on hygiene intended for medical men only. Except for Dr. R. S. Tracy's little book on "Sanitary Information," and Mr. P. Gerhardt's popular books on plumbing, there are no books from which the municipal sanitary inspector, and especially the candidate for such a position, can learn what is necessary for him to know.

These were the considerations which have induced me to undertake the present work. While I do not pretend to have written a text-book on the subject of Sanitation, I hope to have succeeded in presenting the subject in a condensed and practical form, so as to enable the student and candidate to make a creditable showing in the civil-service competitive examinations, as well as subsequently to fill one of the sanitary positions.

The first step in the study of Sanitation is to understand the principles of the science. In Part I., on Sanitary Science, I have endeavored to give a condensed but comprehensive resumé of the best text-books on the subject.

Part II. is on Sanitary Practice, upon which very little has hitherto been written from a practical standpoint. In this part are given the methods of application of sanitary science in the various municipal departments, with extracts from the laws, rules, and regulations of New York and other municipalities.

Part III. of the book relates to the inspector himself, his duties, the art of his profession, his standing, qualifications, etc.; this part also contains some useful hints which will doubtless aid him, as they will the candidate for an inspectorship.

Part IV. contains, besides the chapters on Sanitary Law and Sanitary Organization in the United States, extracts from model laws on the various branches of Sanitation.

It is right here to mention that for all information as to the laws and practice of Sanitation outside of New York, I am indebted to the new book on "Municipal Sanitation in the United States," by Dr. Chas. V. Chapin, for the publication of which all interested in Sanitation will be thankful.

I cannot close these few remarks on the scope of the book without publicly acknowledging my deep gratitude to, and appreciation of, the assistance of those who have, in one way or another, kindly helped me in the preparation of this work.

Figures 20, 21, and 22 are from "House Drainage and Sanitary Plumbing," by Mr. W. P. Gerhard, published by D. Van Nostrand Co., New York, and are here used with the kind permission of the author.

To the eminent sanitarian, Dr. Roger Sherman Tracy, I herein render my deep regard for the advice and valuable suggestions given me. My heartfelt thanks are due to my friend, Dr. Walter Brooks Brouner, for the laborious task of revising the manuscript of the book.

Finally, I must ask the forbearance of readers for any and all inaccuracies and errors that may be found in my book, promising to correct these in any future editions of the work, if such are called for.

**254 East Broadway, New York City,**
**October, 1901.**

# CONTENTS.

## PART FIRST.—SANITARY SCIENCE.

## PART SECOND.—SANITARY PRACTICE.

### *SECTION FIRST.—HABITATIONS.*

*SECTION SECOND.—OCCUPATIONS AND TRADES.*



*SECTION THIRD.—FOODS.*

# LIST OF ILLUSTRATIONS.

# HANDBOOK ON SANITATION.

## PART FIRST.

## SANITARY SCIENCE.

### CHAPTER I.

### SOIL AND SITES.

**Definition.**—By the term "soil" we mean the superficial layer of the earth, a result of the geological disintegration of the primitive rock by the action of the elements upon it and of the decay of vegetable and animal life.

**Composition.**—Soil consists of solids, water, and air.

**Solids.**—The solid constituents of the soil are inorganic and organic in character.

The inorganic constituents are the various minerals and elements found alone or in combination in the earth, such as silica, aluminum, calcium, iron, carbon, sodium, chlorine, potassium, etc.

The characteristics of the soil depend upon its constituents, and upon the predominance of one or the other of its composing elements. The nature of the soil also depends upon its physical properties. When the disintegrated rock consists of quite large particles, the soil is called a *gravel soil.* A *sandy soil* is one in which the particles are very small. *Sandstone* is consolidated sand. *Clay* is soil consisting principally of aluminum silicate; in *chalk* soft calcium carbonate predominates.

The organic constituents of the soil are the result of vegetable and animal growth and decomposition in the soil.

**Ground-water.**—Ground-water is that continuous body or sheet of water formed by the complete filling and saturation of the soil to a certain level by rain-water; it is that stratum of subterranean lakes and rivers filled up with alluvium which we reach at a higher or lower level when we dig wells.

The level of the ground-water depends upon the underlying strata, and also upon the movements of the subterranean water-bed. The relative position of the impermeable underlying strata varies in its distance from the surface-soil. In marshy land the ground-water is at the surface; in other places it can be reached only by deep borings. The source of the ground-water is the rainfall, part of which drains into the porous soil until it reaches an impermeable stratum, where it collects.

The movements of the ground-water are in two directions—horizontal and vertical. The horizontal or lateral movement is toward the seas and adjacent water-courses, and is determined by hydrostatic laws and topographical relations. The vertical motion of the ground-water is to and from the surface, and is due to the amount of rainfall, the pressure of tides, and watercourses into which the ground-water drains. The vertical variations of the ground-water determine the distance of its surface-level from the soil-surface, and are divided into a persistently low-water level, about 15 feet from the surface; a persistently high-water level, about 5 feet from the surface, and a fluctuating level, sometimes high, sometimes low.

**Ground-air.**—Except in the hardest granite rocks and in soil completely filled with water, the interstices of the soil are filled with a continuation of atmospheric air, the amount depending on the degree of porosity of the soil. The nature of the ground-air differs from that of the atmosphere only as it is influenced by its location. The principal constituents of the air—nitrogen, oxygen, and carbonic acid—are also found in the ground-air, but in the latter the relative quantities of O and $CO_2$ are different.

AVERAGE COMPOSITION OF ATMOSPHERIC AIR IN 100 VOLUMES.

| | |
|---|---|
| Nitrogen | 79.00% |
| Oxygen | 20.96% |
| Carbonic acid | 0.04% |

AVERAGE COMPOSITION OF GROUND-AIR.

| | |
|---|---|
| Nitrogen | 79.00% |
| Oxygen | 10.35% |
| Carbonic acid | 9.74% |

Of course, these quantities are not constant, but vary in different soils, and at different depths, times, etc. The greater quantity of $CO_2$ in ground-air is due to the processes of oxidation and decomposition taking place in the soil. Ground-air also contains a large quantity of bacterial and other organic matter found in the soil.

Ground-air is in constant motion, its movements depending upon a great many factors, some among these being the winds and movements of the atmospheric air; the temperature of the soil; the surface temperature; the pressure from the ground-water from below, and surface- and rain-water from above, etc.

**Ground-moisture.**—The interstices of the soil above the ground-water level are filled with air ONLY, when the soil is absolutely dry; but as such a soil is very rare, all soils being more or less damp, soil usually contains a mixture of air and water, or what is called *ground-moisture.*

Ground-moisture is derived partly from the evaporation of the ground-water and its capillary absorption by the surface-soil, and partly by the retention of water from rains upon the surface. The power of the soil to absorb and retain moisture varies according to the physical and chemical, as well as the thermal, properties of the soil.

Loose sand may hold about 2 gallons of water per cubic foot; granite takes up about 4% of moisture; chalk about 15%; clay about 20%; sandy loam 33 to 35%; humus about 40%.

**Ground-temperature.**—The temperature of the soil is due to the direct rays of the sun, the physico-chemical changes in its interior, and to the internal heat of the earth.

The ground-temperature varies according to the annual and diurnal changes of the external temperature; also according to the character of the soil, its color, composition, depth, degree of organic oxidation, ground-water level, and degree of dampness. In hot weather the surface-soil is cooler, and the subsurface-soil still more so, than the surrounding air; in cold weather the opposite is the case. The contact of the cool soil with the warm surface-air on summer evenings is what produces the condensation of air-moisture which we call dew.

**Bacteria.**—Quite a large number of bacteria are found in the soil, especially near the surface, where chemical and organic changes are most active. From 200,000 to 1,000,000 bacteria have been found in one c.c. of earth. The ground bacteria are divided into two groups—saprophytic and pathogenic. The saprophytic bacteria are the bacteria of decay, putrefaction, and fermentation. It is to their benevolent action that vegetable and animal débris is decomposed, oxidized, and reduced to its elements. To these bacteria the soil owes its self-purifying capacity and the faculty of disintegrating animal and vegetable débris.

The pathogenic bacteria are either those formed during the process of organic decay, and which, introduced into the human system, are capable of producing various diseases, or those which become lodged in the soil through the contamination of the latter by ground-water and air, and which find in the soil a favorable lodging ground, until forced out of the soil by the movements of the ground-water and air.

**Contamination of the Soil.**—The natural capacity of the soil to decompose and reduce organic matter is sometimes taxed to its utmost by the introduction into the soil of extraneous matters in quantities which the soil is unable to oxidize in a given period. This is called contamination or pollution of soil, and is due:

1) to surface pollution by refuse, garbage, animal, and human excreta;

2) to interment of dead bodies of beasts and men;

3) to the introduction of foreign deleterious gases, etc.

*Pollution by Surface Refuse and Sewage.*—This occurs where a large number of people congregate, as in cities, towns, etc., and very seriously contaminates the ground by the surcharge of the surface-soil with sewage matter, saturating the ground with it, polluting the ground-water from which the drinking-water is derived, and increasing the putrefactive changes taking place in the soil. Here the pathogenic bacteria abound, and, by multiplying, exert a very marked influence upon the health by the possible spread of infectious diseases. Sewage pollution of the soils and of the source of water-supply is a matter of grave importance, and is one of the chief factors of high mortality in cities and towns.

*Interment of Bodies.*—The second cause of soil contamination is also of great importance. Owing to the intense physico-chemical and organic changes taking place within the soil, all dead-animal matter interred therein is easily disposed of in a certain time, being reduced to the primary constituents, viz., ammonia, nitrous acid, carbonic acid, sulphuretted and carburetted hydrogen, etc. But whenever the number of interred bodies is too great, and the products of decomposition are allowed to accumulate to a very great degree, until the capacity of the soil to absorb and oxidize them is overtaxed, the soil, and the air and water therein, are polluted by the noxious poisons produced by the processes of decomposition.

*Introduction of Various Foreign Materials and Gases.*—In cities and towns various pipes are laid in the ground for conducting certain substances, as illuminating gas, fuel coal-gas, etc.; the pipes at times are defective, allowing leakage therefrom, and permitting the saturation of the soil with poisonous gases which are frequently drawn up by the various currents of ground-air into the open air and adjacent dwellings.

**Influence of the Soil on Health.**—The intimate relations existing between the soil upon which we live and our health, and the marked influence of the soil on the life and well-being of man, have been recognized from time immemorial.

The influence of the soil upon health is due to:

1) the physical and chemical character of the soil;

2) the ground-water level and degree of dampness;

3) the organic impurities and contamination of the soil.

The physical and chemical nature of the soil, irrespective of its water, moisture, and air, has been regarded by some authorities as having an effect on the health, growth, and constitution of man. Certain diseases, like cretinism, goitre, and others, have been attributed to a predominance of certain chemicals in the soil.

The ground-water level is of great importance to the well-being of man. Prof. Pettenkofer claimed that a persistently low-water level (about 15 feet from the surface) is healthy, the mortality being the lowest in such places; a persistently high ground-water level (about 5 feet from the surface) is unhealthy; and a fluctuating level, varying from high to low, is the most unhealthy, and is dangerous to life and health. Many authorities have sought to demonstrate the intimate relations between a high-water level in the soil and various diseases.

A damp soil, viz., a soil wherein the ground-moisture is very great and persistent, has been found inimical to the health of the inhabitants, predisposing them to various diseases by the direct effects of the dampness itself, and by the greater proneness of damp ground to become contaminated with various pathogenic bacteria and organisms which may be drawn into the dwellings by the movements of the ground-air. As a rule, there is very little to hinder the ground-air from penetrating the dwellings of man, air being drawn in through cellars by changes in temperature, and by the artificial heating of houses.

The organic impurities and bacteria found in the soil are especially abundant in large cities, and are a great cause of the evil influence of soil upon health. The impurities are allowed to drain into the ground, to pollute the ground-water and the source of water-supply, and to poison the ground-air, loading it with bacteria and products of putrefaction, thus contaminating the air and water so necessary to life.

**Diseases due to Soil.**—A great many diseases have been thought to be due to the influence of the soil. An etiological relation had been sought between soil and the following diseases: Malaria, Paroxysmal Fevers, Tuberculosis, Neuralgias, Cholera, Yellow Fever, Bubonic Plague, Typhoid, Dysentery, Goitre and Cretinism, Tetanus, Anthrax, Malignant Œdema, Septicæmia, etc.

**Sites.**—From what we have already learned about the soil, it is evident that it is a matter of great importance as to where the site for a human habitation is selected, for upon the proper selection of the site depend the health, well-being, and longevity of the inhabitants. The requisite characteristics of a healthy site for dwellings are: A dry, porous, permeable soil; a low and non-fluctuating ground-water level, and a soil retaining very little dampness, free from organic impurities, and the ground-water of which is well drained into distant watercourses, while its ground-air is uncontaminated by pathogenic bacteria. Exposure to sunlight, and free circulation of air, are also requisite.

According to Parkes, the soils in the order of their fitness for building purposes are as follows: 1) primitive rock; 2) gravel with pervious soil; 3) sandstone; 4) limestone; 5) sandstone with impervious subsoil; 6) clays and marls; 7) marshy land; and 8) made soils.

It is very seldom, however, that a soil can be secured having all the requisites of a healthy site. In smaller places, as well as in cities, commercial and other reasons frequently compel the acquisition of and building upon a site not fit for the purpose; it then becomes a sanitary problem how to remedy the defects and make the soil suitable for habitation.

**Prevention of the Bad Effects of the Soil on Health.**—The methods taught by sanitary science to improve a defective soil and to prepare a healthy site are following:

1) Street-paving and tree-planting.

2) Proper construction of houses.

3) Subsoil drainage.

*Street-paving* serves a double sanitary purpose. It prevents street-refuse and sewage from penetrating the ground and contaminating the surface-soil, and it acts as a barrier to the free ascension of deleterious ground-air.

*Tree-planting* serves as a factor in absorbing the ground-moisture and in oxidizing organic impurities.

*The Proper Construction of the House* has for its purpose the prevention of the entrance of ground-moisture and air inside the house by building the foundations and cellar in such a manner as to entirely cut off communication between the ground and the dwelling. This is accomplished by putting under the foundation a solid bed of concrete, and under the foundation-walls damp-proof courses.

The following are the methods recommended by the New York City Tenement House Department for the water-proofing and damp-proofing of foundation walls and cellars:

*Water-proofing and Damp-proofing of Foundation Walls:* "There shall be built in with the foundation walls, at a level of six (6) inches below the finished floor

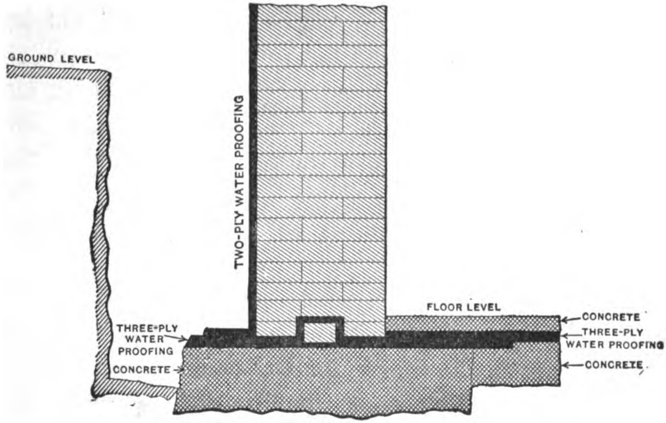



**FIG. 1.**

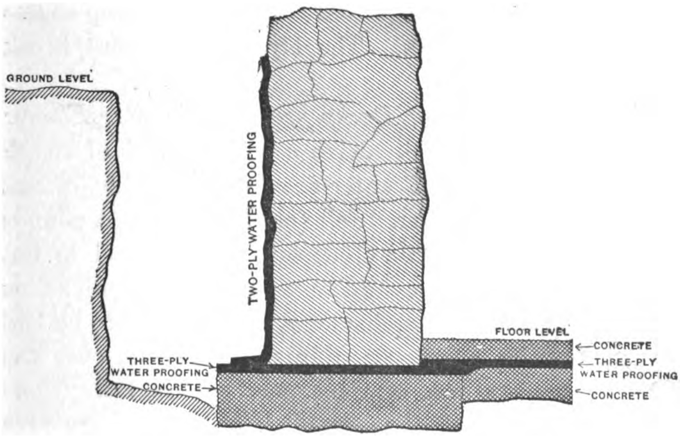



**FIG. 2.**

**CONCRETE FOUNDATION AND DAMP-PROOF COURSE.**

level, a course of damp-proofing consisting of not less than two (2) ply of tarred felt (not less than fifteen (15) pounds weight per one hundred (100) square feet), and one (1) ply of burlap, laid in alternate layers, having the burlap placed between the felt, and all laid in hot heavy coal-tar pitch, or liquid asphalt, and projecting six (6) inches inside and six (6) inches outside of the walls.

"There shall be constructed on the outside surface of the walls a water-proofing lapping on to the damp-proof course in the foundation walls and extending up to the soil level. This water-proofing shall consist of not less than two (2) ply of tarred felt (of weight specified above), laid in hot heavy coal-tar pitch, or liquid asphalt, finished with a flow of hot pitch of the same character. This water-proofing to be well stuck to the damp course in the foundation walls. The layers of felt must break joints.

*Water-proofing and Damp-proofing of Cellar Floors:* "There shall be laid, above a suitable bed of rough concrete, a course of water-proofing consisting of not less than (3) ply of tarred felt (not less than (15) pounds weight per one hundred (100) square feet), laid in hot heavy coal-tar pitch, or liquid asphalt, finished with a flow of hot pitch of the same character. The felt is to be laid so that each layer laps two-thirds of its width over the layer immediately below, the contact surface being thoroughly coated with the hot pitch over its entire area before placing the upper layer. The water-proofing course must be properly lapped on and secured to the damp course in the foundation walls."

Other methods of damp-proofing foundations and cellars consist in the use of slate or sheet lead instead of tar and tarred paper. An additional means of preventing water and dampness from coming into houses has been proposed in the so-called "dry areas," which are open spaces 4 to 8 feet wide between the house proper and the surrounding ground; the open spaces running as deep as the foundation, if possible. The dry areas are certainly a good preventive against dampness coming from the sides of the house.

The method illustrated in Fig. 1 is what is required by the Department in the case of brick walls. The method shown in Fig. 2 will be accepted in the case of stone walls, and in the case of brick walls under special circumstances.

*Subsoil Drainage.*—By subsoil drainage is meant the reducing of the level of the ground-water by draining all subsoil water into certain watercourses, either artificial or natural. Subsoil drainage is not a modern discovery, as it was used in many ancient lands, and was extensively employed in ancient Rome, the valleys and suburbs of which would have been uninhabitable but for the draining of the marshes by the so-called "cloacæ" or drains, which lowered the ground-water level of the low parts of the city and made them fit to build upon. The drains for the conduction of subsoil water are placed at a certain depth, with a fall toward the exit. The materials for the drain are either stone and gravel trenches, or, better, porous earthenware pipes or ordinary drain-tile. The drains must not be impermeable or closed, and sewers are not to be used for drainage purposes. Sometimes open V-shaped pipes are laid under the regular sewers, if these are at the proper depth.

By subsoil drainage it is possible to lower the level of ground-water wherever it is near or at the surface, as in swamps, marsh, and other lands, and prepare lands previously uninhabitable for healthy sites.

# CHAPTER II.

## AIR.

**Composition.**—The composition of atmospheric air is quite uniform, and is as follows in 100 volumes:

| | |
|---|---|
| Nitrogen | 79.00% |
| Oxygen | 20.96% |
| Carbonic acid | 00.04% |

Besides these principal constituents, air contains also ozone, argon, traces of ammonia, aqueous vapor, suspended soli and various gases.

*Nitrogen.*—The quantity of this constituent is invariable. Its function seems to be that of a diluent of the oxygen, and as a participant in the various chemical processes of vegetable life.

*Oxygen* varies in quantity but very little, from 20.98% in pure mountain air to 20.87% in the air of cities. The greatest variation exists between inspired and expired air. In expired air the volume of oxygen present is 16.03%, as compared with the 20.87% in city air. Oxygen is the most important of all the air constituents. Light, heat, growth, and life itself, are due to the oxygen in the air, without which vegetable, animal, and human life would be extinct, and the earth cold, barren, and lifeless. When the relative quantity of oxygen in the air falls below 8%, animals cannot live.

*Carbonic acid* or $CO_2$ (its chemical formula) is found in the air in the small average quantity of 0.04%, or 4 parts in 10,000; in pure air there may be less than 0.03% of $CO_2$; in ground air, in the air of mines, and in holds of badly ventilated ships the percentage of $CO_2$ may read 10 per 100.

Carbonic acid is the product of organic decomposition and oxidation, and is indispensable to vegetable life, which absorbs it and exhales oxygen.

Ozone, argon, and ammonia are found in very minute quantities, and their functions are not as yet definitely determined.

**Humidity, Temperature, and Pressure.**—The atmosphere is never entirely dry, there always being a relative amount of aqueous vapor, varying from 30% to 100%, or saturation. The relative proportions of aqueous vapor determine the degree of humidity, 65-75% being regarded as the most beneficial to health. The warmth of the air is derived from the rays of the sun, according to the intensity of which the temperature varies. The atmosphere extends from the surface to an indefinite height, and, according to the law of gravitation, presses downward with a certain force. This force, called atmospheric pressure, varies according to the temperature and relative humidity of the air, a warmer air being lighter, a cold air heavier, and a dry air weighing less than a damp air. These differences in relative pressure, temperature, and humidity produce the constant motion of the air, called "wind."

**Impurities in Air.**—The atmosphere surrounds our earth, participates in its life, and is charged with débris and particles of mineral, vegetable, and animal life of the earth. By the action of gravitation and winds the suspended matters and gases are scattered and diffused, fall to the earth again, and are there digested, worked over, and oxidized in the great laboratory of Nature.

The impurities in air, according to their substance and character, are as follows: Mineral, Vegetable, Animal, Bacteria, and Gases.

The mineral substances found in the air are the particles of soil, such as silica, sand, chalk, iron, lead, arsenic, zinc, copper, etc.

The vegetable substances are carbon, fibres and cells, starch, grains, cotton, moulds, fungi, pollen, etc.

The animal substances are either the débris from the various living and dead animals, or the microscopic animalculi suspended in the air. The following are some of the animal particles found in air: wool, silk fibres, human hair, epithelial cells, fragments of insects, pus cells, molecular débris, and the various micro-organisms.

The bacteria in the air are either saprophytic or pathogenic, and their number varies from 0 in pure mountain air to 79,000 per cubic metre in the air of Paris.

The gaseous impurities of the air are the various compounds of carbon (carbon monoxide and dioxide), of hydrogen (sulphuretted and carburetted), of nitrogen (ammonia, ammonia acetate, sulphide, nitrous and nitric acids), of sulphur, etc.

**Impurities According to their Source.**—According to their source the impurities in the air are:

Impurities due to respiration.

Impurities due to organic decomposition.

Impurities due to combustion.

Impurities due to various trades.

*Impurities Due to Respiration.*—The expired air from the lungs of man or beast is poorer in oxygen by about 4%, and richer in $CO_2$ by a similar quantity—4%. This increase in the $CO_2$ is not of much importance when in the free air, for any excess of one gas is speedily reduced; in confined spaces, however, the air which has been expired is soon laden with $CO_2$ until it becomes unfit for further respiration. Besides the increased $CO_2$, respired air contains the organic exhalations which go hand in hand with the increase of $CO_2$. This organic matter, which vitiates the air and renders it malodorous and offensive, is a product of nitrogenous animal decomposition; it yields ammonia, darkens sulphuric acid, decolorizes potassium permanganate, and is, together with the decrease of O and increase of $CO_2$, the cause of the poisonous action which unventilated rooms and places have upon people. That a room in which the respired air is unchanged is directly poisonous, has been proved over and over again; and the oft-quoted Black Hole of Calcutta, in which 123 out of 146 people died within 10 hours, is cited as an example.

*Organic Decomposition* is a prolific source of air impurity. Of the organic human effluvia, we have already spoken; air is, however, largely vitiated by the emanation of the various decomposition products of organic matter, *e.g.*, the effete products of man and beast, such as urine, sewage, and other excrementitious matter. The atmosphere of cities is constantly contaminated with the effluvia from soil, ground-air, sewer-gases, etc.

*Combustion* is also a very important source of air vitiation. The products of coal and wood combustion are carbon monoxide and dioxide, $CO$ and $CO_2$, various sulphur compounds, and a large quantity of soot and tarry matter. Illumination by oil, candles, gas, etc., is also a source of various impurities. Every cubic foot of gas burnt per hour vitiates as much air as would be rendered impure by one individual. Electric light is the only illuminant that does not add impurities to the air.

In certain *trades* a large amount of dust and also of various chemical substances and gases are produced which render the air in and about said places impure.

**Influence of Air on Health.**—That the air, without which we cannot live more than a few minutes, has a great influence on the health of man, is self-evident. The physical condition of the air, the temperature, pressure, humidity, motion, relative content of one or the other of its constituents, the degree of vitiation, and the impurities in the air, all have a marked influence on the health, life, and longevity of man.

**Diseases Due to Impure Air.**—Impure air has a directly bad effect on health, and is capable of producing certain diseases. These diseases may be due to the direct or indirect effects of the various impurities found in the air; impurities which may have a very detrimental influence upon the respiratory, digestive, and general functions of the body.

$CO_2$ when habitually inhaled in small amounts causes malaise, headache, debility; in large amounts it is a virulent poison.

The products of organic decomposition, sewer-gas, and the many pathogenic bacteria which abound and multiply in decomposed organic matter are all capable of producing bad effects on health.

Carbon monoxide and the other products of combustion and illumination cause, when constantly inhaled, various respiratory and constitutional diseases, and may produce death when inhaled in large amounts.

The mechanical and chemical impurities which are produced during and in the process of the various manufactures and trades are the direct cause of many of the diseases of those employed in those trades. Altogether the influence of atmospheric air in the causation and spread of disease has been underestimated rather than overestimated.

## CHAPTER III.

### VENTILATION.

**Definition.**—The air within an uninhabited room does not differ from that without. If the room is occupied by one or more individuals, however, then the air in the room soon deteriorates, until the impurities therein reach a certain degree incompatible with health. This is due to the fact that with each breath a certain quantity of $CO_2$, organic impurities, and aqueous vapor is exhaled; and these products of respiration soon surcharge the air until it is rendered impure and unfit for breathing. In order to render the air pure in such a room, and make life possible, it is necessary to change the air by withdrawing the impure, and substituting pure air from the outside. This is *ventilation.*

*Ventilation,* therefore, is the maintenance of the air in a confined space in a condition conducive to health; in other words, " ventilation is the replacing of the impure air in a confined space by pure air from the outside."

**Quantity of Air Required.**—What do we regard as impure air? What is the index of impurity? How much air is required to render pure an air in a given space, in a given time, for a given number of people?

How often can the change be safely made, and how? These are the problems of ventilation.

An increase in the quantity of $CO_2$, and a proportionate increase of organic impurities, are the results of respiratory vitiation of the air; and it has been agreed to regard the relative quantity of $CO_2$ as the standard of impurity, its increase serving as an index of the condition of the air. We have seen that the normal quantity of $CO_2$ in the air is 0.04%, or 4 volumes in 10,000; and it has been determined that whenever the $CO_2$ reaches 0.06%, or 6 parts per 10,000, the maximum of air vitiation is reached—a point beyond which the breathing of the air becomes dangerous to health.

We therefore know that an increase of 2 volumes of $CO_2$ in 10,000 of air constitutes the maximum of admissible impurity; the difference between 0.04% and 0.06%. Now, a healthy average adult at rest exhales in one hour 0.6 cubic foot of $CO_2$. Having determined these two factors—the amount of $CO_2$ exhaled in one hour and the maximum of admissible impurity—we can find by dividing 0.6 by 0.0002 (or 0.02 per cent.) the number of cubic feet of air needed for one hour, = 3000.

Therefore, a room with a space of 3000 cubic feet, occupied by one average adult at rest, will not reach its maximum of impurity (that is, the air in such a room will not be in need of a change) before one hour has elapsed.

The relative quantity of fresh air needed will differ for adults at work and at rest, for children, women, etc.;

it will also differ according to the illuminant employed, whether oil, candle, gas, etc.—an ordinary 3-foot gas-burner requiring 1800 cubic feet of air in one hour.

It is not necessary, however, to have 3000 cubic feet of space for each individual in a room, for the air in the latter can safely be changed at least three times within one hour, thus reducing the air-space needed to about 1000 cubic feet. This change of air or ventilation of a room can be accomplished by mechanical means oftener than three times in an hour, but a natural change of more than three times in an hour will ordinarily create too strong a current of air, and may cause draughts and chills dangerous to health.

In determining the cubic space needed, the height of the room as well as the floor-space must be taken into consideration. As a rule the height of a room ought to be in proportion to the floor space, and in ordinary rooms should not exceed 14 feet, as a height beyond that is of very little advantage.

**Forces of Ventilation.**—We now come to the question of the various modes by which change in the air of a room is possible. Ventilation is natural or artificial according to whether artificial or mechanical devices are or are not used. Natural ventilation is only possible because our buildings and houses, their material and construction, are such that numerous apertures and crevices are left for air to come in; for it is evident that if a room were hermetically air-tight, no natural ventilation would be possible.

The properties of air which render both natural and artificial ventilation possible are diffusion, motion, and gravity. These three forces are the natural agents of ventilation.

There is a constant diffusion of gases taking place in the air; this diffusion takes place even through stone and through brick walls. The more porous the material of which the building is constructed, the more readily does diffusion take place. Dampness, plastering, painting, and papering of walls diminish diffusion, however.

The second force in ventilation is the motion of air, or winds. This is the most powerful agent of ventilation, for even a slight, imperceptible wind travelling about two miles an hour is capable, when the windows and doors of a room are open, of changing the air of a room 528 times in one hour. Air passes also through brick and stone walls. The objections to winds as a sole mode of ventilation are their inconstancy and irregularity. When the wind is very slight, its ventilating influence is very small; on the other hand, when the wind is strong, it cannot be utilized as a means of ventilation on account of the air-currents being too strong and capable of exerting deleterious effects on health.

The third, the most constant and reliable, and, in fact, principal agent of ventilation, is the specific gravity of the air, and the variations in the gravity and consequent pressure which are results of the variations in temperature, humidity, etc. Whenever air is warmer in one place than in another, the warmer air being lighter and the colder air outside being heavier, the latter exerts pressure upon the air in the room, causing the lighter air in the room to escape and be displaced by the heavier air from the outside, thus changing the air in the room. This mode of ventilation is always constant and at work, as the very presence of living beings in the room warms the air therein, thus causing a difference from the outside air and effecting change of air from the outside to the inside of the room.

**Methods of Ventilation.**—The application of these principles of ventilation is said to be accomplished in a natural or an artificial way, according as mechanical means to utilize the forces and properties of air are used or not. But in reality natural ventilation can hardly be said to exist, since dwellings are so constructed as to guard against exposure and changes of temperature, and are usually equipped with numerous appliances for promoting change of air. Windows, doors, fire-places, chimneys, shafts, courts, etc., are all artificial methods of securing ventilation, although we usually regard them as means of natural ventilation.

**Natural Ventilation.**—The means employed for applying the properties of diffusion are the materials of construction. A porous material being favorable for diffusion, some such material is placed in several places within the wall, thus favoring change of air. Imperfect carpenter-work is also a help, as the cracks and openings left are favorable for the escape and entrance of air.

Wind, or the motion of air, is utilized either directly, through windows, doors, and other openings; or indirectly, by producing a partial vacuum in passing over chimneys and shafts, causing suction of the air in them and the consequent withdrawal of the air from the rooms.

The opening of windows and doors is possible only in warm weather; and as ventilation becomes a problem only in temperate and cold weather, the opening of windows and doors cannot very well be utilized without causing colds, etc. Various methods have therefore been proposed for using windows for the purposes of ventilation without producing forcible currents of air.

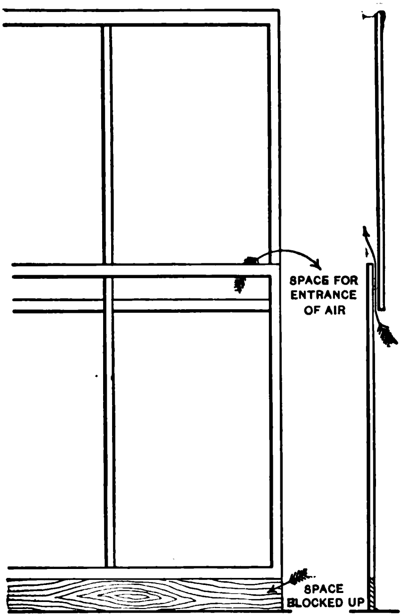



FIG. 3.—HINKES BIRD WINDOW. (TAYLOR.)

The part of the window best fitted for the introduction of air is the space between the two sashes, where they meet. The ingress of air is made possible whenever the lower sash is raised or the upper one is lowered.

In order to prevent cold air from without entering through the openings thus made, it has been proposed by Hinkes Bird to fit a block of wood in the lower opening; or else, as in Dr. Keen's arrangement, a piece of paper or cloth is used to cover the space left by the lifting or lowering of either or both sashes. Louvers or inclined panes or parts of these may also be used. Parts or entire window-panes are sometimes wholly removed and replaced by tubes or perforated pieces of zinc, so that air may come in through the apertures. Again,

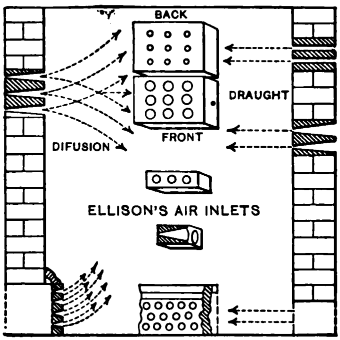



Fig. 4. (Knight.)

apertures for inlets and outlets may be made directly in the walls of the rooms. These openings are filled in with porous bricks or with specially made bricks (like Ellison's conical bricks), or boxes provided with several openings. A very useful apparatus of this kind is the so-called Sherringham valve, which consists of an iron box fitted into the wall, the front of the box facing the room having an iron valve hinged along its lower edge, and so constructed that it can be opened or be closed at will to let a current of air pass upward. Another very good appa-

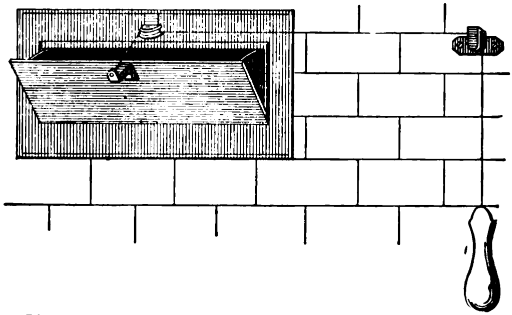


FIG. 5.—SHERRINGHAM VALVE. (TAYLOR.)

ratus of this kind is the Tobin ventilator, consisting of horizontal tubes let through the walls, the outer ends

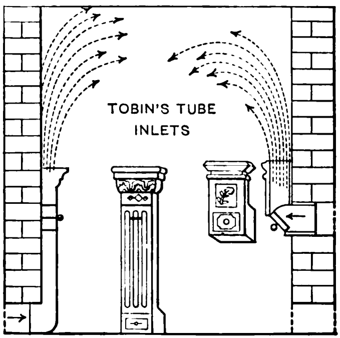



FIG. 6. (KNIGHT.)

open to the air, but the inner ends projecting into the room, where they are joined by vertical tubes carried up 5 feet or more from the floor, thus allowing the outside air to enter upwardly into the room. This plan is also adapted for filtering and cleaning the incoming air by placing cloth or other material across the lumen of the horizontal tubes to intercept dust, etc. McKinnell's ventilator is also a useful method of ventilation, especially of underground rooms.

To assist the action of winds over the tops of shafts

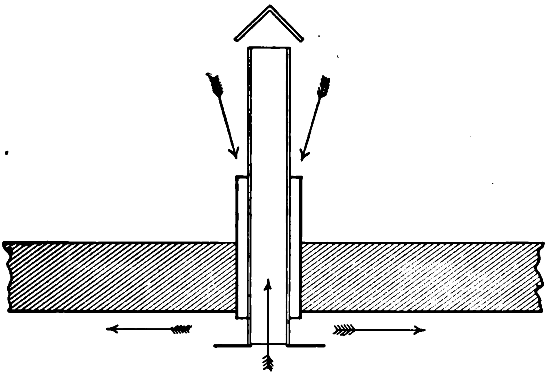


FIG. 7.—MCKINNELL'S VENTILATOR. (TAYLOR.)

and chimneys, various cowls have been devised. These cowls are arranged so as to help aspirate the air from the tubes and chimneys, and prevent a down-draught.

The same inlets and outlets which are made to utilize winds may also be used for the ventilation effected by the motion of air due to difference in the specific gravity of outside and inside air. Any artificial warming of the air in the room, whether by illuminants or by the various methods of heating rooms, will aid in ventilating it, the chimneys acting as powerful means of removal for the warmer air. Various methods have also been proposed for utilizing the chimney, even when no stoves, etc., are connected with it, by placing a gaslight within the chimney to cause an up-draught and consequent aspiration of the air of the room through it.

The question of the number, relative size, and position of the inlets and outlets is a very important one,

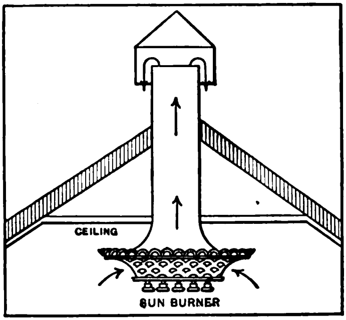



FIG. 8. (KNIGHT.)

but we can here give only an epitome of the requirements.

The inlet and outlet openings should be about 24 inches square per head. Inlet openings should be short, easily cleaned, sufficient in number to insure a proper distribution of air; should be protected from heat, provided with valves so as to regulate the inflow of air, and, if possible, should be placed so as to allow the air passing through them to be warmed before entering the room. Outlet openings should be placed near the ceiling, should be straight and smooth, and, if possible, should be heated so as to make the air therein warmer, thus preventing a down-draught, as is frequently the case when the outlets become inlets.

**Artificial Ventilation.**—Artificial ventilation is accomplished either by aspirating the air from the building, known as the vacuum or extraction method, or by forcing into the building air from without; this is known as the plenum or propulsion method.

The extraction of the air in a building is done by

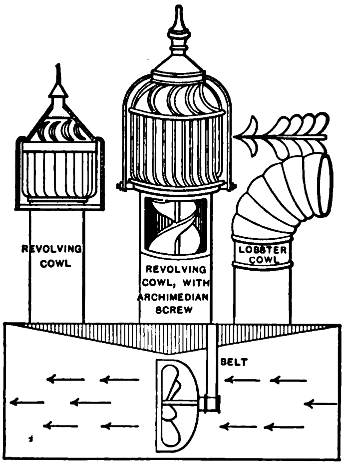



FIG. 9.—COWL VENTILATORS. (KNIGHT.)

means of heat, by warming the air in chimneys or special tubes, or by mechanical means with screws or fans run by steam or electricity; these screws or fans revolve and aspirate the air of the rooms, and thus cause pure air to enter.

The propelling method of ventilation is carried out by mechanical means only, air being forced in from the outside by fans, screws, bellows, etc.

Artificial ventilation is applicable only where a large volume of air is needed, and for large spaces, such as theatres, churches, lecture-rooms, etc. For the ordi-

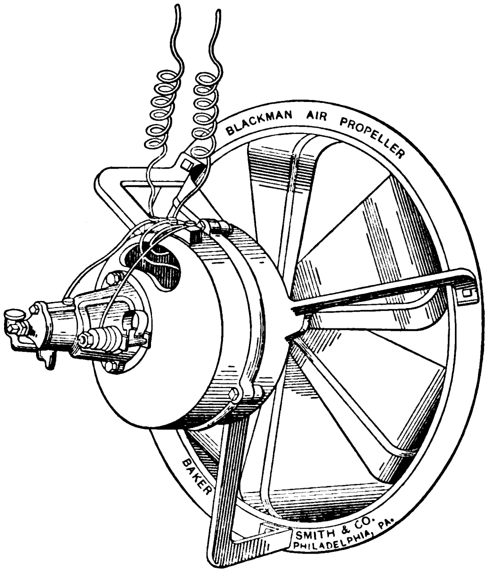



FIG. 10.

nary building the expense for mechanical contrivances is too high.

On the whole, ventilation without complex and cumbersome mechanisms is to be preferred.

For further particulars as to artificial ventilation, see chapter on ventilation of factories.

# CHAPTER IV.

## WARMING.

**Ventilation and Heating.**—The subject of the heating of our rooms and houses is very closely allied to that of ventilation, not only because both are a special necessity at the same time of the year, but also because we cannot heat a room without at the same time having to ventilate it, by providing an egress for the products of combustion and introducing fresh air to replace the vitiated.

**Need of Heating.**—In a large part of the country, and during the greater period of the year, some mode of artificial heating of rooms is absolutely necessary for our comfort and health. The temperature of the body is 98° to 99° F., and there is a constant radiation of heat due to the cooling of the body surface. If the external temperature is very much below that of the body, and if the low temperature is prolonged, the radiation of heat from the body is too rapid, and colds, pneumonia, etc., result. The temperature essential for the individual varies according to age, constitution, health, environment, occupation, etc. A child, a sick person, or one at rest requires a relatively higher temperature than a healthy adult at work. The mean temperature of a room most conducive to the health of the average person is from 65° to 75° F.

**The Three Methods of Heating.**—The heating of a room can be accomplished either *directly* by the rays of the sun or processes of combustion. We thus receive *radiant* heat, exemplified by that of open fires and grates.

Or, the heating of places can be accomplished by the heat of combustion being conducted through certain materials, like brick walls, tile, stone, and also iron; this is *conductive* heat, as afforded by stoves, etc.

Or, the heat is *conveyed* by means of air, water, or steam from one place to another, as in the hot-water, hot-air, and steam systems of heating; this we call *convected* heat.

There is no strict line of demarcation differentiating the three methods of heating, as it is possible that a radiant heat may at the same time be conductive as well as convective—as is the case in the Galton fire-place, etc.

**Materials of Combustion.**—The materials of combustion are air, wood, coal, oil, and gas. Air is indispensable, for, without oxygen, there can be no combustion. Wood is used in many places, but is too bulky and expensive. Oil is rarely used as a material of combustion, its principal use being for illumination. Coal is the best and cheapest material for combustion. The chief objection against its use is the production of smoke, soot, and of various gases, as $CO$, $CO_2$, etc. Gas is a very good, in fact, the best material for heating, especially if, when used, it is connected with chimneys; otherwise it is objectionable, as it burns up too much air, vitiates the atmosphere, and the products of combustion are deleterious; it is also quite expensive. The ideal means of heating is electricity.

**Chimneys.**—All materials used for combustion yield products more or less injurious to health. Every system of artificially heating houses must therefore have not only means of introducing fresh air to aid in the burning up of the materials, but also an outlet for the vitiated, warmed air, partly charged with the products of combustion. These outlets are provided by chimneys. Chimneys are hollow tubes or shafts built of brick and lined with earthen pipes or other material inside. These tubes begin at the lowest fireplace or connection, and are carried up several feet above the roof. The thickness of a chimney is from 4 to 9 inches; the shape square, rectangular, or preferably circular. The diameter of the chimney depends upon the size of the house, the number of fire-connections, etc. It should be neither too small nor too large. Square chimneys should be 12 to 16 inches square; circular ones from 6 to 8 inches in diameter for each fire-connection. The chimney consists of a *shaft*, or vertical tube, and *cowls* placed over chimneys on the roof to prevent down-draughts and the falling in of foreign bodies. That part of the chimney opening into the fireplace is called the *throat*.

**Smoky Chimneys.**—A very frequent cause of complaint in a great many houses is the so-called "smoky chimney"; this is the case when smoke and coal-gas escape from the chimney and enter the living rooms. The principal causes of this nuisance are:

1) A too wide or too narrow diameter of the shafts. A shaft which is too narrow does not let all the smoke escape; one which is too wide lets the smoke go up only in a part of its diameter, and when the smoke meets a counter-current of cold air it is liable to be forced back into the rooms.

2) The throat of the chimney may be too wide, and will hold cold air, preventing the warming of the air in the chimneys and the consequent up-draught.

3) The cowls may be too low or too tight, preventing the escape of the smoke.

4) The brickwork of the chimney may be loose, badly constructed, or broken into by nails, etc., thus allowing smoke to escape therefrom.

5) The supply of air may be deficient, as when all doors and windows are tightly closed.

6) The chimney may be obstructed by soot or some foreign material.

7) The wind above the house may be so strong that its pressure will cause the smoke from the chimney to be forced back.

8) If two chimneys rise together from the same house, and one is shorter than the other, the draught of the longer chimney may cause an inversion of the current of air in the lower chimney.

9) Wet fuel when used will cause smoke by its incomplete combustion.

10) A chimney without a fire may suck down the smoke from a neighboring chimney; or, if two fire-

places in different rooms are connected with the same chimney, the smoke from one room may be drawn into the other.

**Methods of Heating. Open Fire-places and Grates.** —Open fire-places and fires in grates connected with chimneys, and using coal, wood, or gas, are very comfortable; nevertheless there are weighty objections to them. Firstly, but a very small part of the heat of the material burning is utilized, only about 12% being radiated into the room, the rest going up the chimney. Secondly, the heat of grates and fire-places is only local, being near the fires and warming only that part of the person exposed to it, leaving the other parts of the room and person cold. Thirdly, the burning of open fires necessitates a great supply of air, and causes powerful draughts.

The open fire-place can, however, be greatly improved by surrounding its back and sides by an air-space, in which air can be warmed and conveyed into the upper part of the room; and if a special air-inlet is provided for supplying the fire with fresh air to be warmed, we get a very valuable means of heating. These principles are embodied in the Franklin and Galton grates. A great many other grates have been suggested, and put on the market, but the principal objection to them is their complexity and expense, making their use a luxury not attainable by the masses.

**Stoves.**—Stoves are closed receptacles in which fuel is burned, and the heat produced is radiated towards the persons, etc., near them, and also conducted through the iron or other materials of which the stoves are made to surrounding objects. In stoves 75% of the fuel burned is utilized. They are made of brick, tile, and cast or wrought iron.

Brick stoves, and stoves made of tile, are extensively used in some European countries, as Russia, Germany,

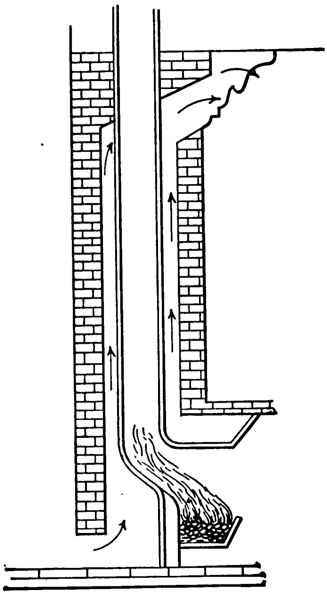


FIG. 11.—GALTON GRATE. (TRACY.)

Sweden, etc.; they are made of slow-conducting material, and give a very equable, efficient, and cheap heat, although their ventilating power is very small.

Iron is used very extensively because it is a very good conductor of heat, and can be made into very convenient forms. Iron stoves, however, often become superheated, dry up, and sometimes burn the air around them, and produce certain deleterious gases during combustion. When the fire is confined in a clay fire-box, and the stove is not overheated, a good supply of fresh air being provided and a vessel of water placed

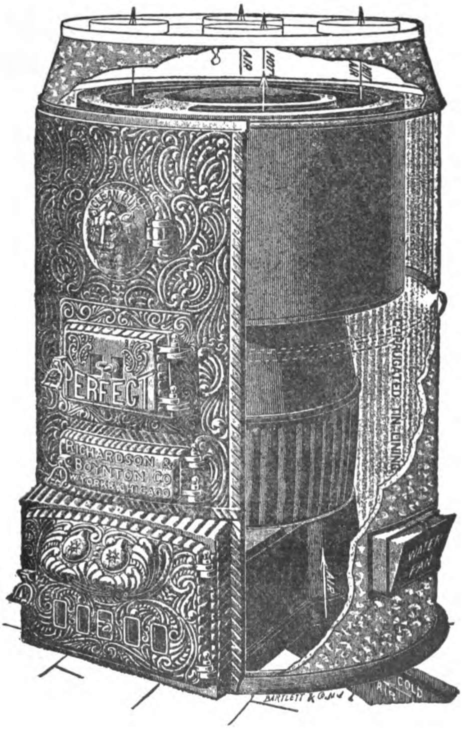



FIG. 12.—HOT-AIR FURNACE.

on the stove to reduce the dryness of the air, iron stoves are quite efficient.

**Hot-air Warming.**—In small houses the warming of the various rooms and halls can be accomplished by placing the stove or furnace in the cellar, heating a large quantity of air and conveying it through proper tubes to the rooms and places to be warmed. The points to be observed in a proper and efficient hot-air heating system are the following:

1) The furnace must be of a proper size in proportion to the area of space to be warmed. 2) The joints and parts of the furnace must be gas-tight. 3) The furnace should be placed on the cold side of the house, and provision made to prevent cellar-air from being drawn up into the cold-air box of the furnace. 4) The air for the supply of the furnace must be gotten from outside, and the source must be pure, above the ground-level, and free from contamination of any kind. 5) The cold-air box and ducts must be clean, protected against the entrance of vermin, etc., and easily cleaned. 6) The air should not be overheated. 7) The hot-air flues or tubes must be short, direct, circular, and covered with asbestos or some other non-conducting material.

**Hot-water System.**—The principles of hot-water heating are very simple. Given a circuit of pipes filled with water, on heating the lower part of the circuit, the water, becoming warmer, will rise, circulate, and heat the pipes in which it is contained, thus warming the air in contact with the pipes. The lower part of the circuit of pipe begins in the furnace or heater, and the other parts of the circuit are conducted through the various rooms and halls throughout the house to the uppermost story. The pipes need not be straight all through; hence, to secure a larger area for heating, they are convoluted within the furnace, and also in the rooms, where the convoluted pipes are called *radiators.* The water may be warmed by the low- or high-pressure system; in the latter pipes of small diameter may be employed, while in the former pipes of a large diameter will be required. The character, etc., of the boilers, furnace, pipes, etc., cannot be gone into here.

**Steam-heating System.**—The principle of steam heating does not differ from that of the hot-water system. Here the pressure is greater and steam is employed instead of water. The steam gives a greater degree of heat, but the pipes must be stronger and able to withstand the pressure. There are also combinations of steam and hot-water heating. For large houses either steam or hot-water heating is the best means of warming, and, if properly constructed and cared for, quite healthy.

## CHAPTER V.

### WATER.

**Composition.**—Water is a compound of two elements: Hydrogen and Oxygen, united in the proportion of 2 volumes of the former to 1 of the latter; its chemical formula is $H_2O$.

**Quantity Required.**—Owing to the many uses to which water is put, a large quantity is needed. The quantity varies according to the people and their degree of civilization, according to place, supply, etc. The average quantity of water needed for all purposes has been estimated to be about 50 gallons per head per day. Most of the cities furnish a larger supply, however.

**Characteristics and Quality of Water.**—Water for drinking purposes must be clear, colorless, and without taste or odor; it should be aerated and free from impurities. Water is a powerful solvent, and therefore, in a state of nature, contains a great number of elements, compounds, and gases in solution as well as in suspension. The taste of water depends upon its source, character, substances present, gases, etc. When water contains a large quantity of calcium bicarbonate and magnesium salts, it is called *hard*. Soft water is better than hard for washing and cooking purposes, as well as for production of steam, hard water causing much trouble by forming incrustations within pipes and boilers. Not every palatable water is wholesome, as sometimes a palatable, sparkling water is due to excess of $CO_2$ produced by pollution with organic matter. Rain-water, when uncontaminated, is the purest and most wholesome, but it is not very palatable owing to its being unaerated.

**Source.**—All water is derived primarily from the precipitation of aqueous vapor in form of rain, snow, and dew.

The sources of water are:

1) Rain-water,—collected immediately after falling, and stored for future use.

2) Surface-water,—found in lakes, rivers, and ponds.

3) Ground-water,—obtained from springs and wells.

According to the Report of the River-Pollution Commission, waters are:

| | | |
|---|---|---|
| **Wholesome..** | **Spring-water,** | **very palatable.** |
| | **Deep well-water,** | |
| | **Upland surface-water,** | **moderately palatable.** |
| **Suspicious...** | **Stored rain-water,** | |
| | **Surface-water from cultivated land,** | **palatable.** |
| | **River-water contaminated with sewage,** | |
| | **Shallow well-water,** | |

**Impurities.**—Absolutely pure water can only be found in the laboratory in the form of distilled water, immediately after its condensation; otherwise water, being a powerful solvent, will take up foreign materials and gases with which it may come in contact. Rain is the purest water found in nature, but in its transit through the air it takes up suspended impurities, and when it reaches the ground it is already contaminated by those impurities. The impurities found in water are classified according to their character: mineral, vegetable, animal, bacterial, and gaseous; or according to their source, character of the soils, and contamination of the water due to the methods of its collection, storage, distribution, etc.

**Pollution.**—Owing to the fact that water takes up most inorganic and organic matters, it is often polluted by various poisonous materials, metals, organic impurities, and pathogenic bacteria with which it comes in contact on passing from its various sources, through the soil, surface-air, ground-water, etc. The sources of water-supply, especially within the soil and also on the surface, such as rivers and lakes, are prone to be contaminated by sewage, refuse, bacteria, and other impurities, and the water derived from these sources may take up any or all of these impurities.

**Influence on Health and Diseases Due to Impure Water.**—Next to air, water is most indispensable to life and health; and the lack of water, or a supply of water contaminated by impurities, naturally exerts a great influence on health. A deficient supply for drinking purposes will cause failing health, and a lack of water for body cleansing and flushing purposes will impair the health and predispose to various diseases. The impurities contained in water are capable of producing various diseases, according to the character of the impurity and the quantity present.

Drinking water is the ever-present agent in the spread of many diseases.

Diarrhœas, Intestinal Disorders, Gastric and Intestinal Parasites, Yellow Fever, Cholera, and Typhoid Fever are among the diseases due to organic and bacterial pollution of the drinking-water. The death-rate from typhoid fever has been very considerably reduced in those cities which have installed plants for the purification of their drinking-water supply.

# CHAPTER VI.

## WATER-SUPPLY.

**Water-supply.**—Wherever there is a large number of people in one place, the quantity of water needed for the use of the population is very great, and a supply of sufficient quantity and quality becomes a sanitary problem of great importance. The importance of this problem had been recognized very early in the history of man; and we find in many ancient lands quite successful attempts to supply water on a grand scale. In Egypt artificial lakes were made to provide an adequate water-supply in places where the natural supply by the Nile was insufficient. Remains of gigantic water-basins of marvellous construction have been found in Peru and Mexico. In Ceylon there is found the remains of a great tank or artificial lake, 40 miles in circumference. It was in ancient Rome, however, that municipal water-supply reached its zenith of development. In the year 624 B.C. King Ancus Marcius began the first great aqueduct which supplied Rome with pure water drawn from a distant mountain; and at the end of the first century A.D. we find in Rome 14 aqueducts supplying 375 millions of gallons, or about 300 gallons per head per diem.

During the middle ages all sanitary measures, and also municipal water-supply, were neglected; and coming down to more recent times, we find that in the United States, at the beginning of the 19th century, only 17 water-works were in existence. During the past century, however, great progress has been made in this as well as in other sanitary matters; and at present we find in the United States nearly 4,000 water-supplying works, most of them being owned by municipalities.

**Sources of Water-supply.**—The sources of water are, as we have seen in the last chapter: 1) Rain, 2) surface-water, and 3) subsurface-water.

**Rain-water.**—The supply of rain-water is uncertain, variable in quantity, and unreliable in quality.

The quality of rain-water, apart from its lack of aeration, is good, but only a small part of the water needed can be conveniently collected for immediate use; and in order to make provision for future use, various receptacles must be employed for the storage of rain-water and its distribution. The receptacles employed for storage, etc., of rain-water are liable to be contaminated, causing the impurities to pollute the water. As a rule, little reliance can be placed upon supplying a large number of people from rain-water directly.

**Surface-water.**—Surface-water is but rain collected on the surface in the form of ponds, lakes, and rivers, which serve as natural reservoirs and storage-tanks for the collection of fresh water. The water from these sources is easy to obtain, and in unpopulated districts is, as a rule, very pure and fit for drinking purposes. The character of these waters depends, however, upon the nature of the soil in which they are located, and the degree of contamination due to sewage, refuse, and organic impurities drained into the watercourses. The proximity of dwellings, towns, factories, etc., is of great importance, and greatly influences the character and purity of the natural water-supply.

**Subsurface-waters.**—The water gained from underground sources is that found in springs and wells.

*Springs* are natural outcroppings of subsoil-water, and are numerous in some mountain regions. The character of spring-water varies according to the source, temperature, and physical character of the soils through which the water passes. There are iron, sulphur, salt, and other springs, according to the minerals they contain; there are also springs the waters of which are of high temperature. But in the great majority of springs the water is cool, free from impurities, and wholesome.

*Wells* are holes bored in the ground to certain levels at which water is found. They are of two kinds: shallow and deep. The shallow wells are those in which the water percolated into the ground and collected immediately under the first permeable soil-stratum, usually 20 to 50 feet from the surface. The quality of shallow-well water is suspicious on account of the frequent contamination of the soil by the drainage from nearby as well as far-distant cesspools and sewers, whereby a great quantity of organic impurities may drain into it. When free from contamination the water from shallow wells is wholesome.

Deep wells, or artesian wells, are those which pass through an impermeable stratum, usually far from surface; and as the water in these wells is from the deep underlying soil-strata, it is consequently free from surface contamination, and is very good for drinking purposes.

**Storage, Collection, and Distribution.**—Whenever a large quantity of water is required for future use, the water must be collected and stored in appropriate receptacles made for the purpose. The collection, storage, and distribution of water is an engineering problem which cannot be gone into here. Storage-tanks and reservoirs are constructed of brick, stone, or cement, if large, and of iron or wood, if small. All storage-vessels are liable to be contaminated, hence means must be provided to protect and cleanse them.

Where the source of water-supply is distant from the place of delivery, means have to be provided for conveying the water into the towns, etc., where it is to be used; this is done by stone and brick, also iron and lead conduits and pipes, through which the water passes. There are some objections to iron as well as to lead pipes. Iron becomes rusty in time, and lead is prone to impart to the water some of its metal, and thus may cause lead-poisoning. Glazed iron pipes and pipes coated with various non-absorbing substances have been devised to meet these objections.

**Purification.**—To free water from its impurities, the following various processes are in use.

1) *Distillation.* This is the best and only way to get absolutely pure water free from any contamination. Distilled water has a somewhat insipid taste, but this is overcome after thorough aeration of the water.

2) *Boiling.* This is the second best method, as the subjection of water to a continuous temperature of 212° F. kills most of the bacteria, and renders harmless all other impurities except mineral poisons.

3) *Chemical treatment.* The addition of certain chemicals, such as alum, boric acid, potassium permanganate, etc. These purify the water, but their use is not a desirable method of purification.

4) *Filtration.* Water, when passing through gravel, sand, powdered pumice-stone, charcoal, etc., loses part or most of the suspended impurities contained in it. The method of purification of water by filtration is most in vogue, not only in domestic, but also in municipal, economy. To be effective, filtration must be thorough, and a more or less frequent change of filter is necessary. The average domestic filter, however, is a snare and a delusion, and gives but little protection.

To be of any value a filter should be made so as to be readily accessible for cleansing purposes, and the filtering medium such as will effectually intercept all suspended impurities in the water. Sand, stone, animal charcoal, spongy iron, magnetic carbide of iron, porcelain, infusorial earth, baked and compressed diatomaceous earth have been employed as media for water filters. The Berkfeldt filter is made in various sizes, is readily attached to service pipes; the filtering cylinder is made of baked and compressed diatomaceous earth which, the manufacturers claim, gives almost a germ-proof water. The main trouble with this, as with other filters, is that the filtering medium easily clogs up, and must be removed and cleansed every day, in order to be of any efficiency.

# CHAPTER VII.

## DISPOSAL OF SEWAGE.

**Waste Products.**—There is a large amount of waste products in human and social economy. The products of combustion, such as ashes, cinders, etc.; the products of street sweepings and waste from houses, as dust, rubbish, paper, etc.; the waste from various trades; the waste from kitchens, *e.g.*, scraps of food, etc.; the waste water from the cleansing processes of individuals, domestic animals, clothing, etc.; and finally the excreta—urine and feces—of man and animals; all these are waste products that cannot be left undisposed of, more especially in cities and wherever a large number of people congregate. All waste products are classified into three distinct groups: 1) Refuse, 2) Garbage, and 3) Sewage.

The amount of *refuse* and *garbage* in cities is quite considerable; in Manhattan alone the dry refuse amounts to 1,000,000 tons a year, and that of garbage to 175,000 tons per year. A large percentage of the dry refuse and garbage is valuable from a commercial standpoint, and could be utilized with proper facilities for collection and separation. The disposal of refuse and garbage has not as yet been satisfactorily dealt with. The modes of waste disposal in the United States are: 1) Dumping into the sea; 2) filling in made land, or ploughing into lands; 3) cremation; and 4) reduction by various processes and the products utilized.

**Sewage.**—By sewage we mean the waste and effete human matter and excreta—the urine and feces of human beings and the urine of domestic animals (the feces of horses, etc., has great commercial value, and is usually collected separately and disposed of for fertilizing purposes).

The amount of excreta per person has been estimated (Frankland) as 3 ounces of solid and 40 ounces of fluid per day, or about 30 tons of solid and 100,000 gallons of fluid for each 1000 persons per year.

In sparsely populated districts the removal and ultimate disposal of sewage presents no difficulties; it is returned to the soil, which, as we know, is capable of purifying, disintegrating, and assimilating quite a large amount of organic matter. But when the number of inhabitants to the square mile increases, and the population becomes as dense as it is in some towns and cities, the disposal of the human waste products becomes a question of vast importance, and the proper, as well as the immediate and final, disposal of sewage becomes a serious sanitary problem.

It is evident that sewage must be removed in a thorough manner, otherwise it would endanger the lives and health of the people.

The dangers of sewage to health are:

1) From its offensive odors, which, while not always directly dangerous to health, often produce headaches, nausea, etc.

2) The organic matter contained in sewage decomposes and eliminates gases and other products of decomposition.

3) Sewage may contain a large number of pathogenic bacteria (typhoid, dysentery, cholera, etc.).

4) Contamination of the soil, ground-water, and air, by percolation of sewage.

The problem of sewage-disposal is twofold: 1) Immediate; viz., the need of not allowing sewage to remain too long on the premises, and its immediate removal beyond the limits of the city; and 2) the final disposition of the sewage, after its removal from the cities, etc.

**Modes of Ultimate Disposal of Sewage.**—The chief constituents of sewage are organic matter, mineral salts, nitrogenous substances, potash, and phosphoric acid. Fresh-mixed excrementitious matter has an acid reaction, but within 12–20 hours it becomes alkaline, because of the free ammonia formed in it. Sewage rapidly decomposes, evolving organic and fetid matters, ammonium sulphide, sulphuretted and carburetted hydrogen, etc., besides teeming with animal and bacterial life. A great many of the substances contained in sewage are valuable as fertilizers of soil.

The systems of final disposal of sewage are as follows:

1) Discharge into seas, lakes, and rivers.

2) Cremation.

3) Physical and chemical precipitation.

4) Intermittent filtration.

5) Land irrigation.

6) "Bacterial" methods.

*Discharge into Waters.*—The easiest way to dispose of sewage is to let it flow into the sea or other running watercourse. The objections to sewage discharging into the rivers and lakes near cities, and especially such lakes and rivers as supply water to the municipalities, are obvious. But as water can purify a great amount of sewage, this method is still in vogue in certain places, although it is to be hoped that it will in the near futue be superseded by more proper methods. The objection against discharging into seas is the operation of the tides, which cause a backflow and overflow of sewage from the pipes. This backflow is remedied by the following methods: 1) Providing tidal flap-valves, permitting the outflow of sewage, but preventing the inflow of sea-water; 2) discharging the sewage intermittently, only during low tide; and 3) providing a constant outflow by means of steam-power pressure.

*Cremation.*—Another method of getting rid of the sewage without attempting to utilize it is by cremation. The liquid portion of the sewage is allowed to drain and discharge into watercourses, and the more or less solid residues are collected and cremated in suitable crematories.

*Precipitation.*—This method consists in separating the solid matters from the sewage by precipitation by physical or chemical processes, the liquid being allowed to drain into rivers and other waters, and the precipitated solids utilized for certain purposes. The precipitation is done either by straining the sewage, collecting it into tanks, and letting it subside, when the liquid is drawn off and the solids remain at the bottom of the tanks, a rather unsatisfactory method; or, by chemical processes, precipitating the sewage by chemical means, and utilizing the products of such precipitation. The chemical agents by which precipitation is accomplished are many and various; among them are lime, alum, iron perchloride, phosphates, etc.

*Intermittent Filtration.*—Sewage may be purified mechanically and chemically by method of intermittent filtration by passing it through filter-beds of gravel, sand, coke, cinders, or any such materials. Intermittent filtration has passed beyond the experimental stage and has been adopted already by a number of cities where such a method of sewage disposal seems to answer all purposes.

*Land Irrigation.*—In this method the organic and other useful portions of sewage are utilized for irrigating land, to improve garden and other vegetable growths by feeding the plants with the organic products of animal excretion. Flat land, with a gentle slope, is best suited for irrigation. The quantity of sewage disposed of will depend on the character of the soil, its porosity, the time of the year, temperature, intermittency of irrigation, etc. As a rule, one acre of land is sufficient to dispose of the sewage of 100 to 150 people.

*Bacterial Methods.*—The other biological methods, or the so-called "bacterial" sewage treatment, are but modifications of the filtration and irrigation methods of sewage disposal. Properly speaking the bacterial purification of sewage is the scientific application of the knowledge gained by the study of bacterial life and their action upon sewage.

In intermittent filtration the sewage is passed through filter-beds of sands, etc., upon which filter-beds the whole burden of the purification of the sewage rests. In the bacterial methods the work of purification is divided between the septic tanks where the sewage is first let into and where it undergoes the action of the anaerobic bacteria, and from these septic tanks the sewage is run to the contact-beds of coke and cinders to further undergo the action of the aerobic bacteria, after the action of which the nitrified sewage is in a proper form to be utilized for fertilization of land, etc. The septic tanks are but a modification of the common cesspool, and are constructed of masonry, brick, and concrete.

There are a number of special applications of the bacterial methods of sewage treatment into which we cannot go here.

**Sewage-disposal in the United States.**—According to its location, position, etc., each city in the United States has its own method of final disposition of sewage. Either one or the other, or a combination of two of the above methods, is used.

The following cities discharge their sewage into the sea: Portland, Salem, Lynn, Gloucester, Boston, Providence, New York, Baltimore, Charleston, and Savannah.

The following cities discharge their sewage into rivers and lakes: Philadelphia, Cincinnati, St. Louis, Albany, Minneapolis, St. Paul, Washington, Buffalo, Detroit, Richmond, Chicago, Milwaukee, and Cleveland.

"Worcester uses chemical precipitation. In Atlanta a part of the soil is cremated, but the rest is deposited in pits 8 × 10 feet, and 5 feet deep. It is then thoroughly mixed with dry ashes from the crematory, and afterwards covered with either grain or grass. In Salt Lake City and in Woonsocket it is disposed of in the same way. In Indianapolis it is composted with marl and sawdust, and after some months used as a fertilizer. A portion of the sewage is cremated in Atlanta, Camden, Dayton, Evansville, Findlay, O., Jacksonville, McKeesport, Pa., Muncie, and New Brighton. In Atlanta, in 1898, there were cremated 2362 loads of sewage. In Dayton, during 30 days, there were cremated 1900 barrels of 300 pounds each." (*Chapin, Mun. San. in U. S.*)

**The Immediate Disposal of Sewage.**—The final disposition of sewage is only one part of the problem of sewage-disposal; the other part is how to remove it from the house into the street, and from the street into the places from which it is finally disposed.

The immediate disposal of sewage is accomplished by two methods—the so-called *dry*, and the *water-carriage*, methods. By the *dry method* we mean the removal of sewage without the aid of water, simply collecting the dry and liquid portions of excreta, storing it for some time, and then removing it for final disposal. By the *water-carriage method* is understood the system by which sewage, solid and liquid, is flushed out by means of water, through pipes or conduits called sewers, from the houses through the streets to the final destination.

**The Dry Methods.**—The dry or conservacy method of sewage-disposal is a primitive method used by all ancient peoples; in China at the present time, and in all villages and sparsely populated districts; it has for its basic principle the return to mother earth of all excreta, to be used and worked over in its natural laboratory. The excreta are simply left in the ground to undergo in the soil the various organic changes, the difference in methods being only as regards the vessels of collection and storage.

The methods are:

1) Cesspool and privy-vault.

2) Pail system.

3) Pneumatic system.

*The Privy-vault* is the general mode of sewage-disposal in villages, some towns, and even in some large cities, wherever sewers are not provided. In its primitive and unfortunately common form, the privy-vault is nothing but a hole dug in the ground near or at some distance from the house; the hole is but a few feet deep, with a plank or rough seat over it, and an improvised shed over all. The privy is filled with the excreta; the liquids drain into the adjacent ground, which becomes saturated, and contaminates the nearest wells and watercourses. The solid portion is left to accumulate until the hole is filled or the stench becomes unbearable, when the hole is either covered up and forgotten, or the excreta are removed and the hole used over again. This is the common privy as we so often find it near the cottages and mansions of our rural populace, and even in towns. A better and improved form of privy is that built in the ground, and made water-tight by being constructed of bricks set in cement, the privy being placed at a distance from the house, the shed over it ventilated, and the contents of the privy removed regularly and at stated intervals before they become a nuisance. At its best, however, the privy-vault is an abomination, as it can scarcely be so well constructed as not to contaminate the surrounding soil, or so often cleaned as to prevent decomposition and the escape of poisonous gases.

*The Pail System* is an economic, simple, and, on the whole, very efficient method of removing fresh excreta. The excreta are passed directly into stone or metal water- and gas-tight pails, which, after filling, are hermetically covered and removed to the places for final disposal. This system is in use in Rochedale, Manchester, Glasgow, and other places in England.

The pails may also be filled with dried earth, ashes, etc., which are mixed with the excreta and convert it into a substance fit for fertilization.

*The Pneumatic System* is a rather complicated mechanical method invented by Captain Lieurneur, and is used extensively in some places. In this system the excreta are passed to certain pipes and receptacles, and from there aspirated by means of air-exhausts.

**The Water-carriage System.**—We now come to the modern mode of using water to carry and flush all sewage material. This method is being adopted throughout the civilized world. For it is claimed the reduction of the mortality rate wherever it is introduced. The water-carriage system presupposes the construction and existence of pipes from the house to and through the street to the place of final disposition. The pipes running from the house to the streets are called house-sewers; and when in the streets, are called street-sewers.

**The Separate and Combined Systems.**—Whenever the water-carriage system is used, it is either intended to carry only sewage proper, viz., solid and liquid excreta flushed by water, or rain-water and other was-water from the household, in addition. The water-carriage system is accordingly divided into two systems: *the combined*, by which all sewage and all waste and rain-water are carried through the sewers, and the *separate* system, in which two groups of pipes are used: the sewers proper to carry sewage only, and the other pipes to dispose of rain-water and other uncontaminated waste water. Each system has its advocates, its advantages, and disadvantages. The advantages claimed for the separate system are as follows:

1) Sewers may be of small diameter, not more than 6 inches.

2) Constant, efficient flow and flushing of sewage.

3) The sewage gained is richer in fertilizing matter.

4) The sewers never overflow, as is frequently the case in the combined system.

5) The sewers being small, no decomposition takes place therein.

6) Sewers of small diameter need no special means of ventilation, or main traps on house-drains, and can be ventilated through the house-pipes.

On the other hand, the disadvantages of the separate system are:

1) The need of two systems of sewers, for sewage and for rain-water, and the expense attached thereto.

2) The sewers used for sewage proper require some system for periodically flushing them, which, in the combined system, is done by the occasional rains.

3) Small sewers cannot be as well cleaned or gotten at as larger ones.

The separate system has been used in Memphis and in Keene, N. H., for a number of years with complete satisfaction. Most cities, however, use the combined system.

# CHAPTER VIII.

## SEWERS.

**Definitions.**—A sewer is a conduit or pipe intended for the passage of sewage, waste, and rain-water.

A *house-sewer* is the branch sewer extending from a point two feet outside of the outer wall of the building to its connection with the street-sewer, etc.

**Materials.**—The materials from which sewers are constructed are iron, cement, and vitrified pipe.

Iron is used only for pipes of small diameter; and as most of the sewers are of greater diameter than 6 inches, they are made of other material than iron.

Cement and brick sewers are frequently used, and, when properly constructed, are efficient, although the inner surface of such pipes is rough, which causes adherence of sewage matter.

The most common material of which sewers are manufactured is earthenware, "vitrified pipes."

"Vitrified pipes are manufactured from some kind of clay, and are salt-glazed inside. Good vitrified pipe must be circular and true in section, of a uniform thickness, perfectly straight, and free from cracks or other defects; they must be hard, tough, not porous, and have a highly smooth surface. The thicknesses of vitrified pipes are as follows:

| | | | | | |
|---|---|---|---|---|---|
| 4 | inches | diameter.... | $\frac{1}{2}$ | inch | thick |
| 6 | " | " .... | $\frac{11}{16}$ | " | " |
| 8 | " | " .... | $\frac{3}{4}$ | " | " |
| 12 | " | " .... | 1 | " | " |

The pipes are made in 2- and 3-foot lengths, with spigot- and socket-ends." (Gerhardt.)

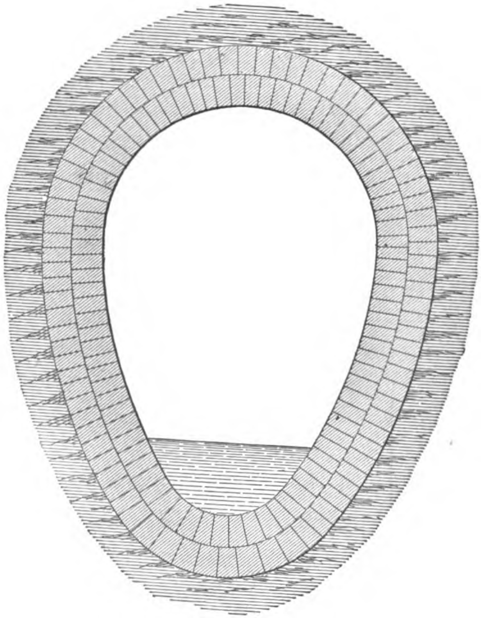


FIG. 13.—BRICK SEWER.

Sewer-pipes are laid in trenches at least 3 feet deep, to insure against the action of frosts.

**Construction.**—The level of the trenches in which sewers are laid should be accurate, and a hard bed must be secured or prepared for the pipes to lie on. If the ground is sandy and soft, a solid bed of concrete should be laid, and the places where the joints are should be hollowed out, and the latter embedded in cement.

**Joints.**—The joints of the various lengths must be gas-tight, and are made as follows: Into the hub (the enlargement on one end of the pipe) the spigot-end of the next length is inserted, and in the space left between the two a small piece, or gasket, of oakum, is rammed in; the remaining space is filled in with a mixture of the best Portland cement and clean, sharp sand. The office of the oakum is to prevent the cement from getting on the inside of the pipe. The joint is then wiped around with additional cement.

**Fall.**—In order that there should be a steady and certain flow of the contents of the sewer, the size and fall of the latter must be suitable; that is, the pipes must be laid with a steady, gradual inclination or fall toward the exit. This fall must be even, without sudden changes, and not too great or too small.

The following has been determined to be about the right fall for the sizes stated:

| | | | | | |
|---|---|---|---|---|---|
| 4-inch | pipe.... | 1 | foot | in | 40 feet |
| 6 " | " .... | 1 | " | " | 60 " |
| 9 " | " .... | 1 | " | " | 90 " |
| 12 " | " .... | 1 | " | " | 120 " |

**Flow.**—The velocity of the flow in sewers depends on the volume of their contents, the size of the pipes, and the fall. The velocity should not be less than 120 feet in a minute, or the sewer will not be self-cleansing.

**Size.**—In order for the sewer to be self-cleansing, its size must be proportional to the work to be accomplished, so that it may be fully and thoroughly flushed and not permit stagnation and consequent decomposition of its contents. If the sewer be too small, it will not be adequate for its purpose, and will overflow, back up, etc.; if too large, the velocity of the flow will be too low, and stagnation will result. In the separate system, where there is a separate provision for rain-water, the size of the sewer ought not to exceed 6 inches in diameter. In the combined system, however, when arrangements must be made for the disposal of large volumes of storm-water, the size of the sewer must be larger, thus making it less self-cleansing.

**Connections.**—The connections of the branch sewers and the house-sewers with the main sewer must be carefully made, so that there shall be no impediment to the flow of the contents, either of the branches or of the main pipe. The connections must be made gas-tight; not at right angles or by T branches, but by bends, curves, and Y branches, in the direction of the current of the main pipe, and not opposite other branch pipes; and the junction of the branch pipes and the main pipe must not be made at the crown or at the bottom of the sewer, but just within the water-line.

**Tide-valves.**—Where sewers discharge their contents into the sea, the tide may exert pressure upon the contents of the sewer and cause "backing up," blocking up the sewer, bursting open trap-covers, and overflowing into streets and houses. To prevent this, there are constructed at the mouth of the street-sewers, at the outlets to the sea, proper valves or tide-flaps, so constructed as to permit the contents of the sewers to flow out, yet prevent sea-water from backing up by immediately closing upon the slightest pressure from outside.

**House-sewers.**—Where the ground is "made," or filled in, the house-sewer must be made of cast iron, with the joints properly calked with lead. Where the soil consists of a natural bed of loam, sand, or rock, the house-sewer may be of hard, salt-glazed, and cylindrical earthenware pipe, laid in a smooth bottom free from projections of rock, and with the soil well rammed to prevent any settling of the pipe. Each section must be wetted before applying the cement, and the space between each hub and the small end of the next section must be completely and uniformly filled with the best hydraulic cement. Care must be taken to prevent any cement being forced into the pipe to form an obstruction. No tempered-up cement should be used. A straight-edge must be used inside the pipe, and the different sections must be laid in perfect line on the bottom and sides.

Connections of the house-sewer [when of iron] with the house main pipe must be made by lead-calked joints; the connection of the iron house-pipe with the earthenware house-sewer must be made with cement, and should be gas-tight.

**Sewer-air and Gas.**—Sewer-gas is not a gas at all. What is commonly understood by the term is the air of sewers, the ordinary atmospheric air, but charged and contaminated with the various products of organic decomposition taking place in sewers. Sewer-air is a mixture of gases, the principal gases being carbonic acid; marsh gas; compounds of hydrogen and carbon; carbonate and sulphides of ammonium; ammonia; sulphuretted hydrogen; carbonic oxide, volatile fetid matter; organic putrefactive matter, and may also contain some bacteria, saprophytic or pathogenic.

Any and all the above constituents may be contained in sewer-air in larger or smaller doses, in minute or toxic doses.

It is evident that an habitual breathing of air in which even minute doses of toxic substances and gases are floating will in time impair the health of human beings, and that large doses of those substances may be directly toxic and dangerous to health. It is certainly an error to ascribe to sewer-air death-dealing properties, but it would be a more serious mistake to undervalue the evil influence of bad sewer-air upon health.

**Ventilation.**—To guard against the bad effects of sewer-air, it is necessary to dilute, change, and ventilate the air in sewers. This is accomplished by the various openings left in the sewers, the so-called lamp and man-holes which ventilate by diluting the sewer-air with the street-air. In some places, chemical methods of disinfecting the contents of sewers have been undertaken with a view to killing the disease-germs and deodorizing the sewage. In the separate system of sewage-disposal, where sewer-pipes are small and usually self-cleansing, the late Col. Waring proposed to ventilate the sewers through the house-pipes, omitting the usual disconnection of the house-sewer from the house-pipes. But in the combined system such a procedure would be dangerous, as the sewer-air would be apt to enter the house.

Rain-storms are the usual means by which a thorough flushing of the street-sewers is effected. There are, however, many devices proposed for flushing sewers; *e.g.*, by special flushing-tanks, which either automatically or otherwise discharge a large volume of water, thereby flushing the contents of the street-sewers.

## CHAPTER IX.

### PLUMBING. GENERAL PRINCIPLES.

**Purpose and Requisites of House-plumbing.**—A system of house-plumbing presupposes the existence of a street-sewer, and a water-supply distribution within the house. While the former is not absolutely essential, as a house may have a system of plumbing without there being a sewer in the street, still in the water-carriage system of disposal of sewage the street-sewer is the outlet for the various waste and excrementitious matter of the house. The house-water distribution serves for the purpose of flushing and cleaning the various pipes in the house-plumbing.

The purposes of house-plumbing are: 1) to get rid of all excreta and waste water; 2) to prevent any foreign matter and gases in the sewer from entering the house through the pipes; and 3) to dilute the air in the pipes so as to make all deleterious gases therein innocuous.

To accomplish these results, house-plumbing demands the following requisites:

1) *Receptacles* for collecting the waste and excreta. These receptacles, or plumbing fixtures, must be adequate for the purpose, small, non-corrosive, self-cleans-

ing, well flushed, accessible, and so constructed as to easily dispose of their contents.

2) *Separate vertical pipes* for sewage proper, for waste water, and for rain-water; upright, direct, straight, non-corrosive, water- and gas-tight, well flushed, and ventilated.

3) Short, direct, clean, well flushed, gas-tight branch pipes to connect receptacles with vertical pipes.

4) *Disconnection* of the house-sewer from the house-pipes by the main trap on house-drain, and disconnection of house from the house-pipes by traps on all fixtures.

5) *Ventilation* of the whole system by the fresh-air inlet, vent-pipes, and the extension of all vertical pipes.

**Definitions.**—The *house-drain* is the horizontal main pipe receiving all waste water and sewage from the vertical pipes, and conducting them outside of the foundation-walls, where it joins the house-sewer.

The *soil-pipe* is the vertical pipe or pipes receiving sewage matter from the water-closets in the house.

The *main waste-pipe* is the pipe receiving waste water from any fixtures except the water-closets.

*Branch soil- and waste-pipes* are the short pipes between the fixtures in the house and the main soil- and waste-pipes.

*Traps* are bends in pipes, so constructed as to hold a certain volume of water, called the water-seal; this water-seal serves as a barrier to prevent air and gases from the sewer from entering the house.

*Vent-pipes* are the special pipes to which the traps or fixtures are connected by short-branch vent-pipes, and serve to ventilate the air in the pipes, and prevent syphonage.

The *rain-leader* is the pipe receiving rain and storm-water from the roof of the house.

**Materials Used for Plumbing Pipes.**—The materials from which the different pipes used in house-plumbing are made differ according to the use of each pipe, its position, size, etc. The following materials are used: cement, vitrified pipe, lead, cast, wrought, and galvanized iron, brass, steel, nickel, sheet metal, etc.

*Cement and vitrified pipes* are used for the manufacture of street- and house-sewers. In some places vitrified pipe is used for house-drains, but in most cities this is strongly objected to; and in New York City no earthenware pipes are permitted within the house. The objection to earthenware pipes are that they are not strong enough for the purpose, break easily, and cannot be made gas-tight.

*Lead pipe* is used for all branch waste-pipes, and short lengths of water-pipes. The advantage of lead pipes is that they can be easily bent and shaped, hence their use for traps and connections. The disadvantage of lead for pipes is the softness of the material, which is easily broken into by nails, gnawed through by rats, etc.

*Brass, nickel, steel,* and other such materials are used in the manufacture of expensive plumbing, but are not commonly employed.

*Sheet metal* and *galvanized iron* are used for rain-leaders, refrigerator-pipes, etc.

*Wrought iron* is used in the so-called Durham system of plumbing. Wrought iron is very strong; the sections of pipe are 20 feet long, the connections are made by screw-joints, and a system of house-plumbing made of this material is very durable, unyielding, strong, and perfectly gas-tight. The objections to wrought iron for plumbing-pipes are that the pipes cannot be readily repaired and that it is too expensive.

*Cast iron* is the material universally used for all vertical and horizontal pipes in the house. There are two kinds of cast-iron pipes manufactured for plumbing uses: the "standard and the extra heavy."

The following are the relative weights of each:

| Standard. | | | | | | Extra Heavy. |
|---|---|---|---|---|---|---|
| 2-inch | pipe, | 4 lbs. | per | foot | | 5½ lbs. |
| 3 " | " | 6 " | " | " | | 9½ " |
| 4 " | " | 9 " | " | " | | 13 " |
| 5 " | " | 12 " | " | " | | 17 " |
| 6 " | " | 15 " | " | " | | 20 " |
| 7 " | " | 20 " | " | " | | 27 " |
| 8 " | " | 25 " | " | " | | 33½ " |

The light-weight pipe, though extensively used by plumbers, is generally prohibited by most municipalities, as it is not strong enough for the purpose, and it is difficult to make a gas-tight joint with these pipes without breaking them.

Cast-iron pipes are made in lengths of 5 feet each, with an enlargement on one end of the pipe, called the "hub" or "socket," into which the other, or "spigot" end, is fitted. All cast-iron pipe must be straight, sound, cylindrical and smooth, free from sand-holes, cracks, and other defects, and of a uniform thickness.

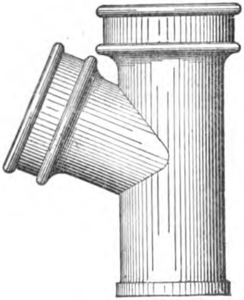
The thickness of cast-iron pipes should be as follows:

| | | | | | |
|---|---|---|---|---|---|
| 2-inch | pipe | $\frac{5}{16}$ | inches | thick. |
| 3 | " | " | " | " | " |
| 4 | " | " | $\frac{3}{8}$ | " | " |
| 5 | " | " | $\frac{7}{16}$ | " | " |
| 6 | " | " | $\frac{1}{2}$ | " | " |

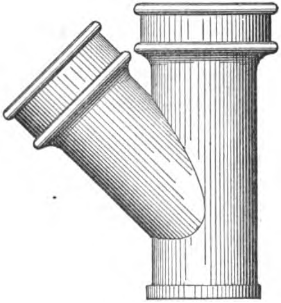
Cast-iron pipes are sometimes coated by dipping into hot tar, or by some other process. Tar-coating is, however, not allowed in New York, because it conceals the sand-holes and other flaws in the pipes.

**Joints and Connections.**—To facilitate connections of cast-iron pipes, short and convenient forms and fittings are cast, as seen in Figs. 14 and 15. Some of these connections are named according to their shape, such as L, T, Y, etc.

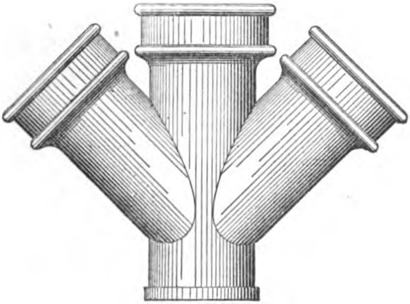
*Iron pipe* is joined to *iron pipe* by lead-calked joints. These joints are made as follows: the spigot end of one pipe is inserted into the enlarged end, or the "hub," of the next pipe. The space between the spigot and hub is half filled with oakum or dry hemp. The remaining space is filled with hot molten lead, which, on cooling, is well rammed and calked in by special tools made for the purpose. To make a good, gas-tight, lead-calked joint, experience and skill are necessary. The ring of lead joining the two lengths of pipe must be from 1 to 2 inches deep, and from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch thick; 12 ounces of lead must be used at each joint for each inch



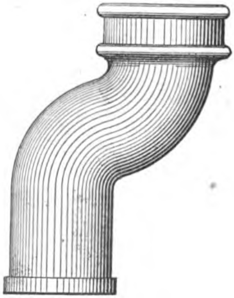
SHORT Y BRANCH.



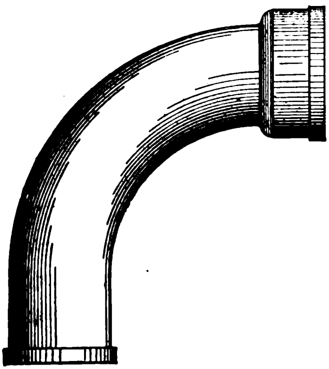
LONG Y BRANCH.



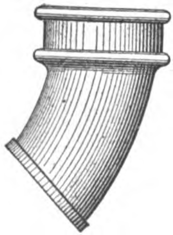
DOUBLE Y BRANCH.



OFFSET.

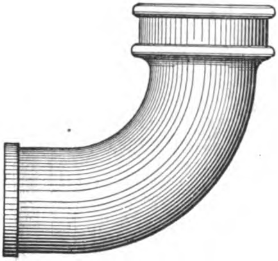


90° BEND.

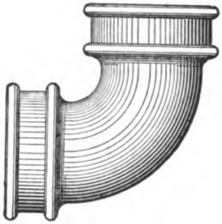


⅛ BEND.

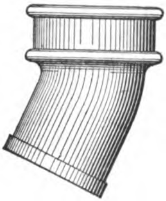
FIGS. 14–15.



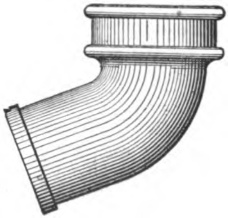
¼ Bend.



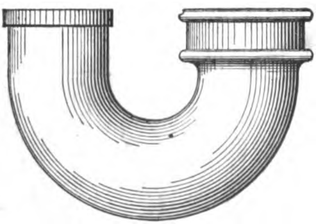
¼ Bend.



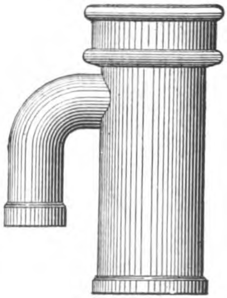
1/16 Bend.



⅛ Bend.

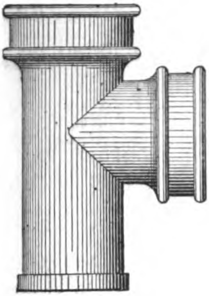


Return-bend.

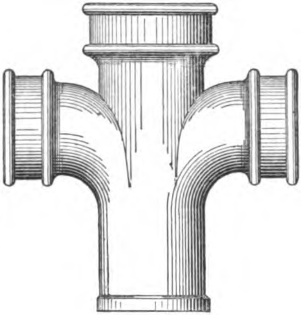


Vent-branch for Back Air-pipe.

Figs. 14–15.

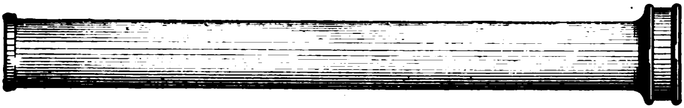


T BRANCH.

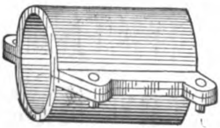


DOUBLE T-Y.

Y-SADDLE HUB.

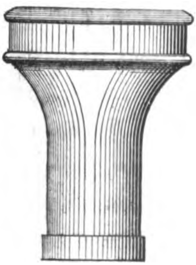


LENGTH OF SOIL-PIPE WITH SINGLE HUB.

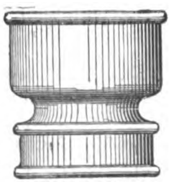


SADDLE HUB.

BRASS FERRULE.



INCREASER.



REDUCER.

FIGS. 14–15.

in the diameter of the pipe. Iron pipes are sometimes connected by means of so-called rust-joints. Instead of lead, the space between the socket and spigot is filled in with an iron cement consisting of 98 parts of cast-iron borings, 1 part of flowers of sulphur, and 1 part of sal ammoniac.

All connections between *lead pipes* and between *lead* and *brass* or *copper* pipes must be made by means of "wiped" solder-joints. A wiped joint is made by solder being poured on two ends of the two pipes, the solder being worked about the joint, shaped into an oval lump, and wiped around with a cloth, giving the joint a bulbous form.

All connections between *lead pipes* and *iron pipes* are made by means of brass ferrules. Lead cannot be soldered to iron, so a brass fitting or ferrule is used; it is jointed to the lead pipe by a wiped joint, and to the iron pipe by an ordinary lead-calked joint.

*Putty, cement,* and *slip* joints should not be tolerated on any pipes.

**Traps.**—We have seen that a trap is a bend in a pipe so constructed as to hold a quantity of water sufficient to interpose a barrier between the sewer and the fixture. There are many and various kinds of traps, some depending on water alone as their "seal," others employing mechanical means, such as balls, valves, lips, also mercury, etc., to assist in the disconnection between the house and sewer ends of the pipe system.

The value of a trap depends: 1) on the depth of its water-seal; 2) on the strengths and permanency of the seal; 3) on the diameter and uniformity of the trap;

4) on its simplicity; 5) on its accessibility; and 6) on its self-cleansing character.

The depth of a trap should be about 3 inches for water-closet traps, and about 2 inches for sink and other traps.

Traps must not be larger in diameter than the pipe to which they are attached.

The simpler the trap, the better it is.

Traps should be provided with cleanout screw-openings, caps, etc., to facilitate cleaning.

The shapes of traps vary, and the number of the various kinds of traps manufactured is very great.

Traps are named according to their use: gully, grease, sediment, intercepting, etc.; according to their shape: D, P, S, V, bell, bottle, pot, globe, etc,; and according to the name of their inventor: Buchan, Cottam, Dodd, Antill, Renk, Hellyer, Croydon, and others too numerous to mention. Figs. 16 and 17 show some forms of traps.

The S trap is the best for sink waste-pipes; the running trap is the best on house-drains.

**Loss of Seal by Traps.**—The seals of traps are not always secure, and the causes of unsealing of traps are as follows:

1) *Evaporation.* If a fixture in a house is not used for a long time, the water constituting the seal in the trap of the fixture will evaporate; the seal will thus be lost, and ingress of sewer-air will result. To guard against evaporation, fixtures must be frequently flushed; and during summer, or at such times as the house is unoccupied and the fixtures not used, the traps

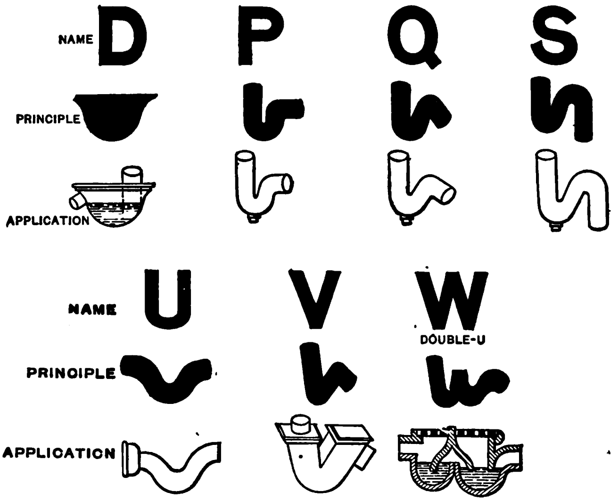



FIG. 16.—NOMENCLATURE. (KNIGHT).

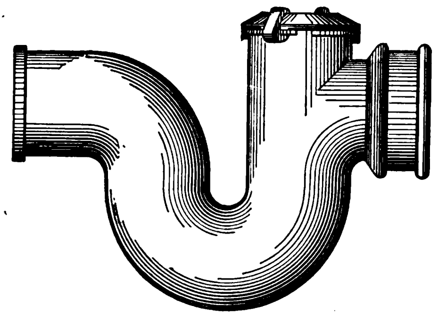
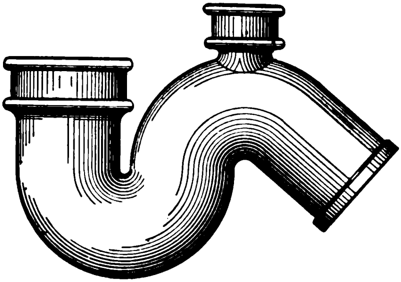
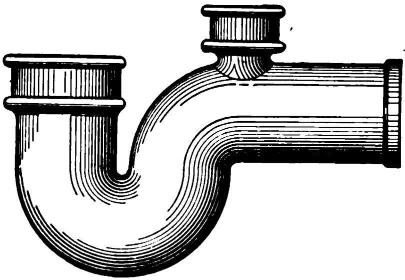


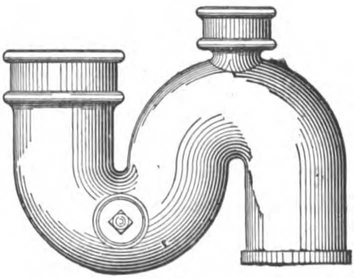
FIG. 16.—RUNNING TRAP.



¾ S Trap.



½ S Trap.



S Trap.

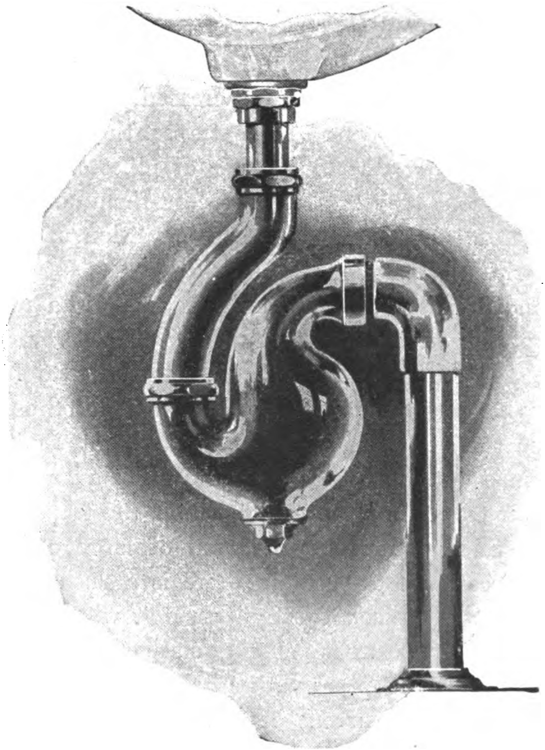
Fig. 17.

are to be filled with oil or glycerine, either of which will serve as an efficient seal.

2) *Momentum.* A sudden flow of water from the fixture may, by the force of its momentum, empty all water in the trap and thus leave it unsealed. To prevent the unsealing of traps by momentum, they must be of a proper size, not less than the waste-pipe of the fixture, the seal must be deep, and the trap in a perfectly straight position, as a slight inclination will favor its emptying. Care should also be taken while emptying the fixture to do it slowly so as to preserve the seal.

3) *Capillary attraction.* If a piece of paper, cotton, thread, hair, etc., remain in the trap, and a part of the paper, etc., projecting into the lumen of the pipe, a part of the water will be withdrawn by capillary attraction from the trap and may unseal it. To guard against unsealing of traps by capillary attraction, traps should be of a uniform diameter, without nooks and corners and of not too large a size, and should also be well flushed, so that nothing but water remain in the trap.

*Siphonage and Back-pressure.*—The water in the trap, or the "seal," is suspended between two columns of air, that from the fixture to the seal, and from the seal of the trap to the seal of the main trap on house-drain. The seal in the trap is therefore not very secure, as it is influenced by any and all currents and agitations of air from both sides, and especially from its distal side. Any heating of the air in the pipes with which the trap is connected, any increase of temperature in the air contents of the vertical pipes with which the trap is connected and any evolution of gases within those pipes will naturally increase the weight and pressure of the air within them, with the result that the increased pressure



Copyright by the J. L. Mott Iron Works.

FIG. 17.—NON-SYPHONING TRAP.

will influence the contents of the trap, or the "seal," and may dislodge the seal backwards, if the pressure is very great, or, at any rate, may force the foul air from the pipes through the seal of the traps and foul the water therein, thus allowing foul odors to enter the rooms from the traps of the fixtures. This condition, which in practice exists oftener than it is ordinarily thought, is called "back-pressure." By "back-pressure" is therefore understood the *forcing back*, or, at least, the *fouling*, of the water in traps, due to the increased pressure of the air within the pipes back of the traps; the increase in air-pressure being due to heating of pipes by the hot water occasionally circulating within them, or by the evolution of gases due to the decomposition of organic matter within the pipes.

A condition somewhat similar but acting in a reverse way is presented in what is commonly termed "siphonage." Just as well as the seal in traps may be forced back by the increased pressure of the air within the pipes, the same seal may be *forced out*, pulled out, aspirated, or siphoned out by a sudden withdrawal of a large quantity of air from the pipes with which the trap is connected. Such a sudden withdrawal of large quantities of air is occasioned every time there is a rush of large column of water through the pipes, e.g. when a water-closet or similar fixture is suddenly discharged; the water rushes through the pipes with a great velocity and creates a strong down-current of air, with the result that where the down-rushing column passes by a trap, the air in the trap and later its seal are aspirated or siphoned out, thus leaving the trap without a seal. By "siphonage" is therefore meant the emptying of the seal in a trap by the aspiration of the water in the trap due to the downward rush of water and air in the pipes with which the trap is connected.

To guard against the loss of seal through siphonage "non-siphoning" traps have been invented, that is, the traps are so constructed that the seal therein is very large, and the shape of the traps made so that siphonage is difficult. Fig. 17 shows such a trap. These traps are, however, open to the objection that in the first place they do not prevent the fouling of the seals by back-pressure, and in the second place they are not easily cleansable and may retain dirt in their large pockets. The universal method of preventing both siphonage and back-pressure is by the system of vent-pipes, or what plumbers call "back-air" pipes. Every trap is connected by branches leading from the crown or near the crown of the trap to a main vertical pipe which runs through the house the same as the waste- and soil-pipes, and which contains nothing but air, which air serves as a medium to be pressed upon by the "back-pressure" air, or to be drawn upon by the siphoning, and thus preventing any agitation and influence upon the seal in the traps; for it is self-evident that as long as there is plenty of air at the distal part of the seal, the seal itself will remain uninfluenced by any agitation or condition of the air within the pipes with which the trap is connected.

The vent-pipe system is also an additional means of ventilating the plumbing system of the house already partly ventilated by the extension of the vertical pipes above the roof and by the fresh-air inlet. The principal objection urged against the installation of the vent-pipe system is the added expense, which is considerable; and plumbers have sought therefore to substitute for the vent-pipes various mechanical traps, also non-siphoning traps. The vent-pipes are, however, worth the additional expense, as they are certainly the best means to prevent siphonage and back-pressure and are free from the objections against the cumbersome mechanical traps and the filthy non-siphoning traps.

# CHAPTER X.

## PLUMBING-PIPES.

**The House-drain.**—All waste and soil matter in the house is carried from the receptacles into the waste- and soil-pipes, and from these into the house-drain, the main pipe of the house, which carries all waste and soil into the street-sewer. The house-drain extends from the junction of the soil- and waste-pipes of the house through the house to outside of the foundations 2–5 feet, whence it is called "house-sewer." The house-drain is a very important part of the house-plumbing system, and great care must be taken to make its construction perfect.

*Material.* The material of which house-drains are manufactured is extra heavy cast iron. Lighter pipes should never be used, and the use of vitrified pipes for this purpose should not be allowed.

*Size.* The size of the house-drain must be proportional to the work to be performed. Too large a pipe will not be self-cleansing, and the bottom of it will fill with sediment and slime. Were it not for the need of carrying off large volumes of storm-water, the house-drain could be a great deal smaller than it usually is. A 3-inch pipe is sufficient for a small house, though a 4-

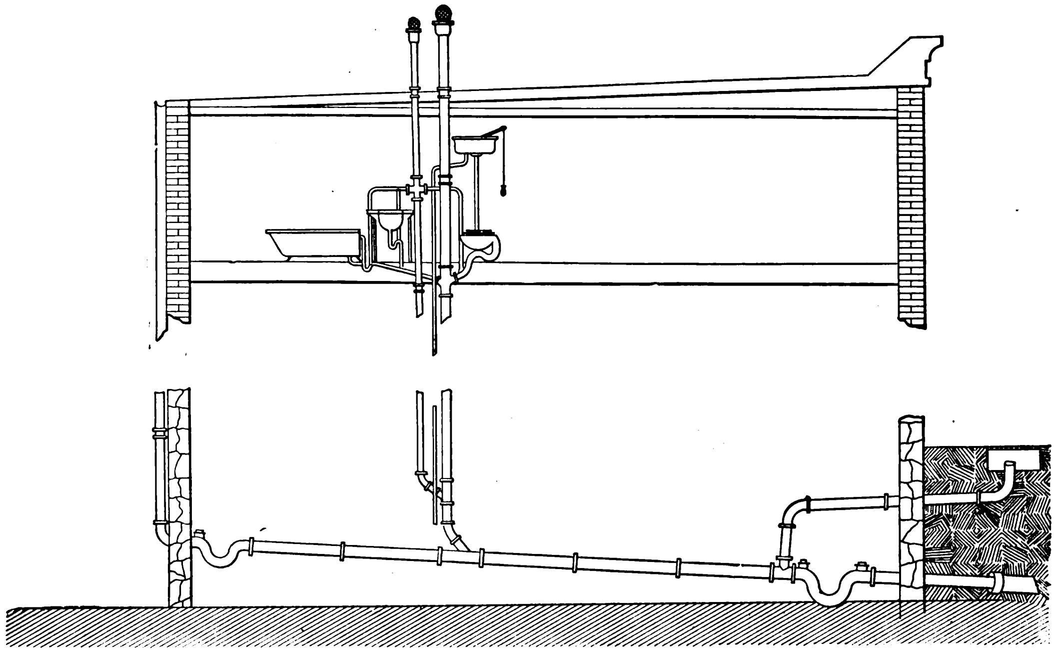


FIG. 18.—SYSTEM OF HOUSE DRAINAGE, SHOWING THE PLUMBING OF A HOUSE. (H. BRAMLEY.)

House-drain with running-trap and two handholes, connections with house-sewer and fresh-air inlet. Main soil-pipe, with sink, bath-tub and water-closet trapped and vented; also main vent extended above roof, the soil- and vent-pipe openings on roof protected with wire baskets. The pipe on the left outside of the wall is the rain-leader trapped at its base. The main waste-pipe has been omitted.

inch pipe is made obligatory in most cities. In New York City no house-drains are allowed of smaller diameter than 6 inches.

*Fall.* The fall or inclination of the house-drain depends on its size. Every house-drain must be laid so that it should have a certain inclination toward the house-sewer, so as to increase the velocity of flow in it and make it self-flushing and self-cleansing. The rate of fall should be as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| For | 4-inch | pipe.... | 1 | in | 40 | feet |
| " | 5 " | " .... | 1 | " | 50 | " |
| " | 6 " | " .... | 1 | " | 60 | " |

*Position.* The house-drain lies in a horizontal position in the cellar, and should, if possible, be exposed to view. It should be hung on the cellar-wall or ceiling, unless this is impracticable, as when fixtures in the cellar discharge into it; in this case it must be laid in a trench cut in a uniform grade, walled upon the sides with bricks laid in cement, and provided with movable covers and with a hydraulic-cement base 4 inches thick, on which the pipe is to rest. The house-drain must be laid in straight lines, if possible; all changes in direction must be made with curved pipes, the curves to be of a large radius.

*Connections.* The house-drain must properly connect with the house-sewer at a point about 2 feet outside of the outer front vault or area-wall of the building. An arched or other proper opening in the wall must be provided for the drain, to prevent damage by settlement.

All joints of the pipe must be gas-tight, lead-calked joints, as stated before. The junction of the vertical soil-, waste-, and rain-leader pipes must not be made by right-angle joints, but by a curved-elbow fitting of a large radius, or by "Y" branches and 45° bends.

When the house-drain does not rest on the floor, but is hung on the wall or ceiling of the cellar, the connection of the vertical soil- and waste-pipes must have suitable supports, the best support being a brick pier laid 9 inches in cement and securely fastened to the wall.

Near all bends, traps, and connections of other pipes with the house-drain, suitable handholes should be provided, these handholes to be tightly covered by brass screw-ferrules, screwed in and fitted with red lead.

"No steam-exhaust, boiler blow-off, or drip-pipe shall be connected with the house-drain or sewer. Such pipes must first discharge into a proper condensing-tank, and from this a proper outlet to the house-sewer outside of the building must be provided."

*Main traps.* The disconnection of the house-pipes from the street-sewer is accomplished by a trap on the house-drain near the front wall, inside the house, or just outside the foundation-wall, but usually inside of the house. The best trap for this purpose is the syphon or running-trap. This trap must be constructed with a cleaning handhole on the inside or house side of the trap, or on both sides, and the handholes are to be covered gas-tight by brass screw-ferrules.

*Extension of vertical pipes.* By the main trap the house-plumbing system is disconnected from the sewer;

and by the traps on each fixture from the air in the rooms; still, as the soil-, waste-, and drain-pipes usually contain offensive solids and liquids which contaminate the air in the pipes, it is a good method to ventilate these pipes. This ventilation of the soil-, waste-, and house-drain pipes prevents the bad effects on health from the odors, etc., given off by the slime and excreta adhering in the pipes, and it is accomplished by two means: 1) by extension of the vertical pipes to the fresh air above the roof, and 2) by the fresh-air inlet on the house-drain.

By these means a current of air is established through the vertical and horizontal pipes.

Every vertical pipe must be extended above the roof at least 2 feet above the highest coping of the roof or chimney. The extension must be far from the air-shafts, windows, ventilators, and mouths of chimneys, so as to prevent air from the pipes being drawn into them. The extension must be not less than the full size of each pipe, so as to avoid friction from the circulation of air. The use of covers, cowls, return-bends, etc., is reprehensible, as they interfere with the free circulation of air. A wire basket may be inserted to prevent foreign substances from falling into pipes.

*Fresh-air inlet.* The fresh-air inlet is a pipe of about 4 inches in diameter; it enters the house-drain on the house side of the main trap, and extends to the external air at or near the curb, or at any convenient place, at least 15 feet from the nearest window. The fresh-air inlet pipe usually terminates in a receptacle covered by an iron grating, and should be far from any hot-air furnace cold-air box. When clean, properly cared for, and extended above the ground, the fresh-air inlet, in conjunction with the open extended vertical pipe, is an efficient means of ventilating the air in the house-pipes; unfortunately, most fresh-air inlets are constantly obstructed, and do not serve the purpose for which they are made.

**The Soil- and Waste-pipes.**—The soil-pipe receives liquid and solid sewage from the water-closets and urinals; the waste-pipe receives all waste water from sinks, wash-basins, bath-tubs, etc.

The material of which the vertical soil- and waste-pipes are made is cast iron.

The size of main waste-pipes is from 3 to 4 inches; of main soil-pipes, from 4 to 5 inches. In tenement-houses with five water-closets or more, not less than 5 inches.

The joints of the waste- and soil-pipes should be lead-calked. The connections of the lead branch pipes or traps with the vertical lines must be by Y-joints, and by means of brass ferrules, as explained above.

The location of the vertical pipes must never be within the wall, built in, nor outside the house, but preferably in a special 3-foot square shaft adjacent to the fixtures, extending from the cellar to the roof, where the air-shaft should be covered by a louvered skylight; that is, with a skylight with slats outwardly inclined, so as to favor ventilation.

The vertical pipes must be accessible, exposed to view in all their lengths, and, when covered with boards, so fitted that the boards may be readily removed.

Vertical pipes must be extended above the roof in full diameter, as previously stated. When less than 4 inches in diameter, they must be enlarged to 4 inches at a point not less than 1 foot below the roof-surface by an "increaser" of not less than 9 inches long.

All soil- and waste-pipes must, whenever necessary, be securely fastened with wrought-iron hooks or straps.

Vertical soil- and waste-pipes must not be trapped at their base, as the trap would not serve any purpose, and would prevent a perfect flow of the contents.

**Branch Soil- and Waste-pipes.**—The fixtures must be near the vertical soil- and waste-pipes in order that the branch waste- and soil-pipes should be as short as possible. The trap of the branch soil- and waste-pipes must not be far from the fixture, not more than 2 feet from it, otherwise the accumulated foul air and slime in the waste- and soil-branch will emit bad odors.

The minimum sizes for branch pipes should be as follows:

| | |
|---|---|
| Kitchen sinks.............. | 2 inches. |
| Bath-tubs ................. | 1½ to 2 inches. |
| Laundry-tubs ............. | 1½ to 2 inches. |
| Water-closets......... | not less than 4 inches. |

Branch soil- and waste-pipes must have a fall of at least ¼ inch to 1 foot.

The branch waste- and soil-pipes and traps must be exposed, accessible, and provided with screw-caps, etc., for inspection and cleaning purposes.

Each fixture should be separately trapped as close to the fixture as possible, as two traps on the same line of branch waste- or soil-pipes will cause the air between the traps to be closed in, forming a so-called " cushion " that will prevent the ready flow of contents.

" All traps must be well supported and rest true with respect to their water-level."

**Vent-pipes and their Branches.**—The purpose of vent-pipes, we have seen, is to prevent syphoning of traps and to ventilate the air in the traps and pipes. The material of which vent-pipes are made is cast iron.

The size of vent-pipes depends on the number of traps with which they are connected; it is usually 2 or 3 inches. The connection of the branch vent to the trap must be at the crown of the trap, and the connection of the branch vent to the main vent-pipe must be above the trap, so as to prevent friction of air. The vent-pipes are not perfectly vertical, but with a continuous slope so as to prevent condensation of air or vapor therein.

The vent-pipes should be extended above the roof, several feet above coping, etc.; and the extension above the roof should not be of less than 4 inches diameter, so as to avoid obstruction by frost. No return-bends or cowls should be tolerated on top of the vent-pipes. Sometimes the vent, instead of running above the roof, is connected with the soil-pipe several feet above all fixtures.

**Rain-leaders.**—The rain-leader serves to collect the rain-water from the roof and eaves-gutter. It usually discharges its contents into the house-drain, although some leaders are led to the street-gutter, while others are connected with school-sinks in the yard. The latter practice is objectionable, as it may lead the foul air from the school-sink into the rooms, the windows of which are near the rain-leader; besides, the stirring up of the contents of the school-sink produces bad odors. When the rain-leader is placed within the house, it must be made of cast iron with lead-calked joints; when

FIG. 19.—LEADER-PIPE.

outside, as is the rule, it may be of sheet metal or galvanized-iron pipe with soldered joints. When the rain-leader is run near windows, the rules and practice are that it should be trapped at its base, the trap to be a deep one to prevent evaporation, and it should be placed several feet below the ground, so as to prevent freezing.

## CHAPTER XI.

### PLUMBING FIXTURES.

THE receptacles or fixtures within the house for receiving the waste and excrementitious matter and carrying it off through the pipes to the sewer are very important parts of house-plumbing. Great care must be bestowed upon the construction, material, fitting, etc., of the plumbing fixtures, that they be a source of comfort in the house instead of becoming a curse to the occupants.

**Sinks.**—The waste water from the kitchen is disposed of by means of sinks. Sinks are usually made of cast iron, painted, enamelled, or galvanized. They are also made of wrought iron, as well as of earthenware and porcelain. Sinks must be set level, and provided with a strainer at the outlet to prevent large particles of kitchen-refuse from being swept into the pipe and obstruct it. If possible, the back and sides of a sink should be cast from one piece; the back and sides, when of wood, should be covered by non-absorbent material, to prevent the wood from becoming saturated with waste water. No woodwork should enclose sinks; they should be supported on iron legs and be open beneath and around. The trap of a sink is usually 2 inches in diameter, and should be near the sink; it should have a screw-cap for cleaning and inspection, and the branch vent-pipe should be at the crown of the trap.

**Wash-basins.**—Wash-basins are placed in bathrooms, and, when properly constructed and fitted, are a source of comfort. They should not be located in bedrooms, and should be open, without any woodwork around them. The wash-bowls are made of porcelain or marble, with a socket at the outlet, into which a plug is fitted.

**Wash-tubs.**—For laundry purposes wooden, iron-enamelled, stone, and porcelain tubs are fitted in the kitchen or laundry-róom. Porcelain is the best material, although very expensive. The soapstone tub is the next best; it is clean, non-absorbent, and not too expensive. Wood should never be used, as it soon becomes saturated, is foul, leaks, and is offensive. In old houses, wherever there are wooden tubs, they should be covered with zinc or some non-absorbent material. The wash-tubs are placed in pairs, sometimes three in a row, and they are generally connected with one lead waste-pipe 1½ to 2 inches in diameter, with one trap for all the tubs.

**Bath-tubs.**—Bath-tubs are made of enamelled iron or porcelain, and should not be covered or enclosed by any woodwork. The branch waste-pipe should be trapped and connected with the main waste- or soil-pipe. The floor about the tub in the bathroom should be of non-absorbent material.

**Refrigerators.**—The waste-pipes of refrigerators should not connect with any of the house-pipes, but should be emptied into a basin or pail; or, if the refrigerator is large, its waste-pipe should be conducted to the cellar, where it should discharge into a properly-trapped, sewer-connected, water-supplied, open sink.

**Boilers.**—The so-called sediment-pipe from the hot-water boiler in the kitchen should be connected with the sink-trap at the inlet side of the trap.

**Urinals.**—As a rule, no urinals should be tolerated within a house; they are permissible only in factories and office buildings. The material is enamelled iron or porcelain. They must be provided with a proper water-supply to flush them.

**Overflows.**—To guard against overflow of wash-basins, bath-tubs, etc., overflow-pipes from the upper portion of the fixtures are commonly provided. These pipes are connected with the inlet side of the trap of the same fixture. They are, however, liable to become a nuisance by being obstructed with dirt and not being constantly flushed; whenever possible they should be dispensed with.

**Safes and Wastes.**—A common usage with plumbers in the past has been to provide sinks, wash-basins, bath-tubs, and water-closets, not only with overflow-pipes, but also with so-called safes, which consist of sheets of lead turned up several inches at the edges so as to catch all drippings and overflow from fixtures; from these safes a drip-pipe or waste is conducted to the cellar, where it empties into a sink. Of course, when such safe-wastes are connected with the soil- or waste-pipes, they become a source of danger, even if they are trapped, as they are not properly cared for or flushed; and their traps are usually not sealed. Even when discharging into a sink in the cellar, safes and safe-waste are very unsightly, dirty, liable to accumulate filth, and are offensive. With open plumbing, and with the floors under the fixtures of non-absorbent material, they are useless.

**Water-closets.**—The most important plumbing fixtures within the house are the water-closets. Upon the proper construction and location of the water-closets greatly depends the health of the inhabitants of the house. Water-closets should be placed in separate, well lighted, perfectly ventilated, damp-proof, and clean compartments, and no water-closet should be used by more than one family in a tenement-house. The type and construction of the water-closets should be carefully attended to, as the many existing, old and obsolete types of water-closets are still being installed in houses, or are left there to foul the air of rooms and apartments. There are many water-closets on the market, some of which will be described below; the best are those made of one piece, of porcelain or enamelled earthenware, and so constructed as always to be and remain clean.

*The pan closet.* The water-closet most commonly used in former times was a representative of the group of water-closets with mechanical contrivances. This is the *pan closet*, now universally condemned and prohibited from further use. The pan closet consists of 4 principal parts: 1) a basin, of china, small and round; 2) a copper 6-inch pan under the basin; 3) a large iron container, into which the basin with the pan under it is placed; and 4) a D trap to which the container is joined. The pan is attached with a lever to a handle, which, when pulled, moves the pan, this describes a half circle

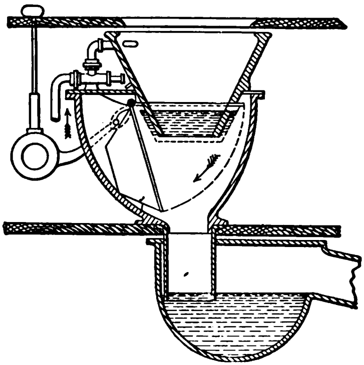


FIG. 20.—PAN WATER-CLOSET. (GERHARD.)

and drops the contents into the container and trap. The objections to pan closets are the following:

1) There being a number of parts, and mechanical contrivances, they are liable to get out of order.

2) The bowl is set into the container and cannot be inspected, and is usually very dirty beneath.

3) The pan is often missing, gets out of order, and is liable to be soiled by adhering excreta.

4) The container is large, excreta adhere to its upper parts, and the iron becomes corroded and coated with filth.

5) With every pull of the handle and pan, foul air enters rooms.

6) The junctions between the bowl and container, and the container and trap, are usually not gas-tight.

7) The pan breaks the force of the water flush, and the trap is usually not completely emptied.

*Valve and plunger closets* are an improvement upon the pan closets, but are not free from several objections enumerated above. As a rule, all water-closets with mechanical parts are objectionable.

*Hopper closets* are made of iron or earthenware. Iron

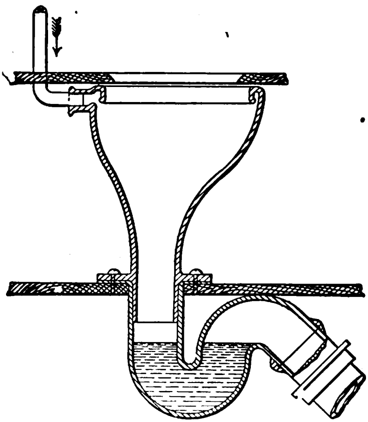


FIG. 21.—LONG HOPPER WATER-CLOSET. (GERHARD.)

hopper closets easily corrode; they are usually enamelled on the inside. Earthenware hoppers are preferable to iron ones. Hopper closets are either long or short; when long, they expose a very large surface to be fouled, require a trap below the floor and are, as a rule, very difficult to clean or to keep clean. Short hopper closets are preferable, as they are easily kept clean and are well flushed. When provided with flushing-rim, and with a good water-supply cistern and large supply-pipe, the short hopper closet is a good form of water-closet.

The washout and washdown water-closets are an improvement upon the hopper closets. They are manufactured from earthenware or porcelain, and are so

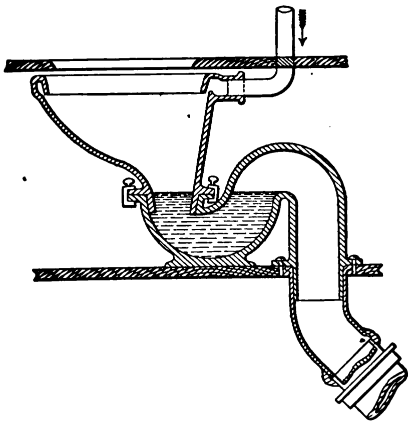


FIG. 22.—SHORT HOPPER WATER-CLOSET. (GERHARD.)

shaped that they contain a water-seal, obviating the necessity of a separate trap under the closet.

*Flush-tanks.*—Water-closets must not be flushed directly from the water-supply pipes, as there is a possibility of contaminating the water-supply. Water-closets should be flushed from flush-tanks, either of iron or of wood metal lined; these cisterns should be placed not less than 4 feet above the water-closet, and provided with a straight flush-pipe of at least 1¼ in. diameter.

The cistern is fitted with plug and handle, so that by pulling at the handle the plug is lifted out of the

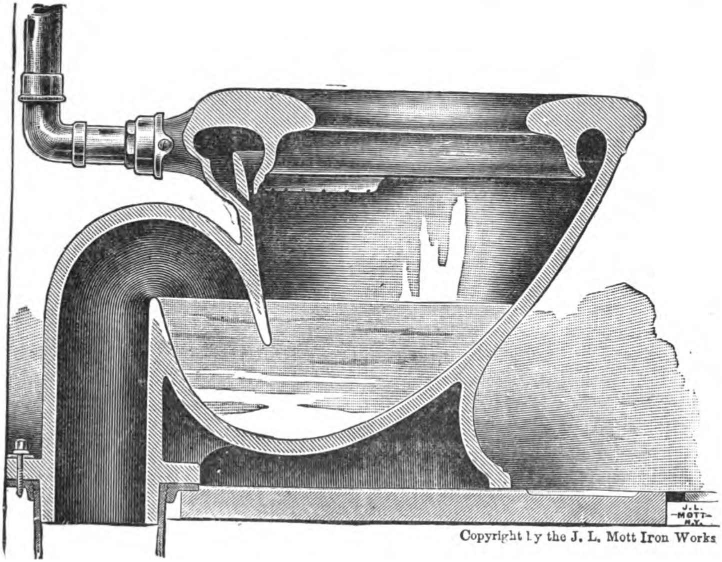



FIG. 23.—WASHDOWN WATER-CLOSET.

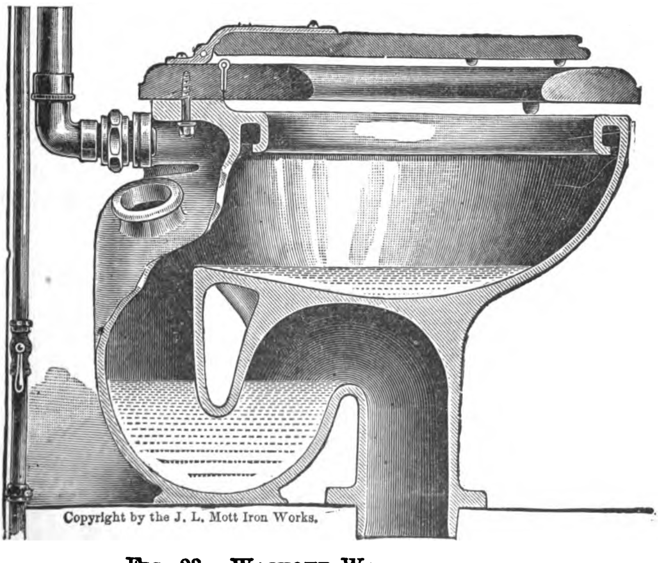



FIG. 23.—WASHOUT WATER-CLOSET.

socket of the cistern and the contents permitted to rush through the pipe and flush the water-closet. A separate ball arrangement is made for closing the water-supply when the cistern is full. The cistern must have a capacity of at least 3–5 gallons of water; the flush-pipe

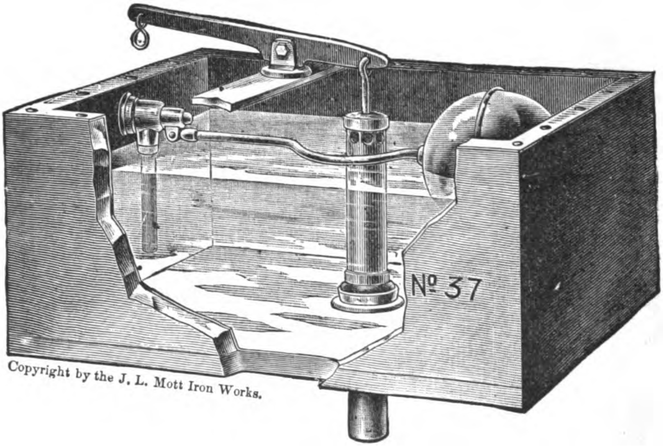



FIG. 24.—FLUSHING CISTERN.

must have a diameter of not less than one and one-quarter inch, and the pipe must be straight, without bends, and the arrangement within the closets such as to flush all parts of the bowl at the same time.

**Yard Closets.**—In many old houses the water-closet accommodations are placed in the yard. There are two forms of these yard closets commonly used; the School-sink and the Yard Hopper.

The *school-sink* is an iron trough from 5 to 12 or more feet long, and 1 to 2 feet wide and 1 foot deep, set in a trench several feet below the surface, with an inclination toward the exit; on one end of the trough there is a socket fitted with a plug, and on the other a flushing apparatus consisting simply of a water service-pipe.

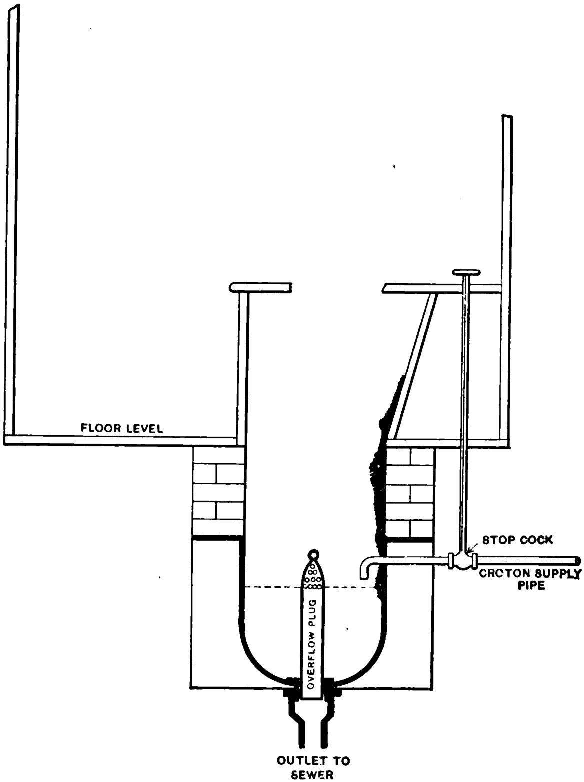



FIG. 25.—SCHOOL SINK AFTER SEVERAL MONTHS' USE. (J. SULLIVAN)

Above the iron trough brick walls are built up, enclosing it; over it are placed wooden seats, and surrounding the whole is a wooden shed with compartments for every seat. The excreta are allowed to fall into the trough, which is partly filled with water, and once a day, or as often as the caretaker chooses, the plug is pulled up and the excreta allowed to flow into the sewer with which the school-sink is connected. These school-sinks are, as a rule, a nuisance, and are dangerous to health. The objections to them are the following:

1) The excreta lies exposed in the iron trough, and may decompose even in one day; and it is always offensive.

2) The iron trough is easily corroded.

3) The iron trough, being large, presents a large surface for adherence of excreta.

4) The brickwork above the trough is not flushed when the school-sink is emptied, and excreta which usually adheres to it decomposes, creating offensive odors.

5) The junction of the iron trough with the brickwork, and the brickwork itself, is usually defective, or becomes defective, and allows foul water and sewage to pass into the yard, or into the wall adjacent to the school-sink. By the Tenement-house Law of New York, after 1903 the use of school-sinks is prohibited even in old buildings.

*Yard hopper closets.* Where the water-closet accommodations cannot, for some reason, be put within the house, yard hopper closets are commonly employed. These closets are simply long, iron enamelled hoppers, trapped, and connected with a drain-pipe discharging into the house-drain. These closets are flushed from cisterns, but, in such case, the cisterns must be protected from freezing; this is accomplished in some houses by putting the yard hopper near the house and placing the cistern within the house; however, this can hardly be done where several hoppers must be employed. In most cases, yard hoppers are flushed by automatic

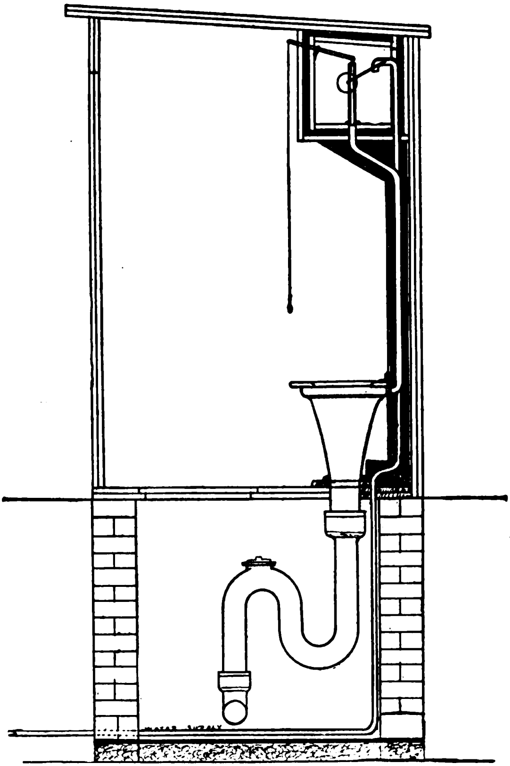


FIG. 26.—J. SULLIVAN'S IMPROVED YARD HOPPER CLOSET.

rod-valves, so constructed as to flush the bowl of the hopper whenever the seat it pressed upon. These valves, as a rule, frequently get out of order and leak, and care

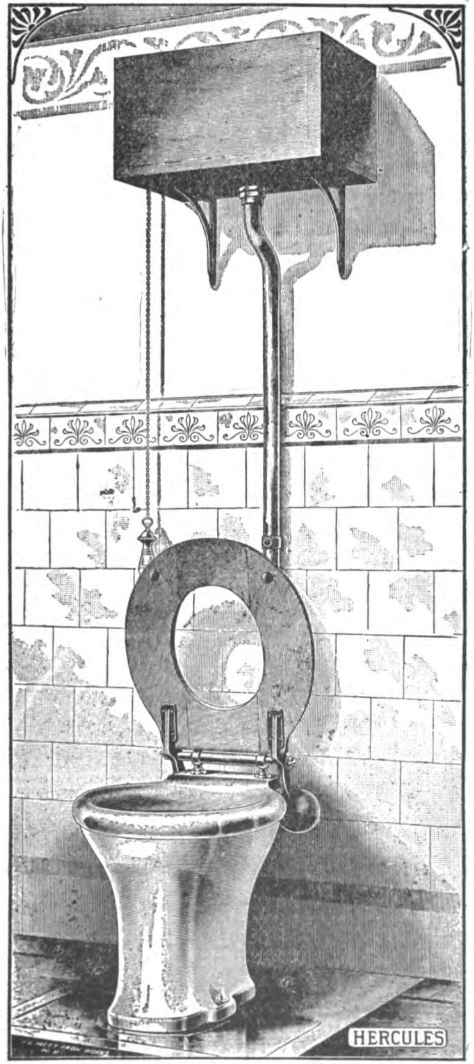



FIG. 27. (J. L. MOTT IRON WORKS.)

must be taken to construct the vault under the hoppers so that it be perfectly water-tight. The cut on page 101 represents an improved form of yard hopper suggested by Inspector J. Sullivan, of the New York Health Department, and used in a number of places with complete satisfaction. The improvement consists in the doors and walls of the privy apartment being of double thickness, lined with builders' lining on the inside, and the water-service pipes and cistern being protected by felt or mineral wool packing.

**Yard- and Area-drains.**—The draining of the surface of the yard or other areas is done by tile or iron pipes connecting with the sewer or house-drain in the cellar. The "bell" or the "lip" traps are to be condemned and should not be used for yard drains. The gully and trap should be made of one piece; the trap should be of the siphon type and should be deep enough in the ground to prevent the freezing of seal in winter.

# CHAPTER XII.

## DEFECTS IN PLUMBING; EXAMINATION AND TESTS.

THE materials used in house-plumbing are many and various, the parts are very numerous, the joints and connections are frequent, the position and location of pipes, etc., are often inaccessible and hidden, and the whole system quite complicated. Moreover, no part of the house construction is subjected to so many strains and uses, as well as abuses, as the plumbing of the house. Hence, in no part of house construction can there be as much bad work and "scamping" done as in the plumbing; and no part of the house is liable to have so many defects in construction, maintenance, and condition as the plumbing. At the same time, the plumbing of a house is of very great importance and influence on the health of the tenants, for defective materials, bad workmanship and improper condition of the plumbing of a house may endanger the lives of its inhabitants by causing various diseases.

**Defects in Plumbing.**—The defects usually found in plumbing are so many that they cannot all be enumerated here. Among the principal and most common defects, however, are the following:

*Materials.* Light-weight iron pipes; these crack easily and cannot stand the strain of calking. Sandholes made during casting; these cannot always be detected, especially when the pipes are tar-coated. Thin lead pipe, not heavy enough to withstand the bending and drawing it is subjected to.

*Location and Position.* Pipes may be located within the walls and built in, in which case they are inaccessible, and may be defective without any one being able to discover the defects. Pipes may be laid with a wrong or an insufficient fall, thus leaving them unflushed, or retarding the proper velocity of the flow in the pipes. Pipes may be put underground and have no support underneath, when some parts or lengths may sink, get out of joint and the sewage run into the ground instead of through the pipes. The pipes may be so located as to require sharp bends and curves, which will retard the flow in them.

*Joints.* Joints in pipes may be defective, leaking and not gas-tight, because of imperfect calking, insufficient lead having been used; or, no oakum having been used and the lead running into the lumen of the pipe; or, not sufficient care and time being taken for the work. Joints may be defective because of iron ferrules being used instead of brass ferrules; through improperly wiped joints; through bad workmanship, bad material, or ignorance of the plumber. Plumbers often use T branches instead of Y branches; sharp bends instead of bends of 45 degrees or more; slip joints instead of lead-calked ones; also, they often connect a pipe of larger diameter with a pipe of small diameter, etc., etc.

*Traps.* The traps may be bad in principle and in construction; they may be badly situated or connected, or they may be easily unsealed, frequently obstructed, inaccessible, foul, etc.

*Ventilation.* The house-drain may have no fresh-air inlet, or the fresh-air inlet may be obstructed; the vent-pipes may be absent, or obstructed; the vertical pipes may not be extended.

*Condition.* Pipes may have holes, may be badly repaired, bent, out of shape, or have holes patched up with cement or putty; pipes may be corroded, gnawed by rats, or they may be obstructed, etc., etc.

The above are only a few of the many defects that may be found in the plumbing of a house. It is, therefore, of paramount importance to have the house-plumbing regularly, frequently, and thoroughly examined and inspected, as well as put to the various tests, so as to discover the defects and remedy them.

**Plumbing Tests.**—The following are a few minor points for testing plumbing:

1) To test a trap with a view to finding out whether its seal is lost or not, knock on the trap with a piece of metal; if the trap is empty, a hollow sound will be given out; if full, the sound will be dull. This is not reliable in case the trap is full or half-full with slime, etc. Another test for the same purpose is as follows: Hold a light near the outlet of the fixture; if the light is drawn in, it is a sign that the trap is empty.

2) Defects in leaded joints can be detected if white lead has been used, as it will be discolored in case sewer-gas escape from the joints.

3) The connection of a waste-pipe of a bath-tub with the trap of the water-closet can sometimes be discovered by suddenly emptying the bath-tub and watching the contents of the water-closet trap; the latter will be agitated if the waste-pipe is discharged into the trap or on the inlet side of trap of the water-closet.

4) The presence of sewer-gas in a room can be detected by the following chemical method: Saturate a piece of unglazed paper with a solution of acetate of lead in rain or boiled water, in the proportion of 1 to 8; allow the paper to dry and hang up in the room where the escape of sewer-gas is suspected; if sewer-gas is present, the paper will be completely blackened.

The main tests for plumbing are: 1) The *Hydraulic*, or water-pressure test; 2) the *Smoke*, or sight test; and 3) the *Scent*, or peppermint, etc., test.

*The Water-pressure Test* is used to test the vertical and horizontal pipes in new plumbing before the fixtures have been connected. It is applied as follows: The end of the house-drain is plugged up with a proper air-tight plug, of which there are a number on the market. The pipes are then filled with water to a certain level, which is carefully noted. The water is allowed to stand in the pipes for half an hour, at the expiration of which time, if the joints show no sign of leakage, and are not sweating, and if the level of the water in the pipes has not fallen, the pipes are water-tight. This is a very reliable test, and is made obligatory for testing all new plumbing work.

*The Smoke Test* is also a very good test. It is applied as follows: By means of bellows, or some explod ing, smoke-producing rocket, smoke is forced into the system of pipes, the ends plugged up, and the escape of the smoke watched for, as wherever there are defects in the pipes the smoke will appear. A number of special appliances for this test are manufactured, all of them more or less ingenious.

*The Scent Test* is made by putting into the pipes a certain quantity of some pungent chemical, like peppermint-oil, etc., the odor of which will escape from the defects in the pipes if there are any. Oil of peppermint is commonly used in this country for the test. The following is the way this test is applied: All the openings of the pipes on roof, except one, are closed up tightly with paper, rags, etc. Into the one open pipe is poured from 2 to 4 ounces of peppermint-oil, followed by a pail of hot water, and then the pipe into which the oil has been put is also plugged up. This is done preferably by an assistant. The inspector then proceeds to slowly follow the course of the various pipes, and will detect the smell of the oil wherever it may escape from any defects in the pipes. If the test is thoroughly and carefully done, if care is taken that no fixture in the house is used and the traps of same not disturbed during the test, if the openings of the pipes on the roofs are plugged up tightly, if the main house-trap is not unsealed (otherwise the oil will escape into the sewer), and if the handling of the oil has been done by an assistant, so that none adheres to the inspector; if all these conditions are carried out, the peppermint test is a most valuable test for the detection of any and all defects in plumbing. Another precaution to be taken is with regard to the rain-leader. If the rain-leader is not trapped, or if its trap is empty, the peppermint-oil may escape from the pipes into the rain-leader. Care must be taken, therefore, that the trap at the base of the rain-leader be sealed; or, if no trap is existing, to close up the connection of the rain-leader with the house-drain; or, if this be impossible, to plug up the opening of the leader near the roof.

Instead of putting the oil into the opening of a pipe on the roof, it may be put through a fixture on the top floor of the house, although this is not so satisfactory.

Various appliances have been manufactured to make this test more easy and accurate. Of the English appliances, the Banner patent drain-grenade, and Kemp's drain-tester are worthy of mention. The former consists "of a thin glass vial charged with pungent and volatile chemicals. One of the grenades, when dropped down any suitable pipe, such as the soil-pipe, breaks, or the grenade may be inserted through a trap into the drain, where it is exploded." (Taylor.) Kemp's drain-tester consists of a glass tube containing a chemical with a strong odor; the tube is fitted with a glass cover, held in place by a spring and a paper band. When the tester is thrown into the pipes and hot water poured after it, the paper band breaks, the spring opens the cover, and the contents of the tube fall into the drain.

Recently Dr. W. G. Hudson, an inspector in the Department of Health of New York, has invented a very ingenious "peppermint cartridge" for testing plumbing. The invention is, however, not yet manufactured, and is not on the market.

# PART SECOND.

## SANITARY PRACTICE.

### *SECTION I.—HABITATION.*

---

## CHAPTER I.

### THE TENEMENT-HOUSE PROBLEM.

"Man, in constructing protection from exposure, has constructed conditions of disease. In an age when he could not foresee the results of his own work, he created these conditions, and it is not fair to blame him, because he did not, in his primitive days, know better. We do know better now, and it is our fault if we do not improve on the original bad work, rectify it and remove intelligently the evils which, from deficient intelligence, have been so long perpetuated. This should be the uniform object of the sanitary scholar. The intention (and object) of domestic sanitation is so to construct homes for human beings, or, if the homes be constructed, so to improve them, that the various diseases and ailments incident to bad construction may be removed to the fullest possible extent."

BENJAMIN W. RICHARDSON, in *Health in the Home.*

THE above words of Dr. Richardson are the quintessence of the tenement-house problem and its solution. In ignorance, in folly, and in carelessness, society had permitted certain conditions to exist and be perpetuated; conditions vitally affecting life and health, and which have been allowed to become a fearful menace to social prosperity.

In the relentless march of industrial progress and the fierce struggle for commercial superiority, modern cities have developed evils which threaten to undermine the very existence of urban life, and have created conditions which threaten to cause the extinction of these cities by depopulating them through disease and plague, due to defective sanitation.

Owing to various causes, a very large proportion (in New York State 71%, according to the last census) of the population of the country is concentrated in cities; a great part of the city inhabitants is herded in small, confined areas; the majority of the urban population is compelled to crowd into the vast barrack-like structures called tenements, defective in construction, unsanitary in drainage, faulty in condition, and lacking in light, air, and water—the three essentials of life.

These conditions cause the large average mortality of cities, the fearful slaughter of innocent infants and children, the dwarfing of the constitutions of the growing generation, the spreading of infection and contagion, the degenerating of the intellectual and the corrupting of the moral life of the community.

The houses men live in bear an intimate relation with soil, light, air, water, and drainage; and the influence of these upon health has already been spoken of. Moreover, the construction of houses, overcrowding, and the density of population, have each a direct influence on man's health and longevity.

Tuberculosis, the scourge of nations, is a disease of over-crowded tenements; typhoid fever is a disease of defective drainage; the diarrhœas from which so many thousands of babies die every summer are tenement-house diseases. Rheumatism is a disease of damp and dark dwellings; smallpox, scarlet fever, and other human plagues spread like wildfire in crowded, ill-constructed, ill-ventilated, badly-lighted, and miserable tenement districts.

There are blocks in New York City with one thousand human beings to the square acre. There are blocks solidly built upon, with not more than 10% space left for air and light. There are barracks (miscalled houses) in which not less than 36 families make their home. There are floors in 25 × 100-lot houses with 6 families to a floor. There are apartments of 2 or 3 rooms each, containing 10 to 15 persons.

Where there is such density of population, there cannot be sufficient light, air, or breathing space; hence the sanitary conditions are often horrible beyond description, and the moral pollution vile beyond mention.

Here are a few figures from statistics on the influence of dwellings upon health.

Dr. Farr gives the following on mortality and density of population (Notter and Firth):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 86 | people | to | the | square | mile.... | 14 | in | 1000 |
| 172 | " | " | " | " | " .... | 17 | " | " |
| 255 | " | " | " | " | " .... | 20 | " | " |
| 1128 | " | " | " | " | " .... | 23 | " | " |
| 3399 | " | " | " | " | " .... | 26 | " | " |

Dr. Anderson, Medical Officer of Dundee, gives the following figures on the comparative death-rates of inhabitants of one-, two-, three-, and four-room apartments (Dr. Sykes, Brit. Med. Jour.):

| | | | |
|---|---|---|---|
| One-room | apartments.... | 21.4 | in 1000 |
| Two-room | " .... | 18.8 | " " |
| Three-room | " .... | 17.2 | " " |
| Four-room | " .... | 12.3 | " " |

According to the New York Tenement Report of 1894, the death-rate in New York in the First Ward in single houses on one lot was 29.03; and in lots where there were front and rear houses the death-rate reached 61.97! In the same ward the death-rate of children under 5 years of age reached, in the former, 109.58, and in the latter the terrible rate of 204.55 in a thousand! It is hardly necessary to cite more figures to prove that overcrowding and high death-rate walk hand in hand.

The tenement-house is an offspring of municipal neglect, of overcrowding in small areas, of industrial expansion, of commercial encroachment, of poverty and destitution, of deficient transportation, and of the necessity of the working classes to dwell near their industrial occupations.

Originally, the tenement-houses consisted of former private dwellings, whose occupants, being crowded out by commerce and manufacture, left them and moved into less crowded locations, leaving their houses to be occupied by the less fortunate, who were compelled to remain near their work. As population pressed on, these spacious houses were divided and sub-divided without any control or regard to light and ventilation;

hence, many apartments were soon overfilled, and the demand for such homes induced the wide-awake real-estate men to build houses expressly for poor tenants. That these buildings were constructed with no regard for proper sanitation, etc., goes without saying; for in those times there were no restricting laws, and every builder and speculator constructed houses with the sole idea of the number of families that could possibly be crowded in, and the largest amount of rent that could possibly be gotten out of them.

It was then that the cry of the philanthropists went up (*vide* first report of the "Committee on Housing" of the Association for the Improvement of the Poor, 1853): "Pure air, light, and water, being indispensable to health and life, if tenements are so badly constructed as to preclude a proper supply of these essential elements, the *law* should interpose for the protection of the sufferers, and either *close up* such dwellings, or cause them to be remodelled so as to be fit for human habitations."

But for a long, a very long time, this was only a cry in the wilderness, and tenements continued to spring up without regard to the "essential elements." At last, in the middle seventies, a law was passed by the State legislature restricting uncontrolled tenement construction, and from that time onward progressive changes and laws were made in behalf of tenement improvement; not, however, without various selfish interests interposing hindrances, objecting to the so-called tyrannical socialistic tendencies of tenement legislation, and doing all possible to counteract the growing tendency for tenement reform. But, in spite of all these, the better elements of society have gained the upper hand, and the evils of unsanitary tenements have been curtailed in many cities, and especially in New York, by the wise and beneficent laws of 1887, 1895, and by the last and crowning model tenement-house law of 1901.

Hand in hand with those beneficial laws are the provisions for their enforcement by the proper municipal departments.

The proper solution of the tenement-house problem is, therefore: Legislation, Restriction, Strict Supervision, Careful Inspection, Constant Vigilance and *the rigid and impartial enforcement of all existing laws now on the statute books*; and last, though not least, the inculcating of habits of personal cleanliness among the masses of the foreign population, who constitute so large a proportion of tenement-house dwellers; for there is no doubt that lazy, indolent, dirty, ignorant or malicious tenants often are as much responsible for the unsanitary conditions existing in tenements as are indifferent, grasping owners or lessees.

## CHAPTER II.

### TENEMENT-HOUSE LEGISLATION AND SUPERVISION.

THE problem of housing the poor is not one incident to New York City alone; it applies to all large industrial and commercial centres. It is a burning question wherever large industries are segregated in confined, narrow areas, and wherever modern production creates huge towns with an overcrowded working population. In the United States most of the cities have a housing problem; thus Chicago, Pittsburg, Boston, Buffalo, Philadelphia, and other cities have already a more or less large tenement-house population, and the problem of how to limit the further spread of the peculiar conditions incident to tenement-house life engages the minds of the best elements of those cities. It is in New York City, however, that the tenement-house problem is in its acutest stage, and has already a history of a half-century of struggles, attempts at improvement, successes, and triumphs.

It is needless to dwell long here upon the peculiar conditions which have made New York City the centre of a huge tenement-house population, and have compressed a two-million populace within the boundaries of one comparatively small island. That New York City is destined to become a typical tenement-house town, and that the evils of the overcrowding were

## TYPES OF TENEMENT-HOUSES.

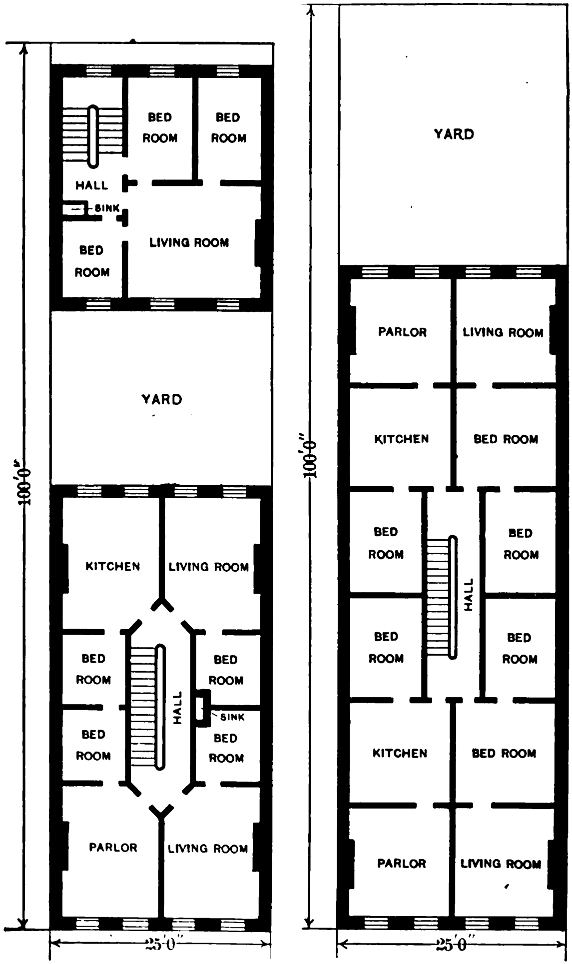
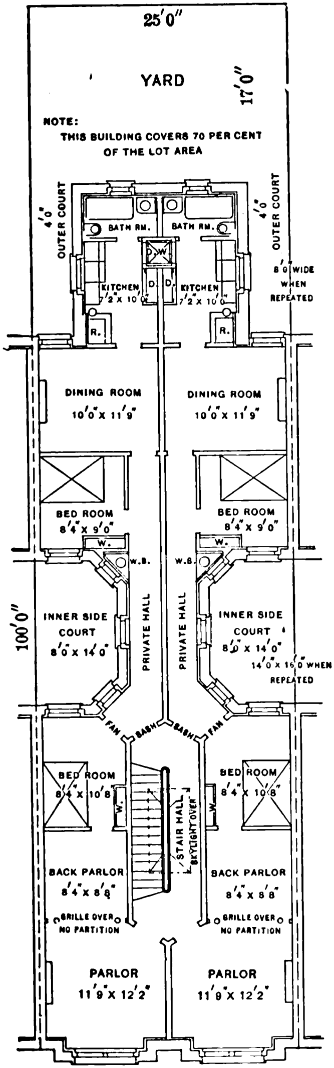



Fig. 28.

1. Front and rear house on one lot.

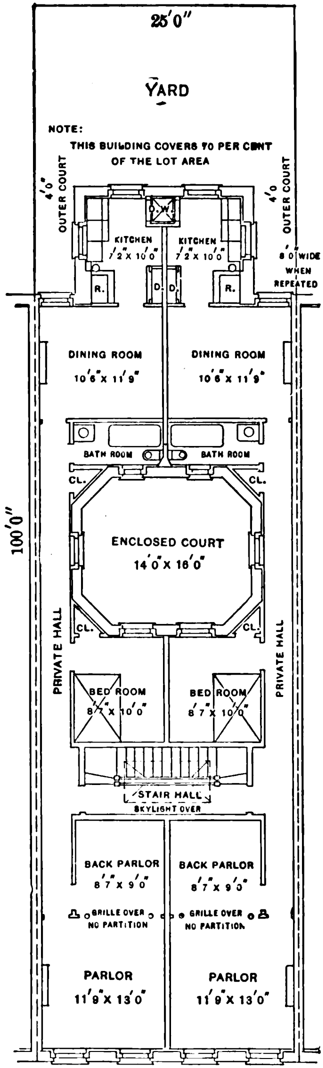
2. Type of tenement-house without light or ventilation. except in outer rooms.

(From Report of the Tenement-house Commission, 1894.)




**THREE-STORY DOUBLE-FLAT TENEMENT.**

This diagram, by Harde & Short, shows a structure, 25x70 feet, on a 100-ft. lot. It contains two inner side courts, 8x14 feet, and two outer courts, 4 feet wide; windows opening into all the courts.




**THREE-STORY DOUBLE TENEMENT.**

This plan is of a building, 25x70 feet, on a 100-ft. lot. The inclosed court, with brick wall, is 14x16 feet. Closet room is continued at available points. There are also two 4 feet wide outer courts. Harde & Short, architects.

bound to increase, was foreseen as early as in 1834, when Dr. J. H. Griscom, then City Inspector of the Board of Health, issued a report and "A Brief View of the Sanitary Conditions of the City," in which he outlined the evils of overcrowded unsanitary dwellings, and in which, for the first time, there was urged legislative action to curb the further spread of the growing evil, and to improve the sanitary conditions of the already existing dwellings. Had his words not remained a cry in the wilderness, we should not perhaps have at present a tenement-house problem. But neither Dr. Griscom's report nor the subsequent investigation and movement of the New York Association for the Improvement of the Conditions of the Poor, undertaken in 1846 and 1853, resulted in immediate action; and even after the official legislative investigation of 1856, which disclosed the steadily progressing evils of the neglected tenement-house conditions, nothing was done to improve them. It took thirty-three years from the time of Dr. Griscom's report until the first tenement-house law was enacted; and that was after the most vigorous and the most perfectly organized movement undertaken by the Council of Hygiene in 1864, which at last disclosed conditions which could no longer be ignored.

In 1867 there were 15,000 tenement-houses erected without any restrictions or regard to the health and safety to the life of their tenants.

The tenement-house law of 1857, although it was the best legislative enactment for that time, did not solve the problem, and the friends of the tenement-house population did not stop in their agitation and efforts for the further improvement of those conditions, but at last succeeded in 1879 in having passed a more progressive law in which, among other items, was for the first time a restriction as to the percentage of the lot to be occupied by a tenement-house, and limiting it to 65% of the lot-area, which provision was, however, nullified by the discretionary power given to the Board of Health in regard to this percentage. Since 1879 the vigorous agitation for further progress had not stopped, with the result that there were several legislative investigating committees—in 1884, 1894, and finally in 1900—the labor of which culminated in the tenement-house laws of 1887, 1895, and finally 1901—the present Tenement-house Law.

**Notable Features of the New York Tenement-house Law of 1901.**—We cannot here give in detail all the features of the law of 1901, and will cite but several showing the progressive trend of this last legislative enactment.

The most important and notable features of the law are as follows:

1) The definite restriction as to percentage of lot to be built upon with stringent provisions as to the minimum size of yards, courts, shafts, rooms, window area, etc., so as to materially improve the light and ventilation of the tenement-houses, and make it unprofitable for builders to erect houses on 25-foot front lots.

2) Increased regard for the safety of tenants in case of fires and the provisions about fire-proof materials and construction of houses. In the better and improved form of fire-escapes; in the provisions about

fire-proof stairways, etc.; in the restriction of non-fire-proof buildings as to their height and number of stories; in the prohibition of the occupation of tenement-houses by businesses which are dangerous to life and health, etc.

3) Regulating the occupation of cellars and basements, and prohibiting the location in tenement-houses of stables, rag-shops, etc.

4) Abolition of obsolete unsanitary plumbing fixtures like privy-vaults and school-sinks, and making provisions as to the compulsory construction of separate water-closets in every apartment; also as to water-supply in new and in old houses.

5) Many wise provisions for improving the sanitary conditions of tenement-houses, and providing for the safety, health, and comfort of their tenants.

6) Very stringent provisions for driving out prostitution from tenement-houses, thus abolishing one of the greatest dangers to the growing population.

7) The registration of the names of all owners of tenement-houses, and the application of the new principle of certification, *i.e.*, that no tenement-house newly constructed can be occupied without a previous certificate from the proper department stating that the house was constructed according to the law and is fit for habitation.

8) The establishment of a separate department to supervise the proper enforcement of all tenement-house laws, and to take charge of all matters concerning the construction and maintenance and sanitary condition of new and old tenement-houses, with a proper system-

atic inspection of all houses and a constant vigilance in all tenement-house matters.

The above are briefly the most notable features of the tenement-house law of 1901, to the progressive provisions of which will be due the improvement in tenement-house conditions in New York as well as, it is hoped, in other cities.

**The Organization of the Tenement-house Department.**—Restrictive legislation is of no value unless proper provision is made for a suitable and strict supervision and enforcement of the legislative enactments. This partly explains why the already existing tenement-house laws in New York were inadequately enforced. Until the establishment of a separate department to care for tenement-house legislation, the enforcement of the existing laws concerning tenement-houses was a part of the multitudinous and multifarious duties of the Health Department, which had but an inadequate inspectorial force already overburdened with work. The promoters of the tenement-house legislation of 1900 and 1901 felt that so paramount an interest as the housing conditions of the majority of the metropolitan population deserved a better supervision than can be accorded it by a subdivision of a bureau of a general department, like that of Health, and have therefore urged the establishment of separate municipal machinery to take sole care of tenement-houses and to have the sole responsibility for the enforcement of all tenement-house laws. The establishment of a separate Tenement-house Department by the New York Legislature marked an important epoch in housing legislation of the city and country. The importance of this act cannot be overestimated, and it once and for all gives expression to the deep-rooted conviction that the proper sanitation of the houses of the working classes is one of the most important duties of municipalities.

The New York Tenement-house Department was first established on January 1, 1902, under the commissionership of the Hon. Robert W. DeForest, who, together with Laurence Veiller, were the principal sponsors of the tenement-house legislation of that period, and were the chairman and secretary, respectively, of the Tenement-house Commission of 1900.

The department consists of three principal bureaus: the bureau of new buildings, the bureau of inspections, and the bureau of records. The bureau of new buildings has sole charge of the construction of new tenement-houses, from the examination and approval of architect's plans through the process of construction to the final certification that the building is permitted to be occupied as a tenement-house (without which permit not one apartment may be occupied for living purposes). This bureau employs not less than three plan examiners and a number of clerks, draughtsmen, and light, ventilation, and plumbing inspectors. The bureau of inspection takes charge of the inspection of existing houses, either in regular periodical monthly inspections, or upon complaints of citizens of unsanitary conditions in the houses, or upon the occurrence of infectious diseases in the houses. This bureau employs not less than 190 inspectors who are supposed to understand tenement-house sanitation, and who have passed a civil-service examination to that effect. This inspectorial force is four times greater than the one previously employed by the Health Department for inspection of ALL unsanitary conditions in the city.

The bureau of records provides for a complete system of records regarding each and every tenement-house within the city, with records not only of its plans, construction, inspection, etc., but also of every infectious disease, every accident, fire, etc., in the house. Such a system of records is bound to be of priceless value to the future sanitarian.

The first two years of the existence of the Tenement-house Department were devoted to valuable preparatory work, which will no doubt prove of great importance to the subsequent history of the department.

## CHAPTER III.

### TENEMENT-HOUSE CONSTRUCTION AND SANITATION.

CONVENIENCE, strength, and beauty are, according to Vitruvius, the three cardinal principles which should guide the architect in the process of house construction. Unfortunately these are not the guiding principles of modern tenement-house construction, for many of these houses are neither convenient, nor strong, nor beautiful, and certainly not comfortable or healthy.

Industrial factors cause the concentration of population in certain overcrowded districts, and tenement-house dwellers cannot, as a rule, chose the location, site, type, class, and character of house they wish to inhabit. There are, however, gradations in the class of what are commonly termed tenement-houses. The legislative definition of "tenement-houses" includes all houses which are occupied by three or more families living independently of each other; the legal definition includes all multiple domiciles whether of inferior or of the most modern construction. The popular and generally accepted meaning of "tenement-house," however, differs from the legal one, and applies only to such houses as are of a common and inferior construction, the average monthly rental of which does not exceed $25 and which is inhabited by a poorer class of tenants. While, therefore, adhering to the legal definition of the term "tenement-house," we exclude in our discussion the more expensive and better-built houses.

**Sites.**—Tenement-house dwellers cannot choose the sites upon which the houses they live in are situated. The same conditions which cause the laboring man to live in the industrial centres of the city also compel him to inhabit houses upon certain streets, blocks, and alleys, without regard to the sanitary requirements of the location of the houses, or, in fact, any other similar considerations. That the ground upon which a house is situated has a great influence upon the health and well-being of the inhabitants has been recognized of old, and is an established dictum of sanitary science. Some sites are rocky, others sandy, others loamy, yet others consist of made and filled-in ground; again, there is ground which is marshy and waterlogged. In towns with extensive river- and sea-fronts, large tracts of the city are situated upon marshy ground; and considerable ground is also regained from the sea and rivers, filled in, and built upon. As a rule, such land is cheaper and therefore is occupied for cheaper sorts of tenement-houses, thus compelling a large part of the population to live in houses situated upon wet ground; these houses are, of course, unhealthy and productive of injurious influences upon the health of the inhabitants of their tenants, especially as, owing to cheap and flimsy construction, precautions are rarely or never taken to underdrain the ground, or to isolate the house from the wet soil upon which it stands.

*Construction.*—The prevalent method of tenement-house construction is the building up of the entire street frontage, leaving but a small 10% to 20%) unoccupied space in the rear of the house. These so-called "attached" houses are a special feature of New York tenement-house construction, with the result that whole blocks are solidly built upon except for a narrow space in the middle of the block, and formed by the yards in the rear of houses. At times these unoccupied spaces do not form more than 10% of the whole area of the block. The tendency of modern legislation is to restrict as much as possible the area of the lot built upon, thus increasing the area available for breathing purposes. There has been no attempt as yet at legislative enactments prohibiting or curbing the system of attached house construction and insisting upon detached or semi-attached construction, although many individual builders have already tried the latter form of construction and found it not only more healthy for the occupants, but also productive of financial rewards. Of course, the wider the streets, the larger the yard, the more spacious the courts and areas surrounding and included in the houses, the more light and ventilation there is available for the occupants of the house, and the healthier the houses of such construction are.

*The Materials of Construction.*—The materials from which a house is built form an important item in sanitary as well as other respects; the present tendency is to discourage the construction of frame buildings, especially in large cities, and to build tenement-houses of stone and brick, with iron beams in one or more stories of the house. There are many grades and qualities of building brick, speculative builders preferring, of course, the cheaper and inferior, as well as old and second-hand kinds. The building regulations of most municipalities prescribe in detail the kind and qualities of material to be used, but the conformation of the builders to the law depends upon the careful supervision and enforcement by the building inspectors. The rigid enforcement of laws concerning construction is one of the most important municipal duties, and should be entrusted to competent, expert, reliable, and *well-paid* men. The frequent accidents involving frightful risk to limb and life, and due to faulty construction and bad material, prove over and over again that municipalities cannot overlook this most important part of municipal sanitation, nor can they afford to save on the character and compensation of their employees.

The restriction of the height of buildings is a necessity, and had been practised since the days of Augustus. In overcrowded areas and in narrow streets the height of houses should be carefully supervised and restricted, and the provision of the New York Tenement-house Law restricting the height of tenement-houses to one and one-half times the width of the streets on which they are situated is a wise one, and will tend to discourage the construction of 6- and 7-story houses upon narrow streets; another salutary provision is the one making the construction of high houses more expensive by the provision that all houses above six stories in height must be fireproof throughout.

*Foundations.*—Not only the stability but also the healthfulness of a house depends upon the proper construction of the foundations. The methods of constructing the foundations depend largely upon the character of the ground upon which the house stands. In marshy, waterlogged, boggy, and filled-in land it is necessary to drive piles into the soft soil and then prepare a solid bed of concrete upon them with proper provision for damp- and water-proofing by the use of sheet lead, slate, asphalt, or tar. Not only the footings in the foundation walls but the entire lower story of the house should be completely isolated from the ground by damp-proof materials, so as to effectually prevent dampness from being drawn into the house walls. While some sort of damp-proofing, very faultily applied, is put into new houses, there are a very large number of tenement-houses built in pre-restrictive times which have no provision for damp-proofing whatever, although they are situated directly upon watercourses, filled-in ground, or tide-ridden soil, with the result that these houses are damp and wet, and unhealthy to inhabit. This brings us to the important subject of house-dampness and water in cellars, which deserves a more extended discussion.

**House-dampness and Water in Cellars.**—*Causes of House-dampness.*—The causes of dampness in houses may be those due to conditions existing above the cellar, or those in and under the cellar. Dampness in houses above the cellar may be due to the following causes:

1) Porosity of building materials.

2) Water from various sources coming in contact with house.

3) Defects in construction and maintenance.

4) Occupation, uses, and abuses of the house.

5) Capillary attraction from the ground and cellar.

*The Porosity of the Various Building Materials.*—The nature of most materials of which houses are built renders it possible for the latter to be damp. Wood, brick, mortar, and even stone, are all porous and absorbent, and are capable of retaining a large quantity of water for some time. Lumber when unseasoned contains a very large percentage of water, estimated by some to reach 50% and even 60% of their weight; even thoroughly seasoned and dried wood still contains about 20% of moisture. Brick, which is so extensively employed as a building material, possesses a considerable absorptive power, estimated from 10% to 30% according to the quality of the brick. A brick that absorbs only 10% of moisture is considered good. It was calculated by Eassie that an ordinary brick absorbs about half a pint of water. Brick walls, therefore, are capable of absorbing and retaining very large quantities of water.

Mortar which is used to bind brick, and the quantity of which in buildings amounts to nearly one-third of the brick surface, is still more absorbent than brick. Mortar is a mixture of sand with lime or cement. Common lime mortar absorbs from 50% to 60% of its own weight, and the best Portland-cement mortar absorbs from 10% to 20%.

All stones, even the most dense granites, are more or less porous and possess the power of absorbing water. A cubic foot of ordinary stone will absorb from 5 to 10 lbs. of water.

It is evident, therefore, that the porosity of building materials alone is a potent cause of house-dampness, and this becomes more evident when combined with the other causes enumerated above.

*Water from Various Sources coming in Contact with Walls and Ceilings.*—We now know that the materials from which the house is constructed are absorbent, and the factors of dampness which we are to consider are the causes of water coming in contact with the house. As a matter of fact these causes are very numerous. From the time the materials are gathered at their original sources, and during all the time they are a part of the house, they are repeatedly and frequently wetted and watered. During construction large quantities of water are purposely incorporated in the mortar and the bricks, besides the water due to the occasional rain-storms wetting the whole building under construction. The practice of builders to hurry with the plastering, ornamenting, and the painting of the walls inside and outside is also a cause of dampness, as the large quantity of water in the materials is thus prevented from evaporating. Even after the house is built there are numerous sources of water coming in contact with the walls and ceilings of house; thus, the occasional driving rains wetting the walls, and the other occasions enumerated below, help to render the house damp.

*Defects in House Construction and Maintenance.*—Defective, too absorbent materials, hasty construction, too early plastering and painting have already been mentioned as causes of house-dampness; the further causes are the defects in maintenance, such as leaky roofs, bad rain-leaders, faulty eaves, gutters, etc., all causing large quantities of water to come in contact with the walls or ceilings and rendering the house damp.

*Occupation, Uses, and Abuses of House.*—Besides all the causes enumerated there are others that help to increase the moisture within the house; thus the very occupation of the house, the moisture produced by the occupants, by the illuminants, and by the heating, as well as by the abuse of water on the floors and walls, overflowing of basins, steam produced in kitchens, laundries, and bath-rooms, and other uses of water in the house.

*The Capillary Attraction from the Ground* is another and very potent cause of damp houses, as all water within the cellar and lower part of house is drawn up by capillary attraction into the walls, and the causes of the cellars being wet and damp are very numerous, as will be seen immediately.

**Sources of Water in Cellars.**—The following is a classification of the various sources of water in cellars:

I. NATURAL SOURCES.

*Surface-water.*—Location of house.
Proximity of adjoining ground.
Condition of surrounding ground.

*Subsoil-water.*—Ground water.
Underground lakes, streams, and ponds.
Underground springs and ponds.

*Tide-water.*—Coming through the ground.
Coming through sewer-pipes.

II. ARTIFICIAL SOURCES.

*Water-service Leaks.*—Street mains.
House mains.
Yard and dead pipes.

*Sewage-water.*—Permeability of sewers.
Street and private sewers.
House and yard drains.
Cesspools, privies, school-sinks, etc.

*Manufacture and Storage.*—Manufacture of mineral waters.
Storage of ice, etc.
Overflow from various fixtures.

The enumerated sources of water in cellars may exist in a house singly or in combination, and cause the cellars, subcellars, and walls of the lower story of the house to be damp, which dampness may be drawn up by capillary attraction into the walls of the upper stories of the house.

The examination for the sources of the water in cellars is sometimes a very difficult matter, demanding ingenuity, practical knowledge, and experience on the part of inspectors.

**Prevention of House-dampness and Water in Cellars.**—The prevention of the dampness in houses and of water in cellars may be palliative or radical. The radical means of prevention are twofold: (1st) the removal of the cause or causes of the dampness and water, and (2d) the construction of the house so as to keep dampness and water out. The palliative means of preventing dampness and water from gaining into houses are: (1st) the scraping off and drying of all walls and ceilings infected with dampness, and (2d) the coating of the walls and ceilings with damp-proof materials.

The removal of the causes of dampness and water in cellars is the best prevention against the evil, and may consist in the following procedures:

1) Selection of non-porous, dry, and well-seasoned building materials;

2) Location of house upon dry, well-drained sites;

3) Thorough drying of the newly constructed house before occupation;

4) Proper construction of walls, ceilings, roofs, gutters, window-sills, etc.;

5) Careful use of water within the building;

6) Proper heating and ventilation of the rooms before and during occupation;

7) Prevention of any and all defects caused by the leaks from various sources.

The art of constructing a house so as to prevent dampness from entering is within the province of the important science of architecture, and cannot be gone into here.

**Internal Decoration.**—The proper finishing of floors, walls, and ceilings is not without importance to the health of the occupants of the building.

*Floors* are made of narrow or wide planks well fitted together. Such a flooring, especially when the planks are narrow, is better than the mud and rush floors used by our forefathers; there is, however, still much room for improvement, for the reason that such flooring easily cracks, the spaces between the individual planks become wider and wider with the drying of the wood, and are filled in with dust, dirt, and decomposed vegetable and animal matter. Such a floor it is almost impossible to keep clean, and it has been proven that, owing to its periodical and frequent wetting, many pathogenic germs may thrive in the cracks and spaces. The growing practice of covering the floor with oilcloth and linoleum is to be encouraged, although a hard-wood flooring or a stone-tile floor is the best in sanitary respects. For halls and for bath-room and water-closet apartments of tenement-houses a tiled or slate floor should be insisted upon; the same for stairs, as there is nothing more dusty and insanitary than a carpeted stairway.

*Walls and Ceilings* should be covered with a hard, smooth, easily washed, light paint; papering the walls and ceilings is unhygienic on account of the difficulty of cleaning and washing it, and the growing practice of covering walls of halls in tenement-houses with burlap is bad and should be discouraged, as the burlap has a rough surface and cannot be properly cleaned; moreover, being expensive, it is not changed for years. Metal-covered ceilings and walls of halls are good, and are already extensively introduced in newly built tenement-houses, especially in stores and halls. The New York Tenement-house Law of 1901 contains a provision prohibiting putting new paper on the ceilings and walls of rooms in tenement-houses unless the old paper is first removed. This provision of the law is, however, a dead letter, and hardly ever enforced owing to the expense of the procedure and the reluctance of owners to spend the additional sum for the removal of the old paper, and also to the utter impossibility of municipal supervision of the action of individual paper-hangers. Kalsomining of ceilings and walls is advocated by some for the reason that it is very cheap and can be repeated very frequently, and also for the reason that carbonate of lime acts as a disinfectant.

**Light, Heating, and Ventilation.**—*Light.*—One of the greatest of the evils of the tenement-house system is the complete or semi-darkness of most of the rooms of the apartments—a condition which leads to bad health and danger to life and limb. The prevailing mode of tenement construction does not provide for the natural lighting of all the rooms, and with the 25×100 lot it is rather difficult to provide every room with windows into the outer air. Most of the older tenement-houses have been built with practically but two light rooms in each apartment, *i.e.*, the rooms to the front and rear of house, leaving all the middle rooms in entire darkness. With the advent of the dumb-bell-shaped houses the middle rooms received light from the narrow air-shafts; these have been ordered to be widened with every legislative new tenement-house enactment, until, at present, the New York law provides for the entire abolition of dark rooms and narrow air-shafts, and according to which law even bath-rooms must have windows into the outer air. Thus the fight against the powers of darkness has been won after many years of agitation and struggle. The most potent cause, however, of the dark rooms and insufficiency of lighting halls, etc., lies in the peculiar method of lot division prevalent in New York City, and the prevalent methods of building houses attached and close to each other. With semi- or completely detached houses provision may be had for lighting the house from all sides instead of but from the front and rear of the house as heretofore.

So far as artificial lighting of halls and rooms is concerned, some progress has been made of late. The New York law provided for the compulsory lighting of all halls from sunset till 10 P.M., and of two halls the whole night through; there is also a provision compelling the owners of houses the halls of which are dark in the daytime to keep a light burning the whole day. Unfortunately no municipal department can possibly have so many inspectors as to secure the enforcement of this law, hence the result that the lighting provision of the law is but a dead letter.

*Heating.*—The prevalent methods of heating tenement-houses is still the old one by stoves and ranges in each apartment, although many houses are being built with provisions for steam-heat and hot-water supply. So far as convenience is concerned steam-heating is certainly better than the old way of individual heating by stoves; but hygienically speaking it is to be doubted whether steam-heating is the better mode of the two. The disadvantages of steam-heating are the following: 1) the oppressive heat given by steam-pipes under high pressure; 2) the irregularity in the provision of the heat, depending upon the ability, honesty, regularity, and competence of the janitors;

and 3) the difficulty of regulating the degree of temperature suitable to each individual tenant of the house. Heating by furnaces is applicable only to small houses, and is hardly ever used in tenement-houses; the same may be said of heating by hot-water pipes, which is the best and most hygienic form of heating rooms and houses. Whatever the methods employed for heating rooms, the halls should be provided with a warming-plant.

*Ventilation.*—No special provisions are made, as a rule, for ventilating the rooms and halls of tenement-houses, except by means of the windows, transoms, and doors in each room and in the halls. The halls are provided with additional means of ventilation, either by scuttles or by the louvred skylights. The openings from every room into the chimneys are of course additional means of ventilating the rooms, especially in winter when the rooms are heated. Ordinarily the above means of ventilation ought to be adequate for the purposes, but when the rooms are overcrowded and doors and windows hermetically closed, as is often the case in most tenement-houses, the air within the rooms is apt to become foul and vitiated. There is certainly great need of popular education on the boon of fresh air. There are many tenement-houses where there are a number of rooms without any windows whatever, and the ventilation of such houses is very bad. However, the days of these houses are numbered, as the laws are more stringent and require such rooms to be vacated, or provided with windows into the outer air. Cellars are ventilated by windows, gratings, and doors. Water-closets and bath-rooms need ample ventilation, although these rooms have been, as a rule, neglected hitherto. The New York Tenement-house Law makes strict provisions for the ventilation and lighting of these rooms. The increased area of the yards, courts, and other unbuilt spaces adds so much to the ventilation of the rooms of the house. The minimum air-space set by the Tenement-house Law is 400 cubic feet for adults, and 200 for children under twelve years of age. This minimum is not adequate and should at least be doubled.

The extension of the public park and playground system, especially in crowded tenement-house districts, is a great boon for tenement-dwellers, as these open-air spots increase the breathing-spaces in those districts and are veritable oases in the tenement Saharas.

**Water-supply.**—Owners of houses are compelled to furnish an adequate supply of water for all domestic purposes, and each and every floor must be provided with proper fixtures to distribute it. In some old houses the main water-service pipe, originally intended for one family, is made to serve for a number of families, and is inadequate, not being sufficient to supply water to the upper floors. The remedy is a water-pipe of larger size. In houses of 4 or more stories the ordinary street pressure is not sufficient to raise the water to the upper floors, and it is then necessary to instal gas-, gasoline-, or steam-engines to pump water into tanks above the highest floor, from whence it is supplied to the upper floors. These tanks may become a source of nuisance, as they may leak and cause dampness of ceilings of the upper story, or furnish dirty water from sediments and dirt gaining access thereto. Tanks should be properly constructed, water-tight, well covered, accessible, easily cleaned, and frequently emptied, scrubbed and cleaned. The overflow from the tank must not discharge into the rain-leader, or into other house-pipes, but should be led down into the cellar to discharge into a sink. The washers on the water-faucets must be renewed once in a while to prevent leakage.

**Plumbing.**—The plumbing of a tenement-house does not differ from the house-plumbing described in the first part, except in so far as the tenement-houses are built for poor people and all the materials, plumbing included, are of inferior grades, and the workmanship cheaper and inferior.

One of the most dangerous defects in tenement-house plumbing is the old brick or earthenware house-drains. These drains are too large, laid without any fall, and situated underground, with the joints unsupported and broken, and with great holes here and there—the whole a channel of indescribable filth, giving off miasmatic effluvia, saturating the cellar-ground with liquid sewage, poisoning the air in cellar and house, and causing disease and pestilence. Whenever such drains are found they should be ordered out, as even the best of them are not without danger, and the law now prohibits any but extra heavy iron pipe-drains in houses. There is scarcely an earthenware house-drain that will stand a properly applied test.

The iron house-drains in tenements are often underground, owing to the presence of fixtures in the cellar; in such a case an examination of the house-drain is not possible without a test. Plumbers in cleaning house-drains of obstructions are in the habit of leaving open holes in the drains, or, if they take the trouble to close the holes, they do so with sheet-metal, putty, or cement, or sometimes with only a rag tied around the pipe. These openings are a means of escape for sewer-air. They should be closed gas-tight with iron bands, patent saddle-hubs, or screw-nuts. The covers of the handholes of traps on house-drains should be adjusted gas-tight. Very frequently there will be found connected with the house-drain the overflow pipes from refrigerators, roof-tanks, waste-pipes from stores, pressure-pumps from beer-saloons, etc. All such pipes must be disconnected from the house-drain, the opening at the disconnected place closed gas-tight, and the waste-pipes made to discharge into a sewer-connected, properly-trapped, water-supplied open sink.

Sinks and water-closets are often found in cellars, and, apart from the fact that such fixtures ought never to have been put there, they are hardly ever used, and their seals have evaporated, allowing sewer-gas to enter the cellar through the empty trap. Such disused fixtures should be disconnected and removed.

Traps of fixtures are not yet vented in every house, hence siphonage is rather a common occurrence. The soil- and main waste-pipes are not always extended above the roof, and, when extended, are often fitted with return-bends and cowls. A common defect in tenement-house plumbing is the improper joint-connection of pipes, putty and cement joints being frequent. In some houses the traps are of quite an antiquated form, bottle and other old traps being occasionally found. Holes in traps, in waste-pipes, and in all other pipes, abound, and are either left open or are closed with putty, dough, or rags. The sinks have woodwork enclosing them beneath and around, the spaces within such enclosures being exceedingly foul and filthy. Water-closets are the most abused fixtures in the house: So many people use, so many more abuse, and so few clean them, it is no wonder at all that water-closets are masses of filth and that they poison the air. In some houses the water-closets are situated in cellars. Of school-sinks I have already spoken. The long Philadelphia hopper closets, those especially with a spiral flush, are a nuisance, as they are never clean, nor well flushed. Pan closets are not so frequent in tenements, thanks to sanitary inspectors, who order them out as soon as they discover them.

There are a great many ways in which plumbing may be defective, as we have seen in Part I., and the only remedy is to be constantly on guard, inspect the plumbing frequently, and have it put in proper condition by licensed plumbers.

**Condition.**—No matter how well constructed the tenement-house may be, if, after construction, the house is not properly taken care of, it will become dilapidated, filthy and offensive. A strict supervision over and care of the yard, fixtures, etc., are essential to the house being fit to live in, and therefore the law not only calls for proper cleaning of the house and its several parts, but also that, in each and every tenement-house, there should reside a housekeeper, whose sole duty it should be to take care of the house, clean all its parts, and exercise supervision over it.

*Yards* in tenement-houses are usually very small, and are greatly abused. In a space of 10–12 × 25 feet will often be found the yard hoppers or school-sink; and the space is filled by the inevitable clothes-lines. The yard should be properly cemented or flagged, and so graded as to discharge all surface-water into a properly trapped, sewer-connected, drain. The yard should be swept clean, and kept free from rubbish.

*The Air-shafts, Courts, and Areas* should be properly paved, graded, and drained, and should be kept clean. The fresh-air inlet in the front area, or in front sidewalk, should be kept clear of all obstructions.

*The Cellar.* Even the best-constructed cellar will become offensive if not properly taken care of. The floor of the cellar should not be broken, as the holes become receptacles for dirt, and the walls and ceiling should be whitewashed or painted frequently. The cellar-floor is to be drained when the house-drain is underground, the drain to be trapped with a syphon trap provided with very deep seal to prevent evaporation. The cellar should be cleaned of all offensive refuse and rubbish, and be frequently disinfected.

*The Halls* of tenements are, as a rule, dark and dreary, dimly lighted by day, and little more so by night. The New York law relating to lights at night in halls is as follows:

"In every tenement-house a proper light shall be kept burning by the owner in the public hallways, near the stairs, upon the entrance floor, and upon the second floor above the entrance floor of said house, every night from sunset to sunrise throughout the year, and upon all other floors from sunset till 10 P. M."

The rails and balusters of stairs should be secure and in good repair, and the wainscoting and floors of the halls shall be well kept and frequently scrubbed and cleaned. The practice of papering walls of halls is pernicious; a light-colored paint being the best covering over walls and ceilings of halls, as well as of water-closet apartments.

*The Water-closet Apartment* should be well looked after, as it is the place most likely to be dirty in a tenement-house. The floor should be clean, and must be of an impervious material. The floor, seats, walls, ceilings, windows, etc., should be frequently cleaned.

*The Roofs* of tenement-houses require great care, and should be clean and free from defects and leaks. Guard-rails should protect the roof on all sides, and the eaves-gutters should be in good repair and tight; the whole roof should be painted once a year. The chimney, pipes, and tank on roof also should be kept in good condition.

*The Plumbing Fixtures* have often been alluded to already, and nothing remains but to emphasize the fact that, of all parts of the house, the plumbing and plumbing fixtures must be constantly watched, that all defects may be promptly repaired, and cleanliness exercised to the utmost.

*The Rooms* should be clean, the walls and ceilings painted, and floors scrubbed; the windows should be easily opened and cleaned, and often left open to change the air in the rooms.

# CHAPTER IV.

## PRIVATE DWELLINGS.

HOUSES built for one or two families are, as a rule, of better construction than tenement-houses, but there is a large number of old houses which were built years ago, and which are in a bad sanitary condition, that are used as private dwellings.

The points especially to be looked after by the inspector examining private dwellings are the cellar and the plumbing.

The cellar is, as a rule, large and spacious, but is usually filled with rubbish and refuse, and the floor is rarely a cemented one. The antiquated hot-air furnace so often found in the cellars of private houses is a cause of frequent complaint, as it is hardly ever in good order, is badly constructed, the joints not being tight, the flues and air-conduits defective, the cold-air box in the wrong place, and the whole a source of smoke and coal-gas. The servants' closet (usually an old pan closet) is located in the cellar; the house-drain is underground, and either of earthenware or of brick. The cellar, as a whole, is a repository for sewer-air and a breeding-place for disease germs.

The plumbing in old private houses is sometimes so complicated and so full of defects that it is at times a matter of difficulty to examine it. The reason for this is that these old houses have been subjected to the bungling of several generations of plumbers, each trying to remedy certain evils, but instead adding to them by some new complicated "by-pass," connection, etc. The wash-basins in the many bedrooms may be a convenience, but they are certainly additional means of allowing sewer-air to enter the house. These wash-basins are all over the house, irrespective of the location of the main waste-pipe, and consequently require the running of long, horizontal, lead branch-pipes under the floor, with the likelihood of these being gnawed by rats and broken into by nails. The wash-basins are also left unused for long periods, and the traps consequently lose their water-seal by evaporation, thus permitting the escape of sewer-air from the drain. Vent-pipes are not often found, and siphoning is frequent. Private dwellings are the places where the pan water-closet is still frequently found; nor is the extension of vertical pipes the rule in these old houses.

Altogether the sanitary condition of many old dwellings is deplorable; and as the municipal authorities are mostly occupied looking after tenement-houses, the private dwellings receive little or no attention unless some disease breaks out, or some tenant has the courage to complain to the proper department.

# SECTION II.—OCCUPATIONS AND TRADES.

## CHAPTER I.

### FACTORIES AND WORKSHOPS.

FACTORIES are places where work is being done with the aid of mechanical power, while a workshop is a place where work is being done without the aid of any mechanical power; thus, a tailor shop with machines run by hand or foot is a workshop, while shops where the machines are run by steam or electricity are to be designated as factories. This is the differentiation and definition of the terms as accepted in England, although the New York State Law reads "the term factory shall be construed to include also any mill, workshop, or other manufacturing or business establishment where one or more persons are employed at labor."

A great part of the workingman's life is spent in the workshop or factory, and the sanitary condition of the place of work is of great importance to the health and well-being of the workingman. The proper construction, lighting, ventilation, plumbing, and cleanliness of the place of work affect the health and life of the worker, and are therefore subjects of great importance to the sanitarian.

**The Construction of Factories and Workshops.**— All industrial establishments should be specially constructed for the specific purposes for which they are to be used; and the usual plan of adapting any ramshackle, out-of-date building, unfit for any other purpose, to the uses of a factory or workshop, as frequently is the case, should be legislatively prohibited. All factory construction should be done under the strict supervision of the labor and factory authorities, who should issue a permit for occupation only after thorough inspection and conviction that the building is fit for the purposes for which it is constructed.

The size of the work place should, of course, be proportional to the number of employees and to the needs of each establishment. The legal minimum of four hundred cubic feet of space for each worker, established by several legislatures, is entirely inadequate; there should be at least 1000 cubic feet of space for each individual, as a general rule, and this allowance should be increased in especially dusty or otherwise dangerous trades. The walls, ceilings, floors, and all surfaces of work places should be constructed with special regard to the industry carried on. Thus, in all places where large quantities of dust abound, the walls and especially the floors should be made of a smooth material, such as glass, tiling, etc., which can easily be washed and scrubbed; and all nooks, corners, crevices, etc., where dust may accumulate, shonld be avoided.

In all places where the humidity of air is above the average, the walls, ceilings, and floors should be made of impervious, non-absorbent material. Wherever possible, the floors should be made of concrete and cement, or asphalt, or of tile and stone materials; and wherever large quantities of water may be spilled upon the floors these should be so graded and drained as to discharge all the water into special pipes, not, however, connected with the general plumbing system of the house.

**Lighting.**—On the proper lighting of factories and workshops depend not only the condition of the eyesight of the workers but their general good health. Shops should have ample window area, such area to be at least 20 per cent. of the superficial area of the room, and so distributed as to give proper and ample light in all parts of the workroom. There is nothing so conducive to ill health and occupation-diseases as dark and dingy workrooms, which no doubt play an important rôle in the prevalence of tubercular diseases among various workers. The ideal factory and work place is where no work is done except by daylight, but as this is not always possible, the artificial lighting of work places is a matter of great importance. The best illuminant is, of course, electricity, which not only gives a better and stronger light but also adds no impurities to the air nor raises the temperature of the place. The lights next best to electricity are the white lights given by Welsbach and kindred burners; they should not be placed too near the persons of the workers, and should be uniformly distributed.

**Plumbing.**—The plumbing pipes and fixtures of factories and workshops do not differ essentially from those in tenement-houses and other dwellings. There should be ample wash-rooms, urinals, and water-closets on every floor in every work place; these fixtures should be of the best and most modern type, and should be under the constant and especial care of proper persons, for where there are a large number of persons using those fixtures they are liable to be abused. The factory laws of most states demand separate wash-room and toilet accommodations for male and female employees.

**Preventions of Accidents.**—The best mode ef preventing accidents in work places is to have the machinery, etc., properly safeguarded, and also by properly drilling the employees and educating them in the proper handling of the various tools and machinery and in the best methods of self-protection. Motor engines, fly-wheels, etc., as well as hoists and elevator shafts should be properly fenced in and guarded; wheels, shafts, drums, belts, and all gearing, circular saws, planes, power looms, and all other machinery should be properly safeguarded so as to protect the worker from possible injury. Inexperienced persons, women, and children should not be allowed to handle and work near dangerous machinery. So far as the proper maintenance of the work places is concerned, this demands the special care of proper persons, and should not be left to the workers themselves, as upon the proper cleaning, washing, and disinfecting of workshops, etc., depend the health and well-being of the workers, and as the law compels janitors to be engaged for tenement-houses, there is still more ample reason to require factories, where hundreds of persons are working, to be kept clean and in good sanitary condition by special caretakers.

**Home Work.**—The carrying on of manufacture and work at the home of the operatives instead of at the shop and factory is an evil from which many industries and many cities are great sufferers. This so-called "sweatshop" work is especially prevalent in the clothing industries, and wherever there is a large foreign working population in big cities. Not so long ago home work was also prevalent in the tobacco and cigar industries. There are a great many dangers following and accompanying sweat-shop work: (1) The tendency to child and female labor, as home work is either being carried on by the father of the family assisted by his wife and children, or is exclusively in the hands of the mother and children with the usual baneful result of female- and child-labor on their organisms. (2) The unsanitary condition of the living rooms owing to the dust and debris from the work, the insufficient ventilation, and the dirt incident to home work. (3) The danger of infection and of spreading the infection to the material and product of manufacture, and through them, outside. There should certainly be a complete separation of home from factory, the home not to be used for any but its legitimate purposes, while all work should be carried on in places specially constructed and fitted for it.

# CHAPTER II.

## VENTILATION OF FACTORIES AND WORKSHOPS.

THE health and well-being, as well as labor-efficiency, of operatives depend upon the state and purity of the air in the workshops and factories. Where comparatively small rooms are used by a great number of employees, it is evident that the air of the work place will soon become greatly deteriorated, and so foul as to constitute a menace to the health of the working people breathing the impure and foul air. In order to reduce the dangers and to remove the impurities from the air of factories, etc., efficient ventilation becomes necessary.

**Deterioration of Air in Industrial Establishments.**—These are due to the following:

I. *Caused by the Workers.*—Decrease of oxygen, increase in the relative amount of carbonic acid, increase in amount of moisture, increase of temperature, and increase in relative amount of organic matter.

II. *Due to the Place of Work.*—Detritus from walls, floor, ceilings, and other surfaces; increased humidity due to the dampness of walls and other parts of the building; molds, fungi, and other low forms of organic life.

III. *Due to the Artificial Lighting and the Heating of Rooms.*—Increase in relative amount of carbonic acid and increase in temperature.

IV. *Due to Machinery, etc.*—Increase of temperature from the motion and friction of machinery, etc., and waste and detritus from tools, stones, machinery, etc.

V. *Due to Industrial Processes.*—Waste from the crude materials which are being torn, crushed, ground, milled, polished, etc.; dust from the organic and inorganic substances of manufacture; poisons, fumes, and gases, infective agents, bacteria, etc.

The above-named causes of deterioration of the air can be removed by ventilation, either natural, artificial, or mechanical.

Ventilation by means of the porosity of the walls and building materials and by the additional means of the ordinary openings made in the building, such as windows, transoms, and doors, may be adequate for very small workshops with a very limited number of workers, but will be inadequate for larger shops and manufactories. Nor will the special artificial openings made for ventilating purposes, such as special outlets, chimney flues, cowls, and other arrangements mentioned in the chapter on ventilation in the early part of this book, prove sufficient for the thorough and adequate removal of all the many impurities which abound in the larger workshops and factories, and certainly will be utterly insufficient where dust, gas, and noxious fumes are produced in the processes of manufacture and industry. Here we cannot depend upon the ordinary means of ventilation, but must have recourse to the system of so-called "artificial" ventilation, which should rather be termed "mechanical" ventilation.

**Mechanical Ventilation.** — Mechanical ventilation consists in removing the vitiated air from a place, or in forcing fresh air into a place, or both, by means of mechanical contrivances and with the aid of motors run by steam, electricity, or compressed air, etc. These methods were termed *vacuum* or *extraction*, and *plenum* or *propulsion* ventilation. Both systems, as well as their combinations, are accomplished by means of fans run by some motor power, the fans being so constructed that they either exhaust the air from the room or they force outside air into the room, according to the construction of the blades of the fan.

Besides the simple expedient of exhausting the foul air or providing fresh air, mechanical ventilation has the advantages that in the propulsion method additional means may be provided for warming the incoming air to a desired temperature, and also for regulating its relative humidity. In the extraction method means may be provided for collecting the impurities of the extracted air in proper receptacles, for cleaning the air of dust, etc., by filtration, precipitation, or compression, and the absorption of gases, etc., by chemical means.

Ventilation by fans, by which is meant mechanical ventilation, has very great advantages over all other methods of ventilation, and it should be resorted to in all large industrial establishments where there are a great number of workers, and where the processes of industry develop large quantities of various impurities. Ventilation by fans can be easily installed in any industrial establishment where some motor power, such as compressed air, steam, or electricity, may be conveniently had. Not only are the quantities of air which may be supplied by fans practically unlimited and the supply under perfect control, and not only may provisions be made, as stated above, for warming the air and removing dust, etc., but there is the additional advantage of the possibility of removing the dust, fumes, etc., at the *very point* where they are given off. This is an absolute necessity in some industries where the amount of dust given off or the fumes generated would be injurious to health if not promptly removed.

The proper ventilating devices for removal of dust consist of the following:

(1) An expansion, hood, box, or cap, properly fitting or enclosing the tool, machine, or stand of each dust-producing process or worker.

(2) Tubes or ducts connecting from the above-named hoods, etc., and leading to the outlets.

(3) The fans proper, which are at the ends of the outlet, tubes, or ducts, and which serve to exhaust and extract the air with the dust from the tubes and hoods, etc.; and

(4) Receptacles into which the dust settles by gravitation, centrifugal motion, etc., after it is extracted. Various other appliances, such as for wetting the air, etc., may be connected with apparatus.

For purposes of general ventilation the exhaust or propelling fans may be placed in one or two parts of the building without regard to local ventilation of the individual industrial processes. It is needless to say that the installation of a ventilating apparatus demands proper engineering knowledge and skill, and a detailed calculation of the various conditions arising in the process.

# CHAPTER III.

## INSPECTION OF FACTORIES AND WORKSHOPS.

The sanitary inspection of factories and workshops does not differ in general from the sanitary inspection of dwellings, etc., except in so far as there are a great many items of inspection not found in other establishments. The principal groups of points of inspection can be divided as follows:

(I) *Place of Work.*—Construction of shop, its lighting, ventilation, plumbing, and maintenance, etc.

(II) *The Workers.*—Numbers, males and females, children, etc., licenses, etc.

(III) *The Processes of Work.*—Character of industry, manner of work, machinery, dust, etc.

(IV) *Protection against Accidents.*—Elevators, hoists, machinery, boilers, etc. A proper inspection of an industrial establishment embraces a detailed and thorough inspection of all the various points as indicated below in the example of an official report of inspection by the New York Bureau of Labor:

## REPORT OF INSPECTION.

Street and number..........................................
Date of inspection..........................................
Name of person, licensee, firm, or corporation....................
[If establishment has removed or there is a change of name, so state]
..........................................................
..........................................................
If incorporated or joint-stock concern, give president's name.......
..........................................................
Name and address of owner, agent, or lessee of building...........
..........................................................
Number of stories?.............. Floors occupied?..............
Building used wholly for manufacturing or business purposes?....
Goods made or work done?..................................
Principal material used?..................................
If made in front or rear shop, state whether by *piece, contract,* or *sub-contract*............. Custom or ready-made?.............
For whom?............................................
Number of owners or proprietors at work?......................

| EMPLOYEES (Exclusive of Working Proprietors, Managers, etc.) | Office Help, Messengers, etc. | In the Work-shops. | Total Number Employed. | Regular Weekly Hours of Labor in Workshops. |
|---|---|---|---|---|
| Males 18 years old or over.. | ............ | ............ | ............ | ............ |
| " under 18 years....... | ............ | ............ | ............ | ............ |
| Females .................. | ............ | ............ | ............ | ............ |
| Children 14-16 years* Boys | ............ | ............ | ............ | .......... |
| Children 14-16 years* Girls | ............ | ............ | ............ | |
| " under 14 years..... | ............ | ............ | ............ | X |
| " illiterate.......... | ............ | ............ | ............ | X |
| *Largest number of employees at any time in year past.* ............. | ............ | ............ | ............ | X |

* Children are also to be included in number of Males and Females.

**Board of Health Certificates**—Are they filed?......................
How many missing?............ Is record kept?.............
**Hours of Labor**—Is notice posted as to hours for males 16–18 years old and women?......... For children under 16? ......... Do children work more than 9 hours in any day?........ If former work more than 16 hours in any day, state reason...............
..................................................................
Was inspector notified of change in hours of labor?.............
Is overtime record kept?.......................... Do either class work nights (9 P.M.–6 A.M.)?.........................
**Meal Time**—Time for noonday meal?............................
Has permit been granted?... Is it continued...? Is it posted?...
If overtime be required, how much time for lunch?.............
**Wages**—If incorporated or joint-stock concern, how often are employees paid?........... In cash, checks, store orders?..........
**Law**—Is it posted in workroom?..................................
**Elevators**—Number of?............ Are cables, gearings, etc., in apparently safe condition?........ How is well-hole enclosed or covered?.................................................
..................................................................
How is elevator entrance guarded?...............................
..................................................................
Are other guards required?....... How do doors open?.......
Is passenger elevator properly enclosed?........ Is child under 15 allowed to operate or care for elevator? ......... Is minor under 18 permitted to do so?....... If so, state speed?.......
**Hoistways**—Number of?................ Are they enclosed or secured?....... Is apparatus in apparently safe condition?.......
**Machinery**—Are males under 18 or women under 21 permitted to clean same while in motion?........... Are children under 16 employed on dangerous machinery?....... Belt shifters in use? ...... Any machinery specially dangerous?...... Has its use been prohibited?......... Are belting, machinery, gearing, set screws, vats, pans, etc., safely guarded?.......................
..................................................................
**Dust-creating Machinery**—Any in operation?......................
How many emery or buffing wheels in use?.....................
Number of persons continually employed on same?.............
Males under 18 or females employed at polishing or buffing?.....
Is proper exhaust fan provided and kept in operation?..........

**Boilers**—(Applicable to localities where inspections are not provided by local laws or ordinances)—Number in use?..............
Were they inspected?........ Date of inspection?........19...
By whom?.................................................
Has duplicate certificate been filed?..........................
Have they proper steam and water gauges and safety valves?....

**Accidents**—Any since previous inspection?......................
Were they reported?........................................

**Safety of Building**—Are floors, walls, and all parts apparently safe?...................................................

**Walls, Ceilings**—Do they need lime-washing or painting?.... .....

**Stairways**—Number of main stairways inside?............. Outside?....... Have they hand-rails?.. .... Properly screened? ........ Are rubber coverings for stair steps necessary?........

**Fire-escapes**............. Balcony and inclined ladder? Balcony and straight ladder?......... Straight ladder?......... Other means?...................................................
Are exits unobstructed and accessible?.........................

**Lighting**—Are workrooms, halls, and stairs leading to workrooms properly lighted?....... Are such lights independent of motive power?.................................................

**Doors**—Are they locked, bolted, or fastened during working hours? ................ How do they open?........................

**Water-closets**—How many inside of building?........... ....Outside?....... Is it practicable to maintain them on inside?....... Separate for sexes?.... Properly screened?... Well ventilated and clean?....... Free from obscene writing or marking? .....

**Wash-rooms**—Are they suitable and convenient?..................

**Dressing-room**—Is one provided for females?.....................

**Seats for Females**—Are they maintained?................. Is use thereof permitted?..........................................

**Air Space**—Is it ample during working hours?............ If not, state cubic feet of same in workroom..........................

**Registers**—All work done on premises?.........................
Is register of outside help kept?...............................
Has copy of same been filed?..................................

**Date of Previous Inspection**—...................................
By......................................... Inspector

## CHAPTER IV.

### BAKERIES AND BAKEHOUSES.

THE occupation of bread-making, baking and selling is undoubtedly one of the most important industries of urban life, and the sanitary conditions under which this industry is conducted are of the utmost importance to the health and well-being of the population. Unfortunately there is hardly an occupation which is so badly situated, so far as its sanitary aspects are concerned, as bread-making. The hygienic surroundings of bakeries, their unsanitary condition, the filthy state of most of the bakehouses in large cities, the uncleanly and unhealthy character of the workers in bakeries, and the unsavory and dirty condition of the bread and other bakery-products, have been noted and described over and over again.

**The Causes.**—The following are the most potent causes of the unsanitary conditions of bakeries, their products, and of the workers in that industry:

(I) *Night-work.*—The fact that city dwellers demand their daily bread in a fresh, almost hot, just-baked condition, compels the bakeries to do most of the baking during the night. Night-work is not conducive to the health of employees, and is partly the cause of the anæmias, ill-health, various skin eruptions, and the predisposition to tubercular diseases from which bakers suffer. Night-work also implies artificial lighting, which is conducive to neither cleanliness nor health.

(II) *Location in Cellar.*—Most occupations and trades find a home in houses and places specially built, constructed, or adapted to their general and special needs. Hence the places where these industries are carried on are more or less specially adapted and fit for their several uses. This is not the case with most bakeries. While in large cities there are, and their number is happily on the increase, a number of large establishments constructed for manufacturing bread and bread-products on a large scale, most of the bread-making is carried on not only in ill-fitted and ill-adapted places, but not less than nine-tenths of the bakeries are situated in cellars of tenements and old houses. Any cellar at all is considered a fit and proper place for the establishment of bakeshops, with very little or no reconstruction except that of building an oven. The results of this anomalous condition are: (1) That the bakeries are located in very dark, damp, and foul-smelling habitations; (2) that they endanger the life of the inhabitants of the houses in which they are situated; (3) that they are extremely unhealthy for the workers who are compelled to spend a large part of their lives in the badly ventilated, badly lighted underground holes; (4) that the products of these underground manufactories are being produced under unsanitary conditions, and are often in a filthy state, contaminated with sewage and infected with vermin; and (5) that there is an entire impossibility of so controlling the trade of bread-making as to make it perfectly sanitary so long as this trade is carried on in cellars.

(III) *Lack of Sanitary Supervision.*—In spite of the many laws and more or less progressive legislation on the subject of bakeries which are found on most of the statute books in most States, there is still a lamentable lack of proper supervision and regulation of the industry, its sanitary control being divided, as for instance in New York City, among three different departments, *i.e.*, two municipal and one State, and even then bakery supervision being only one of the many minor side affairs of those very busy departments.

If the above-named causes are the right ones and are productive of such dire results, it is evident that only by their removal can an amelioration and a practical reform of the bakery industry be accomplished.

**Remedies.**—It is almost impossible to abolish night-work in the bread-making industry; the evils of night-work cannot be abolished, but may only be mitigated, and with the reform of the other conditions the effect of night-work upon the workers greatly reduced.

The most radical and the most urgent of all reforms in the industry is an immediate or gradual, complete or partial, abolition of cellar bakeries.

No bakery or bakeshop should be allowed to be conducted underground, or in any cellar of either private dwellings or tenement houses. All bakeries should be carried on in buildings or stores specially adapted or constructed for the purpose, and not one should be permitted to carry on the trade without a permit or license from a supervising sanitary department.

Only in this way will all the unsanitary features of bakeries, such as defective ventilation, dim lighting, bad plumbing, uncleanliness, danger of fires, and the many other evils resultant of cellar bakeries, disappear. The last, but not least, reform is the proper codification of laws and regulations about bakeries and the promulgation of a law creating one municipal department, with a separate division on bakeries, responsible for the supervision of the industry.

**Bakery Inspection.**—In bakery inspection attention must be paid to the following principal divisions: The place of work, the manner of work, and the character of the workers. In the inspection of the place of work the construction of the bakery must be noted, as well as the character of the floor, walls and ceilings, the protection against fire, the proper ventilation of the premises, the number, location and character of lights, the location and conditions of the plumbing pipes and fixtures, the temperature of the room, and the general maintenance of the premises. The inspection of the manner of the work consists in the proper noting of the processes of the bread- and cake-making; the adaptability and cleanliness of all the utensils, the manner of storing and handling the flour, dough, and bread, and the cleanliness of the whole process. The inspection of the employees themselves consists in the inquiry as to the number of employees, the presence and number of minors and children, the number of working hours, the general health of the workers, the provision of certain comforts, such as dressing- and wash-rooms for the workers, etc.

The following rules are from the Pennsylvania law (Chapin):

"1) All bakeries shall be plumbed and drained in a satisfactory manner as approved by the law; and should also be ventilated by means of air-shafts, windows, or ventilating-pipes.

"2) They must have an impervious floor, constructed of cement or of tiles laid in cement, or of wood of which all the crevices shall be filled in with putty, and the whole surface treated with oil varnish. The inside walls and ceilings shall be plastered, and either be painted with oil paint, three coats, or be lime-washed, or the side walls plastered and wainscoted to the height of 6 feet from the floor, and painted or oiled; when painted, paint shall be renewed at least once every 5 years, and shall be washed with hot water and soap at least once in every 3 months; when lime-washed, the lime-washing shall be renewed at least once in every 3 months. No domestic or pet animal shall be allowed in the room.

"3) The manufactured products shall be kept in perfectly dry and airy rooms.

"4) Every such bakery shall be provided with a proper wash-room and water-closets, apart from the bake-room, and no water-closet, earth-closet, privy, or ash-pit shall be within or communicate directly with the bake-room.

"5) Every sleeping-room for persons employed in every bakery shall be kept separate from the room where flour or meal-products are manufactured or stored, and shall be provided with one or more external glazed windows, each of which shall be at least 9 superficial feet in area, of which 4½ feet shall be made to open for ventilation."

# CHAPTER V.*

## OFFENSIVE TRADES. (NOISE, DUST, AND SMOKE.)

THERE are a large number of occupations and trades which not only may affect the health of the workers themselves, but frequently become a menace to the comfort and health of the neighboring community, the inhabitants of their immediate vicinity, and thus come under the legal definition of "public nuisances." The direct influence of most of the occupations mentioned, which are known under the term "offensive trades," is not always harmful to health or dangerous to life, and except in the case of trades in which poisonous gases and fumes are allowed to escape from the premises, it is difficult to prove direct harmful effect on the health. Most of the unpleasant effects of the trades are evidenced in the dust, noise, smoke, or bad odors produced by them. The number of trades which are offensive and may become public nuisances on account of the noise, dust, smoke and smell produced is very large,

* Most of these chapters, as well as the previous chapter in Section II on "Occupations and Trades," have been reprinted (with kind permission of Messrs. Wm. Wood & Co.) from the author's article on "Hygiene of Occupation," in the last edition of the Reference Handbook of Medical Sciences.

and cannot be enumerated here, nor can a detailed description of each be given.

**Noise.**—The number of businesses which are characterized by excessive noise is quite large, especially in populous towns. Surface and elevated railroads, driving of heavy wagons over rough pavements, machine shops, forge rooms, blacksmith shops, saw and planing mills, street venders, street music, etc., are a few of them. Excessive noises affect especially nervous, neurasthenic, and sick persons, causing irritability, sleeplessness, anorexia, and general disturbances. A New York physician gave to these symptoms the name of "Newyorkitis," but the malady, if there is such, could better be termed "urbantis," as it is characteristic of all large cities. The prevention of excessive noise is possible in a large degree by municipal action. Thus in New York it is not allowed to create unnecessary noises, especially at night, and near residential streets; street-band music is prohibited in the boroughs of Manhattan and the Bronx, railroad companies are compelled to remove "flat-wheel cars," street peddling is not allowed at night, etc.; with a wider introduction of asphalt pavement a fruitful cause of noises will also be largely abolished.

**Smoke.**—Among the many nuisances incident to city life is the black smoke belched forth from the chimneys of manufacturing establishments. The composition of the smoke as it leaves the chimney depends on the character of fuel burned, as well as on the methods of combustion and the care with which it is carried on. Black smoke consists of carbon mechanically suspended, and also of other gases, such as carbonic acid, carbonic oxide, and hydrogen sulphide. Wood and bituminous coal give off very abundant and black smoke, while hard coal gives off very little on account of its cohesiveness and complete combustion. When furnaces are of adequate capacity, with grates having a large area, with the coal spread in a thin continuous sheet, and with the requisite amount of air, the production of smoke is greatly diminished. The other remedies, outside of using anthracite coal, are the providing of tall chimneys, so that the smoke shall be emitted above the windows or living houses; and the voluntary or compulsory introduction of smoke-consuming devices. There are a very large number of patented smoke consumers, most of them based on the principle of making a more thorough and complete combustion of all particles of carbon in the fuel.

**Dust.**—There are only a few businesses in which large quantities of dust may escape outside of the establishments and become a public nuisance. These are carpet-cleaning and beating works, sandblasting of glass, and street sweepings. Carpet-cleaning is now done in large establishments without producing dust. Proper methods have been devised for collecting the dust and preventing its coming outside. Sandblasting of glass is to be relegated outside of residential streets, the dust usually not falling farther than about three hundred feet from the establishments. Street sweeping may be done with comparatively little dust if the streets are previously well sprinkled with water and the cleaners are careful.

**Smell.**—The trades and businesses which are or may become offensive on account of their smells are very numerous indeed. They include the greatest bulk of generally offensive trades, as they are composed of all the numerous industries in which animal or vegetable matter is mauufactured or stored, and which may at certain periods of the procedure give rise to offensive odors. We shall here allude only to the following: (1) The keeping of live animals and of animal matter. (2) Killing of animals. (3) Manufacture and utilization of animal substances. (4) Manufacture of vegetable substances, etc.

## CHAPTER VI.

### OFFENSIVE TRADES. (THE KEEPING AND KILLING OF ANIMALS.)

**Keeping of Live Animals.**—As in all offensive trades, the keeping of live animals becomes a nuisance only in populous towns. The nuisance created by the keeping of live animals, such as horses, cows, calves, swine, sheep, goats, birds, poultry, and rare and wild animals consist in: (1) The specific odors peculiar to each kind of animal. (2) The smell from the urine, excreta, and other organic matter from the animals. (3) The noises which are made by them and which disturb the rest of the neighborhood. (4) The flies and parasites which they attract to themselves. (5) Possible infective materials and germs likely to be transmitted to men.

Most municipalities have laws which are intended to abate the nuisances created by the keeping of animals. The remedies for the nuisance are the following: (1) Total prohibition of the keeping of certain animals within the city limits, or at least in over-crowded neighborhoods. (2) Restricting the building of new places for animals. (3) Proper veterinary supervision and disinfection, to prevent disease of animals and infection. (4)

Proper construction and maintenance of the places where they are kept. (5) Removal of all animal matter likely to give offensive odors, or to become putrefied. The rules and regulations of municipalities embrace all of the above-enumerated prophylactic measures. Thus in New York no cows, horses, calves, swine, sheep, or goats are allowed to be kept in tenement houses; no stables are allowed on the same lot with a tenement-house; and the keeping of all kinds of animals, even pigeons and chickens, requires a permit from the Health Department. In Boston stables are prohibited within two hundred feet of a church; in Chicago, in order to build a stable it is necessary to get the permission of the owners living within six hundred feet of the proposed stable.

**Stable.**—Most of the offence given by the keeping of live animals is given by horse stables, as comparatively few other animals are kept in cities. Stables should be specially constructed for the purpose. They should contain at least twelve hundred cubic feet of space and one hundred and twenty cubic feet of floor space for each horse; stalls should be at least six feet wide and nine feet long, and the stable should be well ventilated. The floors of stables should be of some impervious material, such as concrete, cement, brick set in cement; no woodwork that cannot be easily taken off should be laid on flooring. There should be provision for an unlimited supply of water, and the floor should be properly graded and drained, and the stalls provided with longitudinal "valley drains," provided with adjustable covers easily taken up, and the drains should all be tightly connected with the sewer by a properly trapped, extra heavy drain.

No accumulations of manure are to be allowed; as soon as it is collected, it should be put into barrels or pressed into bales and daily removed. The removal of manure should be done within the stable, and the carts should be well covered before they start out from the stable. The removal hour should be at night or early in the morning. Thus in Boston manure can be removed only after 12 (midnight); in Jersey City between 6 P.M. and 7 A.M. The stables should be kept scrupulously clean and frequently disinfected with a solution of one pint of formalin to three gallons of water or a similar solution of carbolic acid; corrosive sublimate solution and creolin can also be used. There is no reason why, with such precautions, the keeping of horses should be attended with offence. The keeping of other animals may be made inoffensive by means of similar methods.

**The Keeping of Animal Matter.**—The storage or keeping of animal matter, manure, offal, bones, hides, horns, skins, fish, garbage, etc., may be attended with offence, on account of the tendency to speedy putrefaction and decomposition, when the decomposing matters may emit very offensive and sickening odors, unbearable by many, and causing headache, loss of appetite, and nausea in others. The prevention of their becoming nuisances can be summed up in the following measures: Immediate destruction, by burning all needless matter likely to decompose; immediate removal from habitations; scrupulous cleanliness; disinfection; keeping of matter in tightly closed vsssels.

**The Killing of Animals.**—The killing of animals is one of the oldest industries of mankind, and has been always in need of State supervision and control from the time of Moses in ancient Egypt until the present. The nuisance created by slaughtering animals consists mostly in the odors peculiar to the slaughter-houses, although other things, such as the noise created by the animals, the flies and parasites attracted by the animal matter, as also the possibility of infection by animal diseases, all play their part in the creation of this nuisance. The offensive smell is due to the animals themselves, the fresh animal guts, blood, and other products, and the decomposing animal matter within the buildings. The remedies for the nuisance are: Prohibition of slaughtering in any but specified localities; the construction of special municipal abattoirs; the proper building and maintenance of the slaughter-houses, their supervision and inspection; the immediate removal of all by- and waste-products; the refrigeration of meat; the absolutely clean condition of the places; the provision of special means for destroying foul- and ill-smelling matter, and the disinfection of the premises.

Municipal provisions regarding **slaughter-houses** were inaugurated in the United States as early as 1692 in Boston, and are now found in nearly every community. In New York City slaughter-houses are located only in specified localities, of which there are only four or five. In Boston the slaughtering of animals is concentrated in the Brighton abattoir, and in New Orleans in the municipal abattoir. Cleanliness in the slaughter-houses is provided for in the various sanitary codes, the following being from a section of the New York law; "All those who are responsible for the places should cause such places and their yards and appurtenances to be thoroughly cleansed and purified, and all offal, blood, fat, garbage, refuse, and unwholesome or offensive matter to be removed at least once in every twenty-four hours after the use thereof; and they shall also at all times keep all woodwork, save floors and counters, thoroughly painted or whitewashed." An unlimited supply of water is even more needed in abattoirs than in stables. The slaughtering of poultry and smaller animals should also be controlled by the municipalities, and most of the prophylactic measures used in slaughter-houses of larger animals are applicable to them also.

# CHAPTER VII.

## OTHER OFFENSIVE TRADES.

**Utilization and Manufacture of Animal Substances.**—Modern industry does not allow anything to go to waste, and in animal trades there is hardly a substance which is not utilized in some way. Among the many branches of these utilization industries to be discussed here are the following: The rendering of fat and lard; bone and blood-boiling; gut-cleaning; manufacture of glycerin, soap, and glue, and the preparing and tanning of skins and hides.

**Fat Rendering, Lard Refining.**—Most of the rendering of fat is done by the action of heat, although there are several chemical methods in vogue. Since the trade became concentrated in large establishments, the old method of rendering fat in open kettles has become happily obsolete. The chief nuisance of fat-rendering consists in the odors "which are all caused, partly by the storage of decomposing fat on the premises, but mainly by the distillation of portions of the fat; which produces certain ill-smelling substances, such as acrolein and allylic alcohol, with sometimes capric, caprylic, and caproic acids."

The prevention of fat-rendering from becoming a nuisance is accomplished by the following measures: (1) The use of undecomposed animal matter. (2) The employment of a low temperature in rendering. (3) The boiling of fat in tightly closed vessels. (4) The use of condensers for the removal and destruction of the gases and odors. The New York Sanitary Code has the following section: "That no fat, tallow, or lard shall be melted or rendered except when fresh from the slaughtered animal; and taken directly from the place of slaughter, and in a condition free from sourness and taint, and all other causes of offence at the time of rendering; and that all melting and rendering are to be in steam-tight vessels; the gases and odors therefrom to be destroyed by combustion or other means equally effective." Himes says: "The great secret in preventing nuisance is the avoidance of burning the materials, or even raising them to high temperature. The lower the temperature at which the work can be successfully carried on, the less is the risk of producing offensive smells. The temperature need not exceed 120° F." When steam methods of rendering are used, the need of condensers is imperative. "Condensers may be of several styles and shapes. The water may be introduced at the top, and broken by means of a plate, a short distance below, the shower may also be made by means of a rosette. The condenser itself may be made of iron, copper, or even wood. It should be made as high as possible, in proportion to the diameter. The gase should be introduced at the bottom, and passing up through the water shower, connect with the furnace fires by a pipe near the top." (Goldsmith.) Of the chemical methods of fat-rendering D'Arcet's method is by separation of the fat from its membranes by the action of sulphuric acid. Lard refining differs little from the general rendering of other fats, and, being done mostly by the low temperature method, it is not offensive.

**Bone and Blood Boiling.**—In the processes of boiling these animal substances odors may arise which may be quite offensive. The following preventive measures are recommended by the Philadelphia Board of Health: "The floors of all bone-boiling establishments and depositories of dead animals shall be paved with asphalt or with brick or stone, well laid in cement, and shall be well drained. The boiling of bones, etc., shall be conducted in steam-tight kettles, boilers, or cauldrons, from which the foul vapors shall first be conducted through scrubbers or condensers, and then into the back part of the ashpit of the furnace fire, to be consumed. When bones are being dried after boiling, they shall be placed in closed chambers, through which shall be passed, by means of pipes, large volumes of fresh air, the outlet pipe terminating in the fire-pit."

**Gut-cleaning.**—The utilization of the small intestines of animals for sausage skins and the manufacture of catgut is necessarily accompanied by a great deal of stench from the foul-smelling contents of the guts and the decomposition of animal matter. "The processes should be carried on away from habitations; the guts, etc., should not be allowed to come in a foul state, but must be utilized immediately, and proper precautions taken to let no foul matter cling to the floor or surfaces of the establishment. This may be accomplished by the use of plenty of water. The water in the tank where the intestines are macerated may be disinfected by a weak solution of chloralum or chlorinated soda."

**The Manufacture of Soap.**—Soap is manufactured from fat and alkalies. It may become a nuisance: (1) On account of the large quantity of fat, tallow, and fat animal residue which are collected from all animal waste matter, and which are, by the time they reach the soap factory, in a decomposing state. (2) By the processes inherent in fat rendering. (3) By the odors arising from the huge vats and tanks where the fat is being boiled with the alkaline lye. The prevention of the first nuisance is accomplished by insisting that only fat in a fresh state shall be allowed in the soap factories. The means of preventing fat-melting and rendering from becoming a nuisance have already been described. The nuisances caused by the odors arising from the boiling tanks can be prevented by fitting these with covers and conducting the vapors either outside through a tall chimney, or, as in fat-rendering, through proper condensers.

**Glycerin.**—When the fatty acids of the fats in soap manufacture combine with the alkalies, the base left is a residue in the form of glycerin, which, before being fitted for the market, must be refined several times. During this process sweetish unpleasant odors are given off, which can be prevented by the same means as those which are used in treating odors from fat rendering.

**Glue-making.**—All kinds of animal waste matter, hoofs, horns, skin scraps, leather scraps, etc., are used for the extraction of glue. As in the other processes employed for the utilization of all animal waste matter, the nuisance comes from the decomposing material, from the odors given out during boiling, etc., and from the offensive residue or "scrutch." The remedies are the same as in other kindred processes.

**Treating and Tanning of Skins and Hides.**—Animal skins, before they are converted into lasting leather, must go through a number of complicated processes. In the scraping, salting, hairing, brining, liming, puering, tanning, curing, and other processes very offensive and disgusting odors often arise; and in liming some sulphuretted hydrogen may also be evolved. The process named "puering" consists in soaking the hides in a liquid composed of dog's dung. Tanning establishments should not be allowed in residential localities. The various manipulations may be done with little offence if the places are properly constructed and well kept.

**Manufacture of Other Substances.**—Among the other substances, the manufacture of which may become offensive, are the following: Illuminating-gas, petroleum refining, distilling, brewing, vinegar-making, sugar-refining, boiling of oil, manufacture of varnish, cooking, etc.

**Illuminating-gas.**—The nuisance caused by the presence of gas-works in populous localities is due to various gases and odors given off, during the many stages required, in the process of distilling gas from bituminous coal. The process especially objectionable is the "liming," or passing the gas through a closed chamber filled with quicklime, which is afterward deoxidized and gives off ammonium sulphide and sulphuretted hydrogen. Oxide of iron has been substituted for quicklime, with a material lessening of offensiveness. Notwithstanding all the care employed and despite the modern inventions of condensers, scrubbers, and other means for destroying and absorbing offensive gases during the manufacture of illuminating-gas, this business is still quite a nuisance to a neighborhood, and the best remedy is to remove it as far as possible from habitations.

In the processes of refining petroleum, offensive odors are given off. These are due to the escape of fumes during its distillation, as well as during the agitation of the refuse or "sludge" acid with alkaline solutions. Goldsmith recommends that the wash water from the agitators should be passed through a series of troughs furnished with cross slots, to retain all oily or tarry matter; and the treatment of the sludge should be carried on at a distance from crowded neighborhoods.

The nuisances caused in the processes of brewing, distilling, sugar-refining, and other industries mentioned, consist in the odors given off at certain stages of manufacture and may be prevented by the same methods as those described in the section on Fat Rendering.

Tracy lays down the principles of controlling the nuisance caused by the odors and vapors which are given off during the manufacture of various substances as follows: (1) Conveying and storing in tight vessels. (2) Substitution of less offensive processes for the more offensive. (3) Proper construction of the places where nuisances arise. (4) The use of plenty of water, proper cleanliness, and drainage. (5) The destruction of all offensive odors by passing them through condensers, etc., and from there into the fire pits where they will be consumed.

**Gases and Vapors.**—The number of the trades which may become a nuisance to the community on account of the vapors, acid fumes, and gases which are evolved in their processes, and are allowed to escape into the surrounding air, is very large. Among the more important of these are all the chemical trades, the manufacture of alkalies, ammonia, bleaching-powder, soda, and glass, assaying, smelting, and the manufacture of jewelry, lead paint, certain drugs, etc.

The nuisance created by all of these trades can be summed up in the following: (1) Odors offensive to the neighborhood. (2) Deleterious gases. (3) Destruction of vegetation in the neighborhood.

The remedies advised for the prevention, or at least mitigation, of the nuisances are: (1) Removal, whenever possible, from crowded localities. (2) Dilution of the gases and vapors by air. (3) Condensation of gases by cooling them with water, by passing them once, or several times, either through condensers filled with water or through scrubbers filled with wet coke. (4) Absorption through discharging all gases into fire pits, where they are destroyed by the action of fire or by passing them through neutralizing substances, which are of course different for each of the different gases.

## *SECTION III. FOODS.*

---

# CHAPTER I.

## MEAT FOODS.

THE flesh of certain herbivorous and omnivorous animals is used for food by man, and it is a matter of the utmost importance that the flesh used be derived from healthy sources and be in a condition fit to be consumed.

**Diseased Animals.**—No animal should be slaughtered and used for food when it suffers from exhaustion or wounds, when too young or too old, immediately or a few days after parturition, in the last weeks of pregnancy, or when it has died of old age or other causes, or is suffering from certain diseases below mentioned.

**Diseases of Animals Rendering their Flesh Unfit for Consumption.**—Pleuropneumonia, Septicæmia and Pyæmia, Cattle-plague, Anthrax, Tuberculosis, Actinomycosis, Texas cattle fever, Sheep-pox, Liver-flukes, Measles, Cholera, and Trichinosis.

*Pleuropneumonia.*—The meat is not necessarily unhealthy. Disease limited to lungs. Symptoms: Cough, high temperature, and labored breathing.

*Septicæmia and Pyæmia.*—Meat unfit for use. Disease general. Local or general septic condition, abscesses, general prostration, etc.

*Cattle-plague* (Rinderpest). — Recognized by early prostration, shivering, discharge from nose, eyes, and mouth, and cessation of rumination.

*Anthrax.*—Meat is dangerous as a food. The disease may be general or localized. If local, it may be recognized by the boils, pustules, and carbuncles. The disease is recognized by the microscopic demonstration of the anthrax bacilli.

*Tuberculosis.*—Tuberculosis lesions may be local or general. It may affect the lungs, pleura, brain, kidneys, liver, intestines, or lymphatic glands, or may even be in the muscular system. Tubercular meat is unfit for food. The disease may run its course rapidly or slowly. The tuberculosis may be acute or chronic. In the acute form it is not very difficult to recognize by the rapid emaciation, dry cough, loss of appetite, short breath, loss of power, etc. In the chronic form the symptoms are slow in appearing and difficult of recognition. Tuberculin tests are made to discover the incipient forms of tuberculosis in animals.

*Texas Cattle Fever.*—Intense fever and prostration; ears and head droop, and the hind legs are drawn under the body.

*Sheep-pox* is known by the high fever, by the flea-bitten appearance of the skin in the early stage, and by the defined pustules later.

*Liver-flukes* are large parasites, an inch or more in length, found in the bile-ducts of the liver. The disease is known as "rot." Sluggishness, wasting, pallor of mucous membranes, diarrhœa, yellowness of the eyes, and falling out of hair and dropsical swellings characterize the disease.

*Measles.*—By "measly" beef or pork is meant such meat as is infected with the parasite which, on being ingested in the human system, develops into tape and other worms. The animal shows little in its appearance that it is "measly," and only when the cyst can be seen on the under side of the tongue, or between the tongue and the lower jaw, is the diagnosis certain.

*Trichinosis.*—Trichinæ are found more often in pork than in the flesh of other animals. They are small, thread-like worms, embedded in the fat and voluntary muscles, and they can sometimes be seen by the naked eye as small white specks.

*Hog-cholera.*—Fever, shivering, fetid diarrhœa.

**Methods of Slaughtering.**—There are two principal methods of slaughtering animals; the first by stunning the animal by a blow upon the head with an iron hammer, driving a bolt into the brain, or by shooting; the second by direct bleeding by cutting the throat. The latter method is sometimes called "the Jewish method," and it has been used by Hebrews from time immemorial. It is considered by some as more hygienic than the usual method of killing by stunning, as this leaves the blood within the body and in the fibres of the muscles, while by the "Jewish" method all blood is effectually drained from the flesh.

**Characteristics of Good Meat.**—Good meat is uniform in color, not too dark red or too pale, firm and elastic to the touch, and moist but not wet; it should not pit (œdema), nor crackle (emphysema) on pressure, and it should have a "marbled" appearance due to the small layers of fat embedded in the muscles. It should be free from unpleasant odor. The meat juice should slightly redden litmus paper, showing a faint acidity. The fat should not run, but be firm and white.

**The Flesh of Different Animals.**—Beef is bright red, more marbled than other meat. Veal is paler than beef, and less firm to the touch. Mutton is of a dull-red color and firm, its fat white or yellowish.

Horse-flesh is coarser in texture and darker in color than beef, is without layers of fat in the muscles, and of fat runs down in drops when the carcass is hung up. Horse-meat has a peculiar odor and sweetish taste.

**Characteristics of Bad Meat.**—Meat which is too dark or of a deep-purple color probably comes from an animal that was not killed and bled, but which died with the blood in it, or was in a feverish condition, or was choked. When meat is wet, moist, flabby, or sodden, or pits or crackles on touch, when the odor is unpleasant, when it tears easily, when the fat is too yellow and soft, when litmus paper shows a decided alkaline reaction, it should be rejected as unfit for food.

**Characteristics of Good Fish.**—Fish should be in season, should be fairly fresh, and firm and elastic to the touch; if held in a horizontal position in the hand it should not droop but remain rigid; the gills should be of a bright-red color and be moist, the eye clear, and the skin over it transparent; the flesh should be free from unpleasant odor. Stale fish float, while fresh fish sink in water.

**Meat Preservation.**—With the death of the animal begins the natural decomposition process which, if not stopped, soon renders the meat unfit for human consumption. Hence the necessity of methods of preserving the meat, which necessity is of still greater importance when the meat is to be carried long distances and kept for prolonged periods, as it is in war and on ships, etc. The processes of preservation later to be discussed in greater detail are also employed for the preservation of other foods.

*Cold* is an excellent method of preservation, and meat can be kept in good condition in refrigerators and in cold storage for a year and longer. The disadvantages of cold are that it does not destroy bacteria or parasites in the meat, and also that meat which has been frozen or kept in cold storage deteriorates very rapidly when removed into ordinary temperatures.

*Drying* of meat as a means of preserving it has been used by primitive peoples, who cut up the meat into small slices and dry it thoroughly in the air, when it may be kept for long periods. The various meat powders in modern use are but the results of a modification of the ancient process of drying and desiccation.

*Smoking and pickling* are often used for various meats, without, however, killing any bacteria or parasites in the meat. Meat and fish when smoked are not as digestible as fresh meat, as the fibres are toughened and the natural aroma of the meat is lost.

*Heat* is the best preservative, in that it kills all bacteria and absolutely sterilizes the meat. For the purposes of preservation for long periods cooked meat must be put immediately after cooking into hermetically closed receptacles. This is done in the canning methods which preserve the meat, but somewhat change the digestibility and taste of the product.

*Chemical methods of preservation* consist in treatment of the meat and meat products with such substances as boric acid, calcium bisulphite, etc., and are in some cases very effective. In view of the possibility of harm resulting from the effect of these chemicals on the health of the consumer, their indiscriminate use should be condemned.

## CHAPTER II.

## MILK AND DAIRY PRODUCTS.

MILK is an animal secretion, and it consists of water in which are dissolved and suspended various solids, the relative proportions of which depend upon various factors, such as the kind of animal, its age, health, condition, the character of the food it consumes, as well as the time of the year and day when it is milked. The average composition of cow's milk is 87 per cent of water and 13 per cent of solids. The following is the relative composition of the solids: Fats, 4 per cent; sugar, 4.95 per cent; proteid matter, 3.30 per cent; mineral matter, 0.75 per cent; total, 13 per cent.

**Fat.**—Milk-fat is formed of the glycerides of about ten fatty acids, oleic acids forming about 50 per cent of the whole. The fat is in the form of globules, more or less minute, distributed throughout the milk, and which, being lighter, has a tendency to rise to the surface, and forming what is commonly called *cream*. Cream therefore is not all fat, nor is it all the fat of the milk, as a small part of the fat may remain in the residue of the milk after all the cream that has risen has been skimmed off. A good milk gives, on standing for twenty-four hours, an average of 12 to 14 per cent of cream.

**Sugar.**—The sugar found in milk is lactose. It is faintly sweet, and is less liable to fermentation in the stomach than is cane-sugar; in the presence of lactic ferments it is converted into lactic acid. Heated to 212° F. lactose becomes brownish, and at a higher temperature it is transformed into lactocaramel.

**Proteids.**—The proteid matter in the milk consists of casein about 80 per cent and of other albumins 20 per cent. Casein is not coagulable by heat, but is coagulable and curdled by the action of acids, when it is precipitated in firm, tough clots. Like the other albumins, lactoalbumin is coagulable by heat.

**Mineral Matter.**—Milk contains the phosphates and chlorides of potassium, sodium, calcium, and magnesium, and traces of iron.

**Variability.** — The quality of milk perceptibly changes while being taken from the animal. Thus the first part of a milking is very poor, while the last part is very rich in fat. The first is called "fore-milk," the last "strippings." During the period embracing about a week before and ten to fourteen days after parturition, the milk is called "colostrum," and is yellow, viscid, has a strong odor, and an alkaline reaction. Its composition differs materially from ordinary milk, and among its proteids it contains a large percentage of lactoalbumin and lactoglobulin, to the presence of which is due the well-known property of colostrum of being coagulated by heat. During this stage it acts as a purge upon the young, and is unfit for food.

**The Reaction.**—Fresh milk is of amphoteric reaction, i.e., it is acid to litmus and alkaline to turmeric. On standing, the alkaline reaction is overcome by the lactic acid formation and the milk is of an acid reaction.

**Specific Gravity.**—The specific gravity of the milk depends upon the solid constituents thereof, and among these constituents some, like the fat, are lighter than water, the sp. gr. being about 0.93, while the other principal constituent, sugar, has a sp. gr. of 1.55, and the proteids 1.20 (Rubner). The specific gravity of pure milk varies between the limits of 1.027 and 1 033 at 60° F. The sp. gr. of milk is lowered by an increase of water, increase of fat, higher temperature, and decrease of solids; and, on the contrary, will be higher by an increase of solids, decrease of fat or of water, and lower temperature.

**Appearance.**—Normal milk has a white, or slightly yellowish, color; it is opaque, and has a pleasant odor and sweetish taste. Any deviation from the normal appearance is suspicious, and may be due to deterioration and decomposition, or to special bacteriological infection of the fluid.

**Deterioration.**—Milk, being an animal secretion, is very readily affected by the state of health of the animal from which it is derived, and also by extraneous influences. Thus the state of health of the cow, any specific disease it suffers from, as well as the ingestion by the animal of certain poisonous foods, etc., will affect the milk, giving it dangerous, sometimes toxic, properties. Milk also readily absorbs all odors of objects near it, and is the best culture medium for all kinds of micro-organisms. On standing, the reaction of milk becomes acid, as we have stated before, due to the presence of lactic acid formed from the lactose, and resulting from the action of lactic acid ferments. This acidity, if further developed, turns the milk sour, and the casein curdles and is precipitated. After a longer period there may be developed alcohol and carbonic acid, and finally free ammonia.

**Milk Preservation.**—The principal cause of the deterioration of milk being due to micro-organisms from the outside, the best means of preserving milk for short periods is to insist on absolute cleanliness in all the processes of milking, straining, handling, storing, transporting and sale of the milk. The best method of preservation is by cold. Milk when frozen can be kept indefinitely. When milk is kept at low temperatures the action of bacteria is inhibited, and while they are not destroyed, further decomposition is stopped for a certain time. The advantage of cold as a means of preservation is that the composition of the milk is not altered. The only absolute method of preventing milk from decomposition is by killing the bacteria by heat, or by "sterilizing" it. Sterilization of milk is effected by subjecting the liquid to a temperature of 248° F. under pressure for some time, or at lower temperature for a long period. Sterilization of milk alters the composition, the lactose being converted partly into lactocaramel; the casein, fats, etc., are then also less digestible. Pasteurization consists in subjecting the milk to 156° F. for ten to fifteen minutes and then cooling it. Only a part of the bacteria are destroyed, but the composition of the milk is not materially altered. The preservation of milk by chemicals is universally condemned, because it may encourage the use of milk already partly decomposed, and also because of the possible toxic properties of most of the chemicals used.

**Adulteration.**—Milk is adulterated (1) by addition of water, (2) by abstraction of cream, (3) addition of coloring matters, such as caramel, annatto, or combinations of aniline dyes; (4) by addition of thickeners, such as starch, sugar or gelatine; (5) by addition of preservatives, such as boric acid, borax, salicylic acid, hydrogen peroxide, sodium bicarbonate, and formaldehyde.

**Milk Standards.**—In order to constitute a minimum requirement below which milk should be considered unfit for sale, a standard of the minimum composition has been fixed, which in New York State is 88 per cent of water, 12 per cent of solids, and 3 per cent of fats.

**Dairy Products.**—Among the chief dairy products are the following: Condensed milk, cream, butter, buttermilk, whey, and cheese.

**Condensed Milk** is prepared by evaporating milk to one-third or fourth of its volume. The evaporation is done in vacuum pans, in order not to subject the milk to too high a temperature. The milk is heated and, if immediately put in hermetically closed cans, it will keep for an indefinite period. Condensed milk may be made from whole milk or from skimmed milk, the latter being used in the cheaper grades of milk. It also contains a large proportion of cane-sugar to increase its keeping qualities.

**Cream.**—Cream consists of the fat globules of the milk together with a large part of the other solid constituents of the milk. It is obtained by skimming milk which has been allowed to stand for several hours. The quantity of fat in cream obtained by skimming is about 20 per cent, while cream obtained by the centrifugal method may contain 50 per cent of fat. If the milk is allowed to stand more than twelve hours, especially if the temperature is above 60° F., lactic acid is formed in the milk, the milk sours, and the top layers form what is termed "sour cream," while the lower part of the milk has a thick appearance, owing to the coagulation of the casein by the acids. Cream is sometimes adulterated by the addition of gelatine, coloring matter, and chemicals.

**Butter.**—When cream is violently agitated or "churned," the albuminoid envelopes of the fat globules rupture, the fat coalesces into granular particles and forms butter, after being "worked" to expel the residual "buttermilk." The following is the average composition of butter: Fat, 84 per cent; water, 12 per cent; curd, 1 per cent; salts, 2.5 per cent; lactose, 0.5 per cent. The amount of water depends upon the thoroughness with which the butter is worked. In order to better preserve the butter, salt is added. Butter is adulterated by the addition of coloring matter; also by chemicals, such as boric acid, and mostly by substitution of other fats than that of milk, such as oleomargarine. The substitution of beef fat for butter is more of a fraudulent adulteration than a harmful one, and is very common.

**Cheese.**—When milk is left standing for some time, until lactic acid forms, the casein coagulates, the milk curdles, and this curd when pressed, so as to express the excess of water, form what is called cheese. Instead of waiting for the development of lactic acid, certain ferments may be added to fresh milk, which then curdles, and of the curds cheese is formed. The usual process of cheese-making is based upon the use of ferments. Cheese may be made from skimmed milk, from ordinary milk, and from cream, and the percentage of fat in the cheese will then depend on the amount of cream in the milk. Cheese is hard or soft, according to the pressure to which the curd is subjected. Cheese is usually allowed to be kept for some time, to allow it to "ripen" by decomposition or fermentation. The flavor of the cheese largely depends upon this ripening. Some cheeses are prepared by subjecting them to the action of certain bacteria, which produce characteristic flavors. There are a very large number of varieties of cheese. Cheese is usually adulterated by making it from skimmed milk, by the addition of lard and other fats than milkfat, by the addition of coloring matter, chemical preservatives, etc.

**Whey.**—Whey is the residuum of milk from which the casein and fat has been removed in the process of cheese manufacture. It contains a large percentage of mineral matter and sugar.

## CHAPTER III.

### CEREALS AND OTHER FOODS.

Wheat, rye, barley, oats, corn, buckwheat, and rice are the cereals used as food. They contain a large percentage of starch and cellulose, a small proportion of proteids, also some mineral matter, such as phosphates of calcium and magnesium, silica, and potassium and sodium salts; they also contain some ether extractives. The chemical composition of most of the cereals is identical, the difference being in the proportion of each constituent. Rice and corn are the richest in starch; wheat, rye, and barley are foremost among the proteid cereals. Wheat and rye contain among their proteids the most gluten, which gives them the cohesiveness necessary for bread making; the other cereals having less gluten are not formed into bread.

**Flour.**—Flour is manufactured from the cereals, mostly wheat and rye, which are cleaned, then subjected to a process of crushing and grinding until reduced to the desired fineness, the external cellular coat of the grain being removed in the form of bran. The average composition of flour is about 70 per cent of carbohydrates, 10 to 12 per cent of proteids, water 12 per cent, ether extractives 1 per cent, and 0.5 per cent mineral matter. Flour is adulterated by the admixture of extraneous matter, such as low organisms, mites, etc., dirt, excess of moisture, and by substitution of cheaper grades for high ones. The chief value of flour is in the preparation of crackers, biscuits, and bread.

**Bread.**—For the manufacture of bread from flour the following conditions are necessary: (1) the flour must contain a certain amount of gluten, which, on account of its tenacity, contributes to the cohesiveness of the products; cereals which are poor in gluten, like rice, oats, etc., not being adapted for bread manufacture; (2) a certain amount of water to convert the flour into a paste; (3) high temperature to bake the paste; and last, but not least, some means to make the flour paste spongy, loose, and porous, otherwise the paste on baking would become a solid compact mass unfit for food. Several means are adapted for making the bread porous:

(1) Fermentation.—By the addition of yeast to the flour paste, the yeast causing the sugar of the cereals to split into alcohol and carbonic acid gas, which by its expansion "raises" the mass and makes it porous and spongy. The yeast ferments and bacteria are then killed by the high temperature, the outer layer of the mass which is exposed to the heat solidifying and forming the crust. (2) Instead of yeast, chemicals are used to evolve gases for the "leavening" of the bread. The chemicals used are either sodium bicarbonate with sour milk, which acting upon the salt, decomposes it and evolves carbonic acid, or a staple preparation of sodium bicarbonate with an acid salt, which is then decomposed

and produces the same results. These staple preparations are called "baking powders." The composition of wheat bread is about the following: Water, 35–40 per cent; proteids, 8–10 per cent; carbohydrates, 55 per cent; ether extract and ash about 2 per cent.

Biscuits, crackers, etc., are prepared from flour without ferments or baking powders, and are usually mixed with sugar, fats, and flavoring extracts. Macaroni, spaghetti, and vermicelli are preparations made from wheat flour which has been made into a stiff paste with hot water and then pressed through molds into certain forms and dried.

**Rye.**—The composition of rye does not differ much from that of wheat, but it yields a darker, coarser flour and bread.

**Corn.**—Corn is extensively used in this country, and there are many varieties of it. There are various preparations made of corn, among which the chief are hominy, samp, corn-meal, cracked corn, cerealine, etc.

**The Legumes.**—Under this group are classed peas, beans, and lentils, which are characterized by being rich in legumin, a proteid resembling casein.

**Nuts.**—Almonds, chestnuts, walnuts, cocoanuts, and peanuts are largely used as food, and are rich in proteids and fats.

**Vegetables, Roots, and Vegetable Fruits.**—The leaves, stems, and roots of certain vegetables are used as food. The following are the most important: Asparagus, cabbage, cauliflower, sprouts, celery, lettuce, spinnach, beet tops, dandelions, leeks, and onions.

They contain little nutriment, but are valuable because of their salts, acids, and volatile oils, which all are of use as stimulants and antiscorbutics.

Of the fruits used as vegetables the following are important: Tomato, cucumber, squash, pumpkin, egg-plant, and vegetable marrow. They contain little nutriment, about 90 per cent of water, some sugar, and earthy salt. Of the roots used as food the following are important: Beets, carrots, parsnips, turnips, radishes, and potatoes. The potato is the most important of this group. The average composition of potatoes is as follows: Water, 78 per cent; carbohydrates, 18 per cent; proteids, 2.5 per cent; ash, 1 per cent; and fat, 0.1 per cent.

Potatoes must be cooked in order to be fit for food. Cooking causes the starch granules to swell, and the whole root becomes mealy and crumbling. Potatoes may become unfit for use in the following cases: (1) Through freezing; the root becomes changed chemically, in that the starch or part of it is converted into sugar, it loses the power of growth as seed, and it is exceedingly prone to rapid decomposition on thawing. When cooked such a potato is waxy, watery, and tasteless. (2) Unripe potatoes do not give the mealy appearance on cooking, and are liable to produce diarrhœas and other intestinal troubles. (3) Germination, or budding of potatoes, affects their use as food, as they then are said to develop an alkaloid, "solanin," which may be harmful. (4) Through diseased conditions, to which potatoes, like many other plants, etc., are liable. These diseased conditions are characterized by the discoloration, warts, spots, etc., which are, as a rule, easily recognized.

**Fruits.**—There are many kinds of fruit, and each fruit has innumerable varieties, each of which has some distinctive qualities.

The berry family contains the following: Blackberries, cranberries, currants, gooseberries, huckleberries, mulberries, raspberries, and strawberries. All of these berries are very extensively used in the raw state as well as cooked, and are very valuable for their sugar and free acids; most of them contain seeds which are indigestible and irritate the intestines, and to which their laxative action is partly due. All the berries are very soft and readily perishable, being subject to rapid decomposition.

The chief value of fruit lies in the sugar, salts, and acids which it contains. Fruits are composed of water, starches, sugar, cellulose, pectin, and acids. Pectin is a carbohydrate found only in ripe fruit, and to it are due the jelly properties of the boiled fruit juice. The organic acids contained in fruit are mostly in combination with alkalies in the form of salts. The most important acids are the following: Citric (lemon, oranges, limes), tartaric (grapes), and malic (apples, pears, peaches, apricots). Fruits also contain a small percentage of essential oils and compound ethers. Unripe fruit are unwholesome because the acids and tannin in them are very astringent and irritant to the intestines, and the pulp is very tough, owing to the hard cellulose fibres; as the fruit ripens, it absorbs more oxygen, and the acids and tannin are altered so as to become less astringent and more palatable and digestible.

The skin of the fruit acts as a protective against decomposition; fruit which is damaged, and which has lost part of its protective covering, is very easily decomposed. Most of the fruit comes to the large cities from long distances, and in the case of bananas, oranges, figs, etc., from foreign countries, necessitating the proper package and carriage through very long journeys, during which they are readily damaged and come to markets in a partially or wholly decomposed state. Some fruit, and this is especially the case with bananas, are plucked when they are still green, allowing them to ripen only after arrival in the markets. When carried in holds of ships and becoming overripe, bananas become "baked," and are then unfit for consumption.

## CHAPTER IV.

### FOOD PRESERVATION.

**Decomposition and Deterioration of Food.**—All articles used as food, whether derived from the animal or vegetable kingdoms, are consumed otherwise than in their natural state. As soon as the animal which is taken for food is killed, or the milk secretion taken away from the cow, or the fruit, cereal, and vegetable torn away from the tree, bush or ground, the foodstuff begins to decompose and deteriorate until it becomes unfit for ingestion. By decomposition is meant the breaking up of organic tissue into its simple components, and finally into its primary elements, the decomposition being due to the action of micro-organisms. In order to prevent rapid decomposition of foodstuffs and to preserve them, the action of destroying micro-organisms has to be stopped, or, at least, inhibited; this can be accomplished only by the employment of the agents and conditions that are unfavorable to decomposition. The internal conditions favorable to rapid decomposition are the following: The overripeness of the food; the presence of worms and other parasites, fungi, molds, etc.; and the absence of protective coverings, which helps to prevent decomposition. Of the external factors the following are of importance: (1) Moisture; (2) air; (3) low temperature; (4) high temperature; (5) chemicals.

*Moisture* is absolutely necessary to decomposition, its presence favoring the growth and development of low organic and bacterial life; absence of moisture is a preventive against decomposition, and constitutes a good preservative for many foods.

*Air* is necessary for decomposition to be possible; its absence unfavorable to it.

*Low Temperatures* inhibit the growth of organic matter, stop decomposition, and preserve food for long periods.

*High Temperatures* kill all putrefactive organisms, and absolutely prevent further decomposition.

*Certain Chemicals* prevent or inhibit decomposition by reason of their antiseptic and germicidal properties.

The methods of food preservation are based upon the foregoing factors unfavorable to decomposition.

**Drying.**—The process of drying is efficient in proportion to its thoroughness. Most foodstuffs can be preserved for indefinite periods, provided the moisture they contain is all, or nearly all, expelled. Drying is especially adaptable to meats, which are frequently dried in the sun, or on fires, and are thus preserved for long periods. Cereals, legumes, seeds, and some fruits are also preserved for indefinite periods by drying. In order to facilitate the drying process cereals, and sometimes other food stuffs, are often reduced to a dry powder.

The disadvantages of this method of food preservation are as follows: (1) the abstraction of moisture makes the foods less digestible; (2) the fibers and cellular particles become very hard and undigestible; (3) parasites originally in the food are not destroyed; (4) the natural flavor, etc., are lost.

**Low Temperature.**—As said before, a temperature even below the freezing point, does not kill bacteria, but only inhibits their further growth; at the same time, there is no doubt but that most foods can be preserved for long periods by subjecting them to a temperature near the freezing point. It is, however, necessary either to keep the food frozen; or, if unfrozen, to keep it as dry as possible. The advantages of cold are that no constituent of the food is lost, while the digestibility and nutritive qualities are unimpaired, as well as the original flavor and taste preserved.

**High Temperature.**—Heat, if applied for long periods, or at high degrees, kills all putrefactive elements and absolutely preserves food for indefinite periods, provided the food on being sterilized is then sealed airtight, so as not to allow outside influences to spoil it. Upon this principle the methods of preserving food by canning are based. The process of canning consists in placing the foodstuffs in tin (or glass) vessels, all covered except a small opening, so as to fill the vessel completely, then subjecting the vessels to a high temperature, sufficient to completely sterilize their contents, then sealing the small opening left in the vessels, heating, and finally cooling. If the canning is done properly, the sterilization complete, and all air driven out of the vessel and the latter made air-tight, foods may be preserved indefinitely. The disadvantages of heat as a preservative of foods are that it generally alters the composition of the food, causing certain chemical changes, lessening the digestibility of the food, and destroying its natural flavor and taste. The special disadvantages of canning are: (1) The possibility of action of the acids present in the foods upon the metal vessels, producing poisons; (2) the fact that it is impossible for the buyer to see and examine the food before opening the can.

**Salting and pickling.**—Salting is partly a chemical and partly a physical method of food preservation. The salt prevents decomposition by reason of its antiseptic qualities, and also by its abstraction of water. This method is especially applicable to meats and fish. The immersion of fish in salt solutions, called brine, preserves them for long periods. Pickling is the immersion of food, like fish, certain vegetables and fruit, in vinegar. The disadvantage of salting is that it hardens the fibres and may diminish the nutritive and digestive qualities of the food.

**Exclusion of Air.**—By exclusion of the air some foodstuffs can be kept for a long time. Upon this method are based the sealing of all sterilized foods in sealed cans, vessels, or the placing of foods, in syrups alcoholic extracts, etc. It is especially applicable to eggs, which are immersed in lime, or coated by some air-excluding materials, and thus preserved for long periods. The disadvantages of this method are that it is not applicable to most foods, and that it is only of value when all foods are either primarily sterile or are sterilized before being put into vessels and closed receptacles.

**Smoking.**—The method of food preservation by smoking is really a combination of several methods—drying, salting, and chemical. By exposing the food for some time to the influence of the wood smoke, the food is at the same time thoroughly dried. It is usually salted before smoking, and then impregnated with the smoke, which possesses antiseptic qualities due to pyroligneous acid, creosote, etc. The method of rapid smoking by immersion in a creosote solution is of no value. Smoking is applicable to meats and fish. The disadvantages of this method are that it hardens the fibres, makes them undigestible, and that parasites, etc., are not destroyed.

**Chemical Methods.**—Decomposition and decay of foodstuffs being due to the action of micro-organisms, it was thought that by subjecting the food to the action of some antiseptic chemical further decay could be delayed, if not stopped altogether. In order to be of value the chemicals used must effectually prevent decomposition, and inhibit bacterial growth, and must also be used in quantities not injurious to man. Unfortunately no chemical is known that answers all these requirements. In the quantities usually employed decomposition is not entirely prevented, but is more or less delayed, by the chemicals used; moreover, even minute doses of these chemicals are liable, if ingested for long periods, to be injurious. Besides, the employment of chemicals may promote their constant use by dishonest manufacturers, in order to mask unpleasant odors, etc., of partly decomposed food. The use of chemicals for food preservation has been extensively condemned and prohibited, although it is still universally employed, in spite of all condemnations and prohibitions. The chemicals used are the following: Borax, boracic acid, salicylic acid, formaldehyde, hydrogen peroxide, potassium permanganate, sodium sulfite, sodium bicarbonate, etc.

**Borax and Boric Acid.**—Usually a combination of the two is used. It is used in milk, butter, meat, sausages, preserves, etc., and is sometimes sold under the name of "preservaline," etc. In the doses used it does not delay decomposition for a long time. Recent investigations by Dr. H. W. Wiley seem to indicate that boric acid, when used in food for a long time in small amounts, or for a short time in large doses, does exert a deleterious effect on the health of the consumer.

**Salicylic Acid.**—While there is a tendency to regard salicylic acid as more harmful than boric, this question has not yet been definitely settled by experiment on man. It is used in foods where its taste cannot be detected, such as jams, jellies, preserves, beers, wines, etc.

**Sodium Sulphite** is used in chopped meats and sausages, not only to preserve them, but also to impart a red color to them. Its use is to be discouraged.

**Formaldehyde.**—Owing to its strong antiseptic properties and to its alleged harmlessness, formaldehyde had been hailed as an ideal preservative, especially for liquids like milk. For meats and fish formaldehyde is of no value, as it hardens the fibrinous tissues. In milk a very minute quantity is sufficient to preserve it for 24 to 48 hours, but the milk, it is claimed, is rendered more indigestible. Opinions differ as to the harmfulness of formaldehyde, but in any event its use in milk should not be allowed.

**Hydrogen Peroxide.**—This agent is capable of comparatively little or no harm, and is sometimes used in milk, beer, and fruit juices. Owing to its rapid decomposition its antiseptic value is but temporary.

**Sodium Bicarbonate** is used less as a preservative than as an alkali to overcome the acidity of milk. It is harmless *per se*, and but of little value as a preservative, but by its disguising the sourness of milk it may be harmful.

**Contamination of Food by Chemicals.**—Owing to the presence of acids in foods, the foods sometimes become contaminated by the action of the acids upon the various metals, such as lead, copper, zinc, tin, and nickel. Copper, in the form of dilute solutions of sulphate of copper, is also sometimes used for greening vegetables and pickled goods. There is no need for this procedure, and its effect on health is doubtful.

# CHAPTER V.

## FOOD ADULTERATION.

By adulteration is meant the "altering" of the normal composition and constituency of the food. Food adulteration is accomplished in various ways: (1) By mixing with the food some foreign substance to reduce, lower, or injure its quality and strength; (2) by the entire or partial substitution of an inferior substance; (3) by the entire extraction of a portion of valuable substance from it; (4) by the sale of an imitation of the articles which the consumer never intended to buy; (5) by the food consisting in part or wholly of a diseased, decayed, or decomposed substance; (6) by coloring, coating, polishing, or powdering the food, whereby poor quality is concealed, or it is made to look better than it is; (7) by the food containing a poisonous constituent, or any ingredient likely to be harmful to the consumer.

Adulteration may be harmful, fraudulent, or accidental; under the first are included all adulterations which are either directly harmful by the addition of injurious substances, by the decomposed or unwholesome state of part or of whole of the food, or by the dilution or extraction of some nutrient part of the food, thus rendering the food less nutritious. Under fraudulent adulterations are classed all such which do not directly or indirectly harm the consumer, except in deceiving him and making him pay more than he would have paid for the article supplied him. We shall here mention only a few of the ordinary foods and their injurious and fraudulent adulterations.

The adulteration of milk and of dairy products have been already described. We shall mention here but a few more.

**Baking Powders.**—Baking powders are combinations of an acid or an acid salt with sodium bicarbonate, together with enough starch to keep the powder in a dry state. They are made of either cream of tartar, calcium phosphate, or of alum. The adulterations of the powders consist in adding too large a percentage of the filling (starch), or in the presence of inert or make-weight substances.

**Bread.**—The harmful adulterations in bread are alum, or adulterated and spoilt flour; too much moisture (over 45 per cent), or light weight bread are also adulterations. Fraudulent adulteration consists in the substitution of a cheaper grade of flour than the one it is sold for.

**Butter.**—Butter is adulterated by an addition of too much water, too much curd, salt, and dyes. Butter should not contain more than 12 per cent of water, 1 to 2 per cent of curd, 6 per cent of salt, and no mineral coloring matter. The fraudulent adulterations comprise addition of vegetable coloring matters and the substitution of vegetable and animal oils, like lard, cotton-seed oil, etc.

**Candy and Confectionery.**—These are adulterated by the addition of mineral dyes, clay, gypsum, starch, flour, etc.

**Coffee and Cocoa.**—Coffee is adulterated very extensively, mostly however harmlessly. Chicory, dandelion, roasted cereals, beans, date stones, acorns, etc., are the chief adulterants. Cocoa is usually sold in powdered form, which allows it to be fraudulently adulterated with the starches of various cereals and some animal and vegetable fats.

**Flour.**—Flour is occasionally adulterated by substitution of a cheaper grade, by addition of alum to "improve" its color, and also by the presence of mites, worms, and organic matter. Corn flour has been found as an adulterant of the flour of wheat.

**Fruits.**—Under the general name "adulteration" may be classed the practice of the sale of fruits which are unripe, overripe, damaged, or partly decomposed. Most of the real adulteration is done, however, in the cooked, preserved, and jellied fruits. The preserves, jams, jellies, etc., made of fruits are largely adulterated with decayed fruit, by substitution of cheaper and foregn fruit, by the addition of glucose, and by the use of mineral dyes and preservatives.

**Honey.**—This article is adulterated fraudulently by its partial or complete substitution by glucose, or cane sugar.

The following table of common adulterations is taken from Buck's "Hygiene and Public Health."

## ARTICLES LIABLE TO BE ADULTERATED.

| Articles. | Deleterious Adulteration. | Fraudulent Adulteration. | Accidental Adulteration. |
|---|---|---|---|
| Arrowroot... | ............. | Other starches which are substituted, in whole or in part, for the genuine article. | |
| Brandy..... | ............. | Water, burnt sugar. | |
| Bread....... | Alum, sulphate of copper. | Flours other than wheat, inferior flour, potatoes. | Ashes from oven, grit from millstones. |
| Butter...... | Copper...... | Water, other fats, excess of salts, starch. | Curd. |
| Canned vegetables and meat. | Salts of copper, lead. | Excess of water...... | Meat damaged in the process of canning. |
| Cheese...... | Salts of mercury in the rind. | Oleomargarine. | |
| Candy and Confectionery. | Poisonous colors, artificial essences. | Grape-sugar......... | Flour. |
| Coffee....... | ............. | Chiccory, peas, rye, beans, acorns, chefus-nuts, almond or other nut-shells, burnt sugar, lower-grade coffees. | |
| Cocoa and Chocolate. | Oxide of iron and other coloring matters. | Animal fats, starch, flour, and sugar. | |
| Cayenne pepper. | Red lead..... | Ground rice, flour, salt and ship-bread, Indian-meal. | Oxide of iron. |
| Flour....... | Alum........ | Ground rice......... | Grit & sand. |
| Ginger...... | ............. | Turmeric, Cayenne pepper, mustard, inferior varieties of ginger. | |
| Gin......... | Alum salt, spirits of turpentine. | Water, sugar. | |
| Honey...... | ............. | Glucose, cane-sugar... | Pollen of various plants, insects. |
| Isinglass..... | ............. | Gelatine. | |

ARTICLES LIABLE TO BE ADULTERATED.—*Continued.*

| Articles. | Deleterious Adulteration. | Fraudulent Adulteration. | Accidental Adulteration. |
|---|---|---|---|
| Lard........ | Caustic lime, alum. | Starch, stearine, salt. | |
| Mustard..... | Chromate of lead, sulphate of lime. | Yellow lakes, flour, turmeric, Cayenne pepper. | |
| Milk........ | Water....... | Burnt sugar, annotto. . | Sand, dirt. |
| Meat........ | Infested with parasites. | ..................... | Tainted. |
| Horse-radish. | .............. | Turnip. | |
| Fruit jellies. . | Aniline colors, artificial essences. | Gelatine, apple jelly. | |
| Oatmeal..... | .............. | ..................... | Old & wormy. |
| Pickles...... | Salts of copper, alum. | | |
| Preserves.... | Aniline colors. | Apples, pumpkins, molasses. | |
| Pepper...... | .............. | Flour, ship-bread, mustard, linseed-meal. | Sand. |
| Sago........ | .............. | Potato-starch. | |
| Rum........ | Cayenne pepper, artificial essences. | Water............... | Burnt sugar. |
| Sugar....... | Salts of tin and lead, gypsum. | Rice-flour............ | Sand and dirt, insects dead and alive. |
| Spices...... | .............. | Flour, starches. | |
| Cloves...... | .............. | Arrowroot. | |
| Cinnamon. . | .............. | Spent bark. | |
| Pimento..... | .............. | Ship-bread. | |
| Tea......... | .............. | Foreign leaves, spent tea, plumbago, gum, indigo, Prussian blue, China clay, soap-stone, gypsum. | Ferruginous earth. |
| Vinegar..... | Sulphuric, hydrochloric, and pyroligneous acids. | Burnt sugar, water. | |
| Wine........ | Aniline colors, crude brandy. | Water............... | Sulphate of potassa. |

# CHAPTER VI.

## SANITARY INSPECTION OF PLACES WHERE FOOD IS SOLD.

The sanitary supervision of all places where food is manufactured, prepared, handled, stored, exposed for sale, and distributed is necessary to prevent the infection of the food with injurious elements and to insure its cleanliness. Every municipality, therefore, has rules and regulations framed to control places where food is sold, etc. These rules are either general or they are specially adapted to the particular kinds of foods sold. Thus we have rules and regulations for slaughter-houses, butcher-shops, smoking-houses, dairy depots, milk-wagons, milk stores, bakeries, mineral-water establishments, bottling establishments, restaurants, and other places where food is prepared and sold. The duties of inspecting these places is usually imposed upon sanitary inspectors, although food inspectors may be required to make these inspections. The theoretical basis of all rules and regulations for the sale, etc., of food can be summed up in one word, *cleanliness*, which can be enforced only by rigid municipal control and supervision. This is assured by requiring each of these places to get a permit from the Health Department, which permit is given only after a preliminary inspection, and when all sanitary requirements of the Department have been complied with. In order to get a permit a written application is to be made by the owner of the place. This application is given to the inspector for investigation, inspection, and his indorsement, either recommending the granting or the denial of permit.

**Milk Stores.**—The points to be noted in inspecting a milk store are the following: (1) Name of owner, location and character of place; (2) the possession of permit, its date and number; (3) the general cleanliness of the place: store, floors, walls, and ceilings; * (4) the vessels in which the milk is kept—can, tub, refrigerator, and their proximity to ill-smelling articles of food, as well as the temperature of the milk; † (5) the connection of the refrigerator with the house-drain; ‡ and (6)

* If a store is kept dirty; if it is in a cellar; if walls, ceilings, and floors are dirty, the application may be denied; or if the permit is already possessed, a complaint and report must be made out for an order to clean the place, etc.; or if the place is such as to be unfit for the sale of milk, to revoke the permit.

† The tub or other vessels in which milk is kept must be kept clean, and in the summer filled with ice, so as to have the milk at a temperature not above 50° F. The tub or can must be kept at a distance from oils, herrings, and other ill-smelling articles.

‡ The waste-pipe from the refrigerator must empty either into an empty can, tub, etc., or into a properly trapped, sewer-connected, water-supplied, open sink in the store or in the cellar. Under no consideration must the pipe connect with any of the plumbing-pipes of the house, except through the intermediary of a sink as stated.

the isolation of the place where milk is sold from the living and sleeping rooms. *

**Bakeries.**—Bakeries in New York are under the jurisdiction of the State Factory Department besides the Health Department. The following are the chief sanitary requirements of bakeries: (1) Permit; (2) cleanliness; (3) fireproofing of places where fat is boiled—floors, walls, and ceiling; fireproofing of doors and transoms leading to halls and other parts of house; (4) sinks and other plumbing to be in good condition; (5) absence of any water-closets; (6) sanitary conditions of the sponge-trough, molding-bench, raising-box, molds, pans, and other vessels.

**Mineral-water Establishments and Bottling Places.**—These must have permits; must not be in tenement houses; the floors must be cemented, graded and drained and sewer-connected; the filtering vessels and bottles, etc., to be kept in sanitary condition.

The same rules apply to all places where liquids are used, such as pickle factories, preserve and syrup manufactories, etc.

There are no special rules for groceries, fruit stores, and other stores, except those based on the general rules of sanitary inspection insuring cleanliness of the place and all vessels where the food is kept.

---

* The store or place where milk is sold must be entirely disconnected from the living and sleeping rooms, all doors, windows, and openings between them to be permanently closed. This rule does not apply to stores where only bottled milk is sold.

## CHAPTER VII.

### INSPECTION OF FOOD.

**Duties of Food Inspectors.**—The duties of Food Inspector are:

(1) To report to his superiors and to follow their instructions.

(2) To systematically and thoroughly inspect and examine all places in his district where food is sold, stored, etc.; also all the food therein.

(3) To apply his theoretical and practical knowledge, as well as common sense, to discover violations of food laws.

(4) To collect samples of suspected foods for further chemical analysis by the chemist of the department.

(5) To make proper reports upon all his work and to keep a record of same.

(6) To testify in court, if required, on facts connected with his inspection and sample-taking.

**Collecting Samples.**—The collection of food samples for analysis is regulated by certain rules, the execution of which is absolutely required in order to base legal procedures upon this act. The following rules apply in New York to taking of milk samples:

(1) On entering a store the inspector must announce his authority.

(2) He makes a preliminary lactometric and thermometric examination.

(3) He inquires if the milk is for sale and if the man attending him is the owner of the place.

(4) He stirs the milk himself and causes it to be stirred by the owner.

(5) He fills his cylinder from the milk-can and proceeds with his test.

(6) He records the lactometric and thermometric readings, and announces to the owner that the milk is below standard, if such is the case, and that he is taking sample.

(7) He fills two regulation bottles, which he properly corks and seals with the department seal.

(8) He affixes labels on the bottles stating the number of inspection, date, etc.

(9) After making record in his books according to the printed schedule, he leaves one bottle with the owner, while its mate he places in his satchel to be delivered as soon as possible to the chemist.

The taking of samples of other foods is not hedged in by so many formalities, but it must also conform to the detailed instruction of the chief.

**Methods of Inspection.**—There are two methods of food inspection; the one is superficial, based upon the physical, gross appearance of the food, and is done by the ordinary food inspector at the place where the food is exposed, sold, etc.; the other is the more thorough, scientific method, based upon a complete chemical analysis of the food, and is accomplished by the expert chemist in the laboratory of the department.

The ordinary inspector of foods is required to have but a general knowledge of the properties of the food inspected, of the chief adulterations of each food, and a practical acquaintance with the gross appearance and common tests of ordinary foods. The further examination of suspected foods lies within the province of the chemist. We shall give here a review of the general gross physical tests the knowledge of which is required of the candidate for Food Inspectorship.

**Milk Inspection.**—In the examination of milk the inspector is limited to only two methods of inspection; one based upon the lactometric reading, the other upon the general appearance of the fluid. The lactometer, as used by the N. Y. Health Department, consists of an 8 inch long glass tube, narrow at the top, wider in the middle, and provided with a bulb below which is filled with lead shot. The narrow upper tube is graduated into degrees, the lowermost reading 12°, the uppermost 60°, with a red *P* at 100. The lactometer is tested to show the proper sp. gr. of pure milk at 100 at a temperature of 60° F. Pure milk ordinarily reads at the lactometer between 100 and 110, milk rich in cream and solids may read above that figure; a milk poor in cream will read under 100, and one largely watered may read about 70. A milk skimmed of part of its cream may give a reading above 110, and if, in addition to being skimmed, water is added, the reading may be normal, or between 100 and 110. All these readings are supposed to be at the temperature of 60° F., as shown by the thermometer, which is immersed the milk at the same time with the lactometer. As the fluid is denser at a lower temperature, it will show a higher reading, and if the temperature is higher, the reading will be lower, and the inspector usually *deducts* 4 degrees from the lactometric reading for every 10° below 60° F., and *adds* 4 degrees on the lactometer for every 10° above 60° F. But the lactometric reading alone is insufficient for judging the condition of the milk, for, as we have seen, if the milk is skimmed and watered, it may give a proper reading without showing the adulteration.

A lactometric reading is only valuable in conjunction with the examination of the gross appearance of milk. The color of the fluid, its opacity, the way it runs down the lactometer, the way it adheres to it, the resistance it manifests to the immersion of the lactometer, the visibility of the instrument through the milk and cylinder in which it is tested, are all valuable indications in the hands of an experienced inspector. A milk which is bluish, thin, which allows the lactometer to enter without resistance, which runs down in thin bluish streams, which hardly adheres to the bulb and stem of the instrument on lifting it up, which shows the shot and location of instrument through the glass cylinder in which it is tested, is surely too poor in cream, and rich in water, no matter what the instrument reads. The more the milk contains of cream and other solids, the denser, or more opaque, and thicker it is, and the more it will adhere to the instrument.

**Butter Inspection.**—The inspection of butter lies within the province of the State inspector. The general indication of good butter are its normal appearance (a too yellow color indicates artificial coloring, except in the months of May and June), its odor and taste. Butter when pure, if melted in a spoon, does not sputter as does butter adulterated with oleomargarine.

**Cheese.**—The inspection of cheese is based upon its odor and general appearance.

**Cereals.**—The examination of cereals is limited to the presence of dust, earthy matters, dirt, mites, worms, and of excessive moisture.

**Flour.**—Wheat flour must not be too moist, must have a fine, white appearance, must remain lumpy on pressure, must not show any particles which cannot be crushed; on being thrown upon a wall a part of the flour should adhere to the wall; the taste and odors must not be moldy and musty. If it is suspected that the flour is adulterated with Indian corn meal or rice, the sample of flour may be washed in water, when the corn and rice, being heavier, will sink.

**Bread.**—Bread must not be too light nor too heavy; must not be sour, and the crust should be brown, but not black. The bread should be elastic and not pit; the crust should adhere to the substance. It should show a uniform porosity, and be free from molds.

**Canned Goods.**—An examination of the outside of the can is the only guide in this class of articles. The heads should be slightly concave. If convex, it shows beginning of decomposition.

**Coffee.**—The adulteration of coffee can only be detected by the microscope. If the coffee is over-roasted the burnt smell will show it. Coffee grains are hard and crumble between the teeth. Throwing the suspected sample of coffee in cold water and stirring it around so as to wet each particle, will frequently serve to separate the adulteration. Pure coffee floats much longer than any of the ordinary adulterants, and it colors the water but slowly. Chicory colors the water rapidly; peas sink and color slightly; rye sinks quicker and colors more.

**Vegetables.**—Green vegetables are only examined as to their condition, any signs of decomposition upon their surfaces being an indication of their unfitness. Over-ripe vegetables are unwholesome, because they consist only of water and hard, undigestible, woody fibres. Vegetables which have been freshened by the upper decomposed leaves being torn off can be recognized by the distance of the stem-head from the leaves. The general appearance, consistency, and absence of bad, disagreeable odor are about the only indications for the inspector.

**Fruits.**—Under-ripeness can be recognized by their color and appearance; over-ripe fruit will be partly decomposed; fruit which is denuded of its natural covering, which has a changed appearance, which shows discoloration, spots and damaged parts, or which has disagreeable odors, is to be rejected. In examining fruit care must be taken to see if it is stored in a dry place, properly aired; also to inspect not only top layers of fruit heaps, but the lower layers as well, for dealers very frequently put good and fresh fruit on top of boxes, barrels, etc. This is especially the case with berries, etc.

**Forms of Reports.**—Milk inspectors on taking samples have a printed form of report, in which the date of inspection, place, location, name of owner, character of store, time of inspection, presence of owner, lactometric and thermometric reading, the number of quarts sold, number of quarts left in can, the number of sample, etc., are noted.

Sanitary inspectors of milk stores make their endorsements upon the applications as follows: In case of approval, date, name of applicant, address, "I would repectfully report on the within application that the store is clean, the milk on sale properly cared for and of good quality." In case the application is to be denied, the inspector, after filling out date, etc., as before, states, "that the store opens into living and sleeping rooms," or "that waste-pipe of ice-box is joined to sewer," or "that the walls, ceilings, and floor of store are dirty and offensive"; and then he states: "I respectfully recommend that permit be denied," and a separate complaint is made against conditions found unsanitary, with recommendations towards their abatement.

The reports upon places where food other than milk is sold, do not differ materially from the above, except in the substance.

# *SECTION IV. DISINFECTION AND DISINFECTANTS.*

## CHAPTER I.

### INFECTION AND DISINFECTION.

Disinfection is the destruction of the infective power of infectious material; or, in other words, disinfection is the destruction of the agents of infection.

An infectious material is one contaminated with germs of infection.

The germs of infection are organic micro-organisms, vegetable and animal—protozoa and bacteria.

The germs of infection once being lodged within the body cause certain reactions producing specific pathological changes and a variety of groups of symptoms which we know by the specific names of infectious diseases, *e.g.*, typhoid, typhus, etc.,

Among the infectious diseases known to be due to specific germs are the following: Typhoid, Typhus, Relapsing Fevers, Cholera, Diphtheria, Croup, Tuberculosis, Pneumonia, Malaria, Yellow Fever, Erysipelas, Septicæmia, Anthrax, Tetanus, Gonorrhea, etc.; and among the infectious diseases the germs of which have not as yet been discovered are the following: Scarlet Fever, Measles, Smallpox, Syphilis, Varicella, etc.

The part of the body and the organs in which the germs first find their entrance or which they specifically attack vary with each disease; thus the mucous membranes, skin, internal organs, secretions and excretions are severally either portals of infection, or the places where the infection shows itself the most.

The agents carrying the germs of infection from one person to the other may be the infected persons themselves, or anything which has come in contact with their bodies and its secretions and excretions; thus the air, room, furniture, vessels, clothing, food, and drink, also insects and vermin, may all be carriers of infection.

**Sterilization** is the absolute destruction of *all* organic life, whether infectious or not; it is therefore *more* than disinfection which destroys the germs of infection alone.

A **disinfectant** is an agent which destroys germs of infection.

A **germicide** is the same: an agent destroying germs.

An **insecticide** is an agent capable of destroying insects; it is not necessarily a disinfectant, nor is a disinfectant necessarily an insecticide.

An **antiseptic** is a substance which inhibits and stops the growth of the bacteria of putrefaction and decomposition. A disinfectant is therefore an antiseptic, but an antiseptic may not be a disinfectant.

A **deodorant** is a substance which neutralizes or destroys the unpleasant odors arising from matter undergoing putrefaction. A deodorant is not necessarily a disinfectant, nor is every disinfectant a deodorant.

The ideal disinfectant is one which, while capable of destroying the germs of disease, does not injure the bodies and material upon which the germs may be found; it must also be penetrating, harmless in handling, inexpensive, and reliable. The ideal disinfectant has not as yet been discovered.

For successful scientific disinfection it is necessary to know: (1) the nature of the specific germs of the disease; (2) the methods and agents of its spread and infection; (3) the places where the germs are most likely to be found; (4) the action of each disinfectant upon the germs; and (5) the best methods of applying the disinfectant to the materials infected with germs of disease.

Disinfection is not a routine, uniform, unscientific process; a disinfector must be conversant with the basic principles of disinfection, must make a thorough study of the scientific part of the subject, and moreover must be thoroughly imbued with the importance of his work, upon which the checking of the further spread of disease depends.

# CHAPTER II.

## PHYSICAL DISINFECTANTS.

The physical disinfectants are sunlight, desiccation, and heat.

**Sunlight** is a good disinfectant provided the infected material or germs are directly exposed to the rays of the sun. Bacteria are killed within a short time, but spores need a long time, and some of them resist the action of the sun for an indefinite period. The disadvantages of sunlight as a disinfectant are its superficial action, its variability and uncertainty, and its slow action upon to most germs of infection. Sunlight is a good adjunct other methods of disinfection; it is most valuable in tuberculosis, and should be used wherever possible in conjunction with other physical or chemical methods of disinfection.

**Desiccation** is a good means of disinfection, but can be applied only to very few objects; all bacteria need moisture for their existence and multiplication, hence absolute dryness acts as a good germicide. Meat and fish, certain cereals, and also fruit, when dried become at the same time disinfected.

*Heat* is the best, most valuable, all-pervading, most available, and cheapest disinfectant. The various ways in which heat may be used for disinfection are burning, dry heat, boiling, and steam.

**Burning** is of course the best disinfectant, but it not only destroys the germs in the infected materials, but the materials themselves; its application is therefore limited to articles of little or no value, and to rags, rubbish, and refuse.

**Dry Heat.**—All life is destroyed when exposed to a dry heat of 150° C. for one hour, although most of the bacteria of infection are killed at a lower temperature and in shorter time. Dry heat is a good disinfectant for objects that can stand the heat without injury, but most objects, and especially textile fabrics, are injured by it.

**Boiling.**—Perhaps the best and most valuable disinfectant in existence is boiling, because it is always at command, is applicable to most materials and objects, is an absolutely safe sterilizer and disinfectant, and needs very little if any preparation and apparatus for its use. One half-hour of boiling will destroy all life; and most bacteria can be killed at even a lower temperature. Subjection to a temperature of only 70° C. for half an hour suffices to kill the germs of cholera, tuberculosis, diphtheria, plague, etc. Boiling is especially applicable to textile fabrics and small objects, and can readily be done in the house where the infection exists, thus obviating the necessity of conveying the infected objects elsewhere, and perhaps for some distance, to be disinfected

**Steam.**—Of all the physical disinfectants steam is the most valuable because it is very penetrating, reliable, and rapid; it kills all bacteria at once and all spores in a few minutes, and besides is applicable to a great number and many kinds of materials and objects.

Steam is especially valuable for the disinfection of clothing, bedding, carpets, textile fabrics, mattresses, etc. Steam can be used in a small way, as well as in very large plants. The well-known Arnold sterilizers, used for the sterilization of milk, etc., afford an example of the use of steam in a small apparatus; while municipal authorities usually construct very large steam disinfecting plants. A steam disinfector is made of steel or of wrought iron, is usually cylindrical in shape, and is covered with felt, asbestos, etc. The disinfector has doors on one or both ends, and is fitted inside with rails upon which a specially constructed car can be slid in through one door and out through the other. The car is divided into several compartments in which the infected articles are placed; when thus loaded it is run into the disinfector. The steam disinfectors may be fitted with thermometers, vacuum-formers, steam-jackets, etc.

## CHAPTER III.

### GASEOUS CHEMICAL DISINFECTANTS.

PHYSICAL disinfectants, however valuable and efficient, cannot be employed in many places and for many materials infected with disease germs, and therefore chemicals have been sought to be used wherever physical disinfectants could not for one or more reasons be employed. Chemicals are used as disinfectants either in gaseous form or in solutions; the gaseous kinds are of especial value on account of their penetrating qualities, and are employed for the disinfection of rooms, holds of ships, etc. There are practically but two chemicals which are used in gaseous disinfection, and these are sulphur dioxide and formaldehyde.

**Sulphur Dioxide.**—Sulphur dioxide ($SO_2$) is a good surface disinfectant, and is very destructive to all animal life; it is one of the best insecticides we have, but its germicidal qualities are rather weak, it does not kill spores, and it penetrates only superficially. The main disadvantages of sulphur dioxide as a disinfectant are: 1) that it weakens textile fabrics; 2) blackens and bleaches all vegetable coloring-matter; 3) tarnishes metal; and 4) is very injurious and dangerous to those handling it.

There are several methods of employing sulphur in the disinfection of rooms and objects, *e.g.*, the pot, candle, liquid, and furnace methods.

In the pot methods crude sulphur, preferably ground, is used; it is placed in an iron pot and ignited by the aid of alcohol, and in the burning evolves the sulphur dioxide gas. About 5 lbs. of sulphur are to be used for every 1000 cubic feet of space. As moisture plays a very important part in developing the disinfecting properties of sulphur dioxide, the anhydrous gas being inactive as a disinfectant, it is advisable to place the pot in a large pan filled with water, so that the evaporated water may render the gas active. For the purpose of destroying all insects in a room an exposure of about two hours to the gas are necessary, while for the destruction of bacteria an exposure of at least fifteen to sixteen hours is required.

In the application of disinfection with sulphur dioxide, as with any other gas, it must not be forgotten that gases very readily escape through the many apertures, cracks, and openings in the room and through the slits near doors and windows; and in order to confine the gas in the room it is absolutely necessary to hermetically close all such apertures, cracks, etc., before generating the gaseous disinfectant. The closing of the openings, etc., is done by the pasting over these strips of gummed paper, an important procedure which must not be overlooked, and which must be carried out in a conscientious manner.

When sulphur is used in candle form the expense is considerably increased without any additional efficiency. When a solution of sulphurous acid is employed, exposure of the liquid to the air suffices to disengage the sulphur dioxide necessary for disinfection. The quantity of the solution needed is double that of the crude drug, *i.e.*, 10 lbs. for every 1000 cubic feet of room space.

**Formaldehyde.**—At present the tendency is to employ formaldehyde gas instead of the sulphur so popular some time ago. The advantages of formaldehyde over sulphur are: 1) its non-poisonous nature; 2) it is a very good germicide; 3) it has no injurious effect upon fabrics and objects; 4) it does not change colors; and 5) it can be used for the disinfection of rooms with the richest hangings, bric-a-brac, etc., without danger to these. Formaldehyde is evolved either from paraform or from the liquid formalin; formerly it was also obtained by the action of wood-alcohol vapor upon red-hot platinum.

Formaldehyde gas has not very great penetrating power; it is not an insecticide, but kills bacteria in a very short time, and spores in an hour or two.

Paraform (polymerized formaldehyde; trioxymethylene) is sold in pastiles or in powder form, and when heated reverts again to formaldehyde; it must not burn, for no gas is evolved when the heating reaches the stage of burning. The lamps used for disinfection with paraform are very simple in construction, but as the evolution of the gas is very uncertain, this method is used only for small places, and it demands two ounces of paraform for every 1000 cubic feet of space, with an exposure of twelve hours. Formaldehyde is also used in the form of the liquid formalin either by spraying and sprinkling the objects to be disinfected with the liquid, and then placing them in a tightly covered box, so that they are disinfected by the evolution of the gas, or by wetting sheets with a formalin solution and letting them hang in the room to be disinfected.

The method most frequently employed is to generate the formaldehyde in generators, retorts, and in the so-called autoclaves, and then to force it through apertures into the room.

Of the other gaseous disinfectants used hydrocyanic acid and chlorine may be mentioned, although they are very rarely used because of their irritating and poisonous character.

**Hydrocyanic acid** is frequently used as an insecticide in ships, mills, and greenhouses, but its germicida power is weak.

**Chlorine** is a good germicide, but is very irritating, poisonous, and dangerous to handle; it is evolved by the decomposition of chlorinated lime with sulphuric acid. Chlorine gas is very injurious to objects, materials, and colors, and its use is therefore very limited.

# CHAPTER IV.

## SOLUTIONS OF CHEMICALS USED AS DISINFECTANTS.

SOLUTION of chemicals, in order to be effective, must be used generously, in concentrated form, for a prolonged time and, if possible, warm or hot. The strength of the solution must depend upon the work to be performed and the materials used. The method of applying the solution differs. It may consist in immersing and soaking the infected object in the solution; or the solution may be applied as a wash to surfaces, or used in the form of sprays, atomizers, etc. The most important solutions of chemicals and the ones most frequently employed are those of carbolic acid and bichloride of mercury.

**Carbolic Acid.**—In the strength of 1:15,000 carbolic acid prevents decomposition; a strength of 1:1000 is needed for the destruction of bacteria, and a 3% to 5% solution for the destruction of spores. Carbolic acid is used, as a rule, in 2% to 5% solutions, and is a very good disinfectant for washing floors, walls, ceilings, woodwork, small objects, etc. The cresols, creolin, lysol, and other solutions of the cresols are more germicidal than carbolic acid, and are sometimes used for the same purposes.

**Bichloride of Mercury** (Corrosive Sublimate) is a potent poison and a powerful germicide; in solutions of 1:15,000 it stops decomposition; in solutions of 1:2000 it kills bacteria in two hours; and in a strength of 1:500 it acts very quickly as a germicide for all bacteria, and even for spores. Corrosive sublimate dissolves in 16 parts of cold, and 3 parts of boiling water, but for disinfecting purposes it should be colored so that it may not be inadvertently used for other purposes, as the normal solutions are colorless and may accidentally be used internally. The action of the bichloride is increased by heat.

**Formalin** is a 40% solution of formaldehyde gas, and its uses and methods of employment have already been considered before.

**Potassium Permanganate** is a good germicide, and weak solutions of it are sufficient to kill some bacteria, but the objections against its use are that solutions of potassium permanganate become inert and decompose on coming in contact with any organic matter. Furthermore, the chemical would be too expensive for disinfecting purposes.

**Ferrous Sulphate** (Copperas) was formerly very used extensively for disinfecting purposes, but is not so used at present, owing to the fact that it has been learned that the germicidal power of this material is very slight, and that its value depends mostly upon its deodorizing power, for which reason it is used on excreta, in privy vaults, etc.

**Lime.**—When carbonate of lime is calcined the product is common lime, which, upon being mixed with water, produces slaked lime; when to the latter considerable water is added, the product is milk-of-lime, and also whitewash. Whitewash is often used to disinfect walls and ceilings of cellars as well as of rooms; milk of lime is used to disinfect excreta in privy vaults, school-sinks, etc. Whenever lime is used for disinfecting excreta it should be used generously, and be thoroughly mixed with the material to be disinfected.

## CHAPTER V.

### DISINFECTION OF ROOMS AND INFECTED OBJECTS.

PRACTICAL disinfection is not a routine, uniform, and thoughtless process, but demands the detailed, conscientious application of scientific data gained by research and laboratory experiments. Disinfection to be thorough and successful cannot be applied to all objects, material, and diseases in like manner, but must be adjusted to the needs of every case, and must be performed conscientiously. Placing a sulphur candle in a room, spilling a quart of carbolic acid or a couple of pounds of chlorinated lime upon the floors or objects, may be regarded as disinfection by laymen, but in municipal disinfection the disinfector must be thoroughly versed in the science of disinfection and be prepared to apply its dictates to practice.

**Rooms.**—In the disinfection of rooms the disinfectant used varies with the part of the room as well as with the character of the room. When a gaseous disinfectant is to be used sulphur dioxide or formaldehyde is employed, with the tendency lately to replace the former by the latter. Wherever there are delicate furnishings, tapestries, etc., sulphur cannot be used on account of its destructive character; when sulphur is employed it is, as a rule, in the poorer class of tenement-houses where there is very little of value to be injured by the gas, and where the sulphur is of additional value as an insecticide. Whenever gaseous disinfectants are used the principal work of the disinfector is in the closing up of the cracks, apertures, holes, and all openings from the room to the outer air, as otherwise the gaseous disinfectant will escape. The closing up of the open spaces is accomplished usually by means of gummed-paper strips, which are obtainable in rolls and need only to be moistened and applied to the cracks, etc. Openings into chimneys, ventilators, transoms, and the like, must not be overlooked by the disinfector. After the openings have already been closed up the disinfectant is applied and the disinfector quickly leaves the room, being careful to close the door behind him and to paste gummed paper over the door-cracks. The room must be left closed for at least twelve, or better, for twenty-four hours, when it should be opened and well aired.

**Walls and ceilings** of rooms should be disinfected by scrubbing with a solution of corrosive sublimate or carbolic acid; and in cases of tuberculosis and wherever there is fear of infection adhering to the walls and ceilings, all paper, kalsomine, or paint should be scraped off and new paper, kalsomine, or paint applied.

**Metal furniture** should first be scrubbed and washed with hot soap-suds, and then a solution of formalin, carbolic acid, or bichloride applied to the surfaces and cracks.

**Wooden bedsteads** should be washed with a disinfecting solution and subjected to a gaseous disinfectant in order that all cracks and openings be penetrated and all insects be destroyed.

**Bedding, mattresses, pillows, quilts, etc.,** should be packed in clean sheets moistened with a 5% solution of formalin, and then carted away to be thoroughly disinfected by steam in a special apparatus.

**Sheets, small linen and cotton objects, tablecloths, etc.,** should be soaked in a carbolic-acid solution and then boiled.

**Rubbish, rags, and objects of little value** found in an infected room are best burned.

**Glassware and chinaware** should either be boiled or subjected to dry heat.

**Carpets** should first be subjected to a gaseous disinfectant, and then be wrapped in sheets wetted with formalin solution and sent to be steamed. Spots and stains in carpets should be thoroughly washed before being steamed, as the latter fixes the stains.

**Woolen goods and wool** are injured by being steamed, and hence may be best disinfected by formalin solutions or by formaldehyde gas.

**Books** are very difficult to disinfect, especially such books as were handled by the patient, on account of the difficulty of getting the disinfectant to act on every page of the book. The only way to disinfect books is to hang them up so that the leaves are all open, and then to subject them to the action of formaldehyde gas for twelve hours. Another method sometimes employed is to sprinkle a 5% solution of formalin on every other page of the book; but this is rather a slow process.

**Stables** need careful and thorough disinfection. All manure, hay, feed, etc., should be collected, soaked in oil, and burned. The walls, ceilings, and floors should then be washed with a strong disinfecting solution applied with a hose; all cracks are to be carefully cleaned and washed. The solution to be used is preferably lysol, creolin, or carbolic acid. After this the whole premises should be fumigated with sulphur or formaldehyde, and then the stable left open for a week to be aired and dried, after which all surfaces should be freshly and thickly kalsomined.

**Food** cannot be very well disinfected unless it can be subjected to boiling. When this is impossible it should be burned.

**Cadavers** of infected persons ought to be cremated, but as this is not always practicable, the next best way is to properly wash the surface of the body with a formalin or other disinfecting solution, and then to have the body embalmed, thus disinfecting it internally and externally.

Disinfectors, coming often as they do in contact with infected materials and persons, should know how to disinfect their own *persons and clothing*. So far as clothing is concerned the rule should be that those handling infected materials have a special uniform which is cleaned and disinfected after the day's work is done. The hands should receive careful attention, as otherwise the disinfector may carry infection to his home. The best method of disinfecting the hands is to thoroughly wash and scrub them for five minutes with green soap, brush, and water, then immerse first for one minute in alcohol, and then in a hot 1:1000 bichloride solution. The nails should be carefully scrubbed and cleaned.

# PART THIRD.

## SANITARY INSPECTION.

---

## CHAPTER I.

### SANITATION AS A PROFESSION.

Fifty years ago there was no such profession as Sanitation. There were a number of persons interested in public-health questions and sanitary problems, but these were the philanthropists and public-spirited men, the pioneers of sanitary reform who strove to better the condition of their fellow men; to lower the death-rate of the community, and to inculcate into the minds of the people the wise saying of Franklin, that "Public health is public wealth."

Thanks to the unselfish devotion and strenuous efforts of those pioneers, great strides were made in the sanitary progress of the nation; vast reforms were undertaken and accomplished; the health of communities was improved; the death-rates of city populations cut in half, and permanent sanitary organizations founded by the establishment of various boards of health in villages, towns, and cities.

The organization of the various sanitary authorities in so many places necessitated the employment of a number of sanitary officers; this number has steadily increased until at present there are several thousand men in the United States engaged in the various departments connected with sanitary work.

At first, when the sanitary work was unorganized and crude, the men engaged in the pursuance of the various investigations were mostly volunteers, principally medical men.

The incomparable, painstaking, thoroughly scientific reports left by some of these volunteers are monuments to their efficiency; *vide* the Report of the Quarantine Convention of 1859, the Report on the Sanitary Condition of New York of the Council of Hygiene in 1866, and others.

With the enlargement and widening of the sanitary field, however, volunteer work became inadequate, and a number of men, mostly physicians, were appointed to continue the work so well begun by the volunteers.

With time and progress the sanitary field has become differentiated and specialized, until, at present, we have the various branches of sanitary work, each with its special inspectors; such as Health, Factory, Sanitary, Building, Plumbing, Offensive-trades, Contagious-disease, Meat, Milk, Fruit, Tenement-house, etc., Inspectors, all embraced in the great and noble profession of Sanitation.

But as the medicine of to-day differs from the medicine of the middle of the last century, and as the educational standard of the physician of the twentieth century is above that of the nineteenth century, so is the sanitation of to-day different from that of 50 years ago; and the educational standard of the sanitary inspector of to-day is different (or it ought to be) from the standard of the sanitary officers of years ago.

Unfortunately, the sanitary profession of to-day is not as yet what it ought to be, not being filled with the best elements of the medical and engineering professions which are the proper professions for sanitary work. The reasons for this shortcoming are the following:

1) Political selection of sanitary employees.

2) Inadequate compensation.

3) Insufficient education.

4) Absence of organization among the sanitary employees.

Let us examine these causes more thoroughly.

**Political Selection of Sanitary Officers.**—Dr. Chas. V. Chapin, in his book on "Municipal Sanitation in the United States," says: "Unfortunately most appointees to official sanitary positions in the United States are entirely untrained for the duties they are to perform. To exhibit some degree of natural ability is all that is asked, and often this is not required, the sole qualification of the appointee being his political service to the party which has the appointing power . . . the successful candidate needs no other recommendation than that of 'influential friends.'"

Dr. Wende, of Buffalo, also deplores the political selection of sanitary officers. (*Chicago Medical Record*, April, 1901.)

Of course, while conditions remain as they are; while the sanitary inspector is in danger of losing his place by the frequent political party upheavals; while the tenure of office is insecure; and while the fitness of the candidate is political instead of scientific, educated, intelligent, and trained men will neither seek nor get sanitary positions.

However, there is already noticeable in many cities a tendency toward reform in this direction; and thanks to the various civil-service laws, as well as to public opinion, there are less changes made in health and sanitary departments than before, and sanitary officers are left undisturbed when their fitness for their work has been proven. There is, therefore, a tendency to establish a permanent tenure of office during good behavior, and the position of the sanitary inspector begins to be more and more secure.

A permanent tenure of office should imply a pension for length of service and disability; and in some places, notably so in New York City, quite a liberal pension provision is, in fact, embodied in the Charter of 1901.

Let us hope, too, that the time is not distant when the following desideratum of Dr. Wende in the article quoted will be fulfilled, viz.: "Selection of municipal health officers for fitness, with secure tenure of office and proper compensation. The municipalities should not be exposed to unnecessary risks by politics." This brings us to the next question of

**Proper Compensation.**—The work of the sanitary officer is manifold, arduous, difficult, and fraught with many dangers to health and life. If there are any sinecures in the public employment, they are not in the health and sanitary departments. There is no class of municipal employees whose work is so constant, exacting, difficult, irregular, dangerous, and important, as is that of the sanitary inspectors. The sanitary officer has no 8-hour work-day, with a Saturday half-holiday; he is *always* on duty. Day and night he must be at his post, and when going to bed he is not sure that he will not be called out for some special sanitary work.

He is responsible for the condition of his district; any citizen may come up and find fault with his work; the chronic kicker who finds fault with some intangible nuisance demands that his theories be accepted by the inspector; the "one of the tenants," who is afraid to sign his name to the complaint, threatens to go to the Mayor if his complaint is not attended to at once. Apart from all these, the inspector in the performance of his duties directly endangers his health and life, for he has to climb rickety stairways, go down in cellars full of water and mud, inhale the noxious fumes of open drains and sewers, and come in contact with diphtheria, scarlet fever, typhoid, and other infectious diseases from which the ordinary citizen flees in horror.

If we add to the above the fact that a sanitary officer must possess certain intellectual and educational qualifications, as will be seen later, we should at least expect to find the compensation of the officer adequate to recompense him for his arduous and dangerous work. But on the contrary we find the facts are that, so far from his receiving a high salary, he gets a smaller salary than untrained and uneducated officers in other departments of the municipality. In New York City a janitor of a public school, a messenger in some department, or some other such employee, receives more than the physician or engineer employed in the Health Department.

According to Dr. Chapin, the salaries of sanitary inspectors in the United States range from $600 per annum in Rochester, Cincinnati, Charleston, and Hartford, to $1200 in New York. The average salary in smaller cities is $900, and in larger $1000.

Now, there is no doubt that these salaries are inadequate for the work performed, and for the qualified men who are required for sanitary positions. Most sanitary positions are filled by civil and sanitary engineers and physicians, and it is evident that such men cannot be satisfied with the above salaries. Add to this also the fact that in no position are advancement and increase of salary less to be expected than in municipal positions. When a man works for a private corporation he expects a rise in position and influence proportionate to the years of employment, and the employer need ask no one for permission to raise the salary of a trusted employee. In municipal positions it is difficult to secure an advancement; and every increase of salary raises such a howl from the organs of the party not in power that the heads of departments prefer to let efficient sanitary workers of many years remain at a miserable salary rather than risk harsh criticism from unfriendly organs.

In my opinion, inspectors in large cities should begin with a salary of $1000 or $1200 per annum, and each year should be raised by a certain sum, say $50-60, so that after 15 or 20 years the salary of the sanitary inspector will reach an amount in proportion to his value and experience.

**Inadequate Education.**—In England the public-health laws require that a sanitary inspector shall have a certificate from one of the several sanitary institutes giving diplomas in sanitation, after a course of study and thorough examination. Here in the United States we have no such special institutes, and no educational requirement is made of the candidate except a civil-service examination, which is, at best, insufficient to show the qualification of the candidate. It is true, some medical and other colleges have lately established courses in sanitary science, but the teaching is as yet very rudimentary, and the students are not those who usually seek sanitary positions.

**Absence of Organization and Esprit de Corps among Sanitary Officers.**—In England there are several powerful sanitary organizations, such as the Sanitary Inspectors, the Health Officers' Association, the National Health Workers, etc., and almost every sanitary officer of every hamlet, village, or city, belongs to one or other of these organizations. There are also quite a number of very able and influential sanitary monthly and weekly papers devoted solely to sanitation, and read by inspectors. We have nothing of the kind in the United States. There are only one or two monthly journals, hardly ever read by sanitary officers, and there is no organization whatever among the several thousand employees of the various health departments throughout the States.

The evils enumerated and discussed in detail must be eradicated before sanitation, as a profession, will attain a higher place and receive the recognition to which it is entitled.

The objects sought should be:

The selection of sanitary officers for fitness only, after passing a certain educational test; a permanent tenure of office; a substantial salary at the beginning, increasing every year, with a pension after 20 years; also, a thorough organization of all workers in sanitation, with news organs and proper sanitary publications of their own; meetings, conventions, etc.

## CHAPTER II.

### QUALIFICATIONS FOR AND ART OF INSPECTION.

**Qualifications.**—He who intends to devote himself to the profession of sanitation must be possessed of certain qualifications. In the first place, he should be blessed with a robust, strong constitution, and perfect health, otherwise he will not be able to stand the wear and tear incident to the profession. He should have perfect eyesight, hearing, and sense of smell. He should have at least a high-school education; should know something of geology, physics, chemistry, mathematics, mechanics, physiology, and the allied sciences, and should be able to draw. He should have made a thorough study of sanitation, both theoretical and practical; should understand thoroughly the principles of ventilation, drainage, plumbing, etc., besides knowing enough of practical building construction, etc., that he may not be hoodwinked by builders or plumbers. The inspector should also be fully conversant with all the State and local laws concerning his specialty, and possess the intelligence to pursue the investigations which from time to time may be entrusted to him. The inspector should, of course, have that command of the language which will enable him to make a creditable report to his superiors. He should be sober, industrious, observant, vigilant, conscientious, honest, and thoroughly imbued with the noble spirit of his profession. He should always bear in mind that he is the physician of the community; that the health and life of the people entrusted to his care depend upon the good work he is doing in his field, and that every effort of his to abate a public nuisance lowers the death-rate in his district and conduces to the health of his fellow men.

**The Art of Inspection.**—Sanitary inspection means the application of the teachings of the science of sanitation to practice, and as such, inspection becomes an art in which skill and experience count highly. Any one can inspect a house, and anybody may examine a public nuisance, but not every one can find all the defects in the house, or discover the cause of the nuisance; to do this it requires not only theoretical knowledge, but skill and experience as well. The physician just from college may know more of anatomy, etc., than the old practitioner; but who will not pity the poor unfortunate who entrusts the diagnosis of his malady to the youngster just from the college benches. So it is with the sanitary inspector. The probationer may and should know much regarding the theory of sanitation, but he will make the mistake of his life if he thinks he knows it all; and he may find himself rather humiliated when he fails to find defects which an ignorant plumber is able to point out to him in a moment. In sanitation, as in any other profession, experience and practice are required before the inspector can be depended upon to thoroughly know and understand his subject, and be owner may spend on maintaining his house in good repair, and on cleaning and beautifying it, the house is bound to become a menace to health and a breeding-place for bacteria, if the class of tenants is such that cleanliness is unknown among them; if they persist in tearing down walls, piling refuse everywhere, making holes in pipes, abusing fixtures, etc.

These considerations have to be kept in view in tenement-house inspection, in order to know how to inspect and whom to make responsible for the defects found and the conditions discovered detrimental to health.

An inspection of tenement-houses as to construction and defects in them, also as to light and ventilation, should be made by the building, light, and ventilation inspectors during and after construction of the building. The sanitary or tenement-house inspector should attend to the inspection of the defects of repair and maintenance of the house, while the inspection of the condition in which the house is kept by the tenants ought to be entrusted to the sanitary police.

The time an inspection of a tenement-house ought to require depends upon the kind of inspection made, as well as upon the number of stories and apartments the house contains. To peep into the cellar, glance at the privy accommodations, look up into the halls, and take in the view of the yard, may mean an inspection; and, unfortunately, many an inspector is compelled to do so from the stress of work and the enormous size of his district. But it is not an inspection, and need not take more than a few minutes of his time.

On the other hand, a thorough inspection of a house, an examination of the construction, ventilation, light, plumbing, drainage, and condition of a five-story tenement-house, requires not only skill, experience, and patience, but also *time*, and can hardly be done in less than several hours. Such an inspection as covered in the "Notes of a Complete Inspection of a Tenement-house," in the following chapters, must take quite a few hours; but, once done, may be put on record, and will facilitate subsequent inspections of the same house. Therefore, every tenement-house ought to be inspected in such a thorough manner at least once a year, and the results of inspection carefully recorded, so that the subsequent inspections need not require as much time. This is one reason why an inspector should be kept for a long time in the same district; for, after a certain time, he becomes intimately acquainted with every house in his district, and will be better able to take care of his district and watch for defects, violations of the law, and public nuisances, than the inspector recently placed in a district.

The mode of inspecting a tenement-house may differ somewhat with every inspector. Some begin in the cellar and work up to the roof; others begin at the roof and inspect while going down to the cellar. The best way would be, in my opinion, to combine both methods, and begin in the cellar, examining and noting all defects while going up to the roof, and then go over the same field and verify, correct, and complete the inspection as one goes down again.

Here I may add one thing which the inspector must always bear in mind, and that is: to mind his own business and *never*, NEVER talk to the owner, housekeeper, or tenants about his inspection, his work, what he finds, and what he is going to report. The inexperienced inspector may feel benevolently disposed to his fellow man, and may not be able to withstand the wiles of the ubiquitous landlord, who will want to know the report and finding of the inspector; but be assured that his every innocent remark may find its way into higher quarters, and he may find himself a victim of his own loquacity. The inspector is sent to investigate and make his report to his chief; and, until he makes such report, all he sees and discovers must not be talked about nor divulged to any one; and it is a wise policy to gently but firmly inform the too-insistent owner, or others, that the inspector must first make his report to his superior, and that in due time the owner will know what the inspector has to report.

Another matter of importance to be kept in mind during inspection of tenement-houses, as well as other inspections, is neither to be too lenient nor too strict, neither to fear nor favor the owner of the house, but always to give facts as they are and nothing more, no matter how the inspector may be treated by the caretaker or owner of the house. Some owners or agents of houses, when meeting an inspector on duty in their houses, are apt to become indignant, insolent, and overbearing; nevertheless the inspector should not be influenced by this in submitting his report. Above all, the inspector must remember his duty, his oath, and his office as guardian of the public health, and be above petty, selfish, and small considerations.

## CHAPTER IV.

### RULES AND REGULATIONS FOR SANITARY INSPECTORS.

In small municipalities the executive health officer performs the duties of a sanitary inspector; in larger places, however, special inspectors are appointed to examine sanitary conditions, inspect houses, report on public nuisances, etc. In New Jersey every town of 2000 inhabitants must appoint a sanitary inspector, otherwise the State Board of Health is entitled to appoint one and charge his salary to the town. There are some cities with a large population, however, where there is not one inspector. In some cities the sanitary inspectors are recruited from the regular police force. In Chicago there are 5 women inspectors. In New York, during the existence of the mercantile division of the Health Department, 10 women were employed.

Inspectors are, as a rule, always on duty; that is, they may be called any time of day or night to perform sanitary work without extra compensation. However, this is done only in cases of emergency, epidemics, and special dangers to public health. The regular time devoted by inspectors to their work varies from 6 to 9 hours a day. In New York City inspectors are required to work from 9 A. M. till 4 P. M., with one hour for lunch. In Denver the inspection hours are from 8 A. M. to 4 P. M., with one hour for lunch. In Augusta, Ga., from 7 A. M. to 6 P. M., with two hours for lunch.

In Atlanta, Cambridge, Milwaukee, Cincinnati, Pittsburg, Columbus, Ga.; St. Paul, San Francisco, Reading (and in New York City, the tenement-house inspectors), inspectors are required to wear uniforms.

Inspectors are required to report at the office at certain times, which differ in each city. In New York inspectors report three times a week. In Denver they report daily at 4 P. M., besides being required to communicate with the office twice a day by telephone. In Providence inspectors report twice a day at the main office. In Charleston the inspectors are required to visit 50 premises daily, report at the office every day at noon, and bring a report with 50 signatures of the occupants of the premises they inspected. In most of the large cities rules and regulations are provided for the conduct of the inspectors. The most elaborate and thorough regulations are those of New York City, excerpts from which are given below:

## EXTRACTS FROM THE NEW YORK CITY CHARTER OF 1901 ON SANITARY INSPECTORS.

"Sec. 1185. **Sanitary Inspectors.**—The Board of Health shall appoint and commission at least fifty sanitary inspectors (this is exclusive of the Police and the other divisions of the Department, such as contagious diseases, food, offensive trades, schools, etc.), and shall have power to appoint 20 additional sanitary inspectors, if it deems that number necessary, and from time to time to prescribe the duties of each of said inspectors, and the place of their performance, and of all other persons exercising any authority under said Department, except as herein specially provided; but 30 of such inspectors shall be physicians of skill and of practical professional experience in said city. The additional sanitary inspectors heretofore duly appointed and commissioned, either in New York City or in the City of Brooklyn, may be included among the sanitary inspectors mentioned in this section, and may continue to act as such without reappointment, but nothing herein contained shall curtail any of the powers vested in the Department of Health by this act, and the number of sanitary inspectors for whom provision is made in this section shall be exclusive of the special inspectors for whom provision is made in section 1186 and elsewhere in this act. All of the said inspectors shall have such practical knowledge of scientific or sanitary matters as qualify them for the duties of their office. Each of such inspectors shall, once in each week, make a written report to said Department, stating what duties he has performed, and where he has performed them, and also such facts as have come to his knowledge connected with the purposes of this chapter as are by him deemed worthy of the attention of said Department, or such as its regulations may require of him; which reports, with the other reports herein elsewhere mentioned, shall be filed among the records of the said Department."

"Sec. 1321. **Pension for physician or employee disabled by reason of performance of duty.**—The board of trustees of said fund shall have power to grant as pension to any physician or employee in the Health Department of The City of New York, who shall, as a consequence of the actual performance of his duty, and without any fault or misconduct on his part, have become permanently disabled physically or mentally, so as to be unfit to perform full duty, a sum not to exceed one-half, nor less than one-fourth of his rate of compensation per annum as such physician or employee, as the case may be.

"Sec. 1322. **Pensions to personal representatives of physician or employee who shall die from disease or injuries suffered in consequence of his performance of duty.**—Whenever such physician or employee shall die while in the service of the Health Department from disease contracted or injuries sustained by him as a consequence of the actual performance of his duty, without any fault or misconduct on his part, leaving a widow, the said board of trustees of said pension fund may grant, award or pay to the widow of said physician or employee the sum of $300 annually, during her life, so long as she remains a widow; and if there be no widow of any such physician or employee, but he shall leave minor children under eighteen surviving him, then said $300 may be given, awarded and paid to said children under eighteen years of age."

"Sec. 1323a. **Pension for twenty years' service.**—Any physician or employee who has or shall have performed duty as such physician or employee in any Department of Health in The City of New York, for a period of 20 years, or upward, upon his own application, in writing, or upon a certificate and report of a board of physicians, appointed by the Board of Health, certifying that such physician or employee is permanently disabled, so as to be unfit for further duty as such physician or employee shall be retired from active service by resolution of the Board of Health of the Health Department of The City of New York, and placed upon the Health Department pension roll, and thereupon shall be awarded, granted, and paid from said Health Department pension fund by the trustees thereof, an annual sum during his lifetime not exceeding one-half the ordinary full pay of a physician or employee in the Health Department service of the rank of the physician or employee so retired; provided, however, that no pension granted under this or the preceding sections, shall exceed the sum of $1200 per annum. Pensions granted under this section shall be for the natural life of the person receiving the same, and shall not be revoked, repealed, or diminished."

## EXTRACTS FROM THE RULES AND REGULATIONS OF THE DEPARTMENT OF HEALTH, NEW YORK CITY, ON SANITARY INSPECTORS.

"The Sanitary Superintendent, the Assistant Sanitary Superintendents, and all Inspectors shall be considered always on duty."

"All officers and employees of the Department of Health shall be at all times courteous and respectful to all persons with whom they come in contact in the performance of their duties; all officers and employees of the Department of Health must be protected from smallpox by proper vaccination. Intoxication or the use of intoxicating beverages during the hours of service are strictly forbidden."

"Inspectors have general charge, and must be held responsible for the sanitary condition of their respective districts. It is their duty to report in writing all violations of the law, Sanitary Code and regulations of the Board coming under their observation, whether such violations belong to the class under their especial charge or not. Such reports should be accompanied with recommendations and suggestions for the consideration of the Sanitary Superintendent."

"Inspectors shall wear their badges prominently displayed when engaged in their official duties. On entering any house or premises they must announce their authority and the object of their visit, and, while endeavoring to avoid giving offence, must make their investigations minutely. If resistance is offered to an Inspector in the performance of his duties, he will at once report the fact.

"Every Sanitary Inspector and every Medical Inspector not a Diagnostician, and every Vaccinator, must give to the work of this Department seven hours daily, except on Sundays and legal holidays. Saturday being a half holiday by statute, three hours will constitute a Saturday's work. When compliance with this rule is impossible, resignations will be expected.

"Inspectors must carefully inspect premises mentioned in complaints referred to them and make full and intelligent reports thereon. The modification of orders is undesirable, and should be rendered unnecessary by the intelligence and completeness of Inspector's recommendations. They are required to make reinspections promptly and carefully. A delay of more than forty-eight hours in making a reinspection must be reported to the President, unless such delay is authorized by the Chief Sanitary Inspector, who will thus assume the responsibility. Discretion in permitting a tardy compliance with an order rests with the Board and not with the Inspector.

"Inspectors will be held responsible for the existence of remediable public nuisances within their respective districts, and are expected to find them by original inspection. If unable to secure their prompt correction by personal efforts, they must report them to the Board, taking special care to correctly name the owners. When not otherwise employed on official business, they are expected to make a house-to-house inspection of tenements, factories, and all causes of nuisance in their districts. The law gives the Board of Health power to require that such conditions shall be thoroughly and properly corrected, and when this is impracticable, to vacate houses. It is prepared to use this power. The object of assigning Inspectors to districts is to familiarize them with local conditions. Every Inspector is expected to know his district intimately, and his efficiency will be judged not so much by what he claims to have done as by the sanitary condition of his district. The existence there of undiscovered and unreported nuisances which should have been found and reported will be held to indicate incompetence or unfaithfulness."

## NUMBER OF SANITARY AND OTHER INSPECTORS IN THE FOLLOWING CITIES.

NOTE.—The following list, which is of course incomplete, is based on Dr. Chapin's book:

| | Sanitary Inspectors. | Plumbing Inspectors. | Food Inspectors. | Infectious Diseases. Inspectors. | School Inspectors. | Tenement-house Inspectors. |
|---|---|---|---|---|---|---|
| Allegheny | ...... | 2 | 1 | | | |
| Asbury Park | 2 | | | | | |
| Atlanta | 7 | | | | | |
| Augusta | 5 | ...... | ...... | 4 | | |
| Baltimore | 6 | 1 | 2 | 4 | | |
| Boston | 16 | 11 | 4 | 2 | | |
| Brockton | ...... | 2 | | | | |
| Brookline | 1 | ..... | 1 | | | |
| Buffalo | 6 | ...... | ...... | 1 | | |
| Cambridge | 3 | 1 | ...... | 4 | | |
| Charlestown | 4 | | | | | |
| Chicago | 34 | 14 | 9 | 20 | 50 | |
| Cincinnati | 20 | 2 | ...... | 4 | | |
| Cleveland | 20 | ...... | 4 | | | |
| Columbus | 8 | 1 | 1 | | | |
| District of Columbia | 7 | ...... | 3 | 1 | | |
| Dayton | 2 | 1 | | | | |
| Denver | 11 | 2 | 2 | 2 | | |
| Evansville | 1 | ...... | 1 | | | |
| Fitchburg | ...... | 1 | 1 | | | |
| Hartford | 2 | 1 | ...... | 1 | | |

NUMBER OF SANITARY AND OTHER INSPECTORS IN THE FOLLOWING CITIES.—*Continued.*

| | Sanitary Inspectors. | Plumbing Inspectors. | Food Inspectors. | Infectious Diseases. | School Inspectors. | Tenement-house Inspectors. |
|---|---|---|---|---|---|---|
| Haverhill | ...... | 1 | 1 | | | |
| Holyoke | ...... | 1 | | | | |
| Indianapolis | 6 | | | | | |
| Lawrence | ...... | 2 | | | | |
| Lowell | 4 | | | | | |
| Lynn | 2 | 1 | 2 | | | |
| Louisville | ...... | ...... | 1 | | | |
| Manchester | 2 | | | | | |
| Memphis | 12 | | | | | |
| Milwaukee | 13 | 4 | 4 | 5 | | |
| Minneapolis | 7 | 2 | 3 | 3 | | |
| New Bedford | ...... | 1 | ...... | 1 | | |
| Newark | 15 | 1 | 2 | 1 | | |
| New Haven | 4 | 1 | | | | |
| New Orleans | 19 | ...... | 14 | | | |
| Newton | 3 | 1 | ...... | ...... | 7 | |
| New York | 61 | 50 | 20 | 50 | 200 | 200 |
| Omaha | ...... | ...... | ...... | 1 | | |
| Paterson | ...... | 1 | | | | |
| Pittsburg | 17 | 5 | 2 | 1 | | |
| Philadelphia | ...... | 13 | 4 | 5 | | |
| Providence | 2 | 3 | 1 | 1 | | |
| Reading | ...... | 1 | | | | |
| Richmond | 4 | | | | | |
| Rochester | 5 | ...... | ...... | 1 | | |
| St. Paul | 6 | ...... | 2 | 1 | | |
| St. Louis | ...... | ...... | 6 | | | |
| Salt Lake City | 1 | ...... | ...... | 1 | | |
| San Francisco | 5 | 5 | 13 | | | |
| Somerville | 1 | 1 | | | | |
| Springfield, Mass | ...... | 1 | | | | |
| Syracuse | 2 | 2 | 1 | | | |
| Toledo | 10 | | | | | |
| Utica | 3 | | | | | |
| Wilmington, Del | 4 | | | | | |

# CHAPTER V.

## CIVIL-SERVICE EXAMINATIONS.

A civil-service examination is not the best test of the fitness of a candidate; but in the absence of any better, and in the absence of proper schools for sanitary training, such examinations show, at least, whether a candidate has any knowledge of the subject in which he is examined.

The questions put in the various sanitary examinations are, as a rule, fair, and not very difficult for any one with a knowledge of sanitation to answer. A very important part of the examination is that containing the questions bearing on the local laws of the department in which the examination is held, and the candidate must make a thorough study of these laws.

From 10 to 30 questions are given to the applicant, who has from 5 to 6 hours in which to answer them. Among so many questions there are a number which are easy to answer, a number somewhat more difficult, and a few to answer which may not be possible to the candidate. The best procedure is to begin with the easiest questions first; answer them as thoroughly as possible, then to proceed to the more difficult and leave the most difficult for the last; otherwise, if the applicant begins with the hard questions first, he is discouraged, loses the time in which he might be answering the easier questions, and loses all spirit and hope, so that he is unfit to give good answers to questions which at first would have been very easy. The answers and explanations must be clear, short, and to the point. The candidate is not expected to write a treatise on each subject, but merely to give a clear and readable opinion, so that the examiner may judge how much the applicant knows of the subject. Legible handwriting is a great advantage in civil-service examinations, as the examiners are but human, and often in despair of deciphering the writing of an able paper, may give up the task and leave the candidate with a low percentage.

## CIVIL-SERVICE-EXAMINATION QUESTIONS.

The questions here published have been given by the New York Municipal Civil-service Commission to candidates for the various sanitary positions. A study of these questions will prove beneficial to candidates and students in general.

### FOOD INSPECTOR.

#### SPECIAL.

**1. What are the duties of a Food Inspector?**

**2. To what extent should a Food Inspector acquaint himself with (*a*) the sources of supply; (*b*) the seasons at which different kinds of food are offered in the markets; (*c*) the points at which these supplies are delivered in the city; (*d*) the distribution of such supplies to the different places of sale?**

**3. How should an ice-box be connected with the sewer? Draw a plan showing pipes and connections.**

4. You are sent as an Inspector to visit five different places where food is offered for sale. In some of these places you find the food not fit for use. In some you find bad arrangements. Assuming such facts as you please, write a report to the Chief Inspector giving the results of your inspection.

*Division I.—Meat and Poultry.*

5. State the common terms applied to diseased or unfit veal, mutton, pork, and poultry, and define precisely each term.

6. (a) What is pleuro-pneumonia and what animals are subject to that disease? (b) What are the indications of this disease in animals before and after slaughtering?

7. What is the "Kosher" method of slaughtering?

8. What are the common diseases (a) of hogs; (b) of poultry? How are they to be detected? Which of them makes the animal unfit for food?

9. How can the existence of fever in an animal, at the time of slaughtering, be detected in the dressed meat? How is the temperature of a living animal ascertained?

10, 11, 12. Give the name and describe the condition of each specimen shown you. (The candidate should make notes, at the time of the inspection, and afterward write description in full, arranging his answers to correspond with the number of each specimen.

*Division II.—Fish.*

5. What kinds of fish are found in our markets and at what time of year is each kind offered for sale?

6. Name the principal sources of supply of each kind you have mentioned in your answer to question 5.

7. In inspecting fish, state precisely to what points you would direct your attention and what indications would, in your opinion, show that the fish were unfit for sale. Answer this question fully.

8. Answer the question put in No. 7 with reference both to cooked and uncooked shell fish.

9. How would you test canned fish and oysters without opening the cans?

10, 11, 12. Give the name and describe the condition of each specimen shown you.

*Division III.—Milk.*

5. Give the terms in common use applied to milk in its different forms and stages, and describe precisely the meaning of each term. State which of these, in your opinion, makes the milk unfit for sale, and state what test you would make of a specimen submitted to you to determine its character.

6. What is a lactometer? Describe it and state how it is used.

7. How would you test canned condensed milk without opening the can?

8. State what, in your opinion, are the necessary arrangements, conditions, and appliances where milk is kept on sale. What is the proper temperature at which to keep milk in places of sale?

9. Name the most common adulterants of milk; state for what purpose each is used. How you would try to detect it, and in what way, if at all, each is harmful.

10, 11, 12. Examine each specimen shown you and give your full opinion of it.

*Division IV.—Fruits and Vegetables.*

5. Describe "baked" banana, "speck" pine, "baked" orange; what causes these imperfections and how are they detected?

6. What conditions, in your opinion, would make potatoes, cabbages, and tomatoes unfit for sale, and how would you determine these conditions?

7. State, fully, the proper arrangements and appliances of shops where fruit and vegetables are on sale.

8. Describe fully your method of judging cocoanuts.

9. How do you test canned goods without opening? State fully.

10 and 11. State the principal sources of supply and the seasons of sale of the staple fruits and vegetables in New York City.

12. Is there any special care to be taken in inspecting fruit offered for sale on the street? If so, what?

13. How do you test melons without cutting? What do you consider the practical value of the test?

14. What are "soaked" canned goods?

*Arithmetic.*

1. Add. 2. Subtract. 3. Multiply. 4. Divide.

*Experience.*

This paper consists of seven questions pertaining to what the education of the candidate consisted of, and experience.

N. B.—All candidates must answer questions 1 to 4. After answering those questions, candidates will select one of the four divisions offered and stay by that. No credit will be given to a candidate in any division who undertakes to answer questions in more than one division.

## FISH INSPECTOR.

### TECHNICAL.

1. What, in general, do you consider to be the duties of a Fish Inspector?
2. What fish are most commonly sold in New York markets? What are the principal seasons for each, and what, generally, the main source of supply?
3. How do you test canned fish and oysters without opening the cans?
4. What tests are employed for determining whether cooked and uncooked shell fish are fit for sale? Include lobsters and crabs in your answer.
5. What are the indications that fish exposed for sale are unfit to eat?
6. What objections are there to exposing fish for sale in the open air?
7. You are sent to inspect five places where fish, oysters, etc., are exposed for sale. Two of the places are found unsatisfactory, the others satisfactory. Assuming such facts as you please, write a report to the Chief Inspector, properly dated, addressed, and signed with your NUMBER and NOT your name, giving the results of the inspection and such recommendations as you think proper.
8. Describe the conditions of each of the specimens shown you and name each kind. (The candidate should make notes at the time of inspection and afterward write description in full.)

*Arithmetic.*

1. Add. 2. Subtract. 3. Multiply. 4. Divide.

## DISINFECTOR.

### Duties.

1. Give a detailed statement of what you understand to be the duties of the position you seek.

2. Show how the proper performance of these duties is a matter of great importance to the public at large.

3. What qualification would you, if in authority, consider especially necessary for an efficient official of this sort?

4. Explain in your own words what you understand by the term disinfection.

5 What you understand by a contagious disease. Give examples.

6. It is proposed to make the corps of disinfectors a uniformed force. Discuss the advantages to the Department of Health, to the public, and to the disinfector himself should this be done.

7. Name substances in use for the general disinfection of rooms after contagious diseases and state briefly how they are employed.

8. How may floors and woodwork be disinfected?

9. If you were ordered to disinfect an apartment in a tenement house, and met with opposition from the family, how would you proceed?

10. If valuables had been left by the family in the room or rooms to be disinfected, what course would you adopt to protect yourself?

### *Arithmetic.*

1. Add 3 1-4, 7 1-3, 8 2-5, 9 7-12.

2. Multiply 78 094 by 60.98.

3. Divide 33.12858 by 789.4.

4. What are the cubical contents of a room 14 feet 6 inches wide, 20 feet 4 inches long, and 8 feet 3 inches high?

### *Experience.*

1. State age and place of birth.

2. Describe fully the educational advantages you have had.

3. How have you been employed for the past five years? If you have changed your employment during that time, state fully the reasons for doing so.

4. Give any details which would show that you were especially trusted by your employers.

5. From what contagious diseases have you suffered?

6. Have you had any experience in nursing the sick, in practical disinfection, or in the handling of chemical substances? If so, what?

## DIETRICIAN.

### Duties.

1. What food principles constitute a complete diet for man? Illustrate with the proximate principles of milk.

2. Mention the important digestive secretions, and explain briefly the functions of each in digesting the various food principles.

3. (a) What articles of food are most difficult to eliminate in diabetic feeding, and what are the substitutes therefor?

4. Discuss the value of alcoholic beverages as food.

5. What details would you insist in teaching nurses to serve a bed-patient's food in order that the service be dainty and appetizing?

6, 7. Outline a course of lectures to pupil-nurses on the subject of diabetics to be given with practical work, stating length of course adequate and topics to be treated at each lecture.

8. Discuss the digestibility of uncooked eggs, of beaten eggs, and eggs prepared in various ways.

9. (a) Explain the "raising" of bread by yeast. (b) In what food principles are breads generally lacking? (c) Discuss the relative food value of whole wheat and of white bread.

10. (a) What are cereals? What leguminous food? Discuss the food value of each. (b) Why are the coarser vegetables indigestible? Explain how digestibility is increased by cooking.

### *Arithmetic.*

1. Add.

2. A tea merchant mixes 40 pounds tea at 45 cents per pound with 50 pounds at 27 cents per pound. He sells the mixture at 42 cents per pound. What per cent. profit on the cost does he make?

3. The yard measure of 1758 was 36.00023 inches long. How many of such yards would there be in our mile of 62,360 inches?

4. A man sold one-third of a bag of coffee, then one-half of it, and took home the rest—12 pounds. How many pounds did he have at first?

5. A gardener raised four-fifths of a bushel of beans in one patch and seven-eighths of a bushel in another. He sold 3 pecks, 6 quarts, 1 pint. How much had he left?

## MEDICAI. INSPECTOR.

1. Differentiate smallpox from each of the following diseases, stating stages or types which each might stimulate: (1) measles; (2) varicella; (3) typhus fever; (4) the pustular syphilis.

2. Give physical signs of lobar pneumonia and state how they differ from those of pleurisy with effusion.

3. Mention four etiologically distinct contagious skin diseases, and describe briefly the characteristic dermatological appearances in each.

4. Differentiate between malignant, ulcerative, or mycotic endocarditis, and the infectious disease possibly simulating it.

5. Describe briefly the organism or malarial infection, its types, transmissions, and bearing of these facts on prophylaxis.

6. In what ways is the plumbing of a house apt to be defective?

7 and 8. (a) Give clinical history of scarlet fever up to the fourth day of the disease; (b) tabulate possible complications of the disease; (c) tabulate important sequelæ of this disease; (d) if in authority in an individual case, what steps would you insist upon to prevent spread? (Give details.)

9. What are the causes of (a) hæmatemesis; (b) hemorrhagic (petechial) rashes; (c) of what value is the pressure or absence of leucocytosis in differential diagnosis of infectious diseases?

10. What are the diagnostic symptoms of yellow fever and what is the present belief as regards its transmission by fomites, etc.?

## INSPECTOR OF TENEMENTS.

### TECHNICAL.

1. State clearly, concisely and precisely, the conditions of living in New York City which have made necessary the establishment of a Separate Tenement House Department.

2. Suppose a fashionable apartment house, five stories high, with two apartments on each floor. There are no kitchens in any apartment, but there is a restaurant on the ground floor. Some of the tenants introduce gas ranges into their apartments. Does this action make a tenement house of the place or not? Give reasons with your answer.

3. Explain the meaning of the words "superficial area" in the provision that "the total window area in each room, except water

closet compartments and bathroom shall be at least one-tenth of the superficial area of the room."

4. State for what purposes (a) a tenement house or a part thereof may not be used for business or storage; (b) for what it may be used under certain restrictions; (c) what these restrictions are; (d) what is "wire glass" and "fire-proof material" as applied to walls and ceilings?

5. Define "cellar" and "basement" and state as precisely as you can all the purposes to which the law allows them to be put and under what conditions.

6. State the laws governing fire escapes; how they must be constructed; where placed; whose duty it is, apart from the tenants, to see that they are kept clear and in good condition.

7. What is meant by a "trap" in plumbing? Why is a trap necessary in a water closet? What is the provision of the Sanitary Code as to trapping sinks, etc.? What is meant by "siphoning," how is it caused, and how best prevented?

8. What are the duties of an owner or tenant with reference to the sidewalk upon the premises of which he is owner or tenant? State one instance in which the law governing this matter has been conspicuously disregarded in the past few weeks. Upon what city department does the responsibility of this matter rest?

9. State the reasons why a water closet flush should not come directly from the supply pipe.

10. Taking in order, tubs, drains, ventilation pipes: State the best materials for each and indicate the objections to other materials sometimes used.

11. State as concisely as possible, the conditions in existing tenement houses (a) which are allowed to continue; (b) which must be changed in case of alteration; (c) which must be changed if not altered; (d) which will not be allowed in houses to be hereafter erected; and give briefly your opinion for the reason of the law in each case.

12. You are sent to inspect (a) a tenement house of ordinary character, five years old; (b) a tenement house in process of construction; (c) a tenement house of the so-called "model" character, one year old; state precisely to what points you would direct your investigations, and assume any facts you please, write a report of your inspection, addressed to the commissioner. N. B.—Sign this report with your examination number and not your name.

13. Suppose that in case (a) of question 12 you discovered some conditions or violations of the law, not of a very serious character, but created by the tenants themselves. What would be your course toward the tenants? Would your course be in any way determined by any of the following: nationality; length of residence in the city; means of subsistence; comparative ignorance? If so, how and why?

14 and 15. See the annexed plan.

## INSPECTOR OF TENEMENTS.

### Special Paper.

1. Enumerate the evils which are likely to arise from overcrowding in tenement houses.

2. Suppose a fashionable apartment house, five stories high, with two apartments on each floor. There are no kitchens in any apartment, but the occupants take their meals in a restaurant on the gound floor. In the summer the restaurant is closed for several months for repairs. Some of the tenants then prepare their own breakfasts in their apartments. Does this action make a tenement house of the place or not? Give reasons with your answer.

3. Explain the meaning of the following terms: "Gooseneck ladder," "winder," "string" in stairways, "louvre."

4. State the principal changes made in the Tenement House Law by the amending act of 1902.

5. Under what conditions may a cellar be occupied for living purposes?

6. What is the provision of the law as to stairways on non-fireproof tenements to be hereafter erected?

7. If in making an inspection you should find tenants beating a carpet on a roof or hanging it out of windows, what would you do?

8. What are the requirements as to lighting public halls in tenements? (This question refers both to windows and artificial lighting.)

9. In what way is the height of a tenement house determined by the width of the street on which it is built?

10. What restrictions are there as to building rear tenements?

11. Why is it forbidden to connect the waste pipe from a bathtub with a water closet trap?

12. Why is it required that plumbing work under water closets should be uncovered?

13. You are sent to inspect three tenement houses of different character. In some instances you find violations of the law as to construction, and in some violations of the Sanitary Code. Assuming such facts as you please, write a report, addressed to the Commissioner.

## INSPECTOR OF TENEMENTS.

### TECHNICAL.

1. What evils, sanitary or moral, have existed in the past, not reached by previous city departments, which the Department of Tenement Houses is expected to correct? Answer this question completely, but concisely.

2. Give your opinion as to what makes the difference (a) in general language, (b) in legal terms, between an apartment house and a tenement house.

3. Explain, so that an ordinary person can understand, the meaning of the following requirements of the Tenement House Law concerning fire escapes: "The platforms or balconies shall be constructed and erected to safely sustain in all their parts a safe load at a ratio of four to one of not less than eighty pounds per square foot of surface."

4. What are the restrictions with reference to bakeries in tenement houses? What do you understand to be the meaning of "fireproof materials" in connection with such restrictions? What are the "other dangerous businesses" as to which there are restrictions, and what is the meaning of the technical term used in the law with reference to them?

5. State clearly the difference between a court and a yard, and also the difference between a cellar and a basement.

6. The law provides that stairways on a fire escape shall be placed "at an angle of not more than sixty degrees." From what line is this angle determined? Define the following words used in the same connection: "Gooseneck ladder," "battens," "clear head way," "tread," "string," "bracket."

7. Suppose an apartment with a kitchen sink, a water closet and a wash basin. How many traps are necessary? State reasons for your answer. What, if any, differences in the plumbing arrangements would be necessary if the apartment were supplied with water from the street main or from a roof tank?

8. State the rules or ordinances concerning the location and con-

dition of fire escapes. If fire escapes are used as storage rooms, or as places for keeping flowers or the like, whose duty is it, apart from the Tenement House Inspector's, to see that they are kept clear? If you saw such a case, what would you do?

9. What objection is there to enclosing plumbing fixtures with woodwork? In the city of Paris all gas pipes must be exposed. Do you consider this a reasonable rule or not? Give reasons with your answer.

10. Taking the ordinary tenement house, state what material, you consider best for the following named purposes: Leaders, tubs, floors, partitions where there are windows and the windows themselves, drains, and give, in each case, your reasons.

11. State clearly the distinction made in the application of the Tenement House Law between houses already erected and those to be hereafter erected.

12. Draw up what you consider to be a proper blank form of report for a Tenement House Inspector, and, assuming three different buildings and conditions, make out a full report in each case.

13. How often do you think an inspection should be made? Would the character of the tenants make any difference in this matter? Would the particular points to which your inspection was directed be determined in any way by consideration of nationality, length of residence, means of subsistence or similar considerations? If so, state clearly how and why.

## TENEMENT INSPECTOR.

### TECHNICAL.

1. Name the bureaus of the Tenement House Department, and state in a general way the difference in the duties of inspector attached to the different bureaus.

2. (a) If the owner of a private dwelling desired to add a story to or otherwise enlarge it for the use of his family, where would plans have to be filed and permission obtained to make the alterations? (b) In case the owner desired to alter the building to make it accommodate four families, what different steps must he take?

3. State the difference between yard and court as used in the Building Code; also between cellar and basement, and under what condition may a cellar be occupied for living purposes?

4. What is the rule as to the height of a new tenement house

under the present law and how are height, length and breadth of such a building measured?

5. State fully the requirements as to windows in rooms under the Tenement House Law. What window area would be necessary in a room thirteen feet long, fifteen feet wide and nine feet high?

6. What is an "intake" and what is its object? What area must the intake have for a court thirteen feet by twenty-six feet?

7. What are the special advantages of so-called "open plumbing"? Would it be well, in your opinion, to extend the requirements of the law to gas piping? Give reasons for your answer.

8. To what extent has the requirement as to inner courts been changed by recent amendments of the Tenement House Law? Give minimum measurements of such courts under the original law, and as changed by amendment.

9. What advantage is gained by requiring careful registration of agents and owners of tenement houses? How may an owner or agent be considered to have permitted the use of tenement property for illegal purposes in spite of his denial of the same?

10. State clearly the distinctions made in applying the Tenement House Law to buildings already erected and those hereafter to be erected.

11. Under what conditions, if at all, may a tenement house be erected on the rear of a lot on the front of which lot there is already a tenement house standing?

12. Define a fireproof building, according to the requirements of the present Building Code of New York City. What is meant by skeleton construction, and when must a tenement house be made fireproof?

13. Make a full report of your inspection of three tenement houses, assuming such conditions as you deem fit in each case.

14 and 15. It is proposed to erect a tenement house 57 feet high with the dimensions shown on the plan below. State whether this is lawful or not. Give reasons clearly for opinions. The lot is an interior lot.

## INSPECTOR OF LIGHT AND VENTILATION.

1. There are certain natural forces acting to produce ventilation in buildings; what are they? (Note: This does not refer to windows, ducts, courts, shafts, etc., which are only helps to ventilation.)

2. (a) Define what you mean by ventilation. (b) Can you have proper ventilation without light? (Give your reasons.)

3. (a) State what must be the cubical contents of an apartment for every person occupying the same. (b) What do you understand by an apartment? (c) State the minimum dimensions allowed for a bedroom in a tenement yet to be built. (d) State the same in an existing tenement.

4. State the difference between 7 square feet and 7 feet square, and show how you obtain it.

5. (a) Would the light radiating from a point be more intense or less intense as you move from it? (b) State the law governing the relative intensity of a light at two differing distances from the light.

6. (a) Is the purity of the air in a room dependent upon the size of the room or the amount of fresh air entering it? State which. (b) If the latter, about how much air should be supplied per minute for each individual occupying the room?

7. (a) State fully and clearly the arrangement and exact dimensions required of a window in an existing tenement. (b) State the law governing the size and arrangement, and the minimum size allowed in tenements yet to be built. (c) State how windows must be measured. (d) State what the windows of every room in a new tenement must open upon. How does this differ from that for tenements now existing?

8. (a) Give an exact definition of the outer courts of a tenement and their sizes. (b) Give an exact definition of the inner courts of a tenement and their sizes. (c) Why were the narrow courts previously in use not considered of sufficient size?

9. What provisions are made in the new law for the ventilation and cleanliness of shafts and courts? State fully.

10. A room is 13 ft. 10 in. long and 9 ft. 6 in. wide. It has one window 2 ft. 10 in. wide. How high must the window be to conform to the law for new tenements?

11. (a) A street is 70 feet wide. How high may a new tenement facing upon it be built? (b) State exactly how and where this height must be measured.

12. The law requires for every tenement on an interior lot, a certain amount of vacant space not built upon; is this space the same in area as a yard, or of what is it constituted?

13. (a) How many kinds of shafts are provided for in new tenements? (b) Which of these, if any, may be covered, and under what restrictions?

14. (a) What must be the minimum area and least dimension of a vent-shaft in a new tenement 48 feet high? (b) What must be the minimum size and area for a vent-shaft in an existing tenement, and under what conditions may this be reduced? (c) What rooms may have windows opening into vent-shafts?

## INSPECTOR OF PLUMBING, LIGHT AND VENTILATION.

### Technical.

1. (a) Give the rules governing the open space required on every lot occupied by a tenement house or a lodging house. (b) Define what constitutes a tenement house and also a lodging house.

2. Give the rules governing the light and ventilation of every sleeping room in such houses.

3. (a) Is there any difference between the expression "three feet square" and "three square feet," and if so, what is it? (b) What do you mean by percentage in the expression 65 per cent. of a lot surface?

4. (a) What is the least area allowed in all shafts and courts? (b) Under what conditions may such shafts be covered? (c) How must all halls be ventilated?

5. What are the least cubical contents allowed in sleeping rooms?

6. Name, without describing them, all the pipes in a system of plumbing in a tenement house, giving them in order from the top of the building to the connection with the sewer.

7. State all the ways in which such a system, when thoroughly good as put in, may afterward be damaged, either during construction of the building or at a later period.

8. Describe a thoroughly good "house drain," including in your description everything which must be done to prevent leakage and stoppage, and to make it durable and efficient in every way.

9 and 10. (a) Describe the "vent pipe" in a tenement. (b) State where the branches should be attached at each closet and the other requirements for making the branches effective (c) State where the vent should be attached to the soil pipe at the upper end (if it is so attached), where at the lower end, the method of such attachment, and all the requirements of a good job.

11. Describe the fresh-air pipe, including the proper terminations to make it most effective.

12. State, as far as you can, all the methods pursued by dishonest workmen or employers in "scamping" work.

13. Describe the best method of testing a system of plumbing; give full details.

14. What constitutes a good and sufficient flushing system to a water closet?

15. (a) Describe a "soil pipe" in a large tenement. (b) How it should be supported. (c) How it should be terminated at the top. (d) How it should be attached to the house drain.

*Arithmetic.*

1. Multiply 8 ft. 5 in. by 17.

2. Divide 165 ft. 7 in. by 6.

3. What is the area of a lot having parallel sides 102 ft. 6 in. and 98 ft. 4 in., the width being 18 ft. 4 in.?

4. A room is 12 ft. 8 in. by 15 ft. 6 in. by 9 ft. 9 in. in height. How many persons should be allowed to occupy the room, allowing 400 cubic feet of air for each person?

## CLERK.

### TECHNICAL.

1. The latest amendments to the Tenement House Law aim to improve the safety, health and comfort of occupants of tenement houses. On what general lines is this accomplished?

2. Before a tenement house can be constructed or altered, what information must be furnished to the department?

3. Name the plans necessary to determine whether a proposed tenement house complies with the law.

4. Does a fireplace and chimney affect ventilation? State your reasons.

5. A tenement house is to be built on a corner lot 75 feet wide. What per cent. of the lot may be built upon? In determining this, at what elevation is the measurement taken?

6. How deep must a yard be for a tenement house 75 feet high, built on an interior lot? Where is the measurement taken?

7. What must be the window areas in (a) a living room 13 ft. by 10 ft.? (b) a bedrooom 10 ft. by 8 ft.? How must the windows be otherwise arranged?

8. What is the distinction between courts on the lot line and other courts as to size?

9. What is the distinction between different kinds of courts as to location and relative size?

10. How does the height of a tenement house affect the portions of the lot not built upon? State what these portions are (detail figures not required).

11. What is a vent-shaft? How is ventilation assisted in a vent-shaft? What are the general sanitary provisions for vent-shafts?

12. How are vent-shafts provided over stair wells?

13. Write a letter (not less than one-half nor more than one page) to an assumed superior regarding an examination of a set of specifications, and the discovery that they do not comply with the law, assuming such facts as you please.

14 and 15. Ground plans of a tenement house, five stories high, on an interior lot, 25 feet by 80 feet. The shaded part represents the buildings. State in what particulars, if any, the law is not complied with. Give your reasons, and any figures necessary.

## SANITARY INSPECTOR.—HEALTH DEPARTMENT.

### Technical.

1. What are the duties of a lay sanitary inspector?

2. How should the waste pipe of a refrigerator or water tank be connected?

3. What points would you observe when inspecting a water closet?

4. What defects would you look for when inspecting the iron pipes in a building?

5. When may a cellar be used as a dwelling?

6. What does the Sanitary Code require in the case of privy vaults? Manure vaults?

7. How many cubic feet of air space must be allowed to each person in a sleeping room?

8. Define tenement house.

9. Define lodging house.

10. Define cellar.

### State Deputy Factory Inspector.

Describe the organization of the State Department of Labor.

What are its powers?

Of what bureaus is it composed?

Define the terms *employee* and *employer*, as used in the General Labor Law.

Define the terms, *factory* and "*mercantile establishment.*"

What officials are charged with the enforcement of the General Labor Law?

State the substance of the Eight Hour Law (Section 3). To whom does it not apply?

State all possible exceptions in the application of the Eight Hour Law.

What do you understand by the term "extraordinary emergency," as used in the Eight Hour Law?

State the reason for the non-enforcement of the "prevailing rate of wages" clause.

What penalty is imposed upon contractors for public work who violate the Labor Law? How is such penalty to be enforced?

Describe the manner in which wages are required to be paid and state the intervals of payment with exceptions.

Outline the penalties for the violation of the law in this respect.

In what case or cases is the assignment of future wages invalid?

State the provisions of the law regarding seats for female employees. To what forms of employment does this apply?

What safeguards are required in the interest of employees using scaffolding in any form?

Describe the precautions that are required to protect from injury persons engaged in building construction in cities.

What are the duties of a factory inspector?

What is required of applicants upon obtaining work?

What do you understand by "indenture of apprentices"?

What are the age limits in the employment of minors?

What is required before a minor between the ages of 14 and 16 may be so employed?

State the requirements of the law as to certificate and school attendance.

What is a vacation certificate?

Describe the register of employed children that is required by law.

What are the time limits in the hours of employment for women and children? Describe the notice that must be posted in accordance with this clause of the law.

For what purpose may the hours of labor for women and minors be lengthened? How is this done?

Give a summary of the requirements of the law for the protection of employees in the following particulars: Elevators, hoisting shafts, stairs, stair-wells, doors, machinery, vats, etc.

Describe the requirements of the law as to fire escapes on factories. What are the powers of the factory inspector in this respect?

What provision for air space and ventilation must be made in all factories?

Give the necessary measurements of work-rooms.

What must be done in case of accident, both by employers and factory inspectors?

What is a tenement-house? What is necessary before manufacturing may be carried on in a tenement-house?

State the substance of the amendment of the current year relative to the licensing of tenement manufacture.

What goods may be made in a tenement after a license has been procured?

Compare the General Labor Law and the Public Health Law (L. 1893, Chap. 661, Sec. 28).

Under what circumstances is night work allowed in a tenement?

What is a "sweatshop"?

Describe the sanitary regulations that affect sweatshops.

What class of persons is exempted from the application of the sweatshop law?

What is the penalty for unlawful manufacture in tenements?

How are goods so made to be marked?

What powers have the health authorities relative to tenement-made articles?

In what way is an owner responsible for illegal manufacture in a tenement?

State the maximum hours of labor in bakeries and confectionery establishments.

How are such establishments to be kept in a sanitary condition?

Outline the law affecting sleeping places, washrooms, and similar rooms in bakeshops.

What is the State Board of Mediation and Arbitration? Outline its duties.

How may differences between employers and employees be settled in accordance with law?

State the hours of labor for women and minors in mercantile establishments.

To what sections of the State is this article (XI.) of the law confined?

What employment of children is permitted during vacation periods? What is required is a vacation certificate.

Describe an employer's registry of children.

What seating facilities are required for women in mercantile establishments?

Compare the various provisions of the law that provide seats for women.

What is a contract?

What do you understand by contract labor?

What is the penalty for unlawfully dealing in convict-made goods?

Outline the penalties for the following violations:

(1) Failure to pay wages when due.

(2) Failure to furnish seats for female employees.

(3) General violation of the labor law.

(4) Illegal acceptance of a fee by a State employment bureau.

What is the difference between a misdemeanor and a felony?

What employments are prohibited for children?

Who is held responsible for the illegal employment of a child?

Outline the Compulsory Education Law.

Who is charged with its enforcement in New York City?

Describe the penalties for the unlawful employment of children.

What labor is permitted on Sunday? How is the law modified for persons observing another than the first day of the week as the Sabbath?

In what ways are employees protected against coercion by employers in the right of independent suffrage.

In what way, if at all, may a workingman's tools be attached for debt?

**What do you understand by the term, preferred creditor?**

**What is the nature of the claim of an employee for wages in a case of assignment for the benefit of creditors?**

**What is a mechanic's lien?**

**How does it operate to protect laborers on real property?**

**Outline briefly the general mechanic's lien law.**

**What is the meaning of the expression, "industrial education," referring to Section 70, Chapter 272, Laws of 1896?**

**What must be contained in an indenture? Define an indenture.**

**By whom must an indenture be signed?**

**What penalty attaches to the failure of a master or employer to fulfill an indenture?**

**May a contract with apprentices in restraint of trade be enforced?**

**Outline 927–928, Code of Criminal Procedure, as to proceedings in indenture cases.**

**What trades must be licensed in New York City?**

**How are such licenses issued?**

**Outline in general terms the liability of employers for risk on the part of or injury to employees.**

## MILK INSPECTOR.

### Special.

Date: Dec. 27.

1. State what you understand by the following terms:
   (1) Colostrum.
   (2) Strippings.
   (3) Foremilk.
   (4) Pasteurization.
   (5) Skimmed milk.
   (6) Sterilized milk.
   (7) Condensed milk.
   (8) Casein.

2. (a) What is the approximate chemical composition of pure milk? (b) What are its physical appearances and characteristics? (c) What is "adulterated" milk of the Sanitary Code? (d) What are the standards of richness insisted upon for salable milk?

3. What is an infectious disease? Mention some which may be certainly or probably transmitted by milk? State any other dangers which may arise from the sale of improper milk.

4. What are bacteria? State any facts you can about their rapidity and possibilities of growth, and the conditions which favor or retard their growth.

5. Describe a cream-gauge and show its uses. Describe a lactometer and show its uses.

6. (a) State briefly the duties of a milk inspector assigned to duty within the city limits. (b) State briefly the duties of a milk inspector assigned to duty outside city limits. (c) What should be the equipment of each?

7. (a) What powers has the city, as represented by the Department of Health, to regulate the management of dairies outside city limits? (b) If you, as an inspector, were refused admission to such a dairy, what would be your rights in the matter, and how would you proceed?

8. If assigned to inspect milk exposed for sale, indicate how you would go about it, and the point on which you would lay especial stress in declaring it salable or otherwise. If in doubt of the purity of the milk, what would you do?

9. Why is it essential that the water-supply of a dairy or creamery should be free from all possible contamination? If this supply be from a well or running stream, what points would you investigate as bearing on the possibility of pollution?

10. (a) What are considered desirable features in the construction and arrangement of a dairy? (b) Discuss the methods to be observed in milking and the care of the milk immediately afterward? (c) Discuss the temperature at which the milk should be kept after leaving the dairy until it reaches the consumer. (In each answer give your reasons therefor.)

11 to 14. You will be given four specimens of milk. Indicate under the number of each specimen your findings and deductions from same as to the character of the milk.

### Report.

A stable ntaining 34 cows is found upon inspection to be as follows· Building of wood, size $60' \times 25' \times 9'$, two windows on a side, 2×2 door in one end, wooden floors and cow-beds with saturated earth beneath, hay stored on loose boarding overhead, cesspool 4 feet deep and 3 feet in diameter 10 feet from barn, 75 feet from this a dug well, 25 feet from which water is pumped into tank above stable. Milk immediately strained into cans standing in front door and taken to back porch of house and bottled.

Write a report of at least two pages with recommendations. Sign this report with your examination number and not your name.

## LAY SANITARY INSPECTOR.

### SPECIAL.

1. What kind of tenements must be fire-proof? What are the most common fire-proof materials? Describe how these materials are to be used in (a) floor construction; (b) partitions; (c) the casing of posts, girders, trusses, etc.

2. (a) Where and how must concrete be used in tenement-house construction? (b) What constitutes good concrete? Describe one way of making it.

3. (a) What are the provisions of the Tenement House Act in reference to windows in living rooms of tenements for purposes of light and ventilation? (b) What is wired glass and for what is it chiefly used? (c) Name two parts of a tenement house which must be painted in light colors, giving the reasons.

4. (a) What are the principal objections to earthenware house drains? (b) Under what conditions may a house drain be connected to two buildings? (c) In what way must openings in pipes be closed after a fixture has been removed? (d) In setting cast-iron drain pipes, it is discovered that several have blow-holes. In what manner and under what restrictions may such holes be plugged?

5. (a) How must joints in iron drain pipes be connected? (b) In what manner must connections of lead pipes be made with iron pipes? (c) How must connections of lead waste pipes be made? (d) In a bath room it is proposed to place a trap three feet away from a water closet that it may be connected with the waste pipe from a bath tub. State whether this is permissible, giving your reasons.

6. What is the remedy in each of the following cases: (a) A tenant in an apartment house is annoyed by odors arising from garbage and stagnant water in an adjoining vacant lot. (b) The noise of machinery in a printing establishment disturbs the rest of tenants in adjacent houses.

7. (a) How should you test a trap with a view of finding out whether its seal is lost or not? (b) How should the scent or peppermint test for plumbing be applied?

8. (a) Give briefly the provisions of the Tenement House Law in regard to railings of fire escapes. (b) What is meant by each of the following: filling in bars or standards, angle iron, cast iron?

10. (a) If an order has been issued by the Tenement House Department that a school sink be removed, state fully what is to be done before the violation is dismissed. (b) Compare from a sanitary standpoint a long hopper and a short hopper closet, drawing a rough sketch of each.

### Report.

Give all the figuring on the ruled sheets.

To be finished by 4 o'clock.

A complaint has been made to the Tenement House Department that the water-supply in a certain tenement house is inadequate. You are sent to investigate the matter. Assuming such facts as you please, make a detailed report of the result of your investigation, give all the essential particulars and make such recommendations as you deem necessary.

### Special.

1. (a) In what manner must the stair-halls of tenements four stories in height be enclosed? (b) What may be the construction if the tenement does not exceed three stories? (c) What is the composition of mortar for building purposes? (d) What is metal lath?

2. What are the essential points of differences between brick and terra-cotta as regards (a) composition; (b) method of manufacture; (c) uses; (d) durability?

3. (a) How would you determine when it is necessary to use damp-proofing in tenement construction? (b) Mention the materials most commonly used in damp-proofing and describe the way in which they are used.

4 and 5. Explain briefly but clearly the functions of each of the following: (a) house drains; (b) running traps; (c) soil pipe; (d) vent pipe; (e) main waste pipe; (f) rain leaders; (g) fresh-air inlet; (h) house seal.

6. Name five different conditions which would render a house uninhabitable during alterations and necessitate the issuance of a vacation notice by the Tenement House Department.

7. (a) In what manner must the waste pipes of tenements be ventilated? (b) How may an attempt be made by a plumbing contractor to avoid complying fully with this regulation? (c) What test may be made to see that the law is complied with in this respect and how is it applied?

8. (a) What are the most common causes of escaping sewer gas in tenements? How can these be remedied? (b) What is siphonage? How is it caused and prevented?

9. (a) Name five kinds of wood most commonly used in building construction. (b) What is the cause of dry rot in woodwork and in what part of a tenement does this most frequently occur? (c) What recommendations would you make as tenement house inspector under these conditions?

10. (a) Draw a rough sketch of a properly constructed water closet to be erected in the yard of a tenement house. (b) Name three materials which may be used for water-proofing the floor of this closet, giving a brief description of each.

## Report.

To be finished by 4 o'clock.

You are sent to investigate the condition of the water closets in a certain tenement house, the ground floor of which is occupied as a saloon. Assuming such facts as you please, make a detailed report covering such defects as you may have discovered, and suggest such improvements as the case seems to demand.

## FOOD INSPECTOR.

### Fish Inspector—Technical.

Date, June 24, 1908.

1. (a) In putting up salmon in cans, what precautions must be taken so that the fish may continue sound and wholesome for as long a period as possible? (b) Describe a method of preserving salmon in addition to the canning process.

2. (a) In a general way name the local waters from which oysters may be taken for sale in New York, giving reasons for the prohibition. (b) Describe the method of fattening oysters, and explain the danger that may result from the fattening process. (c) Name five varieties of oysters usually on sale in New York, specify the manner in which the different types may be distinguished and name the waters in which each variety is raised.

3. How may you test the fitness of a salmon, as an article of food, (a) by simple inspection; (b) by handling; (c) by placing it in the water?

4. (a) How would you determine whether, in a lobster, it was placed in the hot water alive or dead? (b) In what way would you find out whether or not a boiled lobster was fit for food?

5. Mention any chemicals that you know to be employed for the purpose of giving fish a natural appearance, describe the method of using such chemicals, and explain the injurious effects produced by their use.

6. (a) In inspecting a boat load, tell how you would distinguish dead clams from live ones; (b) what course would you follow if you discovered many dead clams in a boat load?

7. (a) How would you determine that a frozen fish was good for food? (b) How long can fish be left in cold storage without losing their nutritive qualities?

8. Write a report describing the results of an inspection of a quantity of fish which you found on sale in Fulton Market and were obliged to condemn as unfit for food.

9. Give the name and describe the condition of each specimen shown you. (The candidate should make notes at the time of inspection and afterward write description in full arranging his answers to correspond with the number of each specimen.)

### Meat Inspector—Technical.

Date, June 25, 1908.

1. (a) Give in detail the process of curing a ham from the time it is trimmed until it is ready for shipment. (b) Describe a modern method of making lard on a large scale.

2. (a) Explain how ordinary pork sausages are made, naming the various ingredients, showing the proportion of each. (b) Do the same for frankfurters. (c) How would you detect bad meat in sausages?

3. (a) How would you determine whether or not a fore quarter of beef was fit for human food? (b) How would you differentiate between meat that was aging and meat that was decomposing? (c) In a freshly slaughtered steer, where would you look for evidence of tuberculosis and how would you determine that it was infected with tuberculosis and not pneumonia?

4. Tell what you know about each of the following: (1) Stearin. (2) Measly meat. (3) Wooden tongues. (4) Septicemia.

5. What preservatives and coloring matters are used in meats? Which of these preservatives and coloring matters are forbidden for use in New York City by the Board of Health? What appearances or conditions would lead you to suspect that a forbidden preservative or coloring matter had been used?

6. What are the indications that poultry has begun to spoil? What is the appearance of a fowl affected with pip, with roup, with gapes? What artificial methods are used for keeping poultry?

7. How would you recognize meat inflation? Why is it done and what are the objections thereto? How would you be able to distinguish between a lamb and a sheep, if both were caul dressed and of the same size?

8. Write a letter to the chief inspector showing how meats are handled and kept under modern methods of cold storage?

9. Give the name and describe the condition of each specimen shown you. (The candidate should make notes at time of inspection and afterward write description in full, arranging his answers to correspond with the number of each specimen.)

## Inspector Fruits and Vegetables—Technical.

Date, June 26, 1908.

1. What fruits picked before ripening will decompose and not ripen? Name the fruits which after being frozen become unfit for food? Tell what you know about the transportation and marketing of pineapples and mangoes.

2. What are "pricked" potatoes? Define potato scab, blight and brown rot. If you have a cargo of barrels of potatoes to inspect of a morning, how would you proceed to do so with quickness and accuracy?

3. Tell exactly what you, as inspector, would do upon seeing offered for sale: (a) Figs exposed to the air and covered with flies. (b) Yellow "cukes." (c) "Nested" string beans. (d) Cocoanuts with one eye plugged. (e) Black bananas. (f) Rice cauliflower. (g) Slices of pineapples on a tray.

4. What are the differences in color and other appearances between (a) unripe and rotten red bananas; (b) discolored and "speck" pineapples; (c) blistered and speck tomatoes?

5. What examination would you make of the following vegetables and what conditions would cause you to condemn the same for food: Onions, lettuce, turnips, peas-in-the-pod, cucumbers, spinach, rhubarb, cabbage, and green corn?

6. What appearances and conditions in dried or evaporated apples and apricots would cause you to reject them for food purposes? What conditions would tend to cause deterioration in dried apples? You are ordered to take a sample of dried apples for laboratory analysis. Tell fully what you would do.

7. In a physical examination of the following preserved substances in glass jars, what would lead you to suspect adulteration? (a) Tomatoes; (b) pickles; (c) cherries; (d) strawberries; (e) raspberries; (f) chow-chow; (g) rhubarb. What does a concave head on a can indicate?

8. A carload of potatoes, crated tomatoes and yellow turnips arrives at the terminal in New York in a frozen condition. Tell what disposition you would order for these vegetables and give your reasons therefor in the form of a report to the chief inspector. Sign this report "John Doe."

9. Give the name and describe the condition of each specimen shown you. (The candidate should make notes at time of inspection and afterward write description in full, arranging his answers to correspond with the number of each specimen.)

# CHAPTER VI.

## CALCULATION OF AREAS AND CUBIC SPACE.

In investigating overcrowding of lodging-houses or tenements, it is often necessary to find out the cubic space of rooms in order to show how many people may inhabit them. The following rules will be helpful for this purpose :

The *floor-space* of a room is the width of the room multiplied by its length.

The *cubic space* of a square or rectangular room is the width multiplied by the length, and the result again multiplied by the height.

The *area of a triangle* will be the base multiplied by $\frac{1}{2}$ the height, or the height multiplied by $\frac{1}{2}$ the base.

The *cubic space of a triangle* equals the area of the section multiplied by its depth.

The *area of a circle* equals the square of the diameter multiplied by 0.7854.

The *cubic capacity of a sphere* equals the cube of the diameter multiplied by .5236.

Projections of chimneys, furniture, etc., must be deducted from the cubic space of the room.

A grown person occupies about 3 cubic feet of space.

The minimum of air-space in a lodging-house for each individual is 400 cubic feet.

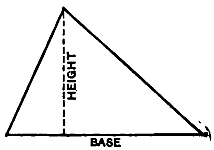
The minimum of air-space in a workshop for each individual is 250 cubic feet.

The minimum of air-space in a tenement-house for adults is 400 cubic feet, and 200 cubic feet for children under 12 years of age.

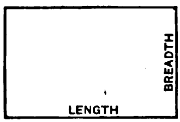
### TRIANGLE.

Area = Half the product of base and height.

This may be obtained by multiplying the base by the height and halving the product, or by multiplying the base by half the height or the height by half the base.




### QUADRILATERAL OF FOUR-SIDED FIGURES.

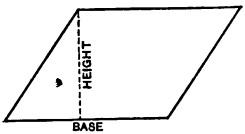


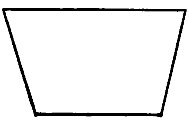

*Rectangle and square* (in both of which all angles are square).

Area = The length multiplied by the breadth.

*Rhombus or rhomboid* (in which the opposite sides are parallel).

Area = The base multiplied by the perpendicular height.



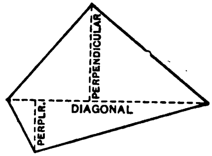



*Trapezoid* (in which two sides only are parallel).

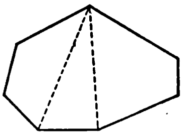
Area = The mean length of the parallel sides multiplied by the perpendicular distance between them.

*Trapezium* (which has none of its sides parallel).

Area = Half the sum of the perpendiculars multiplied by the diagonal on which they fall.

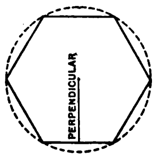



## POLYGONS.



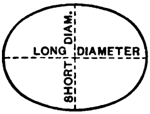
*Irregular polygons* may be divided into triangles {or/and} trapeziums and the areas found by the foregoing rules.

*Regular polygons.* Area = The sum of the sides (perimeter) multiplied by half the perpendicular (drawn from the centre to the middle point of any side) *or* half the perimeter multiplied by the perpendicular, *or* square the length of one side and multiply by—




1·72 if pentagon (5-sided)
2·598 if hexagon (6-sided)
3·634 if heptagon (7-sided)
4·828 if octagon (8-sided)
6·182 if nonagon (9-sided)
7·694 if decagon (10-sided)

## ELLIPSE.

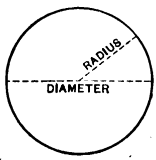



Area = The long and short diameters multiplied together and the result multiplied by .7854.

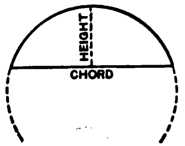
## CIRCLE.

Area = Square of diameter multiplied by ·7854 *or* square of radius multiplied by 3.1416.

NOTE.—The area of a circle is equal to that of a triangle whose base and altitude are equal to the circle's circumference and radius.



## SEGMENT OF A CIRCLE.

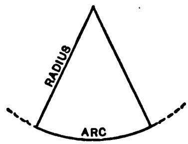



Area = The cube of the height divided by twice the length of the chord added to two-thirds of the product of chord and height, *or* the area of the sector which has the same arc, less the area of the triangle formed by the radii and the chord.

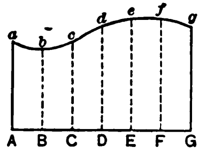
NOTE.—When the segment is greater than a semicircle, find the area of the circle and deduct the area of the smaller segment.

## SECTOR OF A CIRCLE.

Area = Half the product of the arc multiplied by the radius, *or* length of arc multiplied by half the radius, *or* the number of degrees in the arc multiplied by the area of the circle and divided by 360.




## CURVILINEAL FIGURES.

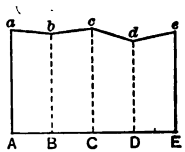



Area = The first ordinate + the last ordinate + twice the sum of all other odd ordinates + four times the sum of all even ordinates, multiplied by one-third of the distance between two adjacent ordinates.

NOTE.—The ordinates should be drawn equidistant and the divisions made even in number. In the figure *a* A is the first ordinate, *g* G the last, *b* B, *d* D, and *f* F the even, and *c* C and *e* E the odd ordinates.

## IRREGULAR FIGURES.

Area = The mean of the extreme ordinates added to the sum of the intermediate ones and multiplied by the whole length of the figure divided by the number of ordinates less one.




NOTE.—The areas of other irregular figures may be ascertained by dividing the latter into squares, triangles, and segments, finding the areas of each of these separately, and then adding them together.

## CUBIC SPACE.

*Cubic space or contents* is arrived at by multiplying the area of the base by the perpendicular height when the latter is uniform over the whole area. If the contrary be the case, the mean, or average, height must be ascertained and the area multiplied by it.

# CHAPTER VII.

## USEFUL INFORMATION FOR SANITARY ENGINEERS AND INSPECTORS.

(Compiled by William Kent, M.E.)

### WEIGHT OF WATER.

1 cub. ft. of fresh water at 62° F. = { 62.355 lb. / 0.03118 net ton / 7.4805 gals.

1 cub. in. of fresh water = { 0.036085 lb. / 0.004329 gal.

1 U. S. gal. = { 8.336 lb. / 0.13368 cub. ft. / 231 cub. in.

1 net ton (2000 lb.) = { 32.074 cub. ft. / 239.93 gals.

### TABLE OF PRESSURE AND THEORETICAL VELOCITY OF WATER UNDER VARIOUS HEADS.

| Head of water in ft. | Pressure in lb. per sq. in. | Velocity in feet per second. | Head of water in ft. | Pressure in lb. per sq. in. | Velocity in feet per second. |
|---|---|---|---|---|---|
| 1 | 0.433 | 8.02 | 17 | 7.361 | 33.1 |
| 2 | 0.866 | 11.4 | 18 | 7.794 | 34.0 |
| 3 | 1.299 | 13 9 | 19 | 8.227 | 35.0 |
| 4 | 1.732 | 16.0 | 20 | 8.660 | 35.9 |
| 5 | 2.165 | 17.9 | 25 | 10.825 | 40.1 |
| 6 | 2.598 | 19.7 | 30 | 12.990 | 43.9 |
| 7 | 3.03 | 21.2 | 35 | 15.155 | 47.4 |
| 8 | 3.464 | 22.7 | 40 | 17.320 | 50.7 |
| 9 | 3 897 | 24.1 | 45 | 19.485 | 53.8 |
| 10 | 4.330 | 25.4 | 50 | 21.650 | 56.7 |
| 11 | 4.763 | 26.6 | 55 | 23.815 | 59.5 |
| 12 | 5.196 | 27.8 | 60 | 25.980 | 62.1 |
| 13 | 5.629 | 28.9 | 70 | 30.310 | 67.1 |
| 14 | 6.062 | 30.0 | 80 | 34.640 | 71.8 |
| 15 | 6.495 | 31.1 | 90 | 38.970 | 76.1 |
| 16 | 6.928 | 32.1 | 100 | 43.330 | 80.2 |

## DRAINAGE.

The velocity of the flow in drains should be from 3 ft. to 4.5 ft. per second.

An easy rule for determining the proper inclination at which drains should be laid is to multiply the diameter of the drain (in inches) by 10. The result will be the number of feet in which the drain should fall 1 ft.; thus,

4 in. = 1 in 40. 6 in. = 1 in 60.

## TABLE OF FALL NECESSARY TO OBTAIN CERTAIN VELOCITIES (IN FEET PER SECOND) IN DRAINS RUNNING FULL OR HALF FULL.

| Dia. of drain in inches. | $V = 2.5.$ | $V = 3.$ | $V = 3.5.$ | $V = 4.$ | $V = 4.5.$ | $V = 5.$ | $V = 5.5.$ | $V = 6.$ |
|---|---|---|---|---|---|---|---|---|
| | 1 in | 1 in | 1 in | 1 in | 1 in | 1 in | 1 in | 1 in |
| 4 | 129 | 92 | 68 | 53 | 42 | 34 | 29 | 24 |
| 5 | 161 | 115 | 85 | 66 | 52 | 42 | 36 | 30 |
| 6 | 193 | 137 | 102 | 80 | 62 | 51 | 43 | 36 |
| 9 | 290 | 206 | 154 | 119 | 95 | 77 | 65 | 54 |
| 12 | 386 | 275 | 205 | 159 | 127 | 103 | 86 | 72 |

## RELATIVE DISCHARGING POWER OF PIPES.

(When the fall and the length of the pipes remain constant, the discharge varies as the square root of the fifth power of the diameter, or as $d^{2.5}$).

| Diameter of pipe. | $d^{2.5}$ |
|---|---|
| $2\frac{1}{2}$ | 9.88 |
| 3 | 15.59 |
| 4 | 32.0 |
| 5 | 55.9 |
| 6 | 88.18 |
| 9 | 243.0 |
| 12 | 498.8 |
| 15 | 871.4 |
| 18 | 1375.0 |
| 24 | 2822.0 |
| 30 | 4930.0 |
| 36 | 7776.0 |

## CONTENTS OF WELLS IN U. S. GALLONS.

| Diameter of Well. ft. | in. | Contents in gals. per ft. of depth. |
|---|---|---|
| 2 | 6 | 36.72 |
| 3 | 0 | 52.88 |
| 3 | 6 | 71.97 |
| 4 | 0 | 94.00 |
| 4 | 6 | 118.97 |
| 5 | 0 | 146.88 |
| 5 | 6 | 177.22 |
| 6 | 0 | 211.51 |

## CAPACITY OF RECTANGULAR CISTERNS.

| Length in feet. | Width in feet. | Depth in feet. | U. S. Gallons. | Length in feet. | Width in feet. | Depth in feet. | U. S. Gallons. |
|---|---|---|---|---|---|---|---|
| 2 | 1 | 1 | 14.96 | 5 | 2½ | 2½ | 233.8 |
| 2 | 1½ | 1½ | 33.66 | 5 | 3 | 2½ | 280.5 |
| 2½ | 1½ | 1½ | 42.08 | 5 | 3 | 3 | 336.6 |
| 2½ | 2 | 1½ | 56.10 | 5 | 4 | 3 | 448.8 |
| 2½ | 1½ | 2 | 74.80 | 5 | 4 | 4 | 598.4 |
| 3 | 1½ | 1½ | 50.49 | 6 | 3 | 3 | 403.9 |
| 3 | 2 | 1½ | 67.32 | 6 | 3½ | 3½ | 550.5 |
| 3 | 2 | 2 | 89.76 | 6 | 4 | 4 | 718.1 |
| 4 | 2 | 2 | 119.7 | 7 | 3½ | 3½ | 641.4 |
| 4 | 2½ | 2½ | 187.0 | 7 | 4 | 4 | 837.8 |
| 4 | 3 | 2 | 179.5 | 7 | 5 | 5 | 1309 |
| 4 | 3 | 2½ | 224.4 | 8 | 5 | 5 | 1496 |

## FORMULÆ FOR CALCULATING THE CAPACITY OF DRAIN AND OTHER CYLINDRICAL PIPES.

$D$ = Diameter of pipe in inches.
$A$ = Area of pipe in square inches.
$L$ = Contents per foot of pipe in lbs.
$F$ = " " " " " " cub. ft.
$G$ = " " " " " " gallons.

$L = D^2 \times 0.34$ $\qquad$ $L = A \times 0.433.$

$F = D^2 \times 0.005454$ $\qquad$ $G = D^2 \times 0.408$ (U. S. gals.).

**TABLE OF VELOCITY (IN FEET PER MINUTE) AND DISCHARGE (IN GALLONS PER MINUTE) OF DRAINS WITH VARIOUS FALLS WHEN RUNNING FULL.**

| Diameter. | 4 Inches. | | 5 Inches. | | 6 Inches. | |
|---|---|---|---|---|---|---|
| Fall. | Velocity | Discharge. | Velocity | Discharge. | Velocity | Discharge |
| 1 in 20 | 395 | 257.88 | 441 | 450.48 | 481 | 707.02 |
| 1 in 25 | 353 | 230.49 | 395 | 402.62 | 432 | 634.98 |
| 1 in 30 | 322 | 210.25 | 360 | 367.28 | 395 | 580.61 |
| 1 in 35 | 298 | 194.62 | 333 | 339.97 | 366 | 538.01 |
| 1 in 40 | 278 | 181.50 | 311 | 317.05 | 342 | 502.74 |
| 1 in 45 | 261 | 170.42 | 291 | 297.71 | 322 | 473.32 |
| 1 in 50 | 246 | 160.85 | 278 | 280.98 | 307 | 450.55 |
| 1 in 60 | 226 | 147.73 | 253 | 258.07 | 279 | 409.44 |
| 1 in 70 | 209 | 136.66 | 234 | 238.72 | 257 | 377.17 |
| 1 in 80 | 194 | 126.85 | 217 | 221.59 | 239 | 350.74 |
| 1 in 90 | 182 | 118.98 | 203 | 207.84 | 225 | 330.22 |
| 1 in 100 | 172 | 112.46 | 192 | 196.45 | 213 | 312.62 |

| Diameter. | 9 Inches. | | 12 Inches. | |
|---|---|---|---|---|
| Fall. | Velocity. | Discharge. | Velocity. | Discharge. |
| 1 in 20 | 582 | 1925.16 | 664 | 3904.97 |
| 1 in 25 | 525 | 1737.12 | 600 | 3528.34 |
| 1 in 30 | 481 | 1591.20 | 551 | 3240.80 |
| 1 in 35 | 446 | 1475.16 | 513 | 3016.91 |
| 1 in 40 | 418 | 1382.04 | 481 | 2828.96 |
| 1 in 45 | 395 | 1306.56 | 454 | 2670.23 |
| 1 in 50 | 375 | 1240.68 | 432 | 2539.18 |
| 1 in 60 | 343 | 1135.18 | 395 | 2322.04 |
| 1 in 70 | 317 | 1049.06 | 366 | 2151.30 |
| 1 in 80 | 296 | 979.43 | 342 | 2010.53 |
| 1 in 90 | 279 | 923.27 | 322 | 1892.96 |
| 1 in 100 | 264 | 873.85 | 306 | 1798.52 |

# INDEX.