THE SANITARY PLUMBING OF A MODERN HOUSE

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The Sanitary Plumbing of a Modern House

The busy housewife hails with delight any sensible labor-saving device. Of all the modern arrangements, the house plumbing system is undoubtedly the most convenient. It supplies all the water necessary for domestic and other purposes and removes quickly all fluid and semi-fluid waste with no effort whatever on the part of the occupants of the house.

Not only is this system convenient, but sanitary as well, if properly cared for. All foul gases from decomposing and putrid material are kept from the air of the house and surrounding yard; thus maintaining a higher level of health to all members of the family and community.

Then, too, the plumbing system is truly economical, for, as the sage has said, "health makes wealth"; and the strong healthy family certainly saves much in a financial way by keeping the doctor and his bills at a distance.

In considering a system of plumbing it is important to know the source of the water used. All water is derived primarily from the precipitation of aqueous vapor in the form of rain, snow or dew. The immediate sources of water supply comprise (1) stored rain, (2) surface waters, including rivers, lakes and gathering basins, (3) ground waters, including deep wells, springs and filter galleries.

Where other water is not obtainable and where the natural water is unfit for drinking or for domestic purposes, stored rain water is used. In collecting rain from roofs it is very necessary to allow the first flow to run to waste, thus avoiding contamination by dirt, leaves and other organic material deposited on the roof. If this is done and the water properly stored it gives a very wholesome supply. Cisterns for the storage of rain should be so constructed that they may be easily inspected and cleaned. They should be kept covered, so as to exclude not only dust and dirt of all kinds, but the light as well, for the presence of light is an aid to the development of lower plant forms.

For public supplies, surface waters (rivers, lakes, and collecting basins) are generally more available than ground water and in unpopulated districts are, as a rule, very pure and fit for drinking purposes. The character of these waters depends, however, upon the nature of the soil in which they are located and the degree of contamination due to sewage, refuse and organic impurities drained into the water courses from dwellings, towns and manufacturing establishments which are near.

Generally, ground water of not excessive hardness and free from contamination is preferable to surface water on account of the greater exposure of the latter to the many risks of pollution. Springs are natural outcroppings of the water table and are very subject to variations in the volume of outflow. The character of spring water depends upon the source, temperature and nature of the soils through which the water passes, but in the majority of springs the water is cool, free from impurities and wholesome.

Wells may be shallow or deep. The water from a shallow well - one from twenty to fifty feet deep - is usually unfit for drinking purposes, on account of contamination by drainage from cesspools and sewers. Water from a well more than fifty feet deep is better because the water is generally obtained from below the first impervious stratum and is free from organic contamination.

A filter gallery is a large underground tunnel sunk parallel to a river or lake and near to it. The river water does not, as many suppose, percolate outward into this tunnel, but rather the ground water flowing to the river finds its way in.

For public use, the water is stored in reservoirs or storage tanks of brick, stone or cement, with means provided to protect and cleanse them.

The supply of water to houses may be of one of two systems, intermittent or constant. In the first, there is storage in the house for from one to three days; in the latter, there is either no storage, or it is only on a very small scale for the supply of flushing cistern of watercloset and of kitchen boiler.

When storage is made on the premises there are chances of contamination in cisterns and imperfect means of storage. Wooden casks or barrels ought never to be used, but a supply tank of noncorrodible material, easily accessible and easily cleaned. Cement and slate are the materials usually employed. These yield nothing to the stored water. Metal and mortar should not be used.

The size of the cistern will depend upon the amount of the supply required, according to the number of persons occupying the house and the frequency with which the supply can be replenished. It should be placed away from any contaminating agent, but never in a dark or out-of-the-way place. And so in the constant system, even though the water supply is sometimes turned off for a few hours, it is conceded to be the best and most sanitary. In both plans the water is conducted from the reservoir in pipes. Iron is the best material for the larger pipes and iron or non-metallic substances for the smaller pipes. Lead, tin, zinc, tinned copper and earthenware are used, but water has more undesirable effect upon these than upon iron. Dissolving the lead not only weakens the pipes but renders the water poisonous. The service pipes leading from the main pipe to the taps in the house need not be more than one half inch in diameter.

Various kinds of taps are made of brass and of nickeled cast iron. The bib-tap is so constructed that the flow of water is regulated by means of a rubber stopper with a hole through one way. By turning the handle to which the stopper is connected, the water may flow through, or may be shut off entirely.

The compression tap regulates the flow of water by raising or lowering a plug by means of a handle.

The automatic tap has a spring which causes the pipe valve to close automatically after being held open. This kind is good where there is danger of one's leaving the tap turned on, allowing the water to run over.

Every plumbing system should have a tap to shut off the water from the house, that the pipes may be emptied when in disuse or being repaired. This tap is most often placed in the basement so all the water may be drained from the house pipes. For this use there are two kind of taps; the one where the water is simply shut off from the main supply pipe and the house pipes left full, and the kind that not only shuts off the main supply but drains out the water in the house pipes. The latter kind is better where one intends to leave the house unoccupied for a time and does not care to leave the water in the house pipes, because of the danger of freezing or corroding.

Under all circumstances the objects to be fulfilled by a perfect system of house drainage are (1) to get rid of all liquid and semi-liquid wastes as quickly as possible; (2) to prevent any foreign matter and gases in the sewer from returning to the house through the pipes; (3) to oxidize and dilute the air in the pipes so as to make all deleterious gases therein harmless.

To accomplish these results house plumbing demands the following requisites:- (1) Receptacles for collecting the waste and excreta; these fixtures must be adequate for the purpose, non-corrodible, well flushed, accessible and so constructed as to easily dispose of their contents; (2) separate vertical pipes for sewage proper, for waste water and for rain water; upright, direct, straight, non-corrodible, water- and gas-tight, well flushed and ventilated; (3) short, direct, clean, well flushed, gas-tight branch pipes to connect fixtures with vertical pipes; (4) disconnection of the house sewer from the house pipes by the main trap on the house drain, and disconnection of the house from the house pipes by traps under all fixtures; (5) ventilation of the whole system by the fresh-air inlet, vent pipes and the extension of all vertical pipes.

The house drain is the horizontal main pipe receiving all waste water and sewage from the vertical pipes and conducting them outside of the foundation walls where it joins the house sewer. The house drain lies in a horizontal position in the cellar and should, if possible, be exposed to view; and should be hung on the cellar wall or ceiling if no pipes are to join it in the cellar and be laid in straight lines if possible. All changes in direction must be made with curves of a large radius. The material should be extra heavy cast iron. The size depends upon the work to be performed. Too large a pipe will not be self-cleansing and the bottom of it will fill with sediment and slime. A four inch pipe is sufficient for any ordinary sized dwelling. A six inch pipe is very seldom required. The fall or inclination of the house drain depends on its size:

For 4-inch pipe	1 inch, 40 feet
" 5 " "	1 " 50 "
" 6 " "	1 " 60 "

The house drain must connect with the house sewer about five feet outside of the wall of the building, the joints between the iron pipe and the earthenware pipe being made gas-tight. Where the iron pipe passes through the wall a relieving arch should be built over it, so that in case the wall settles the pipe will not be cracked or broken.

The soil pipe is the vertical pipe or pipes receiving sewage matter from the water closets in the house. The main waste-pipe is the pipe receiving waste water from any fixtures except the water closets. These enter the main house drain by means of a Y-branch (Fig. 1). The vertical pipes must never be within the wall, nor outside the house; they must be accessible, exposed to view in all their lengths. The material of which both soil and waste pipes are made is cast iron. The pipes should be thoroughly sound, free from flaws, and sand holes, and of a uniform thickness throughout. The inside should be truly cylindrical and of smooth finish. The advantages of iron over lead are many. It is lighter, stiffer, stronger, cheaper, more durable and is not subject to accidental perforations by driven nails and gnawing rats. Lead pipe of large size sags by reason of its weight and it is very easily corroded, dented, flattened and perforated. Waste pipes are usually two or three inches in diameter; soil pipes, three or four inches. The joints of waste and soil pipes should be lead calked to insure them to be perfectly gas-tight.

Branch soil and waste pipes are the short pipes between the fixtures in the house and the main soil and waste pipes. The fixtures must be near the vertical pipes in order that the branch pipes may be as short as possible. The minimum sizes for branch pipes should be:

Kitchen sinks	2 inches

Bath tubs	1-1/2 to 2 inches
Laundry	1-1/2 to 2 "
Water closets, not less than 4	"

The pipes must have a fall of at least one fourth inch to one foot.

A trap is a bend in a pipe so constructed as to hold a certain volume of water, known as the water seal; this water seal serves as a barrier to prevent air and gases from the sewer entering the house. Each separate fixture connected with the soil pipe should be provided with some form of trap situated as near it as possible. Improperly trapped or untrapped fixtures are as much to be avoided as leaks. The value of a trap depends on:

(1) depth of its water seal

(2) strength and permanency of seal

(3) diameter and uniformity of the trap

(4) simplicity

(5) accessibility

(6) self-cleaning character

The depth of the seal should be three inches for water closet traps and two inches for sink and other traps. The trap must not be larger in diameter than the pipe to which it is attached, thus insuring an even flow through it. The simpler the trap, the better. It should be provided with cleanout screw openings and caps, to facilitate cleaning.

The simplest form of trap, called the running trap, consists of a downward bend in a horizontal pipe, (Fig. 2). When water is discharged through such a pipe the depressed portion will stand full of water when the discharge ceases. This will prevent the passage of air in either direction. Such a trap should be placed in the house drain just outside the house wall. The water seal should be at least two inches deep. Besides the running trap there are several other forms of the round pipe traps; the S-trap, the half-S-trap, the three-quarter S-trap and the double S-trap (Fig. 2). All these are of the same size throughout and so will pass anything that can gain entrance, and with proper flushing are easily kept clean.

Another class of simple traps includes all those known as Bottle or Pot traps. In one form of the bottle trap, the principle of which is shown in Fig. 3, the end of the inlet pipe dips several inches into the pool of water. In order to drive air backward through the inlet pipe, A, it would be necessary to exert pressure sufficient to force the water in B upward through A until its level is brought down to the lower end of A. Under ordinary circumstances this would be impossible. The objection to this form of trap is the likelihood of the accumulation of filth, for unlike the round pipe trap, it is not self-cleansing, since the whole contents are not set in motion each time the fixture is used. If such a trap is used a cleanout hole (C), closed with a metallic screw-cap should be provided, but it should never under any circumstances be used under water closets.

Other traps have mechanical devices to assist the water seal. The Ball-trap may be taken as a type (Fig. 4). The ball, B, has a specific gravity slightly greater than that of water. When the contents of the trap are at rest, this ball rests in the position shown and makes a gas-tight joint. When liquid is discharged into the trap the ball is thrown upward as indicated and when the flow ceases, it drops into its original position. The objection to this trap is the seat of the ball is likely to become the point of deposit for bits of cotton, linen fiber, or hair, and then a gas-tight joint can not be made with the ball. As a matter of fact, all mechanical devices in traps are much inferior to the ordinary water seal.

Grease traps are devices for preventing the choking of drains by grease which, discharged in the liquid state with hot water, solidifies when it comes in contact with the cold surface of the waste pipe. Grease traps may be placed beneath the sink or outside the house, provided the distance from the sink to the grease trap is not too great, otherwise the grease would congeal on its way to the interceptor. A common type is here illustrated (Fig. 5). The greasy water runs into the reservoir through the inlet, I, and the liquid grease being lighter than water, rises to the surface and forms a scum, which, when cold, solidifies into a cake. The outlet, O, of the trap dips far beneath the surface and so discharges none of the accumulated grease. The grease may be removed through the cleanout, C.

Traps may lose their seal in various ways: by evaporation, by back pressure, by leakage, by accumulation of sediment, by capillary attraction and by siphonage.

If a fixture is not used for a long time the water seal in the trap of the fixture will evaporate and the seal thus be lost. To prevent this the fixture may be frequently flushed or the trap may be filled with glycerine which will take water from, rather than yield it to the atmosphere; or oil which will float on the surface of the water and prevent its evaporation.

Back pressure seldom occurs. Formerly, the winds and the action of the tides through the sewer caused the air in the whole plumbing system to be compressed and the trap forced backward; but since the soil pipes are ventilated this seldom happens.

Loss of seal by leakage is always due to a defect in the pipe. Enough sediment may accumulate to replace a great part of the water of the seal.

If a small amount of lint or thread remains in the body of the trap, with one end lying over the outlet bend, a part of the water in the trap may be drawn off by capillary attraction and the seal destroyed. To avoid this, traps should be of a uniform diameter, without nooks and corners and of not too large a size and should be well flushed. It is desirable, too, to so arrange traps under fixtures that their water seal is always visible.

As water absorbs gases it was formerly believed that the water in traps would absorb sewer air and give it off on the house side of the trap by evaporation, but investigations have proved that this is not as perilous as it might seem.

The seal is most often lost by siphonage. A large volume of water completely filling and descending a vertical pipe, creates powerful suction and may, by the force of this and the vacuum created, draw off the contents of the trap connected with the same vertical pipe, thus taking out the water seal. This may be prevented by the use of vent pipes, which not only prevent siphonage but ventilate the air in the traps and pipes. Each trap at its upper portion or crown is connected with a branch vent pipe, as in Fig. 6. This slopes up to and at a point above the fixture joins a straight pipe which is extended above the roof, several feet above the coping. The extension above the roof should not be of less than four inches in diameter, so as to avoid obstruction by frost. No return bends or cowls should be allowed at the top. Sometimes the vent pipe, instead of running above the roof, is connected with the soil pipe several feet above all fixtures and this must be extended above the roof with a diameter of at least four inches. The air in all vent pipes prevents the formation of a vacuum and consequent siphonage of traps. The pipes are made of cast iron. The size depends on the number of traps with which they are connected; it is usually two or three inches.

The rain leader collects the rain water from the roof and eaves gutter. It usually discharges it into the house drain, though some leaders are led to the street gutter. The pipe may be of sheet-metal or galvanized iron with soldered joints.

The receptacles or fixtures within the house for receiving the waste matter are very important parts of house plumbing. Great care should be given to the construction, material and fitting of the fixtures that they may not be a curse but a comfort to the occupants of the house.

The waste water from the kitchen is disposed of by means of sinks, which may be made of cast iron, enamelled or galvanized, or of earthenware or porcelain. Sinks must have a strainer at the outlet to prevent large particles of refuse from being swept into the pipe. Each sink should have as near it as possible a trap two inches in diameter and should be provided with a screw cap for cleaning and with a branch vent pipe. Kitchen sinks are best connected with a grease trap also.

Washbasins, or lavatories, are usually placed in bathrooms, should never be in bedrooms and should be left without any woodwork around them. The bowls are made of porcelain with a socket at the outlet into which a plug is fitted. If oval in shape, more space is afforded for free action of the arms than in a circular bowl of the same capacity. In the upper part of the common form of basin (Fig. 7) a number of perforations A, communicate with the overflow horn, B, connected with the waste pipe above the trap. In some bowls, however, the overflow horn is a part of the fixture itself, and opens just beneath the plug (Fig. 8).

For laundry tubs wood, enamelled iron, stone and porcelain are used. Porcelain is the best material, though very expensive. The soap-stone tub is the next best; it is clean, non-absorbent and not too expensive. The tubs are placed in pairs or in rows of three and are generally connected with one waste pipe one and a half or two inches in diameter, with one trap for all the tubs.

Bath tubs are made of enamelled iron, or preferably, porcelain. They should not be covered or enclosed by any woodwork. The ordinary tub is provided with a waste plug, chain and overflow (Fig. 9). Often, instead of chain and plug, an ordinary pipe of the desired length fits into the outlet of the tub and thus acts both as a plug and overflow, and renders a special overflow pipe unnecessary.

The most important plumbing fixture in the house is the watercloset. It is of the greatest importance that it should not be placed in the kitchen or bedroom but in a separate apartment, well lighted and ventilated. The essential points to be considered in examining waterclosets are:- the material and shape of the bowl or vessel receiving the faecal matter; the apparatus for discharging the contents of the bowl; the manner of trapping the watercloset; the manner of flushing the bowl; the trap and the ventilation of the watercloset and the durability and simplicity of the working apparatus.

The best material, if obtainable, for waterclosets would be glass; however, good earthenware or porcelain answer the purpose well. The smoother the surface and the less surface a watercloset has exposed to fouling and the fewer movable parts it has, the cleaner and better it will be.

The waterclosets of the present day may be divided into two classes: those having movable internal mechanism and those having none. A type of the first class is the pan closet, now universally condemned. The principle of this apparatus is shown in Fig. 10. The excreta are received in a bowl, B, closed at the bottom by a copper pan, P, holding a few inches of water, forming a seal against the air from the container, C. The closet is emptied by pulling a handle which releases the pan, which then describes a half circle and drops the contents into the container and the trap below. The mechanism which releases the pan also starts a flush of water through the flushing run over the surface of the bowl. The objections to the pan closet are:-

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

(2). The bowl is set into the container and can not be inspected, and is usually very soiled beneath.

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

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

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

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

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

The simplest form of non-mechanical closets is the hopper closet (Fig. 11). The device consists of a hopper, either long or short, connected with a simple S-trap. The hopper should be provided with a generous flush from a flushing run, for the fouling of the interior surface is inevitable, more so with the long hopper than the short. Improved forms of the hopper closet are the washout and washdown closets. They are usually made in one single piece of earthenware and are entirely free from any movable parts.

In the washout closet, Fig. 12, the bowl, provided with a flushing run, holds a pool of water. In use the contents of the bowl are swept by the flush into the trap, -S, and on into the soil pipe. But the washout closet is not as desirable as the washdown, Fig. 13, which holds a much greater depth of water. In both, however, the lip of the trap should dip not less than 1.5 inches beneath the water level; less than that increases the risk of loss of seal by evaporation.

Water closets must not be directly flushed from the water supply pipes, but from special cisterns, which should be placed at least four feet above the closet, and holding from three to five gallons of water. The supply pipe from the cistern to the bowl should be of a diameter never less than one inch. The best arrangement is that in which the bowl is provided around the upper edge with a flushing run into which the water from the supply pipe enters simultaneously at all sides and is directed so as to rush vertically downward, thoroughly washing the sides of the closet and retaining sufficient force to expel the foul contents of the trap. In order to be efficient the flushing water should come down in a sudden dash. The cistern is fitted with plug and handle, so that by pulling at the handle, the plug is lifted out of the socket of the cistern and the contents permitted to rush downward through the pipe and flush the watercloset. A separate ball arrangement is made for closing the water supply when the cistern is full.

The soil pipe from all waterclosets should be extended vertically above the roof to serve as ventilators.

The defects usually found in house plumbing are many and various. Among the most common ones are the following:-

(1). Light weight iron pipes; sand holes made during casting and covered with a coating of tar; thin lead pipes.

(2). Pipes built in walls and laid with insufficient fall, without proper support, or with sharp bends.

(3). Defective joints, not gas-tight because of imperfect manipulation in joining; T-branches instead of Y.

(4). Traps, bad in principle and in construction, easily unsealed and inaccessible.

(5). No fresh air inlet for house drain; absence of vent pipes; vertical pipes not extended.

It is evident that all these defects lead to the same danger--leakage or loss of seal of traps, resulting in sewer-gas entering the room. Sewer-gas is a mixture of carbonic acid gas, carburetted hydrogen, ammonium and hydrogen sulphide, nitrogen and other gases together with a considerable amount of fetid organic matter. The air from a closed cesspool may be extremely foul and poisonous, so much so that it has brought death to those who have inhaled it in full concentration.

Bacteria are present in varying numbers, with always the possibility of some of them being the germs of specific diseases. The bursting of bubbles of the gas on the surface may throw the bacteria into the air.

It is then important to have the plumbing frequently examined thoroughly and tested for defects. There are several tests which may be used. To test a trap to find out whether or not its seal is lost, a light may be held near the outlet of the fixture; if the light is drawn in, it is a sign that the trap is empty.

Defects in leaded joints can be detected if white lead has been used, as it will be blackened if sewer-gas escapes from the joints.

The main tests for plumbing are the water-pressure test, the smoke test and the scent or peppermint test.

The water-pressure test is used to test new plumbing, before the fixtures have been connected. All outlets are plugged and the pipes then filled with water to a certain level, which is carefully noted. If after half an hour, the level of the water is not lowered the pipes are water tight. This is a very reliable test.

The smoke test is also good. Smoke is forced into the system of pipes, the ends plugged up and the escape of smoke watched for. If leaks exist it will be made evident to the sense of smell and to the sight.

The scent, or peppermint, test is made by plugging all outlets except one on the roof. Into this one is poured about two ounces of oil of peppermint, followed by a pail of hot water and then this pipe is also plugged up. The person who pours in the oil should remain on the roof and keep all openings to the rooms below tightly closed while the inspector slowly follows the course of the various pipes and will detect the smell of the oil wherever it may escape from any defects in the pipes. During the test no fixture in the house must be used and the main house trap must not be unsealed or the oil will escape into the sewer. If carefully done this is a valuable test for detections of any defects in plumbing.

The materials used in plumbing are so many, the parts so numerous, the joints and connections so frequent and the whole system so complicated that there is great chance of much bad work and cheating on the part of the plumber. At the same time, the plumbing of a house is of so very great importance and the influence on the health of the tenants is so great, that to avoid any defects, intentional or otherwise, on the workman's part, it is best for the one interested in the well being of the occupants to know well the principles of plumbing and to personally supervise the work.

Further the best materials, the very best workmanship and the greatest care, even though at a greater outlay of money at the start, are by far the cheapest in the end.

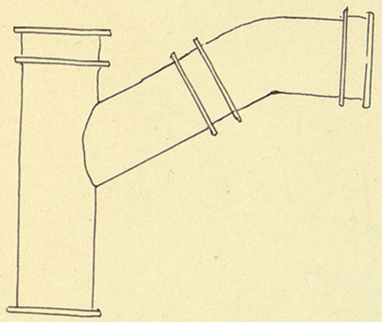

Fig. 1, Y-branch.

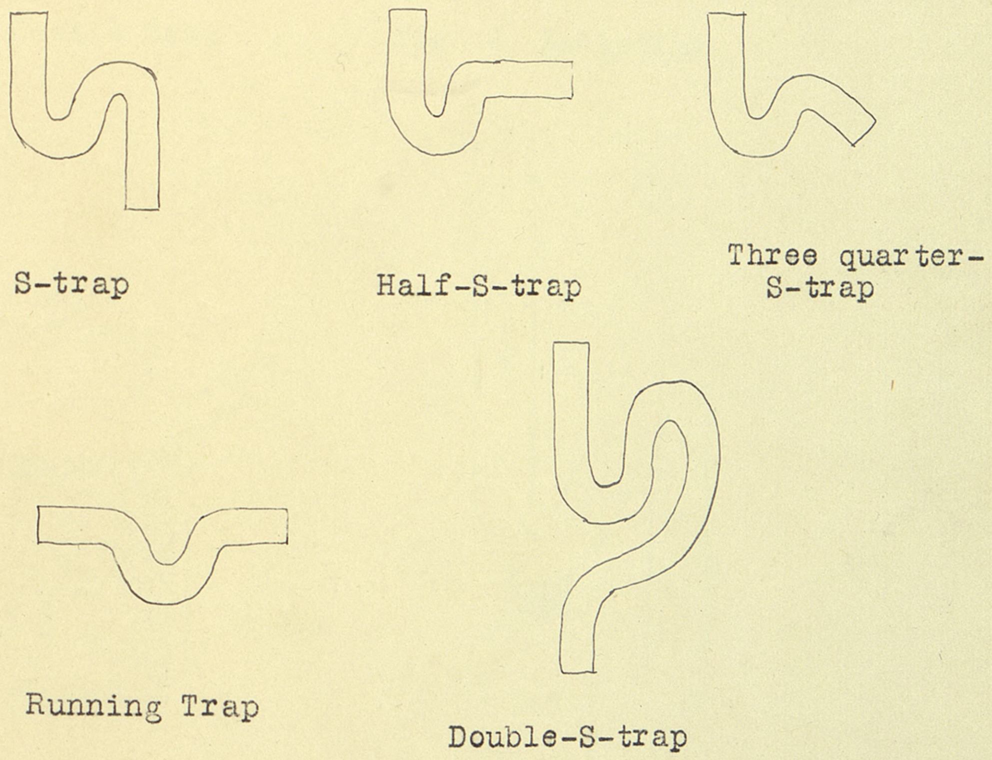

Fig. 2, Round Pipe Traps.

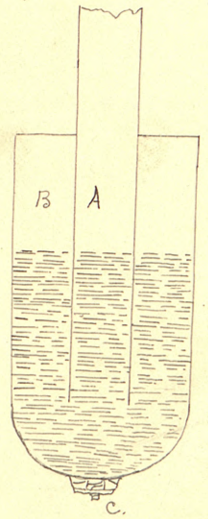

Fig. 3, Bottle Trap

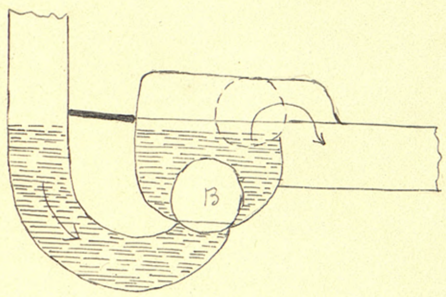

Fig. 4, Ball-trap

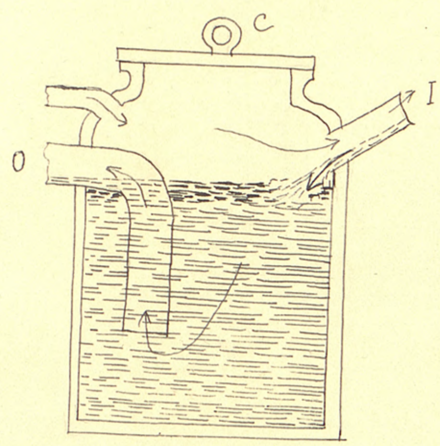

Fig. 5, Grease-trap

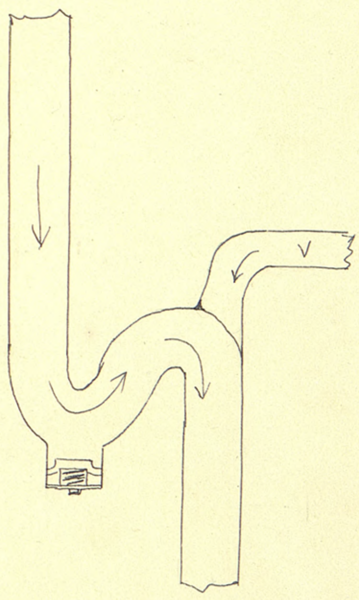

Fig. 6, Branch Vent Pipe

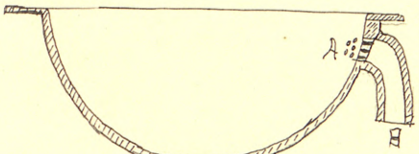

Fig. 7, Overflow

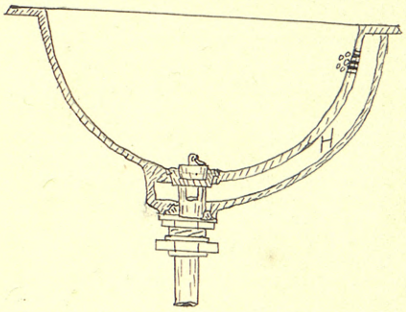

Fig. 8, Overflow

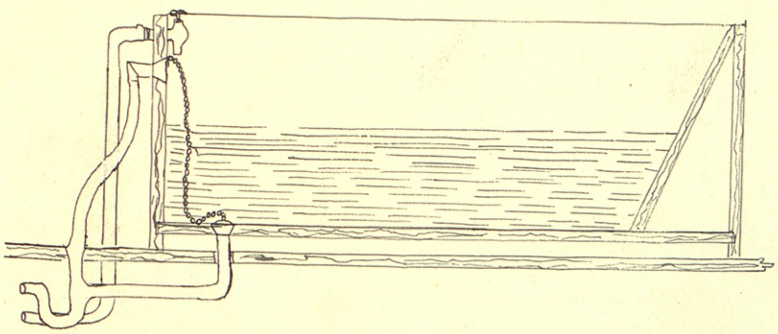

Fig. 9, Bath Tub

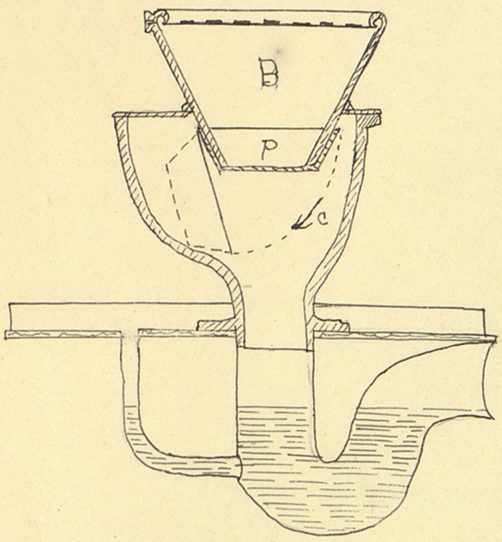

Fig. 10, Pan Closet

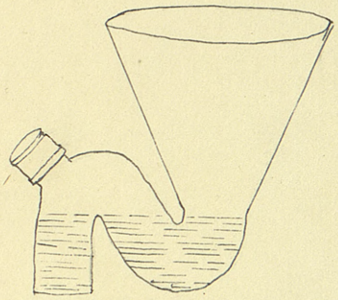

Fig. 11, Hopper Closet

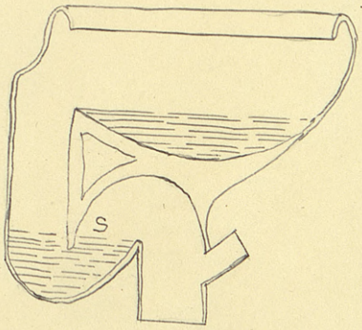

Fig. 12, Washout Closet

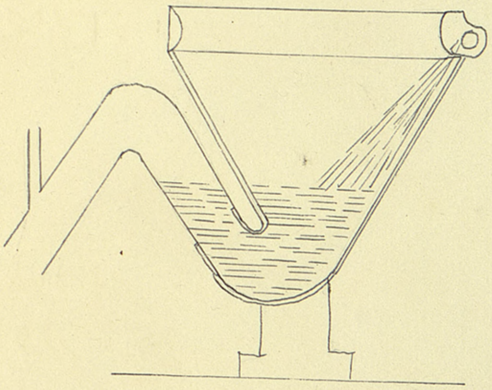

Fig. 13, Washdown Closet