REPORTS

ON

SANITARY ENGINEERING IN HOUSES,
HOSPITALS, AND PUBLIC
INSTITUTIONS.

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IV.—RULES RELATIVE TO DRAINAGE.

THE chief adjuncts to a perfect condition of drainage having been explained in the former papers, it will perhaps be found useful to add a few remarks on the subject of each class of goods—*i.e.*, the manner in which they should be used, and what errors are mostly to be guarded against.

House-Drains.

1. Drain-pipes, whatever pattern be chosen, should be bedded in proper clay, and have the joints well luted; for, if the joints be badly made, the liquid drainage will escape, and the sediment which is left behind may collect to such an extent as to choke the drain altogether.

2. If any drain-pipes be laid inside the house—and in crescents and streets this is unavoidable—the pipes should in that case be laid upon a bed of concrete, and covered over with a few inches of the same material.

3. Where the drain-pipes pass through the walls, it is wise to turn a relieving arch over them; for, if a settlement should take place in the building, the superimposed weight will in all likelihood crack the pipes, and cause the drain to leak at a most dangerous place, or perhaps break them, and cause the greatest annoyance.

4. When drains are laid in new-made ground, unless care be taken to ram the earth sufficiently hard round about them—and this is next to impossible—the pipes will open at the sockets, and sodden the ground in their neighbourhood to a dangerous extent. It is best in such a case to rest the pipes upon boards laid upon occasional piles, or what is better, upon piers of brickwork.

5. The only kind of drain-pipes to use is the glass-glazed or salt-glazed earthenware pipes. All others present a roughness inside which gathers “fur”, and engenders a vegetation sufficient in time to impede the passage of the sewage and other wastes.

6. A matter of paramount importance is the declination which is given to the pipes. If this be inadequate, stagnation will ensue, and a costly and troublesome flushing be repeatedly necessary. Inside a drain in use, everything should be in gentle motion. If laid too flatly, the heavier effete matters are deposited and clog the way; and if the incline be extravagant, the water will hasten away and leave the solid wastes behind. In a late work, a writer states that too great a fall cannot be given to a drain; but I have noticed that when the fall of the tributary drain has been in excess, that part of the main drain which received the contents of such house-drain has been almost choked up. The authorities formerly recommended a quarter of an inch fall to each foot, but the best practice is to allow a fall of $2\frac{3}{4}$ inches, or three inches to every ten feet.

7. Drain-pipes can be too large. Some people use nine-inch pipes throughout a house, and think it commendable; whilst the reverse of this rather would be true. A four-inch drain-pipe for sinks, back-yards, and basements, is ample. Even the closet-drains in a house need not be more than six inches in diameter. Six-inch pipes well laid will suffice for the largest house, and in the hugest mansion nine inches will not be required until it is sought to carry the sum total of the smaller sized drains away in one channel to the sewer or manure-tank. Drain-pipes of too large diameter are incompatible with that steady onward movement of the sewage which every addition to the contents of the drain beneficially increases.

8. The junctions of the drain-pipes should never be of the right-angled kind; and an obtuse-angled or curved junction should be used; in other words, the sewage should be delivered in the line of the flow of sewerage. A T or L shaped delivery is very apt to cause a deposit at that particular part of the drain.

9. It is considered wise to give the drain a little extra dip wherever a bend or a junction occurs in its length, in order to counteract the effects of friction. A very small amount will usually suffice.

10. In laying down a system of drains to a house, etc., it will often prove beneficial and save much expense on some future occasion if

what is called a dummy junction be here and there laid in the march of the drain. The orifices of these junctions should, however, be stopped up with the disc-plugs sold for the purpose.

11. A larger pipe should never deliver into a smaller pipe, or even a pipe into one of the same diameter. There should be a difference of three inches between the larger pipes, and of two inches between the smaller ones: for instance, twelve-inch pipes can deliver into fifteen-inch pipes, nine-inch into twelve-inch, six-inch into nine-inch, four-inch into six-inch, and two-inch into four-inch pipes.

12. Where a diminishing of the drain-pipe is found needful, the proper tapering pipes should be used: any other contrivance is at the best unworkmanlike.

13. A certain number of access-pipes will be often found useful if laid in a length of drain, say one to every ten of the socket-sealed pipes. Some pattern or another of these pipes with a movable cover might wisely be inserted close to all angles, bends, and junctions, and a well-hole built round them to facilitate inspection.

14. The pipes should be so laid in or about a house that the human ordure may enter nearest the sewer, or, what is the same thing, nearest the point of delivery of the house-drain or the disconnection arrangements. The wastes from the sinks should enter the house-drain between the closet delivery and the house; and the rain-water—from town roofs and from country houses, if not stored—nearest to the house. By this means a persistent movement of the sewage is better obtainable.

15. A flap-trap should be affixed to the end of the house-drain at its connection with the sewer or manure-tank, so that if the sewer be surcharged at any time it cannot flow up the tributary pipes. This contrivance will also tend to prevent a return of foul gases.

16. The communication with the sewer should be made with additional care, and is most durable if cement be used instead of common mortar.

17. From the disconnecting trap on to the sewer, at least where the distance is great, an egg-shaped drain-pipe should be laid. This section secures the maximum speed of flow and the minimum chance of any solid deposit.

18. When pipes of the proper kind are well and sufficiently laid with proper fall, the best means of occasionally flushing them should be provided for. Drains should be flushed at least once a quarter, and the outlet, an access-pipe opening, or the point of disconnection watched to see that the flow is unimpeded. A little lime-water thrown down a sink or closet is a good test, provided that the operator is acquainted with the line of drains, and knows when the whitened fluid should normally appear. Some people flush the drains by removing the sink-trap and allowing a cistern to be emptied through the water-tap into the drains; but this is for the most part useless, and the very term “flushing” means the imparting of a rushing action to a body of water—at least that is the only effectual method of cleansing underground channels. To provide an efficient quantity of flushing material, the rain-water may be stored in an upper or underground cistern; and when the drain is opened, the water having been caused by flowing or pumping to fill a large vessel above such opening, one side of the vessel should be removed at a certain moment and a thorough scour thus ensured. Proper openings for this purpose should be left in the drain both below and above the point of disconnection; but these should never occur inside the house, as is but too common, for, as the water runs down, the foul gases levitate and invade the house. A flushing arrangement may be made hopper or funnel fashion, so as to fill the sectional area of the drain, or nearly that with the cleansing fluid. Sometimes a disinfectant may with advantage be added to the water. After this wholesale flushing, in all likelihood any siphon-traps in the line of drain will be emptied, and it is needful to pour a small supplementary supply of water gently into the drain before leaving it. Should the drain from some cause be stopped up, which will be readily ascertained, a series of swivel-jointed rods, such as are used by chimney-sweepers, but with a roller at one end, or a series of Malacca canes screwed together, should be pushed up the drain. It is here where the access-pipes perform excellent work, since if the rods or canes cannot reach the matted obstructions at one place, they can do so from another point.

19. A correct drainage plan, showing the different size of pipes used, the positions of bends and junctions, the site of syphon-traps and access-pipes, the depth from the surface, and the nature of the ground, should always be prepared when the drains are first laid down. This may save much future inconvenience and outlay.

Brick-Drains and Sewers in Private Grounds, etc.

20. No reliance should be placed in old brick-drains. If in the house, they should be removed or opened up, the site disinfected, and filled with

concrete. The portions outside the house should be dug up, as they otherwise harbour rats and other vermin.

21. As a rule, no brick-drains need be laid down inside private grounds or residential estates, as this material is now chiefly confined to the main sewers of towns. Earthenware-pipes are manufactured up to thirty-six inches in diameter, and will be found cheaper and better.

22. Should it, however, for some reason be imperative to build brick, barrel, or egg-shaped drains or culverts, the old-fashioned square drain with flag-cover should never be used, but rather the circular or egg-shaped pattern. The bricks should, moreover, be moulded to the proper radii; and if invert blocks of earthenware or grouted bricks be not adopted, the bottom portion of the drain should be laid in cement. The inverts of different sized brick-drains should never be laid upon the same level, but the difference in height should act as a fall for the lesser drain. Ventilating arrangements, such as already figured, will also be found indispensable, and perhaps deodorising media in addition.

23. Where drains of any kind are subjected to tidal influences, it will be prudent not to rely upon ball-valve traps to resist the evils of backwater and any compression of the gases, but to break the connection of the outlet-drain or sewer above the high-water line.

Disconnection and Ventilation of Drains.

24. The house-drain should be disconnected from the main drain or sewer, in some efficient manner, as already pointed out.

25. The point of disconnection should be made as near to the house as is convenient, as foul gas will generate wherever sewage is diluted with water.

26. There should be only one disconnection between the sewer and the house. All house-drains should lead into one main collecting pipe on the house side of the delivery into the sewer or sewage-tank.

27. All waste-pipes or overflows from closet-trays, cisterns, or lavatories, and all rain-water pipes, ought to deliver above ground.

28. Where a proper disconnection cannot be carried out, as is the case in many town-houses, an efficient ventilation of the drains should be provided; and the safe rule is to fix an upright tube with easy bends—if bends be unavoidable—at the head of every drain and at the end of every ramification of the drain. The ventilating-pipe should be at all events equal to half the sectional area of the drain. An inch-pipe is quite inadequate to the work to be performed. If a sink or wash-basin must perforce communicate with the drain, a ventilating-pipe should be carried from the underside of the trap out to the open air and to the top of the roof.

29. Rain-water down-pipes are sometimes solely relied upon as ventilators; but this is wrong, for such pipes often terminate under the sill level of dormer windows, and, when most needed, are performing their own duties in clearing the water from the leads and gutters.

30. The soil-pipes of closets should in all cases be well ventilated below the trap, and the pipe carried to the highest part of the exterior. It might in some instances be well to ventilate the trap of the closet itself.

31. Where there is any danger that the ventilators of a house on a lower level may taint the atmosphere of a house or building at a higher level, the evil can be averted by fitting to the top of the ventilator a final containing trays of charcoal or other disinfectants. Several of these contrivances have been already described and figured.

32. If the ventilating-pipes do not terminate in a properly shaped column containing deodorants or disinfectants, the top should be protected from down-draughts and rain by some sort of hood.

Water-Closets.

33. The water-closets are best confined to one part of the house, and ought to be built one over the other. The building which accommodates them should, wherever possible, project out from the house; a separate tower is, however, most desirable. They should never open into a passage of the house, but command a vestibule or anteroom.

34. The windows in the closet and vestibule should reach ceiling high; and if they be made so that they can shut entirely to the top, or if they be unprovided with ventilating-glass in the upper panes, air-bricks should be inserted in the line of cornice. Closets too often ventilate into a badly ventilated staircase.

35. The soil-pipe should be made of the strongest lead, as the sewer-gases often injuriously affect it. Iron soil-pipes are objectionable, and also iron continuations of the lead-pipes—at least indoors—because lead and iron will not join properly together. Iron also expands and contracts very much, and the joints open and allow the effluvia to escape. Earthenware-pipes should always be held inadmissible.

36. A zinc safe should be fixed tray-fashion under the indoor-closets, in order to guard against any leakage of the working parts.

37. Common hopper closets should never be erected inside the house,

as they accumulate filth largely. Pans with a large evaporating surface are likewise objectionable, unless the supply of water be ample. An automatic flushing action should be arranged to all juvenile and all servants' apparatus.

38. The wooden casing or framing should be made so as to come readily asunder, and the clamped flap or lid should have a hole in it just over the pull-up handle, so that the contents of the pan can be discharged when the lid is down. The wisdom of this will be admitted after noticing the blackness caused on the lead-painted-underside of the flap by the action of sulphuretted hydrogen gas.

39. Where the expense is not objectionable, and in all cases where the ventilation of the soil-pipe is insufficient—a state of things always to be found in crowded towns and in badly arranged houses—a self-acting apparatus may be fixed above the seat, by which the flushing water can be mingled with some powerful disinfecting fluid at every discharge of the closet.

40. A housemaid's sink should be provided on every floor of a house; otherwise the closet will certainly be used for her purposes, the safe below filled with the overflows, and an influx of bad air drawn into the house every time the handle is lifted up to quickly empty the slops.

Traps.

41. The old bell-traps which permit the covers to be removed should never be used, for the reasons previously stated. An Antill trap, or some similar one which is difficult to untrap, is the safest of all.

42. The readiest manner in which to cleanse out a closed trap is to pour boiling water through it twice a week; this will melt all grease and otherwise clear it.

43. A house which is thoroughly disconnected from the sewer, and the soil-pipes of which are well ventilated, might, perhaps, as far as smell is concerned, safely dispense with traps altogether; still it will be found wise to affix one to the sinks, trough, wash-basins, bath-overflows, and cistern-wastes, if only to assist in keeping out the winter cold.

44. In ordinary cases, the pressure of air in the drains is not great, but sometimes the extra pressure proceeding from fermentation is sufficient to force the hydraulic seals of some traps. Traps may, therefore, be used which are too small, for other other reasons than the liability to evaporation. A trap should interpose a good body of water between the air of the drains and that of the house. Of course, when foul gases are seen to bubble up through the trapping liquid, the necessity for a ventilation of the drains is very patent.

45. Where traps are in any way depended upon, care should be taken to keep them in cleanly condition. The least foul water left in the bottom of the trap will soon infect the rest.

46. Where houses, otherwise close and confined, are not, and cannot be, properly disconnected from the sewers, the latter derive air from various inlets, and this is drawn upon through the traps by the house-fires for the air necessary for combustion. In such a case, a supply of fresh air for the fireplaces should be brought from the outside at any cost. In some houses where even the house-drains are well ventilated, and where disconnection from the sewer has been attained, the fires have been known to suck up air from the empty spaces round about the foundations when the doors and windows were closed.

47. Where syphon-traps are attached to sinks or other wastes, they cannot be relied upon if the pipe runs quite full; for sometimes, and always when the incline is great, the syphon-action will empty the depression of the pipe, and leave the room open to the air from the drains. The cure is to make the trapping portion of the pipe larger than the pipe itself. A waste-pipe, however, should never run full.

I have now concluded the drainage portion of my subject. It could easily be lengthened; but the foregoing papers will be found sufficient, I trust, for all ordinary purposes. In formulating the above few rules, I have not hesitated to make use of some useful suggestions which have appeared of late in the public press.

UNIVERSITY INTELLIGENCE.

UNIVERSITY OF CAMBRIDGE.

ANATOMY AND PHYSIOLOGY.—Dr. Humphry has given notice that his course of lectures on Practical Anatomy will be continued on Tuesday, January 14th, at 9 A.M., and daily at the same hour until the 27th, after which they will be continued on alternate days. The course of lectures on Anatomy and Physiology will be continued on January 28th, at 1 P.M., and on Tuesdays, Thursdays, and Saturdays at the same hour.