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THE ROYAL SOCIETY
FOR THE PROMOTION
OF HEALTH

Founded 1876

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THE ROYAL SOCIETY OF HEALTH

90 BUCKINGHAM PALACE ROAD, LONDON, S.W.1

O.B., Truro — November, 1961

David Brandon Esq

from the Author

Dec. 12: 1889.

THE

PLUMBER AND SANITARY HOUSES.

The Plumber and Sanitary Houses.

A Practical Treatise *on the* Principles *of* Internal Plumbing Work, *or the* Best *means for* effectually *excluding* Noxious Gases *from our Houses.*

BY

S. Stevens Hellyer,

Author of "Lectures on Sanitary Plumbing."

FOURTH EDITION.

LONDON:
B. T. BATSFORD, 52, HIGH HOLBORN.

[1887]

DEDICATION.

To the

DESIGNERS AND BUILDERS OF HOUSES,

HEAD-WORKERS AND HAND-WORKERS,

THIS LITTLE WORK

IS,

WITH ALL DUE RESPECT,

Inscribed

BY THEIR OBEDIENT SERVANT,

S. STEVENS HELLYER.

CONTENTS.

PLATES AND FULL-PAGE ILLUSTRATIONS.

PREFACE TO THE FOURTH EDITION.

To keep all the particulars of a work dealing with a growing science right up to the knowledge of the last five minutes would need a perpetual re-issue, and though such persistent publication might be profitable enough to the publisher, printer, and papermaker, it would hardly be so to the purchasers. But when a new edition is called for by the exhaustion of the old one, it becomes the peculiar privilege of the poor author to revise and, if necessary, to add to his work.

In this edition new matter has been added in the form of an appendix, leaving the work itself intact, except that a few errors have been corrected.

An advance copy of this edition has been translated into the French language, under the patronage of La Chambre Syndicate des Entrepreneurs de Plomberie de la Ville de Paris, and is published by MM. Andre, Daly Fils, and Cie., 51, Rue des Ecoles, Paris. The work has been so well received that a fresh edition is already in preparation.

NEW-HOLME,

January, 1887.

PREFACE TO THE THIRD EDITION.

This work, with the exception of the chapters on "Cowl-Testing" and "Hand-Workers," has been entirely re-written, whilst many new chapters have been added, some of them to call special attention to certain errors of principle and practice in the modern method of plumbing and draining a house. A lengthy chapter has also been added on the important subject of the loss of seal in traps, and trap-ventilation.

For greater ease in opening the folding plates, the size of the book has been enlarged; whilst to prevent its becoming cumbersome, the size of the type has been reduced.

No detail has been considered too small to dwell upon, for if he who takes care of his pence is pretty sure to take care of his pounds, so he who takes care that he is right in the detail will take care that he is right in the whole.

A farmer knows that however well hedged-in his cornfield may be, it will not be safe against the ravages of stray beasts if only one gap is left. And we have learnt that however well considered and well planned the plumber's work and drainage of a house may be, it will not be perfectly sanitary with a defect here and there in the workmanship or appliances.

During the last few years many improvements have been made by inventors and manufacturers in various sanitary appliances—improvements small perhaps in themselves, yet great in their results. A man's life is said at times to "hang on a thread." At such times a "little defect" in the water-closet arrangement—a poor kind of closet, or a closet poorly flushed, an uncleansed or an unsealed trap, an unsound jointing of a "fixture" with its waste-pipe or soil-pipe, or the exhalations from badly positioned ventilating pipes of soil-pipes, or drains—may be quite sufficient to "eat" that thread away. Or a glass of water drawn from a cistern contaminated with sewer-air (from its juxtaposition to ventilating terminals from soil-pipes or drains), or his food cooked in water drawn from closet-cisterns, or from uncleansed cisterns—cisterns which have never had their contents entirely changed from the time they were fixed—may be quite sufficient to carry the poor patient to that bourne whence no traveller returns.

That this book has imperfections no one is more conscious of than myself; but it may be some apology to say that it has been written in the tired hours after busy days.

[New-Holme, Bromley, Kent.]
January, 1884.

PREFACE TO THE FIRST EDITION.

THERE are a "thousand gates to death!" Few are wider, or open more readily, than those in our own homes, when unlocked by noxious gases or bad air from drains, etc.

How many deaths have been caused by a polluted water-tank, a brick cesspool, a foul drain, a diseased water-closet trap, a bottled-up soil-pipe, a sink "*bell*"-trap! Is not the very name ominous, and ought it not rather to be called a "death-bell-trap?" At any rate, it sets the death-bell ringing occasionally.

All England was alarmed some time ago when it heard one of these gates to death rattling upon its hinges, and threatening at every moment to fly open—under the influence of one of the evils enumerated above—for a royal prince to pass through. Another puff of bad air, and who knows how wide the gate would have opened?

"Shut this gate," is the gratuitous advice given to passengers as they ride along on our railways, and look out upon the broad acres. But both the *hard* seated and the *comfortably* seated observers of this advice alike ride on, careless of the notice, for they cannot touch the gates, even with their longest fingers, and the gate that is open for any stray beast to go through must be open still.

But the gates of which I speak can be reached, and shut too, by every house-maker, if he will but take the trouble and precaution. To aid him in this most *wholesome* work, and to help him to put a padlock upon such gates, is the aim of the writer in this little treatise.

In every house a water-closet may be considered a necessity, and a slop-sink a convenience. By English people lavatories and baths, fitted up with hot and cold services, would, I suppose, be considered a luxury. Well, so is a bed, but few John Bulls would care to sleep without one, if they could at all manage to buy it. And where cleanliness is valued, and the funds are at all elastic, a bath should be provided in every house. Of course it is not necessary to have hot water laid on to it, but in case of illness it is a good provision, and the comfort of it in the winter is worth one or two decorated ceilings.

But this treatise is not to show the comforts and conveniences of such sanitary fittings as have just been referred to, but to prove that it is possible to have all these things, without the smallest fear of making them *inlets* for foul air or noxious gases, and, in fact, that if the principles laid down in the following pages are strictly adhered to, there will be *no* foul air in any of the soil, waste, or drain-pipes to escape into our houses, for a constant stream of fresh air will always be passing through the whole of the pipes.

Under the old system these sanitary conveniences generally *advertised themselves*, especially in hotels and places of that kind; and all that one had to do in such buildings was to follow the scent, like a hound after a fox, by the dictates of an organ which is very useful, but which one does not care to abuse in such a way, for, to say the least, it is an offensive way of following up a thing.

It is, then, from no desire to "ventilate" the writer's thoughts, or to "*air*" his ideas in print, but to give the public the benefit of his experience—an experience gained by a thorough examination of the working of the *old way* of doing these things, and by many practical and costly experiments on the *new way*, as laid down by the following principles, that the author has written this treatise.

It may be worth while to say that these principles have been thoroughly tested, and that the internal plumbing work in some of the most important houses in the kingdom has been carried out upon these principles with a complete success.

For any imperfections in this little work, the writer's apology is that his pen is quite new, and his ink is unused to travel in such a channel. But go ye forthe, ye lyttle booke, and do ye work of *ventilation*, if not in the minds of the people, at least in the pipes and drains of their houses.

21, *Newcastle Street, Strand,*
London, 1877.

PREFACE AND INTRODUCTION TO THE SECOND EDITION.

THE first edition of this book was made larger than was at first intended, not because booksellers, like bakers, count thirteen to the dozen, but because the Author wanted some little time to elapse before issuing a second edition. In this, however, he is agreeably disappointed, for the book, having found favour with the public, is already in need of a reprint. The chief fear in this re-issue is that, as the book has grown so much larger, holders of the original copies will be somewhat dissatisfied, especially as the price of the new copies has been but little increased, though the cost of reproduction has been considerably enhanced by the additional illustrations. The family tailor must often be puzzled to know when to turn the youth into a man. His coat cuts into as much cloth as the father's, yet he dare not charge the father's price for it—poor goose!

This treatise was dedicated to *head-workers* and *hand-workers*, hoping to gain the audience of both classes, and to stimulate all concerned—and that surely is every house-dweller—to take greater interest in Sanitary Plumbing. No house is safe for a human being to live in—much less, therefore, to become his *home*—where the plumbing-work (or house-drainage) is in an *un*sanitary state. Call in the surveyor before taking a house by all means; but call in an expert—the sanitarian—and medical* man, too, if need be, to certify that the house is in a perfectly sanitary condition, and then take possession, and make it " Home, sweet Home."

What a happy day it will be when the *hygiene* of a dwelling-house, as well as the style of its architecture, shall receive its due consideration, when the three most essential, and at the same time the most inexpensive, things in the world shall be let freely into our homes: when *pure air* shall be made to circulate, not only through

* The shoemaker should stick to his last.

every room and cupboard in the house, but through every waste-pipe, soil-pipe, and drain; when *light*, the revealer, shall be made to shine into every corner of a dwelling, to shame dirt and filth away; when *pure water* shall be made to flow through every draw-off cock in the house; and when the want of these hygienic essentials shall "no more hurt nor destroy" in homes of peasant or king.

The public are largely indebted to medical men and civil engineers for taking up this question, the greatest of the age; not only because of the knowledge that such men, *when they have studied the subject*, can bring to bear upon it, but also because they can seriously and conscientiously advise householders to "put their drains in order" whenever they find them defective: whereas a sanitary engineer cannot at all times do this without creating a suspicion that he has selfish interests to serve.

There is no lack of wisdom in the sanitary world now, for a host of "sanitary engineers" have sprung up, like the 500 Clan Alpine warriors of Roderick Dhu, at a moment's notice. It is true they have been following other professions all their life; but a "fresh door is open here, and "Right about face!" is the order of the day, which they gladly obey, and turn in to "fresh fields and pastures new."

The writer has been trying to trace the course of the first edition of this book, and he is saddened to find that whilst it has circulated very freely among *head-workers*, it has only sparingly passed into the hands of *hand-workers*. He believes this is not because the latter class cannot afford to buy the book—for less than one day's wage would purchase a copy—but because many of the old plumbers do not take sufficient interest in their work to make it sanitarily perfect. They have bottled-up soil-pipes, waste-pipes, and drains, all their "professional" lifetime, or only ventilated these in a half-inch way; they have "united" pan-closets to D-traps ever since they used the "cloth;" and now they stand unmoved by the wants of the time, unmoved by the charms of Hygeia, and cry, "What the plumber hath joined together, let no sanitarian pull asunder." No! better destroy than divorce such generating evils—at any rate, it is quite time they were extinct. No doubt, if they were sent in pairs—the pan-closet and D-trap, not the old-fashioned plumber and his mate—to Dr. Darwin, it would help him in his evolution theory, for the one must have grown out of the other.

The writer does not want to make a profit out of the *knowledge-*

seeking hand-worker (for, like the majority of men, his means are but small); on the contrary, the author is anxious to help him; and therefore any dozen plumbers clubbing together and buying a dozen copies of this volume shall receive them at *two-thirds* of the published price.

The plumbing-work at Marlborough House, Buckingham Palace, and in scores of noblemen's and gentlemen's houses in various parts of the country, has been reconstructed on the principles laid down in the first edition of this book, and further shown and illustrated in this second edition.

This second edition consists of an Appendix of six chapters, in which the subjects treated of in the previous edition are dealt with in greater detail; whilst a topic of much importance, on which nothing was written in the other edition, has here been fully considered—viz., *Cowl-testing.*

The knowledge of Sanitary Plumbing is spreading rapidly, both in England and America; though in each country it is chiefly levelling downwards. In the latter country, the bad principles of internal plumbing are not so thoroughly ingrained in the plumber as in the former country, and are therefore more easily eradicated. But while the claim to greater theoretical knowledge, with the desire to increase that knowledge, might be given to the American plumber, the claim to greater practical skill must be yielded to the English plumber—that is, as far as the writer is a judge.

It is, of course, of very great importance that the man who *plans* a work—the *head-worker*—should thoroughly understand what he plans; but it is equally important that the man who *does* the work—the *hand-worker*—should understand it too; not only the practical part of what he has to do, but the theoretical part also; for during the progress of the work, *he* will be ever on the *spot*, and if his eyes are open, he will see (especially if it be Sanitary Plumbing) many little things which will help or mar the whole thing, just as these things are treated *per se:* whereas the head-worker, the man who planned the thing, will often only revisit the work, Rip-van-Winkle-like, when all is changed, when the chief work is all hidden over and *in situ.* Then, *Educate the hand-worker!* should be the cry of all who wish for true progress in sanitary matters.

In this busy age, when the swiftness of time can only be checkmated by labour-saving inventions; when printer, postman, and telegraph-boy combine to give the worker no rest; anything that saves time is of value. Therefore the writer has added largely to the illustrations in this second edition, whilst he has added but little (in comparison) to the letter-press; knowing that a five minutes' study of any well-illustrated scheme will give the student a better understanding of it than an hour's reading, for a *page* of illustrations is worth a *book* of description.

The main object of this book is to illustrate and explain how Plumbing and House Drainage may be made sanitarily perfect. If, in doing this, the Author has largely illustrated his own Sanitary Appliances, it is because he is best acquainted with them, and from no desire to shut the door upon other "Fittings" which may be equally good.

August, 1880.

THE

Plumber and Sanitary Houses.

CHAPTER I.

INTRODUCTORY.

Harper's Monthly Magazine, in reviewing my "Lectures on the Science and Art of Sanitary Plumbing," states that H.R.H. the Prince of Wales said, when slowly recovering from the fever that so nearly proved fatal to him, "If I were not a Prince, I would be a plumber." The serious illness of His Royal Highness (perhaps from bad plumbing) has done more for the advancement of the knowledge of the principles of sanitary plumbing than any work he could have accomplished by being a member of the craft. For, since his illness, architects, civil engineers, medical men, sanitary engineers (a new profession), and the general public—greatly encouraged by the Press—have been turning their attention to House-plumbing and Drainage, and wherever they have turned, from the mansion to the cottage, they have found the laws of health ignored. And if George Smith had been alive, he would have found, from the discoveries made in this direction, another argument in favour of his theory, "that civilisation and knowledge of the arts is rather retro- than progressive, that Adam and Eve were perfect in all science, literature, and art, and ever since their time we have been steadily forgetting." Certainly we had forgotten (if we ever knew) how to get rid of sewage and house-refuse from our homes without endangering the health of the inhabitants.

Positions of Water-closets.

We had become so "civilised" that, for luxurious ease and privacy, instead of a common privy at the bottom of the garden, or a general water-closet outside the house, a "place of convenience" for the use of visitors and members of the family had to be formed to every suite of rooms, as well as on every floor inside the house, no matter where. Any dark hole, corner, cupboard, place or recess next a living room or bed-room, or even in a bed-room if it could be screened from sight, was considered a fit place to "stick" a water-closet in. And it generally happened that the only spare places to be found for these "conveniences" were in the middle parts of the house,* where only borrowed light, if any at all, could be given them, and where the effluvia from them could only escape by passing into the adjoining apartments. A favourite place for the servants' water-closet was (alas! still *is*, with some people) close to the larder or kitchen, so that the odour from it could easily reach the food and contaminate it.

Bad appliances.

And what appliances were (and *are*) used for getting rid of the soil! It is almost a wonder, if bad smells are so deadly as some would have us believe, that anybody is alive to tell the tale.

Bad state of things.

In a very large percentage of houses examined during the last ten years, the basements (under the floors, and out of sight, though not out of scent) have been found to be nothing less than huge privies:† the *un*trapped‡ drains, conductors of cesspool or sewer-air into the houses; the house-drains, from falling the wrong way,§ or from want of proper con-

* In a fine old mansion in Norfolk, I found a water-closet so remote from the external walls of the house, that I had to take the ventilating shafts (inlet and outlet) from above the roof, using about 130 feet of 6-inch pipe, for making the water-closet anything like fit for use. The closet was not allowed to be abolished, for it was treated by the owner as an heirloom.

† As much as forty cartloads of sewage have been taken out from under the basement floor of some houses, from drain leakages, brick cesspool traps at the feet of soil pipes, and disused wells, where the sewage has leaked into them.

‡ To sit upon a water-closet with an untrapped drain, and an untrapped soil-pipe—unless such conduits are "disconnected," as in the modern method—means practically to sit over a cesspool or sewer, no matter how far away such receptacles may be from the water-closet; and the greater the distance, the greater the risk in using such places.

§ Drains are often found with a fall *towards the house*, instead of towards the sewer.

nection with the sewer, or, from their great size*, elongated cesspools; the waste-pipes and soil-pipes, from want of ventilation, noxious gas-holders—except where they have been eaten through by such gases, and ventilate themselves into the house; the sinks, dirt-collecting places; the water-closet apparatus, excrement-containers; the traps under the sinks, baths, water-closet safes, lavatories, and water-closets, as well as to the soil-pipes and drains, filth-collection boxes.

And what shall be said of the cisterns for supplying the "fittings" just enumerated, apart from the poorness of the supply of water to such places? Placed where no servant or anybody else can get at them to properly clean them out, and where the water cannot help getting contaminated, they are to be found in very large numbers, even to-day, where the effluvia from water-closets, the foul air from ventilating pipes, the exhalations from dust-bins, the vitiated air in bed-rooms, can reach them; fixed as they are, in water-closets, cupboards under stairs, in sculleries, under bed-room floors,—where not only the drainings from floor-washings, but an accident with a chamber-utensil would also drain into them,—and in all sorts of out-of-the-way places. And the water is not only contaminated by cisterns being badly placed, but also from the method of supplying the water-closet apparatus, viz., on the service-box or cistern-valve principle. And the cistern, with its water contaminated in the way we have just seen, is made to supply the drinking-water tap, the draw-off tap for potable purposes, the kitchen boiler, the hot-water circulation, and the water-closets and urinals, without the slightest attempt at separation. Cisterns, Water contaminators.

Then there are the dust-bins or dust-holes for the house refuse—places that might often be called fever beds. Every kind of abomination is to be found in them at times, from rotten eggs to dead cats. On lifting the covers from such places, the stench is often strong enough to pollute the air over a large area. Dust-bins.

* It is not at all an uncommon thing to find a 16-inch pipe-drain, where a 6-inch would be ample size; and it may be said to be a general thing to find 9-inch drains where 6-inch, if not 4-inch, would be the better size.

The bad air from such unsanitary appliances and defective arrangements circulates freely over the house, impregnating carpets, draperies, &c., and pervading the whole house with an unhealthy atmosphere. For, as a rule, there is no attempt at ventilation in such house; *i.e.*, no special means are provided for the ingress of pure air, and the egress of vitiated air.

Means for remedying such evils.

The means taken for remedying this state of things, where the sanitary expert is called in to make the house wholesome, may vary somewhat in details, but the leading sanitarians are now more or less agreed upon the general principles which should be adopted to make a house sanitarily perfect. In the early history of this great reform in House-plumbing and Drainage, dangerous "little learnings" were brought to bear upon such matters, and many grave errors have been committed, and, alas! are still being committed, in the name of sanitary reform. Rome was not built in a day, nor is the knowledge of sanitary plumbing gained in an hour.

Errors in Trapping.

Take the case of traps *versus* no traps. Some finding that traps were of value for shutting out bad smells, in their ignorance doubly trapped, and, in some cases, even trebly* trapped, their pipes. Others, finding that the traps in general use either formed themselves into "collection-boxes," or "cesspools," or were little better than sham traps, and knowing that the small water-seal of a trap fixed upon *un*-ventilated sewage-carrying pipes will not prevent noxious gases from passing through it, tried to do away with traps altogether, except in connection with the drain, and so fixed (and still fix!) waste-pipes and soil-pipes—sometimes in very long lengths—*without* traps, leaving the house exposed to the bad air generated by foul matter decomposing in such pipes.

* In a country mansion I examined this spring, I found several of the water-closets in the central part of the house with *three* traps to them! One to the closet itself, the basin and trap being in one piece: one, a lead trap, immediately under the closet; and one, a drain, or brick-trap at the foot of the soil-pipe, though in many cases the soil-pipe was not more than 10 feet in length, and without ventilation. The space between the closet-traps was *vented* in one or two cases with a ¾-inch pipe, taken into a furnace flue, but in others this vent-hole was made to serve as the overflow-pipe from the closet-safe.

It was a great step forward when traps which admit of being easily and thoroughly cleansed by small water flushings were first used; but unfortunately such traps have been largely fixed without ventilation, and the protection which ought to have been gained from them has often been only a mockery, for the discharges sent into them and their pipings, from want of efficient ventilation, have often unsealed them by syphonage, and thereby rendered them valueless.

Traps self-cleansing.

Another great advance towards a better state of things was made when the house-drain was "disconnected" from the sewer (or cesspool), and a "self-cleansing" water-trap substituted for the valve-flaps; * for whilst the flap, by its weight, impeded the flow of water or passage of matters through the drain, it was of little or no value for keeping out the sewer air.† (See Figs. 222—225, pp. 273—275.)

Sewers disconnected.

The *disconnection* of all pipes for the removal of "dirty water" and sewage, where they enter the house, may be considered as the key to sanitary (that is to say, wholesome) plumbing and drainage; it literally opens all such pipes to the purifying atmosphere *outside* the house. But if we want perfection in sanitary matters, and to exclude noxious gases effectually from our houses, we must not rely too much upon the disconnection of waste-pipes, soil-pipes, and drains; for though such pipes may he completely cut off from the sewer or cesspool, as well as from one another, they may, by bad trapping, bad arrangement, and bad appliances, become generators themselves of foul gases.

Disconnection of Pipes.

The value of good water-flushings through all such pipes *at the time they are fouled*, (*i.e.*, used) cannot be over-estimated, and this can be done by proper appliances without any appreciable difference in the total consumption of water, the water being sent into the fittings and pipes in copious flushes, instead of continuous driblets; so water companies need not

Water-flushings.

* Many Vestry Boards in London even now insist upon valve-flaps, whether the drain be trapped or not.

† My assistant made an inspection of a large number of flaps in one of the London sewers, but he did not find *one* perfectly sealed. (See Fig. 222, p. 273.

be alarmed. Three gallons of water sent through a water-closet in four or five seconds would be of greater value for keeping a water-closet and its belongings wholesome than three times that quantity dribbled into it at the rate of one gallon in fifteen seconds, or in the general sluggish way of supplying such fittings with water. And fifty gallons of water discharged into a drain by one of Mr. Rogers Field's "annular syphons," would be of greater value for cleansing the drain than a thousand gallons of water sent into it in driblets. In this well-watered island home of ours, where there is a greater scarcity of sunshine than of rain, and where the separate system does not exist, there should not be a foul drain anywhere; for at the head of each drain, in cottage, mansion, or palace, either in a town, city, or country, a cistern to hold about fifty gallons of water could be fixed, or a tank holding twice or thrice that quantity could be built, and the rain-water (or as much of it as could be spared) collected and discharged, automatically, by one of these annular syphons into the drain at the rate of from two to four gallons per second.

Ventilation.

Then there is the ventilation of waste-pipes, soil-pipes, and drains. How badly this is often done; for the ventilating pipes used are not only insufficient in size, but they are often wrongly placed, *i.e.*, they leave long lengths of piping or drainage unventilated. And their "outlets" or terminals are often so placed that they conduct the bad air coming from such pipes through a doorway, window, dormer, skylight or chimney right into the house, or into a cistern where it can contaminate the drinking-water.

Sanitary Works visited.

It would be a valuable help towards the correction of errors in sanitary matters, if sanitarians met sometimes, and visited each other's works when in progress, and it would at the same time give a stimulus to the workmen engaged upon such works to do their work faithfully; but in the present rush of things there seems to be no leisure for anything outside one's ordinary duties and engagements.

It is an astounding thing that while the nations of the civilised world use up the resources of their countries in training soldiers and sailors in the art of war, teaching them how to *protect* life and property from the ravages of war, they do comparatively nothing to teach the people—to teach plumbers, the professions and the trades concerned—how to make healthy homes, that is, to *save* life from the diseases arising from filth and badly-drained houses.

Want of Government aid.

The nations do not look at these things as they ought. The people have gradually grown up into such a state of things that their inconsistencies are not noticed. How would such a state of things strike a visitor, say from another planet? One would like such a visitor of the Carlylean type (if there be such in other worlds) to visit our own shores, and for the Commander-in-Chief and the First Lord of the Admiralty to take him to our military academies and naval schools, to our arsenals and dockyards, and show him England's great apparatus for *protecting* this "tight little island" from the ravages of war. And then one would like this visitor passed on to the Home Secretary and the First Commissioner of Works for a time, to see what the State is doing to *save* the life of her sons from the illnesses incident to bad plumbing, bad drainage, and ignorance of the laws of health; to see her splendid institutions, her magnificent sanitary science halls, where willing students may perfect themselves in the knowledge of *sanitary* plumbing and drainage, &c.

Visitor from another planet.

Visit to the armies and navies.

One would also like to take this visitor to Hyde Park, on an afternoon in the London season, and show him the *élite* of society, the groups of grandly-dressed people, the fine horses, the magnificent equipages and their powdered "fixtures"—the gaily-coloured, motionless footmen standing up behind—the "strings" of grand carriages, the *rolling* wealth; and then to take him to the one-room lodgings of the London poor—rooms bare of everything except children, dirt, and poverty; to the "rookeries" of St. Giles's; the slums of Lambeth and Whitechapel; to the stinking holes

Visit to Hyde Park.

The slums of London.

in cellars and garrets, where half-starved parents and children exist and grow up together as rabbits in holes. How shocked and disgusted such a visitor would be with the sights he would see, and the smells he would "feel," and what an article he would be able to write to the *Nineteenth Century*, "On the Blessings of Christianity and Civilization; the brotherhood of men, as witnessed in this the greatest and wealthiest metropolis in the world."

Atmosphere.

What a wonderful thing the atmosphere is, to receive the bad air exhaled from millions of foul places in this metropolis, and yet not to be deadly to breathe,—the bad smells coming from unwashed feet and unwashed bodies of men, women, and children; from filthy rags and dirty linen; from beastly houses and areas; from putrefying house-refuse in dust-bins and dust-holes; from filth-collecting cesspool-traps, gullies and sewer gratings; from ventilating-pipes to uncleansed waste-pipes, soil-pipes, drains and sewers; from gas-escapes in leaky gas-pipes; from a thousand-and-one other sources in the "1,607 miles of streets" in the metropolis.

Bad smells preventible.

It is not too much to say that nine-tenths of the bad air now sent into the London atmosphere would be prevented by the proper sanitation of each house and its occupants.

Before an English ship can sail out of any port on our British coast, it must be pronounced sea-worthy by a fully qualified and experienced surveyor under the Government, and the captain who is to steer the vessel, as well as the officers and engineers, must each and all hold certificates as to their fitness for their respective positions. But *any* place enclosed within four walls, and roofed, or even semi-roofed over, may be inhabited, however dangerous to the health of the occupants it may be, and *anybody*, whether qualified or not, may plan the sanitary arrangements of a house, and *anybody* may do the plumber's work and drainage.

Poor men's houses.

The poorest of men and women, whatever else they may lack, should never lack healthy houses to live in, and it ought to be the care of the rich, whether the Government of the country aids in this matter or not, to see, for their own sakes if for no higher reason, that the dwellings of the poor are made wholesome. The poor have no power or means to do this themselves.

The execrable arrangements provided for the very poor are a disgrace to our country. One wonders how landlords can take the rents of such hovels. The money must surely burn holes in their pockets, at times. One is glad he is not a landlord when he sees such miserable places, and thinks of the sanitary (!) arrangements belonging thereto.

Cost of making houses healthy.

In this commercial age, everything (except bric-à-brac, dress, and high living) becomes a question of cost. It may therefore be encouraging to those who invest their money in house property, as well as to house-owners and builders of houses generally, to know, that when building a house it costs little more, with good planning and simple appliances, to make it wholesome, as far as the plumbing and drainage are concerned, than to make it unwholesome on the old or ignorant order of doing the plumber's work and drainage. The houses "run up" here, there, and everywhere, in our London suburbs, by Tom, Dick, or Harry, for the classes who have little or no knowledge of building, or house sanitation, and who have but little choice in selecting *where* their home shall be, ought to have this redeeming feature about them, however ugly, ill-designed, and badly-constructed they may be, viz., that they are *safe to live in*, as far as the internal plumbing and drainage are concerned.

It is all very well to blame architects for bad buildings and bad drainage, but what have architects to do with nine-tenths of the dwelling-houses erected, especially in the "suburbs?" As to the thousands of "villas," the terraces, and the rows of houses down the side-streets, closer to each other than peas in a pod, and about as diversified; the chances are, such buildings have never been entered by an architect, and the only good thing about them has probably been copied, without the smallest acknowledgment: for we live in an age of such peculiar morality, that ideas (the produce of the mind) may be stolen with impunity, whilst a turnip stolen out of a field will send the thief to prison. In some cases, perhaps in many, the speculative builder has given an architect's assistant a few guineas for a "bit of an elevation, and a plan or two," and his other houses have been copied from his first production with a slight modification here and there, a little alteration in the door-knocker or chimney-pot.

Houses unfit for occupation.

When a house is found to be unfit for occupation—and there are tens of thousands in this metropolis alone—the Law ought to step in, and either compel the owner to make it healthy, or to let the occupants go out, free of rent, and put a sealed padlock on the front door. What a demand this would create for padlocks!

It is better to have fewer sanitary "fittings," to have only one sink and one water-closet, and the latter would be better *outside* the house, rather than have several such "fittings" and "conveniences," where the cost would be too great to make them and their belongings sanitarily perfect.

Cutting out bad plumbing.

To cut out the plumbing and drainage of a house, and re-construct such work, may become a costly affair, but not so costly, perhaps, as having to take a sea voyage, or going to Cannes, to recruit one's health after an illness caused by not cutting them out. It is better to pay a drain-doctor than a grave-digger; and it surely is more satisfactory to one's self to pay one's money away, than that one's executors should pay it away for one. There are scores of houses in England where the plumbing and drainage are allowed to remain in a very bad state, because of the expense; and yet, a vase off one of the mantelpieces or sideboards, or a picture out of the gallery or dining-room, would pay for putting the house in perfect sanitary order. A man made strong objections, not long ago, to the writer to having his drainage put right, and directly afterwards made an offer of nearly a thousand pounds for a very little table to stand in one of his drawing-rooms

In mansions with marble tessellated pavements in the halls and corridors, polished oak flooring in all the best rooms, with costly decorated walls and ceilings everywhere, with grand paintings hanging upon every wall, with marble statuettes standing in every niche in the "grand" staircase, and at every corner of the terraced walks, with large stables filled with hunters—the writer has heard the owners of all this whistle to the tune of "Hang the drainage, let it be!" when he has told them that their fine house is honeycombed with bad drainage, and that it is not safe to live in. Grand mansions and bad drainage.

There is great talk in some quarters about "Woman's Rights;" this is one of them, to see that the house is kept clean and wholesome. Once a week the mistress of the house, or her representative, should go over the whole house, and look into every water-closet, sink, housemaid's closet, cupboard, scullery, and servants' bed-room, as well as into the dust-bin or dust-hole. Such periodical inspection of houses would be a great stimulus to servants to keep them clean. Where this is done, and the sanitary appliances and arrangements of the house are perfect, the air inside the house will be just as pure as that outside, and much sickness will be prevented. Woman's Rights.

Testing Plumbing and Drainage.—Just a word on the testing of waste-pipes, soil-pipes, and drains, to see that they are both air-tight and fluid-tight. The *peppermint test* is a ready means of showing certain defects in the sanitary state of a house; but it is not always sufficiently convincing, especially to those who have to be convinced against their will. Not long ago, we wanted to prove to a house-owner that the drain which ran through the house was faulty. Some peppermint had been sent into the drain from the outside, through a soil-pipe, and the scent of it was coming through the drain quite strong enough to show that it was defective; but as the letting of the house depended upon the soundness of his drain, neither he nor his surveyor would admit that he smelt it; and as two noses could smell it on behalf of the would-be-tenant, and two could not on behalf Peppermint test.

of the would-be-landlord, the cabman who had brought some of the visitors to the house, and who was waiting outside, was brought down into the basement and asked if he noticed anything. "Yes, a smell of peppermint!"

Smoke test.

I consider a *smoke test* a more effective means of finding out defects in waste-pipes, soil-pipes, and drains, especially when driven into such pipes by an apparatus called the "Asphyxiator." With the very smallest defect in a pipe, etc., the house could soon be filled with smoke, and the defect or defects traced as easily as it is to trace which chimney the smoke is issuing from when only one fire is lighted in the house. But the strongest test for doubtful soil-pipes and drains is the *hydraulic test*, and this is generally pretty easily applied. The drain has only to be sundered at the lowest end outside the house, and plugged up with a ball of clay or cement, and then charged with water, and if the water subsides, or is found to have subsided after standing for a few hours, it will demonstrate to everybody concerned that the drain is defective. In testing long lengths of vertical *lead* soil-pipe with water, it is better to do it in sections, sundering the pipes here and there, for the purpose of preventing too great a strain upon the pipe; but lengths of 30 or 40 feet should stand the pressure well enough, though the water should only be allowed to remain in the pipes just long enough to see that it is sound. With a peppermint-test a piece of solid excrement or congealed grease may have covered a small defect in the pipe or drain for the nonce, and made the drain appear sound, though in reality it was unsound. And this may also be the case with a smoke-test, but no such accidental and temporary stoppage would prevent a water-test from showing any defect, however small, either of air-tightness, or fluid-tightness, in a soil-pipe, waste-pipe, or drain.

Hydraulic test.

In examining a house a short time ago, where the drainage had been recently overhauled and pronounced perfect, I noticed a very faint sewage smell on going into a room near the foot of a long stack of soil-pipe. I had this piece of drainage stopped up, and two tests made with peppermint, putting about an ounce of Mitcham oil-of-peppermint each time into a can of boiling water and pouring that down the soil-pipe from its ventilating outlet above the roof. A can or two of hot water was then thrown down after it to carry it well through the pipe and piece of branch-drain. But so well was the drain and its junction with the soil-pipe concreted over, that no *trace* of peppermint was noticed for nearly an hour, but on attempting to charge the soil-pipe (which was built in the wall, and plastered and papered over) with water, the pipe could not be filled. The water leaked through the jointing of the soil-pipe with the drain, and through defects in the lower part of the piping, as fast as it could be poured into it, from a water-closet fixed on the third floor, and from water-cans emptied into it on the second floor, where a water-closet had been taken up for the purpose.

Curious test with smoke.

A very curious thing happened the other day in testing with prepared smoke-paper some drains which ran underneath a country mansion. An offensive smell was noticed near a doorway inside a wing of the house; the drain was opened up outside the walls of the house, and a hole made in the branch-drain running under this part of the house (the main drain being blocked off), for the nozzle of the tubing from an "Asphyxiator" to enter. The smoke was then driven into the drain as rapidly as possible. I watched the door-jambs, hoping to see the smoke come through somewhere, but nothing came out for some little time, and then only a little smoke. I could not understand this, but on walking about the house, I found clouds of smoke coming from a chimney into one of the best rooms, quite in another wing, and about 100 feet distant. The room was too full of smoke for anybody to get to the chimney for some time, but standing up in the chimney, about three or four feet above the chimney-breast, was a 4-inch iron ventilating-pipe taken from the head of the soil-drain right into the chimney! The curious part of the smoke-test was, that the smoke, instead of coming through where we supposed a defect to exist (and which was ultimately found to be a large defect) in the chief branch-drain, and only six or seven yards from the point where the smoke was introduced, travelled through a minor branch for a length of about forty yards, and delivered itself into the chimney. But who would have expected to find a drain-ventilating-pipe standing up in a chimney in a mansion only *re*-built about twelve years ago? The smoke not only came into the room, but it poured out of the chimney in volumes; and my belief is, that if we had not burnt a large quantity of prepared smoke-paper, and had not sent the smoke very rapidly into the drain, we should not have found this drain air-pipe out, especially if there had been a fire in the room at the time, or the chimney had had greater drawing power.

I conclude these introductory remarks by stating, not only as my opinion but as my experience, that more filth is often found in a single water-closet and trap badly constructed than could be found in the whole plumbing and drainage of a large house, if well considered and well constructed on a proper system of drainage.

CHAPTER II.

UNTRAPPED WASTE-PIPES AND SOIL-PIPES; OR THE NECESSITY OF TRAPS.

Untrapped pipes—Waste-pipes get foul—Waste-pipes acting as ventilators—Specimens of untrapped lavatories, sinks, baths, &c.—Untrapped water-closets.

Untrapped pipes.

IT is almost incredible, after all that has been said and written about sanitary plumbing, that such "fittings" or "fixtures" as sinks, lavatories, and water-closets, or even baths, can be fixed—unless under most exceptional circumstances—*without* traps. Such "fittings," however, are still being fixed, especially in London and its suburbs, though in decreasing numbers. The men who fix these "fittings," or direct them to be fixed, are quite content if the discharging ends of the waste-pipes from them are left open to the atmosphere, *i.e.*, are "disconnected" from the drain, no matter what the size or the length of the pipings may be, so long as the "outlet" is within measurable distance of the "inlet." They do not seem to know that such waste-pipes may become in time as foul as the drains from which they have been "disconnected;" that, in fact, they may become *drains* in themselves; or they would surely trap them off from the house, and not treat them as if nothing but clean water had to pass through them. Nor can they know that such waste-pipes become *ventilators*, or they would never allow pipes which carry off the suillage of a house to bring in also its fresh (?) air.

Waste-pipes get foul.

That waste-pipes from such "fittings" become foul is readily proved by putting the nose over their "inlets;" or where the sense of smell is defective, or obstinate (as is not unfrequently the case with owners when wanting to let or sell their houses), by tying a sponge or white pocket handkerchief to a thick piece of copper wire, and pulling it through the piping.

This fouling is easily understood when we consider what is sent into such waste-pipes. Take the case of a lavatory or housemaid's sink. The hands are here freed from all kinds of dirt; and at times a great deal of soap is needed to make them clean. A plug or valve is opened by the person using the lavatory, and the soapy water is made to *drain* itself away without any attempt to wash out the waste-pipe, or even to rinse the basin. The soap-suds dry and decompose upon the waste-pipe, and the bad air coming from this passes freely into the house, either through the waste-plug or valve (B, Fig. 1) or, when this is shut, through the overflow-arm (C). This fouling of the waste-pipe is sometimes augmented, for the writer has proved to more than one householder (by putting a heated poker into the pipe for intensifying the smell) that chamber-utensils, etc., are emptied at times into lavatory basins and sinks—butlers often treat their sinks as badly—and that, too, in houses whose rental has exceeded a thousand pounds a year. Unfortunately, where there is any willingness to wash out the basin, or sink, and the waste-pipe after usage, the appliances are ill-adapted for giving the pipe an efficient flushing; for the plugs-and-washers or waste-valves are often only equal in their bore to about *one-sixth* of the area of the waste-pipe, and are therefore much too small to allow any water to pass from the sink or basin into the waste-pipe in a body large enough to be of value as a cleansing-force. And the supply of water to lavatories is often so poor (having to come in through a ⅜-inch supply-valve, bib-cock or urn-cock, with but little pressure, that is, head of water) that, in this busy age, no one can spare time to refill a basin for the purpose of rinsing out its waste-pipe.

If waste-pipes from "washing-up" sinks, pantry-sinks, and lavatories get foul, waste-pipes from slop-sinks, scullery-sinks, urinals, and water-closets—being conductors of more offensive matter—must also get foul. Experience proves that *all* pipes conveying "dirty" water and excremental matters get foul; for, sooner or later, no matter what flushing appliances may be adopted, they get insufficiently flushed out with clean water *at the time they are used*, and the offensive matters passed through them are allowed not only to stain, but to dry and corrode upon the pipe. Let the sceptical reader, if there be one, cut out a piece of a waste-pipe or soil-pipe (an untrapped pipe, if he prefers), the one he thinks the sweetest in his house, and fixed on the principles we are now examining, and when he has got the piece of pipe in his hand, let him put his finger inside and "scrape" it round, and then let this anti-trap man put his stained finger to his nose, and say how he would like ten, fifty, or a hundred feet of that kind of piping sending its offensive matter into the rooms of his house.

Waste-pipes as ventilators.

We have seen how waste-pipes from sinks, lavatories, etc., become foul; and it will not take many words to show how, when untrapped, they become *ventilators.* Such pipes being open right through, like chimney-shafts, and having their upper part in warmer and more rarefied air (being inside the house) than their lower part, become great conductors of air into the house, especially when many fires are going and in the night-time, and also in cold weather, when the doors and windows are shut. This can be easily tested,* by holding a lighted taper over their "inlets"—*i.e.*, their connections with the sink or lavatory, etc.,—or by a more ready way still, by placing the nose or the back part of the hand over them; or a more scientific test can be made by placing an anemometer over the grating of the sink, or the plug-hole of the lavatory, etc., and registering the lineal feet of air coming through, though some air would pass in unregistered. This, of course, varies very much with circumstances, but the writer has registered thousands of feet (lineal) per hour as having come through such pipings. The atmosphere coming thus into the house, and taking with it the bad air, perhaps disease-germs from decaying matters in the waste-pipe, cannot be pure and must be unhealthy, especially for invalids and sleeping persons.

The writer knows of many cases where complaints of bad smells have been made, and where serious illnesses have

* A very ready test is to put a smouldering rag, or piece of smoke-paper, under the discharging-end of an untrapped pipe, and see the fumes come through the piping into the house.

arisen, through such bad treatment of waste-pipes; and as the practice of fixing untrapped pipes is still common even under the direction of men who would be offended if they

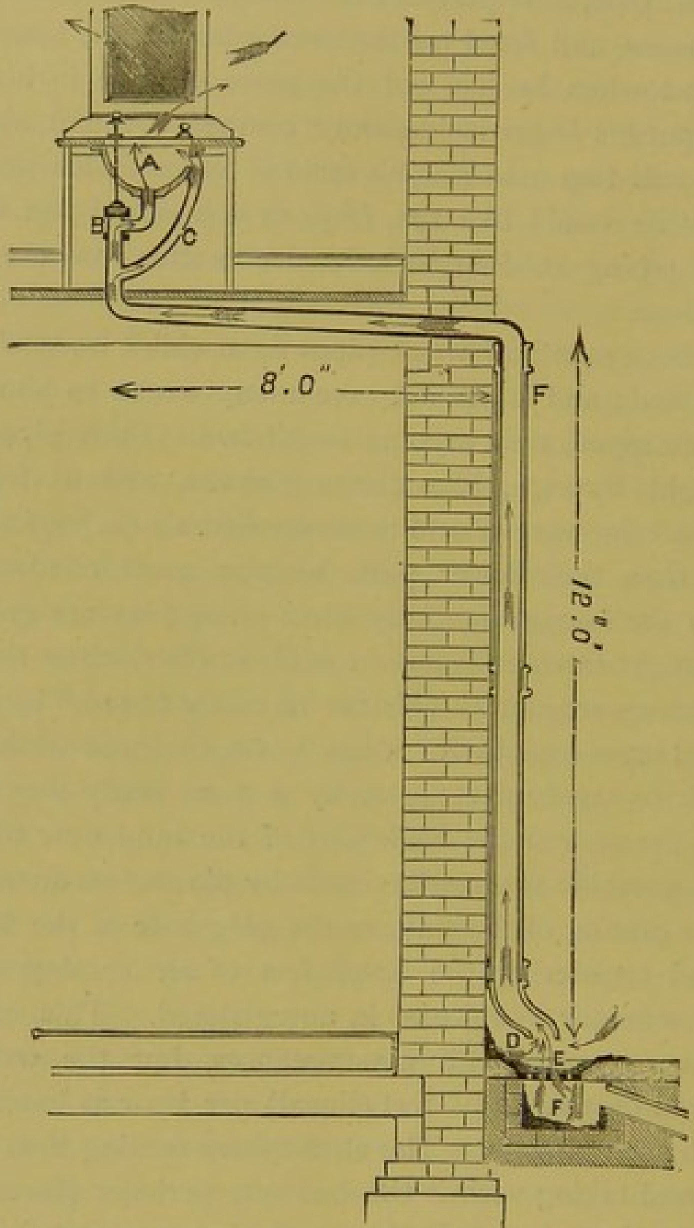

FIG. 1.—Untrapped Lavatory Waste;—a bad arrangement.

were not called sanitarians, he illustrates here a few out of the very many cases which have had to be remedied.

Fig. 1 shows a lavatory, fixed in a dressing-room of a country mansion, with a long length of untrapped waste from it, discharging over a large gulley-trap. The water-way from the basin, A, into the waste-pipe, through the waste-valve, B, was only equal to the area of a half-inch pipe, but the "horizontal" waste was a two-inch lead pipe, and the vertical waste, F, 4-inch cast-iron pipe. The gulley, F, was so

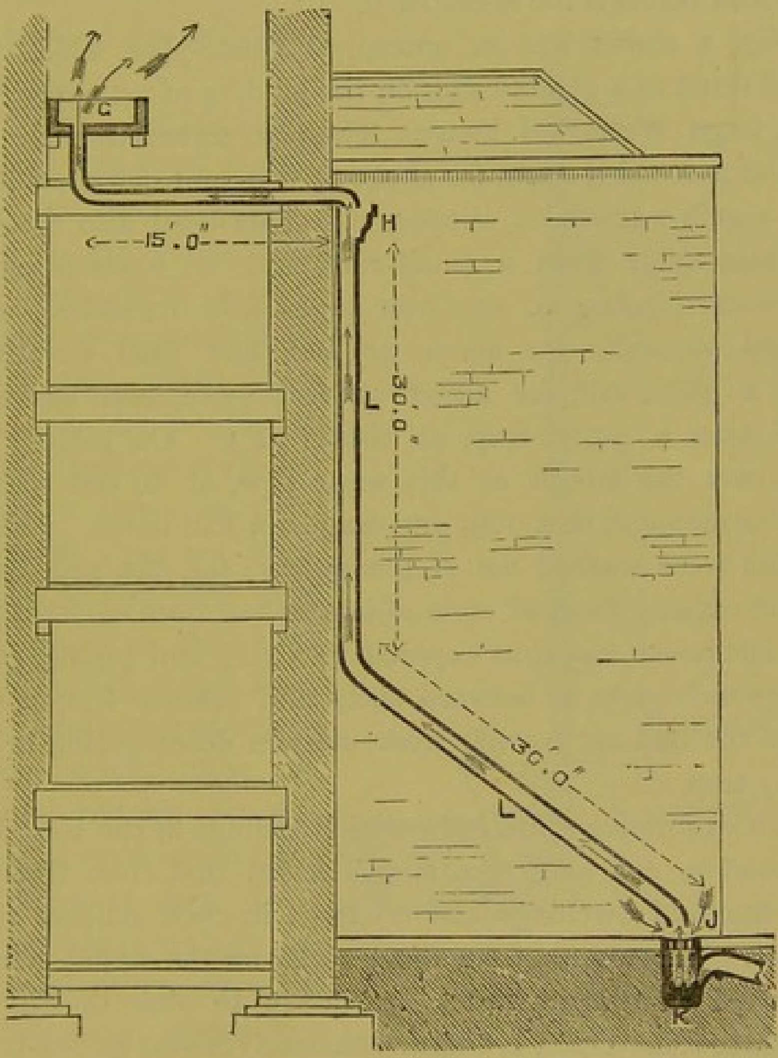

FIG. 2.—Untrapped Sink Waste;—a bad arrangement.

large that no amount of water sent through the lavatory would have cleansed it. The contents of this gulley, when stirred up with the end of a walking-stick, gave forth a most offensive smell, and the bad air from this, as well as that coming from the splashings at the foot of the pipe, D, and from the foul waste-pipe itself, passed freely enough into the dressing-room and over the house, though no doubt it was mixed with the atmosphere which went in with it through the discharging-end of the waste-pipe, at E. The servants were supposed to keep the waste-valve, B, closed; but closed or not, the bad air from the pipe would find ready access to the room through the overflow, C.

Fig. 2 shows a 2-in. untrapped waste-pipe, which was found fixed to a general sink on the landing of an upper floor of a large West End house. The pipe travelled under the floor of a dressing-room for about 15 feet, and delivered itself into a rain-water-head outside, H. This head also received the rain-water from a small roof, and the waste-pipe and rain-water-pipe—4-in. cast-iron pipe—now combined, descended vertically for about 30 feet, and then continued, with a quick fall, for about 30 feet more, and delivered itself into a gulley-trap, as shown at J. On placing the nose over the mouth of this waste-pipe, at G, one wished, for the moment, that only anti-trap men had noses. Pailfuls of filth were washed out of the piping; for, the sink being on the nursery floor, all sorts of matter had been emptied into it. The house was thus exposed to a very foul piping, equal in superficial area to between sixty and seventy feet, as well as to the bad air coming from matters decomposing in the gulley trap, K.

On examining some Industrial Dwellings in the East End of London, not long ago, it was found that from three to four hundred dwellings had no traps in their scullery sink-wastes. The wastes from these sinks on the upper storeys branched into main-wastes, as shown to sink G, Fig. 3; and these stack-pipes, L, emptied themselves over gulley-traps, as shown at T. The wastes from the sinks on the ground floor, H, also discharged over gulley-traps outside an external wall of the building, as shown at P. To keep out the very offensive smell coming into the rooms through these untrapped wastes, in some instances rags were placed over the sink-gratings with a brick to keep them down; in others the gratings had been knocked out and the wastes corked up; and in one, the grating of the sink-waste had been soldered over, and the water-closet turned into a sink, as well as a

W. C. The surface of the ground in the yards adjacent to the waste-discharges was in a filthy state from the splashings from the waste-pipes; and in some cases where pieces of paper had washed over the gully grating, the mess was two or three inches deep. The arrows in the drawing show how such pipes act as ventilators.

With untrapped waste-pipes there is not only the danger of getting disease germs into the house, from organic matter decomposing in uncleansed pipes, but there is the additional risk of getting drain air through them as well, for such pipes are often made to discharge over bell-traps, as shown at D, Fig. 245, page 299 ; and a bell-trap, as everybody ought now to know, cannot be depended upon for an hour to keep its seal. In a house where such an arrangement was recently rectified, a gentleman lost his child, and when his doctor told him the death had been caused by bad drainage, he could not understand it, as he had had "all the waste-pipes *disconnected* from the drain," etc.; but on examining the house, the bath-waste was found to have no trap in it, and to discharge over a *bell-trap* outside the house ; but the bell-trap was unsealed, and the bad air coming through it from the drain travelled readily enough up the bath-waste and into the house. In a similar case, the other day, it was proved to a clerk of the works

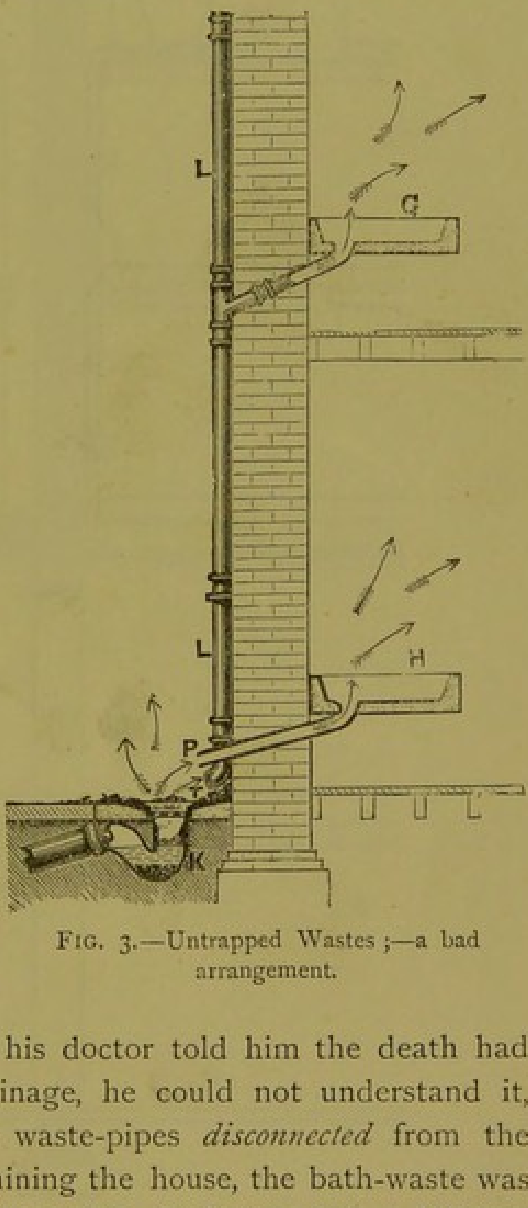

FIG. 3.—Untrapped Wastes ;—a bad arrangement.

of the old school how valueless such traps were, and how readily the air in the drain passed through them and

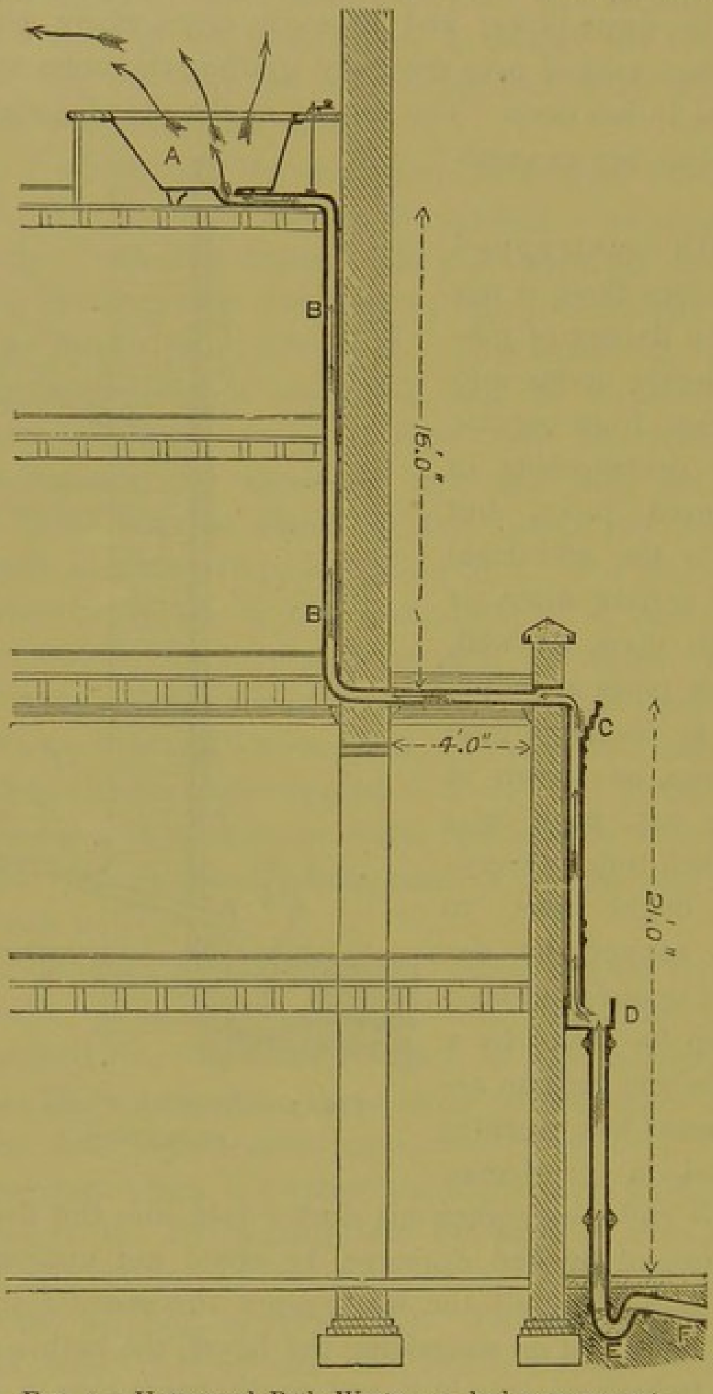

FIG. 4.—Untrapped Bath Waste ;—a bad arrangement.

through any untrapped pipe discharging over them into the house. A little peppermint put into a can of boiling water and poured into the drain, though at a considerable distance

PLATE I.

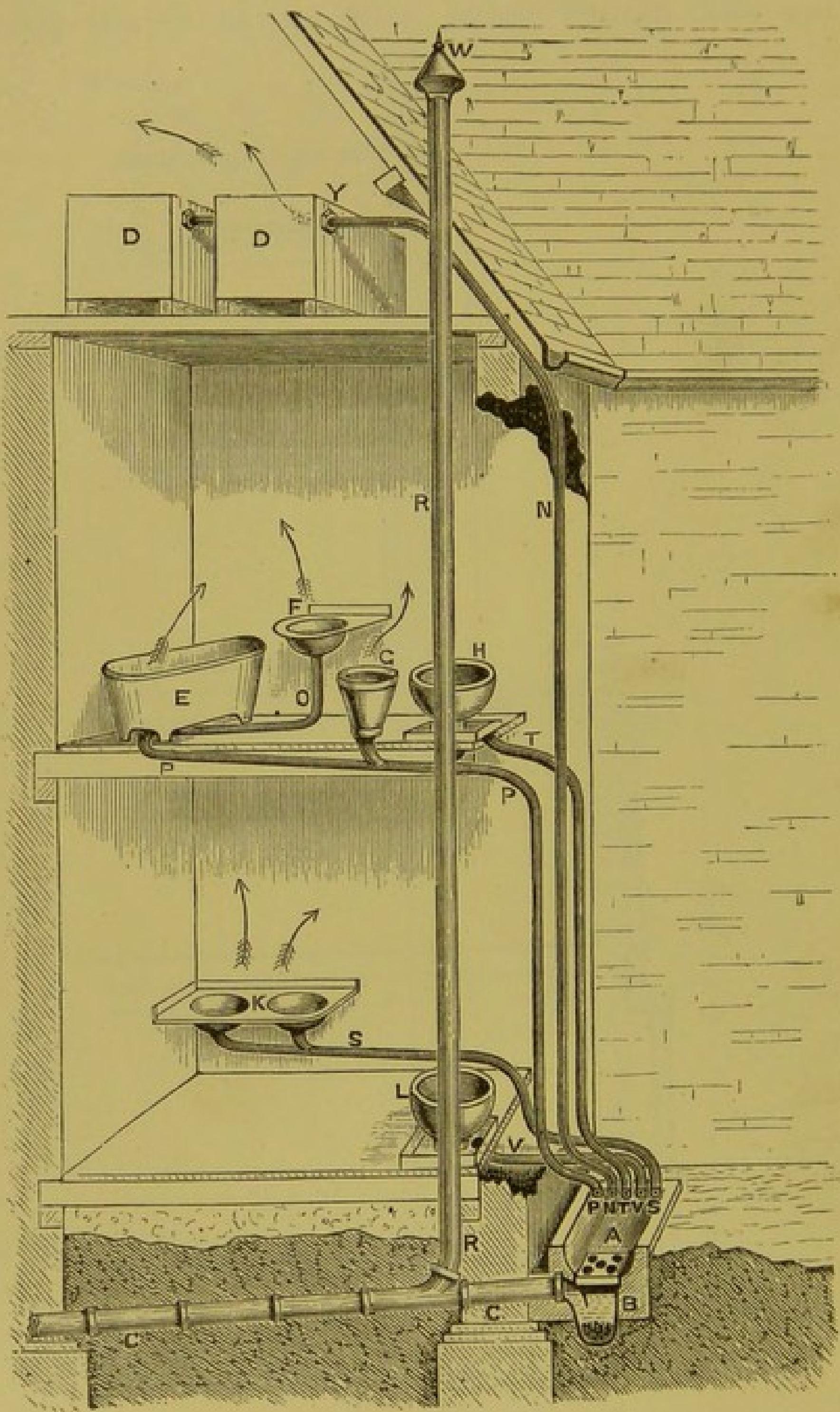

FIG. 5.—Untrapped Waste-pipes ;—bad arrangement.

from such traps, will soon satisfy the most sceptical on this point.

Fig. 4 shows a bath, with a long length of untrapped waste from it. The bath, A, was much used for the family washings, and as the wastes, B, C, and D, were large, and the way into them very small (through the bath-waste valve), the pipe became foul, and the bad air coming from the decomposing soap-suds in the pipe passed freely into the house. The householder would not believe this, until a bit of burnt rag (for want of a better means) was put into the head, at C, and the fumes thereof disclosed themselves to his nasal organ where he was standing in the bath-room.

A gentleman, an amateur sanitarian, living in a nice country house, thought he could not do better than follow the rules laid down by the Local Government Board for "disconnecting" the waste-pipes in his house, but he soon found bad smells in various parts of the house. The drawing, Fig. 5, Plate I, illustrates what was found. The waste-pipes from bath, E, lavatory, F, and slop-sink, G, and from the double lavatory, K, as well as the overflow pipes from the two cisterns, D, and water-closet safe, T, were all collected together outside the external wall, and made to discharge into an open stone channel, A, *without* traps, as shown at P, N, T, V, S. The "five-holed" trap, B, had often become covered over by the filth coming from one or more of these waste-pipes, and the ground outside the stone channel * was completely saturated with decomposing matters. The waste-pipes, P and S, from the slop-sink and lavatories, had become very foul, and as they were not trapped in any way, the bad air coming from matter decomposing inside them found an easy passage through the "fittings" to the house, as shown by the arrows. The bad air also coming from the filth collecting around the dischargeing ends of these pipes, and in the stone channel, found a ready entrance through the overflow-pipes, T, V, to the house, as well as through the overflow-pipe, N, to the drinking-water stored in the cisterns, D. Other defects were found,

Local board.

* This channel is shown quite clean in the drawing, but as a rule it is generally very dirty from the splashings from the waste-pipes.

but having little bearing upon the subject of traps are not referred to here.

Untrapped Water-Closets.—In "Lectures on Sanitary Plumbing," my opinion is given *in extenso* on the evils of fixing water-closets without traps, and I have illustrated there the several modes in which these evils arise. I do not, therefore, enlarge on this question here, but simply repeat what appeared in the earlier edition of this work.

W.C.'s without traps.

When water-closets are fixed *without* traps, the house is only "protected" from the soil-pipe air, and perhaps drain air too, by a mechanical valve or plug (fixed somewhere on the outlet of the water-closet basin) which at times *must* get out of order. When this occurs, what is there in the water-closet apparatus to prevent the noxious gases escaping into the house? Again, water-closets are often used by careless people who pull the discharging-handle (if they pull it at all) in such a way as to catch some of the solid excrement, or paper, under the basin-plug or valve. In such cases, this plug or valve is imperfectly sealed, and the water not only leaks out of the basin—leaving it dry for the next user of the closet—but the air in the soil-pipe, whether it be what is called "sewer-gas" or not, *finds an easy passage*, through such imperfect sealing of the valve, *into the house.*

Trapless closets.

A *tier* of trapless closets may, in the way just referred to, become more or less *air-feeders*, and help, in their little but stinking way, to satisfy the demands for air made by the several fires on the various floors of the house. For the top of the soil-pipe being open to the atmosphere would allow the colder and heavier air outside in winter to push its way through the pipe—notwithstanding the strongest upcast cowl that could be put upon it—to the warmer and lighter air inside the house; and the drawing power of the several fires would help to pull the air through such defective valve-sealings as we have just been considering.

CHAPTER III.

THE ADVANTAGES OF TRAPS.

Well-sealed traps exclude bad air—Traps condemned in ignorance—A cesspool trap—Traps on soil-pipes—Traps largely used, and for a long period—Experiments to see the value of "water-seals"—Traps and sewer-gas—Dr. Carmichael's experiments with traps—The Sanitary Engineer.

Traps of value.

By fixing well-sealed self-cleansing traps under the various sanitary fittings, *i.e.*, between the "fitting"—be it a bath, sink, urinal, lavatory, or water-closet—and the waste-pipe or soil-pipe, the house is protected from any air, good or bad, moving or standing in such pipes, as well as from any particles coming from decomposing excremental matter left in the piping or drain through inefficient flushing, provided that the pipes on which such traps are fixed are properly ventilated. The water-seal of an efficient trap will prevent the passage of air through it, though under considerable pressure. Nor will the strongest fire or rarefied air inside a house draw any air through a well-sealed water-trap; therefore, traps must be of great advantage.

Traps condemned in ignorance.

Traps have been condemned by many persons inexperienced in sanitary plumbing, because of the bad smells invariably found in connection with plumbing and drainage works done on the old methods. Finding bad smells in water-closets, &c., &c., such persons have erroneously concluded that the smells have come *through* the *water-seal* of the trap from the regions below. The truth is, that traps having very poor water-seals have often been used, and that no means have been taken for preventing the loss of what little seals they may have had. Then again, the traps used in thousands of instances have been of a non-cleansing kind, and so, collecting and holding their filth, have become small cesspools, giving forth in themselves a stink which might well be attributed to drains and sewers.

Cesspool traps.

Many instances might be given to show that efficient water-traps are of great value for keeping out the most powerful sewage smells. In a country mansion, about three years ago, the people were driven away from the house by the horrible smell which came out of a 4-in. air-pipe, fixed at the head of the drain. The smell from this pipe, in a line with the wind, was most execrable even at a distance of 100 feet from it. The drain had been carried into a huge cesspool *without* a trap. The owner would not allow a proper disconnection of the drain with the cesspool, nor would he allow the drain to be ventilated; that is, he would only allow this one air-pipe to be upon the drain. The clerk of the works, who had left the house for about a year, was sent for to explain the cause of this horrible smell, and he came to me for advice. I told him that if his master was stupid enough to store up sewage in such a way, and would not allow the drain to be properly "disconnected" and ventilated every 100 feet or so, he should, at any rate, trap off the cesspool. This he did, and there has never been any bad smell noticed from the air-pipe since. This is only to show that traps are of value for keeping out bad smells.

Traps upon soil-pipes.

As a further proof that traps are of great value for keeping out soil-pipe air, it may be stated that the author has often had several valve-closet apparatus taken up for repairs in large buildings, where they were fixed on a stack of very old soil-pipe, leaving the *traps only* to protect the house from the soil-pipe; and, though such closets have been away for several days together, he has never known that anybody has detected the slightest offensive smell as having passed through any of the traps. Yet no stack of soil-pipe, or even waste-pipe, could be left for half an hour *without* a trap, in such a case, without becoming an offence to everybody in the house.

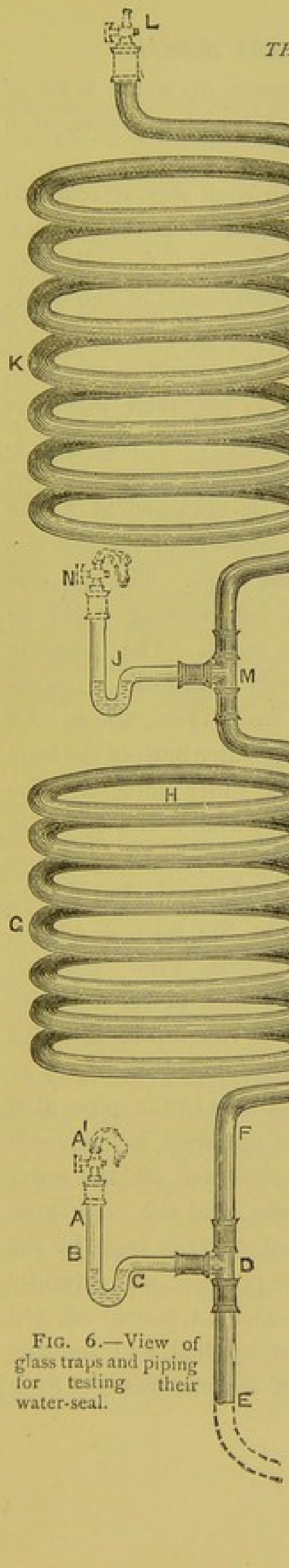

FIG. 6.—View of glass traps and piping for testing their water-seal.

Used for a long period.

If traps had not been valuable for keeping out bad smells in waste-pipes, soil-pipes, and drains, they would never have been used for so long a period as they have been, nor would they have been so widely and so generally used in all civilised countries for such purposes. My own impression is that if *self-cleansing* traps had *always* been used, and such traps had been made, by proper ventilation, etc., to maintain their seals against syphonage, momentum, and evaporation, traps would never have been condemned at all. A trap with a water-seal of a depth of $1\frac{1}{2}$-in. or more, is of much greater value for resisting noxious gases, etc., in pipes than many people suppose. I will give here the results of a few experiments out of many which I have recently made to see the value of water-seal-traps.

Glass traps for experiments.

Two glass traps (made in the shape of the well-known half S-trap) 1-in. bore, and having a water-seal $1\frac{1}{2}$-in. deep, were branched into a very long length of 1-in. lead piping, as illustrated in Fig. 6. About 120 feet of 1-inch lead piping was coiled round in two separate coils, as shown at G and K, to get a good resistance, by friction, etc., of anything sent up

Piping.

the piping, and to throw greater pressure upon the seals of the traps, one trap being fixed under each coil, as shown at B and J.

Air-cocks.

For some of the experiments an air-cock was attached to the "inlet" of each trap, as shown at N, and over the air-cock was fastened an india-rubber bag, as shown at A′, for collecting any air, should any pass through the water-seals of the traps. An air-cock was also fixed on the top of the piping, as shown at L, for opening or closing this part of the piping as required.

Gas test.

(*a.*) A test was made with gas. A half-inch pipe was laid on from the gas-main, and connected to the piping at E, and the gas turned on. When the gas had driven out the air in the piping, and a light could be obtained at L, the cock at L was turned off, and the full pressure of the gas was then thrown upon the water-seals of the traps. The gas was allowed to remain on for forty hours, but nothing could be traced as having passed through the traps. The pressure upon the "standing-water" of the trap depressed it on its outlet side, C, gradually until it had sunk 1¼-in., about. Of course as the water was depressed in the outer limb of the trap, C, it was correspondingly raised in the inner limb, B. The highest point registered during the forty hours was 2½-in. in the "inlet," B, above the water-line of the trap. The pressure of the gas varied, of course, during the forty hours, but during the daytime the water was kept up in the dips, B and J, about an inch-and-a-quarter above its normal level. Towards evening the company increased the pressure in the mains to about fourteen-twentieths, and the water rose up in the dips accordingly, standing at times as already mentioned, 2½-in. above its normal level. By pricking a hole in the pipe at H with a very fine pin, a very fine jet was obtained, but this will be well understood. When the gas was turned off, the water returned to its normal level in the traps, and the very small quantity of air which had been pressed into the bags by the water rising up in the dips, when under pressure, was carefully squeezed back again, and the little air-cocks, A, turned off, and the bags removed. A light was then applied, and the air-cocks. A and N, opened, but no sign of a flame was got from either trap,* though on squeezing the little air out of the bag into the dip of the lower trap it depressed the water an eighth of an inch.

(*b.*) Another test was made with prepared smoke-paper. The smoke was driven into the piping at E by an Asphyxiator, and when the whole of the piping was well charged with smoke, the air-cock L, on the top of the pipe, was turned off, and a pressure strong enough to raise the water an inch in the dips of the traps was put upon the seals, but though the smoke was applied in this way for half-an-hour, not a particle passed through the water-seal of either trap. Nor could the smallest smell of this strong-smelling smoke-paper be noticed by keeping the nose for a considerable time over the dip of the trap, at A, the small air-cock being removed for the purpose. Nor was anything collected in the bag over the other trap. A very fine thread of smoke was obtained by pulling the pin out of the pin-hole, H. Smoke test.

(*c.*) A precisely similar test to the last was made, but with peppermint. Nearly an ounce of oil of peppermint was put in two lots into the Asphyxiator, and as much of this as possible was sent into the piping; but though the pipe was kept well charged with this for half-an-hour, no trace of peppermint could be found as having passed the water-seal of either trap. By removing the pin from the fine pin-hole at H, the room was soon filled with this powerful odour. Peppermint test.

(*d.*) Another test was made later on, precisely similar to the last, but using ether instead of peppermint. A small sponge well saturated with ether was put into the Asphyxiator, and the pungent smell from this was sent into the piping at E, as before, but no trace of this could be detected on the inlet sides, A, of the water-seals of the traps, though my assistant, on opening the air-cock J, and putting his nose over it, drew Ether test.

* Since this experiment, I have kept the gas upon the water-seal of the trap, C, direct, for two months together, without being able to get a particle of gas in the india-rubber bag, A'.

back as if he had discovered dynamite on the point of exploding.

Ammonia test.

(*e.*) Other tests were made with ammonia and assafœtida, in a way similar to the last, but in no case was anything sent through the water-seals of the traps. By pumping in air with an air-pump the water would be sent right out of the traps, as a matter of course, but that is not the point under consideration; the question is: Of what value is a water-trap for keeping out bad smells in waste-pipes, soil-pipes, and drains? And my opinion is, that when the plumbing work is carried out on the principles laid down in this work, the water-seal of a trap will exclude noxious gases from our houses.

Traps and sewer gas.

To what extent traps may be of value for keeping out "sewer gases" in *unventilated* pipings, the writer leaves to chemists to determine, though he would consider a house unsafe to live in which was only "protected" from the soil-pipe, drain, and sewer as well, by the water-seal of a single trap, fixed under a "sanitary fitting" inside the house, especially when the "sewer gases" were under pressure. But where the sanitary arrangements are carried out on the principles laid down, there would be no sewer gases under pressure in any of the soil-pipes or waste-pipes, for not only would such pipes be *disconnected* from the drain, but the drain itself would also be "disconnected," as well as trapped off from the sewer; and the pipes and drains being properly ventilated, both at their receiving and discharging ends, a constant stream of fresh air would be passing through them. Besides, all the traps, waste-pipes, soil-pipes, and drains being made of a *self-cleansing* size and character (and receiving good water flushings), would have no place or lodgment for filth to collect in to generate "sewer-gases."

Traps fixed under the various sanitary fittings inside or outside our houses ought only to be wanted to answer the purpose of air-screens or air-guards, and never treated as impassible barriers to what are called "sewer-gases," especially when under pressure. They should be made to stand like a sentinel between the "sanitary fitting" (be it bath, lavatory, draw-off-sink, pantry-sink, washing-up-sink, urinal, slop-sink, or water-closet) and the waste-pipe, or soil-pipe—even when such pipes are cut off, that is disconnected, from the drain, and ventilated—to guard the house from the air in, or travelling through, such pipes. It is worth while, however, to notice this fact: that though the writer has seen hundreds of old lead D-traps, with their *upper* portions—the parts above the "standing water"—eaten through, he has never seen one where the sewer-gas has eaten through it *below* the level of the water-line, except where the whole trap has perished through age. And though he has also seen many old lead "round-pipe" traps eaten through on the soil-pipe side of the water-seal, he has never seen one eaten through by noxious or sewer gas on the *house* side of the seal, nor below its water-line. Some may say "Yes, when sewer gas has passed through the water-seal of a trap, it has not much difficulty in making its way into the house." But in a well-constructed valve-closet it has; for there is the basin-valve and the seal of the overflow trap to keep it out. But the fact that sewer gases eat their way through the lead top and "outgo" of the trap, instead of passing at once through the water-seal, proves that water is of value in keeping out even sewer gas. An important contribution on the value of traps has been made by Dr. Carmichael. He read his paper, "An experimental investigation into the trap and water-closet system, and the relation of the same to sewage products, gaseous and other," at the Philosophical Society of Glasgow, on the 18th of February, 1880. Dr. Carmichael says:—

Dr. Carmichael on traps.

"*Water-traps are, therefore, for the purpose for which they are employed, that is, for the exclusion from houses of injurious substances* contained in the soil-pipe, perfectly trustworthy. They exclude the soil-pipe atmosphere to such an extent that what escapes through the water is so little in amount, and so purified by filtration, as to be perfectly harmless; and they exclude entirely all germs and particles, including, without doubt, the specific germs or contagia of disease, which, we have already seen, are so far as known distinctly particulate."

THE SANITARY ENGINEER, a paper which is doing a great amount of good in the sanitary world, and which should have a large circulation in England, as well as in America, in its issue of January 25th, 1883, says :—

"The results obtained by Dr. Carmichael are sustained by the experiments of Dr. A. Wernich, of Berlin, reported in a paper entitled 'Die Luft als Trägerin Entwicklungsfähiger Keime,' which was published in the *Archiv f. Path. Anat. u Physiol.*, Berlin, 1880, Vol. 79, p. 424, and also reported in a different form in No. 179 of the *Sammlung Klinischer Vorträge*, edited by Volkmann, and published at Leipzic in 1880, with the title 'Ueber verdorbene Luft in Krankenraumen.'

"A brief summary of the results obtained by Dr. Wernich is given in the number of this journal for May 1st, 1880, page 210.

"The results of Carmichael and Wernich were still further confirmed by the results obtained in the very careful and extensive series of investigations made for the National Board of Health, under the direction of Prof. Raphael Pumpelly, of the U. S. Geological Survey, and reported in Supplement No. 13 of the National Board of Health Bulletin, dated April 16, 1881. On page 22 of this Supplement it is stated as the result of the series of experiments detailed that '*At normal summer temperatures no germs were given off from the decomposing liquids whenever their surfaces remain unbroken, even though in some of the experiments the air was continuously conducted over them in a slow current. When the surfaces of the liquids were broken, however, by the bursting of bubbles, germs were invariably given off and the sterilized infusions infected.*' It is a question whether at higher temperatures germs may not be given off from putrefying liquids.

"Miguel, in the *Annuaire Meteorologique de Montsouris* for 1878, page 540. says that in the evaporation of putrid liquids at temperatures of 104°-112° F. germs are given off, but this is yet doubtful, and such results are probably due to the drying of a film at the edge of the liquid and the subsequent detachment of fragments of this film by the air current. Such high temperatures are, however, never observed in sewer air."

CHAPTER IV.

TRAPS FOR HOUSE-PLUMBING.*

Importance of good trapping—Material for traps—Traps independent of the "fitting" or fixture—Junction of the trap with the waste or soil-pipe—Trap to each "fitting"—Principles of self-cleansing traps—Lead-traps—Screw-caps in traps—Bell trap—Antill's trap—D-traps—Narrow-band D-trap—Helmet trap—"Eclipse" trap—"Mansion" trap—Lead soil-pipe trap—"Anti-D-trap"—Beard and Dent's trap—Du Bois trap—Traps with check-valves—Bower traps—Table showing the relative value of various traps against fouling.

Efficient traps of the utmost importance.—It is impossible to exaggerate the importance of having efficient traps to the various sanitary appliances inside our houses, for what are they but *doorways* to the waste-pipes and soil-pipes, and when such pipes are not intercepted from the drains, then to the drains as well? † We have seen in a previous chapter how foul such pipes may become, and we have now to see what kind of traps should be used for trapping them off from the house. The "dip," or water-seal, of a trap may be considered as the door, and if by such doors we cannot shut off these pipes they become worse than useless, for traps having defective dips would not only expose the house to the perhaps deadly attacks of noxious gases coming from any organic matter decomposing in the pipes, but would themselves attack the house by not air-sealing the foul matters they had caught.

Traps, doorways.

Perhaps no sanitary "fitting" wants more care in selecting than a trap, for if it be either faulty in construction or bad

* See Chapter VIII., on "The Loss of Seal in Traps."

† In thousands of cases in London, as well as elsewhere, the water-seal of a trap, though fixed under a "fitting" *inside* the house, is the only "protection," not from the drain only, but also from the sewer or cesspool besides, for it is only here and there that the drains are "disconnected" from these lower regions.

in principle, or both, it will soon become the foulest thing in or about the house. And when once it has become foul, not all the waters of all the water companies combined would make it perfectly clean again, especially if it is only allowed to *dribble* into it two gallons at a time—the quantity graciously allowed by most companies for "washing" (?) out closets and their belongings.

Arch-offenders, Bell trap and D-trap.

Take, for instance, the two arch-offenders, the Bell trap and the D-trap—used still by the hundred. Shade of Hygeia! Could anything be less adapted for sanitary uses, more ill-considered, and less sound in principle? The Bell trap is only of very questionable value when the *top* is *down* and the trap full of water; but who ever saw the top "down" and the trap full of water? As for the D-trap, no man living ever saw a wholesome one after it had been in use for half a year. And yet, D-traps with the accumulations, not of half a year only but of a score of years, are breathing out their venomous filth by the half-dozen or more in thousands of mansions and houses throughout England: people are too wise to use D-traps in Scotland and America.

Traps legion.

The material of which traps should be made.—I am not about to discuss the merits or demerits of each individual trap now in use, for their name is legion, nor to consider at any length the material of which traps should be made; but I must remark that the material for traps for fixing inside the house should be of such a kind as can be easily and securely jointed to the waste-pipe or soil-pipe, with which it should be *perfectly united*, for any defect here—*i.e.*, in the jointing of the trap to the pipe—would allow any bad air in the pipe to escape through it into the house. And where the pipe (waste-pipe or soil-pipe) did not discharge into the open air, but was connected directly with the drain, without an intercepting trap of any kind, then any noxious gases in the drain can travel up the pipe into the house, through the defective jointing of the trap with the waste-pipe or soil-pipe.

Lead.

Further, as lead is the best material for waste-pipes and soil-pipes (as I hope to show under the head of "soil-pipes," Chapter X., page 149), so it is also the best material for traps for all the sanitary appliances and "fittings" *inside* our houses, not only because of its special fitness for soundly jointing to waste-pipes and soil-pipes of lead, but also on account of its smoothness, non-corrosiveness, and durability.

Stoneware.

In yards, areas, and out-door positions, where the trap is connected directly with the drain-pipe, and where a defect in the jointing would not be so dangerous to health as if it occurred inside the house, there is nothing better than stoneware. And as the drain-pipe is of the same material, the connection with the trap can be better made. Moreover, these traps are clean, smooth, non-corrosive, and very durable ; but such traps should always be carefully examined, to see that they are made with a proper water-dip ; as a general rule, they are *insufficiently dipped to be of any value as a trap.*

Cast-iron.

Such corrosive material as *cast-iron* should never be used for trapping off places where urine and such-like corrosive matters are likely to pass through them.

Traps independent of the "fitting" or sanitary appliance.— All traps fixed inside a house should be separate and *independent* of the "fitting," be that what it may, which is to be fixed upon them, and be made *fixtures* in a very complete way with the soil or waste-pipe to which they are to be attached.

And then, when the "fitting" gets out of order, whether water-closet, urinal, slop-sink, or whatever the fitting may be, it can be removed for repairs without interfering with the trap, or exposing the house to the waste-pipe, soil-pipe, or drain.

But when the trap forms a part of the "fitting," and is in "one piece" with it, it cannot be removed for repairs without exposing the soil-pipe, and perhaps drain as well, to the house, leaving it, in fact, in free and open communication with the soil or waste-pipe on which the fitting was fixed.

Jointing with pipes.

But there is another and stronger reason why the trap should be independent of the fitting. The junction of the "fitting" or sanitary appliance with the trap is not so important as the junction of the trap with the waste-pipe or soil-pipe, for the latter being on the drain side of the water-seal of the trap would allow any bad air or noxious gases in such pipe to escape through a defective jointing into the house, as shown by the arrows in the drawing, at A, Fig. 7, and F, Fig. 8; whereas the former, being on the house side of the trap, D, Fig. 7, would still, in case of a defect, leave the house protected by its water-seal. The jointing of a trap with a waste-pipe or soil-pipe is, therefore, of the utmost importance.*

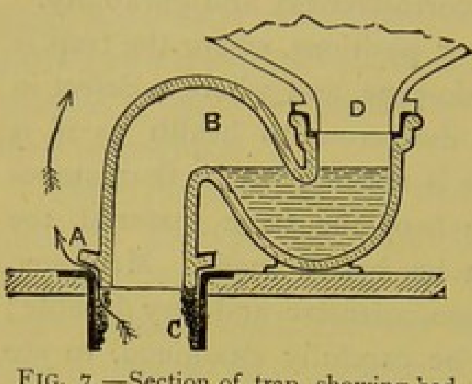

FIG. 7.—Section of trap, showing bad jointing with soil-pipe.

"Fittings" in one piece.

When any "fitting" or sanitary appliance—be it a water-closet, urinal, or slop-sink—and trap are all in *one piece*, and the material of which it is made is earthenware, or cast-iron, how is it possible to make a perfect and *durable* connection with a soil or waste-pipe which is of another material? The ordinary way of making such connections is by a cement joint, made of putty, or white or red lead, or almost anything; but such a joint is always *breakable*. A rough cleansing of the apparatus, a shaking of the floor, or a little sinking of the building, and the connection is broken and the house left exposed to the air in the soil or waste-pipe, without any protection as far as the trap is concerned. But if the connection does not get broken in this way, the cement in time dries up, and leaves the joint unsound, and the evil is that this joint may remain unsound for some time before it is discovered: for it is not like a water-leak in a pipe, it is only an air-escape, and you cannot find it out as they find out gas leakages; you know there is an un-

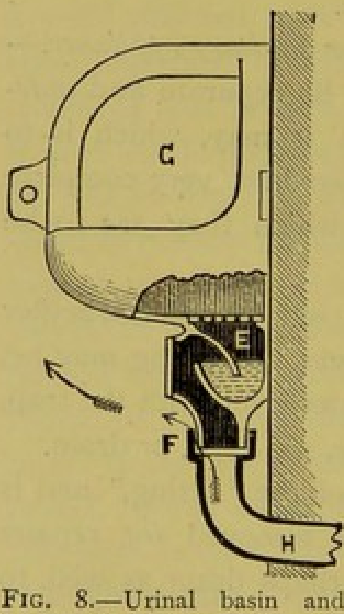

FIG. 8.—Urinal basin and trap in one piece, showing defective jointing with its waste.

* See page 170.

pleasant smell, but you cannot trace it with a light, but only in the way a dog turns up a rabbit—by the nose.

In thousands of cases where water-closets are in one piece of earthenware, or where earthenware traps are jointed to lead and cast-iron soil-pipes, defective jointings would be found on examination, and there would be very little difficulty in proving this to householders, where such "fittings" exist, if they would allow a smoke or peppermint test to be made in their soil-pipes. The writer knows of several deaths and many serious illnesses through using closets and traps which could not be soldered, or perfectly and durably jointed, to waste-pipes and soil-pipes.

EVERY SANITARY "FITTING" SHOULD HAVE ITS OWN TRAP.—No sanitary appliance—"fitting" or "fixture"—inside a house should be without a trap, which should be of lead, for reasons already given, so that it may be *soldered* to the lead waste-pipe or soil-pipe; or where cast-iron pipe is used instead of lead it should be soldered to a brass ferrule, or thimble-piece, and this ferrule should be well caulked, with spun yarn and lead, into the socket of the cast-iron branch-pipe.

The trap should be as close to the "fitting" as possible, to prevent any length of waste-pipe from being untrapped on the house side of the pipe, as it is sure, sooner or later, to get corroded, and become (more or less) offensive. Whatever unpleasant smell of air there may be in a pipe may as well be made to blow away through the air-pipe outside the house, and this can always be done by keeping the trap close to the "fitting," and ventilating the waste-pipe or soil-pipe. Trap close to "fitting."

There may be nothing terribly injurious in leaving a *short* piece of waste-pipe or soil-pipe untrapped, provided that the discharging end of such pipe does not discharge over an untrapped drain, or gulley-trap, where, if it did not become foul itself, it might become a conductor of foul air into the house. And there is nothing terribly injurious, I suppose, in going into a room filled with stale smoke from a dozen cigars and old pipes a few hours after the smokers have left the room; and yet, who would care to live or sleep in such a room? Short pipes.

WHICH TRAP TO USE.—The kind of trap must, to some extent, depend upon circumstances. When a trap is likely to remain in disuse for some months together, as in country mansions, it ought to have a greater *dip*, or water-seal, to allow for evaporation, than a trap in daily use.

Self-cleansing traps.

The most important thing in a trap is its self-cleansing powers—*i.e.*, that every part of the inside of a trap shall be washed by its own action in the passage of the water through it.

In "Lectures on the Science and Art of Sanitary Plumbing," I have laid down the principles on which traps should be constructed, and being unable to improve upon what is written there, it is here copied *in extenso*.

"PRINCIPLES OF 'SELF-CLEANSING' TRAPS.

"(1) The trap should be free from all angles, corners, and places where filth could accumulate and generate noxious gases.

"(2) A free way should be made for the discharges to pass through the trap without breaking their form, *i.e.*, the traps should be like a round pipe, so made or bent as to form a water-seal of about 1½ or 2-in. deep.

"(3) The body of the trap, for fixing in 'horizontal' pipes or drains, should be smaller than its inlet, so as to hold as small a quantity of water as possible, consistent with the position in which it will be placed and the work it will have to do, to admit of easy changing every time a flush of water is sent through it.

"(4) The minimum size* trap should be used consistent with circumstances, but governed to some extent by the size of the waste-pipe or drain on which it is fixed, and the flush of water likely to be sent into it.

"(5) The water-way into a trap for fixing to flat-bottomed vessels with a grating over its mouth should be larger than its body-part, or than the waste-pipe with which its outlet may be connected, so as to be able to send efficient water-flushes through the trap to cleanse it and its waste-pipe. (See Figs. 36 and 37 showing such traps) or the plumber can easily cone a piece of lead pipe, for receiving a larger grating or plug-and-washer, and solder this to the inlet of a syphon-trap. When the trap is much smaller than the waste-pipe, no good flushes can be sent through such piping to cleanse it.

"(6) The inlet or mouth of the trap should be so arranged that the water-flushes shall fall upon the 'standing water' of the trap with a vertical pressure, so as to drive everything foreign out of the trap, and to entirely change its previous contents.

* A trap, though of a self-cleansing form, may become a little cesspool if the size is greater than can be cleansed by an ordinary flush of water from the "fitting"—wash-hand-basin, sink, or water-closet—on which it is fixed.

"(7) The inlet side of all traps fixed upon drains outside the house should be open to the atmosphere, so that any bad air rising from foul matter decomposing in the trap, or coming through it from the drain or sewer, may readily pass into the open air, or be largely diluted with fresh air before passing into any waste-pipe, soil-pipe, or drain discharging into such traps.

"In cold countries, where the water standing in such traps would be liable to freeze in severe frosts, the mouth of the trap should be sealed over, and the foot-ventilation or air-induct should be taken into the waste-pipe, soil-pipe or drain, some little distance away from the standing-water of the trap, to prevent the cold air currents playing upon it and freezing it.* In this country, in sheltered places, there is little or no risk, and if the trap (for disconnecting waste-pipes, soil-pipes, or drains) is kept well down into the ground in exposed places, there is no danger from frosts, though in severe frosts it is well to throw a little straw over the gratings of such traps. During the severe winter of 1880-81, out of hundreds that I have had fixed, I only heard of one such disconnecting trap being frozen; and scores of them have their standing water within fifteen inches of the ground level."

Traps exposed to frost.

The traps which may be used with safety.—Any trap which in its action is self-cleansing, and is sufficiently water-locked to allow for evaporation, and to prevent "blow-downs" † or back-draughts from coming through, may be used with safety, if of a smooth and non-corrosive nature, and always provided that the trap can be made to maintain its water-seal by proper ventilation against syphonage, etc.

Lead traps.—When the trap is made of lead, it should be equal in substance to lead weighing 7-lbs. or 8-lbs. to the superficial foot, according to circumstances; in no case should it be less than equal to 6-lb. lead; and where any

* Another advantage is gained by keeping the air-induct pipe some little distance up (say 15-in.) from the bottom of a trapped soil or waste-pipe; for when a full and rapid discharge of water is sent into a soil or waste-pipe, it does not get away as fast as it enters, but accumulates in the bottom of the pipe, and, rising up in the pipe, would readily flow into the foot-ventilating or air-induct pipe if kept too low down, and foul it, and perhaps stop it up, with the discharges sent through the main piping.

† In gusty weather, where stacks of soil-pipes and waste-pipes are of full size right throughout, and are open at their upper and lower ends to the atmosphere (as they always should be), there is often a great "blow-down" of air in them. The writer has not only seen the water-seal of a trap broken, when fixed on the upper floors, but he has also seen traps entirely unsealed by the gusts of air which have blown down through a soil-pipe with an open end. A good cowl fixed on the tops of such pipes corrects this by preventing such a down-current of air through them.

quantity of hot water is likely to pass through, it should not be less than 8-lb. lead.

Caps-and-screws in traps in case of stoppage.—Traps with movable screw-caps in them, as Figs. 33 and 34, for unstopping them or the pipes on which they are fixed, are always very convenient when fixed to sinks and lavatories, etc., but to traps fixed under water-closets they are of no value, for the hand can always get down to the trap through the basin. When a trap has a " cap-and-screw " attached to it, care should be taken to see that this cleansing screw-cap is *below* the water-dip, and on the *house side of the trap*, *i.e.*, it should be under the level of the water in the trap. Where this cannot be done, through insufficiency of room or any other cause, then the cap-and-screw should be fixed on the *inlet* side of the trap, and never on the outlet or drain side, except when the trap itself is *outside the house.* The screw-cap will need to be taken off occasionally, to cleanse the trap ; but unfortunately you cannot depend upon everybody, and though it may be screwed up all right at one time it may not be at another; then, if this screw-cap is on the *drain* side of the trap, any air in the drain will work its way through this imperfect connection into the house. This may go on for some time before it is discovered where the foul air is coming from. But when the screw-cap is *under* the water, it is not only below any air in the pipe, but it is in a place that would show at once if it were not perfectly sound. And when it is on the inlet or house side of the trap, if it is not quite tight, the evil would not be so great as it would be if fixed on the drain side of the water-seal.

Bell-trap.—The " bell-trap " is one of the oldest traps now in use. It is generally employed for trapping off waste-pipes to sinks, and for surface drainage, but it is *worse than useless.* The small pipe, Fig. 10, which stands about half-way up in the body of the trap, and which forms the dip, obstructs the free passage of the water through the trap, and makes the lower part, *b*, a receptacle for dirt, which ought to pass into the waste-pipe without any obstruction.

Again, there is no room for any body of water to pass through this trap: a glance at the Section, *c*, Fig. 10, will show this. This sluggishness in emptying might have done very well in an age when time was of little value, and the people treated years as we do days. But it will not do now for servants to wait half-an-hour for a sink to empty itself through a bell-trap. And they take care not to do this; for they soon remedy this evil by pulling or knocking off the "bell-grate." But the remedy then becomes worse than the disease; for by removing the grate they have virtually

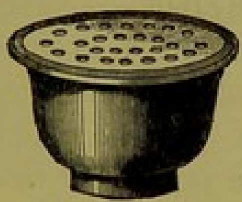

FIG. 9.—Bell-trap.

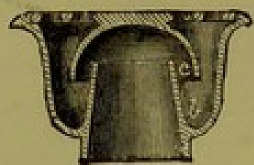

FIG. 10.—Section.

destroyed the trap, and exposed the drain to the house, and the cold, nasty air from the drain soon makes its way into the warmer atmosphere of the house.

Apart from all this, a bell-trap is imperfect; for the water-dip, as a rule, is only about three-eighths of an inch—perhaps, in some cases, it may be a little more; therefore, the slightest back draught or "puff" of air in the drain or waste-pipe soon enters the house, or the water in the trap soon evaporates and leaves it uncharged.

Antill's Patent Trap.—Fig. 11. This is a great improvement upon the bell-trap, and by the arrangement of its water-dip it remains as much trapped with the grating off as on. But it is far from what a water-trap should be: the water-dip is insufficient to shut out any strong current of air in the waste-pipe, and from the peculiarity of its construction it is not self-cleansing; any sediment getting into the compartment A, Fig. 11, is almost sure to remain there, and the compartment B cannot be got at to be cleaned out, and the covering over this compartment makes a lodgment for

FIG. 11.—Section.

grease and dirt; also there is no free passage for water to pass through the trap quickly. The partitions are soldered with a copper-bit, and the lead is too thin to last long.

D-trap.—This old-fashioned trap is a great favourite with some plumbers, and is still in pretty general use, notwithstanding all that has been said against it. It is difficult to understand why plumbers should like this trap, except it is that having so much to do with them—as undertakers with dead bodies—they think little or nothing at all about the thing. If anybody (but a plumber) could see the *inside* of this trap after it has been in use under a water-closet, say for half-a-dozen years, he would be disgusted with the sight, and would certainly prohibit its use in any house of his own. And yet, many plumbers, though they have seen the inside of a hundred traps, go on fixing them as a matter of course, and would, if they could, rise out of their very graves to fix yet another.

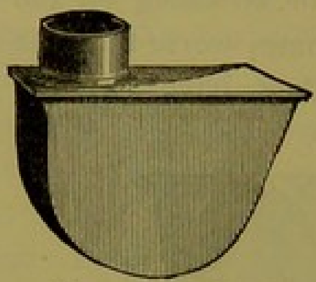

FIG. 12.—D-Trap.

Dip, position of.

The dip-pipe, *a* (see Section, Fig. 13), goes down more than

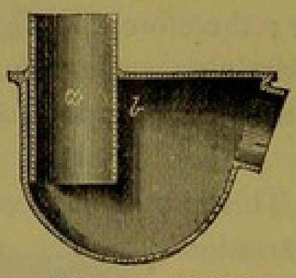

FIG. 13.—Section.

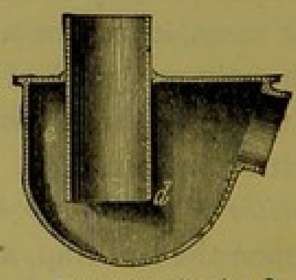

FIG. 14.—Section.*

half-way into the body of the trap, and is made to dip into the water from half an inch to an inch and a half, according to the ideas of the maker. This dip-pipe, entering so far into the trap, forms a sort of collector for all kinds of filth upon its *outer side*, where it is *impossible* to get at it to clean it away. Moreover, this trap, from its peculiar construction, is

* This is a section of a D-trap which was made by a plumber from the country between thirty and forty years of age.

PLATE II.

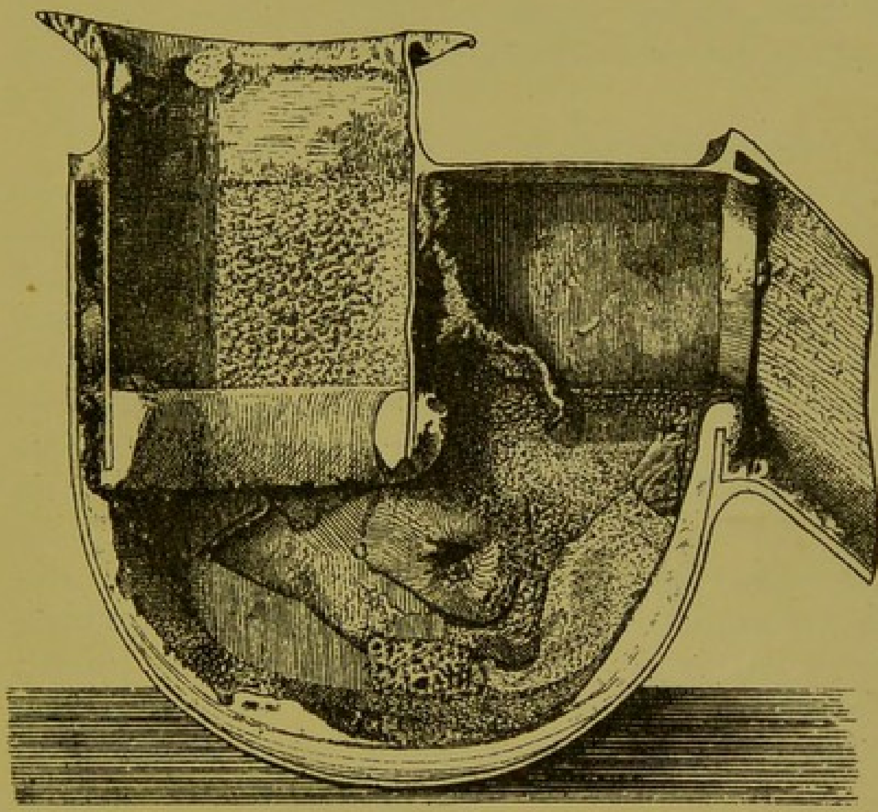

FIG. 15.

A View of the interior of an old D-trap.

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To face page 44.

full of corners and places for filth to accumulate in, without any chance of its ever being washed out; for with the utmost desire to cleanse such a trap, it is impossible to get at part *b*, Fig. 13; and round on the *outer side* of the dip-pipe (next the top part of the trap) and the space between the dip-pipe and band of the trap, *e*, Fig. 14, with any kind of brush or cleansing instrument; so that whatever collects about the inside of a trap of this kind must remain to corrode and make it foul.

The writer has seen more *old* D-traps, perhaps, than any man living; but he has never yet seen one fit for any position —except, perhaps, to put *under* the *sink of iniquity*, wherever that may be. He knows that he is *considered* to have too strongly condemned the D-trap in the first edition (pp. 9-12), but only by those who are wedded to it, and who, having noses, smell not; so he has had a faithful drawing made of an *old* D-trap,* and, unless such noseless people have eyes which see not, he thinks a sight of it, as shown in Plate II. without any *colouring*, will convince them that, after all, an old D-trap *is* a foul and filthy thing.† If this is not enough to teach them better than to use them again, they are like Romeo, in a very different sense—past help, past cure, past hope. One thing is certain, that the day of the D-trap is over, and that it is literally "going to the *pot*"—where we have consigned thousands during the last few years. Old D-traps.

There is much ignorance displayed by some plumbers in fixing the *dip-pipe* in this trap, which often gives rise to another evil: Instead of fixing it close to the "band" of the trap, as shown in Section, Fig. 13, they fix it an inch or so away, as shown by Section, *c*, Fig. 14, and thus diminish the passage-way, *d*, to the outlet, and at the same time give more room for Badly dipped.

* The trap shown in Plate II. has been drawn with great care, and faithfully represents a *general view* of the *inside* of an *old D-trap*. Scores of such traps come into our stores every month; but the trap from which this view is taken was cut out of a block of buildings where there are scores more just like it.

† The internal surface of a 9-in. D-trap, Fig. 13, is equal to about 3-ft. 6-ins. and there is no possibility of cleansing this when it has become fouled; whereas in the "Anti-D-traps," Fig. 28, the surface is only about 16-ins. sup. (leaving out the "outgo," in each case), and the whole of this surface is easily washed by a fair flush of water.

filth to aggregate round the pipe between the dip and the band, *e*. Again, the dip-pipe is either not fixed far enough down into the trap, or it is fixed too far down. When the dip is not low enough, it gets insufficiently water-trapped, and allows any air in the waste or soil-pipe to blow through it into the house; but when the dip-pipe is too far down in the trap, it obstructs the free passage of the discharge and stops up the trap.

Made by apprentices.

But these evils of the dip-pipe do not, of course, occur when the trap is made by a skilled plumber; but unfortunately everybody, not excepting apprentices, is set to work making up D-traps when there is nothing else to do, and so the trap may be right or wrong, as it happens.

The usual size D-trap for fixing under water-closets measures 9-in. from the "top" to the "band;" but some plumbers make their traps on the principle that it is impossible to have too much of a "good thing." On examining the sanitary arrangements of a nobleman's house a month or two ago, I found a 13-INCH D-trap fixed under a water-closet on the chamber-floor. This trap is illustrated in Fig. 16, and its sizes are engraven upon it. A 4½-inch pipe, C, was soldered to the "cheek" of the trap to receive the overflow-pipe from the cistern which supplied the water-closet, and into this cistern—to save pumping at times—a rain-water pipe from the roof was taken. The trap is still in the writer's possession. It holds just two gallons of water up to its proper water-line (!) but it takes 4¾ gallons of water to quite fill the trap. The smaller-sized D-traps, 6-in., 7-in., and 8-in., are used for fixing under sinks, baths, and lavatories, etc.

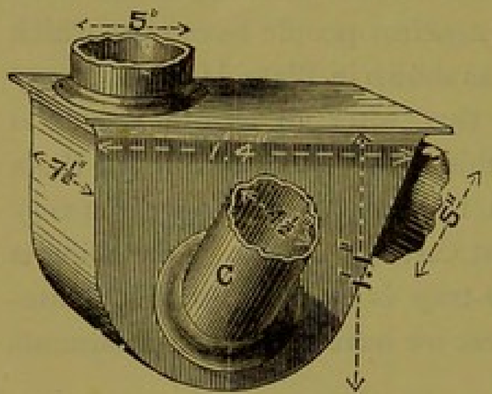


FIG. 16.—View of a 13-in. D-trap.

Dip-pipes inside traps.

There is another evil, perhaps as great as any mentioned before in connection with the principles on which D-traps are made. And this evil applies also to all traps having their dip-pipes *inside* the body of the trap. An extract from the "Lectures on Plumbing" deals with this :—

"*The evil of a dip-pipe inside the body of a trap.*—It is important also to notice the evil of having a dip-pipe inside a trap, for the dip-pipe becoming defective—from age, want of ventilation in the soil-pipe branch, or any other cause—would not show itself; *i.e.*, the dip-pipe, standing inside the walls of the trap, as in a box, would not show a water-leak, for any water escaping through a defect in the dip-pipe would fall inside the trap. But though no evil would arise from a leakage of water, great danger may come from a defect in the dip-pipe, for soil-pipe air would then find an easy passage to the house, above the water-lock of the trap, as shown by the arrows in Fig. 17. This illustration is taken from an old D-trap, recently cut out from under a valve-closet. The dip-pipe, right round, above the water-line of the trap (equal to about 12-in. by 4-in.), is eaten away in large holes, as shown in the illustration at B. The cheeks are also eaten through, and two or three holes are eaten through the top. This old D-trap shows clearly enough that serious evils may arise from using traps with dip-pipes inside them, for though the defects in the cheeks showed a water-leakage, and called attention to the trap, the dip-pipe, though more defective, and to all appearances of much earlier date, showed no such defect, for the water which escaped through its holes fell inside the walls of the trap and disclosed nothing."

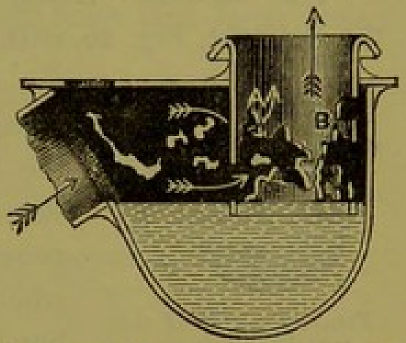


FIG. 17.—Internal view of an old D-trap, showing the dip-pipe eaten through.

The best place for all such traps is the melting-pot when it is seven times heated.

"*Narrow-band*" *D-trap.*—This is certainly an improvement upon the old form of D-trap, but it is *not* self-cleansing, as will be readily seen by a glance at the two illustrations,

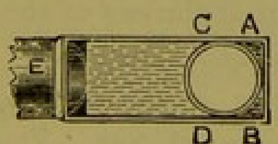


FIG. 18.—Plan of the "Narrow-band" D-trap.

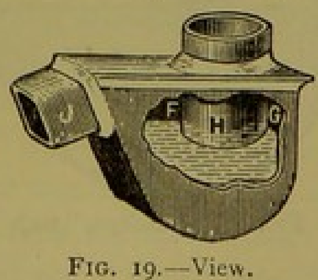


FIG. 19.—View.

Figs. 18 and 19, taken from the Author's "Lectures." The only difference between this trap and the well-known D-trap is, that the "cheeks" of this trap are brought closer to each other; but all the other evils of the old form of D-trap are to be found in this "narrow-band" or improved D-trap. As I have criticised this trap at length elsewhere, nothing more is said about it here.

The "Helmet" D-trap.—A view of this trap is given in the woodcut, Fig. 20, with the "cheek" broken away to show the dip-pipe inside the trap. The trap is made by machinery, in cast lead, and the bottom (or band) is rounded, as shown in the illustration. It is an improvement upon the old form of D-trap, whether hand-made or machine-made; but being a box kind of trap, it is an accumulator of filth, and it has also the evil of having its dip-pipe inside its body.

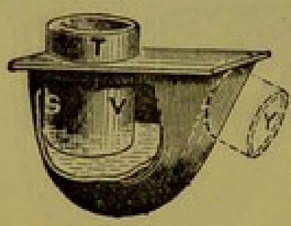


FIG. 20.—View of the "Helmet" D-trap.

"Eclipse" trap.

Fig. 21 shows a longitudinal vertical section of the *patent cast-lead "Eclipse"* trap, with an internal view of the dip-pipe. Why the patentees have called this trap the "*Eclipse*" the writer fails to see, except that they mean by it that they now intend to have nothing more to do with "d's," and so drop this letter out at the *end* of the word "*eclipse*," as they have done at the *beginning* of the word *trap*. The title is misleading in more senses than one, as the trap is *eclipsed* in more senses than one. It is pretty considerably eclipsed when under a water-closet, for instance, and still more so when fixed (as it

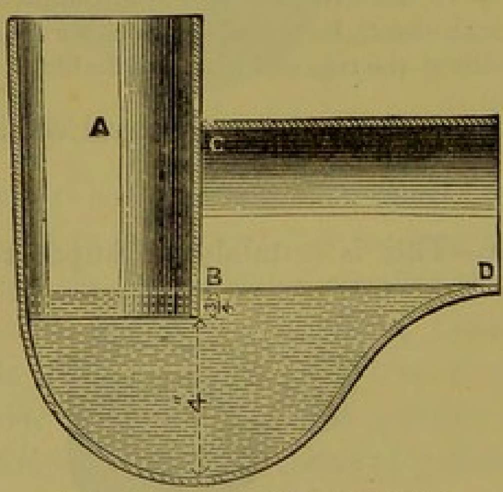


FIG. 21.—"Eclipse" trap, section.

generally would be) between the floor and ceiling. But let us examine this trap a little. In the second edition of this work, the insufficiency of its water-seal was pointed out, which was then only three-quarters of an inch. And though the seal has been increased by lowering the dip-pipe, A, as much, perhaps, as the moulds will allow, it is still insufficient to make it a good trap, apart from its other evils. Surely the inventors cannot consider an inch "dip"—if it is as much—a sufficient water-lock for a trap of that form that is to *eclipse* all other traps.

Again, the trap is *not* self-cleansing. The *outer side* of the circular partition, or dip-pipe, which goes down into the body of the trap, and which forms the water-lock just referred to,

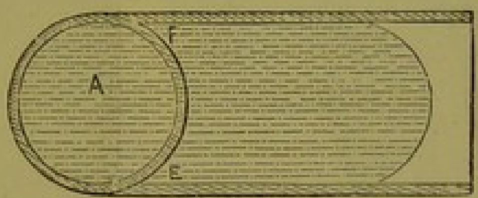


FIG. 22.—Plan.

from B to C, Fig. 21, and E to F, Fig. 22, would rarely, if ever, get thoroughly washed, though it would often get *splashed* with such offensive matter as passed through the trap.

Again, the two recesses, E and F, between the top of the trap and the level of the standing-water would become collecting-places for filth, and when once they have become foul, how will they get cleaned? The water sent down into the trap would not turn sharply round the dip at E and F, and go up to the underside of the top of the trap to C, with any scouring process to clean away the filth collected there, but would pass out of the trap at once, at D. A further evil is that the "standing-water" on the "outgo" side of the trap, from B to D, Fig. 21, is too large, as it is about two-thirds larger than the area of the inlet, and so does not stand a proper chance of being driven out at each flush of the closet. (See Plan, Fig. 22, showing this.)

The writer also considers it a mistake to have formed this dip-pipe or *circular partition*, E F, Fig. 22, which is to shut out the soil-pipe air from the house, *inside* the trap, especially as the trap, being a kind of *box*, would not disclose either an air-leakage or a water-leakage in the partition, which at times might occur through a flaw in the casting; and in such a case, any bad air in the soil-pipe would have an easy access to the *house side* of the water-seal of the trap.* But notwithstanding all the writer has said about this trap, he considers it cleaner than the old-fashioned D-traps.

"*Mansion*" *water-closet trap or* "*V-dip*" *trap.*—This trap, a view of which is given in Fig. 23, and a section in Fig. 24, is just the same in principle as Beard and Dent's "patent

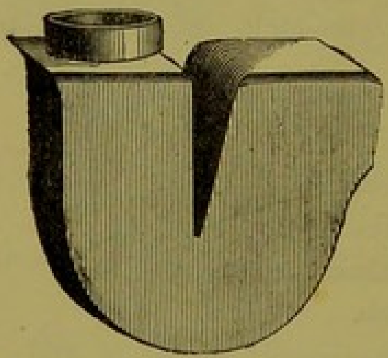


FIG. 23.—View of a "Mansion" trap.

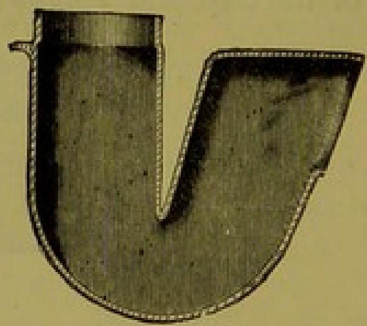


FIG. 24.—Section.

cast-lead trap." It differs from it in this: that whilst the "patent cast-lead trap" is a *round-pipe* trap, this is a *square-pipe* trap, with a square "outgo," though it may be made with a *round* outgo. And the former is made by machinery without solder, and the latter by hand with soldered angles.

Any plumber can make it.

This trap, in any size, can be made by any skilled plumber, with lead of any substance to suit the purpose for which it may be required. But the weight of the lead should never be less than 6-lb., and 7-lb or 8-lb. lead should be used for water-closet traps, and never less than 8-lb. for hot-water wastes.

To prevent the trap holding too great a body of water, it should be made as small as possible; that is, it should only

* See page 47, on the evils of dip-pipes being inside the walls of a trap.

be made just large enough for the "outlet" of the water-closet or slop-sink to enter its "inlet" or dip. It should be so constructed that the water-dip, or seal, should never be less than 1½-in. Grave errors have been committed in making this trap too large to be kept wholesome by ordinary flushings, and also by giving it too small a seal.

Finding, many years ago, that Beard and Dent's 4-inch "patent cast-lead trap" could not be depended upon to

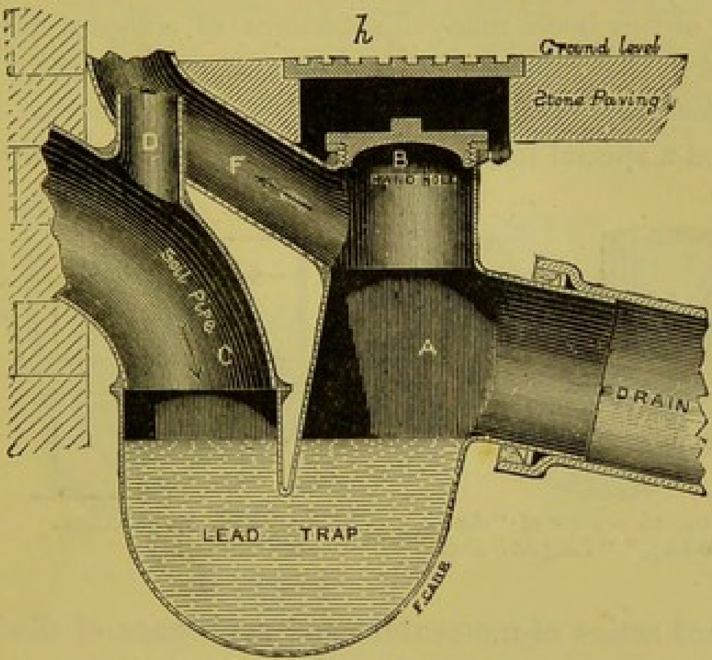


FIG. 25.—Section of a lead soil-pipe trap.

maintain its water-seal, when fixed under a *valve*-closet, used also as a slop-closet or slop-sink, with *large* "outlets," and refusing to use the D-trap on account of its uncleanliness, the writer introduced into his works this "V-dip" trap for valve-closets and slop-sinks, though this trap—in much larger sizes—has been in use by one or two plumbers for nearly thirty years. He has found, however, that this trap is not self-cleansing, though it is much easier flushed than the D-trap. Filth collects in the four angles of the square dip-pipe, especially in the part above the water-line; but as no vestige of excremental or other matters sent into a trap should find a lodgment in any part of it, he has abandoned the use of this trap for some years.

E 2

This trap, in somewhat various forms, but on the same principle, has been largely fixed by us at the bottom of soil-pipes, for trapping them off at the drains; but only one form is given here, and this is of value for showing about the first stage of giving *foot-ventilation* (D, Fig. 25) to soil-pipes, about twelve or thirteen years ago. As such rapid strides have been made in the mode of intercepting, or disconnecting, soil-pipes and waste-pipes from drains, since the publication of the first edition of this book, many illustrations of soil-pipe traps are omitted in this edition, as they have become obsolete.

Patent cast-lead "anti-D-trap."—A year or two ago I designed a special form of "round-pipe" trap, to reduce the

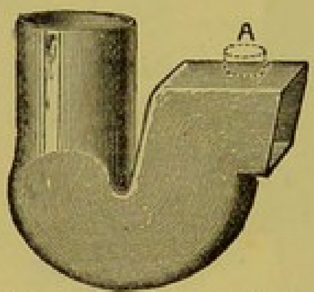


FIG. 26.—View of "Anti-D-trap," "Largest" size.

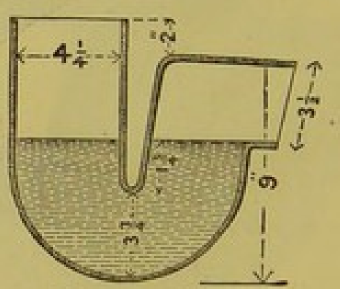


FIG. 27.—Section.

combined action of momentum and syphonage of discharges sent through a trap, giving it also a greater depth of water-seal, to allow for a little loss of water either by syphonage or evaporation.

The configuration of the trap is clearly shown by the drawings Figs. 26 to 31. This trap is made in *three* sizes, but I consider that the "largest" size, Figs. 26 and 27, is never wanted, for the "medium" size (Figs. 28 and 29) is large enough for any water-closet or slop-sink. The "largest" size is never used now on any works of which I have the direction.

These traps are made of pure pig-lead without solder of any kind. The two larger sizes are of a substance equal to sheet-lead 8 lbs. to the superficial foot, and the smallest size, 1¼-inch, Figs. 30 and 31, is equal to 9-lb. lead.

These traps have a water-seal 1¾-in. deep, and the size of each trap is given in the drawings.

The "medium" size "Anti-D-trap" (Figs. 28 and 29) is the most "self-cleansing" water-closet trap with which I am acquainted. It holds only two pints and a half of water, and the entire contents of this trap are changed* by an ordinary flush of water from the water-closet under which it may be fixed; and this is more than can be said of nine-tenths of the traps now in use under water-closets.

When fixed upon a properly-ventilated soil or waste-pipe —having its branch also ventilated—it cannot be unsealed by a discharge of the largest body of water, from a slop-pail or other vessel, that can be passed through a water-closet or slop-sink, no matter on what floor such fittings may be

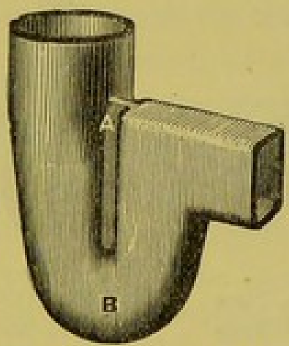


FIG. 28.—View of "Anti-D-trap," "Small" size, for valve-closets, etc.

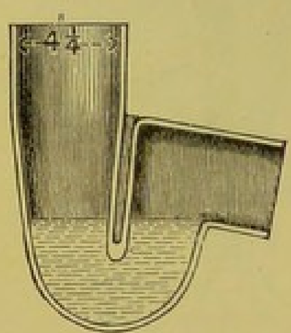


FIG. 29.—Section.

fixed nor the height at which they may stand above the trap. Nor can the seal of this trap be broken when fixed upon a stack of soil or waste-pipe, provided that the branch on which it is fixed is properly ventilated, by any discharge of water sent into or through the main piping, either from a higher or lower level than that on which the trap is fixed—*i.e.*, the trap cannot be syphoned in properly ventilated soil-pipes and waste-pipes, nor can it be unsealed by the momentum of any discharge of water sent through it, whether from a slop-pail or any other vessel. (See trap syphonage, pp. 102-138.)

On usage, every part of the inside of this "anti-D-trap" is scoured out by friction, and as will be seen by a glance at the illustrations, Figs. 28-31, there are no places where anything can accumulate and become foul. To ensure a thorough

* See Table, p. 61.

cleansing of the lower part of the trap, the water-way under the throat or dip is reduced in size, as shown by the figured dimensions, Section Fig. 29.

One of these "medium" size "anti-D-traps," Fig. 28, fixed under a valve-closet in my offices, has been used for several years by about a dozen clerks, and it has never shown any sign of stoppage, and it is just as clean now as it was after the first day or two's usage,—this is readily seen by looking into it through the glass "windows" placed in its sides for taking observations. Another of these traps has been fixed under an "artisan" water-closet for the workmen's

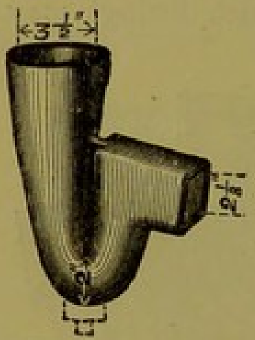


FIG. 29A.—View of $3\frac{1}{2}$-in. to 2-in. Anti-D."

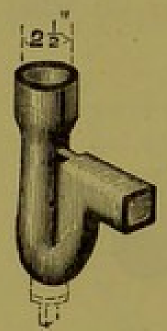


FIG. 30.—View of $1\frac{1}{4}$-in. "Anti-D-trap," with enlarged mouth.

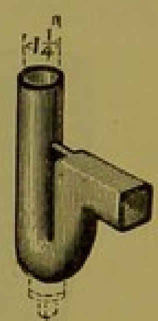


FIG. 31.—View of $1\frac{1}{4}$-in. "Anti-D-trap."

use for about the same time, and though this closet has been used by a large number of men, and has received the usual treatment workmen's water-closets get, it is just as wholesome now as it was just after it was fixed, and it has never been stopped up; and this is the result wherever these traps have been fixed.

The "smallest" size "anti-D-trap," $1\frac{1}{4}$-in., Figs. 30 and 31, is specially constructed for fixing under *quick-waste* lavatories, baths, etc., and in places where there is likely to be great syphoning action, from discharges sent through the trap itself, or through the waste-pipe on which it may be fixed, as this form of trap is found to retain its water-seal under every condition, when properly ventilated: see loss of seal in trap pp. 102-138. As this trap only holds one-quarter of a pint of water, its contents are very readily changed by a very small flush of water sent through it. Fig. 30 is intended for baths and sinks, and Fig. 31 for lavatories.

"*The patent cast-lead trap.*"—These traps are perfectly self-cleansing. They are made out of the best soft pig-lead, and are as smooth inside and out as pipe made by hydraulic pressure. The substance of the lead is regulated, but the strength is equal to sheet lead, 7lb. and 8lb. to the superficial foot.

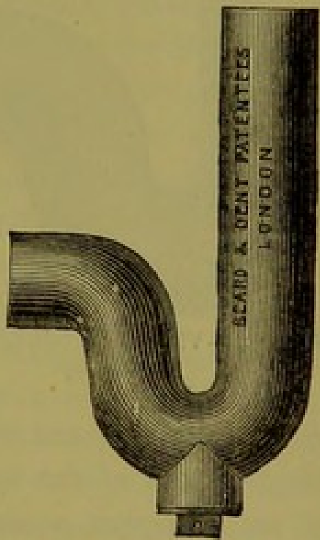


FIG. 32.—View of a "Half-S" trap.

This trap is made in two shapes, to fit "horizontal" and vertical wastes from it; and in sizes from 4-in. to 1½-in., as the clear diameter of the water-way through the trap.

It consists simply of a round pipe cast into the shape somewhat of a reaper's hook in the one case, as Figs. 32 and 34; and in the other, somewhat of the letter S, as Fig. 33. Figs. 32 and 34 are known in the trade by "P" or "Half-S," and Fig. 33 by "S."

A cap-and-screw are attached to the smaller-sized traps, as shown in Sections, Figs. 33 and 34, for cleaning-out purposes,

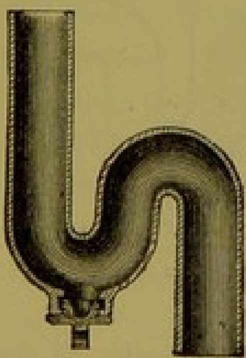


FIG. 33.—Section, "S"-trap.

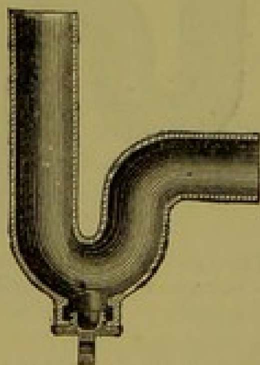


FIG. 34.—Section, "Half-S"-trap.

and for unstopping the waste-pipes on which they are fixed when necessary. The 4-in. trap, Fig. 35, can always have a cap-and-screw soldered to it when fixed in places where the hand cannot be put into the inlet, or the dip part of the trap ; but this can generally be done.

The small sizes are especially adapted for trapping off baths, sinks, and lavatories. The writer considers that the 2-in. trap, whether S or Half-S shape, is large enough for any sink, whether it be in the scullery, housemaid's room, or butler's pantry, and in the latter place, 1½-in. would generally be the better size. In all such sinks, to get good flushings through the trap and waste-pipe, the trap should have an enlarged mouth, as shown in Figs. 36 and 37, to receive the plug-and-washer or grating. For lavatories, when the "outlet" of the basin is only equal to charging the area of an inch-pipe, a smaller-sized trap than 1½-in. should be

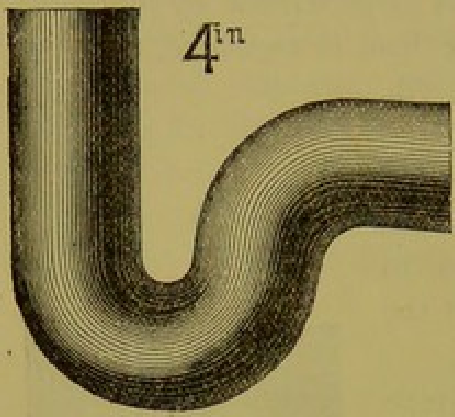


FIG. 35.—View of "Half-S" "round-pipe" trap.

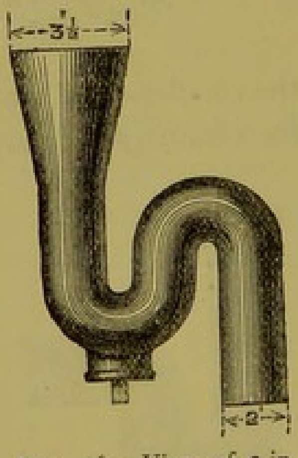


FIG. 36.—View of 2-in. S-trap with enlarged mouth.

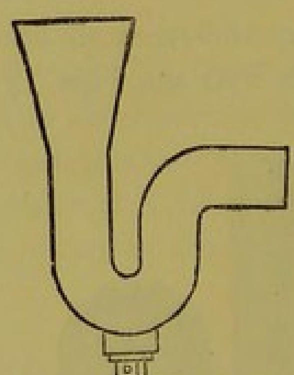


FIG. 37.—2-in. Half-S-trap with enlarged mouth.

used, though it is better to increase the outlet of the basin rather than decrease the size of the waste-pipe to an impracticable size. The "patent cast-lead trap" is not made smaller than 1½-in.,—1¼-in. would be generally the better size trap to use for lavatories (see Fig. 31).

The "patent cast-lead trap," like all traps of that form, *i.e.*, round-pipe traps, is easily unsealed—by its own action as well as from the action of others upon it—unless it is properly ventilated; therefore, where this cannot be done no such trap should be used. Acting on the principle of the well-known syphon, it is liable, when a large body of water is thrown suddenly into it, or into a pipe on which it is fixed—as from a slop-pail—to be syphoned out,—*i.e.*, untrapped. A pail of water thrown quickly into the trap fills the discharging orifice or receiving waste-pipe, and the suction at once commences; and if the waste-pipe is a long length of vertical piping, without proper ventilation, the syphoning action will continue until it has pulled the water out below the dip—the water-lock of the trap—when it immediately gets air and stops the syphoning. And then, unless there is some water behind (from the "fitting") to drain into the trap, to re-charge it, it will allow the air in the waste-pipe to escape through the trap into the house. But this defect is easily remedied. A ventilating pipe fixed on the outgo of the trap, or on the branch-waste close to the trap, will at once break the syphoning action of the discharge, except under certain conditions, and free the trap from too great a suction power of the passage, through the soil or waste-pipe. (See ventilation of traps, pp. 102-138.)

Beard and Dent's 4-in. "P" "cast-lead trap," Fig. 38, is badly shaped for maintaining its water-seal. Having explained the evil of this form of trap in my "Lectures," I make an extract here—"Though U-shaped traps (as Figs. 32 and 33) hold their seal securely enough against syphonage when ventilated,

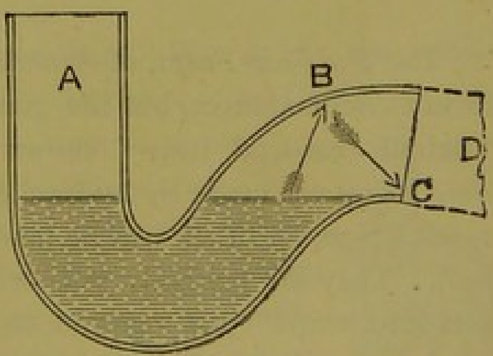


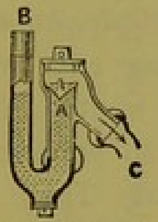
FIG. 38.—Section, trap badly shaped.

round-pipe traps having an *easy rise* to their "outlets," as Fig. 38, will not under certain conditions. When, for instance, such a trap is fixed under a *valve*-closet, and the basin is filled with water up to the brim, or nearly so, and discharged quickly by a *sharp* pull of the closet handle, the water falls in a column through the space A, between the basin and the water of the trap, and strikes the "standing-water" of the trap with such force that where a too easy passage-way exists, as in trap Fig. 38, the contents of the trap are not only *forced* out (in itself a merit) but the water rushes through the trap with such momentum that insufficient is left in the trap to re-charge it, except where a proper service of water is laid on to the closet to pass through with the discharge in a more broken form."

But this is not the case with the "anti-D-trap," Fig. 28, possessing as it does, a more "vertical" rise to its peculiarly-shaped "outlet." The water, when discharged with some force into such a trap as Fig. 38, as from a valve-closet basin or slop-pail, in a long hopper closet, strikes against the too-sloping side B, and then glancing off, as a ball would, to C—as shown by the arrows—runs away through the soil-pipe D; but in a trap shaped as Figs. 28, 29 and 31, the water would have no such sloping side to glance off from, but rising vertically out of the trap would strike against the *flat top* of the outgo, and partly fall back again into the trap and re-charge it, unless at the same moment a syphoning action was set up by the passage of the discharge through the soil-pipe, *through insufficient ventilation.* (See trap syphonage, pp. 102-138.)

The *Du Bois Traps*, of America, can be made in *any* shape to suit circumstances, but the general form is similar to the "patent cast-lead traps" shown in Figs 32—34. The *Du Bois Traps* are made by hydraulic pressure in the same way as lead pipe, and they can be made with any depth of water-lock. They are perfectly self-cleansing, but like the "patent cast-lead traps" just referred to must be ventilated to prevent syphonage. These traps would be more valuable if made of greater strength.

Traps with check-valves, or *mechanical traps.*—It should be a *sine quâ non* that all traps should be *self-cleansing*. The writer therefore prefers the trap to be free from any check-valve, so that the discharges may pass freely through them to the waste-pipe without any impediment. But where it is impossible to leave the discharging end of the waste-pipe open to the atmosphere, or where the waste-pipe is of considerable length, and where the "fitting" itself cannot be moved, it is better, perhaps, that the trap on such a waste-pipe should have a double check—such a trap, for instance, as Waring's "*sewer-gas check-valve*," as shown in Fig. 39, or Buchan's "*syphon-*



'IG. 39.—Section, Waring's check-valve.

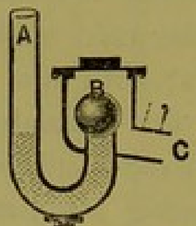


FIG. 40.—Section, Buchan's check-valve.

trap with check-valve," as Fig. 40. These traps are wonderfully alike in principle. They are similar in shape to the patent cast lead S-trap, but they have this addition—immediately over the standing water of the trap, on the outlet side next the waste-pipe (at A, Fig. 39, and B, Fig. 49), a metallic or other valve is made to *seal* over the passage-way to the waste-pipe, when this is out of use. (See Sections, Figs. 39 and 40, showing this.)

BOWER'S "*patent sewer-gas trap*," Fig. 41, is also made with a *double check*; but the extra check is on the house side of the standing water of this trap, at E, leaving the water (as in other and ordinary traps) exposed, and to be impregnated with the gases, when they exist, in the pipe. And should this extra check become imperfect (as it would through dirt, etc., getting under the seating of the ball), such noxious gases would pass through this trap as easily as through the ordinary syphon trap. But that is not its chief objection. The body or well of the trap, into which the dip-pipe enters several inches to form its water-seal, must from its very construction become filthy, though it is advertised as "self-

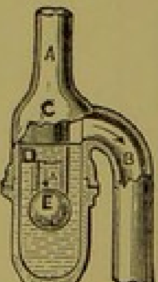


FIG. 41.—Section.

scouring." Another objection is, that the power by which this check, E, is formed has to be overcome by the discharges before they can pass through the trap—*i.e.*, the discharges into the trap must first force down the india-rubber ball or float, E, (buoyed up though it be by the standing water in the trap) before they can push their way through to the waste-pipe.

Traps to prevent pipes becoming ventilators.

When traps are fixed as shown in Plates IX., X., and XX., with the main waste-pipes and soil-pipes open to the atmosphere at both the *upper* and *lower* end, and the traps themselves are ventilated, all that is wanted is, that such traps shall have a sufficient water-lock to prevent the waste-pipes becoming air-inlets to the house. There will be no need, in such cases, of check-valves to exclude noxious gases; for when they exist at all they will not, with such an arrangement of ventilation, press their way through the water-seal of the traps, but will escape through such ventilating-pipes to the open air.

The following tables, showing the water-flushes required to cleanse certain traps, and the necessity of trap-ventilation, is taken from my " Lectures on Sanitary Plumbing."

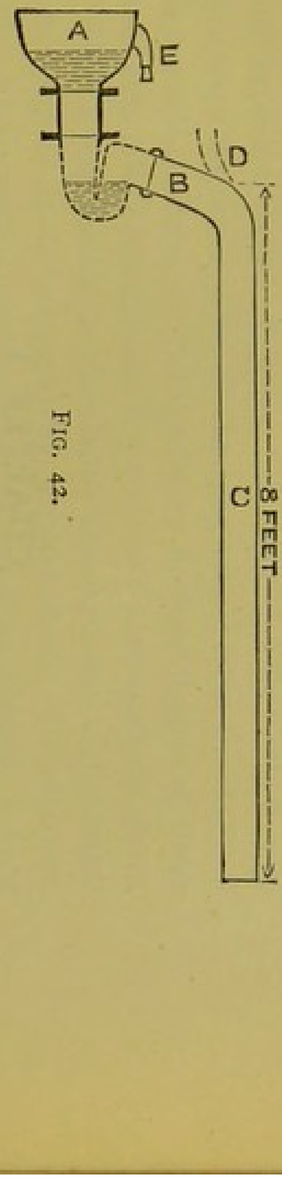


FIG. 42.

TABLE (No. 1) SHOWING THE NUMBER OF WATER-FLUSHES REQUIRED TO CLEANSE VARIOUS TRAPS OF CERTAIN MATTERS PUT INTO THEM.

NOTE.—The traps were each fixed in turn under the valve-closet, A, and connected to the 4-in. soil-pipe at B, as shown in the wood-cut, Fig. 42. The basin was filled up to the overflow-arm in each flush (about one gallon of water), and no water was allowed to come into the closet during the time of the discharge.

Quantity of Water in Trap.	Depth of *Dip*, or *Seal*.	Traps Tested.	RESULTS. Matter put into Traps, with number of Flushes to clean same out.			
			Twelve pieces of W.C. Paper, 6½-in. × 5-in.	Six pieces of Paper, and six pieces of short India-rubber Tubing.	Ten pieces of India-rubber Tubing.	Two teaspoonfuls of Ink.
2½ Pints	1⅜-in., *f.*	"Anti-D-Trap," "*Small*" size, Fig. 28 ...	One flush	One flush	One flush	One flush
5¾ Pints	1¾-in., *b.*	,, ,, "*Large*" size, Fig. 26 ...	Two flushes	Two flushes	Two flushes	Two flushes
6½ Pints	1¼-in.	D-Trap (*cast lead*)	Two flushes	Three flushes	Four flushes	Three flushes
5 Pints	1¼-in.	,, "*Narrow-band*," Fig. 19	Three flushes	Three flushes	Three flushes	Three flushes
4¾ Pints	1¼-in.	,, "*Helmet*," Fig. 20	Three flushes	Two flushes	Three flushes	Three flushes
3½ Pints	1-in., *b.*	"Eclipse" Trap, Fig. 21	Two flushes	Two flushes cleared all, except one piece of paper.	Two flushes	Two flushes
4½ Pints	2-in.	"Round-pipe" Trap, "U-shaped," Fig. 35	One flush	One flush cleared all, except one piece of paper.	One flush cleared all, except one piece of I. R.	One flush

N.B.—With the same matters put into the closet-basin, A, instead of into the traps, it took an *extra* flush in the "self-cleansing" traps, and in the "non-cleansing" traps two extra flushes, to pass the same matters out of the basin and through the trap. With a proper service of water laid on to the closet, and the matters put into the basin instead of into the trap, the results were about the same as (in Table 1) with the matters put into the trap and no water laid on to the basin. The tabulated tests were made without any water laid on to the closet at the time of the discharge, to prevent one trap getting a greater flush than another.

CHAPTER V.

DRAIN-INTERCEPTING TRAPS FOR WASTE-PIPES, RAIN-WATER PIPES, AND SOIL-PIPES.

Triple-dip trap—Mansergh trap—Gulley-trap—Dean's trap—Lip-trap—Field's Flushing-tank, used as a trap—Drain-interceptors—Rain-water trap—Rain-water shoe—Grease traps—Soil-pipe intercepting traps—"Combination" soil-pipe traps.

Traps for intercepting waste-pipes from drains.—Knowing the importance of intercepting all waste-pipes which enter the house, and also of exposing the discharging-ends of such pipes

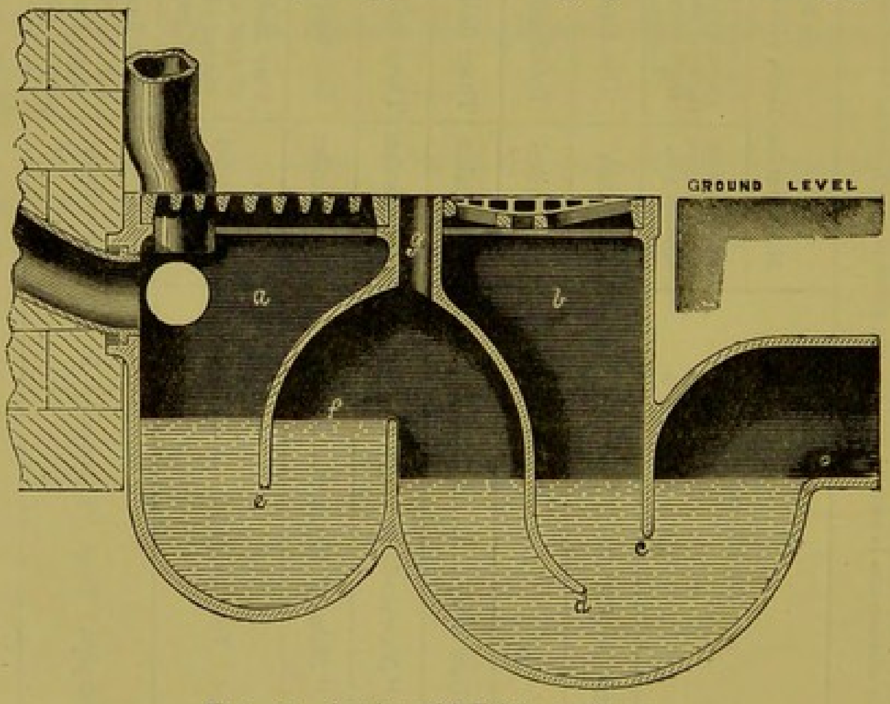


FIG. 43.—Section of "Triple-dip" trap.

to the atmosphere outside the house, I designed, some years ago, a stoneware trap which most effectually does this. In constructing this trap more care was taken to make it an *intercepting* trap than a self-cleansing one. This trap, as shown by a glance at the section, Fig. 43, has three dips, and two separate bodies of water, but however effectually it may intercept the waste-pipes discharging into it from the drain, it is not self-cleansing—*i.e.*, an ordinary flush or flushes of water sent into it will not cleanse it ; and, as I have said elsewhere, " when a trap cannot be thoroughly cleansed, and all the water standing in it be changed by a good flush of water sent into it, it ought never to be used ; and so, though I hold a patent for this trap, *I condemn it* as unfit for use."

" *Mansergh" trap.*—This is a stoneware trap, much liked by many, and though modern has had an extensive sale. It was one of the earliest traps used for breaking a direct connection of the waste-pipe with the drain, and is entitled to some consideration on that account, but it is not a fit trap to use for intercepting waste-pipes from drains. I condemn this trap, first, because it is *non-cleansing ;* and secondly, because it does not leave the end of the waste-pipe (discharging into it) *open* to the atmosphere.

A fair look at the illustration, Fig. 44, will show practical men that this flat-bottomed, trunk-shaped trap is non-cleansing. The body part is shaped like a trunk, or box, with a partition across it, dividing it into two unequal compartments for holding water in each, as shown at A and B. An opening is made in the middle or upper-part of this partition, for the discharges to pass from the inlet-compartment to the outlet-compartment.

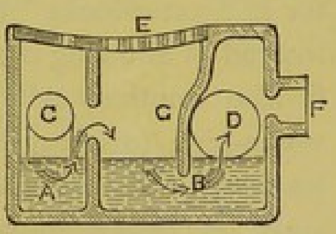


FIG. 44.—"Mansergh" trap, section.

A dwarfed partition is taken down from the top of the trap, as shown at G, to screen the outlet and to prevent the drain-air escaping. A round bent-pipe, called the " inlet," is formed in the side of the smaller compartment, as shown at C, for receiving the end of a sink or lavatory waste (or any other such pipe), and this pipe is dipped into the " standing-water " of the trap. The " outlet " of the trap, a round-pipe, is formed at the opposite angle, as shown at D. Provision is made at F for ventilating the drain with which the trap is connected. A large opening over the centre part of the top of the trap is made, as shown in the illustration, for receiving surface drainage, and for allowing any gases which may generate in the trap to escape through the grating E. So much for its construction: a word or two will suffice to show that this trap is not only not self-cleansing but that it is dirt-holding. In use it must form itself into a "collecting-box," for there are no less than eight corners for filth to accumulate in; and no amount of water sent through such a trap could scour the parts fouled. The bottom is flat, the sides are vertical, the partition dividing the two compartments is upright, and the area of the surface water of the trap is several times greater than its inlet or its outlet. So that the "standing-water" of the trap, with its decomposing matter, could not get changed by any single flush, nor by many flushes of water sent through its "inlet." The bad air from this contaminated body of water, if it did not escape through a *waste-pipe* into the house, would at times blow in at the window, or door, when near it.

Again, the arrangement of the "inlet" is bad in principle, for it "water-locks" the discharging end of the waste-pipe, instead of allowing it to be exposed to the atmosphere. There is also another evil in connection with this, namely, the waste-pipe (discharging into such a trap) being trapped at its *outlet* end—*i.e.*, the remotest end of the pipe from the sink, or "fitting"—would expose the house to any bad air or decomposing matter left in such a waste-pipe. We saw in Chap. II. how foul such pipes get, and we know that every time a little hot water is sent through them what action is set up by the corrosive matter on the sides of the waste-pipes; the vapour coming from this would pass readily through the sink-grating into the house. This trap, therefore, is not the right kind of trap to use for receiving "dirty water" wastes, *i.e.*, from sinks, lavatories, urinals, etc., where such water, remaining stagnant in the trap, would become offensive. If any reader doubts this, let him try the effect of stirring up the water standing in such a trap, and his doubts will soon be removed.

Gulley-trap. Fig. 45 shows a view of the inside of a well-known gulley-trap, which is being largely used for intercepting waste-pipes from drains, and therefore an illustration is given here (with a section of a waste-pipe, E, coming through a wall and discharging into it at D) to show its unfitness for such purposes. The arrows show the evils likely to arise from using such a trap. As well might a school-boy attempt to change the contents of a pond by discharging his little syringe into it, as to attempt to flush out the contents of such a trap by discharging a "flush" of water from a lavatory or any other similar vessel into it. As I have said elsewhere: "It

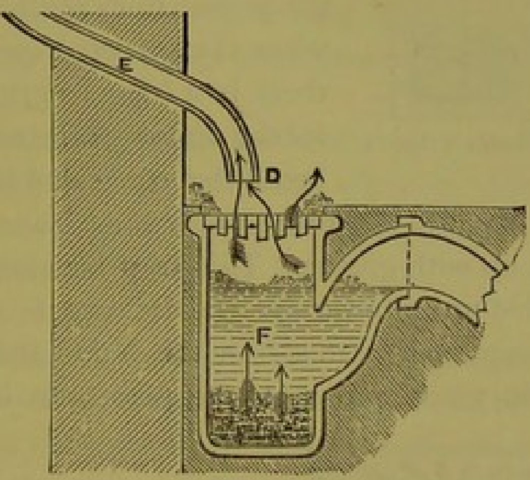


FIG. 45.—Internal View of a Gulley-trap.

may be a good trap for catching detritus, and therefore just the trap to use in yards and streets for surface drainage; but as traps for receiving the discharges from waste-pipes are not wanted for *catching* (in the sense of holding) anything—not even a 'sunbeam,' much less decomposing matter—it is not the right kind of trap for sink, urinal, and lavatory wastes, etc. etc. It forms a catch-pit for filth and decomposing matter, and no ordinary flushes of water would cleanse it."

Dean's Patent Stench-Trap.—Fig. 46 shows a section of this stoneware trap. As will be seen by the drawing, it is constructed on the principle of the gulley-trap, and it has this great advantage over it, that the matter collecting in the well of the trap is easily removed by drawing up the silt-box B. But this trap being non-cleansing is not a fit trap to fix near any opening to the house, especially for receiving the discharges from sinks, lavatories, urinals, etc., for whenever foul water is collected and allowed to stand in a vessel, it is sure to throw off bad air and become a nuisance; and such a trap, as will readily be seen by the drawing, holds a body of water so large that it would never be driven out, or changed, by the use of any of the "fittings" or "fixtures" discharging into it. Nor is it the right kind of trap to use for intercepting the grease from scullery-sink wastes where there is much cooking, or where there is a long length of drainage; for the discharges into the trap would break the congealed head and send pieces of grease into the drain. Besides, such a trap would soon get clogged up with grease. This trap is valuable for fixing outside stable walls to receive the drainage from stables, etc., and to intercept such matters from the drain. It is also valuable for fixing in yards and such-like places, to intercept mud,

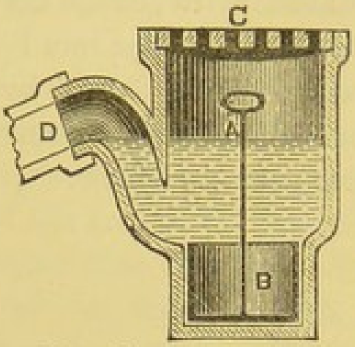


FIG. 46.—Dean's Trap.

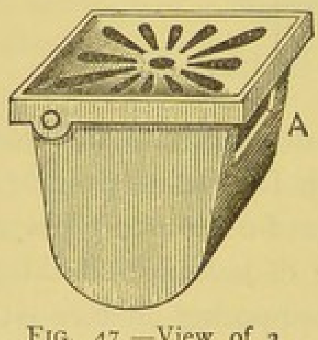


FIG. 47.—View of a "Lip"-trap.

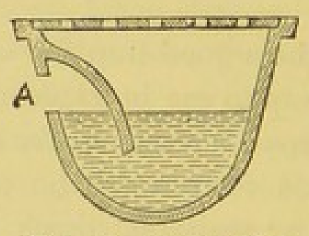


FIG. 48.—Section of a "Lip"-trap.

yard-sweepings, etc., from the house drain, as the detritus collecting in the silt-box, B, of the trap could easily be cleared. The trap is provided with an excellent water-seal, for fixing in such places as just referred to, as it allows for evaporation.

"Lip"-trap. Another trap much used for intercepting waste-pipes from drains is illustrated in Figs. 47 and 48. It is called the "lip"-trap—from the form of its outlet, A—and is made of cast-iron, but why it should have received so much favour is a mystery to anybody concerned for the fitness of things. The illustrations show that there is no outlet *nozzle* (see A, Figs. 47 and 48) to this trap, for connecting it properly to a drain-pipe. The fact is, a very clumsy connection is nearly always made with this trap. It is generally let into a stone and fixed over a brick-shaft, and in such a manner that it is impossible to send a flush of water through such a trap in the ordinary way, which shall keep the shafting clean and wholesome. Then the trap itself, though much superior to a bell-trap, is not of the right shape to be flushed out by the use of any waste-pipe discharging into it, or over it, as must be the case whether the trap be let into a sunk stone or not.

What is wanted is a small earthenware "round-pipe" trap, with a receiving head for the waste-pipes to discharge into, which will allow its contents to be changed by a small flush of water sent into it through its waste-pipe.

Field's Patent "Flushing Tank" for receiving "Dirty" Water-wastes.—This apparatus is very valuable for many purposes, as for collecting rain-water for the flushing out of drains (see pp. 281, 282); but it is hardly the thing for collecting the waste-water discharges from sinks, unless it is kept some distance from the windows and doors of the house.

Everybody knows that Mr. Rogers Field is much too good a sanitarian ever to have intended that this tank should be fixed in such a position. He invented this tank, I believe, for *collecting* the *general wastes* of a small house, to pass them in larger bodies into the drain, instead of allowing each sink-waste to dribble separately into it; and for this purpose, where there is a *long* length of drainage, it is valuable, but where so used, another flushing-tank should be fixed at the head of the drain for the periodical cleansing of the drain with *clean* water. The drain would otherwise get fouled (on its upper side) by the full charges from the "dirty" water flushing-tank, where it would not be likely to be cleansed again, and great evils might ensue. (See pp. 6 and 282, showing the value of this tank for flushing out drains.)

We will suppose this tank is fixed just outside the scullery window (where, no doubt, it is often fixed) of a gentleman's house in the country. The cook and scullery-maid empty *all sorts of slops* down the scullery-sinks, greasy water from the soup and dinner plates, green-water (hot and strong) from the saucepans, soapy water from the wash-hand bowl, and sour milk-cans are scalded out and drained into this common receptacle. And this goes on from day to day until the tank is nearly full to the brim, at which point it may remain for several days; for the discharges into the tank would often not be rapid enough to start the syphon; but, by-and-by, the syphon-pipe is charged, and this stagnant body is syphoned out. No, not out! for from a sixth to an eighth of its water would be left behind, as shown at G, Fig. 49, as the syphon would draw air, and cease to act, so that the filth which would be constantly settling down in the tank would remain there until the tank was cleaned out by hand, which, one is afraid, would not be often, as it is too deep to get at conveniently.

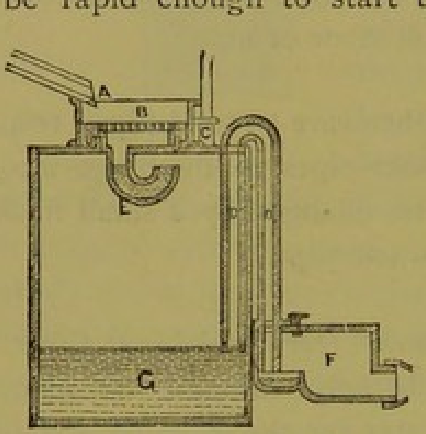


FIG. 49.—Vertical Section.

Water in the tank unchanged.

Again, at times the family would leave their country house for their town house, just when this tank was about half or two-thirds full, when this stagnant water, or miscellaneous mixture, would remain unchanged for consecutive weeks or months.

Filth on the trap.

Another fault is that the slops from the various sinks discharge *over* the grating, B, of the trap, at the top of the tank, so that bits of grease, soap, boiled cabbage, and such-like offensive matter are allowed to splash about on the top of this tank.

Waste-pipes as ventilators.

There is another evil, though the tank *per se* ought not to be blamed for this. Untrapped waste-pipes varying in length from 5 to 15 feet, from the scullery or other sinks, are made to deliver on to the top of the grating to this tank.

Such pipes, therefore, become *air-inlet* pipes to the house, *i.e.*, the air is drawn into the house at A through a pipe, which in time is sure to become very foul.

Intercepting-traps.

"*Drain-Interceptors.*"—I have designed a variety of intercepting-traps, for receiving waste-pipes and soil-pipes, and exposing the ends of such pipes to the atmosphere, thereby insuring perfect disconnection from the drain. These traps are made in strong stoneware, and have a water-seal of 2½ in., and are well vitrified and salt-glazed. They are specially constructed to be self-cleansing; for this purpose the

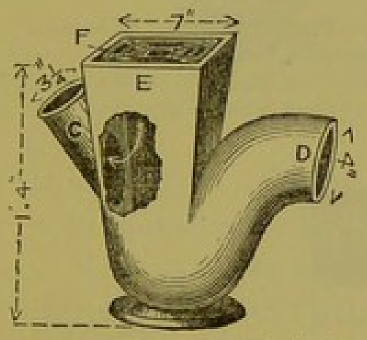


FIG. 50.—View of "Drain-interceptor," "No. 1" size, with oblique arm, C, at end.

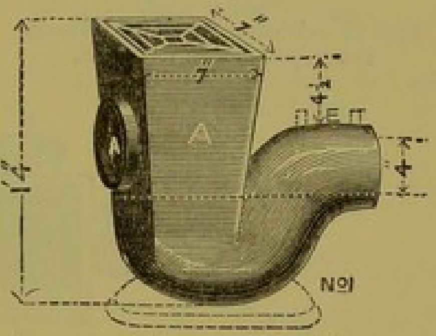


FIG. 51.—View of "Drain-interceptor," "No. 1" size, with socket-hole, A.

smaller sizes are strongly recommended in preference to the large size.*

Fig. 50 shows a view of the small-size, or "No. 1," "Drain-interceptor," with a short oblique arm, C, for receiving a waste-pipe from a sink, bath, or lavatory, and exposing its end to the atmosphere, as shown by the arrow in Fig. 50.

Fig. 51 shows a similar trap, but with a socket-hole, A, instead of the oblique arm, for receiving "horizontal" waste-pipes.

Figs. 52 and 53 show a *plan* of this small-size, or "No. 1" "Drain-interceptor," for receiving *one* waste-pipe, either on the right-hand side, as shown at W, or on the left-hand side, as shown at T.

* Wherever *foul water* is collected and allowed to stand in a vessel, it is likely, sooner or later, to become a source of danger; therefore, keep the traps *small* that the water in them may be changed by every flush passing through the trap.

These traps are made both with arms and holes in their sides for receiving one, two, or three waste-pipes—from baths, sinks, lavatories, etc.—as shown in the several plans, J, H, L, M, P, R, S, T, W, Figs. 52 to 56.

There is great advantage in using the traps with the

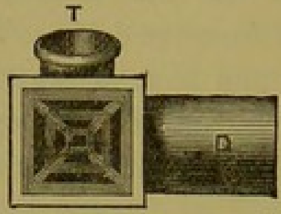


FIG. 52.—Plan of "No. 1" "Drain-interceptor," arm left-hand.

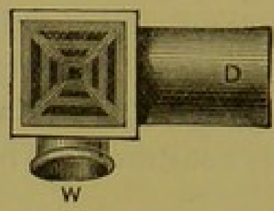


FIG. 53.—Plan of "No. 1" "Drain-interceptor," arm right-hand.

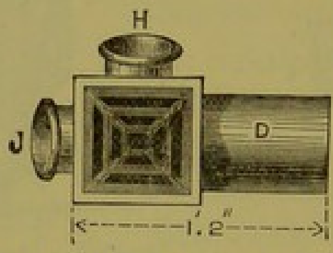


FIG. 54.—Arm at end, and left-hand.

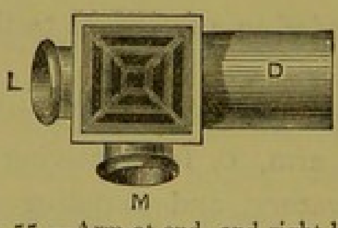


FIG. 55.—Arm at end, and right-hand.

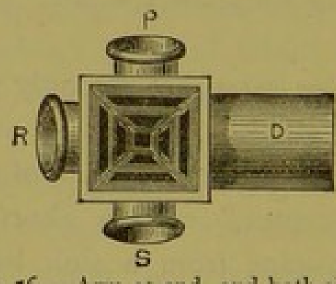


FIG. 56.—Arm at end, and both sides.

oblique arms, for the discharges are then made to fall with an unbroken vertical force upon the "standing-water" of the trap, to change its contents every time a flush of water is sent into it, through one or more of the waste-pipes discharging into it.

The "*medium*" *size*, or "No. 2," "Drain-interceptor" is constructed for fixing in yards, or areas, to drain away the surface-water, and also to receive one or more rain-water drains, etc. Short socket-arms are made in the end, or on either side, or on all three sides, as shown at N, T, V, Fig. 57, for receiving waste-pipes or drain-pipes, and for the discharges through such drains to fall with a vertical force upon the "standing-water" of the trap to change its contents and make

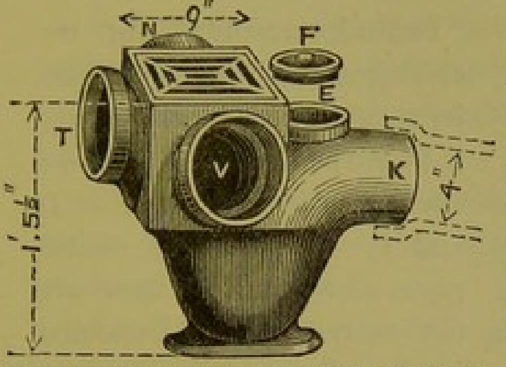


FIG. 57.—View of "medium" size "Drain-interceptor," with socket arms.

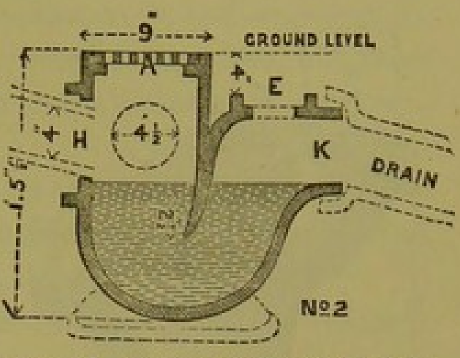


FIG. 58.—Section of Trap, with *holes* instead of arms.

it wholesome. Or this intercepting trap, "No. 2," can be had with counter-sunk holes, as shown in Fig. 58.

Fig. 59 shows a view of the large-size, or "No. 3," "Drain-interceptor," with "outgo" for fitting into the socket of a 6-in.

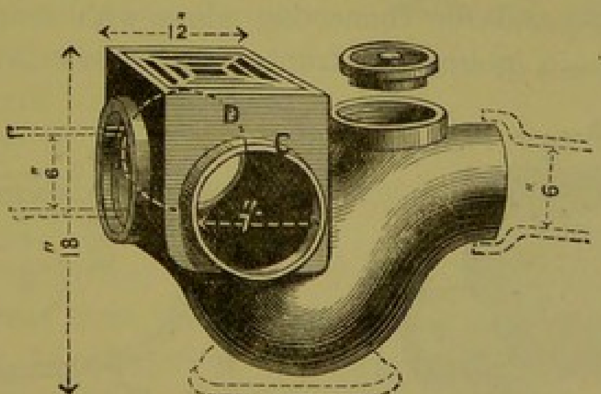


FIG. 59.—View of "Drain-interceptor," large size, or "No. 3."

drain-pipe. The head of the trap is enlarged, as shown in the wood-cut, for receiving a 6-in. drain at the back, and two 4-in. drains in the sides, at D and C. Provision is made for ventilating the drain as shown or this aperture can be used for giving access to the drain.

The larger sizes should never be used where the smaller or smallest, size can be made to answer the purpose, to prevent a larger body of water "standing" in a trap than can be flushed out by the ordinary use of the waste-pipe, or drain, discharging into it.

Rain-water Trap.—Fig. 60 shows a view of a "No. 1" "Drain-interceptor," for receiving a rain-water pipe into its socket, A, and intercepting it from the drain. Apertures are made in the sides, at D and E, for receiving waste-pipes as well; when these are not wanted they can be sealed over. Stoppers are sent out with each trap for the purpose.

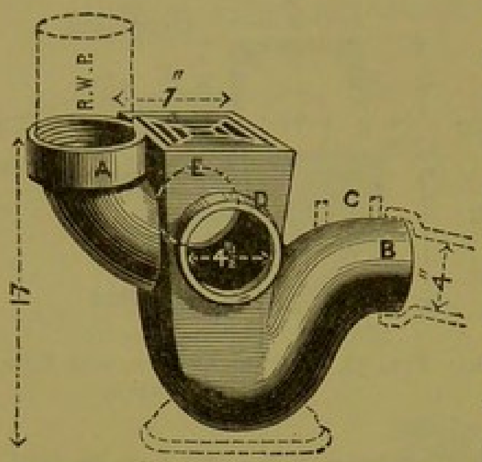


FIG. 60.—View of "Rain-water Interceptor" Trap.

Fig. 61 gives a perspective view, and Fig. 62 a section of a stoneware "Rain-water shoe," or "Disconnector,"* which I have patented, for fixing at the bottoms of R.W. pipes and waste-pipes, and for connecting same with branch drains leading to an intercepting-trap on the main drain, as shown

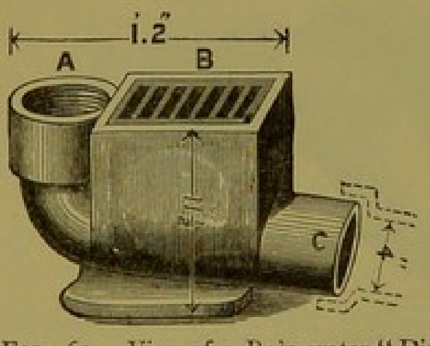


FIG. 61.—View of a Rain-water "Disconnector."

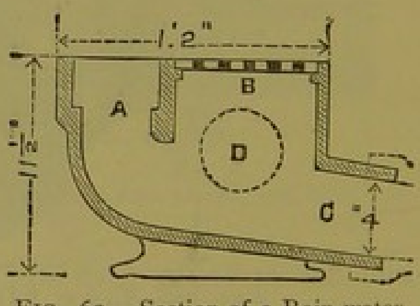


FIG. 62.—Section of a Rain-water "Disconnector."

at Fig. 232, page 284, to avoid long lengths of unventilated branch-drains. The elbow socket, A, is made large enough to receive a 4-in. cast-iron rain-water pipe; but, of course, a smaller pipe can be made good into it. The *outgo,* C, is made to enter the socket of a 4-in. drain-pipe, but when the drain is only 3-in. a diminishing-pipe can be fixed to the shoe-piece to

* See Plate XXIV., facing page 284, showing these "shoes" fixed.

suit the size of the drain. This outgo, C, can be turned round to any point to suit circumstances. The grating, B, is made to take away, to give access to both the drain and rain-water pipe.

Apertures are shown in the sides, at D, and opposite, for receiving 4-in. (or smaller) pipes when so required, but these rain-water shoes are always sent out without such apertures, unless they are so ordered.

Sockets to receive various-sized cast-iron rectangular rain-water pipes for connecting with the socket, A, Fig. 61, can easily be made in lead.

Fig. 63 shows a view of a 4-in. stoneware drain "disconnector," or air-shaft, for fixing in a long length of drain, between the intercepting-trap of a branch drain and the "rain-water shoe," explained in a paragraph just preceding this. When the head of the shaft, B, is not high enough to reach the surface, it can always be heightened by brick-work as required, and the grating, B, let into a stone over it. The socket, A, Fig. 63, is made to receive the spigot end of a 4-in. drain-pipe.

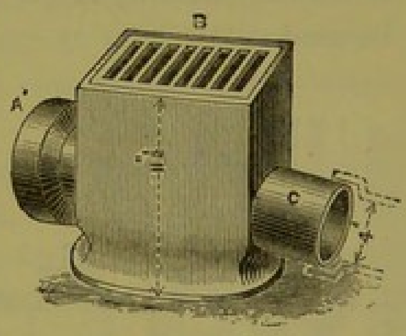


FIG. 63.—Air-shaft.

Grease-intercepting Traps or Tanks.—Traps for receiving the discharges from scullery-sink wastes are treated under the heading, "Scullery Sinks and their Wastes," Chapter VII. Grease-traps.

Drain-intercepting Traps for Soil-pipes.—Sanitarians are now agreed that waste-pipes from sinks, baths, lavatories, etc., should discharge with *open ends* into intercepting traps (either under or over their gratings) outside the external walls of the house. But they are not all agreed on this matter with regard to soil-pipes. I have proved in many ways, and by a large experience in the use of the open or "disconnecting" traps described in the following pages, that soil-pipes may be severed from the drain in nine cases out of ten (if not in the tenth), and made to discharge with open ends into Soil-pipes with open ends.

intercepting-traps; but they and their belongings must be properly treated. (See pp. 164—167.) In cold countries, as in certain parts of America, it would be impossible to use such open traps (on account of frost) for intercepting either soil-pipes or waste-pipes; and in this matter they stand at a great disadvantage, for the opening out of waste-pipes, soil-pipes, and drains to the atmosphere is one great method for excluding noxious gases from the interior of our houses.

Drain-traps, small size.

In selecting intercepting-traps, for fixing on any part of the drain, it is important to remember that unless such traps are "self-cleansing" they will, sooner or later, become a nuisance. No trap larger than is absolutely necessary should be used.

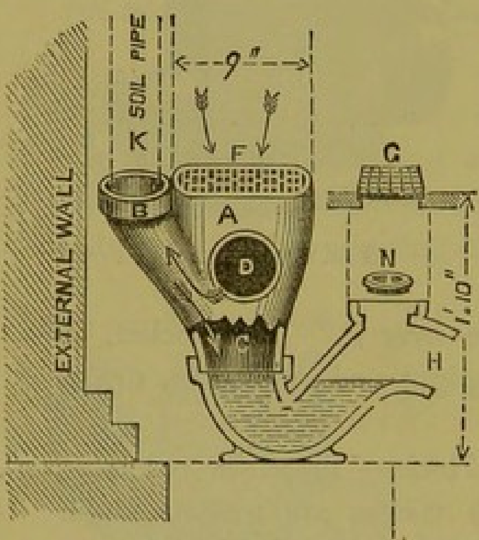


FIG. 64.—"Soil-pipe Intercepting-trap," for vertical soil-pipe.

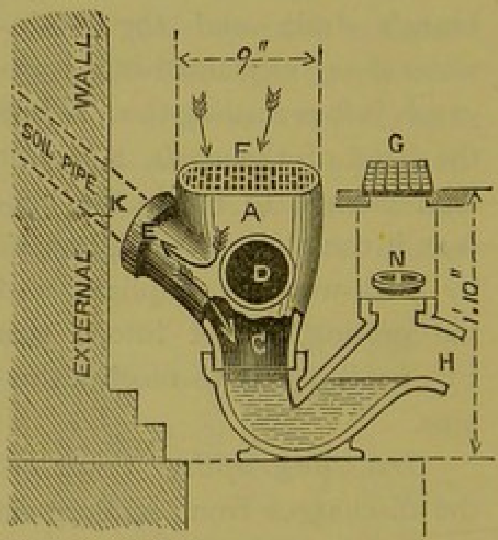


FIG. 65.—"Soil-pipe Intercepting-trap," for "raking" soil-pipe."

Soil-pipe traps.

Figs. 64 and 65 illustrate a stoneware trap which I have designed, and patented, for intercepting soil-pipes and waste-pipes from the drain, and exposing their discharging-ends to the atmosphere. The body part of this trap is contracted to hold as small a quantity of water as practicable, so that its entire contents may be changed by a flush of water sent into it through any of the pipes discharging into the trap. It has a $2\frac{1}{2}$-in. water-seal. The way into this trap from the soil-pipe, as shown at B C, Fig. 64, and E C, Fig. 65, is so arranged that the discharges shall fall with a direct vertical pressure upon the "standing-water" of the trap to drive it out. I consider this of very great value for keeping such traps clean. The hopper, or head, A, of the trap is enlarged, to receive one or more waste-pipes in its sides, through the counter-sunk hole, D, and opposite, and to give free access for the atmosphere to pass into the soil-pipe, through the grating, F, as shown by the arrows. This hopper, A, can be turned round on the trap to receive the soil-pipe into its socket (B, Fig. 64, and E, Fig. 65) at any point. When this trap cannot be left open to the air, through its grating, F, the grating can be removed, the top sealed over, and an air-induct for the soil-pipe can be brought from any point into the trap at D, or in its counter-sunk hole opposite. (See Fig. 94, showing such an arrangement.)

Fig. 64 shows this trap for receiving a soil-pipe fixed outside the house. The inlet arm, B, of the trap is brought up level with the top of the hopper, A, for the soil-pipe, K, to enter above the ground-level, where its connection can always be seen. Inlets.

Fig. 65 shows this trap for receiving a "horizontal" or raking soil-pipe—*e.g.*, a soil-pipe carried down *inside* the wall of the house and coming through to the outside to discharge into the intercepting drain-trap, as shown at K and E.

The outgo of the trap, H, can be turned round to any point to enter the drain. It is made to fit the socket of a 4-in. drain, but when so wanted it can be had with a 6-in outgo. Outgo.

A counter-sunk hole is made on the crown of the outgo, as shown at N, for giving access to the drain, or for ventilating it. A cover is sent out with each trap for bedding down into the socket. (See Plates X., XI., and XV. showing such traps fixed.) Ventilating-hole.

When a soil-pipe coming down inside the wall of the house cannot be brought through high enough for the top of the trap to stand level with the ground, the trap can be lowered to suit circumstances, and a brick air-shaft built over Traps with air-shaft.

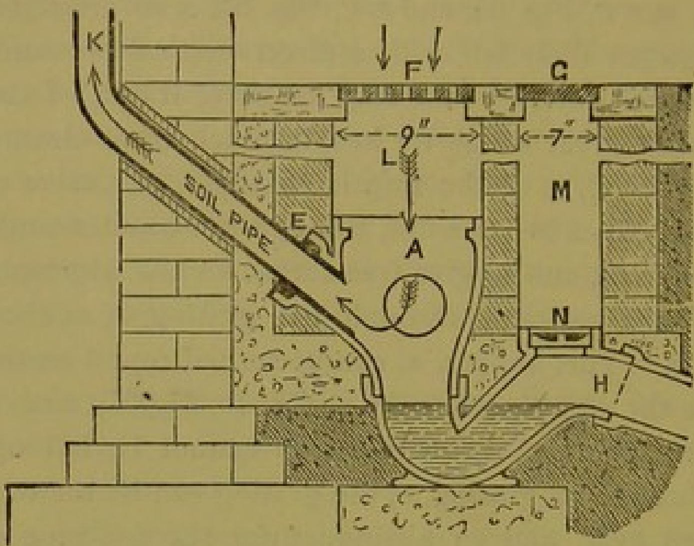


FIG. 66.—Section of "Soil-pipe Intercepting-trap," with air-shaft.

it, as shown in section, Fig. 66. The illustration shows such a trap *in situ*, and the arrows show the air-currents.

"*Combination*" *Soil-pipe Trap.*—I designed another trap for trapping off drains from soil-pipes, where such an open trap as we have just been considering would be thought by some people too open a trap to use. The lower part or body of this trap is precisely like the trap last described; the outgo, C, is shown for a 6-in. drain, but they are chiefly sent out with a 4-in. outgo.

This "combination soil-pipe trap" is specially constructed for trapping off drains from the soil-pipe, for ventilating the drain (when required at this point), and also for forming an air-induct to the foot of a soil-pipe.

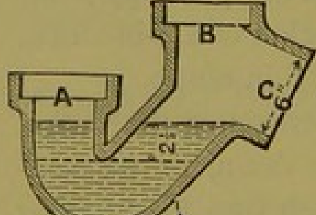


FIG. 67.—Vertical Section of "Combination Soil-pipe Trap."

It is a *round-pipe* trap, and in its action is thoroughly *self-cleansing*. The body of the trap is purposely made a little smaller than the inlet, to insure its being thoroughly flushed out whenever the soil-pipe is used. And though it has a 2½-in. depth of water-seal to ward off the drain-air from the soil-pipe, it only holds such a body of water as is easily driven out by the discharge of a flush of water through any of the water-closets, etc., upon the soil-pipe.

Connecting-pieces.

This trap and its connecting-pieces are so arranged that the discharges must always fall *vertically* upon the *face* of the standing-water in the trap, and thus the previous water in the trap must be changed every time a flush is passed into the stack-pipe on which the trap is fixed.

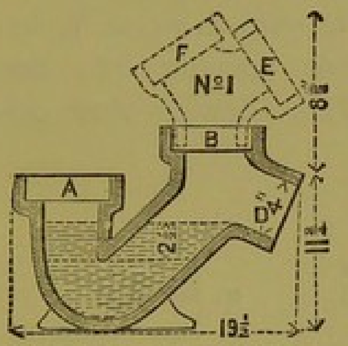


FIG. 68.—*Vertical Section* of "Combination Soil-pipe Trap" with "Connecting-piece" for ventilating the Drain, and for access to Trap.

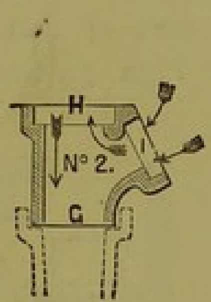


FIG. 69.—Section of "Connecting-piece" for *Horizontal* Air Inlet to Soil-pipe.

The position of this trap, at the foot of a soil-pipe, prevents the water from ever being syphoned out. And as the trap would always be *under-ground*, the water in it would rarely, if ever, evaporate, nor would it be likely to get frozen.

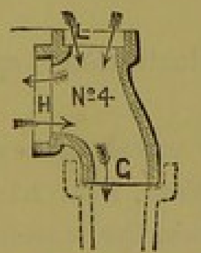


FIG. 70.—Section of "Connecting-piece" for *Vertical* Air Inlet to *Horizontal* Soil-pipe.

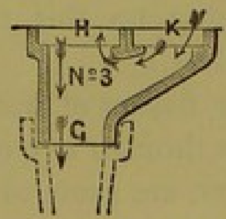


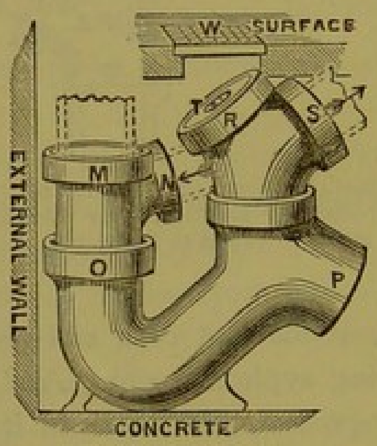
FIG. 71.—Section of "Connecting-piece" for *Vertical* Air Inlet to *Vertical* Soil-pipe.

This trap can be rigged up in many ways to suit circumstances. Fig. 72 shows a view, in perspective, of a patent "combination soil-pipe trap," with *double connecting-piece*—"No. 1"—for forming access to trap, T, and for ventilating drain, S; and, also, with connecting-piece (as "No. 2," Fig. 69) for "horizontal" air-induct, N, Fig. 72, to foot of soil-pipe, M. (See D, Plate III., showing such a trap fixed.)

Fig. 73 shows a section of this trap *without* the double connecting-piece, "No. 1," giving access, Z, to trap, and with connecting-piece, "No. 4," fixed on the *inlet* side of the trap, to receive "horizontal" soil-pipe, and for air-induct pipe, Y and X, to foot of soil-pipe.

Trap with mica-valve.

When this *air-induct pipe*, X, stands near a window or door it is advisable to fix a *mica-valve* at Y, to prevent any exit of foul air near an opening into the house. (See Figs. 74 to 77, Plate III., showing *four* other ways



M. Soil-pipe.
N. Foot Ventilation.
S. Ventilation of Drain.
T. Access to Trap and Drain.
W. Galvanised cast-iron Movable Cover.

FIG. 72.—*Perspective View* of a "Combination Soil-pipe Trap," for 3½-in. to 4½-in. Soil-pipe.

of rigging up this trap; but the illustrations speak for themselves.)

Discharges, vertical.

The flushes of water following the waste or sewage discharges through any of the *connecting-pieces*, Nos. 2 to 4, Figs. 69 to 71, are made to fall *vertically* upon the standing-water of the trap, to drive out its previous contents and to keep the trap wholesome.

Outgo.

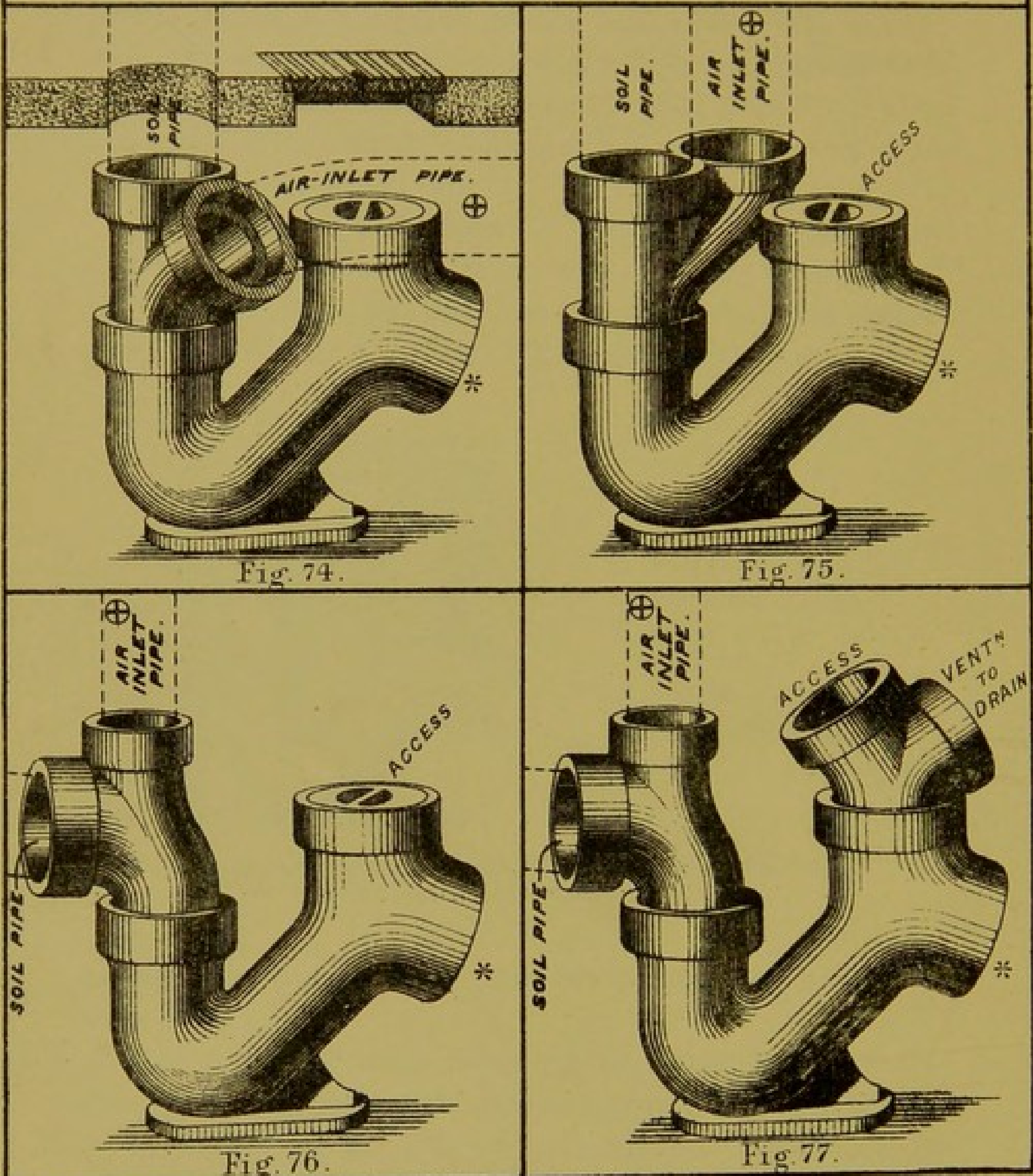
The *outgo* (P, Fig. 72) can be turned round to any point to suit the drain. The "connecting-pieces" can also be turned round in their sockets to suit any position of the pipes, etc.

Confined places.

These traps are specially designed for fixing in confined places where any offensive air, driven down by the discharges through the soil-pipe, could not readily get away, and where

THE PLUMBER AND SANITARY HOUSES.

PLATE III.



S. S. Hellyer, del.

To face page 79.

Four Views shewing further ways of rigging up the

"COMBINATION SOIL-PIPE TRAP."

* The "out-go" here is shown for a 6-inch drain, but the trap is chiefly made with a 4-inch out-go.

⊕ Foot-ventilation.

there would be a possibility of such vitiated air coming into the house through a window or door near such a trap.

In open places, where there is no such risk, it is better to fix such a trap as shown at Figs. 64 and 65, as the "disconnection" from the drain would then be absolute. Open places.

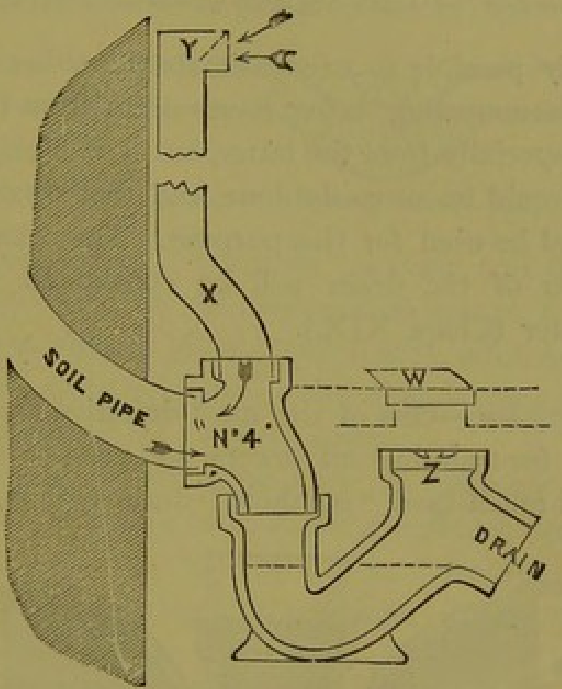


FIG. 73.—*Vertical Section* of Trap, showing *Induct Pipe* and "Mica-valve" over same.

As this "combination soil-pipe trap" can be fitted up in such a variety of ways, I have thought it best to illustrate same. (See Figs. 73 to 77.) The illustrations speak for themselves.

CHAPTER VI.

DRAIN-TRAPS FOR INTERCEPTING DRAINS FROM SEWERS AND CESSPOOLS.*

Manhole drain-syphon—"Croydon" syphon—Buchan's trap—Weaver's trap—"Drain-sentinel"—"Ventilating drain-syphon and sewer-interceptor."

Drain disconnection.

It is hardly possible to over-estimate the value of trapping off, and "disconnecting"† the house-drain from the sewer or cesspool, especially from the latter, but it is highly important that this should be properly done, and that "self-cleansing" traps should be used for this purpose. The question of the *disconnection* of the drain will be considered in a subsequent chapter (Chap. XIX.).

Drain-syphon.—One of the most defective and unsanitary traps used for trapping off sewers and cesspools is the well-known and much-used "manhole" drain-syphon, a section of

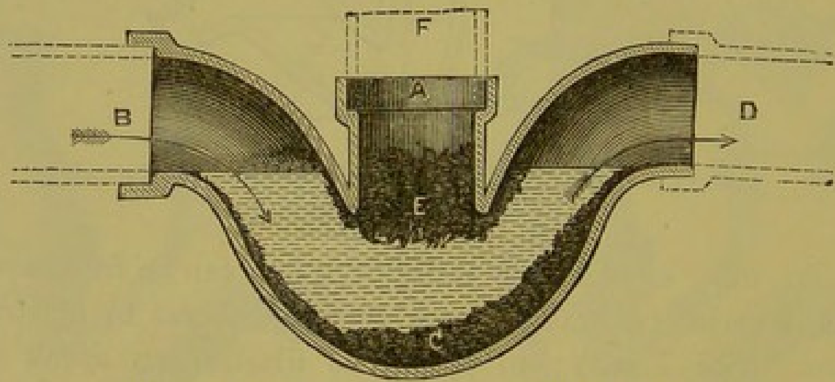


Fig. 78.—Section of a "Manhole" Drain-syphon.

which is shown in Fig. 78; yet this *Bashi-Bazouk* kind of trap is set to guard the house in its most vital part.

This trap is bad in principle and faulty in construction. The passages through such a trap must always be very sluggish. The discharges from the drain into it only just *gravitate*

* See pp. 272—277.

† As some persons confuse "interception" with "disconnection," I think it well to explain here what is meant in this work by the latter term. A rain-pipe, waste-pipe, or soil-pipe may be "intercepted" (*i.e.*, trapped off) from a drain; or a drain may be "intercepted" from a sewer or cesspool without being "disconnected," for, though the water-seal of the trap would separate the air between the one and the other, there would be no "disconnection" in the sense intended in this work. "Disconnection" here signifies that a drain is not only "trapped off" from a sewer or cesspool, or a rain-pipe, waste-pipe, or soil-pipe from a drain, but that such pipes or drain are open in some way to the atmosphere outside the house for the ingress of fresh air—*i.e.*, for proper ventilation.—S. S. H.

through the trap, without any attempt at cleaning out its filth, for often the entire length of drainage would have to be filled up to its head before half a pound of pressure could be brought to bear upon the "standing-water" of the trap. A glance at C to D, Fig. 79, will show this at once. The "solids" stand about, at B, until a greater body of water is sent into

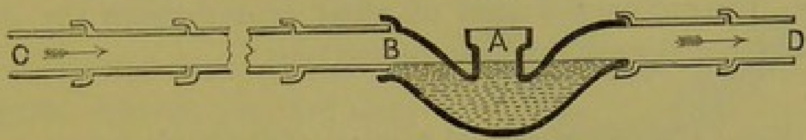


FIG. 79.—Section of a Drain-syphon *in situ*.

the drain, when they "move on" a stage and float up into the inspection-hole, or manhole, as shown at E A, Fig. 78, unless that is already filled; and finally, after having taken some hours—perhaps days—in the transit, they drain themselves out at D into the common sewer.

The quantity of water held by an ordinary 6-in. drain-syphon, with a manhole in it, is about eighteen pints, or more than twice the quantity held by a 6-in. "drain-sentinel," Fig. 83, or a 6-in. "ventilating drain-syphon," Fig. 90, though the latter has a much deeper water-seal. With a trap holding such a body of water how would it be possible to change its contents by the ordinary use of a sink, lavatory, or water-closet, however good the flushing arrangements may be to such fittings? The bad air coming from the filth accumulating in such non-cleansing traps is supposed, by persons inexperienced in such matters, to be a necessary consequence of trapping off the drain, but the *exposure* of the drain in such an instance is the *exposure* of the trap, and the only "ex" about it now should be in the word "extinct."

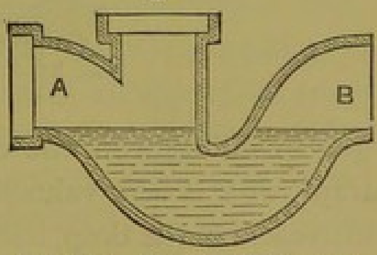


FIG. 80.—"Croydon" Syphon.

"*Croydon*" *Syphon*.—This trap is a great improvement on the common drain-syphon, as will be seen by a glance at the drawing, Fig. 80; but it holds much too large a quantity of water (a 6-in. trap holds two gallons!) for its contents to be readily changed by a flush of water sent into the drain from a water-closet, or such-like fitting. The arrangement of its head, or socket, C, for ventilating the drain, in conjunction with its inlet, A, has not been well considered. Foul matters would accumulate in such a large mouth and become offensive, for ordinary flushes of water sent through the drain would not cleanse this part of the trap.

Buchan's traps.

Fig. 81 shows a vertical section of Buchan's patent *ventilating drain-trap.** The "*drop* of 2-in. or so which the water

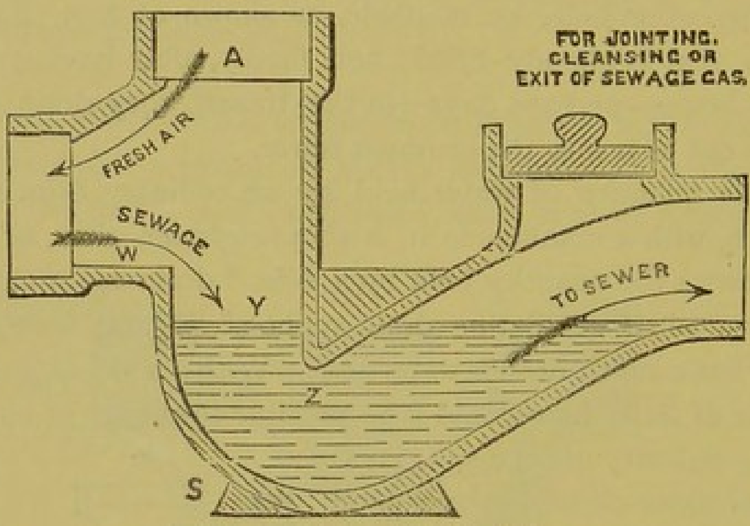


FIG. 81.—Section of Buchan's Trap.

gets in falling from the drain-branch, W, into the well of the trap" at Y is very valuable, though its value would have been increased if the drop had been twice as great. The dip, or water-seal, of 1½-in. is hardly sufficient to allow for evaporation when the trap is out of use for days together, as would be sure to be the case at times when fixed in many places, especially as a stream of air would be constantly passing just over the exposed surface of the water in the well of the trap to lick it up—*i.e.*, to induce evaporation.

This trap is sound in principle, and by its cheapness is put within the reach of every builder.

* This trap is also largely used for intercepting soil-pipes from drains.

Fig. 82 shows a *perspective view* of Weaver's "Ventilator Trap" for fixing to drains, etc. This trap is a great improvement upon the ordinary drain-syphon. Its chief value is its *fresh-air inlet*, A, and this would be increased if the inlet pipe were made more open to the atmosphere, *i.e.*, if the perforated top, A, were entirely removed. It has one great demerit, viz., the want of a drop between the drain-branch and the level of the standing-water in the trap, as explained in the evils of the drain-syphon (page 81). The water-seal of 3½-in. would make it all the more difficult for the discharges through the drains to flush out this trap. How doctors disagree! The water-seal in this trap is 3½-in., but in the last trap that we were considering it was only 1½-in. Weaver's trap.

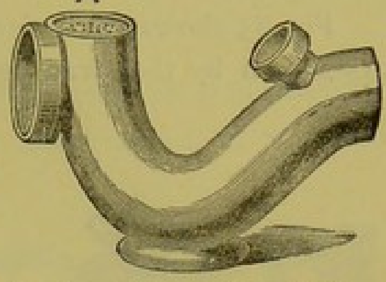


FIG. 82.—View of Weaver's Trap.

The "Drain-sentinel," or *House-drain disconnecting trap with access to both sides of its water-seal.*—I have designed and patented this trap for the special purposes of "disconnecting" one drain from another, or a drain from the sewer or cesspool, and for affording access to the drain on *each side of the trap*, without any disturbance of the surroundings. The trap is made in strong stoneware, and the water-holding * part is much contracted to insure an entire change of its contents every time a flush of water is sent into the drain. "Drain-sentinel."

The "Drain-sentinel" is made in three sizes, 4-in., 6-in. and 9-in., with "channel-pipes" complete. The sizes given in the illustrations (Figs. 83, 84) are taken from the 6-in.

The trap is provided with a good *drop* for the discharges from the drain to fall upon the "standing-water" with some force, to drive it out and change the contents of the trap every time a flush of water is sent into the drain. There is no place—no nook or corner—where filth can accumulate to decompose and send off bad air. As will be seen by the section, Fig. 84, there is only a small disc or surface of water

* This 6-in. trap holds about one gallon of water less than a 6-in. "Croydon" syphon.

exposed for throwing off impurities or for evaporation; and though it has a water-seal of 2½-in. there is only such a body of water as will easily be driven out by a fair flush of water sent into it.

Fig. 83 shows a full view of this trap, and Fig. 84 a section. As shown by the drawings, a U-shaped inlet is given to the

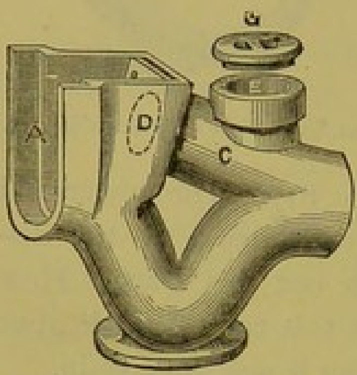


FIG. 83.—"Drain-sentinel," Perspective View.

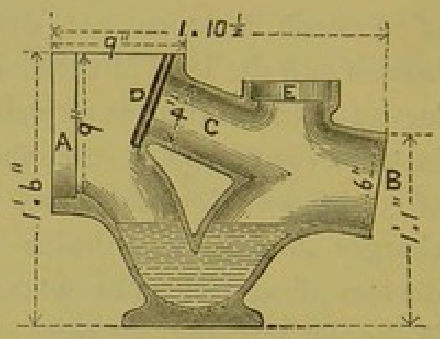


FIG. 84.—"Drain-sentinel," Section.

trap for receiving the ordinary split drain-pipe, where a man-hole or disconnection-chamber is built; or a special channel-pipe, as Fig. 85, may be used; the U-shaped spigot end of the channel-pipe, M, being made to fit into the U-shaped socket-inlet of the trap, A, as shown in Figs. 86 and 87, and Fig. 223. The bridge-pipe, C, spans the space between the "inlet" or head of the trap and its "outlet," and affords ready access to the drain on the outfall side of the water-seal. The mouth of this pipe, D, is sealed over by a strongly-made galvanised iron plate, well and securely packed, and is easily removed, when so required, by unscrewing four thumb-screws. A counter-sunk hole is formed at E for ventilating the drain on the outfall side of the seal, and when not wanted the cover, G, is bedded down into it. The head of the trap is considerably deepened, as shown by the drawings, for build-

Channel-pipe.

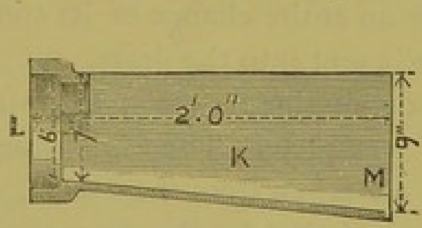


FIG. 85.—Section of Channel-pipe for Disconnection-chamber.

"Sentinel" with channel-pipe.

ing up the sides of the split-pipes, or for receiving the high-walled channel-pipe, K, Fig. 85, to prevent all matters passing through the drain from flowing on to the floor (sloping or otherwise) of the disconnection-chamber. Fig. 223, p. 274, shows this trap *in situ*.

In the drawing, Fig. 87, a view is given of a high-walled channel-pipe for receiving one or more drains, at W and Y,

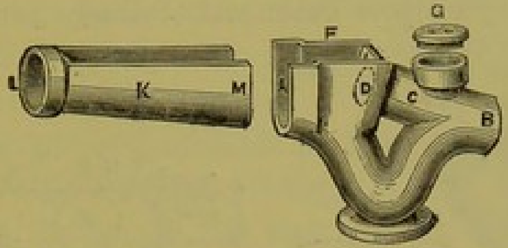


FIG. 86.—"Drain-sentinel" and Channel-pipe.

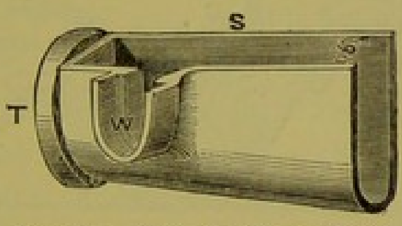


FIG. 87.—View of a Channel-pipe with side inlets.

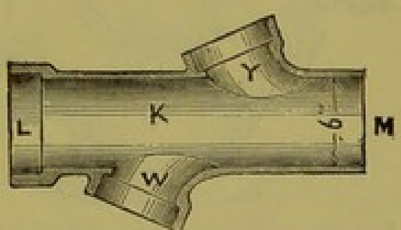


FIG. 88.—Plan.

in addition to the main drain, and exposing them to the atmosphere, *i.e.*, "disconnecting" them from the main drain. Fig. 88 shows a plan of a 6-in. channel-pipe with two side inlets, J and H, for 4-in. drains.

"*Ventilating Drain-syphon and Sewer-interceptor.*"—Some years ago I designed and patented this trap to remedy the defects of the manhole drain-syphon. They have been largely used and with excellent results.

These traps are made in strong stoneware, and are specially constructed for intercepting, or rather "disconnecting," sewers and sewage-tanks from the house-drain.

This "*Ventilating Drain-syphon and Sewer-interceptor*" is at present only made in *three sizes*—viz., 4-in.,* 6-in., and 9-in., as the latter size is large enough for any purpose for which it is likely to be used. Fig. 92 shows a 4-in., Figs. 89 and 90 a 6-in., and Fig. 93 a 9-in. Fig. 89 shows a *perspective view* of this trap (with its stopper, R, for fixing in lieu of the grating, I, when so required), Fig. 90 a *section*, and Fig. 91 a *plan*.

Construction of traps.

The trap consists of a *round pipe* shaped in the form of the letter V, giving a dip or water-seal of nearly 3-in. (to ward off

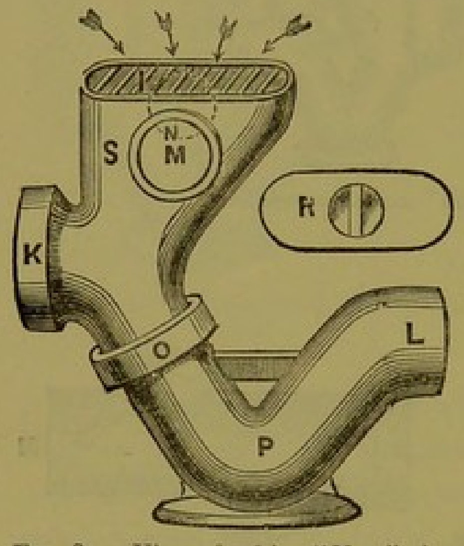


Fig. 89.—View of a 6-in. "Ventilating Drain-syphon and Sewer-interceptor."

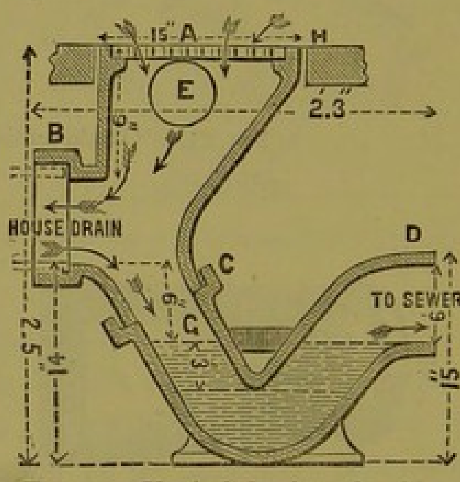


Fig. 90.—Vertical Section of a 6-in. "Ventilating Drain-syphon," &c.

any air seeking to come through); and the body of the trap —P, Fig. 89—is comparatively of much smaller diameter, to prevent any filth collecting in the trap, and also to allow the water in the trap to be more easily driven out by the flushes from the drain. The "inlet" G, Fig. 90, is of extra depth, as shown, so as to keep the "standing-water" of the trap *6-in. below* the drain which discharges into it. By this arrangement the discharges from the drain are made to fall with a *vertical pressure* upon the water in the trap, to drive it out

* This size is made with a double socket-inlet to receive two 4-in. drains, and with a 9-in. socket hopper for continuing up the air-shaft to the surface of the ground with 9-in. drain-pipes.

with the smallest flush sent into the drain. A glance at the section, Fig. 90, will show this. The drain will thus empty itself, and at the same time allow more room for ventilation in it.

Air-chamber.

The *upper part* of the trap is considerably enlarged, and is continued upwards, as shown at S, Fig. 89—and also in the other drawings—for the admission of fresh air into the house-drain. When this part of the trap is not high enough to reach the surface of the ground, it should be continued upwards in brickwork, as shown in section, Fig. 93; and the grating,* I, Fig. 89, should be removed from the top of the trap and let into a stone, as shown in Fig. 93, for fresh air to pass freely into the house-drain.

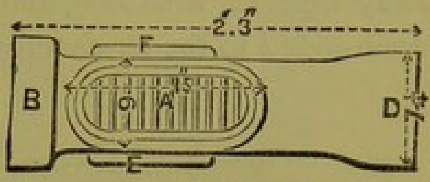


FIG. 91.—Plan of a 6-in. "Ventilating Drain-syphon and Sewer-interceptor."

No danger in using such open traps.

When this trap is used for "disconnecting" sewage-tanks from the main drain in *country houses*, there is absolutely no danger attending it whatever, if the drains are properly ventilated; nor is there any danger in using them for "disconnecting" the sewers from the house-drain in *town houses*, if proper care be taken in selecting the right position for fixing them. When there is no "area,"† or when the drain is brought into the house under a "covered way," where the atmosphere cannot readily reach the mouth of the trap; or where any bad air escaping

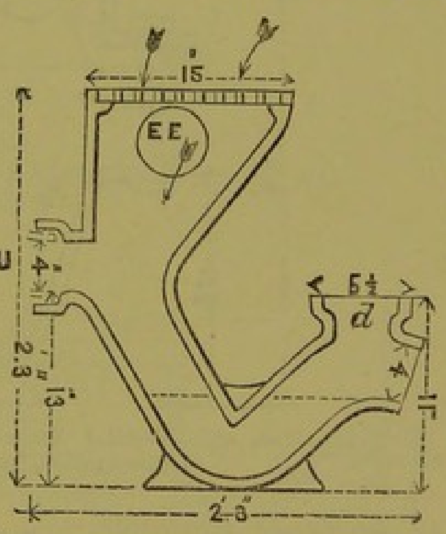


FIG. 92.—Vertical Section of a 4-in. "Ventilating Drain-syphon and Sewer-interceptor."

* Stronger gratings should be used where cattle are likely to walk over them.

† See Plates XXII. and XXIII., showing treatment of drainage where there is an "area." Ditto (Plate XXIII.), showing treatment of drainage where there is a "covered way."

through the trap from the sewer, or coming from the drain, could easily get into the house, through a window or door, the top of the trap should be sealed down, as shown at R and *a*, Fig. 94. And in such cases a 4-in. fresh-air induct, as A A, should be taken from a corner of the area (farthest away from all windows), and continued under the paving in drain-pipe *b* to the air-chamber of the trap at B B, with which

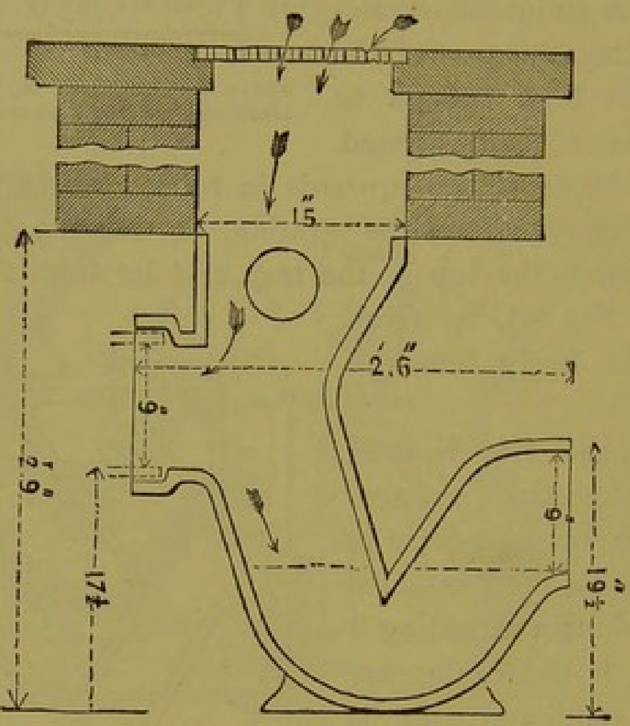


FIG. 93.—Vertical Section of a 9-in. "Ventilating Drain-syphon," with Brick Air-shaft.

it should be connected. Inlet socket-holes are purposely made in the air chamber of each trap for receiving such pipes —as shown at M and N, Fig. 89, and E and F, on *plan*, Fig. 91. Loose stoneware covers are sent out with each trap for sealing over the top and the two side-inlets. A "mica-valve" should be fixed on the top of the air induct-pipe, A A, as shown at C C, when fixed near a window, to prevent back draught; but this mica valve should be so fixed as not to interfere with fresh air passing into the induct-pipe.

Mica-valve over induct pipe.

A view of this trap is given in Fig. 95, and a section in Fig. 96, for fixing a pipe-shaft on the top of the trap, for inspection and fresh-air induct. The cost of a manhole-shaft cannot always be afforded, and especially when the drains are

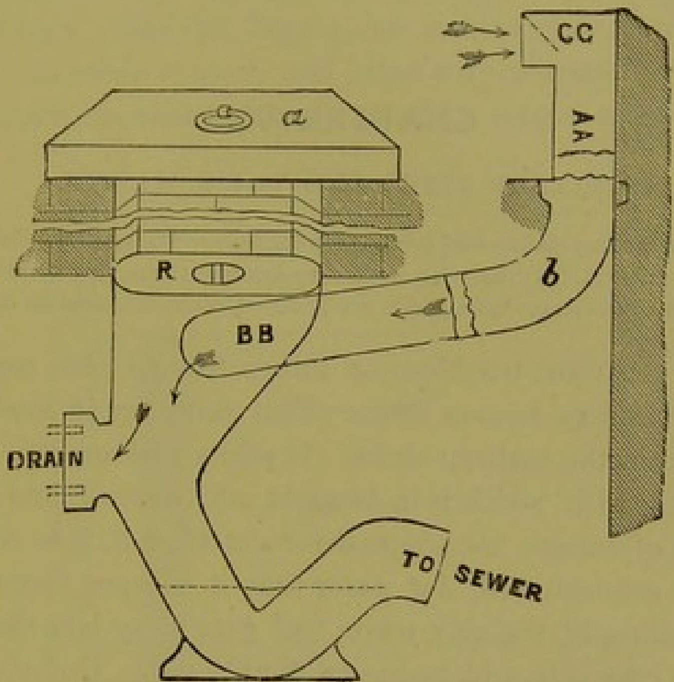


FIG. 94.—View of a 6-in. "Ventilating Drain-syphon" with Air Induct-pipe.

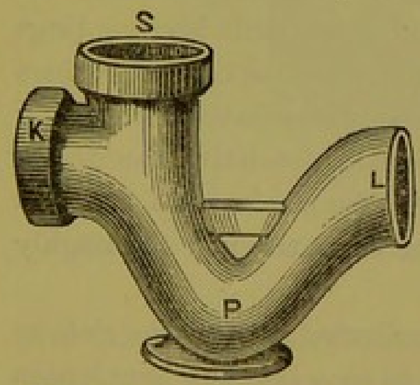


FIG. 95.—View of Trap for Pipe-shaft.

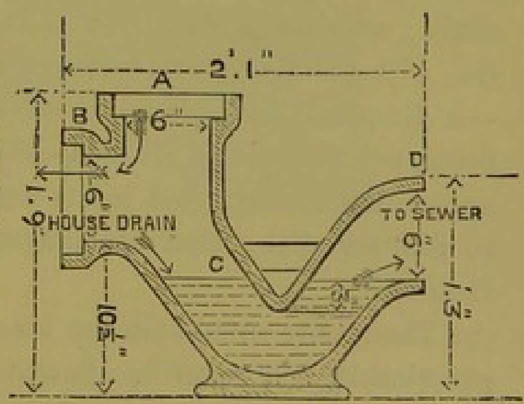


FIG. 96.—Section of Trap for Pipe-shaft.

very deep, but the cost of fixing a pipe-shaft (in drain-pipe) when laying in a drain, however deep, would not be much. (See Fig. 226, p. 276, showing such an arrangement.)

CHAPTER VII.

SCULLERY SINKS AND THEIR WASTES.

Grease from scullery sinks—Bad jointings in the drain—The scullery—Bricklayers traps—Inlet to the house for drain-air—Grease-intercepting tanks—Grease tank *in situ*—Grease-tanks inside the house—Grease-collectors for daily use.

Grease from scullery sinks.

ONE of the most troublesome things to deal with, especially in large country houses where much company is kept, is the grease from the scullery sinks. It sticks and accumulates on everything with which it is brought into contact, and though all sorts of means are adopted for catching it, it is so subtle when in solution with *hot* water that it escapes through the finest grating of the sink-waste and gets away into the drain, where it congeals and becomes a nuisance. Unfortunately, too, the scullery sink generally stands near the head of the house-drain, *i.e.*, at the remotest point from the outfall of the drain; and when the drain is laid down with bad jointings (*i.e.*, with annular spaces between the pipes, or cement oozings —a frequent occurrence where the pipes have been badly fitted, or imperfectly cleaned off inside the drain), the grease accumulates about such joints until the whole drain becomes so foul and filthy that no amount of water will thoroughly cleanse it.

Bad joints in the drain.

Collection of grease.

The grease should always be collected as near the sink as practicable, and never be allowed to pass into any long length of drainage. I think it ought to be kept out of the drain, even when there is only a short distance for it to travel to enter the sewer, for grease should not be allowed to enter the sewer at all. However short a drain may be, if grease is allowed to pass into it, sooner or later it is sure to become a nuisance.

The scullery.

Apart from any danger to health, the scullery is generally a place to be avoided by those who have any respect for their olfactory nerves. The aggregation of bad smells generally found in a scullery makes one wonder how it is that scullery-maids stand it and still live. Instead of well-glazed porcelain sinks which could be kept clean and nice, such absorbent material as stone is used, and often very porous stone, too: I suppose for the sink to absorb as much matter as possible, to

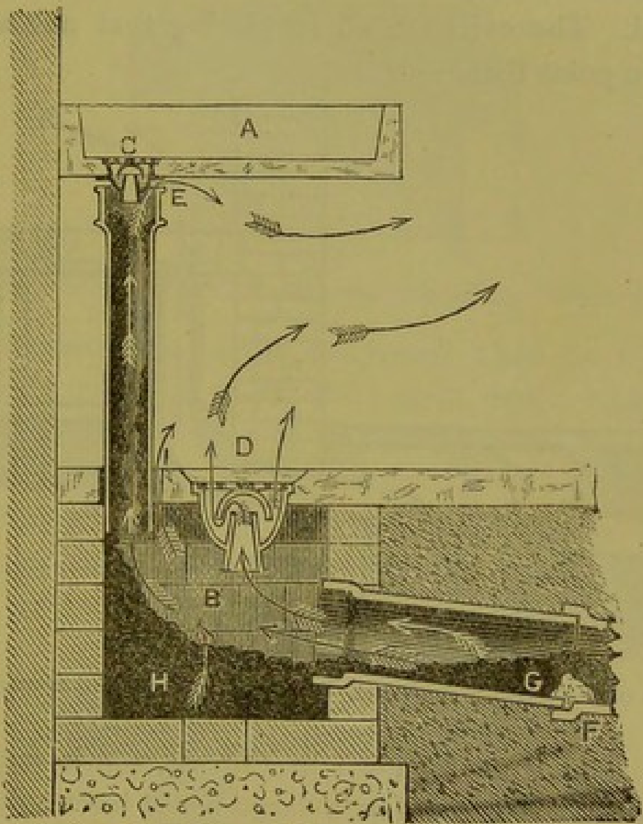


FIG. 97.—Section of a Scullery Sink found in a House in the West-end.

give the room in which it stands a scullery air. And, as if that were not sufficient to gain a good name for the scullery, the plumber and bricklayer do all they can to augment the evils, and if they do not join hands over it, they join the ends of the sink-waste to traps of very bad character. The plumber solders a bell-trap over the receiving end of the sink-waste, and winks to the bricklayer, and then the bricklayer builds a huge brick cesspool-trap *under the floor* (!) and "makes good" to the discharging end of the waste, and nods to the plumber, and then they retire, leaving the scullery to its fate.

The plumber and bricklayer.

But the plumber has grown wiser in this matter, too wise for the speculative builder, who now dispenses with the service of the plumber in this matter, and leaves the bricklayer to his own devices, and this is how the thing is now done.

In the drawing, Fig. 97, a good representation is given of what was found only the other day in a large house in the West-end. The evils are all so glaring that not a word is wanted to point them out.

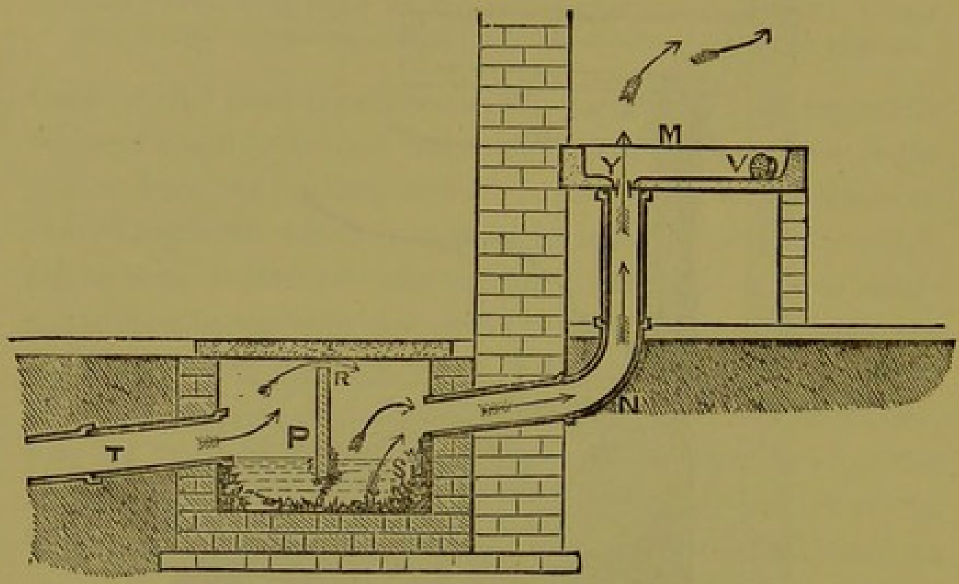


FIG. 98.—Section of Sink, and Brick Grease-trap : bad arrangement.

Inlets for drain-air.

The arrangement shown in Fig. 98, which faithfully represents what was found in a large house built only in 1881, is an "improvement" in so far that the brick grease-trap is built outside the house, but all the other evils remain the same as in the other arrangement. As shown by the arrows, the drain-air had free access to the house, for the dip, P, which was formed in slate, had a space between the cover-stone of the trap and its upper edge, R, large enough to put one's finger through. This is a very frequent occurrence with the "dip-stone" of brick traps. The little "protection" to be gained from the use of a bell-trap was in this case (as generally) lost, for the scullery-maid had removed the bell-grate to a corner of the sink, as shown at V, where its powers of obstruction would cease to worry her.

A few years ago I patented a Grease-intercepting tank, or trap, for collecting the grease and sand from discharges from a scullery sink, the grease to float to the surface of the standing-water, and the sand to sink to the bottom of the tank. These traps are now made in four sizes—viz., small-size, medium-size, large-size, and extra-large-size, and Grease-tank.

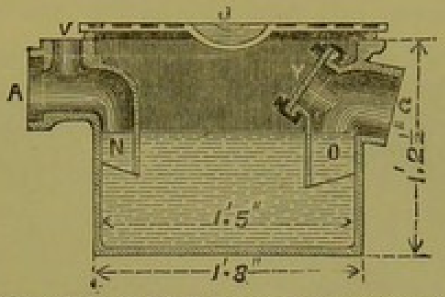


FIG. 99.—Section of the "Medium-size" Stoneware "Grease-trap."

measure respectively in the body part 13-in. by 13-in., and 18-in. deep; 20-in. by 13-in., and 14½-in. deep; 24-in. by 20-in., and 14½-in. deep; and 36-in. by 20-in., and 14½-in. deep, all outside dimensions.

The "inlet" socket, A, of the Grease-trap is made to receive a 3-in. drain-pipe, but in practice a 2-in. lead waste-

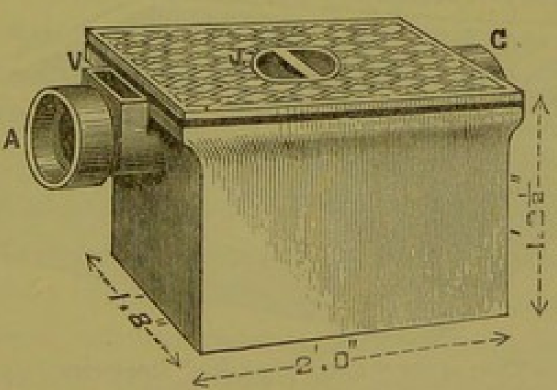


FIG. 100.—View of the "Large-size" Stoneware "Grease-trap."

pipe is generally fixed between the sink and Grease-trap, as shown in Fig. 103. The "outlet," C, is made to fit into the socket of a 4-in. drain-pipe.

The sizes mostly used are the "Medium-size" and the "Large-size." The "Medium-size" answers very well for small and moderate size houses, where the grease and sand are removed very frequently. But where the wash-up sinks are of considerable size, discharging large bodies of hot greasy water at one time, it is necessary to have a large volume of cold water (which the "Extra-large-size" Grease-tank is specially constructed to contain), for cooling the discharges, or the grease will not be congealed and arrested within the tank, but will pass in a fluid state with the hot water into the

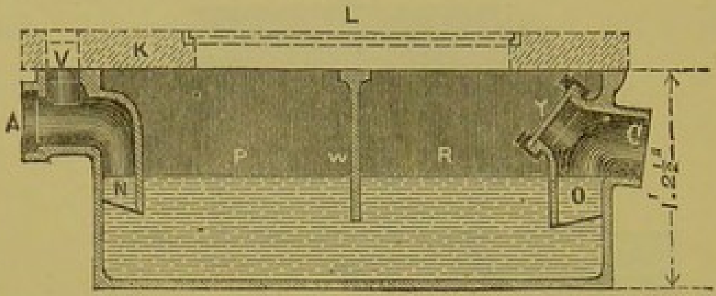


FIG. 101.—Section of the "Extra-large-size" Stoneware "Grease-trap."

drain. This fact is often overlooked by many persons; and, notwithstanding a grease-trap of some kind is used, the drain sooner or later becomes largely charged with grease. It is, therefore, important in determining the size of the grease-trap to consider the sizes of the wash-up plug-sinks, and the

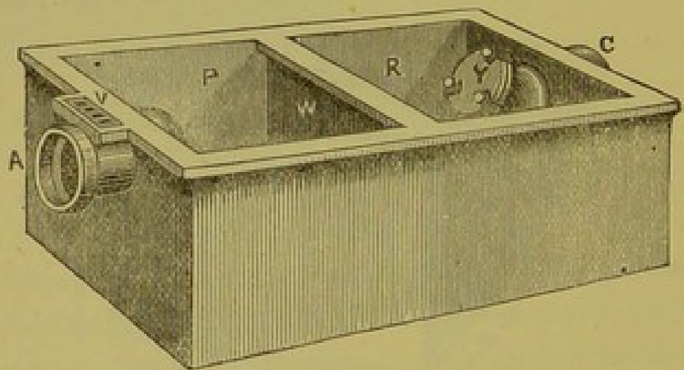


FIG. 102.—View of the "Extra-large-size" Stoneware "Grease-trap."

quantities of hot water that will be likely to be discharged from them at one time through the grease-trap. Where there is a long length of drainage, and hot water, rich with grease, is discharged in great quantities, a specially constructed intercepting-tank with a water-cooler is necessary, if the drain is to be kept free from grease; for no drain which receives grease can be kept clean and wholesome.

In these grease-intercepting traps the greasy water from the scullery sink passes into the trap through a specially constructed pipe, a few inches below the standing-water of the trap, as shown at N in the illustrations, to prevent the incoming water from disturbing the congealed grease in the trap. The gross fat of the hot greasy water becomes congealed in its transit from N to O by the cold water in the trap which cools the discharges, and the grease rises to the surface and is solidified.

The mouth of the "outlet" pipe, as shown at O, is kept well below the level of the standing-water to trap off the

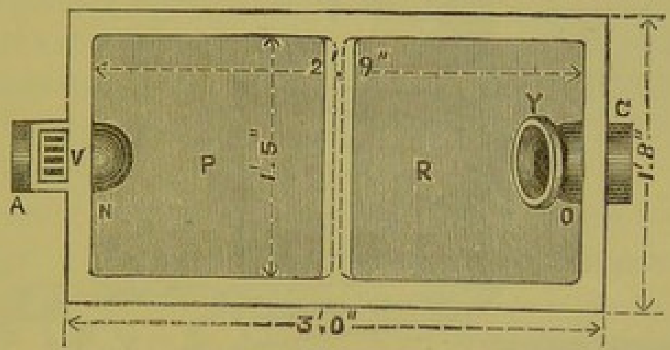


FIG. 102A.—Plan of the "Extra-large-size" Stoneware "Grease-trap."

drain, and also to prevent pieces of congealed grease floating into the drain-pipe.

An opening is made in the inlet-pipe of the trap, as shown at V, for exposing the sink-waste to the atmosphere and properly "disconnecting" it.

A hole for inspecting the drain or for passing rods into it is formed in the outlet-pipe, and is sealed over with a galvanised cast-iron cover, bolted down, as shown at Y.

A galvanised cast-iron cover, J, is made to fit over the top of the three smaller traps; but over the "Extra-large-size" trap a stone cover should be fixed, as shown at K (Fig. 101), with a galvanised cast-iron movable cover, L, let into it.

These traps require to be cleaned out very frequently to remove the grease and the sand (used in cleaning the utensils), as, apart from the wholesomeness of the trap, its capacity would be very much reduced by the rapid accumulation of the grease, sand, etc.

As many errors have been made in fixing this tank, I give

Grease-tank *in situ.*

a drawing, in Fig. 103, showing its proper position, viz., outside the house, but it is not necessary that it should stand down into the ground, as shown here; it may, with advantage when the fall of the drain is poor, be made to stand partly or wholly above the ground. I consider a 2-in. lead syphon-trap, and a 2-in. lead waste, as shown at W, quite large enough to take the discharges from a scullery sink in the largest of mansions. I have found a 4-in. waste and a 4-in. trap to

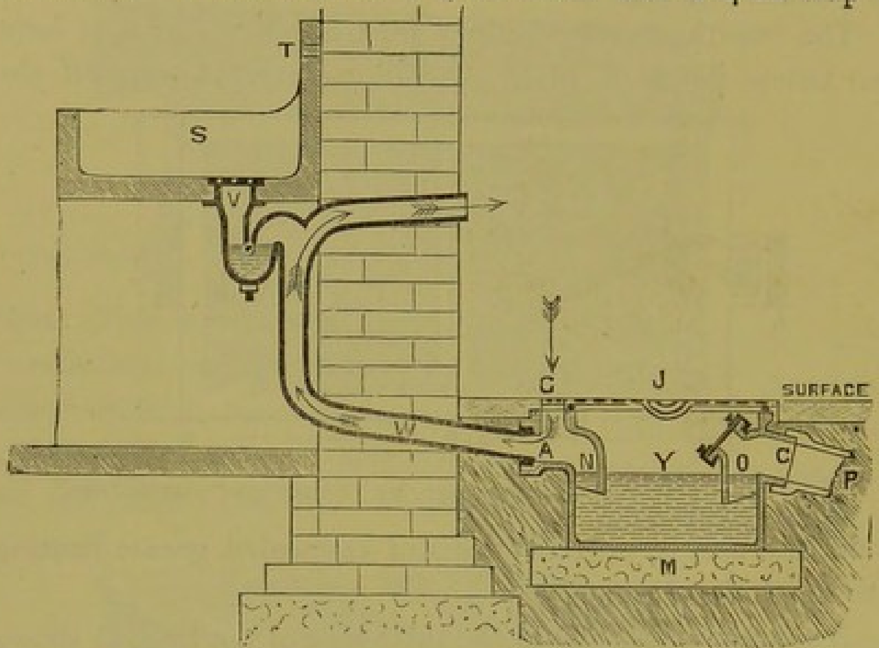


FIG. 103.—Section of "Grease-intercepting Tank" *in situ*, showing the waste-pipe from sink, and ventilation.

stop up in a year or two, and have had this size replaced by 2-in., and never known the latter size to stop up, with a $3\frac{1}{2}$-in. diameter cobweb grating fixed in the sink, over an enlarged mouth of a 2-in. trap, as shown at V.

Grease-tank inside the house.

The scullery in town houses is often so situated that the grease-trap, to be of any value, must be placed inside the house. When this is the case great care should be taken to see that it is done in a sanitary way, or it may become a great nuisance. When it is compulsory to fix the trap under the floor, a concrete base should be formed for it to stand upon, and this should be well cemented over, and the sides of the trap should be walled up in brick and cement, and over the whole should be placed a piece of 3-in. York stone, with a full-sized perforation in it for giving good access to the interior of the trap. Over this perforation a movable galvanised cast-iron plate should be bolted down, in a similar way to the manhole-cover of a boiler, so that the whole thing can be sealed over hermetically, independent of the floor. The trap should, of course, be ventilated by a pipe carried up to the external air.

Grease collector.

Some time ago I designed a grease-collector for placing under kitchen or scullery sinks for *daily* cleansing, to avoid the risk of fixing a grease-trap *under* a floor *inside* the house. It is the same in principle as the grease-tank just described. Two "grease-collectors" are required for each scullery sink. All that the cook has to do is to remove one

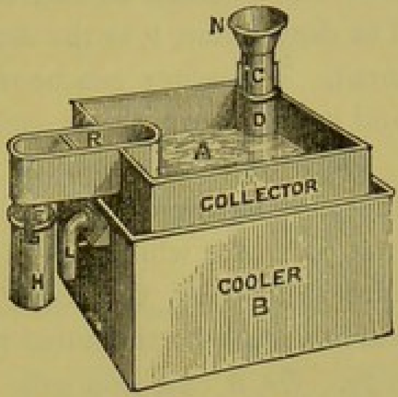


FIG. 104.—View of "Grease-collector."*

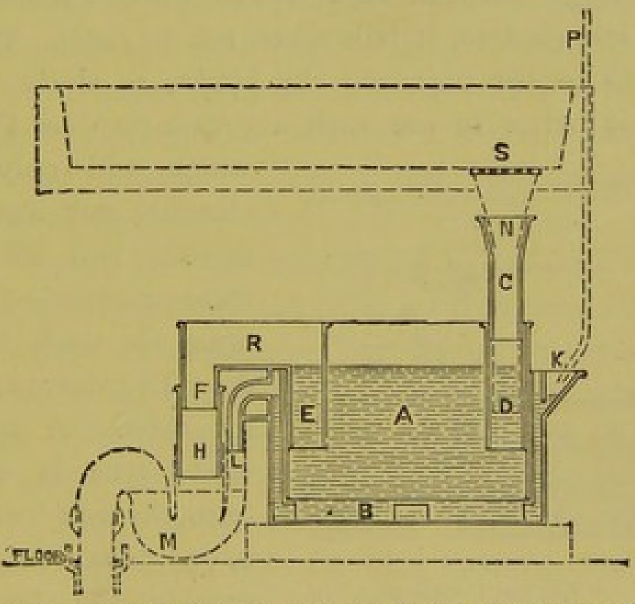


FIG. 105.—Section of "Grease-collector" under the Scullery Sink.

grease-collector (made in sheet-tin for lightness) for another, and this is done in two minutes, by dropping the telescope-pipe, C, and raising the connecting-pipe, H. The cook, by this arrangement, has a good perquisite always "floating" under

* The cover of this "grease-collector" is omitted in this drawing.

the sink, which she can make good use of. A *view* of this "grease-collector" is shown in Fig. 104, and section in Fig. 105. Where a great deal of cooking is done a service of cold water should be laid on to pass through the "cooler," B. The dotted line, P, in the drawing, Fig. 105, shows the arrangement. The water can be made to dribble into the cup at K, and it will then pass through the "cooler" and out at L.

If a *lead* waste is fixed for conveying the discharges from the sink to the drain, a 2-in. lead pipe should be used, and that part of it which passes under the floor should be encased with drain-pipe, to protect it from rats, etc.: *i.e.*, the lead waste should be threadled through a 3-in. earthenware drain-pipe. Or if cast-iron pipe is used, it should be connected to the trap, M, by a brass ferrule, soldered to the outgo of the trap with a wiped soldered joint, and caulked with lead to the iron waste, as shown in Fig. 105; and the trap should be ventilated to prevent its syphonage.

But though such an arrangement works admirably when properly attended to, it fails when left to itself. When this is likely to be the case, and the *kitchen is at the top of the house*, it is better to use such a grease-trap as Fig. 105A, which will only require cleaning out about every month, two months, or three months—depending upon the work it has to do. The drawing speaks for itself. A 2-in. lead waste-pipe is continued from the *lead* "outlet," W, to a "drain-interceptor" outside the house, and this pipe is ventilated as shown at A. If a sink-trap (T) is fixed it should be ventilated, as shown in dotted lines. These traps are made in two sizes —the smallest size is shown in the cut. The cover is bolted down with gun-metal thumb-nuts and bolts, and is easily removed for taking out the grease.

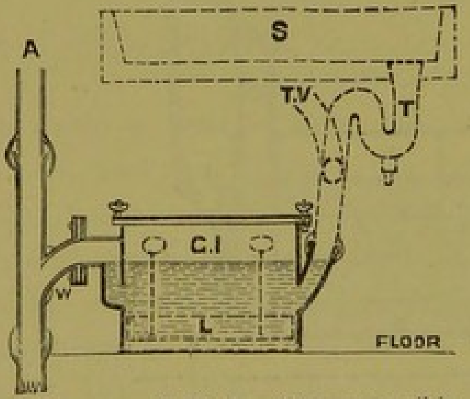


FIG. 105A.—"Kitchen Grease-trap," in cast iron, galvanised.

CHAPTER VIII.

THE LOSS OF SEAL IN TRAPS, AND TRAP-VENTILATION.

Traps with broken seals—Mechanical traps—Water-seal traps—Obstructionists' traps—Importance of a good seal — Syphon traps easily syphoned — Tiers of traps first ventilated—Value of ventilation for preventing syphonage—Experiments with traps in America—Traps vented from the top—Experiments with traps, apparatus used, and the results—Syphonage and momentum —Seal of traps forced—Loss of seal by evaporation—Loss of seal by a blow-down of air in the piping.

Traps with broken seals.

As a door with its lock broken is of no value for keeping out thieves, so a trap with its seal broken is of no value for keeping out bad air, whether in waste-pipes, soil-pipes, or drains. In fact the only value of a trap is its *seal*, and if this cannot be maintained under every condition to which it is likely to be subjected in practice, it becomes a *trap* in quite another sense to that intended. Yet a large percentage of the traps now in use have their seal often broken from the following causes, viz.: (*a*) from being badly constructed, (*b*) from insufficiency of dip, and (*c*) from inefficient ventilation.

Ignorance in selecting traps.

It is surely an imperative duty before directing a certain trap to be fixed to know that the trap so selected is a reliable one—reliable at any rate in the position assigned it—especially as its seal will often be the only barrier between a foul pipe, and in some cases drain too, and the occupants of the house. And yet many a man, deeming himself fully qualified to direct plumbing work, would be very much puzzled to say where such-and-such a trap would be safe to fix and where it would not, or would be at a loss to say *how* the trap should be treated to maintain its water-seal under every condition. Thousands of traps are fixed every year in utter ignorance of their capabilities of retaining their seal in the positions in which they are placed; and, in consequence, thousands of traps would, on examination, be found to be without a proper seal.

Ignorance in venting traps.

There is also great ignorance shown in the mode of venting a trap to prevent its syphonage. Traps are not only vented by pipes of too small a bore, or too great a length, to be of any value for preventing their syphonage, but they are often vented in the wrong place—the vent-pipe being connected to the branch too far away from the trap. A very curious method of venting a trap came under my notice the other day, and as it is so curious I give a drawing of it in Fig. 106. A large house had been thoroughly

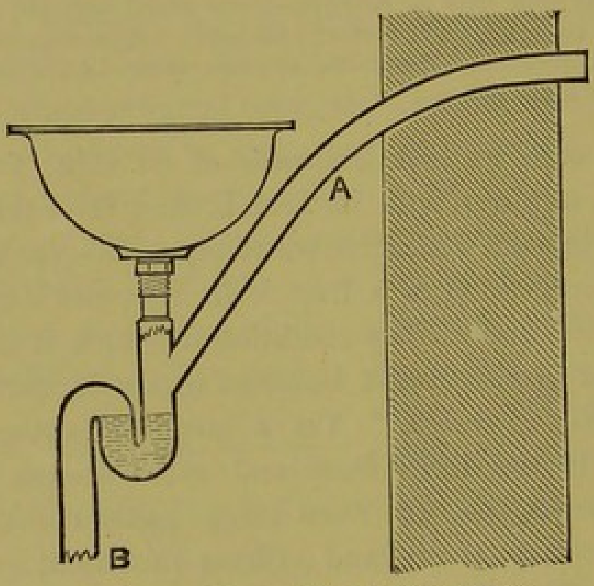


FIG. 106.—Vent on Wrong Side of Trap.

re-drained about two years ago, but two or three things had failed, and among them a lavatory, which had to be disused on account of the bad smell coming from it. It had a long length of waste (1-in. pipe). This waste-pipe, B, was disconnected rightly enough at the bottom, but the trap was vented on the *wrong* side of the water-seal, as shown at A, to be of any value either for preventing the syphonage of the trap, or for the ventilation of the waste-pipe; and, as a consequence, the trap was frequently syphoned, and the house exposed to the bad air coming from soap-suds decomposing in the waste-pipe.

The traps chiefly used in plumbing and drainage works are dependent entirely upon water for their seal. But there are traps now specially constructed for maintaining a seal of some sort in addition to, as well as independent of, their water-seal. These mechanical traps are either made with floating balls for sealing their "inlets"—as in the "Bower" trap (Fig. 41), and are only of value so long as sufficient water is retained in them to buoy the floating ball well up against the dip-pipe; or with gravitating balls for sealing their "outlets," as Figs. 39 and 40, p. 59. And these mechanical seals (liable though they are, at any moment, like all mechanical things, to get out of order) are considered, by some people, to be a fair protection against bad air in pipes, supposing their water-seal to have been lost by syphonage or other cause. But a piece of soap, or a bit of dirt, on the ball or on its seating, would at once make the seal imperfect, and leave a passage for bad air in the waste-pipe to come into the house. I consider all such traps, traps with "check-valves," as Bower's, Buchan's, Cudell's, Waring's, &c., *obstructionists*, and I suppose their inventors would admit that the way through them is not so clear as in traps without such impediments. It is of the utmost importance that the passage-way through a trap should be perfectly free, that there should not only be no obstruction—as there would be when a check-valve or ball is employed, for giving the trap a mechanical seal—but that there should be no place of lodgment inside a trap where filth can accumulate, for whenever filth is retained a nuisance is sure to accrue. But whilst it is of the utmost importance that a trap, for fixing under the fittings and fixtures inside a house, should be "self-cleansing," it is of equal importance that the trap should retain its seal, and if this cannot be done without the aid of some mechanical appliance, this should be adopted, though I have never found it necessary to resort to such aids. I have tested the "Anti-D-trap" (Figs. 28—31)—a trap without any obstruction, and solely dependent upon water for its seal—in almost every conceivable condition, and have never found a case

Mechanical traps.

Obstructionists' traps.

The seal important.

where it has failed when properly treated—*i.e.*, properly ventilated—to maintain a good seal. But the results of several tests with this and other traps, which will be given later on, will show the value of this trap.

Traps lose their seal through syphonage, momentum, and evaporation. And under certain conditions sufficient water is blown out of them, by a down-current of air in their vent-pipes, to seriously affect their seal.

THE SYPHONAGE OF TRAPS.

Before the introduction of the well-known "patent cast-lead syphon-trap" little was heard about the syphonage of traps, except, perhaps, in the case of the "bell-trap;" but no one, with any fair knowledge of plumbing, ever expected to find such a sham trap as a bell-trap with a protective seal of any value, whether sealed or unsealed.

"Syphon" traps easily syphoned.

As no trap is more easily cleansed than a syphon-trap (a round-pipe trap), so no trap is more easily syphoned—that is, unsealed. Therefore the depth of the water-seal of such a trap should never be less than 1½-in., though many syphon-traps are now in the market with only about an inch seal. When such a trap is fixed in a position where a great strain is liable to be put upon its seal, the depth of water-seal should be increased to 2½ or 3-in. And even with such a seal as this, in a badly* formed syphon-trap—that is, a round-pipe trap having too easy a rise to its "outlet"—it would not be safe to fix a syphon-trap under a valve-closet, or the hopper class of water-closet, used also for receiving slops from slop-pails, unless so ventilated that a portion of the discharge could go up into its vent-pipe, to fall back again into the trap to re-charge it and give it its seal. The combined action of momentum and syphonage from the discharge of a pailful of slops through a hopper closet, or the discharge of a valve-closet when filled to the brim, is so great that such traps are often left with insufficient water in them to seal off the soil-pipe, and the

* See Fig. 38.

house is then exposed to the bad air in the soil-pipe, and perhaps drain too. The remedy for such a trap is to flatten the crown of its "outgo," and to boss the up-pipe into the shape of the "Anti-D-trap."

Whilst no trap is more easily cleansed or more easily syphoned than a syphon-trap, so no trap with which I am acquainted is more *difficult* to cleanse or more difficult to unseal than the well-known D-trap. But under certain conditions this trap is (like all traps when unventilated) unsealed. It would, however, be possible to unseal the "Bower" trap (believed in so strongly by some people) twenty times to once that of the D-trap, though fixed under precisely equal conditions. D-traps difficult to syphon.

It is not a little curious that the first trap which I should direct to be ventilated should be a D-trap. This was done in 1864 or 1865. It was an old trap fixed upon the third or fourth floor of a house overlooking Hyde Park. A bad smell was complained of, and I ordered this trap to be vented to give the bad air coming from matter decomposing in such a trap a chance of escape, and also to prevent its syphonage. D-trap ventilated in 1865.

In 1867 I directed a 4-in. syphon-trap (Fig. 38) to be ventilated, having some doubt about the safety of its seal, though it had only a few feet of soil-pipe.

It was not till 1869 and 1870 that we began ventilating each individual trap fixed upon a stack of soil-pipe. And at that time I was satisfied for such vent-pipes to be taken from the top of the trap into the soil-pipe, even though other traps branched into the same soil-pipe on a higher level, so long as the soil-pipe was continued up full-size to the atmosphere above the roof. But finding a year or two later that such a mode of venting traps—though of value for preventing their syphonage from discharges sent through them, or through a main pipe from traps fixed *below* them—was of no value for preventing their syphonage from discharges sent into a main pipe *above* the connection of their air-vents, I directed that where a series Traps vented individually.

of traps branched into one stack-pipe the trap ventilation-pipe should be taken from the lowest trap, or from the main pipe a few feet below the lowest trap, and be continued up and branched into the main air-pipe of the waste-pipe or soil-pipe a few feet above the highest trap, receiving the air-vents from the other traps, fixed on the intervening floors, on its way up. And it is somewhat singular that the first two tiers of traps to be so treated should be D-traps. I have referred to this elsewhere, but the particulars are given again here, as there is surely some historical value attached to the *first* series of traps vented on a sound principle.

Tiers of traps vented in 1872.

In February, 1872, I had the D-traps on two separate stacks of 5-in. lead soil-pipe vented to prevent their syphonage. The soil-pipes and traps were fixed in a large drapery establishment in 1865. There are four valve water-closets on one stack, as shown in Fig. 107, one on each of four lofty floors, and three valve-closets on the other stack—one on each of the three upper floors. The water-closets are very greatly used for emptying the slops from the chamber utensils in the long ranges of dormitories, as well as for the purpose for which they were chiefly fixed. I made many experiments with these stacks of soil-pipe. In discharging the two upper valve-closets at one time, with the lower valve-closet apparatus removed, to see what effect such a discharge would have upon the lower trap, without the trap-vent, the water was blown out of this trap in one of the tests to the height of about ten feet. In another test, with the vent-hole made in the top of the same trap, but before the vent-pipe was connected, such a rush of air was sent out of the vent-hole that one of my assistants had his hat blown off. I had forgotten this incident until my assistant reminded me of it the other day. I had the traps on the three-closet stack vented with 1½-in. lead air-pipe, but finding that the results were not so great as expected from this sized pipe, I had the traps on the four-closet stack vented with a 2-in. pipe. The vent-pipe in the latter case, which gave better results (and would have been better still if it had been larger), was treated as shown in the illustration, Fig. 107. The pipe (2-in.) was taken from the soil-pipe at A, a few feet below the lowest trap, and continued up, and branched into the main air-pipe of the soil-pipe at B, a few feet above the highest trap—a distance of about sixty-five feet from point to point. And from the top of each trap a 1½-in. vent-pipe was taken and branched into the trap ventilation-pipe, as shown. Instead of the old 2-in. air-pipe to the soil-pipe, I had the soil-pipes carried up through the roof full-size, and they were trapped at the bottom, the total length of each stack being nearly 100 feet. The traps were tested in May of this year (1883) to see if their air-vents, being fixed from the *top* of the traps, were clogged up, as slops emptied daily into the water-closets from slop-pails would be constantly washing up into the vent-pipes; but though a very large number of discharges were sent through each stack of soil-pipe from two water-closets at a time, and each filled up to the brim, the traps could not be unsealed, showing that the trap-vents are not stopped up after eleven years of bad usage. But a vent taken from the top of a trap is liable, no doubt, to chokage, and I shall have something more to say on this when considering the ventilation of pipes and traps.

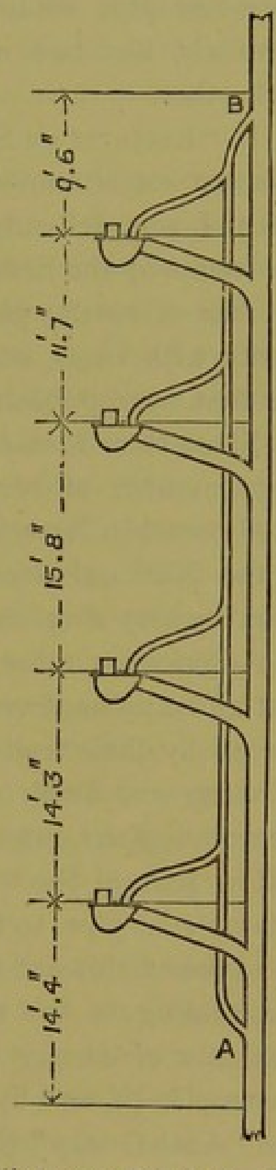


FIG. 107.—A Tier of D-traps, as vented in 1872.

First edition. Two traps destroy each other.

In the first edition of this book I explained the liability of all unventilated traps to syphonage, not only from discharges sent through them, but also from discharges sent through the pipe (waste-pipe or soil-pipe) into which they were branched, and I gave the remedy for this. I said it was necessary to ventilate each individual trap, whether fixed singly or with others on one pipe, and many illustrations were given showing how this should be done. When two traps are fixed upon one pipe without a vent-pipe to relieve them and give them air, like two negatives in one sentence, they destroy each other.

"Lectures." Experiments with traps.

In "Lectures on Sanitary Plumbing" are given the results of some experiments made with traps on working models when I was delivering a course of lectures to plumbers at the rooms of the Society of Arts. I have also given a large number of results gained from time to time in my experiments with traps, and, as far as I know, these results were the first ever published.

Messrs Philbrick's experiments.

Since then Messrs. Philbrick and Bowditch have made a large number of very valuable experiments with the traps chiefly used in America, and a copy of their very able report to the National Board of Health, Washington, appeared in *The Sanitary Engineer* of August 31st, 1882. Their testings in America, as mine in England, clearly establish this fact, that all traps want venting to prevent their syphonage. They proved by their testings that, if a *syphon*-trap is to maintain its water-seal under every condition, it must be *vented from the crown of its outgo;* that it must be vented in such a way that a part of the discharge sent into the trap shall go up into its vent-pipe, to fall back again into the trap to re-charge it. I found this out some years ago, but did not recommend the venting of the traps in such a way as this, as I saw elements of danger in it. I sought rather for a remedy in the trap itself, and by bossing a syphon-trap into the shape of the "Anti-D-trap" (Fig. 28) I found it.

Traps vented from the top.

I have not allowed the venting of traps from the crown of their outgo on any of my works for the last few years (though possibly one here and there may get so treated occasionally), because (*a*) it is possible for a vent-pipe so placed to get stopped up; then (*b*) the vent-pipe being just over the "standing-water" of the trap, the air travelling through it would absorb enough water in a trap when out of use for some length of time to endanger its seal; and (*c*) because a vent-pipe so fixed would often get fouled (by splashings of filth, etc.) where it would not be readily cleansed, as there would be no passage of water through such pipes to wash them out, and the bad air coming from such befouled vent-pipes would pass out of the ventilation-pipe of the waste-pipe or soil-pipe to contaminate the atmosphere surrounding the house.

Col. George E. Waring, jun., has also made a series of experiments with the various plumbers' traps used in America, and the results of his experiments, which were also made for the National Board of Health, Washington, in the latter half of the year 1881, were reported in *The Sanitary Engineer*,* November 2nd, 1882. His experiments would have been of more value had he used almost any other water-closet than a *pan* closet—a closet which every sanitarian now condemns, and, I believe, himself among the number. Besides, in practice there is no risk, or but very slight, of a pan water-closet ever unsealing a trap, either its own trap, or any other fixed on the same stack-pipe as itself; for the tipping-pan holds too small a quantity of water to charge a soil-pipe full-bore, and what is held in it is so much broken up by its fall upon the lower part of the "receiver," that it passes through the trap and soil-pipe in too feeble a form to unseal any trap fixed upon a well-ventilated soil-pipe four inches in diameter. Col. Waring's experiments.

Instead of repeating here the results gained by experiments with traps a year or two ago, and which are published in another work, I give, in the following pages, the results of several series of testings made in May and June of this year (1883), and I think these results will put the reader in possession of sufficient data to form a sound opinion on the value of trap-ventilation for preventing the syphonage of traps.

As the chief object of my experiments with traps was to find out to what extent the seal of water-seal self-cleansing traps can be trusted with *absolute safety*, very severe measures —severer than are ever likely to obtain in practice—were The object of my experiments.

* Also in the *American Architect*, Oct. 14, 1882

taken to break their seal. The traps were tested (chiefly) on minimum-sized waste-pipes and soil-pipes to increase the friction, and therefore the syphonic action, of the flow of water through the piping.

Fixtures used. I confined myself also to the use of that class of "fitting," or "fixture," that puts the seal of a trap to its greatest strain, whether from syphonage or momentum, or the action of both combined. For instance, as there is little or no danger of any kind of trap being left unsealed from discharges sent *through* it from a flat-bottomed vessel (the drainings being always sufficient from such fittings to re-charge their traps), the following fittings were not used, viz., draw-off sinks, wash-up sinks, pantry sinks, and scullery sinks. Nor were lavatories with "flat" bottoms, or shallow wash-basins, or wash-basins with small waste connections (½-inch or ¾-inch plugs and washers), or pan water-closets, as in practice there is little or no risk of syphonage from the discharges of such fittings, either of their own trap or other traps fixed on the same piping.

Though a quick-waste bath may unseal its own trap several times during its discharge, the drainings from its bottom more than suffice to leave its trap fully charged at the end. There is, therefore, no danger of a bath leaving its *own* trap unsealed, when ventilated, however rapidly the bath may be emptied, but there is great danger of syphonage, with insufficient ventilation, of any other trap (or traps) fixed on the same branch, or on the same vertical pipe, whether on a higher or lower level, and this will be seen by the results given later on.

APPARATUS USED IN TESTING THE VARIOUS TRAPS.

A.—*Bath* with "flushing-valve" (flap-valve, 2-in. clear way), emptying 80 gallons of water out of a bath, filled to the brim, in two minutes and a half. (See N, Fig. 118, p. 129.)

B.—*Lavatory*—an extra-deep basin with an extra-large grated outlet, as shown in the drawings, Figs. 108 and 109, which are to scale. The "feather-waste" valve shown in the drawing, Fig. 109, at D, empties nine pints of water out of the basin, filled up to its overflow line, R, in five seconds. The "quick discharge-valve," S, Fig. 108, empties the same quantity of water out of the basin in six seconds, as does also the large plug-and-washer, N, Fig. 110. T e clear diameter of the lining, P, Fig. 109, is $1\frac{1}{2}$ inches ; O, Fig. 108, $1\frac{7}{16}$ inches ; and N, Fig. 110, $1\frac{1}{4}$ inches, but these three drawings are to scale.

Note.—It made but slight difference which of the two discharging arrangements was used, Fig. 108 or Fig. 109, for though the waste apparatus, Fig. 109, discharged the basin the quickest, the drainings from its piping more than made up for any extra loss of seal caused by the more rapid flow of water through the trap. But the waste-valve S, Fig. 108, put a little greater strain upon the traps than either of the other two arrangements, and this was, therefore, the waste-valve chiefly used in the testings.

C.—*Slop-sink*, as Fig. 180, p. 222, with a 3-inch outlet, clear way. This sink was used for emptying a three-gallon pailful of water into it at a time, to see the effect upon traps of such a body of water flowing through a small waste-pipe.

D.—*Slop-sink*, as last, but discharged with a plug, for emptying the contents of the sink into the waste-pipe without any admission of air with the water.

E.—*Slop-pails*, holding three gallons of water.

F.—*Water-closet—valve* closet holding three gallons of water when filled up to the brim, as was the case in these tests, and discharged in *less* than two seconds by a sharp pull of the closet handle. The clear diameter of the basin outlet is $3\frac{1}{2}$-in. A view of this water-closet is given in Fig. 150, p. 188, and a section in Fig. 141, p. 179. In these experiments the vent-arm of the valve-box and the overflow-arm of the basin were sealed off to get stronger tests, and no water was allowed to come into the basin during the time of the discharge.

G.—*Water-closet*, "Artisan" basin, Fig. 155. This basin, having an outlet $3\frac{1}{2}$ inches diameter (clear way), was used to see the effect upon the water-seal of traps by emptying pailfuls of water into such closets.

Memoranda.—The discharge of nine pints of water from the lavatory, if sent full-bore into the waste-pipe, would form a water-plug in $1\frac{1}{4}$-inch pipe, 21 feet 9 inches long; in $1\frac{1}{2}$-inch pipe, 15 feet long ; and in 2-inch pipe, 8 feet 5 inches long.

The discharge of three gallons of water from the valve water-closet, and also from the slop-pail—through the "Artisan" water-closet, or slop-sink—would form a water-plug about 9 feet 3 inches long in a 3-inch pipe, 6 feet 10 inches long in a $3\frac{1}{2}$-inch pipe, and 5 feet 4 inches long in a 4-inch pipe.

In practice, in the larger pipes, both in the waste-pipes and soil-pipes, the "water-plug" would not be so "solid" as in the smaller pipes (the bore of the fittings and traps being of smaller diameter); the syphonage would, therefore, not be quite so great in such pipes.

The traps experimented with were the

"Anti-D-trap," 3½-in. and 1¼-in. (See pp. 52—54 for a description of this trap.)

"Bower" trap, 2-in. and 1¼-in.	" 59—60	"
D-trap, "Narrow-band."	" 47—48	"
"Eclipse."	" 48—49	"
"Helmet" D-trap.	" 48	"

Syphon-traps, 4-in., 2-in., 1½-in., and 1¼-in. As "*the patent cast-lead trap*" ("Half-S" or "Full-S") is not made of smaller size than 1½-in., the 1¼-*in.* "Half-S" experimented with here is a "Du Bois" syphon.

I.—*Experiments with small traps branched singly into vertical waste-pipes of various sizes and lengths. The drawing, Fig.* 108, *which is to scale—except in the* SIZE *of the pipes, and in the* LENGTHS *of the main waste and air-pipes—shows the relative positions of the branch waste and branch air-pipe. In changing the size of the vertical waste-pipe these branches would also be changed, to make the size of the piping equal throughout.*

1*a*.—With 60 feet of 1½-in. vertical lead waste-pipe connected to the pipe at W, and 34 feet of 1½-in. air-pipe continued up vertically from Y, a 1¼-in., 1½-in., and 2-in. "Half-S" syphon-traps, fixed at T, were all syphoned five times in succession by a discharge from the lavatory, R.

2*a*.—A 1¼-in. "Anti-D-trap" was then tested, but though eleven trials were made (using the different lavatory valves, Figs. 108, 109, and 110), this trap could not be syphoned, nor in any of these eleven trials was it left with less than 1¼-in. depth of seal.

3*a*.—With 60 feet of 1½-in. waste-pipe, and only a few inches length of air-pipe—the air-pipe being open at Y—the syphon-traps were each syphoned several times in succession—the 1½-in. syphon twelve times out of thirteen.

4*a*.—With 40 feet of 1½-in. waste-pipe instead of 60 feet, and with 44 feet of air-pipe instead of 34 feet, the results were just the same, viz., a syphonage of the syphon-traps, and a non-syphonage of the "Anti-D-trap."

5*a*.—With the air-pipe heightened, and standing 60 feet above Y, the 1¼-in. "Anti-D-trap" was affected as follows:—By a discharge of 9 pints of water from the lavatory in six seconds, through the 40 feet of vertical waste-pipe, viz.: first discharge, loss of water $\frac{3}{16}$-in.; second

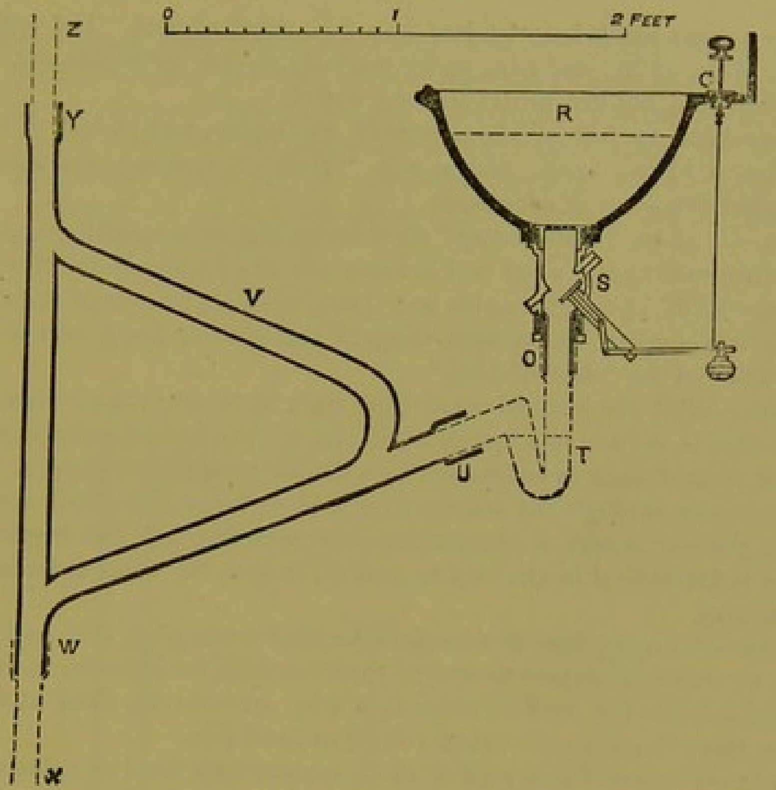


FIG. 108.—Apparatus for testing Waste-traps.

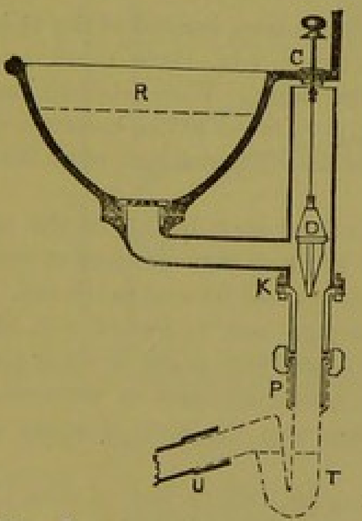


FIG. 109.—Lavatory with "Feather-waste-valve."

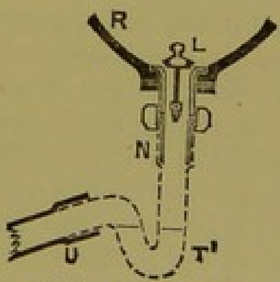


FIG. 110.—Lavatory with extra-large Plug.

discharge, $\frac{3}{16}$-in.; and in each of three further discharges it maintained a full seal.

6*a*.—With the air-pipe heightened still more, and made to stand 80 feet above Y, the "Anti-D-trap" was more affected, and lost in several trials $\frac{1}{2}$-in. depth of water. And when some trials were made in a very heavy atmosphere, it lost, under similar conditions, as much as $1\frac{1}{8}$-in.;

but in no case was it left with less than $\frac{5}{8}$-in. depth of seal. The syphon-traps, $1\frac{1}{4}$-in., $1\frac{1}{2}$-in., and 2-in., under precisely similar conditions, not only lost their seal, but lost nearly all their water.

7a.—With 12 feet of $1\frac{1}{4}$-in. vertical waste-pipe, and 12 feet of $1\frac{1}{4}$-in. air-pipe, a $1\frac{1}{4}$-in., $1\frac{1}{2}$-in., and a 2-in. "Half-S" syphon-traps were all syphoned five times in succession.

8a.—A $1\frac{1}{4}$-in. "Anti-D-trap" fixed under the same conditions as last described maintained a full seal in every one of a large number of tests.

9a.—With $1\frac{1}{2}$-in. waste-pipe and $1\frac{1}{2}$-in. air-pipe, instead of $1\frac{1}{4}$-in., the result was similar, viz., a syphoning of the syphon traps, and a non-syphoning of the "Anti-D-trap."

10a.—With the vertical waste-pipe open at W, and the air-pipe open at Y—that is, with only a foot or so of piping—the syphon-traps were unsealed several times in succession by a discharge of the lavatory, R. The passage-way through the waste-valve, S, is so large and direct, and the water passes through a syphon-trap with such freedom, that insufficient water is left behind in the trap to seal it ; in fact, the water is forced out of the trap.

11a.—With 40 feet of 2-in. lead vertical waste-pipe, and 40 feet of 2-in. air-pipe (galvanised sheet-iron pipe was used, for lightness in fixing), in eight trials the loss of water in a 2-in. syphon-trap, fixed at T, was $1\frac{1}{8}$-in. three times, $1\frac{1}{16}$-in. twice, 1-in., $\frac{3}{4}$-in., and $\frac{3}{4}$-in.

12a.—In seven trials with a $1\frac{1}{2}$-in. syphon-trap, fixed at T, instead of the 2-inch trap, the loss of water was as follows :—$\frac{7}{8}$-in. four times, $\frac{3}{4}$-in. three times.

13a.—In ten trials with a $1\frac{1}{4}$-in. syphon-trap, instead of the $1\frac{1}{2}$-in., the loss of water was respectively $\frac{3}{4}$-in. twice, 1-in. three times, and four times the seal was reduced to breaking point. With this trap, but with the enlarged plug and washer (Fig. 110), fitted to the lavatory, instead of the waste-valve S, in five trials the trap did not lose more than $\frac{3}{8}$-in. depth of seal.

14a.—A $1\frac{1}{4}$-in. "Anti-D-trap" was fixed at T, in lieu of the syphon-trap, and in five discharges from the lavatory through each of the three discharging arrangements this trap maintained its seal to the full.

15a.—With 40 feet of 2-in. waste-pipe, and 24 feet of 2-in. air-pipe, instead of 40 feet, a 2-in. syphon-trap lost $\frac{3}{4}$-in. depth of water six times in succession ; a $1\frac{1}{2}$-in. syphon-trap, $\frac{1}{2}$-in. four times in succession, and $\frac{3}{8}$-in. once; and with a $1\frac{1}{4}$-in. syphon-trap the loss of water did not exceed $\frac{3}{8}$-in. in any of five trials.

16a.—With 40 feet of 2-in. waste-pipe, and 12 feet of 2-in. air-pipe, instead of 24 feet, a 2-in. syphon-trap lost in nine trials as follows :—$\frac{3}{4}$-in. six times, $\frac{1}{2}$-in. three times. A $1\frac{1}{2}$-in. syphon-trap, under the same conditions, only lost $\frac{3}{8}$-in. depth of seal in any of the five trials ; and the loss of water with a $1\frac{1}{4}$-in. syphon-trap, fixed under the same conditions, did not exceed $\frac{1}{4}$-in. in any of the eight trials made with it.

II.—*Experiments with water-closet traps branched singly into a 3-in. vertical stack of soil-pipe, discharging with an open end at a point 40 feet below its branch,* S P, *and with its air-pipe carried up full size to a point 47 feet above* A P, *and left open at the top, unless where otherwise described.* (*See drawing, Fig.* 111, *showing the arrangement.*) *The water-closet, and the mode of discharging it, are described at* F, *p.* 109.

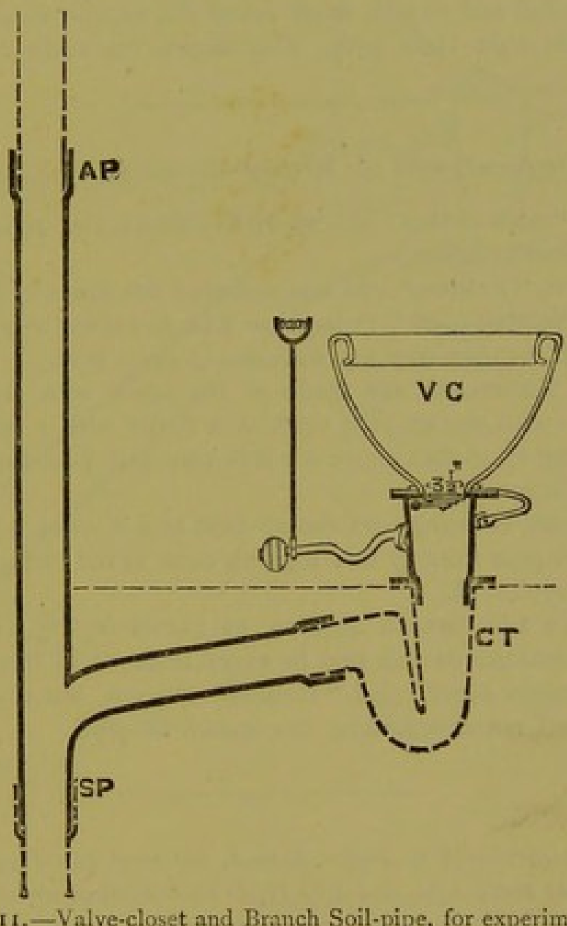


FIG. 111.—Valve-closet and Branch Soil-pipe, for experimenting.

Note.—The "Anti-D-trap" experimented with here is the "Medium" size (see Fig. 28, p. 53), as I consider the larger size (Fig. 26) too large to be kept perfectly wholesome, especially when fixed under a water-closet.

1*b*.—With a discharge from a valve-closet filled to the brim, the "Anti-D-trap" lost 1¼-in. of water ten times, and a little less in each of nine further trials, but in no trial was it left with less than ½-in. depth of seal. (See experiment No. 6*b*.)

2*b*.—A 4-in. syphon-trap (Fig. 38, p. 57) was unsealed in each trial.

3*b*.—A 4-in. "Eclipse" trap was unsealed six times in succession, the water standing in some of the trials ⅜-in. below the bottom of the dip-pipe.

4*b*.—A "Helmet" D-trap lost 1-in. ten times out of twelve tests, and ⅞-in. twice.

5*b*.—A "Narrow-band" D-trap lost 1-in. five times, and ⅞-in. five times.

6*b*.—With the same arrangement, but with the branch soil-pipe vented by a 2-in. pipe, as shown in the drawing, Fig. 113, the "Anti-D-trap" maintained a full seal in nine trials out of eleven, and in no trial was the loss of water more than ¼-in. This shows the value of venting the branches.

III.—*Experiments with the air-pipe shortened and left open at* A P.

1*c*.—The "Anti-D-trap" lost 1⅛-in. five times, and 1¼-in. three times. (See experiment 5*c* below.)

2*c*.—A 4-in. "Eclipse" trap was unsealed five times in succession.

3*c*.—A "Narrow-band" D-trap lost ⅞-in. five times in succession.

4*c*.—A 4-in. syphon-trap was unsealed in everv trial.

Note.—(1) No record was made of the trials with the "Helmet" D-trap with the air-pipe open at A P, but with a full-size air-pipe standing up 26 feet above A P this trap lost ⅞-in. depth of seal six times in succession.

Note.—(2) By covering over the air-pipe at A P (or at a point with the long air-pipe fixed 47 feet higher), each of the foregoing traps was easily syphoned.

5*c*.—With a 2-in. branch air-pipe, as shown in Fig. 113, the "Anti-D-trap" maintained its full seal in every trial. And this was the case with the "Narrow-band" and "Helmet" D-traps, but the syphon-trap still lost its seal, notwithstanding this branch air-pipe.

IV.—*Experiments with a longer branch, the trap standing* 4 *feet away from the main pipe, and with the branch fixed at an angle of* 45 *deg. upon a* 40-*feet length of* 3-*in. waste-pipe, and with* 47 *feet of* 3-*in. air-pipe, as before described.*

1*d*.—With an "Artisan" hopper closet fixed in lieu of a valve-closet, and a pailful of water, three gallons, thrown down the closet sharply, the "Anti-D-trap" lost 1⅛-in. nine times, and 1 in. twice.

2*d*.—A 4-in. syphon-trap lost its seal in every trial made with it.

3*d*.—With a 2-in. branch air-pipe from the branch waste or soil-pipe, as shown in Fig. 113, the "Anti-D-trap" maintained a full seal in each of the five trials made with it, but the syphon-trap was still syphoned.

4*d*.—With a valve-closet fixed, as shown in the drawing, Fig. 112, as in the previous experiments, instead of the "Artisan" closet, a "Narrow-band" D-trap lost 1-in. five times, and ⅞-in. twice.

5*d*.—A "Helmet" D-trap lost (fully) 1-in. six times in succession.

V.—*Experiments with water-closet traps fixed singly upon a vertical stack of 4-in. pipe 40 feet long from* S P², *Fig.* 112, *and with 47 feet of 4-in. air-pipe, continued up from* A P². *To increase the friction in the discharge through the piping, galvanised iron pipe was used instead of lead.*

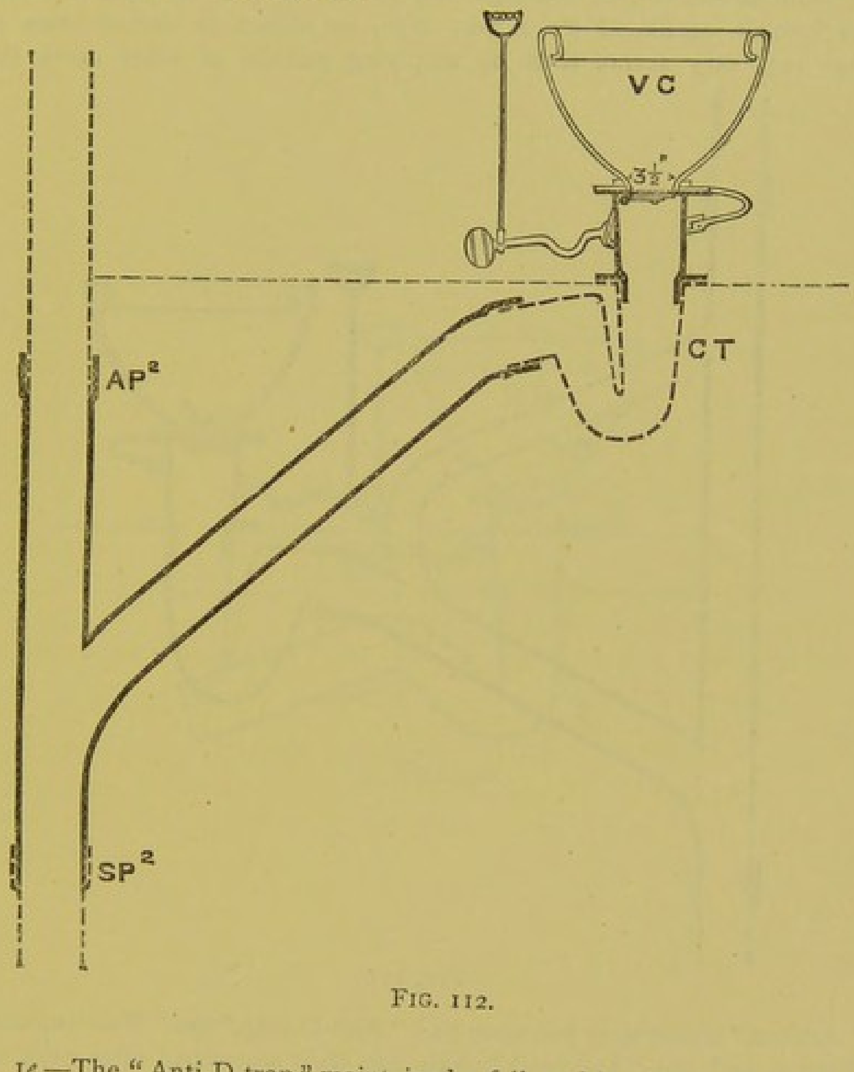


FIG. 112.

1*e*.—The "Anti-D-trap" maintained a full seal in eleven trials out of twenty-one, by a discharge of a valve-closet filled to the brim, and the trap was left with more than 1½-in. depth of seal in each of the other trials.

2*e*.—A 4-in. "Eclipse" trap was unsealed six times in succession.

3*e*.—The "Helmet" D-trap lost in nine trials as follows :—⅜-in. six times, $\frac{3}{16}$-in. twice, and ⅛-in. once.

4*e*.—A "Narrow-band" D-trap maintained a full seal in each of seven trials.

5*e*.—A 4-in. syphon-trap was unsealed nine times in succession, and in some of these tests the water stood as much as 1¼-in. below the dip.

VI.—*Experiments with single traps fixed upon a ventilated branch, as shown in the drawing, Fig.* 113, *but with an "Artisan" hopper closet fixed over the trap, instead of the valve-closet shown in the drawing.*

With 40 feet of 4-in. soil-pipe and 36 feet of 4-in. air-pipe, and with the branch ventilated by a 2-in. pipe, as shown in dotted lines in Fig. 113, very severe tests by emptying pailfuls of water down the

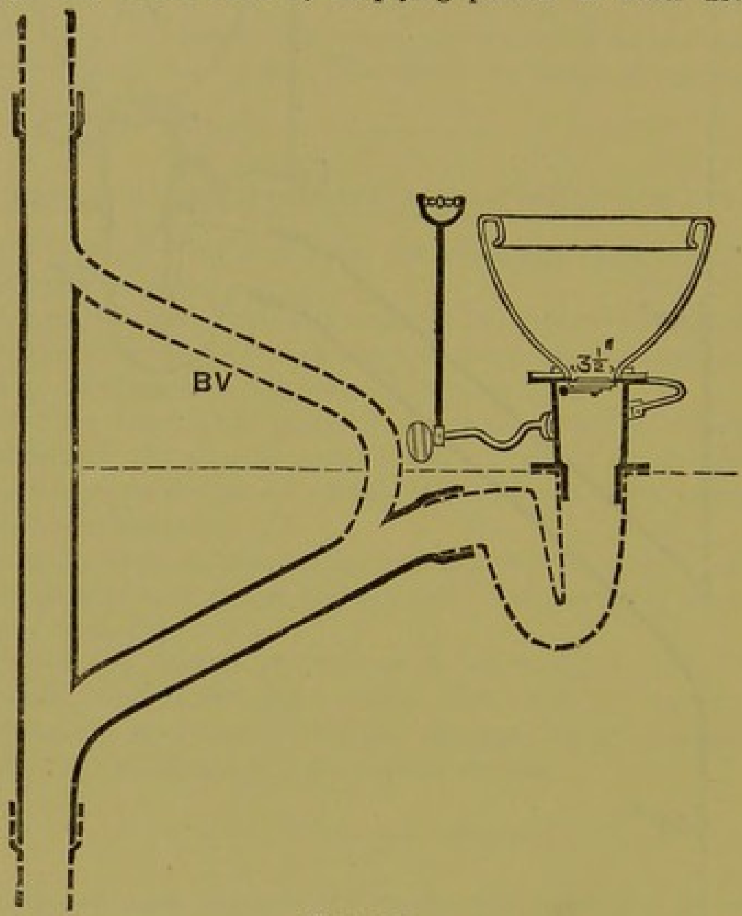


FIG. 113.

"Artisan" closet were put upon the "Anti-D-trap," the "Narrow-band" D-trap, and the "Helmet" D-trap, but their water-seal after each test was found to be of the normal depth. But the "Eclipse" trap was unsealed in every one of eight discharges from a slop-pail, and this was also the case with a 4-in. syphon-trap.

VII.—*Experiments with only one foot of* 4-*in. soil-pipe connected to the "outgo" of certain traps, as shown in the drawing, Fig.* 114.

1*f*.—A 4-in. syphon-trap loses its seal, by a discharge of a valve-closet filled to the brim, with only 12 inches of 4-in. piping attached to it. This trap lost its seal six times in succession.

2*f*.—A 4-in. "Eclipse" trap also lost its seal in each of four trials. The water is momentumed out of these traps.

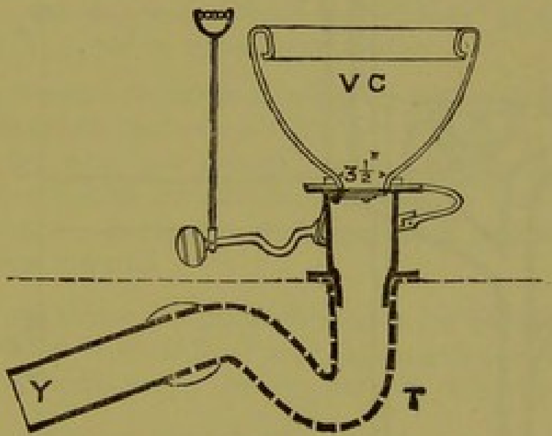


FIG. 114.

PLATE IV.

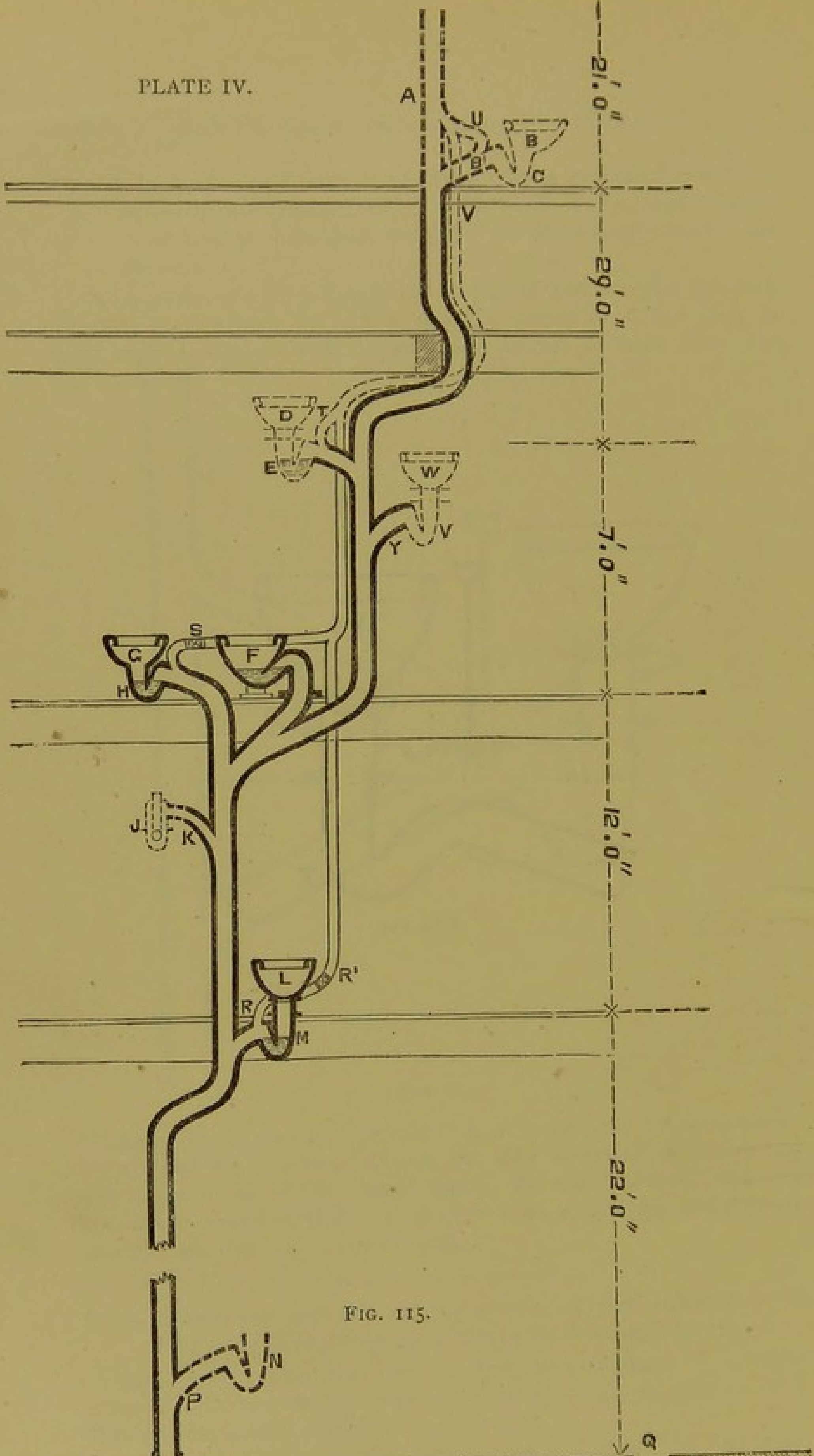


FIG. 115.

VIII.—*Experiments with traps branched at different levels into a stack of 3-in. lead soil-pipe, open full bore at top* (A) *and bottom* (Q) *to see the effect upon their seal of water flowing through the main pipe in large volumes:—The three water-closets* G F L, *and the piping shown in thick lines in the drawing, Fig.* 115, PLATE IV.—*which is an illustration of the apparatus experimented with—have been in use in my factory by at least fifty persons daily for about two years.*

1*g.*—With a pailful of water thrown down each of the "hopper" class of closets, B F G, and with the valve-closet basin D filled to the brim and emptied sharply, and with the water from two small supply cisterns running into the two water-closets F and G as well, making in all about 15 gallons, discharged into the main pipe at one time—the 2-in. trap-ventilation, R V, being in use—a 2-in. "Bower" trap fixed at J, on the 2-in. branch K, was unsealed; and a 9-in. "Helmet" D-trap fixed on the 3-in. branch P, at N, had its water lowered ⅜-in.

2*g.*—With another discharge of water as last, without refilling the traps, the india-rubber ball of the "Bower" trap floated away from the dip-pipe, and the water was lowered enough in the trap to pass smoke through it into the room from the main pipe. The "Helmet" trap lost ⅛-in. more water by the second discharge, but it took ten further discharges to unseal this trap.

3*g.*—With the twelve foregoing discharges (15 gallons of water at a time) the ventilated "Anti-D-trap" at M did not lose ¼-in. depth of water, *i.e.*, after the twelve discharges this trap had still 1½-in. depth of seal.

4*g.*—With a 1¼-in. "Bower" trap fixed at J, instead of a 2-in., a discharge of water through the main pipe as before completely unsealed it. After two such discharges smoke was sent through the trap into the room in volumes, by using an "Asphyxiator," and sending the smoke into the main pipe from the top, at A, above the roof.

5*g.*—With the 2-in. branch K lengthened, and the "Bower" trap—either 1¼-in. or 2-in.—standing 16 feet away from the main pipe, there was little, if any, difference; for in similar trials to the last the trap lost its seal—both water-seal and "mechanical" seal.

6*g.*—With a similar discharge as before, a 1¼-in. "Du Bois" trap, a 1½-in., and 2-in. "patent cast-lead syphon trap" fixed at J, on the branch K, were each syphoned in succession. A 4-in. ditto lost 1½-in. depth of seal in the first discharge, and after the second discharge the water stood ½-in. below the dip.

7*g.*—With a similar discharge, a 2-in. "Eclipse" trap, fixed in the same position as last, was unsealed in every trial. A 4-in. "Eclipse" trap lost in the first discharge ½-in., second ⅜-in., and the third discharge unsealed it.

8*g.*—With a 1¼-in. "Anti-D-trap" fixed in the same position, and with a similar discharge of water, this trap was also unsealed. A larger-size "Anti-D-trap" held its seal much better.

9*g*.—With a small "Narrow-band" D-trap — $1\frac{1}{2}$-in. between the cheeks, and with $1\frac{1}{2}$-in. "outgo"—fixed on the branch K, a similar discharge of water as before lowered the water 1-in., another discharge lowered it $\frac{1}{8}$-in. more, the third discharge a little more, and the fourth discharge unsealed it. With a *full-size* "Narrow-band" D-trap it took forty discharges to unseal it. The first discharge took out $\frac{3}{8}$-in., second $\frac{1}{8}$-in., and seven succeeding discharges took each $\frac{1}{16}$-in.

10*g*.—With a *full-size* "Helmet" D-trap, fixed as last, the first discharge lowered the water in the trap $\frac{3}{4}$-in., second $\frac{1}{8}$-in., third $\frac{1}{8}$-in., and five succeeding discharges took out by each discharge $\frac{1}{16}$-in.

IX.—*Experiments with traps and pipes precisely as in the last arrangement, but with the branch* K *ventilated by a 2-in. lead vent-pipe taken into the trap-ventilation*, R V.

1*h*.—With the branch K ventilated, a $1\frac{1}{4}$-in. "Du Bois" trap, fixed at J, was unsealed with two discharges of water sent through the main pipe as before, and a 2-in. "patent cast-lead trap" ("Half-S" syphon-trap) had its water lowered $\frac{1}{2}$-in. below the dip or seal with four discharges. With a 4-in. syphon-trap fixed instead of the 2-in., it took twelve discharges to lower the water $\frac{1}{2}$-in., and in ten further discharges this trap lost no more water—*i.e.*, in twenty-two discharges a 4-in. "round-pipe" trap, fixed on the ventilated branch K, lost about one-third of its seal.

2*h*.—With a 4-in. "Eclipse" trap, fixed on the ventilated branch K, instead of the 4-in. syphon-trap, ten discharges, as before, unsealed the trap, and left the water standing $\frac{1}{4}$-in. below its dip-pipe. A 2-in. "Eclipse" trap fixed in the same position, under the same conditions, lost $\frac{1}{2}$-in. in the first discharge, $\frac{1}{8}$-in. in the second, $\frac{1}{8}$-in. in the third, and after six further discharges this trap was unsealed.

3*h*.—A $1\frac{1}{4}$-in. "Anti-D-trap," fixed on the ventilated branch K, lost in the first discharge of 15 gallons of water through the main pipe as before, $\frac{3}{4}$-in.; in the second discharge (without re-charging it) $\frac{1}{8}$-in. more; in the third $\frac{1}{16}$-in.; but ten succeeding discharges did not further affect the seal; so that after thirteen discharges this trap was left with fully $1\frac{3}{4}$-in. of water-seal The larger-size "Anti-D-trap," in similar tests, did not suffer so much as this one—$1\frac{1}{4}$-in.

4*h*.—A small-size "Narrow-band" D trap, fixed on the ventilated branch K, lost in four discharges respectively $\frac{1}{2}$-in., $\frac{3}{16}$-in., $\frac{1}{8}$-in., $\frac{1}{16}$-in., but ten more discharges did not further reduce the seal. (See experiment 9*g*.)

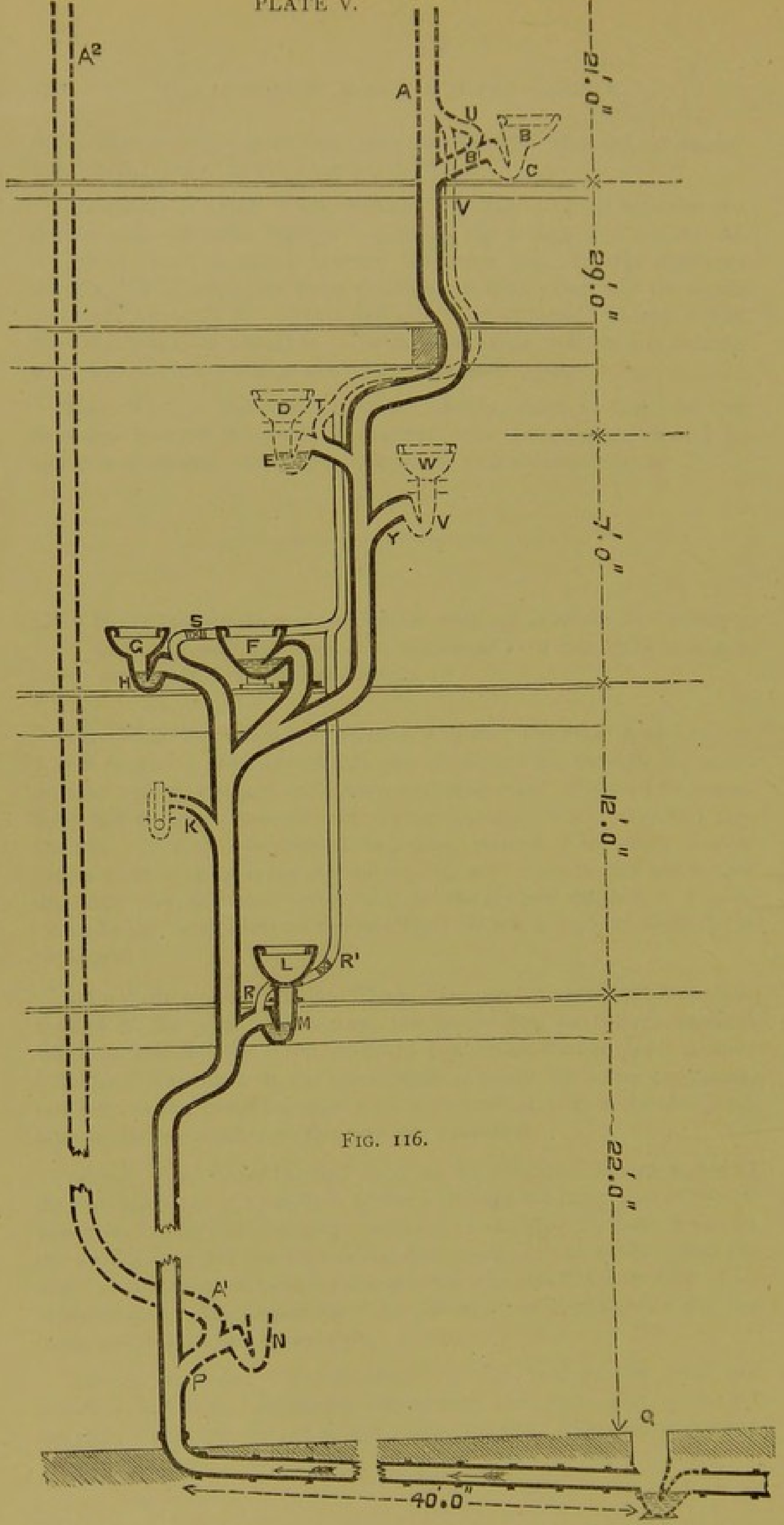


Fig. 116.

5*h*.—A 2-in. "Bower" trap, fixed on the ventilated branch K, did not lose $\frac{1}{8}$-in. depth of water in six discharges. (See experiments Nos. 1*g* and 2*g*.)

X.—*Experiments with the same stack of 3-in. soil-pipe described in No. VIII. series, but with the bottom branch* P *ventilated, as shown in dotted lines in the drawing*, A^1 A^2, PLATE V.

1*i*.—With 48 feet of 2-in. vent-pipe fixed on the branch P, as shown by the dotted lines A^1 A^2, with the two valve-closets D and L filled to the brim, and a pailful of water thrown down each of the two water-closets F G, and discharged at one time into the main pipe, a 4-in. syphon-trap, a 4-in. "Eclipse" trap, and a $3\frac{1}{2}$-in. "Anti-D-trap," fixed at N, were each unsealed by two such discharges. (See succeeding tests with 3-in. vent.)

2*i*.—With 40 feet of 3-in. vent-pipe fixed on the branch P (instead of the 2-in.) as shown by the dotted lines A^1 A^2, the water was lowered in a $3\frac{1}{2}$-in. "Anti-D-trap," fixed at N, $\frac{3}{16}$-in. by three discharges together of the three water-closets D F G, but three further discharges did not lower the water any more.

3*i*.—With the two valve water-closets D and L filled to the brim, and a pailful of water thrown down each of the two water-closets F G, and passed into the main pipe at one time as before, the water was lowered in the "Anti-D-trap," fixed at N, $\frac{5}{16}$-in. after three trials; and three more trials did not further reduce its seal.

4*i*.—With the air-pipe heightened 10 feet more, and a discharge of water as in the last experiment, the water was lowered in the "Anti-D-trap," fixed as before at N, $\frac{1}{4}$-in.; in the second discharge, without refilling the trap, $\frac{1}{8}$-in. more; and in the third discharge $\frac{3}{16}$-in., but further discharges did not lower the water any more.

5*i*.—With the air-pipe heightened 12 feet more, in five trials as before, the water was lowered in the trap (fixed as last described) as follows:—$\frac{3}{8}$-in, $\frac{1}{8}$-in. twice, $\frac{1}{16}$-in. twice, and subsequent discharges had no effect upon the seal.

6*i*.—With the air-pipe heightened still more, and made to stand 80 feet above the trap, it lost respectively in four trials $\frac{3}{8}$-in., $\frac{1}{4}$-in., $\frac{1}{8}$-in., $\frac{1}{16}$-in.; but further trials did not lower the water any more, so that with this long length (80 feet) of branch ventilation, this trap was left with more than $\frac{7}{8}$-in. depth of water-seal.

7*i*.—With the 80-feet length of branch ventilation (A^1 A^2), a 4-in. syphon-trap, and a 4-in. "Eclipse" trap, fixed at N, were unsealed by four such discharges as last.

Note.—With a 4-in. vent-pipe instead of a 3-in., the effect of similar discharges was very much less upon any of the traps fixed at N, but this will be understood.

XI.—*Experiments with the same stack of 3-in. piping as last, but with the branch to the lower trap ventilated as in practice.*

1*k.*—With a 2-in. vent fixed on the branch P (3-in. away from the trap at A^1, instead of the dotted line 3-in. vent A^1 A^2), and continued up by the side of the soil-pipe, and connected to the branch air-pipe at R^1, a discharge of a bath containing about 80 gallons of water into the top branch B^1, in two minutes and a half, and with a pailful of water thrown down each of the two water-closets F G at the same time, the water was lowered $\frac{3}{16}$-in. in the "Anti-D-trap" M, and $\frac{3}{4}$-in. in the "Anti-D-trap" N. A 4-in. "Eclipse" trap fixed at J, but without the ventilation of its branch, lost the whole of its seal by this discharge. In further trials with the same quantity of water, the "Anti-D-traps" at M and N lost $\frac{1}{16}$-in. more, but they were not unsealed by many more discharges, and the one at N without re-charging was left with more than 1-in. depth of seal after the whole of the many discharges.*

2*k.*—With the branch ventilation *disconnected at top from the main air-pipe* of the soil-pipe, and continued up and left open to the atmosphere, the "Anti-D-trap" at N, in a similar trial to the last, lost $1\frac{1}{4}$-in. depth of seal. This shows the *dis*advantage of continuing the branch or trap ventilation through to the atmosphere separately. The branch ventilation should therefore be connected to the main pipe just above the highest trap branched into it in the usual way.

N.B.—In practice, where it is necessary for the branch ventilation to be of great length to reach the atmosphere, and especially where the main waste-pipe or soil-pipe is of small diameter, the branch or trap ventilation should be of the same calibre as the largest branch, or as the main pipe itself.

XII.—*Experiments with large flushes of water sent into a 3-in. soil-pipe from several water-closets at a time, to see the effect of such discharges upon the seal of traps branched into the main pipe at a higher level than the flow of water through it, such pipe being open at the top and bottom full bore.* (*See* PLATE IV.)

1*l.*—With a 4-in. "Eclipse" trap fixed on the branch Y—the *branch* being unventilated—and a discharge from the three water-closets F G I, equal in all to 12 gallons of water sent into the pipe simultaneously, the water was lowered in the trap $\frac{1}{2}$-in., and with a second discharge (without re-charging it) it was unsealed.

* See pp. 134, 137.

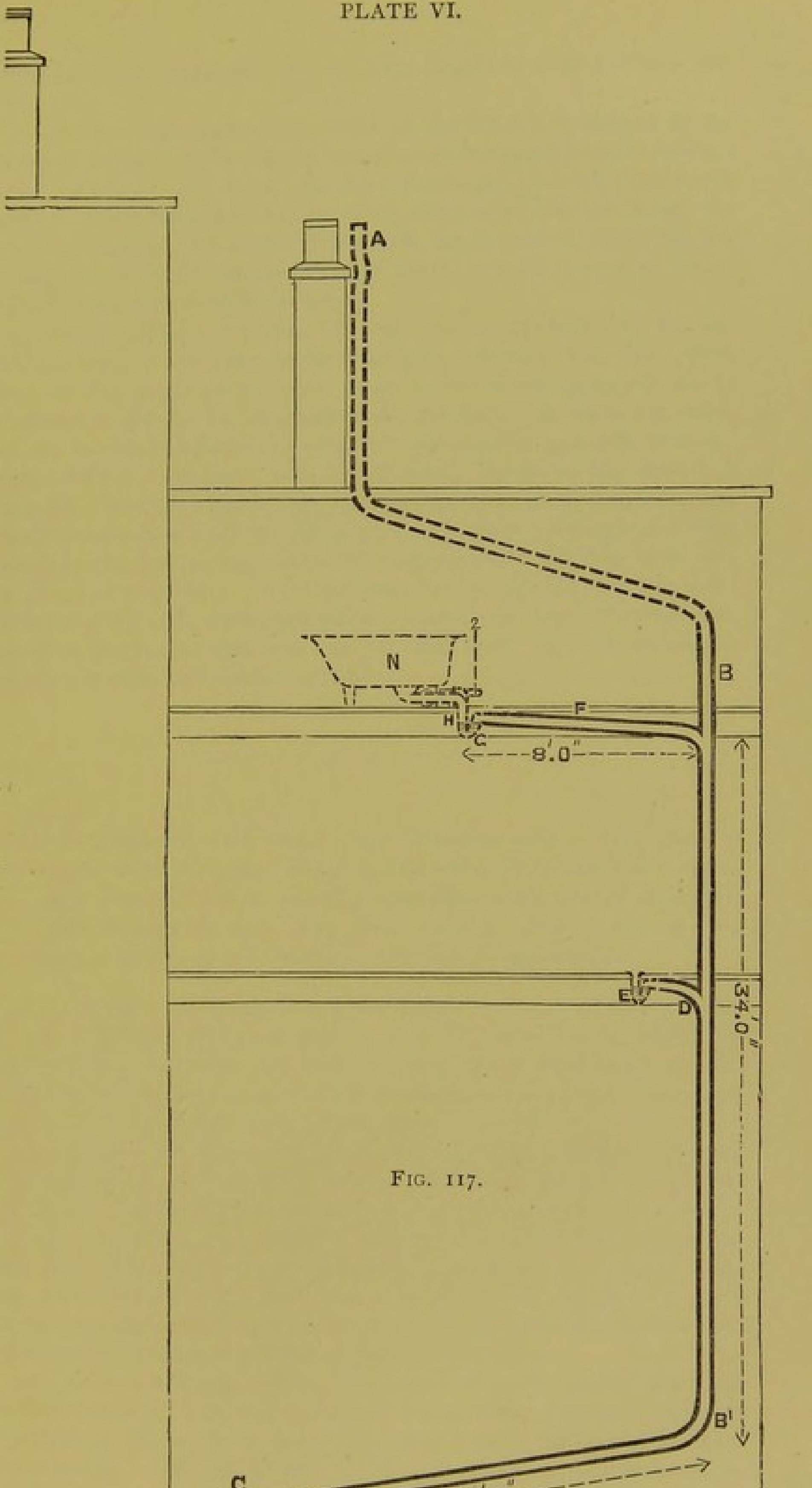


Fig. 117.

2*l.*—With a 4-in. syphon-trap fixed on the branch Y, instead of the "Eclipse," a discharge of water as last lowered the water in the trap ½-in.; another discharge, ¼-in. more; the third discharge, 1/16-in. full; the fourth discharge, 1/16-in. bare, and fifteen more discharges did not lower the water ⅛-in. further. In similar trials with the branch Y, ventilated, the seal was not so much affected, though twenty-five discharges of water, as before, were sent through the piping.

3*l.*—With a full-size "Helmet" D-trap fixed on the branch Y, the first discharge lowered the water in the trap ⅜-in.; second, ⅛-in. full; third, 3/16-in.; six discharges more, 1/16-in.; seven further discharges, 1/16-in. more; and after that ten further discharges did not lower the water any more. With the branch ventilated the water was nothing like so much affected.

4*l.*—With a "medium" size "Anti-D-trap" fixed on the branch Y as last, the first discharge of water lowered the water in the trap ½-in.; the second, third, fourth, and fifth, each ⅛-in.; sixth, 1/16-in.; and fifteen further discharges did not further lower the water, leaving the trap with fully ⅝-in. depth of water-seal. With the branch on which the trap was fixed ventilated, *forty* such discharges did not unseal ½-in. depth of water—*i.e.*, after forty discharges this trap was left with 1¾-in. depth of water-seal, showing the value of branch ventilation.

XIII.—*Experiments with small traps branched into a long stack of 1½-in. waste-pipe, open at top,* A, *and bottom,* C *(except where otherwise described), to see the effect upon their water-seal of discharges sent through the main pipe from a bath or slop-sink fixed on a higher level.* (See PLATE VI., *showing the apparatus.*)

1*m.*—Without the ventilation of the branch waste D, a 1¼-in., 1½-in., and 2-in. "Half-S" syphon-traps, also a 1¼-in. "Anti-D-trap," fixed at E, were not only unsealed, but each of these traps, fixed in succession, lost nearly the whole of its water by a discharge from a quick-waste bath through the 1½-in. branch F, and 1¾-in. main waste B B′.

2*m.*—Under the same conditions as last, a 1½-in. Bower trap fixed at E had its water lowered to within ⅛-in. of the bottom of its dip-pipe by the discharge from a bath through the branch F, and main waste B¹. And although a second discharge of the bath only lowered the water 1/16-in. more, the trap was practically unsealed; for though sufficient water was left in it to float the ball up against the dip-pipe, a piece of dirt, or soap, on the ball or edge of the dip would prevent a perfect seal, and thus expose the house to the air in the waste-pipe.

3*m.*—It was also easy with a slop-sink fixed at H, instead of a bath, by throwing down a pailful or two of water, three gallons at a time, to unseal a 1¼-in., 1½-in., and 2-in. syphon-trap, and also a 1¼-in. "Anti-D-trap" fixed at E, with the branch waste, D, unventilated as before.

XIV.—*Experiments as last, but with the branch waste* D *ventilated, as shown in the diagram, Fig.* 118, PLATE VII.

1*n*.—With 52-feet length of 1½-in. lead air-pipe fixed on the branch waste D, as shown by the dotted lines J K, Fig. 118, Plate VII., a pailful of water discharged quickly into a slop-sink fixed at H, lowered the water in a 1½-in. syphon-trap, fixed at E, ½-in. Another pailful lowered it ¼-in. more; and four more pailfuls unsealed the trap. It was also found that the 1¼-in. and 2-in. syphon-traps could be similarly unsealed with this length of air-pipe.

2*n*.—With a 1¼-in. "Anti-D-trap" fixed at E, instead of the 1½-in. syphon-trap, under precisely the same conditions as last described, a pailful of water thrown down the slop-sink, fixed at H, lowered the water in the trap fully ¼-in.; another pailful lowered it ¼-in. more; and a third pailful ⅛-in. further; but five more discharges did not syphon out any more water, and this trap was left with 1-in. depth of water-seal.

XV.—*Experiments as last, but with 2-in. main waste-pipe instead of* 1½-*in.*

1*o*.—With a 2-in. waste-pipe from B to C, instead of 1½-in., and 1½-in. main air-pipe B to A, and with the branch waste ventilated by 1½-in. pipes, as shown by the dotted lines J K, a pailful of water thrown down the slop-sink at H lowered the water in a 1½-in. syphon-trap, fixed at E, ⅞-in.; another pailful, ¼-in. more; a third pailful, ⅛-in. further; and three more pailfuls unsealed the trap.

2*o*.—With a 1¼-in. "Anti-D-trap" fixed at E, instead of the 1½-in. syphon-trap, the first pailful lowered the water ½-in; the second, ⅛-in. more; but ten further discharges did not take any more water out, and the trap was left with over an inch water-seal after twelve discharges.

3*o*.—Under the same conditions as last, but with a 2-in. ventilating-pipe to the branch waste (52 feet long as before) instead of the 1½-in., a 1½-in. syphon-trap lost ½-in. and ⅛-in. twice, but three additional pailfuls did not further lower the water in the trap. A 1¼-in. "Anti-D-trap" lost ⅜-in., ⅛-in., and $\frac{1}{16}$-in. twice; but five further pailfuls did not syphon a drop of water out of the trap, leaving it with more than an inch seal.

4*o*.—With the same conditions as last, but with a bath fixed at H, instead of a slop-sink, the water was lowered in a 1½-in. syphon-trap, fixed at E, 1-in. by the discharge of a bath filled nearly to the brim, about 80 gallons of water, in two minutes and a half.

5*o*.—A 1¼-in. "Anti-D-trap," fixed in lieu of the 1½-in. syphon-trap, had its water lowered ⅜-in. by one discharge of a bath, but subsequent discharges had no further effect upon it.

6*o*.—With a 2½-in. branch air-pipe, as shown by the dotted lines J K (52 feet long), instead of 1½-in., the syphon-trap did not lose ¼-in., and the "Anti-D-trap" did not lose ⅛-in. from many discharges, either from a bath or slop-sink fixed at H.

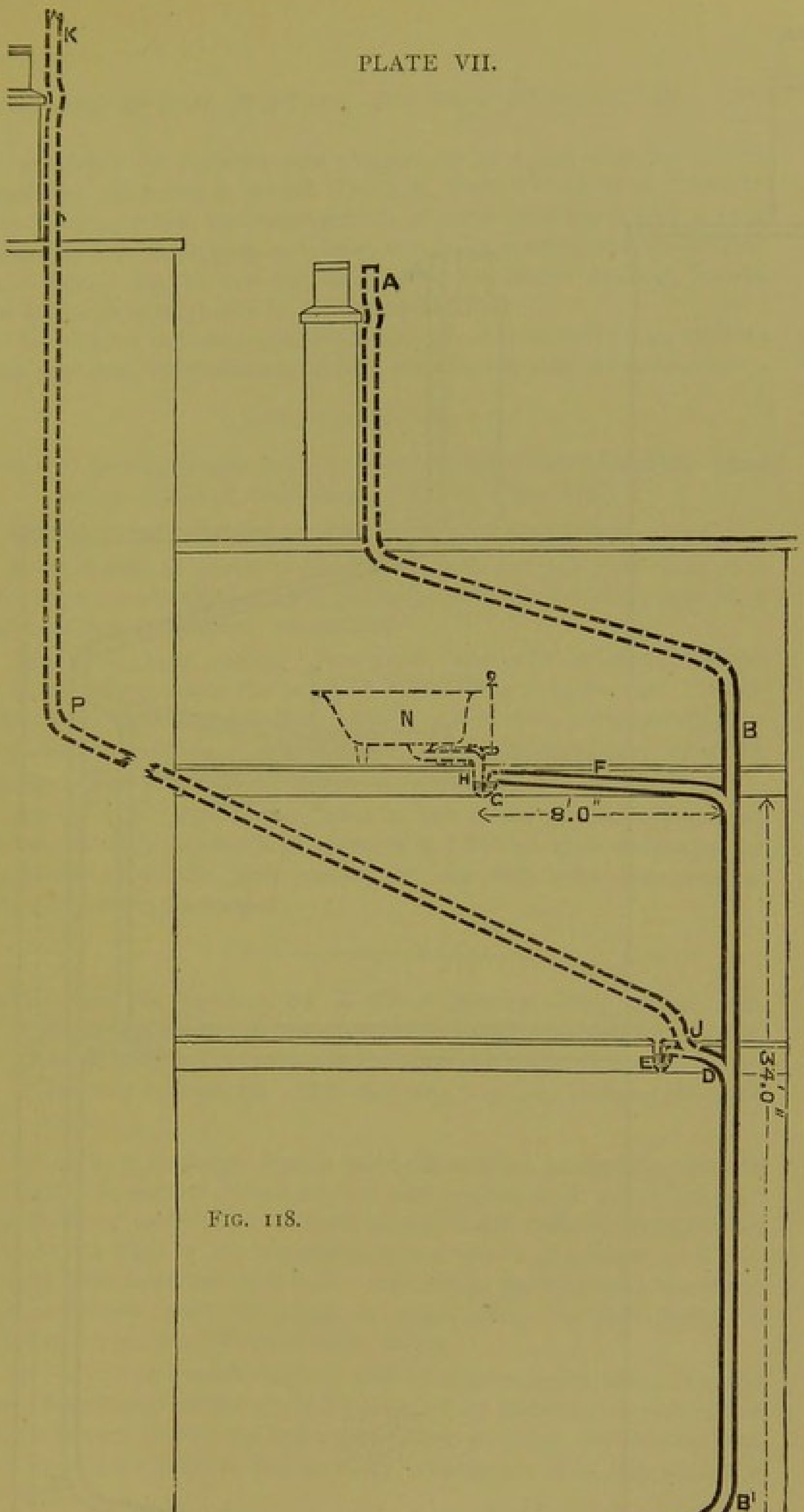


FIG. 118.

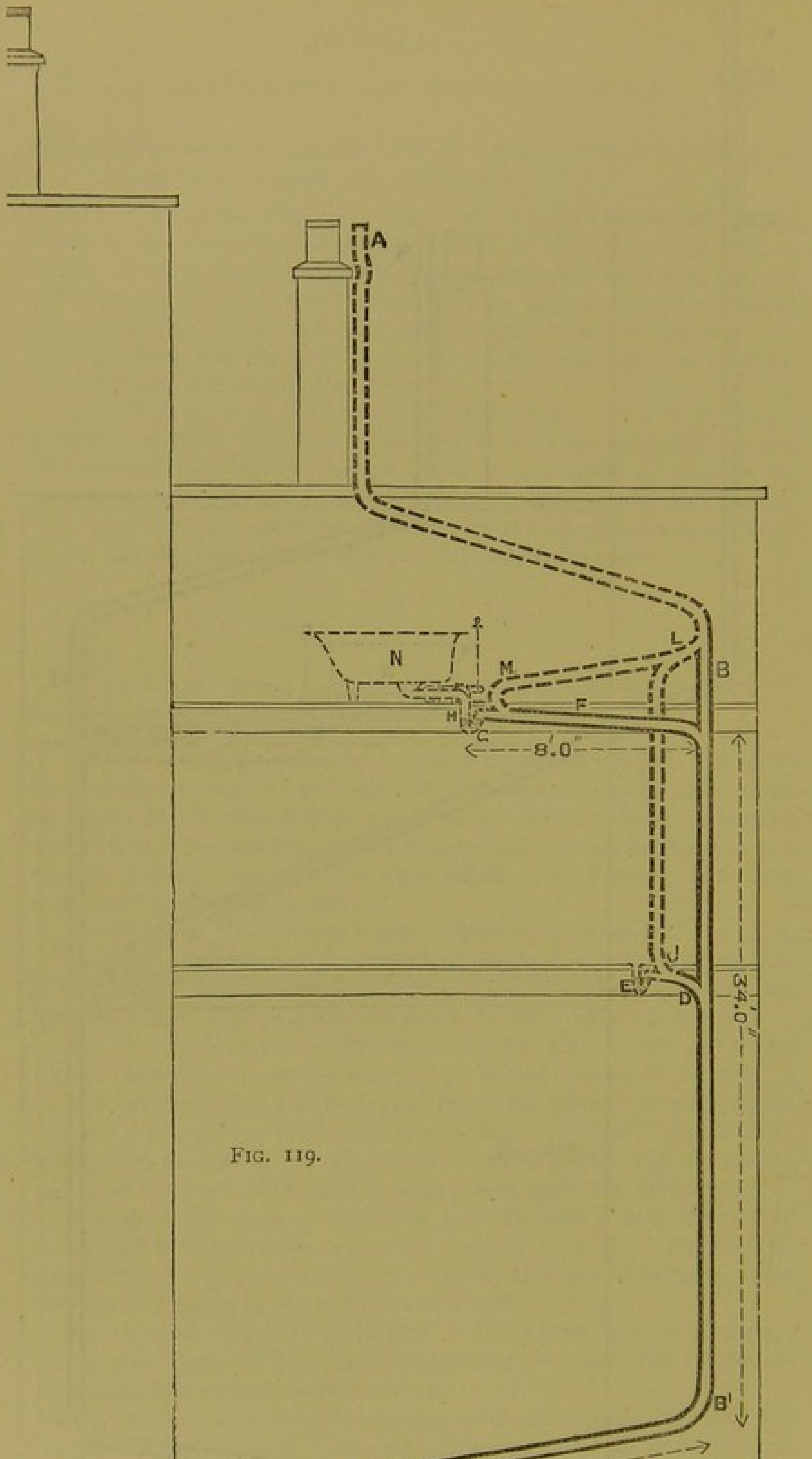


Fig. 119.

7o.—With the main air-pipe stopped up at A, but with the branch ventilated, as shown in dotted lines J K, Plate VII., a 1¼-in. "Anti-D-trap" fixed at E lost, by twelve pailfuls of water discharged into a slop-sink fixed over the trap H, as follows :—⅛-in. in each of five discharges ; 1/16-in. once ; but in the six succeeding discharges nothing, leaving the trap with more than 1-in. depth of seal.

8*o.*—Under the same conditions as last, a 1¼-in. and 1½-in. syphon-trap were unsealed in succession with a similar number of discharges.

XVI.—*Experiments with traps or their branches ventilated in the usual way, as shown in the diagram*, Fig. 119, Plate VIII.

1*p.*—With the long air-pipe taken down, and with the trap branches, D F, ventilated, as shown in the dotted lines J M L, a trap fixed at E was not so much affected by a discharge through the main pipe as it had been with the separate ventilation.

2*p.*—With 1½-in. piping throughout, and with a 20-feet length of air-pipe fixed *above* the point A, Plate VIII., a 1¼-in., and a 1½-in. syphon-trap fixed at E, and ventilated as shown, were each unsealed by four discharges from a slop-pail, through a slop-sink fixed over the trap H. After the fourth discharge the water stood ½-in. below the dip.

3*p.*—A 1¼-in. "Anti-D-trap," fixed in lieu of the syphon trap, lost as follows, viz. :—¼-in., ⅛-in. three times, 1/16-in. ; but ten more discharges did not further affect the seal, leaving the trap with more than 1-in. of seal after sixteen discharges.

XVII.—The Water-seal of a Trap Forced.—*Experiments with water-closet traps fixed on a 4-in. soil-pipe open full bore at top, but trapped at the bottom, and without foot ventilation, or the ventilation of its branches.* (See *drawing*, Fig. 120, *showing the apparatus.*)

1*q.*—With a discharge from a valve-closet filled to the brim through the branch A, water is forced out of a 4-in. syphon, or a 4-in. "Eclipse" trap fixed at B to the height of three or four feet,* from the compression of air in the pipe by the water-plug D, and with half a dozen such discharges these traps lose their seal. And it does not take more than from eight to a dozen similar discharges to unseal either an "Anti-D-trap," a "Helmet" trap, or a "Narrow-band" D-trap.

2*q.*—With trap-ventilation, *i.e.*, with a 2-in. vent-pipe taken from the lowest branch and carried up and connected to the main pipe above the highest branch (or with the soil-pipe made to discharge with an open end at C) the evil is remedied, and no water is forced out of a trap fixed at B as before.

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* See water forced to a height of ten feet out of traps, page 104.

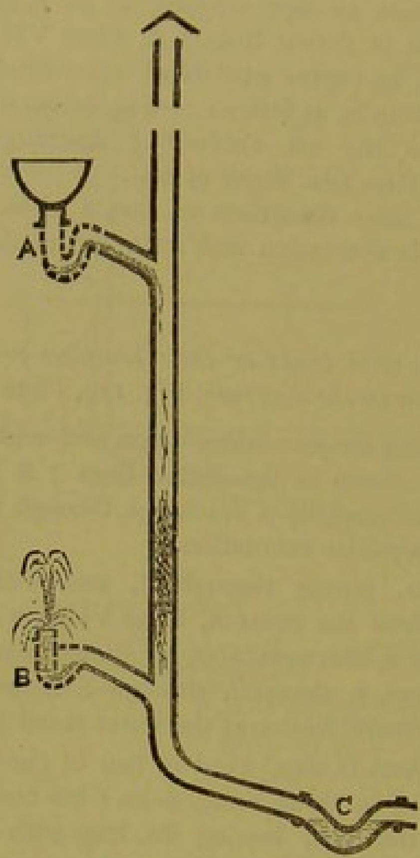


FIG. 120.—Water forced out of trap.

Tests with traps on 3-in. pipe.

Experiments with traps and pipes which have been in use for some time.—As already explained (see p. 119), I have had some traps tested after they have been in use for some time to see the value of trap ventilation. I have also had a tier of "Anti-D-traps" fixed upon a stack of 3-in. soil-pipe, with 2-in. trap ventilation, tested after they have been in use for about half a year. This stack of piping is illustrated in Fig. 115, Plate IV., facing page 119. The ordinary use of any one of the water-closets did not affect the seal of any trap fixed upon the pipe. A pailful of water thrown into the top water-closet (B) and the handle pulled up sharply caused a loss of ⅛-in. depth of seal in each of the four lower traps. The closet basin filled up to overflowing (equal to three gallons of water) and discharged quickly took ¼-in. out of each trap on the stack. But after ten such discharges the water was not lowered more than ⅜-in., and not one trap upon the stack was left with less than 1½-in. depth of seal after fifteen discharges, though the trap ventilation pipe is only of 2-in. calibre.

Ditto, 2-in. pipe.

I have also had a tier of 2-in. "round-pipe" traps ("patent cast-lead traps") tested after being in use six months. The arrangement is illustrated in Plate XX. The traps are 2-in., and the waste and branches are 2-in. The trap ventilation ought to have been 2-in., the same size as the waste, but by an error 1½-in. only was fixed. The discharge of two baths, B and C at one time in less than three minutes, though the baths were filled right up to their overflow line, did not take more than ⅛-in. of water out of any of the traps G L M N, fixed on the main pipe P P.

Want of air.

Where there is an *extensive* length of vertical soil-pipe or waste-pipe, or soil-pipe and waste-pipe combined, and the branches into it are situated somewhere about the middle part or lower half—*i.e.*, at a point remote from the atmosphere—to prevent the syphonage of any of its traps, the ventilating-pipe from the traps should be of the same calibre as the main-pipe (or larger), and the main-pipe should be of larger bore than any of its branches. For in a building of great height—say six storeys high with a sub-basement—the momentum of a volume of water from the discharge of two or three valve-closets or two or three slop-pails at one time through a pipe is very great, and the sudden demand for air is enormous.

If any reader doubts this demand for air in a soil-pipe or waste-pipe during the passage of such discharges, let him go on the top of his house, and place his handkerchief over the mouth of a soil-pipe (supposing the pipe to be carried up to the roof), and then order two water-closets or two slop-pails to be filled with water and discharged quickly into the pipe, say from closets or slop-sinks on the second and third floors, and he will then have a practical illustration of the suction power of volumes of water passing through a soil-pipe or waste-pipe, and will return to his arm-chair a wiser, though perhaps a sadder, man, for probably he will have lost his pocket-handkerchief down the soil-pipe

Action of discharges.

The volume of water discharged from a valve-closet when filled up to the brim, or from a full slop-pail emptied into a hopper class of water-closet, exerts two influences while passing through the soil-pipe, the one a suction, or pulling, and the other a driving force. Forming itself into a sort of water-plug in the pipe, it acts as a piston, pulling or sucking the water out of every unventilated water-seal trap, and it also acts at the same time as a forcing-plug, driving everything before it. When, therefore, the traps or branches are not ventilated, and the pipe is air-sealed at its foot, where is the air in the pipe, which this "water-plug" is forcing down before it, to go to, but out of the lowest closet-trap? The pipe in its normal state is full of air, and this must go somewhere. The pressure of this water-plug will prevent its passage to the air-pipe at the top of the soil-pipe, and escaping in that way; and so, where there is no trap-ventilation, it must force its way through some one or more water-seal traps below the discharge into the house, as shown at B, Fig. 120.

If any reader still doubts whether the air in a soil-pipe is forced through a water-closet trap, where the soil-pipe is not disconnected, and there is no trap-ventilation, by the discharge of a water-closet on a higher level, let him test it. He can easily do this by going into the lowest water-closet on the soil-pipe, say in the basement, and getting the apparatus removed, and then sending some one to discharge a valve water-closet at the highest point, on the third or fourth floor; and if *he* is not satisfied about it after making such an experiment, his tailor will be—if he stands anyway near the trap—for whatever was in the trap before he made the experiment will be sent out of it into the room. I have seen the contents driven out, in such experiments, to a height of several feet above the trap. When this occurs the house is without any protection from the soil-pipe air, as far as this trap is concerned.

High buildings.

In buildings of great height, where there are water-closets, &c., on the upper floors as well as in the basement, instead of branching them all into one main-pipe, two pipes should be fixed, separating the traps on the basement and ground floor from the traps on the upper floors. In fact, the soil (or waste-pipe) from the "fixtures" on the upper floors should be so arranged that no opening is made in it below the level of the first floor. The air-pipe from the "lower" stack can be connected with the air-pipe (above the highest trap) of the "upper" stack.

Syphon traps.

Syphon-traps, as proved by a large number of the foregoing experiments, are not proof against syphonage under very many conditions even though their *branches* are *vented*. Nor are they proof against the action of momentum, or momentum and syphonage combined. But though the venting of a *branch* waste (or the main waste-pipe) will not save the seal of a "syphon" trap against loss from the momentum, or momentum and syphonage combined, of discharges sent through the trap, the venting of the trap itself, from the crown of its outgo, will—*i.e.*, a syphon trap vented as shown in the drawing, Fig. 121, is rendered perfectly secure from loss of seal from any discharge that may be sent *through* the trap, no matter what the length of its waste and air pipes may be; for, as explained elsewhere, in sending a volume of water into such vented traps part of the water will pass up into the vent-pipe (V P, Fig. 121) to fall back again into the trap to re-charge it. (See page 106.) Though the venting of a syphon-trap from the crown of its outgo insures its seal in any discharge sent *through it*, such a mode of ventilation will not secure its seal against the syphonage of water running *through the pipe* on which it may be branched, under certain conditions, as proved by many of the tests.

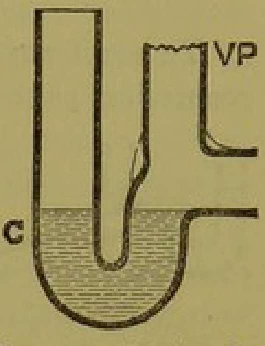


FIG. 121.—Section of a vented Syphon Trap.

And this is also the case with the "Eclipse" trap, for neither the "Eclipse," nor syphon, nor "round-pipe" trap is rightly constructed to withstand the action of momentum, *i.e.*, of water rushing through the *trap*; or of syphonage, *i.e.*, the suction power of water running through the *pipe* on which the trap may be branched. (See Experiments, p. 116.) "Eclipse trap.

The "Anti-D-trap," though as "self-cleansing" as a round-pipe trap (from the reduced size of its body part), is specially designed to maintain its seal, when fixed on a vented branch, against both these actions, viz., syphonage and momentum, and this it did in the severest tests. As the inventor of this trap I may be considered prejudiced in its favour, but facts are facts, and the results are given of the actual tests made with this trap in conjunction with others; moreover, I have as great a pecuniary interest in the "syphon" trap (Beard and Dent's patent cast-lead trap) as in the "Anti-D-trap."

To see if anything could be gained by using an enlarged connecting piece A, at the junction of the branch with the main pipe, to lessen in some measure the friction of discharges through the piping at such points, I had an arrangement made as shown in section, Fig. 122, and this was inserted in the testing apparatus at D, Fig. 117, but it was found to have no value for preventing the syphonage of a trap fixed on its branch, and is therefore worse than useless.

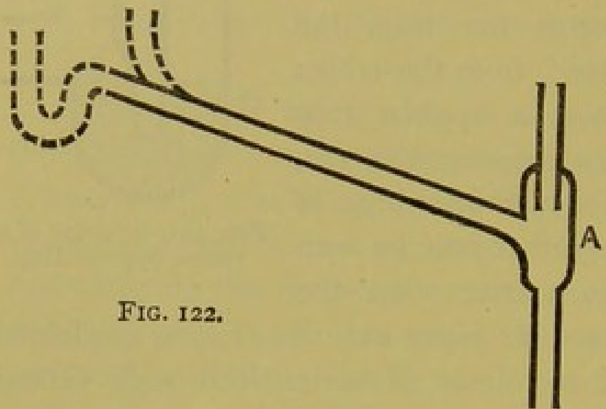


FIG. 122.

"Anti-syphon" trap.

In some further experiments, I found that a "syphon" trap, or a "round-pipe" trap bossed into the shape of the letter *b*, as shown in section, Fig. 123, at A, is proof against momentum and syphonage. A $1\frac{1}{4}$-in. "Anti-syphon," or "*b*"-trap with 2-in. water-seal, as shown at A B, Fig. 123, was fixed on a 37-feet vertical length of $1\frac{1}{2}$-in. waste-pipe, and though there was a 70-feet length of $1\frac{1}{2}$-in. air-pipe on the top of this waste-pipe, the trap maintained a good seal in every experiment. Though this trap protects its seal, I have not in any way protected *it*, and anybody can therefore make it.

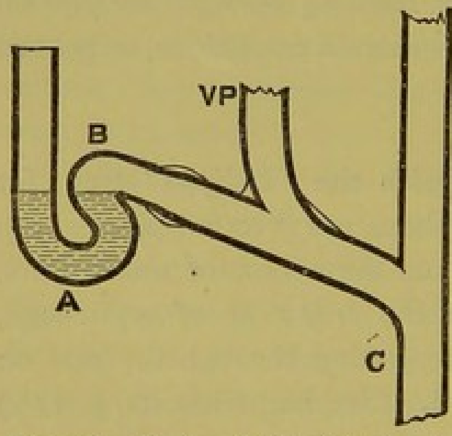


FIG. 123.—Section of "Anti-Syphon" Trap, "b."

Trap-ventilation.

The necessity of "trap ventilation" in the case of *every* trap experimented with, to maintain its seal under certain conditions—conditions which occur in almost every house of good dimensions—has been abundantly proved, but though the *venting* of a trap may save its seal it does not turn a non-cleansing kind of trap into a "self-cleansing" one. The principles and character of a trap should therefore be well considered before assigning it a position in which it would not be able to maintain its seal under any treatment it might receive, or holding its seal well enough would hold matter with it, and so become in itself a greater nuisance than the pipe or drain it was set to guard.

Many branches lessen syphonage.

When several traps on various floors are branched into a long length of vertical piping, the strain upon the seal of any one of its many traps is not so great as it would be if only *two* traps were fixed on the pipe; for the syphonic action of a discharge of water through the main pipe would be more or less broken by each of the vented branches. The air drawn into the main pipe at each vented branch, and going down with the water running through the pipe, not only reduces the syphonage, but it also breaks the suction power upon the traps of the piston-like plug of water passing through the pipe. But when only *two* traps are fixed at different levels somewhere about the middle part of a long length of vertical piping (so that the air must travel a long way to reach the lowest branch, to save the seal of the trap fixed upon it) and the discharge through the highest trap is of sufficient volume to fill the calibre of the main pipe to pass through it as a water-plug, the strain upon the lowest trap is immense; and if the passage-way out of the trap to the branch waste be an easy one—as in the case of the syphon and "Eclipse" traps—it is very liable to lose its seal, even though it be ventilated by a pipe equal in calibre to the main pipe.*

Having explained in another work the principles of the syphonage of traps, I say nothing more here on this head.

Loss of seal in traps by evaporation.

Thousands of traps in areas, cellars, and such-like places, could be found in London to-day as "dry as a bone," and

* By fixing a vent-pipe from the traps about twice the size of the main waste, for the air to pass more freely into the branch wastes, it would be possible to save the seal almost of any trap placed in the trying position we are now considering.

were it not that in many cases such unsealed traps act as air-inducts to drains—where the drains are ventilated—more illness than at present might be the consequence. No surface trap, *i.e.*, no trap should be fixed in a floor anywhere *inside* a house for receiving the washings-down of the floor, for besides becoming a nuisance from its collections of filth, it is sure to become "dry," and to emit drain-air into the house. Traps fixed in areas, and in places where the rays of the sun can reach the "standing-water" of the trap, are liable to the loss of their seal from evaporation. Great care therefore should be taken that they have means of being kept constantly charged with water.

Traps inside the house.

Traps with shallow seals are very liable to become uncharged by evaporation when out of use for any length of time, especially when fixed under the "hopper" or "wash-out"* kind of water-closet; this is also the case with some of the other sorts of plumbing fixtures, though the water would not evaporate anything like so readily from a trap fixed under a grated sink, lavatory, or bath (unless near to a hot-water coil) as from an open-mouthed water-closet. And in this, as in several other ways, the valve water-closet has the advantage of all such closets. I had a valve water-closet fixed over an "Anti-D-trap" at E, on our factory stack of water-closets, shown in drawing, Fig. 115, Plate IV. for six months, and though the water-closet had been kept out of use all that time, and not a drop of water had passed into the trap, it had not lost one-third of its seal, either from evaporation, or the ordinary use of the water-closets below it.

The seal of a trap blown out.

I have known the seal of a water-closet trap, fixed on a stack of pipe on the top floor of a house, blown out, by a down-current of air through the soil-pipe, when it has been carried up through the roof full size, and has had no proper cowl or protective cap fixed over it. And this is the case in gusty weather in town as well as in country houses. Cowls are therefore not without their advantage from another point of view than that generally considered, for they prevent the seal of a trap from being blown out.

* See page 180.

CHAPTER IX.

GENERAL ARRANGEMENT OF SANITARY APPLIANCES.

Economy in concentration of sanitary fittings—Ill-considered positions for sanitary fittings—Grouping sanitary appliances—Country mansions and long drains—Consider the drainage—Cisterns and their wastes—Houses properly sanitated—Isolation of branch drains—The old way of draining houses.

Economy.

SANITARY appliances inside our houses should be concentrated as much as possible, not only for the sake of economy —though that would be greater than many imagine—but also for the sake of better sanitary results.

Places of fittings ill-considered.

The positions of water-closets, baths, sinks, &c., are often most ill-considered with regard to their chief requirements—light, ventilation, and drainage. Such "fittings" are often placed here, there, or anywhere about the house, like the corn-ricks one sees in Ireland (and in many parts of Scotland too) in all parts of the field—for "shure and isn't one part of the field as good as another?"

Advantages of concentrating w.c.'s, &c.

As one tree will carry many branches, but must have trunk and roots if only one branch be upon it, so a stack of soil-pipe will take the branches from many water-closets, but must have the same belongings, at top and bottom, if only one water-closet be branched into it. The *economy*, therefore, in fixing water-closets, or sinks, etc., in "tiers" will at once be seen, and it will not take many words to show that *better sanitary results* will be obtained by concentrating such fittings in tiers, instead of spreading them over the house with a long length of drainage to each. When water-closets, slop-sinks, lavatories, baths, &c., are fixed in "tiers," as shown on Plates IX. and X., there is only a short length of branch piping to wash out to get the discharges into the main soil or waste-pipe, where discharges and flushes from the various fittings are constantly passing through to keep the pipe wholesome.

But when water-closets, or slop-sinks, etc., are fixed *singly* in various parts of the house, and especially when fixed on the upper floors, there is often from 30 to 60 feet of soil-pipe or waste-pipe to cleanse after each usage of the "fitting," besides a long length of branch drainage. The consequence is, that where any such long length of drainage exists it rarely gets properly flushed out. And to save the expense of ventilating the branch drain, such pieces of drainage are often left unventilated.

Country mansions.

In country mansions, it is not at all an infrequent thing to find a water-closet, sink, or lavatory so situated that a little fortune has to be spent upon it to make it and its belongings sanitarily perfect. In such cases the "fitting" should be done away with, or a better place found for it. It is better that a person should be his own carrier, and walk a few feet more to reach a water-closet, than put a strain upon the drain which it would not bear without becoming offensive. I am often coming across water-closets fixed in remote corners (upstairs and downstairs) in a wing of the house, remote from all other sanitary fittings, and two and three hundred feet away from the main drain.

TABLE OF REFERENCES TO PLATE IX., WITH SOME EXPLANATION.

B W L.—Branch-waste to lavatories, 1½-in. strong lead pipe.

B W S.—Branch-waste to slop-sinks, 2½-in. strong lead pipe, equal to 10-lb. sheet lead.

B S.—Branch soil-pipe, 3½-in. "patent" lead pipe, equal to sheet lead weighing 8-lbs. to the superficial foot.

D C.—"Double-cap" ventilating cowl, as Fig. 262, p. 338.

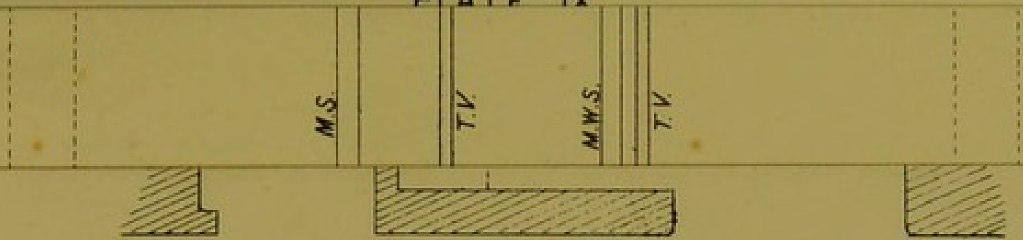
D S.—"Drain-sentinel" trap and disconnection chamber, as Fig. 223:—When circumstances will not admit of a fixed *grating* over the man-hole, an air induct-pipe should be brought into the disconnection chamber, as shown at I P, the mouth of the induct being placed where it cannot get stopped up with dirt, leaves, &c. See pages 274-275.

D O S.—Draw-off sinks or wash-up sinks. Wood sinks lined with sheet lead, equal to 7-lbs. per foot superficial in the sides, and 10-lbs. in the bottoms. Where cold water only is laid on to such sinks, 6-lb. sides and 8-lb. bottoms would make good durable sinks.

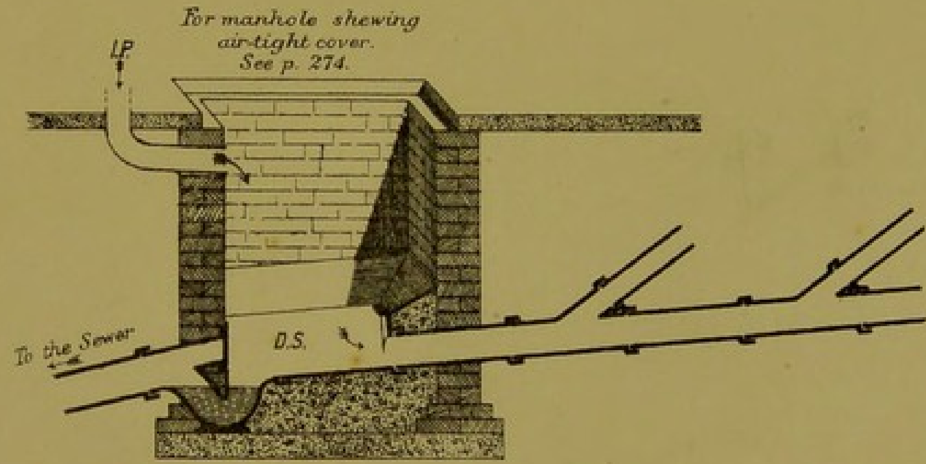
L.—Lavatories. Marbled earthenware table-tops with quick wastes.

...AND SANITARY HOUSES.

PLATE IX



PLAN SHOWING THE PIPES.



S. S. Hellyer, del.

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M S.—Main soil-pipe, 4-in. "patent" lead pipe, equal in substance to sheet lead 8-lbs. to the foot superficial, fixed with tacks, as shown in Fig. 4, Plate XII.

M W L.—Main waste to lavatories, 2-in. strong lead pipe, secured in its position with lead tacks, soldered to the pipe, and hooks driven into the wall, as in the case of soil-pipes.

M W S.—Main waste to slop-sinks, 3-in. "patent" lead pipe, equal in substance to sheet-lead 10-lbs. to the superficial foot, and fixed with lead tacks, as in the case of soil-pipes. When only cold water is laid on to the sinks 8-lb. lead is quite strong enough for such wastes.

S W.—Sink wastes, 2-in. strong lead waste-pipe from the draw-off sink into the arm of the slop-sink. By filling up the draw-off or wash-up sink with water, and pulling out the plug, a good flush of water can be sent through the slop-sink and the main waste.

S D.—"Soil-pipe Disconnector," with double inlets, for disconnecting the soil-pipe and the waste-pipe from the drain.

T V.—Trap-ventilation, 2-in. lead-pipe (about 14 or 15-lbs. per yard) taken out of the lowest branch, and carried up and connected to the main pipe above the highest branch, to prevent syphonage, &c.

V C.—Valve water-closet, as Fig. 144.

In planning a house a large expenditure of money may be saved by giving the plumbing and drainage due consideration. Avoid all long lengths of branch drainage, and limit the number of water-closets to the requirements of the household. Never place any sanitary "fitting" where light and air cannot freely reach it, and always see that such places can be easily kept wholesome. Consider the drainage.

Place the cisterns where they can be easily got at to cleanse, and where no vitiated air can reach them to contaminate their water, and separate the drinking water from the water-closet supply. Insist upon the separation of the cistern-wastes from *all* other wastes, and keep the ends of such pipes away from all places where any foul air can reach them, from ventilating-pipes, water-closets, sinks, and dust-bins, to prevent any contaminated air passing through the pipes to the water in the cisterns. Cisterns and their wastes.

Use that class of sanitary "fitting" and "fixture" which is the most "self-cleansing," and see that no trap, waste-pipe, soil-pipe, or drain is of a larger size than can be kept perfectly wholesome. Self-cleansing "fittings."

Disconnection.

"Disconnect" all waste-pipes and soil-pipes from the drain outside the house, and intercept the sewer, or cesspool, from the house-drain by a proper intercepting trap and disconnection chamber.

Isolation of drains, &c.

Soil-pipes and waste-pipes should not only be "disconnected" from the drain, but *long branch drains* should be disconnected from the main drain in large mansions, to localise them. By this means any bad air (from offensive matter passing through or left standing in one portion of the drain) is excluded from every other branch. This is important, especially when any of the household is suffering from any infectious disease, for by such means the drainage from one wing of a house is completely isolated from that of another.

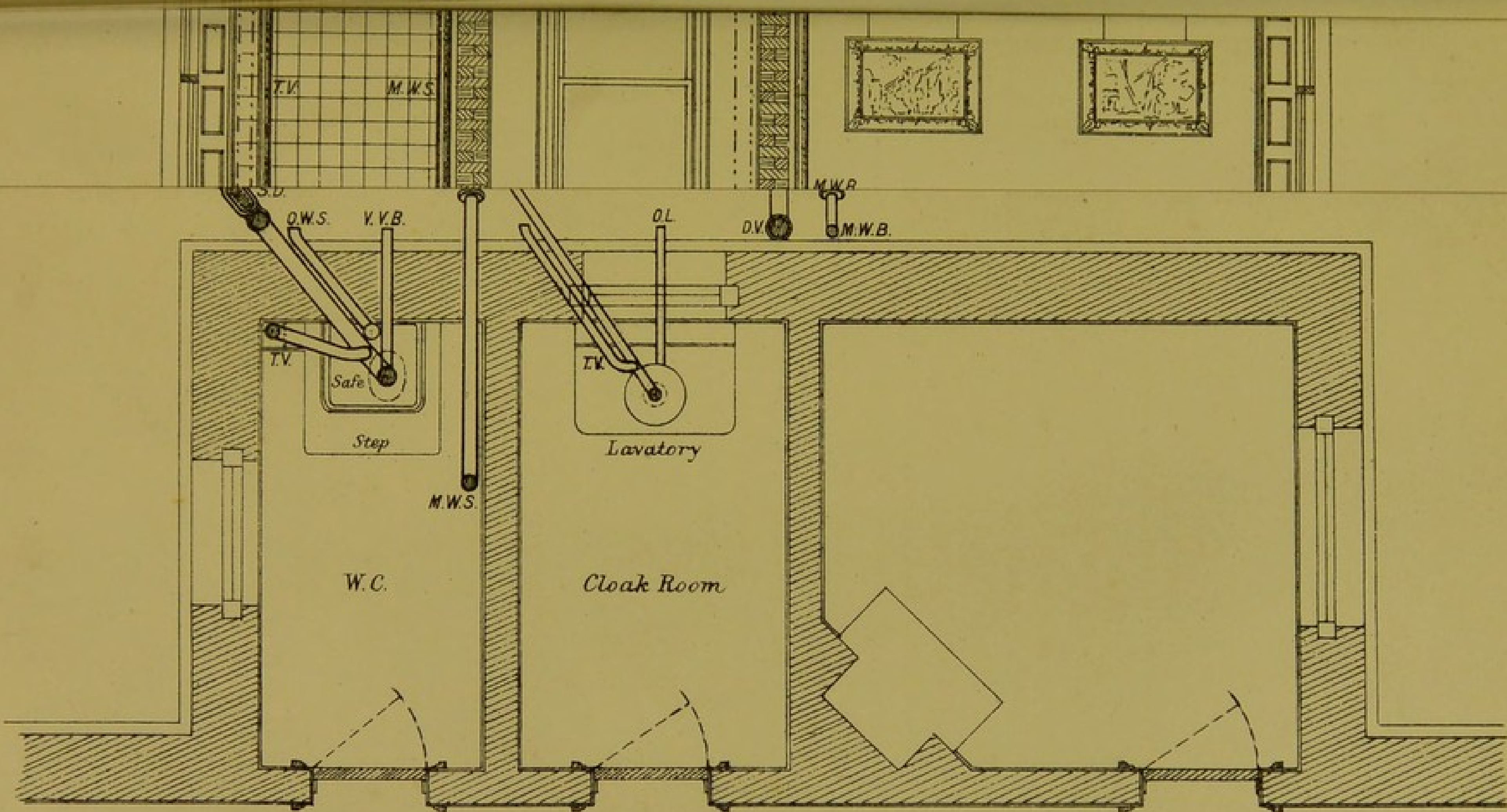
House properly sanitated.

For a house to be wholesome every sanitary appliance should have a bountiful supply of water, for cleansing it and its belongings, and every room where a water-closet, sink, bath, or lavatory is placed, should be well lighted and well ventilated. Nor should the sanitarian turn his back upon the house before he has seen that the dust-bin is only of such capacity as must necessitate the changing of its contents every day (or two days), and that it is properly placed. Every bed-room should have a chimney in it, and the staircases should not be made into huge "stuffy" air-bottles from want of ventilation.

The old way.

In the *old* way of draining a house the air in the pipes and drains was confined as much as possible, and only allowed to escape in the form of noxious gases through the water-seals of the various traps, or the gas-holes they had made in the pipes. But *now* every waste-pipe, every soil-pipe, every piece of drainage—whether long or short—has, or should have, a ventilating-pipe. Now if such drainage-pipes are allowed to get foul, as they most certainly will unless they are well flushed out with water, what an aggregate of foul stinks will be poured forth from the multiplied ventilating-pipes*

* Where the drainage has been properly constructed, and where the sanitary appliances are "self-cleansing," the air coming out of such pipes is often quite inoffensive.



PLAN OF GROUND FLOOR.

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To face page 142.

Whiteman & Bass Photo-Litho London.

from the hundreds of thousands of houses in this metropolis! Pray for a great wind? Yes! and move your house, my friend, to the wind side of the breeze. Air-flushes will help to sweeten the pipe, but good water-flushes are necessary after each usage to keep it wholesome.

Fittings over Sewers.

If we could only fix our closets, urinals, sinks, and lavatories directly over the sewers (provided that the sewers were properly flushed and properly ventilated) how soon we should arrive at what Dr. Richardson would be able to call Salutland; and if this could have been done a year or two ago, what a war of words, and a purse of gold, would have been saved on the water question; for less than one-half the water now used would suffice to keep these fittings in such positions wholesome.

TABLE OF REFERENCES TO PLATE X.

B.—Copper-bath, see Fig. 192.
B T.—1¼-in. cast-lead "Anti-D-trap," as Fig. 30, p. 54.
B W B.—1½-in. lead branch pipe to waste of bath.
B W S.—2-in. lead branch pipe to waste of sinks.
B S.—3½-in. 8-lb. lead soil-pipe, branch to water-closets.
C C.—Cistern for supplying the closets, with overflow into safe.
C D.—Cistern for supplying drinking and potable water with waste-pipe (for cleaning out same) into gutter, and overflow discharging into overflow of cistern safe.
C T.—"Medium" size cast-lead "Anti-D-trap," as Figs. 28 and 29, p. 53.
D C.—"Double-cap" ventilating cowl.
D T.—Stoneware "Drain-intercepting-trap," as Fig. 50, p. 69.
D V.—4-in. 7-lb. lead pipe to ventilate drain, fixed outside of the external wall.
L.—Lavatory basin, as Fig. 193.
L T.—1¼-in. cast-lead "Anti-D-trap," as Fig. 31, p. 54.
O B S.—2-in. lead pipe, overflow to bath-safe discharging in the open air.
O L.—1½-in. lead pipe, overflow to lavatory discharging into the open air.
O W S.—2-in. lead pipe, overflow to water-closet safe.
M S.—3½-in. 8-lb. lead soil-pipe.
M W B.—2-in. strong lead waste pipe to baths.
M W S.—2-in. strong lead waste pipe to sinks.
S S.—"Water-shoot" slop-sink and wash-up sink combined, as Fig. 182, p. 224.
T. V.—2-in. lead-pipe, to ventilate traps to W.-C.'s and sinks, to prevent syphonage.
T V B.—1½-in lead-pipe, to ventilate traps to baths, to prevent syphonage.
V C.—Valve water-closet, as Figs. 143-4, pages 182-183.

CHAPTER X.

SOIL-PIPES, AND THEIR VENTILATION, AND DISCONNECTION.

Chases for Pipes—Sizes of soil-pipes—Soil-pipes in Paris—Materials for making soil-pipes—Cement joints—Caulked lead joints—Position of soil-pipes—Rain-water and soil-pipe combined—Lead soil-pipe, soldered joints, and tacks—Ventilation of soil-pipes—Bad positions of ventilating-pipe terminals—Disconnection of soil-pipes from drains.

Chases.

IN all new buildings, except where circumstances call for the pipes to be fixed on the face of the wall, proper chases should be left or provided in the walls for the several pipes that will be required in the plumbing-work, and more especially for the soil, waste, and service pipes—the latter being kept on the cross-walls, for greater protection against frost; and all such pipes should be cased with wood framings with hinged doors, or with movable casings (secured with brass cups and screws) for easy access to the pipes.

Size of soil-pipe.

Sizes of Soil-pipes.—As a rule soil-pipes are fixed of larger size than needed, and as it has now become the practice in all good plumbing to continue both soil-pipes and waste-pipes above the roof, full size, for efficient ventilation, it is a question of cost as well as of wholesomeness (small pipes being easier cleansed than large ones) to see that such pipes are not larger than necessary.

It was not at all uncommon some years ago to see a 6-in. soil-pipe fixed where a 4-in. would have been ample. And 5-in. and 4½-in. soil-pipes are fixed now where 4-in. and 3½-in. would be better. I have proved by many severe tests, as well as from two or three years' experience, that 3-in. soil-pipe may be used with perfect freedom from stoppage, even though several water-closets be branched into it. It is rather a question of the syphonage of the traps fixed on so small a soil-pipe than the stoppage of the pipe.

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PLATE XI.

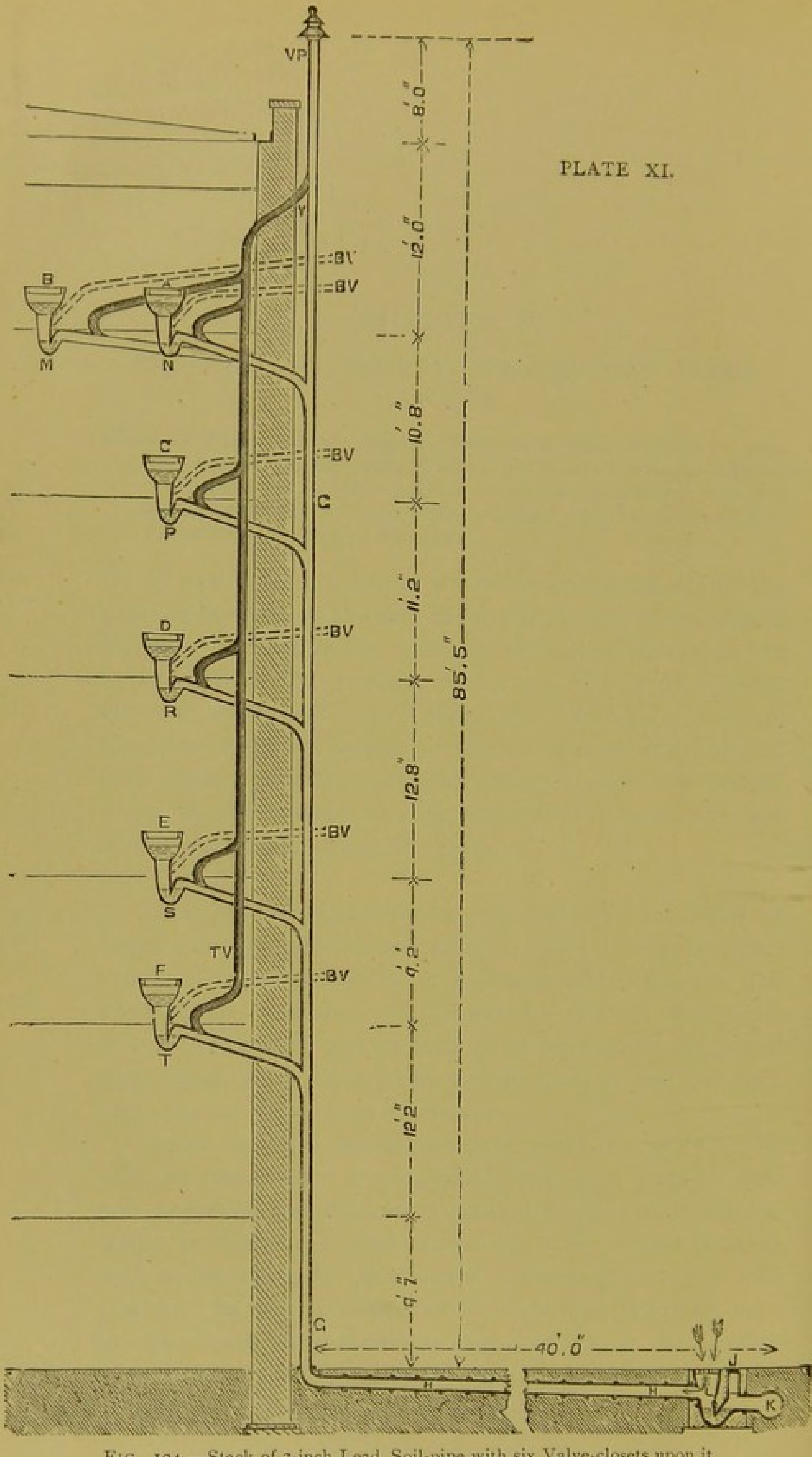


FIG. 124.—Stack of 3-inch Lead Soil-pipe with six Valve-closets upon it.

The advantages of fixing small-sized soil-pipes, are (1) saving of expense; (2) neatness of appearance when fixed on the external face of a building, and compactness when fixed inside; and (3) better sanitary results, as greater cleansing force is obtained in the two-gallon flush (or three-gallon flush) of water through a small than a large pipe.

In the drawing, Fig. 124, Plate XI., a stack of 3-in. soil-pipe is shown with six water-closets upon it, and though the closets have been much used for over a year, the soil-pipe has never shown any sign of stoppage. Another stack of 3-in. soil-pipe is illustrated in Plate IV., facing p. 119. The three water-closets G F L, as explained elsewhere, have been greatly used for three years without any stoppage, and the soil-pipe when examined the other day was found to be as clean as it was after the first week's usage. 3-in. pipe.

Where several water-closets, one on each of several storeys in a many-storied house, are branched into one main soil-pipe, it is better that the pipe should be 3½-in., to lessen the syphoning action of the discharges through the piping; and where double water-closets are fixed on several floors, or where the soil-pipe is required to ventilate a piece of drain (branch or otherwise, to prevent such branch drains from being "bottled up"), 4-in. main soil-pipe would be the better size.* 3½-in. pipe.

In planning some sanitary arrangements in a house in Paris, this summer (1883), I astonished my friends there by mentioning 3½-in. soil-pipe as the correct size for the work, but was not a little astonished myself when informed that the Municipal Authority would not allow a main soil-pipe to be of less diameter than 8-in.! I asked *mon ami l'architecte*, if they had such huge pipes for the purpose of lowering their *plombieres* down inside, to scrape off the yearly accumulations and to keep the jointings sound? I had the curiosity to examine some stacks of soil piping which were being fixed in a fine stone building in one of the best parts of Paris. Two stacks of 8-in. (internal diameter) plain cast-iron pipe—about the strength that we should use for rain-water—were Size of soil-pipe in Paris.

* See Plates IX. and X., between pages 139 and 143.

being fixed with 7-in. branches for the water-closets on the several floors, and the joints were made of that nondescript material, "cement," and, as necessary where iron pipe is used, there were three joints to each branch. The soil-pipe was carried up through the roof full size, but it was not carried up high enough or far enough away from the dormer windows to prevent the stink which would come out of it by-and-by from entering the house. At the bottom of the soil-pipe (in a large chamber built for the purpose, and where possible made accessible from the outside through a manhole leading down from the pavement) is placed a movable vessel, called a *tinette.* This "tinette" is for the purpose of screening the "solids," and holds, when full, about a dozen gallons of sewage. A small pipe coupled to the "tinnette," close to the bottom, conveys the liquid sewage into a small pipe-drain running to the sewer. The waste-pipes from baths and lavatories, and the rain-water pipes from the roofs, discharge into a separate drain, also leading to the sewer, but this drain is trapped. The latter drain in the case examined was carried against the wall of the souterrain, or as I called the place, when in it and looking into one of the "tinettes," the Chamber of Horrors. The tinettes are removed about every three days, or when they are full, and are replaced by clean ones. The arrangements are such that no cessation is needed in the use of the soil-pipe, though a little mishap may occur occasionally, and "matter" may be found in the "wrong place" as a consequence, *i.e.*, a sudden discharge into the soil-pipe, at the instant of the removal of the tinette, may pass into the attendant's boot, instead of into the empty tinette, but the tinette is changed in a few seconds. From the souterrain an 8-in. cast-iron ventilating-pipe is carried up to the roof, by order of the Municipal Authorities, for the men to enter such places to change the tinnettes without risk to their health. The collection of the sewage of Paris and its disposal, is quite an Industry, and if I had a share in the concern—a share in the Cie. Richer—I should strongly object to the soil-pipes being turned into "collectors." The capacity of a stack of 8-in. soil-pipe for collecting and holding sewage is enormous, and there are tens of thousands of such pipes in Paris, holding back the sewage which ought to be passing into vegetable matter, instead of corroding upon the pipes, or wasting itself on the city air. It is astounding that in such a charming city as Paris, where so much attention is paid to the commissariat, so little attention should be paid to the drainage, and that so much sewage-gas should be allowed to poison the atmosphere. The streets, the courts, the houses, are kept beautifully clean, but the things out of sight, the plumbing appliances, the waste-pipes, the soil-pipes, and the house-drainage, are a disgrace to any civilised country.

Material for making soil-pipes and ventilating-pipes.—It ought not to be necessary to say a word on the material of which soil-pipes should be made; but as there is a tendency * in some quarters to use cast-iron, it may be well to look at this matter, and see what advantages *lead* has over *iron.*

Lead. *Lead soil-pipe* is smoother and cleaner in its action than cast-iron pipe, and is therefore more wholesome; and, being of a closer texture, it is not so corrosive, and is consequently more durable.

Compactness. Lead soil-pipe can be bent to suit any position, and when in its place is more *compact* than cast-iron pipe, and does not occupy so much room.

Joints. Then the joints and connections of lead soil-pipes are more to be depended upon than the cement-joints with iron pipe. Lead pipe will stretch without breaking its joints in the case of a little sinking of the building.

Corrosion, inside and outside. Urine is very corrosive, and acts much more on cast-iron than on lead. But not only is this corrosive action going on *inside* an iron pipe; there is another action taking place on the *outside* of the pipe when it is in cast-iron. The atmosphere of the house condenses on the pipes, and *rusts,* and eats its way into the pipe—so that whilst a corrosive action is wearing away the pipe on the inside, a similar rusting action is eating away on the outside. Painting it periodically

* The tendency to use iron soil-pipe in England has very much decreased.

would prevent the atmospheric action; but this would involve a constant expense, and the back part of the pipe would not be reached even then. But with a lead soil-pipe, the action of any condensation is merely nominal; and hence, lead soil-pipes (when they are without soldered seams) are as sound on the *outside* years after they have been in use as they were when first fixed.

Difficulty in making reliable joints.

Then there is the difficulty of making *sound and reliable joints** in cast-iron soil-pipes with the lead branches, or with the traps, when the latter are of lead. And no man with any sanitary knowledge of water-closet work would recommend iron traps for water-closet use. There would not, of course, be the same difficulty in making a sound and durable joint if the two metals to be united were the same.

Iron pipe too thin to caulk in lead.

As the pipe generally used for soil-pipe, when cast-iron is required, is only of the ordinary rain-water pipe substance, the joints cannot be caulked in lead (the pipe is too thin to stand the knocking required for this) and are therefore made in *cement*—a very vague sort of thing, meaning anything or nothing; for *any sort of stopping* by some people is called "cement;" and there is this danger attending such joints—the front part of the pipe is often stopped; the back, or part next the wall, *un*stopped—because it cannot be reached.

No safety in cement joints.

With such joints as those referred to in the last paragraph there is no safety. The stopping may be imperfectly done, or may dry up, or the joint may be broken; for the two pipes are not really *united* by such a connection. And this joint, when broken, will allow any bad air in the pipe to escape *insidiously* into the house; for, unfortunately, a leakage of *soil-pipe air* does not show itself like water, or proclaim itself like gas, but in a cowardly sort of way stabs you in the dark, or kills you by a slow kind of poison—a thousandth part of an inch at a time. See drawing, Fig. 125, showing a section

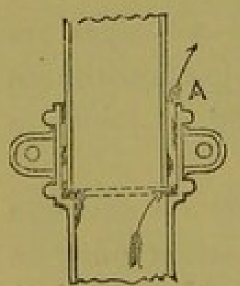


FIG. 125.—Section of a "Cement" Joint.

*To every branch in an *iron* soil-pipe there are three joints against one in a *lead* soil-pipe.

of a cement joint. The arrows show the evil of such a jointing.

Strong iron pipe.

But supposing a stronger pipe is used, so that the joints can be caulked in lead. This simply overcomes the difficulty of jointing, while the other evils remain. It involves the expense of lead without securing its advantages, for the corrosion, &c., referred to takes place as before, and the unwholesomeness is quite as great. Moreover, when a leak occurs in *iron* pipe, it cannot be soldered as in lead, and there is no help but to cut it out bodily. What is it worth as old material? Why, hardly sufficient to pay for taking it away. On the contrary, lead soil-pipe can be repaired when a leakage occurs, and when no longer fit for its original purpose it can be sold for about half its original cost.

Durability of lead pipe.

Lead soil-pipe, of a strength equal to sheet-lead 8-lb. to the superficial foot, will last when properly fixed for a century, without costing a penny in repairs or paint. And with good flushing valve water-closets upon it, it will not have a coating of excrementitious matter upon it one-eighth of an inch thick at the end of that period. To make some alterations in a building, a piece of a stack of 4½-in. soldered seam lead soil-pipe had to be cut out in the early part of this year. The pipe was fixed by one of our late foremen forty-eight years ago, and when it was cut out the other day it was found to be quite sound and good, almost as perfect as when it was first fixed. And though four much-used water-closets had been upon it, there was not a coating or incrustation upon its inside one-sixteenth of an inch thick.

Cast-iron soil-pipe.

When plumbers are not skilled in pipe-bending and joint-wiping it would be wise to use cast-iron soil-pipe. But such pipes should be of sufficient strength to allow the joints to be caulked in with lead, *i.e.*, water-main or "underground" pipe* should be used. The joints should be made with a ring or two of spun-yarn rammed into the socket to prevent the molten lead from running inside the pipe, and then molten *soft* pig lead should be run into the socket for a depth of at least 2-inches—I prefer 2½-inches—and the lead should be

* See table, page 362.

well caulked into the jointing. When a caulked lead joint is found to be defective, it is generally because the lead has not been properly caulked in, though I have often seen bad jointings through insufficiency of lead, especially in cases where the lead has been less than an inch deep. See B, Fig. 126, showing a section of a caulked lead joint. The lead is not shown deep enough in the drawing. All cast-iron pipes, soil-pipes, waste-pipes, and drains should be well coated with Dr. Angus Smith's solution, or some other equally good coating, to protect it from rust.

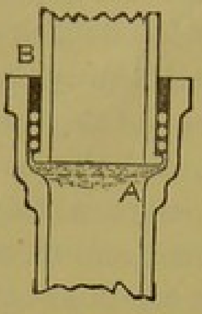


FIG. 126.—Section of a Caulked Lead Joint.

Stoneware soil-pipe.

The man who would now fix stoneware-pipe for soil-pipe inside the walls of a dwelling-house—or outside either nearer than 30 or 40 feet to a window, door, or opening into the house—would show his special fitness for being placed inside the walls of Bedlam. And yet I have come across several stacks of 6-in. stoneware soil-pipe during the last few years. Drain-pipes, too, have been built in the walls of dining-rooms and bed-rooms, to receive the discharges from water-closets on the upper floors, and that not in poor cottages, but in mansions costing over £30,000, and these mansions have been built within the last twelve years!

Zinc soil-pipe.

Zinc soil-pipe is now left for the very worst kind of speculative builders to use; not that they are fond of even zinc, for it is never too thin for their purpose.

Soil-pipes, inside or outside.

The Positions of Soil-pipes.—When the plumbers are skilled in fixing soil-pipes, in making bends and wiping joints, and where honest materials are used—that is good strong lead-piping, traps, &c., it matters little whether the soil-pipe be inside or outside; but where the builder or plumber cannot be depended upon to use honest materials, or where the hand-worker is not skilled in his trade, I would insist upon the soil-pipe being fixed outside the external walls of the house; and if the house were my own I should want the water-closets, traps, and all their belongings, outside as well. Having gone into this subject somewhat at length in my "Lectures," I give an extract here :—

"I would not pull down a house and re-build it to get the soil-pipes in it outside ; but wherever it is at all practicable, and in all new houses, I would insist upon the soil-pipe being fixed outside, unless special circumstances called them inside, and this would, no doubt, be the case in some instances. But what about frost ? Well, there is no danger of that if you keep the water out of it, any more than there is of a gas explosion in the room if you keep the gas turned off. Allow a faulty pipe or gas-cock to leak the gas into a room, and then come into it with a lighted candle, and where are you ? I should say in the street—*i.e.,* all that is left of you. Allow the closet-valve to leak water into an *outside* soil-pipe, when Jack Frost is on the alert to arrest it, and where is it ? why, imprisoned in the pipe, of course. But keep the water from leaking into the pipe, and there will be no risk of freezing. There is also much less risk of freezing when the discharging ends of such pipes are carried down below the ground level, out of the way of the cold sweeping winds, as shown in Fig. 66, for when the ends of such pipes are more exposed, the wind catches the dropping water and freezes it until it has completely corked up the end of the pipe, and then in time the whole of the piping becomes a block of ice. Outside. Frost.

"It is also an evil to take rain-water into soil-pipes, especially outside pipes, for it often happens that the sun melts a little snow near the head of a rain-water pipe, and this snow-water trickles down the pipe, where it soon freezes and stops up the soil-pipe. Rain-water and soil-pipes.

"In the sharpest frost in this country there is not the smallest fear of the legitimate use of a water-closet ever stopping up an outside soil-pipe with ice. The discharges through such a piping are too quick for freezing. When soil-pipes are fixed outside, in bleak positions, however, I *prefer* them to be put into chases, with iron-plates in front of them to look like iron rain-water pipes, for better protection. Pipes freezing.

"I have had our books looked through, and find that in the three years preceding the year 1881 we fixed just 130 stacks of soil-pipe *outside* (or a total length of about 5,000 ft.), and I have not heard of one of them being frozen. It is really a question of good supply-valves to the W.C.'s, and if these are looked after, there is no danger from frost. I have a stack of soil-pipe outside my own house, which faces north-east, and though the closet-valves upon it have not been touched for four or five years, there has never been the smallest inconvenience from frost, or any other thing, and the pipe is open to the atmosphere both at the top and bottom.

"The effect of frosty weather upon outside soil-pipes—when no water is allowed to leak into them—is *not so damaging as the action of the sun* upon them when they are fixed in certain positions; for they would often be *exposed to the direct rays of the sun for many hours together, and the effect of this would be to stretch the lead pipe between the 'tacks,' and this stretching would go on from year to year bending the pipe out of its true vertical line, and perhaps breaking it.** Where 'slip-joints' can be used, such lead pipes, when they are properly ventilated to prevent the action of gases upon them, will last for centuries; but where the joints must be soldered, to prevent soil-pipe air escaping through them into the windows of the house, &c., such pipes should be kept in an angle, or placed where they are likely to be most screened from the rays of the summer's sun.

Air-currents in soil-pipes.

"There is another important reason for keeping soil-pipes out of the sun, for the air in such pipes would get so rarefied that the air-currents through them (where they are ventilated at top to bottom) would be so great that the excremental discharges would partially dry upon the pipe, especially when the water-closets were used with little water. When soil-pipes are exposed to the sun in the way we have just been considering, they not only get warm, but they get quite *hot*, and unless a body of water is sent through them by pulling the closet-handle before using the closet (a good thing always), a portion of the discharge would be likely to dry upon the

* The durability of a soil-pipe fixed externally, and exposed to the rays of the sun, would be nothing like so great as a soil-pipe fixed inside a house, or where the sun could not reach it.

piping, which may be a long length, and foul it. This argument tells also against *inside* soil-pipes, though not with equal force, for though soil-pipes fixed inside a house would generally have greater currents of air through them than soil-pipes fixed outside (on account of the warmth of the house) they would never get so hot as soil-pipes exposed to the sun. But all that is wanted in outside soil-pipes is to keep them out of the full power of the sun's rays; for good air-currents—with efficient ventilation—can be made to pass through soil-pipes though fixed in the coldest quarters—at any rate sufficient to aerate them.

"The risk of getting soil-pipe air into a house is so minimised by fixing soil-pipes outside, that it is worth running the small chance of freezing from a leaky valve; which casualty ought never to be allowed to remain for a single day, winter or summer; for dribbling waters will not cleanse a pipe, though they may drain a reservoir and prevent proper flushing when needed. Soil-pipe air.

"When the soil-pipe is kept outside the house there is no risk of the air in it leaking into the house, either through a nail-hole—made in the pipe by accident; a defective jointing—when fixed by an unskilled man; or from decay of the pipe through old age."

Lead soil-pipe made of sheet-lead, and properly soldered, will last for a very long period. I have seen such pipes in very good condition after they have been in use three-quarters of a century; but, unfortunately, the seams cannot always be relied upon, especially when the pipe has been made by a careless or unskilled plumber. Soil-pipes made by hydraulic pressure should therefore always be used, but care should be taken that such pipes are of an *even substance all round;* for a large amount of such piping is sent out by some manufacturers of a very *un*even substance, being much thicker on one side than on the other, and the strength of a pipe, as of a chain, is only equal to its weakest part. Drawn lead-pipe of any size and substance can be had of a perfectly even thickness all over, and this should be insisted upon, especially with funnel-pipes. Soldered seam pipe. Pipes without seams.

Strength of pipe.

All lead soil-pipe for fixing inside, as well as the branches coming into a house from outside soil-pipes, should be strong, and never of less substance than 7-lb. to the *superficial* foot; but where cost is not the first consideration, and durability is required, the strength should be increased to 8-lb. In some cases it may be desirable to fix 10-lb. lead soil-pipe. I have directed a large quantity of such piping to be fixed under certain circumstances.

Soil-pipes in chases.

Where practicable, proper chases should be provided in building the walls to receive all soil-pipes when fixed inside the house, for there is no better way of fixing funnel-pipes

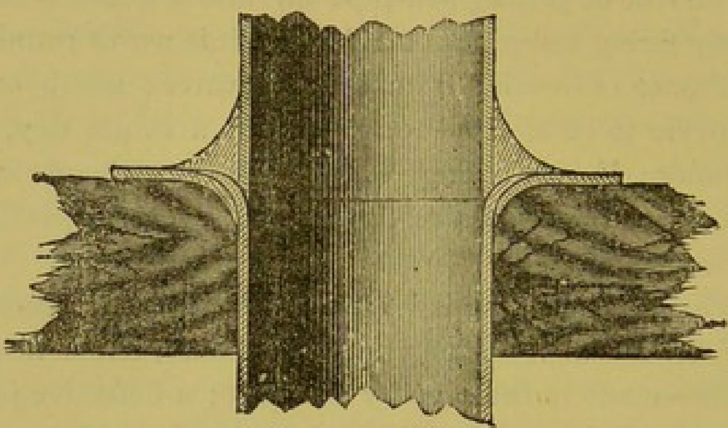


FIG. 127.—Section of a Block-joint.

than on "blocks;" but this can only be properly done when the pipes are fixed in chases.

Blocks.

These blocks can be made of wood or stone, but the former is the cheaper, and is all that is necessary; they should be let into the wall at two opposite sides, the right hand and the left looking at the pipe, and they should be 2½-in. or 3-in. thick, according to the weight of the pipe to be fixed upon them.

A block every 10 feet—which is the length of lead "funnel-pipes" made by hydraulic pressure in London—*may* be all that is necessary for air-pipes, but for soil and waste pipes there should *always* be a supporting-block in the centre—*i.e.*, a lead flange soldered to the pipe, and made to rest on a wood block similar to the block-joints; or a lead tack should be soldered to the pipe, about midway between the block-joints, as an additional support, or the pipe will be liable to "bag out," and break away at the joints. All funnel-pipes, air, soil, or waste, between 3-in. and 6-in. diameter, should have this supporting-block in the centre, regardless of the substance of the pipe.

A section of the usual way of making a block-joint is shown in Fig. 127. The top of the block is rounded off where the pipe passes through, and the end of the pipe is rounded back upon it, with a lead flange underneath, and the two pipes are then soldered together as shown in the diagram. It takes Block-joints.

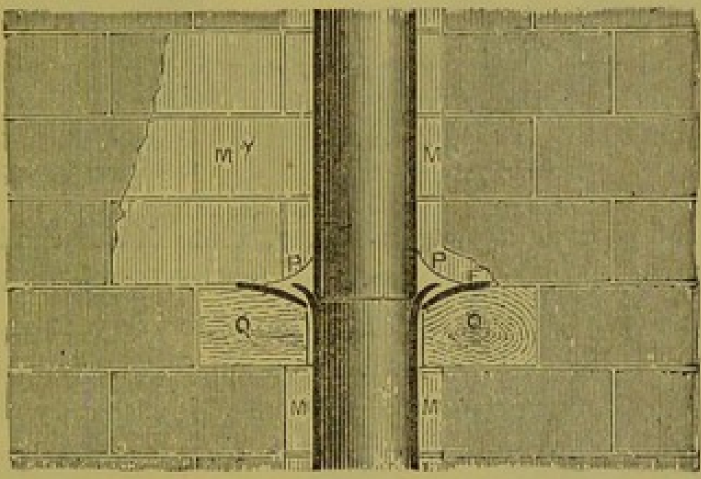


FIG. 128.—Section of a Block-joint *in situ*.

more solder this way than if the pipes were tafted back with a square edge, *i.e.*, at right angles, upon a flat block, as is done by some plumbers, but in such cases the lower pipe is very liable to break away at the taft.

A stronger way still of making a block-joint is shown in Fig. 128, for in this case the solder is united to the end of the lower soil-pipe on both sides, as shown at P. The pipe is shown *in situ*:—M is the chase, Q is the wood-block, F is a lead flange, P the solder, and M Y shows the wall cut away for the plumber to get his hands round the pipes to make the joint.

But the plumber rarely finds that chases have been left for his pipes, and so inside as well as outside the house he has to fix his soil-pipe on the face of the wall. There is no difficulty in Soil-pipes on face of wall.

this, nor is there any objection ; on the contrary, in most cases it is the preferable mode of fixing pipes. But when the pipes are so fixed, there should never be less than three 9-in. or 10-in. tacks of 7-lb. or 8-lb. lead soldered to every 10-feet

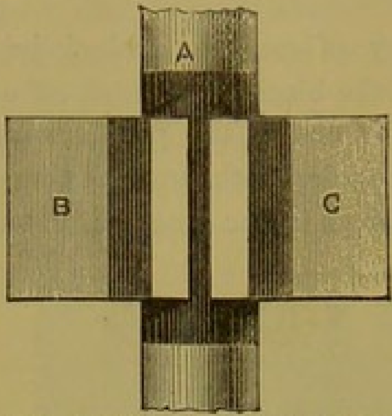


FIG. 129.—Pair of Tacks soldered to a Pipe —back view.

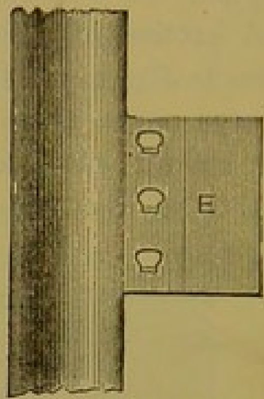


FIG. 130.—Single Tack soldered to a Pipe—front view.

length of pipe, as shown in Fig. 7, Plate XII. And where soil-pipes of larger size than 4-in., or heavier than 8-lb. lead, are fixed, four tacks should be soldered to every 10-ft. length, as shown in Fig. 6, Plate XII. In scamping works one often comes across stacks of soil-pipe with only two tacks to every ten feet, and in some cases I have seen a long stack of soil-pipe hanging on to a few tacks, fixed ten feet away from each other. If a man can save two tacks on every ten feet length of piping, he "pockets" at the rate of from 4d. to 6d. per foot run, and to do this some men will "tack about" a good bit. A plan showing double-tacks soldered to a soil-pipe is given in the drawing Fig. 5, Plate XII. Three wall-hooks should be fixed in every tack, as shown in dotted lines in Fig. 4. A back view of a pair of tacks soldered to a soil-pipe is given in the wood-cut Fig. 129. When a soil-pipe is fixed on the face of a wall, *wiped* joints can be made, as shown in Fig. 131, or for neatness *astragal jointings* and tacks can be fixed, as shown in drawing Fig. 132. The joint should be strongly made with fine solder, as shown at A. The tacks are soldered to the pipe in the usual way,

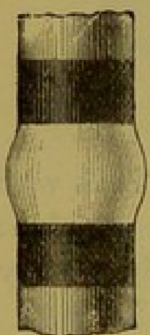
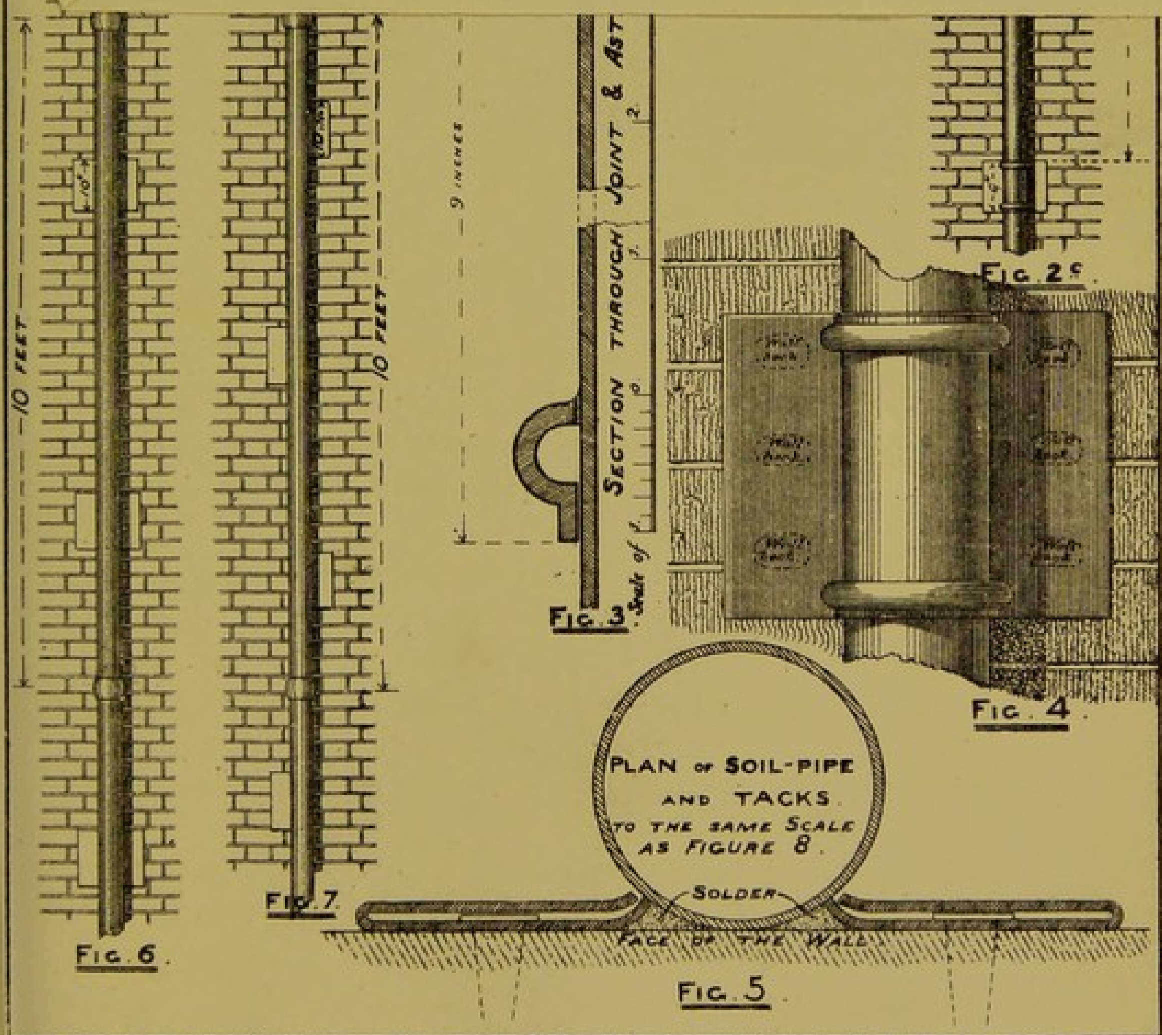


FIG. 131.—View of a Wiped Soldered Joint.



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N.B.–The ends *of the soil-pipes should be* tinned *before the pipes are put together.*

and to make them ornamental a device (which can be varied) is cut out of the centre part, and dots are bossed up over the heads of the nails as shown at D. Part of one of the tacks, G, is unfolded to show the nails, E. Another astragal jointing, with tacks, &c., is shown in the drawing Fig. 4, Plate XII.

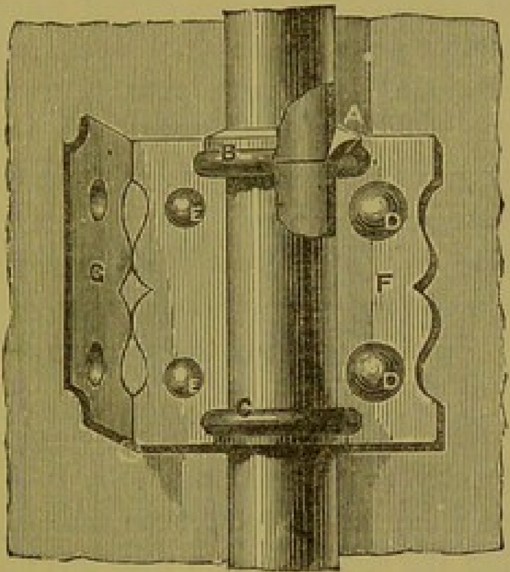


FIG. 132.—View of a soldered joint, with Astragals and Tacks.

REFERENCES TO DRAWINGS ON PLATE XII.

Plate XII. shows several ways of fixing lead soil and ventilating pipes, also *lead heads* for *masking* pipes where they bend through a wall to avoid going over a parapet, &c., &c.

Fig. 1.—*Section* showing the soil-pipe continued up to the highest point of roof for ventilation, with a *lead head to mask the pipe where it turns through the wall.*

" 2C.—*Elevation* showing lead soil or ventilating pipe fixed with tacks and *astragals;* also a lead pipe-head to mask the pipe where it turns through the wall.

" 2A and 2B.—*Lead pipe-heads* for *masking* soil or ventilating pipes where they bend into a wall.

" 3.—*Section* through the *astragals* and *jointing* of pipes.

" 4.—*Elevation* of ditto, and of the tacks.

" 5.—*Plan* showing tacks (of 7-lb. lead) soldered to pipe and folded back to protect the heads of the wall-hooks.

" 6.—*Elevation* of a lead soil-pipe with *wiped* soldered joints, and *four* 10-in. tacks (of 7-lb. lead) soldered to every 10 feet length.

" 7.—*Ditto*, but with *three* tacks to every 10 feet length.

" 8.—*Elevation and Section* of a *wiped* soldered joint (Plumber's joint); the joint is made long to strengthen the pipe, as well as to give it a better appearance.

THE VENTILATION OF SOIL-PIPES.

Ventilation.

"Ventilate! ventilate! ventilate!" should be the cry of all occupiers and builders of houses. As I have said elsewhere, "Air-pipes were first fixed on the tops of soil-pipes about sixty or seventy years ago, except where such pipes received rain-water pipes, when they would probably be of one size throughout. It is quite possible to find soil-pipes fixed within the last few years *without* any air-pipes, but in good plumbing jobs air-pipes were fixed from the top of the soil-pipes at least 40 years ago. The sizes of such air-pipes varied according to the different ideas of the value of such pipes. Some fixed (and such pipes are fixed even now) ½-in. and some 2-in., but I should say the average size from 15 to 30 years ago was 1¼-in.

Pipes full-size.

In 1865, I directed several stacks of soil-pipes in a large building in the city to go up through the roof full size, and since that time many stacks have been similarly treated, but it is only within the last ten years that this practice has become general. It has now become a *sine quâ non* with sanitarians that all soil-pipes shall be carried up full size for ventilation. But however large an air-pipe may be on the top of a soil-pipe, there is no ventilation of the soil-pipe itself unless it is open to the air at the bottom, or unless it has foot-ventilation; *i.e.*, to properly ventilate a soil-pipe, or waste-pipe, it must be open to the atmosphere, either directly or indirectly, at both ends. There must be a means of ingress as well as egress, if the air in the pipe is to be changed.

Experiments for ventilation.

As many people doubt the necessity of this second pipe, or foot ventilation, I will give here the results of two experiments made a short time ago. The spiral piping shown in the drawing Fig. 6, p. 29, was filled with gas. A stop-cock was fixed at L and E to exclude the atmosphere. The stop-cock L was opened and a light applied to it, but the small jet of gas did not burn for more than a second or two. The stop-cock L was then taken off, and the pipe opened full bore, but still there was no flame. A gimlet-hole was then made in the piping at F

—giving it "foot-ventilation"—and a good flame was at once obtained; and this flame continued so long as the hole at F was left open, but directly the finger was placed over the hole the gas went out. On removing the finger the flame could be rekindled instantly.

I then made a more practical experiment, and had a stack of $3\frac{1}{2}$-in. lead soil-pipe fixed vertically. This pipe was just 30 feet long, and was sealed over at the bottom end. Connected to this soil-pipe, close to the bottom, was a 60-ft. length of inch lead piping to give it "foot-ventilation." The soil-pipe was then filled with gas. With the foot-ventilation shut off, by corking up the end of the 60-feet length of piping, the gas would not kindle into a flame at the top of the soil-pipe after the first second or two, though the pipe was open full-bore, but on removing the cork from the end of the foot-ventilating-pipe, though 60 feet away from the soil-pipe, the gas flared up to a great height. The flame, or jet, as well as the smell of gas, depended entirely upon whether the foot-ventilating-pipe was shut or open.

Soil-pipe open to the atmosphere.

All soil-pipes should therefore have their discharging ends exposed to the atmosphere, either directly, as shown in the drawings, Plates IX. and X., and also in Figs. 64 and 65, or indirectly, by an air-induct pipe, *i.e.*, foot-ventilation, as shown in Plate XV., at Z, except where the soil-pipe has to be made an upcast pipe, to ventilate its own piece of drain. (See "Disconnection" of Soil-pipes, p. 164.)

Air-cleansing.

To get a good current of air through the soil-pipe, to air-cleanse it, the ventilating pipe should be the same size as the soil-pipe, and to prevent any air coming out of such pipes from entering the house, the pipe should be carried up well above all windows and openings to the house. The straighter such pipes are kept the better, but it is better that they should follow the lines of the roof rather than disfigure the building in any way, for a few bends in such pipes make but little difference, as I have often proved with an anemometer.

As the ventilating-pipe of the soil-pipe is in all good sanitary plumbing the means adopted for giving air to the traps branched into the soil-pipe to prevent their syphonage, the sooner such pipes are made to reach the atmosphere the greater will be their value for such purposes. (See Trap-syphonage, pp. 102—138.)

Ignorance in determining air-pipes.

The ignorance displayed in assigning the positions of ventilating-pipe terminals is most deplorable. Ventilating-pipes to waste-pipes, soil-pipes, and drains are terminated in such ill-considered positions that the air emitted from them often enters the house, through an open window, skylight, dormer, or some other opening. And it is common to find such pipes in close proximity to drinking-water cisterns.

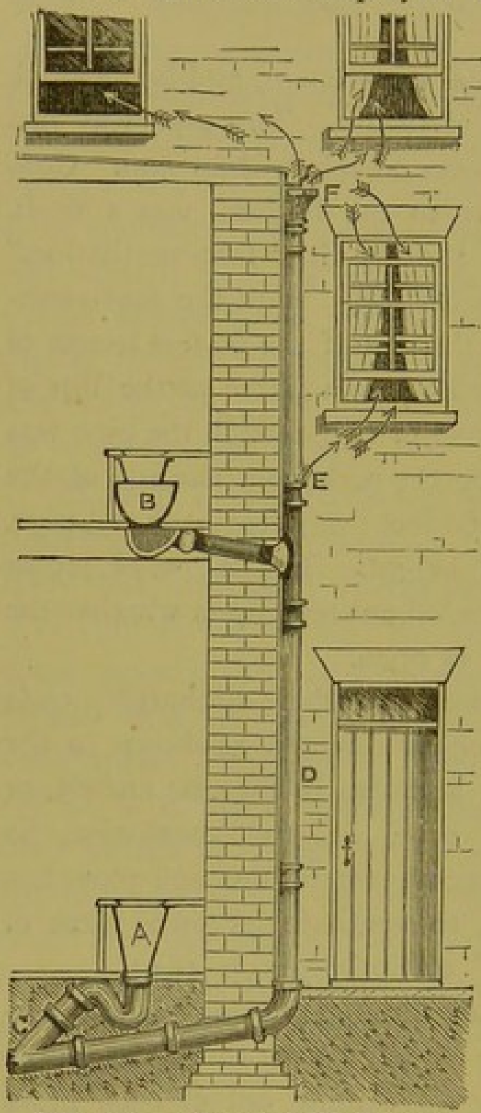


FIG. 133.—"Sewer-air" feeding the fires, etc.

Many cases might be given of serious consequences resulting from such careless modes of fixing such pipes, but I will simply give one instance. We had to make an examination of a house a little while ago, where three children had suffered from diphtheria. The children had slept in the bed-room shown in the drawing, Fig. 133, over the head of the soil-pipe marked F. This soil-pipe, D, was situated at the head of the drain, which ran through the house, and ventilated it. Some peppermint was put into the drain at some considerable distance from the soil-pipe head, but the smell of peppermint was soon noticed very strongly in the bedroom where the children had slept. It would need no experiment to a sanitarian to show that illnesses would be likely to arise from an upcast pipe from a drain terminated as shown at F, in the drawing; but it was necessary to convince the owner of the house. The soil-pipe was composed of lead and cast-iron pipe, and the smell of peppermint could be detected at each of its "cement" jointings. (See Ventilation of Drains, pp. 284—292.)

As I have said elsewhere, "I know of cases where ventilating-pipes from soil-pipes have terminated at such ill-considered points that the bad air from them has been blown down the chimneys into the rooms of the house. How often as one rides about London and through our modern country towns can such pipes be seen, stopping just under a cornice, where there is no wind to blow away the bad air emitted from them; or they are just bent up over the eaves' guttering, where the air escaping from them can easily get into the house between the slates or eaves; or they are carried up to the ridge of the roof and terminated within a foot or two of some skylight; or they are taken up the face of a dormer and left standing a foot above its doorway or window." (See Ventilation of Drains, pp. 284—292.)

It is a great disfigurement to a building with a good elevation to see a ventilating pipe "crawling" round over a parapet and up over a roof. In such cases I can see no danger in carrying such pipes through the wall and up inside the roof, as shown in the drawing, Fig. 1, Plate XII., facing page 158. But when this is done the pipe should be of *lead*, and the thickness should not be *less* than $\frac{7}{64}$-in., *i.e.*, 7-lb. lead. For greater safety the pipe could be lathed and plastered over, as shown in the drawing. Where such pipes turn in through the wall they should be masked over with a "false" lead head, for the sake of appearance, as shown in section, Fig. 1, and in elevation, Figs. 2A, 2B, and 2C, Plate XII. Pipes disfiguring buildings.

To prevent a blow-down, and also to increase the upcast of air in a soil-pipe, an efficient cowl should be fixed on the top of the ventilating-pipe, especially where the "disconnection" of the soil-pipe from the drain is made near an opening into the house. (See the merits of various cowls, Chapter XXIII.)

"DISCONNECTION" OF SOIL-PIPES FROM DRAINS.

All soil-pipes where practicable should be "disconnected" from the drain to prevent them from becoming conductors of drain-air into the house. There is no reason why such pipes should not discharge with open ends into proper drain-intercepting traps *—similar to waste-pipes—as shown in the drawings, Plates IX. and X. It may encourage many to fix soil-pipes with open ends to know that a very large number of such open-ended pipes and such open traps have been fixed, as shown in the drawings, Figs. 65 and 66, in very important places with great success.

Experience with open pipes.

About four or five years ago I had two stacks of soil-pipes fixed with a large number of valve-closets upon each, and they were made to discharge with open ends into open traps as shown in the drawing, Plate IX. But as the gratings over the tops of the drain "disconnecting" traps were right in the footway of a narrow public thoroughfare, and as the parties chiefly concerned in the erection of the building would have been too nervous to have sanctioned any such open ventilation, nothing was said about the arrangement of such ventilating traps, and the gratings were supposed by all concerned, except myself, to be simply covering the ends of rain-water pipes. As a proof of the safety of such an arrangement, it may be mentioned that though the closets upon each of the two stacks of pipes just referred to have been in great use for more than four years; though thousands of people have walked over the gratings; and though office windows are within 8 feet or 10 feet of them, no one has ever noticed the slightest disagreeable smell from the arrangement. Whenever I have examined these intercepting traps, they have been found quite free from any offensive odour, and the atmosphere has been passing freely *into* the discharging end of the soil-pipe at this point, and not *out* of it.

* See Figs. 64—66, pp. 74–76.

The mouth of an induct-pipe, the foot-ventilation of a stack of soil-pipe much used in my factory, has been within 10 feet of my office window for nearly two years, without being in the slightest degree offensive. The current of air passing into such pipes, when there is a good cowl on the top of the ventilating-pipe, often exceeds 100 feet linear per minute, as registered by an anemometer.

Care in fixing open traps.

Care must be taken in fixing such open traps, for when currents of air can blow over them, as when fixed in a passage-way, the soil-pipe air will be drawn *out* through them—*i.e.*, the atmospheric pressure will be removed from the discharging end of the soil-pipe by the wind blowing over the open top of the trap, and a *blow-down* will take place in the soil-pipe, as explained elsewhere.

Soil-pipes near breathing-places.

When soil-pipes discharge themselves into a drain *immediately under a window*, or close to a porch or doorway, where any of the occupants of the house are likely to stand about, or perhaps sit down for a little time, it is better to fix another kind of trap,* as shown in Fig. 7, Plate XXIV., with the mouth of the air induct-pipe removed some little distance away, as shown at E on the same plate, so that the vitiated air driven out by the discharges through the soil-pipe may not come out where it can give offence.

If there are no windows or doors near, the foot-ventilating pipe need only be taken a foot or two above the connection with the soil-pipe, with the end *enlarged*, and grated with copper wire, to prevent birds building in it. Then the air can escape out through, or pass into it, according to the needs of the soil-pipe. If there is much traffic near this induct-pipe, it should be taken up 15 ft. or more above the ground-level, so as to prevent any one inhaling the air which would be sent out through this pipe when any of the water-closets were in action.

But this method is sometimes impracticable, except in country houses, where there is ample space. In towns and cities, where the houses not only elbow each other, but keep one another upright by leaning against each other, it is im-

* See Figs. 72—77.

possible to stick out a pipe from one house without sticking it into the side of another. In such circumstances another plan must be adopted. Take a 2-in. or 3-in. lead pipe from the foot of the soil-pipe, or into the side of the soil-pipe traps, at D or F, Fig. 65, and continue it up *outside* the house, and terminate it in the *open air* at the most convenient place farthest away from openings into the house.

Induct-pipes with mica-valves.

When no convenient place can be found for leaving the mouth of the induct-pipe open to the atmosphere, a *mica-valve* can be fixed over it, as shown at V, Fig. 73, and also as shown on Plate XV., facing p. 200.

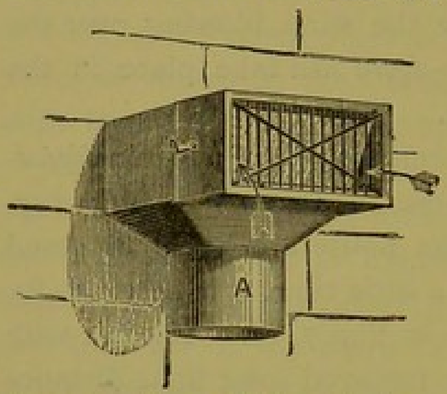


FIG. 134.—View of "Mica-valve"—Vertical.

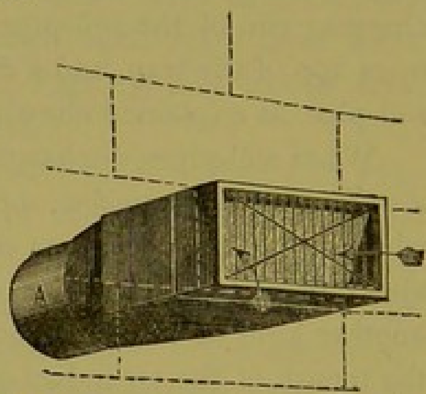


FIG. 135.—View of "Mica-valve"—Horizontal.

Fig. 134 shows a *perspective view* of a "*mica-valve*" for fixing on the top of a *vertical* induct-pipe, and Fig. 135 shows a view of one for fixing on the end of a *horizontal* air induct-pipe. They are made in various sizes, to fit pipes from 2-in. to 4-in. diameter.

These mica-valves are encased in strong zinc, but of course they can be made with any other material—in copper, or stoneware, to suit circumstances. The mica-flap is protected by a movable wire guard, as shown in the cuts.

When these mica-valves are fixed on the tops of the induct-pipes to soil-pipes, drains, &c., directly any discharge is sent into the soil-pipe, the mica-flap is closed by the pressure of the soil-pipe air behind it, and the air driven down by the discharges is made to escape through the air escape-pipe of the traps ; or, when no such air escape-pipe exists, then the air is compressed into the induct-pipe, except what escapes back into the soil-pipe through the discharges. Immediately the discharge has passed out of the soil-pipe, the compressed air in the induct-pipe rebounds back into the soil-pipe, and the upcast of air goes on again—the atmospheric air passing freely through the mica-valve.

The Author claims to be the first to use mica-valves for such purposes as just explained, and believes he can prove this by the date of his design when he had the first one made. Large numbers of these valves have been fixed during the last seven or eight years with great success.

CHAPTER XI.

WATER-CLOSET ROOMS AND WATER-CLOSET SEATS.

The rooms in which water-closet apparatus are fixed—Light and air—Rooms lofty—Ventilation of W.C. rooms—Walls and floors tiled—Water-closet apparatus isolated from the walls—A dangerous water-closet—"Sanitas" water-closet enclosure—Water-closet seats.

Light and Air.

*The Rooms in which Water-closets are Fixed.**—Before entering upon the subject of water-closet apparatus, it is worth while to see that proper rooms are selected or built for such apparatus. No water-closet should be fitted up in a room which cannot be well lighted and ventilated, *i.e.*, all water-closet rooms should be built outside the main walls of the house, or should have an external wall for one of its sides, so that a large window may be put into it for light and air.

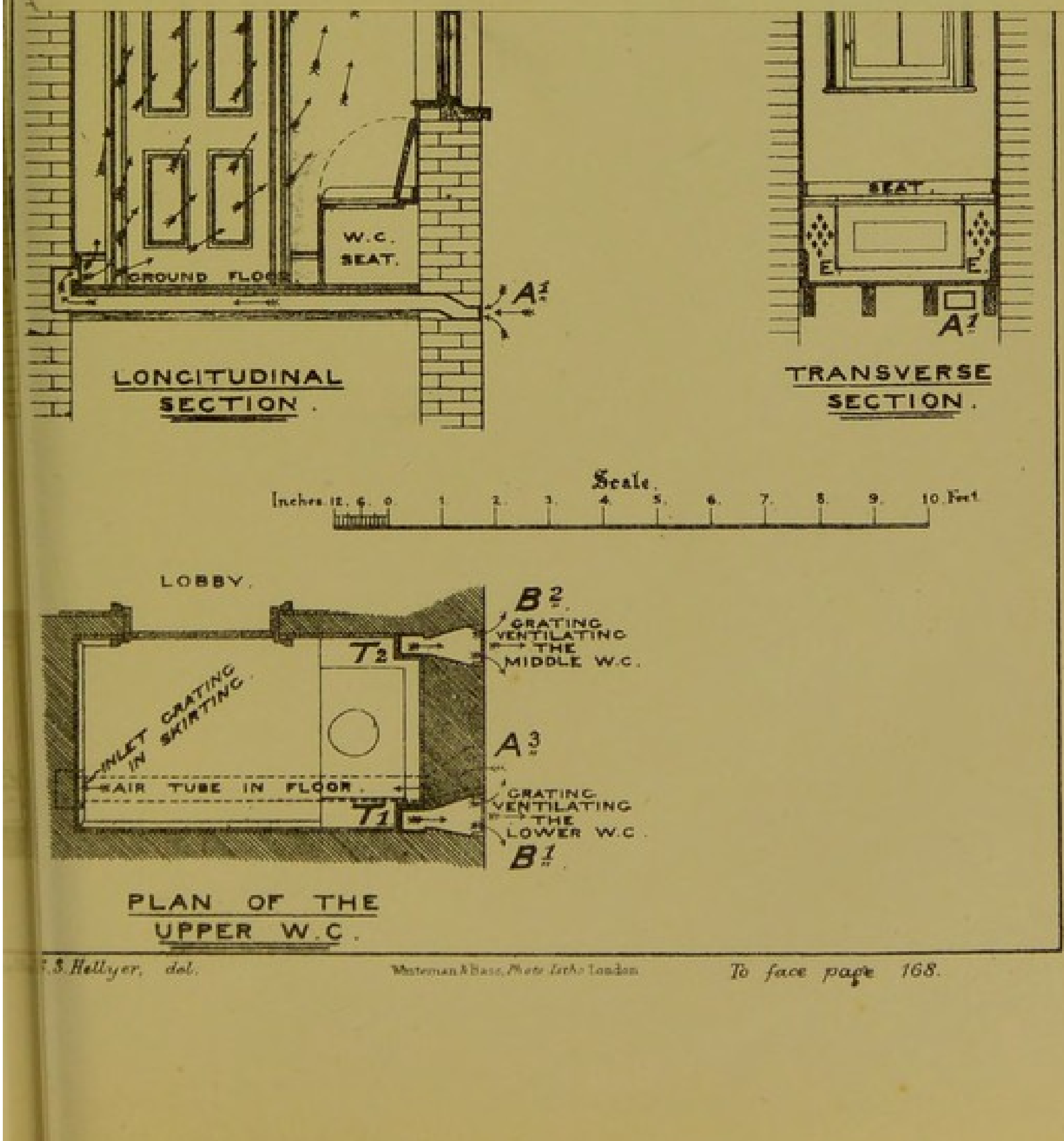
Positions of W.C.'s.

The farther water-closets are kept away from bedrooms and living-rooms the better, and to fix a servants' water-closet near a larder may be a good thing for giving the game a tainted taste, but it is a bad way of seasoning it. Water-closets for servants should be made as wholesome as any other water-closet, to encourage habits of cleanliness, if for no other reason, and they should never be placed near a larder, but if at all practicable should be kept outside the house.

Lofty closets.

The room should be lofty to give good space for the effluvia to ascend well above the breathing point of the person using the water-closet, and where the window is the chief means for changing the air in the closet it should be carried close up to the ceiling. The doorway to the W.C.

* See General Arrangements, p. 139.



E.S. Hellyer, del. Whiteman & Bass, Photo Litho London To face page 168.

should be kept low, and the door made as air-tight as possible, to prevent the effluvia coming into the house.

Ventilation of water-closets.

Every water-closet room should be ventilated. A zinc tube, 9-in. by 3-in., or 6-in. by 3-in., should be fixed from the face of the external wall to some convenient place inside the room—near the door, and only a few inches above the floor by preference for changing the whole of the air in the room. An air-brick can be built in the wall over the mouth of this tubing, and a brass hit-and-miss grating can be fixed in the skirting for closing the pipe when necessary, though it is better always left open. (See Plate XIII. showing air-inlet tubes to W.C.'S, A1, A2, A3.) But a fresh air-inlet into the room of a water-closet is not sufficient in itself for good ventilation, for though a good window be in the closet as well, it will be generally closed. When a water-closet is much used, and especially when inside the house, it ought to have some special means for getting rid of the effluvia, *i.e.*, an up-cast shaft should be taken from the ceiling, the highest point of the room, and continued up to the external air for ventilation, as shown in the drawing, Plate XIII., Figs. 1 and 2, at A, D, G; also at B1 and B2. I have shown one of my own "double-cap" ventilating cowls fixed over the top of the up-cast shaft, but I often use a Buchan's. This 4-in. cowl—or 6-in. when the water-closet is much used—will be found to be very helpful or changing the air in the closet, and it is also a good cowl for preventing a down-draught. (See Chapter XXIII.)

Tiled walls.

As I have said elsewhere, if the walls of *private* water-closets are not covered with white glazed tiles, or made of white glazed bricks, all *public* water-closets should be, and the floors should be tiled as well, so that the walls and floors may be thoroughly washed out occasionally. (See Plate XIV.)

Sound walls.

Serious consequences often arise from the slovenly way in which the walls are left inside the water-closet seats. Often no attempt is made at all to render the walls inside the enclosures, and lathed and plastered partitions are left un-rendered inside the seats—left as open as a latticed window.

In such cases what is to prevent the effluvium from the person sitting upon the seat from passing between the closet basin and seat, through the unfinished partition to the adjoining apartment, as shown by the arrows at B and C, Fig. 136? Though the wall may be rendered rightly enough on the other side of the water-closet, there is sure to be a crevice somewhere in such cases for the vitiated air to pass from the closet into the adjoining room, especially when a fire is in the room to draw it. And not only are the walls

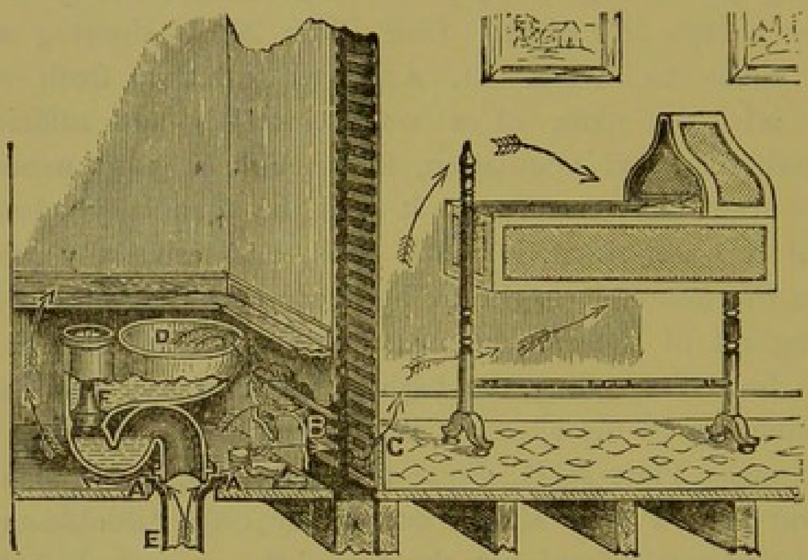
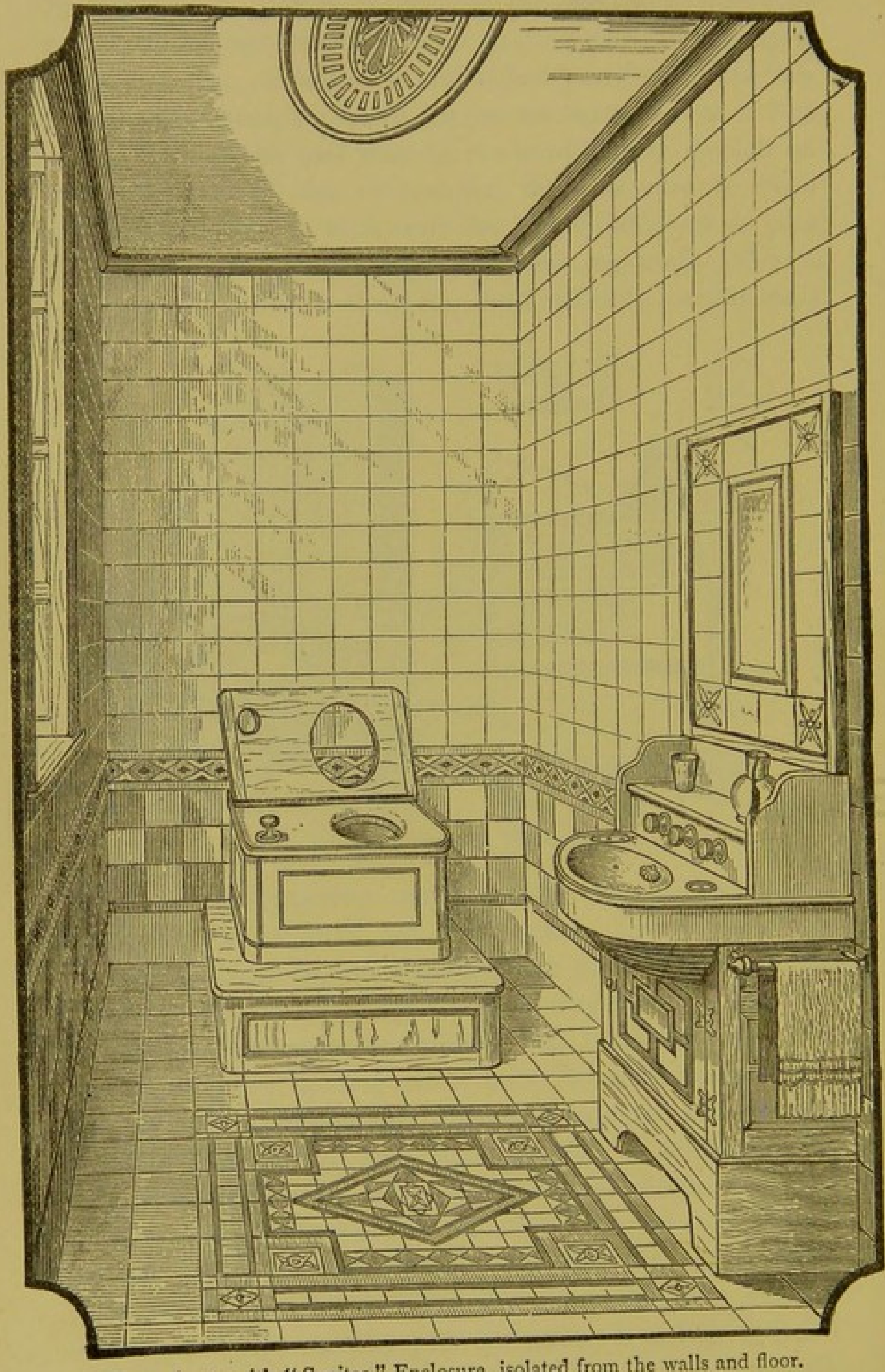


FIG. 136.—A Dangerous Water-closet.

left in a very imperfect state, but the floor of the closet, inside the seat, is often not made good. Spaces are left in the floor, or between the walls and the floor, for the effluvia from the persons using the closet to travel along the joists to come up into other apartments, and I have known it to become offensive several rooms away from the water-closet. Such evils are common, and when a water-closet is fixed with its basin and trap in one piece, so that a soldered joint cannot be made to its soil-pipe, the danger of defective walls is very much aggravated; for in addition to the effluvia from persons using the water-closet, soil-pipe air, and perhaps drain-air too, may be escaping through a defective jointing with the soil-pipe, as shown by the arrows A A, Fig. 136, and this may be passing with the effluvia though the broken wall,

PLATE XIV.



Water-closet, with "Sanitas" Enclosure, isolated from the walls and floor.

or partition, into the adjoining room, as shown by the arrows in the drawing, at D, B, C. Especially would this be the case with a fire in the room. In fact, the drawing faithfully represents what was found in a house a little while ago. A child sleeping in the crib had died, and another child some months afterwards was put into the same room and soon became ill. The jointing of the water-closet to the soil-pipe—like all connections of earthenware to lead or iron—had become unsound. The "cement" had dried up, and I had no difficulty in putting the blade of my knife between the flange of the earthenware out-go of the closet trap and the taft of the lead soil-pipe, at A A.

Rooms of W.C.'s entirely sealed.

There should be no opening, crack, or crevice in the room or floor of a water-closet, under the seat, or through a pipe-casing, or anywhere through which the vitiated air of the closet can pass into any other apartment. This is very important, as in certain states of the body the effluvia is very great, and if this is added to by other persons using the water-closet, the aggregation of bad smells becomes extremely offensive. When such vitiated air is allowed to circulate, and to lurk about between the joists under the floors, or through partitions or pipe-casings, into adjoining rooms, instead of passing out to the open air by the proper ventilation of the W.C., it is no wonder that illnesses arise.

Water-closet Seats.—When a water-closet apparatus and its seat or enclosure are made to stand quite free of the walls, as shown in Plate XIV., any broken plastering or defect in the walls would at once be noticed and remedied, but with the seat made good to the side-walls in the usual way, the space underneath it is quite screened from sight. (See Figs. 145 and 146.)

"Sanitas" Enclosure.

I have designed a water-closet enclosure, and as everything must have a name, have called it the "Sanitas" Enclosure. It is made in white porcelain ware for cleanliness, and, as shown in the drawing, the water-closet by this arrangement is isolated from the walls. To prevent any opening in the floor for the trap—in the case of a valve-closet—or for the branch soil-pipe, the water-closet apparatus is fixed on a raised platform, as shown in Plate XIV., and also in Fig. 145. To perfect this arrangement, a white ware slab, falling all ways to the closet basin and having a rim turned down into it, is made to protect the space inside the enclosure from droppings, or from splashing when slops are emptied into the closet, and as the lip of the slab turns down over the sides—the riser and ends—of the enclosure, nothing is likely to get inside where it cannot be seen, as

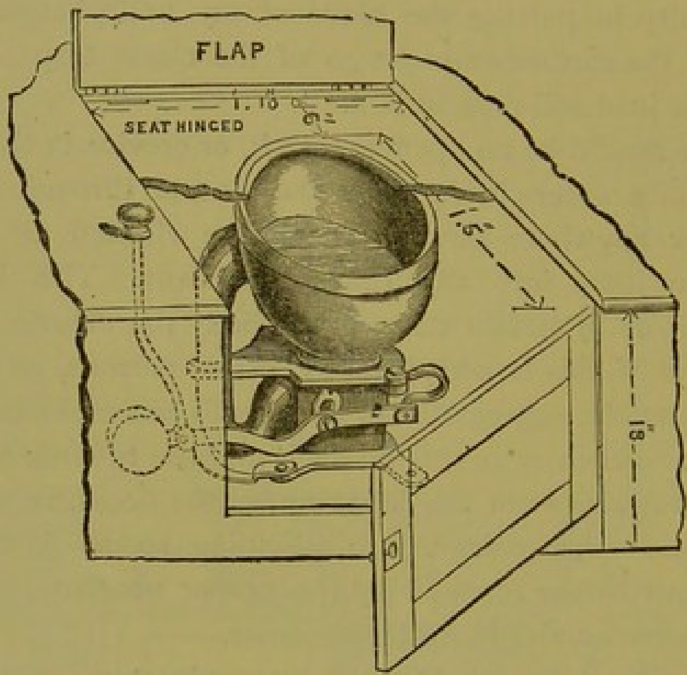


FIG. 137.—Perspective view of a Valve-closet and W.C. seat.*

in the general arrangement of water-closet seats. A hinged wood "top-seat" for sitting upon is fitted over this slab, and when slops are emptied into the closet this seat is turned back.

The *seat* of a W.C. is worth some consideration. As a rule, W.C. seats are fitted up as if they would never want taking down again. If the *seat* and *riser* are *hinged*, as shown at Fig. 137, there would be no necessity for taking down the seat at all; for the closet apparatus could easily be removed by the plumber for repairs, when necessary, and the owner

* See "Sanitas" Enclosure, Plate XIV.

could himself turn off the supply of water, or regulate it when so required. The *flap* is of very little use, especially in public water-closets, and is therefore better dispensed with entirely, to prevent dirt accumulating behind it, and also to save expense. When flaps are used, more room should be given between them and the seat-holes for clothes. (See figured dimensions, Fig. 137.) Flap.

The seat should be made to "sail" about an inch over the inner edge of the closet-basin all round to prevent the excreta touching the rim of the basin, &c. The *holes* in the seat are, as a rule, made too large. When people want a sitz-bath they do not use the closet; what is wanted is such a hole as shall be convenient, and as shall at the same time protect the sides of the basin as much as possible, by keeping the *hole* in the seat about an inch *smaller* all round than the *basin*. It is also very convenient to have the edge of the seat-hole within three inches of the front edge of the seat, and my closets are all so made that this can easily be arranged in fixing the seat, if the joiner's eyes are only opened to the desirability of so doing. The riser should be kept quite close to the closet-basin, and then allowing 1¼-in. for the width of the basin-rim, this will still leave the seat an inch for sailing over the basin. Seat-hole.

CHAPTER XII.

WATER-CLOSET APPARATUS.

Imperfect water-closets—How to test the efficiency of a water-closet—Unwholesome closets not remedied by a new apparatus—"Table-tops" for protecting the space inside water-closet seats—Variety of water-closets—Valve-closets—The "Optimus" valve-closet—Valve-closets with overflows separate—Valve-closets and W.W. Preventers—Pan-closets — "Hopper"-closets—"Sharp's" closet—"Begg's" closet—The "Artisan" or "Hygienic" closet—Water-closet and slop-closet combined—"Vortex" closet—"Wash-out" closet—"Flush-out" closet—"Excelsior" closet—"Water-battery" closet—"Twin-basin" trapless closet—Trapless "plunger" closet—Variety of closets—Water-closets not deodorizers—Trough-closets.

Perfect water-closets.

No water-closet is perfect which does not get rid of every vestige of excrement after usage by one pull of the closet handle, *i.e.*, a water-closet which is not completely cleansed together with its trap and soil-pipe by a fair flush of water—say three gallons—is not a perfect closet. And yet if the water-closets throughout the United Kingdom were examined, not ten in a hundred would be found to free themselves, and their traps, much less their soil-pipes, of every piece of paper, and every particle of excrement, after being used, by one pull of their handles. (See Table No. 1, p. 61.)

The efficiency of water-closets tested.

A good way to test the efficiency of a water-closet is to soil over the whole of the interior of the closet-basin with plumbers' "soil," and then to put half a dozen pieces of paper into it; and if the basin is thoroughly cleansed by a single flush of water from its supply-valve apparatus—or from a three-gallon "Syphon Flushing-cistern," as Fig. 254, or by a Bean's "Valveless Syphon," Fig. 255—and the paper is sent through the closet-trap, soil-pipe, drain (moderate length), and sewer-intercepting trap into the sewer,* the water-closet

* I have found from experiments that certain water-closets do this.

and its belongings may be considered in a sanitary state, provided that it is properly ventilated, and that the closet-trap maintains its seal.

Unwholesome water-closets.

A water-closet to be perfectly wholesome must have all its belongings made sanitary. Some imagine that an offensive closet can be remedied by changing the apparatus. As well might a policeman put a new hat upon a drunkard's head and expect it to make him sober, as for a plumber to put a new water-closet apparatus upon a foul or defective trap and expect thus to make a wholesome water-closet. "What's bred in the bone will come out in the flesh" is an old adage; and what's bred in the trap or soil-pipe will come out into the closet.

Table-tops for water-closets.

Where servants are likely to empty slops * into water-closets, a white glazed earthenware slab or "table-top," as shown in Fig. 138, should be fixed over the closet apparatus. To prevent slops splashing inside the enclosure, and to keep the space round the closet-basin clean, the table should be nicely fitted to the frame of the water-closet seat. To break the jointing of the earthenware table-top with the frame or rail of the seat, a narrow beading should be fixed as shown in section, Fig. 139. And the jointing with the riser should have a thin capping-piece fixed over it, as shown in section, Fig. 140. The beading and capping-piece should be screwed in its place with brass screws, for easy removal when needful. The top surface of the table-top or slab is made to fall in all directions towards the closet-basin into which it turns down about an inch. See drawing A., Plate XIV., showing a view of "Sanitas" Enclosure.

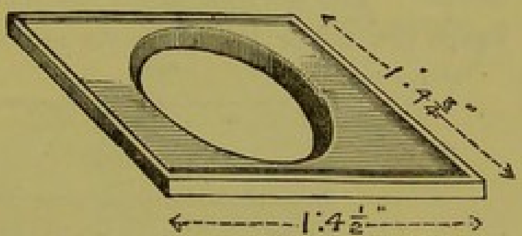


FIG. 138.—View of a whiteware "Table-top," for protecting the space inside the seat of a water-closet.

* See Water-closet and Slop-closet combined, pp. 198-199.

Variety of water-closets

Water-closet apparatus is made in every variety of shape and size, and fitted up under almost every principle that ingenuity can devise or genius invent. But the two *

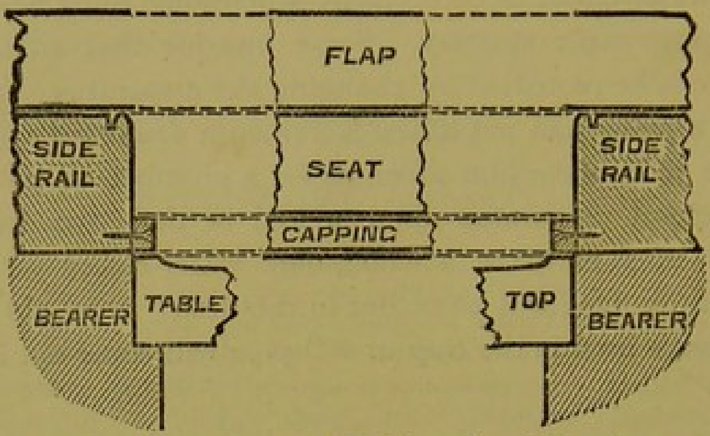


FIG. 139.—Section of "Table-top" and side rails.

classes of water-closets most in use are the *valve* and the *pan* closets. The former takes its name from the *valve* which keeps the water in the basin and not from the *supply-valve*

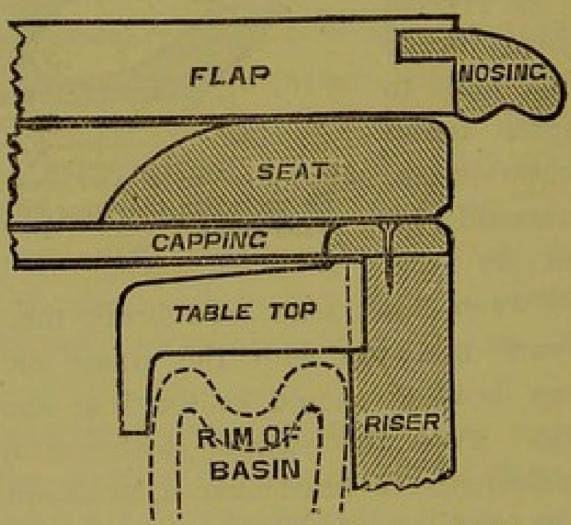


FIG. 140.—Section of "Table-top," and riser, &c.

attached to the apparatus, as many suppose, and thereby make serious mistakes, for the pan-closet is also fitted up with a supply-valve attached to it. The "pan-closet" takes

* During the last few years the "Hopper" and "wash-out" classes of water-closet have been superseding the Pan water-closet, though the latter closet is still largely used.

its name from the tipping-pan which keeps a small quantity of water up in the basin. The valve water-closet apparatus is chiefly fixed in good houses for private and visitors' use and the pan for servants' use. Let us examine the merits of each.

Valve Water-closet.—The valve water-closet—a section of which is shown in Fig. 141—consists (apart from the **Valve-closet.**

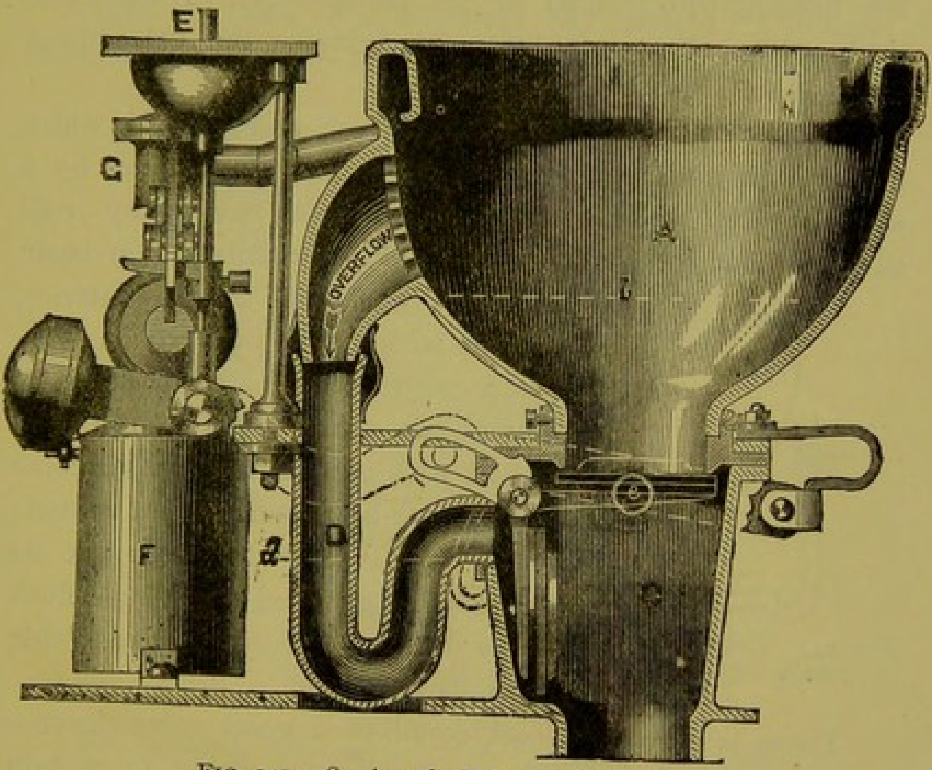


FIG. 141.—Section of a Valve Water-closet.

working fittings) of a deep earthenware basin, A, which is kept about two-thirds full of water by means of a cranked flap-valve fitted to the "outlet" of the basin; and from this valve there is a short conducting-pipe, C, to the trap of the closet.

The valve-box or conductor, C, is made of lead by some manufacturers, and in cast-iron by others. I prefer it of cast-iron *white porcelain enamelled* on the inside, and my valve-closets are made in this way. Such water-closets have been in use for seven or eight years in my own house, and are as clean to-day as they were the first week they were fixed.

The valve water-closet is practically the Bramah water-closet (invented by Joseph Bramah, of Middlesex, a cabinet maker, in 1778), but many improvements have been made in it during the last ten years. Among the most important is the "elastic-valve," instead of a "ground-in" metal valve, and the flushing-rim instead of the fan-spreader. I have also made some other improvements, bringing the valve-closet into a state of perfection.

Simple closet preferable to a poor valve-closet.

I prefer a simple water-closet (such as Fig. 156), which allows itself and its trap to be thoroughly flushed out by a single flush of water, to a *poor* valve-closet, having any or all of the following defects, viz.:—(*a*) Flimsy fittings; (*b*) basin which is not washed all over its interior, *i.e.*, a basin with a fan-spreader; (*c*) overflow-trap with an insufficient depth of water-seal, as shown in Fig. 142; (*d*) valve-box which can corrode and become foul; (*e*) valve-box which is not vented; (*f*) closet-trap which does not get its entire contents changed by a single flush of water from the closet. (See Table No. 1, p. 61.)

FIG. 142.—Overflow-arm badly trapped.

Evaporation of water.

There is no water-closet equal to a good valve-closet—perfect in all its details—especially for fixing in certain positions, *e.g.*, for private use in good houses, and for places where a water-closet is liable to be out of use for several months together. A good valve water-closet, properly fixed and supplied with water, can be kept as clean as a toilet-basin. And it has this great advantage over a "hopper" or wash-out water-closet—viz., that its trap is not so liable to become unsealed by evaporation.*

* I have had the "wash-out," "wash-down," and "water-battery" class of closet-basins tested, where they have been fixed, and the water has been found to evaporate from them in the summer time in four or five weeks, leaving the basins quite dry. Some days they have been noticed to lose as much as ¼-in., and their traps have lost their seal, by evaporation, in less than two months. And this is also the case with the "Vortex" and "Hygienic" closets; in fact, with every

On using a valve-closet with a deep basin (as Figs. 143 and 144), the excrement falls into about a gallon of water, and directly the closet-handle is pulled the contents of the basin (every vestige of it) are sent with some force through the closet-trap to the regions below, and at the same time the basin, trap, and soil-pipe are flushed out by the incoming water from the supply-valve, G.

Figs. 143 and 144 illustrate my patent "Optimus" valve water-closet. Every part of this water-closet is

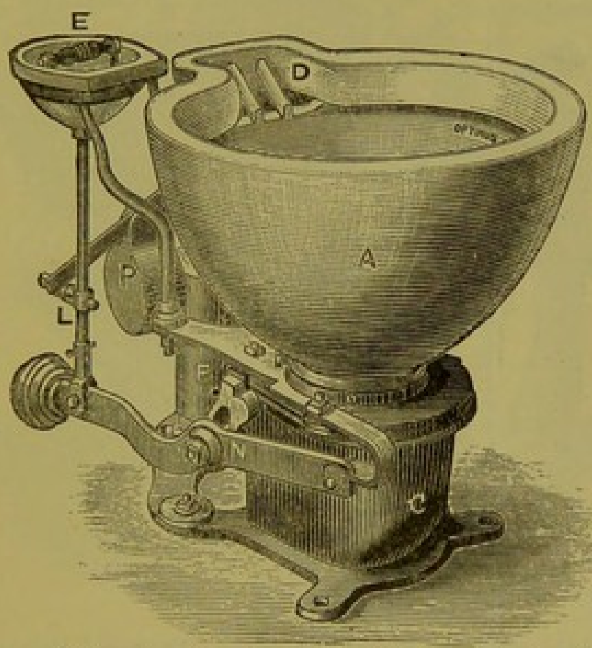


FIG. 143.—Side and partial view of the "Optimus" Valve-closet.

perfectly cleansed by a flush of three gallons of water, and with the medium sized "Anti-D-trap" under it, not a vestige of excrement remains either in the closet or trap after usage by *one* pull of the handle, E.

REFERENCES TO DRAWINGS, FIGS. 143 AND 144.

A.—Deep earthenware basin (fine ware) with flushing-rim, white or coloured.

B.—Flap-valve with India-rubber flange or disc, to keep water in basin; basin-valve.

closet of that class. But, as explained elsewhere (p. 138), a small size "Anti-D-trap" fixed under a valve-closet did not lose one-third of its seal in six months.

C.—Valve-box (or "conductor"); white porcelain, enamelled inside.

D.—Down-right overflow-arm from top of basin, with flushing-rim, R, carried right round it for flushing it out. The overflow-trap, B, is connected to the vent-arm of the valve-box, as shown at R, Fig. 145, instead of being taken direct into the valve-box in the old way, as shown in the drawing, Fig. 141.

E.—Earthenware dish in a brass frame, with ebony or ivory handle to the pull. (See Fig. 151, showing a pull-up knob, a better arrangement.)

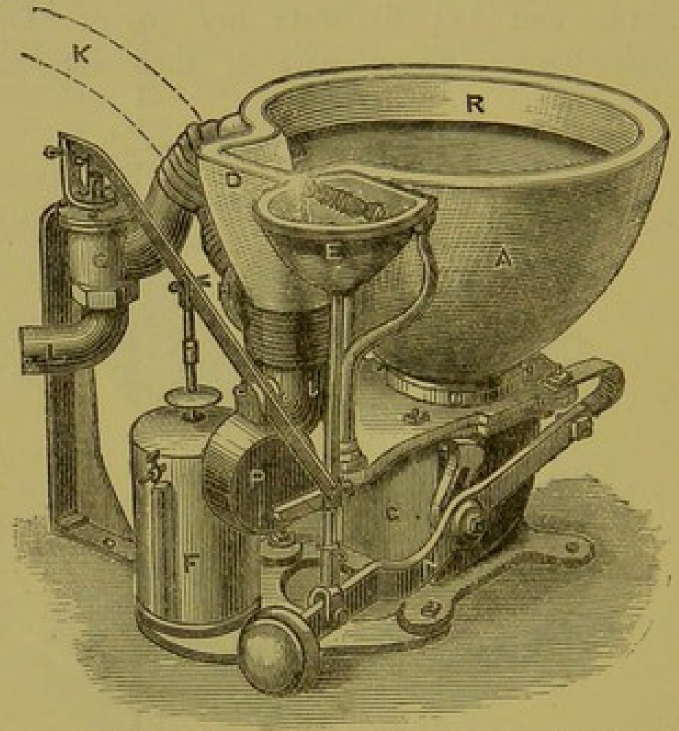


FIG. 144.—Side and partial view of the "Optimus" Valve-closet, with supply valve.

F.—Copper bellows regulator, for regulating the quantity of water to come into the basin.

G.—Brass supply-valve. This valve is made in three sizes—viz., 1-in., 1¼-in., and 1½-in., for connection with service-pipes under different pressure of water. The 1½-in. valve will allow about a gallon of water per second to pass into the closet with only a few feet head of water. The brass "lining," L, Fig. 144, can be turned round to any point to suit the service-pipe.

K.—2-in. or 1½-in. lead-pipe for venting the valve-box. This pipe must never be connected with any other air-pipe. The pipe should just go through the external wall to the open air.

N.—Lever for opening and closing the basin-valve.

P.—Cast-iron weight for shutting the supply-valve.

As shown in section Fig. 145, and on plan Fig. 146, a vent-pipe should be continued from the arm of the valve-box to some convenient spot outside the external wall, and its end left open to the atmosphere. The end of this pipe should be kept a few feet away from windows, but it is not necessary to carry it up to the roof where the closet-trap is self-cleansing and the soil-pipe is ventilated.

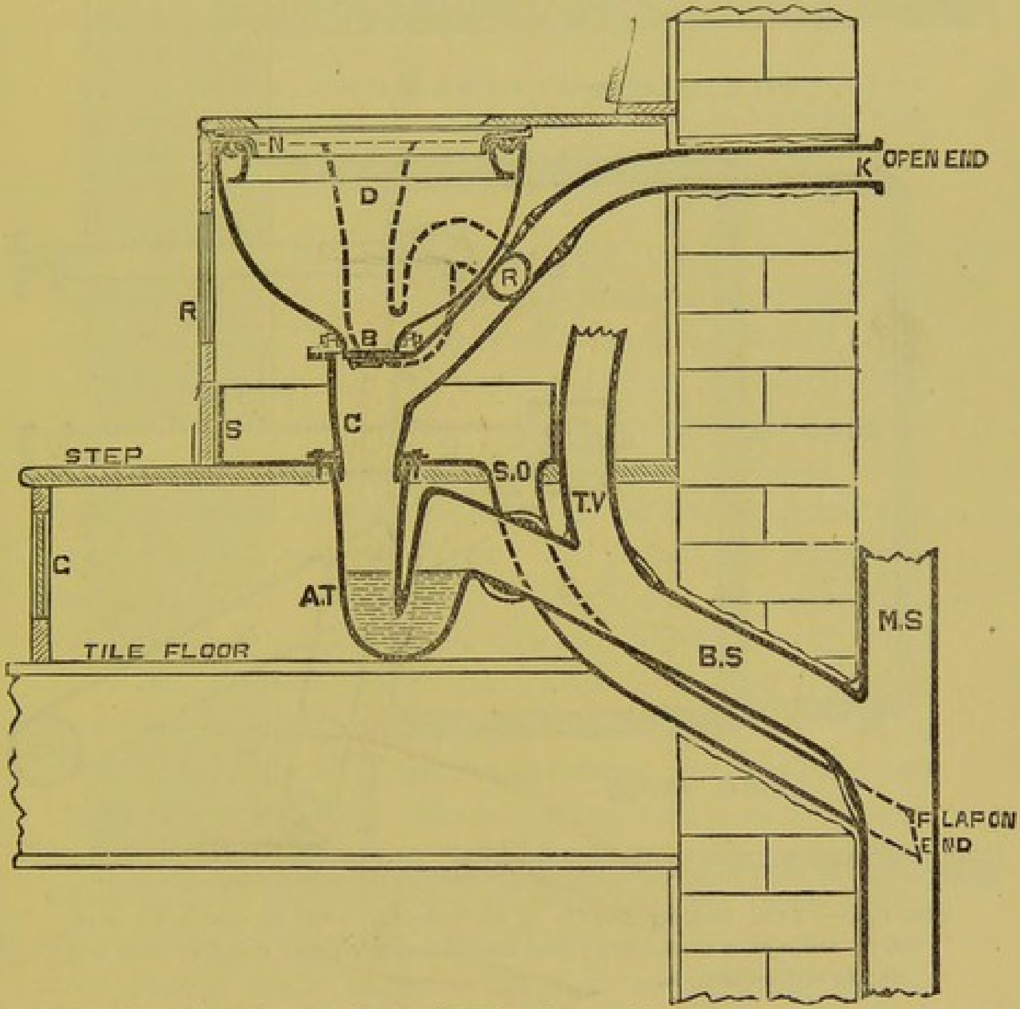


FIG. 145.—Section of "Optimus" Valve-closet, with the vent-pipe from valve-box taken out to the open air, and with the overflow-trap branched into same.

Value of venting valve-box.

The venting of a valve-box is of great importance: (*a*) it prevents the overflow-trap of the basin from being syphoned. I have tested this many times, and found that a valve-closet filled up to the brim (as from a slop-pail) and discharged quickly will often unseal the overflow-trap of the basin. The rush of water through the "conductor," C, Fig. 141, unseals the trap, D, but with the conductor—*i.e.*, the valve-box vented, as shown in the section Fig. 145 *—the trap is *not* unsealed ; (*b*) it allows the overflowing water of the basin to pass freely through the closet-trap, as it gives the valve-box air ; (*c*), it provides an escape for any gases or

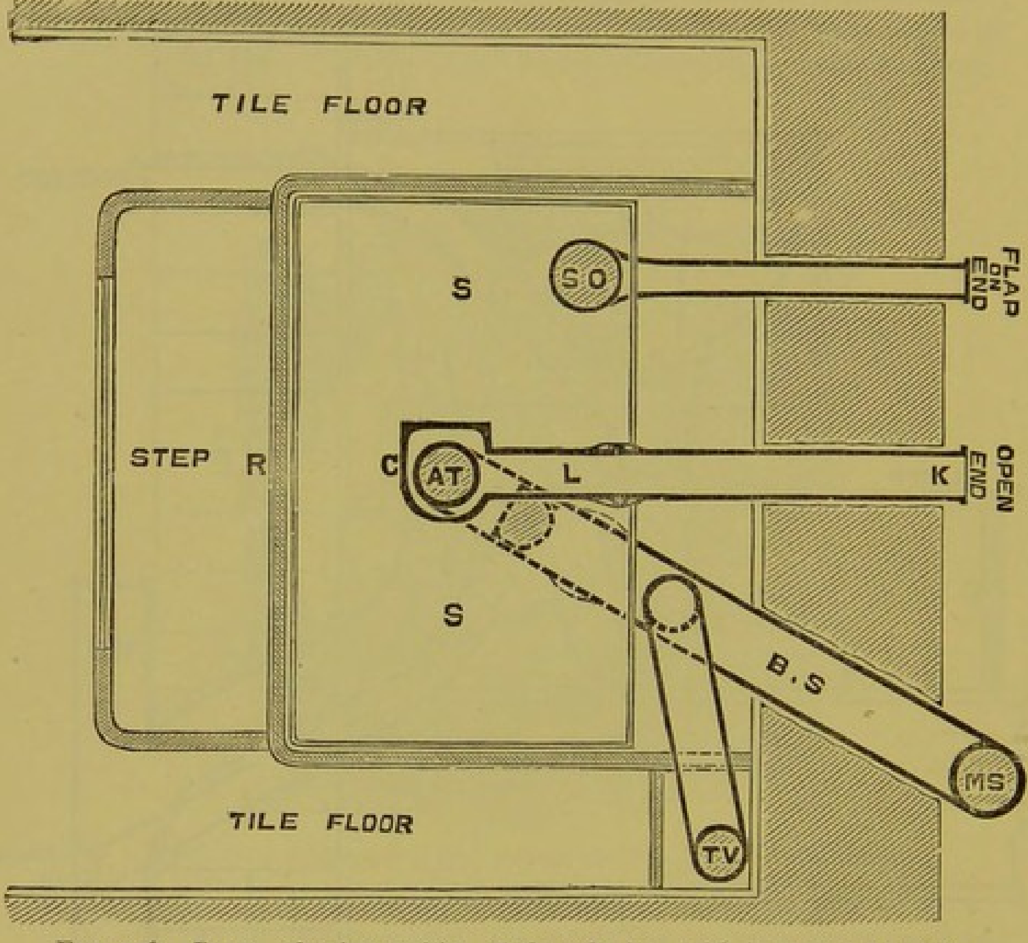


FIG. 146.—PLAN, *showing position of the valve-box, with its vent*, L K ; *trap*, A T ; *soil-pipe*, B S *and* M S ; *trap-ventilation*, T V ; *safe overflow*, S O ; and step to water-closet, R.

bad air coming from excreta decomposing in the closet-trap, for the handle of a water-closet is sometimes so badly pulled that the deposit is only just sent into the closet-trap.

* During the discharge of the water-closet, a continuous stream of air is drawn in through the vent-pipe, K, and this is of value, not only for air-cleansing the pipe, but also for lessening the syphoning action of the discharge upon the traps fixed on the main pipes. And yet people, ignorant of the meaning of such a vent-pipe, illustrate valve-closets with a flap-valve on the end of such pipes to prevent any air from passing *into* them.

REFERENCES TO DRAWING, FIG. 145.

D.—Overflow trap branched into vent-pipe of valve-box at R.
A T.—"Anti-D-trap," medium size.
B S.—Branch soil-pipe.
T V.—Trap-vent.
V B V.—Valve-box vented, the pipe open to the atmosphere at K.
S.—Safe or tray, made of 4-lb. sheet lead, and standing up 5-in. or 6-in. on each side.
S. O.—Safe overflow; 2-in. lead overflow-pipe from safe. This pipe must go through the external wall, and its end must be left open to the atmosphere, or it may have a brass or copper hinged flap, soldered on the end of the pipe, to keep out birds and draught.

Overflow-trap.

In the "Optimus" valve-closet, Fig. 145, at R, the overflow-trap is so arranged that instead of connecting it with the valve-box, where foul matter would wash up into it, it is made to discharge into the vent-pipe, above the level of the basin-valve; *i.e.*, the overflow-trap is branched into a clean pipe with its end open to the atmosphere, as shown at K. And to keep the overflow arrangement from being fouled it is partitioned off from the basin; *i.e.*, before any matter in the water-closet basin (except through the regulation-hole, for keeping a certain depth of water in the basin) could enter the overflow-arm of the closet to foul it, the basin would have to be filled right up to the flushing-rim. (See D, Fig. 143.) This is of great importance, for servants *will* empty the slops* from chamber utensils into water-closets, and the overflow-arm and the holes in the side of a valve-closet basin to the overflow-arm are often very much fouled in consequence; but in the "Optimus" valve-closet the overflow-arm would be protected from such fouling, and as the flushing-rim is carried right round the overflow-arm, as shown at D, Figs. 143 and 144, it gets thoroughly flushed out every time the closet-handle is pulled.

Valve-closets without overflows.

To abolish the overflow-trap from valve-closets, as some suggest, and to fix a *separate* overflow-pipe (unless it is done with great care) may prove a remedy worse than the disease. I tried this about ten years ago, and discovered not only its difficulties, but also its disadvantages.

* See water-closets and slop-sinks combined, p. 199.

When a closet is used by ladies and by children for *one* of the purposes of nature only, the handle of the closet is often not pulled up at all to discharge the contents of the basin, but the liquid excrement is left to run away through the overflow; therefore, to allow a valve-closet to overflow into any long length of separate piping is to create a nuisance. In fact, unless the overflow-pipe were kept unusually high, the excrement (or the "standing-water" of the basin largely impregnated with excrement) during the use of the closet for both purposes of nature would be running away through the overflow-pipe and fouling it, without any means of washing out the pipe and making it wholesome again. And if the overflow were kept high, the "standing-water" in the basin, when the supply-valve leaked, or when the handle of the closet was dropped too quickly, would often be too high for any comfortable usage of the closet.

Complaints were often made of the nearness of the water to the seat in the *old* valve-closets where the overflow-arm was kept near the top.

Overflow through wall.

Again, when the overflow-pipe is carried out through the external wall, there is great difficulty in finding a proper place of discharge for it. And if it required any long length of piping—the evil of which we have just been considering—it would want trapping and ventilating similar to other waste-pipes. There would also be the danger of such a pipe (after it had become fouled by the overflowing excrement) becoming an air-inlet pipe to the house, as well as the discomfort of cold air blowing up against the person using the closet.

In the drawing, Fig. 147, a view is given at B and A of an arrangement which I had made a few years ago for keeping the overflow-pipe separate, and for conveying any overflowing water, by a short pipe connected to the arm, A, through the external wall, but it is very rarely that such an arrangement can be adopted, for reasons already given.

Draught under seat.

To prevent any cold air blowing under the seat to the person using the closet, I designed a valve-closet basin with a groove in the rim to receive a packing of india-rubber, as shown at A, Fig. 148. A piece of India-rubber tube, A, is fitted into the groove on the top of the basin, and the seat, resting upon it, makes it air-tight, thus preventing any effluvia passing under the seat—during the time the closet is

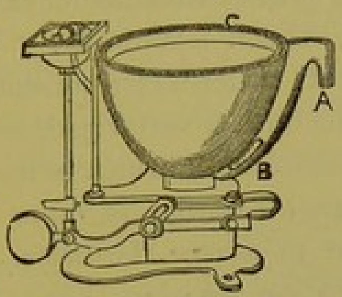


FIG. 147.—View of Valve-closet, with Overflow to go through wall.

FIG. 148.—Section of Basin-rim with india-rubber packing, A.

in use—as in ordinary closets, and also preventing any cold air coming to the occupant.

Fig. 149 shows a *knob-pull* working through the stile of the W.C. seat. With such an arrangement, there is no dish Closet-pull.

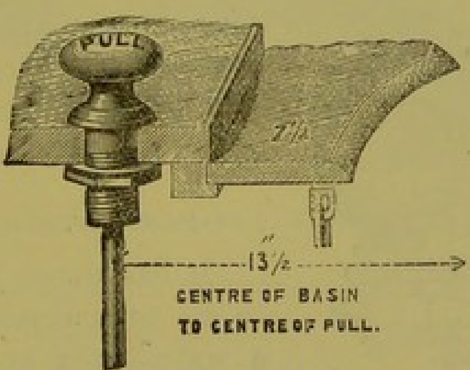


FIG. 149.—View of "Pull" through stile of seat.

for dirt to collect in; and as the knob is made of ivory *, there is nothing about it to require cleaning, as is the case with *brass* plates, or brass dishes and handles. When a knob-pull is used, as shown in Figs. 137 and 149, the flap can be closed before the contents of the basin are discharged.

In the drawing, Fig. 150, a view is given of a valve-closet supplied with water by a water-waste-preventing cistern †, C. A restriction of water to water-closets, at any

* It can also be made in hard wood.

† See Plate XXV., showing valve-closets with water-waste-preventers *in situ*.

rate to two gallons, is a serious error. I prefer the attached supply-valve apparatus as shown in Fig. 144, but where a Water Company insists upon a water-waste-preventing arrangement of some kind, it is better to use a cistern than a supply-valve, as the flush of water is more valuable for cleaning the closet. With the "valve-closet water-waste-preventer,"* C, the flush is very rapid, and the "after-charge," which is made to come in slowly, is quite sufficient to charge the basin.

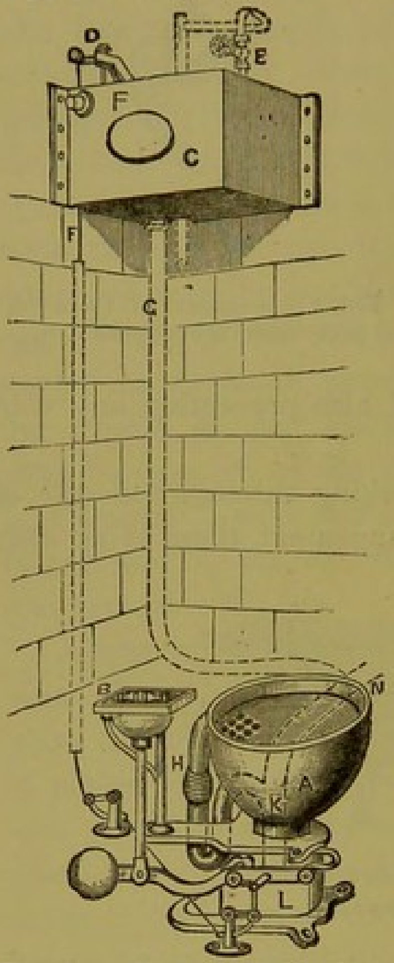


FIG. 150.—View of a Valve-closet with Water-waste-preventer.

In the drawing, Fig. 151, a view is given of a valve-closet with a white glazed earthenware slab (as Fig. 138) fixed over it to prevent splashings, &c., falling down inside the seat. A wood-seat for sitting upon is hinged to the frame of the closet-seat, and when slops are emptied into the closet-basin this top-seat is turned back.

PAN WATER-CLOSETS.

It has always been a puzzle to me to understand how such a water-closet as a pan-closet should become so great a favourite with architects, plumbers, and the public. The only "bliss" that the public can have about so foul a thing is "ignorance" of its nature, but what excuse to make for architects and plumbers I know not, except that it was the custom of their fathers to specify and to fix pan-closets, and this has become a law with them.

In the drawing, Fig. 152, a section is given of a new pan

* See Fig. 252, for a better view of this W.-W.-P.

water-closet. The receiver,* N, is a large cast-iron vessel for the tipping copper-pan, O, to work in and to receive its contents when the water-closet is used. The vessel, O, is a copper-pan † (tinned on the inside) for keeping water to a depth of from 3 in. to 4 in. in the basin, M. This basin is made of glazed earthenware in various shapes and colours, and with "fan" water-spreaders or flushing rims.

On pulling up the handle, *r*, the contents of the basin, M, after usage, are thrown into the receiver, N, by the copper-

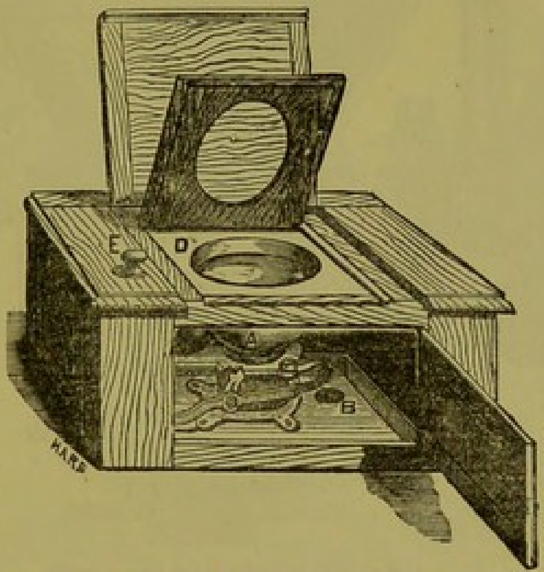


FIG. 151.—Valve-closet with white-ware slab or top, D.

pan, O, and pass into the trap under the apparatus. But a glance at this apparatus in section, Fig. 152, will show the impossibility of keeping it wholesome. The deposit is dashed against the side of the "receiver," N, by the tipping out of the pan, O, and is splashed from side to side of the receiver and all over the *outer side* of the copper-pan, before it finally finds its way into the water-closet trap and soil-pipe. This filth, splashed about over the receiver and copper-pan, is left to corrode, and to be added to by each usage of the closet, for it is impossible to get at it to clear it away, and especially

* This receiver is called by the trade a "container"—and it does contain all sorts of nastiness after it has been in use a little while.

† The pan-closet takes its name from the tipping-pan, O, and not from the basin.

the *under or outer side* of the copper-pan, the *back part* of the receiver where the copper-pan is hinged, and the *under side* of the top of the "container." Moreover, the basin, M, though made of pottery-ware, gets completely corroded with soil and urine up to the water-line on the *outer side* next the copper pan; and there is no means of getting at this, nor is there any friction in the passage of the discharge to wash it away. The only way to thoroughly cleanse a closet of this descrip-

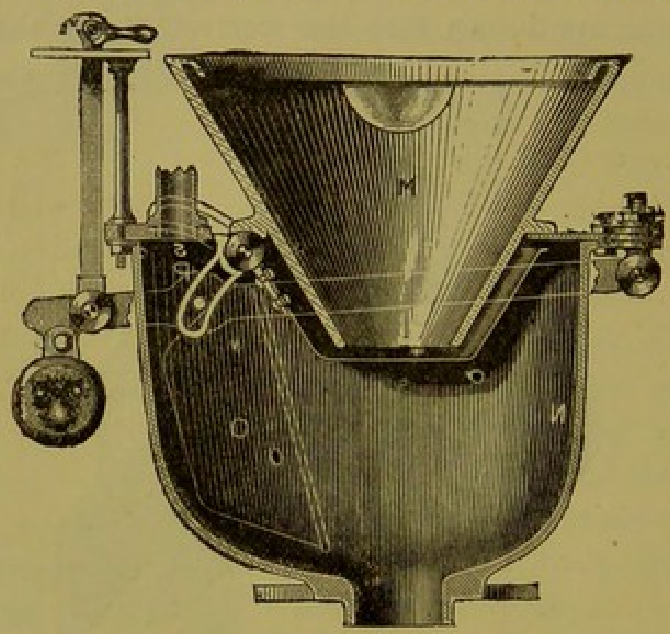


FIG. 152.—Section of a new Pan-closet.

tion is to take it to pieces and burn off the corrosion over a fire.

It is supposed by many that the copper-pan, O, when at rest, shuts off, by the dip of the basin into its water, the "container," N. Well, it does so, *but very imperfectly*, for any bad air in the "container" can always escape through the holes in its side where the axis is hinged. And if it does not escape there, it can easily find its way through the air-hole * in the top of the "container," unless there is an air-pipe from it, which is very rarely the case.

* This air-hole is to give a vent to the container, to the space between the water-seal of the basin and trap, to allow any water when overflowing the tipping-pan to run freely through the closet-trap, and also to prevent the pan from losing its water.

Without this vent the container would be air-bound, or nearly so, by the water-dip of the basin at the top, and of the trap at the bottom, at the first moment of the discharge, and

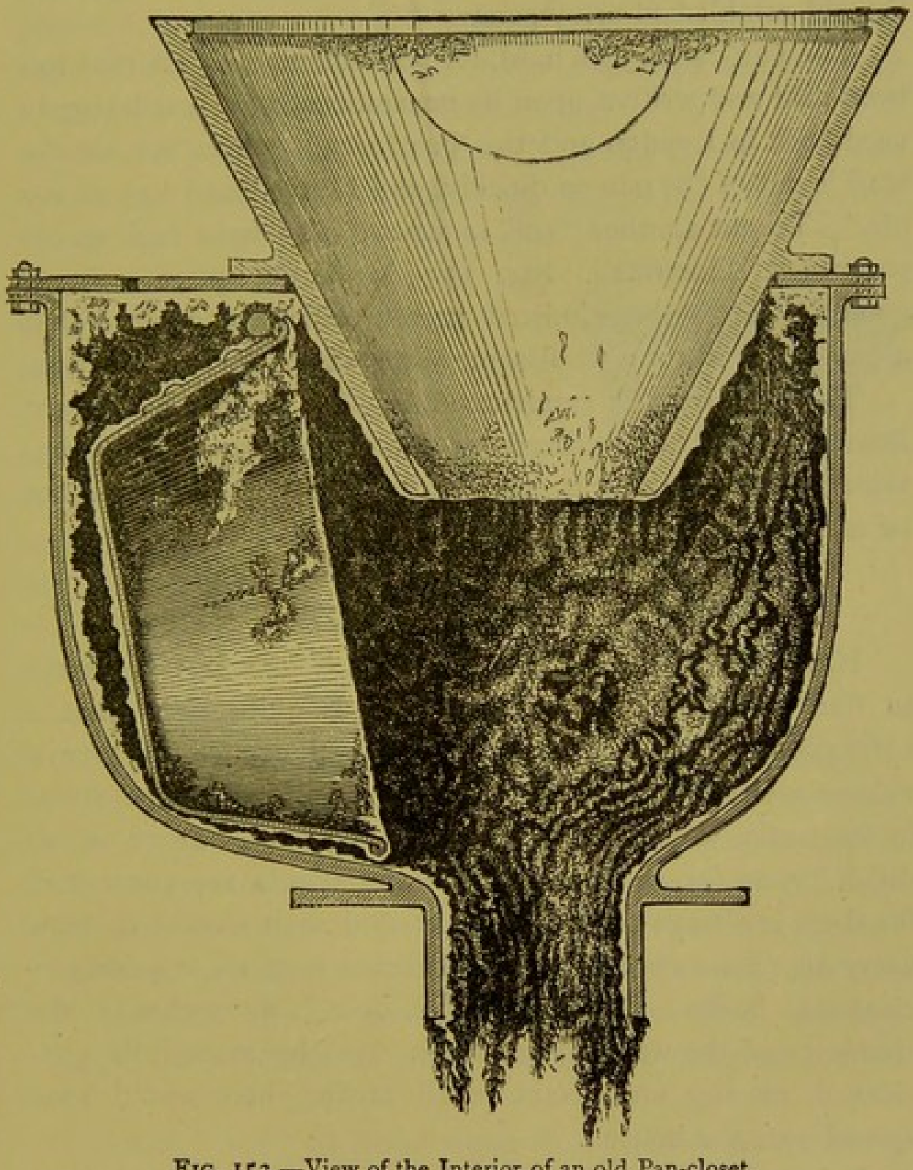


FIG. 153.—View of the Interior of an old Pan-closet.

also when at rest, except that the joints at the axis bearings are never quite air-tight.

Moreover, every time the handle of such a water-closet is pulled the whole of the filthy container is entirely *exposed to the house*, for the copper-pan is drawn back on one side by the action of the closet, thus leaving it to send out what foul air is displaced by the body of water passing through it. The "puffs" of bad smells which such apparatus send up, after they have been fixed for some time, are enough to make one wish for the old-established privy again.

Pan closet dies hard.

The pan-closet dies hard, for notwithstanding all that has been said and written upon its unsanitariness, it is still largely used both in London and the Provinces. "You see, sir, the stuff is out of the pan so quickly, and I have fixed 'em all my life." To put another "nail in its coffin," I have had an old pan-closet illustrated, Fig. 153; and the picture is so good that every unprejudiced person will be convinced that a pan-closet is not a wholesome water-closet for any position.

The pan-closet is condemned by the Local Government Board. It can be improved by porcelain-enamelling its container, and by venting it, but whatever may be done, it cannot be made a wholesome water-closet.

THE HOPPER CLASS OF WATER-CLOSET.

Having condemned the pan-closet, it becomes necessary to find a substitute for it, since it is quite clear that a *valve-closet* is too expensive for general use. Moreover a valve-closet is not suited for out-door positions, as the water in its basin would freeze in frosty weather. There is no difficulty, as far as "out-door" water-closets are concerned, for there is always plenty of air around such closets to blow away any little unpleasant smell arising from an imperfectly-cleansed basin. But in the "in-door" water-closets the character of the water-closet basin must be more fully considered, as any unpleasant smell arising here would soon spread over the house.

It is quite as important to have an efficient water-closet and trap * for the common water-closet as for the best water-closet.

In deciding upon the kind of water-closet to use for

* All "up-stair" water-closet traps, and traps to fittings *inside* a house, are important. Whether the trap is under the best or commonest water-closet it must be effectual, as also must be the connection of the outgo with the soil pipe. Of what use is it to lock the front door and leave the back door unlocked?

servants, workmen, &c., where a *valve* water-closet would be too expensive, or be likely to receive too rough usage, there is nothing more simple, or cleaner, or more durable, than a white glazed earthenware basin. Such basins are made in every variety of shape and size, but many are made without any adaptation for the work they have to do.

Old-fashioned "Hopper.

The old-fashioned "Hopper" water-closet, conical-shaped, as shown in the drawing Fig. 154, whether the "long" or short "Hopper," ought never to be used, even in the very poorest water-closet. The fæces on using such a closet fall upon the side of the basin and foul it, and as the basin is generally dry, hardly any amount of water brought to bear upon it will wash it off. There it is left a "fixture," like the basin itself, which the *out-going* tenant is generous enough to leave behind him for the *in-coming* tenant to see, and have the benefit of without anything to pay.

FIG. 154.—View of a Hopper-closet—bad shape.

Dribbling supply.

The dribbling supply of water which is generally laid on for such water-closets is hardly enough to *wet* the basin ; it never attempts washing it. How is it possible for such closets to be kept clean and wholesome?

It is astonishing to think that such water-closet basins as just described should be used by the hundred, when a "Beggs'" or a "Sharp's" water-closet basin costs but a trifle more.

"Beggs'" and "Sharp's" water-closet basins.

"Beggs'" and "Sharp's" water-closet basins are infinitely superior to the "Hopper" closets just described. They are much the same in principle and shape as the "artisan" water-closet; the latter has a different flushing-rim from Beggs', and is *straighter at the back for the deposit to escape the side of the basin.* Sharp's basin is larger at the back and more tapering than Beggs' basin, but the flushing-rim is better regulated for the distribution of the water-supply.

As a water-closet is only wanted for the purpose of conducting excrement into the soil-pipe, it is obvious that the smaller it is the better, and the less surface there is about it the cleaner will it be kept; for the supply of water to it will not have to travel over so much ground, but will be more confined and concentrated upon the work it has to do—viz., that of cleansing the basin and washing out the trap.

"Hygienic" closet.

In the drawing Fig. 155 a section is given of my patent "Artisan" water-closet—now called the "Hygienic" closet, for the name was not liked, especially as it has found favour and is much used by richer people. It is as small as practicable, so as to confine the water-flush and give it as little surface to wash as possible.

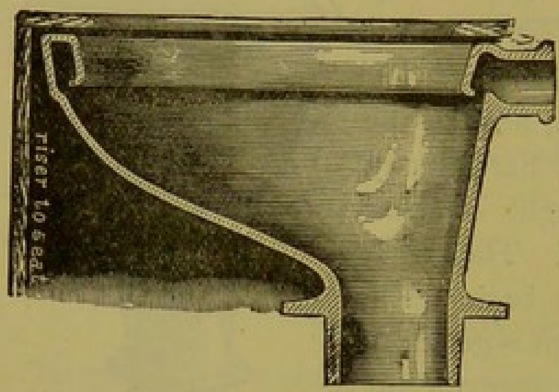


FIG. 155.—Section of the "Artisan" or "Hygienic" closet basin.

The flushing-rim round the top of the basin is so regulated, and the configuration of the basin is such, that the water immediately on coming into the basin converges towards the outlet, and concentrates itself upon the trap, to drive everything foreign out of it. Moreover, the trap is independent, and can be of lead or earthenware, according to circumstances, and is fixed *above the floor-line*, where it can be got at at any time without disturbing anything. (See Plate XV., showing this water-closet fixed complete).

The closet found satisfactory.

A large number of these closets are now in use in various parts of the country, and are giving great satisfaction. A larger deposit and a greater quantity of paper is washed out of this closet with a two-gallon flush of water than with any other closet. And not only is every part of the *basin* thoroughly washed, but the *trap* of the closet is also thoroughly cleansed. The force of the water is not broken as in the "Water-battery," and closet-basins of that kind, but it rushes down the sides of the basin direct from the flushing-rim into the trap. It is, therefore, very rarely that any paper, or other foreign matter, remains in the trap, and with any good method of supply giving two gallons of water at one flush nothing ever remains.

This closet is adapted for fixing in exposed positions, as the water hardly stands high enough in the basin to get frozen.

The only objection to this closet is that the deposit is apt, at times, to fall on and adhere (the basin being dry) to the

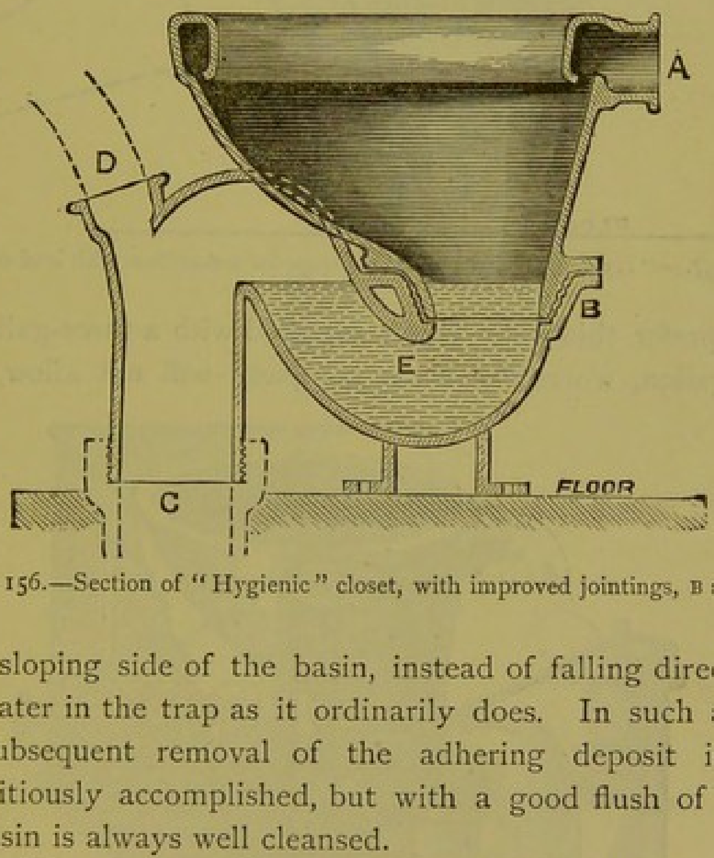


FIG. 156.—Section of "Hygienic" closet, with improved jointings, B and C.

front sloping side of the basin, instead of falling direct into the water in the trap as it ordinarily does. In such a case the subsequent removal of the adhering deposit is less expeditiously accomplished, but with a good flush of water the basin is always well cleansed.

Earthenware trap.

A *white ware* trap (for connecting to the drain-pipe above the floor-line, as shown at C, Fig. 156, where its jointing can always be seen), is made specially to go with this closet-basin, and to give it a good seal, the "dip" is not less than 1¾-in.

Closet with lead trap.

When this water-closet is fixed inside the house, and discharges into a lead soil-pipe, the trap should be of lead,*

* See Plate XV.

as shown at E, in the drawing Fig. 157, so that its connection with the soil-pipe, at H, may be a reliable one—viz., by a *wiped soldered joint*, for reasons given on p. 38.

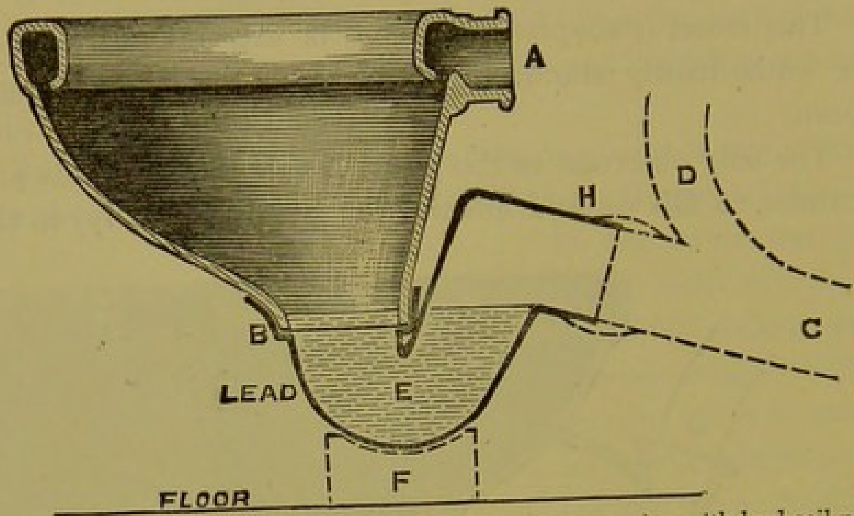


FIG. 157.—"Hygienic" closet with *lead* trap, for connection with lead soil-pipe.

Supply of water.

I prefer this water-closet supplied with a three-gallon (or two-gallon, where the water company will not allow three-

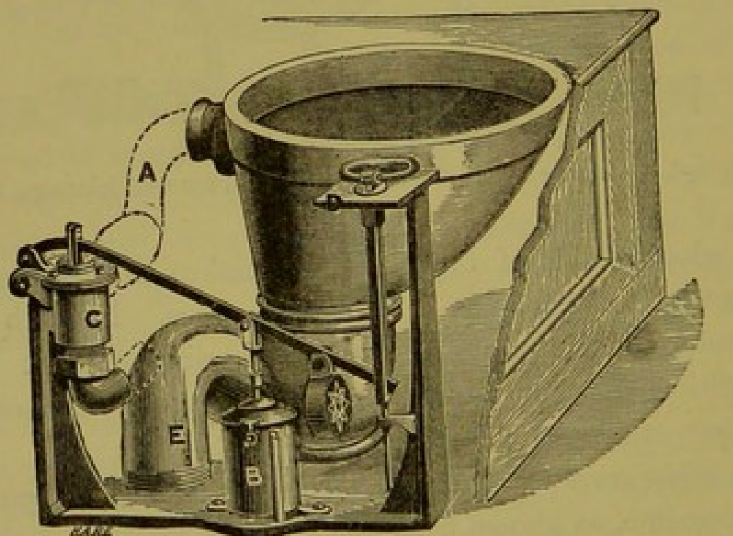


FIG. 158.—View of "Hygienic" closet, with Valve and Regulator supply.

gallons) "Angle-Syphon Cistern," or water-waste-preventer, as shown in Fig. 159, at A, as the water by this arrangement rushes through the closet at the rate of nearly a gallon per second, and thoroughly cleanses it and its belongings. With a syphon supply only one pull of the handle is needed, and the handle does not require holding, as in the old form of water-waste-preventer.

Bean's patent "Direct acting valveless water-waste-preventer," a section of which is shown in Fig. 255, flushes this water-closet out most efficiently by one pull of the supply handle.

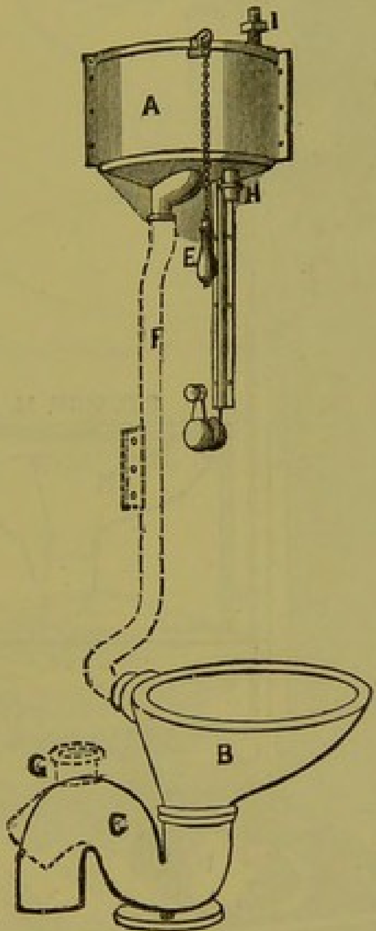


FIG. 159.—"Syphon" supply cistern to the "Hygienic" closet.

A "Hygienic" water-closet with a seat-action arrangement, for supplying the closet with water without pulling any handle, is shown in the drawing Fig. 160. To meet the rules of water companies a water-waste-preventing cistern is fixed, as shown at B. Seat action closet.

On sitting upon the seat, the supply-valve over the service-pipe, G, is shut by the movement of the brass rod, H, and the supply-valve to the water-closet service compartment, B, is opened, allowing two gallons of water (or such quantity as may be arranged) to pass into this compartment, where it remains until the person using the closet rises from the seat, when the supply-valve over the pipe, C, *rises too,* and the two

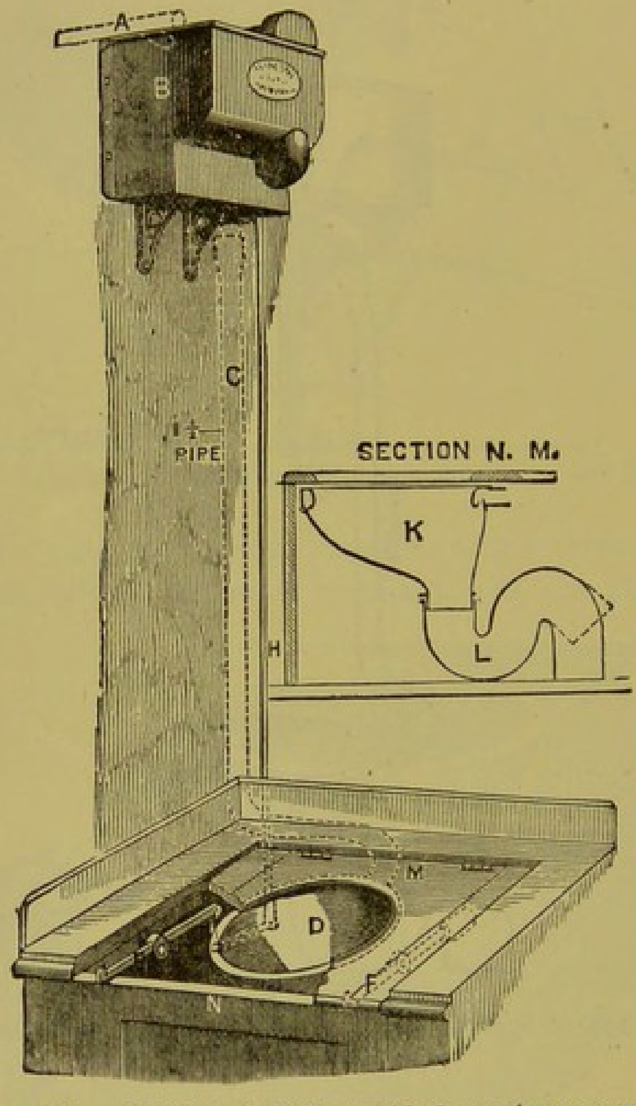


FIG. 160.—View of "Hygienic" Closet with *Seat-action* arrangement and *W. W. Preventing Cistern,* B.

gallons of water rush down through the service-pipe into the closet with a good cleansing force.

Water-closet and slop-closet combined.

"*Hygienic*" *Water-closet and Slop-closet Combined.*—Besides the difficulty of finding a proper place for fixing a slop-sink, it is not always convenient to find the money to pay for such a convenience. Where either or both of these difficulties occur, it is better to fit up the water-closet in such a way that slops may be thrown into it. The "Hygienic" (or "Artisan") closet is made with a "table-top," as shown

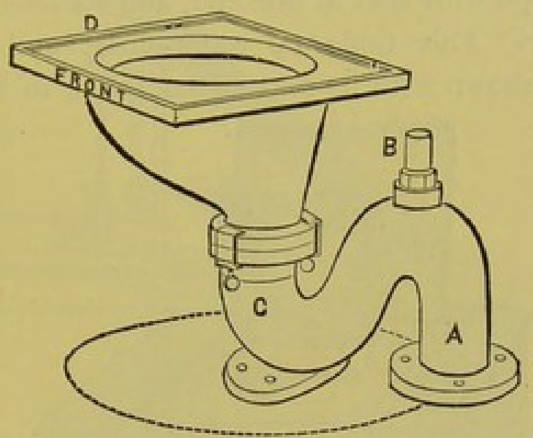


FIG. 161.—"Hygienic" closet with "Table-top" and earthenware trap.

in the drawings, Figs. 161 and 162, for the special purpose of receiving slops in addition to the general use of the basin as

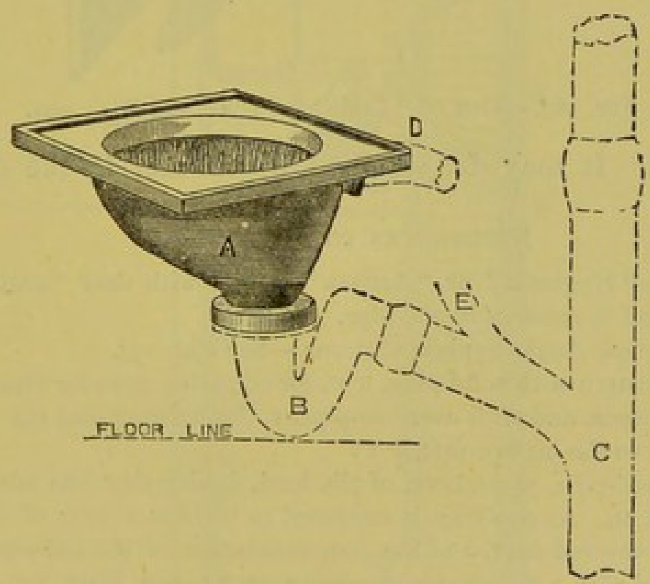


FIG. 162.—"Hygienic" closet with "Table-top" and lead trap.

a water-closet. The top is made in one piece of ware with the basin, and its upper surface is made to fall all ways for splashings to drain into the basin.

When this "Table-top" closet is fixed either upon a lead or cast-iron soil-pipe, its trap should be of lead, as shown at

E, Fig. 157, and B, Fig. 162, so that a *wiped* soldered joint may be made with the pipe; or in the case of cast-iron pipe, then with a brass ferrule, the ferrule being caulked into the socket of the iron pipe with lead at one end, and soldered to the trap at the other. This table-top water-closet and slop-closet combined is shown with its seat all complete in the drawing,

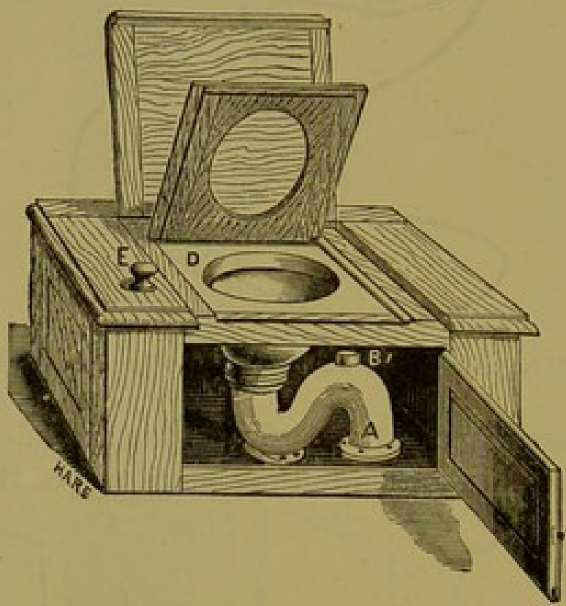


FIG. 163.—View of "Table-top" closet and W.C. seat.

Fig. 163. It may be supplied with water in the ordinary way.

REFERENCES TO PLATE XV.

A and B.—"Hygienic" or "Artisan" closets with *lead* "anti-D-traps" (*a* and *b*) *soldered* to soil-pipe.

C and C^1.—Gal. Angle Syphon Cisterns —See Fig. 253.

D.—Slate cistern with solid plug, E W, for emptying same for cleansing-out purposes, and with overflow-pipe, V, discharging into the overflow-pipe to the cistern safe, T T^1.

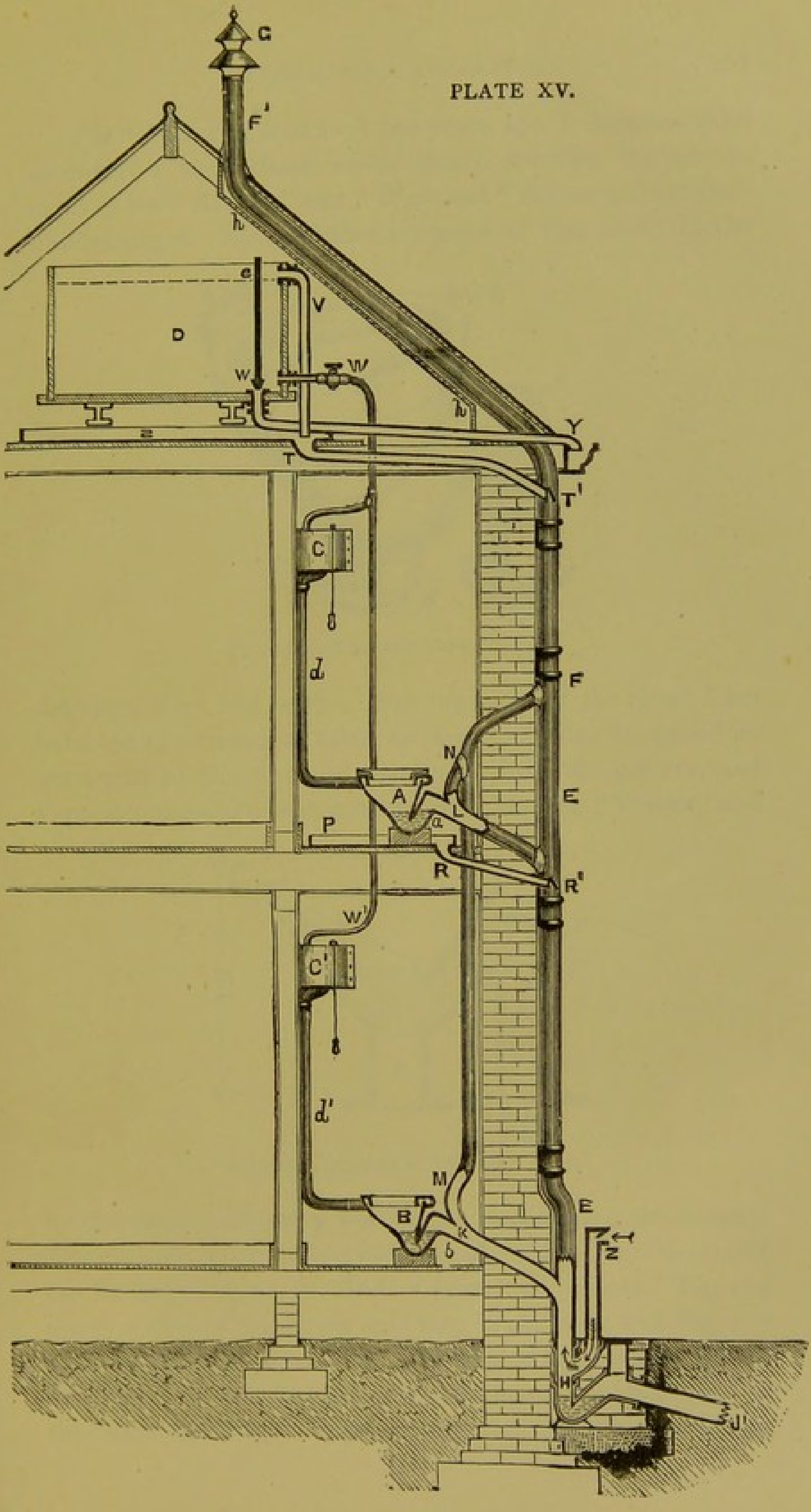
E.—Main soil-pipe, 3½-in. bore, of 7lb. lead, discharging into intercepting-trap, H. As this trap is supposed to be near a door of the house it is covered over, and the foot-ventilation of the soil-pipe is provided with a mica-valve, as shown at Z.—See Plate XVI, showing the trap open to the atmosphere.

G.—"Double-cap" cowl to form the ventilating-pipe terminal of the soil-pipe.

H.—Stoneware "soil-pipe intercepting-trap" as Fig. 72.

M N.—Trap-ventilation.—A 2in. lead pipe is taken out of the soil-pipe branch, at K, and continued up and branched into the main pipe at F, a foot or two above the highest closet, and the branch-vent from the upper closet is connected to it, as shown at L N.

PLATE XV.



The "Vortex" Closet:—A few years ago I designed (and patented) a water-closet which should combine the advantages of the "Artisan" and "Wash-out" closets without their disadvantages. Several views are given of this closet in the

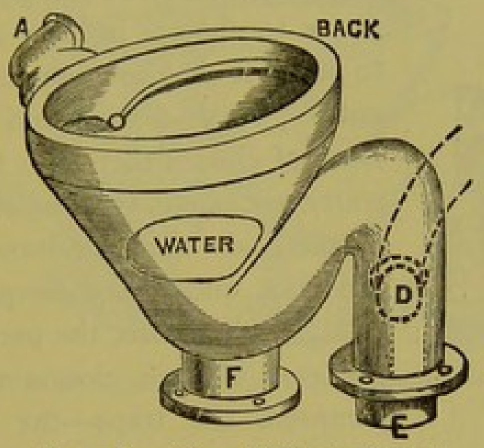


Fig. 164.—View of "Vortex" closet.

drawings, Figs. 164 to 171. For the name of the closet I am indebted to a friend of mine, an architect, who happened to see a trial of the first one that came from the pottery, and suggested there and then a name for it, viz., the "Vortex," and

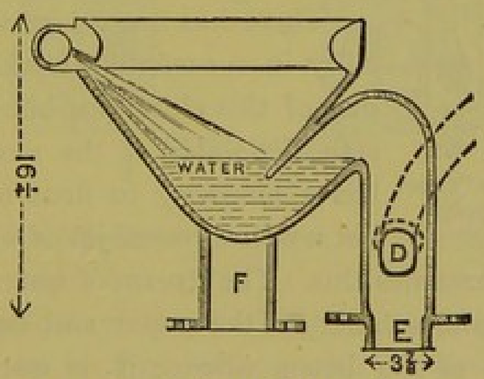


Fig. 165.—Section of "Vortex" closet.

by this name it is pretty well known now all over the country. The closet is made in finely glazed white ware, but the inside can be had coloured, in "Indian-pearl," or "mauve." Fig. 164 shows a view of this closet and trap in *one piece*, and Fig. 165 a transverse vertical section. The trap of this closet is formed in such a way that its inlet or mouth forms the lower part of the basin, and it is so arranged, and the configuration of the basin is such that the "standing-water" of the trap shall give an exposed surface of water about 9 in. by 6 in., and a depth of about 5 in. to receive the deposit, and to prevent any excrement falling upon a dry surface. It will be seen by a glance at the section, Fig. 165, that there is only one body of water to change in such a water-closet to keep it wholesome; in the "Wash-out," "Wash-down," and "Excelsior" class of closets there are two bodies of water to change, viz., the standing-water of the basin and the standing-water of the trap, and the consequence is that though the basins, the parts exposed to the eye, of such closets may be well-cleansed, the traps—the parts out of sight—are often but poorly cleansed. In the "Vortex" closet the trap itself is exposed to view, for on looking into the closet one is looking into the trap and therefore when the basin is clean the trap is clean.

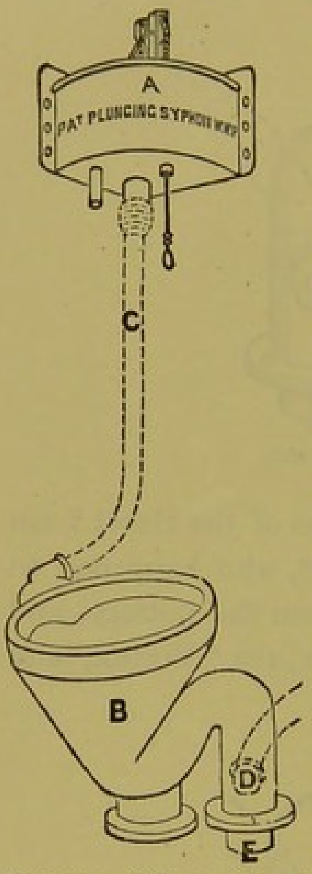


FIG. 166.—"Vortex" closet with Syphon supply.

There has been a good bit of difficulty in successfully washing the paper out of this closet, for buoyed up by the standing-water of the closet the paper has a tendency to float to the surface, but a well-directed jet of water, as shown in Fig. 170, overcomes this. The stream of water coming from the jet or nozzle, submerges the paper and drives it down to the bottom of the basin, whence it is instantly carried away, along with any other foreign matter, by the vigorous flushing obtained from the apertures in the flushing-rim and from the peculiar configuration of the basin.

As the success of this closet depends so much upon the supply of water to it, *it is useless to fix it where the service of water is restricted to two gallons*. A flush of *three* gallons of water properly delivered into the closet will keep it clean and wholesome. Every part of its interior is washed by a fair flush of water. A large number of these closets are now in use, and where the flush of water is adequate, they are giving great satisfaction; but many of these closets

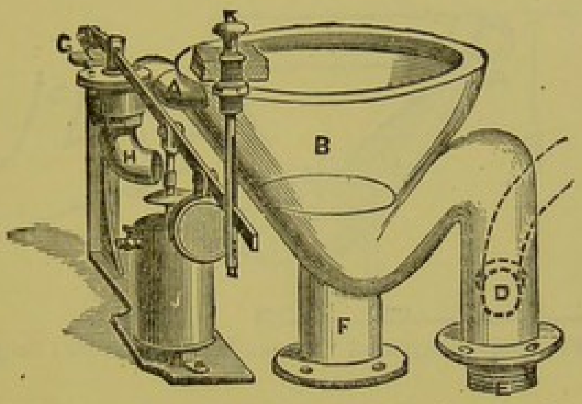


FIG. 167.—"Vortex" closet, with Valve and Regulator supply apparatus.

have been fixed with a very limited supply of water to them, as well as with poor means of supplying it, and the consequence is that there has been great difficulty in getting the paper out of them.

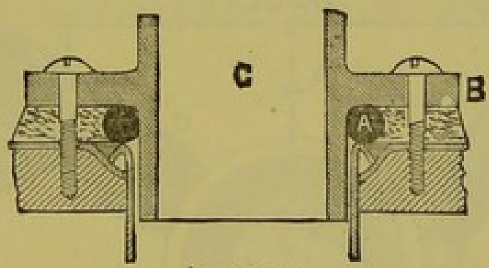


FIG. 168.—Section of jointing with soil-pipe.

With a three-gallon syphon supply, as shown in Fig. 166, or with a valve-and-regulator apparatus, as shown in Fig. 167, there is no difficulty in keeping such a closet perfectly wholesome with one pull of the supply handle. These closets are not allowed to be sent out now unless a proper flushing apparatus is sent with them, or it is known that a good flushing arrangement will be used, such as Bean's three-gallon syphon-flush.

The connection of this closet, as in *all earthenware traps with soil-pipes*, is of the utmost importance. In works over which I have control, I do not allow this closet to be fixed upon a lead soil-pipe, inside the house, unless it has a *lead-pipe outgo* bolted to it, as shown at L and T, Fig. 169,

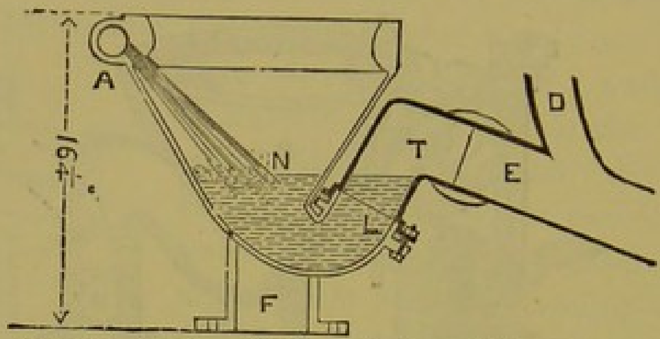


FIG. 169.—Section of "Vortex" closet with lead outgo.

so that its connection with the soil-pipe, and with the trap-ventilation, may be made by *wiped soldered joints*, as shown at C and H, Fig. 170. Fig. 168 shows the connection of the earthenware outlet of a "Vortex" closet with a lead soil-

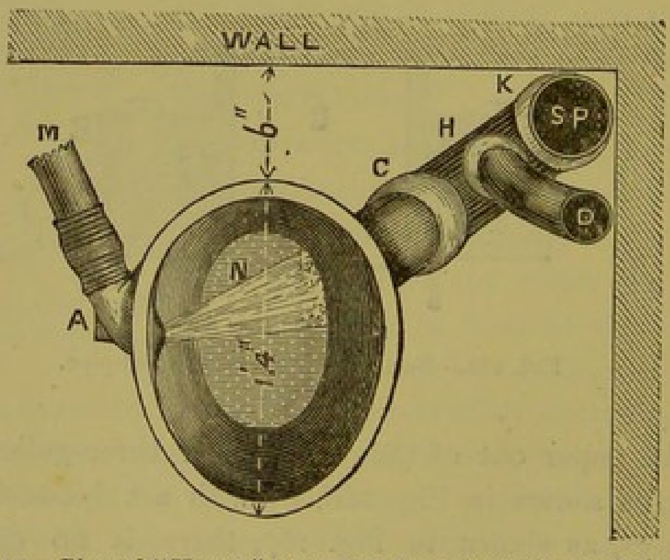
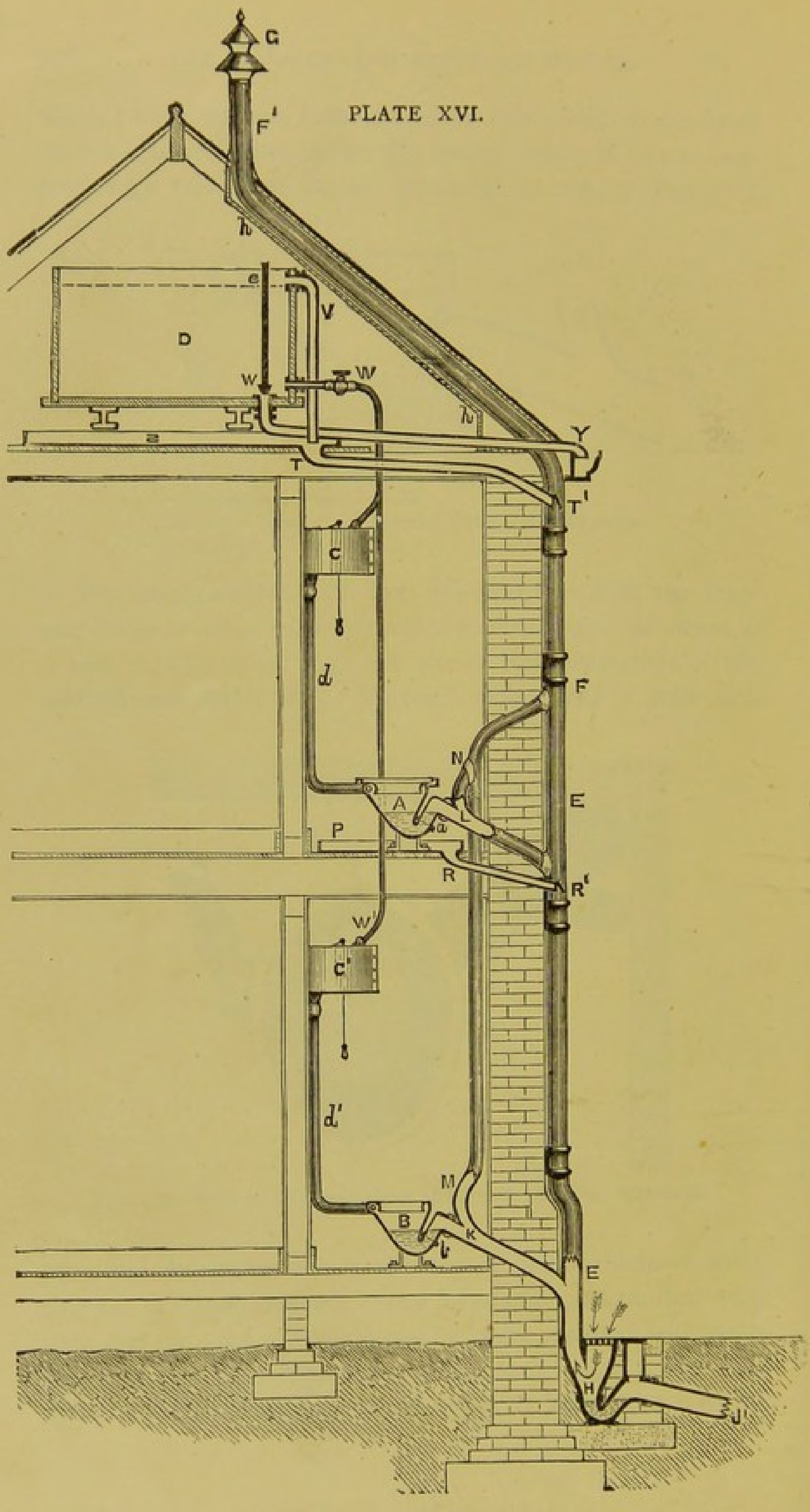


FIG. 170.—Plan of "Vortex" closet and branch soil-pipe, right-hand.

pipe, and though there is a packing of india-rubber—a solid ring of soft india-rubber, A, and a cement joint-caulked with yarn and red-lead—I should not be quite satisfied with such a connection. The connection of the lead outgo T, Fig. 169, with the earthenware trap of the closet is below the level of

PLATE XVI.



the standing-water of the closet, and any leak here would show itself by a water-leakage, and would also be noticed by the loss of water in the closet. A plan is given in Fig. 171 of

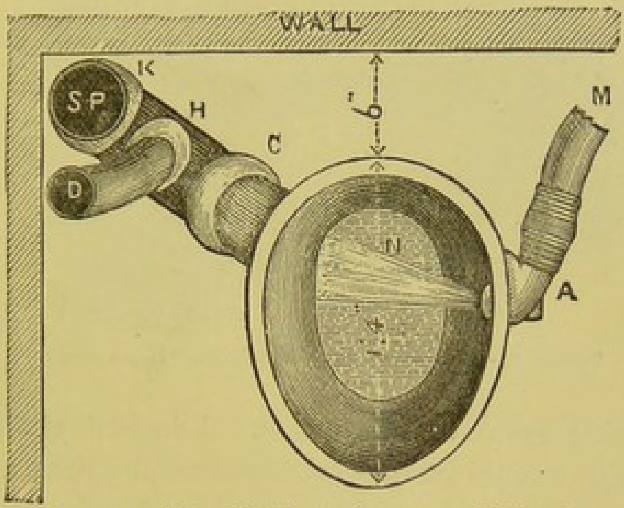


FIG. 171.—Plan of "Vortex" outgo on left-hand.

a "Vortex" closet with its "outgo" on the left hand—looking at the closet—though the closet is not yet made with the outlet on the left hand.

REFERENCES TO PLATE XVI.

A and B.—"Vortex" closet with *lead outgo soldered* to branch soil-pipe.

C and C¹.—The "Plunger" syphon cistern, three-gallon supply.—See Fig. 254.

D.—Slate cistern with solid plug, E W, for emptying same, through waste-pipe, Y, into gutter, and with overflow-pipe, V, discharging into the overflow-pipe of the safe, T T¹.

E.—3½in. lead soil-pipe (with astragal joints), discharging with open end into intercepting-trap, and continued up to above ridge of roof for ventilation, as shown at F¹, with a "double-cap" cowl, G, on top of same. N.B.—The pipe where it passes through the cistern room should be lathed and plastered over, as shown at *h h*.

G.—"Double-cap" cowl, as Fig. 262.

H.—Stoneware "soil-pipe intercepting-trap."—See Figs. 64 and 65.

M N.—2-in. lead ventilating-pipe to branches, to prevent syphonage of closet traps.

P.—Safe or tray under water-closet, made of 5-lb. or 4-lb. lead, and standing up 6 in. on each side.

R.—Overflow-pipe to safe discharging outside of external wall, and having a hinged copper-flap on its end, R¹.

S.—Safe under slate cistern, with its overflow-pipe, T, discharging into the open air, and having a flap on its end.

The Patent "Wash-out" Closet.—Though this closet is patented by Mr. Rowley, potter (Mr. Woodward's representative), it was invented by me. Jennings' "Monkey" closet in "one piece," had been fixed in a warehouse in the city where

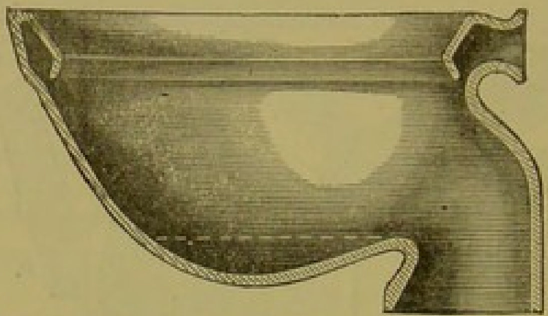


FIG. 172.—Section of the "Wash-out" closet basin.

it was giving great dissatisfaction. I looked at the closet, and thought it could be improved in several points, and had a *lead* one made to try, giving more depth of water in the bottom of the basin for receiving the deposit, and supplying the closet by means of a flushing-rim, instead of a "fan-spreader." I also * separated the trap, making the closet in *two* pieces, so that its "outgo" could be turned round to any point, and also for making the trap of lead for soldering to lead soil-pipe. It is much superior to the old Hopper closet.

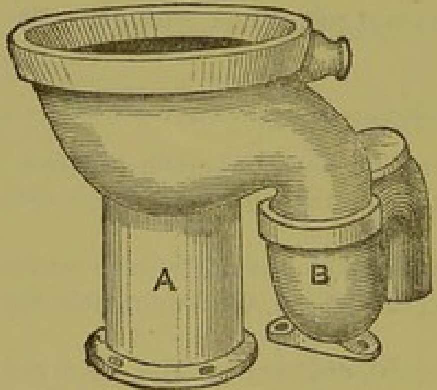


FIG. 173.—"Wash-out" closet and trap in two pieces.

"Excelsior" closet.

The "wash-out" closet has now many imitations, *e.g.*, Messrs. Doultons' "Flush-out," and then there is the "Excelsior"—made almost on the very lines of the "Wash-out." No doubt Mr. Bostell has improved the closet, which he calls the "Excelsior," by bringing *two* inlet-arms into the rim of the basin ; and

* I did not know at this time that Mr. Jennings ever thought of making the trap independent of the basin, but in his valuable book, "Plumbing," Mr. Buchan makes this clear, by stating that the patent for the "Monkey" closet was in one or *two* pieces.

he has also altered one or two other parts of the closet, but as his closet is in *one piece of ware*, there is the difficulty of making sound and durable jointings with the soil-pipe and

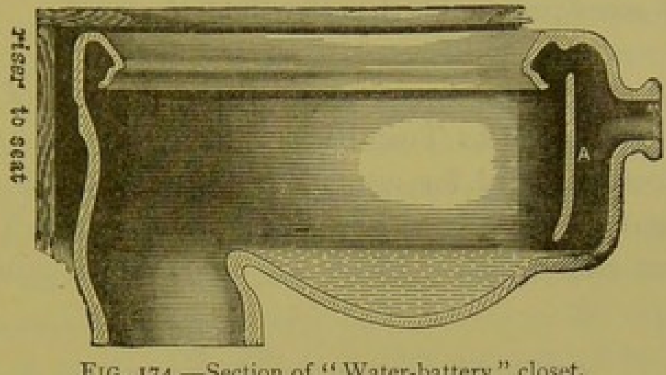


FIG. 174.—Section of "Water-battery" closet.

vent-pipe (as in all closets with earthenware "out-lets") when the closet is fixed inside the house.

"Water-battery" closet.

In the "Water-Battery" closet—which I designed and patented—the outlet of the basin is in the front, where it is

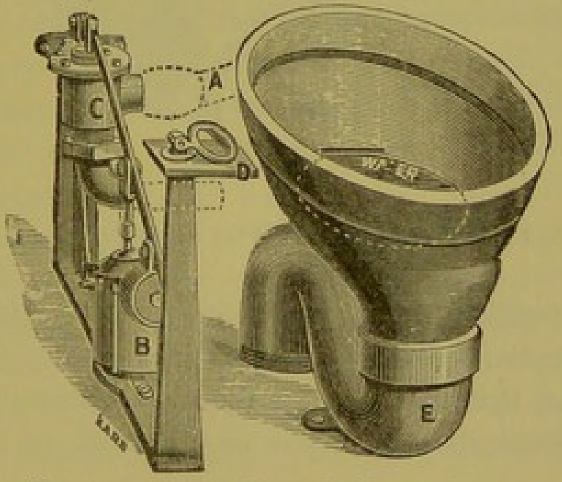


FIG. 175.—"Water-battery" closet and trap.

screened from sight, as shown in section, Fig. 174. The closet is made with double or single inlet arms for supplying the rim, and for washing out the "standing-water" of the basin ; but as in all closets of this class—the "Wash-out," the "Flush-out," "Doulton's," the "Excelsior"—the first force of the incoming supply of water is spent upon the basin, and by the time it reaches the trap its strength, or cleansing force, is gone, and the water then gravitates through the trap in a most unselfish kind of way, taking little or nothing with it. In fact, one flush of water of only two gallons never thoroughly cleanses the trap of such closets. This water-closet is much liked by some people, but I prefer the "Vortex."

Trapless closet.

Fig. 176 shows a transverse vertical "section" of "Pearson's patent Trapless Twin-basin Water-closet." As I have been so often asked for my opinion respecting this closet, I give it here; especially as what I have to say about it applies to a great extent to the whole batch of *trapless* closets now

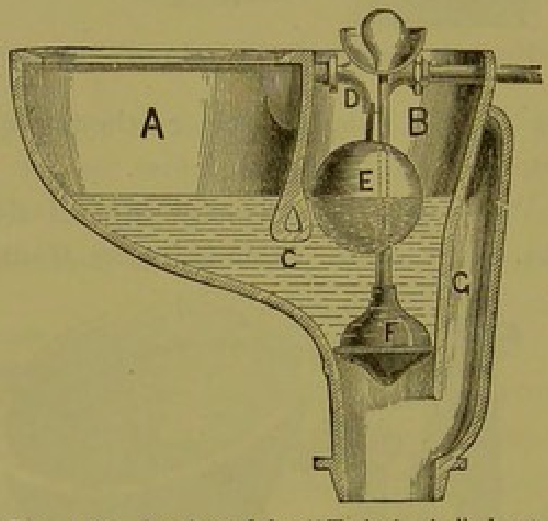


FIG. 176.—Section of the "Twin-basin" closet.

before the public. As we are seeking after perfection in the sanitary appliances of our houses, any fitting (especially a water-closet) that will not bear the closest examination in its smallest detail should be put on one side as unfit for its purpose.

"Twin-basin."

As its name discloses, this trapless "*twin-basin*" closet has *two* basins—not for the purpose of *double* use—for *twins* to enjoy each other's company in using one closet together, as old women cronies often do with old-fashioned *double-holed* seats in country privies; but one basin, or compartment, A, is for *receiving the deposit*, and one, B, for the automatic *supply-valve*, D, to work in. The two basins are connected together, as shown in *section*, upon one trunk, or outlet, like the letter Y, and on *plan* look like two O's joined together, one O being a little larger than the other. A dwarf partition, C, going down from the top to within a few inches of the bottom, divides the upper parts of the two basins, but the lower parts of the two basins are in direct and open communication, so that *anything which may be put into one basin can pass freely into the other.* The water stands at the same level in the two basins, and is kept there by the plug-valve, F.

When the closet is used, the excrement deposited into the larger basin, or closet proper, finds an easy passage under the dwarf partition into the side-basin or ball-valve compartment, B; and, therefore, the sides of this compartment must very soon become coated over with filth, as well as the copper ball or float, E, itself. This evil is further augmented by the fact that the incoming water would have no cleansing effect upon this "side-basin" at all, as the water only gravitates into this basin; but perhaps it is considered that, as this basin is "out of sight," being *under* the seat, it is also "out of mind!" Sides coated with filth. "Out of sight, &c."

Again, the *top* part of the plug-valve, F, must get coated over by the settlement of the liquid excrement upon it, more or less, every time the closet is used. And, as it would always be drawn up out of the way of the incoming flush, for the contents of the basin to pass out, it would never get properly cleansed. Plug valve.

The absence of a trap to this closet is a further evil. The solid excrement, or paper, deposited in this closet, would at times get caught under the seating of the plug-valve, F, and when the water had thus leaked out of the basin, *soil-pipe air*, and perhaps sewer gases too, would have an easy passage, through the imperfect seating of this plug, into the house. And the escape into the house of this soil-pipe air would continue until the closet was used again, which in some cases would not be for hours, or days, together. And, to add to these evils, the basin would not only be *empty*, but it would be *dry* as well, giving the deposit a fair chance of sticking to the place where it fell. Absence of trap.

If the reader's attention is not wearied, the writer would like to point out two other evils in connection with this closet. (*a*) When the basin-plug, F, has leaked out the water of the Water leaked out of cistern.

basin—the evils of which we have just been considering—the leakage still continues until it has emptied the cistern, which supplies the closet, for the supply-valve, D, is shut by the *floating* up of the ball, E, and this can only be done when the basins are full to their regulated height of water. (*b*) The overflow is formed on the side of the closet. It is taken out of the *bottom* of the *side-basin*, and then carried up to within a few inches of the top, when it is brought down again and made to enter the closet just below the basin-plug. The

Overflow.

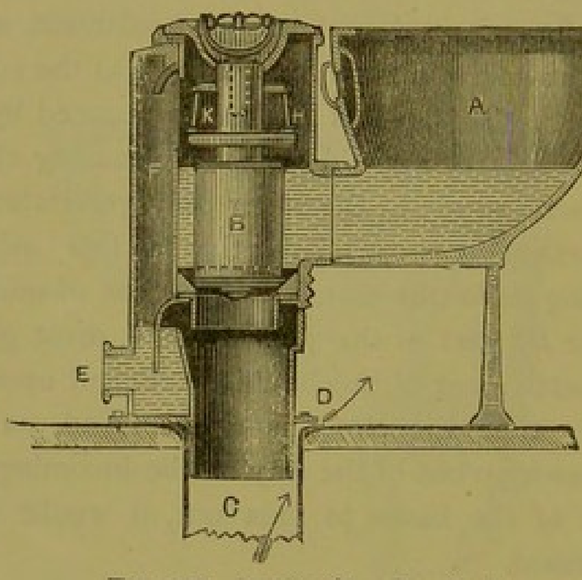


FIG. 177.—Jennings'-trapless closet.

mouth of the overflow* is grated over, but though this may keep out the solid excrement, it will not keep out the liquid excrement, and this part of the overflow must in time get very foul, as it would never get properly washed out. But this is not the chief evil of this overflow, for the water-seal of this overflow is dependent upon the soundness of the plug. When this plug leaks the water out of the basin, it also leaks the water out of the overflow-pipe, except just a little which is kept in its mouth by the saucer-shaped form of the pipe where it is connected. But the *higher* perforations over the mouth of the overflow stand only just below, if they do not stand above, the water, so that any noxious gases in the pipe

Overflow defective.

* I understand an improvement has been made in this overflow arrangement.

would find an easy passage through this overflow (when the basin is empty) to the house.

Jennings' trapless closet, as shown in the drawing, Fig. 177, has many of the defects condemned in the closet last described. Without any close examination of this closet it will suffice to point out one or two defects. The exposed surfaces of the plunger, B, and the parts above it leading to the overflow, F E, would soon get coated over with excrement and become foul. Then there is the difficulty in connecting it, with a reliable and durable jointing, to the soil-pipe. Jennings' closet.

There is such a variety of water-closets now in use that to attempt to describe each individual closet would take more time and space than can be afforded. Besides, water-closets, however perfect they may be, are not the nicest places in the world to linger in. Let it suffice, then, to say that nearly every water-closet made comes under the principle of one or other of those already described. Variety of closets in use.

It is not my intention here to name the best makers of water-closet apparatus, for each maker has his own speciality, but the workmanship and material in some (as in everything else in this world) are so vastly superior that it does not require a finger-pointer to point this out, but an open eye to see it.

All that is wanted in selecting a good water-closet is common sense. *Go to a good house of business*, and select a closet according to the principles laid down in this chapter, and you will have done one great thing towards obtaining a wholesome water-closet; but remember that a water-closet is not a deodorizer, and that if it is to be sanitary all its belongings must be made sanitary. Common sense in selecting the right closet.

Trough Water-Closets.—For the last ten or fifteen years trough closets have been much used in school buildings, and great improvements have been made in such arrangements from time to time. But the principle of a trough closet is not a good one. For the effluvia coming from the occupants of two or three seat-holes to be able to circulate to other occupants of the same range, as shown by the arrows in the drawing, Fig. 178, cannot be wholesome, especially as there would be also the bad air coming from excremental matter standing in the trough and decomposing there, stirred up as it

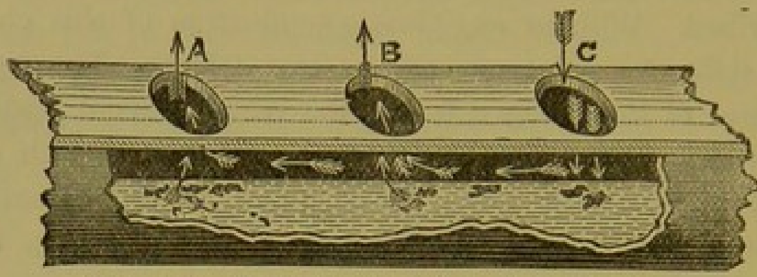


FIG. 178.—Water-closet Trough, bad arrangement.

would be by each usage of a seat-hole. Such arrangements form a ready means for spreading diseases, for there would be no guarantee that each child or person using such a closet

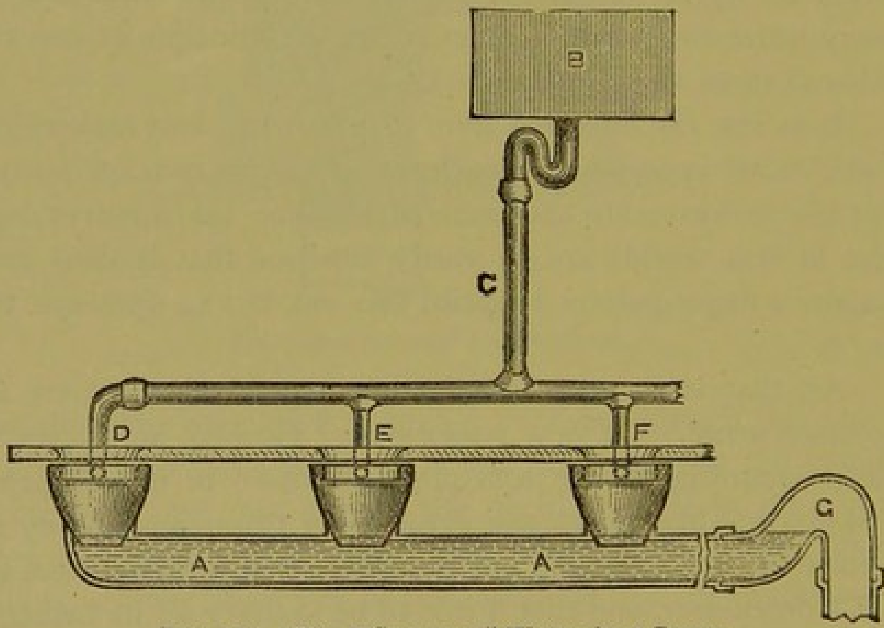


FIG. 179.—The "Greatorex" Water-closet Range.

should be in a healthy state. A child suffering from some contagious disease takes his or her seat on a closet range, as shown in the drawing, say at B; other children on each side, at A and C, are using the closet at the same time, and these children sit and chat away, as if there were no such things as disease germs and sicknesses.

If "trough-closets" must be used, the seat-holes should be so constructed that no air can pass from one to the other—*i.e.*, the closet-holes should be isolated from each other. Instead of a huge trough, a drain-pipe could be carried the whole length of the range, with junctions for receiving basins or conductors from each seat-hole, as shown at D, E, F, Fig. 179. And these "conductors" should be made to dip into the "standing-water" of the closet pipe, A A, about ½ in. The range of closet-basins could be supplied with water by means of a Field's Automatic Flushing-Tank, B, for keeping them clean and wholesome, and for changing the entire contents of the closet as often as required. The "standing-water" of the closet-pipe, A A, could also be changed by means of a syphon, G, which would be started by the discharge of the flushing-tank.

CHAPTER XIII.

WATER-CLOSET SAFES AND THEIR OVERFLOWS.

Safes under Water-Closets—Old Method of Fixing Safe-Wastes—The more Modern Method—The Proper Method.

Safes under Water-Closet Apparatus.—To prevent damage to ceilings by an overflow of water from the apparatus, either through a "stoppage of the water-closet," or a break-down of the supply-valve, a "safe," or tray, should be fixed under each water-closet apparatus, when the closet is "up-stairs," or over an important ceiling.

Lead safes.

This safe should be made of lead, 4, 5, or 6 lb. to the superficial foot—according to the character of the other work in connection with it. It should be turned up at each of the four sides from 4 to 6 in., and soldered at each angle. If the safe is not made the full size of the enclosure, it should be made a few inches larger than the external size of the apparatus, so as to cause the water when overflowing the closet-basin to fall inside the safe.

Soldered to the trap.

When the trap is *under* the floor, the safe should be carefully soldered to the closet-trap; but if it is fixed *on* the floor, with a horizontal branch soil-pipe from it, the safe should go under the trap, and be soldered round the outlet or branch soil-pipe, unless it stands high enough to admit the safe without interfering with its "stand-up."

Old method

Waste-Pipes or Overflow-Pipes from Safes.—The old method of fixing waste-pipes to safes, viz., by taking a pipe from the safe direct into the closet-trap, is not only unsanitary, but it is of no value for preventing damage to ceilings in case of an overflow of the closet, for the pipe generally used for such purposes is only ¾-in. or 1-in. bore. Now, when a water-closet gets stopped up, it is generally by a stoppage in the trap. Of what use can this little safe-waste be in such a case? And if the supply-valve should break down at the same time, where is the overflowing water to go but on the ceilings?

There is another objection to this mode of disposing of this waste. When it is connected with the water-closet trap, this waste-pipe is often inserted into the trap about the water-level, so that the smallest disturbance of the water in the trap allows any air in the soil-pipe to escape through this pipe into the house. But supposing the waste-pipe to be connected to the closet-trap well below the water-line, every time the water-closet is used the foul water of the trap would wash up into the safe-waste and give off bad air.

The more modern method of fixing a separate trap under the safe, and connecting it by a $1\frac{1}{2}$-in. or 2-in. lead pipe with the soil-pipe, may be an improvement on the old plan, but it is a very unsanitary way of providing an escape for any overflow of the closet. True, there is no danger of an overflow of water from such treatment, for a 2-in. round-pipe trap, or a 6-in. D-trap, with a 2-in. waste-pipe into the soil-pipe, would take away the water as fast as it overflowed into the safe; but there are two great evils attending such a mode of fixing safe-wastes, viz.:— The more modern method.

(1.) This safe-trap is charged by the usage of the water-closet in connection with it, and by this closet only; so that when other water-closets are in use upon this stack of pipe, and this water-closet remains in disuse, the water in this trap becomes often unsealed, or it evaporates, and any air in the soil-pipe pushes its way through the unsealed safe-trap into the house, and will continue to do so until its own water-closet is used and the "weeping-pipe" re-charges the trap.

(2.) The "weeping-pipe"—which is connected at one end with the service to the water-closet basin, while the other end is made to discharge into the safe-trap—often fails in its service. A little sediment gets into the pipe, and after a time it becomes stopped up, and fails in its charges to the safe-trap, which soon becomes dry, and leaves the house exposed to the soil-pipe air.

Proper method.

The proper way of fixing safe-wastes or overflow-pipes to water-closet safes is to take a pipe from the safe and continue it through some external wall of the house, *without connecting it in any way with the soil-pipe or any other pipe,** as shown in the drawings, Plates X. and XV. (See Fig. 146, p. 184, showing plan of a water-closet safe, S S, and its overflow-pipe, S D). The shorter this pipe is, the better, and care is required in fixing it, or the ceilings adjacent to the water-closet had better be insured. Its size must depend upon the size of the service to the water-closet, and the pressure of water upon the supply-valve to the apparatus. But a 2-in. lead waste-pipe is large enough for any waste to a water-closet safe.

The outlet should always be a foot lower than the inlet end ; and the inlet end should be opened out a little larger than its diameter, and soldered to the safe with a counter-sunk soldered joint, so as to give all the water-way possible into the pipe, and to ensure a pressure upon the copper flap, to keep it open when the closet is overflowing. (See R^1, Plate XVI., facing p. 209.)

Flap valve.

A brass or copper hinged-flap should be soldered on the discharging end of all such waste-pipes in country houses, to prevent birds building in the pipe, and also to prevent the wind blowing through the pipe—for it can whistle through this pipe in a very objectionable way at times.

* Overflow pipes from W.-C. safes were treated in this way so long ago as 1868, in some works carried out under the direction of the well-known architect, Mr. J. P. St. Aubyn.

CHAPTER XIV.

SLOP-SINKS AND THEIR WASTES.

Slops and Water-closets—Slop-sinks and Water-closets Combined—Many ways of fitting up Slop-sinks—"Water-shoot" Slop-sink—Housemaids' and Nursemaids' Sinks, or Wash-up Sinks and Slop-sinks combined—Draw-off and Slop-sinks Combined—Traps to Slop-sinks—Waste-pipes and their Disconnection and Ventilation—Flushing Cisterns for Cleansing Slop-wastes.

A SLOP-SINK, *i.e.*, a place for emptying slop-pails, is not so essential as a water-closet; but no house of any dimensions should be without one, not only as a convenience for the servants and a means of saving labour, but also as a protection to the water-closet apparatus. Slop-sink.

When there are no slop-sinks, the servants are sure to empty their pails down the nearest water-closet, and this they do, generally, leaving the slops to find their own way through the basin, trap, and soil-pipe, without even pulling up the handle of the apparatus to give it a free passage, or taking the smallest trouble to wash it away—no matter what may be the contents of the slop-pails. Then these corrosive matters from the chamber utensils are left in the water-closet where they have been discharged, to foul the apparatus and trap for hours, and to send forth their unpleasant smell until the next legitimate use of the water-closet occurs. Slops and water-closets.

There is another evil attending such a mode of disposing of the bed-room slops. The slops are often thrown into the water-closets in such a careless way that they splash over the top of the closet basin, and run down inside the enclosure, where they are out of sight and out of mind, though not out of scent. If the apparatus and the floor inside the seats or enclosures of such water-closets were examined they would be found in many instances covered with filth. Besides, a water- Splashing of slops.

closet seat with slops splashed all over it, is not the most comfortable place to sit upon. Many a person after trying such a seat in some dark water-closet in a friend's house, has wished that his host had gone in for slop-sinks as well as for *water*-closet seats.

Slops, where to empty?

But if no proper places are provided where the servants can empty their pails, what are they to do with the slops? Are they to take them down to their own water-closets in the

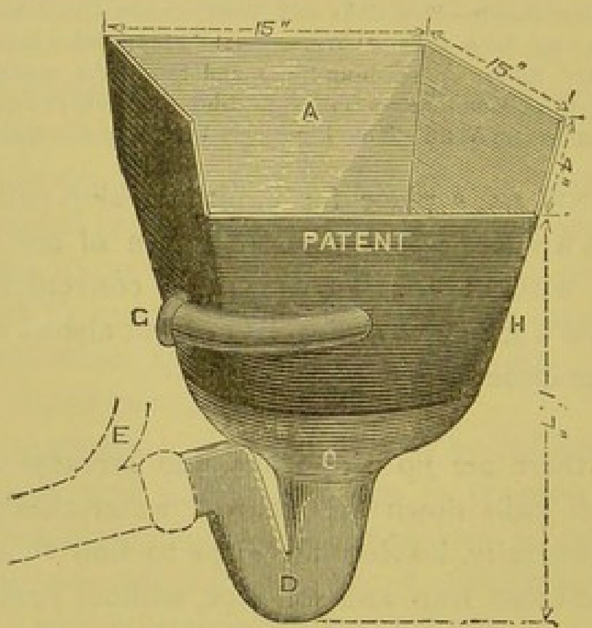


FIG. 180.—View of a "Water-shoot" slop sink.

area—which are certainly better adapted to receive them? What! lug a pail of slops right down through the house to splash their own water-closet seats all over! That is hardly like the English servant of the period.

Proper places.

Proper places should be provided in every house for emptying the slops, and where slop-sinks cannot be afforded the water-closets should be specially fitted up for receiving the slops. (See water-closets and slop-sinks combined, pages 177 and 199.)

Many ways of fitting up.

A slop-sink can be formed in many ways. It can be fitted up by itself, or attached to an ordinary housemaid's sink, and thus the two sinks may be combined. If cheapness is a consideration, it may be fitted up in a most inexpensive and simple way—in addition to the cost of its waste and service. All that is necessary is a pottery-ware basin (white inside), large enough to receive a pailful of slops, and for this an ordinary water-closet hopper will do very well. There should be a lead tray over it, standing up about 6-in. at the back and the two sides, and about 2-in. in the front, to prevent

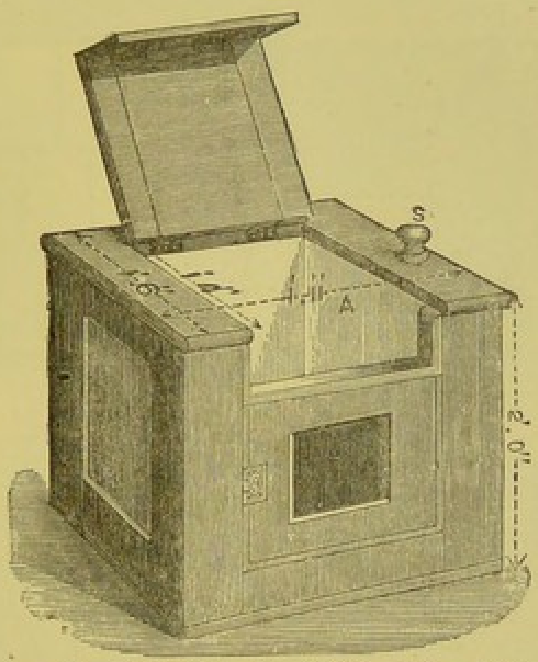


FIG. 181.—View of "Water-shoot" Slop-sink, and Enclosure.

splashings over it; and this tray should fall towards the basin with the lead bossed down a couple of inches into it.

But slop-sinks are now made by many manufacturers of sanitary goods for the special purpose of receiving slops. Some years ago I patented the "water-shoot" slop-sink, shown in Fig. 180. It consists of a deep hemispherical-shaped basin with a square top and dwarfed front—*i.e.*, the back and two sides are carried up 4-in. higher than the front to prevent splashings over the sides of the sink. The sink is made of cast-iron, enamelled on the inside with white porcelain enamel, to prevent corrosion, and to make the sink wholesome. There is no place of lodgment in any part of the

"Water-shoot" slop-sink

sink for anything to make it unwholesome. The sink used to be fitted with a strong white glazed earthenware screener, or grating, as shown by the dotted lines in the drawing, to arrest flannels, soaps, brushes, or anything which might accidentally be thrown away with the slops; but servants allowed the under-part of such gratings to get foul, and a

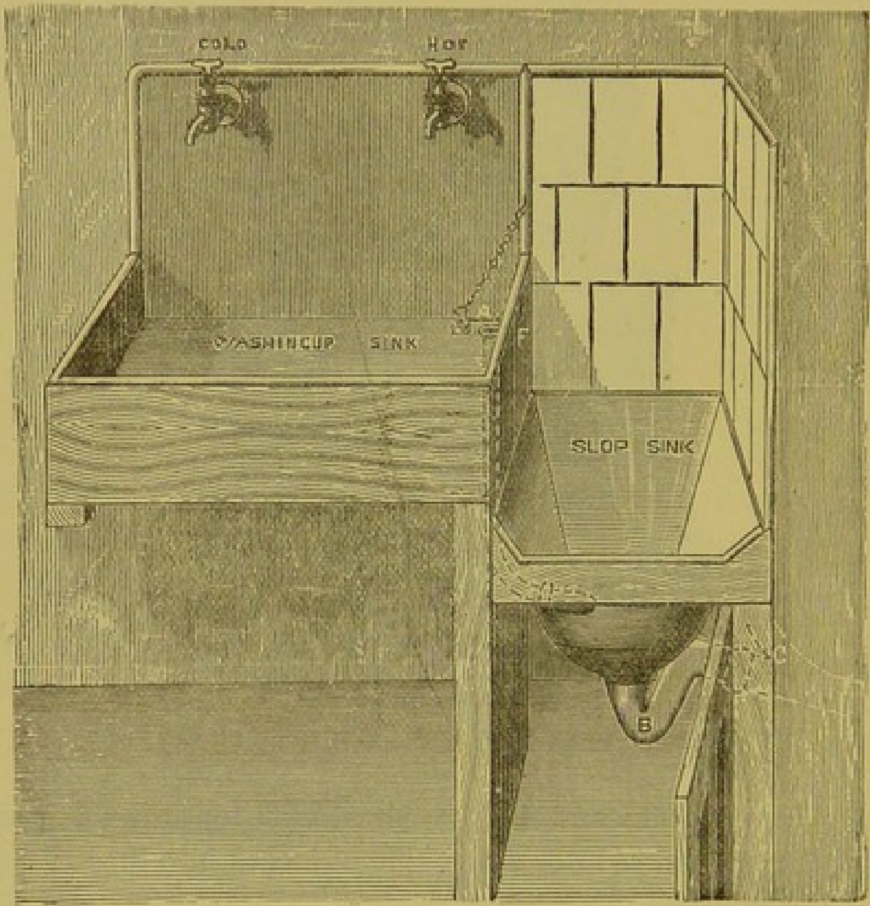


FIG. 182.—View of a Wash-up Sink and Slop-sink combined.

a simple brass grating is now made to answer the purpose, and is more wholesome. This sink can be fitted up by itself, as shown in Fig. 181, and it can be supplied with water by a valve-and-regulator, similar to the mode of supplying water-closets. The valve-and-regulator can be fixed on either side of the sink, and the service-pipe from it connected to the inlet arm of the sink (G, Fig. 180). In the drawing, Fig. 181, the knob-pull for opening the supply-valve is shown on the right-hand side, at S.

Wash-up and Slop-sink combined.—The "water shoot" slop-sink may also be fixed in combination with a wash-up sink, as shown in the drawings, Figs. 182 and 183. When this is the case the waste-pipe from the wash-up sink should be taken into the arm of the slop-sink, as shown at D, Fig. 206, which is enlarged in such cases for the purpose of receiving a 2-in. waste-pipe. The wash-up sink can then be filled up with clean water, from the cocks over it, and dis- "Combination" sinks.

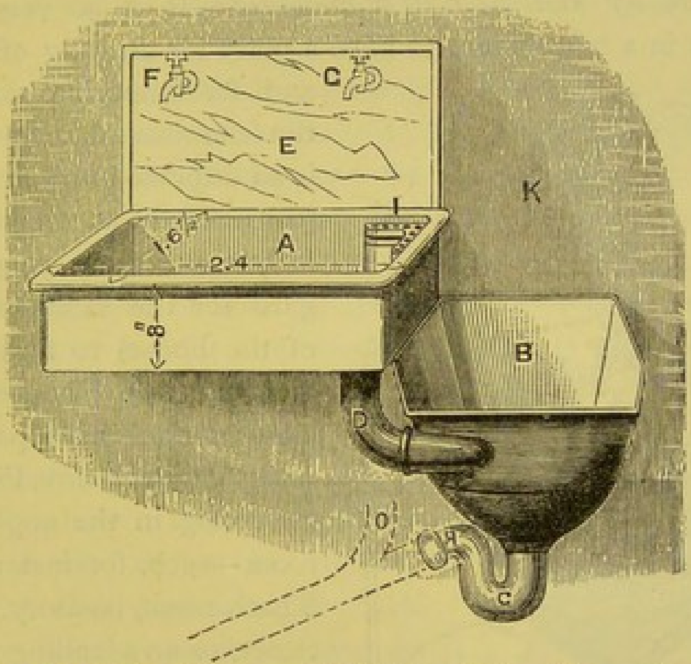


FIG. 183.—View of "Nursemaids'" Sink and Slop-sink combined.

charged in a good cleansing volume for keeping the sinks and their belongings clean and wholesome. Eight gallons can be discharged in this way in as many seconds. The wash-up sink in the drawing, Fig. 182, is a wood sink, lined with strong tinned copper. The back—and this should be the case with the end when it butts against a wall—is carried up an inch or two above the draw-off valves to prevent splashings against the wall. The drawing, Fig. 183, shows a similar sink, but made of fine white glazed earthenware about ¾-in. thick, instead of copper. A piece of marble skirting can be fixed at the back, as shown at E, and also at the end when

Housemaids' sinks.

Nursemaids' sinks.

so required. The former sink is specially adapted for washing up crockery ware, as the material (copper) being elastic prevents breakages. The latter sink being in white ware is made specially for nursemaids' use, for washing children's socks, &c., in. Both sinks are perfectly sanitary, being of a non-absorbent material. I think *wood* sinks are a mistake, especially for washing chamber utensils in, yet such sinks are often fixed where they are sure to be used for such purposes.

Angle slop sink.

Draw-off and Slop-sink combined.—It is so very convenient in a large house to have a place for drawing off water and for emptying slops, on the chamber floors, and it is so difficult in most houses (constructed as they generally are, without proper regard for the sanitary wants of the house) to find space for fitting up a housemaid's closet, that I have patented a very compact sink, Fig. 184, for fixing in the angle of a room—such, for instance, as a bath-room, lavatory, water-closet, or on a landing or any other suitable place, away from bed-rooms. The sink looks neat in itself, but it can be enclosed, as shown in Fig. 184, in any kind of wood to match the surroundings; and with a flower-pot and flowers, or a plant, it can be made ornamental as well as useful.

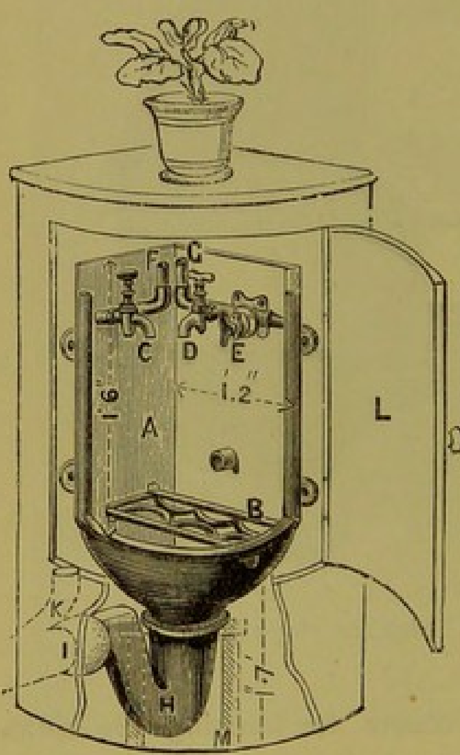


FIG. 184.—View of an "Angle" Slop and Draw-off Sink.

The sink is made of cast-iron, and is *porcelain enamelled* in *white* ware all over the exposed inner surface. The sides of the sink are carried up to a height of 18 ins. above the basin part, to protect the walls from splashings; and the front edges of the two vertical sides, as well as the front of the sink, are recessed to receive an *inch* copper perforated pipe, which is fixed to the sink for flushing-out purposes. A large water-way stop-valve is fixed at E for supplying this flushing-pipe. Cross-bars are fixed across the outlet—which is 3¼-in. clear diameter—to prevent anything passing into the waste-pipe when accidentally thrown into the sink with the slops.

Draw-off cocks are fixed at C and D, for filling jugs and pails with hot or cold water, and union connections are fitted at F and C, for connecting hot and cold service-pipes to same.

A strong galvanised iron grating is fitted to this sink, for standing pails upon, as shown at B; but when emptying slops into the sink, the grating can be turned back against an india-rubber buffer fixed in the side of the sink to receive it.

Another form of sink for fixing under supply-cocks, for drawing water and for emptying slops into, is shown in Fig. 185. This sink can be fixed on the floor, or on a platform raised a few inches above the floor. This sink is made of strong cast-iron, enamelled on the inside, and in its "outlet" pipe with white poreclain. The back and two sides are made to stand up 8-in., and the front 6-in. An extra large grated outlet (tapering from about 5½-in. diameter at top to 4-in. at bottom) is found in the bottom of the sink, to take slops freely away. The walls round the sink can be tiled with white tiles, up to a few inches above the height of the draw-off cocks, or the walls can be flushed with lead, to protect them from splashings.

Sink for drawing water.

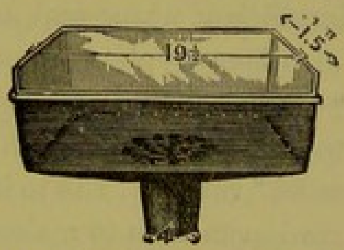


FIG. 185.—"Floor" Sink for Slops, and for fixing under draw-off cocks.

The sink shown at C, Plate XVII., is made of white ware of great strength, to prevent its breakage. It is provided with a perforated hollow rim right round its upper edge for cleansing every part of its interior by the aid of any ordinary flushing arrangement. For this purpose I prefer a two or three gallon flushing cistern (as shown at B, Fig. 186), which

Flushing-rim white ware sinks.

discharges its contents with a single pull of the handle, similar to the flushing cisterns now used for supplying water-closets. It is very important to have a good supply of water to such fixtures, for the contents of bed-room pails are often emptied into such places with very imperfect means of cleansing the sinks and their wastes.

Traps to slop-sinks.

The trap for fixing under a slop-sink is of great importance, as the strain upon the water-seal of such traps is at times very great, especially when such sinks are fixed upon long lengths of waste piping of small diameter. There is not only the danger of *syphonage*, from the rush of water through the main pipe into which slop-sink traps are branched, but of the water-seal being lost in such traps, by the *momentum* of the discharges passing through them. Slop-pails brimful are often so emptied into slop-sinks as to cause a great momentum in the passage of the water through the trap; and where "round-pipe" traps are used they are liable to be left with insufficient water-seal, as explained elsewhere.*

Syphon traps.

When syphon traps are fixed under such sinks, the "outgo" should be bossed up a little, as shown at H, Fig. 183, to give the trap a depth of seal of 2½ in., and also to give it a more "vertical" rise to its "outlet," as shown in Fig. 183, at C H. And even then to make such a trap absolutely safe, it should be ventilated from the crown of its outgo. I prefer to use a 2-in. (or 3-in.) cast-lead "anti-D-trap," as shown in the drawings Figs. 180 and 184.

A slop-sink is entirely dependent upon its trap for keeping any bad air in its waste-pipe out of the house, as there is no "check-valve" between it and the basin, as in a valve water-closet.

Lead.

The traps should be of lead, so that its connection with its waste may be made absolutely reliable,† by a wiped soldered joint, as shown in the drawings.

Size.

The *size* of the trap is also of great importance. The traps generally fixed under slop-sinks are much larger than

* See loss of water-seal in traps, pp. 99—137.

† See pp. 37—39

necessary. For private houses, a 2-in. "round-pipe" trap (with its outgo bossed, as already explained), or a 2-in. "anti-D-trap"—where the length of the piping would be likely to interfere with the seal of a "round-pipe" trap—is quite large enough for private houses, and a 3-in. anti-D-trap anywhere. I have directed a large number of 2-in. traps to be used during the last few years, and have never known a stoppage in any of them. In clubs and hotels, where all sorts of things are thrown down such places, it may be better to use the size larger, but a trap for fixing under a properly-constructed slop-sink should never be larger than 3 in. When 9-in. D-traps, and 4½-in. or 4-in. syphon traps are used, the smell of bad air coming from the standing water is often extremely offensive, especially when the water is disturbed. The way to test this is to stir the water up in such traps with a stick. If the water has been standing in the trap for a short time it will not need much stirring.

Waste-pipes to Slop-sinks.—Waste-pipes from slop-sinks are generally fixed much larger than necessary. For private houses a 2-in. lead waste is large enough to take two, or even three slop-sinks, and 3-in. waste is large enough for any building, no matter how many slop-sinks may be branched into it, provided that such sinks are properly grated to prevent flannels, soaps, and scrubbing-brushes from passing through them. As explained under the heading of "the size of soil-pipes," it is a question of the syphonage of the traps branched upon a small-sized waste-pipe rather than the stoppage of the pipe. When such waste-pipes are of *great* vertical length, the air-pipe from the branches, to ventilate the traps, should be the same size as the waste-pipe—*e.g.*, a 2-in. waste-pipe with 2-in. branches should have 2-in. trap-ventilation ; a 2½-in. waste a 2½-in. trap-ventilation ; and a 3-in. waste-pipe, 3-in. ventilation, though a 3-in. main waste with 2½-in. branches would be quite proof against syphonage with 2½-in. trap-ventilation, provided that the right kind of trap were used. (See Plates X. and XVII., showing a tier of slop sinks, with their wastes and ventilation.) S'op-wastes

Connection with soil-pipes.

When no hot water is laid on, to be drawn off over a slop-sink, or into a "wash-up" sink discharging into a slop-sink waste, there is no reason why the slop-sink waste should not be connected to a lead soil-pipe. But where hot water can find its way into a slop-sink waste, either from a hot-water cock left running, by the carelessness of servants, or from a leaky hot-water cock, the waste should be kept quite separate from the lead soil-pipe, or the soil-pipe will soon get broken by expansion and contraction.

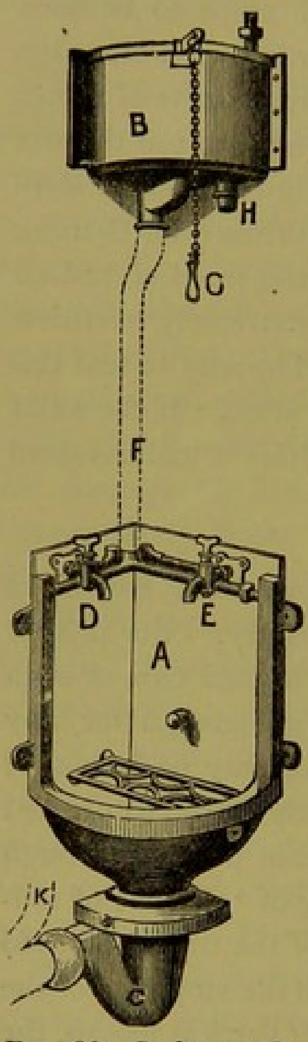


Fig. 186.—Syphon supply to slop-sink.

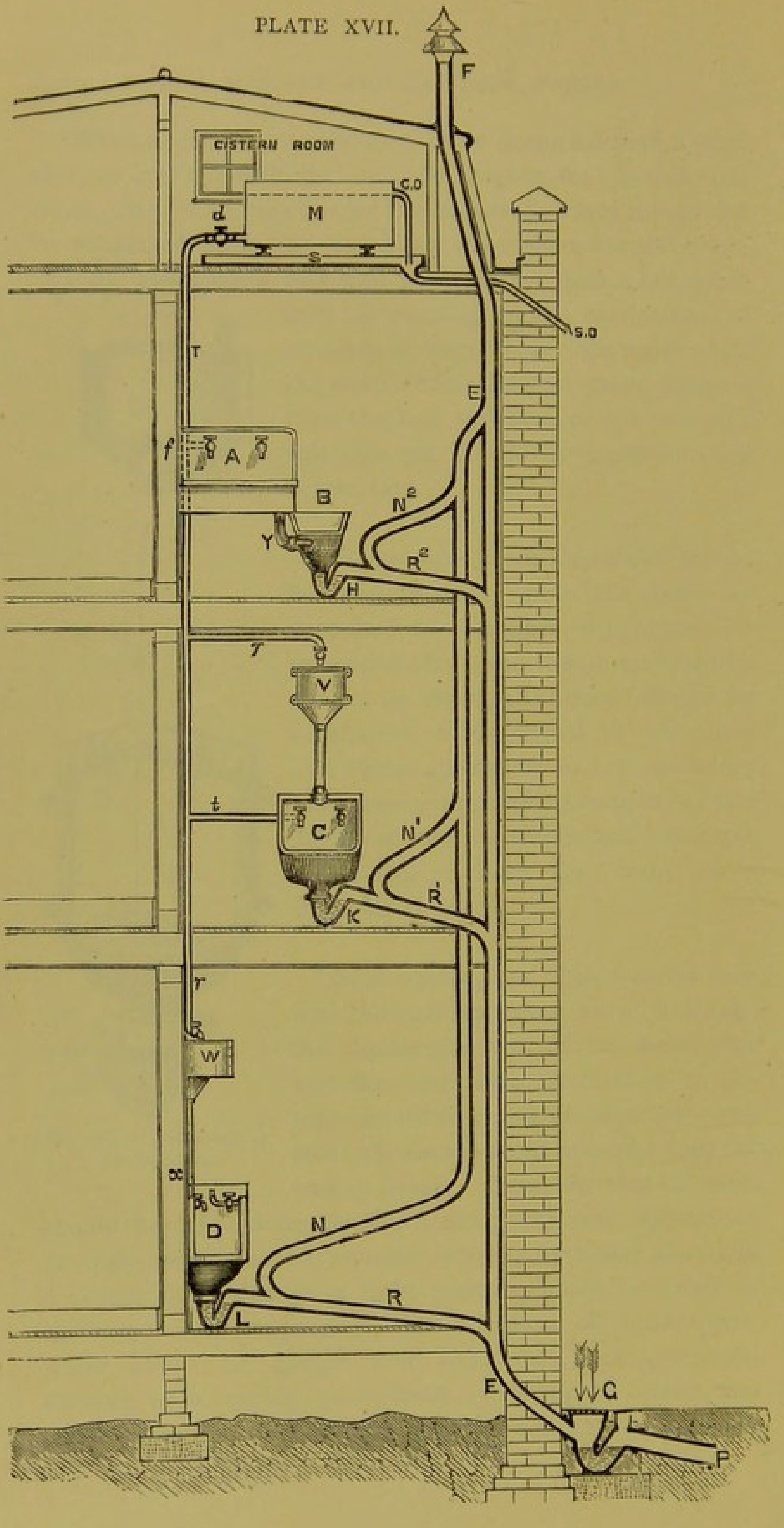
"Disconnection" and ventilation.

Waste-pipes from slop-sinks should be "disconnected" from the drain—as described to soil-pipes—by proper intercepting traps, and the pipe should be carried up through the roof full size for ventilation, as explained to soil-pipes. The waste-pipe can be made to discharge into a drain-intercepting trap, as in Plate XVII., or into the trap which intercepts the soil-pipe from the drain, as in Plate X.

Flushing out sink wastes.

Such waste-pipes often become very foul through imperfect water flushing; the discharging end of the waste-pipe and the ventilating terminal of its air-pipe should therefore be kept well away from all windows and openings into the roof or house. Good services of water should be laid on for readily flushing out such appliances. In many cases Field's annular syphon, by being placed in a proper tank, and in a right position, could be made to discharge from twenty to thirty gallons of water (rain-water could be caught and used for such purposes) through such piping periodically, to keep it clean and wholesome. When baths are situated near slop-sink wastes,

PLATE XVII.



and are fitted up with quick discharging wastes, they may be made to answer the purpose of a flushing-tank, by branching their waste into the main-waste of the slop-sink, care being taken to see that all such appliances are properly trapped and ventilated to prevent syphonage. When baths are in rooms—dressing-rooms or otherwise—having doors from them into bed-rooms, it is better to keep their wastes separate from slop-sink wastes, as in Plate X. Or a flushing syphon cistern, as B, Fig. 186, or V and W, Plate XVII., can always be fixed over such sinks for cleansing them and flushing out their traps and pipes.

References to Plate XVII.

A.—Sink for washing-up purposes (in lead, copper, or earthenware, according to its work), with its waste, Y, discharging into slop-sink, B. The sink can thus be made to flush out the slop-sink, trap, and main waste, by filling it with water, from the draw-off taps over it, and pulling out its plug.

B.—"Water-shoot" slop-sink, as Fig. 180.

C.—"Flushing-rim," white ware draw-off, and slop-sink, combined.

D.—"Angle" slop-sink and draw-off sink combined, as Fig. 186.

E.—Lead waste-pipe (2-in., 2½-in., or 3-in., according to circumstances) with the branches from the sink-traps vented, as shown at N, N^1, N^2.

F.—The air-pipe of the main waste.

G.—Stoneware drain-intercepting trap.

M.—Slate cistern, supplying potable water, with its overflow discharging into the overflow of the safe, and thence into the open air, S O.

V W.—Syphon cisterns ("Flat-back" and "Angle") for flushing out the sinks—working automatically, or by the pulling of a handle.

CHAPTER XV.

BATHS AND THEIR WASTES.

Baths in English houses—Baths in Kitchens—Baths in Bed-rooms—Best Baths—Copper Baths—Porcelain Baths—Marble Baths—Waste-valves—Service to Baths—Baths for flushing out drains—Bath-wastes—Traps for Bath-wastes—Disconnection of Bath-wastes—Safes under Baths.

Baths as scarce as fountains.

INSTEAD of a bath in a house being the exception, it ought to be the rule. But one may as well look for a fountain in a desert as for a bath in any of our old English houses.* It is not too much to say that there are scores of villages in England without a single bath in the entire village, except perhaps in the rector's or squire's house. And many of our towns are scarcely better off, I am afraid, in this respect.

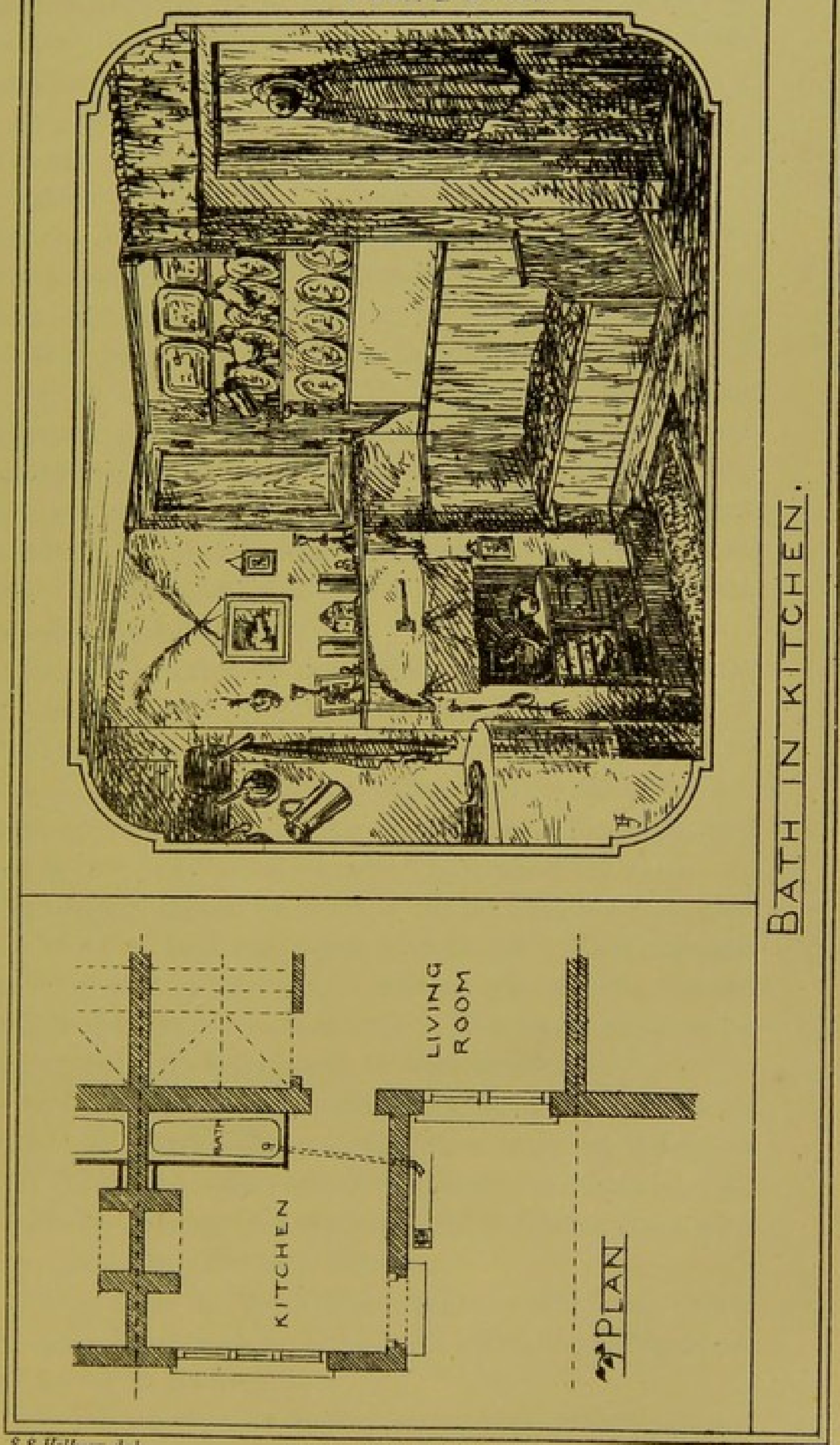
To mention a bath-room to a landlord or householder is to paint before his mind's eye, in a single word, the Bankruptcy Court. And to talk about having hot-water circulation throughout a house is to plunge landlord and tenant into *hot water*. And yet it is astonishing how far a sovereign will go, especially when drawn out into a thin gold wire. Instead of having to pay £30 or £40 for fitting up a bath, as many imagine, this can be done at any cost between £10 and £100.

Baths according to means.

If a West of England broadcloth is too expensive, fall back upon fustian, for any coat is better than no coat at all. And if a luxurious bath-room, with all its convenient appurtenances, cannot be afforded, have a *make-shift* one; for "cleanliness is next to godliness," and any kind of bath is better than none at all.

* English people are beginning to see the value and comfort of full-sized baths with hot and cold water, and no *new* house *now* in London and the suburbs is considered complete without this modern "luxury." I consider that no house, of any fair size, is complete unless it has at least two baths, one for the family and one for the domestics.

PLATE XVIII.



BATH IN KITCHEN.

S. S. Hellyer, del.

Whiteman & Bass Photo-Litho London

To face page 234.

Everybody should be induced to cultivate a habit of personal cleanliness by a bath fitted up with hot as well as cold water. And the poorer the family the greater the need, perhaps, for such a bath.

Baths in the kitchen.

It seems the fashion for *large* families to crowd themselves into *small* houses, because, I suppose, "necessity has no law" with them, and they are only too glad to get any house entirely to themselves. It is difficult in such cases to find a room, or part of a room, that can be spared for fitting up a bath. But rather than not have a bath in the house, it would be better to fit one up in the kitchen. Nor is this such an unreasonable place as at first seems, for in such houses as we are considering there would be no servants, and if there were, it would not materially alter the case, as they could be sent into another part of the house when any of the adults wanted a bath. The advantages of such a position for a bath would be somewhat as follows:—

1. It could be fitted up at a trifling cost. The bath should be of cast-iron, enamelled on the inside, taper shape, with circular ends, and rounded bottom, to take as little water as possible. These baths can be purchased from thirty to fifty shillings, are much more durable than zinc or tinned iron, and do not require any wood "cradle" to support the sides. A plug and washer should be fitted in the bottom, and from this a 1¼-in. or 1½-in. lead waste-pipe should be carried through the external wall and discharged with an *open end* into a stone channel, leading into a surface-trap. This waste must *not* be connected with any other waste, or with the drain.

2. The bath could be enclosed in a wood casing, to look like, and to answer the purpose of, a *seat*, as shown in Plate XVIII.; the cover should be hinged to the back rail, and made to open against the wall, and to button there with wood buttons, when the bath is in use.

3. Being close to the kitchen boiler, a few cans of hot water could be thrown into the bath without any labour or extra expense in heating it.

4. As the service-pipe to the feed-cistern (which supplies

the boiler) would be close at hand, it would be inexpensive to lay on a cold-water service-pipe with a draw-off tap to the bath.

5. As there would always be a fire in the kitchen, the children could have the comfort of it when taking their Saturday night's bath, without any extra cost or additional labour to the poor overworked mother. (See Plate XVIII., showing bath fixed in a kitchen.)

Baths for better houses.

Having explained the most economical way of providing a bath in the poorest houses, a few words will suffice on baths for good houses.

Baths in bed-rooms.

Baths should never be fixed in a bed-room, though where it can be afforded it is a great convenience to have a bath in a dressing-room adjoining one's bed-room, for one can turn out in the morning and take a cold dip or a cold shower; or a hot bath can be taken at night without having to shiver one's way through the cold air of a corridor. The entrance from the bed-room can have two doors, as shown in the drawing, Plate X., facing page 142, and a doorway can also be made from the corridor for other members of the household to use the bath.

Bath-room.

The bath-room can be elaborately fitted up, as shown in the drawing, Plate XIX.

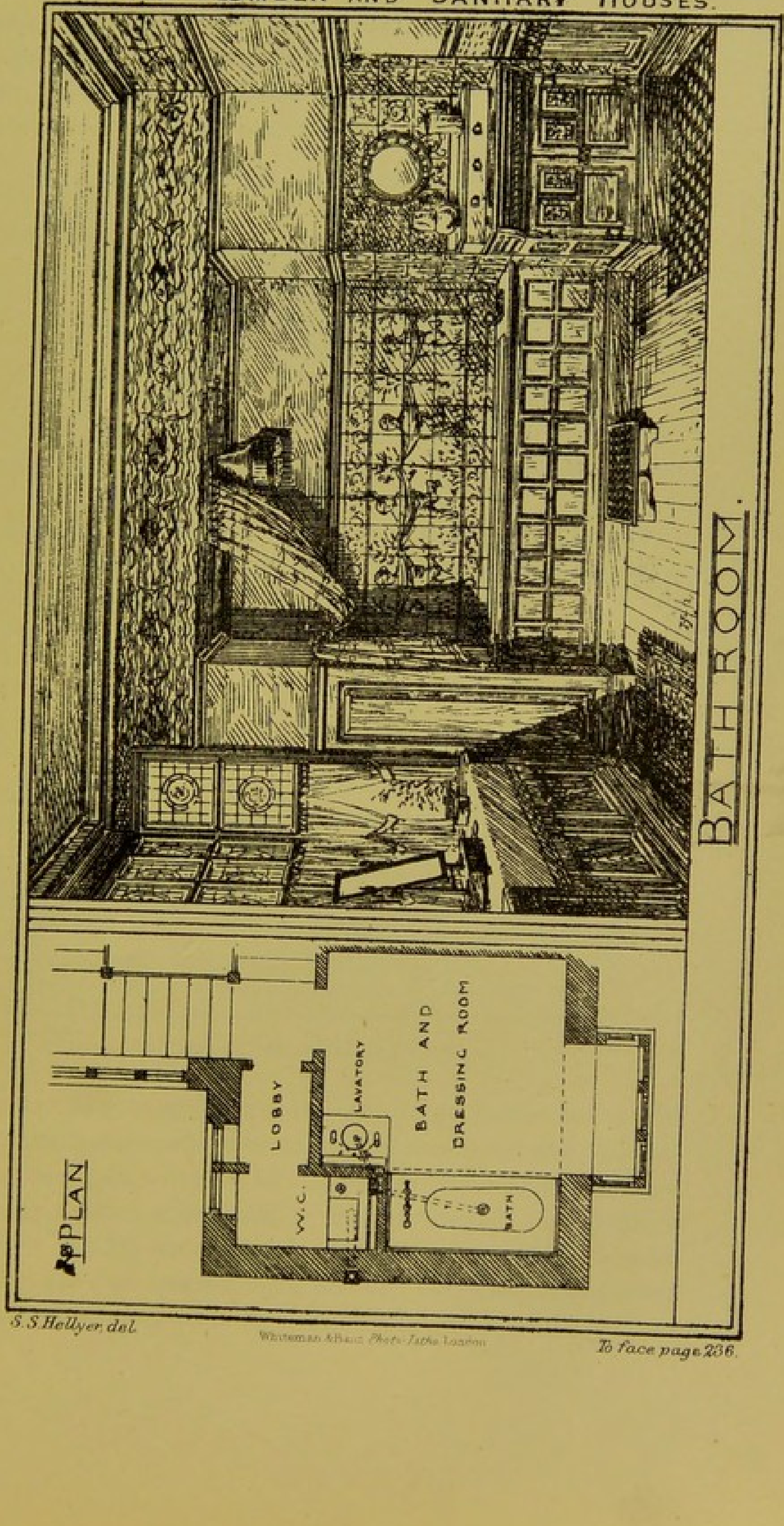
Copper baths.

For good houses there is nothing better than a bath made of copper; for if a hot bath is needed the heat is not absorbed by the material, as in a porcelain bath. And copper is very durable. After years of wear a copper bath can be re-enamelled, and made as new for about one-fifth of its original cost, and when entirely worn-out it can be sold for old metal for about one-eighth of its original price. Copper baths are made in three strengths: "light," "strong," "extra strong." They should be tinned before being enamelled.

Fig. 210 shows a view of a 5 ft. 6 in. taper copper bath, with round ends, and rounded edges to bottom and brim. A

PLATE XIX.

THE PLUMBER AND SANITARY HOUSES.



S. S. Hellyer, del.

Whiteman & Bass, Photo-Litho London

To face page 236.

quick discharging apparatus, C H, is fitted up at the foot of the bath, and this apparatus also forms the overflow of the bath. The supply-valves, A B, are secured in their positions by brackets attached to the stand-pipe, C.

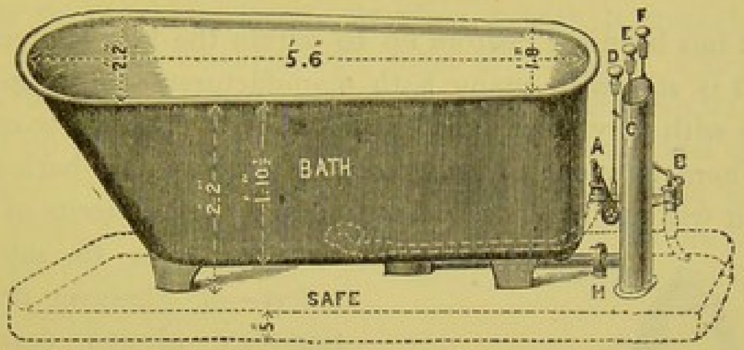


FIG. 187.—View of Bath with Supply-valves and Waste and Overflow Apparatus.

Fig. 188 shows a similar bath with a waste-valve or stop-valve for emptying the bath, but unless a very large stop-valve is used the discharge will be very sluggish. Bath valves.

Porcelain Baths.—A porcelain bath is very clean and durable, and nothing can be better for public baths and hospitals, but for private houses they are heavy and cumbersome, and take too long to heat to the same temperature as the water, when a hot bath is quickly wanted. Rufford's or Finch's well-known porcelain baths have been much used during the last quarter of a century. A thinner porcelain bath is now being made by Messrs. Cliff. Porcelain baths.

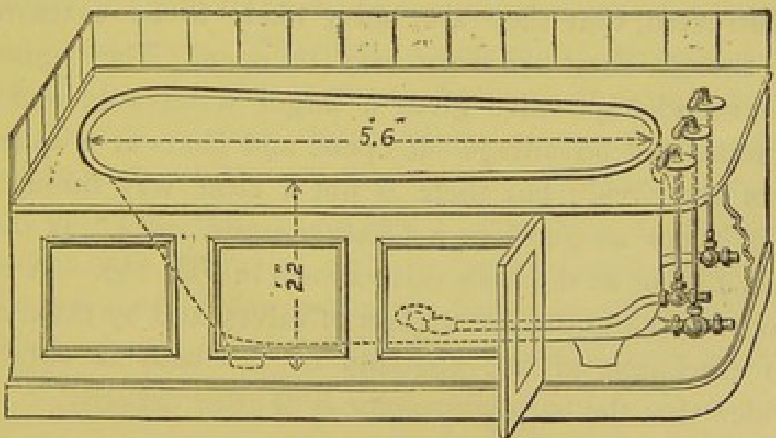


FIG. 188.—View of Bath and Enclosure.

Marble baths.

Marble Baths, when cut out of the solid, look extremely nice, and their appearance in summer-time is very inviting; but in the winter, when a hot bath is needed, or when a bath is needed for invalids, they not only look cold, but strike so.

Variety of bath-valves and cocks.

It has been the custom up to within the last few years—and it is still with many bath manufacturers—to fit up their baths with very small "outlets" and very small waste-cocks.

There is such a variety of bath-valves and bath-cocks, that it will not be worth while to examine the merits of each.

Valves.

Let it suffice to say that *valves*—of whatever description—are always easier to "open" and "shut" than metal *ground-in plug-cocks*. The "screw-down" and "diaphragm" valves take so many turns of the handle to open or shut, and the water-way is so obstructed, that they are never likely to be extensively used, though they are very easy to open. The "quarter-turn" round-way valve gives a larger water-way, and has this additional advantage—it opens and shuts at a quarter-turn of the circle; but there is not a clear way through it, and it is not so good as a "feather-waste valve," as shown in Fig. 189, or as the bath-valve shown in Fig. 190. A child can open or close the latter class of valves, and by their use a rapid discharge of the contents of the bath is obtained, provided that the bath waste-pipe is of good capacity.

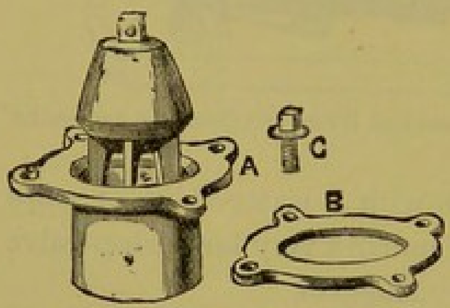


FIG. 189.—"Feather" Waste-valve.

"Quarter-turn" valves.

Step to bath.

When a bath exceeds a certain height, say 2 ft. 3 in. from the floor to the top of the "enclosure," it ought to have a step for the convenience of getting in and out of the bath.

Tile border.

A nice finish is given to a bath—when it would be too expensive to tile the walls, as shown in the drawing, Plate XIX., facing p. 236—by putting a margin of tiles round the top of the bath, as shown lined out in Fig. 188.

Tiles for such purposes can be had to suit almost everybody's taste and purse.

According to the Metropolis Water Act the supply-pipes must come into the bath above the water-line, but this is too high for the hot-water service, as when a bath is needed, the water, if very hot, would fill the room with *steam*. The pipe should be brought into the bath a few inches above the bottom (in either of the two sides, or at the foot), and when the water is very hot the bath could be filled up to a few inches above the hot-water inlet with cold water before turning on the hot-water service; this would prevent steam from coming into the room. Service to baths.

BATH WASTES.

How many a foul and filthy drain would to-day be clean if baths had a proper means of discharge; but whilst many live beyond their means, few live up to their privileges.

As a bath contains from thirty to a hundred gallons of water (according to its size and shape, and the height to which it is filled), it ought to be made a valuable means for flushing out the house-drain. The waste arrangement, the waste-cock, &c., should be of sufficient size to discharge the contents of a bath at the rate of about thirty gallons of water per minute. And when such a body of water can be discharged into the head of the drain (through an intercepting trap, to break the connection with the drain), and the bath is used daily, there will be no need of any automatic flushing-tank for keeping the drain wholesome, for the scour of water from the bath will keep the drain perfectly clean. Baths for flushing drains.

But such miserable appliances are generally provided for emptying baths, that if the water "dribbles" out of them at the rate of about four or five gallons per minute, the user of the bath is contented. And so the stored energy is wasted away, doing no good to the pipes or drains, and saving nothing to the water company which supplied it. Miserable appliances.

How often one comes across a 6-in. or 8-in. D-trap and a 2-in. waste-pipe to take the waste water from a bath, emptied by a ¾-in. or 1-in. bath-pipe, through a ¾-in. or 1-in.

square-way stop-cock! And then, from a groundless dread of stoppage somewhere, or from ignorance in calculating the size and number of holes required in the grated outlet only sufficient perforations are made in the bottom of the

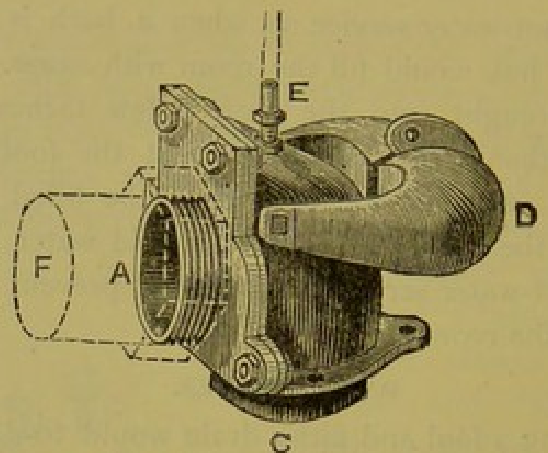


FIG. 190.—View of "Flap-valve" for emptying bath

bath to charge a pipe one-third the area of the main waste-pipe.

Baths in dressing-rooms.

When a bath is fixed in a dressing-room adjoining a bed-room, great care ought to be taken that there is no place

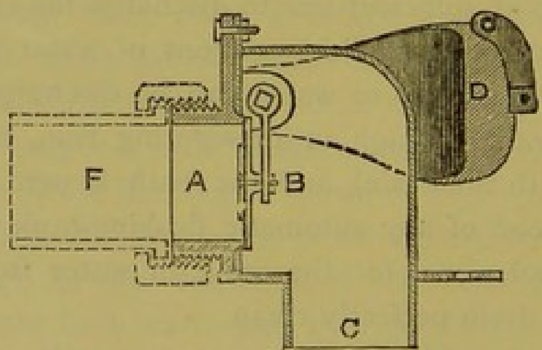
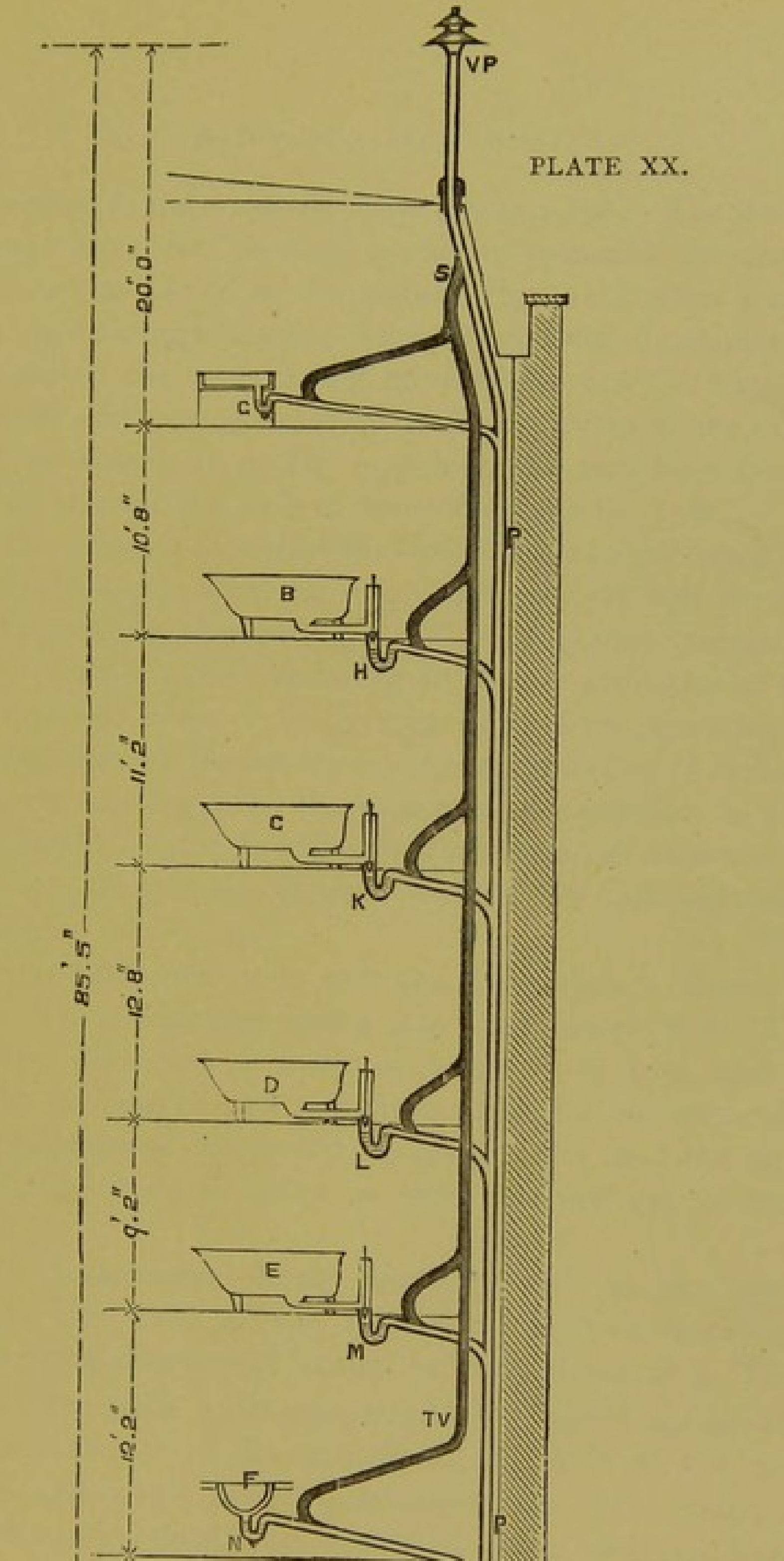


FIG. 191.—Section of Flap-valve.

about it where soap-suds can hang about the waste or over-flow piping to decompose and become a nuisance. The trap should also be of the minimum size—consistent with a quick discharge from the bath—to prevent a large body of stagnant water standing in it. A year or two ago I designed a flap-valve arrangement for the purpose of emptying a bath rapidly, and sealing over the mouth of the trap. This valve is

PLATE XX.



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illustrated in the drawings, Figs. 190 and 191. The interior of the "valve-box" is white porcelain enamelled for cleanliness, and, as shown in the section, Fig. 191, it gives a clear way right through it, A C. There is no place of lodgment in any part of the waste-piping or waste-valve, B C E, Fig. 192. A small vent-pipe (½-in.) is taken from the top of the valve-box, as shown at E, Fig. 190, and this vent-pipe can be carried through the wall, or turned over into the bath.

The overflow-pipe from the bath is made to discharge into the overflow-pipe from the safe which goes through the wall to the open air, as shown at H K L, Fig. 192, thus preventing every possibility of its becoming an inlet, or conductor, of bad air into the house. To prevent water from splashing or running through the overflow-pipe, except in case of accident with the service-valve, the mouth of the overflow is kept considerably higher in the bath than usual, as shown at H, Fig. 192, though the entrance-way is not reduced below its needs.

Four baths, one sink, and one lavatory, are shown on Plate XX. discharging into a 2-in. main waste, P P. This drawing illustrates a stack of baths which have been in use for a year or two, and when examined the other day they were found in perfect working order, and the pipes and traps were as clean as after the first day or two's usage.

All bath-wastes should discharge with an *open end*—outside the walls of the house—into a "self-cleansing" intercepting drain-trap,* similar to that shown at R, Plate XX. The main waste-pipe should be carried up full-size to the external air for ventilation, as shown at V P, well above and away from all windows, &c. The traps, or branch-wastes, should be ventilated by a lead pipe equal in bore to that of the main waste, as shown at T V and S, Plate XX., to prevent syphonage of the traps. (See also Plate X., facing page 142, showing a tier of baths in a country-house.)

* See "Disconnection of Wastes," pp. 267–270.

Bath traps.

It is of great importance to see that every trap fixed on a bath waste has the power of maintaining its seal, for the friction and suction power of a volume of water—say from two or more baths at one time through the main pipe—is so great (especially when such pipe is of small calibre), that unless all the traps upon the piping are well sealed and well ventilated they are liable to be unsealed. (See experiments with traps, pp. 99—139.)

When a bath discharges into a main waste, into which

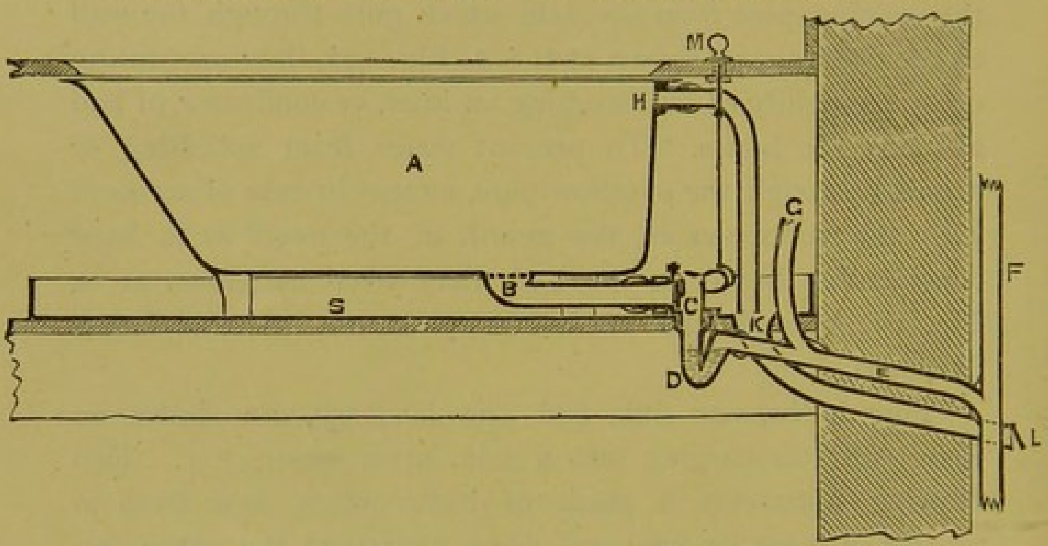


FIG. 192.—Section of Bath, Trap, and Branch Waste, &c.

branches from other baths, sinks, or lavatories are taken, I prefer to fix a 1¼-in. "anti-D-trap" and 1½-in. branch, as shown at D and E, Fig. 192, into a 2-in. main waste, F; and then, if all the traps and branches on the main waste are similarly treated there will be no risk of syphonage, or loss of seal, in any trap so fixed on the piping, provided that each branch from it is properly ventilated,* as shown at G, Fig. 192, and also at T V, Plates X. and XX. A 1¼-in. "anti-D-trap" may seem a small size to fix under a bath, and 1½-in. branch may also appear small, but an ordinary-sized bath, containing about fifty gallons of water, can be emptied by such an arrangement in less than two minutes, and where one bath in England empties in that time twenty take four times as long; and it is more wholesome to use a small than a large trap.

Waste-pipes and hot water.

Waste-pipes from *tiers* of baths in hospitals (and public

* See Trap Ventilation, pp. 135—137.

baths) should be fixed *outside*, on the face of the external walls (out of the power of the sun) so that *slip-joints* or *expansion joints* may be used, for the expansion and contraction of such pipes is sometimes very great. One patient on one floor has a very hot bath, and the discharge of this body of hot water makes the piping very hot. Another patient on another floor is perhaps having a cold bath, just about the same time, and this body of cold water follows pretty closely upon the discharge of the hot bath, and consequently the strain upon the piping is very great, and if it is fixed too rigidly it will in time break in places, most likely at the junctions of the branches, especially if they are short and much confined. I have seen a wrought-iron vertical waste-pipe from a bath bent into the shape somewhat of the letter S, and have known many leakages through the breaking away of the jointings both of iron and lead pipe. A 2½-in. or 3-in. lead waste-pipe ⅛-in. thick with slip-joints, or with expansive joints, will last longer than the same size pipe ¼-in. thick with *soldered* joints. When the main waste is fixed outside in the open air, *slip-joints* can be used; in fact, the piping can be fixed similar to a lead rain-water pipe, for such piping would never become foul if properly treated, and being open at the top and bottom there would be no air in it to become stagnant. No other waste-pipe should be connected with it in such cases. The branches from the baths should be allowed good room for expansion.

In the drawing, Fig. 192, at S, a lead safe is shown the full size of the bath, to prevent damage to the ceiling by an overflow of water from the bath, should the supply-cocks be left open by accident. The safe should be made out of 4-lb. or 5-lb. lead, and turned up 6 in. high on each side, to form a tray. To prevent the overflow pipe of the safe from becoming a conductor of bad air into the house, it should never be connected with the bath-waste, or with any other waste or overflow pipe. A 2-in. lead pipe should be carried through the wall, as shown at K L, Fig. 192, with the end of the pipe left open to the atmosphere, or a hinged copper-flap should be soldered on the end of the pipe, to exclude draught, as shown at L. Safes to baths.

CHAPTER XVI.

LAVATORIES AND THEIR WASTES.

Lavatories may become offensive—Proper places for Lavatories—Lavatories in Dressing-rooms—Variety of Lavatories—"Angle" Lavatory—"Elbow-room" Lavatory—"Newcastle Street" Lavatory—Basin Connections, Plugs and Washers—Quick-wastes—Lavatory Traps and Waste-pipes—Disconnection of Wastes—Ranges of Wash-basins—Errors in Trapping, and in the Connections of Branches—"Tip-up" Lavatories.

Lavatories may become offensive.

BECAUSE it has become the good custom in all well-planned plumber's work to disconnect lavatory wastes from soil-pipes and drains, it seems to be thought by some that it does not much matter where such "fixtures" are placed, or what appliances are used. But a badly-arranged lavatory, *i.e.*, a wash-basin with a small "outlet" and a large trap, and badly-arranged overflow, may become as offensive as an unwholesome water-closet.

Lavatories, where to fix.

No lavatory should be fitted up in a bed-room; but when possible it is a great saving of labour, and a great convenience, to have a "fitted" lavatory in every dressing-room, with hot and cold water.

It is also a great convenience to have a lavatory on the ground floor of all good houses—near the entrance-hall or garden entrance—to save taking casual visitors up-stairs, &c.

Lavatories in hotels.

In hotels and places of that kind the expense of fitting up a lavatory in connection with each bed-room would soon be saved in servants' labour. And there would be this advantage with this arrangement, that hot water would always be ready at hand without the trouble of ringing the bell for it, or waiting for a servant to fetch it.

Dressing-room lavatories.

Lavatories in Dressing-rooms and adjoining Living-rooms.—Great care should be taken in fitting up a sanitary appliance of any kind, no matter where fixed, but special care should be taken with all such fittings when placed in close proximity to bed-rooms and living-rooms. No wash-basin, which will not allow itself, its trap, and waste to be kept perfectly wholesome, should be fitted up in such places. And yet how often "tip-up" lavatories, and wash-basins with small waste-connections, and large traps, and badly-arranged overflows, are fixed, not only in dressing-rooms, but in bed-rooms.

When the overflow-pipe from a wash-basin is branched

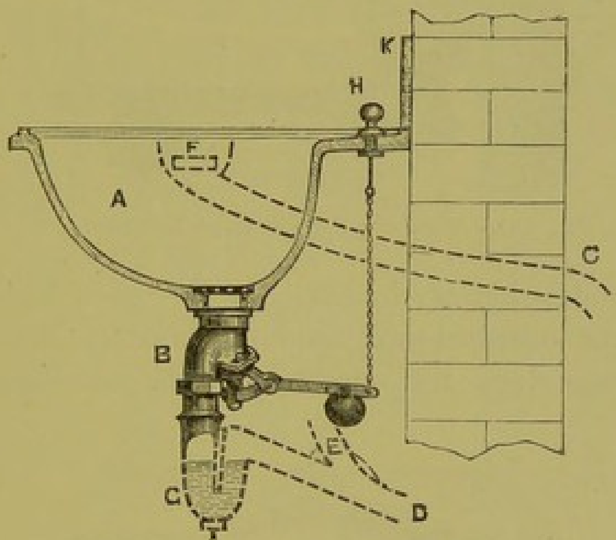


FIG. 193.—"Dressing-room" Lavatory.

into a trap, the contents of the basin, in discharging it, wash up into the overflow-pipe and foul it. And though the length of such a pipe is short, it is long enough when fouled in such a way to become offensive. The only means of cleansing such a pipe is by allowing water to flow from the basin into it, and this is rarely done except by accident. Fig. 193 shows a wash-basin which I have specially designed for fixing in dressing-rooms. As shown at C, the overflow-pipe is separated entirely from the waste-pipe, and to prevent such a pipe becoming an inlet for bad air, it is taken through the external wall to the open air. The mouth of the overflow is kept up as high as possible in the basin to prevent water (dirty or otherwise) flowing into it, except in case of accident, by leaving a supply-valve open, &c., and to prevent splashings into it. It is screened from the inlet by a partition formed between the side of the basin

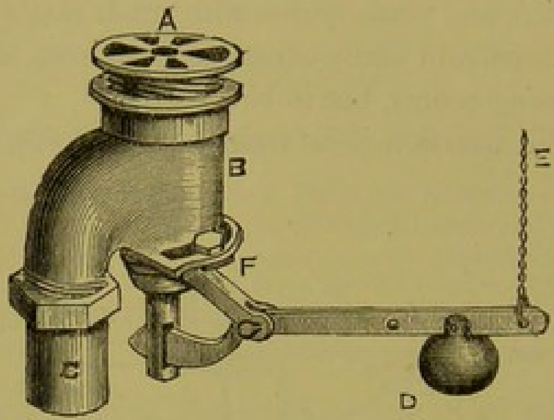


FIG. 194.—View of a "Quick-waste Lever-valve."

and the under-side of the shell, F. When a bath is close at hand, the overflow-pipe from the lavatory can be made to discharge into the mouth of the overflow-pipe of

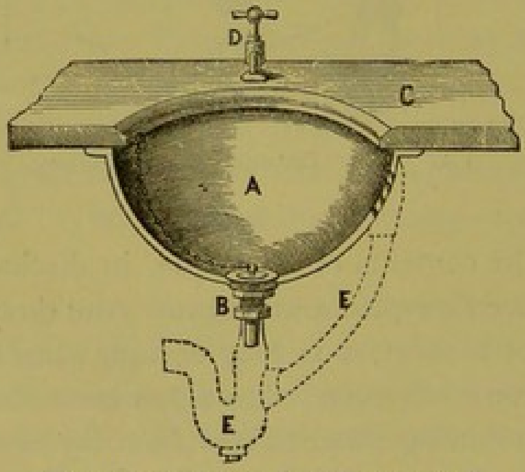


FIG. 195.—Section of a "Plug-basin."

the bath safe, to prevent cutting another hole through the external wall, &c. To ensure an entire change of the contents of the lavatory trap, by each usage of the wash-basin, a small size trap—a $1\frac{1}{4}$-in. "anti-D-trap," containing only one-quarter of a pint of water—is fixed under the lavatory, and its branch waste is ventilated, as shown at E, to prevent syphonage or loss of seal. The grated waste-connection of the basin, and the waste-valve (Fig. 194) are of sufficient size to discharge the lavatory at the rate of over one gallon of water in five seconds. (See Plate X., facing page 142, showing such lavatories fixed in dressing-rooms).

Lavatories, variety of.

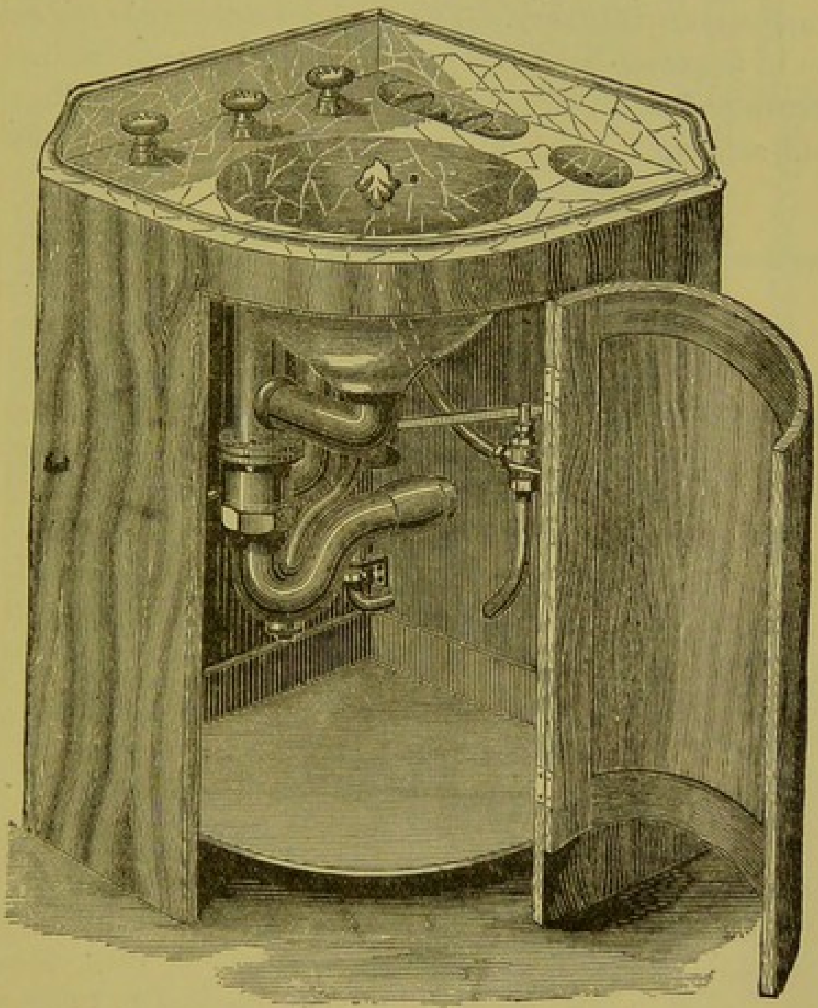


FIG. 196.—View of "Angle" Lavatory.

Lavatories can be fitted up in a variety of styles, from a simple plug-basin, with a cold-water draw-off tap over same, as Fig. 195, to a gold fancy wash-hand basin, with marble top, and sinkings in it for soap and brush, and waste-pipes or drainers from same, together with marble shelf at back for brush and comb, pier-glass, &c., hot and cold water being laid on with ivory-mounted fittings for opening and shutting supply and waste-valves, the whole being enclosed in an elaborate piece of furniture, as shown, *e.g.*, in Plate XXI.

Angle lavatory.

Fig. 196 shows an "Angle" lavatory (made in white glazed earthenware, marbled, or in white and gold) with a front rounded corner for the basin to be large while only occupying a small space. The sinking for the basin is deeper than in the usual lavatories of this kind, and there is a sinking for soap and brush, with drainers from each into the basin, and small skirting at each of the two sides. Under the basin

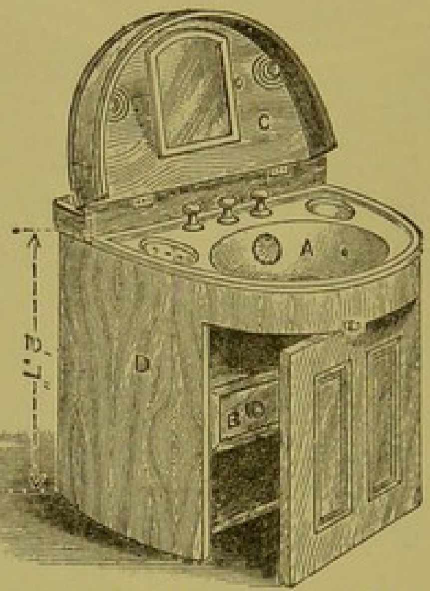


FIG. 197.—View of "Elbow-room" Lavatory.

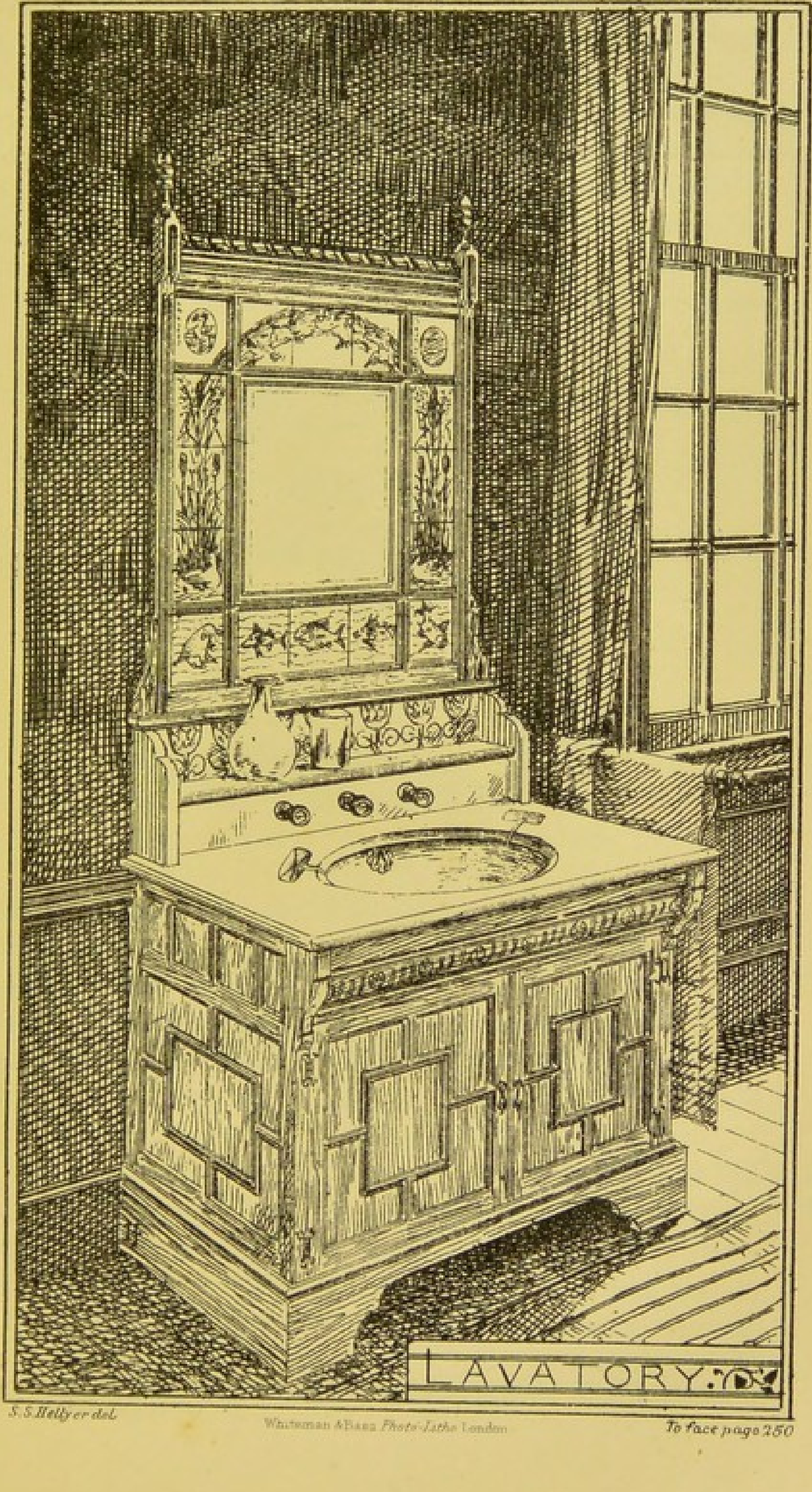
is a shelf for a chamber utensil. The supply-valves for hot and cold water are opened by a pull-up knob connection on the top, and are self-closing, or they can be made to stand open when there are no water companies to interfere and the water is bountiful. The waste-valve is also opened by a pull-up knob fitted to the top, as shown in the drawing, and will discharge the basin in five seconds.

"Elbow-room" lavatory.

Fig. 197 shows an "Elbow-room" table-top lavatory made in white ware, which can be had coloured, or in gold lines. The drawing is so explanatory that little description is needed. The sinking, A, to form the basin is made oval shape, and the waste-pipe is carried to the back to give room for a drawer, as shown at B, or for boots, &c. The hot, cold,

PLATE XXI.

THE PLUMBER AND SANITARY HOUSES.



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Whiteman & Bass Photo-Litho London

To face page 250

and waste valves are opened and shut by pull-up knobs working through the top. This basin is discharged in four seconds.

"Newcastle Street" lavatory.

Fig. 198 shows a lavatory supplying itself with water by means of pull-*out* valves (H C), instead of pull-*up* valves, as in the two lavatories last described. By this arrangement a shelf is formed in marble for putting things upon, and for giving access to the supply and waste valves. This kind of lavatory is generally fitted up with Wedgwood ware

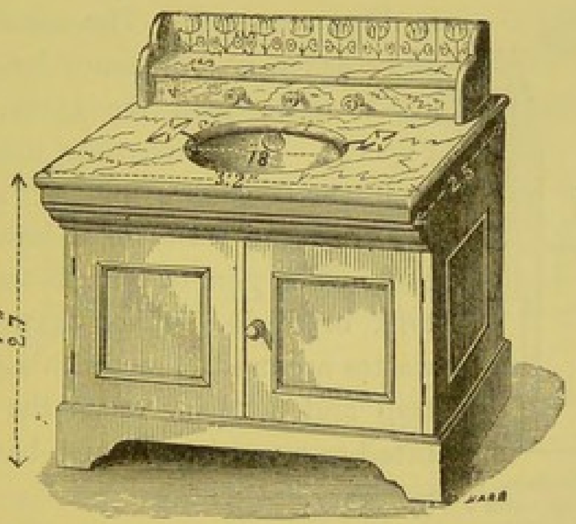


FIG. 198.—View of "Newcastle Street" Lavatory.

basins (white, white and blue lines, white and gold lines) and marble tops, &c. The sinkings for soap and brush are made to drain into the basin by channels * cut in the marble top, where they can be seen and kept clean. The enclosure (in any kind of wood) is made to give plenty of room for the knees and feet, and all lavatory enclosures should be treated in this way.

Basin "outlets."

The holes and counter-sinkings in the bottoms of the foregoing lavatory basins are large enough to receive a 2-in. grated connection, as shown at D, Fig. 109, page 111, or a "quick discharge-valve," as shown at S, Fig. 108, and in drawing Fig. 194. By either of these waste-valve arrange-

* When pipes are used for draining soap-dishes they soon get filled with decomposing soapsuds.

ments, water is emptied out of a basin at the rate of over one gallon in five seconds. In plug-basins the holes are generally too small to receive even an inch plug-and-washer. The consequence is that wash-basins are largely fixed with ¾-in. and ½-in. plug-and-washers, and these are so made that the "lining" or union is about s -in. smaller than the "washer." When plug-basins are insisted upon, the plugs should not be smaller than 1-in., and the "linings" should be made the same bore as the "washer." I prefer 1¼-in. sunk plugs-and-washers with full-bore unions, as shown in Fig. 110, at N. The usual ¾-in. plug-and-washer is four times longer emptying a basin than the 1¼-in., shown in Fig. 199. It is impossible, therefore, with such small calibre plugs, to flush out the trap and waste of a lavatory, especially when 7-in. or 6-in. D-traps, or even 2-in. or 1½-in. syphon traps and large wastes are used. I met with a 3-in. syphon trap and a 2½-in. waste the other day, fitted to a very small wash-basin fixed in a library.

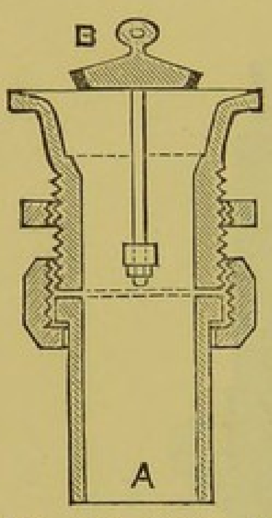


FIG. 199.—Section of 1¼-in. Plug - and - washer, with full-bore union.

Lavatory flushes.

When the waste arrangement of a lavatory is smaller than 1¼-in., no good flushes can be sent through its piping to change the contents of its drain-intercepting trap, but 1¼-in. traps and 1¼-in. or 1½-in. waste-pipes are large enough for any size wash-basin; 1½-in. lead pipe is quite large enough to take the branch wastes from a lavatory basin fixed on each of several floors.

Disconnection of waste-pipes.

All lavatory wastes should discharge with *open ends* into proper drain-intercepting traps fixed outside the external walls of the house, and the top of the pipe should be carried out to the open air (well away from all windows and openings into the house) for ventilation.

Where a bath-waste exists near a lavatory, there is no reason why it should not receive the lavatory wastes, but in all such cases—as whenever quick discharges are sent into a pipe—each trap or branch upon it must be vented by a pipe of equal calibre with the branch or main pipe, to prevent syphonage, as shown in Plate X. (See Chapter VIII. on "The Loss of Seal in Traps.")

Ranges of Wash-basins—Errors in Trapping.—The following extract is taken from what I have said elsewhere:—"How often one sees a range of wash-basins fitted up with the branches from them entering the main branch or waste on the upper side and at right angles, as shown in Fig. 200. When a basin near the main waste, in such an arrangement, is emptied through a minor branch, B or C, into the main branch, E E', the contents of the basin would flow both* ways —*i.e.*, a discharge of soapy water through branches B and C

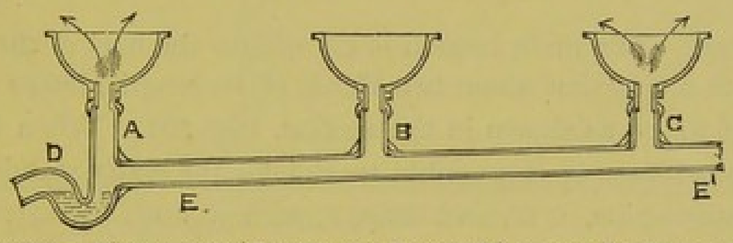


FIG. 200.—Diagrammatic Section of a Range of Lavatory Basins, to show Errors in the Branch Connections.

would flow up the main waste towards E', and its suds would hang about the pipe and corrode upon it, unless basin C or a a basin still more remote, were immediately used.

There is another evil attending such an arrangement. A discharge of water through branch C would drive the vitiated air in the main branch, E, out through the basin A, into the room, as shown by the arrows; in fact, there would be a constant circulation of air from basin to basin, and that air, passing through a pipe which would often be charged with bad air, from stale soapsuds and other matter adhering to the sides of the pipe, would be breathed by the persons bending over such basins to wash their hands; for in the "tip-up" basins the impure air would easily come up between the basin

* At the lectures an ocular demonstration was given with a small washhand-basin and a *glass* waste-pipe, showing this. A little soapy water was put into the basin (similar to the basin B), and on pulling out the plug the water flowed both ways in the pipe, and though the water drained itself out of the piping, the *suds* remained in the pipe.

and the "receiver," and in plug-basins (though the plug may be in its place) the air would easily escape through the overflow arm.

Range of basins into one trap.

Another error is often made in the arrangement of lavatory wastes, where a range of basins is discharged into

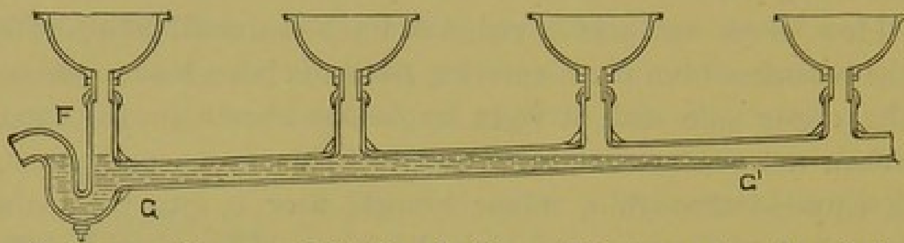


FIG. 201.—Diagrammatic Section of a Range of Basins, to show the evil of emptying into one Trap.

one trap. The main branch is taken into the heel of the trap in such a way that about two-thirds of its length always stand full of water, as shown in the section, Fig. 201. When this is the case, how is it possible to change the water standing in the waste-pipe, G G', and trap, F, with a flush of water sent

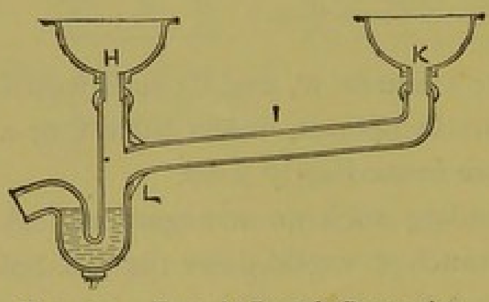


FIG. 202.—Error in Branch Connection.

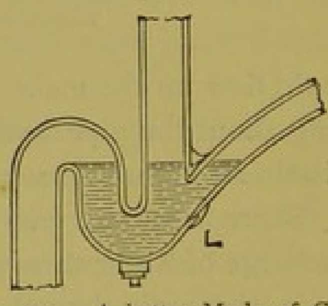


FIG. 203.—A better Mode of Connection than Fig. 202.

through either of the basins? The body of water standing in the trap and piping might become very offensive from the use of scented soap and the washings-down of the lavatory top, and it would prevent the waste-pipe from being cleansed; for no flush of water could be sent through the pipe with any cleansing force in such an arrangement.

When a waste-pipe from *one* "fitting" is branched into the trap fixed under *another* fitting, the connection should be so made that no air can travel from one to the other, as it easily could in the arrangement shown in diagram Fig. 202—*i.e.*, the air would be circulating constantly from H to K, through the foul waste-pipe, I, or *vice versâ*.

Evils of connections with traps.

If one trap must be made to receive the waste-pipes from more than one basin, sink, bath, or urinal, when fixed adjoining each other, the ends of such pipe should be taken into the trap under the normal level of the standing-water, as shown in Fig. 203, at L; but I do not like even this arrangement. It may do for certain places, but is not perfect in principle, and therefore should never be carried out in sanitary fittings near a living-room or bed-room. In dressing-rooms it is common to find the lavatory-waste connected with the bath-

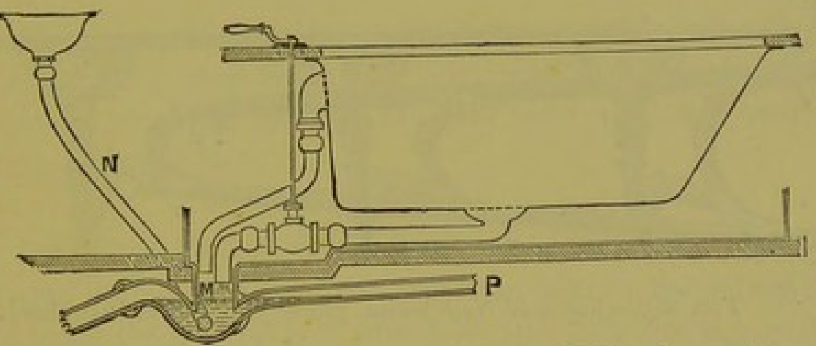


FIG. 204.—Section showing evils of emptying several Fittings into one Trap.

waste, either as shown in Fig. 202 or Fig. 204; but as it is impossible to keep such arrangements absolutely sweet, we will just look at the evils attending them.

One trap and several wastes, evils of.

When two or more waste-pipes discharge into one trap, with their ends under the water-line, the filth carried down one pipe *floats* up into one or more of the other pipes, and collects and lodges there. This will readily be seen by looking at the illustration Fig. 204, showing such an arrangement. A discharge of soapy water is sent out of the basin-waste, N, and the suds from it immediately float up into the dip-pipe of the trap, M; and though the matter sent up may only be small in one usage, it becomes large from many usages. The lavatory would most likely be in constant use, but the bath may not be used more than two or three times a week, and when used the discharges from it would not wash out the dried filth, for that would have collected upon the sides of the dip-pipe, M, and on the outer side of the bath-waste, above its discharging orifice. Besides, in such arrangements, a *large* trap is often used with only small branch-wastes into it from the adjoining "fittings," so that the *trap* could not get properly cleaned out by a flush of water sent into it through such pipes. The fact is that in such cases filth collects very quickly in the dip, or inlet part of the trap, M, and on the outer side of the discharging end of the bath-waste, standing in the mouth of the large trap.

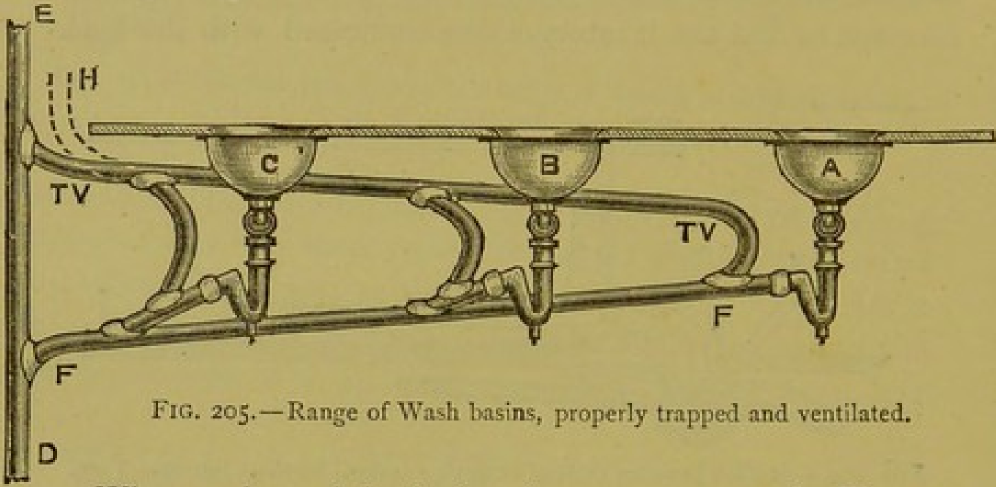


FIG. 205.—Range of Wash basins, properly trapped and ventilated.

When each wash-basin has its own trap, as in Fig. 205 (A B C), a discharge of clean water through it can be made to flush out the trap-piping fouled by the use of the basin. Each trap should be vented by a pipe taken from its branch to prevent syphonage, as shown in the diagram. When other "fixtures" discharge into the main waste, E D, on a higher level, the trap-ventilating-pipe, T V, must be carried up, as shown by the dotted lines, H, above the highest trap upon the piping.

"*Tip-up*" *Lavatories.*—To be able to tip dirty water out of a lavatory basin is certainly a quick way of getting it out of sight, but it is not a sanitary way of disposing of it, for the water is sure to splash over the exposed surface of the interior of the receiver, and unless such splashings are cleaned directly after the lavatory is used, the soapsuds will dry and decompose upon the sides. The interior of such places is often left for months together with no attempt to cleanse it. No "tip-up" (or "lift-up") basin should be fixed in a bed-room, dressing-room, or near a living-room.

CHAPTER XVII.

SINKS AND THEIR WASTES.

Lead-lined Sinks—Copper-lined Sinks—Slate Sinks for Washing Vegetables—Nursemaids' Sinks—Butlers' Sinks—Overflows to Sinks—Sink Gratings and Plugs—Sink Traps and Sink Wastes.

IN Chapter VII. scullery sinks were considered, and in Chapter XIV. slop-sinks and housemaids' sinks. We have therefore only the general draw-off sink and the butlers' sink to speak of here.

Thin lead.

Lead-lined Sinks.—There is often poor economy shown in the lead linings to sinks, 5-lb. and 6-lb. lead to the superficial foot being the general rule, and 7-lb. and 8-lb. the exception. Now the cost of the stronger is so very little more than the weaker that it is a wonder that the lighter lead should ever be used for such purposes. There are only a few superficial feet in an ordinary sink, and the extra cost of 8-lb. lead in lieu of 6-lb. in a bottom would rarely exceed half-a-crown—and this amount the plumber would require to be paid simply to get him to *look* at the light sink after it had been in use a few months, and what he would want to *repair* it—goodness knows!

Strong lead.

Sinks with hot-water draw-offs over them, and when they have much work to do, should have 7-lb. lead sides and 10-lb. bottoms, or if cost is no object, 8-lb. sides and 12-lb. bottoms.

Strength of copper.

Copper-lined Sinks.—Where there is a great deal of rough work to do, it is advisable to line the wood sinks with tinned copper instead of lead. The strength of the bottom should not be less than 4 lb. to the superficial foot, and the sides and ends should be equal to 2½ lb. per foot superficial.

Copper sinks are very durable, and as they are of a smooth substance they can be kept clean and wholesome, and they are nothing like so damaging to crockery-ware as material of an unyielding nature as slate, iron, stone, earthenware, &c. (See Fig. 182, showing a housemaids' sink lined with copper.)

Vegetable sinks.

Slate Sinks.—Sinks for washing vegetables in should be made of slate, or pottery ware, in which there is nothing poisonous. Such sinks should be placed in the scullery. They should never be less than a foot in depth, and there should be a partition across the centre, with a plug-and-washer grating in each compartment, so that both compartments may be filled with water at pleasure, and the one used for washing the vegetables and the other for rinsing them.

Earthenware sinks.

Nursemaids' Sinks.—Fig. 206 shows a white-ware sink which I designed some few years ago for washing nursery

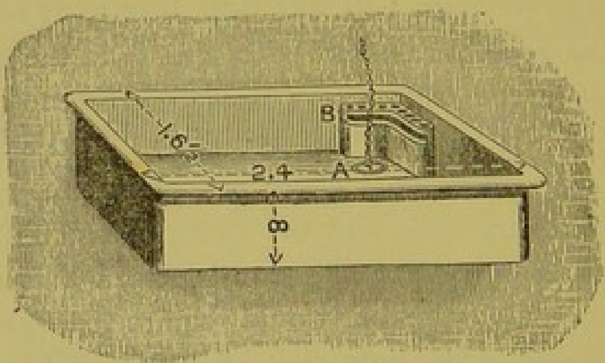


FIG. 206.—View of "Nursemaids'" Sink.

articles in, &c. The sink is made about 1 in. thick for extra strength. The overflow arrangement, B, is formed in the sink itself. A large size brass sunk-plug and grated-washer with fly-nut is fixed in the bottom of the sink, at A, and the shank part of this "washer" is specially prepared for taking away the overflowing water, and conveying it into the waste-pipe when the supply-cocks to the sinks are left open by accident.

Lead sinks for butlers' use.

Butlers' Sinks.—Butlers' sinks are nearly always lined with lead, but are generally made too shallow to give the butler the convenience he requires. Such sinks should not be less than fifteen or sixteen inches deep, then he will easily get a decanter or bottle under the draw-off cocks to fill them with water. Soft water, where it is to be had, should be laid on to these sinks for cleansing " the plate," as the butler can get a much better polish from soft than from hard water.

Overflows to Sinks.—All sinks, as in fact all "plugged" vessels when fixed "upstairs," should have overflows of sufficient capacity to take away the water-supply of the service-valve or valves, should they become defective, or be left open by accident. The cost of such an overflow is nothing in comparison with a ceiling; and all that is wanted is to take a 2-in. pipe out of the top of the sink and continue it down to the trap under the sink, or by preference to the open air outside the external wall. Overflows to sinks.

The pipe should be opened out where it is connected with the sink to 3 in. or 4 in. by $1\frac{1}{2}$ in. or 2 in., to give all the water-way possible without decreasing the depth of the sink.

All sink-bottoms should be made to slope to the waste, which should be fixed in one of the two back angles of the sink, so as to be out of the way of anything to be washed up in the sink. Bottoms of sinks.

The common gratings and "pantry" plugs-and-wasners have such small perforations, that it is impossible to send a flush of water through them for cleansing the sink-trap and sink-waste. Some years ago I designed a "cobweb" grating, as shown in Fig. 207, for fixing over the mouth of the sink-trap, and when the trap is enlarged in its mouth, to receive a grating about 1 in. larger in diameter than the bore of the waste-pipe. Water can be sent through it in a way to be of value for cleansing the waste-pipe and trap of the sink. I also designed the sunk-plug-and-washer shown in Fig. 208, for the special purpose of Sink gratings. Plug and washer.

FIG. 207.—"Cobweb" Grating and Rim.

flushing out the sink-trap and the sink-waste. With such a plug, the sink, when filled up with water from the draw-off traps, can be emptied with great quickness and cleansing force through the waste-pipe.

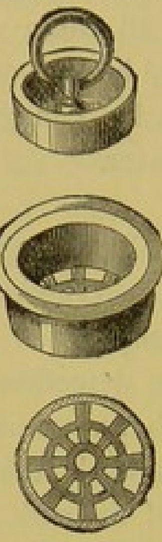


FIG. 208.—Sunk-plug "Washer" and "Cob-web" Grating.

Waste "dis-connection."

Waste-pipes.—Sink-wastes should discharge with open ends into drain-intercepting traps fixed outside the external walls of the house. For the sinks on the ground floor, where the suction power of a discharge through its waste-pipe is not so great as with long lengths of piping, 1½-in. lead traps, and 1½-in. lead wastes are quite large enough. For draw-off sinks fixed with long vertical lengths of waste-piping to them, I prefer 1¼-in. "anti-D-traps" (as Fig. 30, p. 54) and 1½-in. wastes. Such pipes should always be ventilated, as explained to bath wastes and lavatory wastes. (See Chapter XIX., on the "Disconnection of Waste-pipes.")

Sink places ventilated.

All sink places should be ventilated, to take away the smell of flannels, &c., and the cupboards under the sinks should be kept perfectly clean, and free from anything which would be likely to give off bad air.

CHAPTER XVIII.

URINALS AND THEIR WASTES.

Urinals in Private Houses—Urinal Places Light and Airy—Urinal Stalls—Urinal Basins—Ranges of Urinals—Syphon Urinals and Automatic Flushing Arrangements—Treadle-action Urinals.

Urinals in private houses.

URINALS are objectionable things to have inside a private house, for they are liable to become sources for bad smells unless properly fitted up, while to keep them clean they consume a good deal of water. As such places are chiefly necessary when there is a smoking or billiard room in the house, they should be fixed only for the convenience of such rooms.

Public urinals.

Urinal places cannot be too light and airy. The frequent use of such places by many persons will soon make the urinals offensive, unless they are properly constructed and the place well ventilated.

Urine is so corrosive that it ought to be discharged into water, to be diluted, before passing into the waste-pipe; or water ought to be brought into the urinal-basin when it is used, to neutralise the effect of the urine upon the waste-pipe, &c., and prevent its becoming corroded and offensive.

Urine should never be allowed to spread itself over a large surface, but should be confined into as narrow limits as possible, to economise the supply of water, which should be so arranged as to conduct it right away.

Urinal stalls.

Urinal stalls with backs and divisions going down to the floor, and with "aprons" to catch the "droppings"—whether in painted cast-iron, or slate, or enamelled slate—are but an imperfect way of providing accommodation for the public. Urine is discharged all over the lower part of the back and sides of the division without a chance of its being washed away (except when the attendant flushes out the place, perhaps, once a day), for the perforated supply-pipe only sends little channels of water down the *backs*, and as for the "aprons" and divisions, it does not even touch them, for,

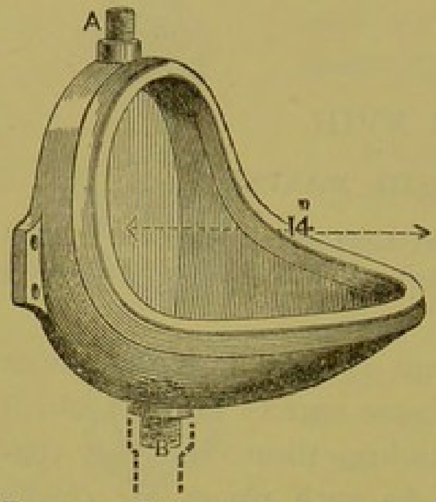


FIG. 209.—View of Urinal-basin, with Large Grated "Outlet."

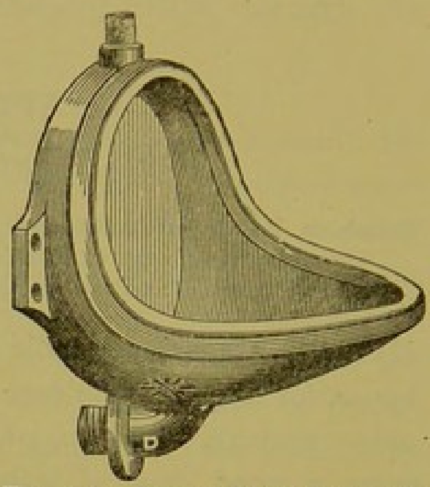


FIG. 210.—View of Urinal-basin, with "Outlet" at Back.

unlike the gun of our friend Pat, it cannot shoot round the corners.

Urinal basins. When basins are used, the urine is confined to narrow

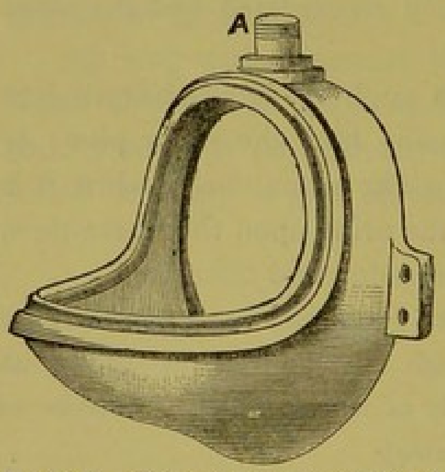


FIG. 211.—View of "Syphon" Urinal.

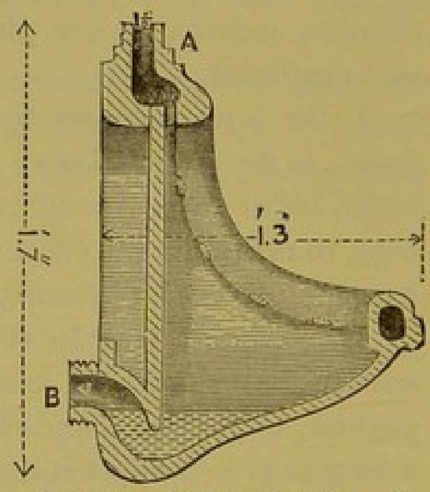


FIG. 212.—Section of "Syphon" Urinal.

limits, and requires less water to wash it away than when it is spread over a large surface, as in slate urinals.

I have made some improvements in the shape and outlets of urinal basins. Fig. 209 shows a white-ware urinal basin with large grated outlet, B. Fig. 210 shows the same basin, but with the outlet going out at the back, as at D, for connection with a waste-pipe fixed behind the slate back, as shown at C, Fig 214.

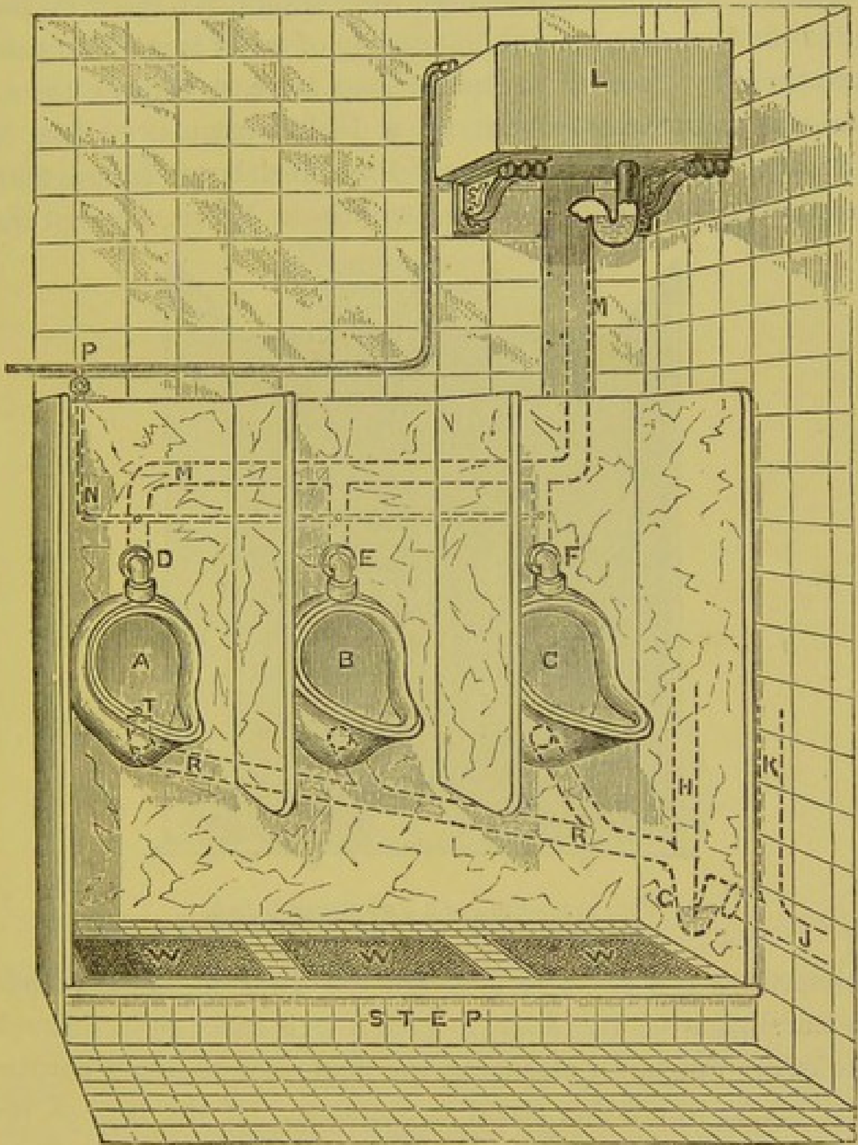


FIG. 213.—View of a Range of "Syphon" Urinal-basins.

Fig. 211 shows a *view*, and Fig. 212 a section of a urinal-basin with a syphon trap in one piece of white-ware (which I patented some time ago), for retaining water in the bottom of **Urinal range.** the basin. A drawing of a range of these urinal-basins is given in Fig. 213. A $2\frac{1}{2}$-in. lead waste-pipe, R R, is carried along behind the marble back with branches to the several basins, and this waste-pipe is trapped at G, before entering the main waste, J, or drain, for the purpose of syphoning out the contents of the basin-syphons every time the basins are flushed. To dilute and change the "standing-water" in the urinal-basins, A B C, a dribbling supply of water is made to pass into them by opening the small stop-valve, P, and the basins and wastes are flushed out by a Field's annular syphon, L. The inlet arm, A, Fig. 211, is made of much larger calibre than usual, to get good flushes of water into the basins, through the

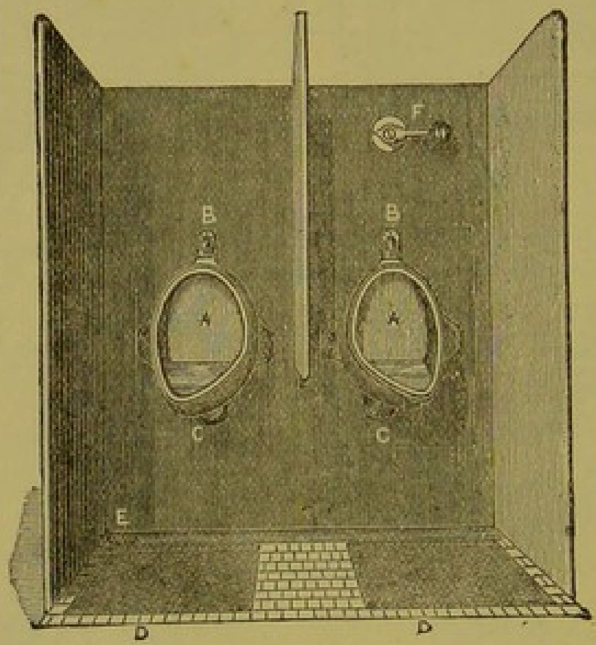


FIG. 214.—View of a Two stalled Urinal.

connections D E F. The divisions are dwarfed, *i.e.*, are made to stand clear of the floor, to give a free space right through the entire range, for cleansing the floor, and to avoid corners and places where dirt could accumulate. If the tops of the divisions are made to stand 4 ft. 9 in. or 5 ft. from the floor, they will be quite high enough, but to take them up to 6 ft. or 6 ft. 6 in. is to waste material, for nobody would crane his neck over a 5-ft. division to look into the next compartment, unless he had the neck of a giraffe, and did not know what to do with his head.

A white ware slab, or a galvanized iron plate, with its exposed surface serrated, can be cemented into the tile floor, to stand upon, as shown at W, Fig. 213, to prevent the feet "picking up" any droppings. When this is done the floor should be washed up every day. Sinkings in the floor, though supplied by perforated pipes, are difficult to keep perfectly clean and wholesome.

To compel persons using the urinal to confine themselves to the basins, the urinal range is purposely fitted up on a raised platform, as shown in Fig. 213.

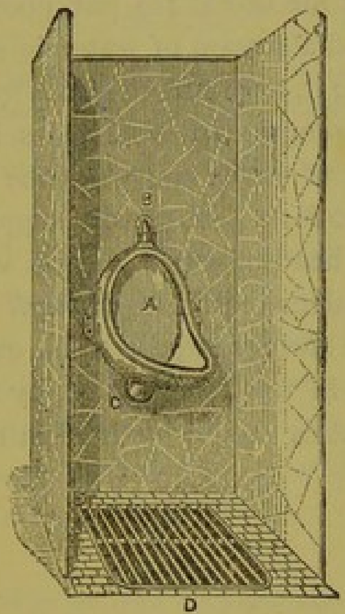


FIG. 215.—Treadle-action Urinal.

A single urinal-basin can be fitted up and supplied with water by an automatic syphon.* Single urinals.

Fig. 214 shows two urinal-basins, as Fig. 210, fitted up in slate "stalls." The water is kept in the basins by a waste-and-overflow apparatus fixed on the main waste. The "standing-water" in the basins, A A, is constantly changed by a supply of water dribbled into it from the supply-pipe, and the basins can be flushed out at pleasure by turning on the supply-cock, F, and opening the waste-valve apparatus. A slate-channel is fixed in the floor at the back with a grating at E for washing down the urinals by a hose-pipe.

* See Fig. 260, showing a Urinal Syphon-supply Cistern.

If people would only stand on a treadle-grating, as in Fig. 215, so that during the use of the urinal a stream of clean water could be sent into the basin, urinals would not be so offensive as they are now. I know of no better arrangement of economising water, and keeping a urinal clean, than a well-arranged treadle-action urinal, as shown in Fig. 215. A supply-valve is fitted in a porcelain-enamelled iron safe,* where it is screened from any droppings, and directly the feet of the person using the urinal are put upon the grating this valve is opened, and a stream of water is made to pass into the basin to cleanse it, and into the safe under the grating to wash out any droppings. In such cases it is important to have a good supply of water, and when the cistern or head-of-water is not over 20 ft., a $\frac{3}{4}$-in. treadle supply-valve should be used; above that head-of-water a $\frac{1}{2}$-in. valve will be large enough. These valves require to be *well made*, and as they are self-closing, the *springs* require to be extra strong, and to prevent concussion in the service-pipe, by the sudden closing of the valve, air-vessels should be fixed in the service.

* See Fig. 261.

CHAPTER XIX.

THE "DISCONNECTION" OF WASTE-PIPES, SOIL-PIPES, AND DRAINS.

Disconnection of Pipes Outside the House—Clean Water-wastes and Overflows—"Dirty" Water-wastes—Errors in the Disconnection of Wastes—Waste-pipes Emptying into Gulleys, Rain-water Heads, and Gutters—Disconnection of Soil-pipes—Disconnection of Drains from Sewers—Valve-flaps—Sewer Intercepting Traps.

NO waste-pipe, soil-pipe, or drain should be allowed to enter a house, unless it is first exposed to the atmosphere, *i.e.*, all "dirty-water" and sewage-carrying-pipes should be "disconnected" somewhere outside the external walls, to allow fresh air to pass into them at such points, and to prevent the foul air in any long length of piping or drain from travelling through a pipe fixed inside the house. Disconnection of pipes.

Clean Water Wastes and Overflows.—Overflow-pipes for preventing damage to ceilings, &c., from a leaky supply-valve, or from a draw-off tap, or valve, accidentally left running, and also waste-pipes for cleaning out cisterns, should discharge with open ends into the open air, away from all intercepting traps, or places where foul air can reach them. (See "Cistern Wastes," p. 303, also Overflow-pipes to Safes, p. 220.)

"Dirty" Water Wastes.—Waste-pipes from sinks, baths, and lavatories, should discharge with open ends into "self-cleansing" intercepting traps fixed outside the external walls of the house, as in Figs. 216 and 217. When such traps are placed where they will be exposed to severe frosts, they should be kept well under the ground, as Fig. 217, and a brick air-shaft should be built over them, as shown at G, for the fresh air to pass into the trap and waste-pipe at F, as

shown by the arrows. (See "Drain-intercepting Traps," pp. 62—80. Also see Plates X., XVII., and XX., showing stacks of waste-pipes fixed complete.)

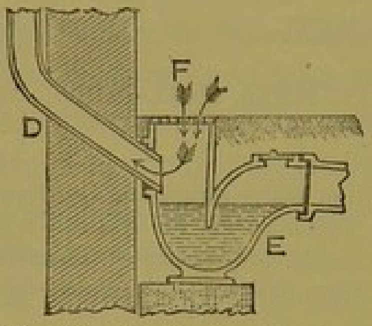


FIG. 216.—Waste-pipe disconnected from Drain.

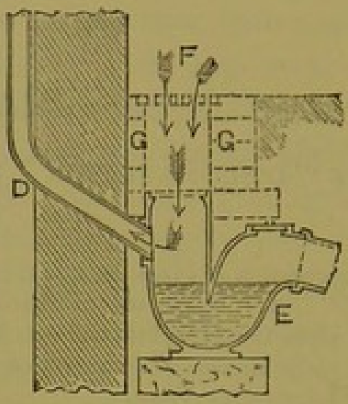


FIG. 217.—Waste-pipe disconnected from Drain.

Errors in "disconnecting" pipes.

In disconnecting waste-pipes from drains, I think it is a mistake for such pipes to discharge *over* the gratings of the intercepting drain-traps, as shown in Fig, 218, though recom-

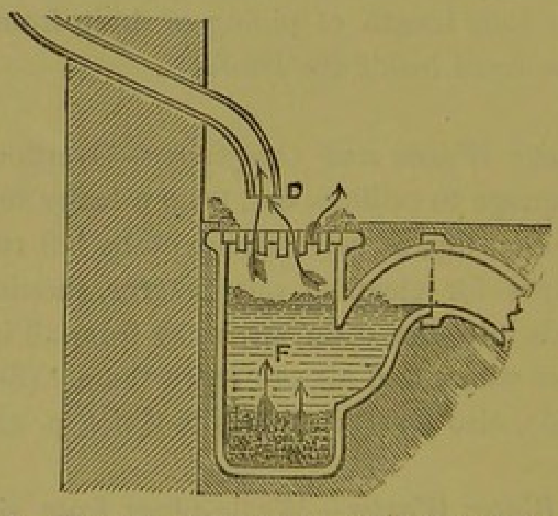


FIG. 218.—Waste-pipe discharging over a Gulley—bad arrangement.

mended by so many, and among them many medical men. The ends of such pipes are more easily seen by this plan than they would be if they discharged under the gratings; but though "seeing is believing," doctors especially have to believe in many things they cannot see. All kinds of matter are sent through such pipes at times, and it does not take long for the gratings and their surroundings to become exceedingly filthy. And as a rule these (what shall I call them ?) surface-cesspools are situated immediately under windows, where the bad air from them can find a ready entrance into the house. I have directed many such places to be remedied.

All "dirty-water" wastes should discharge under the gratings of proper intercepting-traps—where the atmosphere can pass freely into them—and in such a way that no filth

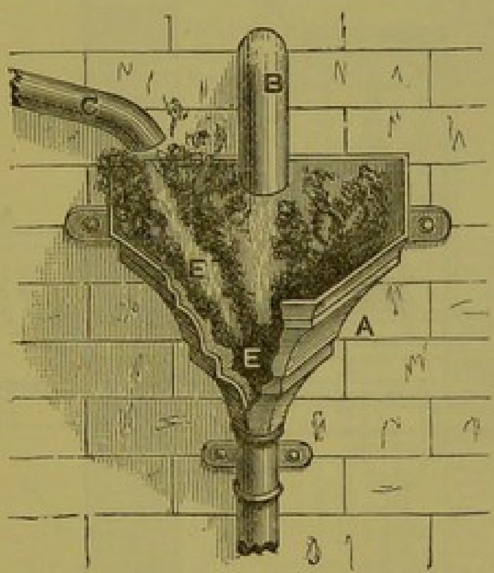


FIG. 219.—Waste-pipes discharging into a Rain-water Head—bad arrangement.

can collect anywhere about the traps or their surroundings to become offensive.

The cry for the last few years has been, " Disconnect ! Disconnect ! ! " No matter where a waste-pipe empties so long as it is disconnected from the drain. And so waste-pipes from sinks and lavatories are made to discharge almost anywhere, *e.g.*, sometimes into rain-water heads, as at B and C, Fig. 219, to foul the head (as shown in the drawing), and perhaps a *long* stack of piping as well, where the air coming from a foul pipe, and from decomposing soap-suds, &c., can enter a window of the house. At other times such pipes are made to enter on to a flat, or into a gutter, at E C G D, Fig. 242, whence the bad air from matters decomposing in such places can readily enter a window, as shown by the arrows, to be breathed by persons occupying the room.

The traps used for trapping off the drain, and for the disconnection of waste-pipes, are often so large that they become ponds of filth. It is impossible to send a body of water of sufficient volume and force through a waste-pipe to keep large traps clean.

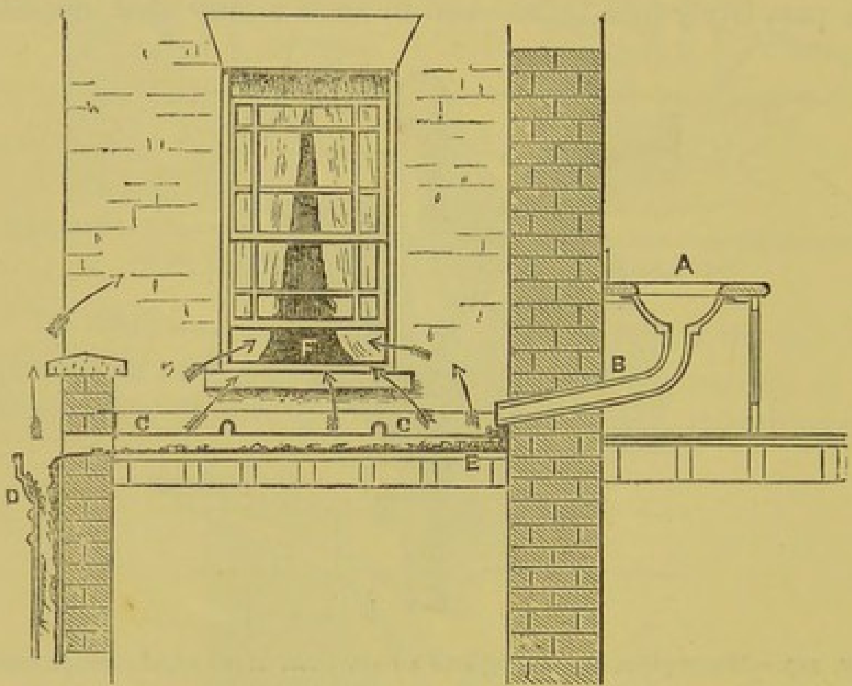


FIG. 220.—Waste-pipe emptying into Gutter—bad arrangement.

Several cases of diphtheria amongst children led to an examination of the drainage of a new building a short while ago, and Fig. 221 illustrates what was found. Not a word is needed—the arrows point out the evils clearly enough; one is tempted to wish some " arrows " could play around the heads of such unsanitary workers.

*The Disconnection of Soil-pipes.**—Sanitary engineers are now pretty well agreed that waste-pipes from baths, sinks, lavatories, &c., should discharge with *open ends*, somewhere outside the external walls of the house. But they are not all agreed on this matter with regard to soil-pipes. I have

* See pp. 73, 74, 164—167.

directed hundreds of soil-pipes to be opened up to the atmosphere, and whenever this has been properly done it has been a great success. To disconnect an old soil-pipe from the drain, close to a window, or near a door, is to run a great risk of getting bad air into the house. A soil-pipe of too large a

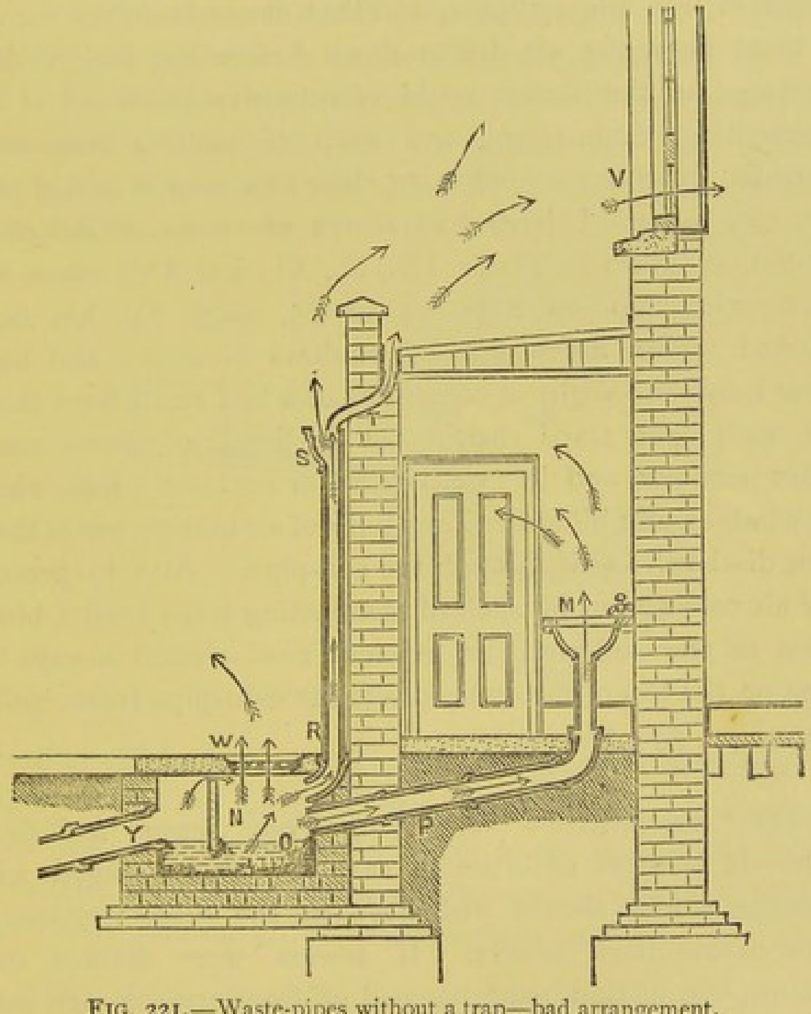


FIG. 221.—Waste-pipes without a trap—bad arrangement.

calibre, or with D-traps upon it, or with *in*efficient supplies of water to the water-closets, could hardly be opened up within a measurable distance of a house without sooner or later giving offence to the inhabitants. But with well-flushed water-closets, self-cleansing traps, and 3-in., 3½-in. (or 4-in.) well-ventilated soil-pipes, there is no risk. On the contrary, there is great advantage in disconnecting soil-pipes from drains. It is better, however, that the traps for disconnecting the soil-pipes should be kept ten or fifteen feet away from windows and doors, especially in single-branch stacks. Where several water-closets branch into one stack, a large quantity of the air previously standing or moving in the soil-pipe is sent up the trap air-pipe, but where only one water-closet is branched into the soil-pipe, and that closet is on the second or third floor, the air driven down before the plunger-like discharge of the closet would of necessity come out of the intercepting drain-traps, and then if such a trap were immediately under a window, or close to a door, it would pass into the house. I have had scores of stacks of soil-pipes treated, as shown in Plates IX., X., XI., and XV., where the intercepting-trap (as Figs. 64 or 65, page 74), has been situated within a few feet of windows or doors, and have never heard the slightest complaint of a bad smell from them. But such open traps should not be fixed in narrow areas, under windows, and in "well-areas" or enclosed yards, where the winds cannot blow away any puffs of air coming out of them from discharges sent through the soil-pipe. And to prevent any air coming out of such disconnecting traps from a blow-down in the soil-pipe, an efficient cowl should always be fixed on the top of the soil-pipe. (See "Soil-pipe Intercepting Traps," pp. 73—79.)

Drain disconnection.

The "Disconnection" of Drains from Sewers and Cess-pools.—It is most unfortunate that any one engaged with drainage works should disbelieve in the disconnection of house-drains from sewers. If sewers were divided into sections, one section being trapped off from another, and each section had an efficient air-extracting shaft upon it, then the house-drain might be allowed to enter the sewer without any attempt at disconnection, but for the drain of one house to be in direct communication, through the sewer, with the drain of every other house in a district, town, or city, is a little too communicative,* to say the least. Under the present system of "sewering" towns it is better that every house should be

* See p. 278.

isolated by trapping off its drain from the sewer. In Chapter VI., traps for trapping off sewers and cesspools were fully considered. We have only now to look at the best way of fixing such traps.

It used to be considered quite sufficient to fix a valve-flap on the end of the drain, inside the sewer, as shown at B, Fig. 222, but the man who can be satisfied with such a means for excluding sewer-air from the house-drain can have had little or no experience of their use. In an examination made by my assistant not one in about a hundred could be found

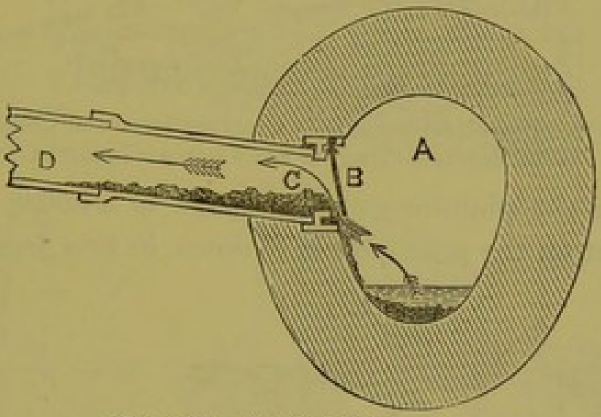


FIG. 222.—Section of Valve-flap.

shutting off the sewer-air from the house-drain perfectly. A valve-flap is not only of little or no value for excluding sewer air; it is a great impediment to the flow of water from the drain, and is therefore worse than useless, though many of the Vestry Boards still insist upon their use.

Every drain should be trapped off from the sewer by a trap * which in its action is "self-cleansing," and this trap should be fixed in every case *outside* the house. For perfect "disconnection," and for the admission of pure air into the house-drain, an air-shaft, acting also as a man-hole, should be built round the trap and the discharging end of the drain, as in Fig. 223, or in Fig. 224. Fig. 223 shows a "Drain sentinel" with its channel-pipe, K, for exposing the end of the drain to the atmosphere, either directly through a grating

* See pp. 81—89.

fixed in the stone covering the man-hole, as at A, Fig. 224, or indirectly through an air induct-pipe, as at A¹, A², Fig. 225.

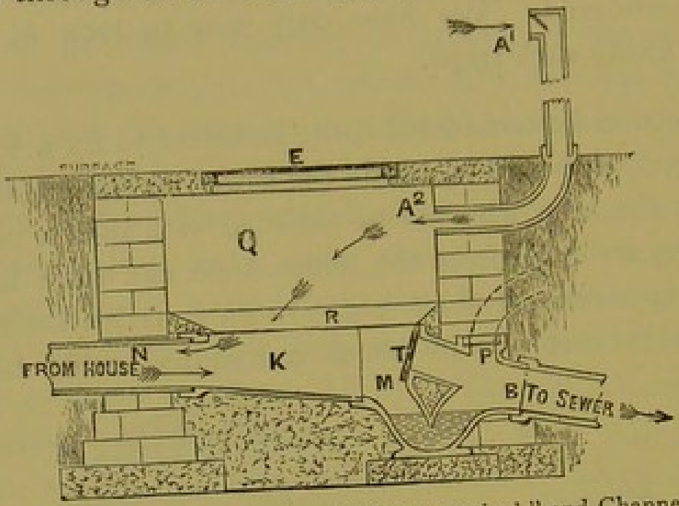


FIG. 223.—Sewer-disconnection—" Drain-sentinel " and Channel-pipe, with Man-hole Cover, E, and Fresh-Air Induct, A.

Where the plumbing and drainage of a house have been carried out on the principles laid down in this treatise, there

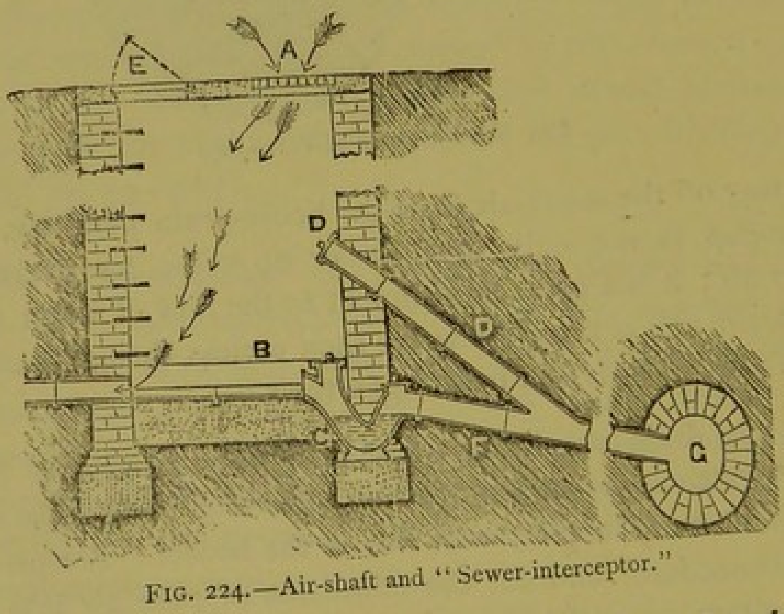


FIG. 224.—Air-shaft and " Sewer-interceptor."

is no risk in opening a well-flushed and well-ventilated drain to the atmosphere near the house, provided the trap for trapping off the sewer is a " self-cleansing " one with a good water-seal (to allow for evaporation, &c.), and provided that it is of such a size as to admit of the whole of its standing-water being changed by a flush of water sent through the drain. But to fix such an arrangement—*e.g.*, in the area of a London house, and to connect it to an old brick drain, saturated with sewage matter, and of such a size that no amount of water that could be sent into it would flush it; or to fix it even to a pipe-drain too large to be flushed out, and therefore too large to be kept wholesome, is to run great risk of getting intolerable stinks at such openings; and if needing to pass near them, I should want a neck as long as a

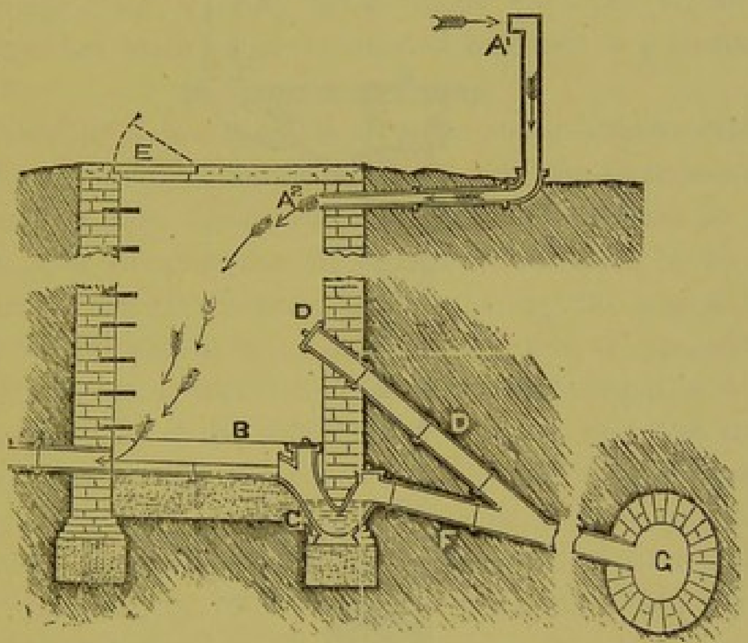


FIG. 225.—Air-induct, through Man-hole, to Drain, &c.

giraffe's, or a body as tall as Chang's, to keep my nose well up out of the way of such offences to mind and body.

It requires experience in such matters to treat open drains successfully; but to fix a 9-in.* trap where a 6-in. would be ample, or to fix a 6-in. where a 4-in. would suffice, is to run a risk of getting bad smells into the house, if the latter is near such openings, for the contents of the trap would under such circumstances only rarely be entirely changed. Where the outlet end of the drain into such traps as we are now considering could not be left open to the atmosphere—as shown in Fig. 93, page 88, or at A B, Fig. 224—for various reasons, as, Open Drains Experience wanted.

* There is not a mansion in London which requires so large a trap (9-in.) to take away its sewage.

for instance, being an old drain which could not be properly flushed out (and might not be changed, on account of the expense), or because the opening would come directly under or near a window, or close to an opening into the house, or under a covered way where any bad air emitted from the trap or drain would get pent up, to enter the house directly a window or door near the place was opened. In such cases,

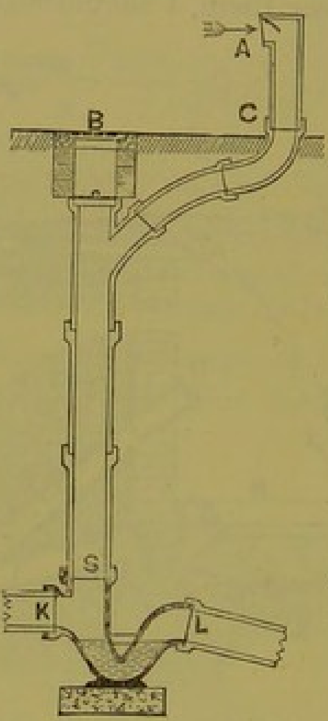


FIG. 226.—Pipe-shaft, with Air-induct to Drain.

Air-inducts. the opening over the top of the air-shaft, or trap, should be sealed up, as shown at E, Fig. 225, and an *air-induct*-pipe taken into it, as shown at A^1, A, for the admission of fresh air into the drain from a point well removed from the house. Where the end of such induct-pipe could not be kept some little distance away from windows, doors, or passenger traffic, a mica-valve should be fixed over its mouth to prevent, as much as possible, any drain-air escaping through it.

Pipe-shaft and Air-induct. Where the expense of building a *brick* air-shaft or man-hole, as shown in Figs. 223, 224, and 225, is greater than could be afforded, a *pipe-shaft*, as shown at C, Fig. 226, could be formed with a small cost; and if the top of the shaft could not be left open to the air, for reasons just explained when speaking of the *open* air-shaft, the top of this trap inspection-shaft could be sealed over as shown at B, and an air-induct-pipe taken into it, as shown at A A[1], with a mica-valve over its mouth, or not, as circumstances required. I have had many such pipe-shafts put in, and found them to answer admirably. A *plunger*, attached to a long rod, can easily be pushed down into the trap, E, for unstopping it, should it ever get stopped up, a thing never likely to occur where the drainage has been properly carried out, and is periodically flushed.

Induct-pipe to roof.

Where it is not possible to make an air-opening directly over the drain, as shown in Fig. 224, or to fix an induct-pipe, as shown in Figs. 225 or 226, the induct-pipe should be continued up to the roof, but its mouth would have to be kept well away from all windows, for lengthening the pipe in such a way would cause it to act at times as a flue or upcast-pipe. In other words, it would become the ventilating-pipe of the drain, especially if the wind had free access over the top of it, and also during the time large discharges were passing through the drain. The *upcast*-pipe of a drain should be carried up as high as possible above the level of the top of the induct-pipe, if good results would be obtained. (See "Sewer-intercepting Traps," pp. 80—89.)

CHAPTER XX.

HOUSE-DRAINS AND THEIR VENTILATION.

Drains Trapped off and Disconnected from Sewers—Drains kept Outside—Drains Inside a House—Connections of Pipes with Drains Inside a House—Drainage Plans of a Town House and a Country House—Dividing Drains into Sections—Localising Soil-pipes—Drain-ventilation—Connections of Ventilating-pipes with Drains—Earthenware Pipes and Iron Pipes for Ventilating Drains—Position of Ventilating Terminals, &c.

Drains trapped off from sewer.

It would occupy too much space to say all that could be said on the advantages of trapping off and "disconnecting" house-drains from sewers and cesspools. Enough was said in the last chapter to show its importance. Only a few words are needful on the drains themselves, and their ventilation, though it might be as well to give another reason for separating each house from the sewer by a proper disconnection chamber.

Evils of untrapped drains.

Where the drains are carried direct into the sewer without traps, the houses, through the sewer, are brought into direct communication with each other, *i.e.*, the air in the drain of one house can pass into the drain of another house. Contagious diseases—typhoid, or what not—may be infecting a house, and however isolated it may be from all other houses *above* ground, it would not be so *under* ground with such a system. The untrapped drains branching into the sewer would form a subterraneous passage for the bad air or disease germs—coming from the stools of the infected patients—between house and house. But when each house-drain is trapped off before entering the sewer, an all but impassable barrier would be placed between the drains, so that the houses would be as much isolated under as above ground. This argument tells also in favour of sewer-disconnection, *i.e.*, trapping off the sewer of one street from that of another. I have applied this system to house-drains for some years with great success, dividing them into sections, and thus isolating one part of the house from another. (See Plate XXIV., p. 284; also "Drain-disconnection," Chapter XIX.)

As there is no absolute necessity, in well-planned plumbing works, for bringing a house-drain inside the external walls of a detached or semi-detached house, it ought to be made a law that no drain shall be brought inside the walls of such houses. Drains and detached houses.

In a line of houses, as in terraces, where it is imperative for the drain to come into the house to receive the soil-pipes, Drains inside.

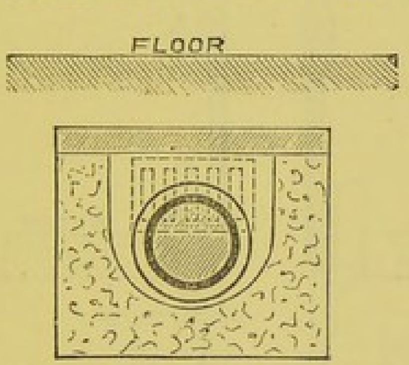


FIG. 227.—Section of Iron Drain in Concrete Trench.

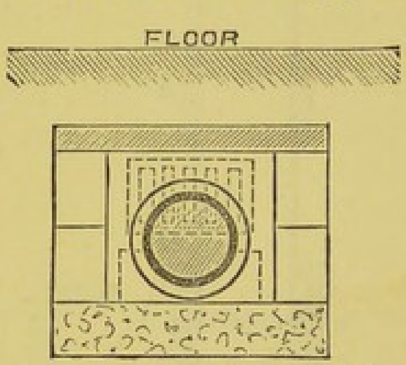


FIG. 228.—Section of Iron Drain in Brick Trench.

etc., the drain should consist of *cast-iron* heavy water-main strength, and this pipe should be protected from rusting, etc., by the Bower-Barff process, or be coated with Dr. Angus Smith's solution, and each joint should be well caulked with lead, 2½ in. deep.

When circumstances compel the drain to be carried *under* the floor of a house, it should be laid in a concrete or brick trench, as in Figs. 227 or 228, with a stone cover over it to keep any jarring of the floor from disturbing the pipe-drain in any way. As a means of inspection, the trench or tunnel could be carried right through the house, with a grating in the face of the external walls, as shown in dotted lines in the diagram; and this could be so arranged that by holding a light at either end the drain could be seen from end to end, without disturbing anything inside the house. Drains under floors.

Drains are very often carried under the floor of a basement, when the only reason why they should not be carried along on the face of the basement walls is want of knowledge or common sense of the man putting in the drain. Wherever it is practicable, the soil-drains inside a house should be kept above the floor, where they can be seen.

Connections with drains.

All connections with the drain inside the house should be avoided, if at all practicable; but where it is necessary to

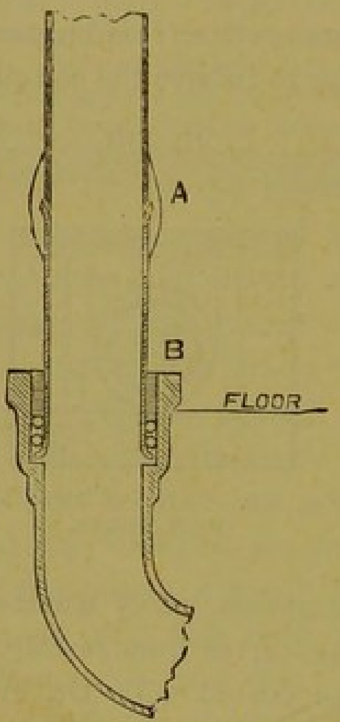


FIG. 229.—Connection of Lead Pipe with Iron.

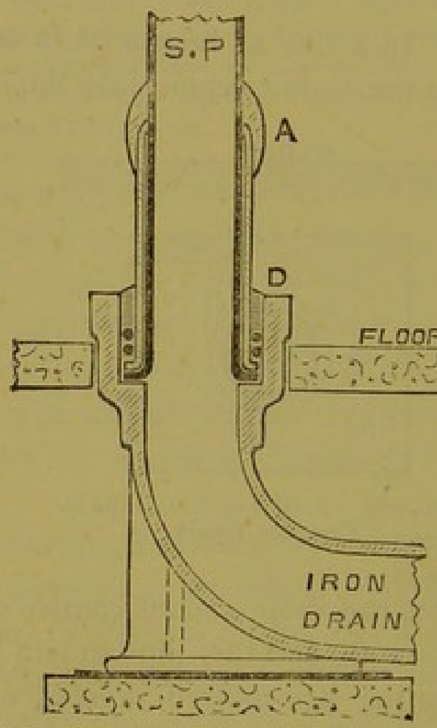
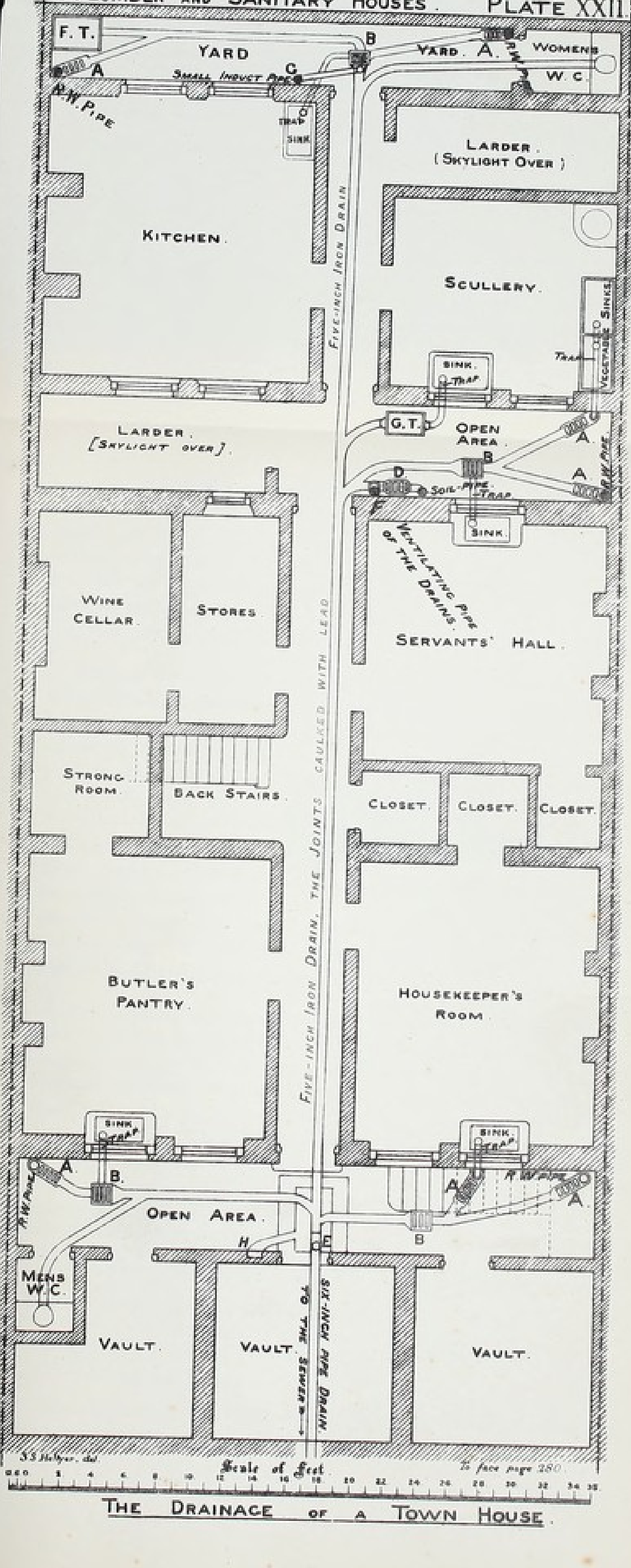


FIG. 230.—Connection of Lead Pipe with Cast-iron Drain—Vertical Section.

connect a waste-pipe or soil-pipe to the iron drain inside the house, such connection should be made by a *strong* brass ferrule, caulked with lead into the socket of the iron drain, as at B, Fig. 229, at one end, and soldered to the lead pipe at the other, as shown at A. And all such branches from the main drain should be continued out to the open air, to prevent a foot of drainage-pipe inside the house from being unventilated.

A better plan of connecting lead pipes with iron is shown in Fig. 230, as by this means the lead protects the ferrule



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THE DRAINAGE OF A TOWN HOUSE.

(copper or brass) from contact with sewage matter. The effect of urine upon copper is well known by those who have seen the old tipping copper-pans of pan-closets. The lead soil-pipe is carried right down into the iron pipe, inside the copper ferrule, as shown at D, Fig. 230.

Where it is necessary to provide means, in a cast-iron drain inside the house, for inspection or cleansing, a proper sight-hole or access-chamber should be formed in the pipe, as shown at A, Fig. 231. The cover B, like the man-hole cover of a boiler, can then be bolted down, and all risk of drain-air escaping through such inspection chambers avoided. The nuts should be made of gun-metal, and the packing should be done with great care, using india-rubber or properly prepared felt flanges.

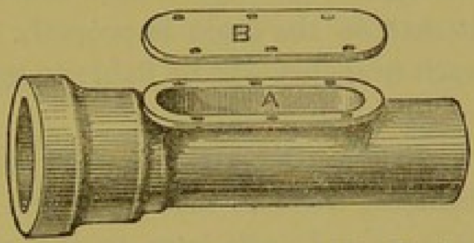


FIG. 231.—Access-chambers to Iron Drains.

No "surface-trap" should be fixed in any floor of the house, and then no connection can be made with it to the drain for the drain-air to escape through such trap, when unsealed, as would often be the case if such a trap were fixed. Surface-trap.

In the drawing, Plate XXII., I give the plan of the house-drain of an imaginary town house.

TABLE OF REFERENCES TO PLATE XXII.

A.—"Rain-water disconnector," as Fig. 61, p. 72.
B.—"Drain-intercepting trap," as Fig. 50, p. 69.
D.—"Soil-pipe disconnector," as Fig. 64, p. 74.
E.—"Disconnection-chamber" and trap, as Figs. 86 and 223, with fresh air induct, H.
F.—4-in. Ventilating-pipe (7-lb. lead) to drain.
F T.—Field's "Flushing-Tank"—fifty gallons.
G.—2-in. Induct-pipe to prevent stagnant air in the rear portion of the drain.
G T.—"Grease-intercepting trap," as Fig. 102.

The waste-pipe from the baths should in such cases be made to discharge into a drain-intercepting trap as near the Drain flushing.

head of the drain as possible; but in any case it is a great advantage to have a Field's Flushing-tank fixed at the very head of the drain, as shown at F T, for automatic cleansing of the whole house-drain. This tank should be made to discharge, if the water can be spared, every twelve or twenty-four hours.

Where the house-drain is flushed out by means of a Flushing-tank, *i.e.*, where large bodies of water are sent through a drain, great care must be taken to see that every branch on the drain is properly ventilated, or the traps upon such branches will be liable to syphonage.

Trapping off sewers.

In Plate XXIII. two ways of trapping off the sewer, and bringing fresh air into the drain, are shown. When the area is large and quite open to the atmosphere, a grating can be fixed over the top of the trap, as shown in section, at G, Fig. 231B (Plate XXIII.), for the admission of pure air into the house-drain at this point. But when the area is partly covered over, to form a covered way to the vault, it is better to seal over the top of the trap, and take an air-induct-pipe into the top of the trap or "disconnection-chamber," as shown at B, Fig. 231A. When necessary, a mica-valve can be fixed over the mouth of the air-induct, as shown at A. (See "Sewer Intercepting-traps," Figs. 81—96, and "Disconnection of drains from Sewers," pp. 272—279.

Drainage of a country house.

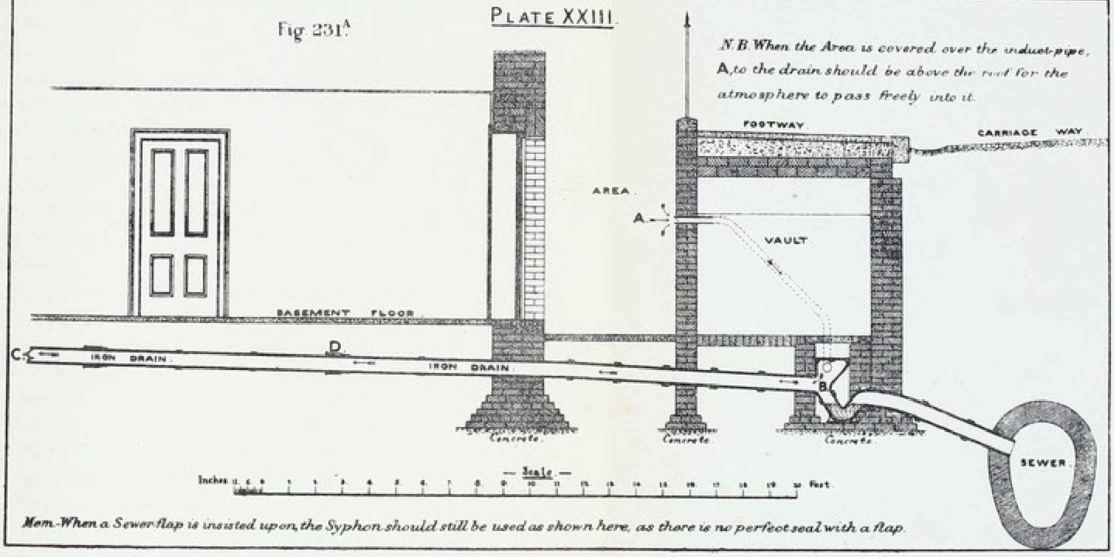
Plate XXIV. shows the plan of the drainage of a country house carried out under my directions some five or six years ago, and which has been very successful in every way. There is not a foot of drain-pipe inside the house. The main drain is divided into three sections, to localise one part of the house-drain from another, and to bring the inlets for pure air nearer the upcast pipes of the drain for better ventilation.

Main drain.

The main drain is specially planned to avoid long branch-drains, to save the cost of ventilating such branches. [Where long-branch drains exist without ventilation, they are sure to become full of stagnant air.] The drain empties itself into

PLATE XXIII.

Fig. 231A.

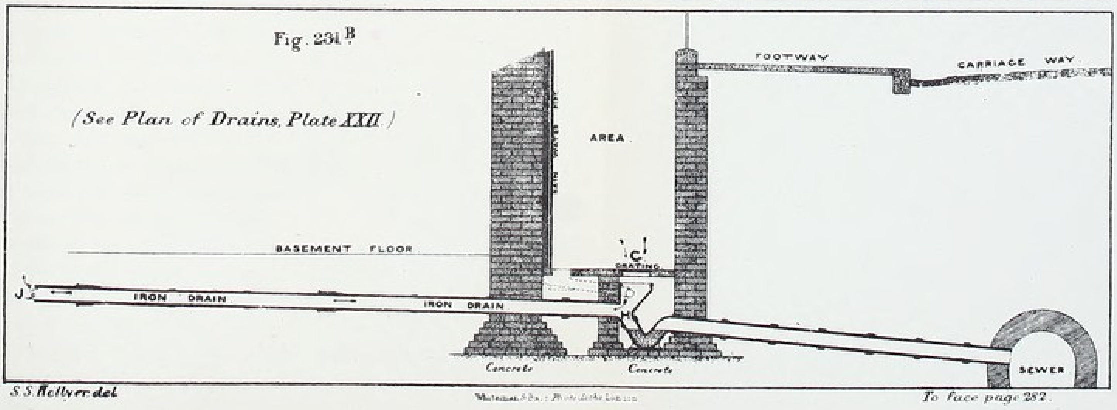


N.B. When the Area is covered over the induct-pipe, A, to the drain should be above the roof for the atmosphere to pass freely into it.

Mem.-When a Sewer flap is insisted upon, the Syphon should still be used as shown here, as there is no perfect seal with a flap.

Fig. 231B.

(See Plan of Drains, Plate XXII.)



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a ditch about half-a-mile away from the house, and air-shafts are formed in it about every thirty yards, as shown at E.

A 5-in. ventilating-pipe is taken from the drain at A^1, and carried up *outside the house*, above the highest parts of the roof, with an exhaust cowl on the top. Another ventilating-pipe is carried up in a similar way at A^2, and another at A. A syphon-trap, as shown at Fig. 4 on the plate, is fixed at G, to separate this section of the drain from the main drain; another trap of the same pattern is fixed at C, to separate that section. Thus the drainage is divided into three sections, each having its own "inlet" and "outlet," for air-cleansing the whole system. Ventilation.

The soil-pipes are also localised, for each stack is trapped off from the drain, and opened to the atmosphere outside the external walls of the house, for a current of air to be constantly passing through it. Soil-pipes.

The waste-pipes—dirty-water wastes—discharge with open ends into drain-intercepting-traps outside the house, so that these pipes are localised as well. The other pipes are treated on the principles laid down in this work. Waste-pipes.

The advantage of localising each stack of pipe is greater than many people imagine. When several pipes are brought into one main drain—no matter how open the drain may be, or how great the stream of fresh air passing through it—there is no means of distributing the air, and one pipe may be thoroughly air-cleansed while another may not have enough air passing through it to shake an aspen-leaf. But when *each* stack of pipe is *disconnected* from the drain, or *intercepted*, as shown on Plate XXIV., each soil-pipe then becomes an *upcast*, and the circulation of atmospheric air through it is constant. Pipes localised.

Each stack of soil or waste-pipe should, therefore, have its own "inlet" and "outlet," to secure a constant change of air taking place in it. And so with the drainage.

The bulk of the rain-water is collected into a rain-water-tank, as shown; but the rain-water from several rain-water-pipes is collected into a "drain-intercepting-trap" at the *head* of *each* drain, I, O, and K, as shown by the dotted Rainwater.

lines, and it is then taken into the soil-drain. Thus, when a sharp shower of rain falls, a tolerable flush is sent through the drain from the collective rain-water-pipes.

Instead of fixing a trap at the bottom of each stack of rain-water-pipe, and taking a long branch from it into the

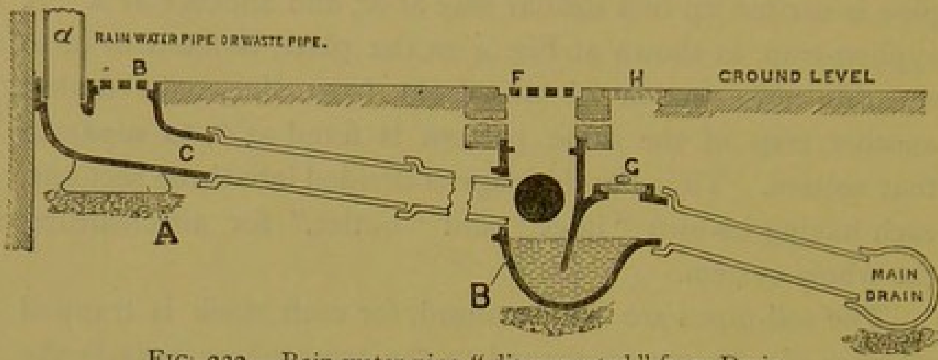


FIG. 232.—Rain-water-pipe "disconnected" from Drain.

main drain, it is better to fix an intercepting-trap close to the main drain, as shown at I, O, K, Plate XXIV., or in Fig. 232, and collect the branches from the rain-water stack-pipes into it.

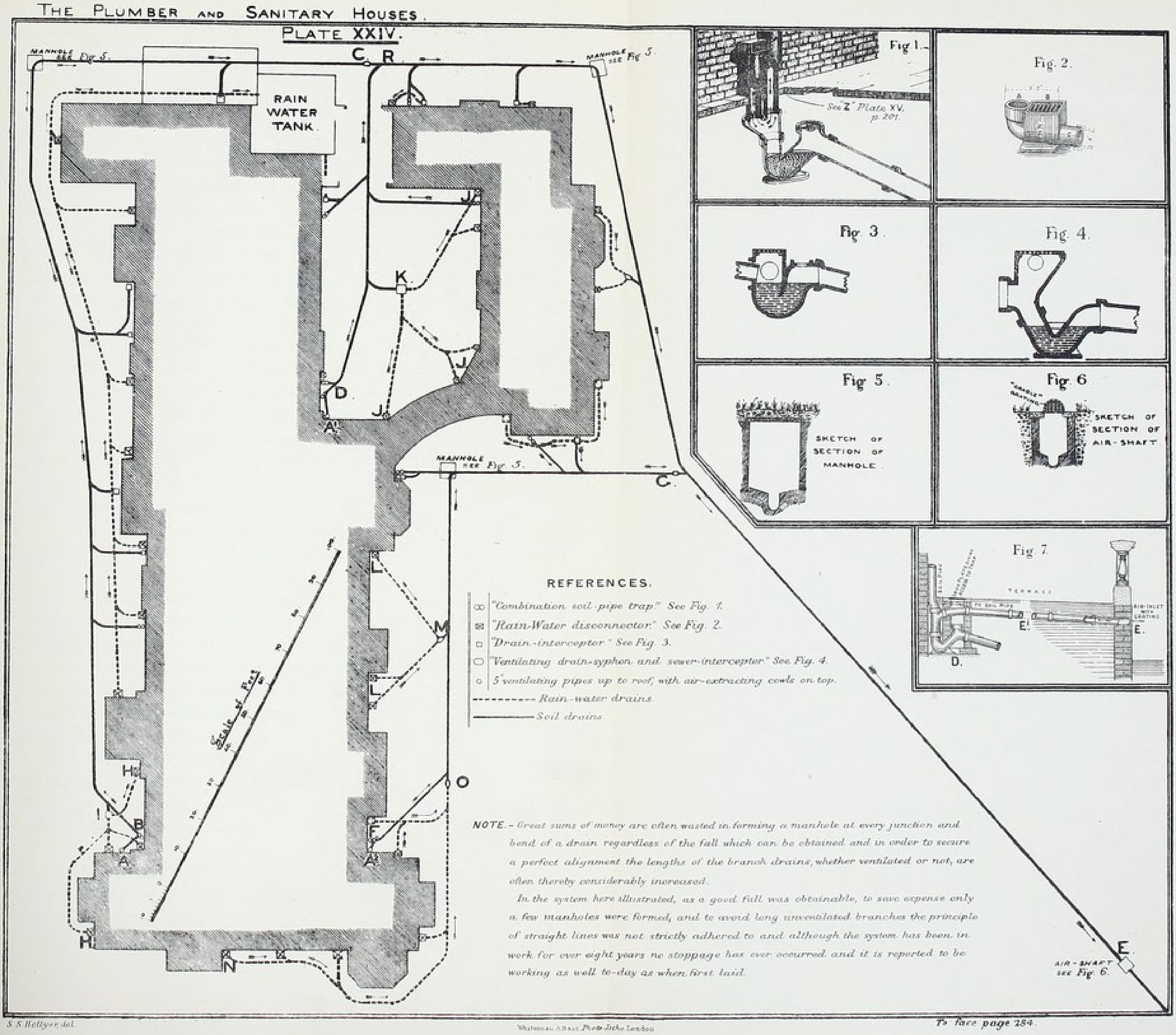
THE VENTILATION OF DRAINS.

Old plan.

In the old plan of draining a house, the air (in the drains, waste-pipes, and soil-pipes) was confined as much as possible. Often a very forest of drains—sink-wastes, bath-wastes, lavatory-wastes, cistern-wastes, soil-pipes, and rain-water-pipes—stood upon a regular network of drains, running in every direction under the floors of the house, and trapped (with cesspool-traps) here, there, and everywhere. The only chance for the air to get out of such imprisoned places was to find out where noxious gases had eaten a way through the soil-pipes, and pass out into the house through such defects. Though not infrequently easier passage-ways would be made, through a forced or unsealed trap; for where the pipes are not properly ventilated, traps are often unsealed.

Air in drains changed.

No drain is properly ventilated which does not allow the air in every part of it to be constantly changed ; and this can only be done by making *two* or more openings in the drain,



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for a current of air to pass through it. *One* air-pipe alone, however great its size, will not ventilate a drain. A 3-in. pipe fixed at the head of a 6-in. or 9-in. drain, and a small opening, or short induct-pipe of 2-in. bore fixed at the outfall or discharging end of the drain, though one hundred yards distant from each other, would change the air in such a drain quicker than a 6-in. or 9-in. pipe fixed at the head of the drain without this second pipe or induct. In fact, one pipe by itself would never change the air in the drain. This has already been explained under the head of "The Ventilation of Soil-pipes," pp. 160—161.

Every drain should have an "inlet" and an "outlet" for air, *i.e.*, provision should be made in all drains, at their lowest ends, for the admission of pure air into them; and exhaust-pipes should be fixed at their highest points, for the air to go into the drain at one point and out at the other. To get good ventilation in say a 6-in. drain, the upcast-pipe should be of 4-in. bore, and the opening or induct-pipe should be the same size. The *induct* ought not to be much more than one hundred feet away from the *exhaust*, though moderate ventilation can be obtained when they are three hundred feet apart. I have tested this often, and have found that where a drain has a good fall, and the upcast-pipe is carried well up above the roof-projections, with an exhaust cowl on it, a good current of air is made to pass through it. I have placed some smoke-paper into an induct-pipe three hundred feet away from the upcast-pipes, and seen the smoke come out of the ventilating-pipe terminal in volumes. Drain ventilation is of much greater importance than seems to be known by even those concerned in drainage works, for by their arrangement of the ventilating-pipes, long lengths of drainage, both in the branches and in the main drain, are often left unventilated. The "inlets" and the "outlets" for changing the air in the drain should be so arranged that no portion of a drain should be left bottled up. In very short branches, in drains of a small calibre, the discharges through them would be sufficient to change the air in them; but long branch-drains should be ventilated at their highest points, to prevent the air in them

Inlet and outlet for air.

becoming stagnant. Sometimes, to save expense, rain-water-pipes can be used for venting the branches; but where this is done, the head of the pipe (the rain-water-head) must be twenty or thirty feet away from all side windows, and no window-dormer or skylight must be over it. And the joints of such pipes, if within thirty feet of a window, must be made sound and reliable.

Errors in connecting air-pipes.

The Connections of Ventilating-pipes with Drains.—The connection of the upcast pipe with the drain is of much

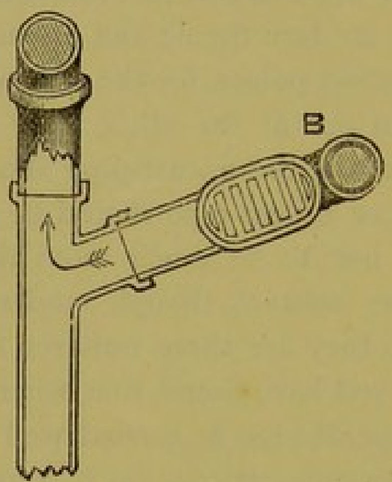


FIG. 233.—Plan, Error in Connection of Air-pipe with Drain.

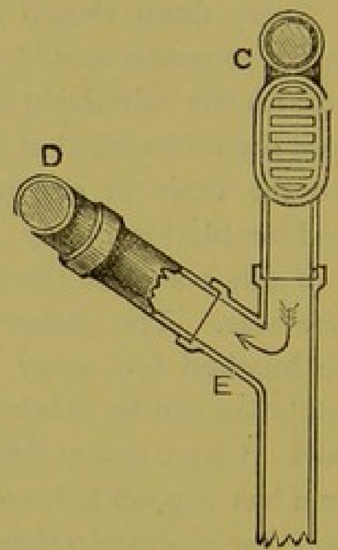


FIG. 234.—Plan, Error in Branching Air-pipe into Drain.

importance. Many connect the pipe with the drain in such a way that it cannot help getting stopped up in time. As shown in Fig. 233, at A, the back flow from a discharge of the closet-stack, B, would wash up into the drain, towards A, and in time stop it up, or materially reduce the air-way to the upcast-pipe. The same evil takes place where the ventilating-pipe is branched into the drain in a way shown at D E, Fig. 234. A discharge through the closet-stack C would wash up into the branch E, and in time reduce the passage way to the upcast-pipe, D.

Correct ways.

The upcast-pipe for ventilating a drain should be connected to the drain-pipe so that no discharges into the drain shall stop it up or foul it, especially as no water passes through such pipes to cleanse them. There is no difficulty in doing this when its value is understood. If the ventilating-

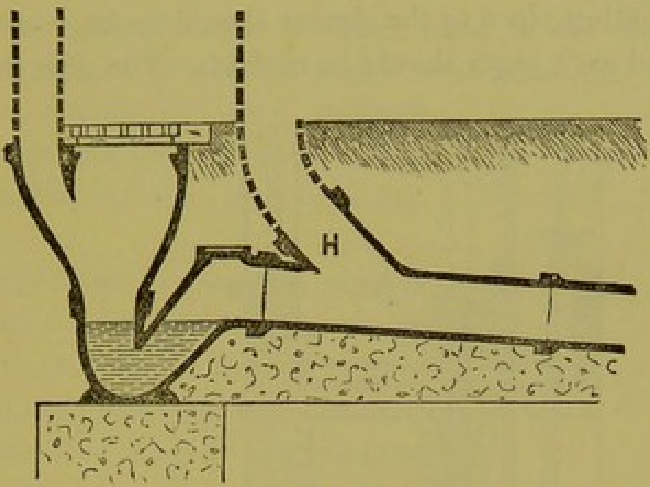


FIG. 235.—Vertical Section, showing Connection of Upcast-pipe with Drain.

pipe cannot be branched into the drain on its upper side, as at H, Fig. 235, a small air-shaft can be formed in the drain, as at K, Fig. 236, and the ventilating-pipe can be taken out of

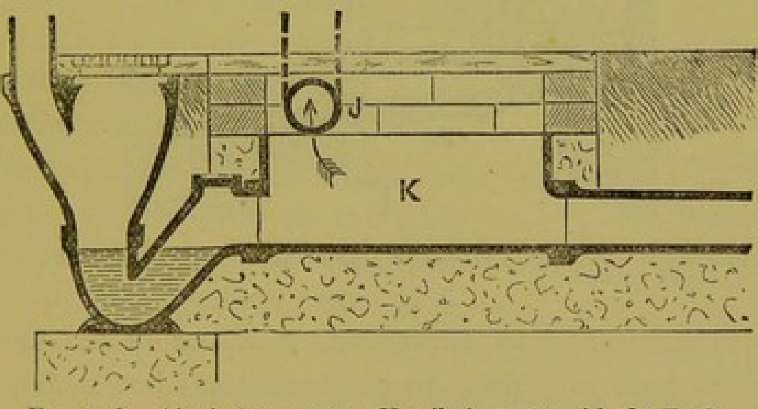


FIG. 236.—Air-shaft to connect Ventilating-pipe with the Drain.

the brick-shaft,* at J, above the water thoroughfare of the drain, where it would not get stopped up or fouled.

Where a drain is brought into a house—as in terraces—it is generally better to make every soil-pipe, every pipe connected with it, an upcast-pipe, to prevent a foot of piping Drains inside.

* See Plate X., showing the ventilating-pipe from the drain treated in this way.

inside the house from being unventilated. It is often quite possible, in terraced houses, to keep both soil-pipe and ventilating-pipe *outside* the house, as in Plate XXII.

Ventilating-pipes lead.

Ventilating-pipes to the drains should be kept *outside* the house, and such pipes should be of *lead*. The pipe should be

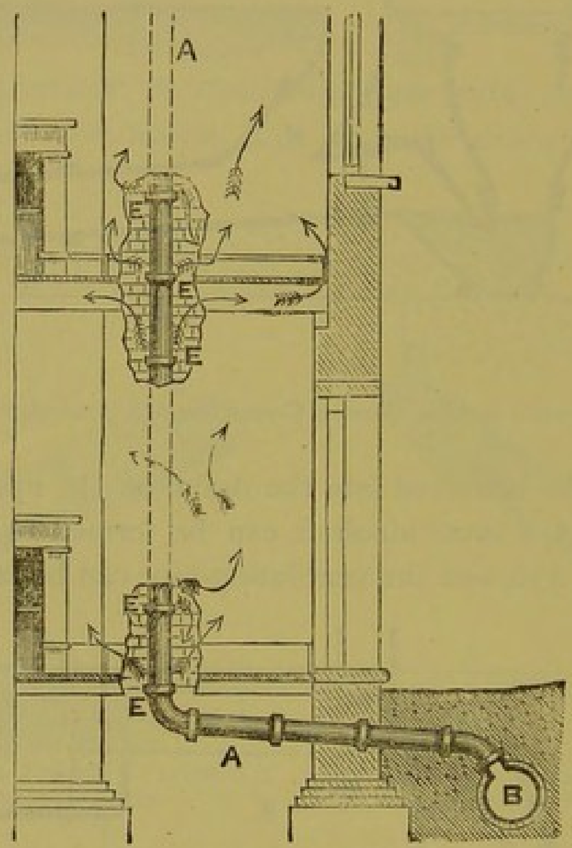


Fig. 237.—Drain-pipe ventilating the Drain through the House!

equal in substance to sheet-lead, 7 lb. or 8 lb. to the superficial foot, according to circumstances; but such pipes should never be less than 6-lb. lead, though many men use only 5-lb. lead. The pipe should be made by hydraulic pressure, and care should be taken to see that it is of an even substance all over. As a rule, 4-in. pipe is quite large enough to ventilate a 6-in. drain.

Earthenware pipe.

It was formerly the custom with some to ventilate their drains with drain-pipe, even in costly houses. Nor were they very particular where such pipes were fixed, whether inside or outside the house. Fig. 237 illustrates what was found in a large house in the West End a year or two ago. Bad smells were complained of in various parts of the house, and on examination it was found that the drain was ventilated by 4-in. drain-pipes, built in a chase made in the face of the staircase wall. Though the pipes were plastered over, the drain-air found its way through cracks here and there in the plastering, for nearly all the joints were unsound.*

Iron pipe.

Wrought-iron or cast-iron pipe is not the right material to use for ventilating a drain. Apart from the durability † of such pipes, there is not only the question of sound and reliable jointings, but that of stoppage also. Two cases have lately come under my notice where cast-iron ventilating pipes from the drains have been completely stopped up. The rusting action, which takes place in all iron pipes (unless they are specially protected from rusting, by some process or solution), had eaten so much into the iron that the corrosions which had dropped away blocked up the pipe, as in Fig. 238. This was found out from testing the drainage with smoke, to see that there was a current through the drain, and finding no result, the drain was opened up, showing the state of things illustrated in Fig. 238.

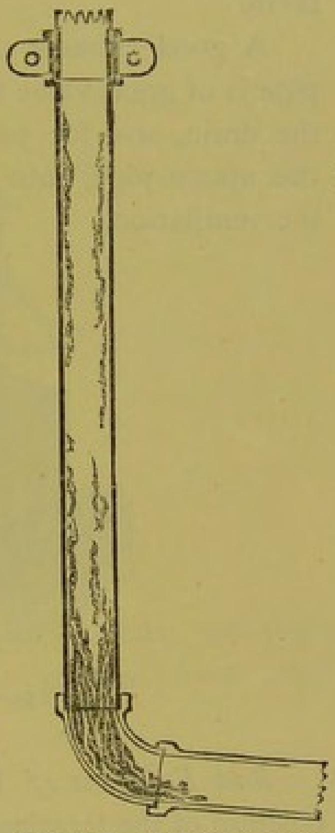


FIG. 238.—Ventilating-pipe stopped up with Rust.

Ventilating terminals.

All ventilating-pipes, especially ventilating-pipes to drains, should be carried up to the highest points of the roof, to keep the air coming out of such pipes as remote as possible from

* In one house, where drain-pipes had been used for ventilating the drain, the bad smell was so great that the occupants had frequently to adjourn from the drawing-room to another part of the house. On examination it was found that the drain-pipe had been broken by plugging the wall to fix the skirting.

† Galvanised *sheet iron* pipe, though much used, only lasts a few years. Galvanised *cast-iron* pipe—rain-pipe strength—is much more durable.

windows and openings into the house, and to gain better results. When such pipes are kept below the roof projections, no good ventilation is obtained, and the air in the drain is much more liable to come out at the disconnection-chamber or induct than if the terminals of the upcast-pipes were kept above the ridge of the roof, where the winds could blow over them.

A good exhaust cowl fixed on the top of a ventilating-pipe is of great value for increasing the current of air through the drain, and for preventing a blow-down of air (through the upcast-pipe) into the drain and causing a reaction in the ventilation.

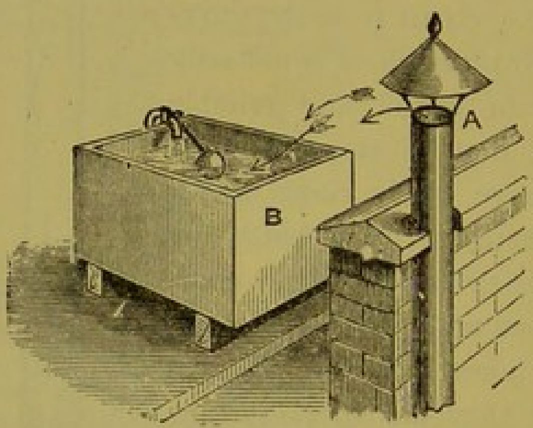


FIG. 239.—Cistern Water Contaminated.

Bad Positions of Ventilating Terminals.—As a rule, the position of the terminals of ventilating-pipes is not sufficiently considered. They are often carried to such points that the bad air from them can contaminate the cistern water, as shown by the arrows in Fig. 239. Or they are taken just through the roof, where the air coming from them can easily pass between the slates into the roof, as in Fig. 240, to go over the house, or to contaminate the cistern water. At other times such pipes are carried up some chimney-stack, and terminated a few inches above the chimney tops, so that the air from them can be blown down into the chimney. If a ventilating-pipe must go up the side of a chimney, to keep it away from windows, it is better to terminate the pipe a foot or two below the top of the chimney, bending the pipe out so as to stand at least a few inches away from the side of the chimney face.

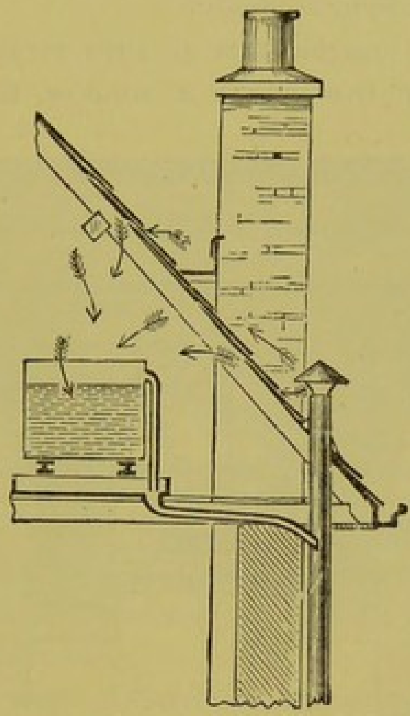


FIG. 240.—Bad Air going into the Roof.

It is common to see ventilating-pipes from soil-pipes and drains terminated where the air emitted from them

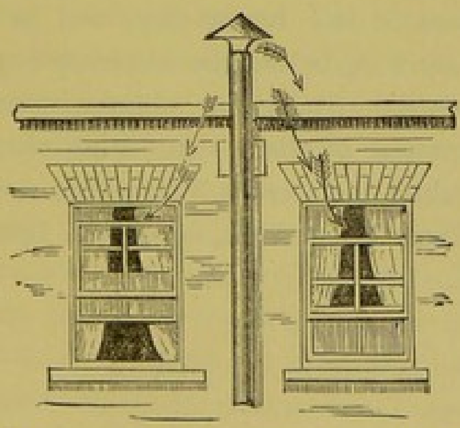


FIG. 241.—Drain Air entering the House.

can easily enter the house when the wind is in certain directions, as shown by the arrows in Fig. 241 or Fig. 242.

When a house is in full occupation, the air from such pipes is at times extremely offensive; and care should be taken that they pour out their unpleasant contents in such places as not to offend anybody.

Some people imagine that if such ventilating-pipes are taken a foot or two above a window, there will be no

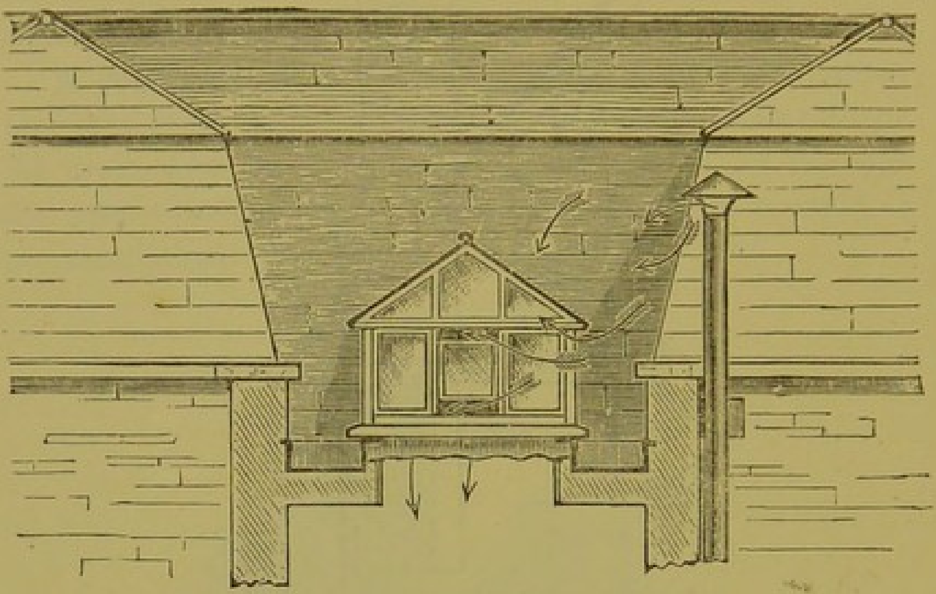


FIG. 242.—Drain Air Entering a House through a Lantern Light.

offence from them. Such people must be *near-sighted*, or wear opaque glasses, or they would have noticed smoke beating down on a dull heavy day, and in gusty weather, to a great many feet below the chimney-tops. And what occurs with smoke from the chimney occurs with the vitiated air sent out of these ventilating-pipes; they should therefore be taken high enough to avoid any offence from them. (See Plates IX. and X., facing pp. 140 and 142.)

CHAPTER XXI.

WATER AND ITS STORAGE.

Pure Water—River Water—Pond Water—Flow-and-return Circulation—Well Water—Rain Water—Place of Storage—Water Contamination—Water Absorbs Air—Service-box Contamination—Water-closet Supply-valves—Cistern Water Contaminated by Bad Arrangement, and by Bad Plumbing—Feed Cisterns—Constant Supply—Cisterns want Cleansing—Cisterns: Their Overflows and Wastes—Slate Cisterns for Storing Drinking-water—Safes under Cisterns—Hinged Flaps on Ends of Overflow Pipes.

PURE water is of such importance in every household, that it ought to be the question of questions before renting a house or erecting one: Is the water supplied to this house *pure?* or can I get pure water here? Pure water.

A stream or river, polluted by the sewage of a village, town, or city, cannot be the proper source of our *drinking*-water. It is hardly possible, with our present system of filtration, to make the water taken from such sources at all times absolutely pure and fit for drinking. River water.

But supposing such water to be filtered, it will be difficult for the drinker to disassociate from his mind the fact that the water he is drinking has been before consumed in a similar way, and perhaps many times. Such an idea will hardly help a sick man to get better.

If river water when polluted here and there in its course by the drainage of sewage, etc., into it, is unfit for dietetic purposes, pond water—stagnant as it often is for weeks together—is much more so. For, as a rule, little or no precaution is taken to keep ponds and their surroundings clean, and almost anything—from yard collections to the drainings of manure heaps—is allowed to be carried into them with the rain. Here cattle wash their feet whilst they quench their thirst. Here dogs clean themselves, whilst diving for a stone or swimming for some object to please their masters. Pond water.

Here the water-loving creatures of the farm-yard come, as to Nature's lavatory, to perform their morning and evening ablutions, cackling and sporting themselves with great glee. And yet water taken from ponds is often the chief source of the water supply, not only for the cottages of the poor, but for country mansions as well.

Flow and return.

Sometimes the evil of making a pond the reservoir for supplying a house with its water is increased by making it also a receptacle for the house-drain to discharge into. There can be no doubt about the completeness of the circulation in such a system. At the moment of writing this, I am concerned in the drainage of a nobleman's mansion where the water is supplied to the house from one end of a long pond, by a ram, while the house-drain empties into it at the other end, the "flow" and "return" circulation being quite complete.

Well water.

There are thousands of cottages and houses in the United Kingdom with a very indifferent supply of pond water to them, when a well sunk twenty or thirty feet would give each house a fair supply of good water. In my early life, in the lovely county of Devonshire, I drank nothing but water drawn, or pumped, from wells, and I never had, nor did I ever hear of, any bad effects from drinking well water.

Where wells are relied upon for the whole of the water for the household, it may cost a little labour in pumping,* but that is very good exercise for men with sluggish livers. In some cases it would be necessary to sink down fifty or a hundred feet to reach the springs, but good well water is worth going down two hundred feet for rather than have to drink water which has been polluted by filth and sewage. Shallow wells, from their surface down almost to their springs, should be made absolutely water-tight to prevent surface drainage into them. And for the same reason deep wells should be made water-tight in their sides for some considerable depth. Great care should be

* Where gas is at hand, an "Otto" engine can be made to pump up in an hour sufficient water for a day's consumption in a household of sixty people.

taken that the drainings from farm-yards, manure heaps, or from any filthy place, shall not enter the well, and no cess-pool should remain within a hundred yards of a well.

Rain-water.

In thousands of cases where there is now a scarcity of water, there might be plenty if proper arrangements were made for catching rain-water. And with proper filtration this could be made fit for potable purposes.

Where there is an insurmountable difficulty in getting a sufficient supply of *pure* water for both drinking and general household use, would it not be worth while to arrange *two* systems of supply to each house—one highly filtered and made pure at any cost, and the other roughly filtered for water-closet and general use ?

No cottage, house, village, or city, should be without a plentiful supply of good water, and there is no good reason why there should be a scarcity of wholesome water in any part of a wet and rich country like ours. But such a subject is too large to dwell upon here.

Plan of storage.

Storage of Water.—Supposing you have been fortunate enough to obtain pure water, the next important consideration is the place of its storage, to prevent contamination.

Water for drinking purposes should be stored remote from all places where bad air or noxious gases are likely to occur. And it is of the utmost importance *to store it away from all outlets to ventilating pipes, from soil-pipes, general wastes, or drains.* Where there is not a constant supply, proper cistern rooms should be formed in every house for placing the cisterns in.

It should not be stored directly over a series of water-closets or urinals, as is sometimes the case, and where the vitiated air of the rooms in which such apparatus are fixed can have easy access to the water.

Water contaminated by bad air.

Water absorbs air, just as a sponge does water ; and when any impure air is near, the water will soon become impregnated with the impurities of the air surrounding it.

The strong painty smell of a newly-painted room is decreased by placing a pail of water in the room. A few hours after the water has been placed there, a coating of an oily nature will be seen floating on its top, proving that the water has been imbibing the vitiated air in the room.

And when a cistern of water is near a foul water-closet, or an outlet of a ventilating-pipe from a soil-pipe or drain,* the impurities in the bad air are imbibed by the water in the cistern, which becomes contaminated just as the pail of water does in the painted room.

By bad arrangement.

A great deal of ignorance exists upon this subject of water-contamination. Many imagine that by putting a partition in a cistern, as Fig. 243, and dividing it thus into two compartments, that they have done all that is necessary to keep the two waters entirely separate from each other. They then confine one compartment to drinking purposes and the other to water-closet uses, leaving the tops of each compartment open—even connecting them together by a waste-pipe, which takes the overflow from the two compartments. Now, the water in these two compartments is about as separate as the late Siamese twins, and the protection thus secured as reliable as the ostrich's when it hides its head in the sands and leaves its body exposed to the huntsman's shots. For if the water in the water-closet service compartment becomes contaminated, what is to prevent the impurities from flying off from this body of water, and passing over the top of the partition to the water in the drinking compartment?

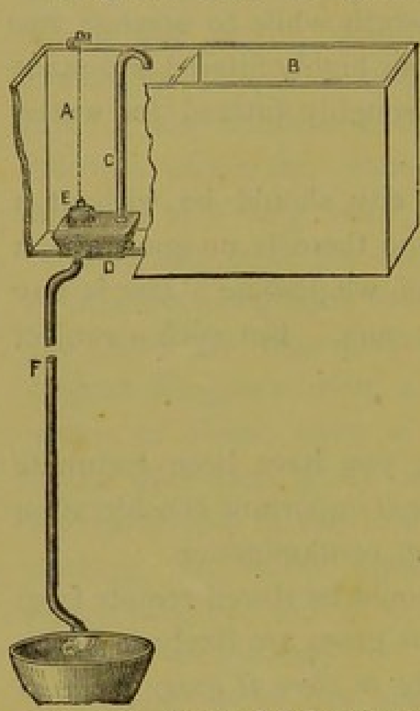


FIG. 243.—Service-box Supply to Water-closet.

Service-box supply.

Moreover, it is, as a rule, only when a *service-box supply* is used for serving a water-closet apparatus, that the water in the cistern which supplies the apparatus gets contaminated:

* See Fig. 239.

and one of the chief means of this is the air-pipe, C, to the service-box, which is always taken up to about the level of the top of the cistern, so that it is almost as near one compartment as the other; and if it contaminates the water in the one compartment, it will speedily vitiate that in the other.

Supply-valve seals the service-pipe.

It is supposed by many that it is impossible to supply a water-closet apparatus without in some way or another contaminating the water in the cistern from which the water is taken. But this depends entirely upon the service fittings by which the water-closet is supplied.

Service-box opens the service-pipe.

A water-closet served by means of a *supply-valve* attached to the apparatus, no matter how near or distant the cistern or reservoir may be, always leaves the service-pipe between this valve and the cistern full of water; how, then, can any air—good or bad—pass back through this water-charged pipe to the cistern? Moreover this valve is, in its normal position, always closed, and acting thus as a stop-valve it most effectually shuts off all communication with the cistern, and becomes a *double* check to the passage of any air from the water-closet apparatus to the cistern.

A water-closet supplied by a service-box, as shown in Fig. 265, always leaves the service-pipe, F, empty, and in direct and open communication (through the air-pipe C), with the cistern which supplies it with water; and there is nothing to prevent any bad air in the water-closet from passing up behind the "fan" of the basin, through the service-pipe, F, and the service-box, D, into the air-pipe, C (to the service-box), and from this air-pipe into the cistern, A and B. But supposing this air-pipe to the service-box to be taken farther away to discharge into the open air instead of into the cistern, which is rarely if ever done, there is still a direct communication between the service-box in the cistern and the water-closet, and this communicating-pipe is always empty, and any bad air in the basin is sure to ascend into this pipe, and directly the valve, E, is open in the service-box it will escape into the cistern. Thus in the one case—with the supply-valve attached to the apparatus—it is impossible for the cistern-water to be contaminated by supplying a water-closet, and in the other case—the service-box action—it is hardly possible to be otherwise.

Supply-valve and regulator.

I am so satisfied that no communication can take place

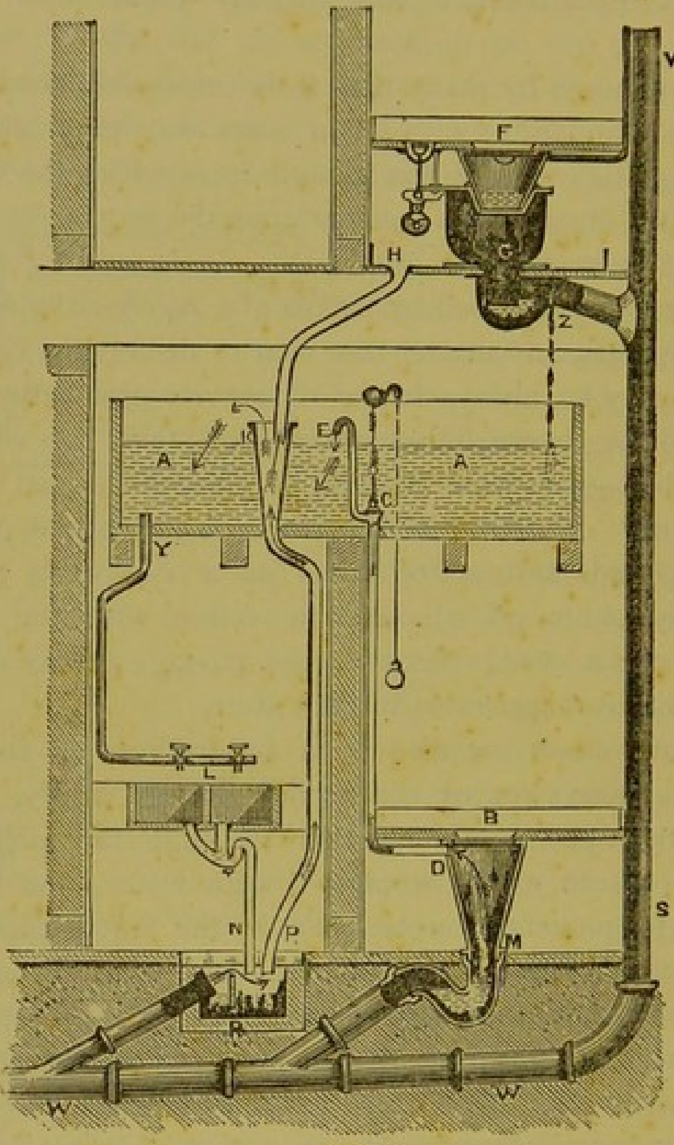


FIG. 244.—Water Contaminated by Bad Appliances and Bad Arrangement.

between a valve-closet supplied with a valve-and-regulator apparatus, and the cistern (the cistern itself being placed in a proper cistern-room) that in my own house such water-closets are supplied by a service-pipe taken from the drinking-water cistern. But no such closet—in fact, no water-closet or urinal—should be supplied with water from a rising-main, constant service, or otherwise, which also supplies the draw-off cocks for drinking purposes. But though my own house

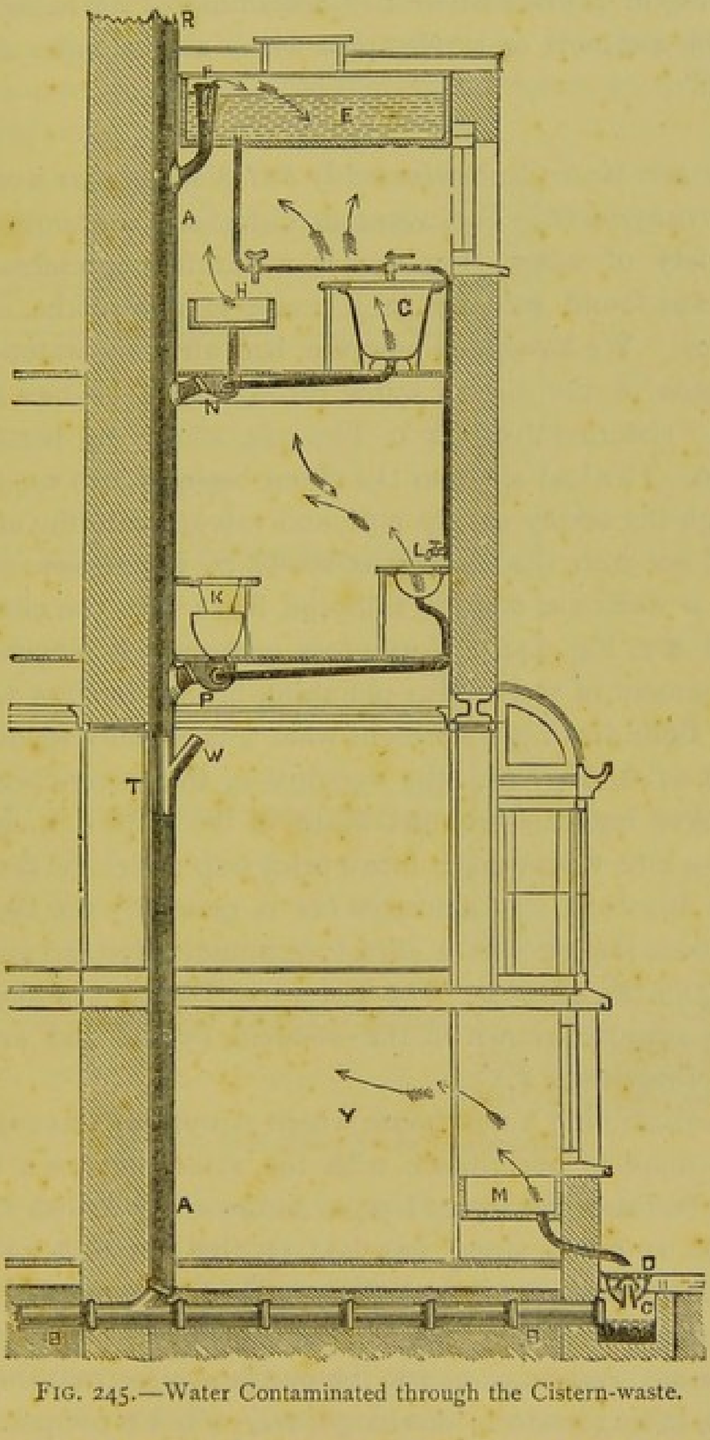


FIG. 245.—Water Contaminated through the Cistern-waste.

is treated in this way, I prefer to keep to the rule which I have laid down elsewhere, viz., "No draw-off cock to any sink, 'fitting,' or fixture, other than a water-closet, shall be supplied from a cistern fixed in a water-closet room, or standing in a place where any contaminated air can reach it, or from a cistern or service-pipe which also supplies a water-closet."

Bad plumbing.

Cistern water contaminated by bad plumbing as well as by bad arrangement.—The water in cisterns is contaminated in a variety of ways. Fig. 244 is a faithful representation of what was found recently in a house in one of the London squares. We have seen how the bad air from water-closets can pass to the cistern water through a service-box supply, but a "cistern-valve," as C, Fig. 244, affords no better protection. The bad air from the closet basin, M, can easily pass through the empty supply-pipe, and valve, C, into the air-pipe, E, and out into the cistern, as shown by the arrows. Sometimes a defective trap, or soil-pipe, leaks into the cistern, as shown at Z, Fig. 244. Very gross ignorance is shown in the arrangement of the various plumbing fittings in Figs. 244 and 245. Both drawings represent what was actually found. As shown at H, Fig. 244, the overflow of the water-closet safe was taken into the trumpet-waste of the cistern, K, and the under-waste, P, was taken into a brick trap under the floor, and as the dip-stone was defective (as is generally the case with such traps) there was a direct communication between the drain and the cistern. The cistern, E, Fig. 245, is also open to the drain, as shown in the woodcut, by the bad arrangement of its waste, F.

Feed-cisterns.

In examining a new house where everything was supposed to be done in accordance with the rules laid down by the Local Board of the town, I came across many foolish things; but as so much stress was laid on the fact that *all* pipes (except the soil-pipes) were "properly disconnected," I give an illustration in Fig. 246 of what was found in one part of the house. As shown at F F, the overflow-pipe from the feed-cistern, B, was made to discharge over a brick cesspool trap. The bad air from decomposing soap-suds splashed about over the grating and its surroundings from the lavatory waste, as well as the bad air from the large body of stagnant water in the cesspool-trap, could easily travel up through the overflow-pipe, F F, to the water in the feed-cistern. And as the dip-stone of the trap was defective, the drain air could also pass up the overflow-pipe, to contaminate the cistern water, as well as to enter the house, as shown by the arrows.

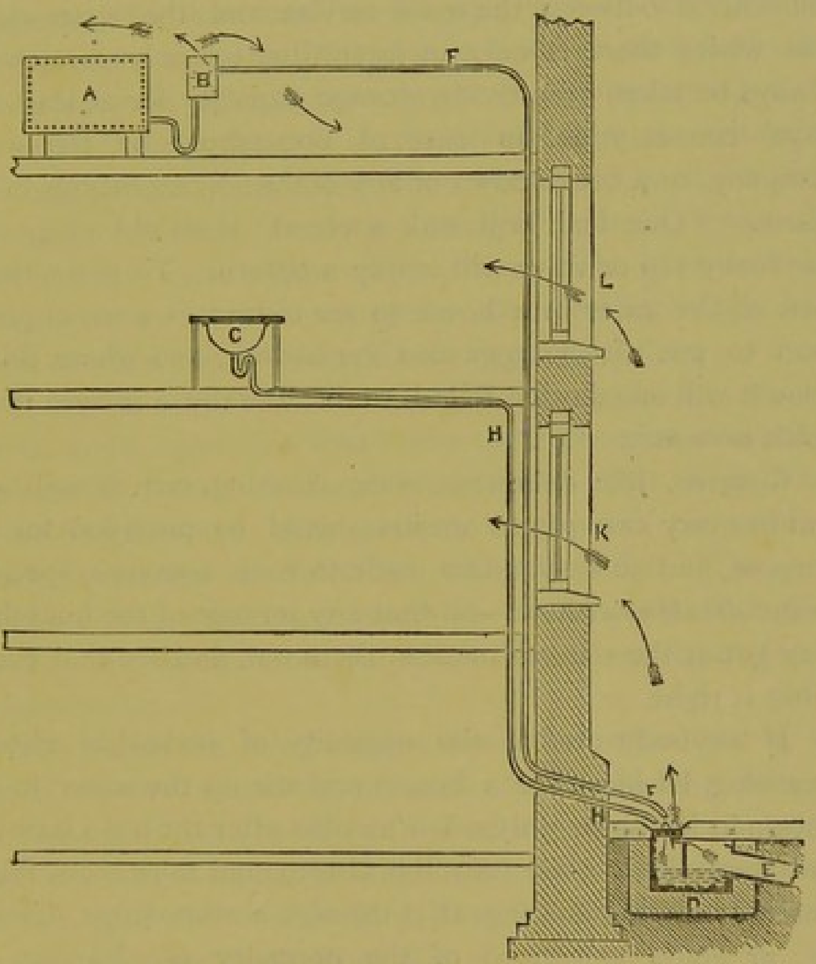


FIG. 246.—Feed-cistern Water Contamination.

It was also impossible to discharge the wash-basin, C, without unsealing its trap, for the waste-pipe was of very small bore, and it had no air-pipe to prevent syphonage, or to ventilate the waste.

Feed cisterns are very small things, and for that reason are often overlooked. They are rarely cleaned out, though the cook often draws water from a hot-water cock—which must have first passed through the feed cistern, except in the

Feed cisterns overlooked.

case of the cylinder principle of circulation—for her culinary purposes. I have often found the water in such cisterns as dirty as the dirtiest of pond waters.

Constant supply.

Where there is a *constant supply* there is no need for cisterns, except to the water-closets, to break the pressure and to get a better regulated supply, and also to prevent communication between the main service and the water-closet. But where there is only an intermittent supply, care should always be taken to provide storage capacity for at least two days' consumption, in case of non-supply by the water company, or a break-down of any of the service fittings in the house. "One leak will sink a vessel" is an old adage, and one leaky tap or valve will empty a cistern. To store, therefore, all the water in a house in *one* cistern, is a worse policy than to put all the eggs into one basket; and where this is done it will one day be found to be literally a cistern which holds no water.

Cisterns want cleaning.

Cisterns, like chimneys, want cleaning out periodically, and in every case proper means should be provided for this purpose, and an easy access made to each cistern—especially to the *drinking-cisterns*—so that any servant of the household may get at the cisterns to clean them out, and see that everything is right.

If anybody doubts the necessity of periodical cistern-cleansing, let him take a broom and stir up the water in any cistern in his house only a few months after the last cleansing, and then dip a glass into the cistern and take it out full of water, and, after looking at it through a microscope, drink it off, or stand convinced of the necessity of cleaning out cisterns periodically.

Water companies' rules.

According to the rules of the London water companies, legalised by Act of Parliament, there are now to be no *wastes* to cisterns in the London radius, and so the comfort of the householder has been ignored; the water to be delivered is to be *so pure* that it will never require changing, however long it remains in the cistern, and the cistern will, therefore, not need any cleaning out. For the Metropolis Water Act of 1871 simply provides for an *overflow-pipe* to prevent waste of water, and to act as an indicator to the water companies to tell them when the cistern ball-valve is defective. But the water will not rise up out of the cistern to go out of an overflow-pipe when the cistern has to be cleaned out.

And the size of this pipe—viz., $\frac{1}{2}$-in. bore—is of little use to the householder, however valuable it may be to the water companies, for how can a -in. pipe, without any pressure upon it, take away the full charge from an *inch* ball-valve with a pressure of from 40 to 70 ft. head-of-water upon it? Of course, where there is a *constant supply*, a much smaller size ball-valve can be fixed; but even then such an overflow-pipe will not be large enough to take away the delivery, say from a $\frac{3}{8}$-in. valve, when it is kept open by a small stone washed up under the seating of the ball-valve, or when the valve itself becomes defective. Overflows.

Many of the water companies are gracious enough not to insist upon this small size overflow-pipe, and allow any size that may be required, provided that it is made to discharge where their servants can see if the water is wasting through a defective ball-valve, &c. For such trumpery ball-valves are used in many cases that they waste more water than the whole house consumes for its legitimate use.

The size of the overflow-pipe should be determined by the size of the service, and the pressure of water likely to be upon the ball-valve. An overflow fixed to a cistern on the ground floor requires to be larger than an overflow fixed to a cistern on the third and fourth floor, if served from the same pipe and by the same size ball-valve. Size of pipe.

As a rule, about *twice* the size of the service will give the size of the overflow, except in the smaller size services, but *no* overflow-pipe from a cistern supplied direct from a rising-main should be less than an inch and a quarter in diameter.

As to cistern-wastes, let the following rule be laid down, and be as binding as the laws of the Medes and Persians. No overflow or waste-pipe from a cistern shall be connected with any other overflow or waste, soil-pipe, or drain; and in all The discharging place of cistern wastes.

cases, such wastes or overflows shall be taken through the external wall of the house, and discharge with an open end. Nor should such a pipe be allowed to discharge into a drain-intercepting-trap, or over the grating of such a trap. The water in such traps evaporates in the summer, and often leaves the trap uncharged; or impurities are thrown off by the water in this trap, or sewer-gas escapes through it; and when there is this cistern-waste or overflow over it, the "gas" passes at once into the pipe, and is drawn up through the pipe, by the warmth of the house, to the water in the cistern. And it is useless to put a trap in this pipe to prevent this, for there are no means of keeping it charged without a great waste of water.

The waste, or overflow, should always discharge some few feet away from the drain-trap, and a channel should be formed from it to the trap, to conduct the waste water, when the cistern is being cleaned out, into the trap.

Where possible, there is no better way of fixing this waste than by taking it into a gutter, with a copper-hinged flap soldered on the end of the pipe, as in Plate X. Of course the end of this waste-pipe must never be fixed near the outlet end of a ventilating-pipe from a drain or soil-pipe, or the vitiated air will pass through the waste to the water in the cistern.

When the cisterns are too low for taking the waste from them into roof gutters, or where there are no roof-gutters to take them to, the pipe should be continued down through the house to the nearest surface-trap *discharging some few feet away from the trap in all cases*, for reasons assigned above.

It is sometimes almost impossible to fix a waste-pipe in this way, except by a pipe as long as from "John-o'-Groat's to Land's End." When this difficulty occurs, and where there are no water companies to interfere, there is no better way of surmounting it than by the following plan, which may be adopted with the utmost safety:—

Take an *overflow-pipe*, at least twice the size of the service-pipe, from the top of the cistern to the *nearest external wall* of the house, and let it stand two or three inches beyond the face of the wall, with a copper-hinged flap, I, Fig. 247, soldered on the end of the pipe, to prevent birds building in it, and stopping it up, &c., and also to shut out the draught in case of frost. The "outlet end" of this overflow-pipe should always be a foot or more below the inlet in the cistern, to give a pressure of water upon the copper flap to keep it open during an overflow (see Fig. 247, H and I). Having provided an overflow-pipe, *i.e.*, for a failure in the ball-valve, the next important thing is to provide proper means for cleaning out

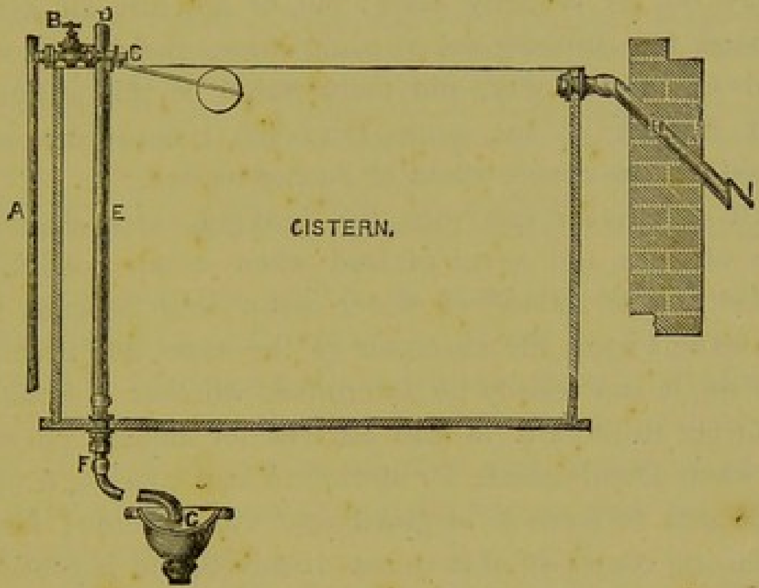


FIG. 247.—Cistern Overflow, and Cleansing Pipe.

the cistern. Fix a brass washer and waste connection in the cistern bottom in the usual way, and as this is only for cleaning out purposes, and not an overflow-pipe and waste combined, the size need not be more than 1 in. or $1\frac{1}{4}$ in. Then take a $1\frac{1}{4}$-in. lead under-waste from it to the nearest rain-water-pipe-head, as shown at F and G, Fig. 247; or, if there is no rain-pipe near or in the vicinity of the cistern, or if the rain-water is collected for household purposes, then take the pipe into a deep draw-off sink—a sink with a large overflow to it. And from this brass washer-and-waste in the cistern-bottom, fix a standing-pipe, as E, Fig. 247, and continue it up to the top of the cistern, with the *end*, D, *soldered over*, to act simply as a *plug*. An ordinary plug and washer

U

with a long chain would answer the same purpose, but it is not so easy of management as the standard lead plug just named. If the chain-plug were pulled out by accident when the cistern was full of water, it would be difficult to replace it; but there would be no difficulty with a standard plug, which by force could be instantly replaced.

With an arrangement of this kind, how can any air, foul or otherwise, pass through this pipe, with a *sealed end* at the top of the cistern? The only danger about such a mode is that it may not be properly done; but, at any rate, all cisterns *not* used for drinking-water could have their wastes disposed of in this way, and there would be this advantage about it, that at the same time the cistern was being cleaned out the drains would be flushed as well.

Materials for cisterns.

All cisterns or reservoirs for drinking-water should be made of slate, and never of lead when it can possibly be avoided. The action* of water upon lead depends to a great extent upon the character of the water, and when this is known, it can readily be determined whether it would be safe or not to store it in lead cisterns for dietetic purposes. And when found unsafe for storing in lead cisterns, it would not be safe to store it in *galvanized* iron cisterns; for the galvanizing comes off, if it is not dissolved, and is consumed with the water. When galvanized iron cisterns are used, the thickness of the metal ought never to be less than $\frac{1}{8}$ in. Such cisterns, when about 4ft. square, should be made of $\frac{3}{16}$-in. plate, and over that size $\frac{1}{4}$ in., if they are to last a proper time. Cisterns for water-closets and general use can be made of lead, or any material which may be most convenient.

Safes.

Lead safes should be fixed under slate and iron cisterns with overflows from them discharging into the open air. (See Plates X. and XV., showing same.)

Hinged flaps on ends of pipes.

All overflow-pipes and cistern wastes should have a hinged brass or copper flap, on their ends, to prevent cold air passing through them and freezing the pipes, &c., and also to keep birds from building in the ends of such pipes (See Plates X. and XVI.)

* See p. 365.

CHAPTER XXII.

WATER SUPPLY TO WATER-CLOSETS AND URINALS.

Water of the First Importance—Water Delivered by Companies' Mains—Flimsy Fittings—Water Limited—Water-closets Treated as if they were Deodorisers —Water-closets want Cleansing—A Good Supply of Water Necessary—Closet-traps Imperfectly Cleansed—Closets badly used—Rising-mains—Constant Supply—Intermittent Supply—General Supply—Pipe-freezing—Supply of Water to Water-closets by Valve-and-Regulator, and by Flushing Apparatus—Water-closets Supplied by Waste-preventers—Double-valve Waste-preventers—Syphon waste-preventers—Supply of Water to Urinals.

Water of the first importance.

In the water-carriage system, the supply of water to water-closets, slop-sinks, and urinals, as indeed to all vessels or fixtures, with waste-pipes where polluted water is discharged through them, is of the first importance, and if adequate flushes of water cannot be afforded, such fixtures should be done away with, for sooner or later they or their belongings will become a nuisance.

It ought to be laid down as an *axiom* that no supply of water is adequate to the purpose of keeping a water-closet, or any other such "fixture," with its belongings, wholesome, unless it exceeds in force and volume the body of polluted matter discharged into such fittings.

Water delivered.

Like Mrs. Glass, you must first catch your hare before you can cook it, and so you must get the water into the house before you can use it. Water, like almost everything else nowadays, is *delivered*. It has neither to be fetched from the town pump, nor drawn up by a windlass, nor pumped up from the well in the yard, but is supplied to almost every house in city, town, and village by water companies, under certain regulations. Such companies have a perfect right to make their own rules, within certain limits, but these should always be for the benefit of all concerned, and not solely for the shareholders. Poor shareholders! how the people waste their water! But how conservative the shareholders are of their water! It is a pity they cannot have a "flow and return" circulation to each house from their mains. Well, all the harm that we wish them is that they may always have a reserve of this beverage for their own consumption without anything to add to it. And as for the people who wilfully waste their water, they should be made to collect what they waste, and then be dipped in it by the water companies' servants.

Flow and return.

Flimsy supply fittings.

Water companies can hardly be too strict, or look too sharply after their water, for there are such trumpery ball-cocks and ball-valves used, that they are really nothing less than water-wasters. And the general service supply fittings are, in many cases, of such a flimsy character that they break down almost as soon as they are used, and, like an icicle under the rays of the sun, begin to "drop, drop," until there is no more water left in the cistern to drop through such leaky valves. This is where the water companies should save. But to limit the supply of water to a water-closet or urinal, where it is so essential for health and cleanliness, is a step in the wrong direction. The means taken for the prevention of waste, and the appliances sanctioned or insisted upon by the various water companies, are so poor that it is hardly too much to say that more water is wasted under the new system than under the old. It is hardly likely that anybody —even to spite the water company which supplies his house with water—would care to stand with his nose over a water-closet apparatus on purpose to waste water, and if he does open the valve to flush out the water-closet and soil-pipe occasionally, he does a good thing for himself and his neighbourhood, for he helps thereby to keep his sanitary arrangements wholesome.

Water limited.

Instead of making *rules to limit* the supply of water, as water companies are doing all over the kingdom, to such sanitary fittings as water-closets and urinals, *laws* ought to be enacted *compelling adequate flushes* of water to all such water-wanting " vessels."

The quantity of water allowed by the various water companies, and made legal by Act of Parliament,* is two gallons for each usage of the closet. "Tell it not in Gath, publish it not in the streets of Askelon ! " Two gallons of water to carry away a deposit in a water-closet through some scores of feet of soil-pipe and drainage, flush these pipes out after its passage, and cleanse the whole! This is about as difficult a thing as making bricks without straw.

One is curious to know how and where this exact quantity of water was calculated, and on what sort of water-closet it was tried. If one might make a guess, one would say it must have been somewhere in the dark, and if measured in pints, it must have been on the principle of the baker's dozen. Let us look at the thing practically, *i.e.*, with an open eye. Suppose it takes two gallons of water for a water-closet fixed in the basement (where we have guessed the discovery to have been made), to cleanse the closet after usage, wash out the trap, and deliver the deposit into the sewer, how much water will it take for a closet fixed on the second or third floor at the rear of the building, with about fifty feet more soil-pipe, and fifty or sixty feet of additional drainage? Why, it would require this quantity of water to wet the pipe, and two or three such discharges to thoroughly cleanse the closet, trap, soil-pipe, and drain after the passage of an offensive stool through it, and to keep it wholesome. Some closets require more water than others to keep them clean and wholesome, apart from their positions. And it must be evident even to the most conservative of shareholders, that when a water-closet is fixed a long way off from the sewer or main drain, it must require a good supply of water to keep it, and all its appurtenances, in a sanitary condition.

"Spigot and Bung" principle.

" Take care of the spigot and leave out the bung," would

* The Metropolis Water Act, 1871.

be a good hatband for water companies' servants. "Don't forget the *Rules*, and mind, they are according to Act of Parliament—'two gallons of water,' by *measure*—not a drop more—to cleanse (?) out the water-closet apparatus, trap, soil-pipe, and drain, and flush the whole of the motion into the sewer." "But it was such an *offensive stool*, Mr. Watercompany, and the patient was suffering from *fever*. May we not have another tea-spoonful?" Another tea-spoonful! Why, sensitive noses, you must think we are made of water. No, you must wait until the excrement has dried upon the soil-pipe, and by that time the "water-saver" will be re-charged, and you can then have a second flush. But stay, if you are only in want of *water*, go to the nearest sink or lavatory, and draw as much as you like without stint or hindrance, for according to our *rules* there is no limit to such draw-offs, though we must show some *sign* of 'screwing' even here, but it is only in the 'screw-down' tap." Well, there must be bungling in a world where there are so many bunglers; and if the *spigot* is sometimes mistaken for the *bung*, it is excusable, especially when nothing stronger than water is to come out of it.

More water.

Every sanitarian should lift up his voice against such limitations of water to such sanitary fixtures, and never cease crying, like Oliver Twist, for *more* water until a quantity of double, or even treble, the present amount is allowed for water-closets and urinals.

W.C. s treated as deodorisers.

One would suppose, not only from the rules of water companies, but also from the way in which people (especially servants) treat water-closets and such-like fittings, that they were *deodorisers*. Everybody knows how a chamber-utensil, if left half-full of urine, will smell if kept in a room for only a short time; and yet nine servants out of ten will empty such matter into a closet, and leave it there or thereabout for any length of time, without any attempt to *wash* it away.

Let us shelve water companies' rules for a time, and think only of the needs of water-closets, etc., and the best way of supplying them with water to keep them perfectly wholesome.

Servants receive standing orders to wash out every day, or every other day, the halls and entrances to our houses, but they are rarely ordered or expected to wash out the water-closet apparatus, sinks, lavatories, etc., though the traffic through such fittings is greater and the matter much dirtier than anything that comes from the bottoms of our boots. In every house of any dimensions a turk's-

W.C.'s etc., want cleansing.

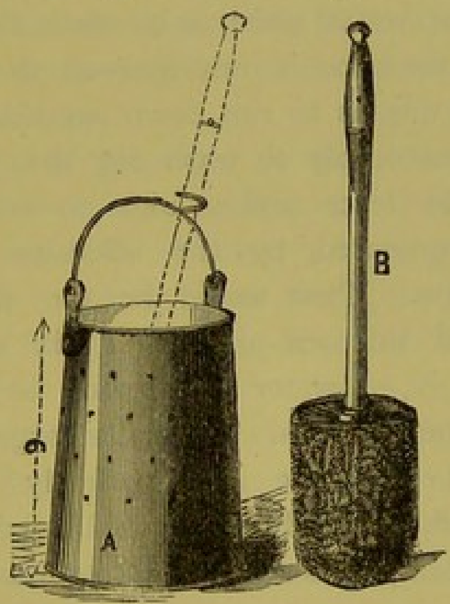


FIG. 248.—View of Can and Closet-brush.

head brush, as Fig. 248, should be kept, for the purpose of washing out the closet-basin and "conductor" of the apparatus, *i.e.*, the closet-basin should be well washed round with this brush, B, and then the brush should be pushed down into the trap as far as it will go, and well rubbed up and down for a few seconds, the water being allowed to pass through the closet all the time; and, after well rinsing the brush, it should be put back into the perforated can, and the can hung up in the housemaid's closet, or out of doors.

Brush for cleansing closets.

The supply of water has much more to do with keeping water-closets and such-like fittings wholesome than most people imagine. A water-closet with its belongings would be found in a better sanitary condition after six years'

A good supply of water necessary.

usage with an *efficient* supply of water, than it would after six months' usage with an *inefficient* supply. A moment's consideration will show this. Let us suppose—and the supposition will be inside the facts—that an offensive stool is deposited either in a pan or valve-closet, and that this fæcal matter is discharged into a long length of 4-in. soil-pipe in such a manner as to pass through it as a sort of plug, staining, as it would more or less, the whole of the inside of the pipe all the way down; and suppose that the water which is to wash this filthy matter out and clean the pipe is only allowed to *dribble* into the closet in such a way as to run down *one* side of the pipe—*i.e.*, that the water-supply to wash out the filthy motion is only sufficient in force and volume to cover *one-third* of the area contaminated by the offensive matter passed through the pipe. What would be the state of the un-washed part of the soil-pipe after six months' usage? Unless the supply of water is greater both in force and volume than the polluted water discharged through such pipes, they will never be kept perfectly wholesome. It would be possible to allow the collected water of the London water companies to pass through a polluted water-closet in such a manner as not to cleanse them, as it would be possible for a gunner to keep firing off gunpowder a grain at a time for ever and ever without getting the shot out of his gun.

Supply not equal to the demand.

When the supply of water is not equal to the demand, *i.e.*, when the flush of water to a water-closet, slop-sink, urinal, or such-like fitting, is not enough to cover the whole area of the waste-piping and drainage contaminated by the discharges of offensive matter through them, the waste-piping soon becomes incrusted with excremental matter, and when once this has corroded the piping, no amount of flushing will make the drainage absolutely clean again. One usage of a water-closet, or urinal, with an *in*efficient supply of water, will foul it more than a dozen usages with an *efficient* supply. Drops of water may wear away stone, but drops of water will not clean away filth. A day's drizzling rain will leave the streets as dirty, and often dirtier, than they were before, but a sharp shower of rain for a few minutes will make them clean, and that, too, with a much less quantity of water.

It would, perhaps, surprise most people to be told that in nine cases out of ten the deposit is not washed wholly out of the closet-trap with *one* flush of two gallons of water. This is especially the case with water-waste-preventing valves fixed under the water-closet seat. If the hand be put down into the trap after the closet has been used—with only a 2-gallon flush—fæces together with paper will be found remaining in the trap. Closet-traps imperfectly cleansed.

I had a strip of glass put in the side of a water-closet trap under a valve-closet, to see into the interior of the trap, and found that one flush of water of two gallons (or a long dribbling supply of three times that quantity) never wholly freed the trap of foreign matter. (See Table 1, p. 61.)

Some people are too careless, or too idle, to give a water-closet a proper flush of water, even when there is no restriction upon it, for they do not pull the handle even once, or only pull it just enough—in the case of a pan or valve-closet—to get the excrement out of the basin. A neat white porcelain tablet, lettered in gold, and placed where the person using the closet can see it, is a good way of getting a valve-closet properly treated. Closets badly used.

After*, using the Water-closet, pull up the handle TWICE, as far as it will go, and hold it there a second or two each time.

Rising-mains or Service-pipes from the Water Companies' Mains for supplying houses in the Metropolis with Water.—The size of the pipe, for laying on the water from the water

* It is a good plan to send a flush of water through the closet *before* using it, to prevent the excrement sticking upon any part of the basin, trap, or soil-pipe.

company's main, must generally be determined by the company from whose main the water is supplied, though there is not much difficulty in deciding upon the necessary size, which varies, of course, with circumstances.

Constant supply.

Where there is a *constant supply*, and the water is not drawn direct from the main,* as it should be, except for water-closets and hot-water circulation, ½-in. or ¾-in. (or 1-in.) is generally large enough, though the size † of the main must depend upon the company's pressure, and the quantity of water likely to be used.

Intermittent supply.

Where the supply is *intermittent*, *i.e.*, when the water is only turned on for about an hour or two hours a day, the rising-main must be of sufficient size to charge the storage cisterns in that time, and to do this in high buildings 2-in. or 1½-in. pipe is generally needed, though in private houses where the cisterns are not more than about thirty feet above the street level, 1¼-in., or even 1-in., will be large enough.

Rising mains.

According to Act of Parliament, the pipes between water companies' mains and the cisterns must be of lead, of a certain strength ‡; at any rate, the pipe from the main in the street to the place of ascension, inside the owner's property, must be of lead.

A screw-down stop-valve (brass or gun-metal), with a "cock-box" over same, is required by the water companies to be fixed in each branch from their main, somewhere outside the house, for the sole use of the *turncock*. But it is always advisable to fix another stop-valve in the rising main, directly after the pipe has entered the house, for the occupant's use in case of accident to the rising main itself, or a break-down of any of the ball-valves fixed upon it.

* When there is a *constant supply*, all water for drinking purposes can be drawn *direct* from the *main*, and great risks of drawing contaminated water avoided, for when the water companies deliver wholesome water to a house it is often made unwholesome by being stored in foul cisterns.

† When the rising-main is also used for supplying fire-hydrants, it should not be less than 3 in. (cast-iron water-main), and this pipe should then be fixed in the staircase, where the hydrants can easily be reached.

‡ See Table of Weights of Lead-pipes, p. 360—362.

In large houses, where there are several cisterns, and especially where there is a constant supply, it is advantageous to have a stop-valve in each branch, fixed just behind, and connected with the ball-valve, as B, Fig. 269, page 305, to shut the water off one cistern, when necessary, without interfering with the supply to other cisterns.

General supply.

General Services, or Service-pipes from Cisterns.—Every service-pipe from a cistern should have a stop-cock in it for shutting off the water in case of accident with any valve or fixture upon it, or in case of frost, and this stop-cock should be fixed as close to the cistern as possible (as W, Plate XV., facing p. 200).

No stop-cock, or stop-valve, unless it has a *clear way* through it, should be fixed on a service-pipe to a water-closet. The flush of water to water-closets is often marred, even where there is a good-sized service-pipe, by a stop-cock which is not adequate in the water-way of its plug to the bore of the pipe. A "square-way," or even a "full-way" or "round-way"—so-called—stop-cock is often only equal to charging a pipe one size smaller than the size of the cock. When the general service does not descend immediately it leaves a cistern, it is better to fix that part which is "horizontal," or is about on a level with the cistern, of a size larger than the descending pipe; and the stop-cock or stop-valve,* being in that part of the piping, should also be one size larger. Where the pipe has to be connected with a lead cistern, it can be easily opened a little by driving the "turn-pin" into the end of it; but where it has to be connected to a slate or iron cistern, the brass cistern-connection —"boiler-screw" or "union-connection"—should be one size larger than the descending pipe, *i.e.*, supposing the general service, or descending pipe, to be 1¼ in., the brass cistern-connection should be 1½ in.

Pipes protected from frost.

Pipe-freezing.—With good judgment in positioning cisterns, and in casing them in, and with proper care in fixing

* No stop-valve should be fixed in a service-pipe to a water-closet, unless it can be opened to give a *clear way* right through it.

service-pipes, no occupied house in England need be inconvenienced by frozen pipes. An extract is given here of what I have said elsewhere on this subject:—

"No service-pipe should be fixed on the external nor on the internal face of an external wall, especially a wall facing the north or east, without being cased in and thoroughly protected. When possible, service-pipes should be fixed on the cross-walls inside the house, and never on the main walls; for the cold penetrates through the external walls and reaching any pipe fixed on its face, though inside the house, freezes the water in it. If a pipe *must* come down on the internal face of a main wall, then an inch board should be put between the pipe and the wall, and the pipe cased up, and the casing filled with cocoa-nut fibre. All service-pipes in roofs should be boxed in, and the boxes filled with this fibre. I do not like sawdust, for that decays; nor hair-felt, for that rots; and besides, to cover pipes with such material where bad air could reach it would be to harbour smells, for the effluvia coming from persons using the water-closets would hang about such stuff and cause it to become stuffy. Where the service-pipe could not be boxed or cased in, and where the cold air could reach it—as, *e.g.*, under water-closet seats, where the pipe has to leave the casing to reach the supply-valve of the water-closet—the pipe should be bound round with two or three thicknesses of gaskin, and then be covered over with canvas, to protect it from frost. The cold air coming in through the overflow-pipe of the safe, and blowing upon an unprotected pipe, would soon freeze it."

WATER-CLOSET SUPPLY.

Valve-and-regulator supply.

There is no better way of supplying a water-closet than by a *good* "SUPPLY-VALVE AND BELLOWS REGULATOR." This arrangement is known as *Underhay's*, but his patent expired some years ago, though Mr. Underhay holds another patent for what he considers a better kind of *regulator;* but I prefer the earlier one: a bellows regulator made with a strong copper case.

A valve-and-regulator (the "valve" for opening and closing the service-pipe, and the "regulator" for regulating the quantity of water) can be attached to the apparatus, as shown at G F, Fig. 144; or it can be fixed separately by being mounted on a cast-iron frame, as in Fig. 249. There is this great advantage with such an arrangement, viz., that *any number* of closets can be supplied with branches from one general service-pipe, the main-pipe being increased in size accordingly. But the chief advantage is, that *directly* the handle of the closet is pulled, to get rid of the deposit, the water rushes into the basin to wash it out before the basin-valve (in a valve-closet, or the copper pan in a pan-closet) is closed. With a "service-box" action, or a "water-waste-preventing"* cistern arrangement, the interval between pulling the handle and the water coming into the basin amounts to several seconds, and the basin-valve or the "tipping-pan" is often closed before the basin is washed out.

For *flushing-rim* closets, and for a good flush of water, it is necessary to have supply-valves of a very large size, unless there is a good head of water over them. (See Table No. 1, showing size of service-pipes and supply-valves, page 360.) As a rule, water-closet manufacturers do not make these water-closet supply-valves large enough to get a flush of water through them; but since I introduced the 1¼-in. and 1½-in. some years ago, some manufacturers have increased the size of their valves from ¾-in. to 1-in., and in some cases from 1-in. to 1¼-in. But 1¼-in. is not large enough where the cistern is only a foot or two above the level of the water-closet seat.

A great deal of ignorance exists upon water-pressure and the size of the pipe necessary to give a good flush of water to a closet; and, astonishing as it may seem, few people are more ignorant in this matter than plumbers. A small *feed-cistern* will give just the same pressure as the largest tank in the world, if fixed on the same level. What is wanted is height to give pressure, and where head-way of water cannot be obtained, then the service-pipe must be increased in size—not to give pressure, but to deliver a

* A good supply-valve-and-regulator is not likely to waste as much water as nine tenths of the so-called water-waste-preventers.

greater volume of water into the closet when the handle is pulled. Table No. 1, page 360, will give the size of the valve and pipe necessary according to the head-way of water above the water-closet apparatus.

Fig. 249 shows a "$1\frac{1}{2}$-in." valve, C, with a copper bellows-regulator, B, brass pull-up handle and flat plate, D, fixed complete on a cast-iron frame, A. This sized valve with a 2-in. pipe laid on to it from the cistern—though the cistern be only 4 or 5 ft. above it—will give a good flushing force to the supply of water to cleanse out the basin-trap and soil-

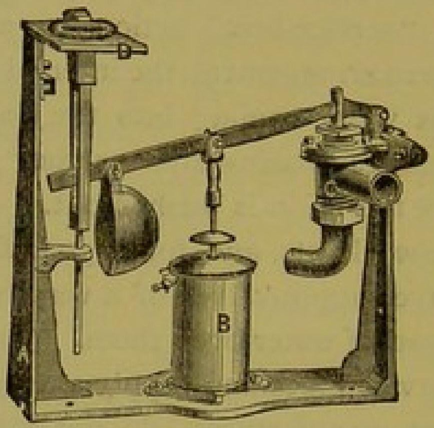


FIG. 249.—Valve-and-regulator.

pipe. But I prefer a larger valve still for flushing out closets when water is plentiful and the cistern is only a foot or two above the water-closet. The little stop-cock shown on regulator, B, is for the purpose of regulating the quantity of water to the water-closet. This cock can be so turned as to allow the air to pass out of the "bellows-regulator" quickly or slowly, thereby allowing a small or large quantity of water to pass into the closet. (See Fig. 158, showing this valve attached to a closet.)

Advantage of rapid flushing.

Another advantage is—and this is the stone on which the water companies' *turncocks* break their keys—that by this arrangement one, two, or three flushes may be given in rapid succession. And if the largest-size valves are used, and the service-pipes are proportionately large, a flush* at the rate of

* See Figs. 143 and 144, and explanation of supply-valve, under reference letter G, p. 182.

three gallons in six seconds may be made to pass through his flushing-rim closets to scour out the basin-trap and soil-pipe; and there is no more extravagance in this than in firing an 80-ton gun to sink the enemy's boat instead of firing a thousand rifle shots upon it, and leaving it where it was—a menace, perhaps a destructive force, to oneself.

Fig. 250 shows an apparatus, which I designed and patented some few years ago, for giving a rapid flush of (Flushing apparatus.)

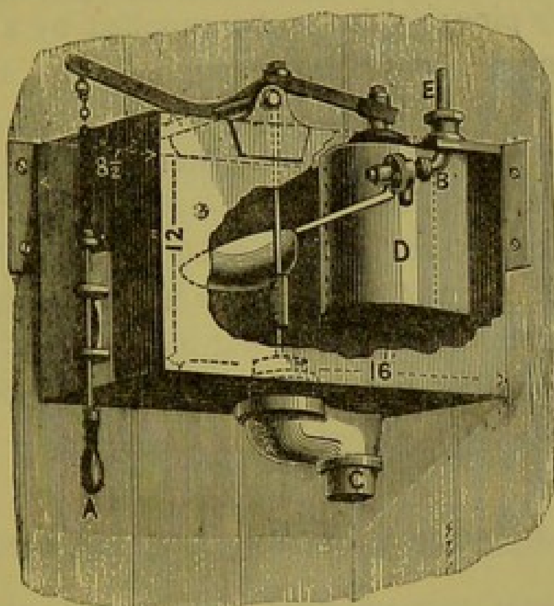


FIG. 250.—View of "SLUICE" Apparatus for Flushing out W.C.'s, &c.

water to the "hopper" and "wash-out" class of water-closets, and to INSURE this flush every time the handle, A, is pulled. It is specially adapted for the use of lazy people and for servants, who never hold up the handle of a water-closet long enough to thoroughly wash out the closet after using it.

The cistern is made in cast-iron, and is galvanised (or it can be Bower-Barffed), to protect it from rust. The round cistern-valve and its fittings are made in gun-metal. The union, E, of the ball-valve is carried up through the top to allow the cistern to stand close to the wall, and for easy connection with the service-pipe without any cutting away. A stop-valve should be fixed at E for shutting off the water supply when so required.

This apparatus is made to give a flush of two or three gallons of water at *each* pull of the handle; and this body of water is made to pass into the closet-basin (when it has a flushing-rim) in five or six seconds, though the apparatus may be only 4 ft. above the closet-seat. Other advantages gained by this apparatus are (1) the closet *must* have its flush of three gallons when once the handle, A, is pulled; (2) it *separates* the *water-closet supply* from the *general service* or *drinking-supply* pipe; (3) it can be supplied by a small pipe, ½-in. bore being generally large enough, though it is better to fix a ¾-in. pipe where there is only a few feet head of water. The service-pipe from the "sluice-cistern" to the water-closet should be 1¼-in. or 1½-in. calibre.

This "sluice-cistern" can also be used for flushing out slop-sinks, or a range of two or three urinal basins.

[It is not intended to meet water companies' regulations, and should therefore not be fixed when two-gallon water-waste preventers are required.]

WATER-CLOSET SUPPLY BY WATER-WASTE PREVENTERS.

As I have said over and over again, a water-closet of good character and principle is often ruined through insufficiency of water or poorness of the flush. It is monstrous that water companies should have the power to enter a man's house—an Englishman's house, no longer his "castle"—and interfere with his comfort by restricting the supply of water to his water-closet. For a small sum of money per annum, the London water companies allow a man to have a bath in his house, where he can consume fifty gallons of water per day; but they will not sanction more than two gallons of water for each use of his closet—for, as a rule, a man only uses a water-closet once a day. And they not only restrict him in the quantity, but also compel him to use a certain class of fitting, which often disfigures a closet and wastes more water than it saves.

There is such a variety of water-waste-preventers now in use that I only refer to two or three here.

Many of the London water companies seem satisfied that "waste-preventers" save their water; but, from my experience, more water is wasted by so-called preventers than by a well-made valve and regulator, or by flushing-cisterns of good character, except in certain circumstances; *e.g.*, in schools, where mischievous boys play with the closets, and in public places; but in private houses the supply-valve and regulator is preferable, for in this case there is only *one*

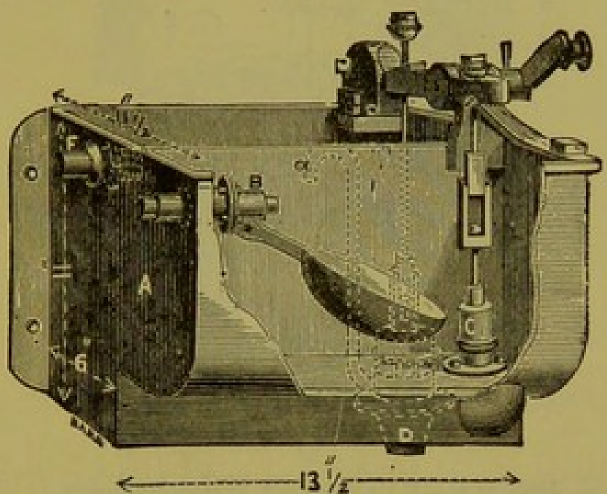


FIG. 251.—"Double-valve Waste-preventer."

valve to get out of order, and, if this is of good workmanship, it will shut off almost any pressure, and is, moreover, very durable and easily repaired. But in the other case, at any rate with the *majority* of the water-waste-preventers, there are *three* valves—viz., the ball-valve to the feeder, the two-gallon supply-valve, and the supply-valve to the water-closet—any one of which getting out of order is liable to waste the water company's water.

It is important that the two gallons graciously allowed by the water companies should be used to the best advantage, *i.e.*, should pass into a water-closet as quickly as possible, so as to get what cleansing force it will allow out of it. **Double-valve waste preventer.**

I have designed and patented six water-waste-preventers for doing this, but only give the drawings of four, as space will not permit of a description of more. The "Tip-up" and

V

the "Cataract" waste-preventers are therefore omitted. Figs. 251 and 252 work on the double-valve principle, one valve being shut while the other is open, in accordance with the rules of the London water companies. The case, or cistern, is made in cast-iron, galvanised all over, and the valves C and D, and their fittings, are made in gun-metal. Fig. 251 is for supplying the "hopper" class of closet, and it is so arranged that water only comes into the closet during the time the handle is pulled, but the two-gallon flush of water is discharged in about three seconds.

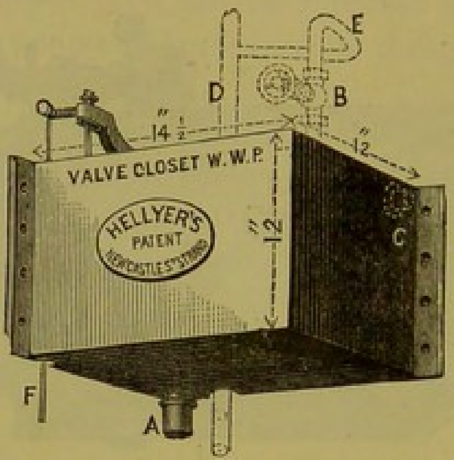


FIG. 252.—"Valve-closet Waste-preventer.

Valve-closet waste-preventer.

Fig. 252 is made specially for supplying *Valve*-closets in the most efficient way with a two-gallon flush. The valve for supplying the closet is made of extra size, and the apparatus is so arranged that directly the closet-handle is pulled the two gallons of water pass rapidly into a compartment leading to the water-closet, sufficient water being retained in the compartment for recharging the basin of a valve-closet should the handle be held up too long, *i.e.*, the flush is sent into the closet in four seconds; but the "after-charge" is made to come slowly into the basin, so as to ensure water being retained in it should the handle of the closet be kept up too long. (See Fig. 150, showing this water-waste-preventer fixed; also see Plate XXV., A.)

"Angle-cistern" syphon-supply.

Fig. 253 gives a view of my "Angle-cistern Syphon-supply," for supplying the "Artisan," the "Hopper," the

"Wash-out," and "Wash-down" classes of water-closets. Its advantage is that *one* pull of the handle, E, discharges the whole of the two gallons of water into the closet, and at the

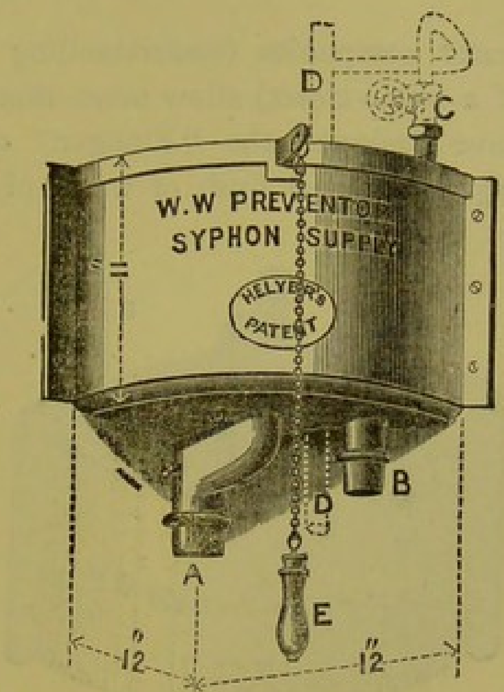


FIG. 253.—"Angle-cistern Syphon-supply."

rate of nearly a gallon per second. It is made as compact as possible, and can be fixed in either angle of the closet-room. It is also made for easy connection with the sluice-pipe (See Plate XXV., showing this waste-preventer *in situ*.)

REFERENCES TO PLATE XXV.

A.—"Valve-closet waste-preventer," as Fig. 252, with basin-feeder.

B.—General service to supply waste-preventers. The backs of the waste-preventers are purposely recessed to allow the general service-pipe to go down behind them without cutting away the wall.

C.—"Optimus" valve-closet, as Fig. 171.

D.—$1\frac{1}{2}$-in. lead service-pipe from waste-preventer to closet-basin. Where the waste-preventer is more than four feet above the seat $1\frac{1}{4}$-in. pipe is large enough.

E.—Enclosure, with hinged door, for concealing the waste-preventer. For the sake of appearance the enclosure is carried right across the closet.

K.—"Angle-cistern syphon supply," as Fig. 253. This cistern waste-preventer is also recessed at the back for allowing the service-pipe to go down behind it without cutting away the wall.

L.—"Artisan" or "Hygienic" closet, as Figs. 157 and 159.

M, N, O.—Three different ways of arranging the pull-handle for flushing out the closet. M shows the chain-pull, N a crank-pull fixed on the wall, and O a knob-pull for working through the frame of the seat.

As some water companies (understanding the sanitary requirements of a water-closet) allow more than two gallons of water, I have designed the "Plunger" syphon waste-preventer, giving an ensured flush of water of *three* gallons

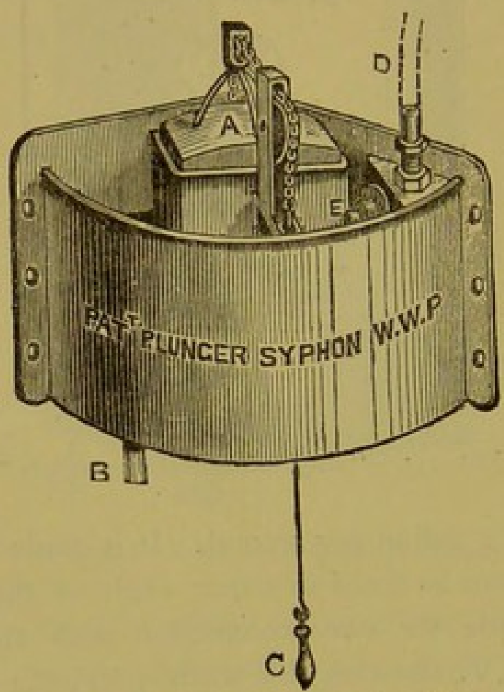
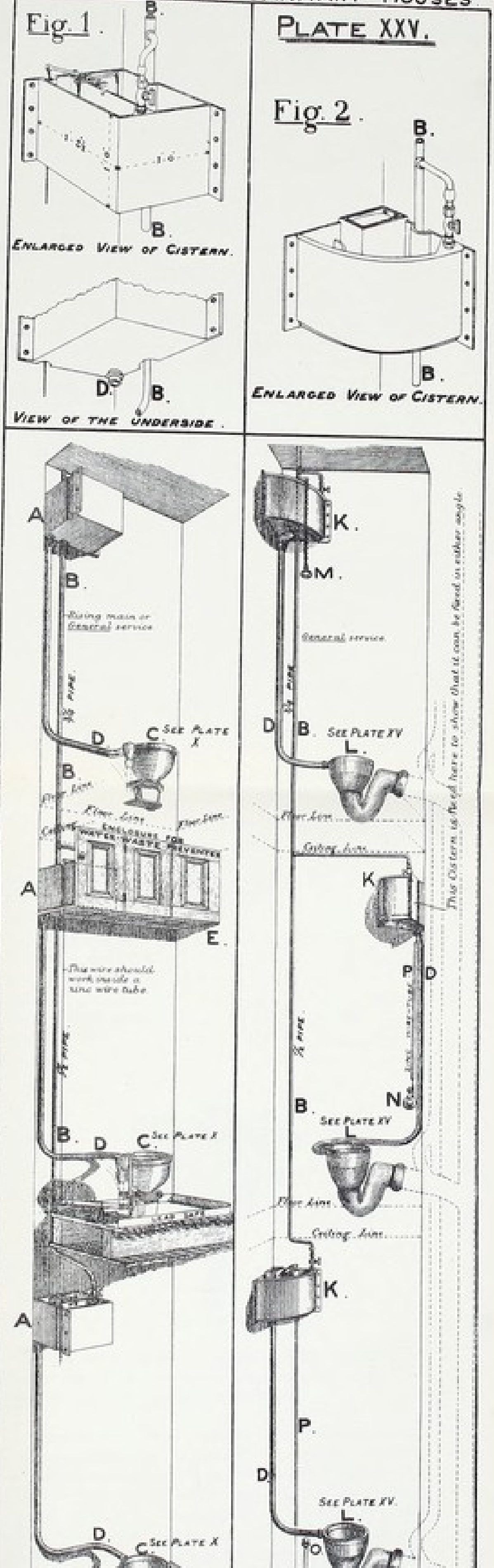


FIG. 254.—"Plunger Syphon."

each time the handle is pulled. This three-gallon syphon is illustrated in Fig. 254. It can be made in larger sizes to give any quantity of water; but *three* gallons of water sent into a water-closet from such a syphon—at the rate of about a gallon per second in the "Hygienic" or "Artisan" closet—is quite sufficient to keep a closet wholesome, and is worth more than *ten* gallons "dribbled" into a closet from an ordinary water-waste-preventing supply-valve fixed under the seat of a closet. By pulling the handle C, the plunger A displaces the water in the cistern and starts the syphon, which is of extra size for the purpose of getting a strong flush of water into the closet. B is the overflow-pipe, D the service-pipe, and E

THE PLUMBER AND SANITARY HOUSES.

PLATE XXV.



S. S. Hellyer, del.

Two Tiers of Water Closets supplied with Water by means of Water waste Preventing Cisterns.

To face page 324

the ball-valve for supplying the cistern. See Fig. 166, page 204, showing a "Plunger" syphon* fixed to a "Vortex" closet.

"*Bean's Patent Direct-Acting Valveless Waste-Preventer*" is valuable for flushing out the "Artisan" or "Hopper" class of water-closet. A section of this apparatus is given in Fig. 255. One pull of the handle is sufficient to ensure the entire contents of the little cistern being sent with a rapid flush into the closet. It can be had for giving two or three gallons of water. The larger size should always be used,

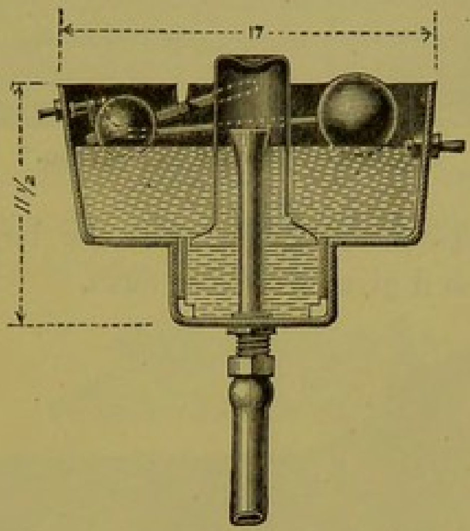


FIG. 255.—Bean's Syphon.

unless the water company* insists upon the smaller size. Omer Ward, of 182, Upper Thames Street, E.C., is the sole manufacturer of this syphon waste-preventer.

"*Braithwaite's Patent Syphon*" water-waste-preventing arrangement, Fig. 256, is valuable, as, like the previous syphons, it ensures a certain quantity of water being given when once the handle of the apparatus is pulled. The quantity of water can be regulated, from one to a dozen gallons, according to circumstances, the vessel in which the syphon is fixed being made of a corresponding size. There are no valves about it to get out of order, and this is one of its chief merits. The only objection to it is that the flush is

* Some of the London Water Companies object to every kind of syphon.

too sluggish in its passage into the closet to be of any *great* value as a cleansing power. These patent syphons are made

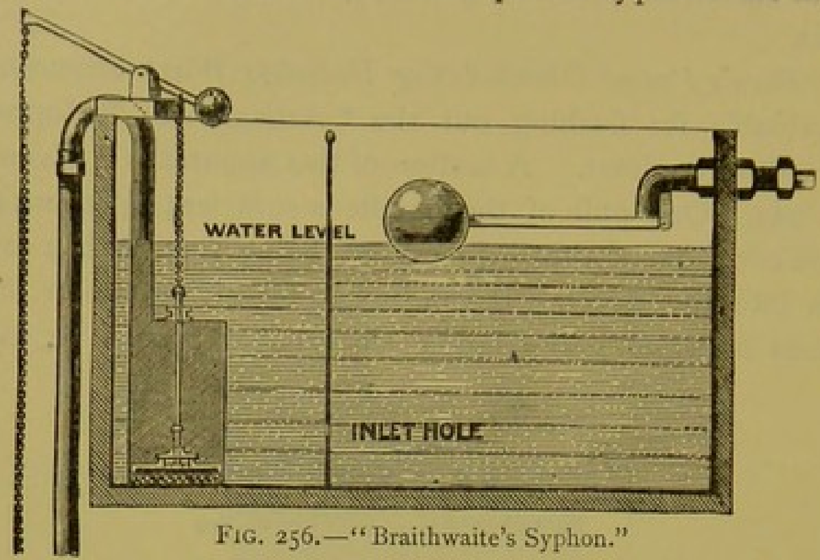


FIG. 256.—"Braithwaite's Syphon."

in two sizes, $1\frac{1}{4}$-in. and $1\frac{1}{2}$-in.; but the larger size is the preferable one, as it gives a quicker flush.

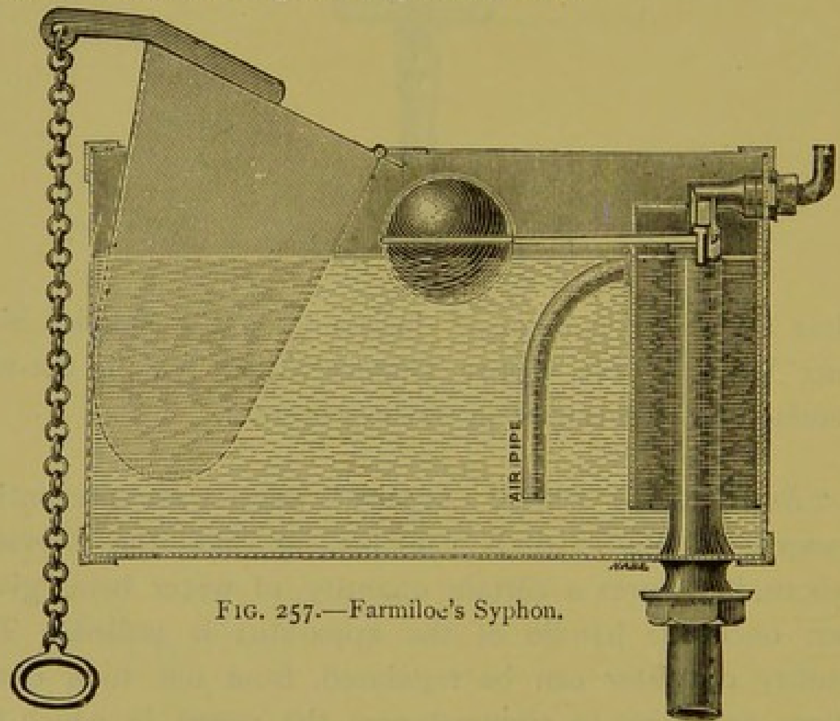


FIG. 257.—Farmiloe's Syphon.

Messrs. T. and W. Farmiloe, of Westminster, have also a patent "Syphon Water-waste Preventer" for supplying the "hopper" and "wash-out" class of water-closets. A section of this waste-preventer is shown in Fig. 257. The syphon is started by means of a water displacer. On pulling the chain the "displacer" is depressed, in the small water-cistern, and this causes the water to flow into the long leg of the syphon, and the syphonage of the water is immediately commenced. It is made to give a two-gallon flush.

Messrs. Doulton and Co., of Lambeth, have also a syphon-cistern for supplying water-closets with water, and many syphons made by various manufacturers of w.c. fittings, are now in the market, but it would be impossible to review them all in this work. We must content ourselves with those already given, to show the value of using syphons, where water companies have no influence, or allow them.

Supply of water to Urinals.—The best means of flushing out urinals with water was considered in conjunction with the urinals described in Chapter XVIII. Urinal supply.

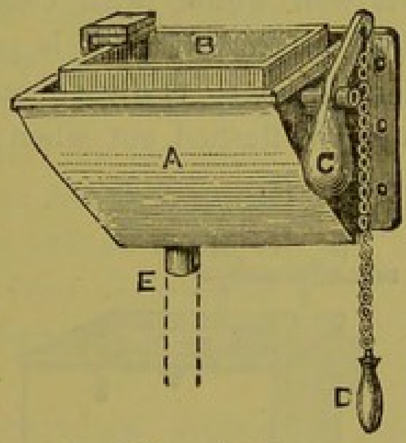


FIG. 258.—"Tip-up" Waste-preventer.

The London water companies limit the supply of water to a urinal to one gallon per usage; therefore, such water-waste-preventers should be used as will give this body of water in the *shortest time*, so as to secure as great a flush as possible with it. The writer patented some years ago a *tip-up* water-waste-preventer, Fig. 258, which turns a gallon of water out into a receiver, and sends it down through the urinal with a good flushing force for keeping it clean directly the supply-handle is pulled; but this water-waste-preventer Waste-preventers.

is too expensive for general use, except when a large one can be made to supply a range of urinal-basins, or stalls. This "tip-up" waste-preventer is fed by a small feed-cistern; or any number in a row, on a perfect level, can be supplied by an ordinary feed-cistern, fixed in some convenient position.

"Waste-not" valve.

Messrs. J. Tylor & Sons, of Newgate Street, have a "Waste-not" valve, with a neat connecting-cap, for supplying urinal basins. They have also a "Waste-not" urinal stop-valve, for supplying urinal stalls with water, and can so regulate these valves that a certain quantity of water shall pass through them when once opened.

Door-action.

When water-waste-preventers are not required, a door-action service-box arrangement can be fitted up to give a good *flush* of water to a urinal every time the door to them is opened. The advantage of such an arrangement is that the *urinal* basin is well wetted with clean water, by the opening of the door, before any urine is passed into it, thus preventing the urine from so easily adhering to the sides; and the urinal is again flushed out when the person opens the door to leave the place.

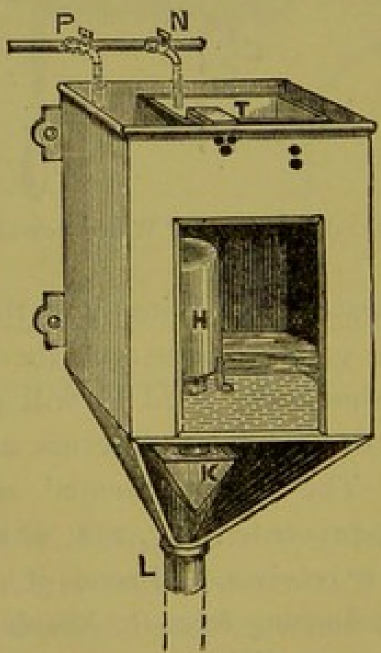


FIG. 259.—"Tip-up Syphon.

Syphon-supply.

Some time ago I patented an arrangement for supplying urinals with water automatically. Finding that a Field's annular syphon, of sufficient size to adequately flush out my syphon-urinal, could not be started with a very small dribbling supply of water, I arranged in one case a *tipping vessel* and in the other a *secondary* syphon. With the tipping vessel, Fig. 259, a *drop* of water will start the syphon. Drop by drop the water can be made to fall into the collecting or tipping vessel, T, and the vessel when full tips itself into the small cistern in which the flushing syphon, H, is placed, and this continues until sufficient quantity of water has been tipped into the cistern to start the syphon. Or the water may be allowed to dribble into the syphon-cistern as well, as shown at P, leaving the sudden charge from the tipping-cistern to start the syphon.

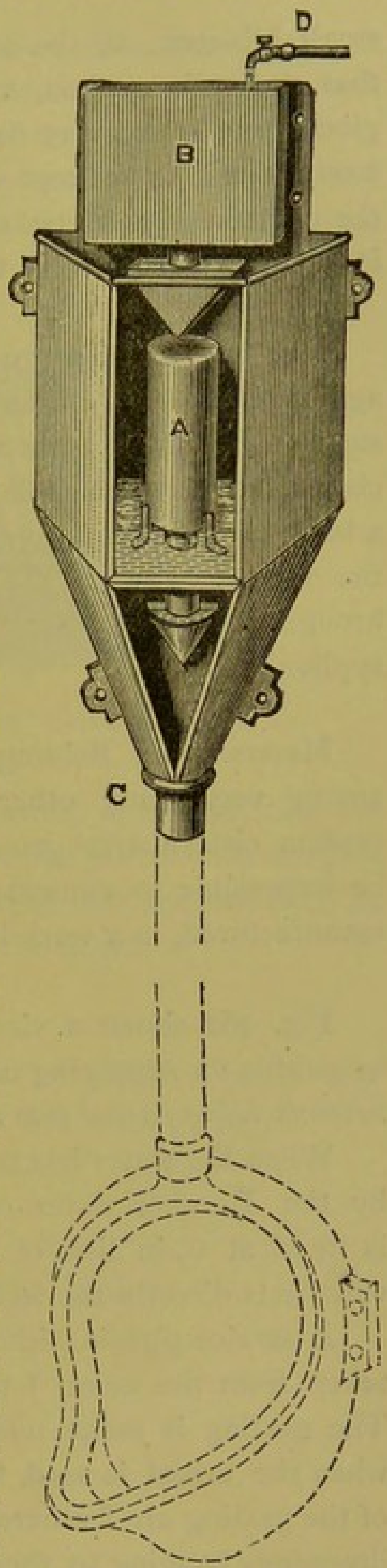


FIG. 260.—Double Syphon-supply.

With the secondary syphon arrangement, Fig. 260, the water can be made to enter very slowly into the small syphon cistern, B, to be emptied suddenly (by its syphon) into the cistern in which the main syphon is placed, until sufficient water has been passed into it to start the main syphon, A. Of course, the size of such cisterns can be regulated to suit any number of urinal basins, to give any quantity of water required. By adjusting the small bib-cock, D, the supply of water can be so arranged that the main syphon, A, shall be started periodically, at a given time, from every five minutes to every hour; but if the waste-pipe is to be kept wholesome, and free from corrosion, the syphon should be made to discharge when the urinal is frequently used, every ten minutes or so.

The late Mr. George Jennings, of Lambeth, some years ago brought out an automatic flushing arrangement for supplying urinals with water, which is much used. The cistern in which the syphon is placed is supplied by means of a ball-valve, made to open as the water rises in the cistern, the reverse way of the usual action. Thus the water is brought into the cistern with sufficient force to start the syphon.

Messrs. John Bolding & Sons, of South Molton Street, among very many other sanitary appliances, have a small syphon cistern arrangement for flushing urinals. It would be impossible to enumerate all the flushing appliances now manufactured, in a work like this.

Treadle-action supply.

Fig. 282 shows a view of my "Treadle-action" flushing apparatus for supplying urinals with water *during the time the urine is being passed into the urinal.* (See Fig. 215.)

When the water has to be limited to the quantity allowed by the London water companies, a waste-preventing-valve is fixed at H, in lieu of the ordinary supply-valve, and this valve acts directly the feet are removed from the treadle.

A service-pipe is laid on to the union J, and a ¾-in. pipe is taken from the union I to the inlet-arm of the urinal basin. The grating is made *wide* to *insure the feet resting upon it,* when the urinal is used, to open the supply valve. The bars of the grating are feathered off at top and bottom to prevent droppings hanging to them, and the supply-valve and flush-pipe are recessed under the urinal frame to prevent any droppings falling upon them. The frame in which the grating works is 2-in. larger each way than the size of the grating shown in the diagram. The outside size is 2-ft. by 1-ft. 9½-in. The grating and frame are galvanized, or they can be "anti-corroded," by the Bower-Barff Rustless Process. The frame is specially made for tiles to bed upon it, and to make a good sound jointing with it, as shown in Fig. 215, p. 265.

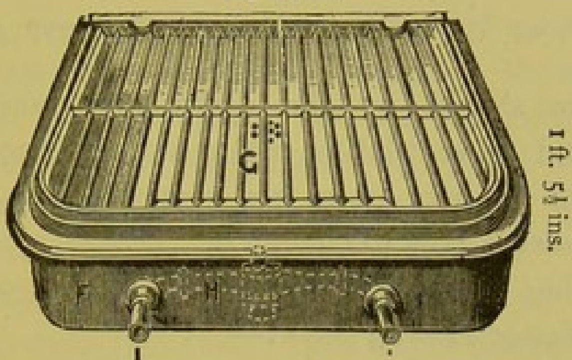


FIG. 261.—View of "Treadle Action" Urinal Apparatus.

The safe, or tray, under the grating, C, for catching the droppings is made of cast-iron, white porcelain-enamelled inside. The apparatus is so arranged that the safe shall be well washed out after each usage of the urinal. Safe.

CHAPTER XXIII.

VENTILATION, OR COWL-TESTING, BUT NOT AT KEW.

Ventilation should be the alpha and omega of the Sanitarian, and as ventilation means nothing more nor less than *changing the air*, let us see something about the *air* itself before seeing how to change it.

In speaking of the *atmosphere*, in his book on "Physiography," Professor Huxley says:—

"On accurately examining a given measure of atmospheric air, it was found that it contained about one-fifth its bulk of the gas oxygen, and four-fifths of nitrogen . . . The following table shows the densities, or specific gravities, of the three gases which compose the atmosphere:—

Nitrogen	0·9713
Oxygen	1·1056
Carbonic-acid Gas	1·5203

"The term *specific gravity* is used to denote the weights of equal bulks of different kinds or species of matter, compared with some known standard. Air is the standard used in the comparison just made, and it is seen from the figures that if a given bulk of atmospheric air weighs 100 lbs., then the same bulk of nitrogen weighs 97 lbs., the same volume of oxygen 110 lbs., and of carbonic acid 152 lbs. Hence it might be assumed that the atmosphere would consist of three strata or layers (like the mixture of quicksilver, water, oil), with the nitrogen as the top layer, and the carbonic acid at the bottom. As a matter of fact, however, this is not the case. All gases tend to intermingle with each other, so that when different gases are mixed they soon produce a uniform mixture, in spite of differences in their relative weights; in fact, the particles of the heavy gas rise and the particles of the light gas fall until they are completely diffused through each other. In consequence of this property, the composition of the atmosphere is kept practically uniform, although local variations within narrow limits may be detected. . . . Atmospheric air is, in fact, about 800 times lighter than an equal bulk of water. . . . It is found by actual weighing that 100 cubic inches of air, under ordinary conditions, weigh about 31 grains; in other words, it requires 13 cubic feet of air to weigh a pound avoirdupois. . . . The air in

Westminster Hall reaches to the enormous amount of nearly 75 *tons!* . . . It is found that our atmosphere exerts a pressure of nearly 15 lbs. (14·73 lbs.) on every exposed square inch of surface. . . . But the pressure downwards is exactly neutralised by the pressure upwards. . . . The air in a room presses on the ceiling not less than on the floor, and on each of the walls not less than on the ceiling."

Now the work of the Sanitarian will never be done until he can so scheme—either with or without the aid of mechanical appliances—that a *constant change* of atmospheric air shall be made to take place, not only in every bedroom, living-room, bath-room, water-closet, and housemaid's closet, but also in every waste-pipe, soil-pipe, drain, or enclosed place where the air is likely to be contaminated. Work of the Sanitarian.

The difficulty in arranging for the air to be changed in such places as those just enumerated ought not to be insuperable, especially as this purifying fluid—atmospheric air—has not to be sought after, like water, but *moves* about everywhere within "about fifty miles of the earth's surface," *ready for use wherever it can be wanted.* The difficulty is not in getting it *into* a place, but getting it *out.* So *insidious* is the air, that it will insinuate itself into places where light could not enter. The difficulty in making the air *circulate—i.e.,* pass *in* and *out*—is lessened by the fact that it is in perpetual motion. Supply of air.

Being chiefly concerned here with the ventilation of waste-pipes, soil-pipes, and drains, I will leave room-ventilation out of consideration—except as far as cowls are advantageous for dwellings as well as drainage—and consider at once the advantages to be gained by the use of cowls in assisting the circulation of air through pipe drainage, etc.

If it is not "ye *cowl* which makes ye *monk*," it certainly is not the cowl which makes the ventilation. But, as the cowl formed a fitting cap to the monk, so a cowl (or ventilator) forms a fitting top to a ventilating-pipe; though its power, when there, for causing an upcast of air through the pipe is not so great as some suppose, though greater than the Cowl Testing Committee of Kew would have us believe. "Ye cowl and ye monk."

In the first edition I explained that, whilst thinking it necessary to put cowls on the tops of ventilating pipes to Cowls on pipes.

drains, I considered *plain caps* quite sufficient for fixing on the tops of ventilating-pipes to *waste-pipes* and *soil-pipes.* I now, however, consider that cowls should be fixed on *all* ventilating-pipes for *foul air*, not so much for assisting the *up-draught* as for *preventing* a *down-draught*, especially where the air *blown down* through such ventilating-pipes would come out near a window or door, where it could be *sucked* into the house.

Cowl-testing.

I have been *testing* cowls for two or three years, to see the relative value of cowls over open pipes, and to find out the most efficient cowls in the market. But, as it was not my intention to publish any results of such testings until within the last six or nine months (Jan., 1880) I have up to that time no reliable facts to give. Since then various* cowls, as shown on Plate XXVII., have been tested with great care, and the readings of the anemometers will be tabulated later on.

Pipes for testing cowls.

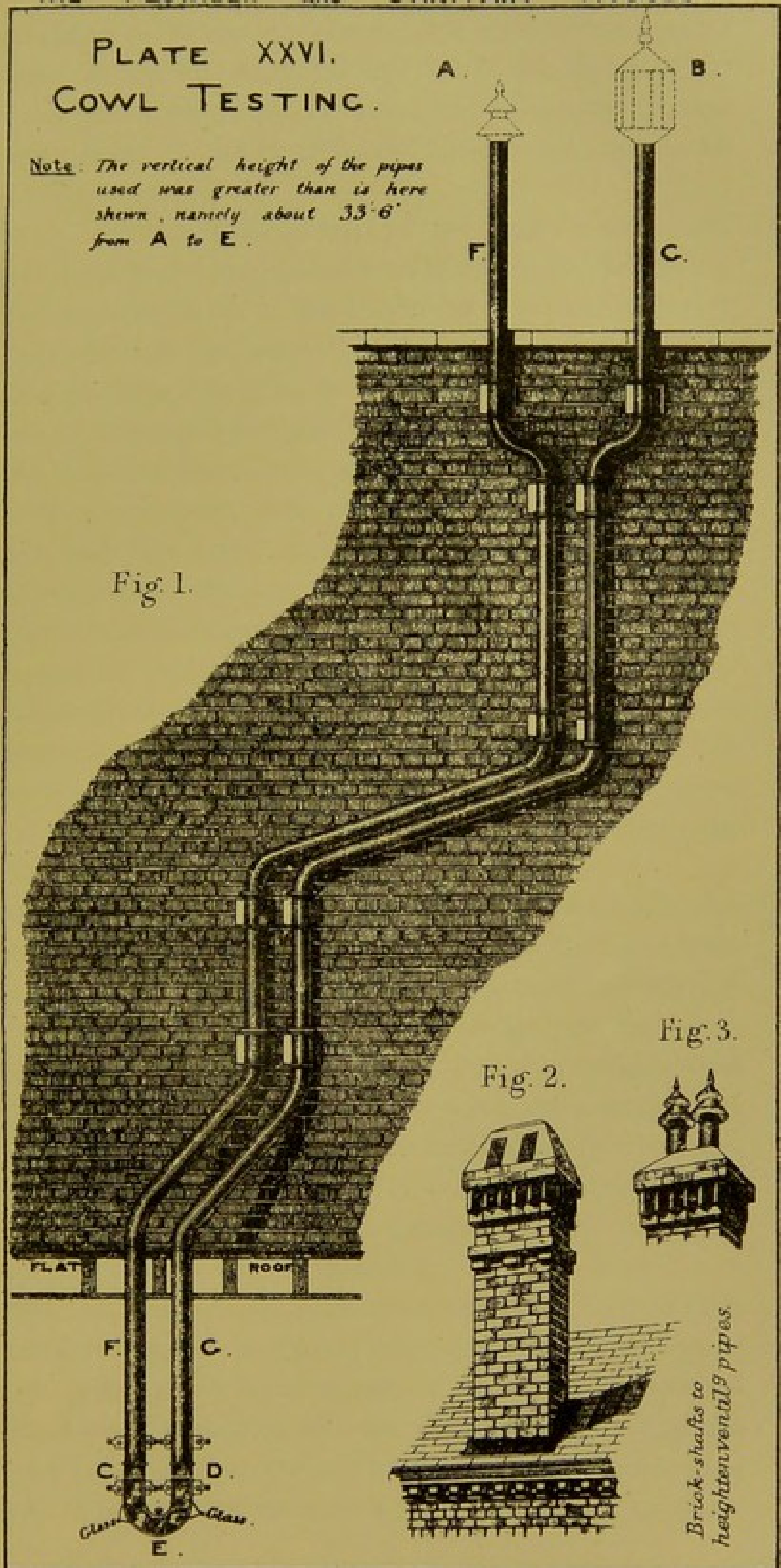
For the purpose of making simple tests, about a couple of years ago I had *two* 4-in. lead pipes fixed, as shown on Plate XXVI., with soldered joints to prevent air leakage. The pipes are fixed outside my factory, and are made to follow precisely the same course to prevent one pipe, or cowl, having an undue advantage over its rival. The pipes start from about 18 ft. above the ground level, and are continued up to a height of about 50 ft., the tops standing 6 or 7 ft. above the roof projections.

These two pipes are bent to suit the position of the building, and in this particular more resemble ventilating-pipes as fixed in practice than if they went up straight. The pipes are kept about a foot apart, except at the top, where they are bent away from each other, as shown on Plate XXVI., and made to stand about four feet apart, to prevent one cowl screening the wind from the other.

U-shaped connecting pipe.

The pipes for one of the chief systems of testing are connected together at bottom by a 4-in. rectangular pipe bent in the shape of the letter U, with the ends rounded and socketed to fit the ends of the 4-in. pipes. The front face of the

* See Plate XXVII., facing p. 338.



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To face page 334.

U-shaped pipe is made of glass, with a well-fitted *glass sliding-door*, as shown at E, Plate XXVI., for inserting an anemometer inside the pipe, or other testing appliance, and for letting air in at the bottom of one or both pipes for various experiments.

A throttle-valve is fixed in each of two short connecting-pipes, and these connecting pipes for various experiments are placed between the limbs of the U-shaped pipe and the two upcast-pipes to shut one pipe off from the other. Throttle-valve.

For the first simple testing of COWLS *versus* OPEN PIPES, a "fan-meter," made by Negretti and Zambra, was fixed in one of the limbs of the U-shaped pipe where it could be seen through the glass front, and many interesting experiments were made with this arrangement. Afterwards, to make the tests more reliable, another "fan-meter" was fixed in the other limb of the U-shaped pipe, and more trials were made. But, though such tests were satisfactory as far as one's judgment was concerned, and enabled one to settle in his own mind the relative merits of the various cowls tested, there were no figures to guide one. And so, to arrive at some reliable statistics, I used two anemometers, and with their aid I am able to give the results of many testings. Simple mode of testing.

TABLES Nos. 1 and 2 are interesting as showing how the cowls vary in themselves in the various trials, but are of no great value in determining the *relative* merits of the various cowls tried. For, though the cowls were tested on the same day, and in rapid succession, they cannot be said to have had *equal* chances; for the state of the wind, as well as the atmosphere, not only at times varies from hour to hour, but from minute to minute, and second to second. But, in these single trials, each cowl had the advantage of being tested on the same pipe and by one anemometer. Tables Nos. 1 and 2.

TABLE No. 3.—A cowl is fixed on the top of one of the pipes, when testing cowls against open pipes, and the top of the other pipe is left open to the atmosphere. An anemometer is then placed inside the U-shaped pipe (through the glass door E), so that any air travelling through the pipe must pass through the anemometer. At the end of an hour Cowls against Open pipes, Table No. 3.

a reading of the anemometer is taken, and the cowl changed over to the other pipe, where it works for another hour, when another reading of the anemometer is taken. If the cowl has drawn the air through the open pipe in both cases, it proves that the cowl is better than the open pipe.

"Pull, Devil! Pull, Beggar!" principle.

TABLE No. 4.—The cowls shown on Plate XXVII. have all been tested one against the other on the U-shaped pipe in the manner just explained with Cowls against Open pipes, on what the Author calls the "Pull, Devil! Pull, Beggar!" principle, and the results of such testing are given in Table No. 4, p. 293. One cowl was fixed on one of the pipes and another cowl on the other, as shown in dotted lines on Plate XXVI., with an anemometer just inside the glass door, E. The cowls were then left for an hour, when a reading of the anemometer was taken, and the cowls changed over (for each to have the like advantages or disadvantages), and another hour's trial was made. It matters little how much the cowls may have struggled with each other for the mastery during the hour's trial, the cowl which pulled in air through both the pipes proved itself to be either the best for *assisting an upcast* or *preventing a blow-down*. As a friend put it: "If two men clasp each other round for a trial of strength in the Strand, at Waterloo Place, the man who finally pulls his adversary to Charing Cross, or Temple Bar, proves himself the stronger of the two, no matter how far they may have pulled each other up and down the Strand in the struggle." But any disadvantage of getting a good grip, through corpulency or other impediment, should, of course, be allowed for.

Double trial of two cowls simultaneously.

TABLES Nos. 5, 6, 7, and 8.—This series of testing was made without the U-shaped pipe. An anemometer was fitted at the foot of each of the 4-in. pipes, with the trial cowls at the top. By this means two cowls were tested simultaneously under almost precisely similar circumstances. To make this series of testing as perfect as possible, the cowls were tested for *one hour* on pipes, F and G, when a reading of the anemometer was taken, and the cowls changed over for each cowl to have a trial, of one hour, on both pipes and both anemometers.

Though the two 4-in. pipes, as shown on Plate XXVI., are similar in every particular, as explained before, one is found to be a better upcast pipe than the other. To correct the workings of these two pipes the cowls were made to work half the time on each pipe—on Tables 3 to 7—to make the conditions equal. Pipes differ.

It would be an extremely difficult thing to fix a dozen pipes, with the upper and lower ends open to the atmosphere, with an anemometer in each pipe, and to find after an hour's trial that *all* the anemometers tallied. A current of air blowing across, or curling round the bottom ends (the inlets) of any of the pipes, would instantly remove the atmospheric pressure at such points, and cause a suspension of the anemometer, if not a reversal in its action. And this *down-fall*, or blow-down, of air, in such cases as just referred to, may occur in any number of the pipes, and for several times during the trial-testing, without taking place in the entire lot. Then there would be the further difficulty of getting such a number of anemometers to work and register *exactly* alike. With the greatest nicety in the make the fans may differ, though in the very smallest degree, yet just sufficient to allow the air to pass through a little easier, or to make one anemometer more sensitive than another. Apart from these objections, it would no doubt be a great advantage to test all the cowls *simultaneously*, instead of two at a time, for the conditions of the atmosphere and wind would be equal over the whole number. But if the trial cowls are compared, as explained in the notes to each table, the reader will have no difficulty in coming to a conclusion on the relative value of the various cowls shown on Plate XXVII. Many other tests were made—both of longer and shorter durations—but as they chiefly support the results tabulated later on, the reader can want no more, whether to satisfy his mind as to the value of cowls or open pipes, or as to the relative value of the various cowls themselves. Difficult to get pipes and anemometers to work alike. Other tests.

The results given in Table No. 4 are all in favour of the "Vacuum," but this table must not be taken by itself, for the other tables clearly show that *this* cowl is not so good as many of the others for inducing an *up-current;* in fact, it is not so good as the open pipe, as shown by the results in Table No. 5.* But though this cowl is of no great value, as far as the writer is a judge, for inducing an up-current in soil-pipes, etc., it is the *best cowl* he has tested for *preventing* a *down-draught* or *blow-down.* This is accounted for, perhaps, by the fact that the air-space is less to this cowl than to most of the others.

Tables 2, 3, 5, and clearly 8, prove that the *best* cowls are better than open pipes.

Variations in up-currents.

To show not only the effect of the wind, but also of the atmosphere upon *up-currents* in ventilating-pipes (and, at the same time, the difficulty of testing cowls to get at their relative value), my patent cowl, Fig. 262, was tested three times on the first day of this month—July, 1880. The cowl was placed on one of the pipes, as shown on Plate XXVI. The first hour, between ten and eleven o'clock, the anemometer registered 11,789 feet (linear) as having passed through it; the second hour, during which a violent thunderstorm broke over London, 4,973 feet; and the third hour's trial, when the storm had blown over, 15,824 feet. Three more trials were made two days after this, with the same cowl on the same pipe, when the anemometer registered the first hour, 21,290 feet, the second hour, 20,659 feet, and the third hour, during which there was a heavy fall of rain, 6,474 feet.

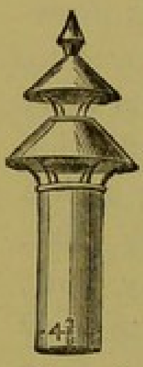
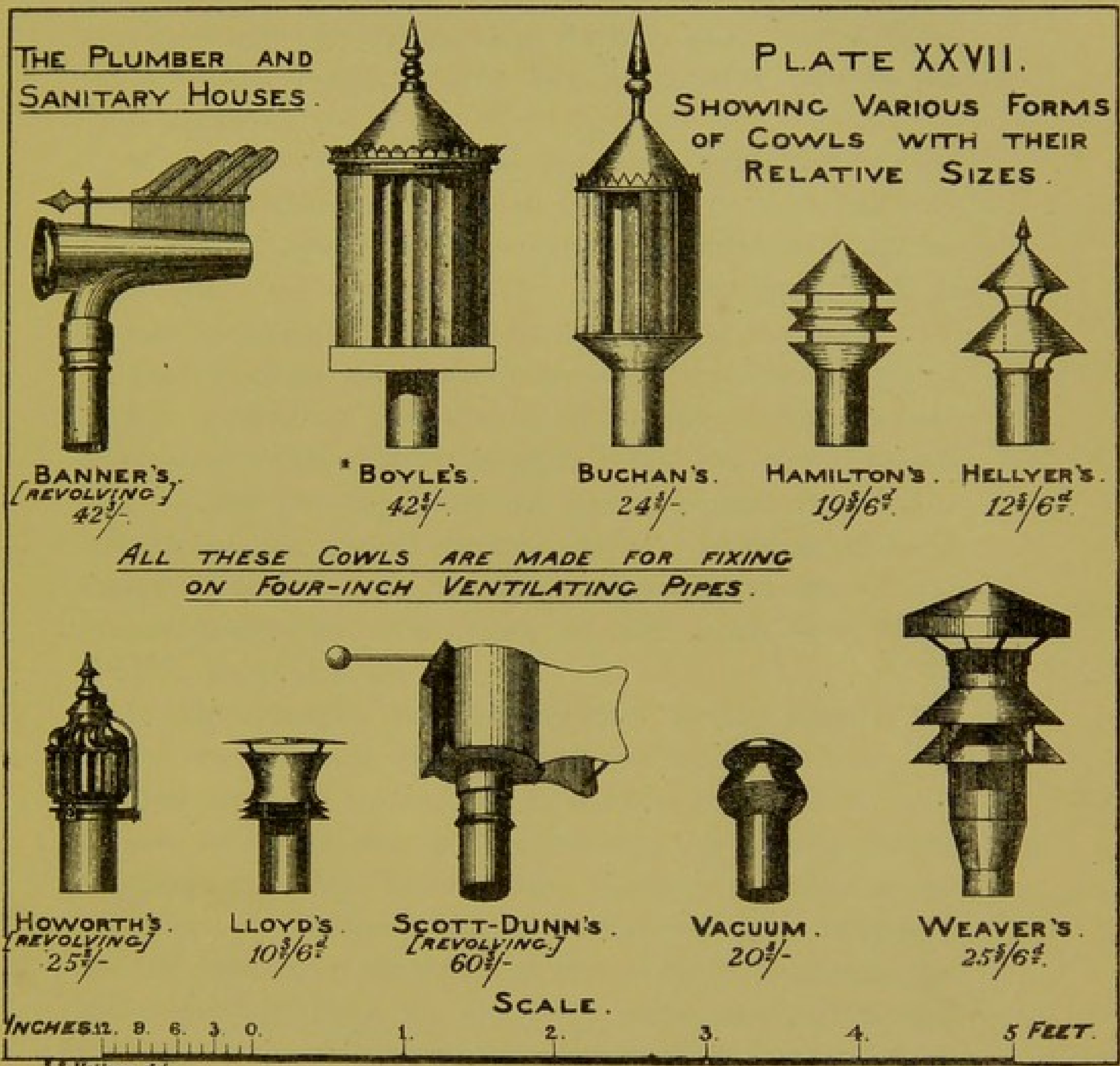


FIG. 262. — View of "Double-cap" Ventilator.

In testing the various cowls it was found that their relative value varied according to the different states of the atmosphere; *e.g.*, my cowl shows greater *comparative* results (both in the testings given and not given) in foggy and heavy atmospheres, as well as when it is raining, and this is one of its special merits, as open pipes are found to work well enough, without any assistance, in clear and light atmospheres. Then again, cowls, like people, are

* Also see Tables Nos. 6, 7, and 8.



S. S. Hellyer, del.

Whiteman & Bass, Photo-Litho London

To face page 338.

*Mr. Boyle is now advertising his Cowls at a great reduction in prices, & this price would be affected thereby.

dependent upon their positions for any *income* of air they may get. Put them in *high* positions and they *draw* accordingly, but put them *under* the roof projections and their *draughts* will not *break* the atmospheric pressure upon any pipe, nor will the *currency* through them ever call for another mint, though it may call for another *coin* to lift them higher.

Cowls vary in their relative value in different weathers.

M. Papier's Patent "Spiral Injector" is found to be so good a cowl that the writer is sorry not to have had one made for *soil-pipes* in time to have illustrated it with the other cowls on Plate XXVII. The trials made with it warrant its being put into the first rank of good cowls.

Taking all the tests, the palm of victory must be given to Mr. Buchan's; and the results given in the various tables warrant the Author in placing his own about second upon the list, but the reader can have no great difficulty in determining for himself the best cowls. In doing this he should, of course, keep one eye on the relative size of the various cowls, and the other on the prices—see Plate XXVII., showing same.

It only remains now to say that having selected the proper cowl, be sure and "stick it up high," not only for the four winds of heaven to blow upon it, to get all you can out of it, but also to prevent any air coming out of it going into the house either through a window or chimney. A volume might be written on the *misplaced* * *ends of ventilating pipes*, but as the writer is tired, and the reader getting weary, we will leave such *terminals* to tell their own tale and bring this to a terminus.

Abbreviations used in the following Tables.

Ba.	Banner's.	Hel.	Hellyer's.	Vac.	Vacuum.
Bo.	Boyle's.	Ho.	Howorth's.	W.	Weaver's.
Bu.	Buchan's.	Ll.	Lloyd's.	O.P.	Open Pipe.
Ham.	Hamilton's.	S.D.	Scott-Dunn's.	P.F.	Pipe F.
				P.G.	Pipe G.

* See pp. 102, 103, 290-292.

TABLE (No. 1) SHOWING THE RESULT OF FIVE *Ten-minutes* TESTS OF VARIOUS COWLS AND AN OPEN PIPE, TESTED ONE AT A TIME, ON ONE PIPE, AND WITH ONE ANEMOMETER, IN QUICK SUCCESSION.

Note.—This Table by itself is of no great value for determining the relative merits of the Cowls tried, as the Cowls not being tried simultaneously, the conditions of the wind and atmosphere were not equal.

				COWLS TESTED, WITH THE RESULT.					
Date.	Wind.	Atmos.	Temp.	Ba.	Bu.	Ham.	Ho.	Vac.	O.P.
1879.			Min. Max.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.
Dec. 29	W.	Light.	34·0-46·0	2637	2829	2931	2841	2752	3125
„ 31	W. and strong.	Thick and rain falling.	45·5-50·0	3144*	3802	3664	3597†	2690	3212
1880.									
Jan. 6	W. and light.	Cloudy.	30·0-35·0	1961	2693	2119	2391	1553	2224
„ 8	E.S.E.	Ditto and moist	29·0-32·0	1836	2289	1969	2252	1566	2205
„ 27	S.E.	Dense fog.	18·0-31·0	232‡	512§	477‖	¶	Nil.	109**

* Suspended 2 seconds. † Suspended 2 seconds, and 6 feet blow-down.
‡ Suspended 6¼ minutes. § Suspended 3½ minutes. ‖ Suspended 3 minutes.
¶ Suspended 8¾ minutes, with 104 feet blow-down.
** Suspended 8 minutes, and blow-down for 20 seconds.

TABLE (No. 2).—THE COWLS WERE TESTED IN THE SAME WAY AS EXPLAINED IN TABLE No. 1, AND THE NOTE TO THAT TABLE ALSO APPLIES TO THIS ONE.

				COWLS TESTED, WITH THE RESULT.									
Date.	Wind.	Atmo.	Temp.	Ba.	Bo.	Bu.	Ham.	Hel.	Ho.	S.D.	Vac.	W.	O.P.
1880.			Max.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.	ft. up.
Feb. 11	N. W.	Light	40·0	1237	1144	1576	1187	1302	1041	1078	960	1281	1240
„ 12	W.	Rain falling	46·0	1407	1560	1531	1368	1902	1659	1575	1192	981	1590
„ 13	W.	Hazy	41·0	1462	1058	929	1332	1395	1065	1295	903	1549	993
„ 14	S.W.	„	43·0	2995	3497	3889	2684	3401	3487	3155	2912	3945	3550
„ 18	S.W.	„	49·0	1390	2348	3873	1069	2517	2872	2552	1784	2616	2577
—	—	—	—	8491	9607	11798	7640	10517	10124	9655	7751	10372	9950

The above Temperatures were taken by Stanley's instruments.

TABLE (No. 3) SHOWING THE RESULTS OF *Two One-hour* TESTS OF VARIOUS COWLS AGAINST OPEN PIPES, TESTED ON THE U-SHAPED PIPE ARRANGEMENT, AS EXPLAINED ON PAGE 335.

N.B.—Only the results of the individual trials, between the horizontal lines, must be compared, as the wind and atmosphere varying with each trial, the conditions of the several trials would not be equal.

Date.	Wind.	Atmos.	Cowls against Open Pipes.		Result. 1st Hour. Pipe F.	Result. 1st Hour. Pipe G.	Result. 2nd Hour. Pipe F.	Result. 2nd Hour. Pipe G.
1880. May 28	W.	Clear.	BANNER'S	*v.* OPEN PIPE, and *draws* in air through it on either Pipe.	Ba. ft.up. 1363	O. P. —	O. P. —	Ba. ft.up. 2222
„ 4 } „ 5 }	N.E.	Cloudy.	BOYLE'S	*v.* „ „ „	Bo. 539	—	—	Bo. 688
„ 26	S.W.	Clear.	BUCHAN'S	*v.* „ „ „	Bu. 970	—	—	Bu. 283
April 29 } „ 30 }	E.	Clear. Cloudy.	HELLYER'S	*v.* „ „ „	Hel. 5300	—	—	Hel. 1927
May 31	N.E.	Rainy.	LLOYD'S	*v.* „ „ „	Ll. 30	—	—	Ll. 3
„ 11	S.E.	Clear.	SCOTT DUNN'S	*v.* „ „ „	S. D. 2765	—	—	S. D. 2543
„ 27	S.W.	Clear.	VACUUM	*v.* „ „ „	Vac. 2007	—	—	Vac. 4528
„ 19	N.W.	Clear.	WEAVER'S	*v.* „ „ „	W. 146	—	—	W. 478
June 8	S.W.	Rainy.	HAMILTON'S	*v.* OPEN PIPE, and *allows* air to be drawn in through it.	Ham —	O. P. 4504	O. P. 4790	Ham —
„ 8	S.W.	Heavy rain.	HOWORTH'S	*v.* „ „ „	Ho. —	O. P. 2215	O. P. 2786	Ho. —

TABLE (No. 4) SHOWING THE RESULTS OF A SERIES OF *Two One-hour* TESTS OF VARIOUS COWLS, TESTED TWO AT A TIME, ONE AGAINST THE OTHER, ON THE U-SHAPED PIPE, AS SHOWN ON PLATE XXVI., AND EXPLAINED ON PAGE 336, ON THE "PULL, DEVIL! PULL, BEGGAR!" PRINCIPLE.

Note.—To make these series of testing as fair as possible, the contesting Cowls worked one hour on each limb of the U-shaped Pipe, *i.e.*, the Cowl that worked the *first* hour on Pipe F, worked the *second* hour on Pipe G, and *vice versâ.*

N.B.—Only the results of the Cowls *paired* against each other (between the horizontal lines) must be compared, as the conditions would not be equal in the whole series of trials, the wind and atmosphere being different in each trial.

Date.	Wind.	Atmos.	Cowls Tested.		Result.			
					1st Hour.		2nd Hour.	
					Pipe F.	Pipe G.	Pipe F.	Pipe G.
1880. May 1	S.E.	Clear.	BANNER'S †	*v.* BOYLE'S.	Ba. Ft.up. 65	Bo. —	Bo. 39	Ba. Ft.up. —
" 28	W.	"	" *	*v.* HAMILTON'S.	3238	Ham. —	Ham. —	3704
" 22	N.W.	Cloudy.	" *	*v.* HOWORTH'S.	1038	Ho. —	Ho. —	1732
" 21	"	Clear.	" *	*v.* LLOYD'S.	820	Ll. —	Ll. —	293
" 21	"	"	" ‡	*v.* SCOTT-DUNN'S.	—	S.D. 100	S.D. 112	—
" 22	W.	Cloudy.	" ‡	*v.* VACUUM.	—	Vac. 958	Vac. 1708	—
" 20	N.N.E.	Clear.	" †	*v.* WEAVER'S.	5	W. 179	W. —	—
" 3	S.E.	Cloudy.	BOYLE'S *	*v.* HOWORTH'S.	Bo. 102	Ho. —	Ho. —	Bo. 49
" 3	N.E.	Hazy.	" †	*v.* LLOYD'S.	2	Ll. —	Ll. —	Suspended
April 30	E.S.E.	Clear.	" ‡	*v.* SCOTT-DUNN'S.	—	S.D. 1458	S.D. 775	—
May 4	N.E.	Cloudy.	" ‡	*v.* VACUUM.	—	Vac. 2024	Vac. 2442	—
" 1	S.E.	Clear.	" ‡	*v.* WEAVER'S.	—	W. 124	W. 87	—

Date.	Wind.	Atmos.	Cowls Tested.		Result. 1st Hour. Pipe F.	Result. 1st Hour. Pipe G.	Result. 2nd Hour. Pipe F.	Result. 2nd Hour. Pipe G.
May 24	W.	Cloudy and Moist.	BUCHAN'S *	v. BANNER'S.	Bu. 556	Ba. —	Ba. —	Bu. 2193
„ 6	N.E.	Cloudy.	„ *	v. BOYLE'S..	1260	Bo. —	Bo. —	1208
„ 26	S.W.	Clear.	„ *	v. HAMILTON'S.	3680	Ham. —	Ham. —	4157
„ 25	W.	„	„ *	v. HELLYER'S.	799	Hel. —	Hel. —	487
„ 24	„	Cloudy and Moist.	„ *	v. HOWARTH'S.	1460	Ho. —	Ho. —	3792
„ 24	„	Light.	„ *	v. LLOYD'S.	7890	Ll. —	Ll. —	5115
„ 12	E.	Clear.	„ *	v. SCOTT-DUNN'S.	1776	S.D. —	S.D. —	1574
„ 25	W.	„	„ ‡	v. VACUUM.	—	Vac. 137	Vac. 1703	—
„ 14	N.E.	„	„ *	v. WEAVER'S.	1110	W. —	W. —	257
April 28	„	Cloudy.	HELLYER'S *	v. BANNER'S.	Hel. 1310	Ba. —	Ba. —	Hel. 1337
„ 27	„	Hazy.	„ *	v. BOYLE'S.	2043	Bo. —	Bo. —	2618
May 27	N.	Clear.	„ *	v. HAMILTON'S.	2143	Ham. —	Ham. —	3655
„ 27	N.W.	Rainy.	„ *	v. HOWORTH'S.	801	Ho. —	Ho. —	1645
April 29	E.	Cloudy.	„ *	v. LLOYD'S.	2727	Ll. —	Ll. —	2497
May 8	N.E.	Hazy.	„ †	v. SCOTT-DUNN'S.	—	S.D. 24	S.D. —	103
April 27	E.N.E.	„	„ *	v. WEAVER'S.	1300	W. —	W. —	1182
May 12	E.	Clear.	SCOTT-DUNN'S *	v. HAMILTON'S.	S.D. 1078	Ham. —	Ham. —	S.D. 1447
„ 11	„	Moist.	„ *	v. HOWORTH'S.	534	Ho. —	Ho. —	638
„ 10	N.E.	Clear.	„ *	v. LLOYD'S.	114	Ll. —	Ll. —	183

Date.	Wind.	Atmos.	Cowls Tested.		Result.			
					1st Hour.		2nd Hour.	
					Pipe F.	Pipe G.	Pipe F.	Pipe G.
May 7	N.E.	Clear.	SCOTT-DUNN'S *	*v.* WEAVER'S.	212	W. —	W. —	362
,, 11	S.E.	,,	,, ‡	*v.* VACUUM.	—	Vac. 536	Vac. 683	—
,, 26	S.W.	,,	VACUUM *	*v.* HAMILTON'S.	Vac. 5914	Ham. —	Ham. —	Vac. 5407
,, 27	W.	,,	,, *	*v.* HELLYER'S.	462	Hel. —	Hel. —	2816
,, 26	S.W.	,,	,, *	*v.* HOWORTH'S.	1407	Ho. —	Ho. —	557
,, 27	,,	,,	,, *	*v.* LLOYD'S.	6314	Ll. —	Ll. —	7724
,, 14	N.E.	,,	,, *	*v.* WEAVER'S.	427	W. —	W. —	1735
,, 28	N.W.	,,	WEAVER'S *	*v.* HAMILTON'S.	W. 3238	Ham. —	Ham. —	W. 1886
,, 13	E.	,,	,, †	*v.* HOWORTH'S.	638	Ho. 848	Ho. —	—
,, 15	N.E.	,,	,, *	*v.* LLOYD'S.	401	Ll. —	Ll. —	893

* *Draws* in air through the other Cowl on either Pipe.
† *Draws* in air through the other Cowl on *one* Pipe only.
‡ *Allows* the air to be drawn through it on either Pipe.

TABLE (NO. 5) SHOWING THE RESULTS OF A SERIES OF *two one-hour** TESTS OF VARIOUS COWLS AGAINST OPEN PIPES, TESTED BY TWO PIPES AND TWO ANEMOMETERS SIMULTANEOUSLY.

N.B.—Notes 1, 2, 3, to Table No. 6, also apply to this Table.

Date.	Wind.	Atmos.	Cowls against Open Pipes.	One Hour on. Pipe F.	One Hour on. Pipe G.	Result. 2 Hours.	Difference.	In favour of
				Ft. up.	Ft. up.			
1880. Mar. 12	E.S.E.	Misty.	Banner's .... Open Pipe ..	12969 14528	12440 = 11591 =	25409 26119	710	O.P.
" 12	"	"	Boyle's ...... Open Pipe ..	17005 13425	15086 = 15168 =	32091 28593	3498	Bo.
" 6	N.W.	Cloudy.	Buchan's .... Open Pipe ..	19603 16882	19088 = 16203 =	38691 33085	5606	Bu.
June 15 " 16	N. N.E.	Hazy & moist. Rainy.	Hamilton's.. Open Pipe ..	7994 5079	8249 = 9277 =	16243 14956	1287	Ham.
Mar. 11	E.	Misty.	Hellyer's .. Open Pipe ..	14353 14674	17694 = 14632 =	32047 29306	2741	Hel.
June 15	N.	Hazy & moist.	Howorth's .. Open Pipe ..	6876 10307	11906 = 8864 =	18782 19171	389	O.P.
April 15	E.	Moist.	Lloyd's...... Open Pipe ..	13488 12670	13533 = 12529 =	27021 25199	1822	Ll.
June 15	N.	Hazy & moist.	Scott-Dunn's Open Pipe ..	8490 7779	10032 = 9844 =	18522 17623	899	S. D.
" 16	N.E.	Rainy.	"Vacuum" .. Open Pipe ..	5533 5341	6126 = 7233 =	11659 12574	915	O. P.
" 17	S.E.	Moist.	Weaver's.... Open Pipe ...	13136 11651	14636 = 11913 =	27772 23564	4208	W.

* See Table No. 8 for *ten-minute* tests.

TABLE (No. 6) SHOWING THE RESULTS OF A SERIES OF DOUBLE HOUR-TESTS* OF VARIOUS COWLS, TESTED TWO AT A TIME WITH TWO ANEMOMETERS *SIMULTANEOUSLY.*

NOTE (1). The U-shaped connecting-pipe, shown on Plate XXVI., C to D, was not used in this series of testing, but the two pipes, F and G, were kept independent of each other, and an anemometer (with 3-in. dia. air-way) was fitted into the bottom end of each of the two pipes.

(2). To make this series of testing as perfect as possible, the cowls, bracketed together, not only worked simultaneously, but they each worked one hour on the same pipe and the same anemometer, *i.e.*, the cowl that worked the first hour on pipe F worked the second hour on pipe G, and *vice versâ*; thus making all the conditions equal.

(3). Only the results of the individual trials (between the horizontal lines bracketed together) must be compared with each other, as the conditions of the wind and atmosphere would vary in every trial.

Date.	Wind.	Atmos.	Cowls Tested.	One Hour on. P. F.	One Hour on. P. G.	Result. 2 Hours.	Difference.	In favour of
1880.				Ft. up.	Ft. up.			
June 29	W.	Clear.	{ Banner's .... { Hamilton's..	15362 13998	11793 = 13833 =	27155 } 27831 }	676	Ham.
" 29	W.	"	{ Banner's .... { Hellyer's ..	17371 19035	17324 = 19338 =	34695 } 38373 }	3678	Hel.
Mar. 13	N.E.	"	{ Banner's .... { Hellyer's ..	9837 11323	12264 = 13254 =	22101 } 24577 }	2476	Hel.
June 9	S.W.	Light, rainy.	{ Banner's .... { Howorth's ..	12709 13562	11149 = 8097 =	23858 } 21659 }	2199	Ba.
" 26	N.E.	Hazy.	{ Banner's .... { Lloyd's.......	7707 5669	1085 = 3115 =	8792 } 8784 }	8	Ba.
" 9	S.W.	Rainy.	{ Banner's .... { Scott-Dunn's	4504 7029	5057 = 3451 =	9561 } 10480 }	919	S. D.
" 9	N.W. } S.W. }	"	{ Banner's .... { Vacuum......	5948 3311	7921 = 10062 =	13869 } 13373 }	496	Ba.
" 18	S.E. } fresh. }	Clear.	{ Banner's.... { Weaver's.....	18436 23685	23214 = 27488 =	41650 } 51173 }	9523	W.
July 12	W.	Light.	{ Boyle's...... { Banner's....	22381 19448	12058 = 7188 =	34439 } 26636 }	7803	Bo.

* See Table No. 7 for *ten-minute* tests.

Date.	Wind.	Atmos.	Cowls Tested.	One Hour on. P. F.	One Hour on. P. G.	Result 2 Hours.	Difference.	In favour of
1880.				Ft. up.	Ft. up.			
July 12	W.	Light.	Boyle's...... Hamilton's	16246 11222	11985 = 11939 =	28231 23161	5070	Bo.
" 9	S.W.	Clear.	Boyle's...... Howorth's ..	30101 27806	28289 = 28792 =	58390 56598	1792	Bo.
" 12	W.	Light.	Boyle's...... Lloyd's......	14766 13211	15512 = 8877 =	30278 22088	7190	Bo.
" 12	"	"	Boyle's...... Scott-Dunn's	21034 15268	11974 = 13038 =	33008 28306	4702	Bo.
" 13	S.W.	Clear.	Boyle's...... Vacuum......	19214 17039	17592 = 11321 =	36806 28360	8446	Bo.
Mar. 3	N.W. very strong.	Cloudy.	Buchan's .... Banner's....	17840 12873	20498 = 13144 =	38338 26017	12321	Bu.
" 3	N.W.	"	Buchan's.... Boyle's......	26567 20154	22763 = 17404 =	49330 37558	11772	Bu.
" 5	"	"	Buchan's .... Hamilton's..	19413 12185	18078 = 12446 =	37491 24631	12860	Bu.
" 8	E.N.E.	"	Buchan's .... Hellyer's ..	15467 10977	14103 = 14517 =	29570 25494	4076	Bu.
" 4	N.W.	Clear.	Buchan's .... Howorth's ..	20481 18039	22105 = 15343 =	42586 33382	9204	Bu.
April 12	N.E.	Showery.	Buchan's .... Lloyd's	10686 9529	10582 = 7970 =	21268 17499	3769	Bu.
Mar. 6	N.W.	Cloudy.	Buchan's .... Scott-Dunn's	15760 13360	19786 = 12168 =	35546 25528	10018	Bu.
" 4	"	Clear.	Buchan's.... Vacuum	17104 10337	16703 = 11510 =	33807 21847	11960	Bu.
" 3	"	Cloudy.	Buchan's .... Weaver's....	21323 18695	20792 = 16661 =	42115 35356	6759	Bu.

Date.	Wind.	Atmos.	Cowls Tested.	One Hour on. P. F.	One Hour on. P. G.	Result 2 Hours.	Difference.	In favour of
1880.				Ft. up.	Ft. up.			
Mar. 13	N.E.	Clear.	Hellyer's .. Banner's	11323 9837	13254 = 12264 =	24577 22101	2476	Hel.
,, 16	E.	Hazy.	Hellyer's .. Boyle's	11273 14139	13557 = 9866 =	24830 24005	825	Hel.
July 31	,,	Showery.	Hellyer's .. Boyle's	9432 10799	9551 = 6950 =	18983 17749	1234	Hel.
Mar. 10	N.W.	Foggy.	Hellyer's .. Hamilton's..	1947 6755	9563 = 3711 =	11510 10466	1044	Hel.
,, 15	E.	Hazy.	Hellyer's .. Howorth's ..	11786 9223	12414 = 14072 =	24200 23295	905	Hel.
April 12	N.E.	Showery.	Hellyer's .. Lloyd's......	8189 7727	11440 = 9796 =	19629 17523	2106	Hel.
Mar. 16	E.	Hazy.	Hellyer's .. Scott-Dunn's	7862 6732	12918 = 10063 =	20780 16795	3985	Hel.
,, 10	N.W.	Foggy.	Hellyer's .. Vacuum	11174 11546	13059 = 8027 =	24233 19573	4660	Hel.
,, 17	E.	Hazy.	Hellyer's .. Weaver's....	16933 19428	15906 = 13461 =	32839 32889	50	W.
July 29	S.W.	Moist.	Hellyer's .. Weaver's....	19874 17576	16151 = 18363 =	36025 35939	86	Hel.
June 2	,,	,,	Lloyd's...... Hamilton's..	14772 9851	10869 = 16234 =	25641 26085	444	Ham.
April 14	,,	Wet.	Lloyd's...... Howorth's ..	3067 2445	4034 = 2724 =	7101 5169	1932	Ll.
June 13	S.E.	Misty.	Lloyd's...... Scott-Dunn's	7712 10456	10186 = 8231 =	17898 18687	789	S. D.
,, 14	E.	Wet.	Lloyd's...... Vacuum	4994 4100	4290 = 4766 =	9284 8866	418	Ll.

Date.	Wind.	Atmos.	Cowls Tested.	One Hour on. P. F.	One Hour on. P. G.	Result 2 Hours.	Difference.	In favour of
1880.				Ft. up.	Ft. up.			
April 13	S.E.	Misty.	Lloyd's...... Weaver's....	5017 6561	8389 = 9149 =	13406 15710	2304	W.
July 9	S.W.	Showery.	Weaver's.... Boyle's......	21676 19709	28564 = 31454 =	50240 51163	923	Bo.
,, 8	W.	Clear.	Weaver's.... Hamilton's	13147 10094	19007 = 11302 =	32154 21396	10758	W.
,, 8	,,	Cloudy and Stormy.	Weaver's.... Howorth's ..	12600 8487	12875 = 14507 =	25475 22994	2481	W.
,, 8	,,	Clear.	Weaver's.... Vacuum	20004 16349	31485 = 22226 =	51489 38575	12914	W.

Table (No. 7).—Cowls Tested as in No. 6 Table, but for *Ten minutes* each Trial, instead of *One hour;* and the Notes to that Table also apply to this.

Date.	Wind.	Atmos.	Cowls Tested.	First Ten Min. P. F.	Second Ten Minutes. P. G.	Result Two Ten Min.	Difference.	In favour of
1880.				Ft. up.	Ft. up.			
July 20	N.W.	Light.	Banner's .... Hamilton's..	611 1374	1361 = 674 =	1972 2048	76	Ham.
,, 20	,,	,,	Banner's .... Hellyer's ..	1356 1663	779 = 1028 =	2135 2691	556	Hel.
,, 20	,,	,,	Banner's .... Howorth's ..	2498 2423	1443 = 2096 =	3941 4519	578	How.
,, 20	,,	,,	Banner's .... Lloyd's......	2699 1885	2096 = 2767 =	4795 4652	143	Ban.

Date.	Wind.	Atmos.	Cowls Tested.	First Ten Min.	Second Ten Minutes.	Result Two Ten Min.	Difference.	In favour of
				P. F.	P. G.			
1880.				Ft. up.	Ft. up.			
July 20	N.W.	Light.	Banner's .... Scott-Dunn's	1564 2041	2011 = 1334 =	3575 3375	200	Ban.
" 20	"	"	Banner's .... Vacuum	2059 1209	1972 = 2471 =	4031 3680	351	Ban.
" 19	W.	"	Boyle's...... Banner's	2281 2169	1878 = 1582 =	4159 3751	408	Bo.
" 19	"	"	Boyle's...... Buchan's	2719 2829	2480 = 3346 =	5199 6175	976	Bu.
" 19	"	"	Boyle's...... Hamilton's..	1664 1632	3379 = 2248 =	5043 3880	1163	Bo.
" 19	"	"	Boyle's...... Hellyer's ..	3028 2419	2115 = 2889 =	5143 5308	165	Hel.
" 19	"	"	Boyle's...... Howorth's ..	2562 1985	2475 = 2953 =	5037 4938	99	Bo.
" 19	"	"	Boyle's...... Lloyd's......	2629 2301	2618 = 1245 =	5247 3546	1701	Bo.
" 19	"	"	Boyle's...... Scott-Dunn's	2199 1353	1087 = 1609 =	3286 2962	324	Bo.
" 19	"	"	Boyle's...... Vacuum......	1401 1615	3533 = 2321 =	4934 3936	998	Bo.
" 19	"	"	Boyle's ..... Weaver's....	3607 3181	3843 = 4151 =	7450 7332	118	Bo.
" 20	N.W.	"	Buchan's .... Banner's	2378 1909	1971 = 1029 =	4349 2938	1411	Bu.
" 23	S.W.	"	Buchan's .... Boyle's......	1830 1981	1627 = 955 =	3457 2936	521	Bu.
" 23	"	"	Buchan's .... Hamilton's..	2362 1880	1838 = 931 =	4200 2811	1389	Bu.

Date.	Wind.	Atmos.	Cowls Tested.	First Ten Min. P. F.	Second Ten Minutes. P. G.	Result Two Ten Min.	Difference.	In favour of
				Ft. up.	Ft. up.			
1880. July 17	E.	Misty.	Buchan's .... Hellyer's ..	1207 1076	534 = 277 =	1741 1353	388	Bu.
„ 23	S.W.	Light.	Buchan's .... Howorth's ..	2213 2046	1954 = 973 =	4167 3019	1148	Bu.
„ 23	„	„	Buchan's .... Lloyd's......	3458 2154	2297 = 1746 =	5755 3900	1855	Bu.
„ 23	„	„	Buchan's .... Papier's	3932 3355	3053 = 3133 =	6985 6488	497	Bu.
„ 23	„	„	Buchan's .... Scott-Dunn's	3425 2652	2870 = 1827 =	6295 4479	1816	Bu.
„ 23	„	„	Buchan's .... Vacuum	2842 2493	2817 = 1395 =	5659 3888	1771	Bu.
„ 21	„	„	Buchan's .... Weaver's....	2645 2290	1945 = 1612 =	4590 3902	688	Bu.
„ 20	N.W.	„	Hellyer's .. Banner's	1663 1356	1028 = 779 =	2691 2135	556	Hel.
„ 17	E.	Misty.	Hellyer's .. Boyle's......	1111 832	95 = 225 =	1206 1057	149	Hel.
„ 17	„	„	Hellyer's .. Hamilton's. .	2478 2268	1633 = 1802 =	4111 4070	41	Hel.
„ 17	„	„	Hellyer's .. Howorth's ..	2212 1994	1476 = 1346 =	3688 3340	348	Hel.
„ 17	„	„	Hellyer's .. Lloyd's......	2290 2039	1499 = 1490 =	3789 3529	260	Hel.
„ 17	„	„	Hellyer's .. Scott-Dunn's	2023 2086	1549 = 970 =	3572 3056	516	Hel.
„ 17	„	„	Hellyer's .. Vacuum	1937 1772	1189 = 1004 =	3126 2776	350	Hel.

Date.	Wind.	Atmos.	Cowls Tested.	First Ten Min. P. F.	Second Ten Minutes. P. G.	Result Ten Min.	Difference.	In favour of
1880.				Ft. up.	Ft. up.			
July 29	S.W.	Rainy.	Hellyer's .. Weaver's....	3169 4241	3796 = 2684 =	6965 6925	40	Hel.
" 23	"	Light.	Papier's .... Banner's	4190 3258	3469 = 2659 =	7659 5917	1742	Pa.
" 23	"	"	Papier's .... Boyle's......	3184 3025	2687 = 2548 =	5871 5573	508	Pa.
" 23	"	"	Papier's .... Hamilton's. .	3548 2446	2340 = 2022 =	5888 4468	1420	Pa.
" 24	W.	Moist.	Papier's .... Hellyer's ..	2032 1829	1226 = 1325 =	3258 3154	104	Pa.
" 24	"	"	Papier's .... Howorth's ..	2116 1264	606 = 989 =	2722 2253	469	Pa.
" 24	"	Rain falling.	Papier's .... Lloyd's......	2137 781	551 = 685 =	2688 1466	1222	Pa.
" 24	"	"	Papier's .... Scott-Dunn's	1892 1322	719 = 774 =	2611 2096	515	Pa.
" 24	"	Moist.	Papier's .... Vacuum	1514 1808	1541 = 362 =	3055 2170	885	Pa.
" 24	"	"	Papier's .... Weaver's....	2490 2400	1698 = 1660 =	4188 4060	128	Pa.
" 20	N.W.	Light.	Weaver's.... Banner's	3031 2470	2491 = 1919 =	5522 4389	1133	W.
" 21	S.W.	"	Weaver's.... Boyle's......	2152 2035	1209 = 1427 =	3361 3462	101	Bo.
" 21	"	"	Weaver's.... Hamilton's..	2647 2211	1818 = 1687 =	4465 3898	567	W.
" 21	"	"	Weaver's.... Howorth's ..	2224 1954	1424 = 1112 =	3648 3066	582	W.

Date.	Wind.	Atmos.	Cowls Tested.	First Ten Min.	Second Ten Minutes.	Result Two Ten Min.	Difference.	In favour of
				P. F.	P. G.			
				Ft. up.	Ft. up.			
1880. July 21	S.E.	Light.	{ Weaver's.... { Lloyd's......	2496 1883	1216 = 1351 =	3712 } 3234 }	478	W.
" 21	"	"	{ Weaver's.... { Scott-Dunn's	2192 2137	1862 = 1054 =	4054 } 3191 }	863	W.
" 21	S.W.	"	{ Weaver's.... { Vacuum	3018 2196	2142 = 1574 =	5160 } 3770 }	1390	W.

Table (No. 8). Cowls against open pipes, Tested as in Table No. 3; but *ten minutes* instead of *one hour*.

Date.	Wind.	Atmos.	Cowls Tested.	First Ten Min.	Second Ten Min.	Result Two Ten Min.	Difference.	In favour of
				P. F.	P. G.			
				Ft. up.	Ft. up.			
1880. July 20	N.W.	Light.	{ Open Pipe .. { Banner's	2425 2794	2473 = 1594 =	4898 } 4388 }	510	O. P.
" 19	W.	"	{ Open Pipe .. { Boyle's	2867 2534	3120 = 3592 =	5987 } 6126 }	139	Bo.
" 23	S.W.	"	{ Open Pipe .. { Buchan's	3339 3481	2425 = 3124 =	5764 } 6605 }	841	Bu.
" 27	W.	,	{ Open Pipe .. { Hamilton's..	1419 1165	2121 = 1957 =	3540 } 3122 }	418	O. P.
" 20	N.W.	"	{ Open Pipe .. { Hellyer's ..	1277 1768	956 = 743 =	2233 } 2511 }	278	Hel.
" 27	W.	"	{ Open Pipe .. { Howorth's ..	2824 2659	2657 = 3347 =	5481 } 6006 }	525	How.
" 27	"	"	{ Open Pipe .. { Lloyd's......	2355 1000	1777 = 1826 =	4132 } 2826 }	1306	O. P.
" 24	"	Moist.	{ Open Pipe .. { Papier's	2867 2898	2128 = 2242 =	4995 } 5140 }	145	Pa.
" 27	"	Light.	{ Open Pipe .. { Scott-Dunn's	2262 1575	2237 = 2688 =	4499 } 4263 }	236	O. P.
" 27	"	"	{ Open Pipe .. { "Vacuum" ..	2478 1514	2541 = 2460 =	5019 } 3974 }	1045	O. P.
" 21	S.W.	"	{ Open Pipe .. { Weaver's	1769 2377	1545 = 978 =	3314 } 3355 }	41	W.

CHAPTER XXIV.

HAND-WORKERS.

VICTORY on the battle-field depends, no doubt, to a large extent upon the general; but in vain will be all his plans for conquest unless he can depend upon his soldiers. To fight battles successfully there must be trained soldiers, and to build sanitary houses there must be skilled workmen. A word or two then, before closing this treatise, to *hand-workers*—the interpreters into bricks and mortar of the plans and ideas of the *head-workers.*

The workman is on the spot, and can see, if he is an intelligent tradesman, when this is right and that is wrong. Upon his skill and industry the success of any work chiefly depends. *What is wanted is for every man to take an interest in his work, and to throw what skill and energy he possesses into it.*

No man should rest satisfied with himself until he has thoroughly mastered his trade. Take the craft of plumber—how few understand the trade thoroughly, practically, and theoretically! With some *anything* is "near enough;" but nothing is near enough unless it is *exactly right.* It takes just the same time to make a disfigured joint as a symmetrical one; just as long to fix a crooked pipe as a straight one; and it takes no longer to put the trap in the right than in the wrong place; nor is any time saved by making the branch-connections anywhere, instead of exactly in the right position.

The costly labour of indolent men, and the destructive labour of unskilled workers, eats up, or wastes, the productive labour of the industrious and skilled tradesman. And to compensate for this non-productive labour of the idlers and the incompetent, inferior materials are often used, and tricks are resorted to which are a disgrace to all concerned.

If every worker earned his wages before holding out his hand to receive them, and remembered that if he is not building his *own* house, he is helping to build a house for somebody, and that this somebody will want the same protection and comfort from it that he would himself, were he going to live in it—if all concerned remembered this, *scamping-work* would be killed at the roots.

The public are not free from blame in this matter. Competition is good and healthy—it keeps the rust out of our activities; but *over*-competition is injurious, as when *because* one man offers to do a work for half-a-crown, another will do it for a florin. But when the public find a man ready to give a guinea in exchange for a sovereign, they may be sure of one thing, that though it has the *guinea-stamp* it will not have the *guinea-gold*—something will be out of square about it.

Union is strength, and hence men combine together into union societies. Trades-unions have, no doubt, done a good work, but they are far from being an *unmixed* good, and the man who falls back upon a society instead of depending upon himself levels the hills which he should manfully climb. Trades-unions are terrible *levellers;* they level upwards sometimes it is true, but they level downwards like ballast in a ship: chain eagles to turkeys, skylarks to bats. They unite the indolent and incompetent to the industrious and skilled, and then strike an average for the value. And whether a man is worth a shilling a day or a shilling an hour, he must be paid according to the society's rules, so much for every hour's work, whatever the worth of the workman. And yet the men who receive alike their 10d. per hour, or whatever the rate may be, differ as the stars.

The best trades-union for a man to join is to unite *his heart to his work;* such a man will not want any help from societies; wherever employed he will not be long in passing from the outer circle of "casual" hands into the inner circle of "regulars," where he will be respected as a workman and a friend. And from this inner circle there rises a spiral staircase, and when once his foot is upon it, he will find that it ever leads upwards.

Builders of other men's houses, but not builders of your own! But why build ye houses only for others to own? Why are ye not yourselves your own landlords? The fault is your own. The advance in wages in the last few years, if you care to use it rightly, would enable every skilled mechanic to purchase a house for himself, through any of the Building Societies, in about twelve years. Take the money spent in drink—these constant "little drops"—and appropriate it to buying your own house, and before twelve years have passed over your head you will each have a little cottage of your own for your old age, and your constitution and you yourself will in every way be the better for your so doing. This is not depriving yourself of your dinner-beer or supper-beer, but simply abolishing these costly 'little drops" at all hours of the day, which are good .or neither body nor mind, and cost on an average weekly more than one day's wages. Hence the majority of artisans work one day a week, or two months of every year, to satisfy a *habit* which ought never to have been formed.

Let me speak specially to the twice six-score journeymen plumbers and assistants in our employ. For nearly a century and a half men skilled in all kinds of lead-work have been going in and out of the "old plumbers' shop, near the Strand." But never in any period of its history have the men, as a body, understood so thoroughly the principles of internal plumbing-work as at the present time. What your grandfathers did is not enough for you; the matter is "ventilated" more, and the why and wherefore of things sought out. The workmanship and thought put into the work by many of you is marked with such individuality that the writer has only to see the work to know the worker. With some of you the tendency is to rather *overdo* your work, *i.e.*, to *waste labour* upon it after it has already been well done; this is so much power lost, a gilding of fine gold.

All are still in the school-house learning, and many of you have a great deal to learn; but keep on learning until you have thoroughly mastered the trade, and by your skill and intelligence, honesty and sobriety, elevated, not yourself only, but the craft as well.

The knowledge of sanitary work is spreading rapidly, and if you would keep abreast of your trade you must educate your eyes as well as your hands: for it is not enough in this Ventilating Age that you become skilled hand-workers, you must become intelligent head-workers as well: *i.e.*, you must add to your skill in joint-wiping, and trap and pipe fixing, the knowledge of sanitation in plumbing, the principle of *con*nection and *dis*connection, *how* to let fresh air into pipes and *where* to let it in, and how to keep vitiated air away from all *breathing-places*, whether inside or outside the house—in short, you must become *sanitary plumbers*.

If the young plumbers—respectable sons of respectable plumbers—who leave us from time to time to settle down with their fathers, or for themselves, in other parts of the country, would only be determined to master the theoretical as well as the practical part of plumbing, we should hear very little about "levelling *downwards*" in sanitary plumbing, but there would be a good deal of work done in "levelling *upwards*." And then, purifying our houses from so many centres, by putting everything in a sanitary state, we should soon make our Island Home—"Home, sweet Home."

You plumbers must maintain your *prestige*, for you are a respectable body; for do you not belong to a high profession? They call the clergy "members of the cloth." Well, are you not members of the "cloth" too? True, your cloth is not *broad* cloth, for it is hardly big enough to cover your nakedness; yet still you are members of the cloth, though it be only the *solder-cloth*. See, then, that you never disgrace your cloth by bad joint-wiping. Let every joint in the house be perfect, not only where it is in sight, but where it is out of sight—and *especially* in such places. I have often noticed in the old lead soil-pipes sent to our place from time to time joints only *half*-made—*i.e.*, the joint has never been *wiped* at all on the *back part* of the pipe; the solder has simply been "splashed" on and rubbed about with the iron. Now such joints, though they may not show a water-leak, often allow soil-pipe-air to escape through them, as many a householder has found to his cost.

Every competent plumber with us has his *mate*—for, like the cuckoo, he must have some one to attend upon him—to feed him with solder, etc.—and there is a wise economy in this—for I have no faith in unskilled labour; therefore we have little or nothing at all to do with the old-fashioned plumber's labourer. The "mates" are *assistant* plumbers with us, and as they must have served their apprenticeship, or had several years' experience before they come with us, and as they come to us from all parts of the kingdom, our House is becoming a University for men to complete their education in plumbing. And, as an encouragement to the men who come to us to perfect their plumbing knowledge, and also to those who remain with us, I got out a Certificate of Merit, which I introduced at the annual Bean-feast, held at the Crown Hotel, Broxbourne, on Saturday, July 10, 1880.

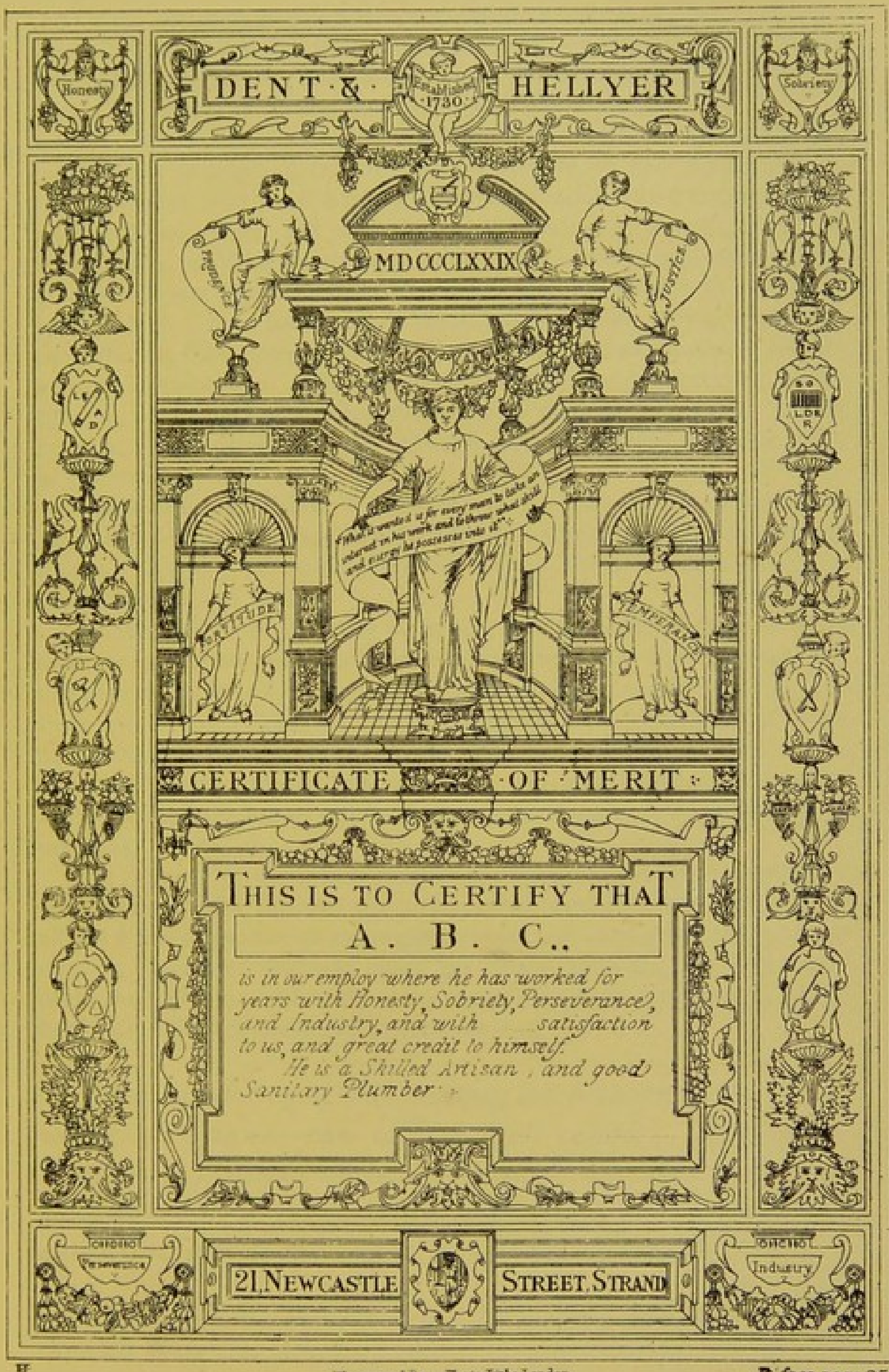
The form* on which the Certificate is written is elaborately got up, and nicely illuminated in many colours and gold; and though the plumber's tools are not in the *hands* of *mates*, they are well illustrated in shields held up by little figures in the margins.

In instituting this Certificate I said:—

"I have something to say to you on a subject of great interest to every plumber in this Firm, and which I hope will form a landmark in his history.

"Medals are struck, and hung upon the breast of the brave soldier or sailor who by *one* grand exploit or daring deed entitles himself to the distinguished notice of his country.

* It was designed for me by Mr. Isaac Jones. The style is Italian Renaissance, with arabesque border, the shields containing tools used by the trade. On the corners are the four cardinal virtues as they would exhibit themselves in a good workman—Honesty being the outcome of Justice; Sobriety, Temperance; Perseverance, Fortitude; and Industry, Prudence. The four figures in the upper division of the design bear shields and labels with the Virtues; the centre figure bearing a label with a motto (taken from the Author's Address to Hand-workers, page 137 of this book) intended to inculcate them. The bottom panel bears the inscription; and in the centre of the bottom border is the Trade Mark of the Firm—the London Apprentice. The whole forms a testimonial to the character and ability of the workman whose name appears thereon, and is expressive of the altogether satisfactory manner in which he has served the Firm for a stated period.



Whiteman & Bass, Photo-Litho London. *To face page 358.*

"And yet it is a beautiful thing, to my mind, that hundreds of men are to be found, among all classes, who if they do not do one *great* deed, do their duty, not once or twice only, but day after day, week after week, and year after year; whether noticed or unnoticed, rewarded or unrewarded. They do it because they have a high and noble sense of what is right and true. We rejoice in having some such men in our employ.

"It is customary, as many of you know, in our professional institutions, in our seats of learning, in our halls of science, to give distinguishing marks to men who have achieved any great success, and it occurred to my mind some time ago that the largest and most ancient House of Plumbers in the three kingdoms should have some mark—some token of goodwill—to bestow upon its leading men. And so this Certificate of Merit, which I now hold in my hand, has been specially prepared for presentation, from time to time, to the men in our employ who comply with its requisitions. The standard is high, for I want you all to become, what many of you are, the foremost men of your craft—first in honesty, first in sobriety, first in industry, and first in skill and knowledge of your trade.

"This certificate can only be possessed by those who have worked in the Firm for ten years, and as I want it to be a guarantee that the holders of it are all that it professes, you must *merit* it, for it is only kissing, you know, that goes by favour.

"There will be no difficulty in settling who are entitled to it, as far as *time* is concerned: our books will show that; nor will there be any difficulty as far as *skill* is concerned: your work will speak for itself; but there will be some difficulty in determining the fit recipients of it as far as *sanitary knowledge* is concerned. And to settle this question, before you can hope to receive this certificate, you must have carried out a sanitary plumbing job of some magnitude on the principles laid down in my book.

"It is in my thoughts at present to have block plans of some extensive buildings made for the men who are entitled to receive this certificate in all the other points except the sanitary one, and to require them to lay down a system of drainage upon the plans, showing how they would drain the buildings, and, at the same time, to specify in their own language how such drainage should be carried out."

After presenting at this meeting the first certificate to our General Foreman—one of the best sanitary plumbers in London—the names of about twenty men were read over, who, according to the Author's judgment, were there and then entitled to receive the certificate—which reads as follows:—

"This is to certify that A.B.C. is in our employ, where he has worked over ten years with Honesty, Sobriety, Perseverance, and Industry, and with much satisfaction to us and great credit to himself. He is a Skilled Artisan and good Sanitary Plumber."

TABLE SHOWING SIZE OF SERVICE-PIPE AND VALVE TO GIVE A GOOD FLUSH OF WATER.

Head-of-water, *i.e.*, Height of Cistern (bottom) above w.c. Apparatus.	Size of Pipe and Valve for *flushing-rim* Closets.	Size of Pipe and Valve for *fan* basins.
4 feet and under 6 feet . . .	1½″ pipe and 1½″ valve.	1¼″ pipe and valve.
7 feet ,, 12 feet . .	1¼″ pipe and ditto.	1″ pipe and 1″ valve.
13 feet ,, 18 feet . .	1″ pipe, and 1¼″ valve.	¾″ pipe and ¾″ valve.
Above 18 feet	1″ pipe, and 1″ valve.	¾″ pipe and ¾″ valve.

TABLE SHOWING WEIGHTS OF LEAD PIPES OF VARIOUS SIZES AND STRENGTHS, FOR USE ACCORDING TO CIRCUMSTANCES.

All lead pipes should be made by hydraulic pressure, and great care should be taken to have the pipe of even substance all over.

—	Class A.	Class B.	Class C.	Class D.
SOIL-PIPE.—3-in., 3½ in., 4-in., and 4½-in.—equal in substance to *sheet* lead per superficial foot	lbs. lbs. 10 or 9	8 lbs.	7 lbs.	6 lbs.
[Thickness of lead	$\frac{5}{32}$ $\frac{9}{64}$	$\frac{1}{8}$	$\frac{7}{64}$	$\frac{3}{32}$]

—	Class A.	Class B.	Class C.	Class D.
VENTILATING-PIPE. — 2½-in., 3-in., 3½-in., 4-in., 4½ in., and 5-in.—equal in substance to *sheet* lead per superficial foot .	8 lbs.	7 lbs.	6 lbs.	5 lbs.
[Thickness of lead . .	$\frac{1}{8}$	$\frac{7}{64}$	$\frac{3}{32}$	$\frac{5}{64}$]
Ditto.—2-in. air-pipe, weight per *yard lin.*	16 lbs.	16 lbs.	14 lbs.	12 lbs.
Ditto.—1½.in. air-pipe, weight per *yard lin.*	14 lbs.	12 lbs.	11 lbs.	9 lbs.

—	Class A.	Class B.	Class C.	Class D.
WASTE-PIPE.—*Cold* water wastes—				
	10 lb. lead	9 lb. lead.	8 lb. lead.	7 lb. lead.
3-in. pipe, weight (about) per yd. lin.	25 lbs.	23 lbs.	20 lbs.	18 lbs.
2½-in. ,, ,, ,, ,,	21 lbs.	19 lbs.	17 lbs.	15 lbs.
2-in. pipe, weight per yard lin.	24 lbs.	21 lbs	18 lbs.	16 lbs.
1½-in. ,, ,, ,, ,,	18 lbs.	16 lbs.	14 lbs.	12 lbs.
1¼-in. ,, ,, ,, ,,	14 lbs.	12 lbs.	10½ lbs.	—

—	Class A.	Class B.	Class C.	Class D.
WASTE-PIPE.—*Hot* water Wastes—				
	14 lb. lead.	10 lb. lead.	9 lb. lead.	8 lb. lead.
3-in. pipe, weight (about) per yd. lin.	35 lbs.	25 lbs.	23 lbs.	20 lbs.
2½-in. ,, ,, ,, ,,	29 lbs.	21 lbs.	19 lbs.	17 lbs.
2-in. pipe, weight per yard lin.	27 lbs.	24 lbs.	21 lbs.	18 lbs. or 16 lbs.
1½-in. ,, ,, ,, ,,	21 lbs.	18 lbs.	16 lbs.	14 lbs.
1¼-in. ,, ,, ,, ,,	16 lbs.	14 lbs.	12 lbs.	10½ lbs.

TABLE SHOWING WEIGHTS OF LEAD SERVICE PIPE PER YARD.

—	½ in.	¾ in.	1 in.	1¼ in.	1½ in.	2 in.
"Extra strong" lead pipe—*Water Companies' weights—as per Metropolis Water Act*, 1871	6 lbs.	9 lbs.	12 lbs.	16 lbs.	21 lbs.	28 lbs.
"Strong" service-pipe. . .	*4½ lbs.	*7¼ lbs.	*10½ lbs	14 lbs.	18 lbs.	24 lbs.
"Service-pipe," *light* . . . "Strong *waste*-pipe," same strength as "light" service-pipe	*3¼ lbs.	*5⅝ lbs.	*8½ lbs.	12 lbs.	16 lbs.	21 lbs.
"Warning-pipe"—Pipes "discharging with an *open end*" *minimum strength, as per Metropolis Water Act*, 1871.	3 lbs.	5 lbs.	7 lbs.			
"Waste-pipe"	. . .	. . .	. . .	*10½ lbs	12 lbs.	18 lbs.

* Within a fraction of the exact weight.

TABLE SHOWING THE *OUTSIDE* AS WELL AS THE *INSIDE* DIAMETER OF CERTAIN STRENGTH PIPES.

Inside diameter.	½-in.	¾-in.	1-in.	1¼-in.	1½-in.	2-in.
Outside ,,	⅞	1 5/32	1 15/32	1¾	2 1/64	2 9/16
†Weight per yard	6 lbs.	9 lbs.	12 lbs.	16 lbs.	21 lbs.	28 lbs.

Pipes from ½" to 1" inclusive are made in *Lengths* of 15 ft., or in *Coils* of 60 ft.

Pipes from 1¼" to 2" inclusive are made in *Lengths* of 12 ft., or in *Coils* of from 40 to 50 ft.

Pipes from 2¼" to 6" inclusive are made in *Lengths* of 10 ft. [Some manufacturers make these pipes in 12-feet *Lengths*.]

Soil-pipes and waste-pipes made by hydraulic pressure, above 2 in. and under 6 in., made in any weight *to the strength of sheet lead*, from 6 lbs. to 14 lbs. per foot superficial.

† Lead *Rising-main*, London water companies' weights.

WEIGHTS OF LEAD PIPES PER LINEAL YARD, AS REQUIRED BY VARIOUS COMPANIES.

	3/8-in.	1/2-in.	5/8-in.	3/4-in.	1-in.	1 1/4-in.
London, according to Metropolis Water Act...	5 lbs.	6 lbs.	7 1/2 lbs.	9 lbs.	12 lbs.	16 lbs.
Kent	...	5	7	9	12	...
West Surrey	4	5 1/2	...	9	14	20
Caterham	5	6	8	10	14	...
Colne Valley	5	7	9	11	16	...
Sevenoaks and Tonbridge	...	5	7	9	12	15

TABLE OF WEIGHTS PER YARD OF PATENT "LEAD-ENCASED BLOCK-TIN PIPE."

Head of Water in Feet.	Corresponding Pressure in lbs. per Square Inch.	1/2-in.		5/8-in.		3/4-in.		1-in.		1 1/4-in.		1 1/2-in.		2-in.	
		Lbs. per Yard.	Average Length of Coils in Yards.	Lbs. per Yard.	Average Length of Coils in Yards.	Lbs. per Yard.	Average Length of Coils in Yards.	Lbs. per Yard.	Average Length of Coils in Yards.	Lbs. per Yard.	Average Length of Coils in Yards.	Lbs. per Yard.	Average Length of Coils in Yards.	Lbs. per Yard.	Length in Feet.
For 50 and under...	21.7	3 1/2	32	4 1/2	26	5 1/2	36	7 1/4	27	9	22	11	17	16	12
,, 250 ,, ...	108.5	4	28	5 1/4	37	6	33	8	25	10	19	12 1/2	15	18 1/2	12
,, 500 ,, ...	217	4 1/2	25	6	33	7	28	9	22	12	16	14	14	21	12

Pipes of 2 1/4-in. to 6-in. dia. can be made to order, and of any weight.

CAST-IRON PIPE FOR DRAINS OR WATER-MAIN, COATED INSIDE AND OUT WITH DR. ANGUS SMITH'S SOLUTION. WEIGHT PER LINEAL YARD. THE SOCKET IS CONSIDERED IN THIS WEIGHT.

Size.	Heavy pipe. Weight per yard (about). cwt. qrs. lbs.	Thickness (about)	*Lighter pipe. Weight per yard (about). cwt. qrs. lbs.	Thickness (about)
3-in.	0 1 9	3/8-in.	0 1 7	11/32-in.
4-in.	0 2 0	3/8-in.	0 1 24	3/8-in.
5-in.	0 2 19	7/16-in.	0 2 14	13/32-in.
6-in.	0 3 9	7/16-in.	0 3 5	7/16-in.
7-in.	1 0 0	1/2-in.	0 3 24	1/2-in.

* Lighter pipes are made than the weights given here, but such pipes should not be used for drainage inside a house.

TABLE SHOWING THICKNESS OF SHEET LEAD OF VARIOUS STRENGTHS.

Weight per ft. super.	4 lbs.	5 lbs.	6 lbs.	7 lbs.	8 lbs.	9 lbs.	10 lbs.	11 lbs.	12 lbs.	15 lbs.
Thickness ...	1/16	5/64	3/32	7/64	1/8	9/64	5/32	11/64	3/16	1/4

Table Showing Weight per Foot Super of Sheet Copper and Iron.

Thickness ...	$\frac{1}{32}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$
Copper, Weight...	lb. oz. 1 7$\frac{1}{4}$	lbs. oz. 2 14$\frac{1}{2}$	lbs. oz. 5 13	lbs. oz. 8 12	lbs. oz. 11 10	lbs. oz. 14 8	lbs. oz. 17 7	lbs. oz. 20 5	lbs. oz. 23 4
Iron, Weight...	1 4	2 8	5 0	7 8	10 0	12 8	15 0	17 8	20 0

Table Showing Thickness of Birmingham Wire Gauge.

No.	1	4	7	9	11	16	22
Thickness	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{5}{32}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$

Table Showing Specific Gravity of Metals.

Names.	Weight, Water being 1,000.	Number of Cubic Inches in a Pound.
Mercury	13.560	2.038
Lead	11.352	2.435
Bismuth	9.823	2.814
Copper	8.910	3.103
Brass	8.396	3.293
Iron	7.700	3.592
Tin	7.291	3.790
Zinc	7.190	3.845

Table Showing the Lineal Expansion of Metals Produced by Raising their Temperatures from 32° to 212° Fahrenheit.

Zinc	1 part to 322
Tin (pure)	,, 351
Tin (impure)	,, 500
Copper	,, 581
Brass	,, 584
Bismuth	,, 719
Iron	,, 812

Table Showing Effects of Heat on Different Metals.

Wrought Iron .	fuses ...	2,910 Deg. Fahrenheit.
Cast Iron	melts ...	2,787 ,, ,,
Copper	,, ...	1,990 ,, ,,
Brass	,, ...	1,870 ,, ,,
Lead	,, ...	612 ,, ,,
Bismuth	,, ...	476 ,, ,,
Tin	,, ...	442 ,, ,,
Tin 1 and Lead 4	,, ...	460 ,, ,,
Tin 3 and Lead 2	,, ...	334 ,, ,,
Tin and Bismuth, equal parts	,, ...	283 ,, ,,
Bismuth 5, tin 3, and lead 2	,, ...	212 ,, ,,

RAINFALL, AVERAGES.

Name.	Time.	Depth.	Per Sq. Foot.
Heavy ...	24 hours	1 in.	1
Heaviest ..	24 ,,	1½ in.	1
In England, Mean Annual Rainfall, 36 inches.			

TABLE SHOWING VELOCITY OF WIND AND WIND'S IMPULSE.

Names.	Miles per hour.	Feet per Second.	Velocity. Feet per Second.	Impulse on a Square Foot in Pounds.
—	1	1·47	10	0·229
Light Airs	2	2·93	20	0·915
	3	4·40	30	2·059
Breeze	4	5·87	40	3·660
	5	7·33	50	5·718
Brisk Gale	10	11·67	60	8·234
	15	20·00	70	11·207
Fresh Gale	20	26·67	80	14·638
	25	29·34	90	18·526
Strong Gale ...	30	40·01	100	22·872
	35	51·34	110	27·675
Hard Gale	40	58·68	120	32·926
	45	66·01	130	38·654
Storm	50	73·35	140	44·830
	55	88·02	150	51·462
Hurricane	80	117·36		
	100	146·70		

ON THE ACTION OF WATERS UPON LEAD.

This extract is taken from my book, "Lectures on Sanitary Plumbing," where it was printed, by permission, from Dr. Sedgwick Saunders' translation of M. Belgrand's essay, "On the Action of Waters upon Lead Pipes." M. Le Blanc had made some experiments, and M. Belgrand quotes from him as follows, viz. :—

"'Chemists have long known with what facility lead becomes oxidised when immersed in distilled water in contact with air. Very small white shiny crystals of the hydrated oxide of lead are very rapidly formed, their quantity augmenting until a copious sediment at the bottom of the vessel has formed ; the same obtains with pure rain water.

"'On the contrary, water containing a given quantity of salts, principally from selenitic wells, does not attack the lead under the same conditions at all.

"'Such are the results of experiments made by Professors of Chemistry during the last forty years in public lectures, and M. Dumas never omitted to place them before his class at the Sorbonne.

"'Chemists have often remarked upon the harmlessness of lead with regard to potable waters, circulating in pipes of this metal, because of the *saline* matters which preserve the metal from oxidation.

"'No doubt it would be difficult to give an explanation of these facts, but they seem of the same kind as those which have been established with regard to iron, which can be preserved without oxidation in distilled water, even when aërated, if only a few drops of an alkali be added to it, whilst it is oxidised rapidly in pure aërated water. But it is curious to observe that by augmenting to a certain extent the proportion of alkali, oxidation can be facilitated.

"'Which salts are the most efficacious, when present in minute quantities, in preventing oxidation of lead in contact with water? Salts of lime alone are unquestionably so, even in the smallest proportions; in the absence of lime other salts are capable of protecting lead, in quantities of 0·1 gramme per litre. Nevertheless, after from 24 to 30 hours the water becomes faintly coloured by sulphuretted hydrogen; but this oxidation soon ceases. The following experiments were made to ascertain the particular influence of different salts.

"'Solutions were made with sulphate of soda, chloride of sodium, chloride of potassium, sulphate of magnesia, the strength of each solution being 0·1 gramme per litre. The lead was immersed in these for 24 hours, when the water became coloured by sulphuretted hydrogen, but the solvent action did not continue, and it may be said that the solutions in question are without notable action upon lead, for, at the end of 10 days, the re-agent did not produce any real precipitate.'

"Upon the whole there is absolutely no danger of poisoning from the use of water flowing through leaden pipes.*

"Furthermore, in the *Journal des Savants* (October, 1871, p. 488), one reads :—

"'It may not be inopportune to draw attention to a fact not sufficiently known to the public—namely, that rain waters alter leaden and zinc vessels more than waters containing salts in solution, well waters for example. The result of this is that *these latter waters may remain in a leaden vessel without attacking it, and without becoming poisonous, while rain waters, free from saline matters, dissolve oxide of lead and thus become poisonous.* This observation, quoted from Guyton de Morveau, is perfectly true. I have verified it at the time of my investigation on the waters of the Bièvre.'"

* M. Belgrand.

APPENDIX.

Future Success of Domestic Sanitation.

THE great attention paid now to sanitary plumbing, and draining work, combined with the superior knowledge now brought to bear upon the subject—knowledge which has been chiefly gained within the last ten or fifteen years—is most promising of success in the future; but if we are ever to arrive at perfection in sanitary science, and its application to our houses, we must, from time to time, examine minutely the works done, to see whether they have been successfully treated in every particular, and whether, after some years of usage, there are any failures; and if failures are found, we must examine very closely into their cause, with a view to their future prevention. We shall then advance in the knowledge of these subjects by the aid of the best of all teachers—experience, and may hope at no very distant date to arrive at a state of perfection in domestic sanitation.

Further Expenditure often Necessary to Success.

No doubt such examinations would, in many cases, call for a further expenditure of money for improvements, but instead of laying this as a charge against sanitarians and plumbers, and being angry with them for wanting to undo at a later period what they did at an earlier period, when their knowledge of the subject was not so advanced, the public ought to look with favour upon such men, and be willing enough to bear the pecuniary burden of such improvements, remembering that pain of some kind is the inevitable consequence of all true progress.

Co-operation of the Public Needed.

In fact, the man who gives his best thought to this subject, and who is ever on the watch for failures for the purpose of inventing further improvements, instead of deserving censure, is entitled to the hearty co-operation of the public, for whose benefit such improvements are made; and the pecuniary advantage gained in carrying out such improvements is trifling compared with the great advantage of possessing wholesome houses to live in.

Errors should now be Avoided.

That errors should have been committed a few years ago, when sanitary science was advancing by "leaps and bounds," is hardly to be wondered at; but now that the subject is so much better understood, and that good appliances are at hand for making the plumbing work of a house quite sanitary, it is greatly to be hoped that sufficient interest will be taken in such works to prevent errors of any moment being committed in future.

Many systems of drainage, which would otherwise be fairly good, are rendered inefficient by oversight in some of their most important details.

I could make this book very bulky with illustrations of errors which one has come across, even within the last few months, and I could tell the most doleful tales of the failures caused thereby, but I remember that "silence is golden," and will, therefore, only call attention to a few of the mistakes which have recently come under my notice.

(1) Ventilating pipes are sometimes so positioned that long lengths of drain are left unventilated, *i.e.*, the ventilating pipe is taken from about the middle part of the drain, instead of from its head, and however long the branch drains may be, no attempt is made to ventilate them.

(2) Ventilating pipes are sometimes so connected with a drain that they soon cease to be of value, for, their lower ends being on a level and continuous with the drain-pipe, paper and solid matters, lying in or travelling slowly through the drain from

water-closets, are met by a sudden discharge from a bath or flushing tank, into the drain from a branch further on, and are carried back into the mouth of the ventilating pipe, which in this way soon gets blocked. The error of such arrangements was clearly pointed out in an earlier edition —*see* pp. 286, 287, also plates IX. and X., showing how to keep ventilating-pipes clear of backwash.

(3) Plain cast-iron pipes are still used for ventilating drains without any receptacles at their bottom ends for catching the rust which is constantly forming in their interior, and falling to the bottom of the pipe ; hence it does not take many years for such accumulation to choke them up, and render them valueless. Several instances of such stoppages have recently come under my notice, and I refer the reader to page 289, where I have dilated more fully on this matter, and where an illustration is given of a stoppage in a ventilating pipe from fallen rust.

(4) One class of ventilating pipes is often connected with another class to the detriment of the whole system. I have met with cases where the ventilating pipe from the sewer or cesspool has been connected with the ventilating pipe from the drain, and even with a soil-pipe. The drain, or soil-pipe, has been trapped off from the cesspool, and a separate ventilating pipe taken from each and carried up above the roof rightly enough ; and then, to show their belief in ventilation, these pipes have actually been connected together at their lower ends, thus rendering the trap (so carefully fixed for shutting out the sewer gases) valueless, and affording an easy passage for the gases to pass from the cesspool, through the " connecting-pipe " into the soil-pipe.

(5) Automatic flushing-tanks are also fixed of much greater capacity than necessary. I know of cases where much better results would have been obtained if such tanks had been about *one-third* or one-fourth the size of that fixed, and *having a more frequent discharge.* I have come across flushing-tanks discharging 300 gallons at a time, where a tank of 50 or 75 gallons would have been ample. When a large body of water is discharged into a drain from

a large syphon, the drain becomes filled with water for some distance, and, unless the branches stand considerably higher, there is a great risk of matters (paper and solids), travelling through the drain at the time, being washed up into them, the evils of which we have just been considering; and I have seen cases where excrementitious matters have been so driven back into the branch drains, that they have actually washed up through the surface traps, and on to the ground.

There is also a further risk of syphonage of the various traps fixed upon the drain and branch drains, an evil which is often overlooked by many. In testing the working of these flushing-tanks, I have known out-door water-closet traps, where they have been fixed on branch drains, without ventilation, to have their seals broken by a discharge from a flushing-tank through the main drain, and I have seen many "surface-traps"—intercepting-traps—similarly situated, with their seals so nearly gone that a little further loss (which evaporation at certain times of the year would soon accomplish), would make them of little or no value for preventing drain air from passing through them. In one case, and that too with only a 50-gallon flushing tank, the water from a large size grease-intercepting trap, was syphoned out of it below its line of seal. A ventilation pipe fixed on the outgo of such traps, or on the branch drains, would of course prevent such syphonage.

(6) Where the drain is of a very long length, it is highly necessary that the flush of water should be greater than that allowed in towns and cities by water companies. Finding that a 2-gallon syphon flushing cistern answers fairly well for the best kinds of "hopper" closets, when fixed in London—*i.e.*, where the main drain is probably only a short distance from the closet, and where only a short length of main drain suffices to convey the discharges into the sewer—inexperienced people frequently use these "fittings" in country buildings where the drains may be of very great length. In such cases, especially where there are no baths or flushing-tanks, it is not surprising that the drains get stopped up.

A good means of testing the capabilities of a water-closet —which I have often adopted—is to put three or four pieces of paper readily distinguished, or two or three apples, and see how far, with one pull of the closet-handle or flushing-cistern, they are carried through the drain. It will be found that when the closets are fixed upon long branches, a 2-gallon flush of water will be insufficient—even with the best of closets—to carry the paper, etc., into the main drain, to be taken away with the general stream. Before determining the apparatus or flushing power to be adopted, the position of the closet should be considered in relation to the drain, and it will be found that where long lengths of drainage exist, a flush of three or four gallons will be necessary to obtain good results.

Many persons may deem some of the errors that we have been considering of minor importance, and may even go so far as to call them trifles. I would remind them that Michael Angelo once said, that " trifles make perfection, and perfection is no trifle."

Slow Progress of Sanitary Knowledge.

The knowledge of sanitary plumbing and draining work is so limited that no such happy results as we have been considering can be expected *generally* for some time to come—even in enlightened London. And Hygeia only knows when it shall spread throughout the country, into every town and village in the United Kingdom, so that a plumber, wherever he is found, shall possess sufficient skill and knowledge to execute his work with efficiency, on the principles laid down by the best authorities.

Encouraging Signs.

Many plumbers, however, during the last ten or fifteen years, have been working hard towards a better state of things, and hundreds of men, scattered here and there throughout the land, could to-day give intelligent reasons for their work, who, a few years back, were very ignorant, if not entirely so, of the science of their craft. And this spread of knowledge is greatly assisted by the workmen engaged by sanitary firms who carry out their works properly, leaving for other employment. The literature, too, emanating from all quarters, is very helpful to the progress of Sanitary Science. In Paris, an excellent work by M. Wazon, entitled, "Principes Techniques d'Assainissement des Villes et Habitations," has recently been published, showing that there is a growing desire in that country for a better state of things.

The spirit of sanitary knowledge is moving about in our cities and towns, and even in our villages, and our younger men, with very praiseworthy efforts, are forming themselves into classes for reading the literature and studying the principles of their art. At the Polytechnic Institution in London a very large number of young men, during the past year or two, have been learning not only the theory but something of the practice of their trade, under the able instruction of my foreman, Mr. J. W. Clarke, who is assisted by another of my foremen, Mr. George Taylor.

I have received many letters from young plumbers in various parts of Great Britain, who are desirous of obtaining the fullest knowledge they can, asking the best means of studying the theoretical side of their craft, and, if my health had permitted it, I would have carried out my original intention of following my course of lectures at the Society of Arts by delivering lectures throughout the country, illustrating them by suitable examples, exhibited by means of the dissolving view apparatus. But at present I am too overwhelmed with work to entertain any such hope.

I may also mention that I have received numerous letters of inquiry from members of the trade and of the architectural and engineering professions residing in the United States, South America, New South Wales, France, Italy, and Sicily, and M. Poupard aîné, the head of one of the leading plumbing houses of Paris, takes so much interest in the progress of sanitary plumbing, that he has sent his son, M. Georges Poupard, to me to learn our English methods of work, and the latter is making every effort to acquire a thorough knowledge of both theory and practice.

As the wave of popular interest in plumbing is passing over the land, I would strongly advise the younger men of the trade to put forth their best efforts to acquire a full and complete knowledge of their craft, and not to rest satisfied with themselves until they can not only give a reason for every process of their work, but also illustrate it with pen and pencil, in fact, they should be as ready with the pencil as with their "bossing-stick."

It would astonish many a plumber to find what a saving of time is effected, and how much more accurate his work can be turned out, if it is executed in accordance with lines correctly set out in geometrical principles on the bench or floor, than if done in the old rule of thumb way, *i.e.*, by taking his work to the site and "offering" it up in position from time to time to see that he is right.

A knowledge of metallurgy—such portions of the science as are applicable to the trade—is no doubt of great value, but to the journeyman plumber I consider a good acquaintance with geometry is of more importance. So many science schools and classes, however, are established all over the country, and especially in London, that young men of ambition should take the opportunity of not only gaining a knowledge of these sciences, but they should also make themselves acquainted with the principles of other sciences bearing upon their trade.

Necessity of Plumbers being Properly Qualified.

If plumbers—masters and journeymen—rightly understood their position, if they were alive to their real interests, they would lose no time in acquiring the knowledge necessary to properly sanitate a house; but if they will not voluntarily do so, the law must step in and compel them; for their work is of so much importance to the general health of the nation that the matter cannot be trifled with any longer. As I said in 1881, when addressing a body of plumbers in the rooms of the Society of Arts, "*Every man should be properly* LICENSED *before being allowed to carry on the practice of sanitary plumbing; and before he could obtain such a licence, he should be made to pass an examination in the science and art of plumbing before duly authorised and properly qualified examiners.*"

Registration of Plumbers.

The Worshipful Company of Plumbers, under the able direction of the Master* (Mr. George Shaw, C.C.), did a good work in 1884 in calling plumbers together from all parts of the country to consider the *state* of the trade and its duty to the public, and after strenuous efforts during the past two years to establish a system of registration of plumbers, the scheme has so far advanced, that it may now be considered *un fait accompli*, and many hundreds of plumbers, from all parts of the country, have been placed upon the register.

In considering the applications, I think too much importance has been attached to apprenticeship, though at this early stage perhaps it could hardly be otherwise. The scheme has become so popular that it ought not to be difficult at an early date for the Registration Committee to fix a time after which no candidate should be put upon the register until he had undergone a searching examination; for there are hundreds of men who have not only served an apprenticeship, but who have also worked many years as journeymen, and have subsequently become masters, and yet have comparatively but little knowledge of the science of their trade, *i.e.*, they know but little of *sanitary* plumbing; while on the other hand—without touching upon the difference of the aptitude of men—from better opportunities, from taking greater interest in their work, from study, from closer observation, there are scores of men who, though they have never served an apprenticeship, or worked more than a few years with their hands, possess a good knowledge of sanitary plumbing.

If I were going to build a house for my own occupation, I

* Since writing this, Mr. Alderman Stuart Knill has succeeded Mr. George Shaw as Master.

should prefer the plumbing work to be done by the man who was more skilled in the science than in the art of his craft—that is to say, I should prefer a poor joint-wiper to a clever one, providing that the former knew what the latter did not, viz., how to select and arrange the traps, pipes, and fittings so that they would be "self-cleansing"; what kind of traps to select and how to ventilate them so that they would not lose their water-seals, how to ventilate the waste-pipes, soil-pipes, and drains, so that the air within them should be constantly changed—knew, in short, how to execute his work on sanitary principles.

Grades of Efficiency.

And to further increase the value of this registration of plumbers, and to afford the public a proper means for distinguishing between the men who can only do the work and the men who can not only do it but direct it also, it would be a good plan, as I have said elsewhere, to institute grades of efficiency, so that whilst many would become entitled to the use of the letters "R. P." (registered plumber) at the end of their names, others still more advanced in knowledge might be allowed to use the letters "R. S. P." (registered sanitary plumber), and this, whilst acting as a powerful stimulus to the younger men, would also be an additional means of raising the social position of the craft. In any case, all who wish to see the trade take its proper stand, and plumbers generally taking a higher and nobler view of their duty, must heartily wish this great undertaking success.

Responsibility for the Work Done.

The registration of plumbers will no doubt be taking a great step towards a better state of things, but it will not alone suffice to ensure good and efficient plumbing and draining work in *all* cases. In addition to being duly qualified, the men executing such works must be made absolutely responsible for the work they do. Where two parties are concerned—one to plan and direct, and the other to execute—

then he who plans and directs must be held responsible for the efficient working of his scheme; and he who executes the work, for the soundness and excellency of his workmanship. And to prevent any such divided responsibility from becoming a sort of two-stooled security, the man who selects the appliances and determines the kind, strength, and quality of the materials to be used, should be held responsible for their working, and for their suitableness and durability; for it would be manifestly unfair to require the man who executed the work, who simply carried out the other's instructions, to guarantee the efficient working of appliances and materials in the selection of which he had no control.

Flimsiness of Plumbers' Fittings.

Such flimsy articles are now manufactured that, after being a short time in use, they cost a little annuity in keeping them in repair, and it is vain to attempt a comparison of prices without at the same time comparing the articles. I will give but one example, namely, an article now largely used in connection with plumbing work, called a water-waste preventer. This "fitting" is inflicted upon the public by water companies, who look more after their dividends than after the needs of water-closets. A manufacturer of plumbers' fittings told me the other day that he now made a "two-gallon water waste-preventer for 5s. 6d. and made a larger percentage of profit out of it than out of those he sold at two guineas each." When I asked about the durability of such articles, the reply I received was, "Well, just long enough for the builder to get his money."

Unwise Economy Disastrous.

Any unwise economy in connection with plumbing and draining works will surely sooner or later lead to disaster. I have known many cases where after only a few years' working the whole of the plumbing of a house has had to be taken out. The owners of such houses wanted more than their money's worth, and so invited trickery; and the men who executed the work being too cunningly clever to lose by it, scamped it. And so it often is with draining work. Instead of seeing how to make such works perfect and lasting, everything is watched to see what can be saved, *i.e.*, scamped. An instance of such scamping and its results occurred about a year ago. A lady, finding some one willing to put the drains of her house in a sanitary state at about two-thirds the price asked elsewhere, thought she was doing a clever thing in giving him the work, but before he had finished she found out her mistake and deplored her error; for so shamefully was the work executed that she had not been in the house six months before she was seized with typhoid fever and died.

Necessity of Honesty.

Possessing the required knowledge and ability, the great thing wanted in sanitary work is *honesty*. And the men—head-workers and hand-workers, masters and journeymen—who have a proper conception of their duty, will at all times consider themselves responsible for their work, and will need no Acts of Parliament, no outside pressure, will in fact need nothing more than the knowledge of what is right to do their work honestly and well.

Owners should be Liable for the Plumbing and Drainage.

With leasehold properties, especially very short leaseholds, it is often very difficult—with a proper respect for the occupier's purse—to know how to treat defective plumbing and drainage works, and it generally happens that the only successful way of treating such works is to clear the whole away. The landlord having let the property for a year or two, or for a term of years on a repairing lease, generally refuses to bear any portion of the expense of making the house healthy. The tenant naturally does not care to spend *his* money upon a property not his own, and where he will not get the full benefit. His lease has, perhaps, only a year or two longer to run, when he is told by his doctor that the bad state of the drainage is the cause of the illness in his house. He does not want to give up possession and sacrifice his right of tenancy, but, on the other hand, he does not want to incur an expenditure which may be equal to doubling his rent, and so he requests the sanitarian to modify his scheme. Now to tamper with drainage is a very dangerous thing, and rather than do this the sanitarian, if a wise man, will let it alone. He should insist upon all such works being properly done, and in default, he should withhold his certificate, and throw the responsibility upon the owner—tenant or landlord—who interfered with his scheme; for a "tinkered" drainage is sure, sooner or later, to prove unsatisfactory to all parties concerned.

As a house is enhanced in value by making its plumbing and drainage perfect, the cost of such work should be borne by the owner; for the larger benefit, after all, accrues to him, and he has the power, by increasing the rent, of recouping himself for any expenditure he may have made. And when the owner of a house refuses to make his house healthy, the law should step in and compel him, so that his tenant may live in it without risk to himself or his family.

DRAINS.

Drains Inside a House.

It is not necessary to enlarge upon what has already been said in the body of the book in reference to drains *inside* a house, but when of necessity they must be laid within the external walls, it is well to emphasise the importance of keeping them *above* the floor as much as possible, where they can be readily seen; *i.e.*, many a drain is now laid *in the ground*, where, if a little more judgment had been used, it would have been found quite practicable to have carried it *above* the floor.

I am constantly coming across long lengths of drainage running under the floors of houses where, with a little care and thought, the drain if of iron could either have been suspended from the arched ceilings of the basements, or carried along the face of the walls to the area.

Of course where water-closets, sinks, &c., are situated on the *lowest* floors, it may be necessary to place the drains *under* the floor, though not to the extent often done, especially if closets having their traps above the floor are adopted. For modes of laying drains under floors see p. 279.

Iron Drains.

In iron drains freedom for expansion should be provided, and where large bodies of hot water, as from baths, &c., are likely to pass through the pipes, an expansion-joint should be fixed in them, here and there, as necessity may require.

Stoneware Drains.

Ordinary drain-pipes, though still largely used under houses, cannot be depended upon, however well laid, for the smallest depression will break their joints, and the pipes are not free from "pinholes," fire cracks, and other small flaws; in fact, the best known makers will not guarantee these pipes to be absolutely water-tight, unless each one is not only selected but tested under water pressure—a costly process, seldom undertaken. The fact that stoneware pipes leak seems little known, although when stoneware pipe-drains are tested, they are generally found to be unsound. If anybody doubts this let him test a dozen pipes separately, which he can readily do by stopping up one end with the now well-known drain-pipe stopper, and filling the pipe with water. He will then find that the pipe will leak without any pressure excepting that of the head of water in it.

Water-closets without Enclosures.

The *open*, or *pedestal*, closet is so much more wholesome than the enclosed, or boxed-in closet, that it ought not to be necessary to say a word further, after what was said in an earlier edition of this work (pp. 169-174), to encourage the use of the former in preference to that of the latter ; but the adoption of the pedestal closet, though now made in some form or other by most closet manufacturers, is so slow that it is quite clear its advantages are indifferently understood.

If the reason for this unwillingness to use the "open" closet had been its cost in such hard times as these are supposed to be, one would have been silent ; but as a matter of fact, in the erection of new closets, the cost would be about the same, whether an open or a closed-in closet were fixed ; for the saving of the mahogany enclosure would be equivalent to the extra cost of the closet, and the making good of the side walls. If cost, then, is not the reason why this closet of "sweetness and light" (to degrade noble words) is not adopted, what is it but the difficulty of civilising the human race. The privy is still "the thing" with thousands, and many people who like something "sweeter" are not over-anxious to have such places perfectly sweet, and so closets which have a "touch" of the privy about them are still in vogue.

With the open closet the eye would see at a glance all its surroundings, and would be a daily corrective against the accumulation of filth ; but with the boxed-in, or enclosed closet, a space of about 8 or 10 cubic feet, or a superficial area of from 25 to 30 feet (apart from the exterior parts of the closet itself) would be always screened from sight, where matters of an offensive nature might go on accumulating for years.

The contents of chamber utensils are emptied into the closet, or the closet is used by men as a urinal in an improper way, and the splashings upon the seat, in either case, flow round the seat-hole, to the underside of the seat, and also run down on the inner side of the "riser," where they are left to dry up, or to be absorbed by the wood ; for it is seldom, if ever, that the inner surfaces of the seat, floor, and enclosure are polished or painted to prevent absorption. The slops and mishaps also flow over the top of the closet-basin, and lodge and dry up upon its rim, sides, and fittings—giving to what otherwise would be a sanitary closet that unpleasant odour which is the peculiar characteristic of that archfiend of one's olfactory nerves, the pan-closet.

Then, with enclosed water-closets, there is the further risk of having defective walls under the seat, places where the effluvia can pass from persons using the closet into other apartments—into bed-rooms or rooms adjoining the closet, as explained in Chap. XI., pp. 169-174.

The Pedestal "Optimus" Valve-Closet.

In an earlier edition (pp. 172, 184) an improved form of water-closet enclosure (which I called the "Sanitas") is shown

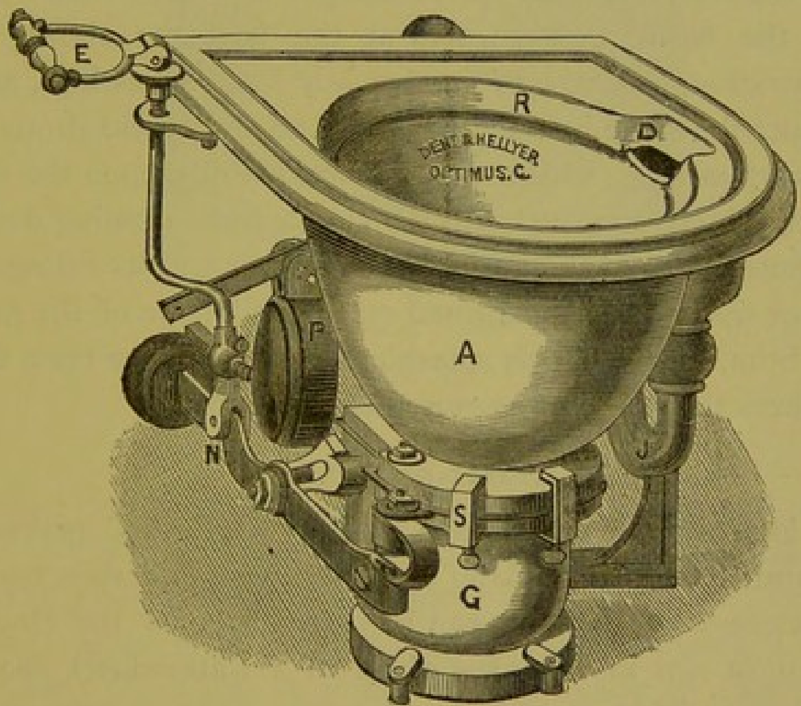


FIG. 263.—Front View of the "Optimus C" or "Pedestal Valve-Closet."

for keeping the closet quite clear of the side walls. This enclosure is much liked, not only in London but also in Paris, but being made of fine white-ware the difficulty of producing it makes it expensive. I have, therefore, designed and patented a much cheaper arrangement for treating the "Optimus" valve-closet as a pedestal closet, without sacrificing any of the more important advantages gained by the use of the "Sanitas" enclosure.

This closet, named the "Optimus C," to distinguish it from its other forms, is illustrated in Figs. 263-266. The *valve-box*, G, Fig. 263, and the basin, A, are both made of fine white-ware of sufficient strength to support any person using the closet without woodwork of any kind,—except for greater comfort it is better to have a wood seat for sitting upon, as shown at D, Figs. 265 and 266. This seat, being hinged, is readily turned up for emptying anything into the closet; and its *underside* can easily be cleansed as occasion requires, the value of which needs not a word of enforcement. A narrow top with a slightly raised margin is formed round the top of the basin, with corners at the back, as shown in the illustration, Fig. 263, to receive any little splashings, and to conduct the same into the basin. And to prevent drops of water or splashings, which may fall accidentally upon the top when anything is emptied into the closet, from running down on the outer sides of the basin and fouling it and its fittings, a groove, or water-check, is formed on the underside of the projecting brim, to cause such splashings to fall at once upon the floor, where they may be seen and cleaned up.

Closet-screen.

To improve the appearance of the "Optimus" pedestal closet, and to hide its working parts, an apron or screen, made in fine white-ware, Fig. 264, can be placed against the closet, as shown *in situ* in the view given of a water-closet room, Fig. 265, at A. Of course this screen can be made of mahogany, but as it is cheaper of white-ware and more wholesome, being of a non-absorbent material, this should be used. It looks clean and nice in plain white ware, but it can be coloured, or lined out in gold, to suit fancy. The sides, when so desired, can be made good in polished mahogany (or other wood), but the closet is better left open at the sides, for then the eye can readily see that all its parts are kept perfectly clean.

Overflow Arrangement.

Possessing in itself a good provision against an overflow,* as shown at D, Fig. 263, it is not necessary to fix a lead safe or tray, under the closet, when fixed on a tiled or marble floor, as represented in Figs. 265 and 266. But when such a closet is supplied with water from a large cistern, or when there is great pressure upon its supply-valve, it is a wise precaution to fix an outlet, or overflow-pipe, from the floor, to discharge in the open air, outside the external wall, with a

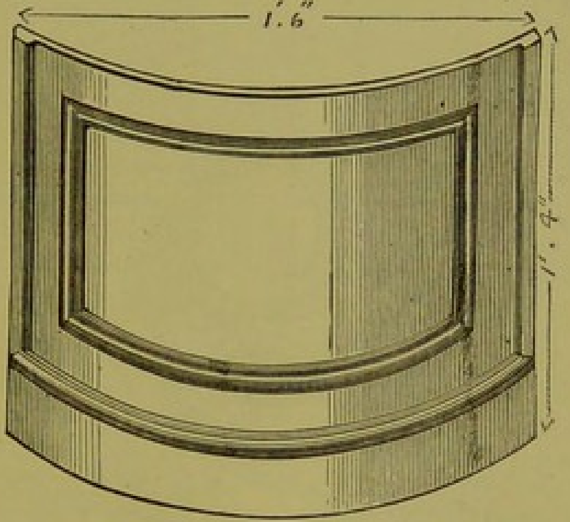


FIG. 264.—View of the "Closet-screen," made of fine White-ware.

grating over its mouth (as shown at K, Fig. 265, and on *plan*, Fig. 268, at O, P) to prevent damage to the ceiling under it, in case of a break-down of its supply-valve, &c. This overflow-pipe from the floor, O, P, Fig. 268, would then answer a double purpose; for whilst it would ever be ready to conduct any overflow of water out of the closet room, it would always be bringing fresh air into it, at any rate just enough to keep the air in the apartment constantly changed.

* To prevent the overflow-arm becoming a source of danger, as is the case in many valve-closets, it is trapped and "disconnected" from the outlet of the closet, by being made to discharge into the vent-arm from the valve-box, as shown in section D, R, K, Fig. 145, p. 183; and as the flushing-rim is continued round it at the top, it is well washed out with water every time the closet is used.

Supply of Water to the Closet.

This closet can be supplied with water in the usual way. Where there are no water companies to interfere, the ordinary

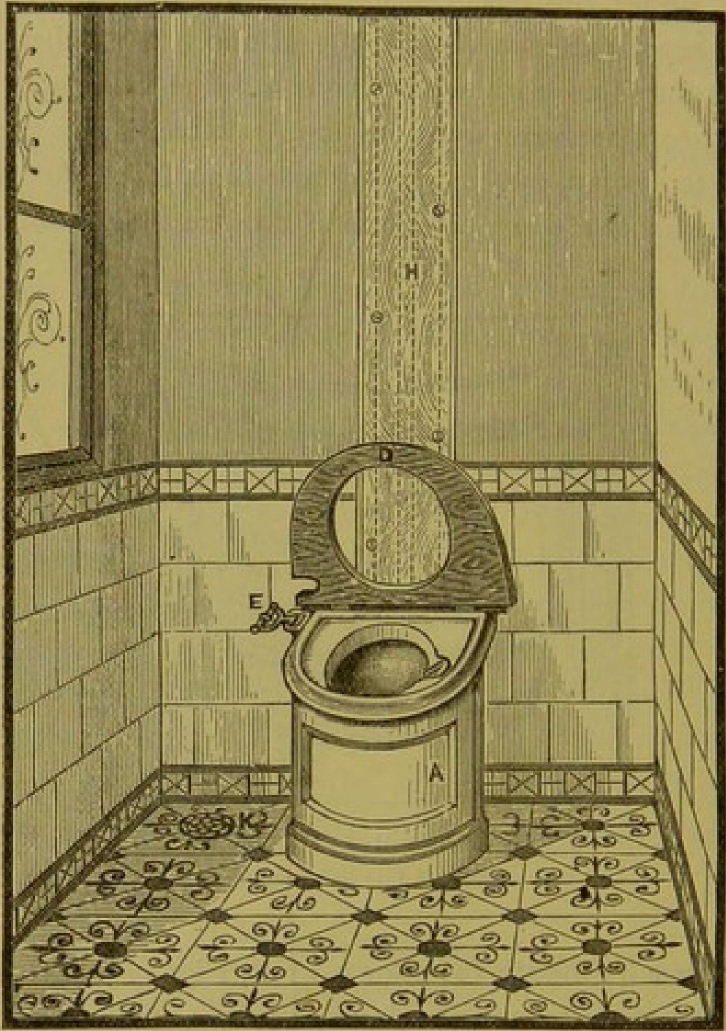


FIG. 265.—View of the "Optimus" Pedestal Closet fixed on a Tiled Floor, isolated from the side walls.

supply-valve—attached to the apparatus—can be used, and a branch-service taken from the nearest general closet service. Or a service-pipe can be brought down in a chase, from a closet cistern fixed in the cistern room and cased over, as shown in Fig. 265, at H, with branches from it to serve the closets on the several floors.

Where the supply of water is restricted, and the Water Company insists upon water-waste-preventers being used, the closet can be supplied as shown in Fig. 150, p. 188; or, where allowed, waste-preventing supply-valves can be attached to the apparatus at the back, and kept out of sight, as in Fig. 265.

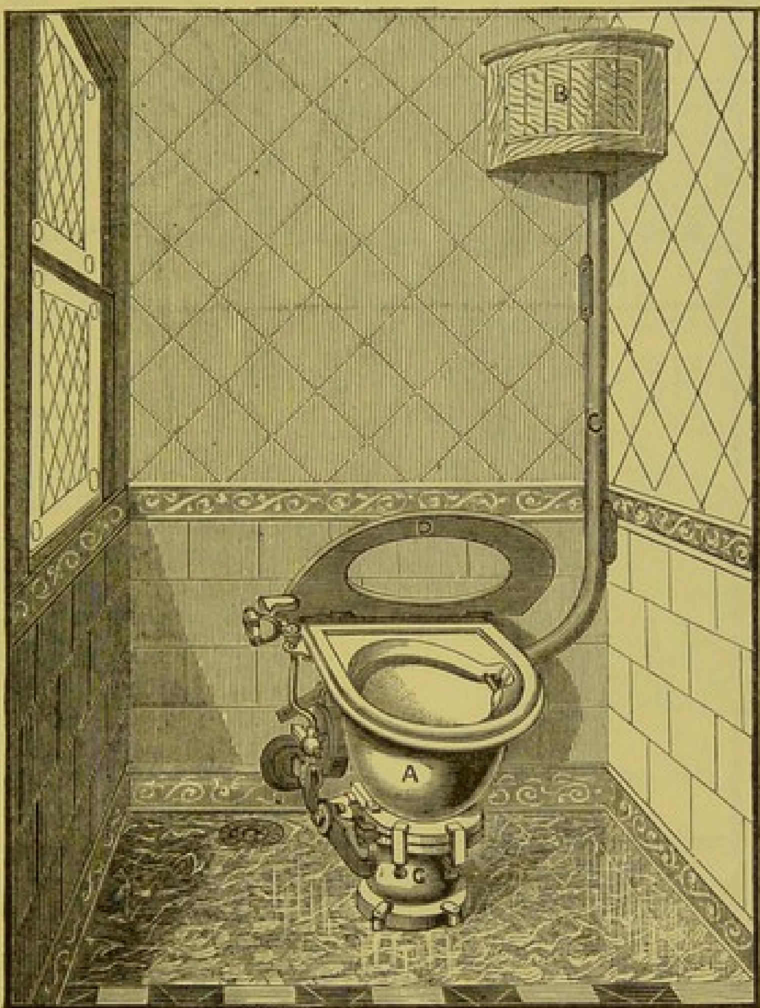


FIG. 266.—View of the "Optimus" Pedestal Closet, with a small cistern over it.

In Fig. 266 a small wood cistern, B, lined with lead, and holding two or three flushes of water, is shown, and but for the appearance of any such projection, there are no better means of supplying such closets with water; for whilst it separates the closet from the drinking supply, it ensures a good flush of water to the closet directly the handle is pulled, and it only gives the supply-valve a pressure which it will stand for years without getting out of repair.

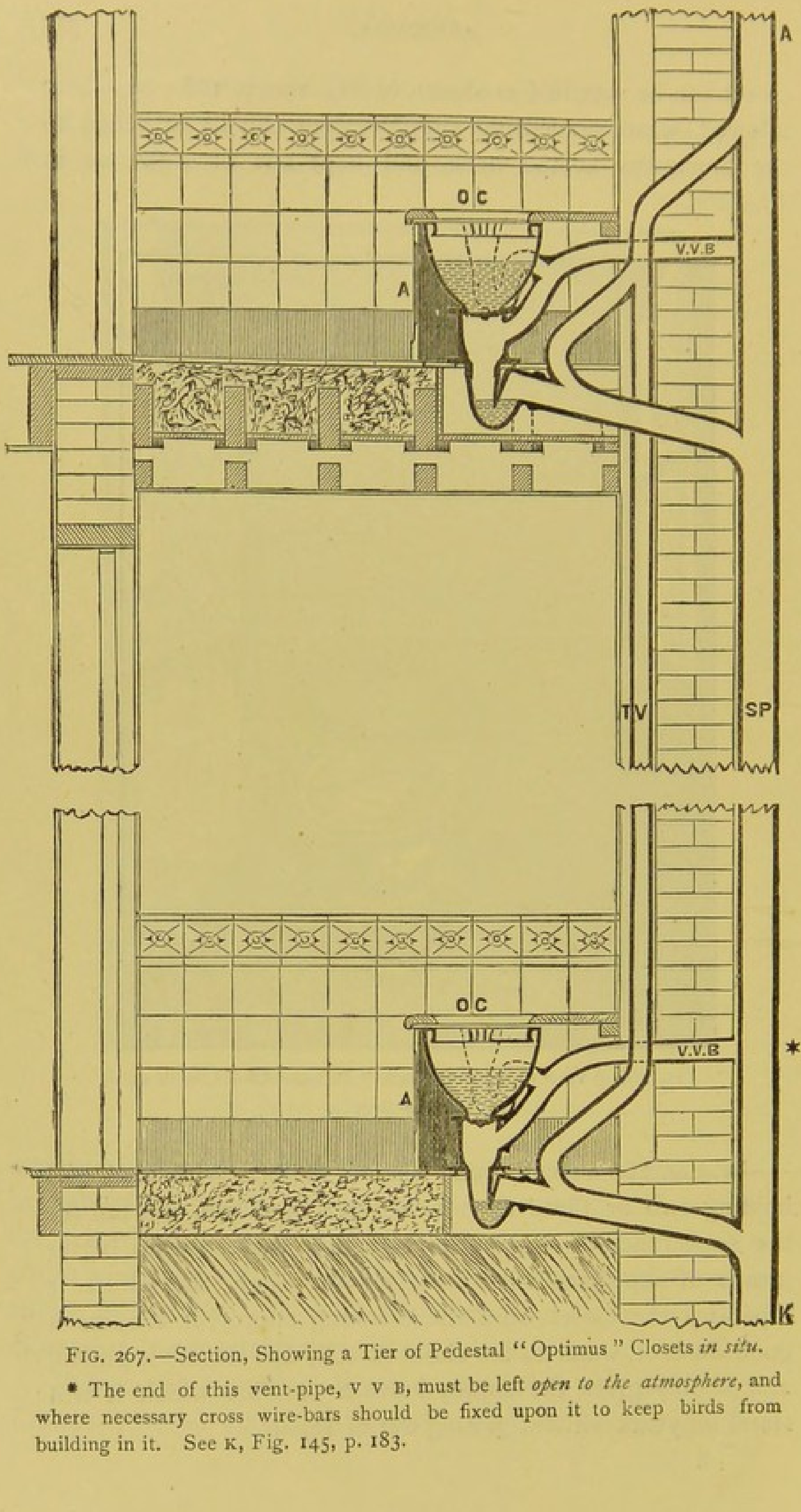


FIG. 267.—Section, Showing a Tier of Pedestal "Optimus" Closets *in situ*.

* The end of this vent-pipe, V V B, must be left *open to the atmosphere*, and where necessary cross wire-bars should be fixed upon it to keep birds from building in it. See K, Fig. 145, p. 183.

Pedestal "Optimus" Closets in Tiers.

In Fig. 267, two pedestal "Optimus" closets are shown in section, to illustrate the mode of fixing a *tier* of such closets; and in Fig. 268 a plan of one of the closets is given.

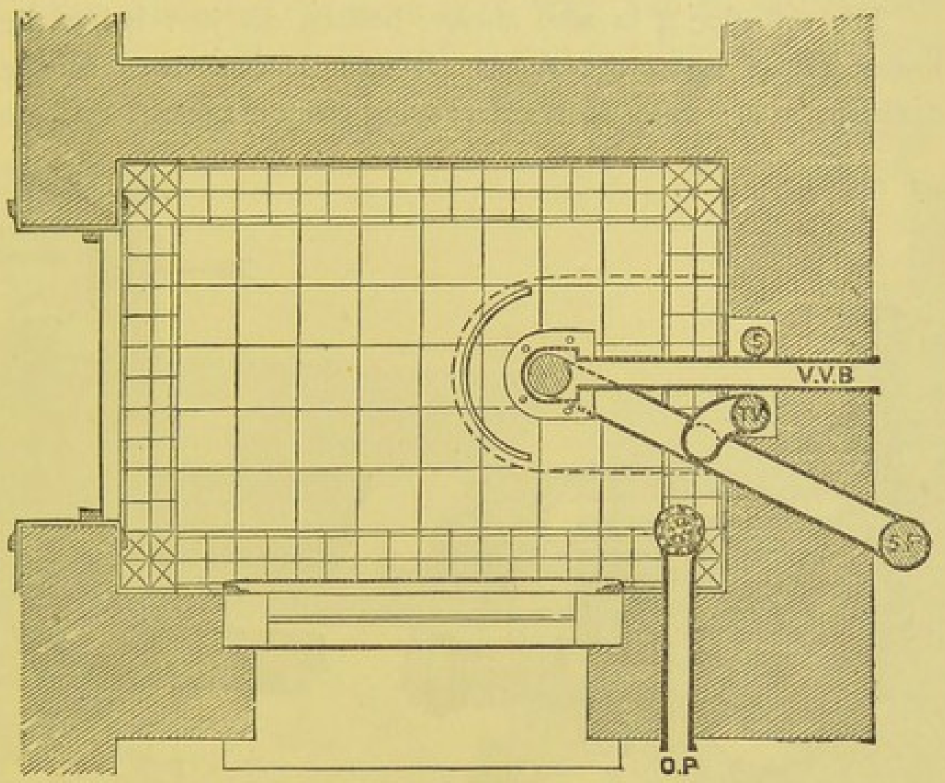


FIG. 268.—Plan of one of the Closets shown in Fig. 267.

REFERENCES TO FIGS. 267 AND 268.

A.—Closet screen, as Fig. 264.
O C.—"Optimus" valve-closet, as Fig. 263.
O P.—Overflow-pipe from floor, 2 in. lead pipe.
S P.—3½in. soil-pipe. (*See* pp. 143—167.)
T V.—2in. lead pipe, trap ventilation.
* V V B.—2in. vent-pipe from "valve-box," with its outer end open to the atmosphere.

The soil-pipe (which should be of lead, equal in substance to sheet lead, weighing 8lbs. to the superficial foot) is shown broken off at A, just above the highest closet apparatus, but in practice it should, of course, be continued up, full size,* for ventilation, and terminated well above all

* In very lofty houses where the air-pipe—to stand well above all windows—would be of great length, in order more readily to supply the demand for air created by discharges through the main soil or waste-pipe, the bore of the air-pipe should be one-fourth or one-third larger than the latter, or the water-seals of the traps are likely to be disturbed, notwithstanding the ventilation of the traps.

windows,—as shown in Plates IX. and X. pp. 140 and 142. The soil and trap ventilation pipes are broken in the middle to show that closets on intervening floors could be connected with them.

The soil-pipe K is also shown broken off just below the lowest closet upon the stack. It can be continued to the drain in many ways to meet varying circumstances. Where

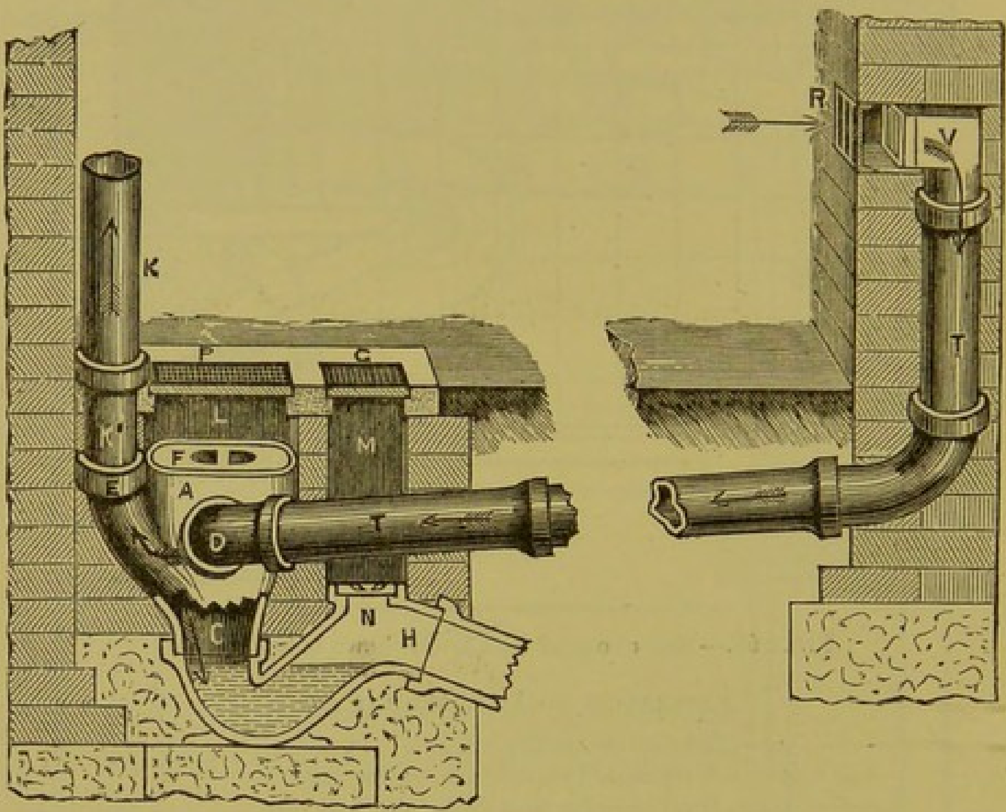


FIG. 269.—Intercepting Trap to Soil-pipe, with "Foot-Ventilation."

there are no windows or doors near its foot, it can be made to discharge with an open end into a "disconnecting" trap, as Figs. 64, 65, or 66, pp. 74 and 76. But where such a pipe discharges close to a window, or doorway of the house, the trap should be sealed down, as shown at F, Fig. 269, and fresh air brought into it by means of a "foot ventilation" pipe, as shown at T, T, D, and a mica-valve, V, fixed over its mouth; or if remote from windows or doors (say 15 or 20 feet away), a simple grating, as shown at R, is all that is necessary. Sometimes such a pipe can be taken from the face of a terrace wall as shown in Fig. 270, at S. I have had such pipes often so treated during the last eight or ten years, with most satisfactory results. With a good supply of water "self-cleansing" traps, such as the *small-size* "Anti-D"—and good arrangements, as shown in Fig. 267, there is no risk whatever in using the more open trap, Fig. 64, (p. 74), and shown also on Plates IX. and X. In fact, hundreds of stacks

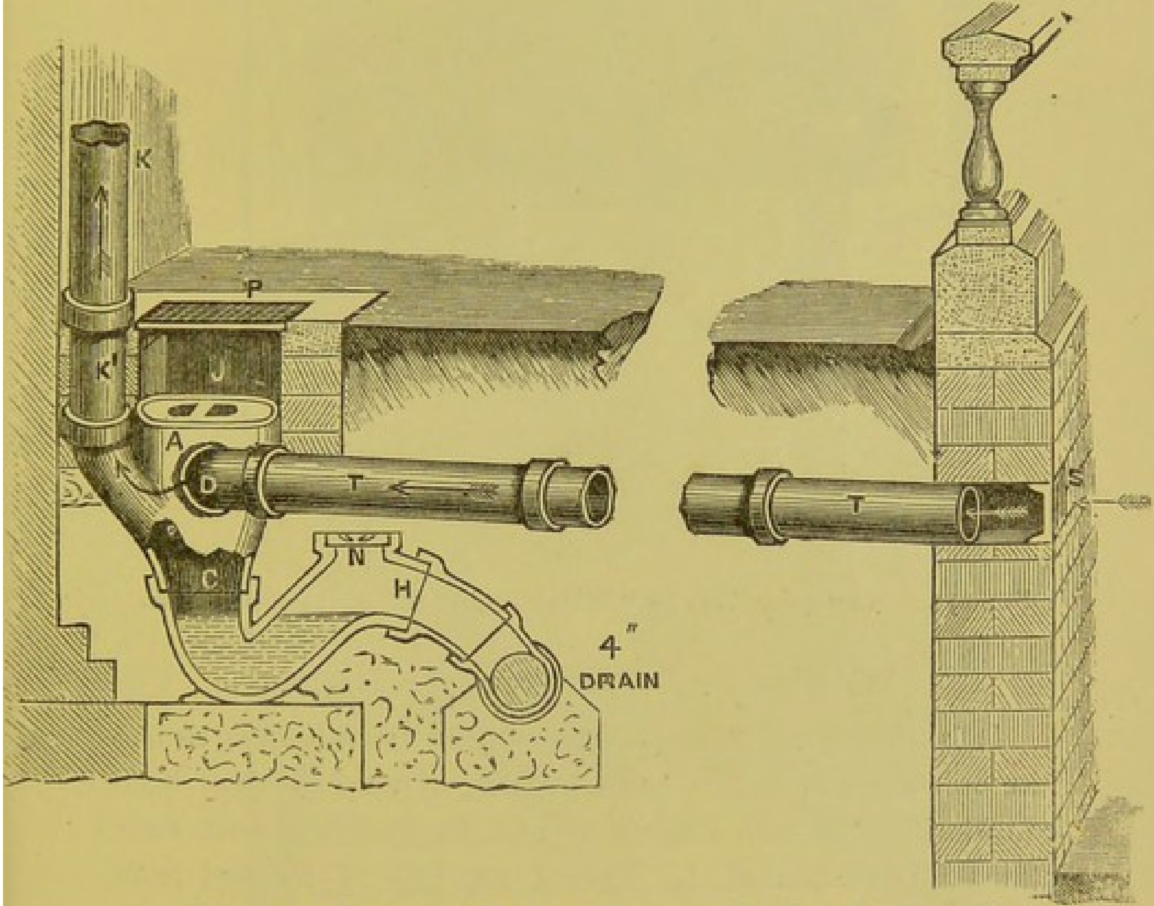


FIG. 270.—Intercepting Trap to Soil-pipe, with "Foot-Ventilation."

of soil-pipes have been so "disconnected" in the last few years, and are now working most satisfactorily.

There is no reason why *one* "disconnecting" trap should not be made to receive *two* soil-pipes—where circumstances call for it, as shown in Fig. 271. The "hopper," or receiving head, F, of the trap, can be turned round on the trap B, to any point to receive the two drains A, A', and the outgo, C, can also be turned round to any point to suit the drain D.

Where the top of the trap would not reach the surface, a piece of 6-in. stoneware drain-pipe can be fitted and connected into its socket-head, as shown in dotted lines, and the grating removed from E and fixed at H.

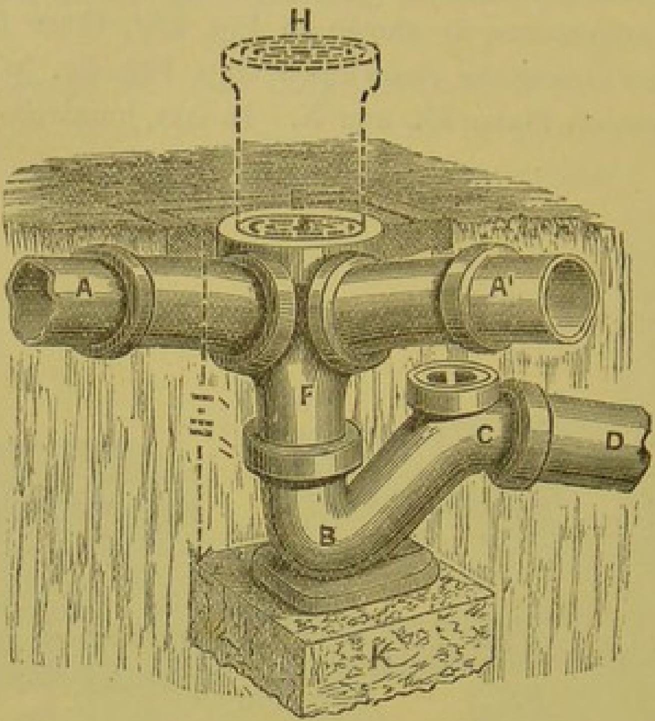


FIG. 271.—Intercepting Trap for "Disconnecting" two Stacks of Soil-pipes.

Isolating Soil-pipes from the Drain.

It is often most difficult, especially in town houses, to isolate soil-pipes in such a complete way as we have just been considering, but with closets so well trapped, and with each closet-trap ventilated, to prevent any loss of its seal from syphonage, as shown in section Fig. 267, at T V, there is no danger of drain-air getting into the house, although such pipes may be made to act as up-casts, *i.e.*, drain ventilation-pipes—especially if each of several stacks upon a drain is so treated, and the drain itself is "disconnected." But of course the ventilation is not so perfect as when *each* stack is provided with its own inlet and outlet ventilation, and the drain is ventilated independently.

The Pedestal "Artisan" or "Hygienic" Closet.

This closet is also now made for use without any enclosure as illustrated in Fig. 272, and is much liked. It is made all in one piece, in fine white ware, and is of sufficient strength for supporting the heaviest person, and it does not require any brackets for the wood seat to rest upon. As shown in Fig. 273, its exterior is kept as plain and smooth as possible

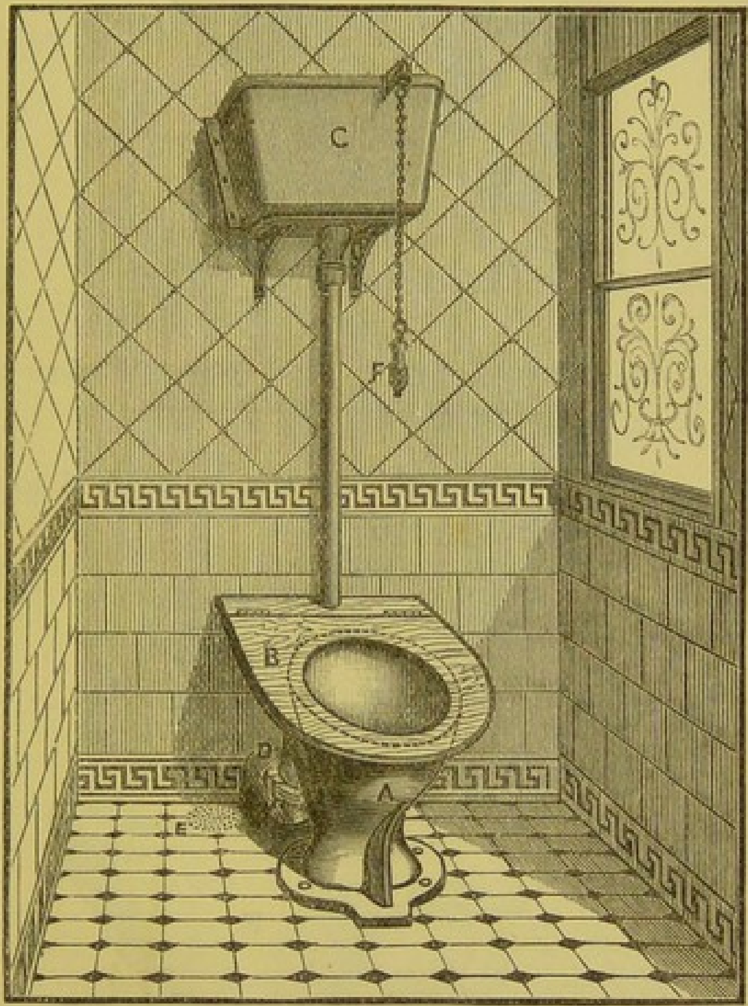


FIG. 272.—View of the " Pedestal " or " Hygienic " Closet, with a Syphon Flushing-cistern over it.

that there might be no place about it for filth to collect in or upon, and also that it may easily be wiped with a cloth and kept clean. To enrich its appearance it can be marbled, or coloured over, on the outside, leaving its interior white, or the latter can be made to correspond with the exterior, or the closet can be cream-coloured all over.

To prevent splashings, etc., from falling down at the back, when the wood seat, S, is turned back for emptying slops into the closet, corners are formed to the top, as shown at R,

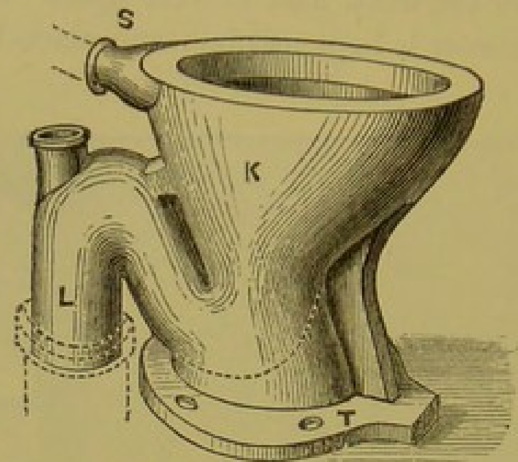


FIG. 273.—Side and Partial View of the Pedestal "Hygienic" Closet, for Connection with a Drain-pipe.

Fig. 274. And this arrangement can be applied to any of the three closets, Figs. 273-276

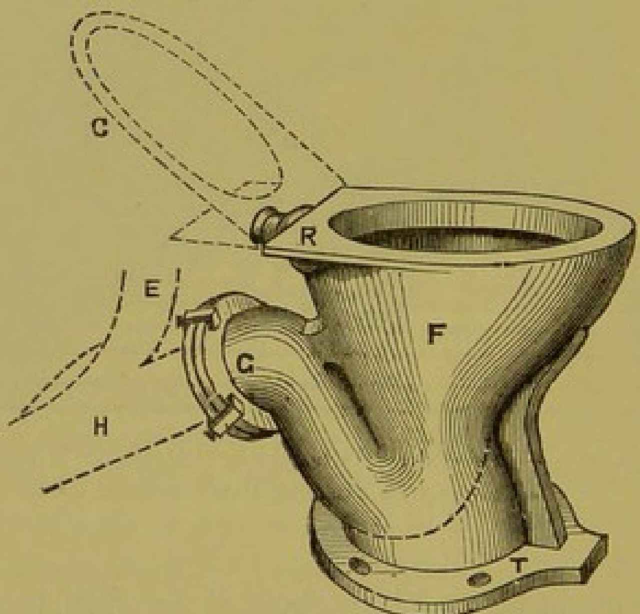


FIG. 274.—Pedestal "Hygienic" Closet, with Flanged Outgo, for Connection with Lead Pipe, and with Corners to the Top at the Back.

This closet is made with *three* different outlets, for easy connection to a soil-pipe, or drain-pipe, in the most convenient way to suit varying circumstances. Fig. 273 shows the closet with its outgo, L, connected directly to a drain-pipe by means of a joint made with Portland cement, and on a level with the floor, where it can be examined at any time to see that it is sound. Fig. 274 shows the closet with a *flanged* outgo for connection with a lead (or iron) soil-pipe passing through the wall in an oblique direction, as shown in Fig. 277, to the stack-pipe outside.

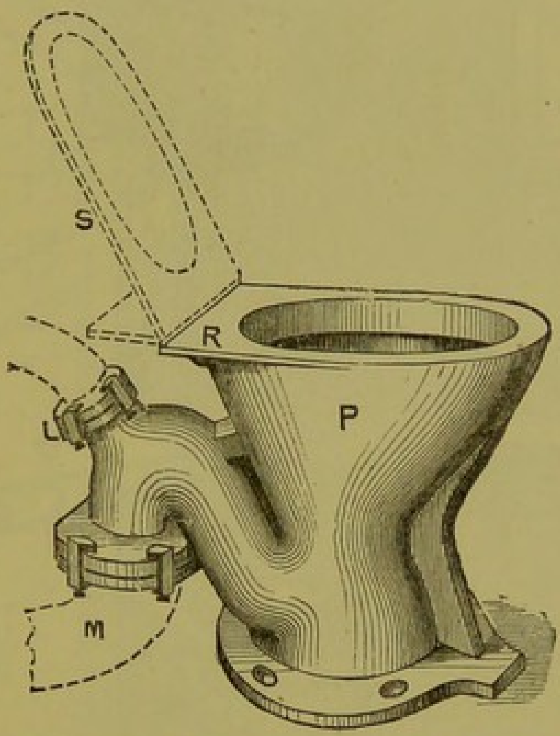


FIG. 275.—Pedestal "Hygienic" Closet, with Flanged Outgo, and Flanged Vent-Arm.

Fig. 275 shows another view of this closet with a flanged outgo for connection with a lead soil-pipe (M) which may be carried to the right or left hand, or may go out through the wall direct, as shown at D, Fig. 272, or may go down vertically through the floor. A vent-arm with a flange upon its end is formed on the outgo of the trap of this closet, as shown at L, for connection with the lead trap-ventilation pipe, but no vent-arm is formed on the closet, Fig. 274, as the pipe can be taken right off the lead soil-pipe, and the connection with it better made, *i.e.*, by a wiped soldered joint, as shown at E, also at T V, Fig. 277.

Fig. 276 shows the closet fixed in an angle of the W. C. apartment, with a syphon flushing-cistern, C, fixed over it. To prevent anything getting into the jointings of the wood floor, the floor is shown covered with a piece of lead (H), but that is not so cleanly as a tiled or marble floor.

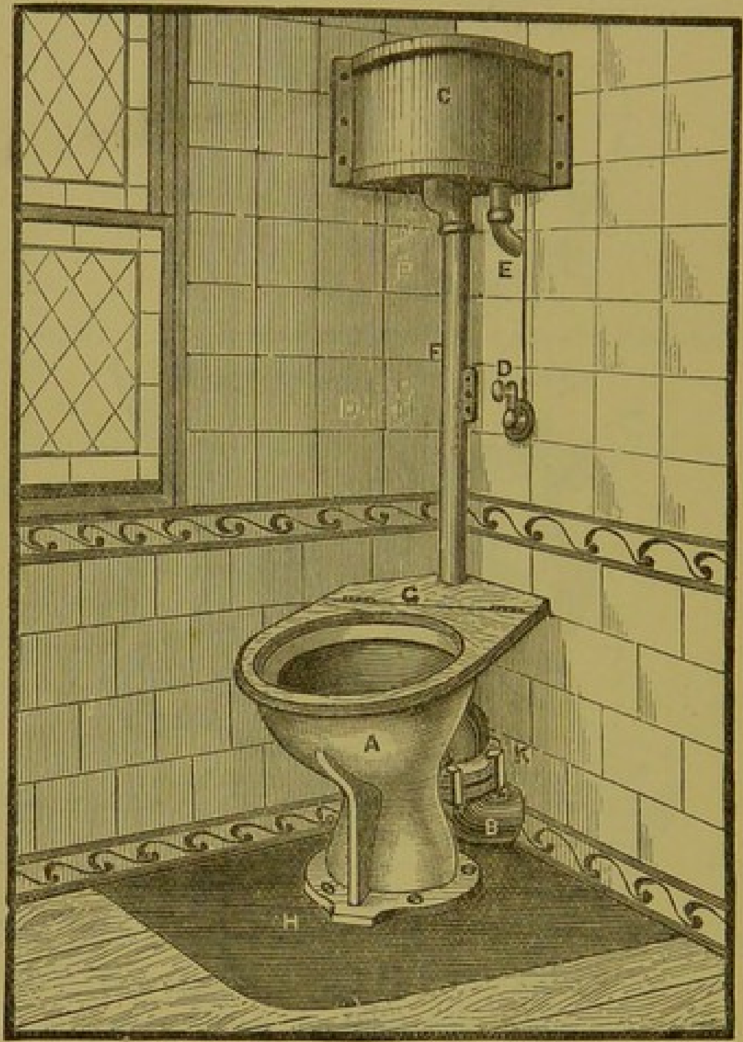


FIG. 276.—View of Closet Fixed in an Angle of the Room.

For Hospitals, Mr. Thomas Jennings' (*builder*, Lambeth) prepared "paraffined flooring" would be better than lead. The preparation of this "Paraffine Dressing renders wood impervious and non-absorbent. It is hot-ironed in a melted state into the pores and tissues of the wood; the surface is then dressed with an improved solution to render it hard,

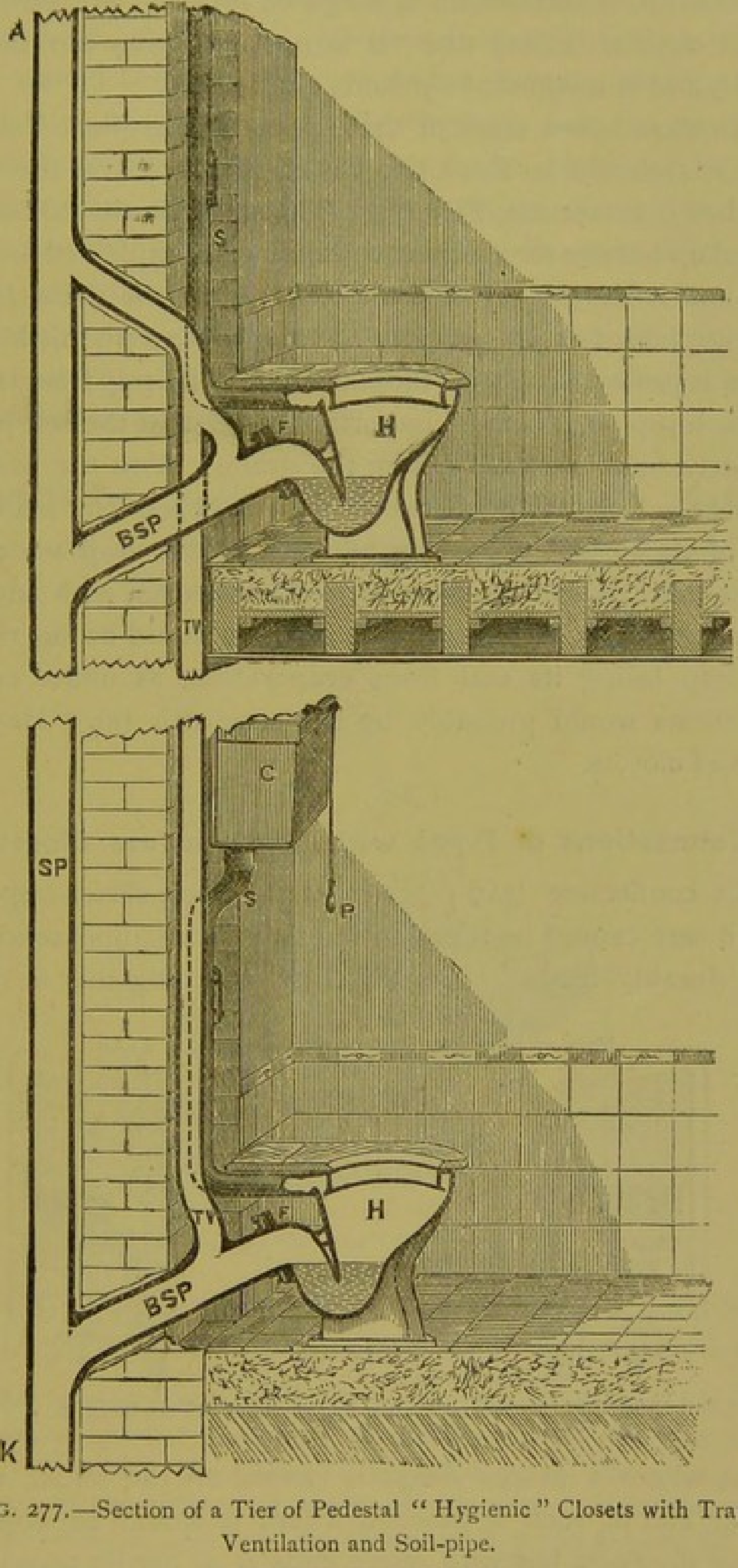


FIG. 277.—Section of a Tier of Pedestal "Hygienic" Closets with Trap-Ventilation and Soil-pipe.

and, finally, polished with a weighted brush." Mr. Jennings, in his circular, states that "it is neither greasy nor inflammable, and is unaffected by fluids and acids."

To show how a stack of these pedestal "hygienic" closets (Fig. 274) should be fixed, two closets fixed one over the other are shown in section, Fig. 277. The soil-pipe should be continued up full size for efficient ventilation, as explained on page 393, and it should be "disconnected" from the drain in the way explained on pp. 394-396. As the house with this kind of closet is protected only by the water-seal of its trap from the air in the soil-pipe, it is most important to see that the soil-pipe is properly "disconnected" from the drain. With the pedestal "Optimus" closet the house is not so dependent upon the seal of its closet-trap, for in addition to the trap under the closet there is the basin-valve, and, moreover, with such an arrangement, as shown in Fig. 267, there would be no risk of the trap losing its seal from evaporation, as under certain conditions would probably be the case with the "Hopper" class of closets.

Connections of Pipes with Earthenware Closets.

In connecting lead pipes to earthenware closet-traps, too much care cannot be taken to see that such joints are soundly and durably made. The difficulty of doing this is not so

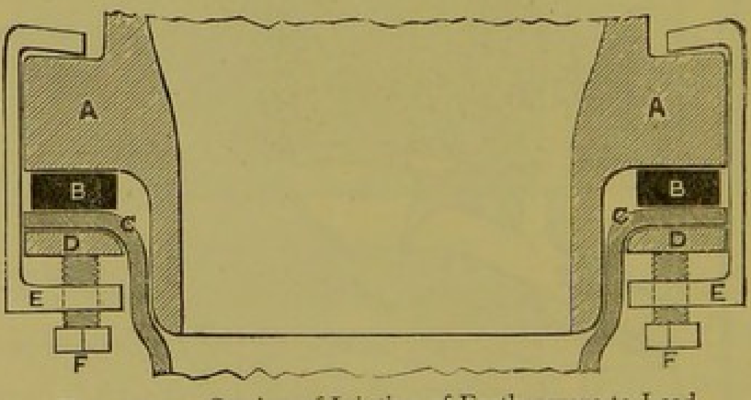


FIG. 277A.—Section of Jointing of Earthenware to Lead.

great where a proper *flange* is formed on the outlet of the closet, and in such a position where it would be accessible above the floor, but with *spigot* ends it is hardly possible, as explained elsewhere in this work, to make durable and reliable connections. A brass or galvanized cast-iron collar, D, Fig. 277A, should be passed over the end of the pipe, and the pipe tafted back to form a flange, C, to exactly face the flange of the earthenware, A, with which it is to be connected. Then a thick washer, B, made of properly prepared printers' blanket-felt—after being well soaked in boiling Russian tallow—or one of indiarubber * should be placed between the lead and earthenware, and the whole screwed up together by means of clips, E, made of brass or galvanized cast-iron and gun metal square-headed screw-bolts, F.

Closets Free of the Floor as well as of the Walls.

In order to afford means for washing the *whole* of the floor of a W.C. apartment, *underneath* the closet as well as

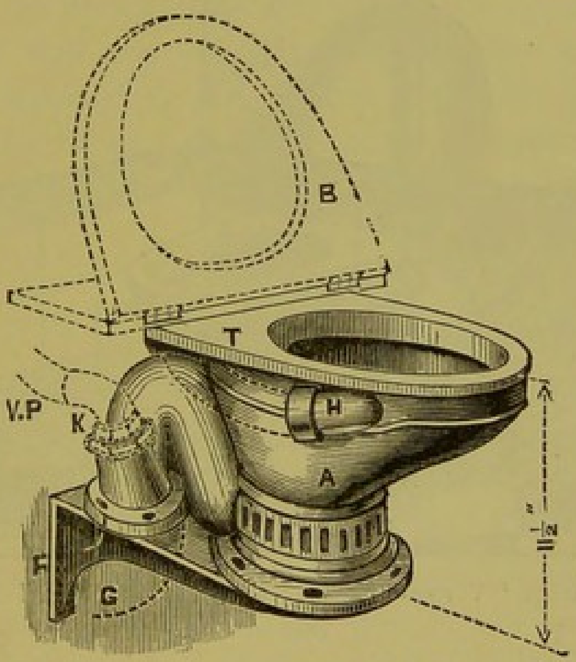


FIG. 278.—View of a " Vortex " Closet, fixed on a Bracket.

around it, and also to prevent any disturbance of its jointing with the soil-pipe by vibration, *i.e.*, a jarring of the floor I have

* When indiarubber is employed, nothing of an oily nature (such as paint, putty, white lead, red lead, and the like) must be used in connection with it, as it soon causes it to perish. This applies to indiarubber flanges, rings, cones, etc., wherever such may be used for making air-tight or water-tight connections. When indiarubber is kept from the atmosphere it is very durable, and it is nourished in water.

designed and patented an arrangement for fixing closets on Brackets, and keeping them quite free of the floor, and my "Vortex" closet is now adapted for use in this way, as shown by the illustrations, Figs. 278—280.

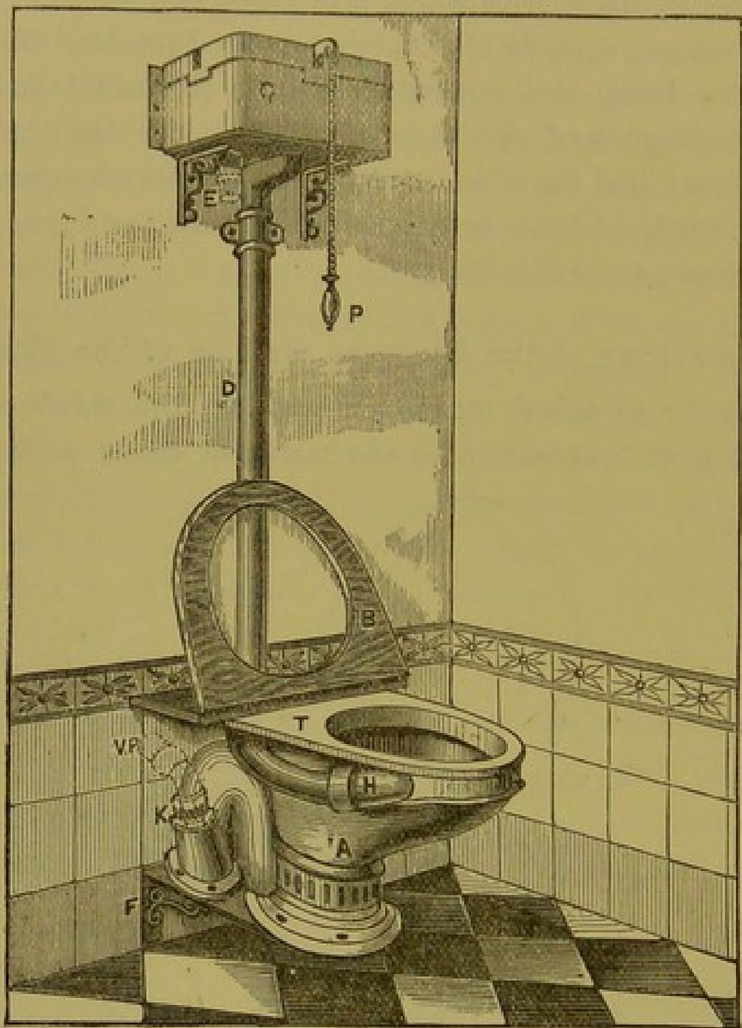


FIG. 279.—Bracket "Vortex" Closet, with a "Flat-back" Syphon Cistern over it.

The closet is secured to a strong galvanised cast-iron bracket, which is let into the wall, as shown at F, Fig. 278, and B, Fig. 280, and is so constructed that when fixed a space of about 3½ inches is left between the bracket and the floor, for the hand to pass under the closet when washing the floor. The value of being able to wash over the *whole* of the floor of a water-closet apartment, especially in hospitals and such like places, needs no words of mine to set forth.

As shown at T, in Figs. 278 and 279, corners are formed to the top of the closet at the back, to prevent open spaces where matters might fall down when emptying slops, etc., into the closet. The closet is most compact, and being made all in one piece of ware, looks very neat, resembling a vase rather than a water-closet. The closet can be coloured to suit tastes, but is better finished white, or cream colour if a warmer appearance is desired.

A strong flange is formed on the outlet of the trap, as shown in Fig. 278, for jointing to the lead soil-pipe at the back of the closet, where the connection can always be seen (to see that it is sound), and where it can readily be got at, as shown in Fig. 280 at F. The advantage of the flange-jointing was explained on page 396. A good connection can also be made with its trap ventilation-pipe (V P, Fig. 279, and T V, Fig. 280) by means of a brass coupling union, one end of which can be well and soundly secured to the earthenware socket,* and fastened by a fly-nut, K, Fig. 279, and the other end soldered to the lead pipe by a wiped soldered joint, as at V P, or a copper-bit joint can be made, as shown in the woodcut, Fig. 278.

Supply of Water to the "Vortex" Closet.

As explained elsewhere (pp. 203—209) this closet will not work properly with the supply of water restricted to two gallons, and where *a flush of at least three gallons cannot be had this closet should not be fixed.* One of these Bracket "Vortex" closets, supplied by an "Angle" syphon cistern, giving three gallons at a flush, has been in use in our factory for many months, and is giving great satisfaction. But a "Flat-back" syphon cistern, as shown at C, Figs. 279 and 280, answers quite as well. The closet also works remarkably well with a valve-and-regulator apparatus, or with a large supply-valve without the "bellows" regulator. This supply-valve can be secured to a bracket and fixed to the wall under

* Instead of a socket, a flange is now formed in the earthenware for cheaper connection with a lead pipe.

REFERENCES TO THE ILLUSTRATION, FIG. 280.

B.—Gal. cast-iron bracket, let into wall, and supporting the closet.
B V.—Bracket "vortex" closets, as Fig. 278—side view and section.
B S P.—3½-in. branch soil-pipe.
C.—Three-gallon syphon flushing cistern.
F.—Jointing of closet with soil-pipe—flange joint, as explained on p. 396.
M.—Marble slab under closet, and tiled floor.
O P.—Overflow-pipe from floor (with silvered grating over its mouth), discharging into the open air, and acting also as fresh air induct into the closet apartment.
S.—1¼-in. lead service-pipe from flushing-cistern. The *lower* closet is supposed to be supplied by means of a valve-and-regulator, or waste-preventing valve, fixed on a bracket under the seat.
S P.—3½-in. lead soil-pipe 8 lbs. to the sup. foot.
W P.—Warning pipe or overflow from the flushing cistern, discharging into the open air. This pipe, when so preferred, may be made to discharge over the overflow-pipe to the floor, O P.

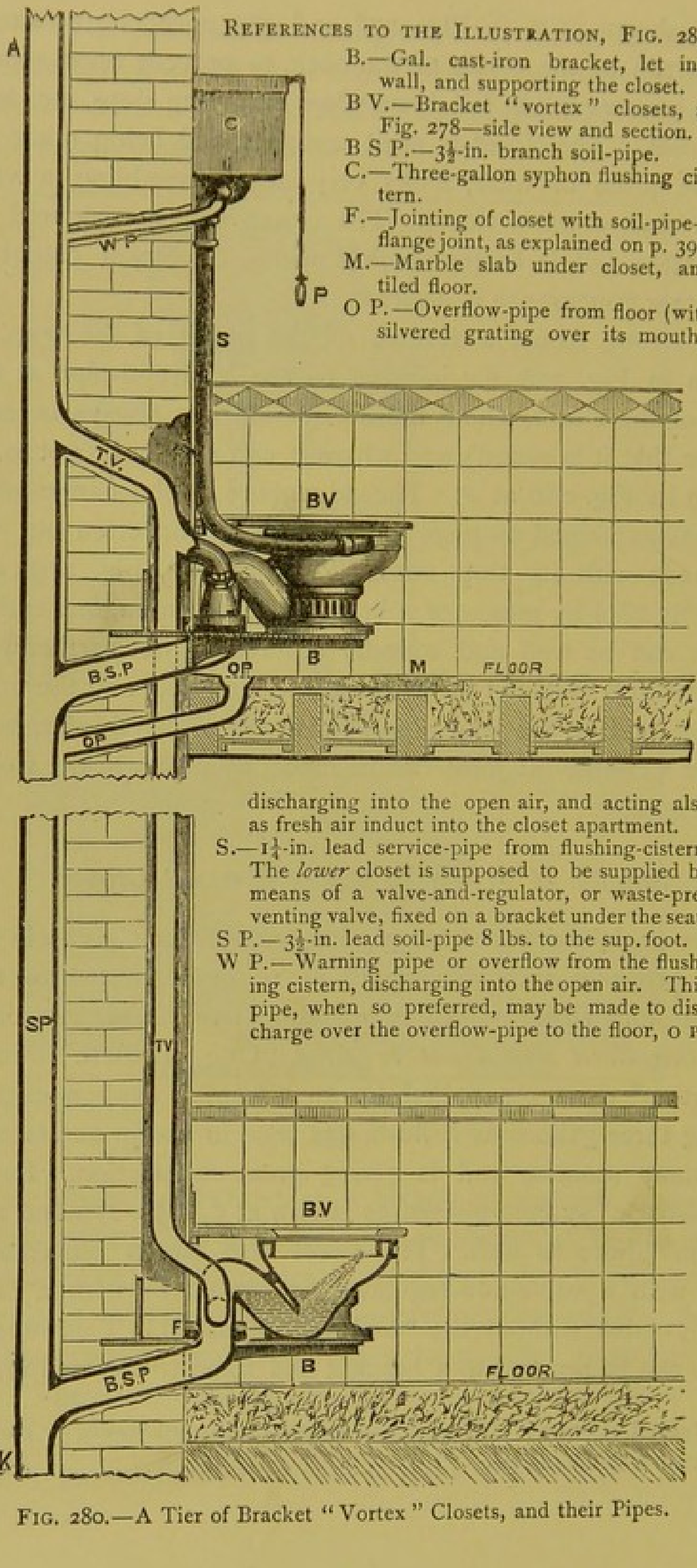


FIG. 280.—A Tier of Bracket "Vortex" Closets, and their Pipes.

the closet seat, and the apparatus, like the closet, can be kept clear of the floor. The *lower* closet in Fig 280 is meant to be served in this way, but the *upper* closet is supplied from a "Flat-back" syphon flushing cistern, discharging three gallons of water by one pull of the handle, P. This closet-pull seems hardly in keeping with the closet and its surroundings, but it is a very effective way of supplying the closet with water. The handle can be made of ebony, and the chain can be electro-plated. A neater arrangement is shown in the wood-cut, Fig. 276, at D, p. 394, *i.e.*, a "bell-pull" handle is fixed on the face of the wall, and the connection between it and the valve-lever is made good with copper-wire, encased in zinc and let into the wall for neatness.

The "Bracket Vortex" Closet Fixed in Tiers.

In Fig. 280 *two* "Bracket Vortex" closets, B V, fixed one over the other, are shown *in situ*, and a *section* is given of the soil-pipe, S P, and trap ventilation-pipe, T V. The pipes are broken in the middle to show that closets on intervening floors can be connected with them. The trap ventilation-pipe, when several closets are on the stack, should not be less than of 2-in. bore, but $3\frac{1}{2}$-in. bore is quite large enough for the soil-pipe for *two* closets, as shown here, see pp. 144—149.

As explained to the other closets, pp. 387 and 396, the soil-pipe from A should be continued up full (or of larger) size for ventilation, and terminated well above all windows. And from the point K it should be continued down to discharge into the drain in one of the modes referred to on pp. 388—390, and illustrated in Figs. 269 and 270, always remembering that, where circumstances will allow, the more open "disconnection," Fig. 64, p. 74, is the one to be preferred; see explanations, p. 390.

Urinals.

Notwithstanding all that was said in the body of the book (Chap. XVIII., pp. 261-266), it may be worth while to add something here, for a urinal is certainly a place where great results often hang on little things; little drops of urine left to lie where they fall to become a nuisance, a menace to one's health and an offence to one's olfactory nerves.

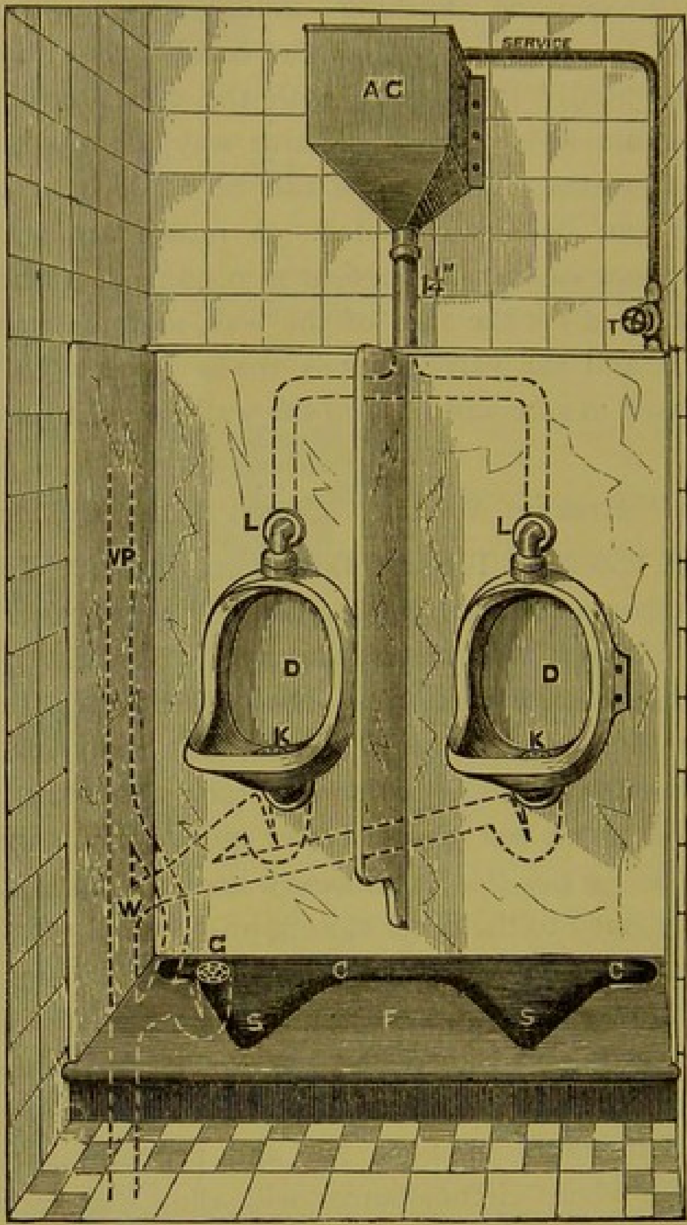


FIG. 281.—Urinal, with its Floor of St. Ann's Marble.

Urinal Floors.

The floor of a urinal should be non-absorbent, for it is impossible to prevent droppings of urine falling now and then upon the floor, and yet one often comes across a wooden floor; and I have seen such floors completely sodden with urine, and most offensive. Nor is a tiled floor for a public urinal all that can be desired; for, though it is much better than a wood floor, the urine is liable after a time to soak through the joints to the under side of the small tiles and become a nuisance.

The floor under the urinal basins, as shown in Fig. 281, at F, should be formed of St. Ann's marble, if possible in one slab, with sinkings corresponding to the projections of the basins, but of larger size, to receive any droppings and to convey them into the channel at the back, as shown by the letters S S and C C in the illustration. St. Ann's marble is very hard, and when highly polished successfully resists the action of the urine; but great care must be taken to see that the polished surface is not destroyed, that is to say, such floors must never be cleaned with spirits of salts, which would at once destroy the polish.

The trapping of the basins and channel, in Fig. 281, and the waste-pipe ventilation and trap-ventilation, are shown in dotted lines. A step is purposely formed to the urinal to compel persons to stand close to the basins.

How to Keep Urinal Places Wholesome.

For washing out urinal places a hydrant should be fixed at some convenient point, so that a hose pipe may be readily attached to it, and the whole of the walls and floors periodically sluiced with water. Where there is a "hot-water circulation" near at hand it is a good plan to lay on a *hot* water supply to the hydrant. At any rate, the floor, walls, and urinal-basins, outside and inside, when much used, should be well scrubbed and washed with strong hot soda-water and soap once a week or oftener.

Supplying Urinals with Water.

All urinals should be well supplied with water, and so fitted up that a flush of water may pass into the urinal basin *immediately* upon its use; and where a treadle action arrangement (as Fig. 215, p. 265) is objected to, a door-action supply, as shown in dotted lines in Fig. 282, is a good means for keeping such places wholesome. Every time the door is opened a gallon

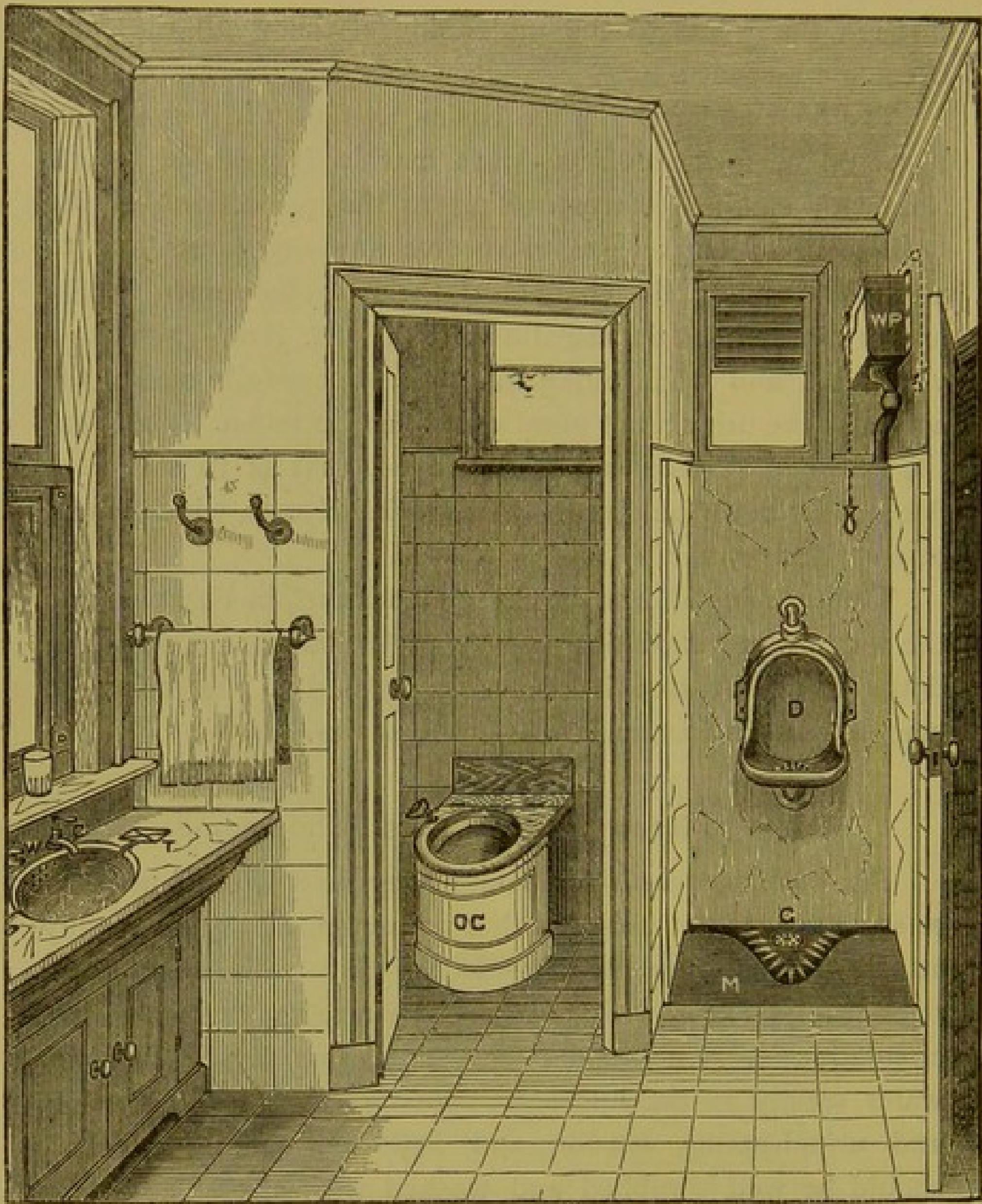


FIG. 282.—View of a Billiard-room Lavatory; or Door-action Urinal, Water-closet, and Lavatory.

of water—the quantity allowed by the London Water Companies—is syphoned out of the small cistern W P, and sent with a good scouring flush through the basin D and its waste-pipe. Where so desired a portion of the flush can be conveyed, by means of a small pipe, to the sinking in the floor, which should be of St. Ann's marble under the urinal as shown at M.

To render urinals inodorous, and to keep the waste-pipes free from deposits, it is a good plan to keep a piece of soda in the basins. I have found that the automatic syphon cistern, discharging about every half-hour (and many of the London Water Companies, if even they allow such flushing-cisterns to be used, will not allow them to discharge oftener) will not keep a urinal waste clean and wholesome, but, aided by the free use of soda in the basins, the waste-pipe is kept tolerably free from deposit. When the urinal would be much used—unless the flushing-cisterns A C, Fig. 281, could be allowed to discharge about every five or ten minutes—a small service-pipe should be attached to the branch service of each basin, for a constant dribble of clean water to pass through them.

Receptacles for Urine.

In selecting the basin, and in designing the urinal, too much care cannot be taken to see that the parts to be fouled

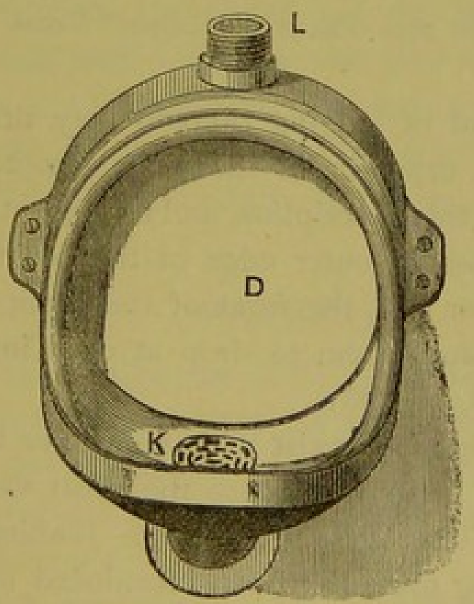


FIG. 283.—Front View of the Registered "Wide-fronted" Urinal Basin.

shall be thoroughly washed by the means provided for flushing the place. As this cannot be done where "stalls" or troughs are used, no such places should be fitted up, at any rate, inside public buildings, offices, club-houses, etc. The place for the reception of the discharge should be reduced to the smallest possible limit consistent with good convenience, in order that there may be but a small surface to be cleansed, and to render as effective as possible the one gallon of water restricted by the London Water Companies to flush each receptacle. And for this purpose it is advisable to use small urinal *basins* so constructed that not only the whole of the interior may be washed over with water every time they are used, but that the front edge be as narrow as possible and bevelled, so that

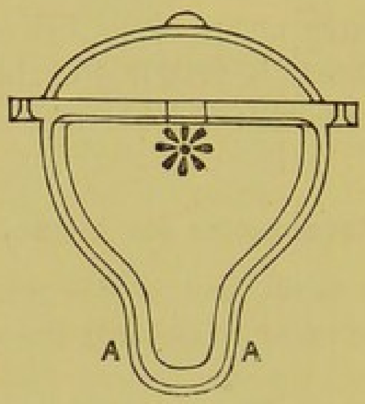


FIG. 284.—Plan of the "Lipped" Urinal.

droppings instead of lodging thereon may drain away into the basin. The urinal-basin shown in Fig. 283 is made to correspond with this description, and to prevent any droppings which may fall on the outer edge of the basin from running down on its outer side, the front of the basin is undercut or "throated" to cause them to drop at once into the sinkings on the floor—S S, Fig. 281.

Conflicting opinions exist with regard to the form of the front of a urinal basin, and hence the great variety of shapes now in use. The late Mr. George Jennings, to prevent droppings falling upon the floor, introduced many years ago what he called the "lipped" urinal, a plan of which is shown in Fig. 284. Fearing, however, that this spoon-like projection may touch their clothes, few people care to stand close to the basin, and consequently it very seldom receives the whole of the urine discharged, and the "flinkings" fall down outside at A A upon the floor. In order to meet the deficiencies of this urinal basin, Mr. John Taylor, surveyor to H.M. Office of Works, suggested to me a *wide fronted* basin, which would allow persons to approach close to the urinal, and afford greater convenience for its proper use. I have, therefore, designed and registered the "wide-fronted" urinal basin, illustrated in Fig. 283, and shown fixed in Figs. 281 and 282.

As explained elsewhere, I do not see the necessity of urinals in private houses, except where there are billiard-rooms, and especially where the "pedestal" form of closet exists, for with this kind of closet the user can sit astride upon it, and far enough back upon the seat or rail to use the closet as a urinal, without undressing more than he would to use an ordinary urinal basin. This idea I have communicated to several of my friends, and they are acting upon it with much comfort and satisfaction.

Any one who uses either the old form of water-closet, or the pedestal kind, in the ordinary way of using a urinal may be termed half civilised ; for, with the greatest care and accuracy in directing the stream, the whole of the discharge would rarely fall into the closet, and the urine falling down outside the basin, and upon the seat and rim of the basin, would become a nuisance. At any rate, so would think the next comer, who wanted to use the closet in a legitimate way, for his clothes would materially suffer by such a barbarous use of the closet.

WATER.

As explained in Chapter XXI., good potable water is of the highest importance, and I believe many illnesses which are now put down solely to bad drainage would, if it were possible to ascertain the actual facts, be attributable to the bad state of the water.

And yet it is astonishing what kind of water can be consumed without any apparent injury to the system. I have had many samples of water from country mansions analysed from time to time, and though the analyses have shown the waters from which the samples were taken to be totally unfit for drinking and dietetic purposes, I have found, upon investigation, that the water had been used for long periods (twenty, thirty, and even forty years) without any known bad effect. I am not writing this to encourage, for a moment, the use of unwholesome or questionable water, but rather to comfort the minds of those who are compelled to use water of a doubtful kind. To be nervous or frightened when one knows that the water he has to drink is not of a high state of purity will not free him from the possible danger attending it. On the contrary, such a state of mind will only render him the more susceptible to its influences.

If water were estimated at its proper value the Government of the country would see that every house in the kingdom had a bountiful supply of this beverage.

So highly do I value pure water that some years ago it formed an important element in determining the selection of my home. Living in a neighbourhood where the houses were supplied by water drawn from the Upper Thames, and frequently seeing the analyst's report, and not caring to trust to filters, I removed my quarters into Kent, where the purity of the water can be depended upon all the year round. But it must not be inferred from these remarks that I am afraid of London water, or that I consider the water supplied by the various Metropolitan Companies unsafe; for, at my office and elsewhere, I have been drinking some of this water daily for the last twenty-five years, but I prefer, of course, that known to be of better quality.

But when good water is found or supplied to a house, it is a most iniquitous thing on the part of any one concerned —be he plumber, architect, or house-owner—to store it in places where it can become contaminated, *e.g.* in underground cisterns, water-closets, living rooms, attic bedrooms, under bedroom floors, and such like places where vitiated air can reach it. (See p. 295, describing proper places of storage.)

Where the water has to be stored, and where it would be likely to have some action upon lead-lined cisterns (see pp. 364, 365, *ante*), that required for drinking and dietetic purposes should be stored in *white enamelled* earthenware cisterns, which are now made to hold about sixty gallons. Where a cistern of this capacity would be insufficient to meet the requirements of the household, slate cisterns should be used in preference to galvanised iron. Or cisterns made of fire-clay and salt-glazed, similar to earthenware drain-pipes, can be used; such cisterns are now made to hold about five hundred gallons. But great care should be taken to see that the interior surfaces are well glazed over to prevent absorption, *i.e.* there should be no fractures or porous parts where the water could enter into the material of the cistern and decompose, and where the usual cleansing of the cistern would not remove it.

FILTERS.

When making an examination of a house to ascertain its sanitary condition, I never forget the household filter and the dust-bin—two possible sources of danger often lost sight of because, practically, they seem to be outside the question of the plumbing and draining work of a house. The general character of the latter is now so well known that I suppose anything I might state about it would readily be believed (see pp. 3 and 4 *ante*), but the former is in such good favour and is so little understood by the public, that if I were to describe the half of what I have seen in regard to its condition it would scarcely be credited.

I have seen the small pieces of sponge which are placed over the inlets of some filters for screening the dirt, etc., and the corks, into which the draw-off taps are secured, in a high state of decomposition; and I have seen cistern-filters (*i.e.* filters placed in cisterns) in a very filthy condition, and have found that such filters had been in use for long periods without any cleansing or changing of their filtering materials. In fact, in some cases where the houses had changed hands, I have come across cistern-filters, the existence of which no one had suspected, and the filtering materials of which could not have been changed for ten and even fifteen years. What the internal state of such filters must have been I will not attempt to describe, except to say that the water must indeed have been bad which left such filters purer than when it entered them.

To pass bad water through a filter day after day for long periods together, regardless of the state of the filter or its capabilities, and to expect the water to be purified, is to show either gross ignorance or great thoughtlessness. I believe some people look upon their filter as a sort of magic wand, capable of doing wonders; for having purchased a filter, they treat it in the way Micawber treated his obligations: having signed a bill of acceptance, he forthwith, and for ever afterwards, dismissed the matter from his mind with these comforting words, "Thank God, that's done with."

If a moment's consideration were given to the subject it would be seen at once that no filter can continue filtering large bodies of water for any lengthened period and still retain its efficiency. The fact is *all* filters require periodical attention, and where animal charcoal is the filtering material some authorities consider that it should be changed about every few months, for though it may not be generally known, it is asserted by some authorities that such material cannot be relied upon after a short period of usage. Notwithstanding this, a large and well-known firm of filter manufacturers state most positively that "every two years is often enough for renewing the animal charcoal of their filters." When the filtering material is spongy iron once a year is considered often enough for its renewal, though, of course, it depends in either case upon the work the filter has to do, as well as upon the kind of water it has to filter.

In some cases where the water has been of known bad quality, and of a dirty nature, and no other source has been attainable, I have arranged *two* systems of filtration, using the first chiefly for clarifying, and the second for purifying.

Where filters are used, if they are to be purifiers, and not contaminators, it should be the special duty of some one of the household to see that they are periodically cleansed, and their filtering materials should be renewed according to their requirements; but, as already explained, the general custom seems to be to leave the filter to take care of itself, or to rely upon somebody seeing to it; but it is an old adage that "what is everybody's business is nobody's business," and so the filter goes without attention.

To ensure the filter receiving proper attention, it is a wise plan to arrange with the manufacturer, or a competent tradesman, to keep the filter in perfect working order, under a yearly contract, and the times of its cleansing, as well as of the renewal of its filtering material, should be recorded in a book.

Having said so much on the attention which filters require, and without attempting to enumerate and describe the many and various kinds now in use, it may be worth while to point out some of the more glaring defects found in *certain* filters, for there are filters *and* filters. Unfortunately the discriminating power of the public is not sufficiently cultivated to distinguish between the bad and the good; and, as in many other things in this world, whether there be a similarity of appearance or not, the former often get chosen in preference to the latter, especially if they be well advertised.

The supreme requisite of a filter is its purifying power, together with the certainty that every drop of water drawn from it shall have been properly filtered, for as a single drop might contain the germs of disease, it is important that no unfiltered water should be drawn off together with filtered water from the filter.

1. Some filters are so constructed that by a little disturbance of the interior or of some of their parts, unfiltered water may be drawn off with the filtered water, *i.e.* some of the water put into such a filter may work its way between the filtering materials and the sides of the vessel without passing through, or coming into proper contact with, the filtering materials. This applies especially to some kinds of household filters, but some of the cistern filters are not

free from this source of danger, and with others the risk is increased ; for in such cases not only is there a possibility of unfiltered water getting into the draw-off pipe, by a dis-arrangement of some of its parts in the way just described, but there is the further risk that the coupling joints, *i.e.* the connections with the filter or filters inside the cistern may not always be water-tight, and in such cases the *un*filtered water standing in the cistern would find a ready entrance to the filtered water draw-off pipe.

2. The stratum of the filtering material of some filters is so thin that the water passes through it without being properly purified, therefore such filters cannot be relied upon.

3. Filters with pieces of sponge, or with their draw-off taps secured to them by cork or indiarubber "washers," should not be used, for reasons referred to above.

4. Filters having their filtering material cemented down should also not be used, because of the difficulty in cleansing them, and in changing the filtering material.

5. Some filters clarify rather than purify; now, however good a filter may be for clarifying water (*i.e.* making dirty water bright and clear), if it has not also the power of purify-ing it, it should not be relied upon for filtering unwholesome water.

6. The filter should be adequate to its demands, for when it is of too small a size to supply filtered water as needed, the servants, rather than stand waiting some time for the water to filter, run off, I beg their pardon—walk off, to the nearest draw-off cock, and charge their jugs with *un*filtered water, saying to themselves as they go, "Nobody will know the difference, and it will be all the same a hundred years hence."

7. Filters should also be self-charging, for when servants have to charge them by hand, it will often happen that they have neglected to do this, and then, when filtered water is quickly needed, rather than fetch water to put into the filter, and wait for it to be filtered, they will draw from the nearest tap, and take *un*filtered water to the table.

The foregoing remarks apply more or less to most of the filters in use, not excluding those working under air-pressure—for aerating the water as well as purifying it.

When filtered water cannot be drawn immediately, or within a very reasonable time of waiting, the slowness of filtration being an important element, the filter should be provided with a small storage chamber; but water which has passed through animal charcoal should not be stored for any time; for according to the XIX. Army Med. Rep., "when water which has been filtered through [animal] charcoal is stored for any time, it soon begins to show evidence of low forms of life, and after a time a more or less abundant sediment of organisms becomes formed." For this reason, and also because spongy iron does not need such frequent renewals, I prefer the latter material for purifying water.

Boiled Water.

In this disturbing age, when everything is undermined with doubt, and the only safe thing left is the Leaning Tower of Pisa, it is comforting to know that by boiling polluted water before drinking it we are doing a really good thing; for though boiling may not destroy certain organisms, it materially lessens the risk attending the consumption of polluted waters, and, to say the least, it is a very wise precaution.

It is now known that certain organisms are not destroyed by boiling, and it appears that to absolutely destroy them the liquid must be heated to a temperature as high as 300° F.

In his popular little work, "Plain Words About Water," Professor Church states "that the poisonous matters in polluted waters, which produce diarrhœa and fevers, may be changed and made harmless by boiling, has been proved; that this always happens is not certain."

Boiled water tastes flat and insipid, but it can be made palatable by pouring it from one tin can or jug to another several times; or, as everybody knows, a pleasant beverage is made by pouring the water when in a boiling state upon some well-browned toast.

Some little time ago I planned an apparatus for boiling and aerating water for drinking purposes, and I give a short description of it here, so that any one may use it and improve upon it as he may feel disposed.

In some convenient place, a well-tinned copper boiler, holding 12 gallons (or half that quantity), with its sides tapering towards its bottom, to obtain as much heating surface as possible, and having a bright tinned-iron outer casing, to prevent the radiation of heat, is placed over one of Fletcher's patent Radial Gas burners. A movable cone-shaped cover is fastened to the top of the boiler, and the jointing is made steam-tight by an indiarubber ring. At the apex of the cone a steam-whistle is fixed to give notice when the water boils, thus dispensing with continuous attention. When it boils the gas is turned off, and the cover lifted a little on one side to allow the water to cool. To assist in the cooling, a stream of cold air is brought in from the external atmosphere by means of a tube made to play around the boiler. When the water is properly cooled, it is conducted by means of a ½-in. pipe, made of pure tin, to a white enamelled earthenware receiver, or vessel, into which from some little height the water is made to drop in the form of fine spray, or in single drops, from a perforated tin pipe, made somewhat in the shape of a gridiron, to divide the water, for the air to play upon it in its passage to the receiver. And in order to aerate the water still further a series of such vessels are placed between the boiler and storage cistern, one below another, as most convenient, for the water to pass from one to the other in a similar way to that just described. The water may be made to run out of the vessels as fast as it enters them, and so gain some further aeration by being splashed up into the air from the fall upon the solid bottoms, or it may be allowed to collect in the vessels and made to pass from one to the other automatically.

When there would be no danger from frost, and the surrounding atmosphere is pure, the receiving and storage vessels might be placed out-of-doors, and the water would by this means become better aerated; but in most houses it would be more convenient to place these vessels in the butler's pantry. A stream of cold air could be brought in from a quarter where no vitiated air could reach it, to blow in a breezy sort of way upon the water in its transit from one vessel to another. It will be understood that the greater the number of intermediate vessels the better the aeration, and in order to keep the water nice and cool in hot weather, the small storage cistern, which should also be made of earthenware, and white enamelled inside, could have an outer casing for placing pieces of ice around it. From the storage vessel a supply of water could be laid on, by pure tin pipe, to a draw-off tap, fixed to the butler's sink, or to some other convenient place of draw-off.

As a further means of making the water more palatable, it may be passed through a filter.

In making some experiments with this apparatus with water taken direct from the water company's main at my manufactory, a good deal of sandy sediment at times was found in the boiler after the boiling.

Hard Water and its Remedy.

What is known as the "hardness" of water arises principally from salts of lime, especially the bicarbonate, being held in solution in the water. Salts of magnesia and iron are also hardening salts.

There are several re-agents available for precipitation of the carbonates and sulphates of lime and magnesia, but the least costly and the most effective in its action upon the bicarbonate of lime is a saturated solution of caustic lime proposed many years ago by the late Dr. Clarke, and known as "Clarke's Process."

The great advantage this re-agent offers, independently of its very low cost, is that it not only precipitates the carbonate of lime of the hard water; but by combination with the excess of carbonic acid that constituted the bicarbonate, the caustic lime is also precipitated as a carbonate.

When water is hard, and it is supplied by a water company, it should be softened before being delivered to the consumer, for apart from the trouble and cost of doing this at every house, it could be done on a large scale at an infinitely lower cost. But where the owner of a house has to provide his own water supply, from a well, spring, reservoir, or other source of supply, and it is hard, what is now known as the "Porter-Clark Process," can be applied with great advantage.

In the "Porter-Clark Process" the lime-water is prepared continually in one vessel, and the mixing of this with the hard water is continuously carried on in a second vessel, whence the chalky water passes to a filtering machine, wherein the precipitate of pure carbonate of lime is utilised as the medium of filtration; the clear, bright water passing from the filter to the storage tanks at the top of the house or water towers.*

This process being carried on in closed vessels and filters under pressure, there is no risk of accidental or mischievous contamination of the water in its passage from the well or water-main to its ultimate destination. This, in large establishments or institutions, is an important consideration. Moreover, a secondary pumping is avoided.

The chemical action of the lime-water upon organic matter in solution is particularly dwelt upon by the Royal Commission of 1874, in their Report upon the Domestic Water Supply of Great Britain.

By the crystallisation of the mineral, or hardening, properties of the water, this system incidentally effects the removal of organic impurity; and this is the more effective, for the accumulation of the precipitated chalk is in such microscopically fine crystals as to form an exceptionally perfect medium of filtration, which, with the impurities it intercepts, is *removed from the filter daily*. *See* page 421.

* The apparatus can be fixed in some apartment in the rear of the premises, or when this would be inconvenient, a small house for it can be built.

Testing Water.

In sanitating country mansions, where no analytical knowledge is possessed of the water supply, I always deem it advisable to get a sample (or samples) of the water analysed; but when the analyst's report has been received, I have often been not a little puzzled to know how to act; for in many cases the analysis has shown the water to be very different to the generally accepted opinion of those who have been consuming it, *i.e.* the analysis has shown the water to be totally "unfit for drinking," but upon inquiries it has been found that the water from which the sample had been taken had been consumed daily by many persons, for long periods, without any known bad effect. An old proverb says, "The proof of the pudding is in the eating," if so, surely the proof of the water is in the drinking. What is one to do in such a case? Is he to ignore the opinion of the analyst, and allow his client (who may be a new occupant of the house) to drink water which may cause him or his family illness? This is a responsibility no one would care to undertake. Or is he to raise a doubt in his client's mind by giving him the result of the analysis, and perhaps put him to a great expense in obtaining water from another source, which, though chemically better, may not be more, or really so, wholesome as that which the analyst has condemned.

The essential thing, therefore, is to be in a position to say absolutely whether the water is wholesome or not, and analysts will not, I am sure, remain satisfied until they can speak more positively, and with greater unanimity, on the wholesomeness of the water they test.

It is now to be hoped that chemical analysis supplemented by the new methods of biological examination—Dr. Koch's and Dr. Frankland's—will enable us to obtain more reliable opinions as to whether certain waters are injurious or not for potable purposes.

By permission of Dr. Frankland I here quote (somewhat largely) from the valuable paper * which he read before a

* "New Aspects of Filtration and other Methods of Water Treatment: The Gelatine Process of Water Examination," by Percy F. Frankland, Ph.D., B.Sc., F.C.S., F.I.C., Associate of the Royal School of Mines.

meeting of the Society of Chemical Industry, at Burlington House, on December 7, 1885.

In his opening remarks Dr. Frankland said :—

"Until recently our definite knowledge of the value of filtration and other methods of water purification has been almost exclusively limited to an acquaintance with the chemical improvement which these processes are capable of effecting. This knowledge, although of the greatest importance in judging of their value, only constitutes a part, and not the whole, of the information which it is desirable to acquire with regard to these processes. For, since the communication of some diseases by means of living organisms has ceased to be a theory, but has become a well-established fact, resting upon the surest foundation, it has been felt that the question of water treatment must be considered from a biological as well as from a chemical point of view. This necessity has for a long time been felt by no one more strongly than by chemists, who have devoted much attention to water and its purification, and it has been only in consequence of the want of reliable means by which the investigation could be prosecuted from this point of view that but little progress has been made in this study."

Methods had from time to time been devised for the biological examination of water, but they could not be relied upon. The method he (Dr. Frankland) had the honour of bringing before the society he had been studying for some years past. It was an adaptation of a more general mode of biological investigation, which had been long practised by Dr. Koch, of Berlin, viz., the cultivation of lower forms of life in a solid medium.

"The great advantage which the use of a solid medium affords, is that the micro-organisms imported into this medium grow and multiply on the spot where they have been first planted, being restricted from undergoing any movement of translation, such as necessarily takes place in a fluid. In consequence of this restriction, the progeny of each organism gathers round the parental home and forms a colony, which, rapidly increasing in size, soon becomes visible to the naked eye, the appearance of the colony being in many cases distinctive of the particular organisms of which it is composed."

"It is necessary, of course, that this solid medium, into which the organisms under examination are imported, should furnish all the materials necessary for their growth and development. The medium recommended by Dr. Koch for this purpose has the following composition :—

Lean meat	1 lb.
Gelatine	100 grms.
Peptone (solid)	10 „
Common Salt	1 „
Distilled Water	1 litre."

Its preparation is then described, and the mode of collecting and examining samples explained. He had thus

"made a large number of experiments, using boiled distilled water, and have found that almost invariably the plates remain absolutely unchanged, whilst only in most exceptional cases does any colony whatsoever make its appearance on the plate. Thus of twelve plates put up with sterilised water a week ago, no colonies made their appearance excepting a mould on one plate. In this respect my results compare favourably with those of Dr. Koch, who finds that three colonies is the average obtained with sterilised water; now this difference may be partly due to my experiments being performed in an atmosphere which is essentially inimical to organic life—viz., that of a chemical laboratory—whilst it is also doubtless due to the use of my mercuric chloride seal as well as to the greater general purity of the atmosphere in English buildings."

In referring to the practical application of the gelatine process, Dr. Frankland said—

"It is obvious that the process of water examination just described enables us to investigate the subject of water-purification from an entirely novel point of view. By determining the number of micro-organisms present in water before and after any process of purification, we are able to obtain for the first time complete and reliable information as to the value of such a process in removing micro-organisms. Such information is, of course, of immense importance in the case of the purification of waters which are liable to dangerous contamination by organised poisons, and constitutes an invaluable supplement to the results of chemical examination."

With the aid of this process he had carried out a large number of experiments on the efficiency of various methods of water treatment, in removing living matter, which are referred to under the following heads:—

1. Purification by Filtration.
2. " " Agitation with Solid Particles.
3. " " Chemical Precipitation.
4. " " Natural Agencies.

With regard to purification by filtration—

"Although it has been long known that some filtering materials, when judiciously applied, are capable of depriving water of all the organisms that it may contain; yet, until the method of gelatine culture was adopted, there was no readily available means by which the relative efficiency of different filtering materials could be estimated on a quantitative basis."

Results of experiments were then given with various filtering materials, from which I quote the following :—

"ANIMAL CHARCOAL.

" *Initial efficiency :—*

Unfiltered water ... Organisms too numerous to count.
Filtered do. ... ... 0 organisms per cc.

Reduction = 100 per cent.

Efficiency after 12 *days' action :—*

Unfiltered water ... ... 2,800 organisms per cc.
Filtered do. ... ... 0 " "

Reduction = 100 per cent.
Rate = ·35 litre per 24 hours.

Efficiency after 1 *month's action :—*

Unfiltered water ... ... 1,280 organisms per cc.
Filtered do. ... ... 7,000 " "

Increase = 447 per cent.
Rate = ·65 litre per 24 hours."

" IRON—SPONGE.

Initial efficiency :—

Unfiltered water ... ... 80 organisms per cc.
Filtered do. ... ... 0 " "

Reduction = 100 per cent.

Efficiency after 12 *days' action :—*

Unfiltered water ... ... 2,800 organisms per cc.
Filtered do. ... ... 0 " "

Reduction = 100 per cent.
Rate = ·30 litre per 24 hours.

Efficiency after 1 *month's action :—*

Unfiltered water ... ... 1,280 organisms per cc.
Filtered do. ... ... 2 " "

Reduction = 99·8 per cent.
Rate = ·34 litre per 24 hours."

" COKE.

Initial efficiency :—

Unfiltered water ... ... 3,000 organisms per cc.
Filtered do. ... ... 0 " "

Reduction = 100 per cent.

Efficiency after 5 *weeks' action :—*

Unfiltered water ... ... 6,000 organisms per cc.
Filtered do. ... ... 90 " "

Reduction = 98·5 per cent.
Rate = ·38 litre per 24 hours."

In referring to these experiments, Dr. Frankland stated—

"It has generally been supposed that most filtering materials offer little or no barrier to micro-organisms, and that the latter are capable of passing without sensible obstruction through the pores of filters containing pulverised materials. These experiments, however, show that it is extremely simple to construct filters which shall possess the power of removing micro-organisms, in the first instance at least. This power is, moreover, possessed by substances which exercise scarcely any chemical action on the organic matter present in the water—*e.g.* coke, vegetable charcoal, and biscuit porcelain, as well as by those which reduce both the organic and mineral ingredients of the water to a very marked extent, like animal charcoal and iron.

"Especially noticeable is the case of vegetable carbon, whether in the form of charcoal or coke; this material has been generally regarded as of but little value for water purification, owing to its chemical inactivity; but as biological filters, we see that these substances occupy a very high place, and, owing to their cheapness and the facility with which they may be renewed and profitably disposed of as fuel, they are in my opinion destined to be of great service in the purification of water."

Also

"My experiments, however, show most distinctly the necessity of frequent renewal even in the case of the best filtering materials, and this is a point which, unfortunately, is too often lost sight of—the idea that 'once a filter always a filter,' being erroneous in the extreme."

"Lastly, we have abundant confirmation of the principle which has long been known to water engineers—viz., that what is gained in rapidity is lost in efficiency, and *vice versa.*"

The result of the experiments upon purification by agitation with solid particles, proved that

"Although a most remarkable purification may be accomplished by this simple process of agitation, yet, owing to the uncertainty of its success, its efficiency cannot at present be relied upon."

In referring to purification by precipitation, he describes Clarke's process, as examined by him in the laboratory, and on a large scale as practised by manufacturers, from which it was found that the biological efficiency of this process is markedly superior to its power as a chemical purifier.

With regard to the purification of water by natural agencies, Dr. Frankland said that it is well known that the purest of natural waters as regards organic matter, of which they often contain the merest trace, are those which have undergone prolonged filtration through porous strata, and that it has been shown by Pasteur that many of these waters are entirely destitute of organic life, but it must not be forgotten that it is very difficult to collect such waters in a sterile condition, owing to the places where they issue being surrounded by conditions favourable to the communication of organised matters to the water. He quotes the Deptford well of the Kent Company as an instance of such a difficulty, but in spite of this he found that the water only contained—

June 4th, 1885 ...	... (temp. 12·4° C)	... 6	organisms per cc.
Oct. 29th „ ...	... („ 12·0 „)	... 6	„ „
Nov. 24th „ ...	... („ 11·7 „)	... 8	„ „

The principal conclusions he draws from his experiments are—

1. That the complete removal of micro-organisms from water, by filtration, is unattainable without frequent renewal of the best filtering matters, and duly restricting the rate of filtration.

2. That a very great reduction in the amount of organised matter in water may be accomplished by filtering materials, which have hitherto been generally regarded as almost ineffectual.

3. That organised matter is, to a large and sometimes to a most remarkable extent, removable from water by agitation with suitable solids in a fine state of division, but that such methods of purification are unreliable.

4. The chemical precipitation is attended with a large reduction in the number of micro-organisms present in the water, in which the precipitate is made to form and allowed to subside.

5. That if subsidence, either after agitation or after precipitation, be continued too long, the organisms first carried down may again become redistributed throughout the water.

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THE PLUMBER AND SANITARY HOUSES.

A Practical Treatise on the Principles of Internal Plumbing Work; or, the Best Means for Effectually Excluding Noxious Gases from our Houses.

WITH A CHAPTER ON COWL TESTING.

By S. STEVENS HELLYER.

EXTRACTS FROM PRESS NOTICES OF PREVIOUS EDITIONS.

"It would be superfluous to say more about a work the principal defect of which is that it advocates a style of work so excellent, and so far beyond the mental powers of the ordinary old-fashioned plumber, that some trouble will no doubt be incurred by those who insist on Mr. Hellyer's rules being put into practice. But there is nothing advocated, after all, that is not suitable to the requirements of ordinary life in cities. *To all about to build a house we would say, Buy Mr. Hellyer's work, and read it.*"—*The Engineer.*

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"The book is well got-up, is nicely printed, and profusely illustrated, and is likely to be of service to Builders and Health Officers, whether medical or otherwise."—*Lancet.*

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