CHAPTER VI

HOUSE DRAINAGE CONNECTIONS

Soil-Pipes

The soil-pipe with which a water closet, urinal, or slop sink, is connected should be placed outside the house as near as possible to the soil fitting and screened, if possible, from the sun’s direct rays to prevent bending or loosening of joints by heat. A 3-inch pipe may be used for one closet, but if for more than one, or if the soil-pipe is the main exit ventilator for the drain air, then a 4-inch pipe should be required. If more than this diameter, flushing of the soil-pipe may not be satisfactory. Drawn lead is the best material, seamed lead is not permissible, but good cast-iron pipes properly protected from corrosion by Angus Smith’s solution, are very satisfactory. In the case of cast-iron soil-pipes, the branches to the closets are usually of lead. Seamed lead pipes become faulty along the seam from corrosion as well as from variations of temperature which, by expansion and contraction, open the seam. A drawn lead pipe should be quite uniform in thickness throughout, and a 4-inch pipe should weigh at least $7\frac{1}{2}$ pounds per foot. Drawn lead pipes in 6-foot lengths with socket and spigot cast on have recently been introduced, and these have proved very satisfactory. The joint is made by lead wool caulking and completed by a wiped metal joint at the top of the socket. Cast-iron pipes are made in 6-foot lengths with socket and spigot, the internal socket depth being not less than 3 inches with a lead caulking space all round of $\frac{1}{4}$ inch. The wall of the pipe itself must not be less than $\frac{1}{4}$ of an inch, and a 6-foot length of 4-inch pipe should weigh over 46 pounds. Copper is a material coming into use for soil-pipes. It is a good metal for the purpose, but it is expensive. A 4-inch pipe of this metal should weigh 4 pounds per foot. Within recent years there has been a tendency to place soil pipes inside buildings (see p. 90). When this is done it is essential that all the work and material should be of best quality, that the pipe is quite air-tight, and that the joints should stand a water test of at least 12 feet head (i.e. up to the first floor).

Ventilators

With regard to the ventilator, or air-pipe, which is simply a continuation upward of the soil-pipe, all bends in it should, as far as possible, be avoided, but when necessary to introduce an angle it ought to be an “easy” one. It is a very common practice to
carry the ventilator round in place of through the eaves of the roof, thereby greatly interfering with the current of air (see p. 40). If there should chance to be a window in the roof near to the point where the ventilator pierces the eaves, the pipe must be carried with an easy bend upwards along the roof to some distance above the window. It would be less unsightly, no doubt, not to pierce the eaves in this case but to carry the ventilating pipe through the wall and upwards inside the roof, bringing it out with an easy bend at the proper point, but this would not be a desirable arrangement.

Cowls are sometimes placed on the top of ventilating pipes to encourage an upward current of air. Except in wet weather it is a question whether anything is gained by their use, and there is a risk that birds will build in them. The same risk applies when the ends of the pipes are left free, so it is advisable to cap them with wire netting of large mesh, fixed so that it projects upwards in a semi-spherical form.

Fig. 55.—Wiped Lead Joint. Fig. 56.—Copper Bit Joint. Fig. 57.—Joint Caulked with Lead.

Joints

The best joint for a lead soil-pipe is a wiped lead joint (Fig. 55), and this should always be insisted on. The copper bit joint (Fig. 56) is a very inferior joint and the blown joint, which is much the same as the copper bit joint, but in which the solder is melted by heating the adjusted pipe ends by a blow pipe instead of a heated copper bit, is worse still.

If iron is the material used for soil-pipes, the joints must be caulked with lead, and to allow of this, the pipe must be stronger than the ordinary rain-pipe. The upper pipe is first adjusted into the socket of the lower, and then, in order to prevent the molten lead from running into the pipe, a few rings of spun yarn are well rammed down into the socket; the lead is now run in, and afterwards it is thoroughly caulked (see Fig. 57). The depth of lead forming the joint should not be less than 2 inches.

An excellent caulked lead joint may now be made without molten lead by using lead wool, which consists of strands of fine lead thread.
These strands are pushed into the joint, and afterwards, by caulking in the usual way, the lead fibres or threads are consolidated together, and thus form a perfectly tight joint. There is no limit to the size of pipe which may thus be jointed with lead, and this method of jointing iron pipes is coming into general favour because of its simplicity.

It is by no means an uncommon practice to make the joints of iron soil-pipes of putty or cement, but this ought never to be done.

**Soil-Pipe Connection**

One of the most important of the water-closet fittings is the soil-pipe connection, especially since the introduction of the wash-down earthenware closets, between which and the lead soil-pipe it is difficult to make a permanently tight junction.

In the case of a wash-down closet fixed on the ground floor, it is a comparatively easy matter, as there is no necessity for a lead connection; the closet pipe may be connected with the drain itself. In such a case it is better that the joint should be above the floor so that it may readily be seen, and in order that this may be managed, the downward curve of the S must stop short at the floor, so as to allow the socket of the drain-pipe to be brought up to it (Fig. 58). Such a joint ought to be made with good Portland cement, and in order that this may be done the end of the outlet-pipe from the closet (the spigot) is left free from glaze for about 2 or 3 inches. If it is intended to fix a closet of this description on an upper floor, it is better to select one the outlet-pipe from which, in place of passing downwards to the floor, is directed backwards, as is represented by the dotted lines on Fig. 44. In some cases the outlet is flanged, and the joint is made by screwing it tightly against a similar flange, which is formed by tafting back the abutting end of the lead connection, an india-rubber ring being interposed, as is represented in section by the drawing (Fig. 59).
This, however, is not a good joint, as india-rubber is perishable, and it is by no means easy to hammer out a flange on the lead connection which will perfectly adjust itself to the flange of the closet, and it is obvious that unless the adjustment is perfect, and the surface of the lead flange is smooth and uniform, tightness of the joint, which is entirely dependent upon the rubber washer, will not be attained.

A good wiped soldered joint may be made when a lead-pipe outgo is bolted on to the closet. The lead outgo is connected to the earthenware trap below the level of the water, so that if any fault should occur, it would be immediately noticed from the leakage occurring. There are also, on the market, closets with special lead pipe outgo fittings, the lead pipe being fixed to the stoneware by patent processes. These metallokeramic fittings enable a wiped lead joint to be made to the soil-pipe and antisiphonage connections, and are very satisfactory, though of course they add to the price of the closet. In making a joint between a lead pipe and an iron pipe, or a lead pipe and a stoneware pipe, the intervention of a brass thimble or brass ferrule makes these patent lead fittings unnecessary and should be used in preference. Brass and lead will solder together firmly, and a caulked lead joint can be made between a brass ferrule and the socket of a cast-iron pipe, while between stoneware pipes and brass thimbles or ferrules a satisfactory joint can always be made with Portland cement. The drawing, Fig. 60, shows such a way of making junctions, this diagram showing the junction of a lead soil-pipe and stoneware drain.

Air-Pipes

As already pointed out, there is always a risk of traps of the S pattern becoming unsealed by syphonage, and to avoid this it is essential to fix an air-pipe close to the top of the outlet of the trap. All stoneware closets of the wash-down kind have now an opening provided for this purpose, and it is not unusual for ignorant workmen to suppose that this is intended for a soil-pipe ventilator, although it is only 2 inches in diameter. If one closet only is connected with the soil-pipe, it answers the purpose perfectly to carry this air-pipe from the top bend of the syphon upwards through the wall, and connect it with the soil-pipe ventilator, but if two or more closets are connected, a
special ventilating-pipe must be carried up to above the highest closet, where it may then unite with the soil-pipe ventilator, having, on the way, received the various air-pipes from each closet trap. Lead is the best material for this, as for other air-pipes, and all the joints ought to be wiped. Here the difficulty again arises of making a tight joint between lead and earthenware, in the case of the wash-down closet, unless it has a lead outgo, or unless it has a flanged vent-arm. For this reason it is best to introduce a brass ferrule, as before, unless a rubber-ring joint can be made. In fixing a valve closet, the opening into the trap is smeared round with red lead and the outgo pipe from the valve-box is introduced into it.

**Ventilation of Valve-boxes**

The valve-box of a valve closet ought also to be ventilated, but in this case, all that is necessary is to carry the pipe through the wall direct, where it may be cut short. The chief object of this ventilating pipe is to prevent syphonage of the trap, connected with the pan overflow, which otherwise may occur, particularly when slop-water is thrown into the closet, and thus a large quantity of water is suddenly discharged.

**Closet Service-Pipes**

The service-pipe to the closet, which, as already pointed out, must on no account be connected direct with a cistern that supplies drinking water, or with a general service-pipe, ought to be of sufficient size to ensure a flush. The diameter must never be less than 1\(\frac{1}{4}\) inches, and this is too small unless the flush-tank with which it is connected is fixed more than 5 feet above the rim of the closet. Any elevation under this requires a service-pipe of at least 1\(\frac{1}{2}\) inches to ensure a good flush. The usual method of connecting the service-pipe with the closet-basin is by means of putty or red lead, but rubber caps are now made which answer the purpose well, and they last for a long time.

**Valve Closet Overflow and Safe**

In the case of a valve closet which is provided with an overflow (see p. 74), frequently trouble arises owing to its being wrongly constructed.

All overflow-pipes, wherever they may come from, must be carefully followed up in investigating into the sanitary condition of a house, as it frequently happens that work, which would otherwise pass muster, has to be condemned because of faulty overflows. One method of dealing with the closet overflow is to connect it with the valve-box, as shown in Fig. 43, a syphon-trap being interposed in all cases. Another method is to carry it into the ventilator of the valve-box.
In case any leakage should occur, it is necessary to fix a *safe* under valve closets, and here again the overflow from the safe is often a source of danger, owing to errors in fixing. The safe itself should be made of lead (4 or 5 lbs. to the superficial foot), the sides being formed by turning up the edges to a depth of about 4 inches, and soldering each angle. If the closet-trap is below the floor, which is generally the case, the edge of the opening in the floor of the safe, through which the outgo-pipe passes from the valve-box, ought to be carefully soldered to the trap in the manner represented in the sketch (Fig. 61). A bevelled opening is made in the floor, as shown in the drawing, the circular hole in the bottom of the safe tray being cut smaller to allow of the lead being tafted into the opening in the floor. The inlet to the trap is then tafted into a bead, so as to rest a little way down the opening, the space above, between the bead and the lead of the safe tray, being filled in with solder. In order that this safe may serve the purpose for which it is intended, it is necessary that its overflow pipe should be large enough to carry off all possible overflow water, should any accident happen to the closet.

*Fig. 61.—Manner of Connecting Safe and Overflow-pipe.*

The $\frac{3}{4}$- or even 1-inch pipe that is usually fixed is useless for this purpose; the proper size is $1\frac{1}{2}$ or 2 inches. Plumbers are apt to think that if a trap is fixed on this overflow-pipe it may be taken anywhere with safety, but this is a gross mistake, for, as it will only be in use when the closet is out of order, the trap will invariably be dry, and, therefore, not a trap. The *proper outlet* is into the open air, direct through the wall, where it should be cut short, and in order to prevent wind blowing through the pipe or birds building in it, a copper hinged flap ought to be fixed on the discharge end.

The accompanying sketch (Fig. 62) shows the proper method of connecting two or more closets with a common soil-pipe.

Besides the soil-pipe, which carries the discharge from water closets, slop sinks and urinals, there are other waste-water pipes which enter the house drains, carrying bath and lavatory waste water and water from kitchen sinks. These waste-water pipes are all connected to the drain through a trapped gully, while lead syphon traps are also provided immediately under the discharge from the bath, lavatory or sink, thereby assuring that there is a complete disconnection from the drains. In the case of a bath and lavatory pipes, this lead
Fig. 62.—Two closets fitted one above the other showing antisyphonage pipes. Note that the antisyphonage pipe should meet the outlet end of the closet pipe in the same direction as its flow.
syphon trap is occasionally omitted in a short length (under 6 feet) passing immediately from a single bath or lavatory basin through the outside wall to the waste pipe head, but while this may be permitted in such circumstances, it is better that even here it should be included. The syphon trap under the kitchen sink is a frequent source of trouble from stopping up with grease, tea leaves, etc., and it is, therefore, important that this trap should be fitted with a means of cleansing underneath. Where baths and lavatories are joined in a common discharge pipe to pass to the waste pipe, special precautions against syphonage of the traps must be taken. This is done by fitting anti-syphonage pipes as shown in Fig. 62.

The One-Pipe System

This system has been the subject of considerable discussion of late among sanitarians, and in its present form is comparatively new to England, but a modified form was in operation over half a century ago, and specimens of this work can be seen in many old buildings, especially in the north. Other countries, particularly the United States, have had the system in operation for some years. The Ministry of Health's Model Bye-laws, 1930, appear to make this system of the "Combined Soil and Waste Pipe" possible. The principle is one which allows all waste matter from sanitary fittings of all descriptions to be joined to a single pipe, which pipe in turn is connected directly to the drain at the foot thereof, thus dispensing with the present system of open gully traps. It can be safely said that, with fittings the best of their respective kind, properly trapped and ventilated, a perfect sanitary installation can be achieved. It must be remembered, however, that the drain air is in direct contact with the water content of each trap beneath every sanitary fitment, and it is essential that extreme care should be taken to ascertain that all joints be made perfectly air-tight, especially in view of the fact that the pipes are subject to sudden changes of temperature by reason of the discharge of hot and cold water from ablutionary fitments. The details involved are too lengthy to be fully explained here, but it can be stated that it simplifies the plumbing arrangement of large buildings, and reduces the cost. To be satisfactory from every standpoint and to obtain full advantage from the system, it is necessary that the building in which it is to be installed should be planned accordingly. It is, therefore, best suited for new buildings. It is usual to fix the main soil-pipes inside a building, in specially prepared plumbing spaces, which should be easily accessible. Branch waste and ventilating pipes should not be too long, or have too much fall, \( \frac{1}{3} \) inch per foot fall is sufficient. In addition, loop venting should be adopted wherever practicable (see Fig. 63). Suitable and
efficient traps with a good water seal should be provided to every sanitary fitting, the depth of the water seal varying according to the size of discharge pipe—being greater in a smaller pipe than in a larger pipe. Each trap should be ventilated in the usual way into the open air at a point as high as the top of the ventilating pipe, or into the ventilating pipe at a point above the highest fitment connected with such pipe. Such ventilating pipes should be of equal bore with the pipe to which they are connected, unless the internal diameter of the pipe is more than 3 inches, when a 2-inch anti-syphonage pipe may be used.

Fig. 63.—One-Pipe System.

Where long horizontal branch pipes are unavoidable, it is advisable to carry down the branch waste pipe vertically, and then horizontally, giving it not more than the maximum amount of fall as previously mentioned. By this method a better scouring action will be obtained, and there is less risk of waste water backing up the anti-syphonage pipe.

Fig. 63 illustrates a method of grouping of the fittings and loop venting of pipes from a bathroom. Access should be provided for inspection and cleaning at all junctions with the main vertical pipe and at the end of each horizontal run.
EXAMPLES OF INSANITARY PLUMBING

Volumes might be written concerning defective plumbing work; it is only possible here to call attention to those defects most commonly met with. From what has already been said, the reader will have gathered in what direction he has to look for them, but, as a preliminary to such an enquiry, it is well to point out that, in investigating the condition of the drainage of any house or premises, nothing must be taken for granted, the enquirer must satisfy himself regarding each detail by personal observation. However likely it may appear that things are as they seem, or as they are reported to be, it is possible that they are not, and much money may be wasted, and extra expenditure incurred, by a too hasty conclusion being formed on evidence that is only presumptive. Owners of property often complain, and justly so, that notwithstanding extensive alterations carried out, it may be, on the advice of an expert, former nuisances continue as bad, or even worse than before. Too often this is to be attributed to ignorance on the part of the adviser, but it also frequently results from a careless investigation in the first instance. It is a golden maxim, therefore, in all such enquiries, to avoid forming conclusions except upon fully ascertained facts.

Fig. 64 gives an example of insanitary plumbing and the student should note the following defects in it. A.—The water supply to the water closets is connected directly to the water cistern of the
Fig. 65.—Another Bad Arrangement.

A. Drinking-water cistern supplying closet direct.
B. Overflow from cistern joining ventilator (?) to soil-pipe.
C. Overflow narrowed by smaller pipe introduced.
D. Old D-trap.
E. Ventilating pipe passing out with downward bend.

Fig. 66.—Another Defective System.
house. B.—The cistern overflow is connected directly to the soil-pipe. The soil-pipe joins a 9-inch drain, C, and falls into a dipstone trap. Pan water closets discharge into D-traps and the overflow pipes, E, from the safes under the water closets connect directly with the soil-pipe. Fig. 65 gives another example, the notes underneath showing the defects. Fig. 66 is still another, showing the following defects:—Immediately under one of the windows the closet-pipe, B, together with an untrapped lavatory waste, A, discharge into the open end of a 4-inch pipe, C, connected with the drain below; about 10 or 15 feet off is a syphon-trap, and the drain, for a distance of 2 or 3 feet on the house side of the trap, is freely open to the surface, except for a perforated iron grating.

Fig. 67 illustrates the importance of using lead in place of iron pipes in ventilators for the dumb ends of drains where there is no flush of water. A solid deposit of iron rust has formed within the pipe, scaled off, fallen down and collected at the angle and stopped ventilation. This, of course, could not occur in an iron soil-pipe ventilator, as the regular flushing would prevent collection of the rust. It is a common, but bad, practice to use rainwater pipes as soil and drain ventilators, thereby liberating drain air under attic windows and through defective joints in the pipe.

**INSPECTION OF HOUSE DRAINAGE**

Inspections into the drainage arrangement of houses ought invariably to be conducted systematically, according to a fixed plan. It is convenient to start in the cellar and work upwards, completing each floor in its turn until the roof is reached, and while keeping in view the conditions that are likely to be met with, they must not be allowed to bias one’s mind, for thus fatal mistakes, which might easily be avoided, are often made; in fact, where proof is possible, take nothing for granted, and believe no one. It sometimes happens that a plan of the drainage exists, but, while this may assist one very much, it does not follow that it is accurate, so that it also has to be verified.

In the cellar any offensive smell must be noticed, and a careful search must be made for any drain connection, all barrels, boxes,
etc., being moved, so that no portion of the floor may escape notice. If there is such a connection, the kind of trap (if any) and whether it contains water must be noted. In the absence of any drain connection, a pit is often provided in the cellar for the convenience of washing the floor, which, if of moderate size, is admissible, but usually it is large and contains foul deposit. A leaking drain under the floor may be suspected if the bricks are damp in circumscribed patches.

On the basement-floor, or on the ground-floor, if there is no basement, the sink connections will next be inspected. It must be noted whether the waste-pipe is trapped within the house, either properly so by a syphon, or improperly by the objectionable bell-trap, for example, and also whether it communicates with the drain direct or by discharging on to an outside gully. If the soil-pipe is within the house, it will probably be found encased in wood within some wall, or in an angle formed by two walls, if it is not actually concealed by the plaster; possibly it may be placed within a pantry or larder. All coverings must be removed to enable the inspection to be made of the joints, seams, and substance of the pipe itself; damp brickwork or plaster will point to the existence of flaws if they are not apparent in themselves. If there should be a water-closet or lavatory on this floor, both should be thoroughly inspected, but probably neither will be found, as servants' closets are usually placed in a detached building.

On the first floor all water-closets, baths, lavatories, and sinks must be overhauled in detail. Any casing of wood that may surround the closet must be removed, so as to expose the soil-pipe connection, and the safe, if there is one, and the waste-pipe from the latter, must be traced; in fact, the investigation must be conducted in view of the requirements of the special class of closet, as already laid down. The water-flush should be tested, if it is a wash-out or wash-down closet, by placing several pieces of paper in the pan, and noticing whether they are carried clear of the trap, and while this is being done, the operator should ascertain whether any smell can be detected. The air-pipe from the top of the trap must be looked for, and if it be a valve closet, its overflow must be traced, as well as the air-pipe from the valve-box. The inspector must be careful to notice whether the supply-pipe is properly cut off from direct communication with the house cistern, should such exist, as will be the case if the water-supply is not a constant one, or if the house is dependent upon a private well for its supply. All pan closets ought to be condemned, however they are fixed. If the soil-pipe should be within the house, and there are other closets on the floor above, it must be inspected as already described. If there is a bath-room on this floor, attention must be directed to the waste-pipe, to ascertain whether it is properly trapped under the bath, and disconnected.
outside from the drain, or whether it improperly discharges, either into the soil-pipe, or directly into the drain. Should there be a safe under the bath, its waste-pipe must be traced, remembering that it should be carried through the wall, where it ought to terminate; the overflow also, which should be similarly treated, must not be overlooked.

Lavatory wastes are often most carelessly dealt with. Not infrequently they are untrapped, and discharge into a soil-pipe or drain; but whether trapped or not, such connections are highly objectionable, and if met with, must be condemned.

The same remarks apply equally to sinks. In old houses it will very often be found that the sink is placed on solid brickwork, through which its waste passes to the drain, which is thus directly connected with the house, except for the feeble protection offered by a bell-trap. In these circumstances, the brickwork is saturated with filth, and in a great many instances the bell part of the trap will be found to be absent, thus allowing of the freest entry of sewer gas into the house.

The enquiry as regards the upper floor of the house must be conducted on the same lines, all drain connections, whether from water-closets, baths, sinks, or lavatories, being carefully inspected.

The inspector's attention must be directed to the various cisterns within the house, either for drinking water, or for rainwater storage. Their condition with regard to cleanliness, their overflows, whether improperly connected with a soil-pipe or drain, or properly discharging into the open, or, in the case of a rainwater cistern, on to a gully-trap outside the house, must invariably be noticed, and, as regards the overflows of cisterns fed by ball-taps, it must be remembered that traps afford no protection against bad connections, as they will not contain water. The possibility that cisterns may be found under floors must not be overlooked.

Having completed the examination inside the house, the outside drains or cesspools, closets, or privies, and the provision for refuse storage, must be inspected.

The true state of the drains cannot be ascertained except by the tests which are described later, but all traps that are accessible, and none ought to exist that are not, should be examined to see that they are structurally in accordance with sanitary principles, and are kept properly cleansed. The provision for drain-ventilation in the shape of air-inlets and outlet-shafts, and the position of the latter with regard to windows, their size, the soundness of their joints, etc., must be noticed. It may be found that the rain-pipes are made use of as soil-pipe or drain-ventilators, or that they are not properly disconnected over gully-traps. If underground rainwater tanks exist, their condition as regards cleanliness should be noticed, and their overflows ought invariably to be traced.
As regards receptacles for filth, privy-middens, ashpits, and cesspools, it should be ascertained whether they are so constructed as to be impervious, and, in the absence of a public water-supply, their position with regard to the well must be considered.

**DRAIN TESTING**

It is not possible to assert positively that the drainage of a house is satisfactory from a mere surface inspection, particularly if the drains and their connections are within the house. The aim of all sanitary experts is to avoid laying drains under houses, and to carry each connection by as direct a route as possible through an external wall, all joints being placed where they can easily be inspected. In such circumstances, it is easy to detect defective work in the case of new houses, but however thoroughly old houses may have been overhauled and their defects corrected, one never can tell that some disused drain may not have been allowed to remain concealed from view, although none the less dangerous on that account. The only means of ascertaining with certainty whether all is right, is by applying one or other of the approved tests, and as this involves but little trouble, it is advisable to make it an invariable practice, however imperfectly the work may seem to have been carried out.

**The Smoke-test**

A handy and fairly reliable test is the smoke-test. It consists in filling the drains with smoke, so that it may find its way through any faulty joint or defective trap, and thus demonstrate by its presence, near to or within the house, the exact site of each of the various faults. It must be remembered that where smoke can penetrate, sewer gas may, and the ocular demonstration of the danger to which the inmates of the house are exposed, will often be the means of convincing them of the necessity for certain alterations, which might otherwise meet with opposition, on account of the expense or temporary discomfort they involve. There is nothing like smoke to convince a sceptic that the suggestions of an expert have a solid foundation in fact, and are not, what they are too often supposed to be, the outcome of a theorist’s imagination.

In applying the smoke-test, one of the various apparatuses that are made for the purpose must be used, and the best opening at which to blow in the smoke is the air-inlet to the drain on the house side of the trap which disconnects it from the sewer or cesspool, or, failing this, it may be introduced at any convenient trap, by removing its water-seal. As soon as the smoke is seen to issue from the various soil-pipe or drain-ventilators, they must be plugged, as all are then
charged with smoke, and afterwards a little pressure applied by the apparatus, not sufficient, however, to force the various traps, will send the smoke through all imperfections, if it has not already found its way through, which is more than likely.

For small systems of drains, handy little machines are made which answer the purpose, but it is well to use one of the larger apparatuses, such as Burn and Baillie's (Fig. 68), in the case of large premises. This apparatus consists of a double-action bellows, which communicates with a cylinder in which the smoke is generated by burning oily cotton-waste, and from which it is carried by a pipe into the drain. At the end of this pipe a flange surrounded by an india-rubber ring is fixed, which acts as a plug when introduced into the drain; these are made of various sizes, to suit different sized pipes. By means of an ingenious contrivance connected with the cylinder this apparatus can determine whether any leakages exist previous to

![Fig. 68.—Burn and Baillie's Smoke-test Apparatus.](image)

their exact position being demonstrated by the smoke. This is managed as follows:—Round the cylinder is an outer casing containing water and supporting a float, which is raised with a few strokes of the bellows; provided there is no leakage at any point, the float will remain in its raised position; on the other hand, it will fall if the slight pressure of air that maintains it is lost through leakage. There is not much advantage gained by this, as, if leakage is demonstrated, it is afterwards necessary to make use of the smoke, in order to establish where the faults are.

In applying this test, it is necessary that the smoke should enter the whole drainage system and that it should not be merely air locked in the drains. This can be assured by emptying certain traps in the system and sealing them with water again as soon as smoke appears through them.

Smoke rockets are sometimes used for testing drains, and they have often been instrumental in exposing faults, but they can in no way compare with an apparatus such as has been described. Having
ignited the rocket, it is introduced at the terminal end of the drain, which, of course, must afterwards be plugged.

**Oil of Peppermint Test**

Oil of peppermint is also used as a drain-tester, although it cannot be compared with smoke in efficiency. It may either be discharged down the soil-pipe (from 1 to 2 ounces, followed by a few cans of boiling water), or introduced at a trap on the soil-pipe drain. The same precautions with regard to sealing up all ventilators is necessary in this case also, and if the trap is the place selected, it must afterwards be thoroughly covered with wet cloths to prevent the odour of the peppermint from escaping at that point. The person who introduces the oil ought not to be the one to search for the smell of it about the house, as the slightest particle of it on his hands or clothes will suffice to distribute its scent wherever he goes, and so blunt his power of detecting any escape. Also, if the peppermint should be introduced from a water-closet, the operator must remain in the closet until such time as others can satisfy themselves with regard to the soundness of the various connections.

**The Coloured Water or Dye Test**

A useful test, to determine the course of drains or the origin of nuisance from drains, is provided by means of coloured water or dyes. The dye generally used is called fluorescein, which, if a small amount in concentrated solution is poured into the drain at one point and flushing proceeded with, gives a bright green unmistakable colour to the water when greatly diluted. This test can be used also to determine whether the drains are retaining water from improper falls, the colour not appearing quickly, as it ought to do in flushing well laid drainage. In the absence of fluorescein, whitening added to water is useful and is indeed better in the case of detecting a bad gradient of a drain.

**Air Test**

A still further test for drains is the air test which is much like the smoke test in theory, air being introduced into a closed drainage system at a gentle pressure insufficient to break trap seals and the maintenance or otherwise of this pressure being observed in a U-shaped manometer tube. It is a delicate test, difficult to apply and difficult to interpret in results. It is, therefore, not of any great value.

**Water Test**

The integrity of drains may be thoroughly tested by filling them full of water, until it teaches the level of one of the traps, having
carefully plugged the outlet into the sewer or cesspool. If the water remains at the same level for about an hour, the drain may be pronounced sound; on the other hand, should it subside, leakage must be taking place, either from imperfect joints or fractured pipes. In order to discover which section of the drains is at fault, each must be tested separately. To apply this test to soil-pipes, even if practicable, would not be reasonable; the smoke test in that case fulfils all requirements, as it at once reveals any leakages arising from imperfect joints or other faults. All new drains before they are covered in should be tested with water as described. This hydraulic or water test is a severe pressure test for drains and its severity depends, of course, on the head given to the water in the drain pipe, not the amount of water to be added to fill the drains, the head being the height the water stands above the bottom of the drain at any particular point. A 2-foot head is usually regarded as sufficient.