Sewage-poisoning : how to avoid it in the cheapest and best way / by Edward T. Blake.

IS DIPHTHERIA PREVENTABLE?

SEWAGE POISONING:

ITS

Causes & Cure.

BY

Edward T. Blake, M.D., M.R.C.S.

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SEWAGE-POISONING;

HOW TO AVOID IT IN THE CHEAPEST AND BEST WAY.

BY

EDWARD T. BLAKE, M.D., M.R.C.S.

Read before one of the London Medical Societies, November, 1878.

ILLUSTRATED BY WOODCUTS.

LONDON:

HARDWICKE AND BOGUE, 192, PICCADILLY, W.

To the Memory

OF

PARKES,

THE FATHER OF BRITISH HYGIENE,

THIS PAPER IS DEDICATED

WITH

SINCERE REVERENCE.

PREFACE.

As these pages were being prepared for the press, the shadow of a great sorrow fell on the whole English-speaking nation.

Another Royal victim paid the sad penalty of our limited knowledge of Sanitary Science.

Poignant indeed would be our grief, could we not reflect that this calamity will lead to an incalculable amount of economy of now wasted life and energy, and that thus the sum of human misery will in the end be lessened. It is impossible to estimate the impetus given to Sanitation in this country by the grave illness of one beloved Prince and by the death of another.

To the physician it is humiliating enough that, with all the wealth of resource in modern art and science, aided by the deepest personal devotion,

disease may yet mock his efforts and death triumphantly snatch its prey! But when the disorder is felt to be preventable, another element of bitterness is added; it is the *chagrin* of which Pope writes, and on which Sir Arthur Helps comments so feelingly in the inimitable 'Brevia.'*

Whilst one learns to bow before the decree of Providence, when inevitable decay claims its own, one cannot cease to grudge, to *preventable* disease, each single victim.

The objects of this little work are twofold: First, to teach that many diseases, which we are in the way of looking upon as unavoidable, are really quite the reverse. Second, to show how we may defeat and destroy those twin demons—Ignorance and Indolence—deadliest enemies of our race!

* P. 183, 1st edit.

Wray Park, Reigate,
Surrey.

TERMINOLOGY.

DRAIN—A conduit for land water (not sewage).

DRAINAGE—*a*. The water which is drained.
b. The act of draining.
c. A system of water conduits.

SEWER—A conduit for house refuse.

SEWAGE—The filth discharged by a sewer.

SEWERAGE—*a*. The act of removing refuse by sewers.
b. A system for the removal of refuse by sewers.

SEWER-DRAIN—Should mean a pipe which conveys both house-refuse and land-water.

SYLLABUS.

1. Symptoms of Sewage Infection.
   - *a.* In adults.
   - *b.* In children.

   Elements of diagnosis.

   Why are children so obnoxious to sewer-gas?
2. Causes.
   - *a.* Predisposing.
   - *b.* Exciting.

   Most common sanitary defects of cities.

   A. *Untrapped wastes.*
      1. Sink-pipes.
      2. Wastes in general.

      Bath, lavatory, drip-pans, closet-safe, slop-sink, tank-overflow, cistern-do.

   B. *Non-ventilated soil-pipe.*

      D-trap.

      Corrosion of indoor soil-pipe.

      Defective or improper junctions and joints.

   C. *Drinking supply* polluted by sewer-gas. Milk supply do.

   D. *Continuous stack-pipes* acting as ventilators.

   E. *Less obvious means* of contamination.

      Cellar-drains, dish-stones in passages, abandoned cesses, storm-water, surface-water, percolation, wells.
3. Cure.
   1. Exclude sewer-gas.
   2. Ventilate each system *at each end.*
   3. Regulate water supply.
      do. milk supply.
4. Maxims.

ON SEWAGE-POISONING.

MR. PRESIDENT AND GENTLEMEN,—You will remember that in the Session 1875—6, we had the pleasure of listening to a communication bearing on this subject, in relation especially to an outburst of enteric fever at Croydon. That paper provoked an exceedingly interesting discussion, and it is in the hope that even more valuable information may be elicited this evening, that I have strung together a few notes on a subject which is daily engrossing more public attention. Sewage-poisoning, in some form, we constantly encounter; it behoves us to know well the phenomena which reveal its presence; and even then we may not rest content, for we must also make ourselves thoroughly acquainted with the conditions which render such poisoning possible.

I fancy I hear some worthy member exclaim, "Oh! that last is no business of ours; it is the domain of the architect, of the builder and *his* satellites."

I reply that, as long as builders* know so little about Chemistry and Physics, so long must we doctors, for the sake of precious lives entrusted to our care, be builders—aye, and architects and plumbers and sanitary inspectors all in one!

To *you* I need not point out the recognised proneness of the *mulier parturiens* to puerperal fever, in insanitary houses, in order to show the gravity of the subject to accoucheurs.

You know well that he would be a bold surgeon indeed who, spite of the terrors of erysipelas, would dare to operate in an atmosphere reeking with sewer-gas!

Not only should midwife and surgeon be cognisant of these hidden perils, but it is equally requisite for the *physician* of the nineteenth century to be master of at least

* The fault lies with the public much more than with the builder; *he* is wise enough to supply what is wanted. As long as we prefer *handsome* to *healthy* houses, so long will the money that should be spent below the surface, go to tawdry ornamentation above it.

the A B C of Sanitary Science. Not only is this necessary that he may avoid egregious blundering in diagnosis—the chagrin of seeing his remedies fail, his patients drift slowly, yet surely, towards—

"That bourne whence no traveler returns,"

but for more personal, more pressing reasons. Most of us have children of our own, whose medical paternity will not, alas! serve to protect them from the onslaughts of the dreaded army of drain-demons—those invisible but potent foes which lurk *perdus* in our sewage-systems and in our water-supplies!

Putting aside such acute specific diseases as cholera, enteric fever, scarlatina, erysipelas, puerperal fever, typhus, including the family so-called "zymotic" which, more or less related to defective sanitation, are obvious in their nature, even if their precise causes be not readily recognisable, let us ask which is the group of symptoms that ought to raise our suspicions of more chronic sewage-poisoning—often so slow, so insidious in character?

You reply, we think of sewage infection when we encounter—

I. Throat affection;
II. Languor;
III. Dull frontal headache, with malaise;
IV. Nausea;
V. Dyspepsia;*
VI. Diarrhœa;
VII. Feverishness;

in adults; and especially when we see in the children of the same household—

I. Anæmia;
II. Loss of appetite;
III. Enlarged cervical glands;
IV. Recurrent diarrhœa;

then we say immediately "there must be something the matter with the drains."

* Amongst the more dubious symptoms are clean-punched ulcers inside lips, with cheesy base and bright red margin. Quinsy. Mental Depression.

But it is evident that these are very ordinary groups of symptoms; they might point to half-a-dozen other causative agents with nearly as much precision as to sewage infection. Here, however, other peculiarities come to our aid.

1st. There is the numerical test; by which I mean that a number of the inmates of a house, if exposed to the same conditions, present a certain similarity in their symptoms.

2nd. Obnoxiousness to ordinary treatment, with speedy cure on changing to a healthy atmosphere.

3rd. Recurrence of the symptoms in children; persistency in adults.

4th. Increase of severity in all the exanthemata and serious vaccination complications.

But of all peculiarities and symptoms the state of the throat is the most typical—the most distinctive.

I do not propose to detain you with a description of the typical sewage-throat; as practical physicians you are well acquainted with its appearance, and *you* will not mistake it for struma or for specific disease. But a question I *will* ask. Why does a man who is constantly exposed to the chance of infection escape at one time to be caught at another?

The explanation is probably to be stated something in this way: a robust adult, with the mucosa of the pharynx intact, will inhale sewage-gas, and the floating germs of disease shall settle innocuously on his tonsils. But let him come some day into the same polluted atmosphere with his nervous system depressed and his pharyngeal mucosa eroded by catarrh; his armour avails him nothing, a germ-arrow pierces an unguarded joint, and the strong man succumbs. Only a tiny spot, it may be, not as large as a pin's point, is denuded of its epithelium, but it is enough for the disease-germ to secure an appropriate nidus, and we find as a result an angina, the character of which is *decided* by the specific nature of the germ, and *modified* by the personal peculiarities of the subject.

It is a matter of clinical experience that the false membrane of diphtheria is not confined to the throat. It has been observed on the surface of wounds, also in the external ear, and at other orifices; probably it is only more

common in the pharynx, because the pharynx, being a kind of atmospheric sieve, a far larger quantity of air comes in contact with it than with the rest of the body.*

There is no ground for doubting that a typically healthy man may lie all night in an atmosphere saturated with sewage-gas, and may rise in the morning feeling very little the worse for it. Similarly a phthisical patient, having a vomica, will systematically swallow tubercular sputa and no evil result ensue, until something shall produce an intestinal excoriation, and thus pave the way for absorption.

Here arises another most interesting question. Why do children suffer more frequently and more severely than adults? Many circumstances conspire to throw the brunt of the battle on raw recruits, the least able of all to bear it. Amongst them, we know that children are more prone to the causes which denude the throat of its protecting membrane.

Owing to the excitability of the nervous system in children, their circulation, controlled by the nerves, is readily disturbed; hence diseases tend to assume a more acute type in childhood.

Many diseases are either entirely protective, or they have the power of diminishing in intensity subsequent attacks. Thus, a man will resist infection because he has had one or more attacks in youth; it is evident that young children cannot possess this safeguard.

Again, children are more exposed to sewer-poisoning because they are kept indoors during "bad weather," just when the gases are rising into the house from the over-flushed sewers.

But there is a physical reason why these little ones should be especially the victims marked out by the destroyer. Children are usually placed in the uppermost parts of the house; in other words, their dormitories are just where sewage-gas accumulates. Unfortunately this state of things is aggravated by the windows and skylights being closed just when the maximum of sewer-gas is introduced, *i. e.* during the night and after a heavy rainfall.

* About 2000 gallons in twenty-four hours.

It is probable, then, that at least three conditions are requisite to enable a child to become diphtheritic:

1. Vitality must be lowered, either by continued exposure to sewage infection, or by some other debilitating agency.

2. There must be actual loss of surface in the throat.

3. There must be the presence of the diphtheritic germ. According to recent views this would consist of a portion of the poisonous secretion from the diphtheritic glands of another.

That some such necessities as these must exist to pave the way, is rendered probable by the failure of physicians to inoculate themselves with the diphtheritic virus; for Trousseau and Peter actually had the temerity to try this hazardous experiment! I myself have frequently had pieces of false membrane propelled into my eyes, yet without evil result.

That catarrh, epidemic or otherwise, is the usual method by which the throat is denuded, is proved by the careful observations of Senator of Berlin.

He points out that typical diphtheria is preceded by catarrh of the air-passages. Is it not a little strange that, in his elaborate clinical lecture of fifty large octavo pages, Senator never once alludes to the possibility of preventing, or at least of moderating, the severity of diphtheria by the exclusion of sewer-products!

Whilst noting the fact that adults and certain children succumb, whilst others, exposed to precisely the same conditions escape, Senator does not attempt to give any explanation.

Is it not probable that adults, as we have said, owe their immunity, not alone to greater robustness, but to preinfection, and consequent protection, at some former date?

Of course, if a house be free from sewage-gas, and both the milk- and the water-supply be unpolluted, then the household may share a prevalent catarrh, and yet evade cynanche. This is plain to our common sense, and it is also clinically confirmed. It serves, too, to throw some light on the croup-diphtheria controversy, for some authorities consider these two diseases to be identical.

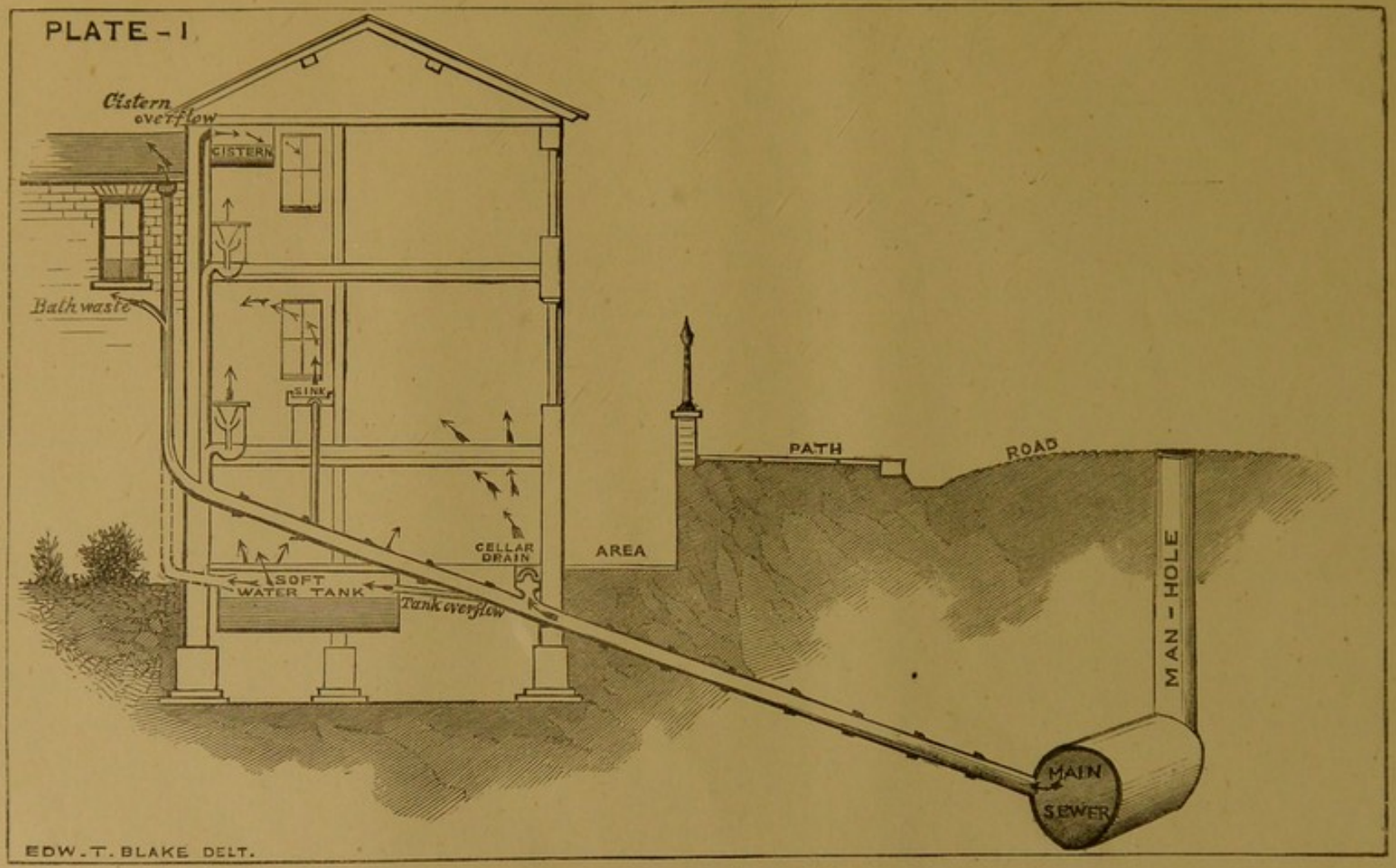


PLATE - I
Cistern overflow
CISTERN
Bath waste
SINK
PATH
ROAD
AREA
CELLAR DRAIN
SOFT WATER TANK
Tank overflow
MAN - HOLE
MAIN SEWER
EDW. T. BLAKE DELT.

PLATE I.—DIAGRAM OF A TYPICAL TOWN HOUSE, 1878.

Wastes and cellar-drain acting as ventilators. Cistern- and tank-water saturated with sewer-gas. *A system as bad as it can be.*

PLATE II.—SAME HOUSE.

1. Disconnected. 2. Trapped. 3. Ventilated. The best made of a bad system.

P. P. Portion of sewerage under house is embedded in concrete, Stanford's joint, arches at A. A. To flush this portion, put a mop down V. V. to E., and keep it there till water flows back into gully at top, then suddenly withdraw. S. Syphon, to cut off the house-system from main-sewer. V. VV. Poles of current always oscillating to and fro in the house-system. Surface water-gully draining area may be turned into V. V. X. XX. Poles of current always oscillating to and fro in system outside the house. C. Cellar-drain, being a brick knocked out at lowest point.

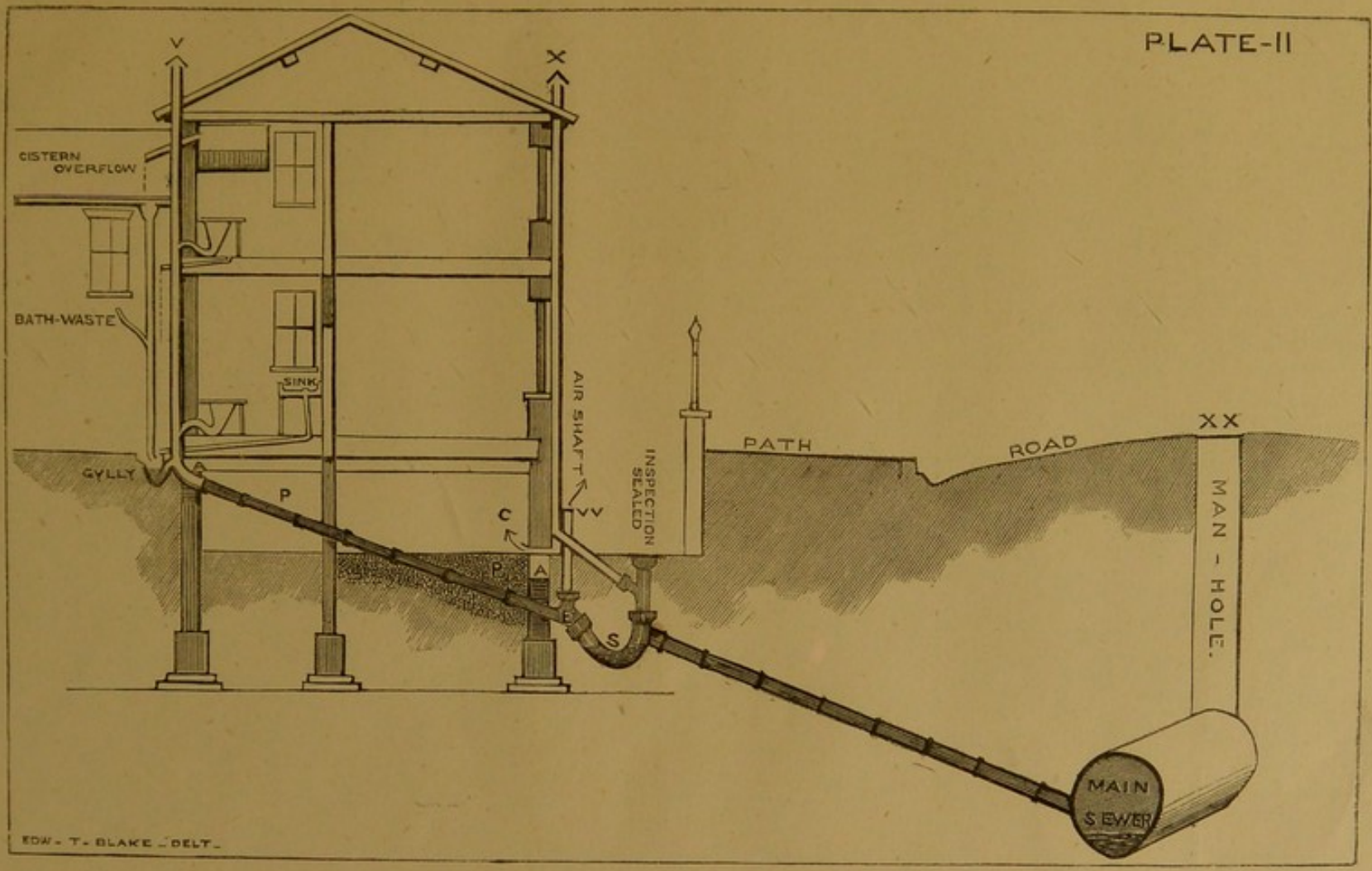


PLATE-II
V
X
CISTERN OVERFLOW
BATH-WASTE
SINK
GYLLY
P
C
P
A
S
AIR SHAFT
V
INSPECTION SEALED
PATH
ROAD
XX
MAN - HOLE.
MAIN SEWER
EDW. T. BLAKE DELT.

1st. Untrapped wastes.

A. Of these the most common is a *non-disconnected sink-pipe.*

B. We must not be content with examining the sinks belonging to the cook and the butler; we should make inquiry if there be a housemaid's—or a slop-sink upstairs.

C. Lavatory- and bath-wastes form a common way in which sewer-gas is led into a house. As bath-rooms are frequently attached immediately to sleeping apartments this is especially dangerous.

D. We should be on the *qui vive* to observe if beneath any upstair water-tap there be a drip-tray having its waste-pipe discharging itself, as is too often the case, into the soil-pipe, so close at hand, so perilously convenient!

E. The overflow from a cistern may be disposed of in the same dangerous way, quite hidden from view in a dark wood-casing or perhaps, *horribile dictu,* even built into the wall with solid masonry!

F. An insidious method of poisoning, which is very common and is very readily overlooked, is the atrocious habit plumbers have, of turning the waste-pipe which drains the tray under the closet, "the safe" as it is technically called, into the adjacent soil-pipe. A near relative of my own was poisoned in this way.

G. Another sanitary sin is boring a hole in a soil-pipe, between two closets, thus affording ingress of air, to prevent what is known as "syphoning" *i.e.* the descent of the soil from the upper syphon, "sucking" as it is called, the water out of the syphon below it.

Though, of course only intended to admit air, this aperture emits "drain-gas" when the water-closets are not in use.

H. In London, the drinking-cistern is often placed over the sink.

During the night the scullery is closed for security, sewer-gas rises to the ceiling hovering over the cistern which is usually uncovered, it is absorbed in large quantities, especially in cold weather, and thus forms a common cause of disease. (See Plate VII.)

2nd. Soil-pipes.

The second in frequency, perhaps, is

A Non-ventilated Soil-pipe.

Let us suppose that a house has, as is usually the case, an indoor leaden soil-pipe, with the ordinary D-trap at the top.

The accumulated gases, chiefly sulphuretted hydrogen, or hydrosulphuric acid as it is now called, lie at the upper domed part of the soil-pipe. The acid having a strong affinity for lead, readily unites with it to form a lead-sulphide, thus the pipe gradually corrodes; pin-hole perforations are first formed and by degrees the upper portion of the pipe is converted into a honeycomb.

3rd. Water Supply.

Another indoor source of peril is the arrangement by which water is supplied from one cistern only, for all purposes; a most objectionable plan. It is an economy to the builder and is a benefit to the purveyors of water because, without a water-meter, an escape from a direct supply is not so readily controlled as from a cistern. If a cistern supply a water-closet in the ordinary way then the water of such cistern is quite unfit for drinking purposes. A moment's thought will show this. The open lower extremity of the pipe is ordinarily filled with air more or less tainted. On drawing the plug, water rushes down towards the pan and as it descends, the air and gas which were in the pipe pass upwards into the cistern, which thus is enabled to supply, not *aqua pura*, but a solution of sewer-gas. We may sometimes detect quite an interval between the raising of the handle and the appearance of the water. During this interval a distinct gurgling sound is heard. This is the sewer-gas getting out of the pipe to let the water take its place. Bedroom water-bottles are often filled with water-closet cistern water.

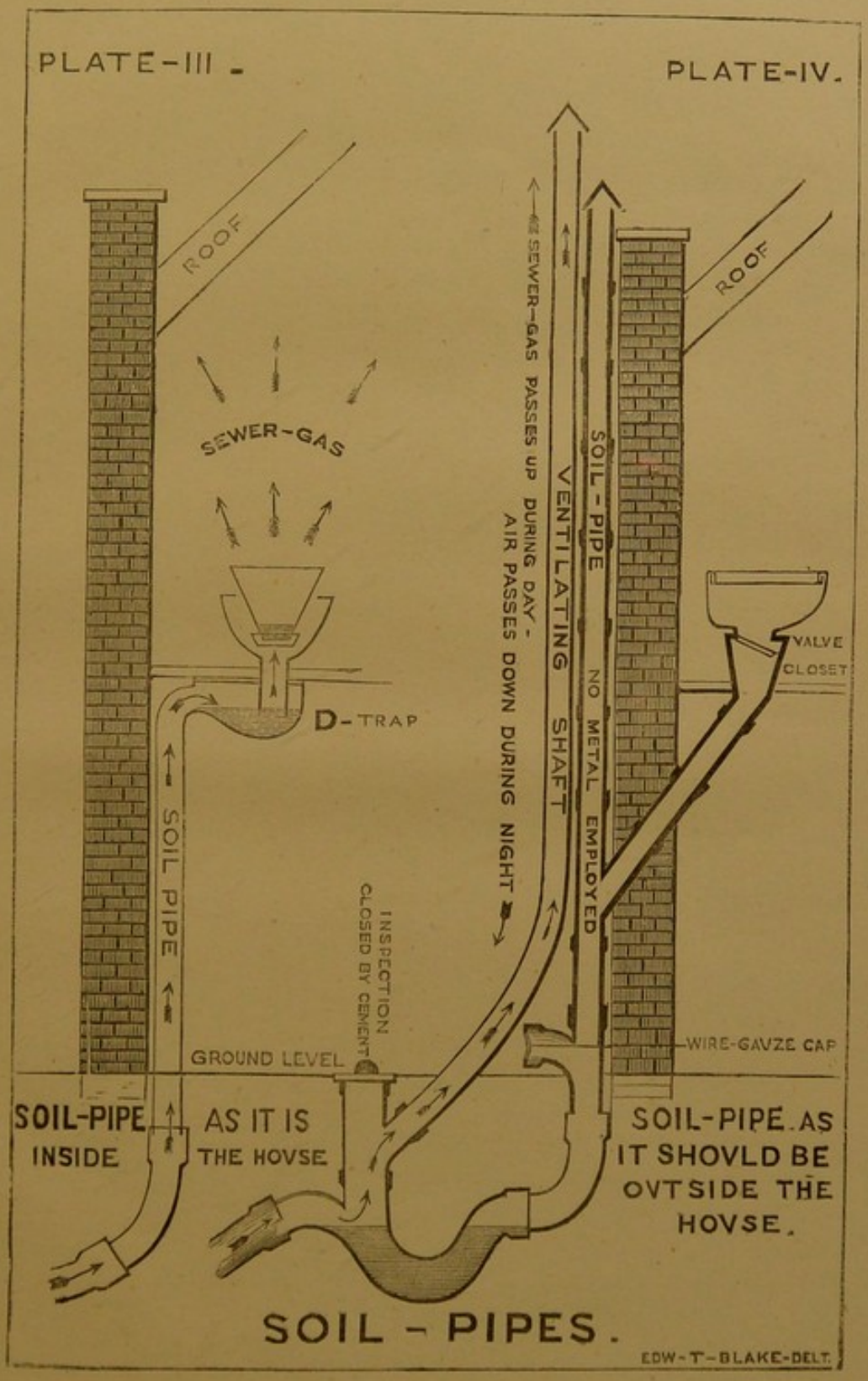


PLATE-III -
PLATE-IV.
ROOF
SEWER-GAS
D-TRAP
SOIL PIPE
INSPECTION CLOSED BY CEMENT
GROUND LEVEL
SOIL-PIPE INSIDE
AS IT IS THE HOVSE
SEWER-GAS PASSES UP DURING DAY - AIR PASSES DOWN DURING NIGHT
VENTILATING SHAFT
SOIL - PIPE
NO METAL EMPLOYED
ROOF
VALVE CLOSET
WIRE-GAVZE CAP
SOIL-PIPE AS IT SHOVLD BE OVTSIDE THE HOVSE.
SOIL - PIPES.
EDW-T-BLAKE-DELT.

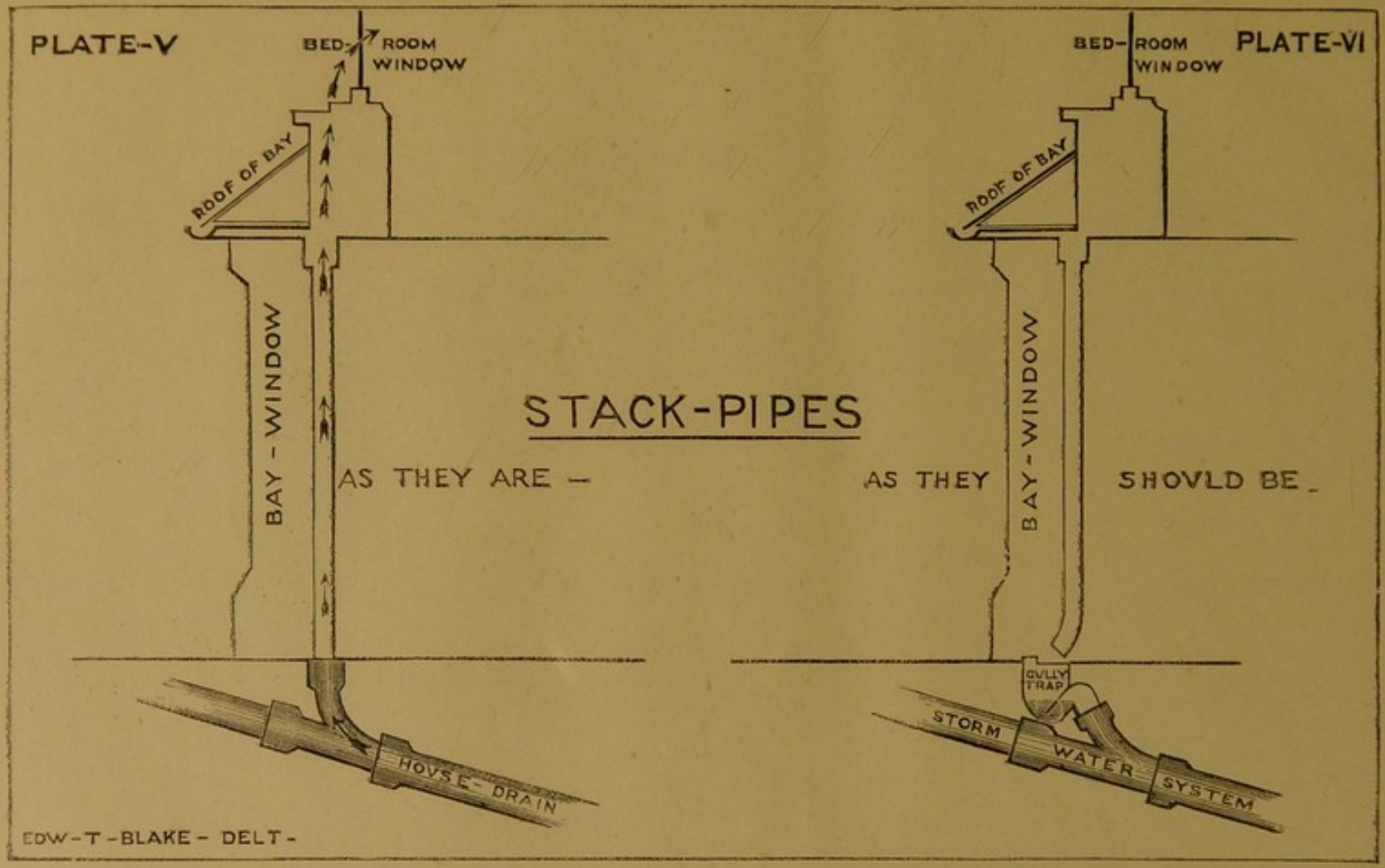


PLATE-V
BED-ROOM WINDOW
ROOF OF BAY
BAY-WINDOW
STACK-PIPES
AS THEY ARE —
HOVSE-DRAIN
EDW-T-BLAKE-DELT-
BED-ROOM WINDOW
PLATE-VI
ROOF OF BAY
BAY-WINDOW
AS THEY SHOVLD BE.
GVLLY TRAP
STORM WATER SYSTEM

4th. Continuous Stack-pipes.

It is evident that if a water-pipe run from the roof into a house-sewer without trapping, such water-pipe, whatever we may be pleased to call it, will act as a ventilating shaft. That this is the ordinary state of things you are all well aware. It so happens in this town, that these stack-pipes terminate above the window level and considerably below the chimney exits. That to this fact London owes an accidental immunity from a vast amount of nuisance and disease, there is no reasonable ground for doubting. Were these stack-pipes so arranged as to terminate under French eaves, at the top of bay windows, near dormers (roof-windows) or level with the chimney tops, the whole case would be altered; for then the gases which rise from the sewer, especially during the hot weather and after heavy showers, would easily gain access to the house. But luckily for London, projecting eaves are rare, bays and dormers are not common and the chimneys are lofty.

A pipe ending near an air-brick has been known to cause disease, by gas entering through the perforations of the air-brick and passing up through the flooring.

I need not say that we have not entered into all the methods by which an ingenious builder, aided by a pains-taking plumber, may arrange to insure us a free and unfailing supply of noxious gases.

To enumerate all the possibilities of percolation into wells and water-pipes, and under badly-concreted foundations; of open cellar-drains and abandoned cesses improperly filled in; to speak of the dangers of storm- and surface-water inadequately disposed of, would occupy a very long evening, and would probably absorb the space of at least two years of our *Annals* to publish.

We have glanced at the commonest ways in which our frail bodies are prone to be poisoned by sewer products; let us now turn to what can be done in the way of prevention or

Cure,

and let us take the case of an ordinary house from which

we want to exclude sewage gas in the most prompt, perfect, and economic manner possible.

Wastes.

First we must deal summarily with the untrapped wastes —they *must* be done away with, and at once. Every sink- and other such pipe must be cut through and placed upon a gully. The end of the pipe should lie above, *not under*, the gully-grating, the latter so neat, so bad a plan! For fat, leaves, hair, rags, and various kinds of filth, accumulate on the grid, close the orifices, and if the end of the sink-pipe be beneath, they reconvert the disconnected pipe into a continuous one.

In the sketch which I send you, you see on the left hand a vertical section of an ordinary waste-pipe, on the right you see a civilised waste-pipe and gully. We shall, of course, remember that this applies equally to all wastes of every description, the most dangerous being those which are prone to fall into disuse and be forgotten, such as bath-wastes and upstair sinks. These are rendered the more pernicious in that they frequently terminate near dormitories whose doors stand open in hot weather; nay sometimes for convenience sake they are led into the very rooms themselves!

Sometimes people plead that they are protected by a bell-trap. I will not affront you, gentlemen, by imagining for one moment that *you* would place the least reliance on that broken reed, "a bell-trap," a trap invented only for entrapping the unwary.

W. C. and Soil-Pipe.

Next, we have a look at the W. C. We find the door open, the lid down, and the window closed; each of these conditions requires inverting. It is a good plan to order the door-latch, if strong, to be removed, and a spring put on, because children on leaving can scarcely be expected to close the door after them. A lid is worse than useless, for if kept down, as tidy people are careful to keep it, what must ensue? Sewer gas which, in hot weather especially,

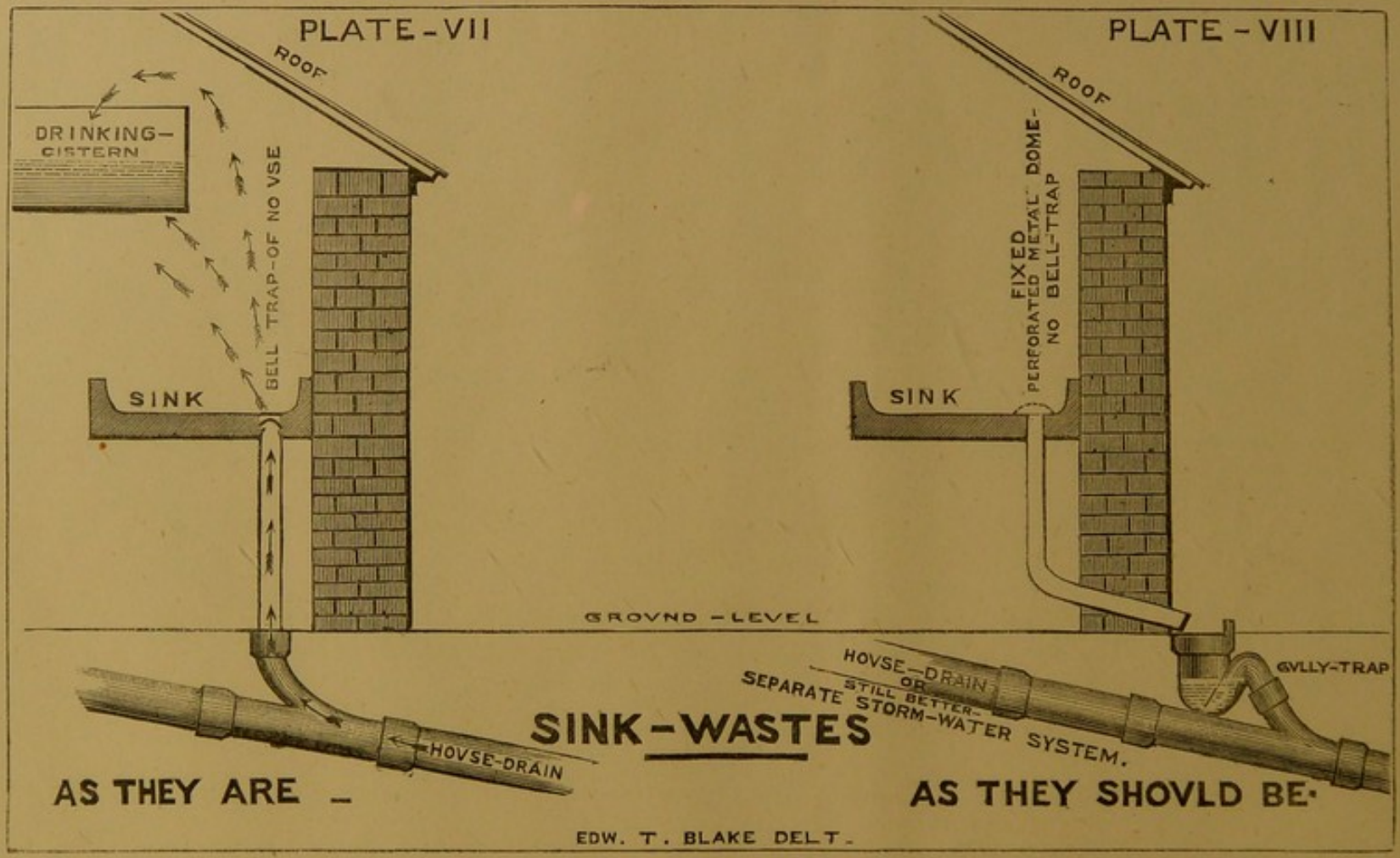


PLATE - VII
ROOF
DRINKING-
CISTERN
BELL TRAP - OF NO VSE
SINK
GROVND - LEVEL
HOVSE-DRAIN
AS THEY ARE -
PLATE - VIII
ROOF
FIXED PERFORATED METAL DOME - NO BELL-TRAP
SINK
HOVSE-DRAIN OR STILL BETTER- SEPARATE STORM-WATER SYSTEM.
GVLLY-TRAP
AS THEY SHOVLD BE·
SINK-WASTES
EDW. T. BLAKE DELT.

PLATE-IX

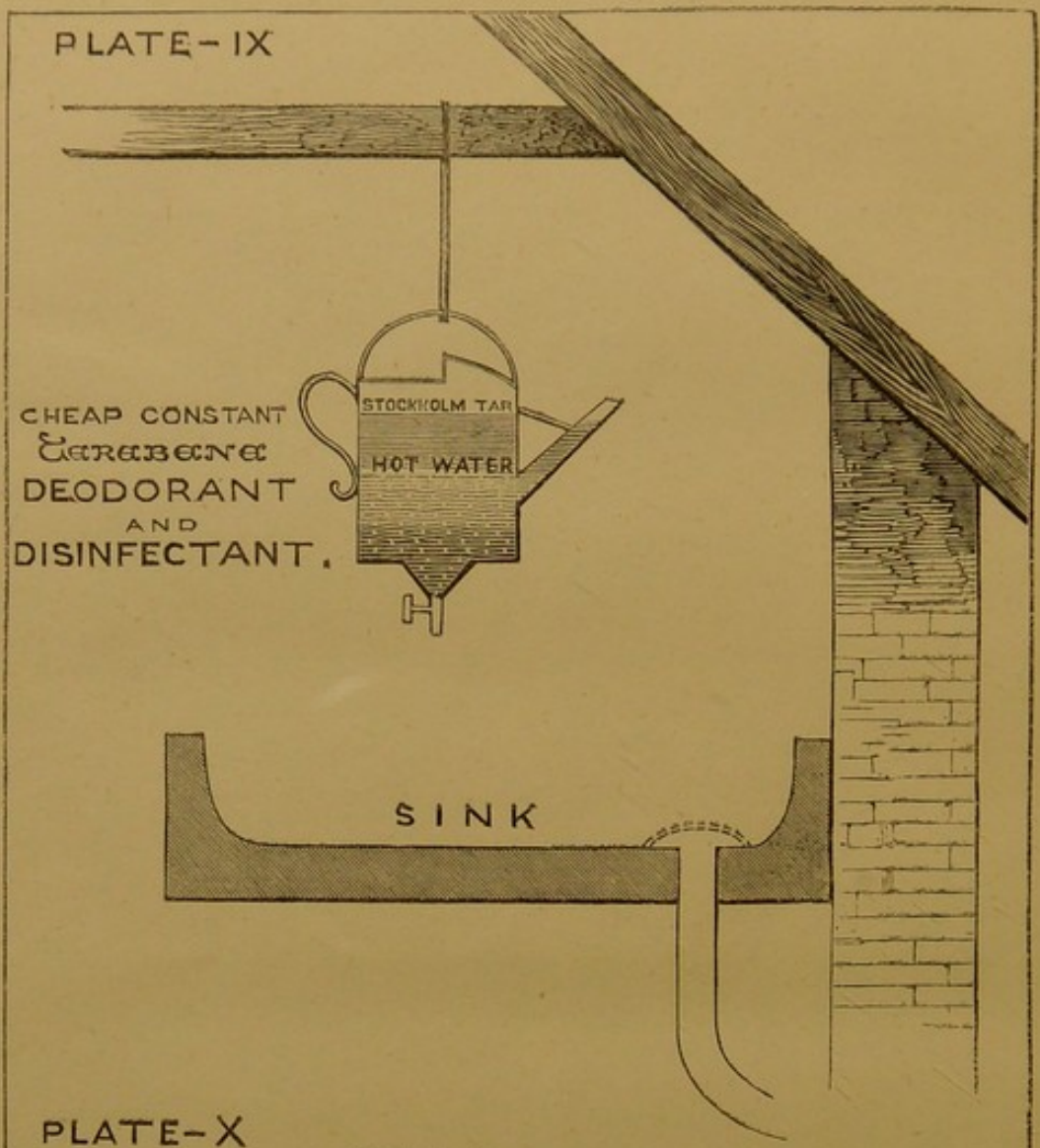
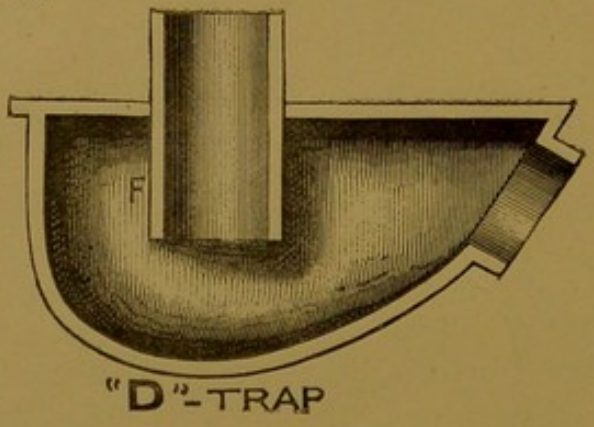


PLATE-X



"D"-TRAP

EDW. T. BLAKE-DELT.

PLATE IX.—Cheap, constant terebene DEODORANT and DISINFECTANT for the cottages of the working-class. Cost of galvanised water-pot, with tap, 4s.; a teaspoonful of ship-tar, about 6d. per lb., is added once a week.

PLATE X.—D-TRAP.—"D" is here supposed to stand for "dirty" or "disgusting." Filth accumulates round entrance-pipe, especially at F.

will force its way upwards through the ordinary D-trap, accumulates under the lid, and is liberated exactly at the most perilous time, *i. e.* when the w. c. is occupied. The window must be kept open, and if there be no direct communication with the outer air, notice ought to be served by the inspector for the abolition of the closet. On raising the the plug, some minutes may elapse before the water descends, meanwhile we hear a peculiar bubbling noise. This is, as we have seen, the sewer-gas which lay imprisoned in the pipe, passing up to the cistern before any water can pour down, thus plainly demonstrating that w. c. cisterns are inappropriate for drinking purposes.

We should exhort the proprietor to do away with his D-trap and his indoor soil-pipe altogether, and, putting the latter out of doors, replace the former by a plain valve. (Pl. VI.) Should this not be feasible, we direct that a ventilating upcast shaft, of the same calibre as the soil-pipe, be placed at the highest point, and be carried well above the roof, with as few bends as possible, taking care, as we have seen, that its termination is not near a shoot, a dormer window, or the top of a chimney; at the same time we see that the waste of the safe, *i. e.* the tray under the w. c. seat, is not turned into the soil-pipe.

Immediate supply of water to a closet-pan from a water system should be absolutely forbidden, for on cutting off the supply at the main the pipe is temporarily empty, and becomes filled with foul gas; the water takes this up on being turned on, and supplies it to other taps, perhaps used for drinking purposes.

If the overflow from the cistern is led into the soil-pipe or into any pipe connected directly with the house-sewer, this must be altered. It should be led through an outer wall, and be cut off in some prominent position, that waste may be readily detected.

Water-closets should always be built in a wing devoted to them, with a cross draught between the w. c. and the body of the house.

Stack Pipes.

The next point is the stack-pipe.

If the rain water is not stored and the stack-pipes be large, with well-luted joints, they might be allowed to act, as they so often do, as ventilating shafts. At the same time it is well to remember that this plan is open to objection. For instance, a solution of sewer-gas has been known to be carried along an eaves-gutter and delivered at a dormer window. There is another reason why it is not well to suffer a fall pipe to act as a ventilator. Such a shaft is always required most during a heavy rain-fall. If a large volume of gas continuously rise, it not only impedes the downward passage of the rain water, but it will sometimes actually prevent its descent, and the stack-pipe will overflow and wet the walls just as much as if the pipe were blocked by some hard foreign body.

Undoubtedly the best plan is to keep the storm-water quite distinct from the sewage system; then it is quite immaterial how the stack-pipes end, care of course being taken by leading water away from foundations, to prevent damp.

I have said nothing about the fact that we may be poisoned by other gases, even more immediately deadly in their effects than sewage gas. *Coal gas*, and one of the products of its combustion, *Carbonic acid gas*, the latter being also given off by our skin and our breath, are extremely detrimental to health. From a large portion of these, electricity now bids fair to free us. Another deleterious vapour is that derived from the evaporation of water. To the evil effects of damp most persons are already so alive, that it demands but a passing notice here.

The four invisible fluids so obnoxious to human life, to which we are specially prone to be exposed are, then—

1. Sewer gas.
2. Coal gas.
3. Carbonic acid gas.
4. Watery vapour.

Maxims.

Ventilation.

1. Cold sewer gas is probably heavier than atmospheric air.

2. Hot sewer gas is lighter than cold air,

3. Sewer gas is "drawn up" by a heated house, and *carried up* by heated air.

4. Sewer gas is *pushed up* by displacement, as in a thunder storm.

5. Bell-traps and bends are of no use without ventilation to keep out sewer gas; bell-traps being frequently forced, syphons being subject to so-called "suction."

6. Syphons also are prone, especially by night, to absorb sewer gas and to deliver it, during a rise of temperature, on the opposite side towards the house.

7. No pipe, excepting soil-pipe and ventilator, should have any immediate communication with the sewage system.

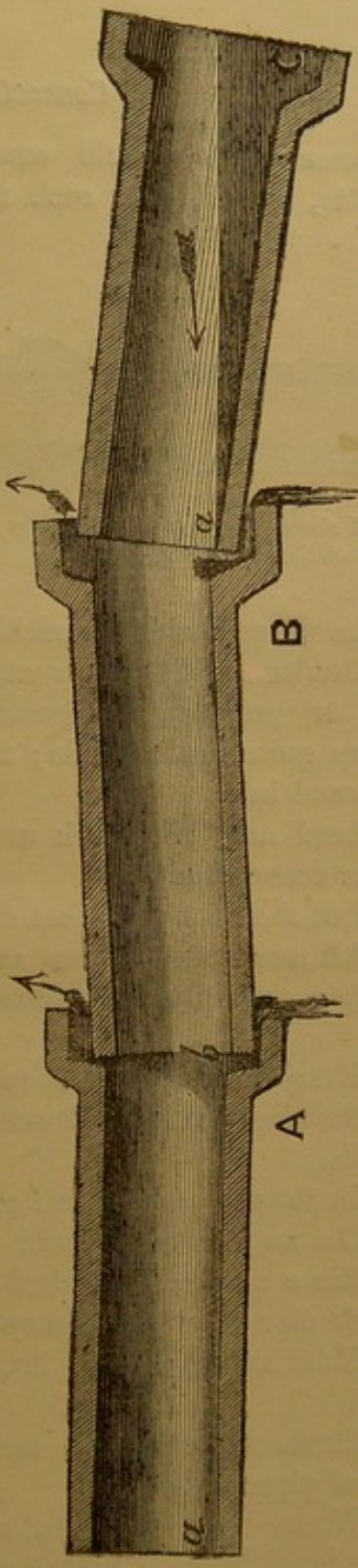


Plate XI.—Ordinary Sewer Pipes.—*b*, owing to its weight, has dropped into soft cement, squeezing the cement out below, and leaving a space above for escape of sewer-gas. But the dropping of *b* necessarily tilts up B. At B mason has forgotten to remove spare cement, increased by droppings from above. This hardening forms a dam, helping to divert the sewage down the chink between B and *a*.

Convection.

8. Sewer pipes should consist of glazed stoneware, terra cotta, or of some such non-absorbent, non-metallic mineral.

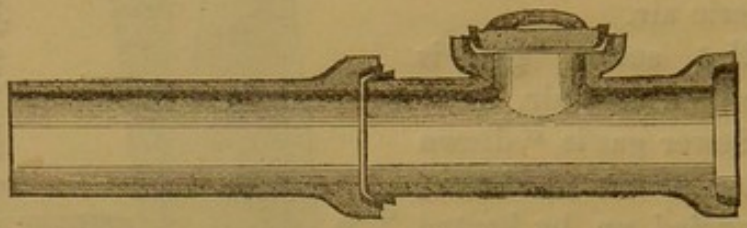


PLATE XII shows STANFORD'S PATENT JOINT (Doulton & Co.), the use of which obviates these serious evils.

9. The pipes should be socketed with *Stanford's Patent Joint* (Doulton and Co.), or at least with cemented joints, caulked or propped, to prevent dropping. Clay-puddle joints are quite inadmissible; they let gas and sewage out and let sand in.

10. Lead and brickwork are bad for traps, sewers, or for water convection.

11. Fall should not be less than *one in sixty*.

12. All new house-sewers *should be laid by the sanitary authority;* certainly, all connections should be made by them.

13. Every kind of pipe should be readily accessible.

14. Soil-pipes should be outside the house, and open at both ends.

15. In towns, back sewers are to be advocated.

16. On no account should any kind of drain or sewer pass under a house; if inevitable, an arch should be turned over each pipe wherever it may pierce a wall.

17. Most sewers are too large; most drain-pipes are too small.

18. Storm-water should not be carried by the same system of pipes as sewage.

19. When water-conduits travel with sewer-pipes, the former should lie on a higher plane.

20. Lead should not be employed for water-convection.

21. The purer the water, the greater the danger of using lead.

22. It is better not to employ lead at all inside a house.

23. Drainage-pipes should not be carried near a house in friable soils.

24. If there be rats in a house, there is certainly something wrong with the sewage-system.

Storage.

25. Lead should not be used for storage of drinking or of cooking water.

26. Best tanks for water-storage are slant-sided (to lessen risk of frost-fracture), and composed of slate, of glazed stone-ware, of terra-cotta, or of iron enameled or galvanised; these should always be open to light and air.

27. Closet-cistern water is unfit for drinking purposes.

28. Shallow wells should be railed in, to exclude animals which deposit ova of tapeworm and of other parasites.

29. All wells should be cemented inside, and surrounded by a water-tight wall to exclude surface-water, &c.

30. Wells are objectionable in porous formations, and only tolerable in virgin soils.

31. All cess-pools should be water-tight.

32. Ingress-pipes should, unless ventilated, be at base of cess.

33. Cesses should be ventilated at highest point.

34. Cess should be emptied daily from lowest point by chain-pump.

35. Cesses should be as far as possible from wells, and never on a higher level.

36. Let no person rent a house without a certificate of its sanitary condition from the Medical Officer of Health.

37. No building to be erected on any site which has been filled up with material impregnated with fæcal matter or with any animal or vegetable refuse.

38. The whole ground surface or site of every new dwelling-house should be properly asphalted or covered with

a layer of good cement concrete at least six inches thick (to keep down rising damp).

39. Every wall of every house should have a proper damp-proof course of either glazed stone-ware or terra-cotta air-tiles, sheet-lead, asphalte, or slates laid in cement, beneath the lowest timbers, and not less than six inches above the ground adjoining such wall.

40. A "*dry area*" should be constructed round every house where there are rooms in the basement.

41. The subsoil of the site of every house should be drained with earthenware open-jointed field-pipes whenever the dampness of the site renders this precaution necessary. Such pipes not to communicate *directly* with any cesspool or sewer, but by means of a ventilated disconnecting trap.

Finally, it should always be borne in mind that the Alpha and Omega of sanitation is

SIMPLICITY.

In conclusion, it is with great pleasure that I acknowledge the very valuable aid in issuing this little work, rendered with so much readiness and courtesy by the sanitary staff of this district; gentlemen to whose conscientious, ill-remunerated, and too often thankless labours the county is very greatly indebted.

*** For an admirable *resumé* of the grave but unsuspected perils which lurk in and around our dwellings, the reader is referred to an excellent work by Dr. Pridgin Teale, 'Dangers to Health.' Churchill.