# PLUMBING

## House Drainage & Ventilation.

WILLIAM PATON BUCHAN.

# PLUMBING.

# PREFACE.

About the end of 1871 great excitement was occasioned in the sanitary world by the severe attack of typhoid fever which his Royal Highness the Prince of Wales then had. Londesborough House—although it possibly had nothing to do with the origin of the Prince's attack—was turned inside out, so far as its drains and sanitary fittings were concerned, while the papers were filled with all sorts of explanations and suggested improvements. I ventured to criticise some of these remarks at the time in a well-known London weekly journal, the consequence of which was that I was then engaged by the proprietors of the journal referred to—*The Building News*—to write a series of articles upon Plumbing for their paper. This was done, and the series of articles in question formed the basis of the present work, with, of course, considerable modifications and a large quantity of additional matter.

In writing these articles upon Plumbing one especial object kept in view was to afford a Handy Text-book to the apprentice-plumber, to which he could turn for an explanation of the mysteries of his craft, and so understand the object and uses of the various pipes used, their different sizes and positions, &c., &c. I felt the want of such a treatise very much when an apprentice, but turn where I would, I could meet with none, so that I had to set to work and make my own notes the best way possible under the circumstances. Now all this was unfair as regards the apprentice-plumber, and unfortunate considering the interests involved, especially when we consider the evil effects liable to be produced by bad Plumbing. The joiner and the mason have had their text-books and literature in abundance, to which they could at any moment turn for information, but not so the Plumber. His craft was still one of the real mysteries, insight to which was only to be obtained by a long probation. This little work will, I hope, supply the *desideratum*, and I shall feel glad should it prove the pioneer of many others of a similar practical kind.

In the new chapters, towards the end, upon Scientific and Safe Water-closets, and an Improved System of House Drainage, it is believed that, so far as the safety *per se* of the house and its inmates are concerned, a practical and simple solution has been found to the scientific theories and problems of such sanitary writers and authorities as Carpenter, Fergus, Gairdner, Latham, Littlejohn, Rawlinson, and Richardson, &c.

Although it was stated above that the principal portion of this work was written with a view to the special edification of the young apprentice-plumber, the hope is indulged that it may be found useful even to architects and medical professors, and also to all having anything to do with sanitary matters, while to many of my brethren in the trade I trust it may prove a useful *vade-mecum.*

21, Renfrew Street, Glasgow,
*June 1st*, 1876.

[N.B.—*The author may be consulted upon any matters referred to in this work.*]

# PREFACE TO THE FIFTH EDITION

ADVANTAGE has been taken of the call for another edition of this work to add about fifty more pages to it, and the same number of new illustrations. The institution of special technical classes for plumbers throughout the kingdom, arising out of the Registration of Plumbers movement, has created a greatly increased demand for this work as the "Text Book," and it is to be hoped that the object of the book—namely, that the plumber should be educated and the public thereby properly served, is now being realised.

There is still much to be done before thorough sanitation throughout the kingdom is obtained, but good progress is being made. "Better homes for the poor" are now recognised as a necessity, and the providing of these in the nineteenth and twentieth centuries will take the place of the erection of chapels in the fourteenth and fifteenth.

Particular reference was made in the Preface to the fourth edition to the dangers from unsanitary dairies; in this we would especially call attention to the necessity for a better oversight of the water supply and sanitary fittings of our roadside railway stations. Many of these would be benefited by a visit from a competent sanitary inspector, or engineer, with the application of the smoke test to the drainage, where they have such

There is room also for a little attention being paid in this country, as is done in the United States, to sanitary provision for the convenience and comfort of railway passengers during long journeys, and especially of the third-class ones; men, women, and children ought not, in countries with any pretence to modern civilisation, to be treated as if they were merely cattle going to market.

While sanitarians of various grades and public authorities have been improving the physical condition of our environment, we must not forget that there is a moral as well as a material atmosphere to be kept pure, or evil will ensue.

* * * * * *

The Author deeply regrets to have to record here the deaths of three earnest sanitarians, whose names and good works have been referred to in the several editions of this book. The death of Dr. Andrew Fergus, of Glasgow, on the 29th July, 1886, is the first to be recorded. This was followed, on 16th August, 1888, by the death of Mr. Wm. Eassie, C.E., F.G.S., who with the late Dr. Parkes, F.R.S., superintended the sanitary arrangements of Renkioi Hospital during the Crimean war. The third name is that of Dr. William Wallace, F.R.S.E., F.C.S., City Analyst, Glasgow, who died (while the last sheets of this edition were in the press) on 5th November, 1888. To the foregoing may be added, with the like regret, the name of Mr. James Sellars, I.A., the architect of the Glasgow International Exhibition of 1888, who died on 9th October last, at the early age of forty-five. Only a few days ago Mr. Alfred Waterhouse, R.A., spoke of him as one of the most prominent of our Scottish architectural brethren.

GLASGOW,

*November 21st*, 1888.

# CONTENTS.

# INTRODUCTION.

There are few things in connection with our modern houses of greater interest or more worthy of careful consideration, so far as the comfort and health of the tenants or inmates are concerned, than the character of the plumber's work. The ramifications of the pipes in thousands of cases are now so many and various, and the evil effects of bad work and of bad planning are so often manifested upon those exposed to their baneful influences, that it becomes a question of the highest importance to all concerned—and who is not?—What is the character and condition of your plumber's work? In answer to this question, and in order to throw some little light upon the subject, it is our intention in the following pages to give such information upon the matter as, we trust, may be both useful and interesting.

If we allow the mind to dwell for a moment upon the subject of architecture in stone, three glorious eras rise up before us, in which the genius of the Egyptian, the Greek, and our Mediæval ancestors had scope, and produced grand results, all in consonance with the wants and aspirations of their several ages, and results, too, which it is yet left for the future to excel. It is different, however, with plumbing, for in no past age have its present productions as a whole either been equalled or surpassed. Of course the mind here may revert to the vast works of the Romans in connection with their water supply; but apart from other considerations, a distinction must be drawn between engineering and plumbing. The present is the era and grand opportunity of plumbing, and in order to bring it to perfection, both the architect and the plumber must work in harmony and together do whatever in them lies to produce such a result as will be both creditable to them, and a blessing to the community at large. The noble and now venerable monuments of the past before alluded to, were not produced by magic—modern science having fairly disposed of the brownies or pixies, gnomes, and fairies of our youthful ideas!—they were produced by each individual in his own sphere, doing well the work that lay to his hand. The smith had to make and sharpen the tools, the mason had to use them, and though they were often only classed and looked upon as "laborers," yet we see what grand results able supervision could cause both the Egyptian slave and the English labourer to produce.

# PLUMBING.

## CHAPTER I.

### Half-Circle Eaves Gutters.

"The roof is ready," is generally the signal which brings the plumber upon the scene. The mason begins at the foundation or the bottom, the plumber, however, begins at the top. The mason—or bricklayer, &c., as the case may be—has carried up the walls to their destined height, the joiner has done his share, so far, by laying the joists and doing the woodwork of the roof, and now the plumber has to do his part at making things watertight, and conveying away the rain-water which may fall upon the roof. There are many ways of doing this, just as it happens to be a large or a small roof, a simple or a complex one; a cheap job, where nothing but plain half-circle eaves gutters are allowed, or one where tons of lead are required for the gutters, flashings or skews, valleys or flanks, skylight openings or dormer windows, hips or piends, ridges, and perhaps one or more flats, or "platforms" as they are sometimes styled. If it be a plain roof with two gables, we will say that only simple half-circle iron rhones—*i.e.*, half-round eaves gutters made of cast iron —are to be put along the eaves on the back and front of the house. In such a case gutters 4½ in. wide—which is a common size—may do; although they can be had from 3 in. upwards. These 4½ in. cast-iron gutters, of which Fig. 1 shows transverse section, are generally cast in 6-ft. lengths, with a faucit at one end; but of course, short pieces can be had to any length, or as much can be cut, filed, or chipped off a full length as to reduce it to the size desired, and a new hole for the bolt, Fig 2, has then to be drilled. Angular gutters can also be had of different shapes, to fit or turn round all sorts of corners. If one half-circle gutter is merely to go along the front of the house, and another along the back, then, according to the length of frontage, &c., so will be the number of the lengths of gutter required, *e.g.*, if the frontage be fully 35 feet then six lengths will do; with a "close-end" on each end of the gutter, and a nozzle, pap, or drop, as it is variously termed, to conduct the rain into the rain-water-pipe (or "conductor"), as per Fig 3.


Fig. 1.

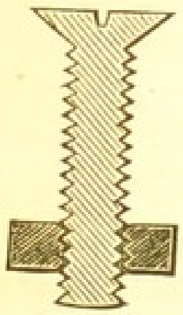


Fig. 2.

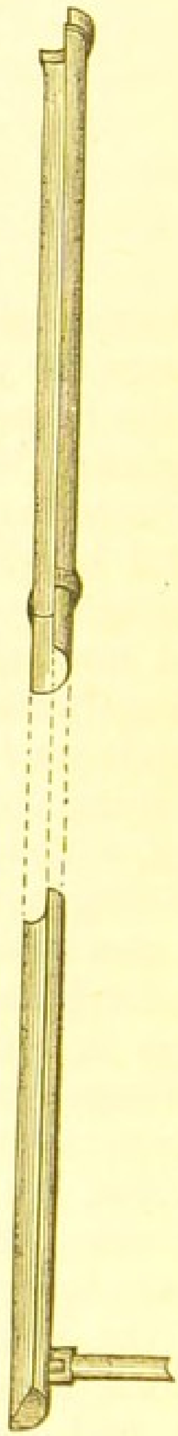


Fig. 3.

The close ends may be had either loose or cast on, but the nozzle is cast along with the gutter. Short pieces of gutter with the nozzle, called "nozzle pieces," may also be had. In cases where the conductor has an ornamental rain-water-head at its top, then the nozzle and one close end are often dispensed with, and the gutter allowed to run quite openly into the rain-water-head, as per Fig. 4. Many prefer the nozzle, however, as it prevents the water running back the under side of the gutter. This may be prevented by putting on a small piece of sheet lead under the end of the gutter. This iron gutter is supported by malleable iron hooks about $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. broad, and from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. thick. These hooks are made to fit the outside of

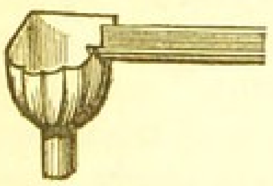


Fig. 4.

the gutter, so that the gutter may lie properly in them, and while at the higher end of the gutter the hook is shallow, at the other end, owing to the declivity which the gutter requires for the proper flow of the water, the hook has to be so much deeper.

Fig. 5 is a view of the shallow hook, and Fig. 6 the deep hook, with the two slate nails or 1½-in. screws which fix it to the wooden roof. In some cases the hooks have to be let into the stone, when they are

Fig. 5.

Fig. 6.

either wedged in firmly, or else, a hole being cut in the stone, the inner end of the hook is bent down, and being inserted into the hole, the hole is run full of lead, as per Fig. 7. This has to be done just as the exigencies of the case may require and the circumstances allow.

To make the hooks for a 4½ in. iron gutter about (say) 48 ft. long (which gives eight six-feet lengths, minus about 1½ in. off for the slip, or overlap at each joint, if the lengths are cast exactly 6 ft. long), will require about 27 ft. of hoop iron, as, allowing for two hooks for each length, or one hook every 3 ft., there will be seventeen hooks, and

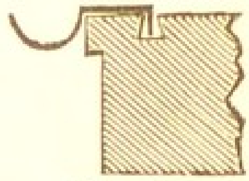


Fig. 7.

each piece of iron of a different length. The shortest piece will be 18 in. long, which allows 11 in. to go up the roof, and 7 in. to support the gutter; every other piece is cut a little longer, say, one-eighth of an inch, which in this case, where the gutter is supposed to have a run all to one end, gives about two inches of declivity in all, or a quarter of an inch to each length. When the pieces of hoop iron which are to form the hooks are cut, they are arranged as per Fig. 8, and a mark struck across them from A to C, A being 7 in. from the end B, and 11 in. from the end E, while C is 9 in. from the end D, and 11 in. from the end F. This arrangement gives 7 + 11 = 18 in. as the length of the shortest hook, and 9 + 11 = 20 in. as the length of the longest hook; the length of the others being all intermediate between these. The pieces at the ends B D may then be heated and bent square as per Fig. 9 at the marks A—C, and being again heated to redness at the same end the points B D are, one by one, inserted into the nose or catch of an iron mould specially made for that purpose, and the hook formed by the hoop iron being bent over it as per sketch Fig. 10.

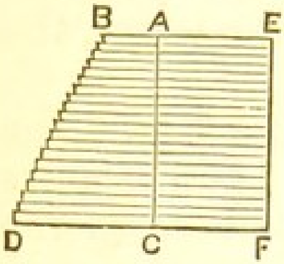


Fig. 8.

Two or three holes having been punched for the nails as shown in Fig. 5, the hooks, when brought to a mild heat, are tarred, and after cooling are ready for use. In place of tarring the hook, when time allows, it may be painted, first with a coat of red lead, and then a coat of paint of the same colour as the gutters. When galvanized hoop-iron is used, heating and tarring and also painting are generally dispensed with. This non-protection is not to be recommended, however.


Fig. 9.

Each of the above lengths of gutter has a faucit end and a spigot, or plain end, the plain end of the one length fitting into and lying upon the faucit of the next length. The joint is made tight with putty or red lead, the spigot of the one length and the faucit of the other being squeezed together and kept tight by means of the bolt and nut, as per Fig. 11.

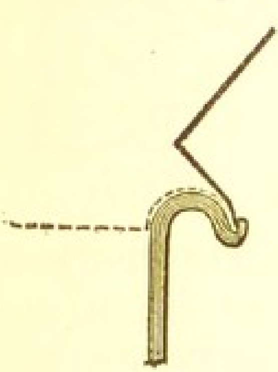


Fig. 10.

After these iron gutters have been put up it sometimes happens that they are blown down in a gale of wind; to prevent that, however, the gutters should either be tied to the hooks with copper wire, or else pieces of hoop iron are fixed to the roof at one end, and the other end put across the top of the gutter to protect it and keep it down, as per


Fig. 11.

Fig. 12. For zinc gutters the hooks have to be made in the same style as above, but the lengths of zinc gutter, in place of being screwed together, with putty, &c., are soldered, while to keep the zinc gutter in its place an iron bolt can be passed through the bottom of the gutter and through a hole made for it in the bottom of the hook, and so it is kept fast, as per Fig. 13. The iron bolts above spoken of are about 1 in. long and $\frac{1}{4}$ in. thick. The holes in the gutters, &c., are, of course, of a corresponding size. Sheet lead used to be largely employed for these half-round eaves gutters, but it is now getting out of use in many cases, on account of the large adoption of cast iron. In some cases, malleable iron has been applied for the purpose.

Fig. 12.

Fig. 13.

## CHAPTER II.

### Ornamental Iron Gutters.

In the foregoing chapter plain semi-circle gutters (or *rhones*, as they are sometimes called), which may possibly be considered to partake more of the character of an excrescence and a necessary evil than an ornament to the building, were treated of. In this case, however, we come to treat of ornamental iron eaves gutters, which are necessary to the completion of the design, and which, as the old saying has it, "kill two birds with one stone," as at one and the same time they

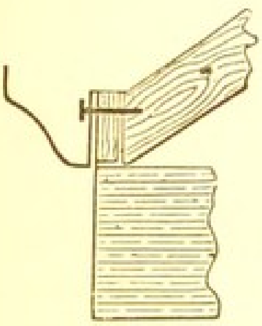


Fig. 14.

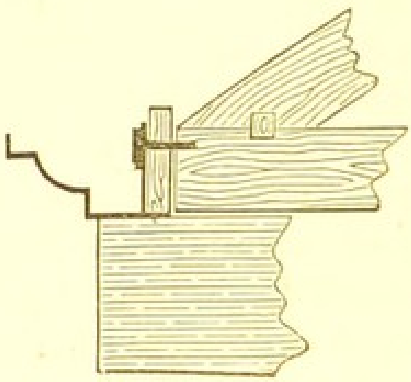


Fig. 15.

Fig. 16.

serve either as the whole or a part of the cornice mouldings, as well as acting as gutters for the rain-water. These ornamental iron gutters do not, generally speaking, require hooks, as provision is made for them being screwed to the woodwork of the roof, a board about 1 in. or $1\frac{1}{4}$ in. thick, and about the same depth as the back of the gutter being fixed up along the back of where they go for that purpose. In some cases all the weight of the gutter is borne by the screws, as per Fig. 14. In other cases a great part of the bottom of the gutter lies on the wall head, as per Fig. 15. In some cases they are upheld by ornamental iron brackets, as per Fig. 16, which brackets are of various styles to suit the place. These ornamental iron gutters require to have close ends—unless in cases where they go all round the building, as in some cottages and villas—and nozzles, just as the plain half-circle ones do, only they are not put up with a declivity to the nozzle, for that would spoil their appearance; they are fitted up quite level or horizontal, but owing to their being several times deeper than the half-circle gutters they can dispense with a declivity. The depth of a $4\frac{1}{2}$-in. semi-circle gutter is

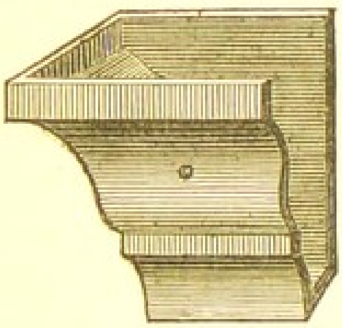


Fig. 17.

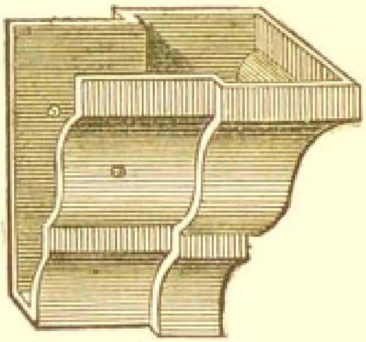


Fig. 18.

only about (or scarcely) 2 in., whereas the depth of ornamental gutters may be 3 in., 6 in., 8 in., &c., with a corresponding breadth, according to circumstances, and as the size of the roof or the character of the building may require. In order to keep an unbroken line of frontage, ornamental iron gutters have no faucits, the plain end of one gutter acting as the faucit, as in Fig. 17, while the end of the other length is contracted so as to slip into it, as per Fig. 18. These figures, 17 and 18, are not full lengths of gutter, but terminal ends; they serve, however, to show the mode of junction. The gutters are put together with putty or red lead, and iron bolts (as per Fig. 2), only the head of the bolt is kept outside, and the hole countersunk so as to leave as little as possible to catch or to be offensive to the eye. The iron-bolts in this case are also a little thicker, as well as longer, than for the plain semi-circular eaves gutters.

In some cases an ornamental iron gutter is put up along the front of the building, while a plain half-circle one is put up along the back eave. This is often done where the building has two gables, and, supposing it to be done at a house in the country, or wherever the water is scarce, instead of merely allowing the rain to run off into the drains, provision is made to catch as much as possible by collecting it either in a tank, cistern, or rain-water barrel. In such a case the barrel, we shall say, is put up at one of the back corners of the house, just as may be most convenient, with the rain-water, both from the back and the front, led into it, as per Fig. 19. In this case the water from the front gutter, E, is conveyed along the gable into the back conductor, F, by means of an iron, lead, or zinc pipe—say 3 in. in diameter, or more or less as may best suit—as shown at G, which pipe is upheld by holdfasts if iron, or if of lead it may be upheld by lead bands, of which more anon. As will easily be understood, an overflow pipe, H, requires to be put into the barrel (or it may be done as per I), so as to make provision for carrying away the surplus rain-water when the barrel is full. The water-tap, or bib-crane, J, is for drawing off the water as required for use. Instead of adopting the plan of the rain-water barrel outside of the house, as per Fig. 19, some may prefer to fit up a large cistern or tank inside the house, as per Fig. 20, in

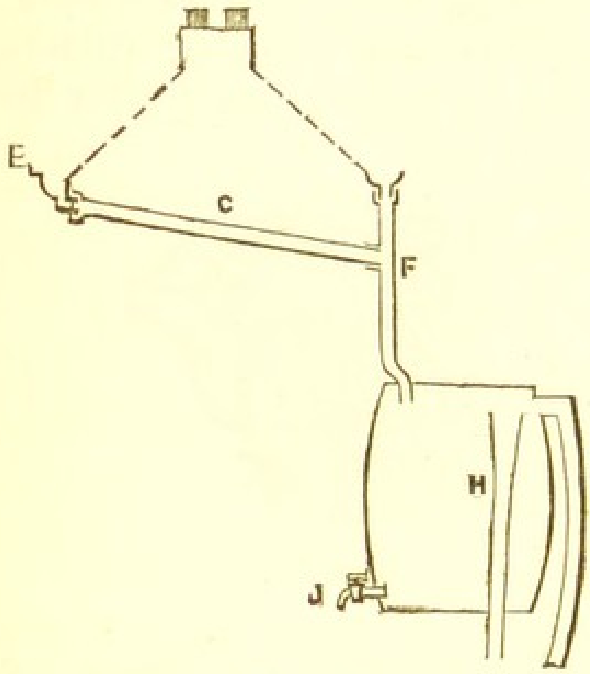


Fig. 19.

which to collect and store up the rain-water. In this latter case the rain-water, in addition to serving the same purposes as in Fig. 19, may also be made to supply any water-closets or baths, &c., inside of the house. As this cistern or tank, K, Fig. 20, is fitted up within the house, care must be taken that a large overflow pipe is put in, 3 in., 4 in., or upwards, in diameter, so as to insure that after the cistern is full the overflow pipe, L N, will be able with ease to carry off more water than the incoming rain-water pipes, M M, can supply.

As this overflow-pipe is sometimes led directly into the house drain, due provision must be made to keep back any bad gases from making their way through it into the house. One way to effect that is by putting in a lead siphon-trap with, say, 9 in. of water-lock, as per L, Fig. 20. In this case, owing to the large quantity, or rather depth, of water which this siphon-trap contains when full, there would be little if any danger of it ever getting emptied so far as to allow any gas to pass the tongue. And if the least suspicion of it being empty were felt, a gallon or so of water could easily be poured in in some exceptional case. In order also to ventilate the lower or outer portion of the overflow-pipe N, Fig. 20, a 1-in. lead or zinc ventilating-pipe should be put in, and attached by a brass coupling to the top of the outlet of the siphon-trap, as per O, Fig. 20. This ventilating-pipe O also prevents any large rush of water down the pipe N from sucking the water out of the siphon-trap, L. The top of the siphon-trap, L, where the water enters, must be kept down, of course, fully 2 in. or so below the top of the cistern. I prefer also to have one side of the top of the pipe a little lower than the other, believing that the water, in start-

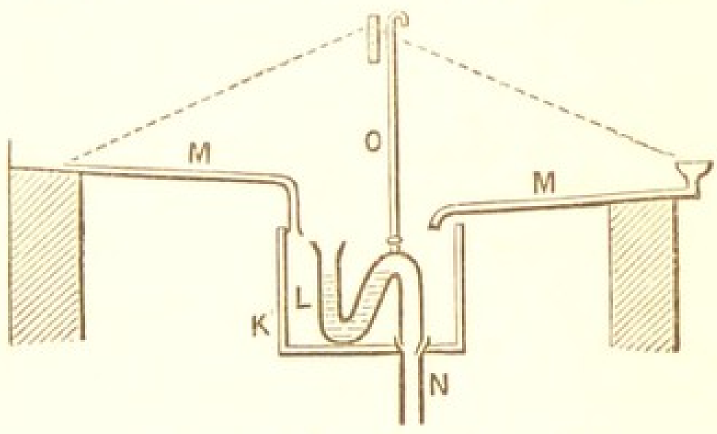


Fig. 20.

ing especially, runs off more freely thereby. Another way of putting in the overflow-pipe, N, would be to make it discharge either above an open grating, or into a ventilated fire-clay siphon-trap situated at the back of the house. As it is a fact that, giving them sufficient time, gases pass through water—although in the case of drain gas, I believe it would be largely purified by the time it got through the water in the siphon-trap, L, Fig. 20—the enclosure wherein the cistern K is situated, if the least confined, should be ventilated, or if the said cistern, K, is covered in on its top, say by boarding, &c., a 2-in. or 3-in. zinc pipe should be carried up or out into the fresh air. This pipe and the pipe O, Fig. 20, must be kept as far apart as convenient.

The great advantage of proper ventilation is that, in checking the collection and concentration of bad gases, it prevents them from doing the harm they might otherwise do.*

In carrying out the work practically, there are often many little differences in detail that start up; but to one who understands the principle, and who thinks before he acts, as every one ought to do, these are easily mastered. In any difficulty, however, a workman should not slubber over the work, but should ask advice. Two heads ought to be better than one.

In some cases, as in that of the supposed house in Chapter I, which had only plain half-circle gutters

Fig. 21.

Fig. 22.

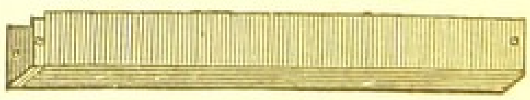


Fig. 23.

on the front eave as well as along the back, the front gutter is simply carried along the gable also, where it is upheld by iron holdfasts of the style shown by

* Mr. R. Rawlinson, C.B., C.E., is of the same opinion, for at page 14 of his A.D. 1878 "Suggestions" as to the working out of the Public Health Act of 1875, we read that permanent ventilation is required "to prevent stagnation or concentration of sewage gases, &c."

Fig. 21. The half-circle in the holdfasts is made to suit the size of the gutter, so that the gutter may fit and lie into it easily. The water which comes along this gutter may fall into a rain-water head which receives the water both from it and the back gutter, and so down the rain-water pipe, or conductor, into the barrel. Fig. 22 shows another style of hook, often employed for zinc gutters.

There are so many patterns of ornamental iron eave gutters, from the plain square one, shown in Fig. 23, to those with the most elaborate mouldings, that we can only refer to them here. What has been said above, however, will serve to show the principle upon which they are fitted up.

While treating of ornamental iron gutters, we may here state that, in order to give them a fair chance to do duty in lieu of stone cornices, they ought to be painted stone colour, so as to correspond with the rest of the front of the building. We have observed that this is often neglected, but consider that to be in great measure an oversight of the architect, for we can hardly suppose otherwise than that a word from him would not only have set that right, but also thereby have given fair play to his own design.

Before concluding this chapter, allusion may be here made to iron centre gutters, which, as they are not put up for ornament, but simply for use, can be made with any declivity wanted, in which case the sole or bottom of the gutter is cast tapered, perhaps 6 in. broad where the water runs off, and 10 in. or 12 in. broad at the higher end. In other cases they are cast without any declivity, being laid level, and therefore the same breadth throughout. The two sides, however, in all cases require to be made to suit the pitch or inclination of the roof, or else the inclination of the roof is set so as to fit them if they are selected beforehand; generally, however, the gutter is made to fit the roof as at R, Fig. 24, where the nozzle, S, is also shown for the outlet, by which the water may be conveyed away by the rain-water pipes as circumstances may require.

These iron centre gutters are made with enlarged faucits, the same as semi-circle gutters, not with contracted ends the same as the ornamental iron gutters above alluded to. They are joined with putty and red lead, and bolts and nuts, the bolts being $1\frac{1}{2}$ in. long

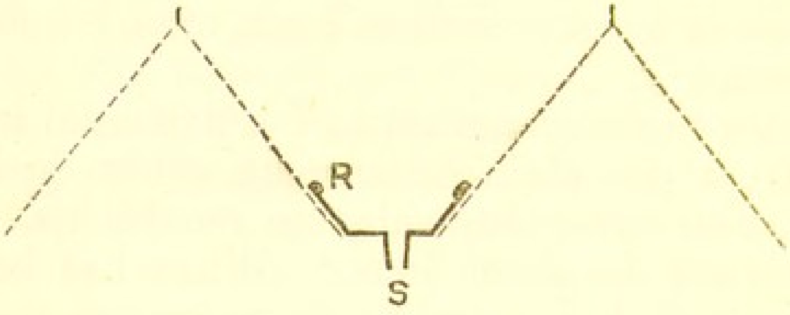



Fig. 24.

and about $\frac{3}{8}$ in. thick. Three bolts are used for each joint, but in some very broad gutters four bolts may be used. Each length may be had either 6 ft. or 7 ft. long, according to the usage of the foundry they are got from; shorter lengths may be had to order or to make up the exact length required.

# CHAPTER III.

## Ridges.

The plumber having put up his gutters, during the time he has been seeing after his pipes the slater has not been idle, for he has got the roof all slated, and the plumber may now put on the ridge, which may be either of lead, zinc, or iron. The least breadth, generally speaking, of either lead or zinc ridges is one foot, which allows a cover of about 4 in., or fully that, on each side over the slates; but in many cases a greater breadth is used and found necessary, in order to give the slates sufficient cover. If it is to be lead for the ridge, then

Fig. 25.

Fig. 26.

a ridge about 48 ft. long can be put on, say, in three pieces (or as the lead at hand will allow), an overlap of about 3 in. being given where the pieces meet. After the lead has been rolled out and beaten into its place with the usual wooden "dresser," Fig. 25, a strong lead-headed slate-nail is driven in at a distance of, say, every two feet or so into each side of the top part of the ridge. Sheet lead for the ridging may be from, at the lowest, 5 lb. up to 7 lb. or more per square foot. When less than 5 lb., it is often torn up in a high gale of wind, and even although (as is done in some cases where the lead is much exposed to thieves as well as to the wind) galvanised iron ridge straps are put on every three feet or so, yet if the lead be too thin it is sometimes torn up between the straps. These ridge straps are made of hoop iron about $1\frac{1}{2}$ in. broad and $\frac{1}{8}$ in. thick, bent into the form shown by Fig. 26, and with two $\frac{1}{4}$-in. holes for the nails to go through as shown.

If, however, the ridge is to be covered with zinc, then zinc ridges are generally put on in 8-ft. lengths, with three straps to each length, or one about every $2\frac{1}{2}$ feet. Where the straps are put on at one every 4 ft. it makes a bad job, and does not give the zinc fair play. Each length of ridge is allowed to overlap the other about 2 in. Zinc ridges are made of sheet zinc from Nos. 10 to 14 and upwards. No. 10, which gives about $12\frac{1}{2}$ oz. to the square foot, is indeed little enough; for a good job a greater weight must be used. Anything less than No. 10 should not be put on unless for some mere temporary purpose. In the neighbourhood of chemical works it is a good thing to give the zinc a coat of white-lead paint.

Iron ridges are put on as cast by the ironfounders; some foundries cast them in 4-ft. lengths, but they can be made as ordered. They are cast to suit the pitch or inclination of the roof. They can be had either quite plain, as per Fig. 27, or with many different styles of

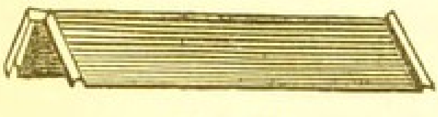


Fig. 27.

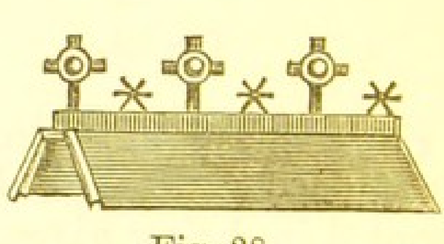


Fig. 28.

ornament to suit the character of the building, as per Fig. 28. The one length overlaps the other, and as each length is cast with a raised bead at the one end, and a corresponding raised cover, or overlap at the other end, the bead of the one length is covered by the overlapping socket of the other length, and so the junction of the two lengths is made water-tight.

# CHAPTER IV.

## Lead Gutters.

We come now to treat of roofs where the material used by the plumber is lead, and shall take what may be called a plain roof first, or one with two gables, in which are the chimneys, and where the line of both the back and front gutters is uninterrupted in its whole length, of which Fig. 29 gives section, showing front

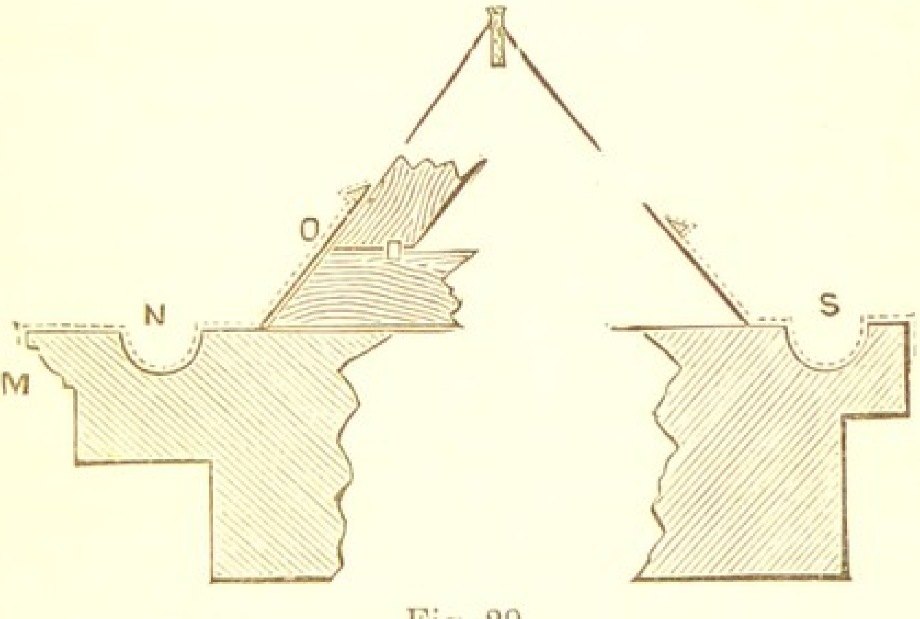



Fig. 29.

and back gutters. In this case M is the stone cornice on the top of the front wall, in which the valley for the gutter, N, is cut out, say, to a depth of one inch at its upper end, and getting gradually deeper towards the end or place where the water runs off, so that at the deeper end its depth may be about 3 in., while throughout it may have a uniform breadth of, say, 5 in. The roof comes down, as shown at o, and it becomes necessary, therefore, to lay the lead, so as both to convey away the rain-water and to do its part in keeping things water-tight at the junction of the roof with the wall-head. For this purpose the lead has to go across the cornice and up about 6 in. on to the roof, as shown by the dotted line. The breadth of the lead in this case will, therefore, be about 2 ft., which is made up by 1 in. bent down over the front, 5 in. from front to edge of the gutter valley, 8 in. for the gutter valley, and the other 10 in. is taken up by the 4 in. from the back edge of the gutter valley to the roof and 6 in. up the roof, as per Fig. 30. A gutter about 48 ft. long may be put on in either two or three pieces. If we say three pieces, that, if all are cut to the same length, gives about 16 ft. for each, and if the weight of

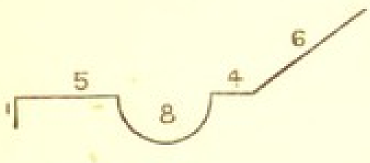



Fig. 30.

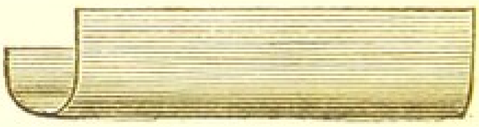


Fig. 31.

the lead be 7 lb. per square foot, each piece will weigh about 2 cwt. The lead being carried up to the roof is then rolled out there, near, or just above where it is to go, each piece by itself, and after being "dressed," or beaten out flat, it is then marked off where to be bent up in a manner suitable to its intended site. For the gutter we are speaking of the mark—at the deeper end —is set at 10 in. from the front at one end and 9 in. from the front at the other end, after which the lead along its whole length is bent up according to mark (as per Fig. 31). It is then lifted down and set inside the gutter valley in stone, and being bent back and over it is then properly "dressed" into its place, and afterwards cut or pared evenly along the edges. When measuring off the length of lead, allowance must be made for any upstand or turn-over at the ends of the gutter, according as the site may require. After the gutter has been laid the "doubling," or long narrow wooden fillet for slates, has then to be put on all along the upper edge, except about 6 in. at each end where the gable "flashings" come down—*i.e.*, if the said "flashings" go underneath slates. This "doubling," so distinguished because the lead is doubled back over it, is of any length, its section being a right-angled triangle, with the base or breadth about two inches, and the perpendicular or depth about three-quarters of an inch.

Where the ends of the lead gutter pieces meet they must be soldered, it being understood that the stone is cut out a little underneath the joint, so that the solder may be "flush" or level, especially in the gutter valley. Where the joint is soldered thus it both looks neater and forms no obstacle to the water running off freely.

We may here describe the operation of joining two lead gutter pieces *in situ*. After the lead is put into its proper place, as described above, its surface for about 4 in. on each side of the joining is rubbed with a piece of card and chalk to take off the grease, &c.; it is then on the same space painted over with "smudge," (a mixture of lamp-black, glue, or size, and sour beer or water, boiled together), and after said "smudge" has been dried, say with a hot iron, about 1 in. back from each edge of the lead is then cleanly scraped with the "shavehook," and to prevent its being tarnished or oxidised it is immediately rubbed over with fresh grease, often a piece of tallow candle. The solder-pot and soldering-irons in the interim being properly heated, the plumber, by means of his small iron ladle, pours a sufficient quantity of solder on to the joint (not merely as much as makes the joint, but sufficient to raise a heat, all surplus being returned to the pot), and then, by the help of the red-hot irons and his soldering cloth, he makes his joint.* The soldering-cloths, which are a

* In dry weather this is easily done; but should it come on wet it is very disagreeable, both taking more time and solder, and not making such a neat job.

*sine quâ non* with all plumbers, are merely pieces of moleskin or strong linen, of four, eight, or twelve thicknesses, and various sizes to suit the particular work. Old moleskin trousers, and old aprons considered to have served their day upon the plumber's person, are afterwards torn up and made to do duty as "soldering-cloths." These cloths are kept well greased on the side which comes in contact with the solder, so as to prevent the solder adhering to them. The following rough sketch, Fig. 32, shows a plumber's chaffer-pan, P, as used on roofs, &c. It stands in the centre of a large iron tray, Q (about 2 ft. square and 4 in. deep), in which is water, so that any hot cinders falling out may be at once quenched. The soldering-iron, R, is all of malleable iron, and is what is used along with the solder heated in the pot. A distinction must be made between this soldering "iron" and the soldering "bolt,"* the latter being made with a copper head and iron handle. A plumber's copper "bolt" is made something like a hatchet, on account of which shape it is often designated the "hatchet-bolt;" this appellation also serves to distinguish between it and the "pointed" or "straight bolt," the latter shape of copper bolt being that generally used in gas-fitting. As observed above, it is hot or melted solder that is used along with the "iron," whereas the solder used along with the "bolt" is cold and generally in the form of strips, or, as for gas-fitting, in small, thin cakes.

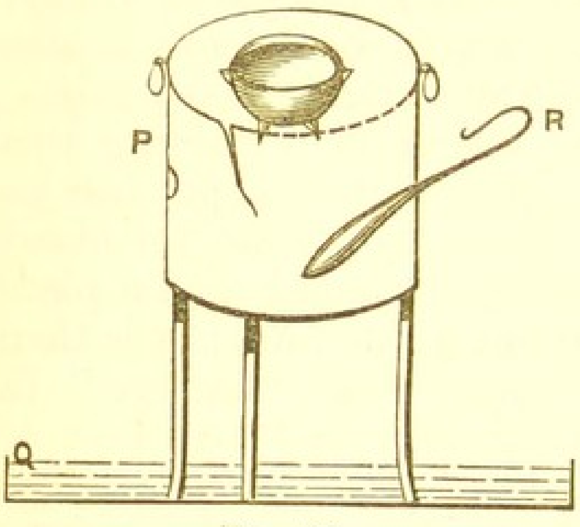


Fig. 32.

Good "working solder"—used with the ladle and the soldering-cloth—is made up by melting pure lead and block tin together in the proportion of 2 lb. of lead to 1 lb. of tin. "Strap solder"—used with the copper

* In some places the copper "bolt" is styled a copper "bit."

hatchet-bolt—is made in the proportion of 1 lb. of tin to fully $1\frac{1}{2}$ lb. of lead. Some just made I find is in the proportion of 1 lb. of tin to 1 lb. $9\frac{1}{2}$ oz. of lead. Some gas-fitting solder just made is in the proportion of 1 lb. of tin to 1 lb. 2 oz. of lead. Some use equal parts of tin and lead for their finest solder. In making up solder, especially "working solder," or "plumber's solder," great care must be taken that no zinc gets near, for a very small piece of zinc spoils a large pot full of solder. For this reason sheet lead is generally preferred before the patent lead pipes. Formerly sheet lead was cast, now, however, it is generally rolled or milled. For special cases, however, good cast lead is still preferred.

To return to our gutter. We have got the front gutter laid, and a similar course has now to be adopted with the back gutter, S, Fig. 29, only, as there is here less breadth of stone to be covered, the lead may be narrower, say 18 in. in breadth. The length of the back gutter is also sometimes less than that of the front, owing to the stone gable-coping coming down to the outside edge of the back gutter, and so forming the ends of the gutter up against which the lead at each end has to be turned, whereas in the front this stone "skew," or gable-coping stops off perpendicular with the line of the wall, the cornice, including the gutter channel, being beyond it.

After laying the gutters, the lead "flashings," which extend up the roof from each end of both the back and the front gutters, have then to be put on (that is, supposing them to be put on, as is often done, before and underneath the slates). In this case twelve pieces of lead are required; four for the flashings for skews which extend from the gutter to the chimneys; four pieces for the "barges," or breaks, or projections at chimneys; and four for the flashings up the sides of the chimneys. These, for the different places, are of different lengths and breadths. The flashings for the "skews," or gable-coping T T, being, say 11 ft. long and 13 in. broad, this 13 in. is taken up by 6 in. on the roof, 4 in. up the side of the skew, and 3 in. on the top of the skew, including half-inch bent down in the groove, or chasing, or "raglet," as it is called in Scotland, cut to receive it. This "skew" or stone-coping of the gable wall, T, as shown by the sketch, Fig. 33, is generally only half the breadth of the chimney, the latter being about 2 ft. broad, or the same thickness as the gable wall. The lead "barge," or chimney corner-piece, U, goes where the skew and the chimney meet, and is

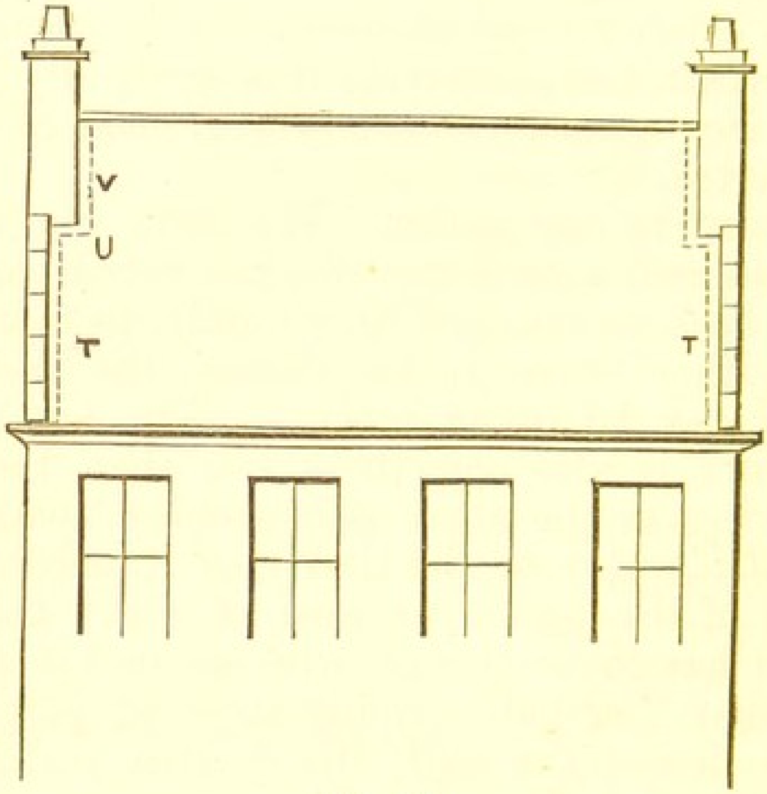



Fig. 33.

put on so as to overlap the top of the skew-flashing, and at the same time be itself overlapped by the flashing of the chimney, V, which comes down on it. This "barge," U, has also to overlap a small portion of the slating, as may be understood from its position on the sketch.

The dotted lines show the margin of the lead flashings on the roof, as also at the same time the situation of the "doubling"—except the "barge" below the chimney, which, as was observed above, goes on the top of the slates. The "doubling" being put on thus, a channel for the water is formed between it and the chimney and the stone side of the skew. The lead for each barge, on account of its situation, has to be fully 2 ft. broad and about 13 in. deep; its depth is taken up by 8 in. or 9 in. on the roof and 4 in. or 5 in. up the face of the chimney. When the barge is being fitted in its place a piece of board about $\frac{5}{8}$ in. thick is put temporarily under it so as to make the barge fit the slates properly. After the barge is fitted the chimney flashing, V, is then put in; its length is, of course, just according to the size of the chimney. We shall say that in this case, including overlaps, it is about 8 ft. long, and its breadth will be about $10\frac{1}{2}$ in., 6 in. on the roof and 4 in. up the chimney side to the chasing, the other $\frac{1}{2}$ in. going into the chasing. This chasing is a narrow slit cut in the stone about $\frac{1}{2}$ in. wide and $\frac{3}{4}$ in. deep, into which the lead is turned and fixed with lead bats every 6 in. or so; after which the chasing is filled with mastic to keep it water-tight. The diagram, Fig. 34, is section of the skew, showing the chasing, or raglet at W; the dotted line X being the lead. All the water in this skew-flashing X running down it goes immediately into the gutter.

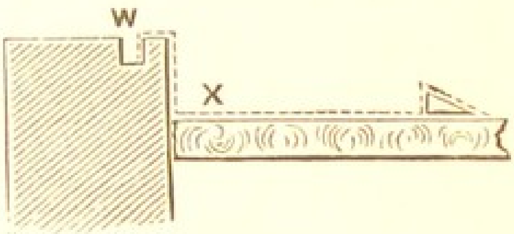


Fig. 34.

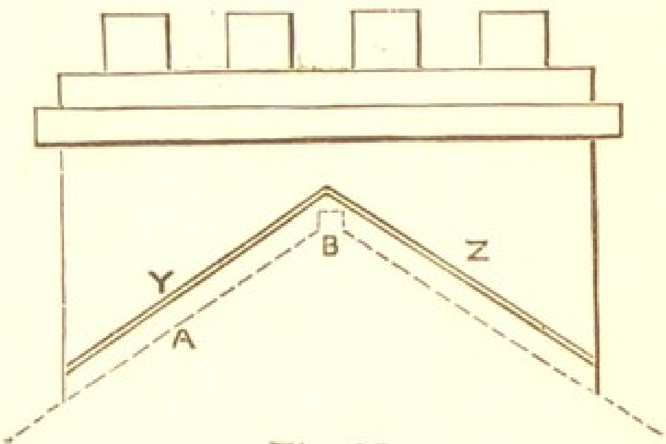


Fig. 35.

Y Z again in Fig. 35 shows how the chasing is cut up the side of the chimney for the chimney flashings, the dotted line A being the line or surface of the roof and B the ridge.*

* The stone chimney here depicted at Fig. 35 is supposed to be built of polished freestone, the blocks at the sides about 3 ft. long, and about 1 ft. high; those at the ends of the chimney 2 ft. long, and some only 1 ft. for filling in.

# CHAPTER V.

## Lead Gutters (*continued*).

In Chapter IV. the manner of laying the lead in stone cornice gutters, and up the sides of the gables, was explained, both the back and the front gutters being uninterrupted in their whole length. Supposing, however, a building is taken which, in addition to its

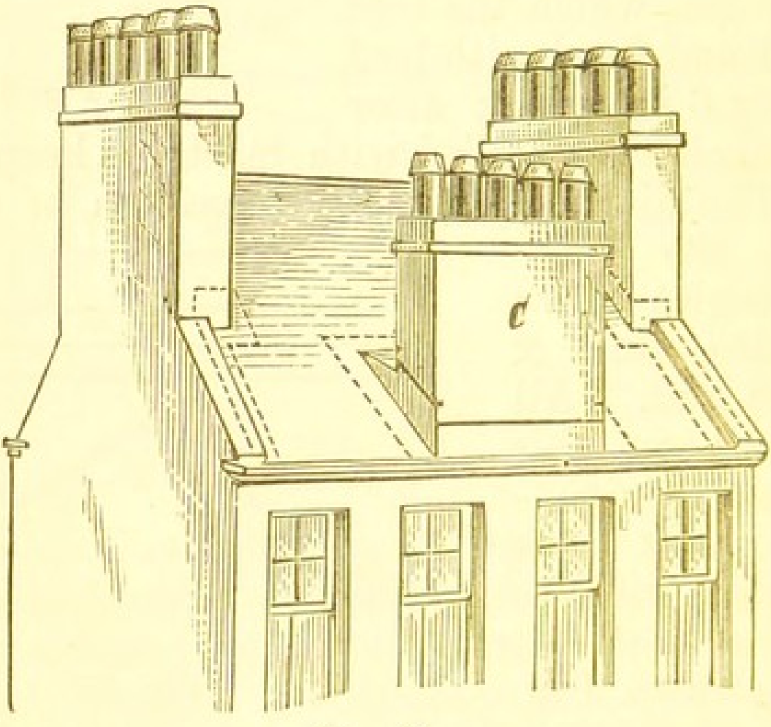



Fig. 36.

two gable chimneys, has a chimney, c, in centre of front elevation, as Fig. 36, of which Fig. 37 gives end or sectional view. In this case it will be seen that while the gutter channel is not interfered with, the back of the lead gutter, instead of going up the roof, stands up against the front of the chimney, as shown by the dotted line, D, Fig. 37. It does not, however, go into the chasing, E, for that would bind the lead too much; but the top edge of the lead is kept a little below the chasing, being allowed to stand up about 3 in. or so; and, to prevent the rain getting down the back of the gutter, a long narrow strip of lead, called the "apron," about 4½ in. broad—more or less according to circumstances—is put along the front of the chimney so as to overlap the back of the gutter. This "apron" has its upper edge bent into the chasing, E, where it is held fast by lead bats, and the chasing afterwards filled up with cement or mastic.

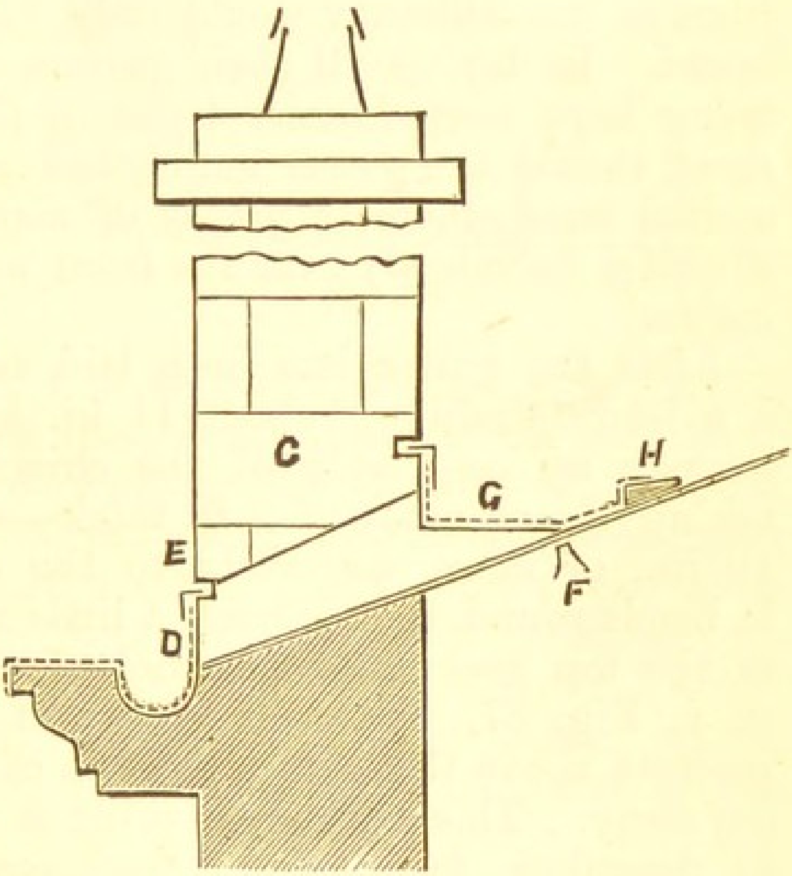


Fig. 37.

It has been said that the back of the gutter fronting the chimney has to be bent straight up, as at D, but as the gutter lead on each side of the chimney lies back on the roof, it follows that the gutter at each front corner of the chimney has to be made to fit the said corners; this is done either by "working" or beating the lead down so that it both lies on the roof and also goes up the side of the chimney so far.

When the lead is to be wrought back into its site, the plumber should take off the sharp edge of the stone corner first, so as both to help himself and prevent tearing the lead. In other cases, instead of working down the lead, some may slit it down close by each end of the chimney, and bend it back, which of course does not thin it any, but causes the plumber to solder in a small piece of lead to make up the deficiency. Another plan is to have a separate piece of lead for the gutter along the front of the chimney, which would cause the gutter in Fig. 36 to be of three pieces; after laying which, there would require to be two soldered joinings, one at each corner of the chimney. In this plan, while the lead for the gutter on each side of the chimney might be cut out at about 2 ft. broad, that in front of the chimney would only be about 1 ft. 5 in. broad. In laying all such gutters as these, the lead, being kept *several inches higher at the back than at the front*, should the gutter get choked up by dirt or half-melted snow, there is plenty of margin for the water running harmlessly over the front without any getting inside.

After the gutter has been laid to fit the chimney, C, a lead "flashing," about 11 in. broad or so, has to be put up each side of the chimney; its length—taking the chimney at 2 ft. thick—will be about 2 ft. 10 in., or more, according to the pitch of the roof. It bends round the chimney a little at the bottom, and at the top goes up to the back of the chimney gutter at F, Fig. 37, whatever portion of the lead flashing projects above the sole, or bottom of the gutter, being cut away. This chimney flashing is put into a chasing, as described for chimney flashings in Chapter IV. After the flashings are on, a lead gutter has to be laid along the back of the chimney, as per dotted line, G, Fig. 37. The lead for gutters so situated may be of various breadths, according to the pitch of the roof, and the way in which the carpenter has been directed to lay the wood; a breadth often used is 1 ft. 6 in.—that is, 3 in. perpendicular upstand against the back of the chimney, and the rest across the wooden sole of the gutter and up the roof. And if we take the length of the chimney at 9 ft.—which is also the length of the gutter at its back—then the length of the lead will require to be about 10 ft. 6 in., as it has to extend out at each end as far as the outer edge of the chimney flashings. It has also to be bent or wrought down over and round the chimney flashings at each end, so as to overlap them. The top of the chimney gutter lying on the roof, as also its ends and the chimney flashings, require "doubling" (or wooden fillet) to be put in under the lead, as per H, Fig. 37, and I, Fig. 38, which latter shows the lead of the chimney flashing as per dotted line.

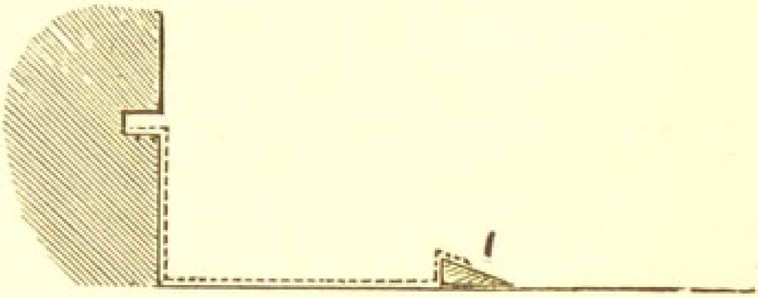



Fig. 38.

In some cases the plumber may make a small roll on the lead in place of putting in the wooden fillet or "doubling," underneath it; but the wooden fillet, as at I, Fig. 38, is better, and it prevents the slater from beating down the lead to fit his slate, instead of making the slate to fit the lead. The back perpendicular upstand of the chimney gutter is protected by an "apron," put on in the same manner as already described for the front of the chimney.

We come now to a different form of gutter, where, instead of the gutter channel being cut out of the top of the cornice, as shown at Fig. 29, Chapter IV., there is a stone "blocking-course" built up above the cornice, behind whch is the gutter, of which Fig. 39 gives section—the dotted line J being the lead gutter, and K the stone "blocking-course."

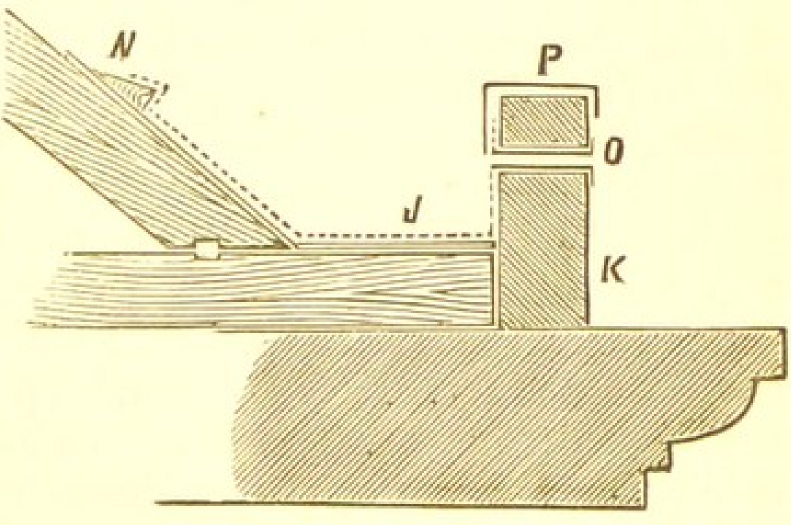



Fig. 39.

In this case the gutter is of a different shape from that at Fig. 29, although the lead required may be of the same breadth—viz., 2 ft. When the lead for it is rolled out on the roof it is marked off and set up to the shape of the gutter, as shown by dotted line J, Fig. 39; the 2 ft. in breadth being taken up by, say 4 in. perpendicular upstand all along the one side, 13 in. at the high end, and 10 in. at the low end, or according to its fall, for the sole or bottom of the gutter; and 7 in. at the high end, and 10 in. at the low end, to go up the roof. After the lead has been thus "set up," before being put into its site, it has also to be set up at each end, so as to form the upstands for the ends of the gutter, which is done, according to the style of the locality, either by

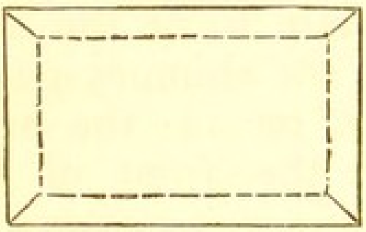


Fig. 40.

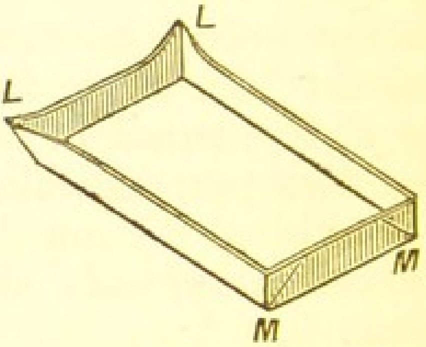



Fig. 41.

working up, or "bossing," as some term it, each end, so that the lead may fit its site; or else by bending up the ends and turning round the corners, which latter system in some places receives the cant terms of "pig-lugging" or "dog-earing" the corners, which may be explained as follows:—Take a piece of white paper, 6 in. by 4 in., as per Fig. 40, and draw a line within it and all round it half-an-inch from its outer edge, as per dotted line, Fig. 40. Bend up the paper at the dotted line, square all round. In attempting to do so it will be found that the corners require to be bent out across or along the diagonals, when they take the form shown at L L, Fig. 41. Press the corners close together, and then turn them round, as shown at M M, and a copy is produced of what is often done with the ends of lead gutters. After the gutter has been put into its site, the "doubling" (or wooden fillet) has to be put on, under the top of the lead on the roof, as at N, Fig. 39; while for the front of the gutter at the "blocking-course" two things have to be done—viz., an "apron" has to be put on, and an overflow-pipe has to be put in; so that if the gutter were choking up, the water would run off harmlessly by this overflow pipe O, Fig. 39, instead of getting over the top edge of the lead gutter, and so damaging the property. The "blocking-course," we shall say, is 6 in. across the top; the "apron," therefore, having to cover it, and go down each side, overlapping gutter inside as per P, Fig. 39, will be about 10 in. broad, which gives 1 in. over front, 6 in. across top, and 3 in. down inside. Of course there may be many "blocking-courses" broader and deeper than this, which will require the lead to be broader; but what is said above shows the principle or method of putting on the lead. The "aprons" on the top of the "blocking-courses" are held fast by lead buttons or rivets, as shown by Fig. 42, which are made as follows:—Before the lead apron is put on, holes are cut in the top of the stone blocking-course about or fully $1\frac{1}{2}$ in. deep, and about $\frac{3}{4}$ in. wide, every 2 or 3 ft.; after the lead apron is put on, a small round hole, about $\frac{3}{8}$ in. in diameter, is cut in the lead right over the centre of the hole in the stone; this hole in the lead is made wider by beating the lead out and up at the same time, as shown in Fig. 42; a small portable ferrule, the size of the lead button, being then put over the hole. After the lead has been poured in, got cooled, and been beaten a little on the top with a hammer, the button permanently assumes the shape shown at A, Fig. 42, which gives perpendicular sectional view.

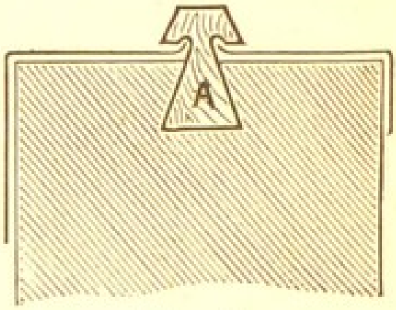


Fig. 42.

In some cases, when the gutters are very shallow—

*i.e.*, when they are laid within a few inches of the top of the blocking-course—there is no apron used, the lead being put on all in one piece over the blocking-course, across the gutter channel and up the roof, as per Fig. 43. Whenever gutters are laid in this manner —which is sometimes done for cheapness—and no overflow-pipe put in, care must be taken that the lead is put up the roof a sufficient distance, so that the water, if the gutter gets choked up and overflows, may run over the front of the blocking-course, and not over the top of the lead next the roof. In other cases, where the gutter channel behind the blocking-course is a sufficient distance below its top, the apron, instead of being put on across the top of the blocking-course, as per P, Fig. 39, may be put on inside the blocking-course, a raglet being cut for it, as per Q, Fig. 44. And as, in this case, there may also be sufficient depth for drips, the carpenter can lay his wood accordingly. Fig. 45 shows longitudinal section of lead where such drips, S S, are put in, the water being taken away from the centre of the gutter, as at T. An overflow-pipe, R, Fig. 44, ought also to be put in.

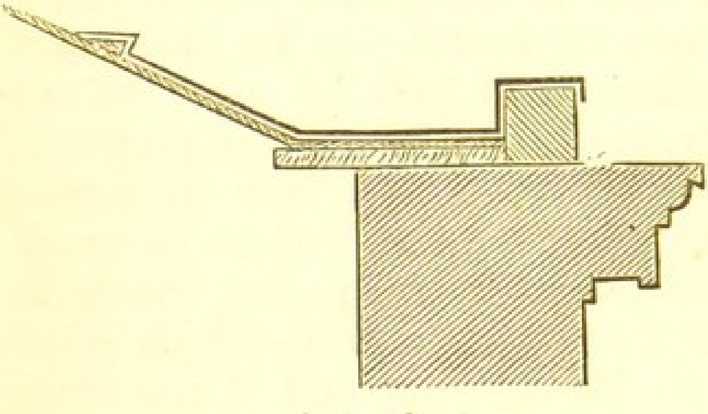


Fig. 43.

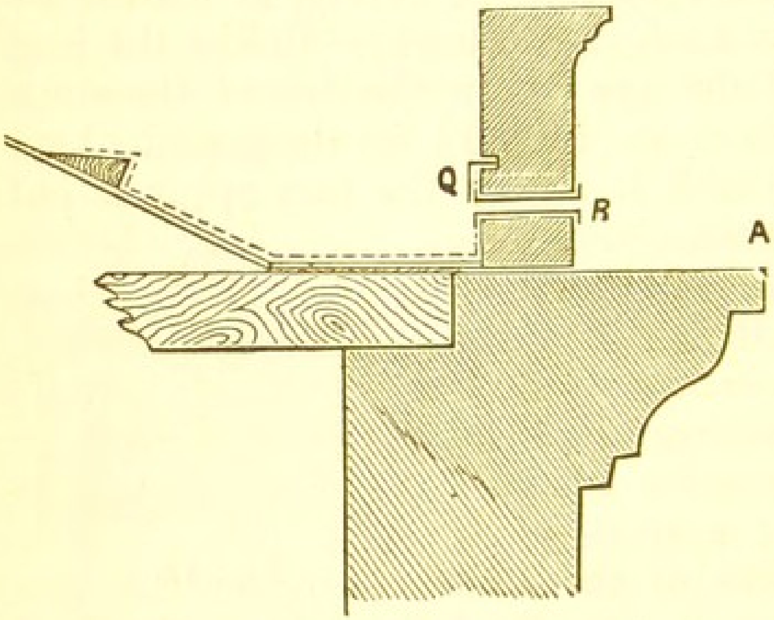



Fig. 44.

In some cases, instead of there being only one pipe, as at Fig. 45, there may be two pipes—viz., one at each end, as per Fig. 46. The drips s s, s s should be about 3 in. deep—no *less*, if possible, whatever more. It sometimes happens, especially when the drips are considerably shallower, or less than 3 in., that after the lead has been on some time a quantity of dirt, soot, sand, lime, &c., gets blown up between the two thick-

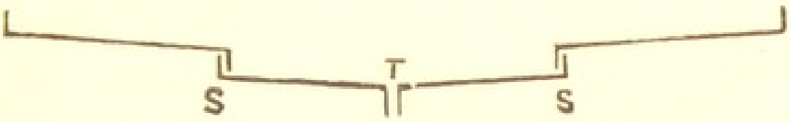



Fig. 45.

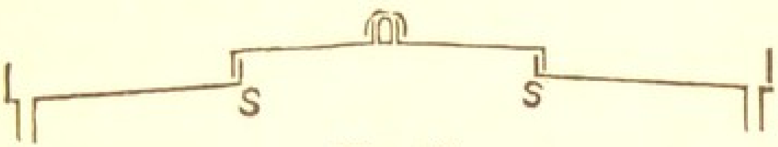



Fig. 46.

nesses of the lead, especially at the corners, and in rainy and blowy weather this dirt, getting wet, acts as a sort of conductor or sponge to suck up the water inside, and so over the top edge of the under lead; when this takes place it keeps the wood underneath the lead continually soaking in water, and tends to rot it.

At s s, Fig. 45, the depth of the drips is supposed to be 3 in., the under lead standing up about $2\frac{3}{4}$ in., and the upper lead bent down over it about 2 in. By only bending down the upper lead 2 in. the water or rain falls clear off it, and so capillary attraction is prevented and a good practical job made. A great many plumbers, however, do not seem to be aware of this, and instead of doing as shown at s s, Fig. 45, they come out in the "fancy" or pseudo-artistic style—shown at B, Fig. 47, where the upper lead is not only bent down the full depth of the drip, but a margin, about 1 in. broad, of lead is also left on the lower gutter. The effect of this is

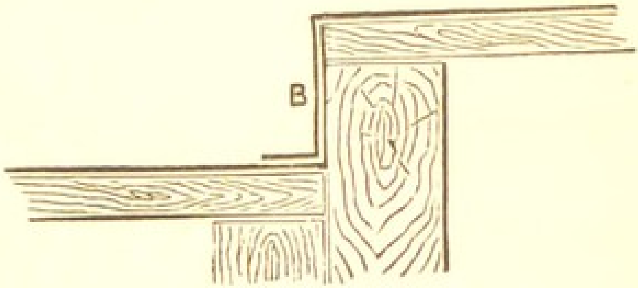



Fig. 47.

that capillary attraction gets full scope—the water rising up between the two inner surfaces of the lead and wetting the wood. The style of over-lapping the lead shown at B, Fig. 47, therefore, although no doubt done with the best intentions, yet makes a very bad job. If any improvement is wanted upon the simple overlap shown at S S, Fig. 45, it may be had by turning down the top edge of the under lead as shown at C, Fig. 48, or a "clinch" may be formed as shown at D, Fig. 49. These two latter styles are adopted where the gutters are broad and much exposed to wind and rain.

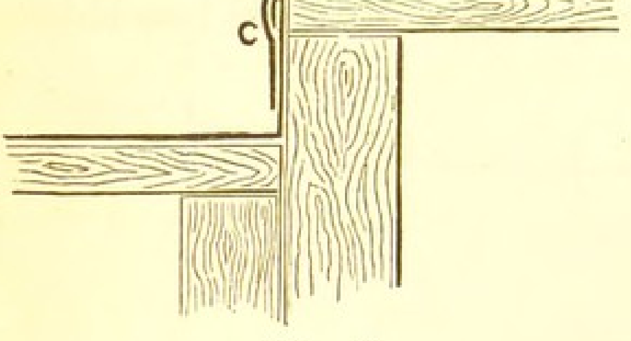



Fig. 48.

When there is a long stretch of gutter, say 80 ft. or 90 ft. long, of the style shown in Figs. 44 and 45, with only one rain-water pipe for it all, then there will require to be about six drips in it; and in order to give each drip a depth of 3 in. the joiner and the plumber should see that the lowest gutter, into which all the others run, is laid as low as possible. In many cases laying the lowest gutter as shown at Fig. 44 will do for a start, the top edge of the first drip being kept up about 1½ in. higher than the bottom of the inner side of the overflow-pipe. If it is required to be still lower, as is sometimes the case, then that may be done by sinking the sole of the gutter 2½ in. lower than the top of the cornice at A, Fig. 44; the overflow-pipe, R, being also lowered down until it rests upon the cornice, A, Fig. 44. The joiner in this case must see that the top edge of the first drip is still about or nearly 1½ in. higher than the cornice; while the plumber must see

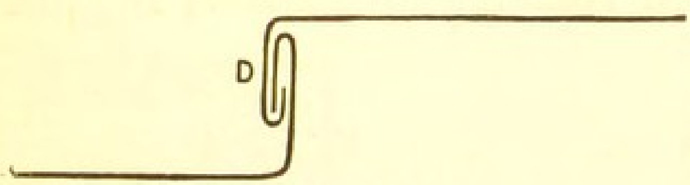



Fig. 49.

that the water or rain gets exit at the overflow-pipe fully 1 in. lower than the top edge of the lowest portion of the gutter out of which the overflow-pipe is led. The gutters we are speaking of are laid in lengths of from 10 ft. to 12 ft. long, and if the joiner lays down the wooden sole properly an inclination of about $1\frac{1}{4}$ in. in the 12 ft. is quite sufficient. An inclination of only 1 in., with a 3-in. drip, makes a far better job than an inclination of 3 in. and only a 1-in. drip.

The lead which goes up the sides of the lower gutters at the drips should be turned in, or doubled over a little so as to form a small roll (say, $\frac{1}{2}$ in. in diameter), the turn in of the said roll being kept

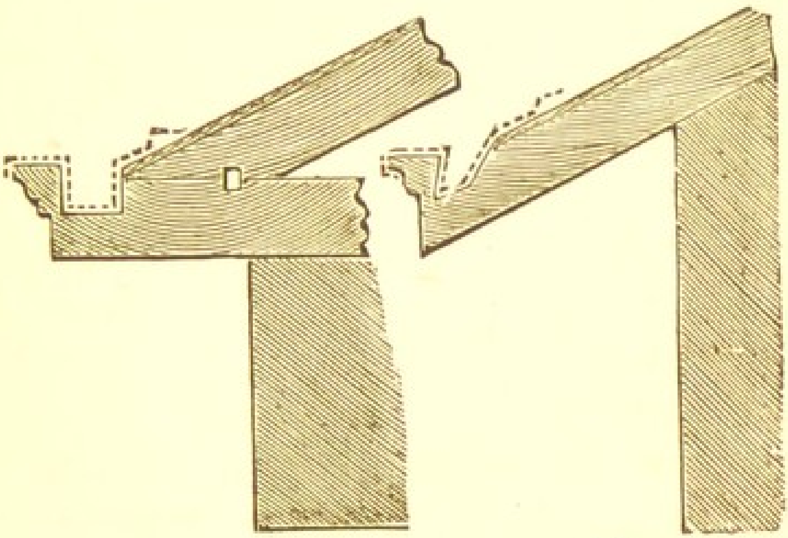


Fig. 50. Fig. 51.

inside the line of the drip. The sides of the lead of the upper gutter at the drips should be left projecting out before the drip about 3 in. or thereby.

We may here mention that the overflow-pipe, R, Fig. 44, is not a round pipe, but a flat or oval pipe made of lead; it is about 6 in. wide horizontally, and $1\frac{1}{2}$ in. high. Its length is of course according to the thickness of the blocking-course. When putting it in it must be seen that no rain gets in under it from the outside.

The gutters above referred to are of the style practised, especially, where stone is the principal material used in construction. In the case of cottages or houses with projecting roofs, Figs. 50 and 51, many little differences in detail occur, and the plumber must make his lead suit the place. To assist in putting the lead into its site in channel in such gutters as here depicted, and also those at Fig. 29, Chapter IV., the plumber often gets a piece of wood made the same shape as the gutter channel, only a little narrower, and about 3 ft. long or so, with which he beats the lead into its seat by striking the wood on the top with his hammer, he standing on the wood at the same time, or else pressing it down with his knee.

## CHAPTER VI.

### Flashings and Valleys.

As regards "flashings," while often put on as per Fig. 38, Chapter V., they may sometimes, upon a large building, or where a very large quantity of water flows down the flashing, be put on as per Fig. 52, where the lead is about 18 in. or 20 in. broad. The raised piece at T is a wooden fillet nailed on; it is about 1½ in. high, and about 1¼ in. broad, over which the lead is turned, as per dotted line, Fig. 52. Where flashings are put on up against a brick wall or chimney, a different style has to be adopted from that hitherto described,

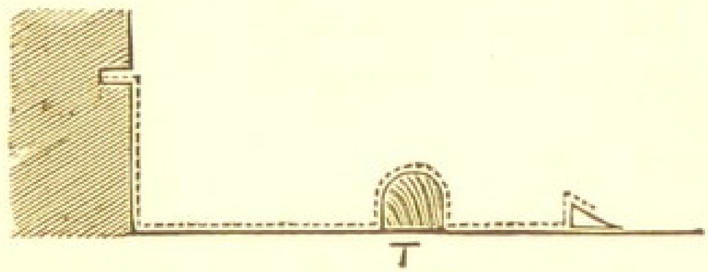



Fig. 52.

as no grooves are cut in the brick the same as in stone. Y Z, in Fig. 35, Chapter IV., shows how the raglet is cut up the side of a stone chimney, but instead of the straight line there shown, in brickwork the joints of the bricks serve for the chasing, as per Fig. 53, which shows part of a chimney built in brick. U V, Fig. 53, is the slope or pitch of the roof, and the undulating lines are the horizontal joints of the bricks. The lowest line and the broken one, which is supposed to be 3 in. above it, show the upstand of the lead or zinc flashing. The line between them, supposed to be 1 in. higher than the lowest line, shows the bottom of the stepped apron pieces, which apron pieces overlap the upstand of the lead or zinc skew about 2 in. or so. The other lines show how the lead steps are put in, the dots showing position of their overlaps. Fig. 54 is cross-section of the skew shown in Fig. 53,

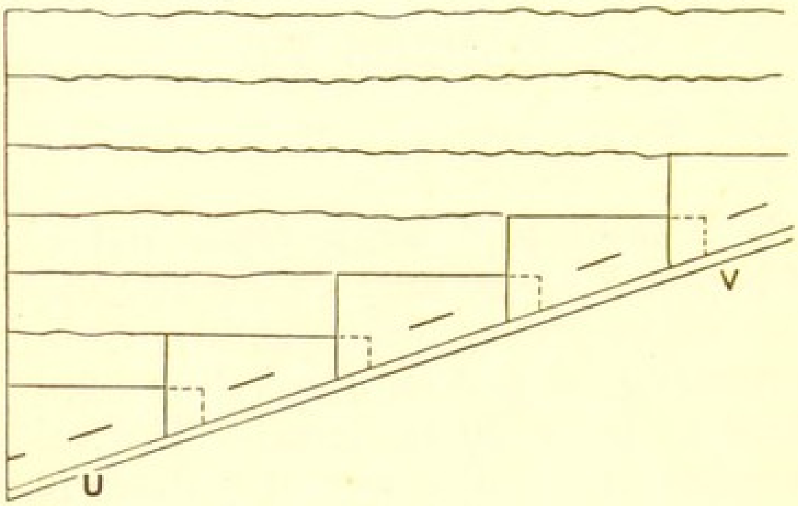



Fig. 53.

w being the lead or zinc stepped apron, and $w^a$ the lead or zinc flashing. To hold the apron into the joints of the bricks, lead bats can be used in some good brickwork. In other cases some use wooden wedges, and others, again, use "thumbats," or iron holdfasts,

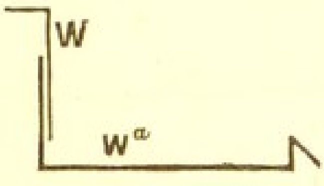



Fig. 54.

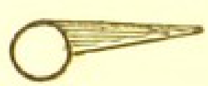


Fig. 55.

about 3 in. long, and with thin flat heads, as per Fig. 55. After the aprons have been fixed, the joints require to be cemented, or filled up with mastic.

Instead of putting on the flashings as described in Figs. 53 and 54, some use "soakers," or put on the flashing in pieces to suit the bricks and slates, one half of each piece of lead going up against the bricks, and the other half underneath the slates.

In Fig. 53 the horizontal length of each lead step will be about 1 ft. (in other cases it may be either more or less), while the breadth at the lower end will be, say, 7 in., and at the higher end, say, 3 in.; 7 in. + 3 in. = 10 in., gives 5 in. as the medium breadth of each step, which 5 in. being multiplied by 1 ft., the product is the measurement of each single step. If the sum total is wanted, then, supposing there are ten steps, 5 in. × 1 ft. × 10 = 4 ft. 2 in.

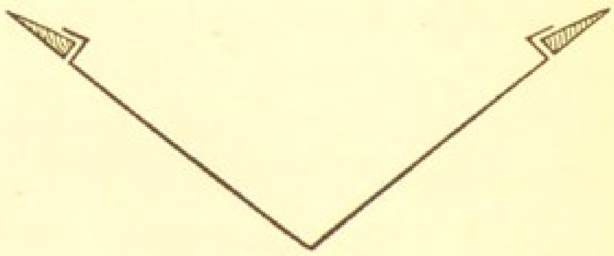


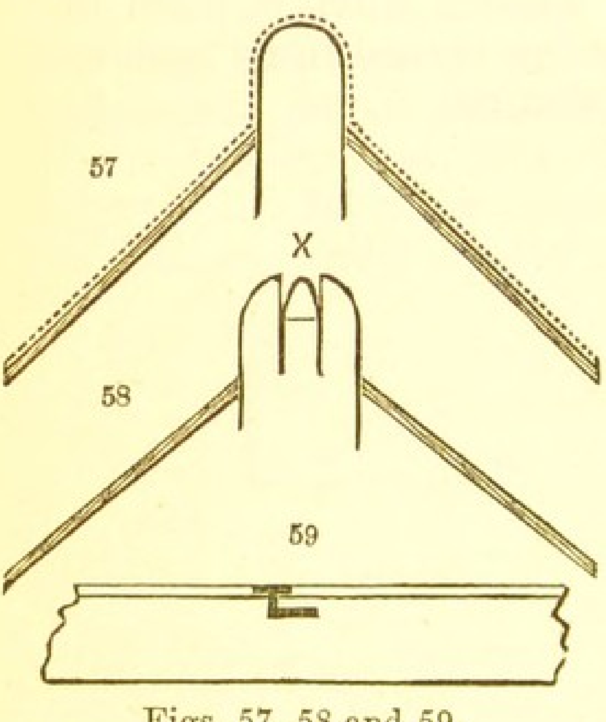
Fig. 56.

The valleys, or "flanks," as they are sometimes termed, are the inclined channels formed by two roofs meeting, say, at right angles; the breadth of either lead or zinc used is from 1 ft. upwards. "Doubling," or wooden fillet is put on all up each side of these "flanks," especially if lead is used, as per Fig. 56. If zinc be used, however, the wooden fillet is often dispensed with, a small roll being turned in on each side of the zinc for the slates to rest on.

## CHAPTER VII.

### Ridges and Hips.

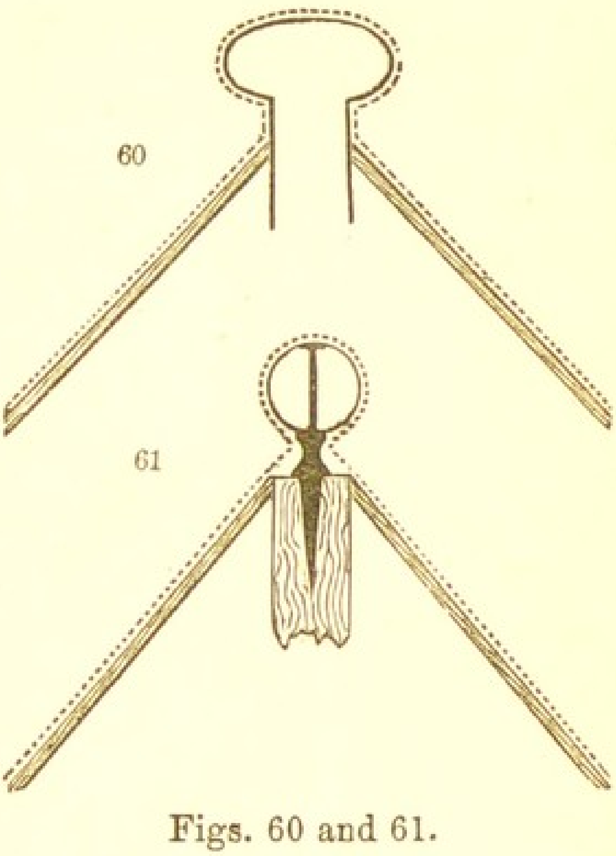
After the gutters, flashings, valleys, &c., have been laid and the slates put on, the ridges come next. These may be put on in the simple manner shown by the dotted line Fig. 57, which is that alluded to in Chapter III., the breadth of the lead used being one foot, or more if necessary. If zinc is used, the common breadth in many cases is one foot, but it may be used broader when required, for the breadth of the material must be in accordance with its site.



Figs. 57, 58 and 59.

Another plan for fastening on the zinc ridges is to groove out the wood ridge as per Fig. 58, and drive in iron staples in the groove, as shown at X; then, at corresponding distances, galvanised iron, or, perhaps, copper hooks are soldered on inside of the zinc ridges, as per Fig. 59, which shows longitudinal section; after which the zinc ridge is put on and slid along into its place, the hook going through the staple, and thus holding down the ridge. To hold the edge of the zinc ridge zinc clips are nailed over the wood ridge and their ends bent up, so as to clasp the edges of the zinc after the zinc ridge is put on. This plan, known as "Fox's Patent Underlock Fastening," is, so far as ridges are concerned, more troublesome and expensive than the former, described at Fig. 26, Chapter III., with straps, but it appears to have the advantage of doing without holes through the zinc ridge, although many may consider that holes in a good zinc ridge which are filled up by either a copper or a lead-headed iron nail, and protected by the galvanised iron strap, are in practice quite harmless.

Another plan of putting on lead on ridges is that shown by dotted line, Fig. 60, which requires the lead to be about 18 in. or 20 in. broad. Fig. 61 is section of another style of ridge; to hold on and keep in position the round wooden baton, shouldered iron spikes are used, which are first driven down into the wooden ridge below them, and, holes being bored in the wooden baton, it is put down on the spikes to the shoulder, and the top of the spike projecting through the hole is then bent over so as to hold like a rivet. The lead or zinc is then put on as per dotted line Fig. 61.




Figs. 60 and 61.

The hips, or *piends* as they are sometimes called, which are the external angles formed by the meeting of two sloping sides of a roof, as at A A, Fig. 73, further on, are generally covered in a similar manner to the ridges, and are put on before them. In some cases, however, the lead of the hip is put under the slates, and is therefore put on before the slates. In other cases one half of the lead goes above the slates, while the other half or side is put underneath them. This latter is done when two sides of a roof meet at different angles, and the lead must be put on under the slates on one side in order to make the roof water-tight. When it is intended to put the slates on both sides of the hip above the lead, the hip rafter should be kept somewhat higher than when the lead goes above the slates, as the appearance of the roof is greatly marred if the edge of the slates shows as high as the hip. A bold hip also serves as a wind-protector to the slates.

## CHAPTER VIII.

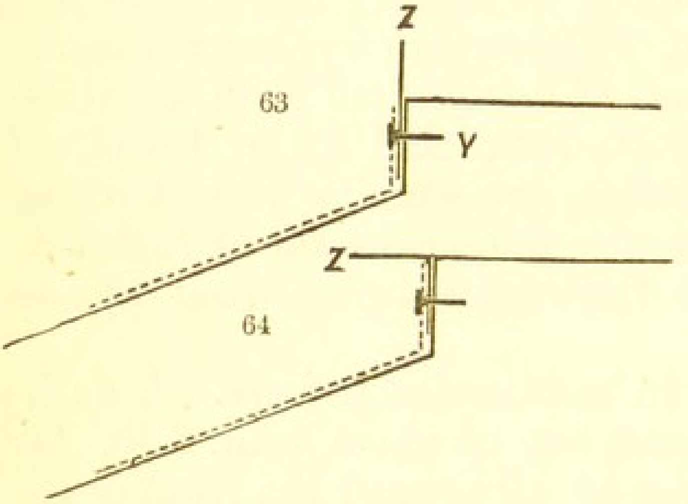
### LEAD-COVERED FLATS, OR "PLATFORMS."

WE shall now describe the method of using lead and zinc in covering flats, or "platforms" as they are sometimes called, on the roofs of houses, and shall, for illustration, take a flat 16 ft. long, and 12 ft. broad, of which Fig. 62 shows section, and which is to be covered with lead. In this case the water runs off at each side of the flat, the rise in the centre being about two or three inches.

Several things have to be attended to here. A flashing about one foot broad, say of sheet lead, 6 lb. per square foot, has to be put on all around the front of the

Fig. 62.

flat, which flashing can be cut in four pieces, two at about 17 ft. long for the front of the sides, and two at about 13. ft. long for the front of the ends. Four long strips of lead about 4 in. broad are also required to go along front of flat for clinch, two at 16 ft. and two at 12 feet long. Then the lead for top of flat has to be cut out, say, of 7 lb. sheet lead, the breadth of the several pieces depending, of course, upon the number of rolls it is intended to have in the length of flat. We shall take the number of rolls at 7, which—as the length of the flat is 16 ft.—makes the distance between the centre of each to be 2 ft., and the number of pieces of lead 8.* Before cutting out the lead the size of the rolls must also be settled, as some allow 3 in. and 4 in. for the roll, and others $2\frac{1}{2}$ in. and $3\frac{1}{2}$ in. I shall, in this case, take the latter, which causes the breadth of each of these eight pieces to be 2 ft. + $2\frac{1}{2}$ in. + $3\frac{1}{2}$ in. = 2 ft. 6 in.; and the length 12 ft. + 4 in. + 2 in. = 12 ft. 6 in. (or, to allow sufficient for the overlap over the front, better say, 12 ft. 7 in.) The extra 6 in. in the latter is for the overlap and turn in, or "clinch", at each end. The first thing to be done, in putting on the above lead cut out, is to nail on the long narrow 4 in. lead strips all round the edge of the flat with $1\frac{1}{2}$ in. flat-headed nails, leaving the top of the lead to project up 2 in. as per z, Fig. 63. Then, in front of this, put on the lead flashing — cut out at 1 ft. broad —as per dotted line, Fig. 63. Its top edge being nearly on a level with the top of the flat, about 3 in. is taken up by the perpendicular upstand, while the other 9 in. lies down on the roof. These flashings overlap each other at the four corners of the flat. Both the flashing and the narrow strip of lead, or "clinch," at its back, are held by nails driven in as at Y, Fig. 63.



Figs. 63 and 64.

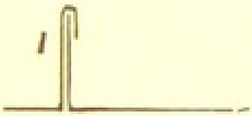
After the flashings have been all properly fixed and dressed, the upstanding lead at z, Fig. 63, is then turned down level with the top of the flat as per z, Fig. 64, and its outer edge planed straight. The situation

* In cutting out the lead do not scrimp it, more especially as any cuttings are not lost, but melt up again. While I have taken the distance between the rolls at 2 ft., some may make it 2 ft. 6 in., but the former is best for lead, and in some cases the distance may be 1 ft. 9 in. or 1 ft. 6 in.

of the rolls is then marked off as per Fig. 65, which shows longitudinal section of flat. Then one of the 12 ft. 7 in. + 2 ft. 6 in. pieces of lead is taken, and after being rolled out across the flat and dressed, it is set up (*i.e.*, turned up) all along each side as per A, Fig. 65, the upstand at one side being 2½ in. and at the other side 3½ in. high. Another 12 ft. 7 in. + 2 ft. 6 in. piece of lead is taken, rolled out, and set up in the same manner, and then put close alongside the former


Fig. 65.

piece as per B, Fig. 65, the side with 2½ n. upstand of B being next the 3½ in. upstand of A (the top of 2½ in. upstand of B having been planed straight before being placed close to it). The upper part of 3½ in. upstand of A is turned over B as per I, Fig. 66, the seam being beat close. The lead is then beat down all along the seam as per J, Fig. 67, and so the first lead roll is formed.



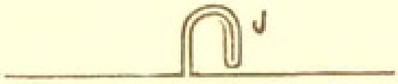




Fig. 66. Fig. 67.

The same process is repeated with the lead at C, the 3½ in. upstand of B turning over on the 2½ in. upstand of C; the same with D and E; then back to F. Where several hands are at the work, one portion may be doing F, G, H, while the other is at C, D, E. The 3½ in. upstand of F folds over the 2½ in. upstand of A, and so on with G and H, only in the case of E and H their outer edges have to lap over the lead shown at Z, Fig. 64, and to be folded in, or "clinched," as per K, Fig.

68, and then bent down as per L, Fig. 69, and beat quite close. What is done to the "outer edges," or sides, of H and E, as per K and L, has also to be done to the ends of H and E, as also to the ends of all the rest, and at the same time; and, in addition, both ends of the seven rolls have to be bent down about 2 in. over the edge of the flat. In bending or working these rolls

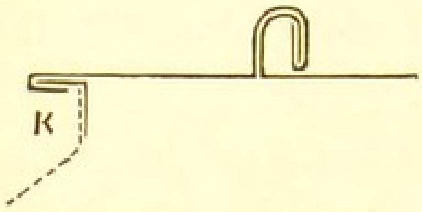



Fig. 68.

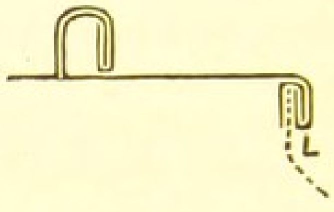
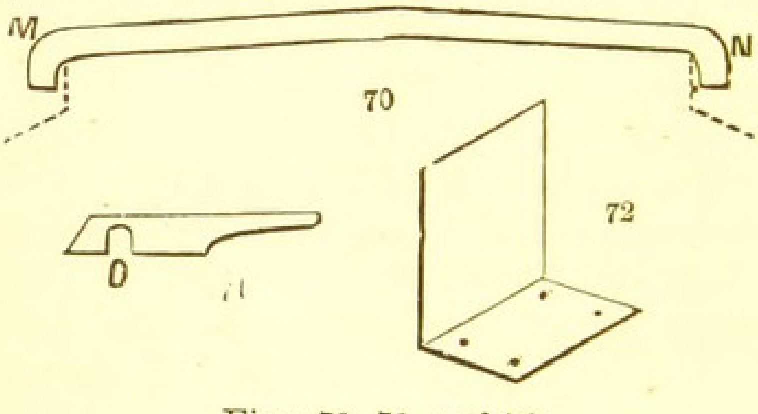



Fig. 69.

down over the edge of the flat, as per M, N, Fig. 70, some can do so without stuffing them, others, again, prefer to stuff the ends of the rolls before beginning to turn them. This stuffing is done by taking a piece of sheet lead about 9 in. long, and rolling it up firmly to the thickness of one's little finger or so, and then slipping this into the roll: the roll is turned down with




Figs. 70, 71, and 72.

stuffing in it. When being turned down a small portion of the end of the roll which is too long is cut off. While working these rolls one of the wooden dressers, cut out to the shape and size of the rolls, as per O, Fig. 71, is generally used. In order to tie down these lead rolls along their length, lead latchets or "clips" are put inside the roll. These latchets are simply pieces of sheet lead, about 5 in. long, and 3 in. or 4 in. broad, which are fixed on to the top of the flat, as per Fig. 72, with screw-nails; 2 in. on the flat, and 3 in. of upstand; they are put on every 4 ft. or so, the upstand going inside the seam, as between A and B, Fig. 65; and as B on that side only stands up $2\frac{1}{2}$ in., while the latchet is 3 in. high, the top of the latchet is bent down over B, and in order to leave no mark in the seam, the thickness of latchet lead is cut out of B's $2\frac{1}{2}$ in. upstand; and, of course, as the lead is being turned over to form roll, Fig. 67, the latchet is turned with it, and perforce takes the same shape, being inside it. The 2 in. of latchet, which is fixed to the wood of the flat, is sunk

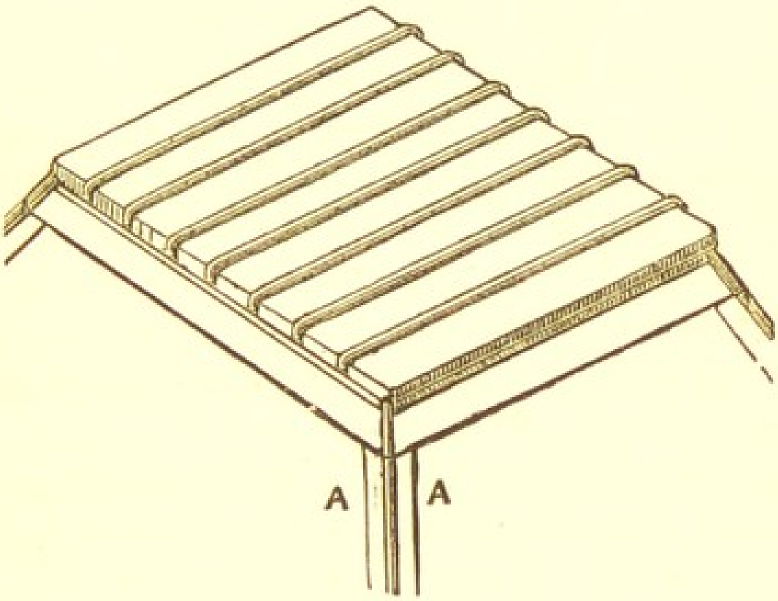



Fig. 73.

down in the wood the depth of its own thickness—viz. about one-twelfth of an inch. As this latchet goes between A and B, Fig. 65 (and in all the rolls—say two to each—which gives fourteen latchets), it is, of course, fixed on before A and B, &c., are brought together; 5 lbs. sheet-lead will serve for the latchets.

In this style of covering flats with lead, no wooden batons are required at all, while the lead is left quite free to expand and contract. In turning over the rolls they should always be turned towards the side which is least exposed to the wind and rain. In beginning to lay the lead on the top of the flat—although in Fig.

65, I have, for the purpose of illustration, begun in the centre with A and B—the plumber may begin at the side—viz. at E, Fig. 65, and in turning the rolls, he must be careful to keep them all straight and even. Fig. 73 is sketch of the flat when finished and covered with lead, as above described. In the above style of work no wooden batons are used, but as some may prefer to have them, say where the lead is apt to be

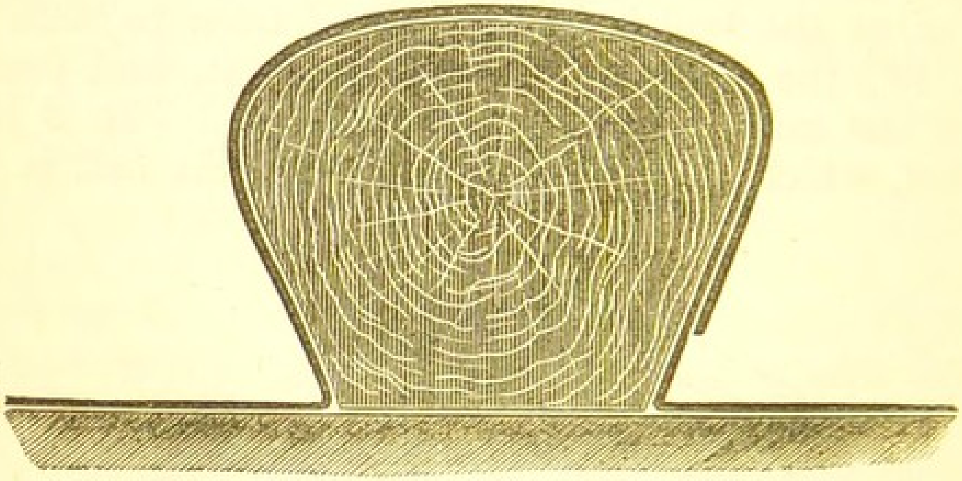


Fig. 74.

trampled upon, Fig. 74 is cross section showing how the lead is overlapped.

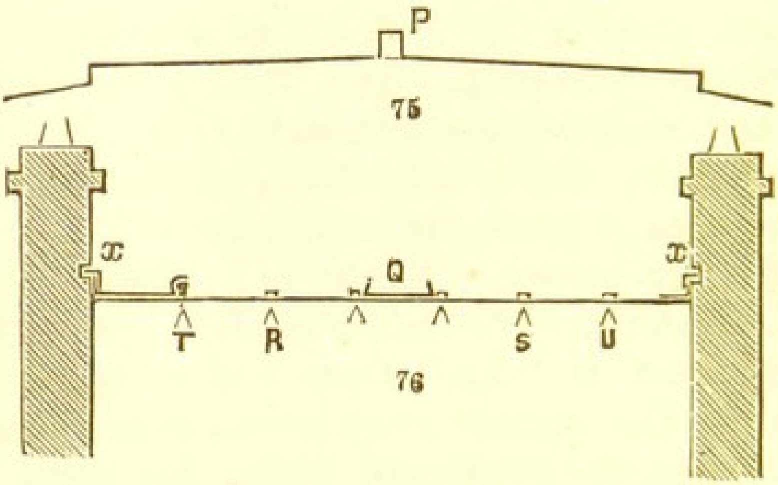
The wooden baton in this case may be put on of various sizes, to suit the place, say 3 in. broad by 2 in. high, or $2\frac{1}{2}$ in. by $1\frac{1}{2}$ in., or even less, as circumstances may require. It is firmly attached, by means of nails or screws, to the wood upon which it rests.

# CHAPTER IX.

## Zinc-covered Flats.

In our last chapter the manner of covering "flat" on the top of a hipped or pavilion roof with lead was described, and supposing the length of the flat had been taken at 116 ft. instead of "16," it would have been all the same as regards style, the only difference being that a greater number of pieces of lead would have been required. Had the *breadth*, however, been greater, say 30 ft. in place of "12," then a division would have been run up the centre lengthwise, something similar to what is to be explained below for zinc. And if broader still then drips would also have been put in.

In this chapter the style of using sheet zinc in place of lead is to be described, and for illustration we shall take a flat 17 ft. long by 15 feet broad, with a raised division running up its centre. Fig 75 is section of such flat, P being the square wooden block or frame, 3 in. broad and 3 in. high, running up the whole length of the flat. Instead, however, of supposing this flat to be situated upon the top of a "hipped" roof, with four trapezoidal inclined sides, as was flat in former article, we shall suppose it to be bounded at the ends by two gables, in which case Fig. 76 shows longitudinal section as distinguished from longitudinal section shown by Fig. 65. The first thing to be done here is to nail on a long narrow strip of sheet lead 17 ft. long by 4 in. broad all along the front of the flat on each side, just as is shown by Z, Fig. 63, then to cover the slates put on the two flashings—whether lead or zinc—one on each side, as shown by dotted line, Fig. 63. Then bend down the top half of the lead strip, which is to form the "clinch,"* as per z, Fig. 64, and then plane its edge straight. Provision must now be made for laying down the zinc on the top of the flat: but it must be understood how wide the sheets are to be. As the general size of zinc sheets is 8 ft. by 3 ft.,† we shall take that as the size to be used here, and as 7 in. is to be taken up by that portion of each side set up, that leaves the breadth of the sheet lying on the flat to be 2 ft. 5 in., and as this flat is 17 ft. long it will take up about seven such




Figs. 75 and 76.

breadths in its length. In order to lay the sheets as regularly as possible, the first one—after one side has been set up 4 in., and the other side 3 in. high—may be placed in the centre of the flat, as at Q, Fig. 76, then all up each side wooden rolls are to be nailed on, of which Fig. 77 shows half-sized section suitable for 2 in. zinc roll caps; this wood roll is $1\frac{7}{8}$ in. broad, and about $2\frac{3}{8}$ in. high over all. This wood roll, which extends

* A lead strip is recommended for the clinch, because when lead is used the clinch lies closer, and a better and neater job is therefore made.

† "Sheet zinc is always attainable in sheets 8 ft. and 7 ft. long, by 3 ft. and 2 ft. 8 in. wide, but it may be rolled of any length under 12 ft. For specially rolled sheets about a month's notice should be given, and for lengths over 10 ft. an additional cost of about £2 per ton is incurred for rolling."—*From printed circular of Vieille Montagne Zinc Mining Company.*

from the central division block to the edge of the flat, need not be made all in one piece, for it may be made and fixed on more readily in two pieces by making that portion below the dotted line of a separate piece, and nailing it on first, and then nailing the larger piece on above it afterwards. We shall take this latter plan, and nail on a $\frac{5}{8}$-in. by $\frac{1}{2}$-in. piece all up each side of Q, Fig. 76; then, at a distance of 2 ft. 5 in. + $\frac{5}{8}$ in. from each side of Q, nail on other two of these pieces, as at R S, Fig. 76, and at a similar distance nail on other two pieces, as at T U, Fig. 76. All these pieces, or wooden strips, are each 7 ft. $4\frac{1}{2}$ in. long. When they are nailed on, and the seven sheets of zinc laid down in their sites, with the top *ends* of all next the central block, or division frame P, Fig. 75, set up 3 in. high (which it will be understood is independent of the one side being set up 4 in. and the other side 3 in. high), the principal portion of the wood roll—viz., that above dotted line, Fig. 77—is

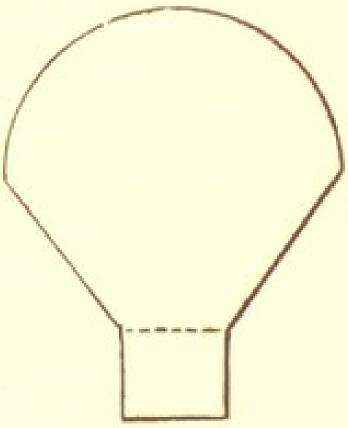


Fig. 77.

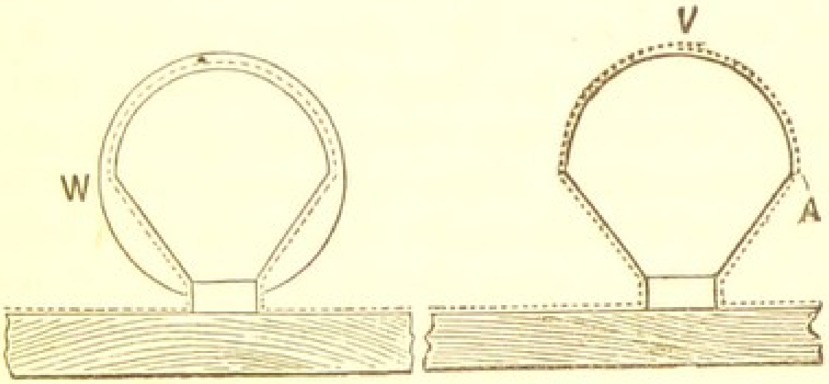



Fig. 78.

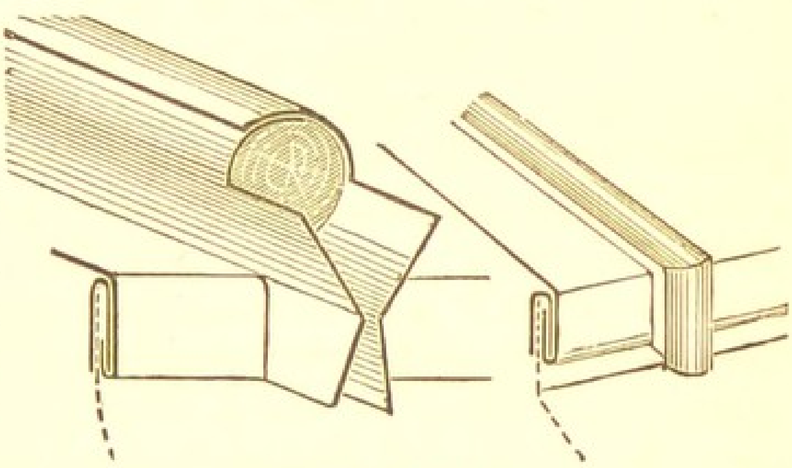
then nailed on; but to nail it properly a gimblet ought to be used to bore through the wood-roll first, which causes the nail when driven down to go in where wanted. Either nails or screws may be used about $3\frac{1}{2}$ in. or 4 in. long. The zinc is then brought over the rolls as per dotted lines, Fig. 78, the 4-in. upstand of the one side overlapping the 3-in. up-stand of the other side, as at v, Fig. 78.

While putting on these sheets the end of the zinc next the central block, P, Fig. 75, has to be soldered at the corners. The side of the zinc with the 3-in. upstand should be soldered first, then the 4-in. one, which overlaps it, and it must be an axiom with the plumber not to solder two different sheets together, but to keep each sheet by itself. In certain cases, of course, a piece may be soldered on to the *end* of a sheet to make that sheet longer, but that is different from joining two sheets together at the sides, or as above prohibited.

In soldering zinc diluted muriatic acid, or "spirits of salt," is used. In the *Family Herald* for March 2, 1872, I find it stated that in preparing spirits of salts for soldering it requires to stand several days in a bottle after the zinc has been put into it, and also to be shaken up every twelve hours; but that is simply a mistake, as the mixture does not require to stand even twelve minutes. In practice, the plumber pours a little of the "spirits" into a small dish, say a saucer, a jelly-can, or a lead dish, set up as per Fig. 41, about 6 in. square, and say 2 in. deep, then some small pieces of zinc are put in, and in a minute or two the mixture is ready for use. I have just made a trial of a mixture called "Baker's Preparation for Tinning and Soldering;" but I find the specimen I got not to be equal to the spirits, especially when applied to old or tarnished zinc, neither did it clean the soldering-bolt half so well. The acid, as I have said above, is diluted by dissolving a little sheet zinc in it. When the zinc is put in among the acid a violent ebullition sets in, which, however, soon subsides. If a light be put to it during ebullition the gas given off will go on burning for a short time. The soldering here is done by means of copper bolts. The acid is put on with a small piece of cane or a small brush.

After soldering the top corners of the zinc sheet next the central block, P, Fig. 75, the front edges of the zinc sheets have then to be clinched, as shown by K, Fig.

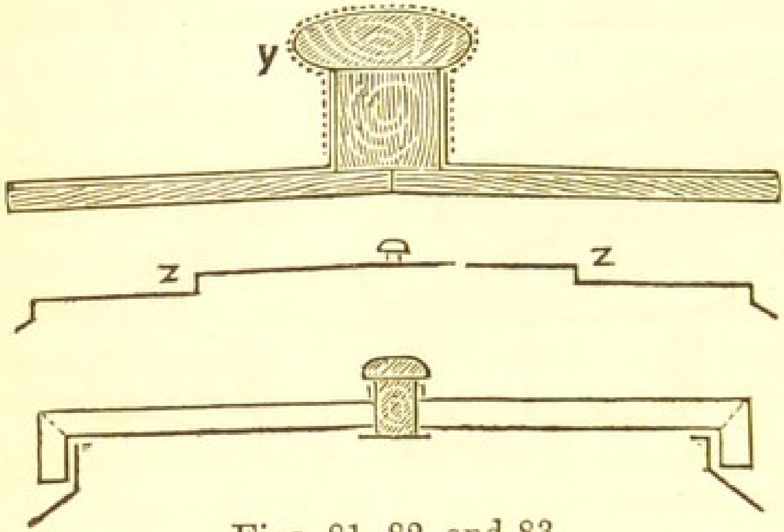
68; only before doing so about 1½ in. has to be cut off the end of the sheet, it being in this case that much too long. The portion of the upstand projecting beyond K is also cut away, so as to allow the zinc to be turned in. The zinc being turned in, as per K, it is then to be bent down as per L, Fig. 69; but as zinc will not work down at the corners in the same manner as lead, the upstands have first to be slit down close by the end of the wood-roll to allow the zinc to be bent down. When clinched and bent down as per L, Fig. 69, a small piece of zinc has to be inserted and soldered to each front corner of the zinc sheet, and so soldered as that each sheet is kept distinct and by itself. The size of this small piece is about 2 in. square. The two front corners of each sheet, therefore, project out before the butt end of the wood-roll fully 1½ in., as per Fig 79, the depth of the projection being about 3½ in. over all. The zinc-roll caps have then to be slid on as per the outer circle at W, Fig. 78, and in order to protect the front edges of the zinc sheets projecting in front of the wood-rolls a short piece of the zinc-roll—about 4½ in.—has to be taken and put on perpendicularly, being first mitred with the front end of the horizontal zinc-roll, and then both soldered together at the mitre. The inner edge of this short perpendicular piece of zinc-roll is to be kept about ½ in. back from the front edge of the flat, just as the bottom of the horizontal zinc-roll is raised a little above the flat. Fig. 80 (which is drawn on a smaller scale than Fig. 79) shows the roll-cap on, Fig. 79 showing it off. The end of the zinc-roll which is next, or comes up against the central block P, Fig. 75, has a small piece of zinc soldered round it, over which the



Figs. 79 and 80.

apron of the saddle comes, so as to make all properly water-tight. The sides of the zinc sheets which are next the gables are bent up about 3 in. high, and an apron put on, as per *x*, *x*, Fig. 76. A pailful of clean water and a brush should then be got, and the whole of the zinc brushed over, so as to clean off all spirits of salt stains, &c.—in fact, the water and a small brush should be there all the time.

The one side of the flat being covered as above described, the same is done to the other side of the flat, and after the saddle is put on the work is finished. This "saddle" is put on as per Y, Fig. 81, the dotted line showing the section of the lead. The saddle Y, here shown, it will be understood, rests upon P, Fig. 75; P being also represented here as supporting Y. The wood for this saddle is 17 ft. long (the length of flat), 5 in. broad, and about



Figs. 81, 82, and 83.

1½ in. thick. After it has been nailed on, and covered with lead about 1 ft. broad, as per dotted line at Y, the plumber-work of the flat is finished—*i. e.*, unless the plumber has also to "point" the chasing with mastic or cement, which "pointing" in some places is left for the slater to do. Although we have mentioned lead as the material to be used for the saddle, yet, if prefererd, zinc may be used, and put on in ridge style. The zinc used for flats is of various thicknesses. No. 14 makes a pretty substantial job. A good deal of No. 12 is used, however, in practice, but to use Nos. 9 or 10, unless for a mere temporary purpose, is extremely bad, and belongs to the "scamping" system, unless, indeed it is done through pure ignorance! To give sheet zinc fair play it ought to be put on of such a thickness as that after its surface has got oxidised by exposure to the atmosphere, there may still be left sufficient body in it to keep itself together, and also duly serve the purpose for which it was put on. When this is properly attended to, zinc stands well for ridges, flats, and sides of roofs. For the latter purpose —viz., for the sides of roofs, it may yet largely supersede the use of slates, as, if properly put on, it is not so apt to be continually going out of order.

In the foregoing flat, above described, the breadth is taken at 15 ft., but supposing the breadth were 30 ft., all the difference would be that twice the number of pieces of zinc would be required, as also two 4-in. drips put in—viz., one on each side as per z z, Fig. 82.

If, however, the breadth of the flat were 23 ft. say, then the zinc would be put on just as described for Figs. 75 and 84, only as an 8-ft. long sheet of zinc would be too short, sheets 12 ft. in length would be put on; but, as these would often be difficult to get, what might be done would be to take the 8 ft. sheets and solder on to the one end of each 4 ft. cut off another sheet, giving 1 in. or so of overlap at the soldering, thereby producing a sheet nearly 12 ft. long.

In the above flat (Figs. 75 and 84), with a slope of only 3 in. or so in the 8 ft. we have said that a little soldering was necessary at certain places, but in the case of a roof with a slope of 3 ft. or so every 8 ft., the greater part, or perhaps the whole of this soldering, could be dispensed with, as we may see in Chapter X. In the foregoing description of covering flat with zinc, we have taken the size of the zinc roll caps at 2 in., but for different purposes, and in different situations, they can be had of various sizes—$1\frac{1}{4}$ in., $1\frac{1}{2}$ in., $1\frac{3}{4}$ in., &c. And instead of keeping the sheets the whole breadth, as above done, they may be split up the centre, which, of course, would require twice as many rolls, the distance between them being only in that case about half the above. In the above illustration we have also set up the zinc 4 in. and 3 in. high on the sides, which allows it to overlap as per V, Fig. 78, but some plumbers only set it up as high as A, Fig. 78, which may do where it is not much exposed, and the flat has sufficient slope. Instead of doing the front corners of the sheets as per Fig. 79, it has been hitherto the custom with many plumbers to solder the front edges of the different sheets together (instead of keeping them all separate as per Fig. 79), which, of course, has the effect of causing them to give way here, as they often do.

Fig. 83 is section across the flat of the zinc roll-cap, in contrast to the skeleton view of the lead roll shown by Fig. 70; and Fig. 84 is sketch of zinc flat when finished, just as Fig. 73 showed lead flat when finished.

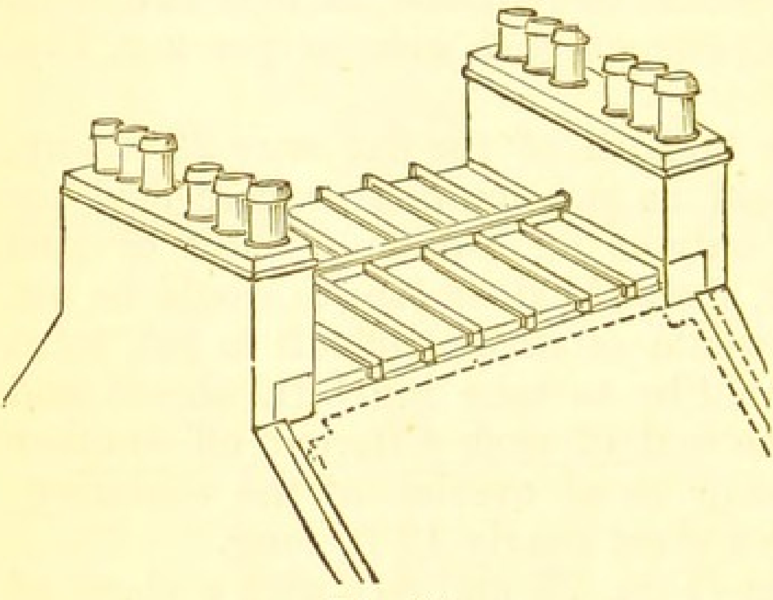
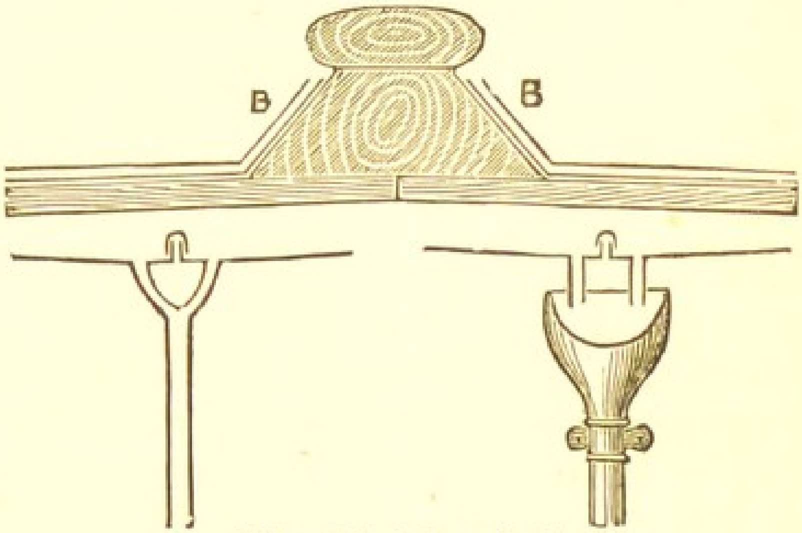


Fig. 84.

In covering broad flats with lead a wooden block, or frame, with saddle piece is often run up the centre as per Fig. 81, only, as in using lead, the lead rolls have to be turned up against it, as per B B, Fig. 85: the block is often made sloping as shown, so that the lead rolls may be turned up more easily.

While the first edition of these articles was being published in the *Building News* about 16 years ago, a considerable amount of correspondence took place about the style of laying the lead in the stone cornice gutter, explained in connection with Figs. 29 and 33 in Chapter IV., we may therefore observe that generally speaking the plumber has little control over the style of laying the gutters in the stone cornice referred to, as he has to make his lead to suit the channel, and in accordance with the architect's plan. If, as is often the case, the architect only allows one outlet for the rain water, and orders the gutter channel to be all inclined to one end, then the plumber is forced to lay his gutter all in one piece, as described ; but if the architect allows two rain-water pipes—viz., one at each end, then the plumber can lay his gutter in two pieces with a roll, an overlap, or a saddle in the middle. And, as regards stone cornice gutters, shown in Fig. 36, if two pipes are put in, then, as in many cases, there is no necessity to lay any gutter along the front of the chimney, shown at Fig. 36, as the gutter-lead can be made to stop off at each front corner of the chimney, which causes the gutter to be in two pieces, and each piece so much shorter. Or, to take another plan, supposing the gutter channel at Figs. 29 and 33 were inclined from each end and made with a slope down towards the middle, then even with one rain-water pipe, the gutter lead could be put in in two pieces, either by using a breeches pipe, as per Fig. 86, or by letting down two short pipes into one rain-water head, as per Fig. 87.



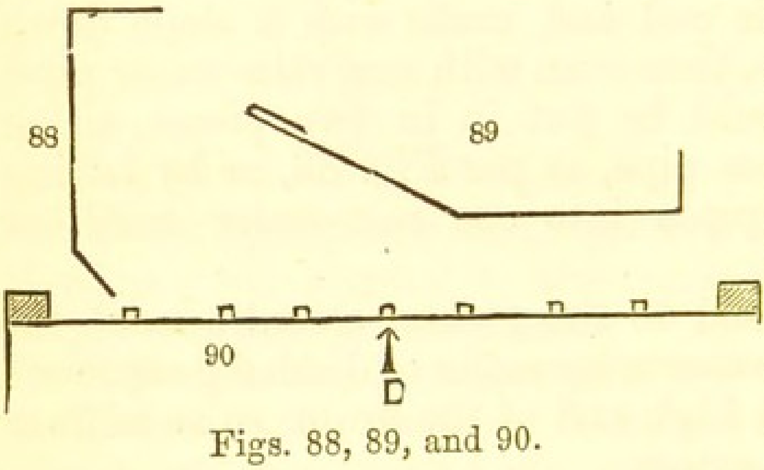
Figs. 85, 86, and 87.

It would often tend to the greater cleanliness of the drains if the rain-water were made to discharge as much as possible into the high end of the drain, so as to flush all below where it enters.

## CHAPTER X.

### ZINC-COVERED ROOFS.

IN Chapter IX. the style of covering a flat on the top of the roof with zinc was described. In this we shall speak of covering the sides of roof with zinc. Before beginning to lay the zinc up the sides the gutters have first to be laid, and we may suppose the front one to be of the style shown in Fig. 44, while the back gutter may be of the style shown by s, in Fig. 29. These gutters may be either of lead or zinc; but as for my part I prefer lead for the gutters we shall suppose lead to be used for the gutters here. The apron shown at Q, Fig. 44, may be of zinc; in fact, in towns it is a good thing to have this apron of zinc,



Figs. 88, 89, and 90.

because when of lead it is often taken away, and it is better, therefore, to lock the door before the steed is stolen than after it has vanished. In order to stiffen it, the lower or outer edge of the zinc apron, or flashing, has to be set in a little, as per Fig. 88. In setting up sheet zinc to the sizes and shape necessary to make it fit its intended site, it is turned over the edge of an iron-faced bench; or if, as is often the case, the zinc is set up at the job, then in many cases a long, stout, sharp-edged wooden plank is made to serve the purpose in lieu of the bench proper.

In the sketch of gutter at Fig. 44, the wooden fillet or "doubling" for slates is shown at the top edge of the lead; such "doubling," however, is dispensed with here, as in this case we are not to have any slates. The style of the roof is the common gable, or "pent" roof, and, for illustration, we shall suppose it to be 10 ft. long between the skews (the reason why we suppose the length to be only 10 ft. is in order to economise the space for engravings, and the principle can be shown all the same with a length of 10 ft. as with one of 100 ft.), the depth of the roof from the ridge to the gutter channel being, we shall say, 15 ft. Before doing anything else to the roof, the whole of its surface ought to be examined to see if there are any nails, &c., projecting above the surface, and if there be any such thing they must all be well punched down. The gutter being laid, and its top edge next the slope of the roof bent over about 2 in., as per Fig. 89, the number and site of the rolls must then be fixed. As the length between the skews is 10 ft. and the 8 ft. by 3 ft. zinc sheets are all to be cut up the middle longitudinally, it follows that there will be seven rolls, and also eight sheets in the length of the roof. The site for the first roll may, therefore, be marked off in the centre of the roof, as per D, Fig. 90. The full breadth of our zinc sheets, after being cut up, being now 1 ft. 6 in., it follows that as

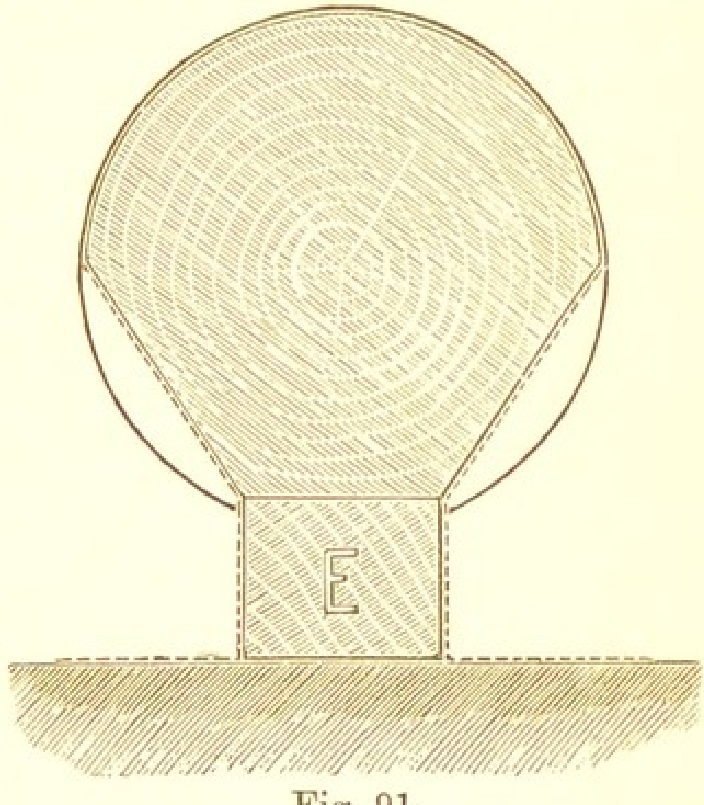
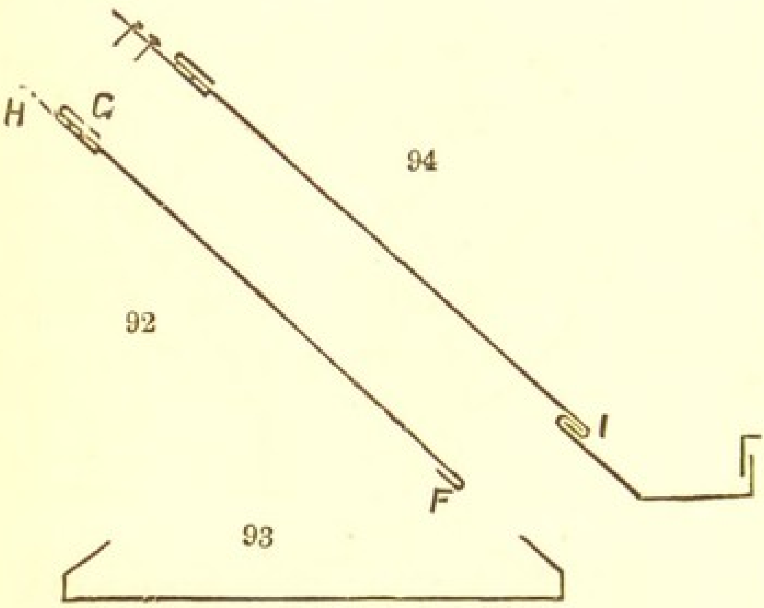


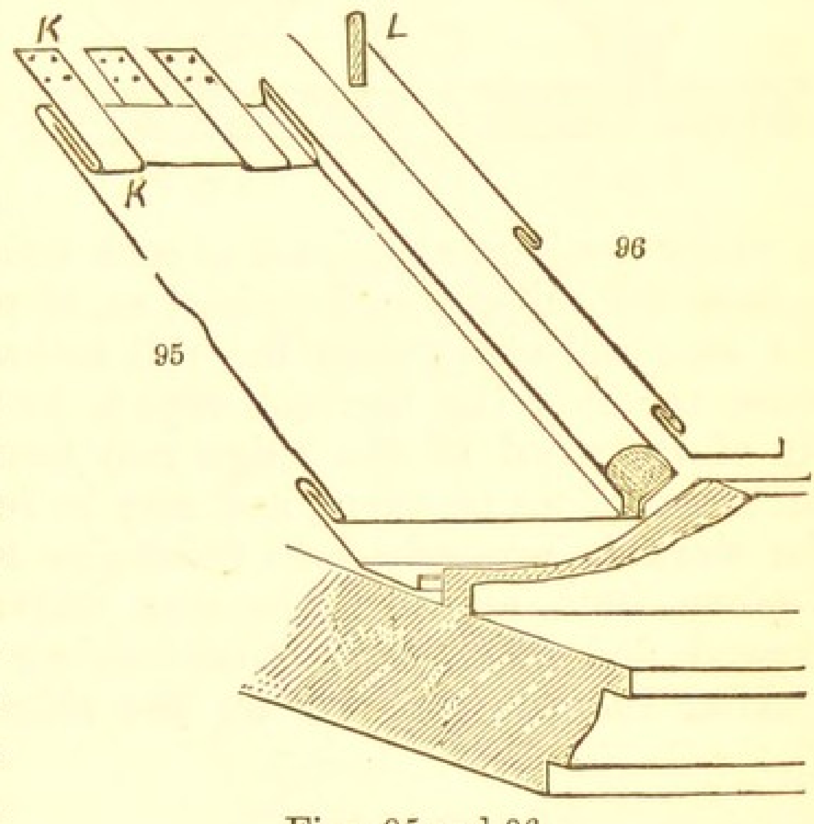
Fig. 91.

1½ in. is to be allowed for the upstands on each side of the sheet there will only be a distance of 1 ft. 3 in. between the rolls, as also that the number of the rolls required will, as we have said above, be seven, as shown on Fig. 90. As the size of the zinc roll-caps is in this case to be 1½ in., Fig. 91 shows full-sized section of wood-roll suitable for same. (The outer circle, shown on Fig. 91, is full-sized section of zinc roll-cap, and the dotted lines show the zinc sheets as turned up against the wood-roll.) The wood-roll, Fig. 91, is about 1⅜ in. broad by 1⅞ in. high over all. It is best to be made and put on in two pieces as described for 2 in. rolls at Fig. 77. We therefore nail on the long strip E, Fig. 91, first, in the centre of the roof, as at D, Fig. 90, and at the distance of 1 ft. 3 in. from each side of it nail on other two pieces, and 1 ft. 3 in. from them other two, and 1 ft. 3. in. from the latter other two: in all seven strips, as shown by Fig. 90. After these long wooden strips are nailed on (as they extend from the gutter up to the ridge, the length of each is about 15 ft.), the zinc has to be turned in at the bottom 1 in., as per F, Fig. 92, and also turned down at the top 2 in., as per G, Fig. 92. The sides of the sheets have then to be set up 1½ in. on each side, as per Fig. 93.



Figs. 92, 93, and 94.

After this is done a small strip of zinc about 6 in. long by 3 in. broad is firmly soldered on to the under side of the sheet at the top, as at H, Fig. 92; it is to be put on in the centre of the width, and its purpose is to support the sheet, and keep it from slipping down after said sheet has been put into its place. When the zinc sheet is put into its place three or four flat-headed nails are driven through the upper half of H, thereby fixing H to boarding, and so suspending the sheet The lower portion of the sheet, turned in as per F, Fig. 92, it will be understood, laps on to the top edge of the gutter, which was turned down to suit it, as per I, Fig. 94. Besides zinc latchet H, Fig. 92, two other zinc "clips," about 6 in. long by 2 in. broad, are put on for top of each sheet, one at each side of H. They are merely nailed to boarding and turned into top of sheet, as per K K, Fig. 95. The eight sheets on the lower half of the roof next the gutter being thus laid—except the two outside sheets next the gables J J, Fig. 90, which may be set up 2 in. or 2½ in. on the side next the gable—it is seen that they only go about half-way up the side of the roof; consequently other eight sheets, each 18 in. broad, have to be taken and their bottoms turned in as per F, Fig. 92, and their sides set up, as per Fig. 93, while their tops may stop off at the ridge, as per L, Fig. 96. Or, for another style of finish, the tops of the sheets may be set up against the ridge. The latchets H, Fig. 92, are to be soldered on for the top sheets, just as mentioned above for the others. It may be here pointed out that Fig. 96 is shown at half the size of scale of Fig. 95.



Figs. 95 and 96.

The other side of the roof being also laid in a similar manner, and the wooden rolls all fixed on between the sheets, as per Fig. 97, the zinc roll-caps (which I may here mention are generally machine-made) are then slid down over them, as per M, Fig. 98. But as these zinc roll-caps are generally in 8 ft. lengths, while the side of the roof is 15 ft. deep, it follows that there must be a joint in each stretch of roll-capping, which joint is simply made by slipping the upper roll-cap an inch or two over the lower one, and also soldering it. One nail or small catch put in under the joint at the top of each roll-cap is sufficient to hold the roll-cap in its place, as, if properly put on, the zinc roll-cap grasps the roll below it firmly. In order to allow the zinc roll-caps to be slid on, a small bit of the wood of the ridge may have to be cut out, but if so it does no harm, and may be replaced. Where the work is properly done these zinc roll-caps fit like a glove, both allowing the zinc underneath them to expand, and at the same time holding it.

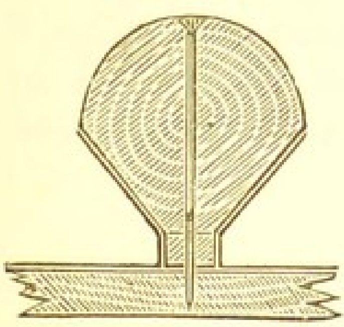


Fig. 97

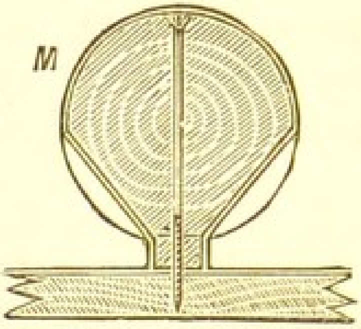



Fig. 98.

After the roll-caps are on the ridge must then be covered. It makes a very neat and tradesmanlike job to put on a good lead ridge of 6 lb. or 7 lb. sheet lead, about 15 in. broad, which can be nicely worked over all the rolls, and allowed to come down the roof several inches, so as to give sufficient overlap. Fig. 99 shows perspective view of the roof when finished.

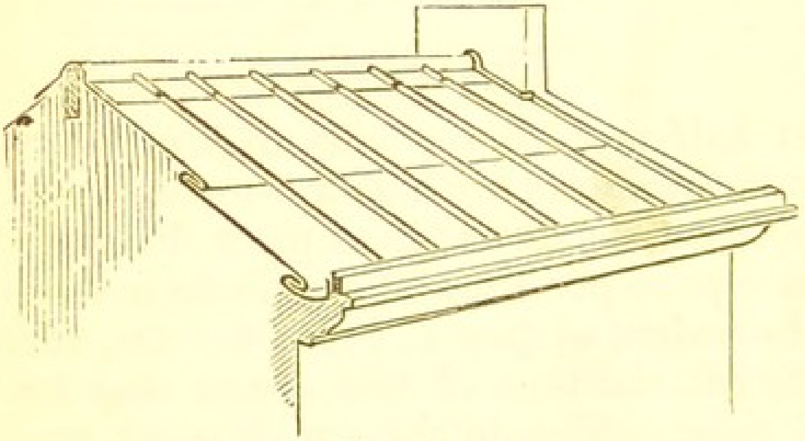
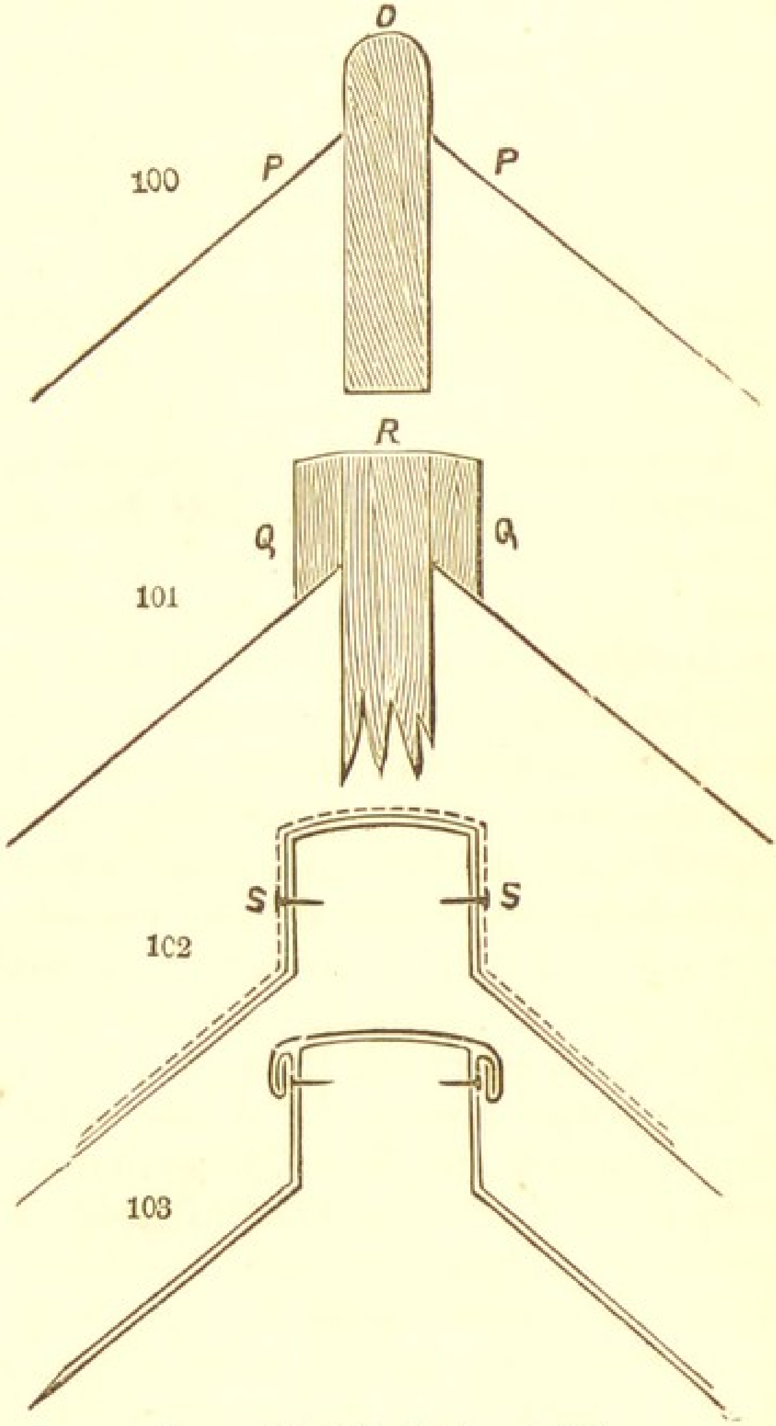


Fig. 99.

In the beautifully-got-up and useful illustrated pamphlet on "Zinc as applied to Roofing Purposes," issued by

Messrs. Braby & Co., it is stated that Mr. H. G. Austin, architect to Canterbury Cathedral, had covered the cloister-roof with zinc, thirty-three years ago, with lead capping, and it had stood so well that he intended to use it further. This employment of the "lead-capping," therefore, agrees with our recommendation as above given of lead for the ridge. Another way to finish the ridge would be one which I would respectfully call the attention of architects and builders to, as it could easily be adopted and used for roofs which are covered with slates, to the great saving of the slates from breakages from the feet of sweeps or other parties who have occasion to walk along the top of the roof. Fig. 100 shows common style of ridge, the centre-piece projecting up about 3 in. or so above the sides. In this case the wood being only $1\frac{1}{2}$ in. or 2 in. broad, and also round at the top, parties walking along cannot very well walk on the top of the ridge, as at o, and so the feet are put down on




Figs. 100, 101, 102, and 103.

each side, as at P P, thus perpetually causing the slates to be broken there. Now, if the top of the ridge at O were more flattened, and also two strips of wood, about 1 in. thick and about 3 in. deep, were taken and nailed on, one on each side of the ridge, as per Q Q, Fig. 101, then parties having occasion to be on the roof could easily walk along the top of the ridge R without requiring to touch the slates at all. To cover this form of ridge where slates are used, the zinc may be put on as per Fig. 102, the dotted line being galvanised iron straps, put on every 2 ft. 6 in. or so. Or, another plan would be to put on a flashing—either lead or zinc—on each side, and a separate piece for the top, as per Fig. 103. Or, again, if we turn back to Figs. 58 and 59, the hook-and-eye system there depicted—designated, "Fox's Patent Underlock Fastening," but which patent is now held by Messrs. Treggon, Hickson, & Co.—may be used; the hooks being driven into each side of the ridge where the nails S S, Fig. 102, are shown, and the eyes soldered on to the inside of the zinc ridge; or *vice versa* as shown at Figs. 58 and 59. It will be observed that the tops of the ridges Figs. 102 and 103, and at R, Fig 101, are not flat, but that they are slightly convex, the rise in the centre in the actual size of the ridge being fully ¼ in.; or, in other words, the top of the form of ridge we are referring to is the arc of a circle 14 in. in diameter, of which the chord is 4 in.

The shape and style of the rolls given here as per Fig. 91, and in Fig. 77 were not included in the pamphlet "Zinc as applied to Roofing Purposes," issued under the auspices of the architects and engineers to the London manufacturing agents of the Vieille Montagne Zinc Co.; but as we not only highly approve of it, and it also has a fine appearance and makes a good job, we could not do otherwise than show it as has been done, more especially, too, as it has for some time back been largely used. The style of overlapping the zinc on the top of the rolls shown by the dotted lines, Fig. 78, Chapter IX., is the maximum for setting up the sides of the sheet: but in thousands of cases, and unless the customer wishes it otherwise, the zinc at the sides of the sheets needs only to be set up about half-way up each side of the roll, as shown by Figs. 91 and 97 above. This is especially the case where there is a good slope, and no danger from half-melted snow lying.

Messrs. J. & R. Fisher, the architects of the Zinc Co. above referred to, in a note to us, recommend the style of roll shown by Fig. 104, which is certainly very plain, and which we will admit may, perhaps, be a little cheaper at first cost and easier to put on than the style at Fig. 91; but we can hardly admit that it either makes a better job or looks so well.

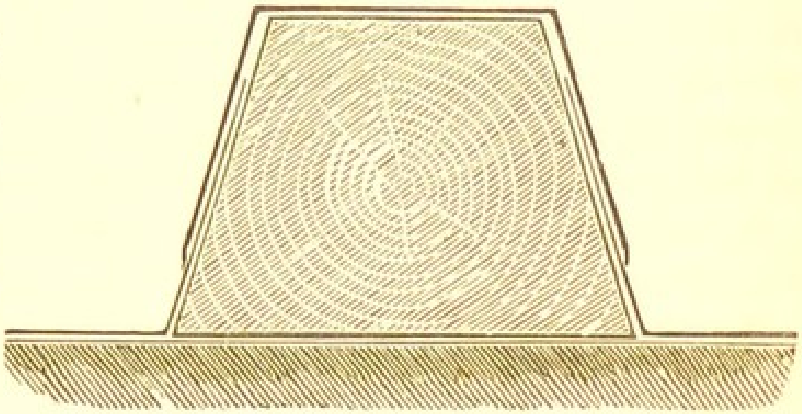


Fig. 104.

However, where there are many men there are many minds, so there is plenty of scope for both plans. Fig. 104 is known as the "French Plan," and if there be no objections, Fig. 91 might be called the *British* Plan.

Another plan of roll is that shown by Fig. 105, with five zinc clips 2 in. broad, in the length of the sheet, put under the wood roll and turned down as shown. This appears to be an improvement upon Fig. 104, but to our mind it could be greatly improved by being rounded at the top and also contracted a little more at the bottom, which would enable zinc roll-cap

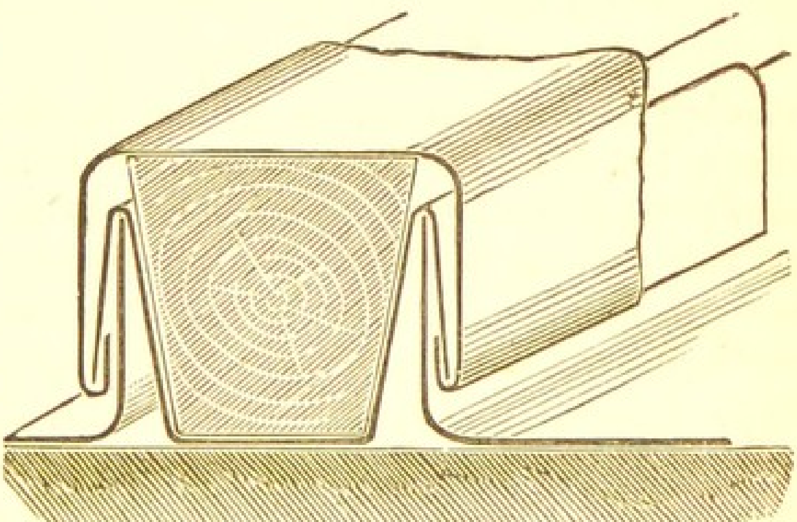


Fig. 105.

to take a firmer hold of the roll, and also suit the purpose better. The style of Fig. 104 also requires zinc clips put under the wood-rolls, as shown in Fig. 105; none such are required for Fig. 91, as the style of the wood-roll renders them unnecessary. The style of roll and shape of roll-cap at Fig. 91 are also unfavourable to capillary attraction having scope. Fig. 106 shows "patent wood-roll with zinc drawn over by machinery." It is 2 in. high, and $2\frac{3}{4}$ in. broad. We cannot say that we consider this style any improvement upon Fig. 105; it is, however, a variety. In Fig. 106 we would be afraid of snow or heavy rain being blown in at the sides of the roll, and so rotting the wood, especially where the roof was very flat.

In the foregoing styles of laying or putting on zinc it will be understood that the roofs underneath the zinc are boarded—*i. e.*, that the zinc lies on wooden boards. In what is known as "Italian corrugation," no boards are used, wooden rolls 3 in. deep, by $1\frac{3}{4}$ in. broad, being put in every 1 ft. 3 in., centre to centre, and purlins fixed every 10 ft. or so. The overlap at the top and bottom of the sheets is about 4 in., and the screw-nail ought not to be put in through both sheets. Fig. 107 is section of this style. The fold in Fig. 108 is an improvement upon the mere overlaps of Fig. 107, especially where the roof is much exposed. For roofs without boards, No. 15 or 16 zinc ought to be used.

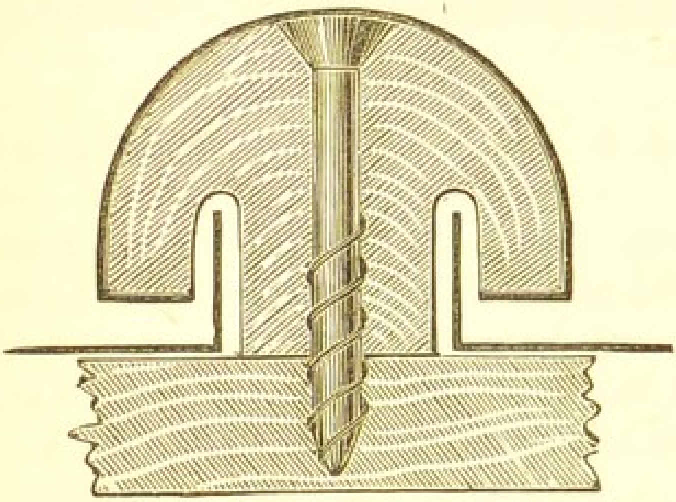
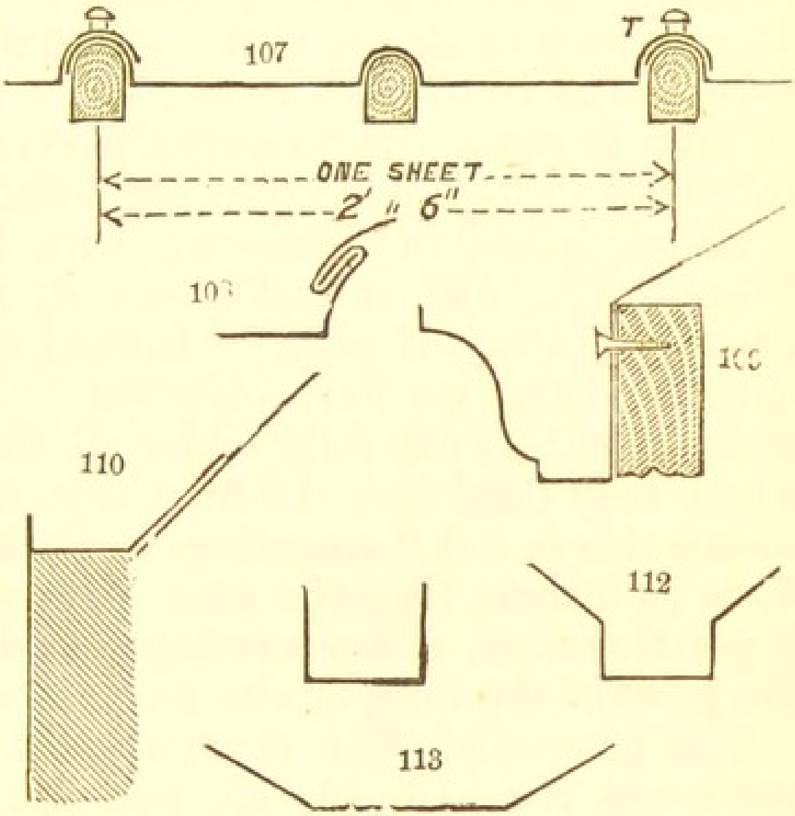


Fig. 106.

The style of roll at Fig. 104, and the overlap at T, Fig. 107, are something similar to the manner in which lead is put on for flats, &c., in many parts of England and Ireland, but neither can for a moment compare to the style of roll shown by Fig. 67; we would, therefore, respectfully recommend the style of laying lead on flats described in Chapter VIII. as being much better than the styles where wood is used for the rolls, especially where the rolls are not liable to be trampled upon.

The gutters for these zinc-covered roofs may be of many patterns similar to those we have already described; and, in addition, we have the zinc eave-gutter (Fig. 109), which may contain various enrichments in stamped zinc; the boundary-wall gutter (Fig. 110); the plain "box-gutter" (Fig. 111), or the same with sloping sides, as per Fig. 112, for the centre-gutter on double roofs. Fig. 113 is the common style of centre-gutter on double roofs in the south-west of Scotland. In using zinc for roofs there are two situations in which it does not stand so well—viz., quite close to the sea-side and where it is much exposed to the fumes from chemical works; but these are exceptional situations. In the latter case a coating of white-lead paint helps to protect the zinc. In the neighbourhood of the St. Rollox chemical works at Glasgow we have seen that side of a zinc ridge which was next the works wholly eaten away, while the off side was still pretty good.



Figs. 107, 108, 109, 110, 111, 112, and 113.

In the article on "Zinc" in Gwilt's "Encyclopædia of Architecture," we are told that zinc is much more used in France than in England, and it goes on to say:

—" Zinc, though subject to oxidize, has this peculiarity, that the oxide does not scale off as that of iron, but forms a permanent coating on the metal, impervious to the action of the atmosphere, and rendering the use of paint wholly unnecessary. Its expansion and contraction is greater than those of any other metal; thus, supposing 1·0030 to represent the expansion of it, 1·0019 is that of copper, and 1·0028 that of lead; hence, in use, proper attention must be paid to this circumstance, or a substantial and durable covering of zinc will not be obtained. The method of accomplishing this is, of course, by always allowing plenty of *play* in the *laps*. The tenacity of zinc to lead is as 16·616 to 3·328, and to copper as 16·616 to 22·570; hence a given substance of zinc is equal (in tenacity) to five times the same substance in lead, and about three-fourths of copper."

As explained in connection with Figs. 79 and 80, Chapter IX., and as just observed, zinc ought to be allowed "plenty of *play*." Instead of doing so, when covering flats, we have observed in our travels that many plumbers carefully solder all the sheets together where they bend over the front edge of the flat. Now, seeing this is not "according to Cocker," we object to it, as in a short time the zinc gives way at the solderings; therefore, either overlap the sheets properly at the front of the rolls, or else finish as shown in Fig. 79.

The gauges of zinc recommended for roofing purposes are Nos. 13, 14, 15, and 16. The following tables of some of the gauges, and their corresponding weights, may be useful. The weights given are not absolutely correct, there being slight variations in the weight of sheets of the same gauge, some being a little heavier than as given in the table, others a little lighter:—

No. 1, Old Tariff.

| Sheet-zinc gauge. No. | | Weight per sq. foot. oz. dr. |
|---|---|---|
| 8 | .. | 9 0 |
| 9 | .. | 10 13 |
| 10 | .. | 12 8 |
| 11 | .. | 15 0 |

No. 2, Newer Tariff, A.D. 1878.

| Sheet-zinc gauge. No. | | Weight per sq. foot. oz. dr. | | Weight of Sheet 8ft. by 3ft. lbs. oz. dr. |
|---|---|---|---|---|
| 8 | .. | 9 2 | .. | 13 11 0 |
| 9 | .. | 10 5 | .. | 15 7 8 |
| 10 | .. | 11 7 | .. | 17 2 10 |
| 11 | .. | 13 5 | .. | 19 15 8 |

No. 1, Old Tariff.

| Sheet-zinc gauge. No. | Weight per sq. foot. oz. dr. |
|---|---|
| 12 | 17 5 |
| 13 | 19 5 |
| 14 | 21 12 |
| 15 | 24 0 |
| 16 | 26 0 |
| 17 | 30 0 |
| 18 | 34 13 |
| 19 | 39 2 |
| 20 | 43 7 |

No. 2, Newer Tariff, a.d. 1878.

| Sheet-zinc gauge. No. | Weight per sq. foot. oz. dr. | Weight of Sheet 8ft. by 3ft. lbs. oz. dr. |
|---|---|---|
| 12 | 15 2 | 22 11 0 |
| 13 | 16 15 | 25 6 8 |
| 14 | 18 12 | 28 2 0 |
| 15 | 21 12 | 32 10 0 |
| 16 | 24 12 | 37 2 0 |
| 17 | 27 11 | 41 8 8 |
| 18 | 30 11 | 46 0 8 |
| 19 | 33 11 | 50 8 8 |
| 20 | 36 10 | 54 15 0 |

Parties wishing further information about the use of zinc for roofing purposes, in connection with the walls and timbers, &c. (as zinc is lighter than slates thinner walls and slighter roofs may often serve), may obtain it from the architects specially retained by the Vieille Montagne Zinc Co.—viz., James Edmeston, Esq., 5, Crown Court, Old Broad Street, City ; or Messrs. J. and R. Fisher, 17, Great George Street, Westminster.

In the foregoing tables the weights of sheet-zinc were given ; in this case we add a table of its approximate thickness, according to No. 2 Tariff :—

| Sheet-zinc gauge. No. | Birmingham wire-gauge. No. | Thickness in decimals of an inch. | | Parts of inch. |
|---|---|---|---|---|
| 9 | 26 | ·017 | = | 1—58th |
| 10 | 25 | ·019 | = | 1—52nd |
| 11 | 24 | ·022 | = | 1—45th |
| 12 | 23 | ·025 | = | 1—40th |
| 13 | 22 | ·028 | = | 1—35th |
| 14 | 21 | ·031 | = | 1—32nd |
| 15 | 20 | ·036 | = | 1—28th |
| 16 | 19 | ·041 | = | 1—24th |
| 17 | — | ·0459 | = | 1—22nd |
| 18 | 18 | ·051 | = | 1—20th |

The exact decimals of an inch of the Birmingham wire-gauge I understand to be :—

| 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|---|---|---|---|---|---|---|---|---|
| ·018 | ·020 | ·022 | ·025 | ·028 | ·032 | ·035 | ·042 | ·049 |

A square foot of zinc 1 in. thick weighs 600 oz., or $37\frac{1}{2}$ lb. ; from above table we therefore see that No. 12 zinc, *e.g.*, is ·025 or 1-40th of an inch thick, and that it would therefore require 40 thicknesses of it to make up one inch. Then, if we turn to page 67, we find from the table there that No. 12 zinc weighs fully 15 oz. to the foot. Now, if we multiply 15 oz. by 40, we get 600 oz., or $37\frac{1}{2}$ lb. Or, again, taking No. 14, we see it is ·031, or 1-22nd thick; then, as per page 67, multiply the $18\frac{3}{4}$ oz. there given for No. 14, by 32, and we also get 600 oz., which shows that it requires 32 layers of No. 14 sheet zinc to make up 1 in. in thickness. Then to get the weight of one cubic inch of zinc, divide the 600 oz., above given, by 144, and we get $4\frac{1}{6}$ oz. as the weight of a cubic inch of zinc. I may add here the two following rules from Messrs. Braby and Co.'s circular, which may be useful:—

Rule to obtain contents of any square or oblong tanks. —Multiply the length by the breadth, and the product by the depth; the result multiplied by $6\frac{1}{4}$ gives contents in gallons.

Rule to obtain contents of round cisterns or tanks.— Multiply the diameter by itself in inches, and the product by ·7854, then multiply this product by the depth in inches, and you get the number of cubic inches. There are $277\frac{1}{4}$ cubic inches in a gallon of water; so that, *e.g.*, a cistern 18 in. diameter, and 3ft. high, would contain, approximately, 33 gallons, $277\frac{1}{4}$ being used as the divisor.

A cubic foot of lead weighs 11,352 oz., or $709\frac{1}{2}$ lb. (water at 40° Fahr. weighs 1,000 oz.). A square foot of lead, 1 in. thick, will, therefore, weigh $59\frac{1}{8}$ lb.; but suppose we call it 60 lb., we get the following thicknesses for the following weights of sheet lead:—

| Weight per sq. ft. in lb. | Parts of an inch. | Decimals of an inch. |
|---|---|---|
| 10 | 1-6th | ·169 |
| 8 | 2-15ths | ·135 |
| $7\frac{1}{2}$ | 1-8th | ·126 |
| 6 | 1-10th | ·101 |
| 5 | 1-12th | ·084 |
| 4 | 1-15th | ·067 |
| 3 | 1-20th | ·050 |

A cubic inch of lead weighs fully $6\frac{1}{2}$ oz., and as we said above that a square foot, 1 in. thick, weighed 59 lb., or 944 oz., a circular slab 1 ft. in diameter and 1 in. thick would weigh fully 735 oz., and a lead circle piece, 1 in. diameter and 1 in. high, weighs five ounces and one-tenth. To get this latter, multiply $6\frac{1}{2}$ oz. by ·7854; and to get the 735 oz. for circular slab 12 in. in diameter, square the diameter, and multiply by ·7854, which gives number of cubic inches, then multiply by $6\frac{1}{2}$ for number of ounces. Again, if circular slab were cylinder 10 in. high, then $12 \times 12 \times {\cdot}7854 \times 10 \times 6\frac{1}{2} = 7{,}351$ oz., or more correctly, $12 \times 12 \times {\cdot}7854 \times 10 \times 6{\cdot}569 = 7430$ oz. To get area of a right-angled triangle, multiply the base by half the height; thus, base 4 ft., perpendicular 4 ft., gives $4 \times 2 = 8$ ft., which 8 ft., it will be observed, is exactly half the area of a square 4 ft. in the side. To get the area of the trapezoid, Fig. 138, multiply the base by half the sum of the perpendicular sides; thus, if the base be 12 in. and the sides 9 in. and 3 in., we say 9 in. $+ 3 = 12$, half $12 = 6$; then $12 \times 6 = 72$ in., or half a square foot.

A simple portable or pocket gauge, capable of accurately indicating at a glance the thickness and weight of sheet lead, zinc, and other metals, has long been wanted, yet I have neither seen nor heard of such an article in the market yet. There are two sorts of gauges sold, viz., one with slots and another with a screw, but they do not seem to suit the purpose properly. To meet this want I took out provisional protection for a simple instrument which I termed the "metro-multiplier," or magnifying gauge, as it magnified the real thickness of the article gauged ten or twenty times or so, and thus the eye could easily distinguish on the scale the small differences between the various thicknesses of zinc sheets. I tried one made of zinc nearly twenty years ago, and it served well, but I kept it private; lately, however, as such had been asked for publicly, I intended to get it up in steel, but could not find a manufacturer for it in that metal. It would have been more easily applied than either the slot or screw gauge.

## CHAPTER XI.

### Snow-Boards.

In gutters, such as Figs. 39 and 44, and also in centre-gutters, such as Fig. 113, &c., annoyance is sometimes felt from half-melted snow filling them up. As a precaution against this, snow-boards of the style shown in Fig. 114—which gives cross section of same—are often laid down. They are formed by bars of wood about 5 in. deep and 2 in. or more thick being placed across the gutter 3 ft. or 4 ft. apart.

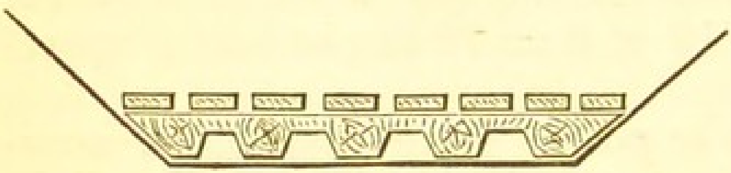


Fig. 114.

In the under side of these bars several checks about 3 in. deep and 4 in. to 6 in. wide are cut out for the passage of the water. Above these cross-bars longitudinal pieces of wood about 3 in. or 4 in. broad and about $\frac{7}{8}$ in. thick are fixed about 1 in. apart from each other. Fig. 115 is another style without checks in the cross-bars, so that these latter cross-bars need only be about 3 in. deep. Fig. 116 is cross section of a style which serves both as a snow-board and as a preventive of broken chimney cans, loose slates, &c., falling over the roof. A long board, w, say 7 in. or so broad, and about 1 in. or $1\frac{1}{4}$ in. thick, is made to run along the whole length of the roof, its lower edge about close to

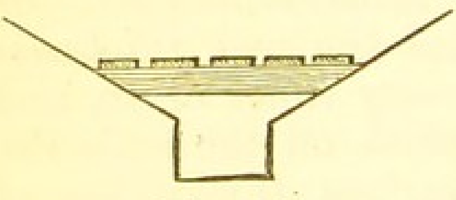


Fig. 115.

the slates. This board is fixed to, and kept in its place by, a number of pieces of iron shaped like the letter L, as per x, Fig. 116. The pieces of iron (made, say, of malleable iron, 2 in. broad and $\frac{3}{8}$ in. or so thick), which may be about 16 in. long over all—10 in. for lying on the roof and 6 in. for the upstand—

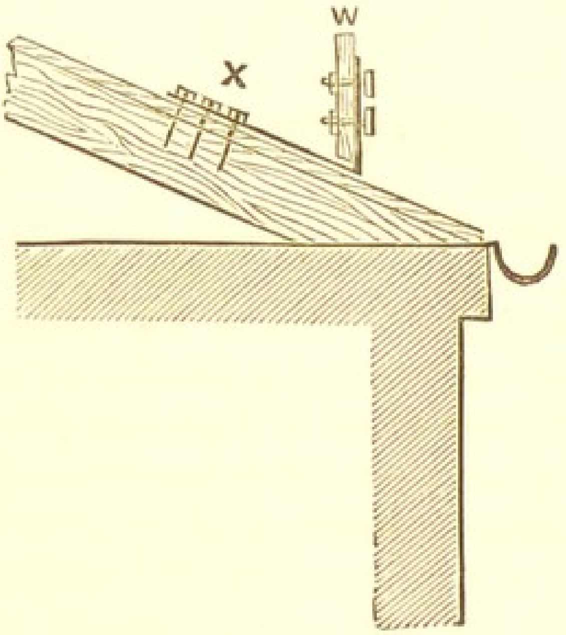



Fig. 116.

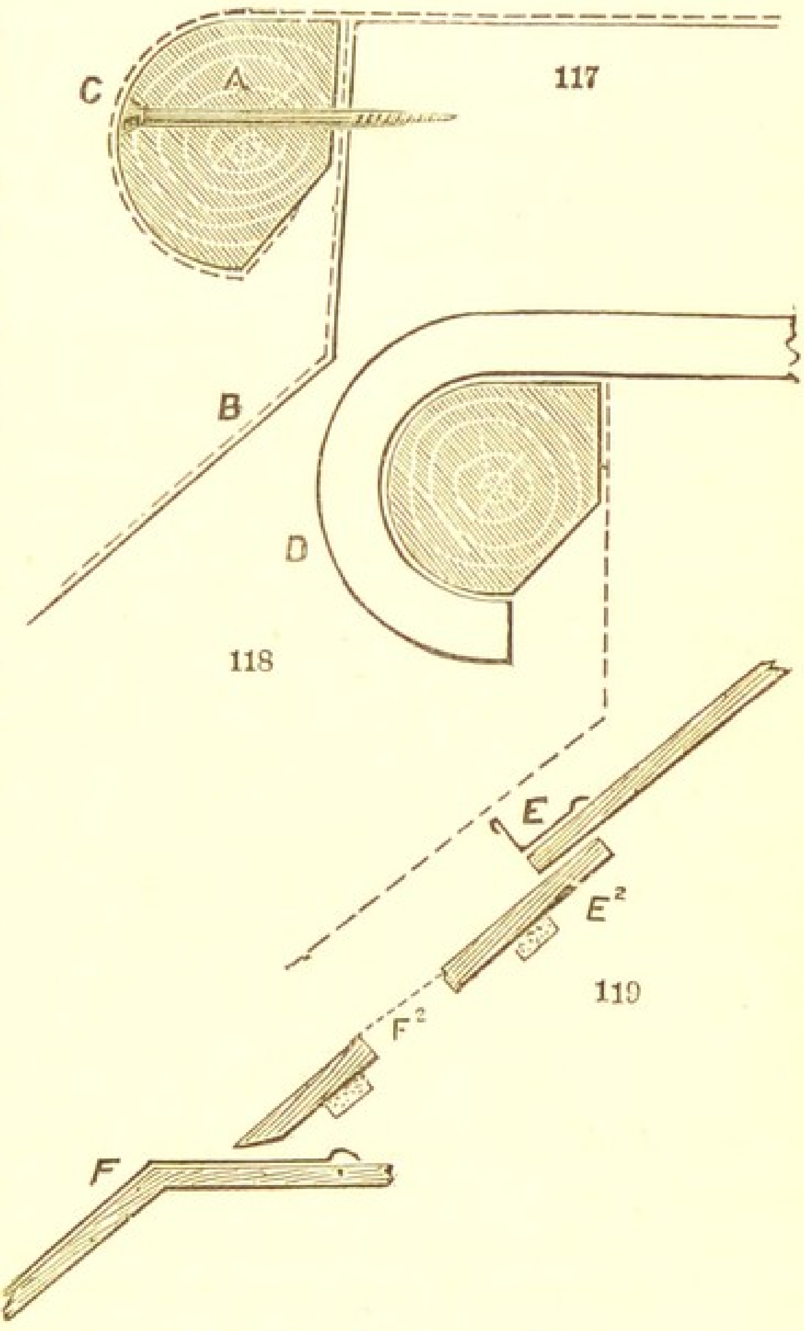
may be put on from 3 ft. to 4 ft. 6. in. or so apart; they may be fixed to the roof with strong iron or brass screws, while $\frac{3}{8}$ in. bolts and nuts may be used to fix the snow-board to the iron, all as per w x, Fig. 116. A piece of sheet lead is put over the inclined portion of the iron lying on the roof.

## CHAPTER XII.

### Hatches, Windows, and Domes.

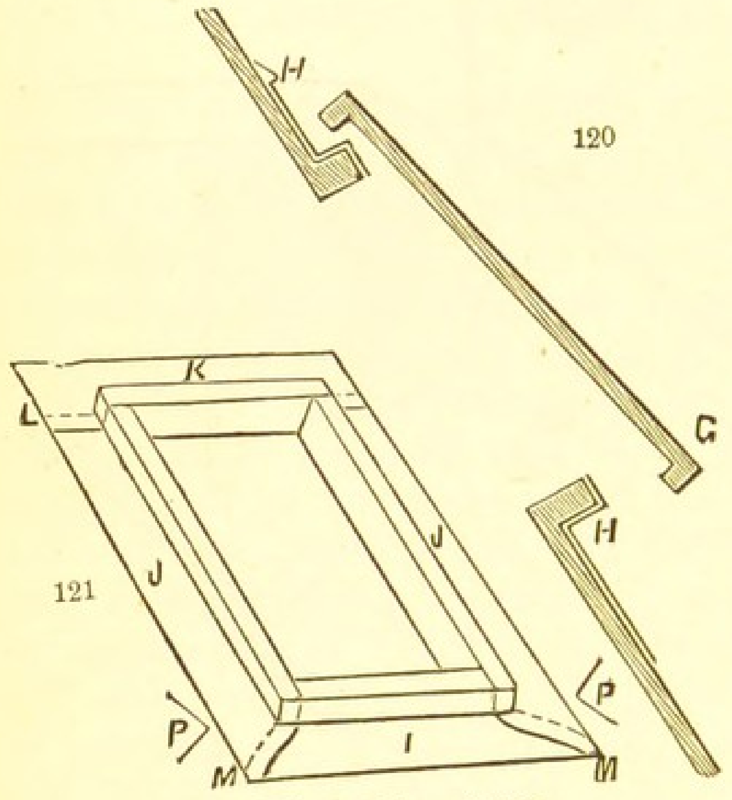
Before leaving the roof there are several things that must be referred to. At L, Fig. 69, we see the manner in which a flat covered with lead has the lead bent over the edge of the flat. There is another way in which it is sometimes done, although I cannot express entire approval of it, especially where it breaks in upon the line of the ridge by projecting beyond it. This style, in contrast to Figs. 63 and 64, is done by fixing on a wooden roll to the front edge of the flat, as per Fig. 117, A being the wooden roll, the dotted line B being the lead flashing put on before A, and the dotted line C being the lead of flat, which is bent around the wooden roll as shown. The lead rolls in this case, while formed as per Fig. 67, instead of being bent over as per M N, Fig. 70, are of course bent around the wooden roll as per D, Fig. 118. The size of this wooden roll A, Fig. 117, is about $2\frac{1}{4}$ in. or $2\frac{1}{2}$ in. deep, and it projects out about 2 in.

We have referred to gutters, flashings, valleys, ridges, hips, and flats on roof, and we shall add a few words about hatches and windows. The simplest form of hatch on roof is known as the sliding-hatch, of which Fig. 119 shows longitudinal section. All the plumber-work required about it is the piece of lead, or zinc, E, along its top, and the sole, F, along its bottom. E will be about 10 in. broad, and if the hatch be 18 in. wide, E will be 2 ft. 6 in. long. F will be about 18 in. broad, and about the same length as E. The sliding board $E^2$ Fig. 119 is made out of a wooden board about 1 in. thick. Its length may be about 3 ft., or rather more, and its breadth the distance between the rafters. There ought to be a hole cut in its centre about 9 in. or so long and 6 in. or so wide, in order to admit light; over this hole a piece of strong glass is put as per $F^2$ Fig. 119. This is a very serviceable form of hatch and also less expensive than the one which follows; there are no hinges about it to break, &c., and where a hatch is merely used for the purpose of chimney - sweeps and tradesmen getting access to the roof, I prefer it when well made to any other I remember of at present. Another form of hatch is that with hinged lid, of which Fig. 120 shows longitudinal section, with lid G partially open, the lines at H H being the top and bottom lead-flashings. If we suppose the daylight of this hatch to be 18 in. wide and 2 ft. 6 in. long, then, as the wooden frame is about 3 in. deep and 2 in. thick, its breadth over all will be 22 in., and its




Figs. 117, 118, and 119.

length over all, 2 ft. 10 in. The lead for this has to be cut out in four pieces, the breadth of all being 6 in. + 3 in. + 2 in. = 11 in., and the length of bottom piece, I, Fig. 121, 22 in. + 6 in. + 6 in. = 2 ft. 10 in. The length of two side pieces J J, Fig. 121, is each 2 ft. 10 in. + 7 in. = 3 ft. 5 in., and the length of top piece K, Fig. 121, 22 in. + 7½ in. + 7½ in. = 3 ft. 1 in. The top piece of lead, K, is cut out longer than the bottom piece, I, because the former has to be wrought down and around the top corners of the frame as far as L, Fig. 121, the dotted line above L showing the position and amount of the overlap which the top piece K has over the top side-pieces J J, the dotted line being top of J, and showing how far the side piece, J, goes up under the top piece, K. M M, Fig. 121, again show how the two side pieces J J overlap the bottom piece I, the two side-pieces at the bottom being worked around the lower corners of the frame something similar to the way in which the top piece K is wrought round the upper corners. After the lead has been cut out, as above stated, the plumber first sets it up as per Fig. 122, in this case allowing 3 in. + 2 in. = 5 in. for the upstand. If it be a slated roof, a board about ½ in. thick has to be put temporarily in front of the bottom of the hatch-frame, so as to allow for the thickness of the slates, just as was previously mentioned for barges, at Fig. 33, Chapter IV. The lead being set



Figs. 120 and 121.

up as per Fig. 122, is put against the frame, as per Fig. 123, and then dressed over, as per Fig. 124, two or three nails being put in as at N, Fig. 124, to hold it. Of course, as will be seen from Fig. 121, which shows perspective view of the hatch with the lead on, the bottom-piece, I, has to be put on first, and simply cut away at the corners as per dotted lines above M M. The two sides are then put on, and last of all the top. After this the wooden "doubling" has to be put along the top, as per O, Fig. 125, and down the sides, as far as P P, Fig. 121. Such is the manner of putting lead around this sort of hatch, and if zinc is to be used it may also be done in the same manner, except that instead of working the zinc round the corners in the same way as with lead, the zinc has to be cut at the corners, pieced, and soldered. It is only the top and bottom pieces that require piecing and soldering, and said soldering, &c., is to be done on each piece *per se*. Owing to the way the bottom piece of zinc is made and slipped up, the sides J J, Fig. 121, when zinc is used, instead of being each 3 ft. 5 in. long, as above shown for lead, need only be 2 ft. 10 in. long, or the same length as the frame, as per Fig. 126, where the two sides Q Q are seen to extend from R to S, the dotted line at R showing how far the side-piece Q is slipped up under the top piece T, and the other dotted line near S, showing how far the bottom-piece U, Fig. 126, is slipped up under the side-pieces Q Q. In setting up the bottom-piece U, if roof is to be slated, the plumber must remember to allow ½ in. or so for the thickness of the slates which are to go under U. This bottom-piece U is only fitted in temporarily at first, until the slates are put on, so

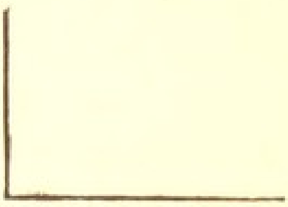


Fig. 122.

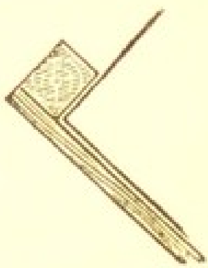


Fig. 123.

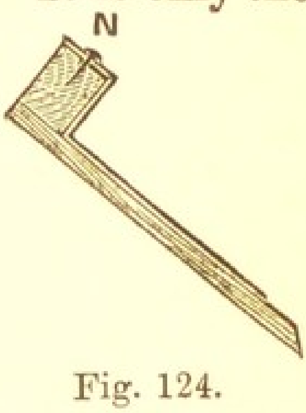



Fig. 124.

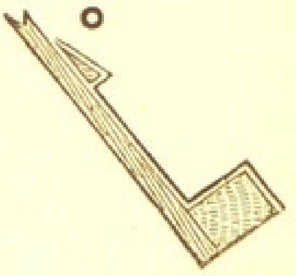
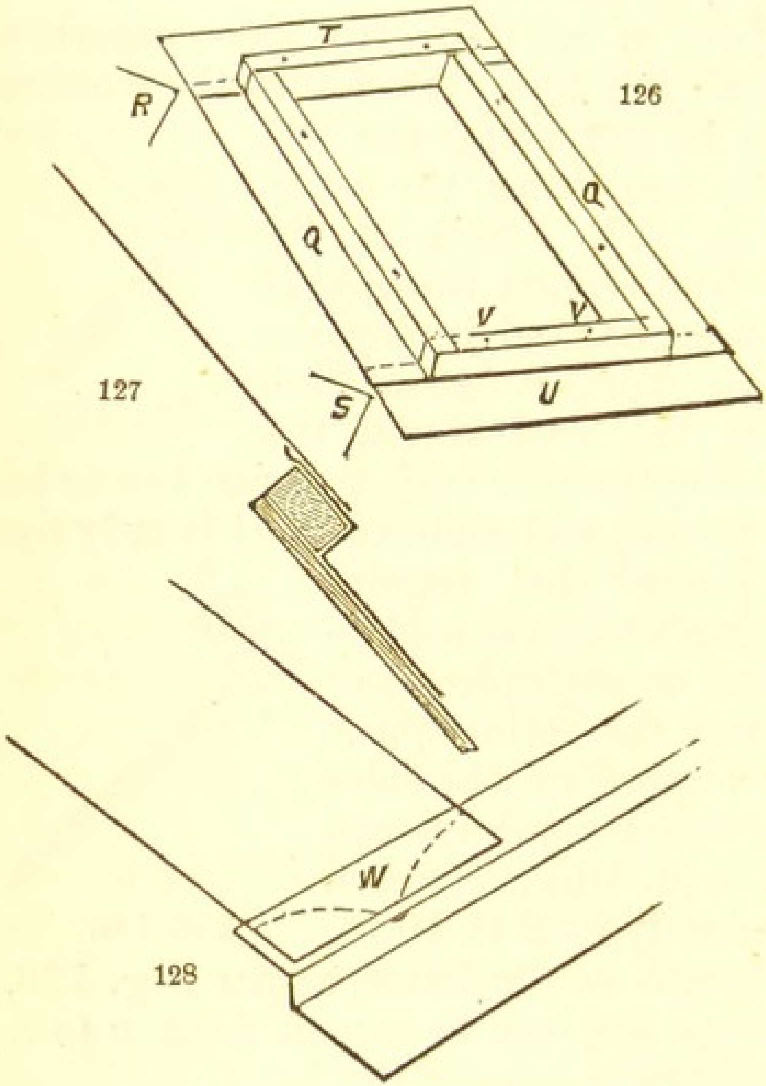



Fig. 125.

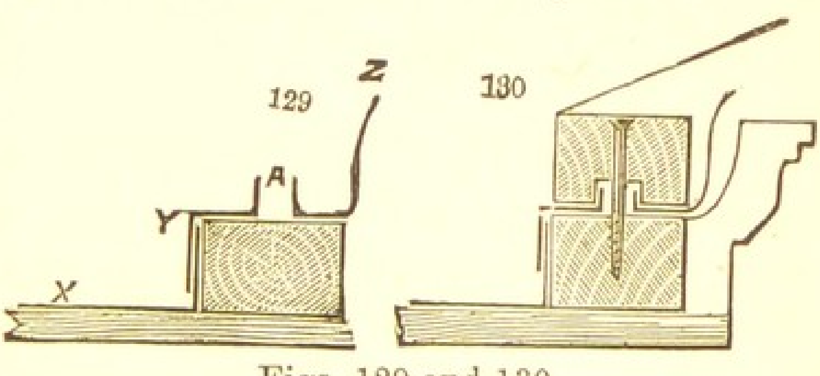
that the slater may lift it out to get his slates nailed, for zinc cannot be bent up and down in the same easy manner as lead. After the slater has finished, the bottom-piece, U, is slipped up and nailed to the frame in the same way as for lead at N, Fig. 124, and as per V V, Fig. 126. When desired the zinc can be put on to return round the corners as at M M, Fig. 121, the zinc being left so much longer and a soldering made at each corner; but the sides not soldered to the bottom, however.




Figs. 126, 127, and 128.

I have been thus particular in explaining the modes of putting lead and zinc round this latter form of hatch because the principle in it is, in great measure, the same as that in use for many sky-light windows, there being only a little difference in detail, such as that the wooden frame may be higher and broader (which, by the way, may also be the case with hatches), the tops and sides may be longer and deeper, &c., and also, in the case of windows, the lead is allowed to come over on the glass (unless in the case of movable windows) about ½ in. at top and sides; and at bottom it goes up under the glass according to the shape of the frame, so as to catch the condensed water which runs down the inside of the glass, and by carrying it outside, thus prevent it running down the inside, and so making those unsightly, dirty marks often seen where the lead or the zinc is improperly put on. The lower portion of the glass ought not to rest closely on the lead unless a channel or channels are cut out of the wood underneath, into which the lead has been dressed, so as to allow the condensed steam or water to get freely away. Fig. 127 shows section of the lead going up under the glass, and Fig. 128 is sketch showing how the channel for the water may be left in the centre of each pane, the dotted line being the top of the putty, $\frac{1}{8}$ in. in thickness, which both keeps the glass off the lead and also prevents the wind in an exposed situation getting in under the pane, and perhaps either blowing it off or breaking it. Or, again, if the joiner were cutting that much out of his wood at W, Fig. 128, the same purpose might be served without the putty, or some other plan might be adopted to suit the circumstances and the form of window. The distance which the lead goes up under the glass, or which the glass overlaps the lead, at W, Fig. 128, is generally for a good job 3 in. On a roof where the incline is small, if the glass is not put on as at W, Fig. 128, and 3 in. or more of overlap given, capillary attraction, or the wind blowing, causes the rain to come in.

Another roof window is the cupola of various shapes, round, square, and oblong. In many cases these cupola windows are brought and put on after the plumber has finished. Fig. 129 shows section of one side before the window is put on, and Fig. 130 after window is on. X, Fig. 129, is the lead or zinc gutter; Y is lead apron overlapping the upstand of the gutter as shown, bending horizontally across the block or under-frame, upon which the window-frame is to rest,



Figs. 129 and 130.

and then up to Z as shown. The upstand at A, Fig. 129, is one of the small lead pipes (say) $\frac{3}{4}$ in. high and the same in diameter, which are soldered to the lead apron, and down through the centre of which the screws to fasten down the window-frame are put, as per Fig. 130. In many cases small grooves or channels are cut across the bottom of the upper wooden frame for the outflow of any condensed water off the inside of the glass.

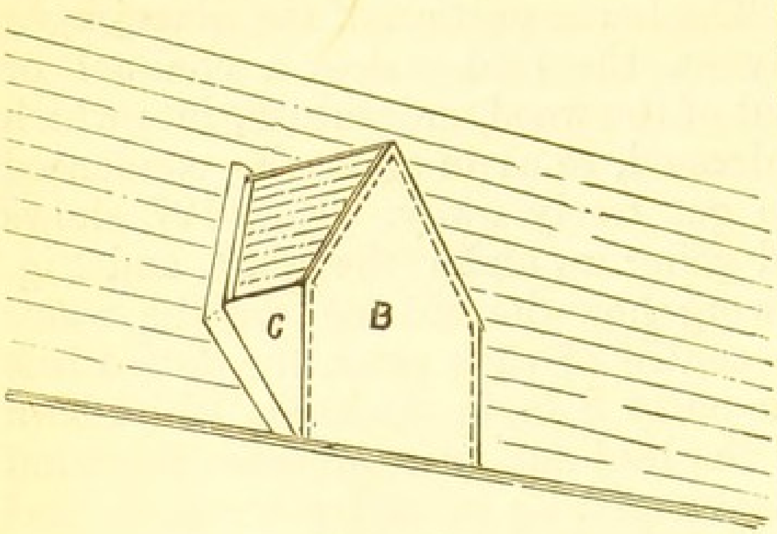


Fig. 131.

In putting lead aprons round circular windows the lead has to be dressed to fit the circle; one plan is to roll up the piece of lead apron and dress in the top side of it as if contracting a lead pipe; when this has been done to one end of the piece, unroll it and then roll it up again, keeping the already contracted end inside, and so make both ends alike, and in this manner make the piece of lead fit the circle.

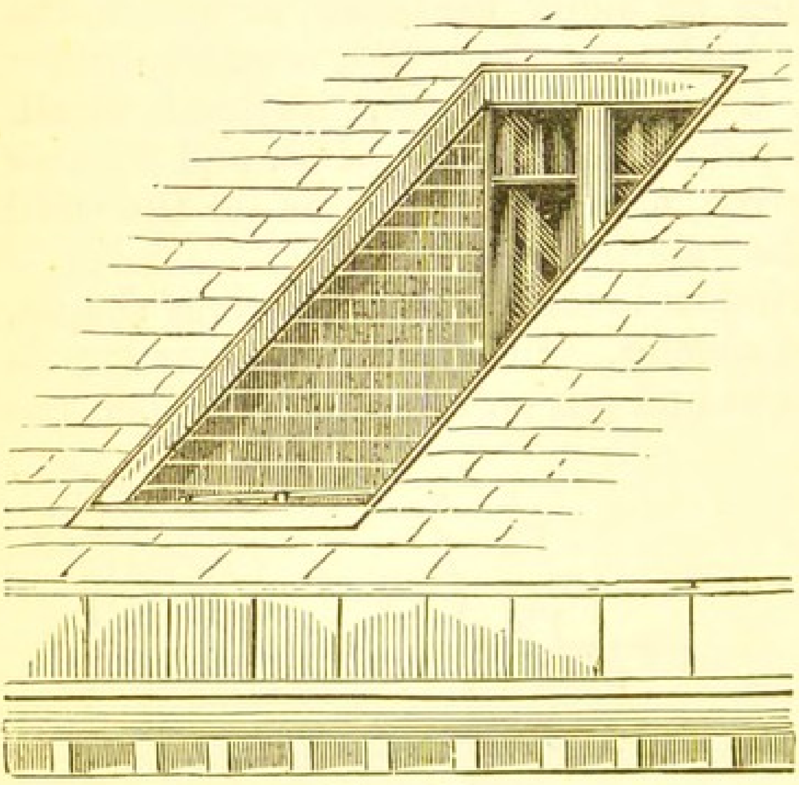


Fig. 132.

The dormer (from the French *dormir*, Latin *dormire*, to sleep; these being generally the windows of the bedrooms or sleeping-apartments), or projecting window B, Fig. 131, is another roof window with a flashing and valley going up each side and a ridge along the top, there being also a large triangular apron on each side, as shown at C,

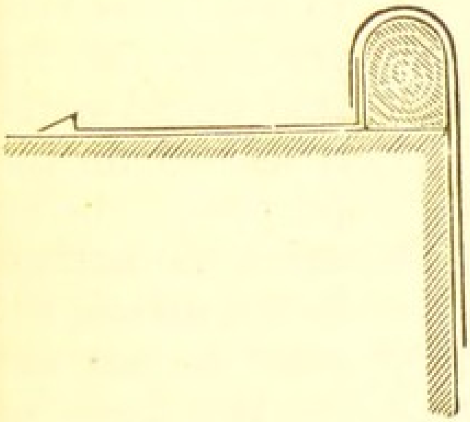


Fig. 133.

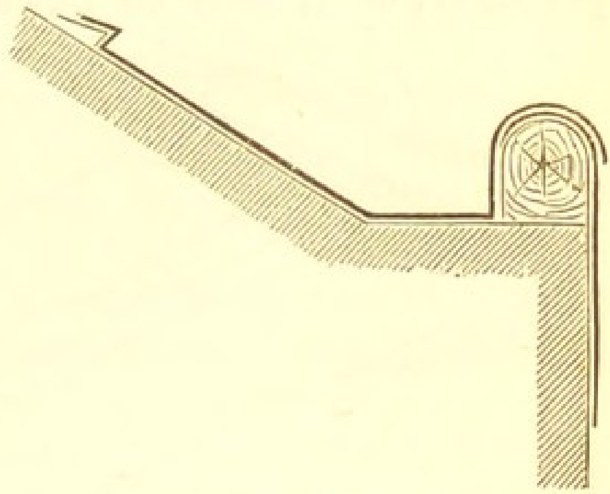
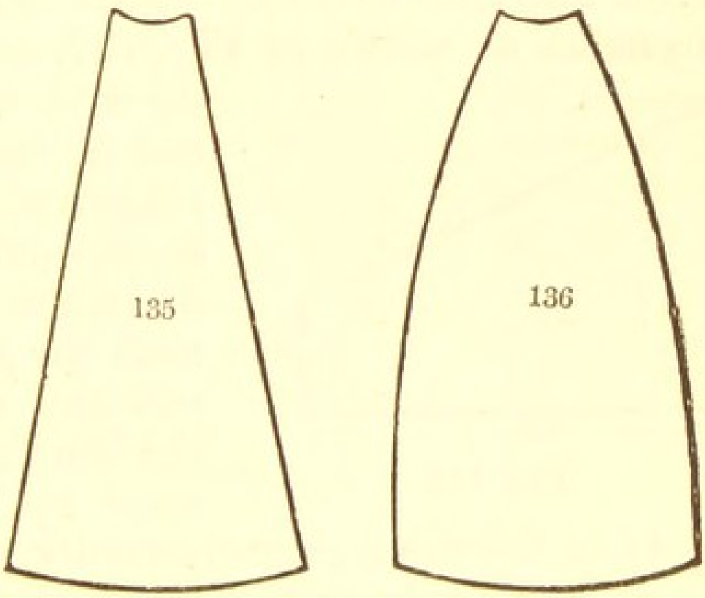


Fig. 134.

Fig. 131. The sketch supposes zinc sides, C, and ridge, and lead skews and flanks, the rest of the roof being slated. In some cases, however, when the sides, C, are pretty large, they are slated. Fig. 132, again (which in some localities is known as the "storm" window), is quite the opposite to Fig. 131, this being as far recessed as the other is projected. Fig. 133 shows how the flashings may be put in down the two sides; but Fig. 134 shows the better plan of overlap for the flashing or rather gutter along the top of the window. The sides may be overlapped in a similar manner if thought desirable. The flat before the window is covered with zinc (of course lead may be used if wished), the two triangular sides of the window and the rest of the roof are slated.




Figs. 135 and 136.

Lead for domes is put on in something the same manner as described for flats in Chapter VIII.—at least, so far as the rolls are concerned; but in cutting out the lead to fit its site great care must be taken to cut it out properly, or it may be cut too narrow; it will not do to cut it out as per Fig. 135, for that would make it useless for the purpose, being much too narrow in the middle; it must be cut out in the form of Fig. 136, and the swell made to correspond with the circle of dome, and in cutting out the lead allowance must also be made, of course, for rolls. When this article was being first published, in April, 1872, I received from Messrs. Braby and Co.—through the kind courtesy of their manager, Mr. Moore—a model of their late improvement in zinc roll-caps. This improvement, as shown in Fig. 137, consisted in bending up and working round the end of the roll-cap next the ridge without soldering it, as at D, and also in bending down the end of the roll-cap next the gutter or drip without any soldering, as at E, the bending down at E being done by "dog-earing" (see Fig. 41, p. 28) the corners inwardly, as shown by dotted lines at E. Their system of embossing the zinc upwardly at hole for screw, as at F, Fig. 137, is also good; it corresponds with that shown at Fig. 42, for lead apron. In using zinc care must be taken not to allow it to come into contact with lime, for lime *eats* it.

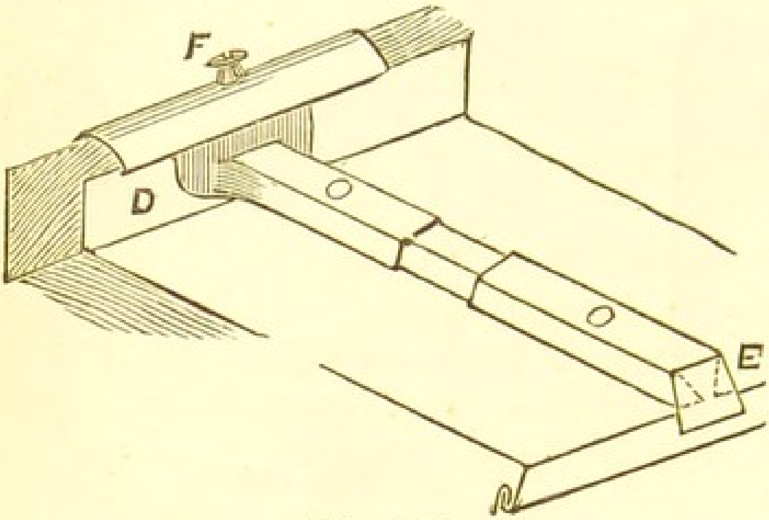


Fig. 137.

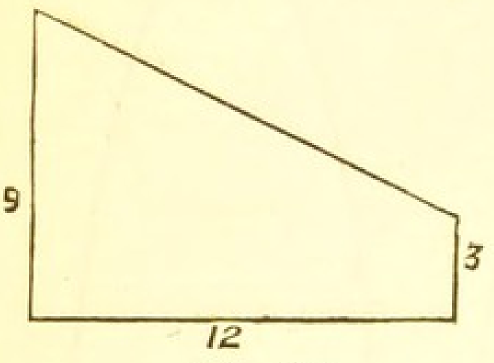
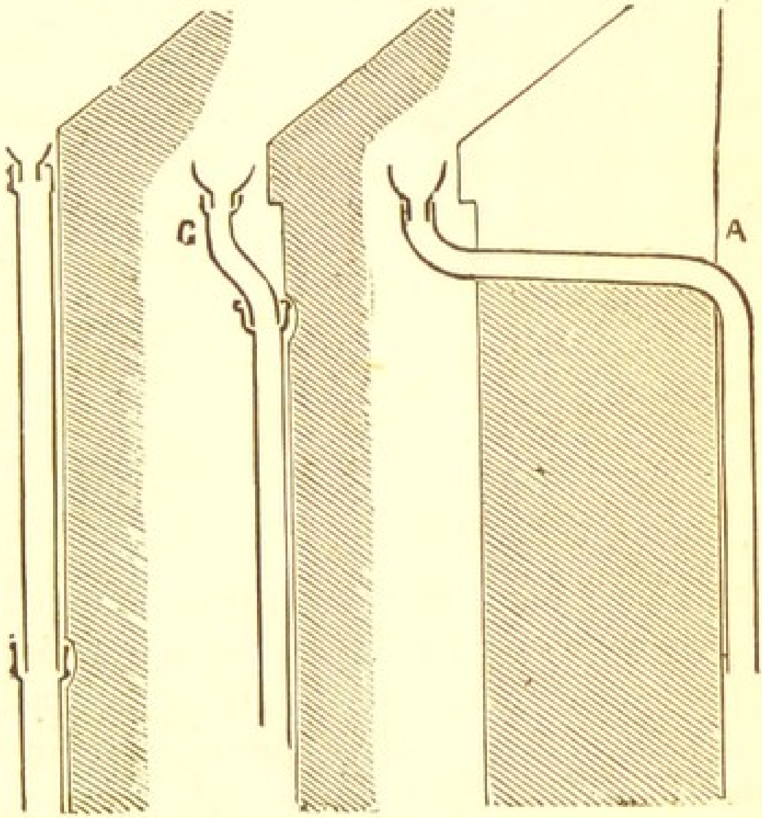


Fig. 138.

# CHAPTER XIII.

## RAIN-WATER PIPES.

THERE are various ways of conducting the rain-water off the roof, and the rain-water pipes, "conductors," or "spouting," may be carried down either on the outside or the inside of the building. The common half-circle eave gutter, Fig. 3, Chap. I., may have its pipe led down either, as per Figs. 139 or 140, on the outside of the building, or, as per Fig. 141, it may be carried through the wall and down the inside of the building. In this latter case a large raglet or recess is generally cut, or rather left, in the wall for it. When put in as per Fig. 141 the



Figs. 139, 140, and 141.

rain-water pipe is often simply carried down far enough to join into the *top* of the water-closet soil-pipe, in which case it also serves as the ventilating-pipe for said soil-pipe;* but this plan is not so good as

* Using a rain-water pipe so does not serve the purpose so well for *top*, or outlet, ventilation as does a rain pipe joining into a disconnecting trap for *foot* ventilation as shown, *e.g.*, in Fig. 269A.

putting in a separate ventilating-pipe *per se* for the soil-pipe, as during rain the mouth of the rain-water pipe may be bridged over by the water. The carrying up perpendicularly of a 3-in. pipe from A, Fig. 141, would help matters a little. The "offsets," or "S bends," G, Fig. 140, are of course of various sizes, to suit the place and style of roof. In stone cornice gutters the rain-water pipe is often dropped down right through the cornice, as per Fig. 142. At other times it is led away from the back of the gutter, as per Fig. 143, and may either go down just inside of the wall, or it may be led away between the ceiling joists right through to the gutter on the opposite side of the building, or it may go along horizontally to the centre of the house and then join into some of the other waste-pipes. Or, again, it may be led into a large cistern put up as a receptacle for the rain-water for the use of the house, as per Fig. 20, Chapter II.

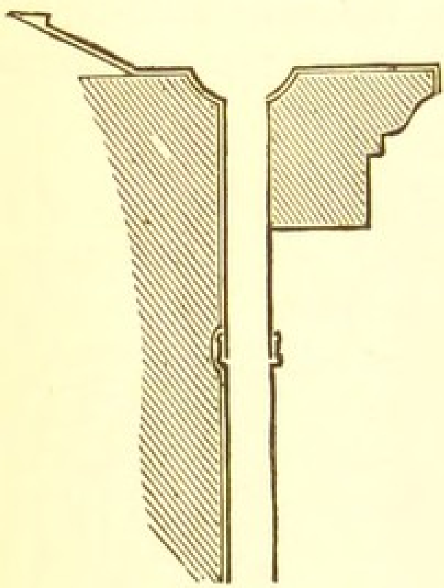


Fig. 142.

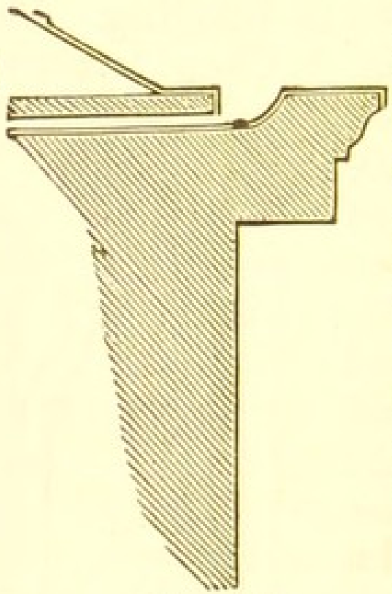
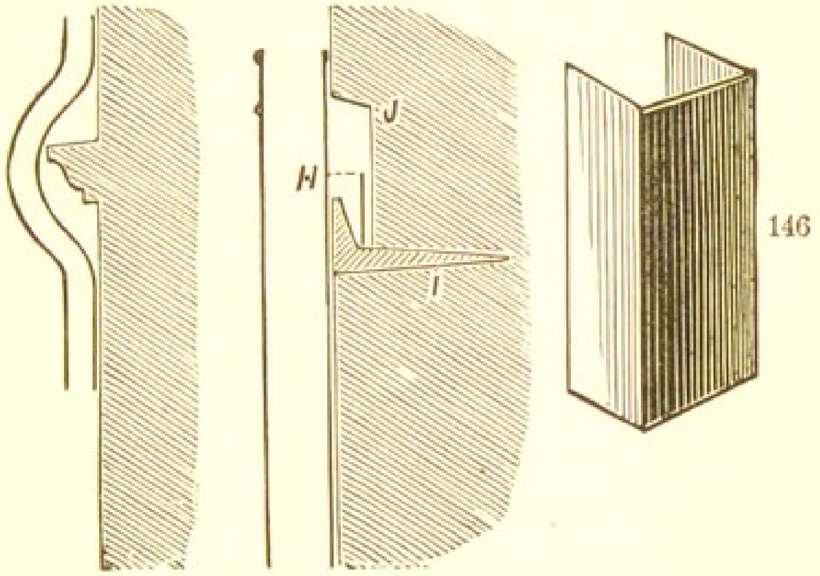


Fig. 143.

In many cases the architect objects to any rain-water pipes appearing on the front elevation of his building, and therefore makes provision for them coming down inside. In other cases, where the conductors are intended to come down in front of the building, and where they will have to come into contact with any string-course or other such mouldings, the architect shows his foresight by marking off a return with hole through it in the string-course for the pipe to go down through; and thus, when the conductor is put up, the string-course appears as if bent around it, which shows good planning. In other cases, where this is omitted and the string-course is cut through, it has never the same appearance; and then again to bend the pipe around the string-course, as per Fig. 144, appears to me to be a very clumsy job. In the case of a projecting base, that of course is a different matter, as it is perfectly legitimate for the descending pipe to be bent out and carried down the face of the base. In some cases, however, even the base is returned and the pipe carried down perpendicularly in line with wall front, and then brought out underground by a bend or "elbow."

Rain-water conductors* are made of lead, zinc, and




Figs. 144, 145, and 146.

cast iron (in many country places both eave-gutters and pipes are often of wood, but that appertains to the joiner or carpenter), and they may be either round, square, or semi-circular. There are various ways of supporting them. The simplest way is by driving in iron holdfasts which clasp the pipe and press it close against the wall; but, except in the case of round iron pipes, these neither look nor hold so well as other systems of fastening.

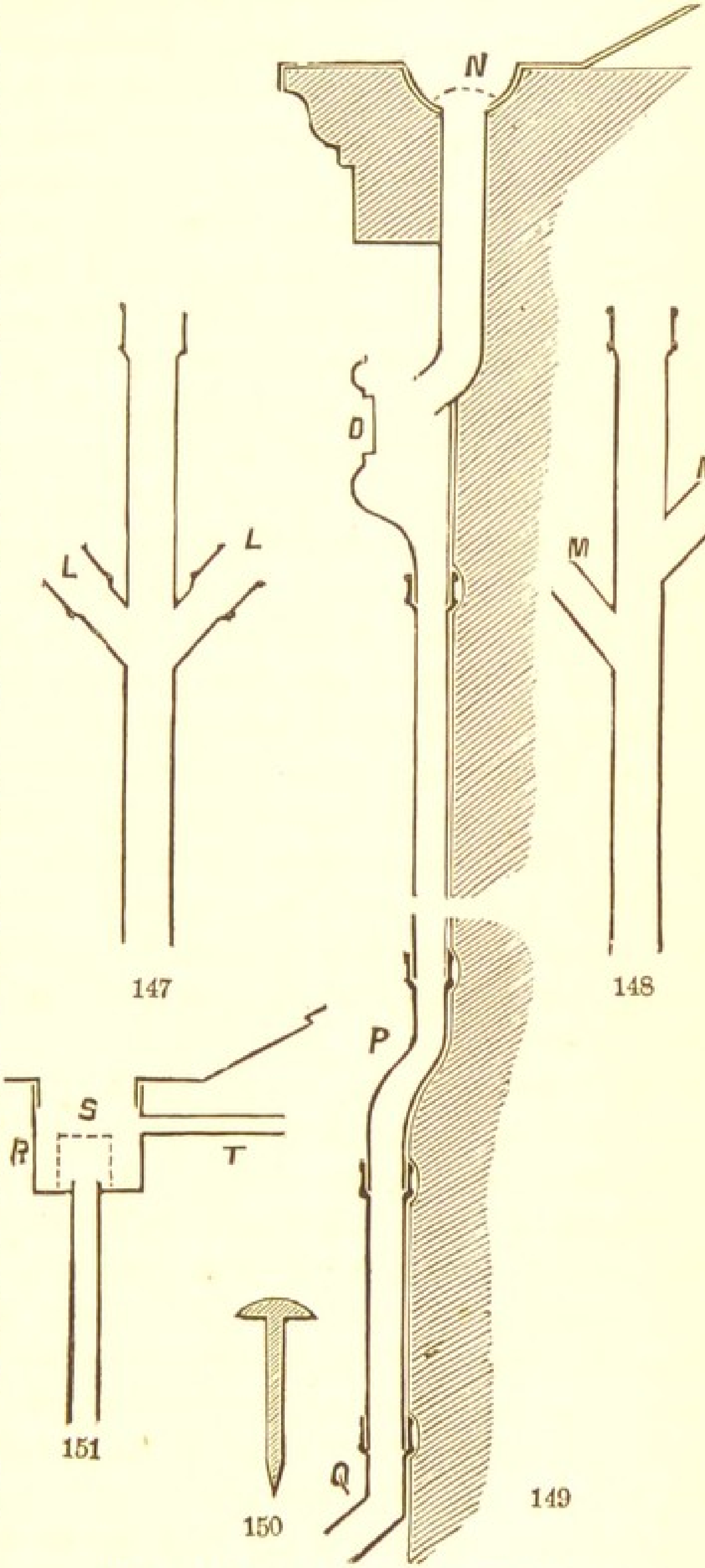
The hook-and-eye fastening does well for either lead or zinc conductors. The eye H, Fig. 145, is a piece of strong sheet copper, about one-tenth of an inch thick, and about 2 in. square, bent round, as per Fig. 146, and

* The metal of all iron *inside* rain pipes should be $\frac{1}{4}$-inch thick, and they should be locked off from drains at foot by a disconnecting drain trap, as *e.g.*, by Fig. 272A one, or they may discharge above ground over an anti-bell trap, Fig. 291.

strongly soldered on each side to the back of the pipe. This copper eye comes down on the iron hook I, Fig. 145; I being driven firmly into the joint of the wall. In order to allow H to slip down over I, a small niche must be cut in the wall, as at J, Fig. 145, for that purpose. In tinning the copper, and in order to do it properly, it is best to file the surface with a sharp "bastard" file, which enables the solder to take a firm hold by riveting itself as it were among the channels left by the teeth of the file. When the copper eye is to be soldered on to a lead pipe, it is best to use rosin in tinning the copper. Some, from laziness, tin the copper without filing it, by using diluted spirits of salts (see Chapter IX.), but this makes a bad job, the solder not holding properly; in fact, it often gives way from this cause. I may here mention that when tinning iron with diluted spirits of salts, a small strip of zinc is a good thing to use for putting "spirits" on with; using a piece of wood for that purpose has a bad effect.

In using zinc pipes, instead of making the eyes out of copper they may be made out of a piece of strong zinc. Sheet brass may also be used; and in the case of lead pipes, where neither copper nor brass can be had, a piece of good strong lead may often serve the purpose, only it must not be put on too narrow, for short eyes tear the pipe. In the case of zinc pipes, one eye in each length may often do, and even in 3-in. lead pipes one good eye in a 6-ft. length holds it for many years, but for a larger size of pipe, or all the better jobs, two eyes in the length will do best. Another plan of supporting lead or zinc conductors is by means of bands put round and soldered to the pipes, which bands have iron flat-headed spikes driven through them and into the wall. The iron pipes are supported by iron bands, or "loose ears," as well as by attached ears; the latter are cast in one with the pipe.

It often happens that one main down-pipe has to receive one or more branch pipes. If these branch pipes are the same size as the main down-pipe then the branches cast on to main pipe require to have faucits, as per L L, Fig. 147; but if the branch pipes be smaller than the main pipe then the branches cast on may do without faucits, as per M M, Fig. 148, only care must be taken in this latter case (say, by marking it) to see that the branch pipe is not slipped in too far, and thereby choking up the passage. The branches with faucits cast on, as per L L, Fig. 147, may be had of various sizes—*e.g.*, supposing the perpendicular pipe, Fig. 147, were 4 in. in diameter, then the branches L L cast on might be made either 4 in. 3 in. or 2½ in. in diameter, or if the main pipe were 3 in. then the branches might be 2½ in., and so on.




Figs. 147, 148, 149, 150, and 151.

These cast-iron pipes are generally made in 6 ft. lengths, and of various diameters. The round pipes vary from 1½ in. up to 8 in. in diameter. The square iron pipes are made from 2½ in. by 2 in. up to 6 in. by 6 in. The iron offsets can also be cast to suit any slope of plinth. The round pipe 3 in. in diameter is a size that is largely used in common house work for the rain-water pipes, and as waste-pipes from the kitchen sinks. Fig. 149 shows conductor with rain-water head, carrying off water from gutter N; O being rain-water head, P offset at plinth, and Q, shoe at bottom to go into drain. In place of shoe Q many prefer a bend or elbow here, one reason being that it projects out farther. When it is necessary to cut one of these iron pipes, or to reduce its length, it may be done either by filing it round where it is wished to be cut, or else by chipping off the portion that is too long. Or, again, short pieces can be had from the foundry. The iron spikes, Fig. 150, referred to above, are made from 3 in. to 5 in. long and from about ⅜ in. to ½ in. thick. A great many designs for rain-water heads are executed in iron, yet both lead and zinc heads are often used. Iron, however, is largely superseding lead for this purpose. When the rain-water pipes are carried down inside the house and connected to drain, care must be taken that all the joints are properly and securely made. Upon jointing the pipes, however, we shall treat more at large as we go on to speak of soil-pipes and waste-pipes, &c.

Another plan in use for leading away the water from the gutters is to have drip-boxes on the top of the rain-water pipes, as per R, Fig. 151. These drip-boxes are of various sizes; some may be 1 ft. deep and the same in length and width, others less, just as they may have to suit the place. A perforated grating, S, and an overflow pipe, T, ought to be put in for them. Perforated gratings ought also to be put in over the mouth of the pipe from other gutters, as per dotted line below N, Fig. 149. These perforated gratings are generally made out of pieces of lead or zinc with a number of round holes about ⅝ in. in diameter either punched or bored through them. Much more satisfactory "gratings" or pipe-mouth guards are made by using *tinned* brass wire about $\frac{1}{8}$ in. thick, placed crosswise and so as to leave square openings about $\frac{3}{4}$ in. or 1 in. in diameter according to the size of the pipe. These latter "gratings" do not get choked up so readily as the former.

I may here add some interesting remarks by Dr. William Wallace, F.C.S., Glasgow, in regard to the action of water upon lead. He states that he has frequently seen lead pipes eaten through by contact with lime, and explains the phenomenon in this way:—Rain-water acts rapidly on lead under certain circumstances, because it contains free oxygen and no carbonic acid. When exposed to the air, however, it rapidly absorbs carbonic acid, which destroys or limits its power of dissolving lead. Rain-water in contact with or passed over lime or mortar (which requires many years to become completely carbonated) acts on lead with great energy, because every trace of carbonic acid is removed from it. On the other hand, it is well known that water highly charged with carbonic acid (as in aërated waters) dissolves an appreciable quantity of lead if passed through a leaden pipe. In the one case a small quantity of carbonic acid protects the metal by forming a film of carbonate upon its surface; in the other the carbonate of lead dissolves in the excess of carbonic acid. Water containing oxygen and free from carbonic acid dissolves lead much more rapidly than water highly charged with carbonic acid, and its action is usually limited to particular spots where wet lime or mortar is either in contact with the pipe or immediately above it. Dr. Wallace says he has seen a thick water-pipe eaten through in a few months.

A good coating of tar would tend to protect lead in the above circumstances I believe.

## CHAPTER XIV.

### Waste-Pipes and Soil-Pipes.

We now approach a branch of our subject which is closely connected with one of the great questions or problems of the day, to wit the sanitary question. The problem here to be solved is:—How can we retain the use of our conveniences, such as kitchen sinks, baths, fixed wash-hand-basins and water-closets, within our houses, and at the same time the health of the occupants not suffer? In the following pages it shall be our endeavour to throw a little light upon this subject, and if what is said be in accordance with true sanitary laws or policy, we trust that architects, plumbers, and others interested will see that the work is *practically* carried out as suggested. If better plans are brought forward, very good, carry them out, only let "scamping" in this matter be everywhere denounced.

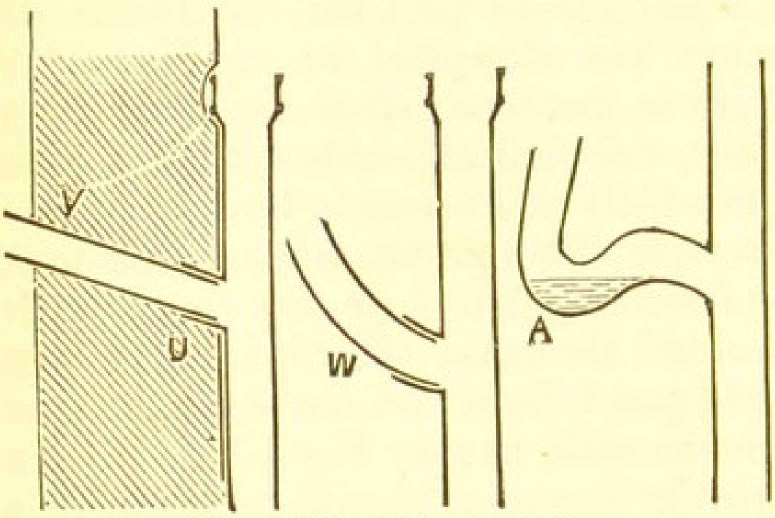
In many cases the waste or discharge-pipes from sinks, baths, &c., and the soil-pipes from water-closets, are either altogether fixed up inside the building, or, at least, have branches carried forward more or less into the interior; it is necessary, therefore, that they be fitted up in such a manner as, while allowing free passage to the soil, &c., to also prevent any foul air from them, or from the drains into which they are led, getting access to the interior of the house. In order to work well it ought to be observed that the pipes are large enough, strong enough, securely fixed, properly jointed, properly trapped, and well ventilated. To give soil-pipes fair play they ought to be, at least, 4½ in. in diameter internally.* This size of pipe allows of a large rush of water and soil through it without filling it up, and thereby helps to prevent said rush from interfering with the water lying in the various siphon traps. Where several water-closets and baths, &c., are led into one soil-pipe, the diameter of main soil-pipe may with advantage be 5 in. inside, the branches being less. Where the water-closets are situated just inside the back wall of the house a 4 in. or 4½ in. cast-iron pipe is sometimes put up on the outside of the wall with branches coming into it. One plan often adopted in regard to these branches is to have the branch pointing into the wall, as per U, Fig. 152, into which the branch pipe V is led; but this, although it may save a little pipe, often proves a dangerous plan for the health of the inmates, as when the slip-joint at U, Fig. 152, begins to get slack, or is, perhaps, left slack, and allows the foul air to get out, this foul air, unless the hole in the wall around V is solidly and securely built up, finds its way along the outside of V into the house. To prevent this, instead of making the hole for the branch pipe immediately behind the main soil-pipe, make it a little to one side, and put a bend on the branch pipe coming out through the wall, as per Fig 153. In this latter case, although the slip-joint should be slack, it is outside the wall, and the hole in the wall at the bend, W, can be easily made good.

These remarks about Figs. 152 and 153 are also equally applicable to the waste-pipes of kitchen sinks, when these sinks are put up inside of flatted houses. In slipping in these branch pipes the plumber ought always to see that they are not slipped in too far. I have seen many instances in which this has been the case, and a chokage caused thereby. These slip joints outside may be made good with red-lead putty. Although this is a cheap style of doing the work, yet if fairly executed it does well enough, only do not neglect to ventilate the pipe at the top. One disadvantage, however, of either soil-pipes or waste-pipes put up outside

* Especially if closets like the Bramah, letting off a large body of water quickly, are used.

the building, is their liability to being frozen up in frosty weather, and so preventing the proper use of the water-closets and sinks, &c., or, if they are used, causing the property to be flooded.* In such circumstances the branch being put in as per Fig. 153 is found to be often of great service, as by cutting a slit in the top of the portion of the lead bend W, Fig. 153, which is outside the wall, the water may be allowed to run off at this slit, and so prevent or lessen damage inside.

When soil-pipes and waste-pipes are put up *inside* the house, great care should be taken that they are properly fitted up and securely jointed. If the main upright pipe is of cast iron then it ought, for a good job, to be heavier and stronger than the ordinary iron rain-water pipe. The iron in the latter may only be about one-eighth of an inch thick, but about double that thickness, or more, ought to be used for the former. The vertical joints may be made with red-lead and hemp, or more firmly still by running in the joints with melted lead and then batting them.



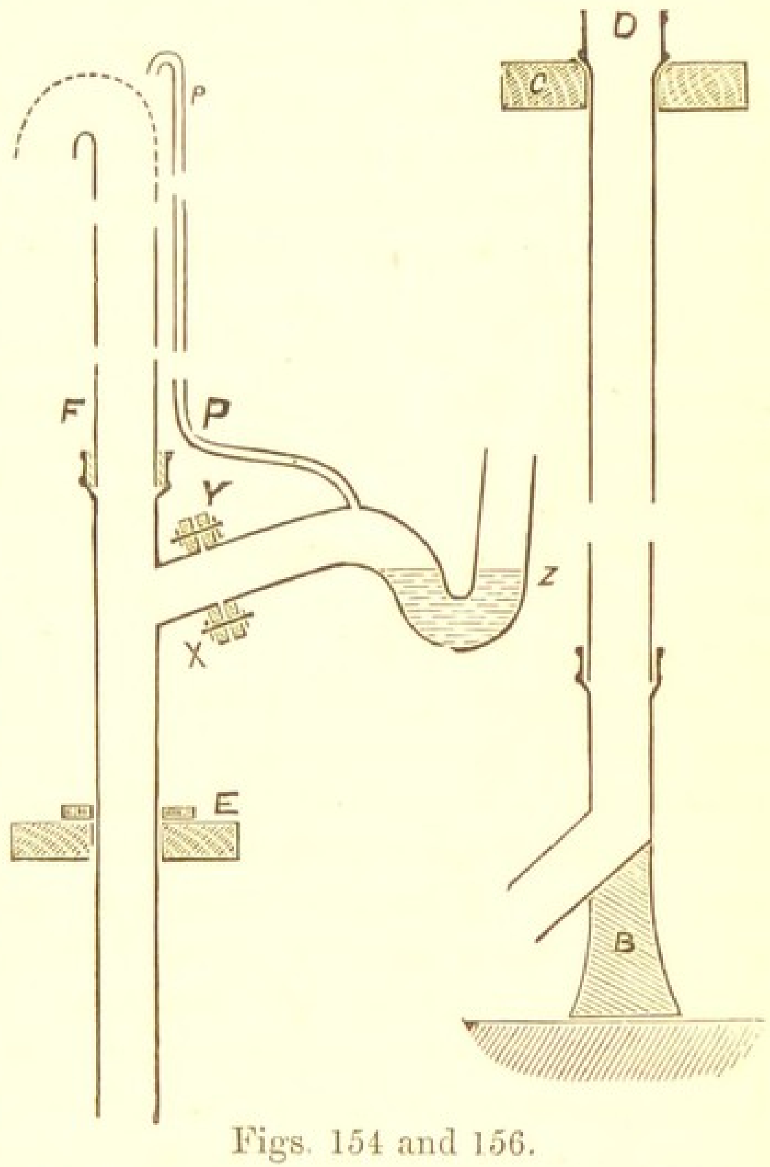
Figs. 152, 153, and 155.

If any slip-joints are made where the lead branch pipe joins the iron, the joint should not only be made with red-lead and hemp packed in firmly, but it ought also to be either lapped or an india-rubber band 3 in. broad put over it, or a brass ferrule used, with one end soldered to the lead pipe and the other end run in with lead.

Where hot water is used another plan is to have flanged iron branches, as per X, Fig. 154, a corresponding lead flange being made and soldered to the lead pipe, as per Y, Fig. 154, after which the two flanges are red-leaded and packed, and then firmly bolted together with four

* It is seldom the waste water put down that freezes, but the water from some bad or leaking crane running continually, which should not be.

iron bolts and nuts, as shown, an iron ring or "washer" being used at the back of the lead flange to strengthen it. In fitting up these heavy iron pipes, and, indeed, all soil-pipes and waste-pipes inside a house, it must be seen that, as stated above, they are *securely fixed.* When this is not done the fact of having them large enough, strong enough, properly trapped, and well-ventilated is, after the lapse of a little time, quite useless in preventing the escape of sewage gas into the house, as when the pipe is not securely fixed it by-and-by slips down, and the siphon-trap, instead of being properly locked, as shown at z, Fig. 154, is dragged down at its outlet until it assumes the position shown at A, Fig. 155, and so becomes quite useless.




Figs. 154 and 156.

I have seen many examples of this, especially in connection with the siphon-traps of kitchen sinks. In order to prevent these heavy iron pipes from slipping down, a good plan is to have a strong iron heel cast on to and along with the lower length or "boot," as per B, Fig. 156, which heel must be set firmly upon a solidly-laid block of stone, so that there may be no chance of the iron pipe sinking.

If the pipe goes up against the wall it ought to be well hold-fasted also; but if a raglet or recess has been left in the wall for it, or if it goes up in a corner, then, instead of the holdfast, a strong block of wood about 3 in. or 4 in. thick, and about 18 in. or so long, and 10 in. or 12 in. broad, as the case may be, with a round hole cut in it large enough to allow the pipe to be slipped down through it, should be got and set into space, and rest cut for it in the wall, as per C, Fig. 156, the pipe resting upon its faucit as shown. When, however, the length of iron pipe has flanged branch upon it, as per X, Fig. 154, then, instead of resting upon its faucit, as shown at D, Fig. 156, it is supported as shown at E, Fig. 154; a pair of strong malleable iron clamps, Fig. 157, being put on, and screwed up so as to grasp the pipe firmly, and at the same time be allowed to rest upon the wooden block.

Instead of the wooden block a malleable iron plate about 1 in. thick or so, with a hole cut in its centre to fit the pipe, may be used. The length and breadth of this plate must, of course, be regulated according to its site. In many cases about 18 in. × 10 in. may do for a $4\frac{1}{2}$-in. iron pipe, or with thicker plate less breadth will serve.

The slipped joints of these pipes, as at F, Fig. 154, may, as we have said above, be made with red-lead and hemp; or stronger still, by stuffing joint partly with hemp and then running in lead; some, again, make rust joints. Whatever plan is adopted, the great point is to see both that it is well done, and that it also thoroughly answers the purpose. These strong iron pipes have been largely used of late for the main upright soil-pipe in many houses, especially where hot water is used, and I consider it quite right to do so. As lead pipes, however, are still largely used, not only for the branches but also for the main upright pipes, we must now refer to the way in which they are fitted up.

Lead soil-pipes should not be made of lead less than 6 lbs. per square foot at the very least, while 7 lb. lead, or heavier, is used for good work. These often require repairs and renewal from three causes: from being put up of too light lead at first, from being too slimly fixed up, and from corrosion, the latter being often in great measure owing to the want of proper ventilation. We cannot do with lead as with iron, for where, as in Fig. 156, the heeled boot B, if solidly fixed and not afterwards interfered with, may almost of itself be trusted to support a high superincumbent stalk of iron pipe above it, yet such could not be done with lead, the material being too soft; its own weight would crush it. To obviate this an upright lead soil-pipe must be well supported all up its entire length, every few feet being supported, as it were, independently of the rest.

The old style used to be to cut out lead bands of the same weight of lead as the pipe, about 5 in. or 6 in. broad and about 20 in. or so long, and solder them on as per G, Fig. 158, these bands being put on every 3 ft. or so. In this case the pipes lie flat, or rather close against the wall. But when the pipe either goes up in the raglet left for it in the wall, or up a corner, then wooden blocks are used, as mentioned above for iron pipes. For lead pipes these wooden blocks are generally put in one at every 6 ft., or, better still, one every 4 ft. or so. If the soil-pipes are hand-made they may be cut out in lengths from 6 ft. to 7 ft. 9 in., according to the breadth of the lead sheet. Or, as is sometimes done, they may be made in lengths about 12 ft. or 14 ft. long, to suit the height of the various flats in the house. In other cases seamless or machine-made pipes are used in lengths as got from lead-works. Fig. 159 gives an idea of a $4\frac{1}{2}$-in. lead soil-pipe as put up in the raglet left for it in the wall of a two-flatted house, with 3-in. or 4-in. ventilating-pipe, H, carried out through the roof. According to the model byelaws, the ventilating-pipe, H, should be of the same diameter as the soil-pipe. I I are the lead siphon-traps of two water-closets; J J J J the wooden blocks resting on the wall and supporting the lead soil-pipe; K is the board for the ventilating-pipe; L is a lead flange put on to the soil-pipe where it enters the drain; M is the $1\frac{1}{2}$-in. or 2-in. lead pipe put in to carry off the water from the lead "safe," or tray placed underneath the trunk of the water-closet. It enters, as it ought to do, below the surface of the water in the trap. N is the same safe-pipe, put in as it ought *not* to be, above the surface of the water in the trap. It often proves a nuisance, and has to be altered when so done. Another plan of putting in the safe-pipe is to let it have a small $1\frac{1}{2}$-in. or 2-in. siphon-trap for itself joined on to the outlet of the water-closet trap, at O. This latter plan is intended to provide for the safe carrying away of the water when the water-closet is choked up, only it must be remembered that, to prevent this small siphon-trap from drying up, a small $\frac{1}{4}$-in. pipe must be led into it from the water-closet service-pipe, so that every time the water-closet is used a little water runs into the

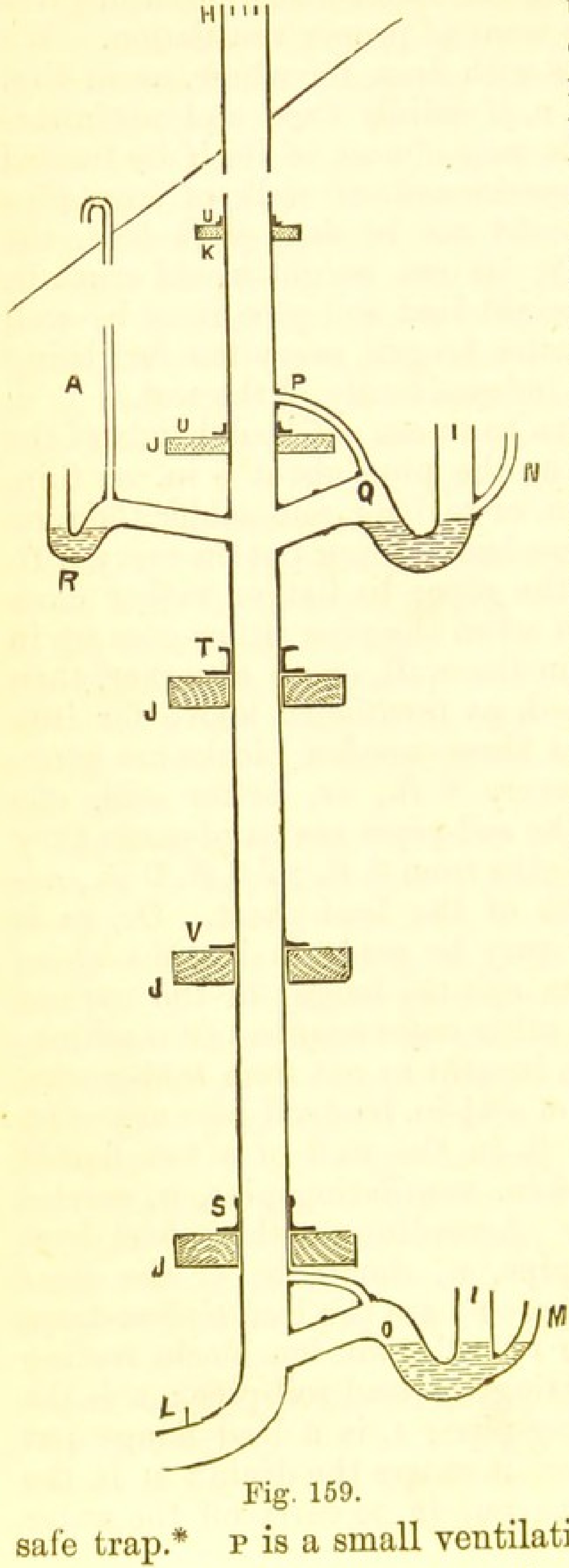


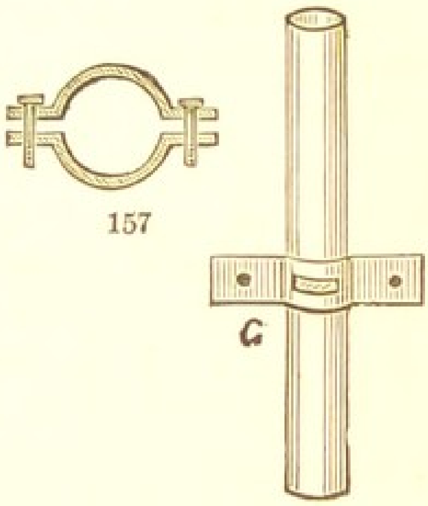

Fig. 159.

safe trap.* P is a small ventilating-pipe, from 1 in. to

* Instead of or with either M or O, a pipe may be led from safe through ... hinged valve at its outlet, which many prefer.

2 in. in diameter; it is put in here because it is found that even with the ventilating-pipe, H, in on the top of the perpendicular soil-pipe, foul air or gas is apt to gather at Q, and in process of time it eats through the pipe there. E.g. I had an instance lately (March, 1872), where the action of the gas on the pipe appeared as if some one's finger had been thrust through the pipe from within. The people in the house complained of a very bad smell occurring at times, and this hole, eaten through the pipe at Q., was the cause of it. Instead of putting in this small ventilating-pipe as per P, Fig. 159, it may with advantage be put in as per P P, Fig. 154.

In the case of iron soil-pipes especially, instead of connecting the air-pipe from the branch soil-pipe—more particularly for the lower traps—into the main soil-pipe directly as in Fig. 159, a $1\frac{1}{2}$-in. or 2-in. air-pipe may be carried up from the lowest trap above all the traps and receiving into it the air-pipe from each trap as it passes.




Figs. 157 and 158.

Another cause of bad smell in houses where the ventilating-pipe, H, is not put in is the rush of water from the water-closets dragging out the water from the bath siphon-trap R. Or, where no bath exists, using the closets themselves in an unventilated soil-pipe affects the siphon-traps. Where the bath trap is at some distance from the main soil-pipe it is good to put in a ventilating-pipe for itself, as at A, Fig. 159. Further information upon this subject will be found in Chapters XXVII., XXIX., and XXX.

While the first edition of this treatise was being published, viz. in 1872, I was rather astonished to read the following statement in connection with the plumber's work of Sandringham House in a recent number* of

* It was at page 272 of No. 69, Vol. III., which came out on March 7th, 1872.

such a largely-read and popular work as Cassell's "Technical Educator," viz. :—" Every soil-pipe should have a ventilating-pipe from its topmost point, communicating with the external air, of not less than two inches in diameter, and then the pipe itself becomes as it were the flue by which the remainder of the system with which it is connected is ventilated ; and in some cases this is so completely carried out, where unusual care is required, that the *space between the bottom of the valve and the water in an ordinary valve-closet has a small air-pipe running into the ventilating soil-pipes.* We may mention Sandringham House as an instance of the adoption of this precaution."

Now this plan here recommended—had it been really carried out—of leading the air-pipe from the water-closet trunk into the ventilating-pipe of the soil-pipe was anything but a "precaution." I am happy to be able to state, however, upon the authority of the firm who executed the work, that the above description is a mistake, and should be "a 2-in. lead air-pipe is taken from the outgo of the trap and branched into the main air or ventilating-pipe of the soil-pipe." This is similar to the pipe P, Fig. 159. Fig. 160 will enable non-practical readers to understand the mistake referred to. 1 is the level of top of water in the siphon-trap, 2 is the valve under the water-closet basin above referred to, while 3 is the "air-pipe running into the ventilating soil-pipe" from the space between the bottom of the valve, and the surface of the water in the trap. Now it will be at once seen that if the valve were open, or if any opening existed about the valve journal (as is often the case), said opening, &c., would allow the sewage gas from the soil-pipe to come back through this air-pipe "3," and so poison the air of the closet in which the water-closet

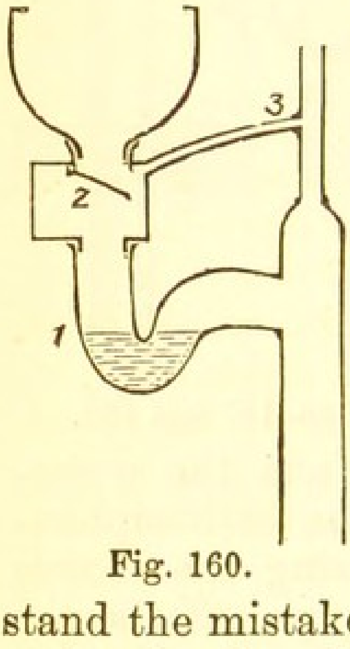


Fig. 160.

is situated, and in such a case any person coming into this closet, say, before breakfast, and with an empty stomach, might carry off the seeds of typhoid, diphtheria, or other fever with him, especially if the soil-pipe were untrapped at its foot and insufficiently ventilated. The description, however, was an unfortunate mistake, and since I first called attention to it I understand that the publishers of "The Technical Educator" have taken means to rectify the error. It is quite correct to put in an air-pipe (I have often put in two) between the water in the trap and the valve or pan above it, but it should not be run into the ventilating soil-pipe, but be carried out to the fresh air outside. By this *latter* plan not only will the space between the water in the trap and the bottom of the valve be kept purer and ventilated, but if any back draught does take place it will be a current of fresh air, not one of bad gas from the drain, as in Fig. 160.

Owing to what I had read and the remarks published thereanent by me in the *Building News* for May 17th, 1872, I wrote to His Royal Highness the Prince of Wales, regarding the occasion of his illness; he very kindly replied, stating that he was quite unaware in what manner he had caught his typhoid fever.

Before closing this article upon lead soil-pipes, attention may be drawn to the different styles of soldered joints referred to at Fig. 159, and drawn to a larger scale at Fig. 161. S, Fig. 161, is section of a "round joint," made about 6 in. or so above the board, the pipe being supported by the wiped soldering, $S^a$, connecting it to the lead flange which rests on the board. T is "flanged joint," with lead flange 6 in. or so below it supporting the pipe. U U, Fig. 159, and U, Fig. 161, are "flange joints," with the tops of the lead pipes flanged back on the boards, the top edges of the boards being rounded off and countersunk so as not to cut the lead where flanged back. This style at U is simpler than that at S and $S^a$, and T, as it saves a soldering, but many plumbers consider that it does not make so good a job. v is simply a lead flange about 8 in. or 9 in. in diameter over all, with wiped soldering attaching it to the pipe, and so supporting the pipe. In the case of lead soil-pipes laid horizontally, they may be supported by being allowed to rest on boards. In some cases lead bands, as per Fig. 158, only differently fixed, are used. When I say "horizontally" I do not mean exactly level, for soil-pipes should always get as much of an incline or "run" as possible. In some cases, where the presence of rats may be feared, a piece of thin sheet zinc put round the lead pipe is a good protection against their teeth, but the best plan is to keep them out of the house altogether by seeing that the drains are laid properly, of which more anon.

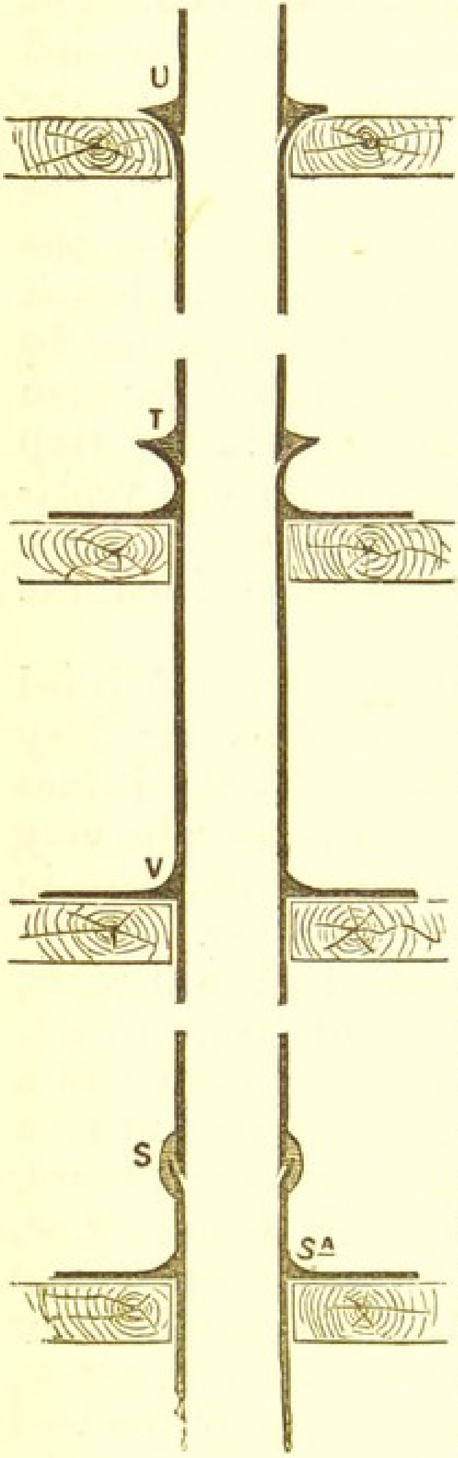
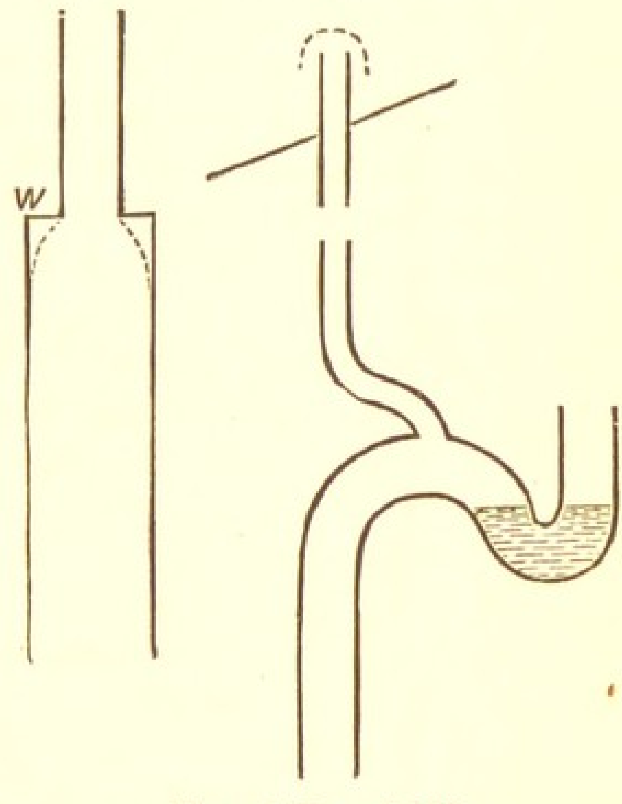


Fig. 161.

Before leaving the subject of the fitting-up of soil-pipes, I would yet make some further remarks, and point out a few precautions necessary to be observed. In connecting (say) a 3-in. ventilating-pipe to the top of a $4\frac{1}{2}$-in. lead soil-pipe, or a $3\frac{1}{2}$-in. pipe to the top of a 5 in., it must be a rule always to contract the top of the $4\frac{1}{2}$ in. or 5 in. pipe, as shown by Figs. 154 and 159, and not to do it in the style I have sometimes seen, and as shown by Fig. 162, where the top of the soil pipe, instead of being gradually contracted as per dotted line—so as to leave no resting-place for the foul air rising up—is cut square across, and a flat disc put on with hole through it, as per w, Fig. 162, in which latter case this flat disc, as I have seen, gets corroded by the foul air and full of holes. When the ventilating-pipe is finished off at the top with a bend, as per Fig. 154, it is a good plan to bore several $\frac{1}{2}$-in. or $\frac{3}{4}$-in. holes through the top of the bend. Another style of finish is that shown by Fig. 163, where the cup may also be perforated. Another plan is to leave the pipe standing up perpendicularly, and to solder on several pieces of tinned copper or brass wire across its mouth, as at H, Fig. 159. Of late, however, the placing of a ventilator upon the top of the soil-pipe, as in Fig. 264, has been highly approved of and largely in use. The best form is the fixed ventilator, and I know of none equal to my own Induced-Current Fixed Ventilators. Various sizes can be had as required.



Figs. 162 and 163

A word now about the amount of "drown" or water-lock which the various lead siphon-traps inside a house should have. In my opinion about $1\frac{1}{2}$ in. or 2 in. of "drown" is little enough; that is to say, that the depth of water lying, *e.g.*, in a $4\frac{1}{2}$-in. water-closet siphon-trap, should be about 6 in. or $6\frac{1}{2}$ in. A good "drown" or deep water-lock should be especially given to the siphon-traps in houses or mansions where the inmates are often from home for months together. For the baths, wash-hand basins, &c., &c., no harm, but good, would be done by making the "drown" 6 in. or 7 in., or even more. To make it only $\frac{1}{2}$ in. or rather less, as is often done, is simply a bad job, and is frequently the cause of those intermittent bad smells which are sometimes so difficult to trace out properly and to the satisfaction of all concerned.

A great deal has lately been said about keeping back the foul gas of common sewer from getting into the house drains, which is very well, but this is not all, for it must be remembered that foul air gathers in the house drains and pipes themselves, independently altogether of the common sewer.* In order to prevent this foul air getting exit into the house, all the joints of the drains and pipes must be properly and securely made; and, as above stated, all the siphon-traps must have plenty of *drown;* and lastly, to prevent its concentration this foul air must be allowed exit either at the ventilating-pipe of the soil-pipe, or waste-pipes, or in some cases when away from a window and provision is made to prevent it going in under the slates, a rain-water pipe may be used, or as I have often done of late, a special outlet ventilating-pipe may be put up for the house drain itself, while the soil and waste-pipes are individually trapped and ventilated.

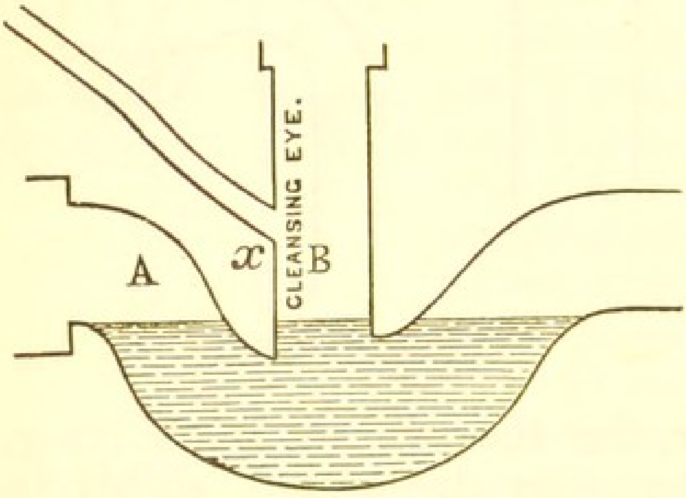


Fig. 164. †

Where the pressure of gas coming back from the main sewer is supposed to be occasionally great, it may be carried off and kept out of the house drains by putting in a ventilating-pipe to the top of the roof from the cleansing eye of the cesspool, or siphon-trap which divides the house drain

* Various members of the medical profession seem to me to have written as if they ignored this fact, nevertheless, so far as I can judge, disease has often arisen from the house drains and pipes, independently of the common sewer. Bad air from either sewer or drain means slow when not rapid poisoning; and drain or sewage gas can kill, no matter what sanitary quack may have set down his "perfect" ventilating cure-all between the house-drain and the sewer, that is if the drain itself and the soil and waste-pipes are not properly put in.

† Fig. 164 old trap is now superseded by Fig. 272A set as in Fig. 273.

proper from the outer drain leading down to the common sewer, as per x, Fig. 164; or, if a rain-water pipe comes handy, which is at a sufficient distance from any window, it may serve if joined below, as per x, Fig. 164. Or, again, if the cleansing eye be at some distance from the house and have an open grating on its top—serving also to allow passage for surface water, perhaps—said cleansing eye alone may serve.* In setting this siphon-trap, Fig. 164, it should be seen that the side of the cleansing eye nearest to the house is sunk 1 in. deeper below the surface of the water than the side farthest from house—that is to say, that the side of tongue of cleansing eye nearest to the house should dip down into the water about 2 in., while side of tongue of cleansing eye nearest common sewer should dip down 1 in. under the surface of the water.

This style of fireclay siphon-trap, Fig. 164, does not provide either for the ventilation of the sewer or for that portion of the drain leading down to the sewer, it simply acts as a sort of safety-valve to prevent any extra pressure of air from the sewer getting through the inner side of the trap. If, however, upon the house side of the trap the length of drain pipe next the trap be put in with a square eye and have a vertical pipe carried up from said eye to the surface and covered with a suitable air-inlet grating, then the house drain can be ventilated thereby.† As to ventilating the house drains and the sewer, &c., in a proper manner, that will be referred to in Chapter XXIX, upon an Improved System of House Drainage.

Supposing the drains and soil-pipes were put in properly and, so far as they are concerned, *per se* all right, yet there are other things still to be attended to which must be done correctly or evil will ensue, and to come to them we must now refer to water-closets, cisterns, and their fittings.

* Water coming down in cleansing eye will tend to keep the top of the water clean and clear at B, yet this Fig. 164 style of trap is a dirty appliance, as foul matter gathers on *house* side of trap, and *out of sight* at A.

† The cleansing eye of the trap at Fig. 164 is supposed to have a stone with an iron hinged stop-cock cover over its top.

# CHAPTER XV.

## Water-Closets.

One of the simplest forms of water-closet is that known as the cottage closet, Fig. 165, supplied by a valve-cock with lever, handle, and weight, the water running only while the lever is held up.

In some cases common ground or screw-down stop-cocks are put on in place of lever-cocks, but the former often cause great waste of water by being left open, and should not therefore be allowed. The other day, *e.g.*, a property in which the tenants were complaining greatly of a want of water was set all to rights, and a good supply given, by merely taking off a screw-down crane which had been put on a water-closet in the lower flat, and putting on a lever cock with weight in its place.

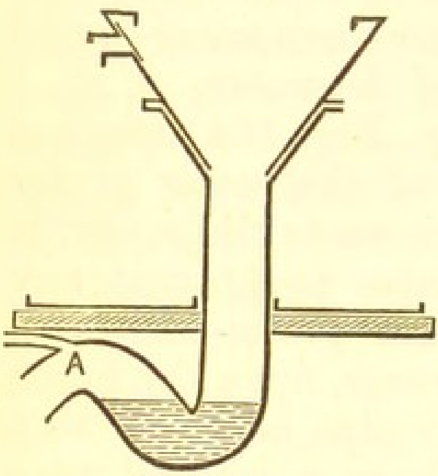


Fig. 165.

The great fault of this cottage closet is that no water lies in the basin ; but if the rule be properly or constantly acted upon that sufficient water is made to run each time the closet is used, then a cottage closet fitted up in the style of Fig. 165 works pretty well.*

I had one in use in my own house, by my own family, for fifteen years, and it served very well, the basin being always clean, simply by acting upon the above rule as to running the water. For general use, however, a wash-down or a wash-out closet (pp. 279—81)

* In Fig. 165 the lead trap is shown under the floor, but it may be, and has been, placed above the floor, and so as that the bottom of the basin may dip into the water more or less. It requires a good supply of water, say by $1\frac{1}{4}$-in. pipe (less or more according to height), if from a cistern, to flush it properly. Mr. S. S. Hellyer of London has patented the " Vortex " closet upon this principle ; the basin and trap in his case being all in one piece of earthenware.

is better. The basin in Fig. 165 is a common round or oval basin, the same as used for the pan water-closet. The fan or water-spreader inside of the water-inlet of the basin is made out of a piece of 5lb. sheet lead, and is secured by means of two brass bolts and nuts. By this means the fan can be easily regulated, so as to suit the pressure of the water in each particular case; for this latter reason water-closet basins with lead or metal fans are often preferable to basins with earthenware fans. The

Fig. 166.

basin at Fig. 165 is supported by the lead tapered seat, and a piece of $4\frac{1}{2}$-in. lead soil-pipe about 9 in. long. Instead of using a basin and lead tapered seat for their cottage closet, as shown in Fig. 165, some, for cheapness, use instead a long tapered, or "hopper" basin, as shown in Fig. 166. This hopper basin is much more difficult to keep clean than the one in Fig. 165, on account of the much greater surface exposed to the *excreta*, and the greater difficulty of getting the rush of water to spread over and cleanse the whole surface of the basin properly. For these reasons they are not to be approved of, and are often taken out owing to that fault.

Another form of water-closet is the well-known pan-closet, which may either be supplied by means of a crane or a valve in the cistern above it.* This cistern is generally put up as per Fig. 167, and in many cases not only serves for the supply of the water-closet, but also for all the water required for culinary and drinking purposes. This latter plan is not to be commended however, unless proper precautions are adopted to protect the water from contamination. The overflow-pipe of this and other cisterns is a fruitful cause of bad smells, and the escape of sewage gas within houses. It is actually in some cases put up as per Y, Fig. 167, with communication to the soil-pipe quite open!

In thousands of other cases it is just about as bad by

* Many who condemn the pan closet, with its "tip-up" copper pan (and large iron "container"), yet rather inconsistently use or recommend "tip-up" wash basins and lavatories, which I think are worse! Neither, however, are good.

having a small useless bell-trap put in at Y only a couple of inches deep, and holding but a few teaspoonfuls of water, and which being hand-filled by the plumber, soon gets empty by evaporation, when the foul air from the soil-pipe comes blowing out quite freely. In this latter case, when a bad smell is complained of, the plumber often comes, and finding his little bell-trap empty, he simply refills it, and, of course, stops the smell; but it is only for a few days or weeks, for it is soon emptied again. The proper remedy in this case is to cut out the small hand-filled bell-trap and put in a self-acting one, about 9 in. deep or so, in its place. Fig. 168 is section of such a self-acting bell-trap—made of lead or sheet block tin—the diameter of the outside pipe being about $3\frac{1}{2}$ in., that of the middle pipe $2\frac{5}{8}$ in., and its depth 8 in. The centre pipe is $1\frac{1}{2}$ in. in diameter. At A, one inch from the top, the outside pipe is all perforated round with holes $\frac{1}{2}$ in. in diameter. At B, 7 in. from top, there are three small holes $\frac{1}{8}$ in. in diameter, while C is the height to which the water rises in the cistern. By this means both waste of water is prevented (unless, indeed, when ball-crane leaks) and bad smell kept back. As

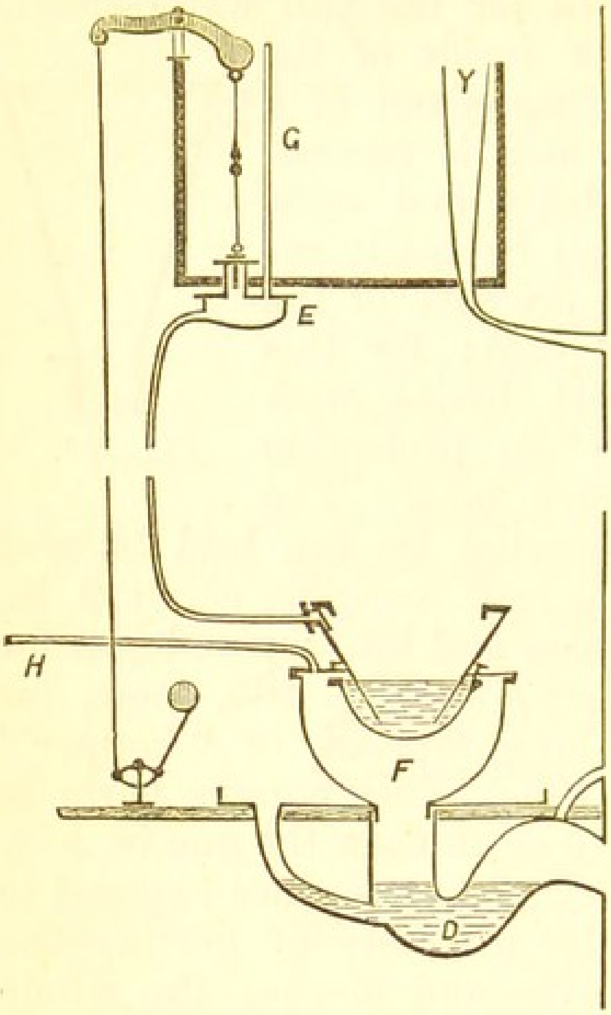


Fig. 167.

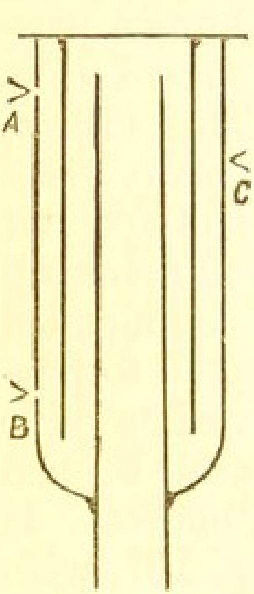


Fig. 168.

this self-acting bell-trap is my own invention, and is not patented, any one may make and use it. I do not recommend its use for cisterns, the water of which is used for drinking, unless in those cases where the overflow-pipe of the cistern is led out to the roof, &c., and has no connection with the soil-pipe or drains Where the overflow-pipe is carried outside of the house and no danger of bad smell need be feared, yet it is often useful to put on such a bell-trap as Fig. 168, in order to prevent cold air draughts. If, however, this bell-trap is put on anywhere with the overflow pipe led into the soil-pipe and the water used for culinary purposes (which it should not), I have heard that a few iron nails put into the bell-trap tend to act as antidotes against the bad effect of any *gas* passing through the water in the trap; but what about disease germs?

Another style of fitting in the overflow-pipe of the cistern is to carry it down to the siphon-trap of the water-closet, and join it as at D, Fig. 167, a couple of inches below the top of the water. When this is properly done, no bell-trap is required. At Fig. 167, E is the "service-box" which fills the pan F with water when the handle is put down; G is the air-pipe of the service-box; H is a small ventilating pipe sometimes put into the iron cover, or top of the water-closet trunk, and carried to *the outer air* for the purpose of carrying off any bad air or foul gas which may gather between the pan and the surface of the water in the siphon-trap. This pipe H may be either a 1-in. or $\frac{3}{4}$-in. lead pipe. If the latter size, a piece of $\frac{3}{4}$-in. lead pipe 5 lbs. or 6 lbs. per yard will do very well. It is connected to the iron cover of the trunk by means of a brass coupling and brass screw ferrule with a brass jam nut. This ventilation of the trunk is important, and no pan, valve, or Bramah water-closet is complete without it.* The very instructive experiments made by Dr. Andrew Fergus, with siphon-traps made of glass, before the Philosophical Society of Glasgow, in December, 1873, proved this pretty well. In these experiments, we clearly saw various gases passing through the body of

* For proper ventilation two pipes, an inlet and outlet, are required.

water in the glass siphon-traps. Some powerful gases passed through in say half-an-hour or so, others took several hours to pass. With unventilated siphon-traps the gas passed through quickly.* When the outer side of the trap was ventilated, however, the gas passed through much more slowly. Before seeing these experiments, I used to imagine that the bad air I often felt coming out of an unventilated water-closet trunk, proceeded solely from soil or *excreta* floating on the surface of the water in the trap, or from off the interior of the trunk ; until then, I never thought that it had either wholly or partially come through the body of the water in the trap and gradually accumulated in the unventilated trunk. With two ventilating pipes put in near H, Fig. 167, this accumulation is so far prevented, and when the handle of the water-closet is lifted, the quick back-action of the pan, together with the rush down of the water, tends to send any bad air in the trunk out through the ventilating pipes. Should the pan F, Fig. 167, be ever empty of water, a back draught could come in through these ventilating pipes ; but as H is led out to the pure air outside, said back draught would be one of fresh air. Our water-jointed gasaliers prove the value of water as a trap, but in their case a very small surface of water is exposed to the gas.

In the published "Transactions of the National Association for the Promotion of Social Science, Glasgow Meeting, 1874," much valuable information upon this subject will be found ; *inter alia*, a paper by Dr. Fergus on "The Sewerage of Towns." To meet the objections brought up against the common system of house drainage, a new and simple style of ventilation and trapping was invented by me in April, 1875, which has

* In the printed Proceedings of the Philosophical Society of Glasgow for Session 1878—79, and in a paper of mine upon "House Drainage and Ventilation," an account is given of some experiments made for me at the University of Glasgow by Professor Ferguson (Professor of Chemistry) relative to the passage of gases through water, which clearly show the value of proper ventilation—*i.e.*, of a *current* of fresh air passing through the pipes. And I may further observe that experimenting with powerful gases on water-traps is apt to lead to undervaluing of the real worth of said traps *in actual use* as against the passage of *ordinary sewage air* to a hurtful extent *through the water*.

done much good. Part of the plan is virtually that afterwards recommended in the recent Model Bye-laws, and will be explained in Chapter XXIX.

An improvement upon the pan-closet is the "Bramah," or valve-closet, Fig. 169; its trunk is much smaller than the trunk of the pan-closet, and its basin being differently shaped, holds much more water than the basin of the pan-closet, and consequently gives a better wash to the siphon-trap and the soil-pipe, but it is considerably more expensive than the pan-closet. The Bramah, like the pan-closet, may also be fitted up either with a crane or with valve in cistern and service-box; I must say, however, that for both I prefer the service-box and valve in cistern, as shown by Fig. 167. For a good job, the service-box of the Bramah closet should be larger than that for the pan-closet. The valve in cistern which fills the service-box should also be larger for the Bramah. The soil and air pipes should also be larger for the Bramah. The use of my patent jet pan to send down the paper would improve the Bramah.

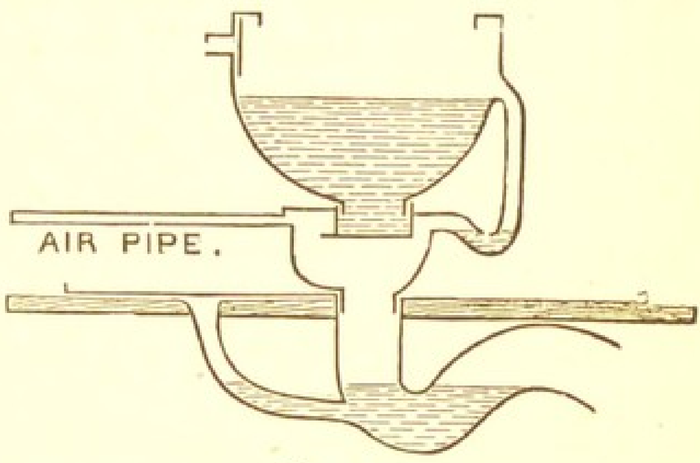


Fig. 169.

As a preventive against the gradual accumulation of bad air or drain gas between the water in the trap and the valve of basin, an air-pipe should be put in from off the trunk, as shown in Fig. 169. This air-pipe must in all cases be carried out to the outer air as already stated. For a gentleman's house, or for any one who chooses to pay for it, I consider a good Bramah closet, with the pipes arranged as explained in Chapter XXVII., to be one of the best machinery closets extant.

Another style of water-closet largely used lately is that where cistern and water-closet are all in one, as per Fig. 170. Of this type "Shanks' patent" may be taken as an example; the handle I and round india-rubber ball or valve J, and in this case, also the siphon-trap, being to one side, as per Fig. 170, K being the cast-iron cistern in which the copper ball, L, of ball-crane, moves up and down. When the handle is lifted, the water flows out of both cistern and basin, which causing the ball L to fall, the water from ball-crane rushes into basin, cleansing it; and when the handle is put down, both filling basin and also small cistern to the necessary height. The use of closets in this style is now interdicted in Glasgow in all new work. In a number of cases where they have been fitted up, I have felt a bad smell come up through the overflow of the cistern. Upon other occasions when the water supply has been short, as in a dry summer, I have felt them smelling most abominably bad.

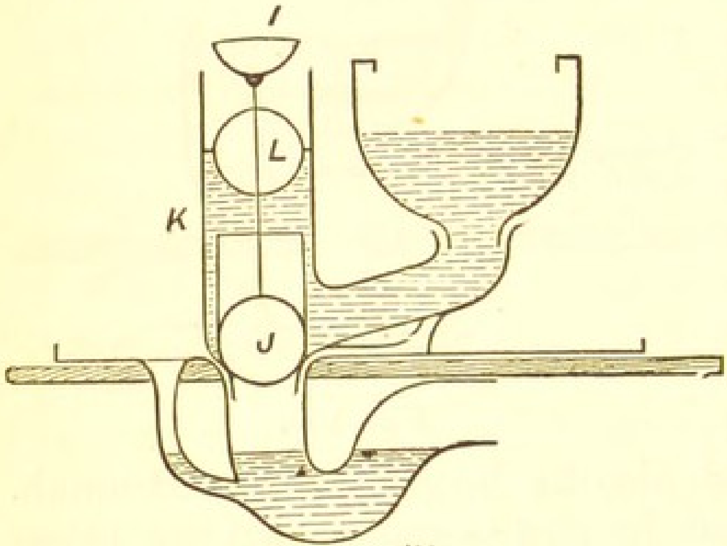


Fig. 170.

Mr. George Jennings, of London, has a "patent valve closet and trap," all in one piece of earthenware. The whole of it, trap included, is above and rests upon the floor, except the short nozzle at the outlet which enters the soil-pipe. This closet is upon somewhat the same principle as Fig. 170, but in my opinion all the closets with side cistern out of sight and communicating with the water in the closet basin, and being upon the same level with it, are liable to become dirty and unsanitary appliances, as, although clean for a time, yet by-and-by foulness gathers in the out-of-sight division, and so may give off not only bad smell but also disease germs. Such closets, therefore, although serviceable for temporary uses on buildings, as at exhibitions, are not, as it seems to me, to be commended for fixtures in houses where the same closet is intended to be used for years. They are, however, possibly superior to the so-called "trapless closets," which in my opinion are unsanitary *traps*, liable to cause disease in the dwelling, especially if not carefully watched. A good water trap upon a closet is like a good lock upon a door, a useful protective against robbers, and health robbers are really far worse than property robbers.

Another style of flushing closet often used to preserve economy of water in its working, and at same time insure a flow of water each time the closet is used, is the double cistern self-acting one, Fig. 171, where the act of pressing down the seat of the water-closet—which is hinged and fitted on purpose—causes the water to flow from the large cistern into the small one, and when the seat is allowed to rise—which it does of itself, being forced up by one end of weighted lever placed under it—the connection between the large and small cisterns is closed, and the valve M, which allows the water to rush down the water-closet service-pipe and flush the basin, opened.

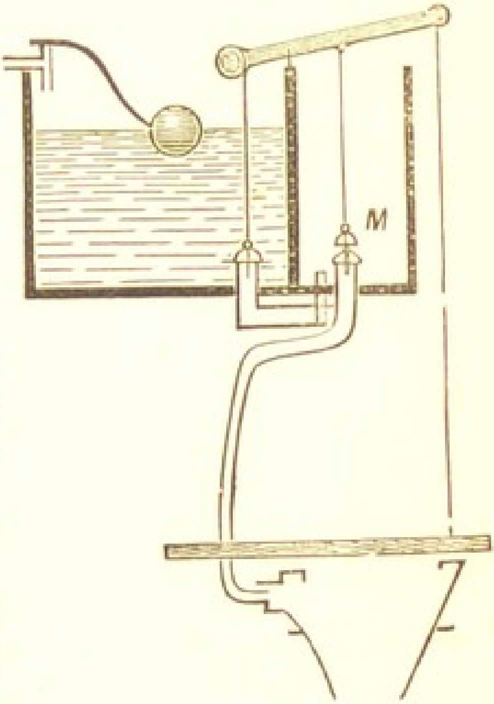


Fig. 171.

To prevent the waste of water in water-closets, various plans and many "patents" have been brought out of late. Formerly, and in many cases still, so long as the handle of the water-closet was held up, so long did the water run; now, however, the water-economising plan is that when the handle is lifted, no more than about two or three gallons of water run off to flush the basin. Before more water can be got the handle must be first put down and again lifted. This rule was really so far necessary, as in very many cases parties would prop up the handles of their water-closets and allow the water to run full bore for hours at a stretch.

Fig. 172 is a vertical sketch of a double cistern with two valves. When the handle of the water-closet is lifted the valve in the smaller division opens, and the valve in larger division shuts, consequently all the water that comes is what is contained in this smaller division, and no more water will come until after the handle has been again put down and again lifted. Consequently to save people's time and allow good and proper flushing of the water-closet both the valves should be no less than $2\frac{1}{2}$ in. To have the one scarcely 2 in. and the other only about 1 in. is a great mistake, and this with too small cisterns has tended to cause dirty closets and pipes, and in consequence more liability to a larger amount of bad health. In some cases it would almost appear that the saving, real or imaginary, of a few gallons of water per day—even with an overflowing fountain-head—was of much more consequence than the increase of the disease and death rate through sewage gas poisoning from foul pipes and drains. The real waste of water is not the quantity used to flush a closet properly, but the continuous leakages from cranes and fittings out of order. In order to give a better chance to the pan being filled after the handle has been put down, the service-pipe leading to the basin from the service-box projects up into the service-box, as shown in Fig. 172, say about 1 in., and it has a small hole in its side close to the bottom of the inside of the service-box; by this means water is expected to dribble into the pan and fill it slowly up after the handle has been put down. Another thing that I would call attention to in connection with the service-box of Fig. 172 is the $1\frac{1}{2}$-in. brass cleansing-screw (the same as used for the traps of kitchen sinks) shown as soldered on to its bottom at s. By unscrewing this brass cleansing-screw any foreign

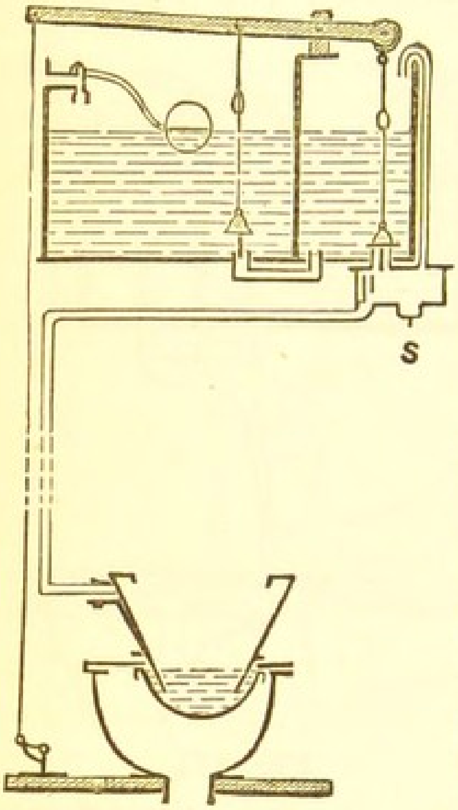



Fig. 172.

matter which may have got into the service-box may easily be got out; at present its use is rare, but the contrary ought to be the case where service boxes are used.

Instead of the double cistern with two valves, "waste not" valves, which close of themselves, may be had for fitting into single cisterns. Messrs J. Tylor and Sons, of London, have patented one of this sort which has been largely used of late. A still more ingenious one has been brought out by Mr. Connell, of Messrs. Wallace and Connell, Glasgow. In this the action of lifting the handle gives so much water and no more, thereafter upon pressing down the handle so much comes as fills the pan. Both, however, at present have the same fault in my eyes, viz., being too small, and so not allowing a sufficient quantity of water to come quickly. Mr. William Ross, of Glasgow, has also various cheap "waste-not" valves.

To describe all the various styles of water-closets would be rather a difficult task, and is unnecessary here;* I therefore proceed to observe that in setting the siphon-traps of the water-closets, as per Figs. 165, 167, and 169, the centre of the top of the siphon-trap generally is the centre of the water-closet basin above it, and in placing the siphon-trap into its position, the plumber must see that it is in its right place and at a sufficient distance from the back wall, due allowance being made for the thickness of the plaster or wood lining, &c. The distance of the centre of the water-closet basin from the outside face of the back lining is generally about 12½ in. or 13 in., or perhaps a little more, and if outside face of lining be 2 in. (say) from the stone or brick wall at its back, then the distance of the centre of the top of the siphon-trap from the stone wall would therefore be 12½ in. + 2 in. = 14½ in. or so. Or again, when it is simply to be lime on brick, then about 13½ in. may serve between the face of the brick and the centre of the siphon-trap. In the case

* I may mention a few, however: J. Tylor & Sons', Jennings', Underhay's, and Hellyer's, London; Dodd's, Liverpool; Bostel's, Brighton; Woodward's and Sharpe's, Swadlincote; and Carmichael, Glasgow. See pages 277—284.

of Fig. 170 the centre of the basin is not plumb, above the centre of the siphon-trap, but the siphon-trap is placed about 10 in. or so to one side, as shown ; the distance out from the back wall is, however, the same in both cases. After the siphon-trap has been properly fitted into its place, and the flooring laid above and round it, the plumber generally lays down a lead safe or tray about 2 ft., 3 ft., or 4 ft. long, as the case may be, and about 2 ft. broad. It is turned up all around its outer edge, to the height of 2 in. or so. Upon this safe the trunk of the water-closet (Figs. 167, 169, 170) is laid, being bedded with putty and fixed with brass screws or nails ; the basin is also bedded with putty, or, in the case of Figs. 169 and 170, with red-lead or cement, while the connection between the basin and "service," or supply-pipe, to it is made with putty and cement formed by melting rosin and tallow together. A lead or tin "fan," or water-spreader, is also fixed to the inside of the basin by two brass bolts and nuts, so as to cause the water to rush round the basin and cleanse it.* In the case of basin for Bramah closet a lead fan with horn is sometimes put on outside, *i.e.*, when there is no earthenware horn.

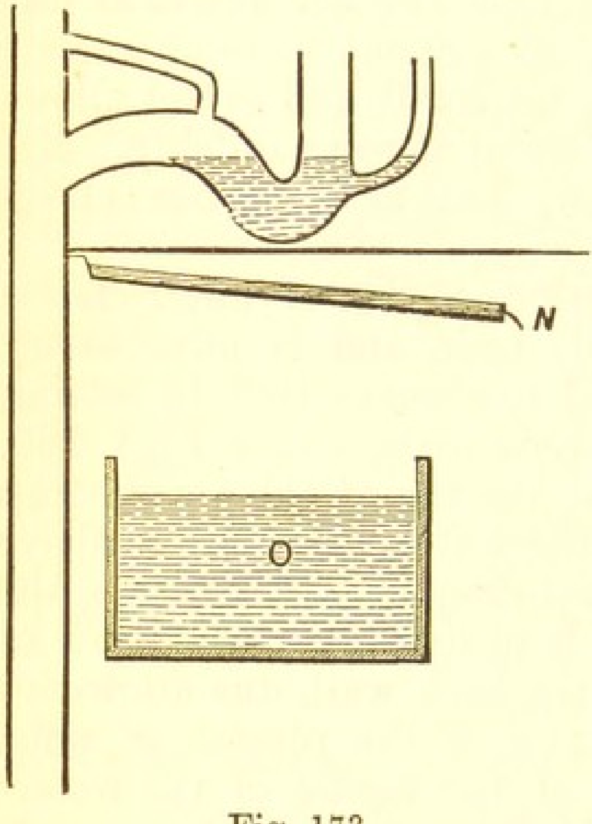


Fig. 173.

Instead of using putty and cement, with a strip of cloth and twine to make the connecting-joint between the basin and supply-pipe, a new plan is to use a tapered india-rubber coupling or cone, open at both ends, and about $2\frac{3}{4}$ in. long ; the small end grasping the supply-pipe and the larger end the horn of the basin.

It is incumbent upon every true architect, and upon

* I prefer the water to flow out at both sides of the fan. When only at one side there is greater danger of flooding should valve stick.

all who have it in their power, to see that the water cistern is properly protected. One style of doing this where cisterns are so placed as that the cistern of one flat or house is immediately under the water-closet in the flat or house above it, is shown by Fig. 173, where a wooden board, N, longer and broader than cistern, and covered with lead, is fixed in above the cistern and close to the ceiling at its back, but with a little inclination downwards and outwards to the front as shown. In this case, supposing the water closet above to be out of order and overflowing, then any foul water coming down cannot get into the cistern O, underneath, but instead falls down beyond it and on to the floor, thus at once giving warning that something is wrong. From inattention to what I am referring to, and the want of some such protection as the board N in Fig. 173, it is no uncommon circumstance for the occupants of houses which draw their whole water supply from cisterns situated as in Fig. 173, to be using water tainted with the droppings from the water-closet above. The continuance of this poison-my-neighbour system, which is still largely in use, is anything but complimentary to those who have it in their power either to put a stop to it, or at least to see that proper precautions are adopted.

All water-closets, especially in dwelling-houses, should be fitted up where the daylight can reach them, and if next an outer wall the window should be in two halves to lift up and down, or open, like an ordinary window, so as to be capable of being used for ventilating purposes. In the winter continuous ventilation might be secured by boring a number of oblique holes in an upward direction in the bottom or sides of the upper sash, say half-inch or so in diameter. I have been in the habit for about fourteen years back, but more especially of late, of boring such holes in windows for ventilation. Daylight admitted into a water-closet generally insures its being more cleanly kept.

# CHAPTER XVI.

## BATHS.

We now come to treat upon baths. The simplest style of bath, and one which serves its purpose very well, is the wooden one. It may be made either quite square at both ends, as per Fig. 174, which gives longitudinal section, or one end may be sloped as per Fig. 179. It is made of $1\frac{3}{4}$-in. wood, planed on both sides, and jointed as per Fig. 175, the ends being checked or

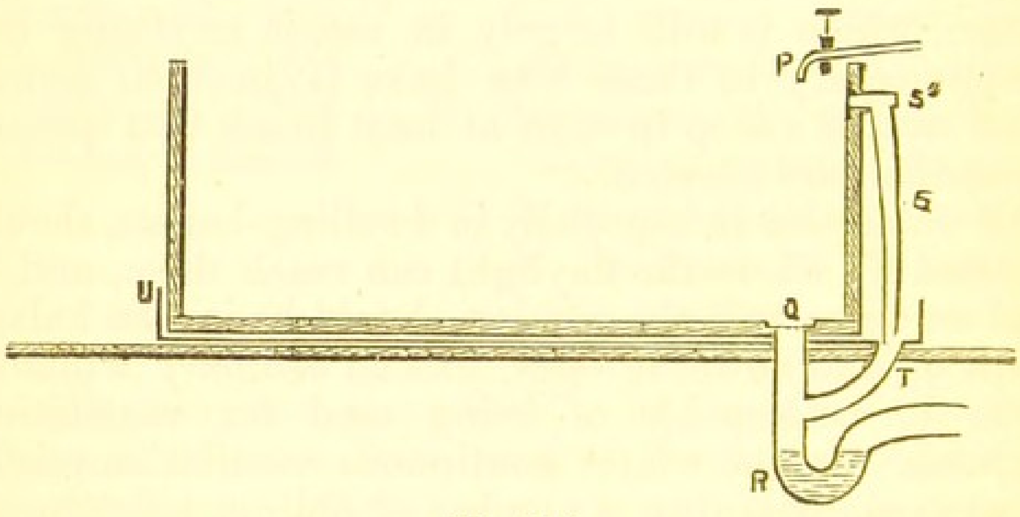



Fig. 174.

inserted into the sides to the depth of about $\frac{3}{8}$ in., white-lead being used for the joints. It is then nailed together. After the bath has been made, the plumber has to fit it up, which may be done in various styles. The simplest is that shown by Fig. 174, where the bath is filled by a simple bib-crane P, and the waste water discharged at the socket-grating Q. Into the brass socket-grating Q, a ground brass plug fits, which is put in when the bath is to be filled, and withdrawn when it is to be emptied. This brass plug has a strong brass chain attached to it, the other end of the chain being fixed to or near the top of the bath. R is the 3-in. syphon-trap underneath the bath, while S is the overflow-pipe which leads into the safe-pipe, T. This safe-pipe, T, takes any water away which may fall into the lead safe, or tray, U, should the bath happen to leak at the bottom or seams. The lead tray is set up at the ends and sides about 4 or 5 inches. The top of the lead syphon-trap just under Q, where it passes up through the lead safe, is, of course, soldered round there to the lead safe. Sheet lead, 4 lbs. per square foot, does very well for this lead tray. When fitting up this and all other plunge-baths, the plumber ought to be careful to see that the bath is so placed as that, upon the withdrawal of the plug, all the water runs easily out of the grating Q.

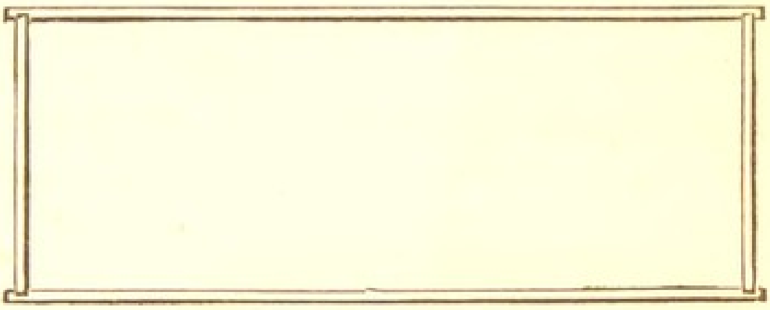
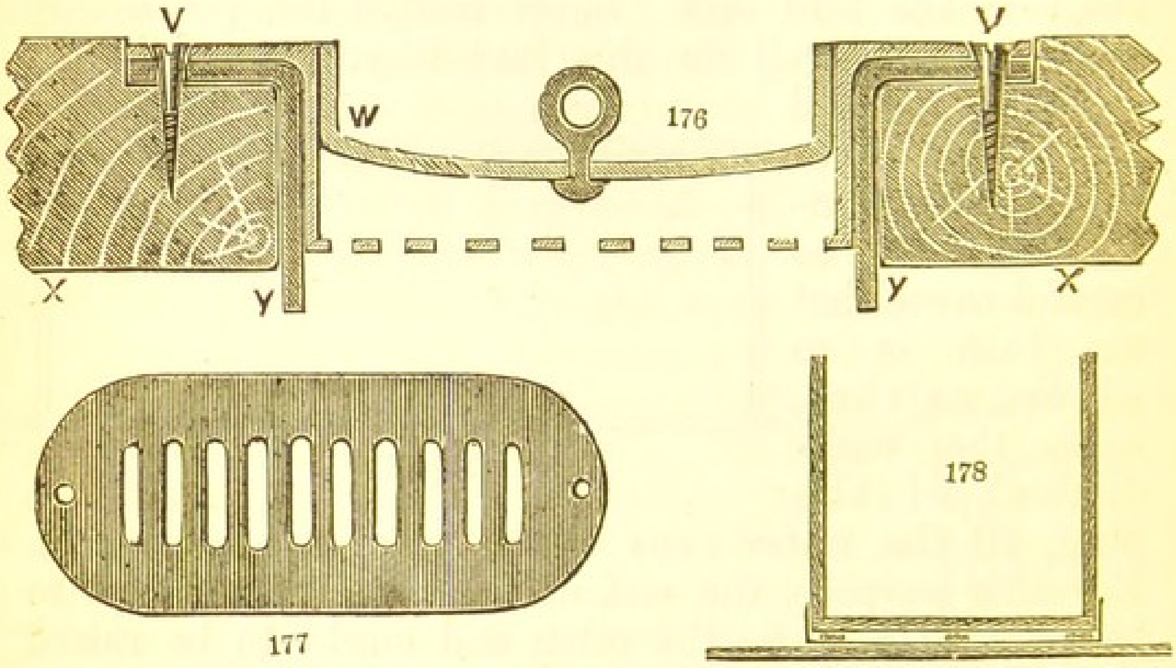


Fig. 175.

For this purpose, the end of the bath at Q ought to be the lowest, while the other end ought to be raised up a little higher. In the case of Fig. 174, three slips of wood, each about 6 ft. long, $2\frac{1}{2}$ in. broad, and about $1\frac{1}{4}$ in. thick at one end, regularly reduced to about $\frac{5}{8}$ in. thick at the other end, should be placed underneath the bath. These slips will not only give the bath the necessary declivity to Q (supposing the floor to be level), but, in the case of Fig. 174, also prevent the bottom of the bath from lying soaking in any water which might get into the lead safe U. Fig. 178 shows cross-section of bath, with the wooden slips referred to under it. To give satisfaction, it is very necessary that proper brass gratings are put in, especially for the bottom one at Q. Fig. 176

shows section of circular brass socket-grating and plug *in situ*, the diameter over all of this socket-grating, from V to V, being $5\frac{3}{8}$ in., and the diameter over all of the plug W fully 3 in. The breadth of the top flange V is about 1 in.; it has four holes bored and countersunk in it, for 1 in. brass screws to fix the socket-grating down to the bath. X X, Fig. 176, is the wooden bottom of the bath, and Y Y the top of the lead syphon-trap, R, Fig. 174; or, rather, Y Y is the top of a short piece of $3\frac{1}{4}$-in. lead pipe joined on to the top of the syphon-trap, going up through the wood, and bent over the wood and under the brass flange, as




Figs. 176, 177, and 178.

shown. Before the lead is bent, or worked over, it is well coated, on the side next the wood, with white-lead, so as to make a tight joint. It will also be observed that at V V, Fig. 176, the wood is checked down, or cut out, to the depth of $\frac{3}{8}$ in., so that after the lead has been turned over, and the brass socket-grating put in, the top of the brass may be rather lower than the surface of the bottom of the bath, which allows all the water to run off freely. Fig. 177 shows the style of the brass overflow grating used for the wooden bath; it is $6\frac{1}{2}$ in. long by $2\frac{5}{8}$ in. broad over all, and $\frac{1}{8}$ in. thick. The wood of the bath is checked out about $\frac{1}{4}$ in. where it goes, thus allowing for the thickness of the lead and brass, so that, when fixed, the face of the brass may be flush with the wood. I have said that the size of the brass overflow-grating is $6\frac{1}{2}$ in. by $2\frac{5}{8}$ in., but the lead mouthpiece, $s^2$, Fig. 174, while also of oval form, is only $4\frac{3}{4}$ in. across by $1\frac{1}{2}$ in. wide, the hole cut through the wood of the bath being made to fit the lead mouthpiece, *i.e.* about 5 in. long by $1\frac{3}{4}$ in. wide.

In Fig. 174 only one crane is shown, as if the bath were only for cold water, but all that is necessary to make it serve for both hot and cold, is simply to put on a hot crane (provided you have hot-water supply) either alongside P, Fig. 174, or else at the other end of the bath, just as may be most suitable. These wooden baths do not require to be lined up along the front, but merely up the ends, or if the bath be in a corner, up the one end; a piece of wood skirting, however, about 6 in. broad, goes along the bottom of the front. In some cases, however, and especially where the wood for the sides is put on in two pieces, this bath is lined up the front, which lining hides the view of the seams from the outside; in this case the wood lining should not be put on close to the wood of the bath, but should be kept apart about half an inch, so that any water which may ooze out at the seam may trickle down unchecked into the lead safe, the upstand of said lead safe being kept back from the wood of the bath about half an inch or so, as shown at U, Fig. 174, so as to allow the water to fall into the safe freely. Due attention to these apparently little matters often makes all the difference between a satisfactory and an unsatisfactory job.

Another style of bath largely used is the wooden one lined with lead. It is generally shaped as per Fig. 179, which shows longitudinal section of it. In this case the wood does not require to be planed, as it is all hid or covered in. A common size is 6 ft. over all in length, which, as the wood used is $1\frac{1}{2}$ in. thick, gives

5 ft. 9 in. for the length *inside*, the inside breadth and depth being each (say) 2 ft. Sometimes the inside length is more than 5 ft. 9 in., and also often less, perhaps 5 ft. 6 in., or 5 ft. 4 in. In lining this bath with lead, the lead used may be either 6, 7, or 8 lbs.

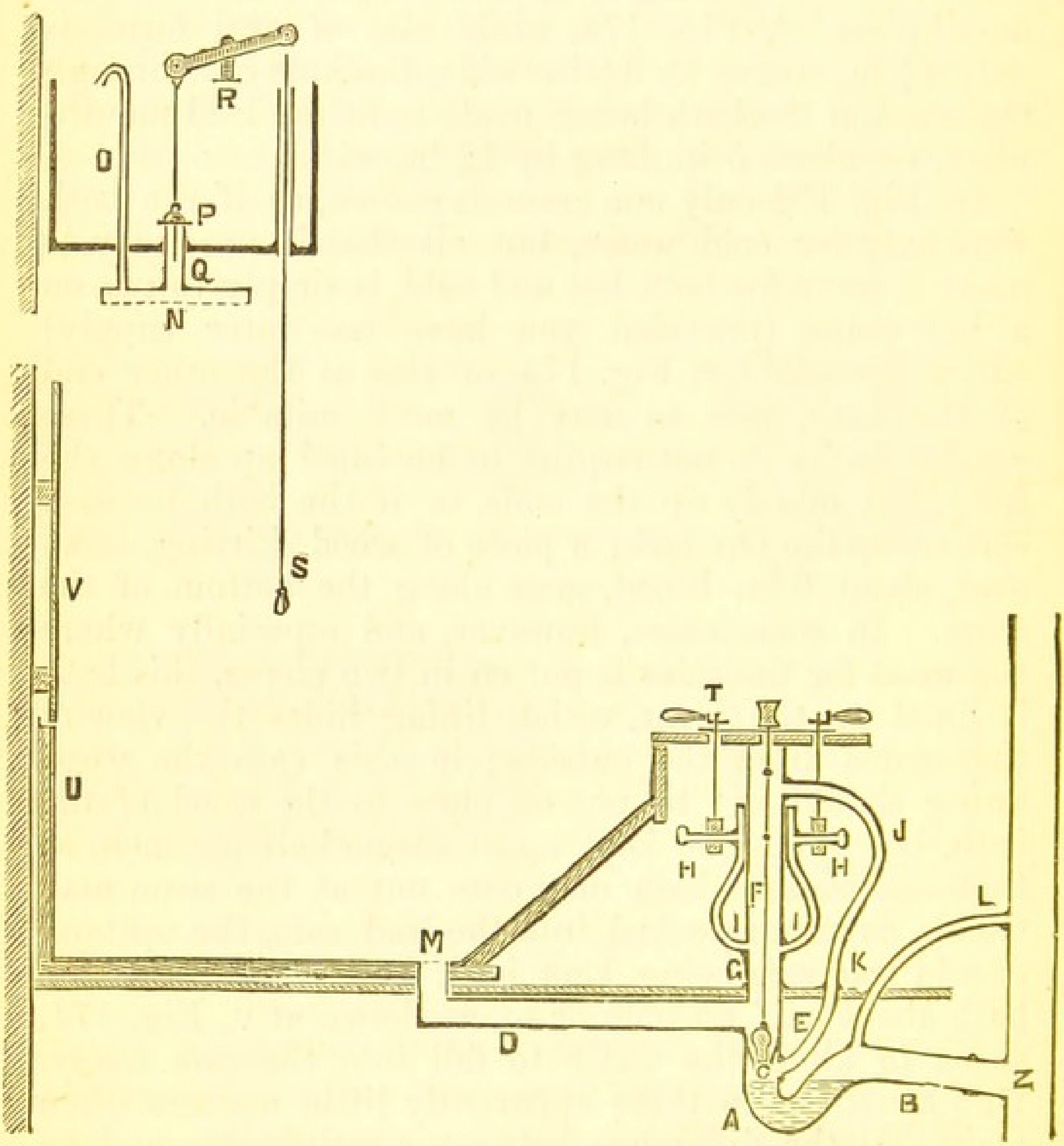
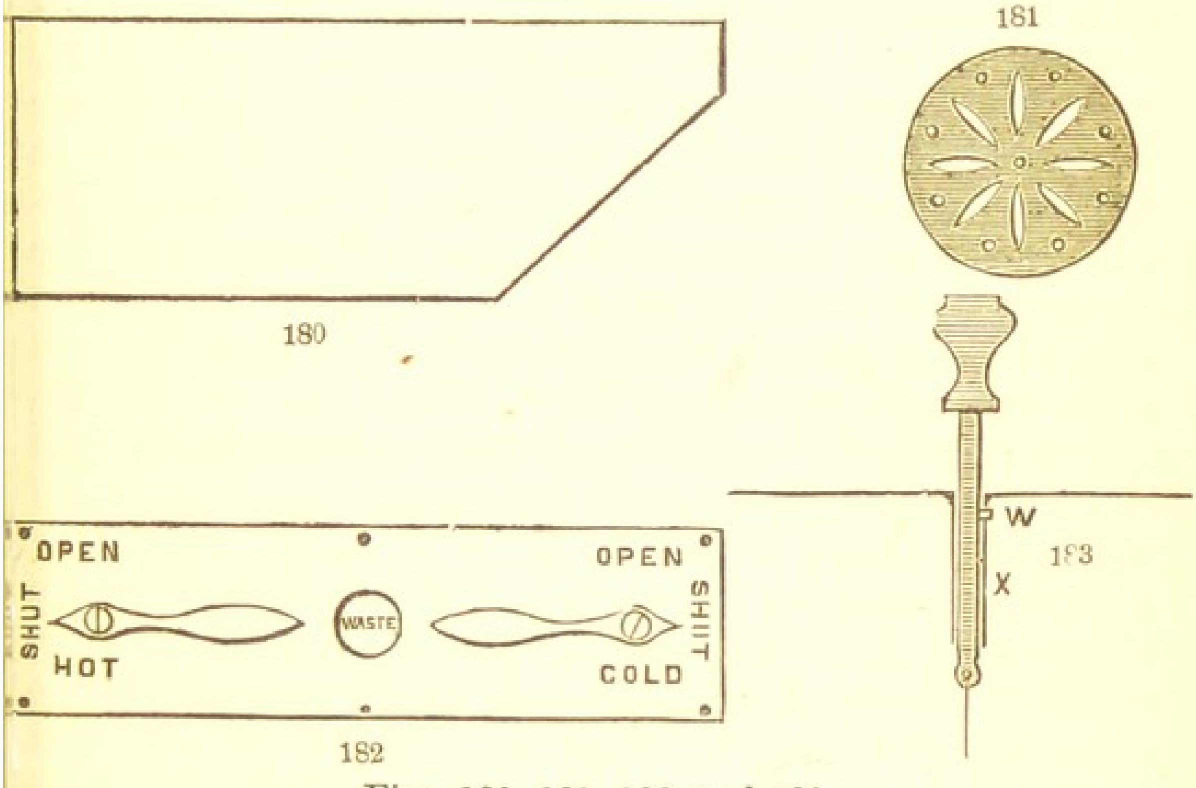



Fig. 179.

per square foot, as the case may be; if for hot water, it is better to be strong. For cold water alone the lead used is often only 5 lbs. per square foot. The plumber cuts out the lead for the ends and bottom all in one piece, and if we suppose the inside length of the bath to be 5 ft. 9 in., and the breadth and depth each 2 ft., then the length of the lead for the bottom and the ends will be 2 in. + 2 ft. + 4 ft. + 2 ft. $3\frac{1}{2}$ in. + 6 in. + 2 in., which gives 9 ft. $1\frac{1}{2}$ in. by 2 ft., as the size of the piece of lead for the bottom and ends. The two pieces of lead for the two sides are then cut out in shape, as per Fig. 180, the greatest length of each being 5 ft. 9 in. along the top, and the depth 2 ft. + 2 in. = 2 ft. 2 in. The length along the bottom is 4 ft. These sides being fitted to the bath, and the




Figs. 180, 181, 182, and 183.

edges of the lead planed straight, they are smudged down each side and along the bottom, and then scraped all along the edge where the soldering is to be, about $\frac{3}{4}$ in. broad. After being scraped, the cleansed surface of the lead is rubbed over with grease or tallow. The bottom piece of lead, being also smudged, scraped, and greased, is put into the bath first, and dressed into its place properly, after which the sides are put in and tacked all along the site of the soldering with $\frac{3}{4}$-in. tinned iron tacks, one being put in between the edges of the lead at every 4 in. or so. After each side of the bath has been soldered, or "wiped," small pieces of sheet lead, each 2 in. square, are soldered into the top corners of the bath with a copper bolt, to make up the deficiencies of the lead there, caused by said lead being folded back over the top edge of the bath. The bath is now ready to be fitted up, and instead of doing it as per Fig. 174, we shall suppose it is to have a rod-pipe, ground brass valve, and hot and cold water supply, and also cold water shower-bath above. As in this case the waste-pipe of the bath is to be discharged into the soil-pipe, Z, Fig. 179, a branch has been left at Z, as shown, for that purpose. The first thing to be done is to put in the 3-in. syphon-trap, A, Fig. 179, with the 3-in. waste-pipe, B, attached; but before doing so, the socket of the valve, C, Fig. 179, has to be soldered in, and also the branch, D, to the bath, likewise portion of bath overflow-pipe sufficient to go up through the floor, as at E. As will be seen from Fig. 179, the branch D, to the bath, joins in at the end next the syphon-trap, a little above the valve. In order, therefore, that it may have something to join into, when the valve socket, C, is put into the top of the syphon-trap, about 7 in. or 8 in. of 3-in. lead pipe is soldered on to the top of the lead syphon-trap along with the valve-socket; this 7 in. of 3-in. pipe, while it has the branch pipe D, which goes under the floor, inserted into it, must also be left of sufficient length thereafter to pass up through the floor and be flanged back about ¾ in. on the floor, after the flooring has been laid. This flanging back after the flooring is in helps to support the syphon-trap (the joiner must be ordered to fit his flooring neatly and properly around the pipes, rounding off the sharp edge of the wood wherever the lead has to be turned over it), and to this part flanged back the bottom of the rod-pipe, F, is afterwards soldered, as at G. This rod-pipe, F (so called because the rod or wire of the valve works up through it), is a piece of 3-in. lead-pipe, about 2 ft. 2 in. long. *In situ*, its top is level with the top of the bath, and should the depth of the bath be either more or less than

2 ft., its length must of course be in proportion. The sheet lead used for these pipes ought not to be less than 6 lbs. per square foot, and may with advantage be 7 or 8 lbs. The same may be said of the lead for the syphon-trap and the waste-pipes. Before the rod-pipe is set into its place, it has first to be mounted with the hot and cold water-cranes, H H. These in Fig. 179 are two stuffing stop-cocks with ground keys (when of good brass and properly fitted they do well for pressures about or under 20 ft.; for higher pressures screw-down or valve-cocks can be used), one end of each being inserted into and soldered to a piece of 1-in. lead-pipe, of say 10 lbs. per yard, and 18 in. long. The two cranes being soldered to 1-in. pipe, after the pipes have been bent into the harp shape shown, the top ends of the pipes are soldered up, and the pipes afterwards joined to the rod-pipe at I I; and in order to keep the cranes steady, the backs of the 1-in. pipes next the rod-pipe, at the height where the cranes are joined, are attached to the rod-pipe by being " bolted " or soldered thereto. The overflow-pipe J, made of 2-in. lead pipe, is also joined to the rod-pipe, being attached from about 4 to 6 in. down from the top. After all these have been joined to the rod-pipe, the rod-pipe is then fixed into its place by being soldered at G, while the overflow-pipe is also soldered at K. The hot and cold cranes are then attached to their respective supply-pipes. In order to show the principle of fitting up rod-pipes as clearly as possible, I have drawn Fig. 179 with the rod-pipe and the two cranes end on to the end of the bath, but in my experience the rod-pipes and cranes are more generally fitted up across, or along the end of the bath; the rod-pipe being placed quite close to the end of the bath, and the overflow-pipe, in place of bending out from the rod-pipe, as far as shown in Fig. 179, is pretty close to it—perhaps 1½ in. between the two, the two cranes being joined to the rod-pipe, one at the back and one at the front, while the overflow-pipe is attached to one side of the rod-pipe, the other side of the rod-pipe being close to the end of the bath; however, the principle in each

case is the same. The pipe shown at L, Fig. 179, is a ventilating pipe for the bath waste-pipe ; it is here shown joined to the soil-pipe, but it may be carried up independently to the roof; 1-in. lead pipe, 8 lbs. to the yard, will serve for this purpose, or, if the expense is not grudged, $1\frac{1}{2}$-in. pipe may be put in in preference. The use of this pipe L is to prevent the rush off of the water from emptying the syphon-trap, in addition to ventilating the pipe B. With small waste-pipes there is great danger of the syphon-trap being emptied, especially where there is no ventilating pipe in, but with large waste-pipes there is much less danger. In tenemental houses, where a bath is fitted up for each house on each flat, the bath in one house or flat being perpendicular with the bath in other houses above or below, if it is not wished to join the ventilating pipe L to the soil-pipe, a $1\frac{1}{2}$-in. hand-made lead pipe, or even a 2-in. pipe, may be carried up all the way to the roof from the lowest bath, the $1\frac{1}{2}$-in. ventilating pipes of the other bath syphon-traps branching into it. After the rod-pipe and its fittings have been put in, the bath may then be lifted into its site (in many cases, of course, the bath is set in before the rod-pipe, and in Fig. 179 the pipes under the floor being all in, it matters little whether the rod-pipe or the bath be put in first) ; but before doing so, a hole $3\frac{1}{4}$ in. in diameter has first to be cut at M, Fig. 179. After being cut right through, the lead inside and around this hole is lifted up a little by the plumber and the wood cut away in a sloping style for about $\frac{3}{4}$ in. back all round the hole, the lead is then dressed down, smudged and cleaned, and the bath then lifted into its place. When there, the top part of the branch D, Fig. 179, being cut to the necessary height, it is flanged back about $\frac{1}{2}$ in. at M, and the brass rose grating, being tinned at edge, covered with paper temporarily and put down, one soldering joins the lead bottom of the bath, the lead pipe D, and the brass grating altogether at M. Fig. 181 shows a common style of this brass rose-grating. It is simply a brass perforated disc about $3\frac{1}{4}$ in. in diameter, and about $\frac{1}{8}$ in. thick. It is generally cast. The plumber's work of the plunge-bath being thus far finished, the shower-bath, N, Fig. 179, is next put up, being attached to the bottom of the cistern. It may be either a round one, 1 ft. in diameter, or else oval, and about 1 ft. 6 in. by 11 in. O is the $\frac{3}{4}$-in. air-pipe which allows the shower to empty after the valve P has been let down; Q is 2-in. or $2\frac{1}{2}$-in. lead valve-pipe attaching the shower to the cistern; R is an iron lever, supposed to be screwed to a wood board laid across the cistern, while S is the cord and pull by which to work the shower. When S is pulled down it lifts the valve P, and the water falls; when S is let go the valve P shuts and the water stops. Fig. 182 shows top view of a brass index-plate for the working apparatus of the plunge-bath fittings, with the two lever handles of the cranes, and the brass knob for the working valve; the index-plate is put on after all the pipes, &c., are covered in, and the woodwork of the bath finished. In Fig. 179 it is put on at T. Fig. 183 shows the valve knob—marked "waste" on the index-plate—in position when the valve is lifted up or open, the small pin, W, being turned into a notch cut for it to rest on; when the knob is lowered to shut the valve, the pin, W, slides down in the slit cut for it in the brass tube X, Fig. 183.

At U, Fig. 179, it will be observed that the lead stands up $\frac{1}{2}$ in. at the back of the wood lining V; this is to prevent any water getting down the back of the plunge-bath or going on the floor when the shower-bath is used. Fig. 179 being longitudinal sectional view, the wood lining, V, which is put up between the top of the plunge-bath and the wood lining of the bottom of the cistern, though only shown there at the end of the bath, is also carried round about 2 ft. on each side of the bath.

In reference to the simple wooden bath and also the wooden bath lined with lead treated on above, it must be clearly understood that in fixing on the bottom, the boards forming the bottom must be put on across the bath: this may be inferred from Fig. 178. Sometimes the joiner, without thinking, puts on the bottom-boards longitudinally, but that is wrong. For wooden bath, such as Fig. 174, the bottom-boards should be jointed as per Fig. 184, which gives sectional view, a slip of wood or "feather" being inserted in the centre of the joint, as shown, and white lead also used. The same should be done with the sides and ends where the boards are not put on all in one, *i.e.* of the full depth. In cases where the floor under the bath is off the level, and especially when the dip is away from and not towards the safe-pipe, to prevent water lying in such safes as shown in Fig. 174, before laying down the lead safe cause the joiner to lay down wooden boarding under it; *e.g.*, if the floor were off the level $\frac{1}{2}$ in. in the 6 ft., then the joiner makes his boarding full size of sole of safe, and about $\frac{3}{4}$ in. thick at one end, and regularly diminished to $\frac{1}{8}$th at other end, as per Fig. 185. In Fig. 179, there is shown the way in which the hot and cold water was generally admitted into bath when the bath had a rod-pipe; now, however, in many places, since our water companies have begun to take more interest in the unnecessary waste of water, instead of the water being allowed to enter the rod-pipe as shown at I I, Fig. 179, it must either enter the bath near the top, as at *y*, Fig. 186, or near the bottom, say at z, Fig. 186. In other cases it may be made to flow in over top of bath, so that should either or both cranes be leaking, the leakage may be at once seen. This style of filling the bath with water does not, however, interfere with the fitting up of the rod-pipe in all other respects, as shown at Fig. 179; all the difference is that the connections, or joints, at I I, Fig. 179, are done away with, and the supply enters the bath directly, as

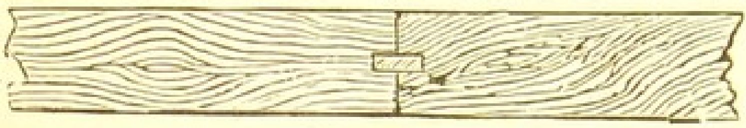


Fig. 184.

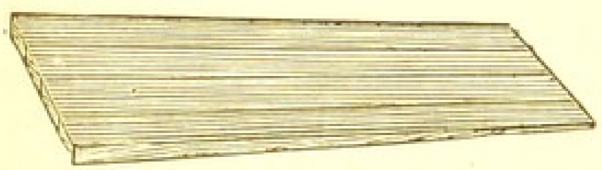
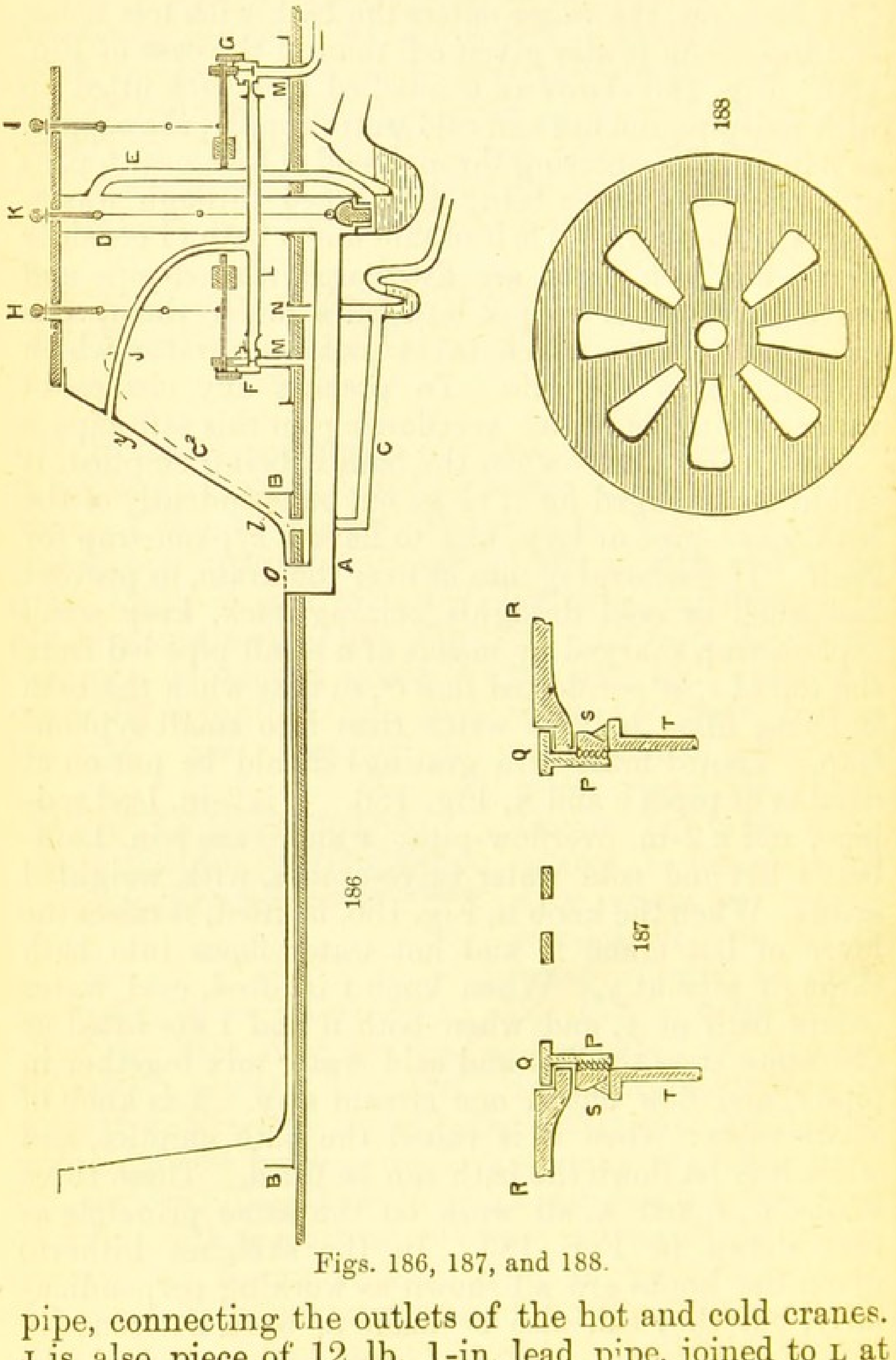


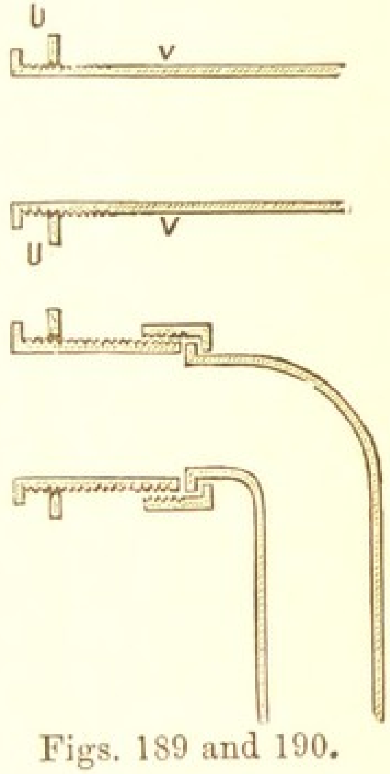
Fig. 185.

shown at *y*, Fig. 186, instead of first down rod-pipe and then rising up through bottom of bath like a fountain, as is the case in Fig. 179. In the case of Fig. 179, however, the water enters the bath with less noise, and less steam is also given off than in the case of Fig. 186. Fig. 186 shows an enamelled iron bath fitted up with rod-pipe and hot and cold water supply, the supply, as stated above, entering through end of bath near top, as at *y*, the waste water being discharged through waste-pipe A, at bottom. B B is lead safe under bath (I consider that when iron baths are fitted up with rod-pipe and valve it is proper to put lead safes under them), C is safe-pipe, or pipe which takes away any water which may fall into the safe. To prevent any chance of water coming back and overflowing up this safe-pipe C —say during frost—when the bath is being emptied, it might be arranged for it to go out independently of the bath waste-pipe or trap, and to have a syphon-trap for itself. If discharging into or over the drain, to prevent bad smell or cold draughts coming back, keep small syphon-trap charged by means of a small pipe led from the top of J, as per dotted line $C^2$, so that when the bath is being filled, a little water runs into small syphon-trap. Tinned brass wire gratings should be put on at mouths of pipes C and N, Fig. 186. D is 3-in. lead rod-pipe, and E 2-in. overflow-pipe. F and G are $\frac{3}{4}$-in. Lambert's hot and cold water valve-cranes, with weighted levers. When the knob H, Fig. 186, is lifted, it raises the lever of hot crane F, and hot water flows into bath through pipe at *y*. When knob I is lifted, cold water enters bath at *y*, and when both H and I are lifted at the same time the hot and cold water mix together in pipe J, and flow out in one stream at *y*. K is knob of waste-valve: when it is raised the bath empties, and when it is let down the bath can be filled. These three knobs, H, I, and K, all work on the same principle as that shown in Fig. 183. In the sketches hitherto given the knobs are all shown as working perpendicularly, but they can also be made to work horizontally —being pulled out instead of lifted—when desired, the pipes being fitted in to suit. Figs. 222 and 226, farther on, show views of knobs and pulls which work horizontally. L, Fig. 186, is piece of 12 lb. 1-in. lead



Figs. 186, 187, and 188.

pipe, connecting the outlets of the hot and cold cranes. J is also piece of 12 lb. 1-in. lead pipe, joined to L at one end and to the bath at other end, at *y*. M M are the inlets of cranes, to which the supply-pipes may be joined in various ways. In order to fix these cranes, F and G, they are screwed to a piece of wood fixed up firmly at the back of each. It will also be observed in Fig. 186 that a lead safe is shown under the cranes with safe-pipe, N. Of course the style of fitting-up in Fig. 186 is much more complicated than that shown in Fig. 174 or in Fig. 192; but it must be remembered that, while there are many who wish their baths fitted up as simply and cheaply as possible, there are others who are ready to pay ten times as much if things are made to please them, and who, not content with the hot and cold supply to bath, as shown in Fig. 186, will also have other three, five, or more cranes, &c., besides; say one cold for drinking, hot and cold for spray bath, and hot and cold cranes, with india-rubber pipes attached, for directing water to any part of the body where wished. These latter are useful in rheumatic complaints. Fig. 187 shows section of brass grating, O, Fig. 186, *in situ*. It must be made to fit the hole left in bottom of bath for it; this must be especially attended to in the case of enamelled iron baths, for any attempt made to enlarge the hole afterwards, or cut a new one, injures the enamel. Fig. 188 is top view of this brass grating. It is about 3 in. in diameter over all. P P, Fig. 187, is pap, or horn of grating projecting down through bottom of bath and screwed on the outside. Underneath Q Q (that is between brass flange and bottom of bath, R R) a bedding, say of red-lead and hemp, or other suitable material, is placed. S S is strong brass ring screwed inside. It is soldered to lead waste-pipe T T, the brass grating being screwed into S S after bath is in its place.



Figs. 189 and 190.

Fig. 189 is the brass coupling used at *y*, Fig. 186, where the supply enters bath; U U is the back, or jam-nut; the tail at V V is left plain, so that lead supply-pipe may be soldered to it. The internal diameter of this coupling is 1 in., and its length about 3 in. Fig. 190 is another style of same. When an iron bath is fitted up with a simple brass socket-grating and plug (as per bath in Fig. 192), then, in place of the overflow on the rod-pipe, brass couplings—with gratings added—such as Figs. 189 or 190, may serve for the overflow; they should be made larger, however.

Where baths are fitted up near water-closets it is far too often the case to lead the bath waste-pipe into the soil-pipe. This plan is open to various objections, and especially where hot-water is led on to the bath. It is a great improvement to keep the waste-pipe apart from the soil-pipe, by causing the former to either discharge above ground over a fire-clay trap, or else underground, into one of my 4 in. disconnecting ventilating traps. This plan not only prevents the discharge of the closet sucking the water out of the bath-trap by siphon action, but also leaves no chance of sewage gas from the soil-pipe getting into or out of the bath waste-pipe. Much disease and death have occurred through the emptying of bath or basin water traps by the siphon action of discharging closets debouching into the same pipe; especially has this been the case in connection with closets of the Bramah type.

## CHAPTER XVII.

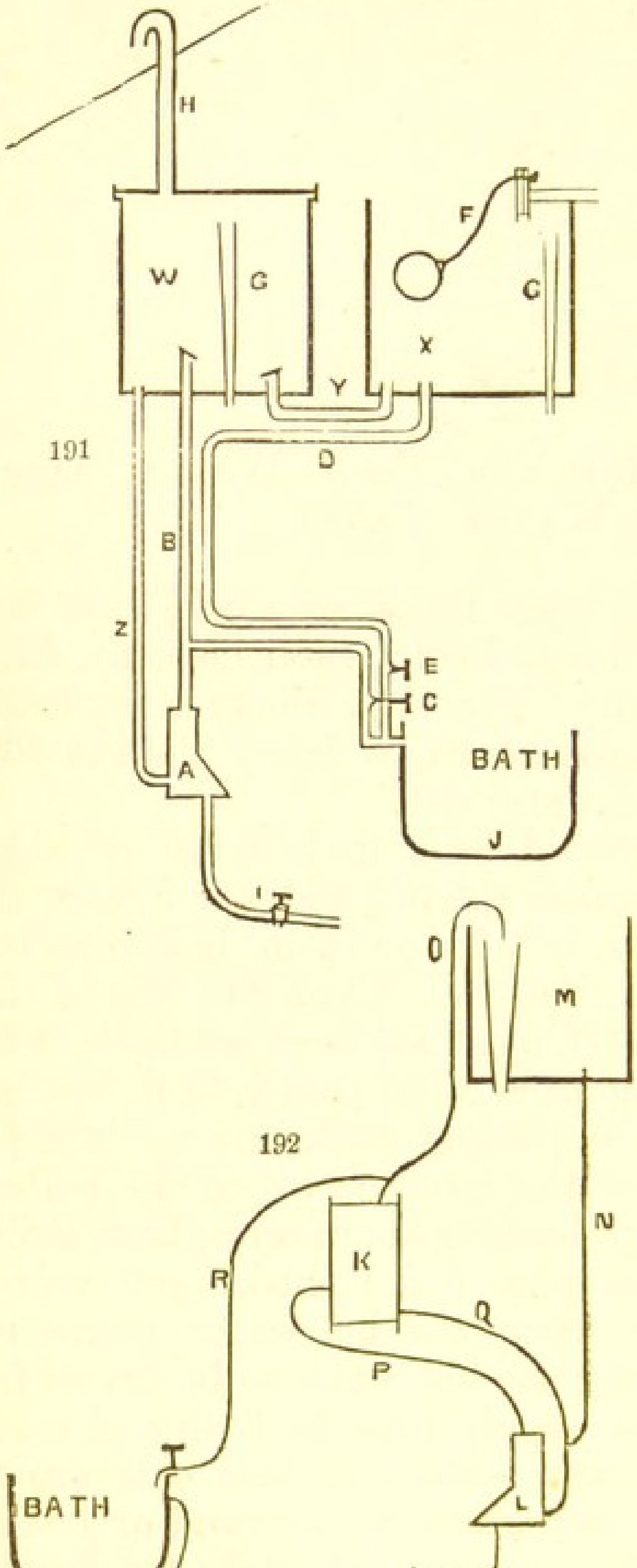
### CISTERNS FOR HOT AND COLD WATER, ALSO HOT-WATER TANKS.

HAVING so far treated upon baths, we would here say a few words about the hot and cold water cisterns, &c., in connection with them. Fig. 191 shows a style that has been in use for many years, W being the hot-water cistern and X the cold-water one.

The hot cistern should be a little taller or higher than the cold one, because the hot water is lighter than the cold. Y, Fig. 191, is 1-in. or $1\frac{1}{2}$-in. lead pipe leading the water from X into W. Upon the top of Y, in hot cistern W, a light-hinged valve is soldered, which allows the cold water from X to pass into W, but prevents the water from W passing back into X. Z is $\frac{3}{4}$-in. 9 lb. lead pipe leading the water down to the boiler A. B is 12 lb. 1-in. lead pipe leading hot water up from boiler.* Upon the top of hot pipe B a light-hinged valve is placed, which shuts when the hot-water crane C is opened, thereby causing the hot water to be drawn from the boiler. D is cold supply-pipe to bath and E cold-water crane. These two cranes in this case are two pillared screw-down stop-cocks, with round or octagon knobs, or, better still, four-pronged knobs for handles. Lambert's cranes are largely used for these, but the

* Of course these sizes are not compulsory, for both pipes may be only $\frac{3}{4}$ in. internal diameter, or both may be 1 in., or even more if wished or necessary; the flow of the hot water is often more satisfactory, however, when the outlet pipe from the boiler is larger.

great fault with Lambert's stop and bib-cranes is that the working screws so often give way, and few things are more common in many plumbers' accounts, than "new bush and screw for Lambert's crane." It is surely within the power of our brassfounders to remedy this, and so to make this "bush and screw" that it will stand better and not be so easily overhauled as it so often is. For cold water especially, and for strong pressures, I know of no bib-cranes which give more satisfaction than Guest and Chrimes' style of screw-down ones. It is a rare thing to see their screws overhauled. For ball-cranes, however, Lambert's patent seems to be the general favourite. A common fault with them is to put on too small balls at first, which have afterwards to be taken off and larger ones put on; better




Figs. 191 and 192.

therefore to put on good-sized balls at first. With a good pressure, a $\frac{5}{8}$-in. Lambert's ball-crane with a 7-in. tinned-copper ball works well. F, Fig. 191, is ball-crane, and G G overflow pipes. In reference to these overflow-pipes, and also the steam-pipe H, it must be seen that they are so put in as that there will be no chance of bad air coming back or up through them to contaminate the water in the cisterns. In the case of the hot cistern W, Fig. 191, which is covered in on the top, if bad air gets in either through H or G it accumulates and in time taints the water very badly. I had pretty strong evidence of this some time ago—viz. at the beginning of June, 1875—when requested by Dr. Fergus to examine a number of the better class of houses at Crosshill, near Glasgow (the scene of the late typhoid fever epidemic), and in one, the first I think we went into, complaint was made of the bad quality of the hot water. A tumblerful was drawn off and smelt, when the odour given off was found to be quite fetid. Upon examination, this was discovered to be caused by the steam-pipe of the hot-water cistern being led back, or connected into the side of the water-closet soil-pipe, instead of being carried out directly to the outer air. One curious point in connection with this case was that the bad plan of connecting the steam-pipe to the soil-pipe necessitated a great deal of work, and considerable expense, whereas, had the proper plan been adopted of carrying up the steam-pipe to the outer air, it might have been done at one-third of the expense. This, and various other matters which have turned up within my own practice, force me to observe that all interested in sanitary matters must get a better knowledge of plumber's work, of the effect of water in motion, and of the various arrangements of the soil-pipes, waste-pipes, and drains of our houses than they as yet generally seem to possess. Of course they may retort upon me—And where can we get it? To which I feel bound to answer that it is difficult to get. At the same time, however, I may, perhaps, be excused for here adding that a careful perusal of this little treatise may possibly help to supply that knowledge, at least in part.

To come back to Fig. 191, we see that the steam-pipe H is correct as it goes right up through the roof. Had the cistern W, however, been a long way from the roof but near a back wall say, then all that was necessary would be that a hole should be cut through the back wall, about a foot or so higher than the cistern, and the steam-pipe H carried up and out through that hole. As W is a cistern and not a close tank, no water, but only steam, can come out at the pipe H. In the case of Fig. 192, which has a close pressure tank K, both steam and water may come out at the steam or expansion pipe O, consequently the outlet of O must be so placed as that there will be no danger of any person being burnt when the water happens to boil. I may here caution servants and even mothers not to allow either laziness or thoughtlessness to cause them to use the water from the boiler instead of the kettle in preparing the children's food. What is good enough for washing may not be quite so good or safe for drinking.

In regard to the overflow-pipe G, in the hot cistern W, Fig. 191, it in this case may be led out from the bottom of the hot cistern and up through the bottom of the cold one in a similar manner to the way in which the pipe Y is put in. To meet the objection that may start up that the hot water might overflow back into the cold cistern X, that might be pretty well prevented by keeping the hot cistern 3 in. higher than the cold one and its overflow-pipe being from $1\frac{1}{2}$ in. to 2 in. lower—*i e.*, that the hot overflow-pipe is from 1 in. to $1\frac{1}{2}$ in. higher than the top of the cold cistern,—then there would be little if any chance of hot water ever coming back into X through the overflow-pipe. The hot-water cistern W, Fig. 191, as we have said above, is covered in, and it has a 2-in. lead or zinc steam-pipe led out to the roof. The top covering of this cistern, which may be of wood, is so put on as to be readily movable, at least in part. I, Fig. 191, is 12 lb. 1-in. lead pipe, with 1-in. ground stop-cock on it for cleansing or scouring out the boiler; the outlet of this 1-in. pipe, I, must either join the drain or some waste-pipe, or else be discharged above the ground where it can do no harm, just as may be most suitable in the circumstances. J, Fig. 191, is cross section of bath, the waste-pipes, &c., of which may be fitted up either as those in Fig. 186, or in the simple style of Fig. 192. When setting in the boiler A, Fig. 191, the end from which hot-water pipe is led out should, if anything, be kept the highest, and the hot pipe B, or rather its coupling, should not project down into the boiler, or if it does project down a little, a slit should be filed out on each side of it. I mention this, because when these precautions are neglected, and the steam thereby prevented from having free exit up the hot pipe, disagreeable noises are often caused when the boiler gets heated up. In regard to the hot and cold pipes from and to the boiler, they should not be allowed to sink, or to "bag" down anywhere, but should have as regular an inclination in every part of their course as circumstances will allow; lowest next boiler, and ascending upwards from it. When being carried horizontally in any part of their course, the pipes should then be laid on a board or boards, properly supported or fixed, said boards having as much of a dip or inclination down towards the boiler as possible. This helps to prevent explosions, as it allows the heated water and any steam to rise up the pipe easily and naturally. The style shown in Fig. 191, if carried out as I have stated, is pretty safe in frosty weather, for if fire be kept on, the boiler pipes Z and B are both kept warm throughout their entire length from the movement of the water. For greater safety, however, it is well to wrap up pipes to and from boiler with felt (in fact as a defence from frost this is good for all pipes). To ascertain if the boiler is being supplied properly, open the hot crane at the kitchen sink or bath, and let it run a minute or so. This should always be done after the cleansing-cock I, Fig. 191, has been used, (due time, five or ten minutes or so, being allowed for the boiler to fill up), for no fire should be on when the boiler is empty, and no water should be allowed to enter an empty boiler when the boiler is hot. As regards the site of baths in houses, they should never be fitted up, as we may often see them, right above the principal rooms, for as accidents will happen, and pipes will burst or overflow occasionally from various causes, the damage done in such cases is sometimes great. In Fig. 192, no hot cistern is used, but instead a good malleable iron or copper intermediate close tank K, is used. Many of these have been put up of late years and given great satisfaction. The tank K is generally placed in a corner of the kitchen as near the boiler L as convenient; it is supported on a strong wooden shelf. If in a one-story house it is sometimes placed in the garret or loft; this latter plan, however, tends to have an injurious effect upon the regular flow of the water, as air is apt to get into the pipe R from O, owing to the pipe P not being able to supply the water quicker, or at least as quickly, as it is drawn off through R. If the pipe P and the brass couplings at each end of it, and also the brass coupling inserted into the top of K and the lower part of O, as far at least as R branches off, are all of 1-in. bore while R is only of $\frac{3}{4}$-in. bore, then, perhaps, the supply may come in through P and up the lower part of O as quickly as R is able to draw it off. The higher, however, that the cistern M is above the tank K, the less chance there is of air getting into R and interrupting the steady full flow of the water. Of course, to get the full benefit of M being higher than K, the pipe R must branch off as near the top of K as possible. In case it should be asked, why not branch R from off the side of P, I answer that that is not done for several reasons; one reason being that we want to get the benefit of the whole of the contents of K and L as warm as possible, and another reason is, that by always leaving K full of water, greater safety is insured to the inmates and less danger of L drying up during any scarcity of water.* Of course the sludge cock I, Fig. 192, empties everything, but it should only be opened

* In one case I had to put R 3 in. from top of K, as M was only 1 ft. above K.

when there is plenty of water, and by some one who understands what he or she is doing.

In Fig. 192, there are only three brass couplings on the boiler, but in some cases four couplings are used, as in Fig. 193; generally, however, three are sufficient, especially if the outlet coupling from off the top is larger than the inlet near the bottom. In Fig. 192 the boiler L is shown with a "sludge," or cleansing cock, I. Where a good job is wanted a coupling may be put into the bottom of the tank K with the necessary pipe and sludge cock, so as to cleanse out the tank also when wished.

In Figs. 191, 192, and 193—supposing the baths to be set upon a higher level than the kitchen boiler—when the bath crane is at some distance from the upright hot pipe, as at J, Fig. 198, it follows that when the hot crane has been shut for some time, the water lying in the *branch* pipe, between the hot cock and the perpendicular pipe, gets quite cold, so that when the hot crane is opened this cold water has first to be all run off before the hot comes. To obviate that, where it is wished and the extra expense is allowed, carry a ½-in. pipe from close behind the hot cock with a downward inclination back into the cold water supply to boiler, so as to allow of a circulation of the water. If no bagging is permitted with any of the horizontal or other branch pipes, a very small inclination if regular may serve.

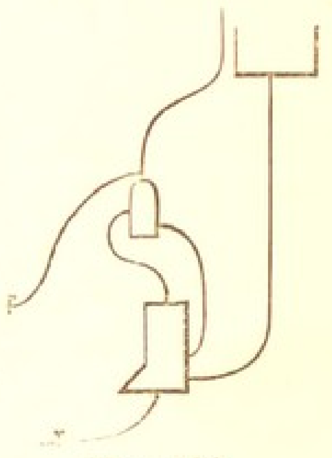


Fig. 193.

In thousands of our houses the water-pipes lie quite exposed in our garrets, &c. Now if people would order or allow their plumbers, &c., to wrap up their pipes and cover in their cisterns, the frost would not interfere with the water-supply in the disagreeable manner it so often does. The hot pipe o, Fig. 192, when bent over the cistern, instead of being carried out to the roof, can be bent down into the overflow-pipe of the cistern, so that should the water in the boiler begin to boil up the hot pipe, it does not dirty the water in the cistern. N, Fig. 192, is the cold supply to the kitchen boiler; P, and Q, Fig. 192, are the hot and cold circulating pipes between tank and boiler, while R is the hot pipe leading to bath and elsewhere where needed. In regard to cranes, I may here add that where the pressure or height of water-supply above crane is only about ten feet or so, then the best crane to use, and the one which gives most satisfaction in that case, is a gun-metal, or good brass, ground cock, requiring only a quarter turn to open or shut. In many cases, with only a few feet of pressure, the valve of a screw-down crane often refuses to open if kept shut for a day, the valve having stuck to its seat, there being too little pressure to open it. I could mention various places where this is the case, the plumber or architect having made the mistake I refer to.

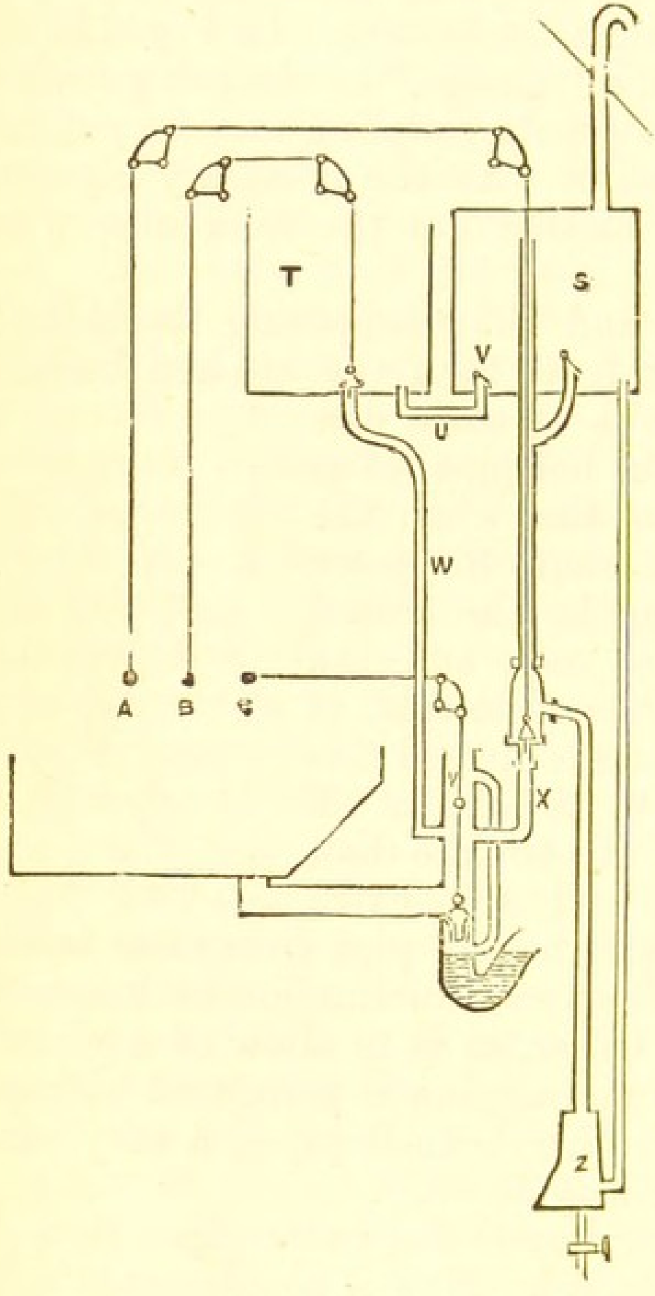


Fig. 194.

I have been requested to give a specimen of bath supplied by means of valves—not valve *cranes*—and accordingly do so. Fig. 194 shows this style of fitting up. I would say it is more applicable to a gentleman's private country-house, where there is a good supply of water and no one to interfere, than for a town-house. S, Fig. 194, is the hot-water cistern; T, the cold one; U, pipe connecting hot and cold cisterns, with a valve at V, at its mouth in hot one; W is cold supply to bath, and X hot supply, both entering into bath rod-pipe Y, and then rising up through bottom of bath, in which is brass grating, same as depicted in Fig. 181; Z is boiler; A, B, and C are the three drawn-out knobs with small pulleys, which work the different copper wires and spring cranks (or weighted levers may be used where applicable) shown for hot, cold, and waste respectively. The hot valve shown in Fig. 194, a little above X, is encased in lead box made for it. This lead box has its bottom of brass, put on similar to the way in which the under-seat or bottom of many beer-pumps is put on, this "brass bottom" also serving as the seat for valve. This "brass bottom" has also brass coupling attached under it for connecting to lead pipe; by this means the valve can be easily got at or got out for repair when necessary. The top of this valve must not be left flat however, but be drawn up to a point, so as to prevent concussion when used. Fig. 195 is section of this hot valve with "brass bottom" and coupling underneath. In the case of Fig. 194, as in Fig. 191, the hot water is drawn direct from the boiler, while the boiler itself again is supplied from the already-heated water in hot cistern, the valve which is put on upon the top of the hot-water pipe inside each hot cistern producing this effect. The intermediate hot-water tank K, Fig. 192, may also be used in houses fitted up as per Figs. 191 and 194, *in addition to* the hot cisterns there shown, and may be used for the purpose of heating the house.

Fig. 195.

At Fig. 227, Chapter XX., a plan is given showing how to get the full benefit of the hot water in the hot cistern. The plan is explained in the text where the sketch occurs.

Fig. 196 is style of brass couplings for boiler, &c., the upper half (which may be also had bent in place of straight), D, being soldered or connected to pipe, and lower half E, screwed into boiler; the internal diameter is generally either $\frac{3}{4}$ in. or 1 in., but for larger pipes larger couplings may be used. Fig. 197 shows section of brass light-hinged valve, used on hot pipes and in cisterns, in Figs. 191 and 194; its internal diameter at bottom is about 1 in. Fig. 198 is simplest style of supplying hot water, no intermediate tank or hot cistern being used. The supply of hot water to house is of course less in this case. F, Fig. 198, is cold-water cistern, G boiler, H supply to boiler; I I, is hot water and expansion or blow-off pipe out to roof; J, is hot water supply-pipe to bath. In all the above boilers I have shown the cold-water pipe entering at, or near, the bottom, but it may also enter at the top if desired, a piece of copper tube being attached to the under side of the coupling, as shown in Fig. 199. This plan does not make such a good job, however.

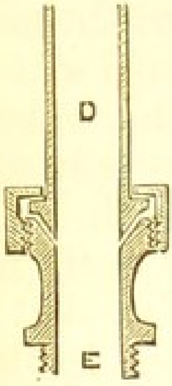


Fig. 196.

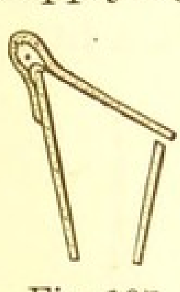


Fig. 197.

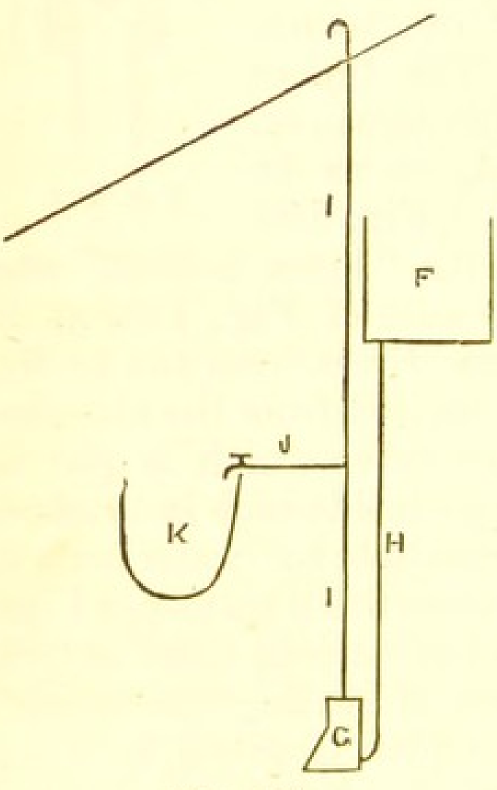


Fig. 198.

Solid-drawn copper pipes have been much used of late for the hot water supply-pipes; hard soldered copper pipes are also much used, being cheaper than the solid-drawn pipes. The thickness of copper is about $\frac{1}{8}$ in. and under; the internal diameter of pipe may be either $\frac{1}{2}$ in., $\frac{3}{4}$ in., or 1 in., or even more if required. They can be had tinned both outside and inside, which is preferable; they are joined with strong brass couplings screwed inside, the ends of pipes being screwed outside. Cast brass Tees are used for the branches; all the joints, where the brass couplings are screwed on to the copper pipes, are soldered—at the junction of the copper pipe with the butt end of the brass coupling—in addition to the

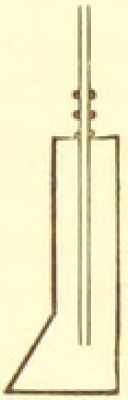


Fig. 199.

screwing. Before the coupling is screwed on, however, both the screwed end of the pipe and the inside screw of the coupling should be tinned if a sure job is desired. In fact, the half of each coupling should be completely fixed on to the end of pipe before the pipe is laid into its place.

As a help to prevent explosions, safety valves have been coming into use lately in connection with kitchen boilers. They are useful in any case, but are more necessary for boilers such as in Fig. 198, which have no intermediate tank, than in Fig. 192 style, which have such tank. Yet as in some cases the hot-water tank is utilised to heat incoming fresh air for the house, a safety valve would be a great advantage placed on the expansion pipe between the boiler and the tank, and be especially serviceable in frosty weather, when it should be examined now and then, to see if it is in working order, and the valve not stuck. These valves are made by various parties in different parts of the kingdom, *e.g.*, by J. Warner and Sons, J. G. Stidder and Co., and J. Tylor and Sons, London; John Mills, Leeds; Fell & Co., Wolverhampton.

# CHAPTER XVIII.

## Marble Baths and Spray-Baths.

Having interrupted the remarks upon baths by the foregoing chapter upon hot cisterns, &c., I now go on to say a few words about marble baths.* These are generally put together as follows:—The piece which forms the bottom is about 6 in. longer and broader over all than the inside size of bath; this allows a check to be cut in it $1\frac{1}{2}$ in. broad and about $\frac{3}{8}$ in. deep all round, besides leaving an outside margin of $1\frac{1}{2}$ in., as shown by Fig. 200, which shows longitudinal section. The marble used is supposed to be all $1\frac{1}{2}$ in. thick, except the bevel piece L, Fig. 200, which is only about $\frac{7}{8}$ in. thick. The pipes, cranes, and valve for Fig. 200 may be fitted up in the style shown by Fig. 186, but instead of the outlet on top of waste-pipe being seen as at O, Fig. 186, it may be concealed by being put in at back of bevelled piece L, viz., at M, Fig. 200. Fig. 201 is face of bevelled piece L, Fig. 200; it is about 2 ft. square,

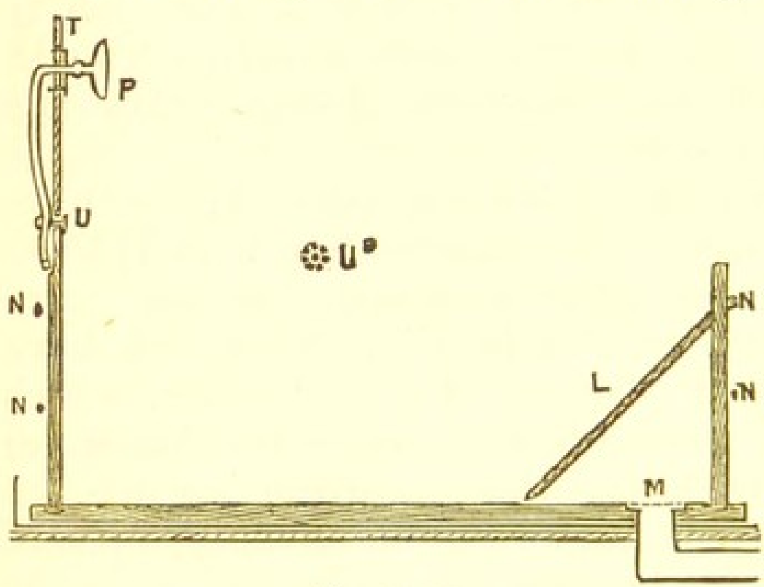


Fig. 200.

* Rufford's or Finch's enamelled stoneware or porcelain baths are good, and largely used. Mr. Finch got a first-class award for these at the International Medical and Sanitary Exhibition, London, 1881. A number of other firms now make enamelled stoneware baths.

and has the bottom cut out to a height of about ½ in., as shown, so as to allow the water to flow out underneath it. The small projections, about 2 in. broad, left at each side, are let into bottom of bath a little, in order to keep the bevelled piece L in its place, and prevent it slipping down. This bevelled piece of marble L, Fig. 200, is merely put in for appearance sake, and is movable at pleasure, and, being so, the portion of bath at back of it can be washed when wished.

If the inside length of marble bath is to be 6 ft., then the three pieces of marble which form bottom and sides are each about 6 ft. 6 in. long, and as for the end pieces, they are grooved into the sides as per Fig. 175, Chapter XVI. Two long brass or iron (the former is best) bolts are also passed through each end of bath, as at N N N N, Fig. 200, with back-nuts to keep sides of bath together. Underneath marble bath a lead safe is placed, with waste-pipe, as per Fig. 186. For the joints of marble baths some use white-lead, but while it makes a good joint, the oil in it has the effect of discolouring the marble near the joints. Stucco, therefore, is used by some, while others use Portland cement; that, however, pertains to the marble-cutter's work. We need hardly say more about plunge-baths, as the plumber who can fit up those already mentioned will have no difficulty with slate or stoneware ones; only I may here observe that I consider it would be well to give the syphon-trap of the bath rather more "drown," or water-lock, than it generally gets, so that instead of there being only 1 in. depth of water for water-lock, there may be 3 in. or more. This would allow some margin for evaporation, &c., in case the bath were disused for some time. The other day I came across a case of bad smell in a house, caused by the water in the syphon-trap of the bath having dried up so far as to allow the passage of bad air from the soil-pipe through it; the bath had not been used for

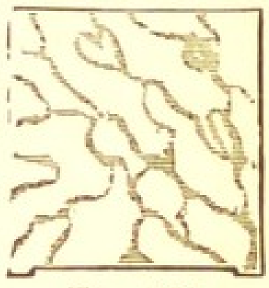
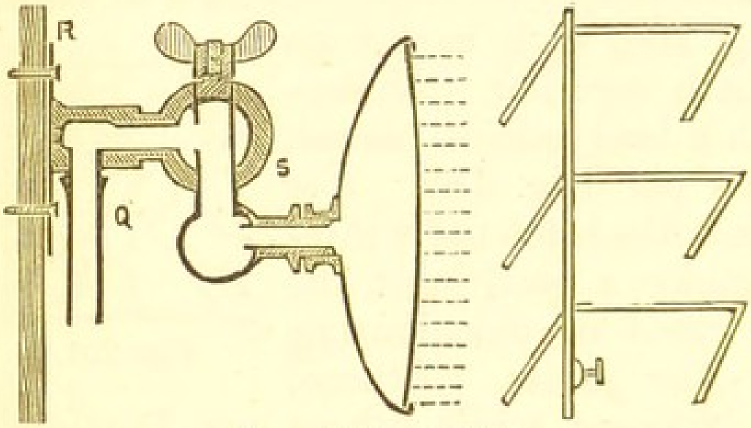


Fig. 201.

some time, and the amount of water held by the trap when full was small.

I must now say a word about spray-baths. These are fitted up in various styles, such as the rose, tube, and case-sprays, either of which may be fitted up at the end of the plunge-baths, above referred to, as at P, Fig. 200, which shows section of rose-spray, supplied by water through one or two stop-cranes, according as there may be only cold supply to it, or both hot and cold. The sort of crane to be used may be either one with ground brass key or a screw-down one, just as may be most suitable for the pressure, &c. The diameter of front or face of rose-spray may be about 6 in., or more if wished, the sheet-brass (or it may be cast) of which the perforated portion is made being pierced all over with holes so small as only to admit the point of a needle. This perforated portion or face of rose-spray ought not to be much rounded outwards, because if so the water is apt to spread out and scatter too much. A projection of about $\frac{1}{8}$ in. in the centre will serve, and the number of small holes in a rose-spray 6 in. in diameter may be from 150 to 200. The rose-spray being jointed at back, the water from it may be made to flow out in the desired direction, higher or lower, as wished. Fig. 202 shows sectional view, cut horizontally, of a rose-spray, with the supply coming in at Q (of $\frac{1}{2}$-in. or $\frac{3}{4}$-in. bore, according to pressure), and being in front of the brass flange R, by which the rose-spray is fixed to wood lining above end of bath; whereas the supply for spray-bath P, Fig. 200, comes in through lining to *back* of flange. The diameter of flange R, Fig. 202, may be about 4 in. The joint at S,



Figs. 202 and 203.

Fig. 202, which allows spray to be moved up and down, is a common ground one, made so as to suit the purpose ; but, instead, some use a ball-and-socket joint. In fact, the roof-plate, including ball and socket, of a gasalier, if larger and stronger than ordinary, and with an extra large drop-screw (straight or knee'd, as most suitable), might serve, and might be that used at T, Fig. 200. It is better, however, and the proper way, to have joint specially made for the purpose; and, for my own part, I like the style of joint shown at S, Fig. 202, best. In Fig. 200 the water-crane at U for working the spray is shown a little below it; but, instead, it may be more handy to place it to one side of plunge-bath, and two or three feet back from spray-bath, as may be thought most convenient, as per $U^2$, Fig. 200.

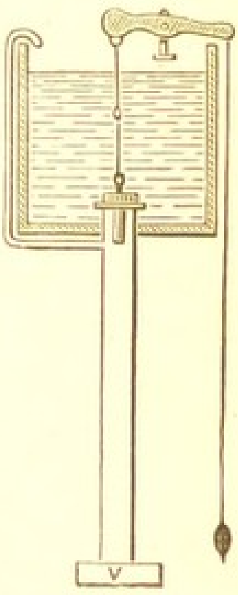



Fig. 204.

The tube-spray can be made by placing a 1-in. or a $\frac{3}{4}$-in. copper, brass, or strong block-tin tube, or even a piece of $\frac{3}{4}$-in. 8 lb. lead pipe, about 2 ft. or $2\frac{1}{2}$ ft. long, up one corner of the bath—or up centre of end of bath—with three or more $\frac{1}{2}$-in. tubes branching off each side of it, as shown by Fig. 203, where the height of lowest horizontal tube may be from 6 in. to 9 in. above the top of the plunge-bath. The horizontal tubes have a number of small holes bored in front of them. The supply is regulated by either one or two cranes, as necessary. The case-spray is set up on top of end of plunge-bath, and stands up, say 2 ft. or $2\frac{1}{2}$ ft. or so. It may stand up not only across end of bath, but also come round each side about 18 in. or 2 ft. It is formed by taking a sheet of strong zinc, No. 16 or upwards, say 5 ft. long by 2 ft. broad, which, being bent round to fit the end of the bath, above which it is to stand, is then bored full of holes to suit the position of the ribs put on at back. These ribs are small half tubes soldered on to back of zinc sheet, and all branching off from a large central "backbone," or main tube of (say) $1\frac{1}{2}$ in. diameter. The spray-bath is a great favourite with many who are afraid of the regular shower-bath, as the water comes out as gently or more strongly as wished, and where there is both hot and cold supply to it, the temperature of spray can be made to suit. In the case of the wave-bath, the water which comes out horizontally does so with much force, deluging the body in a moment. The amount of water and its force can of course be regulated by the size of pipe, valve or crane, and mouthpiece used. The mouthpiece may be either (say) 6 in. by 1 in., or it may be 1 ft. by $\frac{1}{4}$ in., and if wished, a regulator to enlarge or contract the mouth may be put on. Fig. 204 shows wave-bath supplied from cistern above it with 4 in. valve and lever; but instead, a crane or cranes may be used, leading water to a tinned copper mouthpiece of any desired size or shape. In many cases the wave-bath is fitted up with but one mouthpiece; in other cases there are two mouthpieces, in which latter case the water strikes the body on both sides at once. Too strong a wave-bath may be hurtful to some persons, however.

## CHAPTER XIX.

### WASH-HAND BASINS.

WE come now to wash-hand basins; these may be fitted up in many styles, from the simple plug and socket one shown in Fig. 205, to the most elaborately fitted-up cabinet stands. In Fig. 205, W is the wash-hand basin, X is $\frac{1}{2}$-in. pillared stop-crane, Y is 2-in. lead syphon-trap, Z is safe-pipe with overflow of basin led into it. A is brass socket-grating with brass plug. This brass plug has brass chain attached, and is taken out and put in with the hand. The bottom of the socket-grating at A is perforated with holes about $\frac{3}{8}$ in. in diameter. In addition to these holes in the bottom it is a great assistance to the speedy outflow of the water to bore half-a-dozen or more additional holes round the side of the socket-grating near the bottom. These latter holes are not so ready to get choked up as the ones in the bottom. Instead of boring or casting holes in the bottom, the said bottom is sometimes taken out altogether and two pieces of brass wire put in cross-wise. Of course the socket-grating may be cast in this latter style. Fig. 205 shows perpendicular sectional view

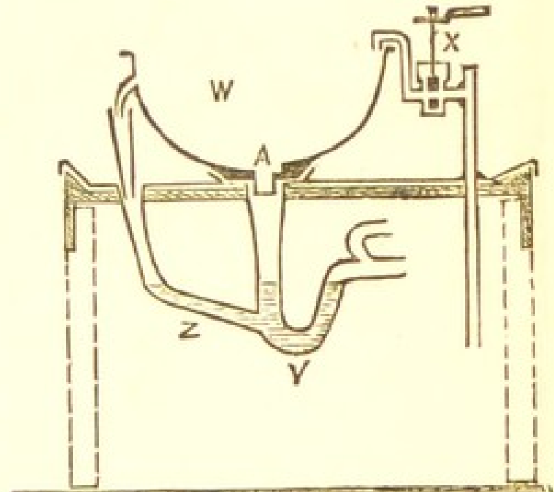



Fig. 205.

of wash-hand basin W, set and bedded with putty upon the top of the wooden wash-hand basin stool. The top of this stool (which is supported by four legs, one at each corner) is covered with lead, say 4 lbs. to the square foot, and the top of syphon-trap Y, being carried up through the hole cut for it in the top of the stool, is soldered to lead safe. The supply-pipe to water-crane X, where it passes up through stool, is also soldered to lead safe, thereby helping to keep the water-crane in its place. The general height from floor to top of basin is about 2 ft. 5 in.; but if put in so as to be most suitable for either short or young people, the height may be a good deal less. This simple style of fitting in wash-hand basin corresponds with that of bath, as shown in Fig. 174, Chapter XVI., but when so fitted up it is generally done to save expense, as, where the customer can afford it, the plug in the bottom of basin, as per A, Fig. 205, is dispensed with, and instead, the valve B, Fig. 206, with its more elaborate arrangement of pipes, is adopted.*

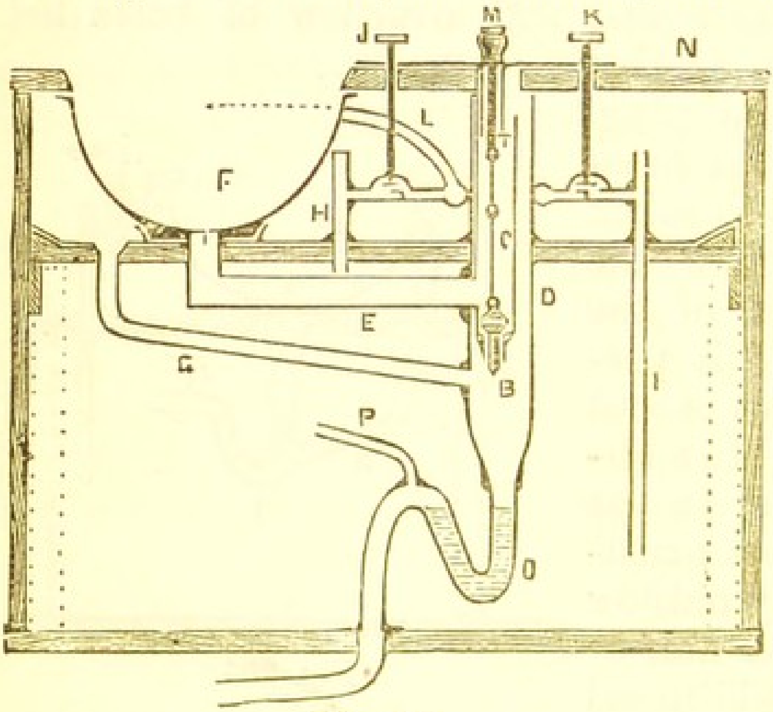



Fig. 206.

In Fig. 206, B is ground brass valve, the diameter of which, or rather of its socket over all, is about $1\frac{3}{4}$ in.; C is 2-in. lead valve-pipe, made of 6 or 7lb. sheet lead, and is placed inside the 3-in. lead rod-pipe D. By keeping two-thirds of the circumference of the top of the valve-pipe, C, about 2 in. lower than the top of the rod-pipe, D, the valve-pipe, C, thereby acts as its own overflow and as the overflow of the basin, F, for as the water rises in

* Fig. 205 style is perhaps the most hygienic, however, see page 151.

basin, F, by the law of fluids it also rises to a corresponding height in the valve-pipe, C; but as the top of the valve-pipe, C, is 2 in. below the top of the rod-pipe, D, which latter is level with top of basin, it follows that whenever the water begins to rise up in the basin higher than 2 in. from its top, it—the water—immediately begins to flow away over the top of the valve-pipe, C, which thus acts as a safety-pipe, at least so long as the communication is left free between basin and valve-pipe. E is waste-pipe from basin; the soldered joint at end of E next the rod-pipe unites E, C, and D together as shown. F is the wash-hand basin, which may be either a plain white one or one with gold and colours, according to taste. A very effective and chaste basin is one with three gold lines, each about $\frac{1}{4}$ in. broad, round it; one round top, one half-way down, and the third circle about 3 in. in diameter, round brass grating in bottom. G is $1\frac{1}{2}$-in. lead safety-pipe for carrying away any water which may fall into the lead safe. H and I are the hot and cold supply-pipes of $\frac{1}{2}$-in. bore, and if of lead, either 6 lbs. or 7 lbs. per yard, according to pressure. If the pressure on both hot and cold pipes is the same, the hot one is put in a pound per yard heavier than the cold pipe. J and K are the hot and cold pillared screw-down stop-cocks; size $\frac{1}{2}$ in., with round ebony or brass handles. The diameter of these handles should be fully $1\frac{1}{2}$ in., when less the crane is often difficult to shut. For mere ornament very small handles may do, but for easy service a certain leverage is necessary. L is the supply-pipe leading water to basin, with small brass tube soldered to end of it, so that said brass tube bends over edge of basin. M is the knob, brass or otherwise, with lifter attached underneath to work the waste-valve at B. N is the wood or marble top of wash-hand basin, and it will be observed that underneath the waste-knob, M, a hole is

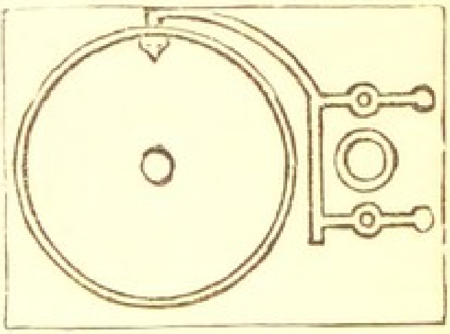


Fig. 207.

cut in it large enough to allow the waste-valve to be drawn up through it, so that the valve can be easily taken out to be examined or cleansed; this hole is not seen when the brass plate is put on. This brass plate, in this case, may be about 14 in. long by $3\frac{1}{2}$ in. broad, but if the cranes were placed, as in Fig. 207, across the rod-pipe instead of end on to it, as in Fig. 206, then the two pillars of cranes being much nearer each other, the plate would be much shorter, say 9 in. long in place of 14 in. It is understood that the pillars of the two cranes pass up through holes in brass plate just large enough to allow them to do so. The two cranes, J and K, at their outlets are joined together by a piece of lead pipe bent round the rod-pipe, out of which goes the pipe L, Fig. 206, carrying water-supply to basin. O, Fig. 206, is a 2-in. or a $2\frac{1}{2}$-in. lead siphon-trap, P is a 1-in. or larger pipe to ventilate the waste-pipe; it also serves to prevent the rush-off of the waste-water from emptying the siphon-trap. Owing to the want of this ventilating pipe, or air-pipe, P, especially where the waste-pipe goes some distance horizontally and is rather small—say $1\frac{3}{4}$ in. in diameter internally in place of $2\frac{1}{4}$ in.—it often happens that the siphon-trap is emptied when the waste water is let off, whereupon bad air comes out into the apartment. It is, therefore, highly necessary, especially where wash-hand basins are fitted up in or near bedrooms, to see that the waste-pipes are so put in as that there will always be plenty of water left in the siphon-trap. Inattention to this—especially where the waste-pipe had direct communication with the drain—has been the cause of disease and death entering many families, particularly of the higher and middle classes.*

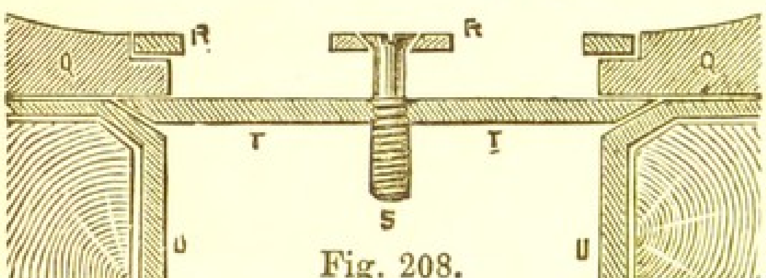


Fig. 208.

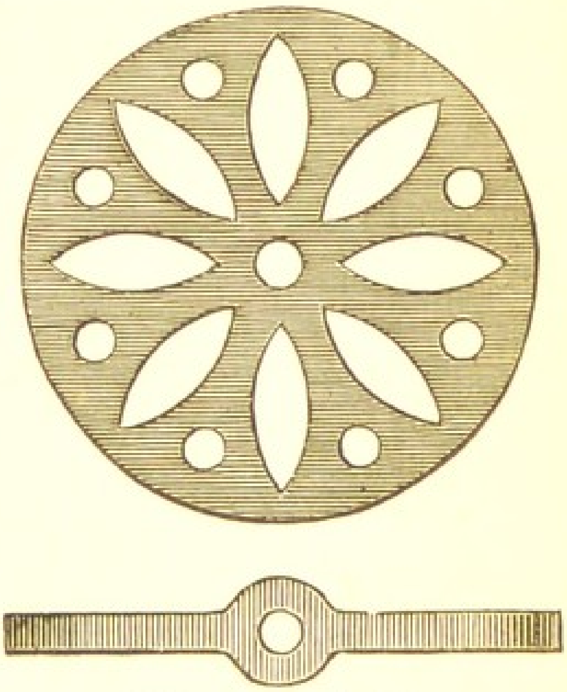
Where extra precaution is desired, instead of carry-

* When near an outer wall the pipe P, Fig. 206, may be put through the wall, but connected, so as not to allow the cold air to play upon the water in the trap.

ing the waste-pipe of the wash-hand basin or bath directly into the drain or soil-pipe, carry it down *per se* and let it discharge above the surface of the water in a ventilated siphon-trap. By this means any danger of bad air from the drains entering the bedroom through the wash-hand basin waste-pipe is prevented. A sketch of the principle here alluded to will be found farther on, in Chapter XXVII., under the heading "Scientific and safe Water-closets," Fig. 269.

I may here add that when the waste-pipe from a wash-hand basin goes some distance horizontally, it does good in preventing the siphon-action to make the waste-pipe a size larger than the siphon-trap, *e.g.*, if the siphon-trap be 2 in. make the waste-pipe 2½ in.

For a good job, and especially where the inmates go from home for months together, the siphon-trap, O, of the wash-hand basin should be so made as to hold a good depth of water. Were that depth in all about 8 in.—thereby giving about 6 in. of water-lock—due provision would be made for evaporation, and loss of water-lock prevented. Instead of adopting this simple, yet effective course, I lately saw a proprietor going to the expense of putting on large 2 in. brass stop-cocks, which cocks were to be shut when the family went from home. Now not to speak of the probable difficulty of turning these large cocks after a time, there was the danger of water being poured into basins when cocks were shut, and as it could not get away a flooding might take place.*



Figs. 209 and 210.

Inside of bottom of wash-hand basin, F, Fig. 206,

* This actually took place and the cocks were then ordered to be taken off. Fig. 278 shows a new plan.

there is a round brass grating, about 2½ in. in diameter. This grating is held in its place by a brass screw, which passes down through its centre and goes into a small brass bar which passes across the top of the waste-pipe, and is soldered at each end to top of waste-pipe. Fig. 208 shows perpendicular section of this brass grating bar and nail *in situ*, Q Q being bottom of basin; R R is brass grating (of which Fig. 209 gives top view); S is brass-screwed nail, and T T brass bar about ⅛ in. thick (Fig. 210 gives top view of brass bar); U U is top of the lead waste-pipe, E, Fig. 206. Outside and around bottom of basin a strip of lead about 2 in. broad, or broader if wished, is soldered to safe, and being made to fit round bottom of basin it thereby helps to keep basin in its place when set. Fig. 211 shows cranes and rod-pipe arranged alongside of wash-hand basin, from back to front, in place of end on to basin, as in Fig. 206. The water in this case enters basin by mouth of lion's head, there being a horn at back of lion's head on outside of basin for supply-pipe to be attached to. The cranes need not necessarily be always put on as shown

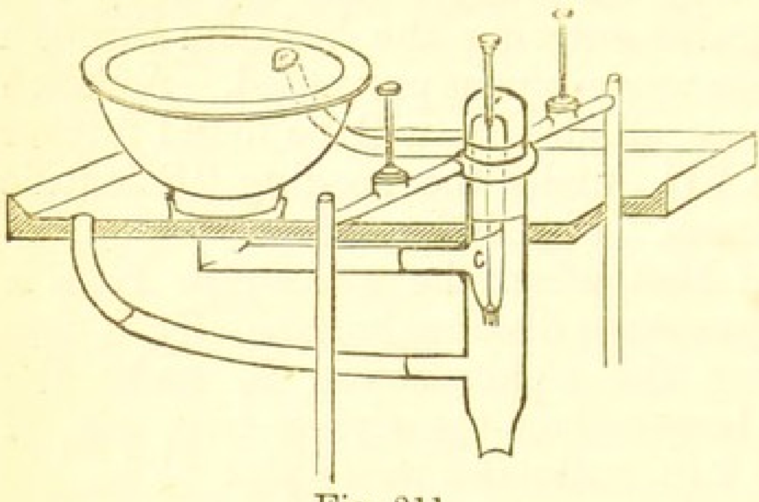
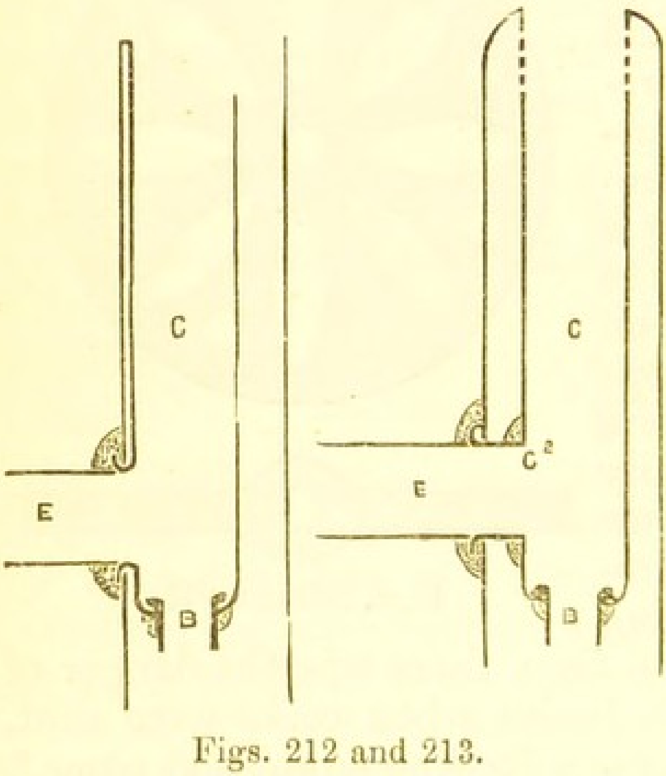



Fig. 211.




Figs. 212 and 213.

in Fig. 211, for by placing them as in Fig. 207, the pillars are brought nearer each other, while the arrangement is still kept up of the cranes and rod-pipe being alongside the basin. In regard to the 2-in. valve-pipes C C, Figs. 206 and 211, there are two ways of fitting them in rod-pipes: Figs. 212 and 213 show these two ways. Fig. 212 is an enlarged view of that in Fig. 206. In Fig. 212 the valve-pipe, C, is put in close to that side of rod-pipe to which the waste-pipe, E, from the wash-hand basin is joined. In Fig. 213 the valve-pipe, C, is placed in the centre of the rod-pipe, and at $C^2$ a short piece of pipe is soldered on sufficient to pass out through side of rod-pipe and be flanged back about $\frac{3}{8}$ in. B B, Figs. 212 and 213, are the brass sockets of the two waste-valves soldered to the bottom of the valve-pipes. Further verbal explanation is unnecessary, as the two drawings explain themselves.

In wash-basins, baths, &c., with rod pipes, as in Figs. 206 and 211, when the basin is empty and whether the waste valve is open or shut, a current of air often will be found passing down the pipe C, along E, and up through the grating of the basin, so that if pipes C and E are dirty inside a slight smell may be felt by a sensitive person at the basin. To stop this, especially if in a bedroom at night, first run off a gallon or two of clean water, then put the valve down, and leave a few inches of clean water in the basin all night. Of course this would do no good against smell from the waste-pipe *beyond* the trap: the trap and pipe must do their duty as regards that.

In the next chapter we proceed to treat upon cabinet-stands and different ways of fitting up from the above.

# CHAPTER XX.

## Cabinet-Stands.

The earthenware wash-hand basins treated upon in Chapter XIX. were all circular, with a simple rim at the top, but, as will be seen from the cabinet-stands we are now to speak of, while the hollow in the centre forming the basin or water receptacle is the same, the simple $1\frac{1}{2}$-in. rim is now transposed into a large square top, with soap and brush-holders, all together forming one piece of earthenware, as per Fig. 214.

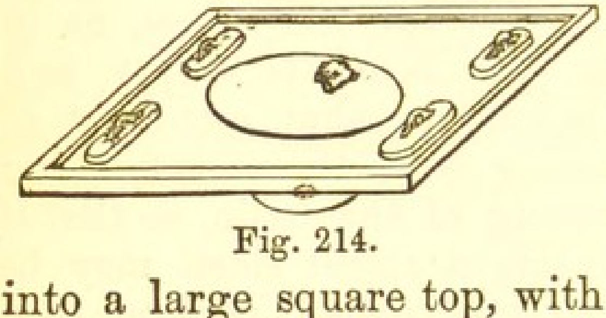


Fig. 214.

In some cases the shape of the top of the cabinet-stand, in place of being square, may be either angular or have rounded front, as shown by Figs. 215 and 216. They are also made with back and sides as per Fig. 217.

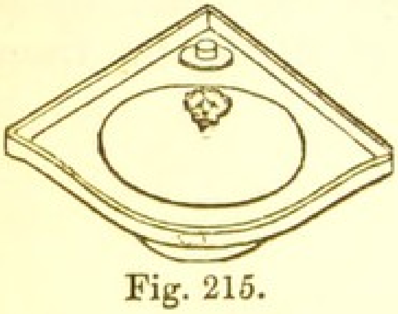


Fig. 215.

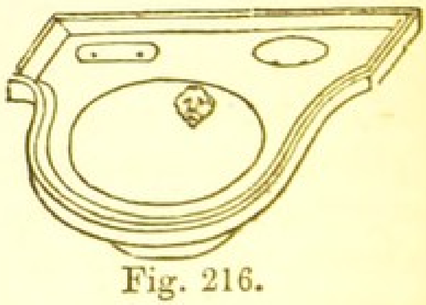


Fig. 216.

Having settled upon the shape of and got his cabinet-stand, which we will suppose is a square one, as shown in Fig. 214, the plumber has next to get the wooden stool upon which it is to rest. The style of this stool, however, depends upon the way in which it is intended to finish the wood-work of the cabinet-stand. If, *e.g.*, the wood lining were intended to be put round the front and sides of stand, just as in Fig. 206, then the stool in this case may have four legs, two at back and two at front, just as in Fig. 206. We will, however, suppose that the stand is not to be lined in down to the ground, or close to it, all the way round, in which case the wooden stool which is to support the cabinet-stand, as also the necessary cranes and pipes, &c., will only have two legs, one at each back corner, as per Fig. 218.

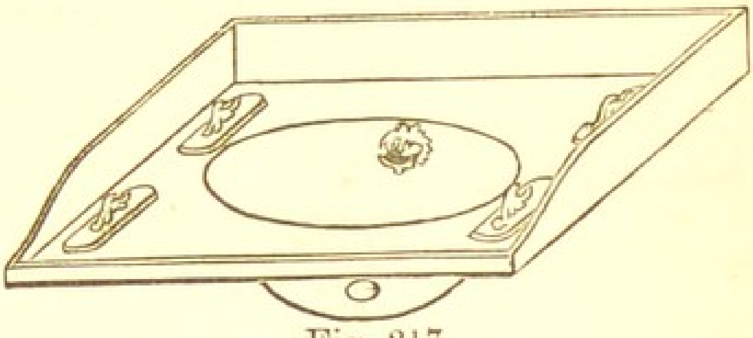


Fig. 217.

In looking at Fig. 218 it will be at once seen that such a stool, with only two legs, could not stand of itself, and far less could it support such a wash basin as that of Fig. 214; consequently, while the plumber is working at it, and before the stool is fixed in its place, a temporary leg has to be put in at its front. When fitted up, the stool is fixed in its place by means of the top bar v, Fig. 218, which top bar is a piece of wood from about 2 ft. 6 in. to about 3 ft. long, as the case may be, and 4 in. broad and 1 in. thick. This top bar is checked into the back of the two back legs, as shown at w w, Fig. 218—or rather as intended to be shown, for the engraving has the bar v nailed against the back legs instead of checked into them—and firmly fixed by means of screws. The stool being set up in

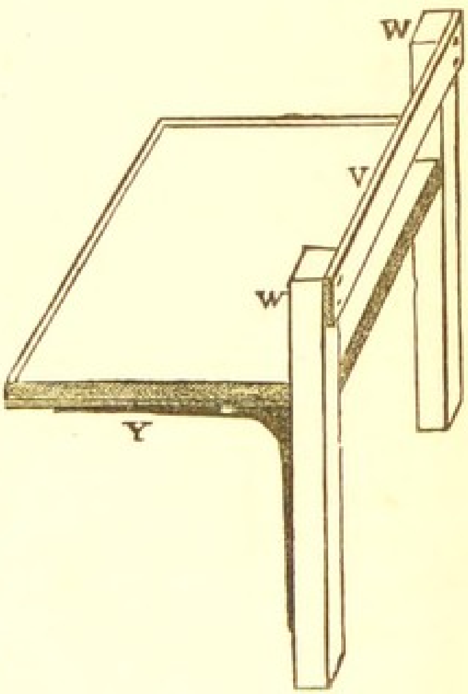



Fig. 218.

its place against the wall, this top bar V, Fig. 218, is then firmly fixed to another wooden bar of the same size which has been firmly fixed to the wall, as per X, Fig. 219. The wall in Fig. 219 being supposed to be either a brick or a stone one covered with plaster, the wooden bar X is shown flush with plaster, the plaster being cut out to allow it to be so. When, therefore, the bar X, Fig 219, is firmly fixed, and the bar V firmly fixed to X, then a considerable weight may be quite safely placed on the seat of the stool, more especially as this seat itself is supported by two iron brackets, as shown at Y, Fig. 218. The length of each arm of these iron brackets may be, say from 14 in. to 18 in., one arm being firmly screwed to back leg of stool, and the other arm supporting a slip or bar of wood as long as the breadth of the top of the stool extends outwards. This slip of wood may therefore be about 2 ft. long by 4 in. broad and $\frac{3}{4}$ in. thick. Screws about $1\frac{1}{2}$ in. long, put in near Y, Fig. 218, will therefore fix iron bracket, wood slip, and seat of stool all together. Around the outer top edge of the stool wood doubling about 1 in. high and $1\frac{1}{2}$ in. broad is placed for the lead safe. The height from floor to the top of the back legs will, in this case, be about 2 ft. 5 in., the top of wooden

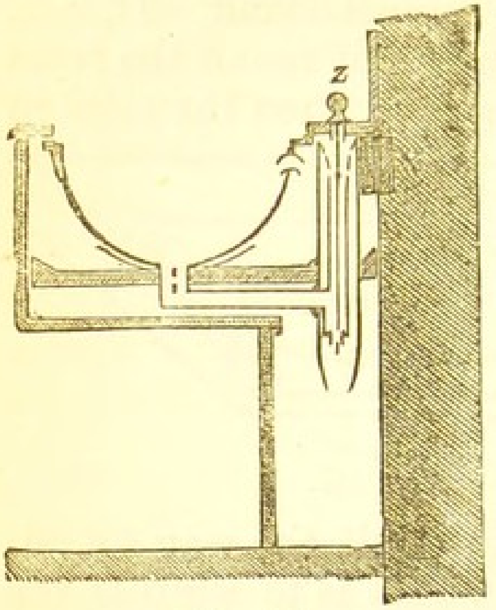



Fig. 219.

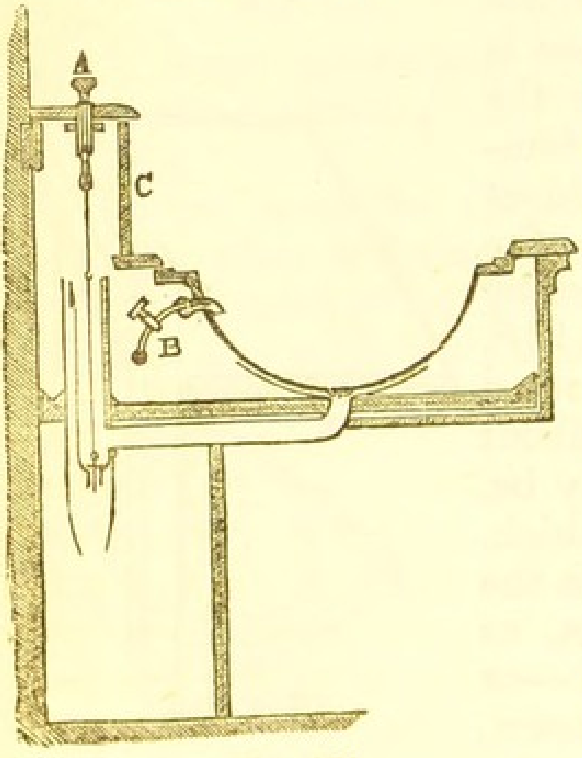



Fig. 220.

leg being level with the top of cabinet-stand. In some cases, however, as in Figs. 220 and 221, the height of the back legs will be above 3 ft., extending up about 9 in. or so above the top of cabinet-stand. This extra height is to suit a difference in the style of fitting up pipes and handles, and in the arrangement of the marble or mahogany. Fig. 219 shows section from back to front of a simple style of finishing either the marble or the mahogany at top, while the supply and waste for stand are regulated by three pull-up knobs, one of which, the waste, is shown at Z, Fig. 219. In Fig. 220 another style is shown, the knobs resting on the marble shelf which goes along at the back of the stand about 9 in. above the top of the basin, as shown at A, Fig. 220. In cases where there is a strong pressure of water on supply-pipe to basin this pressure may be regulated by putting on a good $\frac{3}{8}$-in. or $\frac{1}{2}$-in. gas stop-cock, as at B, Fig. 220. This prevents the incoming water from rushing up over basin and wetting all and sundry near it. If, however, it is only the pressure on cold-water pipe that is extra strong, then the small cock should be put on the pipe coming from cold cock. In fitting up the marble at Fig. 220, the front piece at C should be so fitted as to come out easily when wished without moving the top, so that the plumber may have easy access to arrange or repair his fittings. The neglect of this (which should be provided

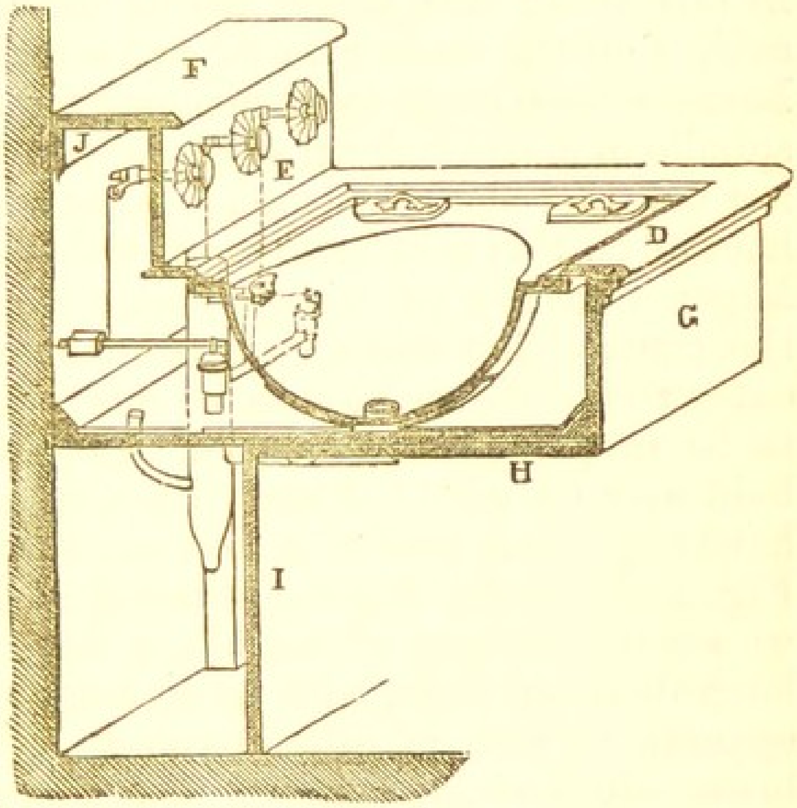


Fig. 221.

for as far as possible in all cases), is often the cause of unnecessary expense and annoyance afterwards.

Fig. 221 gives an idea of the large square cabinet-stand shown in Fig. 214, fitted up with hot and cold water, the cranes and waste-valve being worked by means of pull-out knobs and pulleys. In this case they are arranged from left to right as hot, waste, and cold, the particular words, "HOT," "WASTE," and "COLD," being engraved, or otherwise marked, each on its own appropriate knob. In other cases, if wished, the arrangement may be hot, cold, and waste; the rod-pipe in this latter case being put to the one side, and the cold, if off the main with an extra strong pressure, may have its knob made to turn round, being fixed on to the spindle of a screw-down stop-cock, in the place of pulling out like the other two. In order to get a proper hold of it, this cold knob may in this case be also made larger than the other two, and, owing to its being in the centre, this extra size will be no objection. The outer rim of all such knobs for screw-down cranes ought to be properly roughened or indented, so that a firm hold may be got of them. In place of a round knob, however, some prefer a four-pronged handle, as per Fig. 237, for the screw-down stop-cocks. In Fig. 221 we see three pieces of marble, D being the large square horizontal top piece, with large hole in its centre, which appears to rest on cabinet-stand. E is perpendicular breast-piece which rests on D as shown, and to which the back-check lifters are attached, and through which the pulls work. A small piece of marble is also required at each end of E, being put on at right angles thereto. F is an oblong horizontal top-piece of marble, covering in space between E and the wall. This top-piece, F, should be readily movable at pleasure, so as to allow the plumber to get at fittings. The front piece, E, should also be movable when required. The plumber also on his part ought so to arrange his cranes, &c., in position, or with couplings, as may be necessary, so that repairs may be easily made. If the expense be no objection, a ½-in. stuffing stock-cock may be put on underneath the basin stand, *i.e.* between it and the floor, upon both the hot and cold supply-pipes, so that the water could be easily turned off the basin fittings when necessary without interfering with anything else. The hole in lever handle of said stuffing stop-cock should, in this case, be of an oblong square shape, and the top of pillar, which goes into it, made to fit, and of the same shape, so that the handle could only be put on the one way—viz., to stand across when shut. If these stuffing stop-cocks were put on as described, then the $\frac{3}{8}$-in. regulating stop-cock above referred to could be dispensed with, as the stuffing stop-cocks could serve both as stop-cocks and as regulating cocks. In Fig. 221, G, H, and I, are the different parts of the mahogany lining, while J is the wooden bar going along between the two back legs of the cabinet-stand stool, and which, being firmly fixed to the wall, prevents it from falling forward. Fig. 222 gives enlarged perspective view of one of the brass back-check lifters, knobs, and pulleys, shown in Fig. 221. If the knob K, Fig. 222, is brass, as well as the flange L, then both may be well silver-plated, so as to correspond with the other furniture of the cabinet-stand. The end M of pull, to which the chain is attached, is swivel-jointed, so as not to twist the chain when the knob is turned round after being pulled out, to keep either a crane running or the waste-valve up, as the case may be. And to assist in keeping the back-check lifter itself from turning round, a small projection ought to be left on it when cast, as shown at N, Fig. 223. It is often a great nuisance when this projection at N is omitted. In Fig. 223 the distance from O to P is fully

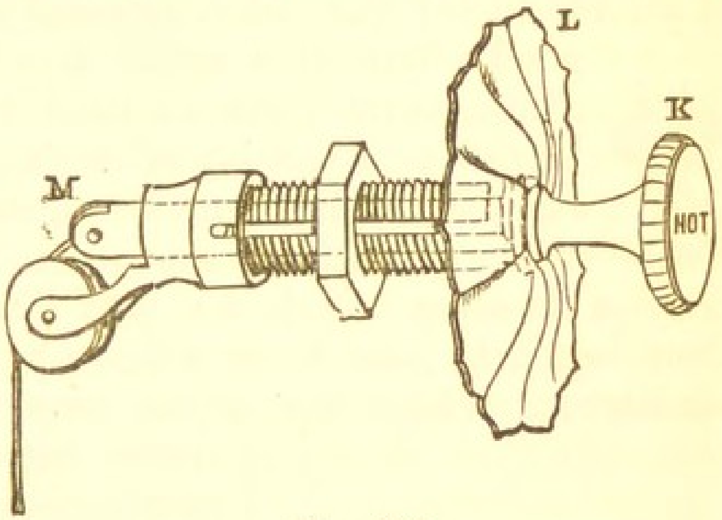


Fig. 222.

$1\frac{3}{4}$ in., while the distance from O to Q is $3\frac{1}{2}$ in. In other cases, where there is room and it is either desired or is necessary, the distance from O to P and from O to Q may be made longer, as wished. In Fig. 223, R is the back tightening-up or jam nut.

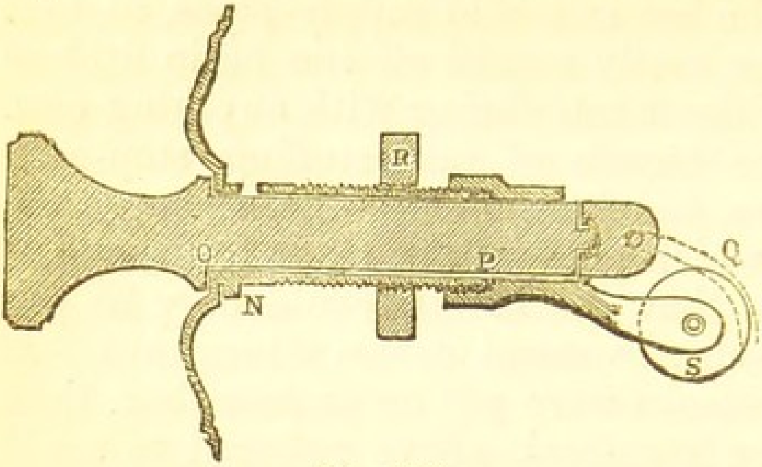


Fig. 223.

Fig. 224 gives cross sectional view of the pulley S, Fig. 223. As will be seen, this pulley has a deep groove in it all round for the chain or cord to work in. A very good chain is a small size of the patent copper chain, same style as used for window-weights. Fig. 225 is section of a cabinet-stand fitted up against a lath and standard partition. In this case the wash-hand basin-stool may be only a wooden shelf, no legs being needed, as the iron brackets can be screwed up against the wooden standards, while the pipes may be placed in the space between the laths and standards.

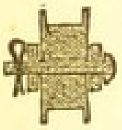


Fig. 224.

Fig. 226 is an enlarged view of the pull-up back-check lifters and knobs shown at Z and A, 219 and 220. The knobs may be either of brass or china, or other material, according to taste. In Fig. 226, T T is the marble or mahogany through which the pulls work. The lead syphon-traps for the foregoing cabinet-stands may be 2 in. in diameter, and no harm will be done to put $1\frac{1}{2}$-in. brass cleansing screws into them. The general size of the waste-pipe is only 2 in. in dia-

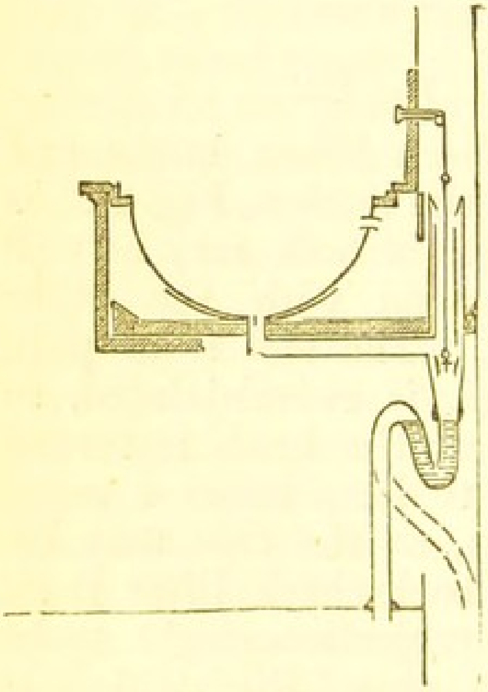


Fig. 225.

meter, but no harm, but good, would often result to make it $2\frac{1}{2}$ in., especially where it goes some distance horizontally. In fitting on the marble top, the portion at front, as at D, Fig. 221, should not be kept any broader than is necessary for strength, as it is disagreeable for

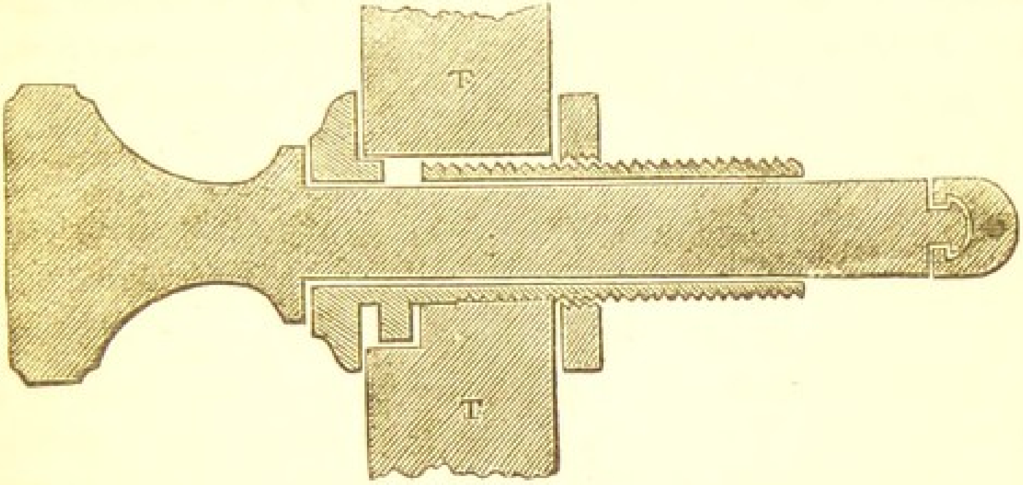


Fig. 226.

the parties using the wash-stand to have to lean forward too far. In arranging his basin on the stool, the plumber ought therefore to see that at most his stool only projects about $\frac{1}{2}$ in. beyond the outer top edge of his basin or cabinet stand. In setting his cabinet stands and basins the plumber generally uses putty, or a mixture of putty and white-lead, and to make the putty adhere, the bottom of the basin is well rubbed with a softened piece of tallow, or a tallow candle, or the bottom of the basin may be heated and then rubbed over with the tallow. We have thought that the omission of this use of the tallow was perhaps the reason why the oil from the putty sometimes appeared through the basin.

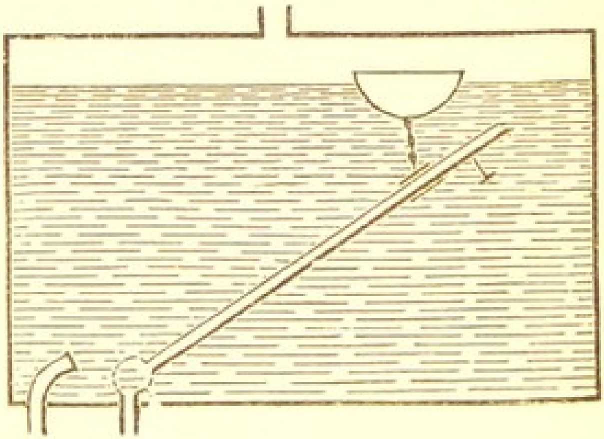


Fig. 227.

In houses fitted up with a hot-water cistern (not a close tank) and a small boiler at back of kitchen fire for the supply of the hot water to the house, it is well, while drawing the hot water direct from the boiler, as already explained in connection with Fig. 191, Chapter XVII., that the water going into the boiler should be as warm as possible. To effect this, cause the water going into the boiler to come from the top of the body of water in the hot cistern, where the water is warmest, and to do this, on supply-pipe to boiler place a crane with long piece of $\frac{3}{4}$-in. brass or copper tube attached to it,

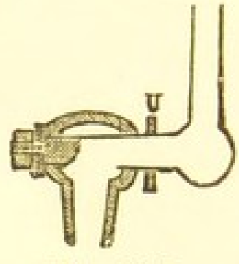



Fig. 228.

and with float-ball, as shown in Fig. 227. The highest end of this brass tube should be kept 2 in. or 3 in. below the surface of the water. In order to prevent the crane sticking, use a ground one, and upon its key fix a brass washer as at U, Fig. 228, then file down the key so that it cannot stick fast in the barrel. Any other plan, however, which answers the purpose, and causes the hot water from the top of the hot cistern to enter the boiler, may be adopted.

# CHAPTER XXI.

## Kitchen-Sinks and Urinals.

Kitchen-Sinks are made of various materials—sometimes of wood, and often with wood lined with lead. In some places, again, iron is the material generally used, while in other cases slate and stoneware sinks are adopted; and so on. The brasswork for the wooden sink may be the same as that shown at Fig. 176 for the wooden bath, only in this case a size smaller may sometimes serve. At Fig. 174, the bath is shown resting upon the floor; the sink in many cases will be raised up upon a stool.

Fig. 229 is perpendicular section of wooden sink resting upon a wooden stool with four legs, one at each corner. In Fig. 229 the inside size of wooden sink is supposed to be 2 ft. long, 1 ft. 2 in. broad, and 8 in. deep, but it may be made of any size, and a lead safe may either be put under it or not, as wished, or according to its site. All the siphon-traps of kitchen-sinks, should have brass trap-screws, as at v, Fig. 229. Another may also be put on, as at w, Fig. 229, or thereabout, for when grease is put down the sink it often sticks fast about there.* Fig. 230 gives a view of a wooden sink lined with lead, and with high back, through which the supply-pipes come, and to which the cranes are attached, as shown. The sheet-lead used

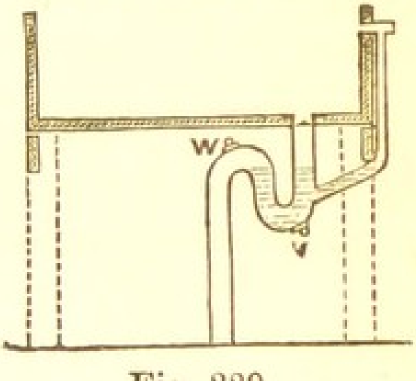


Fig. 229.

* The waste pipes of kitchen sinks should discharge into an outside disconnecting water trap, which may, if desired, have a grease collecting division in it. My No. 2 Trap, page 215, is often used in connection with sinks, while a special grease collecting trap may be had from Messrs. J. & M. Craig, Kilmarnock, if wished. They also make first-class enamelled fireclay sinks which are strong and clean. See pages 302 to 306, where illustrations are given showing how to apply the grease traps.

may be 10 lbs. or 12 lbs. per square foot for bottom and 6 lbs. to 8 lbs. for ends and sides. In Fig. 230 the sink has $1\frac{1}{2}$-in. or 2-in. lead overflow-pipe and 3-in. lead syphon-trap, just as in Fig. 229. The brass overflow-grating and the socket for plug are, however, different. Fig. 231 gives view of a brass overflow-grating $4\frac{3}{4}$ in. by $1\frac{3}{4}$ in., as used for either a lead-lined sink or bath. Fig. 232 is section *in situ* of a 3-in. brass socket and plug for either a wooden bath or sink lined with lead. By comparing Fig. 231 with Fig. 177, and Fig. 232 with Fig. 176, the difference in the style of the brass-work for a plain wooden bath and one lined with lead will be at once seen.

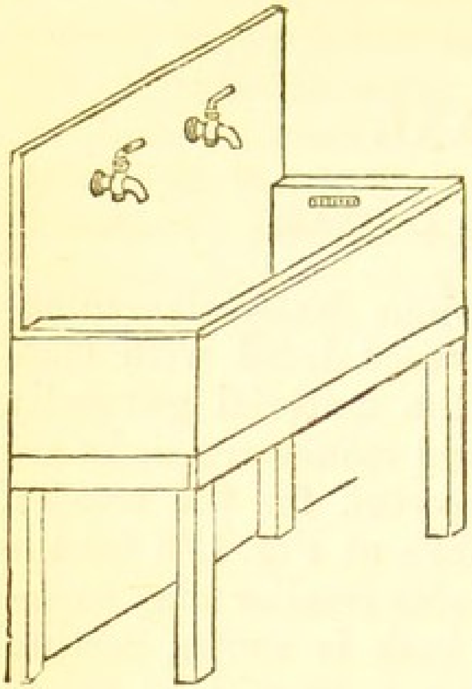


Fig. 230.

In Fig. 232 the brass plug, w, shown is sunk in centre; for sinks many use the plug raised in centre, with projection similar to that at x, Fig. 233; but for my own part I approve of the style shown in Fig. 232, as less apt to break the dishes. Fig. 233 is sectional view *in situ* of a brass cleansing screw for syphon-trap of kitchen-sink, as above referred to. When the syphon-trap gets choked up, the cover, x, is screwed off and the stuff taken out. $1\frac{1}{2}$-in. or 2-in. cleansing-screws are a good size for general use; they are made larger, but I approve of the size stated, because the larger often get so stiff that they will not turn, and the size given serves the purpose.

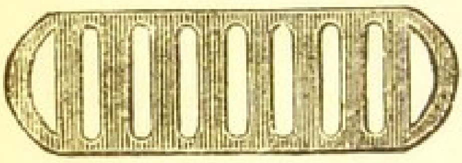


Fig. 231.

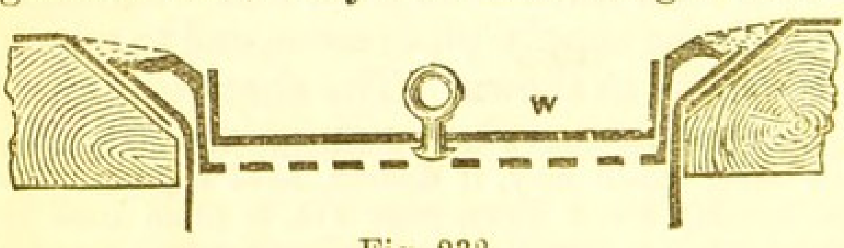



Fig. 232.

Fig. 234 is an iron sink, or "jawbox" as it is called in the west of Scotland, with a screw-down tube-crane. In Glasgow, *e.g.*, these are in general use for the kitchens in the lower and middle-class houses. They are generally placed at the window, which is the cause why a tube crane is shown in Fig. 234, and the reason why the handle is inclined to one side in place of being on the top is to allow the shutter to close. Supposing the distance between the bottom of the

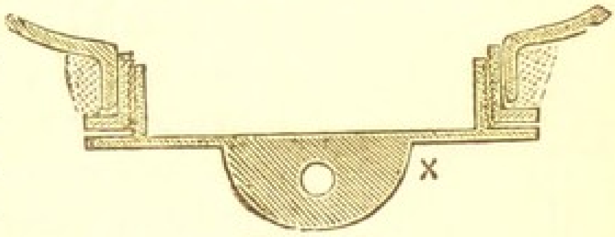



Fig. 233.

shutter and the floor to be 2 ft. 6 in., then the top of the sink will just be kept about 2 in. below the shutter; this will make the sink a very proper height and leave room for the joiner's wood. The rule for placing the sink at window is to keep the inside line of the top edge of end next shutter on a line with the daylight of the window-frame. In soldering on his screw-down tube-crane, the plumber must see that it projects sufficiently into the sink to allow the handle to turn freely after the wood lining has been put on. And to the joiner I may here say, that he may dispense with the use of *nails* for that portion of the upright wooden lining immediately before the syphon-trap, as it often requires to come

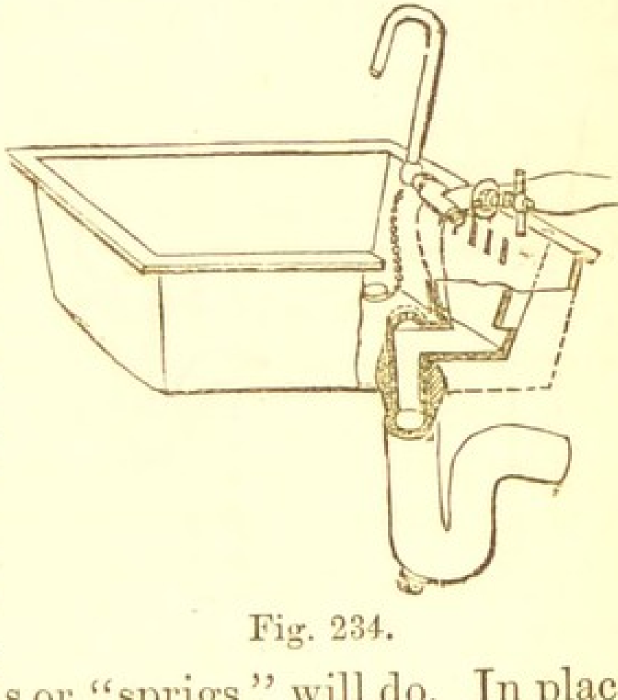


Fig. 234.

off; therefore, $1\frac{3}{4}$-in. brads or "sprigs" will do. In place of brads, some use screws here. Many local brass-founders make screw-down tube-cocks, but those made by Guest and Chrimes are in large demand; consequently, while I formerly approved of their work in connection with other things, they must excuse me pointing out a fault in connection with these, and it is simply this: that, although I have seen scores of them put on for some time back, in, I think, most cases the nut at the end of the barrel was too slack—turning round quite easily with the fingers—and, as a consequence, a few days after the crane would be put on, the tube would not stand up properly, while the water leaked at the key.

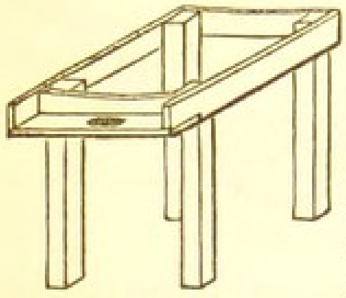


Fig. 235.

A partial remedy for this was to squeeze the nut of every crane in the vice. The proper remedy, however, is for the *makers* either to reduce the size of the hole in their nuts, or else to leave the male screws larger—not merely thicker at the point as has been so often and so stupidly the case, but of the same thickness all the way up, so that the nuts referred to may fit tightly. Considerable improvement might also be made in regard to the stuffing-box, or in the material used for stuffing. Only two days ago one of the water company's officials made a complaint to me on this latter point. I made an objection to Lambert's cranes that the bush and screw so often gave way; he retaliated by condemning Guest and Chrimes's cranes because the stuffing-box did not keep tight sufficiently long. Now which of these well-known firms or their imitators will be the first to remove the objections above made?

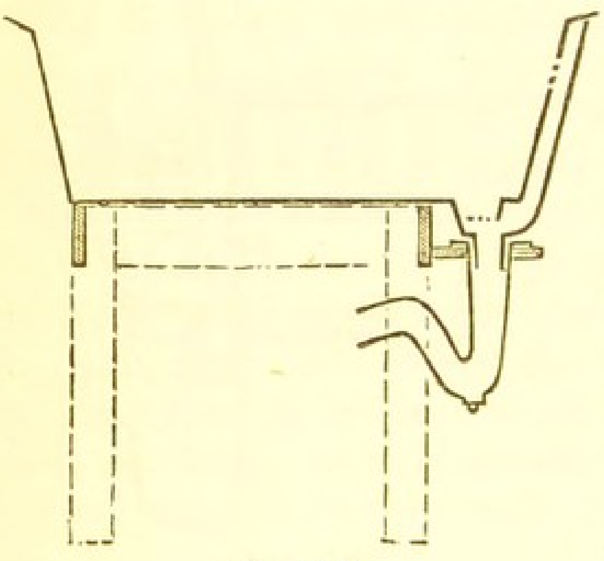


Fig. 236.

The sizes commonly employed of the iron sinks, or "jawboxes," shown in Fig. 234, are, for small houses, 21 in. long, 13½ in. broad, and 8 in. deep, or 24 in. long by 14 in. broad, and 8 in. deep. For larger houses, iron sinks 27 in., 30 in., and 36 in. long, are used; they can be had, however, either smaller or larger than these sizes, up to 6 ft. in length.

Fig. 235 shows how the wooden stool which supports both the iron sink and its lead syphon-trap is made. As the bottom of these iron sinks is slightly rounded, the two cross-bars of the stool must be made slightly concave on the top to suit. Fig. 236 is longitudinal section, showing how the iron sink, wooden stool, and syphon-trap come together, and how the syphon-trap is supported by its top being simply beaten out and turned over upon the wood as shown, the slip of the horn of the iron sink into the top of the lead syphon-trap being made good with putty. In setting these sinks, they should be kept a little lower at the end next the outlet, so that all the water run into the sink may flow freely away. In Fig. 234 only one crane is shown; but if there be hot water in the house, another tube-crane may be put on alongside the one shown. The one farthest off may have its handle right on the top; and if that interferes with the closing of the shutter, the bottom of the shutter may be cut to suit. If, however, the plumber is aware, when fitting up his sink, that hot water is to be put in, by keeping the sink a little lower the shutter will not require to be cut.

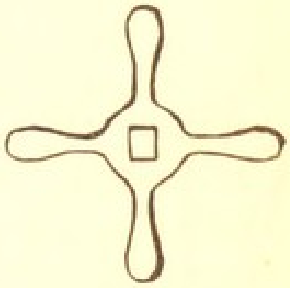


Fig. 237.

In the foregoing remarks I have supposed that every particular house has a private or internal water-supply for itself. In many cases, however, a number of small houses will only have one water-supply between them, say, a well set up in back court. In order to prevent undue waste of the water, it has been found necessary to so construct this well as that it shall only run so long as the hand is held to it. If a common screw-down bib-crane be employed, it is nothing unusual for it to be left running for hours at a stretch; consequently, such a well as Kennedy's self-closing well is now being generally put up. One style much used is that with

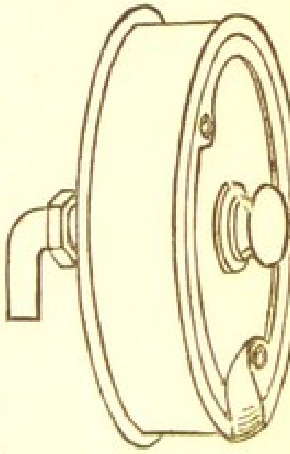


Fig. 238.

the round iron case, about 9 in. in diameter and about 3 in. deep, with a round handle projecting through its face, as per Fig. 238: a weighted lever attached to the spindle inside causes the crane to shut whenever the hand is removed.

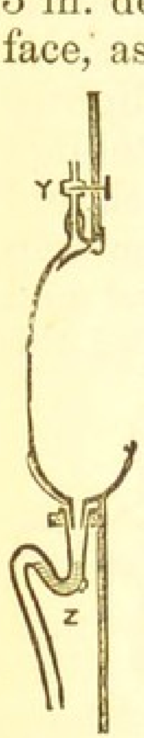


Fig. 239.

We come now to urinals; but after what has been said upon wash-hand basins and sinks, I need not take up much space with them. They are of various styles—high-backed and low-backed, round-backed, flat-backed and cornered. Fig. 239 is section of a high-backed cradle urinal with a $\frac{1}{2}$-in. screw-down stop-cock at Y, and a 2-in. lead syphon-trap at Z. I have often used Lambert's $\frac{1}{2}$-in. stop-cocks for these urinals, the upper part of the round disc with the four screws in it being so exposed and finished flush with the wood as that the top cover could be easily unscrewed and a new india-rubber washer put in without removing any part of the wood lining. In addition to the foregoing exposed crane, another crane is often put on underneath the woodwork, somewhere where the plumber can get access to it; this latter crane is intended to serve as a regulating crane to prevent too much water running into the urinal at once and overflowing it. Fig. 240 is a section of a small flat-backed urinal *in situ*. When the wooden lid A is lifted it pulls a cord which opens a crane and causes the water to run all the time lid is up. The lid may be held up with a spring-catch during use. Another style is to place a crane under the floor immediately before the urinal, which causes the water to run so long as any party is in the position to use the urinal. In Glasgow, however, and some other places unlimited running of the water at urinals is now prohibited (except where parties have water-meters I suppose), and the water must now be drawn either from a cistern having a waste-preventing

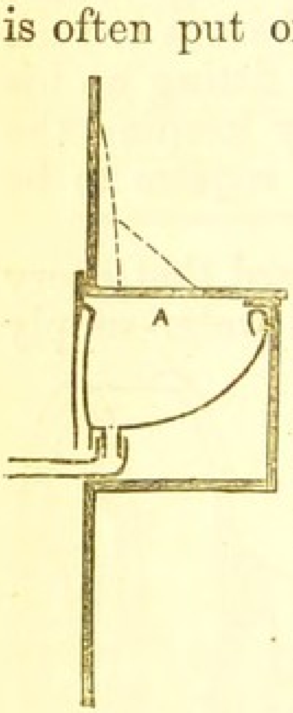


Fig. 240.

apparatus similar in principle to that used for water-closets, or else a self-closing cock must be put on. J. Taylor and Sons, of London, make self-closing cocks for the purpose, and so do Lambert and Sons, but those of the latter especially appear to me to be rather complicated-looking affairs. In several places where I have come across them lately they do not exactly please those who used them. Taylor, too, in my opinion, might dispense with a considerable amount of his brass, and make them much simpler. Taylor's does not appear to work so well sideways. William Ross, and Wallace and Connell of Glasgow, have lately brought out self-closing cocks. A cock that sometimes causes annoyance is Lambert's diaphragm cold water one, from the rattling noise it sometimes makes when running, especially on high pressure. Even the "globe" hot one, with spindle and washer extra, has the same fault. I prefer the nose cock patented by Messrs. Cooper, Jones, & Cadbury, which is much cheaper, and serves for either hot or cold water. Screw-down tube-cocks for either hot or cold water are now made by other parties on a similar principle.

In various localities the water supplied acts upon the lead in a deleterious manner, so that if water which has lain for any considerable time in a lead cistern or pipe be drunk, it is apt to have a bad effect upon the system, whether of man or animals. To meet such cases a "lead-encased block-tin pipe" has been manufactured, and also "tin-plated sheet lead" for cisterns. The offices of the patentees and manufacturers are at 59, Bridgewater Street, Liverpool, and at 15, Finsbury Place South, Moorgate Street, London, where full information will be got upon application. This pipe is not merely washed or coated with tin, but is a compound pipe, a tin pipe enclosed within a lead one. I am not aware of their having been used in Glasgow, the Loch Katrine water having been pronounced pretty safe in practice. They have been in use in other places, however, for years. They ought to serve well for beer pipes; for spirits I have often used block-tin pipes—same as used for gas.

# CHAPTER XXII.

## Glasgow Loch Katrine Water-Supply.

As showing how the water-supply to the various houses in a city is taken off from the water companies' iron main pipes, I may now point to Fig. 241, which shows the style and mode of attachment of the ¾-in. underground stop-cock and screwed ferrule, both brass, as allowed to be used by the Glasgow Water Commissioners for connection to their water-pipes. The distance between the stop-cock and the ferrule is about 2 ft. The stop-cock must not be riveted, but have tightly-fitting nut and washer. In order to get access to the stop-cock when necessary, it must be surmounted by a proper stop-cock case, with lid, which case is set upon bricks. The depth of the stop-cock under the surface of the street may be from 1 ft. 6 in. to 2 ft. When deeper it is often unnecessarily difficult to get at. For handiness, an extra stop-cock is often put in on the pavement, or some other suitable place. As the body of the stop-cock in street is generally concealed from view, it ought to be a rule that all underground stop-cocks, such as in Fig. 241, should be put in straight across the street. This enables the plumber to properly turn off and on the water with ease,

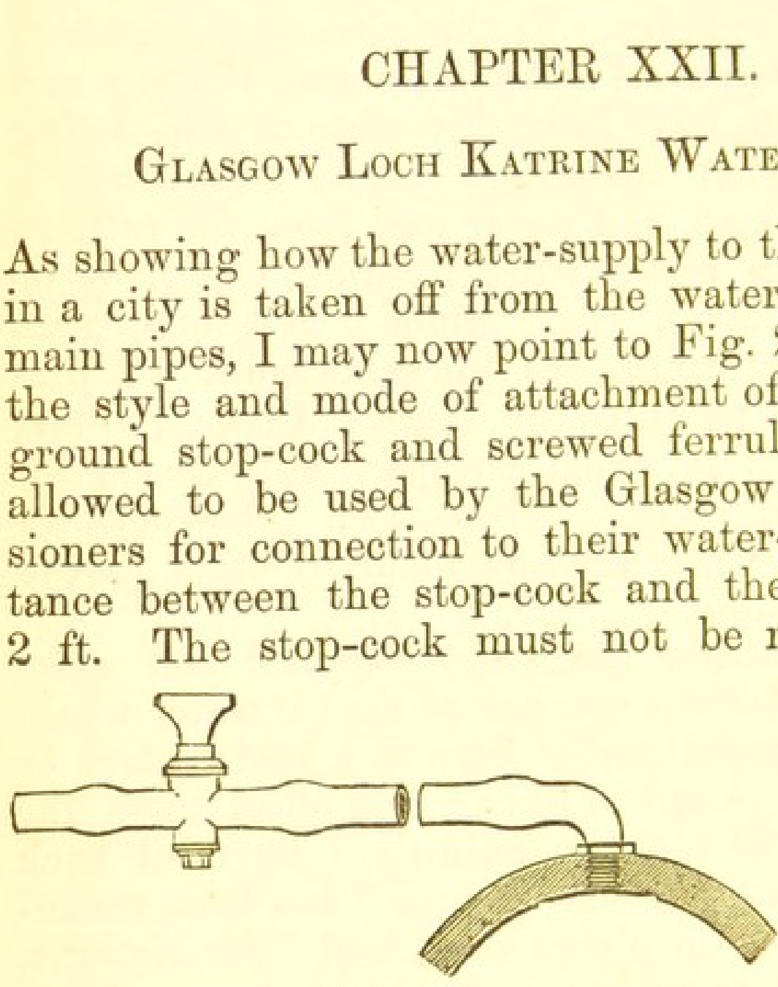


Fig. 241.

and so save time. At Glasgow, which is celebrated for its first-class water-supply, from the bosom of the far famed Loch Katrine, the height of the water in reservoir at Mugdock above the mean level of the water in the harbour is about 317 ft. The whole of this great pressure, however, is not allowed to be wasted by being let on to the lower parts of the city, for by a system of check-valves the pressure about Argyle Street, *e.g.*, stands at about 45 lbs., or about 100 ft. throughout the day, and at night it may rise up to about double that. The full pressure is, therefore, kept for the higher portions of the city, where it is required. The weight of the lead service-pipes off the pressure, as regulated by the Glasgow Water Commissioners, is as follows :—

| | | | | | |
|---|---|---|---|---|---|
| ½ in. | diam. | internally, | 7 lb. | per lineal | yard. |
| ¾ in. | do. | do. | 10 lb. | do. | do. |
| 1 in. | do. | do. | 14 lb. | do. | do. |
| 1¼ in. | do. | do. | 18 lb. | do. | do. |

I think these weights, as specified for the different sizes, very good, and when put in so a first-class job is made. For London I see the weights for the same sizes are rather less—viz., ½ in., 6 lb. ; ¾ in., 9 lb. ; 1 in., 12 lb. ; and 1¼ in., 16 lb. per yard. I expect, however, that the London pressure will not therefore be so strong as that of Glasgow. If not so strong, then pipes when put in of these weights will make a very good job, *i.e.*, when the pipe is properly made—viz., of the same thickness all round. The practice now of putting on screw-down cranes saves the pipes greatly by preventing concussion when being shut. Although, as stated above, ¾-in. ground stop-cocks are allowed off the Water Company's main pipe in street, for sizes at or above 2 in., slide-valve sluices must be used.

As partly related on the granite tablet built into the pediment erected over the entrance to the Loch Katrine aqueduct, the Loch Katrine Water Works were designed in 1853 and 1854, Robert Stewart being then Lord Provost. The Act of Parliament was got with the aid of Lord Palmerston in 1855, and the works commenced in the spring of 1856, Mr. Andrew Orr being then Lord Provost. An opening ceremony took place near the top of Loch Chon on the 20th May, 1856, and on the 14th October, 1859, the water was first admitted into the aqueduct, her Majesty Queen Victoria personally turning the sluice. The water was introduced into Glasgow on 28th December, and by March, 1860, the supply was general throughout the city. In token of their appreciation of the genius and skill of their engineer, the Town Council and a number of the most influential citizens entertained Mr. J. F. Bateman to a banquet on the 23rd October, 1860. The cost of the whole works amounted to upwards of £900,000, the distance traversed being fully thirty-four miles. The work was completed in less than four years. As Mr. James M. Gale, the present engineer to the Glasgow Water Commissioners, observes, it is a work which will bear comparison with the most extensive aqueducts in the world, not excluding those of ancient Rome; and it is one of which any city may well be proud. The distance between Loch Katrine and the reservoir at Mugdock is 25¾ miles. Of these 13 are tunnelled, 3¾ are iron piping across valleys, and the other 9 miles are open cutting and bridges. Where the ground was cut open the surface was restored after the aqueduct was built. At the bridges the aqueduct is covered with timber, to prevent its being choked by snow. Grooves are left in the masonry to receive stop-planks, and discharge sluices put in for repairs. Overflows exist at a number of the bridges to discharge the water, if it should be necessary to stop the flow suddenly at any point. The reservoir at Mugdock has a water surface of 60 acres, and a depth when full of 50 ft.; it contains 548,000,000 gallons, which at this date, November, 1875, is equal to about 17 days' supply. In November, 1863, the average quantity of water sent into Glasgow from Loch Katrine was about 17,000,000 gallons a day; the quantity consumed for domestic and other uses independent of that supplied by meter being then 39 gallons a head.* The average daily quantity sent in during the three months of July, August, and September, 1875, was 31,300,000 gallons, or 52 gallons a head over all; but deducting 7 gallons for meter supply, and 7 gallons for other trade purposes, we have a daily supply of first-class water, sent into Glasgow for domestic use alone, to the amount of 38 gallons a head per day. Of this large supply a considerable quantity runs to waste owing to defective fittings; but, as Lord Provost Bain lately remarked, it is perhaps as well for Glasgow that this waste should go on for the benefit of the Glasgow sewers as that it should overflow into the river Teith. One fault of this, however, is that while the greater part of the city receives abundance of water, some few very highly-situated portions get none: consequently, looking to this and to the rapid growth of the city, the Water Commissioners have adopted stringent measures to prevent waste. Besides causing waste-preventing apparatus for water-closets and urinals to be used, as already explained, they have a body of inspectors, about twenty in number, and mostly plumbers, whose duty it is to examine all fittings, and cause them to be put into proper working order when out of repair, and also to see to it that proper fittings are put in.

In 1863 the annual revenue was £90,000, with a domestic rate of one shilling and fourpence per pound of rental. In 1887 the revenue amounted to £161,000, with the rate reduced to sevenpence per pound of house rental, with a public rate of one penny per pound upon all property within the city. At present Glasgow is supplied from Mugdock reservoir through four iron pipes each 36 inches in diameter. I am indebted to Mr. Gale's courtesy for this information. In the foregoing remarks no allusion is made to the Gorbals Water Works, which are comparatively small, yielding only about four million gallons per day.

* In Glasgow for some time back the Sanitary officials have been striving to have all water for drinking and culinary purposes supplied off the main direct. This should be aimed at as far as possible everywhere.

## CHAPTER XXIII.

### Pumps.

A simple pump is the common lift-pump shown in Fig. 242. In this case, the pump-head B is of lead, and is securely fastened by screws or bolts to the wooden plank C. D is a 3-in. copper chamber, in which the valves work. E is lead pipe, $1\frac{1}{2}$ in. in diameter internally, and from 16 lb. to 22 lb. per yard, according to the depth of well. F is the handle, which, being pressed down, as is supposed to be the case in this sketch, pulls up the working-box G, and so opens the lower, or under valve H, as shown. The cause of the lower valve H opening when the working-box G is pulled up is the pressure of the atmosphere upon the surface of the water in the well into which the lead tail-pipe E dips. When G, Fig. 242, is pulled up from H, it tends to form a vacuum; but instead, the valve at H opens, and first allows any air which may be in the pipe E to escape upwards, above H, and fill the space between G and H. The handle being raised, pushes the working-box or bucket, G, down again towards H, but so soon as this is attempted to be done, the valve at H closes—in fact, the valve at H closes whenever the upward motion of G stops—and the valve at G opens, thus allowing whatever is between G and H to get above G, and so, with several moves of the handle F,

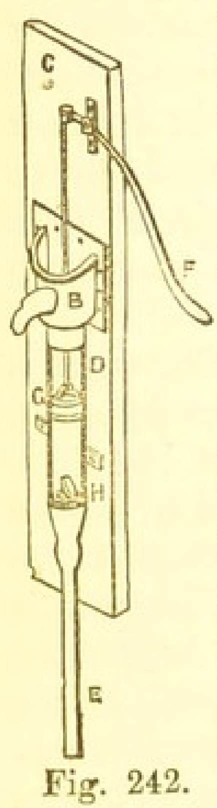



Fig. 242.

the air between G and the surface of the water in the well is all taken out, the water following up after it; and so, the working of the handle being continued, the water rises up E, past H and G, into the head B, and thence out by the spout, and continues so to run as long as the pump is worked and the supply of water in the well continues. It will be observed, of course, that the valves at G and H both open upwards. The top of the copper chamber D stands up about a quarter of an inch in the bottom of the lead head B, so that any sand or such like coming up the chamber D may not fall back again into it. The greatest depth from which such a pump, as in Fig. 242, will properly lift the water, is about 28 ft. below the valves in chamber D. The reason of this is that the power which forces the water up the tail-pipe E during the working of the pump can only do so to the extent of its strength. Now, as the greatest strength of this "power," viz. the pressure of the atmosphere, is only equal to the height of a column of water 30 to 34 ft. high, it follows that, allowing a margin for the working of the valves, about 28 ft. is the greatest depth from which the pump will work freely. Another point for consideration when fixing up the pump is the difference between the well when full and empty. The mean pressure of the atmosphere is about 14 lbs. to the square inch, so a column of water about 32 ft. high, and equal in sectional area to one square inch, will weigh about 14 lbs., and thus the pressure of the atmosphere and the column of water counterbalance each other. From this we see that if we know the number of pounds of pressure on the square inch, we may get the number of feet of water by multiplying by $2\frac{1}{4}$, or 2 2-7ths, thus: 14 lbs. by 2 2-7ths = 32 ft., which comes pretty near it. Mercury, again, is about thirteen times heavier than water, and as was discovered by Torricelli in A.D. 1643, a column of mercury about 29 in. or 30 in. high, according to the density of the air at the time, counterbalances the pressure of the atmosphere, and so $29\frac{1}{2}$ in. for mercury × 13 for water again gives 32 ft.

It must be understood that it is only at the surface of the earth that the pressure is about 14 lbs., or equal to 32 ft. of water; as we ascend, the pressure gets less.

Previous to the time of Galileo, it does not appear that any philosopher considered the weight of the atmosphere had anything to do with natural phenomena. The inventor of the air-pump was Otto Guericke, in or about A.D. 1650. I may here explain Torricelli's experiment:—Take a glass tube, hermetically sealed at the one end, and say $\frac{1}{4}$ in. in diameter internally, and 3 ft. long. Fill it quite full of mercury, then stop up the outlet firmly with the finger, then turn up the tube and insert its lower end into a vessel containing mercury, as per Fig. 242A. When the finger is removed the mercury will be seen to sink down a little in the tube, until it stands about 30 in. higher than the surface of the mercury in the vessel. This perpendicular column of mercury 30 in. high is prevented from falling down into the vessel by the pressure or counterbalancing weight of the atmosphere. The notion that "nature abhors a vacuum," or that she is always able to prevent one being formed, would therefore appear to be wrong, for a vacuum exists inside the glass tube above the 30 in. of mercury. The weight of the atmosphere near the surface of the earth is about $1\frac{1}{4}$ oz. to the cubic foot, while the weight of a cubic foot of water at its maximum density—about 39·1° Fahrenheit—is about $62\frac{1}{2}$ lbs., or 1,000 ounces; the water, in this case, is therefore 800 times heavier than the air. Mercury, again, is 10,000 times heavier than air.

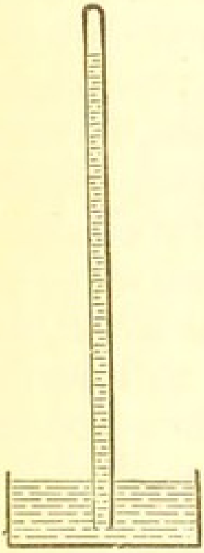


Fig. 242A.

When a pump is newly finished, or has been some time unwrought, and no water in the chamber, it is sometimes difficult to start it at first. By pouring a little water, however, into the chamber, it is soon all right. This water softens the leather of the valves—when they are of leather—and also prevents the air which passes up through H from getting back again. Another style of pump with copper barrel and lead head is the square lead-headed pump in square wooden case. This style of pump is largely used, the wooden case or box in which it is placed serving to protect it. The pump is much the same as in Fig. 242, only as the head in this case is square, and is placed in a case, it is supported and held fast by wooden fillets. In the upper portion of the front of case there is a door with lock upon it to gain easy access to the interior. Fig. 243 is an enlarged view of the 3-in. working-box, or bucket, shown at G, in Fig. 242. I, Fig. 243, is piece of good stout leather, $\frac{1}{4}$ in. thick, and $1\frac{1}{2}$ in. broad, put round the top of the wooden working-box, the rough, or flesh side out; it is secured by $\frac{3}{4}$-in. copper tacks, as shown. The leather is pared off a little where the tacks are put in, so that when driven in the heads of the tacks may not come into contact with the inside of the chamber. The two ends of the leather are made to overlap each other a little, both ends, however, being pared down, so as not to increase the thickness. J, Fig. 243, is the bottom of the iron pump-rod, divided into two prongs, the prongs passing down through the wooden box, and being secured at the bottom by means of rivets or nuts. Fig. 244 is view of the wooden under-box and valve shown *in situ* at H, Fig. 242. This under-box is tapered to suit the taper in the bottom of the copper chamber. To fix it in its place, hemp dipped in melted rosin and grease is wrapped round it at the grooves shown at L L, Fig. 244. When the plumber afterwards wishes to remove the under-box, he heats up the outside of the bottom of the copper chamber by setting fire, say, to a few wood shavings, which, melting the rosin and grease, releases the box. M, Fig. 244, is the clack-

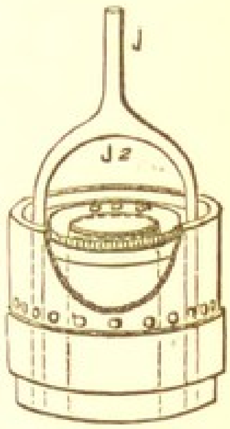


Fig. 243.

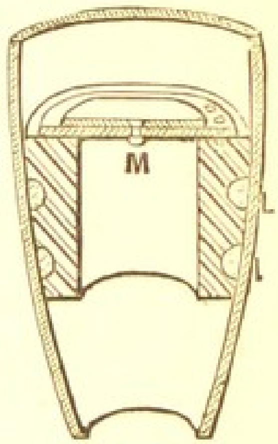


Fig. 244.

valve, formed of a piece of leather about ¼ in. thick. Above the leather, and attached to it, as shown, is a piece of cast lead about ⅜ in. thick, and about 1¾ in. long, and 1¾ in. broad. Fig. 244 is a perpendicular sectional view. Sometimes the under-box is fitted with a bent piece of rod iron, in shape as per $J^2$, Fig. 243, minus the upper part J, for the purpose of drawing it out. Fig. 245 is an iron pump, working upon the same principle as Fig. 242; the chamber in it may either be its own iron, properly bored, or a copper chamber may be inserted if wished.

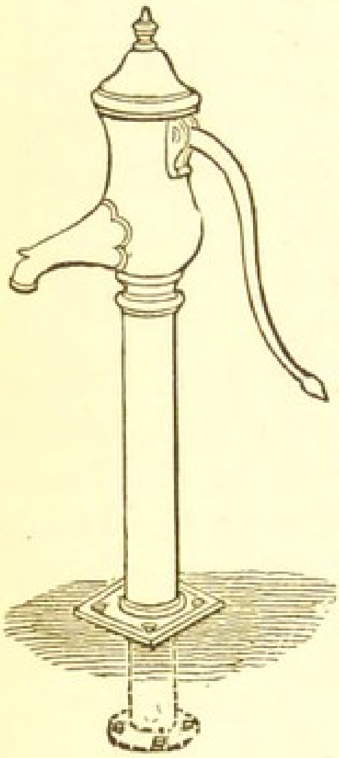


Fig. 245.

Fig. 246 is a 3-in. brass lift-and-force pump, mounted on cast-iron frame, very suitable for a country house, where it is wished to pump the water from a well under the ground up to a cistern in the garret or uppermost flat, for distribution through the house. It may be had, of course, of different sizes, either smaller or larger than 3 in.; but 3 in. is a good working size. The interior diameter of the chamber of the pump being 3 in., the interior diameter of the tail-pipe N, Fig. 246, and of the rising main, O, will be 1½ in. The under-box in this case may be either of the style shown in Fig. 244, or it may be made of brass, in place of wood. The working-box, however, is generally of brass, with cup leather, and may have either a clack-valve or a spindle-valve. Another valve is placed upon the rising main at P, Fig. 246, which valve at P, opening upwards, keeps all it gets and helps to prevent the weight of water in the rising main or ascension-pipe, O, from pressing continually upon the stuffing-box Q, or other parts of the pump below it. The reason why I have mentioned 1½-in. pipe for the 3-in. pump is because a larger size is unnecessary, and to put in a smaller size does not give either the pump, or the person who works it, the same fair-play. R, Fig. 246, is a copper air-vessel, about 8 in. across. It is put on as shown (or the rising main may be led out of its top, as per T, Fig. 247), in order to cause the working of the pump to be easier, and its delivery more regular; by its aid the water in the rising main — in place of being jerked along it every time the working-box is raised — is made to flow continuously, the elasticity of the air in the air-vessel preventing this jerking. When the well is both deep, and the tail-pipe of the pump also goes a considerable distance horizontally, an extra valve is often put in upon the tail-pipe above the water level; another plan sometimes adopted is to put on an air-vessel upon the tail-pipe, as close as convenient to the under valve of the pump. As the cistern to which the water is being pumped up is generally out of sight, and at a considerable distance

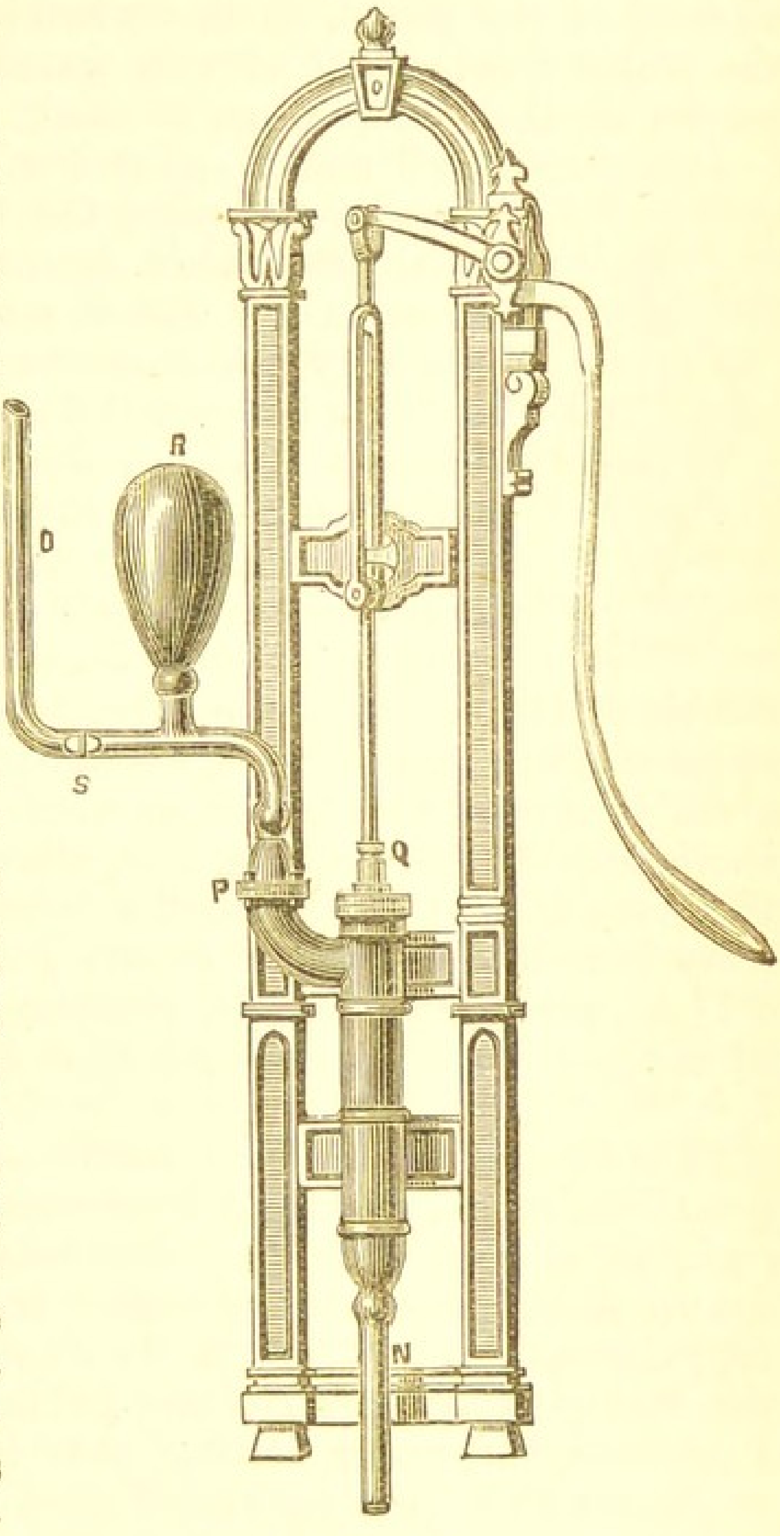



Fig. 246.

perhaps from the pump, some means should be taken to inform the party pumping when the cistern is full. For this purpose, a $\frac{1}{2}$-in. or $\frac{3}{4}$-in. *warning-pipe* is led from the cistern $\frac{1}{2}$ in. below the overflow-pipe, to the vicinity of the pump, so that when the cistern is full, the water flowing out of this warning-pipe tells the person at the pump when to stop. In order to keep small stones and stuff in well from getting into the tail-pipe, the bottom of the end which goes down into the well is closed up and a few inches, more or less, as the case may be, from its bottom, the lead tail-pipe is bored full of small holes about $\frac{1}{4}$ in. or $\frac{3}{8}$ in. in diameter; a sufficient number must be made to allow the water to fill the pipe quite freely. In place of boring the pipe itself a round perforated strainer, whose diameter will be about double or treble that of the pipe, may be put on. This strainer is what is used when the tail-pipe is iron. As the areas of circles are to one another as the squares of their diameters, it follows that, allowing a margin for the extra friction on the smaller holes, it will take fully forty $\frac{1}{4}$-in. holes, or about twenty $\frac{3}{8}$-in. holes, to supply a $1\frac{1}{2}$-in. pipe properly. In practice it is better to err upon the safe side by putting in a few extra than too few.

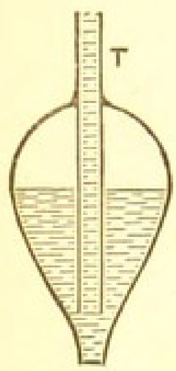


Fig. 247.

It is a common and often useful practice to put on a $\frac{3}{4}$-in. bib-crane, say a good lever-handled stuffing nose-cock, at S, Fig. 246. By this means water can be drawn direct from the pump. In giving a partial reproduction of Fig. 246 in the June, 1875, number of the *Manufacturer and Builder*, published in New York, I observe the editor stating that instead of using a large cistern in the upper flat from which to draw off the water, it has of late become customary in New York for the pump to be placed in the lower flat, while the handle is situated in an upper flat, a long piston-rod, with the requisite guides, being carried up from the pump to the handle. The rising main pipe, Q, being carried up to near the pump handle, and a crane put on, the water is drawn as directly and as cool as possible from the well. As the tail-pipe of the pump may hang down perpendicularly into the well about 30 ft., it is necessary to support it properly. This can be done by fixing up two strong planks horizontally inside the well, each end of plank being thrust into a hole cut for it in each side of the well. One plank may be put in about 10 ft. down and the other about 20 ft. down. Holes are cut through the boards for the tail-pipe to pass through, and with the help of a good lead flange about 9 in. in diameter, which rests on the board, and which is soldered to the lead tail-pipe, the said tail-pipe is thus supported. Regarding working down a deep well, it is sometimes dangerous to go down a well which has been some time closed up. Before doing so the plumber ought first to lower down a candle and see if it will continue burning all the way to the bottom, or to the surface of the water in the well. If it goes out, independent of falling into the water, or a drop of water, &c., falling upon it, then the air is foul, and it would be at the risk of his life and a piece of supreme foolishness for any one to go down (unless with diving-bell apparatus) until the well has been left open some time and the air purified so that the candle will continue to burn properly and the man to breathe freely and safely. Dashing down several buckets of clean water helps to improve the air in a well. Or for a dangerous well the following plan may be adopted:— Take as many feet as required of $1\frac{1}{2}$-in. zinc or other handy pipe, and attach a wide mouthpiece at its bottom. To this mouthpiece (right in centre) suspend a lighted candle. When this lighted candle is lowered with the pipe, the flame causes a current upwards of the foul air, upon which a down current of fresh air sets in to supply the place of the foul. The working-boxes or buckets of the foregoing pumps are pierced in the centre, and with valves in them. Another style of pump is that shown in Fig. 248—which gives sectional view of a plumber's hand force-pump—where, instead of the working-box or bucket, a solid plunger is used. When the plunger rises the water follows it, the under-valve opening up and allowing it to do so. When the plunger is pushed down the lower valve shuts, and the water rushes up the rising-main or outlet pipe, forcing open the rising-main valve, which keeps all it gets. The hand force-pump shown in Fig. 248 is generally used by plumbers to clear service-pipes which have got choked up. The small stop-crane, with coupling, shown on outlet pipe (which in this case is flexible, being made of india-rubber or leather) of Fig 248, is put there for a different purpose. In this case, instead of being used to pump water, it may be made to pump air, serving as a first-class testing-pump for the gas pipes in, say, a large newly-erected house. The *modus operandi* is to close up the ends of all the pipes, and the small stock-cock shown in Fig. 248 being connected with the main gaspipe, the pump is set agoing. If there are many large escapes in the gaspipes, then the air will rush out at the holes, and these holes, or improper connections, can be traced out. If the pipes be all right, this is proved by pumping air into them until a certain pressure is put on—not too much; then the stop-cock being shut, the pump is uncoupled from it, and in a few minutes, the stop-cock being opened, the confined air rushes out with some force and noise. If, however, there be a small escape, this is shown by the air coming out with little

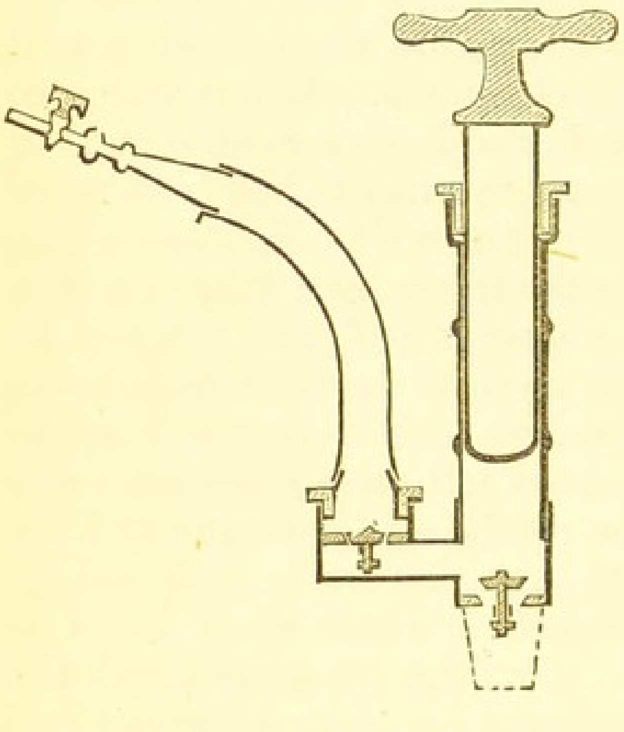


Fig. 248.

force, or, sufficient time being allowed, no air coming out at all.

I have said that a pump will not lift the water from a greater depth than about 30 ft., yet, as many wells are several times 30 ft. deep, it is necessary to lift the water from that depth by some means or other. In this case, by lowering the pump down into the well until it comes to about 28 ft. or somewhat less from the surface of the water, the water may be sent up to the required height. To work the pump or pumps in this situation long iron rods are required. In very deep mines a series of pumps is used. The lowest pump raises the water so far and discharges it into a small cistern; into this cistern the tail-pipe or suction-tube of the pump next above dips, which pump raises the water into another cistern, and so on until the surface of the earth is reached and the desired height for the outflow attained. One long rod, or "spear," set in motion by a steam-engine and the necessary machinery above, is sufficient to set all the various piston-rods of the different pumps working.

I cannot enumerate all the various varieties of pumps and the different styles of working them, by means of levers, eccentrics, cranks, and wheels, for their name is legion; but what I have said will serve to show the principle upon which pumps work.

Fig. 248A shows vertical section of a pump invented by Mr. Laurence Jordan, of Milton-next-Sittingbourne, Kent, which can lift the water, although it has only one valve, viz. the one in the working box. This is effected by the use of the side water receptacle, which is attached on a level with the barrel of the pump.

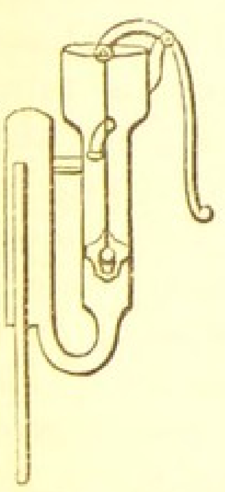


Fig. 248A.

I cannot enumerate all the various varieties of pumps and the different styles of working them, by means of levers, eccentrics, cranks, and wheels, for their name is legion; but what I have said will serve to show the principle upon which pumps work.

## CHAPTER XXIV.

### The Hydraulic Ram.

There is another interesting and useful machine for raising water which I may shortly describe, viz., the hydraulic ram. This instrument is self-acting, and when once properly set agoing it will go on working away day and night without intermission for an indefinite period. Its action is due to the inertia of a *moving* body of water. In Fig. 249, u is the source of the water supply, v the position of the ram, say 100 ft. (it may be somewhat less or much more, according to site, only the distance must not be too little, or the ram refuses to work) from u, and 10 ft. lower. w is the house, say 300 ft. or yards from ram, and its uppermost flat, where the cistern is, about 90 ft. higher than ram; x is the supply-pipe to ram, and y the rising-main from the ram to the house. z is the pipe or drain conveying away the waste water.


Fig. 249.

Fig. 249, therefore, shows the position of the ram relative to its source of supply (which may be either a running stream or a lake, &c.) and point of delivery. In Fig. 250 an idea of the ram itself is given. At a the water enters, and rushing along, it gets exit at b; but, under b, we see the valve c; the water rushing along comes into contact with c, and exerting its power upon it, suddenly lifts it up or closes it. This closing of C so suddenly, tends to at once arrest the motion of the water in the pipe A, which water had a certain amount of momentum in it corresponding to its height and the size of the pipe. Owing to its possessing this momentum, the water, so soon as it has shut the valve C, immediately opens or forces up the valve D, and so much of it passes through and gets above D. This done, the valve D closes, keeping all it gets. The valve C now again falls, simply owing to its own weight, and the water rushes out as before; but again C is carried with it, which closing causes the water to again open D, and fill the air-vessel E, so far. From this alternate closing or working of C and D, it will be seen that in a short time a considerable quantity of water will have passed D; this water, therefore, after it has filled E so far, compressing the air in it—which air acts as a sort of spring—flows up the rising main F towards the receptacle for it at the house. If we suppose the internal diameter of the pipe at A to be 2 in., then the internal diameter of the pipe at F may be 1 in., and the quantity of water which a ram of this size will supply may be about one thousand gallons, more or less, according to circumstances, in the twenty-four hours. Rams, however, can be had of various sizes, from one with $1\frac{1}{2}$-in. inlet and $\frac{3}{4}$-in. outlet, to one with 4-in. inlet and 2-in. outlet, the latter throwing up about five thousand gallons

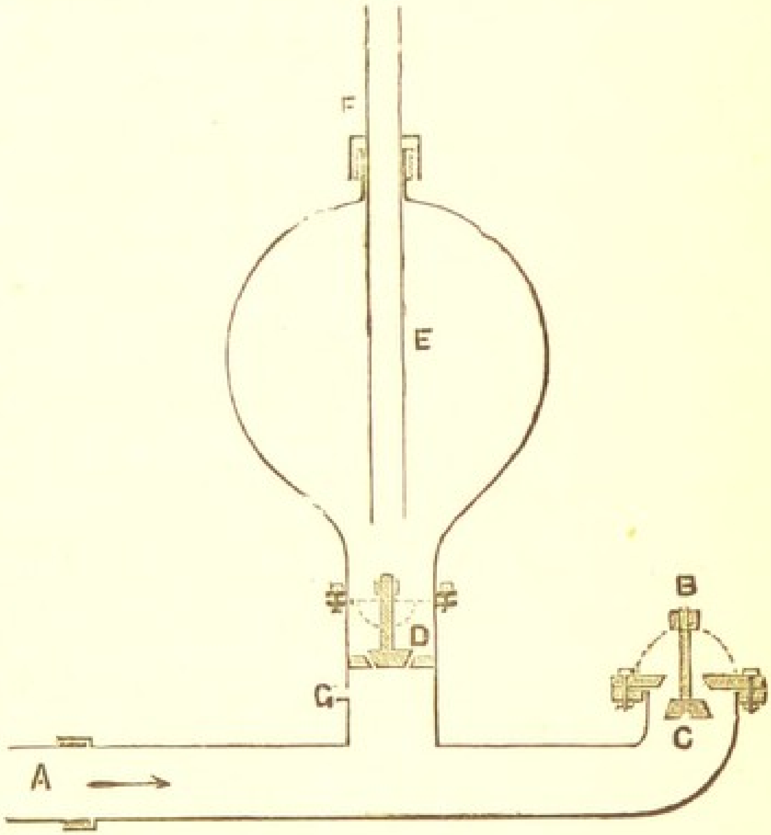


Fig. 250.

a day. Some plumbers have fitted up their rams with 3-in. inlet pipe and only 1-in. outlet; this causes greater friction in the ascension pipe, and I also fear more noise. Many consider the proportion of the fall to the rise in rams should not exceed 1 to 10; thus if the fall of water to ram—taken perpendicularly—be 7 ft., then the height to which the water will be sent above the ram will be about 70 ft. If the fall be 20 ft., then the rise may be as much as 200 ft. and so on.* The quantity saved of the water passing through the ram may be taken at about one-tenth; thus for every ten gallons that enter the ram, one gallon is sent on to the cistern or reservoir, in or near the house. G, Fig. 250, is the snifle valve, a section of which is shown in Fig. 251. This Fig. 251 is a brass bolt with hole drilled up its centre as shown, for the

* In the *Engineer* for January 7th, 1876, a correspondent states that with a fall of 20 ft. the water was sent up 160 ft. above the ram, the quantity lifted being 20 gallons per minute. The length of the discharge pipe was 700 ft.

In the same journal again, but under date January 28th, 1876, Mr. William W. Fyfe, of Aberdeen, gives the following table of results, as obtained by rams made and fitted up by his firm:—

| | Fall in feet. | Quantity in gallons per minute used. | Quantity in gallons per minute lifted. | Height of delivery. | Percentage of duty. | Proportion of lift to fall. |
|---|---|---|---|---|---|---|
| 1 | 8 | 5·949 | 0·669 | 66 | 0·927 | 8·25 |
| 2 | 7 | 9·47 | 0·27 | 200 | 0·81 | 28·57 |
| 3 | 5·5 | 1·2 | 0·214 | 24·2 | 0·78 | 4·4 |
| 4 | 4 | 42 | 1·1 | 96 | 0·625 | 24 |
| 5 | 1·16 | .. | ·5 | 34 | .. | 29·14 |
| 6 | 0·75 | .. | ·15 | 34 | .. | 45·33 |
| 7 | 6 | 42 | 1·2 | 120 | 0·57 | 20 |
| 8 | 10·5 | 9·297 | ·537 | 96 | 0·537 | 9·14 |

The falls were so low, in cases 5 and 6, that the waste could not be measured, and 7 and 8 are pumping rams, lifting pure spring water while being driven by impure streams, which, of course, require a greater expense of power.

valve to work forwards and backwards in. H is the end towards the interior of the ram, I the outlet, which, as will be seen, is very small, just large enough to admit the point of a pin. The use of this small valve to the ram may be said to be somewhat analogous to the use of a man's nostrils to him. The man may speak, although his nostrils are stopped up, as when he has a cold, but he will speak all the better when they are clear.

After having been sometime in use it has often happened that the air-vessel of a pump, or ram, becomes useless on account of the air at first contained in it having somehow vanished, either the water having absorbed it, or else the air has slowly passed through the water as does sewage gas through the water in the

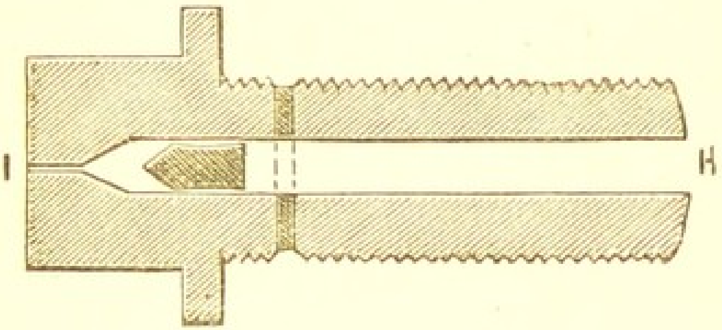



Fig. 251.

syphon-trap of a water-closet. Or, again, *a small hole* somewhere may be the cause. To provide for this some parties attach a small stop-cock to the air-vessel near the top, by means of which air can be admitted when necessary. Professor F. E. Sweet suggests another remedy, viz., to place in the air-vessel some sperm oil, the floating of which on the surface of the water prevents contact between the air and the water, and thereby acts as a sort of check-valve to keep the air imprisoned. I have as yet had no experience of the working of this, and merely mention it. Mr. McTear, of St. Rollox Chemical Works, made some experiments for me as to how this oil would act in keeping back gases from passing through water-locked syphon-traps, but it was found to be useless for that purpose.

A mineral oil such as heavy paraffine, non-inflammable at less than about 400 degrees, would be more suitable where it could be applied. Mr. Townsend has long used this latter in keeping down bad smell at the urinals; the paraffine being made to float on the top of the urine.

## CHAPTER XXV.

### The Siphon.

Siphons are used to transfer various liquids from one vessel or cistern to another, and, on a large scale, to empty lochs or pits of water wherever the water at the outflow end can be discharged at a sufficiently lower level than the water to be emptied.

The power or force which causes a siphon to work is the pressure of the atmosphere upon the surface of the water on the inlet side, combined with the greater weight of water at the outlet. Hence the greatest height over which a siphon will lift the water will be about thirty feet. By a simple experiment it is easy to show the action of the siphon. K, Fig. 252, is the vessel to be emptied, L the vessel to be filled. M is the siphon, and N the tube to charge the siphon by. O is a short pipe through which

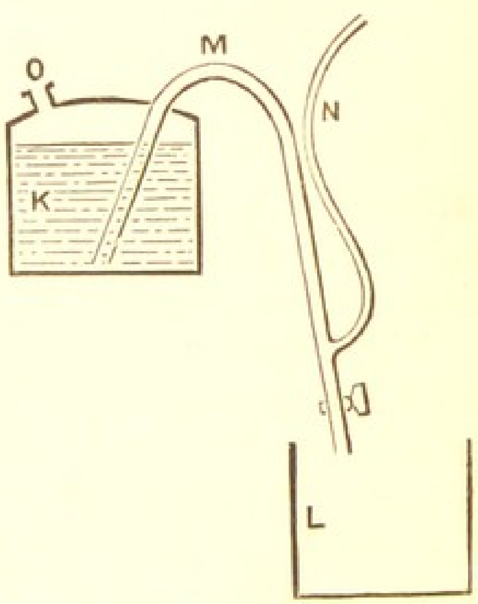


Fig. 252.

liquids or air may be admitted into the close vessel K. K being full and L empty, the lower end of the siphon is either closed up with the hand or by shutting the stop-cock—if one be on upon the end next L—and the mouth being applied to the small pipe at N, the air is all sucked out of the siphon M until the water begins to come into the mouth, the hand and mouth are then withdrawn and the water from K passes up and down M into L. During the rush-off of the water the flow can be stopped at will by simply pressing the finger or hand closely upon the mouth of the pipe at O. In Fig. 252, the top of the round vessel K is shown as arched; were it made quite flat on top, and of sheet tin not extra strong, then upon the rush-off of the water being suddenly suspended by stopping up O, the top of the vessel would collapse or fall in so far owing to the pressure of the atmosphere upon it.

In Fig. 252, the pipe N is shown as long as the siphon, but it may be used much shorter, and with a small stop-cock upon it at its junction with the lower end of the siphon. The discharge would be greater with N shut.

Another way to charge and start a siphon where the pipe is large, is to fix a stop-cock or sluice-valve on each end, and a 2-in. (or larger) brass trap-screw at the highest part of the siphon. The two cocks being shut, the cover of the trap-screw is taken off and water poured in until the siphon is quite full and all the air out. The trap-screw cover being put on again, and screwed up tightly, the two cocks are opened simultaneously and the water flows. In other cases, again, siphons are charged with a force-pump.

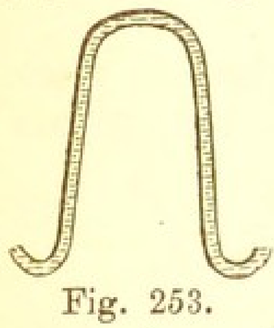


Fig. 253.

Fig. 253 is known as the Wirtemberg siphon; when once filled with the liquid it remains filled so long as it is held perpendicularly. When one end of this siphon is immersed in water or wine, &c., then the balance is disturbed, and the liquid in the end not immersed being heavier relatively to the air than the liquid in the immersed end is to the liquid in the vessel, the effect is that the liquid to be drawn off flows out at the end not immersed.

In regard to Fig. 252, it must be understood that the pipe N does not necessarily form a part of the siphon, for without the pipe N the siphon M can be charged by sucking the lower end of M.

Certain natural phenomena and also some curious tricks are produced by the action of the siphon. Intermittent springs are examples of the former, and the "vase of Tantalus" is a specimen of the latter.

I observed in opening that the greatest height over which a siphon will lift the water is about thirty feet. That refers, of course, to the height above the surface of the water to be lifted. If, however, for some particular reason the siphon has to dip down, or traverse a valley before rising over the hill, then the perpendicular height from the bottom of the valley to the top of the hill might be much more than thirty feet.

# CHAPTER XXVI.

## Flow of Water through Pipes.

It sometimes happens that after a plumber has put in his water supply-pipes, say from one cistern to another, as in Fig. 254, or from a cistern to a kitchen-sink or bath, that the water refuses to flow from the one cistern to the other, or from the cistern to the water-tap. Of course this may occur owing to the pipe having got choked up with some foreign substance, such as rags, paper, wood, or lime, &c., or owing to the worthy plumber having made a "solid joint," but that is not what I wish to refer to here.

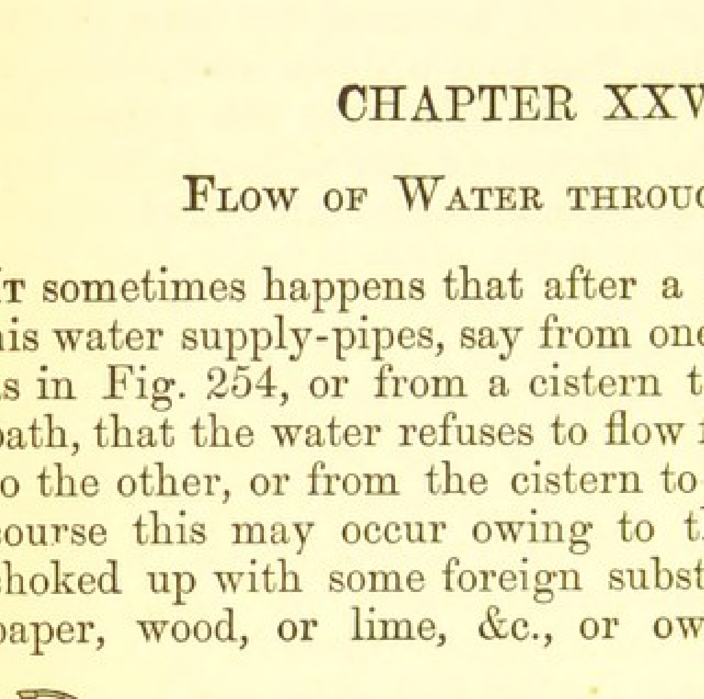


Fig. 254.

In the cases I wish to speak of we shall suppose that no water has yet been put into the cisterns whatever, and that the connecting-pipe between the two cisterns is so clear that it can be blown through quite easily. The water being let on to the cistern P, Fig. 254, and P filled, it is expected that upon looking into the other cistern Q that it will also be filled, or at least be filling up as quickly as possible, instead of that, however, the cistern Q is perhaps found to be empty. The reason for this is that the pipe R connecting the two cisterns has not been put in properly. Instead of that portion of it which goes horizontally being put in quite level, or, if off the level, put in as per dotted line s, Fig. 254, with a valley in the centre, so that no air could lodge in it, the pipe has been put in with a rise in the centre, as shown at R, Fig. 254, and the consequence is that when the water runs down from P a portion of it gets over the ridge at R and fills up the pipe beyond so far; this, however, imprisons the air at R which to the extent of a glassful or a tumblerful or so (according to the size of the pipe) cannot get away, being jammed in betwixt the water upon each side of it, upon which it floats. If the cistern P were a considerable height above the cistern Q, then the pressure of the water from P might force the air before it. In this case, however, both cisterns are on the same level, and the pressure at R only a few feet—about 5 or 7 as the case may be. To get the water to run the plumber may adopt either of the following three courses most suitable in the circumstances:—First, if the position of the pipe will allow of it, he may press down the pipe at R, doing away with the ridge or rise there, whereupon the air will of its own accord rise up through the interior of the pipe and the water begin to flow into Q. Second, he may apply a hand force-pump (see Fig. 248) to the mouth of the pipe in P, and by pumping in water force the air out at the end of the pipe at Q, and the air being once out the water soon rises up into Q and fills it. Third, he may pierce the pipe at the highest part of the rise at R with a nail, and through the small hole thus made the imprisoned air will come blowing out; so soon as that air is out the water immediately flows onwards and upwards into Q until the water in the cistern Q stands at the same level as the water in P. This would be the case supposing the distance between the two cisterns P and Q was several hundred yards and the internal diameter of the pipe only 1 in. or even less; but, of course, the greater the distance and the smaller the pipe the slower the flow, as the friction of water in motion through pipes is very considerable. This friction takes place against the sides of the pipes, the friction of the particles of water amongst themselves being very little.

I have said that the plumber's "third" plan would be to pierce the pipe with a nail; this is a very common thing for plumbers to do with leaden pipes when they wish to let out either air or water, and after the hole—which is only sent through one side of the pipe—has served its purpose it is plugged up with a small piece of good wood, say pine, and the plug being cut off flush the lead is riveted over it to keep it in.

It occasionally happens that the plumber has to provide for the continual gathering of air in a pipe whenever the cistern happens to get empty.

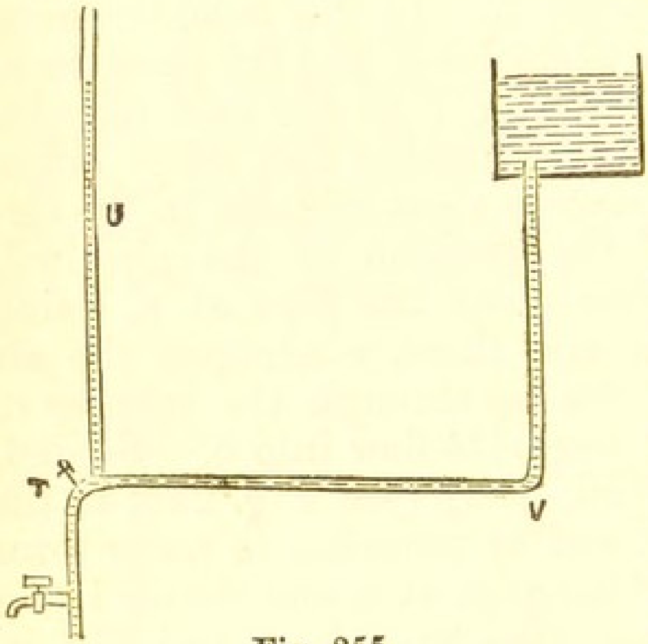



Fig. 255.

In this latter case he may either put on a small stop-cock (a $\frac{3}{8}$-in. gas stop-cock often serves the purpose), to open and shut with the hand whenever necessary, as at T, Fig. 255, or instead of the stop-cock an air-pipe may be put on, as at U, Fig. 255, the top of said air-pipe being carried up higher than the top of the cistern so that no water may come out when the draw-off cock is shut suddenly. The reason why a small stop-cock or an air-pipe is spoken of as being put on at T, Fig. 255, is because the pipe at T is higher than at V, and consequently air lodges at T; were T lower than V and the pipe between T and V straight, no air would lodge.

It was mentioned above that the friction of water in motion through pipes was very considerable, and in consequence the flow of the water was retarded very much thereby. This effect of the friction is known as the "loss of head." In connection with this, and before proceeding farther with my own remarks, I may here quote the following interesting observations which formed part of a leading article in the *Building News* of date December 4th, 1874 :—

"When water is conveyed from one tank or reservoir to another, by means of a long pipe, there is a certain amount of resistance offered to it by the surface of the pipe; this resistance is proportional to the surface of the pipe, and will, therefore, be greater for a small than a large pipe; it is also very nearly proportional to the square of the velocity at which the water is moving. The retardation caused by this resistance prevents water from rising to the same height again after passing through a long pipe,* and occasions what is termed a *loss of head*, the head of water being the height of the surface of the reservoirs above the orifice of discharge at the lower end of the pipe. To find the velocity of discharge from a pipe, multiply the head by the diameter of the pipe, and divide by its length (all in feet), then multiply the square root of this quantity by the constant number 50, and the result is the velocity in feet per second; if this velocity is multiplied by the area of section of the pipe (also in feet), we obtain the number of cubic feet discharged in a second of time; and this multiplied by $6\frac{1}{4}$, gives the number of gallons. For example, if the head is 32 ft., the diameter of the pipe $\frac{1}{2}$ ft., and its length 100 ft., the velocity of discharge will be 20 ft. per second, and the area of section being one-fifth of a foot, the discharge will be 4 cubic feet, or 25 gals. per second. We have here supposed the pipe to be quite straight, without curves or bends, but as these are usually of frequent occurrence in pipes of considerable length, a much greater amount of retardation takes place, and the velocity of discharge decreased thereby. If the change of direction of a pipe is made with a sharp elbow, the retardation is much greater than with a rounded turn; when the angle of deviation is 40°, with a sharp elbow, the loss of head due to the turn

* In connection with this point, see remarks on Fig. 257.

is one-seventh of the head of water due to the velocity at that point. For an angle of 60°, the loss is rather more than one-third; and for 90° the loss is nearly equal to the head itself, or the water is momentarily brought nearly to a standstill. In general, however, the change of direction is made with a circular bend, and the larger the radius of the bend the less the resistance caused by it: thus, if the radius of the bend is five times that of the pipe, the loss of head in a deviation of 40° is only one thirty-second; where the angle is 60° it is one twenty-first, and for 90° it is one-fourteenth."

In order to afford some further explanation of the practical working of this, I proceed to explain some experiments I made. I took a lead pipe $\frac{3}{4}$ in. in diameter internally and 50 ft. long. The end at which the water was poured in was bent up 6 ft. high, and the outlet end only 1 ft. high; the height of the inlet above the outlet being thus 5 ft. When the water flowed full bore out of the lower end it only rose up into the air about 3 in. high, thus showing a loss of head of about 4 ft. 9 in.; when, however, the orifice was contracted to $\frac{1}{4}$ in. in diameter, then the water spouted up into the air about 3 ft. high above the orifice. The explanation of this latter result is that for the amount of water emitted from the contracted orifice there was a proportionately less retardation by friction than when the water spouted out full bore from the uncontracted pipe.

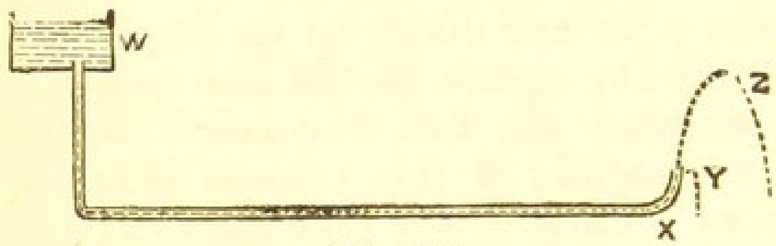


Fig. 256.

In another experiment I took a small gas pipe of only $\frac{1}{4}$ in. bore and 72 ft. long. I joined it at the one end to a small cistern, as per W, Fig. 256. The top of this cistern was 3 ft. 6 in. higher than the orifice of the other end of the pipe, which other end was bent up as shown at X, Fig. 256, about 6 in. above the ground. The length of the horizontal portion of the pipe lying along the ground was, therefore, about 68 ft. Water was poured into the cistern at W, and at first it ran away very freely; but latterly more slowly. I considered the outflow too little, and believed air in the pipe to be the impeding cause. I therefore put my mouth to the orifice at X, and blew in as hard as possible, trying to blow the air out at the other end; but it was no use, the 3 ft. 6 in. of pressure at the cistern end being too much, it seemed, to blow against. I therefore temporarily raised the end of the pipe at X as high as the cistern W, and waited a little, when the water at the end X rose up as high as in W. I then blew into the end X again, when several bubbles of air came up through the water in W. The end of the pipe at X was then lowered down again to its original position, 6 in. above the ground, when, so long as the supply continued at W, the water poured out freely from the orifice at X, coming with such force as to rise up full bore into the air about ½ in. high, as per Y, Fig. 256.

This ½ in. rise of the water while coming out full bore was no great height, yet seeing that the pipe was only ¼ in. bore and 72 ft. long, and the pressure or head of water above the orifice only 3 ft. 6 in., it was pretty good.

I tried how much water came in a given time, and found that it took six minutes to run off one gallon, which was at the rate of 240 gals. a day. From this it will be seen, therefore, that in a ¼-in. pipe, 72 ft. long, with a head in the cistern, above the orifice, of 3 ft. 6 in., the loss of head when the water flowed out full bore was 3 ft. 5½ in. It must not be supposed, however (and this is a point I wish to draw particular attention to), that this 3 ft. 5½ in. of loss of head at the orifice, as per Y, Fig. 256, means that the water will rise no higher. If any one thinks so, then he thinks wrongly; for, in reality, this 3 ft. 5½ in. of loss of head simply means that when coming out full bore out of the orifice the water, in this case, though with a head of 3 ft. 6 in., after passing through a ¼-in. pipe

72 ft. long, comes so slowly that the strength of the current is only able to cause the water to spout up into the air $\frac{1}{2}$ in. high. If, however, the orifice of this $\frac{1}{4}$-in. pipe be contracted, which I did by squeezing it together with a pair of nippers, then the water spouts up at once to nearly 2 ft. above the orifice, as per Z, Fig. 256.

Further, as showing the loss of head does not mean that water if properly guided, refuses to rise up to its level after passing through a long pipe, I put another small cistern upon the outlet end of my 72 ft. of $\frac{1}{4}$-in. pipe, and set it up as per A, Fig. 257, at the same level as the cistern W, Fig. 257. I then poured water into W, and it soon rose up in A to the same height as in W. At least, if there was any slight difference in favour of W, it was so slight that I was unable to detect it. If, however, I had either put on a small bib-crane, as at B, Fig. 257, or instead pierced a hole there, then so long as either was open the water would be prevented from rising up into the cistern A. This is one thing that engineers have to consider when drawing out their plans for the water-supply of towns. They must put in pipes of such sufficient size as that, when the near or low end of a street, &c., is drawing off water, sufficient water will be left to supply the other end.

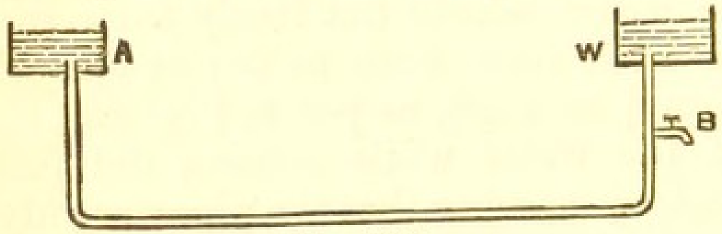
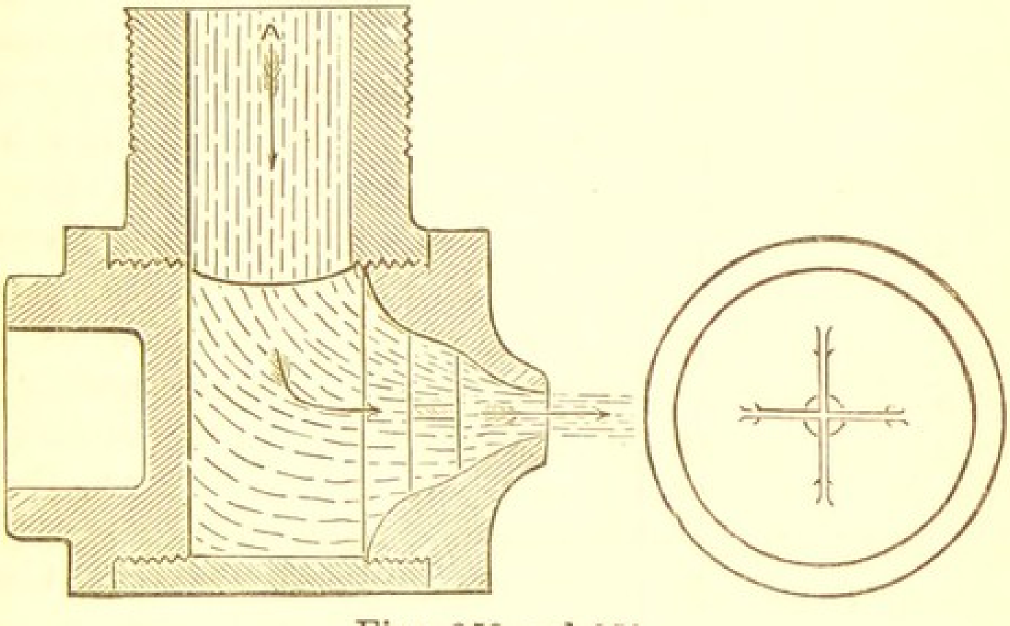


Fig. 257.

From the foregoing it is apparent that friction retards the flow of water very much, yet, even although the distance between two cisterns be great, if sufficient *time* be allowed, *versus* friction, the water will ultimately stand at the same level in both cisterns, unless, indeed, where the connecting pipe is so small as to allow evaporation to show a fraction of difference in favour of the first cistern. Of course, evaporation may affect the first cistern also; but said first cistern being nearer the fountain-head, or having a larger and quicker supply, evaporation need not be taken into account regarding it.

As an example of the distance which water can flow between cisterns upon the same level I shall quote the following, kindly given by a correspondent of the *Building News* (p. 139, January 29th, 1875). "At Ely station on the G.E.R. is a tank which supplies the engines with water; at Ely Junction is a smaller tank built for the same purpose. The tanks are *on a level*, are $1\frac{1}{2}$ miles apart, and are connected by a 3-in. pipe laid under ground descending from the larger tank, and ascending to the bottom of the smaller one. The water is pumped into the larger tank at the station, and flows into the smaller one at the junction without causing any




Figs. 258 and 259.

trouble whatever. . . . At least 20,000 gallons of water per day are taken from the smaller tank."

In another case water was supplied by gravitation through a pipe a mile long, and which, in its course, dipped down to the bottom of an intervening glen. The cistern receiving the water was not much below the level of the fountain-head, and the pipe was not more than an inch bore, and no difficulty was experienced in getting the cistern filled.

I shall close this article upon the Flow of Water with a quotation from a paper read before the Philosophical Society of Glasgow, December 2nd, 1874, by Mr. Alexander Morton, relative to experiments made by him upon *fluid jets and induced currents.* Mr. Morton has kindly permitted me to do so :—

"The apparatus shown in section by Fig. 258, consists of a simple conoidal nozzle screwed into the body of the inlet or supply-tube, which nozzle, when supplied with a head pressure of water of from 8 to 10 ft., discharged a jet vertically to within 1 ft. of the height of the supply level, when there was little or no rotary motion in the jet on leaving the nozzle. To prevent this revolving motion I used a cross piece, shown in plan, Fig. 259, in the wide end of the nozzle, as I found it almost impossible to get steady results without it. Water falling freely through a tube, although perfectly straight and free from any knees or bends, has always an inclination to revolve in some direction in its onward course, and often leaves the nozzle with such a velocity that the jet becomes broken into spray at a short distance from it. Certain knees and bends so increase the revolving motion, that the centrifugal force on issuing from the nozzle may nearly equal the impelling forward force of the jet; hence the necessity of a 'cross piece' in every experiment, as steadiness and accuracy are of the greatest importance in obtaining definite results. With the apparatus, Fig. 258, suspended by a flexible india-rubber tube, as shown by Fig. 260, the reaction of the jet may be approximately obtained by measuring the angle to which it has been deflected ; but in my experiments, to obtain the greatest deflection with a given area of nozzle was my sole aim. To define the

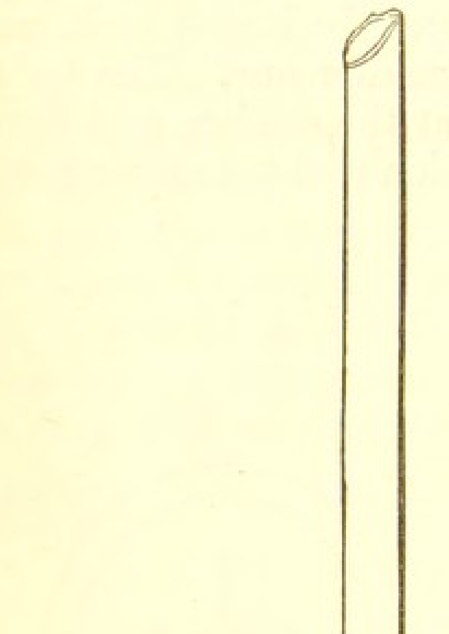


Fig. 260.

exact reaction of a given jet formed no part of these experiments; but when the 'cross piece' was in place, the simple conoidal nozzle, delivering freely into the atmosphere, gave the greatest reaction, and the impelled jet rose to the greatest height.

"The apparatus shown by Fig. 261 has a trumpet-mouthed discharge-tube, the narrow end or throat of which is of exactly the same form and size as the simple nozzle, Fig. 258; and when supplied from the same head of water it will deliver more than double the quantity of water in a given time of that issuing from the simple nozzle; therefore the velocity of the jet at the throat must be also more than double, as the areas of both are

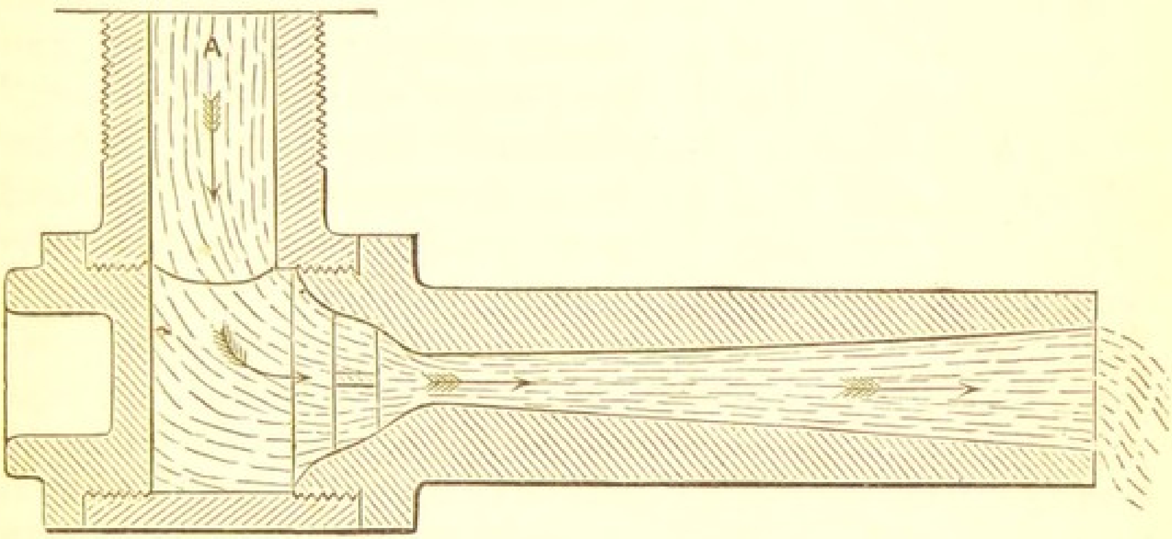



Fig. 261.

exactly equal. It may be asked, why such an increase in quantity? In answer, I can only say that I account for it through some unknown or not yet satisfactorily explained action of the enlarging jet. This action we can see going on within the tube, and can prevent it by greasing the internal surface when water is the fluid passing through it; but within such a tube there lies a secret, which may be explained hereafter. I had newly finished a gun-metal tube which I considered of a better form than any I had previously tried, and having polished the inside of it first with fine emery and oil, and then with crocus and oil, it was therefore, although smooth, very greasy, and on experimenting with it I became bewildered at the inferior and unsteady results; but on substituting an old tube not greasy, immediately the delivery increased and the results became steady as usual, thus proving the fault to lie in the greasy tube.

"I have said that with about 9 ft. head more than *double* the quantity of water would be delivered; but, on lowering the head, thereby reducing the water pressure, a still greater quantity will issue, even as much as three to four times that delivered through Fig. 258, with the same head. Near the throat of the discharge tube there is a constant vacuum, so that the jet of water rushing through the throat attains the velocity due to the head plus the vacuum; whereas with the simple nozzle, Fig. 258, the greatest velocity through it can only be that due to the head alone minus the friction."

In a discussion which followed Mr. Jas. R. Napier observed that he had seen the conoidal nozzle and widening discharge tube very usefully applied in the city of New York. The town lots were, he believed, rated for water according to their area, and the proprietors thereby became entitled to a certain area of pipe from the main. The citizens, in order, apparently, to make the most of this right, have manufactured conoidal nozzles with widening discharge tubes beautifully polished internally. The small end (inserted in the main) has the legal area, while from the other a pipe of three or four times the diameter may lead to the premises.

On page 197 reference is made to water coming through a 1-in. pipe a mile long. I may state that at the residence of Mr. R. B. Robertson-Glasgow, of Montgreenan, Scotland, I took out a $\frac{3}{4}$-in. lead pipe above a mile long which had been supplying the house with water by gravitation from a well higher than the house for a number of years back. The pipe being eaten and leaking in a number of places, and a larger supply wanted, I got orders to take it out and put in a 2-in. cast-iron pipe instead, and also build a larger additional tank. This was done, and the water has been on since July, 1882.

## CHAPTER XXVII.

### Scientific and Safe Water-Closets.

Many people of late have been troubling their minds very much as to whether or not their water-closets were safe, and it was amusing to hear some of the observations made. One gentleman, *e.g.*, made the remark that he felt bound to believe in the truth of the statement that gases come through water, "for," continued he, "when I sit down upon our w.c., I often feel a cold draught of air coming up, which is anything but agreeable!" Now this "cold draught" here spoken of is a common complaint, but it has nothing

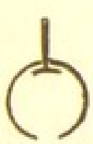


Fig. 262.

Fig. 263.

to do with gas coming through the water, for if it were gas that caused the draught in the case above referred to, the water in the pan would be bubbling up as if it were boiling. Generally speaking, the "cold draught" here referred to is a current of fresh air coming up between the flooring and the wall, and which, taking any opening it can get, blows out between the top of the water-closet basin and the bottom of the seat.* This

* There is room for improvement as to stopping these air passages, as while they can admit cold air sometimes into the closet apartment, they at other times allow stinking air to pass out of it. Even in water-closet enclosures provided with special fresh-air inlet and foul-air outlet ventilation, the passage of personal smell when the closet is

can be easily cured by simply fixing on with ½-in. tacks to that portion of the under side of the wooden seat, all round, right above the rim of the water-closet basin, a piece of ½-in. or ⅝-in. thin india-rubber tube about 4 ft. long, as shown under K K, Fig. 264. Small holes are cut out on the under side of the tube (as per Fig. 262, which shows cross-section of it), 2 in. apart, as per Fig. 263, which shows longitudinal section. Of course the distance between the top of the basin and the under side of the seat must be made to suit the tube, say about, or less, than ½ in. all round. In putting on the wood-work, the joiner should see that the top and front of the water-closet seat are so fitted that they can be taken off and put on quite easily, just like a glove. I have of late adopted brass slip-bolts for the front. They are sunk flush.

In regard to putting up a water-closet in the interior of a house from which, so far as it and its pipes are concerned, all danger from sewer or drain gases may be practically debarred, the adjoined sketch, Fig. 264, will easily show. The water-closet in the sketch is supposed to be situated in the upper floor of a two-story house; but, supposing it were a three or a four-story house, the arrangement of the pipes would be the same.

A, Fig. 264, is the surface of the ground outside, B is one of my patent 6-inch vitrified fire-clay ventilating siphon-traps, C is a strong cast-iron grating, 10 in. square, and perforated with sixty-four ⅜-in. holes.* It is let into a stone; through the centre of this stone an 8-in. round hole is cut. A second grating made of tinned or galvanised wire, or perforated zinc, may also be put in, as shown, to keep out rats or stones when the top grating C is off. By taking off these gratings at C,

in use into other apartments near—perhaps bedrooms—is often not properly guarded against, even although the position marked off for the closet should have caused special precautions to be taken when the house was being built. Up to this date we are a disgustingly uncivilised nation as to this, the general practice being a disgrace both to rulers and to people.

* The grating may be larger and have more holes in it according to taste. I use the gratings 8, 10, 12, and 18 inches square, with 36, 64, 100, and 196 holes, as best suits the case. Also see Fig. 293.

the hand can be easily got in to clean out the siphon-trap B, should such ever be necessary. For extra precaution against frost, a lead disc may be suspended from the iron wire grating, as shown at H, Fig. 274.* In regard to the drain into which the siphon-trap B is led, it must be seen that due provision is made for its ventilation quite apart from anything in Fig. 264. D is the soil-pipe from the water-closet, the perpendicular portion of which is supposed to be composed of 4-inch cast-iron pipes, with a 4-in. iron elbow at the junction with the fire-clay siphon-trap. (If it were for Bramah water-closets, I would recommend the size of the iron pipes to be $4\frac{1}{2}$ in. internally.) At the top of the 4-in. iron pipe, a 4-in. lead bend is put in, as shown

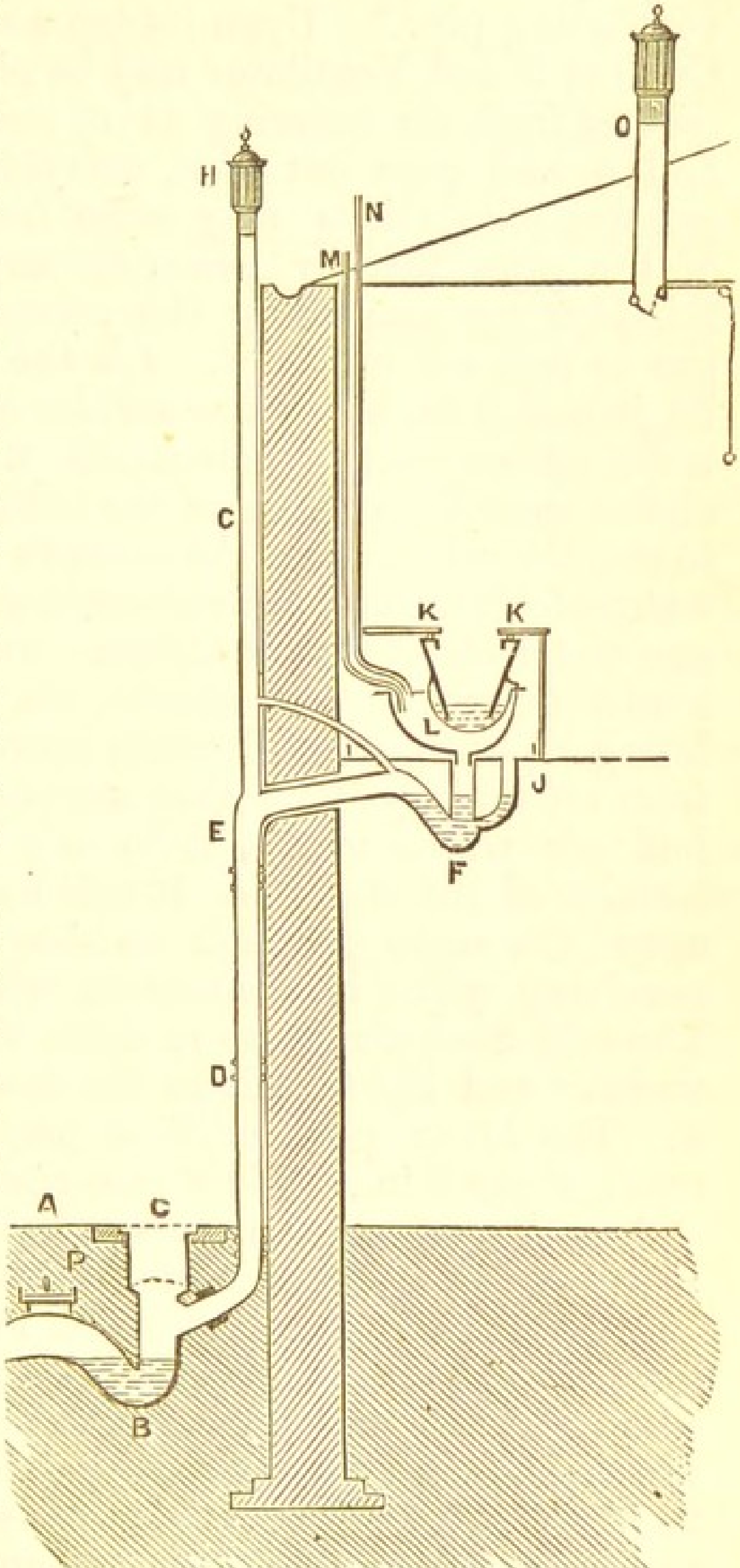



Fig. 264.

* The long frost of 1878-79 has passed, and I have not heard of a single case of one of these traps freezing, and 99 per cent. have no lead disc. The trap fitted as in Fig. 293 is still less liable to freeze.

at E; it goes through the wall, and is soldered to the lead siphon-trap F. G is the 4-in. cast-iron or zinc ventilating pipe.* Upon its top a self-acting Induced-Current Fixed Ventilator may be placed if wished; the cold or fresh air entering at C rises up through D, E, and G, and goes out at H, carrying with it whatever gaseous exhalations may arise from off the interior of the pipe, thereby lessening any danger from the soil-pipe by preventing the *accumulation* of any bad gas or foul air within it. J is the safe pipe: it must be joined 2 in. below the surface of the water in the trap, as shown.† Underneath K K, the two small circles show the position of the india-rubber tube put in to stop the cold air draught as above referred to. L is the water-closet trunk, made of cast iron, it being a common pan water-closet that is shown. In connection with L, a new feature is here shown, viz. the *two* $\frac{3}{4}$-in. ventilating pipes, M and N, leading upwards to the outer air from off the top of L; they are put in to carry off any foul air which might, from any cause, arise in the interior of the trunk L. It will be seen that they act upon the same principle as the hot and cold water revolving pipes in connection with a kitchen boiler. The cold fresh air comes in down through M, while the warmer and lighter air in the trunk rises up through N. The lower portion of M projects down into the trunk about 5 in., while N goes right off the top.

As the action of the pipes M and N, Fig. 264 (also of A and B, Fig. 265), is continuous, they must be of great value for water-closets put up in confined situations, or put up in or near bedrooms. I must here again observe that these ventilating pipes M and N—whether carried up through the roof, as shown in Fig. 264, or led out through the wall—must always go up or out *per se* to the fresh air, and upon no account can either of them be allowed to be joined either to

* The iron is best. The soil-pipe in Fig 264 is shown *outside* the wall, which is a safeguard against sewage gas, and is so ordered in the by-laws of the Local Government Board.

† Or it may be carried through the wall from back of safe, with a hinged valve on its outlet end.

the soil-pipe or to the ventilating pipe of the soil-pipe. Any plumber wilfully acting in defiance of this warning may find that he may, perhaps, leave the way open for a charge of manslaughter. Possibly a mistake upon this point has been the cause of the illness of many people, as explained at Fig. 160, Chapter XIV. O, Fig. 264, is a ventilator for the space or enclosure in which the water-closet is situated; a simple hinged valve is attached to the bottom, by which it may be opened and shut as desired. When opened, an upward current is assisted by my Induced-Current Fixed Ventilator upon the top. I am glad to be able to state that Dr. J. B. Russell, Medical Officer of the Sanitary Department, Glasgow, and Mr. Kenneth Macleod, Sanitary Inspector, express their warm approval of the style of trapping and ventilation shown by Fig. 264, and consider it a decided advance as regards safety upon any system of water-closet fitting yet brought before the public.* As it is possible some may ask how to connect the ventilating pipes M and N to the iron top or cover-plate of the water-closet trunk, so that they may be firmly attached, and also readily detached when required, I may say, take a ¾-in. brass screwed ferrule P, Fig. 266, and fit on a brass nut Q upon its screwed end. To the plain end solder a ¾-in. brass gas coupling R, then to the other end of the coupling R the ventilating pipe M or N is soldered. By means of the coupling R the cover-plate —S shows a portion thereof—can be easily got away or

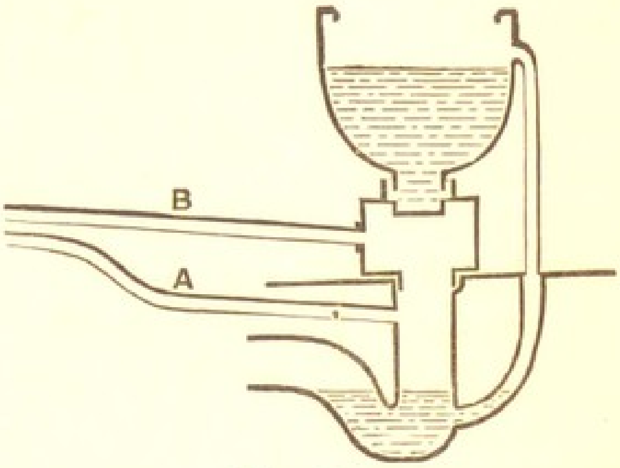



Fig. 265.

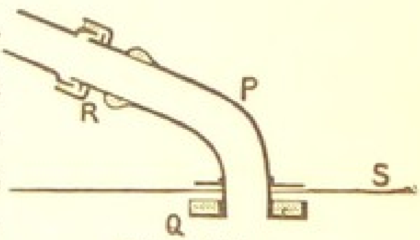



Fig. 266.

* This was about twelve years ago, and was independent of the particular closet shown, there being better closets than the pan one.

detached when wished. For a Bramah water-closet a straight ferrule may sometimes be more suitable than the bent one P, as the ferrule in the case of the Bramah will be let into the side of its small trunk. Instead of soldering a gas coupling and ferrule together, the coupling and ferrule may be got complete from any proper brassfounder. In putting on the iron cover of the pan water-closet trunk, it should be seen to that it is made all tight with putty, especially at the journal. The brass bush should rest on the edge of the iron trunk when properly done.

I may here observe, in reference to the pan water-closet shown at L, Fig. 264, that two objections have often been made against it, viz. the puff-up of bad smell that would often come when the handle was lifted (but which the ventilating pipes M and N will cure), and the copper pan often giving way and getting holed in a short time. This latter objection is a common fault, as I have seen new pans holed in a few days, and often in a few weeks or months, whereas they should last for years. So far as the pan was to blame, the fault lay in the copper being only coated or protected on the one side; for in the cases I refer to the pans were not holed from the inside, but from the outside, owing to the urine or medicine overflowing and running down the outside of the pan, and where it did run down, it eat into the *unprotected* copper. It has been supposed that the hand-made or hammered pan was much better than the spun one, but I consider that to be a mere fanciful notion, as those that were eaten, as above stated, were hammered pans. A $1\frac{1}{4}$-lb. spun pan, while as good as a $1\frac{1}{4}$-lb. hammered one—$1\frac{1}{4}$ lb. is the least weight that ought to be used—is also a good deal cheaper. To put a stop, therefore, to this corrosion of the pans from the outside, and give the pan closet fair play, I had manufactured "double-coated" copper pans, and pans coated on both sides are the only ones I have been using for some time back. The extra price is not much, while the durability has turned out to be considerably greater. The particular coating I wished to introduce was lead, but tin being more easily applied has been that generally used. Notwithstanding these improvements which I made upon it, because it is in such general use, yet upon the whole I cannot recommend the pan closet as a good sanitary appliance. It has far too much dirt-collecting surface about it, the greater part out of sight, and all upon the house side of the water-trap, too. For these reasons its use ought to be discontinued, and water-closets upon the "wash-down" principle employed instead, which have nothing out of sight upon

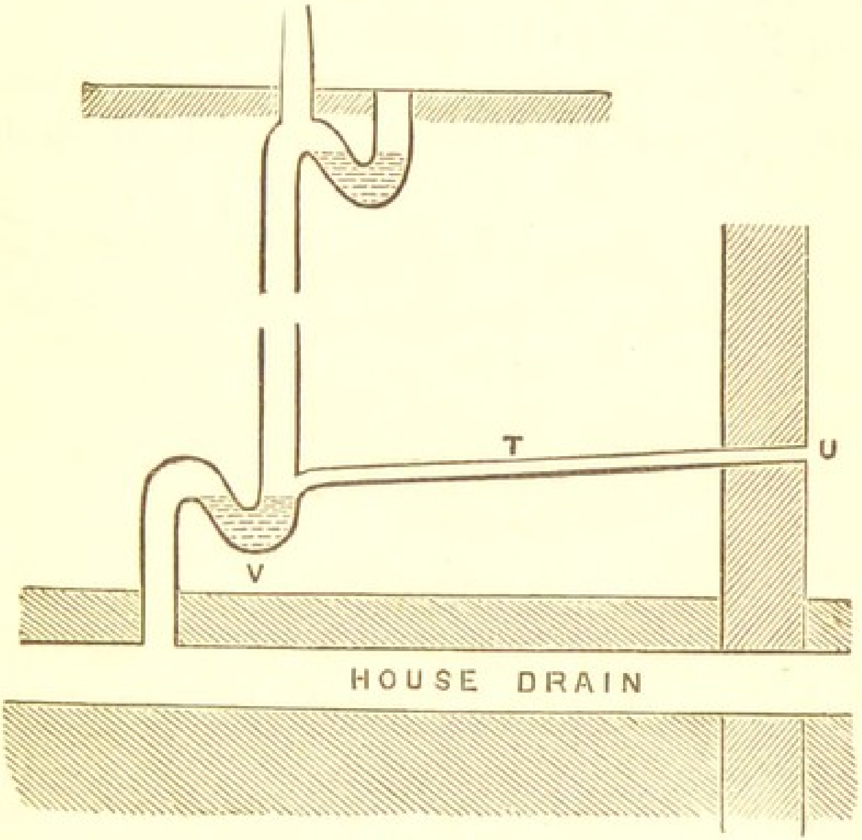



Fig. 267.

the house side of the trap, but in which *the water in the trap is always open to view*, the whole closet being above the floor. The closets in Fig. 269A are in this style.

In regard to Fig. 264, it will be seen that the water-closet is placed next to one of the outer walls of the house; but supposing the water-closet were situated on an upper flat in the centre of the house, the same principle could be adopted, either by having the soil-pipe the same as in Fig. 264, with, instead of the water-closet siphon-trap being attached near to the top of the perpendicular portion of the soil-pipe, a long piece of horizontal, or rather slightly inclined, soil-pipe of the requisite length inserted between the $4\frac{1}{2}$-in. lead siphon-trap and the perpendicular soil-pipe. In this latter case the ventilating pipe, in place of being put in perpendicularly above the soil-pipe, as per G, Fig. 264, would be carried up from close to wherever the lead siphon-trap was situated, so as to ventilate both the perpendicular and horizontal portions of the soil-pipe at one and the same time. Or, in place of adopting this plan, circumstances might cause the plan shown in Fig. 267 to be adopted, the soil-pipe at once dropping down perpendicularly from the outlet of the siphon-trap, and a 2 or $2\frac{1}{2}$-in. lead or iron venti-

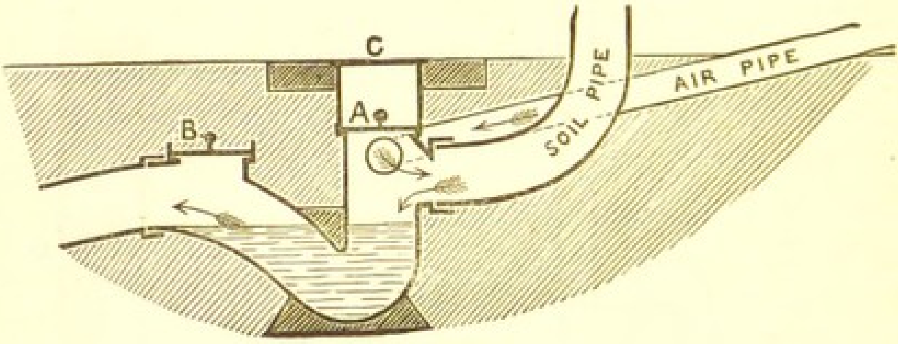



Fig. 268.

lating pipe being inserted as at T, and carried out through the wall, an iron grating being put on as at U, and the pipe where it passes through the wall built round with cement. V, Fig. 267, is a $4\frac{1}{2}$-in. lead siphon-trap, with a brass cleansing screw put in wherever it can be most handily got at afterwards.* Instead of the lead siphon-trap V, Fig. 267, which is put in above the ground, a 6-in. disconnecting trap, with an iron hinged lid and cleansing eye, may be put in as per Fig. 268, below the ground. By the simple insertion of this fire-clay trap, Fig. 268, at the bottom of a perpendicular soil-pipe, into which several water-closets were branched, complaints from the tenants

* In May, 1866, I used this style of trapping and ventilation, but it would be an improvement to add a ventilating-pipe from the top of the outgo of the trap to the outer air, and carried up high enough.

above (as in flatted houses) of bad smells and rats have often at once ceased. These bad smells were generally worse when chemical refuse was discharged into the sewer. Had the drains put in been of good vitrified fire-clay pipe, properly and solidly laid, and securely jointed with good cement, especially in the bottom, and a fire-clay siphon-trap put in to stop the sewer gas from getting into the house-drain, these sewer smells might have been pretty effectually kept out. But bad smells are often generated in houses from the common but very annoying masonic practice of touching up the joints most artistically upon the top, while at the bottom they are left quite open. I have not said anything about the overflow of the water-closet cistern, but instead of connecting it anywhere to the soil-pipe, one plan used is to make the air-pipe of the water-closet service-box act both as air-pipe and overflow-pipe. A better plan is to discharge the overflow to the outside, when the water is used for drinking purposes. Other styles may be found in Chapter XV. In Glasgow the rule for new work (which came into force 1st January, 1876) is that the overflows of cisterns must discharge at a conspicuous place above ground, outside or else overhead, within the premises.

In connection with Fig. 264, it has been shown that, by the insertion of the ventilating siphon-trap B, direct communication with the water-closet soil-pipe and the drain has been cut off, thus rendering the water-closet safe. How much more, therefore, would fixed wash-hand basins in dressing-rooms and bedrooms be made practically safe if they were properly fitted up upon the same principle? viz. a 2-in. deep-locked lead siphon-trap at the basin, with a $2\frac{1}{2}$-in. waste-pipe leading down therefrom and *discharging above the surface of the water in a ventilated siphon-trap;* the $2\frac{1}{2}$-in. waste-pipe being ventilated at its top out to the outer air.*

Fig. 269 will help to give an idea of a wash-hand basin situated on the upper floor of a two-story house,

* The open air-channel style, shown in Fig. 284, may be used.

and the waste-pipe leading down into a ventilating siphon-trap under the ground. In this case the waste-pipe does not generally require to have a ventilating pipe carried up to the roof, as did the soil-pipe in Fig. 264, but instead, the top of the waste-pipe may have a number of $\frac{5}{8}$-in. holes bored near its top for ventilation, as shown at B, Fig. 269. An air-pipe, as at P, Fig. 206, is understood to be put in and led out through the wall. The size of ventilating drain-trap at Fig. 269, is 4 in. For full particulars as to the basin fittings themselves, see Chapter XIX.

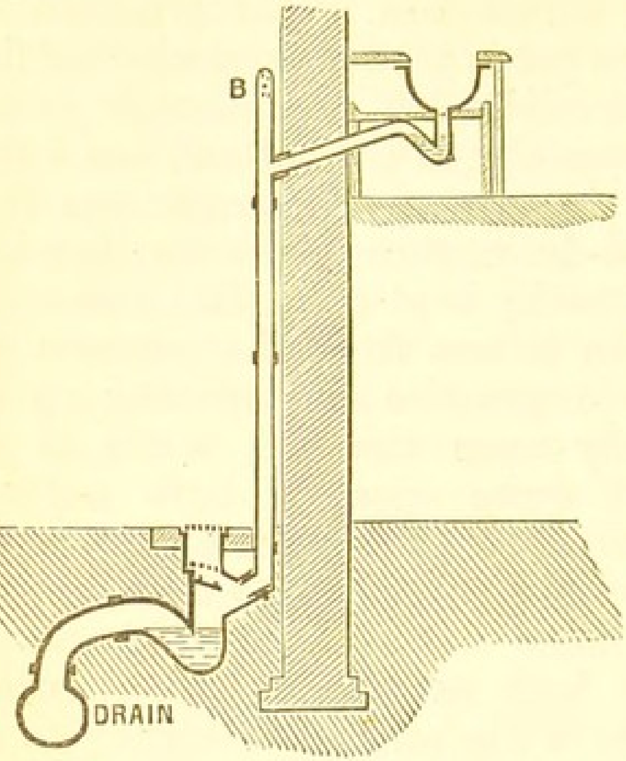


Fig. 269.

I have observed of late some persons asserting that by putting on a ventilating trap at the bottom, and a certain rotating ventilating cowl upon the top, of a main soil-pipe having water-closets, baths, basins, and sink *all branched into it*, that thereby the use of a lead siphon-trap may be dispensed with, not only for the closets but also for the baths, basins, and sink! I consider such an idea a highly dangerous mistake, for the cowl would be of little use when there was no wind, especially if the action of the fires in the house could have any effect upon the soil-pipe, or, as I have seen, it might be stuck fast and its tail to the wind. Then every time a closet was used a stinking puff-out would take place at each basin, bath, or sink. This is the reason, I suppose, why siphon-traps have been put on for the bath and sink at Guy's Hospital,* notwithstand-

* See Plate VII. in Mr. E. G. Banner's pamphlet on "Wholesome Houses," published by Messrs. Crosby Lockwood and Co., or Fig. 17

ing the trap and cowl above referred to are upon the soil-pipe. Without the siphon-traps the soil-pipe would be apt to act as a disagreeable speaking tube, as well as a stinking inlet ventilating-pipe.

Above twenty years ago I saw sinks that had been fitted up without siphon-traps, had afterwards to get them put in, even although the waste-pipe discharged above the ground. It was found that dirty water put down one sink caused a rush of stinking air to come out at the other sinks. The putting on of the siphon-traps stopped this and tended to isolate each sink or house by itself, and so not only remedied a nuisance but also acted as a barrier to disease germs entering the house through the waste-pipe.

Before closing this chapter upon scientific and safe water-closets, I here show a diagram of one of my patent "Carmichael" wash-down closets fitted up and its soil-pipe trapped and ventilated in a way in which I have executed the work at many places lately, especially for houses and schools. B is one of my disconnecting traps, as per Fig. 272A. In this case, instead of the fresh air coming in through a perforated iron grating right over the trap, said fresh air comes down inside the rain-water pipe, through the trap, and up the soil-pipe and out at the Induced-Current Fixed Ventilator, C, which causes the current of air to move through the pipes. This plan is very useful where the trap is quite close to a door, or where the open grating, as at a school, would be a temptation to the boys to be peering down

in a newer edition, which proves that the remarks of mine referred to at page 49 of said pamphlet, and at page 105 of newer edition, published elsewhere, were right after all. At page 487 of *Building News* for October 22nd, 1880, the Architect, Mr. Arthur Billing, admits the waste-pipes were *bent*, so as to serve the purpose of a siphon trap. See also page 63 of the *Plumber and Decorator* for April, 1881. Further, at pp. 376, 377, of the *Sanitary Record* for June 15th, 1877, Mr. Ernest Turner, F.R.I.B.A., gives an account of certain experiments made by him and also by me, in which the danger in practice of the above idea was clearly demonstrated; and now Mr. John P. Seddon, F.R.I.B.A., on pp. 831—832 of the *Building News* for June 30th, 1882, states that the attempt to do without the lead trap on the waste-pipe of his own bath had ended in failure, owing to the bad smell that came up the pipe.

through the holes, or dropping small stones or sticks

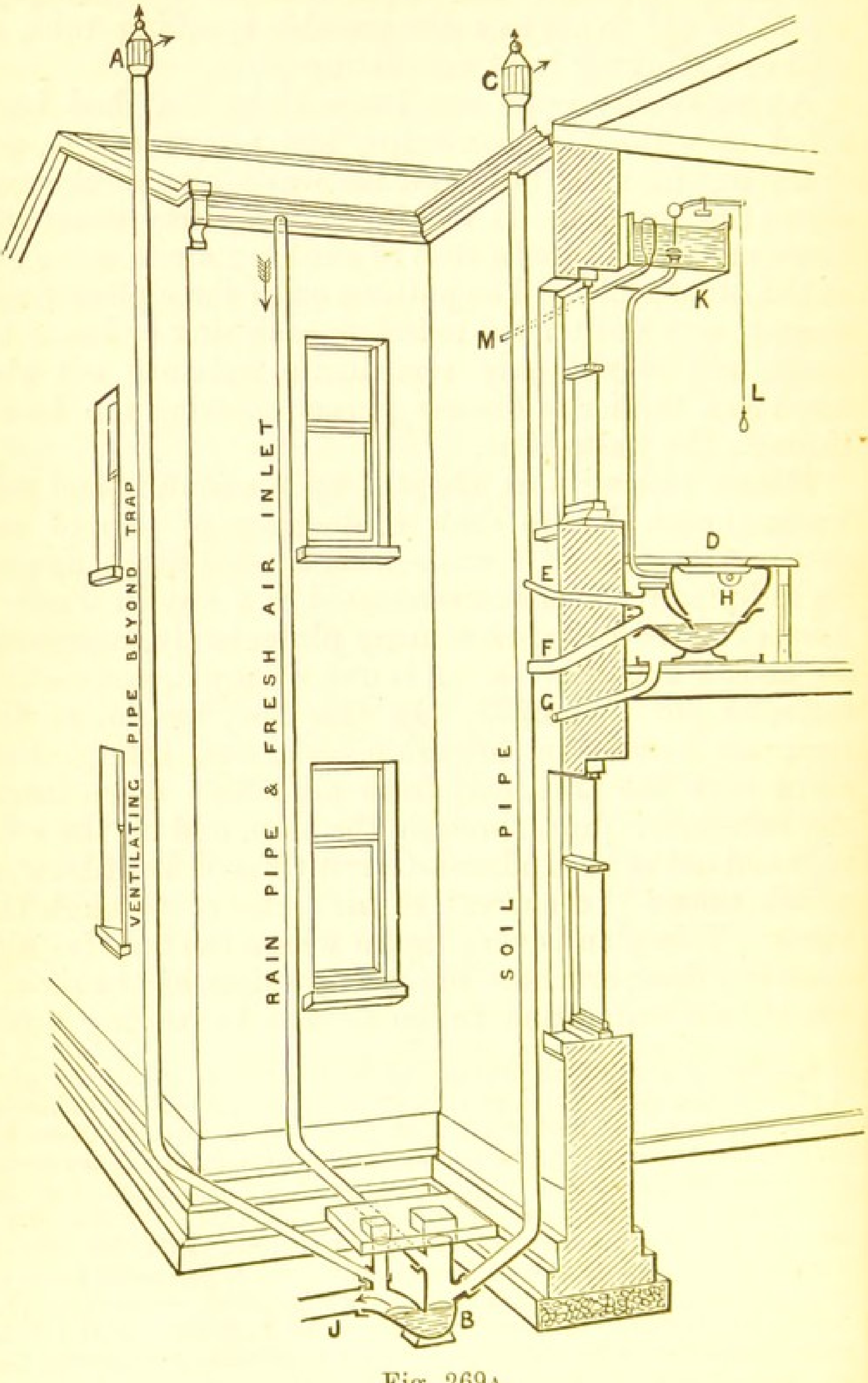



Fig. 269A.

into the trap through the apertures *to see the effect.*

Fig. 293 style of filling in the trap is sometimes used to guard against this latter trick. Fig. 293 belongs to the low level inlet and high level outlet style of ventilation, while Fig. 269A, which I am here describing, shows both inlet and outlet at a *high* level. The closet H here shown has no working parts about it to get out of order, while *the water in the trap* is above the floor and *in sight*. So there are no out-of-view dirt-collecting corners about it to stink. The water-flush is effected and the closet cleaned out by simply pulling down the handle or cord L, the water being supplied from the cistern K. Of course several closets may branch into this same soil-pipe, although I only show one here to illustrate the principle.

Where it is wished to ventilate the drain J beyond the trap, a special up-cast ventilating pipe may be put up and surmounted with one of my Induced-Current Fixed Ventilators A, as shown, *e.g.*, at D, Fig. 301.

I may here again condemn the dangerous unhygienic pseudo-water-saving policy of restricting the water-flush of a closet to only two gallons. Four gallons a flush would be more sensible. I am glad to find a number of practical sanitarians join in disapproving of this foolish curtailment of the water-supply for closets. There is a happy mean in everything, but the two-gallons flush is a long way below it, and the sooner the law is altered, wherever it is in force, upon this point so much the better for the proper working of closet and drains. In connection with this many *civil* engineers are very poor *sanitary* engineers.

## CHAPTER XXVIII.

### DISINFECTANTS FOR WATER-CLOSETS AND CLOTHING.

THE simplest disinfectant for general use is the atmosphere. Proper ventilation should therefore be seen to in connection with all water-closets and their sites. What I have termed the *oxygenous disinfectant* (which is supplied gratis by its universal dispenser Mr. Atmosphere upon proper application), has been already referred to in explaining the action of the two pipes, M and N, Fig. 264, the simple effect of the circulation of the air through the interior of the W.C. trunk constituting said pretty good, although so cheap, *oxygenous disinfectant.* When sickness is in a house, it is often desirable to supplement the action of the atmosphere, hence certain manufactured disinfectants, like medicines, require to be used. One that has been highly recommended is *chloralum.* It may be applied automatically by means of apparatus fitted in near the water-closet for that purpose. Mr. Jennings, of London, supplies an "Automatic Disinfector" for 42s., which, after it is fitted up, discharges so much chloralum into the pan each time the water-closet handle is pulled. Mr. John Baker, 5, Dover Terrace, Southsea, and Mr. C. Nicholas, plumber, Cheltenham, claim to have invented and patented apparatus for this purpose. The worst of these disinfectors is, that unless the supply of the disinfectant is kept up, which costs both money and time, the apparatus is then useless, people getting tired of the trouble, unless during the prevalence of fever either in or near the house. Instead of using these "Automatic Disinfectors," many persons content themselves with pouring the disinfectant down the closet by hand. The following extract from "Healthy Houses," by Mr. William Eassie, C.E.,* will be found both useful and interesting:—"The disinfectant used in a household ought certainly to be a non-poisonous one. Fortunately, or unfortunately, there is not any choice, for the only one of this description is chloralum, now adopted by the Board of Trade. This is the popular name bestowed upon it by its inventor, Professor Gamgee. It contains 1,500 grains of hydrated chloride of aluminum to the pint, or about 75 grains to the ounce, and is sold in a fluid and solid state. Slightly diluted, the former will disinfect secretions in the utensils of a sick-room; and exposed in a saucer in its concentrated form, I have found it to remove even the smell which is given off by a newly painted room. In its powdered state it may be sprinkled in cellars, larders, dust-bins, ash-pits, stables, piggeries, poultry houses, and wherever a smell is continually arising. In the deodorization of sewage, whilst being pumped over the garden, one gallon of the fluid, or three pounds of the powder, will suffice for 150 gallons of sewage."

As regards the disinfection of clothing in the laundry, Mrs. Meredith, the patroness of the Discharged Female Prisoners' Aid Society, lately wrote to the *Standard* newspaper as under:—

"The articles taken in for the wash are fairly sprinkled with chloralum powder; they are then packed in sacks, in which they remain for about two hours, when they arrive at the wash-house. They are then unpacked, and shaken singly. After this they are put in a large tank, where a great quantity of water flows over and through them. In this way they rest for at least twelve hours. They are then wrung out, and undergo the ordinary process of washing. It is highly

* Some years ago Mr. Eassie was engaged upon a new Dictionary of Sanitary appliances, which seemed likely to be a valuable contribution to sanitary literature. The articles appeared in the *Sanitary Record*, published at 15, Waterloo Place, London.

satisfactory to add that not the least deterioration of texture or colour results."

According to Dr. John Dougall, Glasgow, who has studied this subject closely, the best aerial disinfectant is the fumes of burning sulphur.* The use of carbolic acid is, however, condemned as illusory. As to sulphur, we find Homer, in the Odyssey, bk. xxii., saying of Ulysses, that—

> "With fire and sulphur, cure of noxious fumes,
> He purged the walls and blood-polluted rooms."

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In regard to the disinfection of wearing apparel, bed-clothes, &c., on a large scale in a city or town, Mr. Peter Fyfe, Sanitary Inspector for Glasgow, in a paper read before the Philosophical Society of Glasgow, in April, 1888, explained an improved method which he has introduced at the Belvidere Sanitary Washhouse for the purpose of destroying infected matter before the employees begin washing operations upon them. It consists in the use of a solution of bichloride of mercury in water of 1 in 10,000, with which the articles are thoroughly saturated for half an hour. In order to impregnate the clothing *at once* with the liquid, an hydraulic press and suitable bogies are employed.

Mr. Fyfe also referred to the use of steam-disinfectors, in which beds, bolsters, pillows, and all unwashable articles except carpets, are placed and subjected to the influence of steam at 7 lbs. pressure—giving a temperature of 234° F.—for an hour. The effect of steam at this pressure is shown to be better and quicker than that of hot air of much higher temperature. Dr. Koch proved that while four hours' exposure in hot air at 284° F. did not kill the spores of baccilli in the centre of a roll of flannel, the temperature having only risen there to 181° F., exposure for one and a half hours to steam at 248° F. raised the internal temperature to 242° F. and killed the spores. Steam, therefore, penetrates porous objects more rapidly and deeply than hot air.

* The disinfectant he uses for typhoid excreta is hydrochloric acid or "spirits of salts," diluted in twenty times its bulk of water.

## CHAPTER XXIX.

### Improved System of House Drainage.

Until lately the style of the fire-clay siphon-trap that was generally put upon house-drains is that shown in Fig. 270, but, as will be easily seen, while this provides for the locking off of the gas from the common sewer, no provision is made by it for the ventilation of the house-drain.* A slight but highly-important alteration, however, made in its shape, as per Fig. 271 (which shows perpendicular section, just as does Fig. 270), not only shuts off the gas from the common sewer, but also

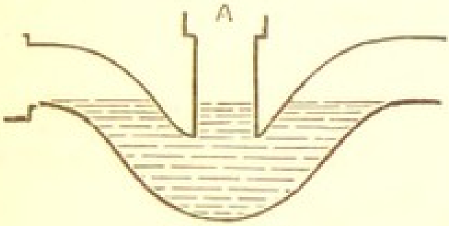


Fig. 270.

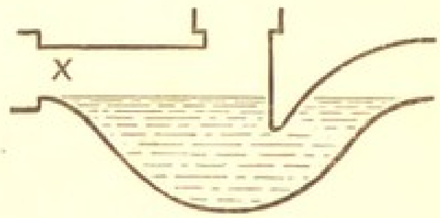


Fig. 271.

allows the drain leading down from the house to be ventilated.

One great objection, however, I make to the style of trap in Fig. 271 is that the surface of water exposed at x is far too great, while no provision is made to prevent the lodgment and accumulation of floating fæces, &c., at x. Another objection against Fig. 271 is that the water cannot be seen coming into the trap. On these points Fig. 271 is no worse than many other traps; that is no reason, however, why these faults should continue to exist. Upon thinking over the matter, therefore, a new form of

* Neither is any provision made for cleansing the *house side* of the trap, as the cleansing eye, A, only provides for clearing out the fæces and sediment which accumulate in the *middle* of the trap. In fact this Fig. 270 style of trap is a very dirty and unsanitary appliance.

siphon-trap came into my mind, and as it not only removed all the above objections, but was also quite simple, and capable of being easily adapted to existing

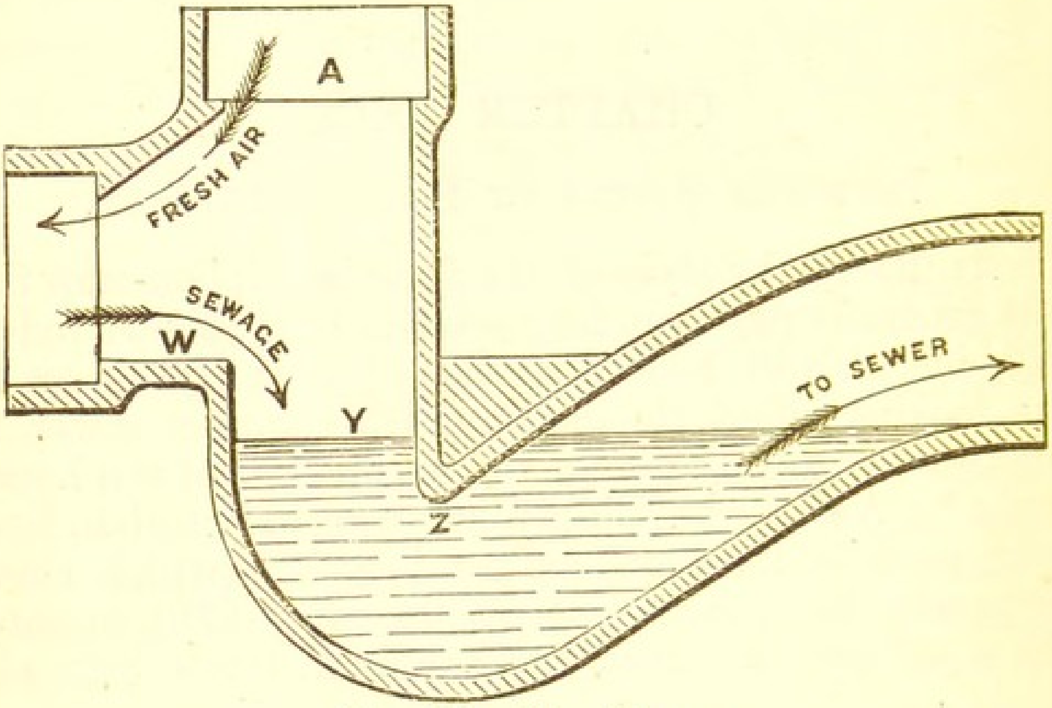


Fig. 272. No. 1 Trap.

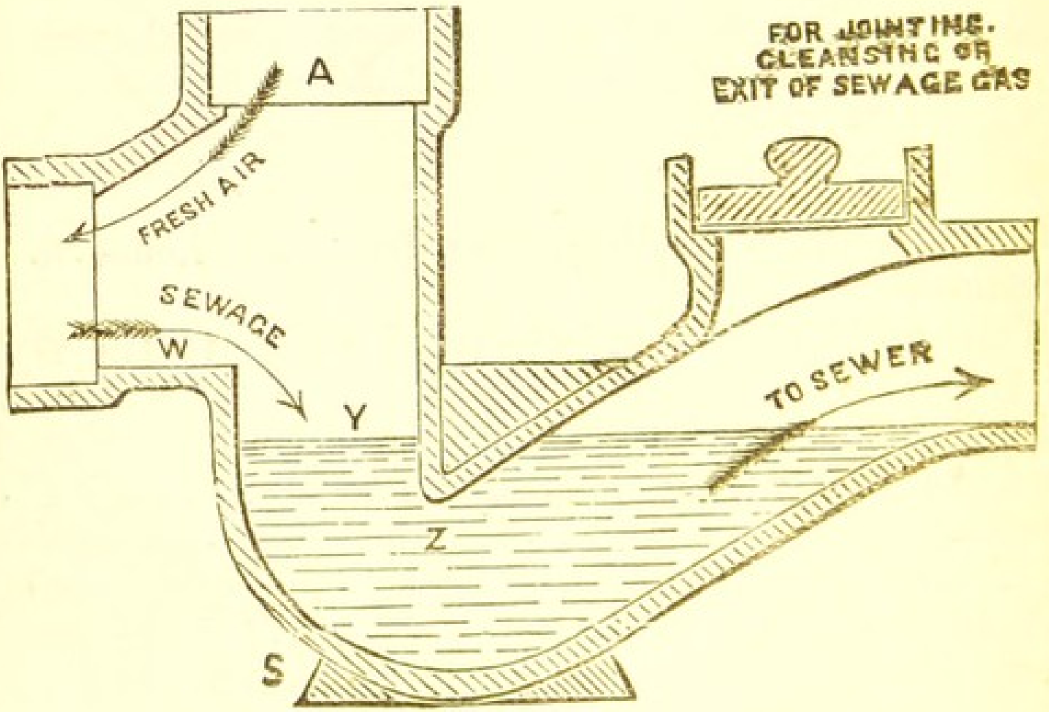


Fig 272A. No. 2. Trap.

drains, and to many various purposes in connection with house-drainage in general, I, in April, 1875, applied for Letters Patent for it, and made arrangements with Messrs. J. & M. Craig, Kilmarnock, Scotland, for its manufacture,* and its wide and increasing popularity shows that it supplied a public want; it combines simplicity and cheapness with thorough efficiency and ready adaptability in a manner that is not found in any other trap.† This is partly due to the "cascade-action," as Professor James Thomson, of the University of Glasgow, termed it, of the water when flowing into the well Y of the trap, and to its simple siphon form.

Figs. 272 and 272A show vertical sections of Nos. 1 and 2 forms of this new patent disconnecting ventilating siphon-trap. They can be had with seat.

In the 6-in. size, which is very suitable for either single water-closets or the main drain of small houses or single tenements, the surface of water exposed at Y, Fig. 272, is under one-fifth of a square foot. Owing to this and the drop of 2 in. or so which the water gets in falling from the drain branch, W, into the well of the trap at Y, the objections made above against Fig. 271 are removed in Fig. 272, and instead of the flow-down of the water merely running away underneath the floating fæces as at X, Fig. 271, the fall of the water at Y, Fig. 272, breaks up and carries away the fæces, &c., thus leaving comparatively pure water always at Y, Fig. 272, in place of the usual accumulations of filth. In setting these traps the best plan is to fill them with water, which shows the exact amount of both the drop and water-lock.‡ *The No. 2 form is the better one to use.*

* They have agents and depôts in many cities and towns.

† Both Mr. Baldwin Latham, C.E., and Mr. John Honeyman, F.R.I.B.A., approve of the vertical drop; the latter wrote me that he considered it a distinct improvement upon his own "Somerset" trap, and that he would use my trap in preference. Drain-traps with round edges are not so self-cleansing as this with the sharp edge at W. I always use the No. 2 style, as with it the workman need not leave cement sticking up at the outer joint as with No. 1. Partly for this reason Messrs. Craig intend reducing price of No. 2 trap to the same as No. 1, so as to give no excuse for using No. 1.

‡ At the Philosophical Society's Exhibition, Glasgow, 1880, the only first class award with medal granted in the Sanitary Section to any exhibit in fire-clay was awarded to this trap; while at the International Medical and Sanitary Exhibition, London, 1881, it received two first class awards; and at the London "Healtheries," in 1884, it got the gold medal; at Edinburgh, in 1886, it got the silver medal.

The amount of water-lock or dip of the tongue z, Fig. 272, into the water is to be about or fully $1\frac{1}{2}$ in.: more is unnecessary and does more harm than good. Dr. Fergus agreed with me upon this point. In the case of the lead siphon-traps, especially for basins and baths *inside* the house, I recommended a greater water-lock, but the circumstances are quite different.

At page 70 of "Reports of the Medical Officer of the Privy Council and Local Government Board," New Series, No. VII. A.D. 1876, Dr. George Buchanan, in his report upon the outbreak of enteric fever at Croydon, recommends the use of a trap upon a similar principle to mine to be placed between the house and the sewer; while Mr. Baldwin Latham, at page 408 of the new 1878 edition of his elaborate work on "Sanitary Engineering," after describing the recent Model By-Laws issued by the Local Government Board in reference to House Drainage, says:—"This is, in fact, the system patented in April, 1875, by Mr. W. P. Buchan," &c. The portion of my patent which agrees with the Model By-Laws is Fig. 5B, but Fig. 5A (see Fig. 264) of said patent, where it can be applied, and I have often done it in conjunction with Fig. 5B, is better. Fig. 273, with the soil-pipe going up outside of the wall, shows the plan ordered in the Model By-Laws, while Fig. 264 agrees with clause 15, page 9, of the "Suggestions" as to drainage, &c., drawn up by Mr. Rawlinson, C.B., C.E., for the Local Government Board, and published at the end of 1878.

I have said that the surface of the water exposed at Y, Fig. 272, is, for the 6-in. trap, under one-fifth of a square foot. This amount for that size, however, is equal to the full area of the pipe. For sizes say at 9 in. and upwards, I think the surface of the water exposed at Y, Fig. 272, might sometimes be less than the full area of the pipe. This will be arrived at by contracting the well on something the same principle that the key-hole of a stop-cock or water-valve is contracted. Fig. 274 gives an idea of a 9-in. trap so contracted at the well, the diameter being about 7 in. at the surface of the water in place of 9 in. Whether therefore the area of the water in the well of my trap be less than the area of the drain-pipe, or just the same, as is generally the case, it will be at once seen that the principle involved in the construction and practical operation of said trap is quite different from the siphon-traps used so much hitherto in England, where the area of the surface of water exposed in the trap will be about six times the area of the pipe. This is absurd, as its effect is to allow a larger evaporating surface for foul air, while the rush of water into the trap is unable to keep it clean. Fig. 150, page 488 of Mr. Latham's "Sanitary Engineering," happens to show such a form of trap, but unless where serving as a sort of sand-pot outside it should not be used. It ought not to be placed inside a house. At H, Fig. 274, a movable lead frost-protecting disc is shown suspended by four brass chains made of tinned brass wire. These chains hang from the wire grating. I do not suppose half-a-dozen of these discs have been used, and although many thousands of these traps are now on drains, I did not hear of even one freezing during the prolonged frost of 1878-79, nor since.

By the insertion, therefore, of such a simple yet efficient style of ventilating trap as Fig. 272 or Fig. 272A, which is better (Fig. 273 shows one mode of application), the foul gas from the sewer is not only kept back as formerly, but also, *in addition,* the inner side of the siphon-trap at W, in conjunction with the opening at A, serves as a ventilator for the house-drain, preventing that accumulation and concentration of drain-gas, the horrid smell from which I have so often felt proceeding from an opening newly made into that portion of the house-drain just behind the old form of siphon-trap. It follows, therefore, that supposing the drain inside of the house to be leaking, the fresh air coming in through A, Fig. 273, dilutes any bad gas in the drain greatly, and makes it less dangerous. Greater safety to the inmates is, however, derived from the use of the Sectional System of drainage, where a special shaft is put up to ventilate the drain,

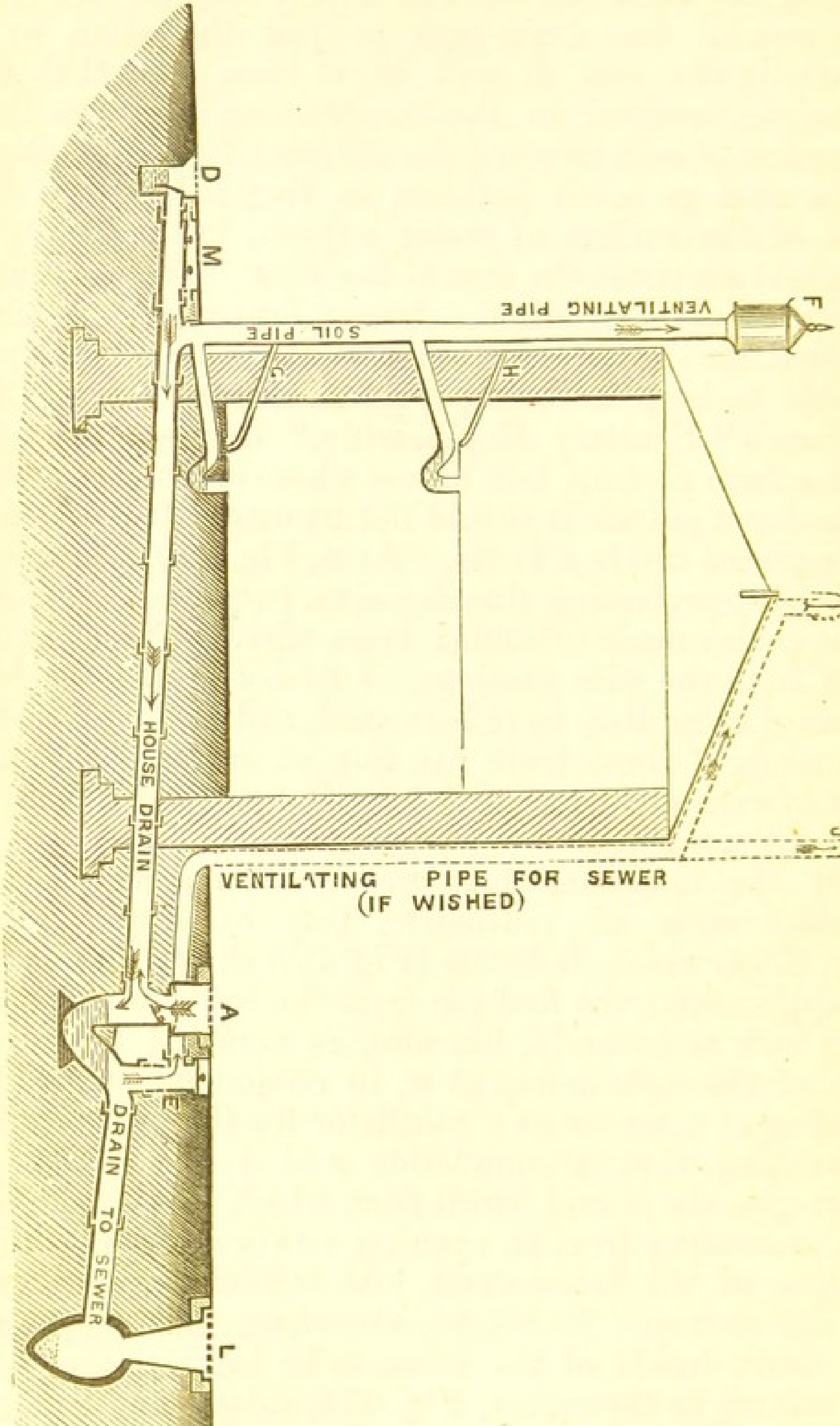


Fig. 273.

and the soil-pipe trapped off from the drain at the bottom and ventilated *per se*. I explain this elsewhere.*

In cases where there is danger of a pressure of sewer-gas forcing itself past the dip or tongue of the siphon-trap, or where it is wished to ventilate the sewer, this may be guarded against, or accomplished, by either putting in a ventilating iron pipe up from, or leading one of the rain-water pipes of sufficient size down to E, Fig. 273.† In many cases the pure ventilating-pipe would be the proper thing to put in, as during rain the action of the rain-water pipe, as a ventilator for the *sewer*, would be interfered with, while the mouth of the rain-water pipe might often be badly situated for the sewer gas blowing into the garret under the slates. The top of this pipe, E, Fig. 273, ought always to be grated, to prevent any rats getting out. Sewer rats can climb up a 3-in. pipe to a great height. With iron gratings in the *middle* of the street above the sewer, the fresh air might enter down through these gratings and the diluted foul air come out *above the roof* at C, Fig. 273, where the oxygen of the atmosphere would deodorize it. I designate this the high-level system of outlets for sewer air in contradistinction to the low-level system, which, by using the gratings in the streets both as inlets and outlets, allows the sewer air to blow off under our noses, and what is worse our mouths, in place of high above our heads. Gratings for sewers should be in the middle of the street, and at the centre of crossings, never in the line of or close to the footpath or pavement, as often very badly put in.‡

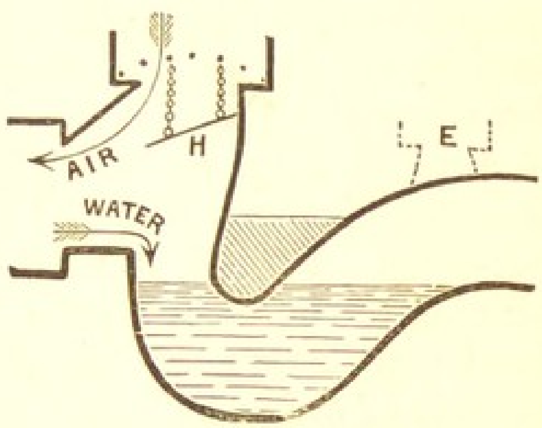


Fig. 274.

* As, *e.g.*, in Figs. 277, 281, and 301.

† See Fig. 283 for the proper way to connect the ventilating-pipe for sewer beyond the trap, viz., up pipe D and along the side pipe H.

‡ Disinfecting the sewage air by means of gas burning in the outlet shaft may sometimes be useful in ventilating sewers and hospital drains, but burning gas means expense and requires attention.

The proper position of the siphon-trap A, Fig. 273, where there is sufficient open space, would be from 8 ft. to 12 ft. out—as found most suitable—from the house, so as to give full and free scope to the admission of the *fresh air* (in various cases the grating is only 1 ft. from the house, yet the traps work satisfactorily, especially when not right opposite and close to a door),* which entering down through the two perforated gratings at A, proceeds along the drain, carrying any foul air in the drain along with it, up through the soil-pipe and out above the roof at F. When the soil-pipe goes up outside of the wall, it is of considerable advantage to the ventilation and the insuring of a constant current of air up through the pipe, to place one of my 4-in. Induced-Current Fixed Ventilators upon the top of the soil-pipe. I tried the Archimedian screw ventilators† for this purpose, but have given them up, as I find the fixed ventilators act much better, and are not liable to get out of order as they have no moving parts. I have found the foregoing 4-in. fixed ventilators (9 in. dia. in body) draw up at the rate of about one thousand lineal feet per minute during a high wind, while even when there was little wind I have found a good current of air immediately set in through the drain or pipe when the ventilator was put on, where without it there was no movement of air through the pipe.

For greater safety so far as the health of the inmates is concerned, the sewer ventilating-pipe when put in should always go up the *outside* of the house. It should be of iron, so that rats could not eat it, and their passage up it from the sewer must be guarded against.

* In cases where the ventilating-trap had to be put in quite close to and in front of the door, I have put an iron close lid immediately above the trap, and put in a branch at the side with pipe led to a convenient distance back from the door where the fresh air entrance grating was placed, see Fig. 293. Sometimes a rain pipe, as at Fig. 269A, may act as the fresh air inlet.

† I do not consider the Archimedian screw ventilator a proper appliance for soil-pipes at all, as when it is moving the screw blades prevent the quick admission of air to the soil-pipe when a closet is discharged, and when not moving, in calm weather, the screw blades choke up the pipe. Some again make a very disagreeable noise when revolving.

In gentlemen's houses which have a sunk area at the front of the house, said area is often a good site for a ventilating fire-clay siphon-trap. I have, however, fitted them in all sorts of positions with the most satisfactory results. In cases where they have supplanted the old built cesspools the improvement has been most marked. Some of the very first alterations in this way were done at the instance of Dr. Andrew Fergus of Glasgow, *e.g.*, at one place where there was a large built cesspool at the place before, the smell that arose and lasted for a long time after the cover was removed was very bad. A portion of this smell got into the house through the rat-holes. The cesspool was emptied and disinfected with Condy's fluid and afterwards filled up, while the rat-holes were built up with Roman cement and broken bottles.

Why so many of these sewage gas retorts have been set down within a few feet of the front of many of our best west-end houses I cannot understand, as with the help of the rats they are bound to manufacture head-aches, fevers, &c., for the inmates, more or less, according as the circumstances happen to be favourable. If there were large gardens attached to the houses, and these sewage tanks put in at the bottom of the gardens, to save and utilise sewage, then one might see some object to be gained, but there is nothing of that in the cases referred to.

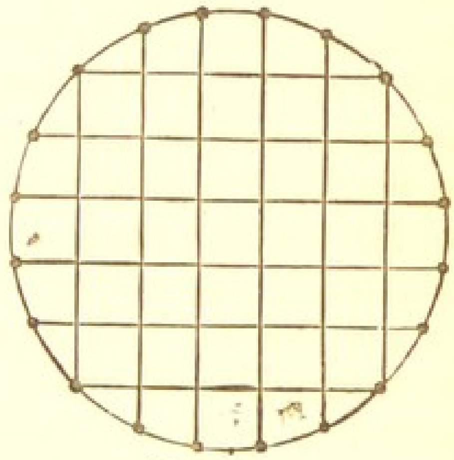

Fig. 275.

I have said that at A, Fig. 273, there are two gratings, the under one—which may be made of iron, or brass wire tinned—is put in to prevent stones or rats getting into the drain if the topmost grating were off. Another use of the under grating, Fig. 275, is to serve as a support for charcoal, should it be wished to turn the ventilating-trap into a deodorizing ventilating-trap. I prefer, however, to dispense with the charcoal in this case, as it stops the draught, and I have considerable faith in the virtues of a good draught of fresh air *when judiciously applied.*

In regard to the question:—And what about the frost? I would mention in reply, that so far as I am aware no particular provision is made to keep off the frost from the water in any other ventilating-trap, reliance being put upon the trap being buried so far in the ground. In the case of A, Fig. 273, however, extra protection is gained from the frost owing to the fact of the surface of the water in the trap being 2 in. or so lower than the bottom of the drain. And in addition a disc made of 5 lb. sheet-lead or other metal may be suspended by three or four short chains made of tinned brass wire, the insertion of which disc prevents the downward draught of cold air from touching the water in the trap.* At the residence of Dr. W. T. Gairdner (Professor of the Practice of Physic in the University of Glasgow) three of these new ventilating traps were put in in 1875, viz., two 6-in. (one of these 6-in. was for the w.c. off his study, to lock it off from the other drains, as shown in Fig. 264), and one 9-in., and a lead disc put inside each, as shown in the trap at H, Fig. 274. At 24, St. Vincent Crescent, the residence of Mr. Kenneth M. Macleod, Sanitary Inspector for Glasgow, one of these new traps, a 9-in. one, was put in on the main drain leading out to the street, the perforated iron grating or ventilating opening being near the outer edge of the pavement and level with its surface. Various theorists prophesied that the thing would never work, as the bad smell, so they said, would come out at the surface grating. It so happens, however, that no complaint has yet been made upon that score, although the trap has been in some years. Nay, more, at the meeting of the Sanitary and Social Economy section of the Philosophical Society of Glasgow, on 6th March, 1876, Mr. Macleod stated that

* Seventy thousand of these improved traps have now been put in, and not half a dozen have discs, yet I have heard of no case of freezing. Generally speaking, a smaller trap than 9 in.—viz. 6 in.—is best for an ordinary house.

what had been done to his water-closet and the drain had not only cured his own house but also benefited the whole tenement.

These theorists seemed not to be aware that the house-drain is a furnace on a small scale, with the soil-pipe as its shaft, which shaft has also its own little fires so far up it. When therefore a ventilating-trap or opening is put in, as at A, Fig. 273, a draught up the ventilating-pipe of the soil-pipe is caused by the weight of the fresh air above the grating A, Fig. 273, being greater than that of the foul gas or warm air within the drain and soil-pipe.* I lately noticed a proposition that the upward draught of the air in the soil-pipe would be improved by side air-openings, but that is a mistake, although such when properly put in may help to freshen the soil-pipe. At the West of Scotland Home for Incurables, Broomhill, Kirkintilloch, where, in A D. 1875, two 9-in. traps were put on about forty feet back from the house, I adopted a different style from those above mentioned, putting a close iron hinged cover directly above the eye of each trap merely for cleansing; then, for ventilation, the first pipe put in on the inner side of the trap had a square eye in it, which was set to look right up, and it did duty as the ventilating opening. The distance between the centre of the square grating and the centre of the iron hinged cover would be about one foot six inches. This style was more expensive than that at A, Fig. 273; but the place would be much exposed in winter, and as the number of inmates would be great it was wished to run no risk.

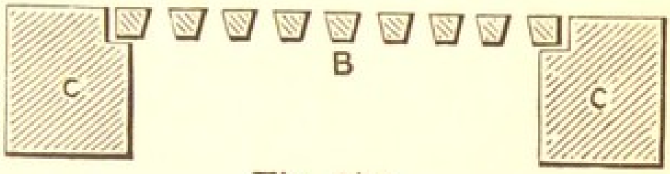

Fig. 276.

Fig. 276 is an enlarged perpendicular section of the upper iron grating shown at A, Fig. 273. The same style, but 8 in. square, may be used at C, Fig. 264. B, Fig. 276, is the iron grating, in this case 10 in.

* Especially when the pipes are inside of the house; but when the soil-pipe is put up outside of the house it is of advantage to place an Induced Current Fixed Ventilator upon it—size to suit situation, &c.

square and perforated with 64 round holes ⅝ in. in diameter, but, when wished, the size may be 12 in. square with 100 holes, or 18 in. square with 196 holes. For 4-in. traps, 8 in. square will do. C C is a block of Arbroath pavement or of good firm freestone,* from 5 in. to 7 in. broader than the grating all round, and into which the grating is neatly fitted as shown. The iron grating B, Fig. 276, is fully ½ in. thick. D, Fig. 273, is the surface grating for the water off the back court. A small *trapped* fire-clay or cast-iron cesspool is shown below it, to prevent the sand getting into the drain. No air is to be allowed to enter at D. In Fig. 273, which gives perpendicular section, the house drain is shown as running right through the house; this is a very common style in buildings erected in cities, where the houses or buildings are packed close together, with only the gables intervening. It is not a plan to be recommended, however. If the sewer were in the lane at the back of the houses it would be better, as then, all the sanitary fittings being at the back of the house, no drain with foul gas in it need go through the house, but only a drain-pipe or conductor for the rain water, which could easily be locked off from the soil-pipe drains by means of a ventilating trap. In country or suburban residences, however, where the houses are more isolated, the drain in many cases does not require to be led into the interior of the house. The annexed rough sketch (Fig. 277) of the ground-plan of Shaftesbury Lodge, Wemyss Bay, the residence of Mr. John P. Paton, will give an idea of how the house was locked off, or disconnected, so far as the passage back of sewage gas into it was concerned, not only from the main drain or sewer, but also from its own private drains. I had nothing to do with the original work, being called in (in February, 1876) owing to bad smells being complained of. The large main

* The masons charged so high for these that I got patent fire-clay blocks made at half the cost, of which a great many are used. Lately, now, for grass, earth, cement or asphalte, and for neatness, I mostly use my cast-iron frames for the gratings or plates. See page 251.

drain is an old square-built drain running through the

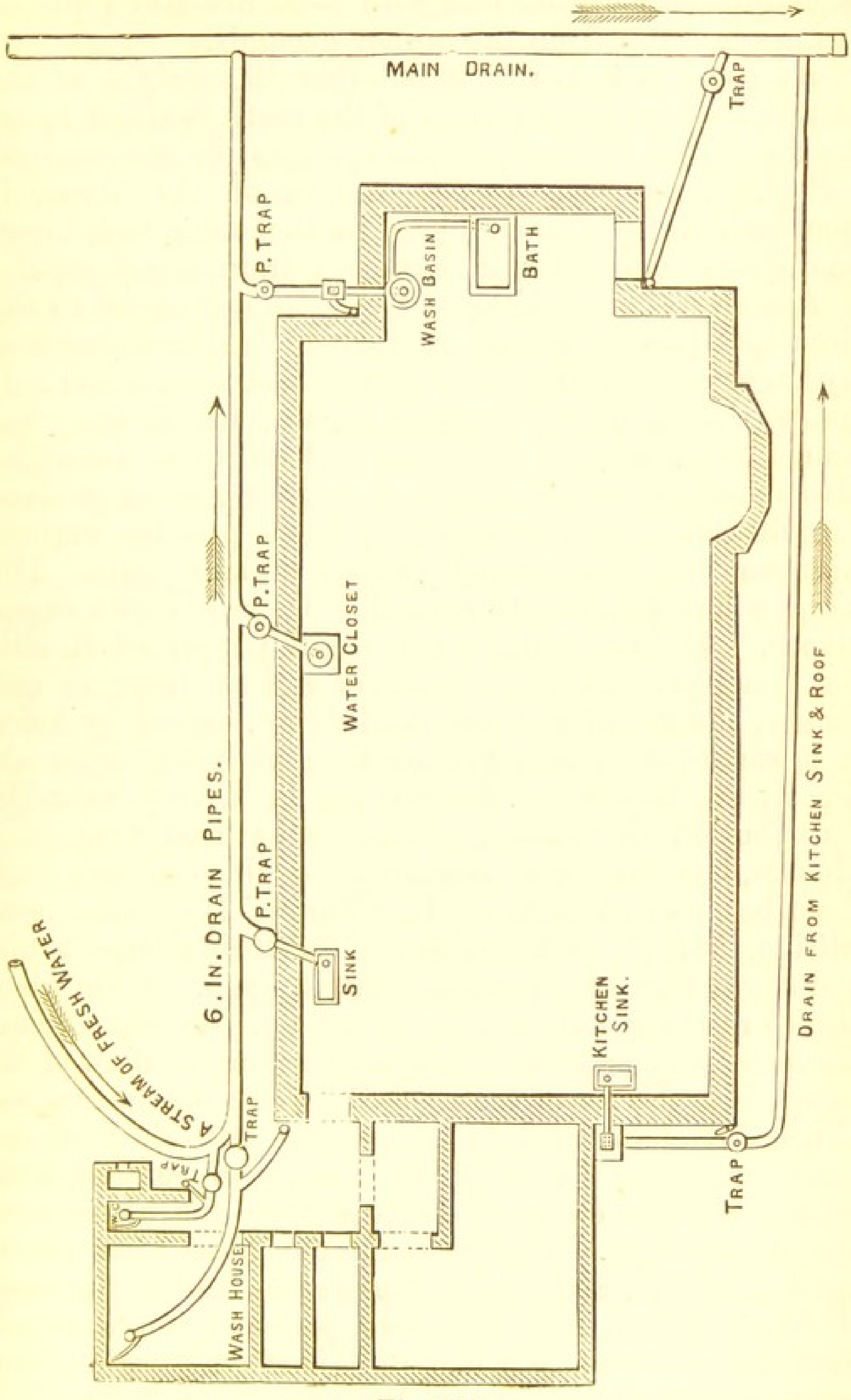


Fig. 277.

grounds: the branches off are fire-clay pipes. The idea of leading in the fresh water is the gentleman's own, a long distance being laid with 6-in. fire-clay pipes to bring the water from the higher grounds.

At page 174 it was stated that the weight of the atmosphere near the surface of the earth is about $1\frac{1}{4}$ oz. to the cubic foot. The sewage gas in the vertical soil-pipes, especially in the interior of the house, is generally lighter, about $1\frac{1}{5}$ oz. to the cubic foot, hence the upward current in a ventilated drain or soil-pipe.

According to Dr. Fergus, "the gases given off by the decomposition of sewage are carbonic acid, carboretted hydrogen, sulphuretted hydrogen, and ammonium sulphide, and a putrid organic vapour, which is carbo-ammoniacal, giving rise in all probability to the offensive smell, and possibly also an active agent in producing disease." That sewage gas can produce various diseases has been amply proved of late years. Dr. Fergus has referred to several cases in his own experience. Dr. J. B. Russell, Medical Officer of Health for Glasgow, had seven cases of enteric fever in one family, the father and one child dying, caused by holes in a waste-pipe which was too long of being repaired. Dr. J. A. Russell of Edinburgh, in a very valuable contribution to Sanitary literature, entitled "Sanitary Houses," refers very pointedly to this subject, and describes its evil effects. In "Parkes' Hygiene," new edition, 1878,* the bad effects of breathing impure air and sewage gases are largely dwelt upon. I am glad also to read the following words at pp. 145-46. "The products of gas combustion should never be allowed to escape into the air of the room." From my own experience I feel inclined to assert that bad air with its accompaniments has often acted as a slow poisoner and been at the root of many diseases, when the blame was placed elsewhere. It poisons the blood, has a bad effect upon the heart, and lowers the system, and in the case of invalids and fever-stricken patients, the want of fresh air—especially when life is trembling in the balance—has sent thousands to a premature grave.

* Edited by Professor F. de Chaumont, M.D., F.R.S.

In large cities the best and purest air is at night—when, too, we need it most—yet how absurdly do people act! Doors and windows are closed and gas is burned, the foul air thereby produced rising from the lower to the higher flats, and so it is allowed to accumulate, and the inmates breathe it for hours after going to bed.*

If fresh air is let into a house, &c., in such a way that the current or currents do not strike the occupants, then a large amount of air may be let in.† Sitting in a direct line between a window and a fire is dangerous for many people; while colds, lung disease, and even death may often all be prevented by simply breathing through the nose instead of through the mouth, especially when passing quickly from a heated to a cold atmosphere. Disease germs may also be thereby kept out of the stomach.‡

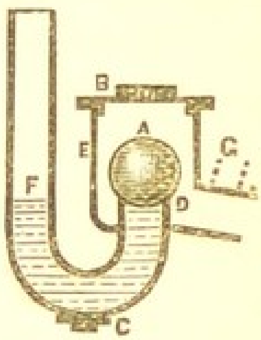

Fig. 278.

Fig. 278 shows vertical section of a new form of siphon trap, lately patented by me, for use where extra safety against the passage into the house of sewage gas *through the trap* is desired. It may be used for various purposes, but especially for basins or baths, &c., in or near bedrooms and dressing-rooms. A is a ball (or it may be a half-ball with guide-pin) of india-rubber, wood, or other substance, resting upon the outlet end of the trap. When water is let off down the

* Should electric lighting supersede coal gas in houses, the air of lighted rooms may be as pure by night as by day. See page 274.

† At Glasgow, when the wind is in a particular north-east direction, the fumes from the chemical and other works pollute the air westwards very badly. This was especially the case in May and June, 1879, and now in May, 1882. A revival of the old curfew bell regulations may yet be found useful for cities.

‡ I observe Dr. Fergus lately stating that "ozone is not to be found in the centre of towns." I am not aware, however, if experiments have been made to show whether or not it may exist in the centre of towns between 2 A.M. and 4.30 A.M. I should like to hear of such. Dr. Day says that ozone passed through putrescent blood changes it as if by magic.—*Sanitary Record*, October 11th, 1878, p. 237. But how about difficulty to cure diphtheria? Is the prevention of or non-encouragement to proper experimentation to blame for this?

side F of the trap, it rushes through the trap, and pushing the ball A up, runs off by the outlet D, and upon the water ceasing to run off, the ball A falls back into its seat and prevents any bad air in the waste-pipe from getting access to the water in the trap, let alone passing through it; and should anything happen to the trap, as in frost, &c., to cause the water in the trap to run off, still the ball-valve A is left to do duty in keeping back any bad air that might be in the waste-pipe from blowing into the house. C is a cleansing screw; B is a trap screw for getting access to the ball; G is an air or ventilating-pipe. When wished the air-pipe may be led from off the top of B. In order to test what difference of effect if any was produced by placing the ball at the outside of the water, as in Fig. 278, or in the middle of the water as in the Bower patent trap, Fig. 279, I sent one of each to Dr. Wallace, City Analyst, Glasgow, to experiment with as to the passage of gases through them, and the following is his report:—

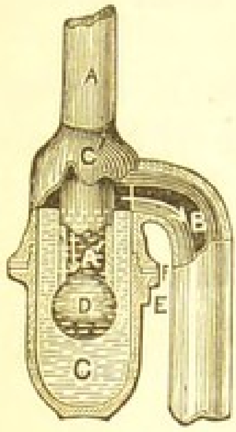

Fig. 279.

"City Analyst's Laboratory,
138, Bath Street,
"GLASGOW, *13th March*, 1879.

"MR. W. P. BUCHAN,

"DEAR SIR,—In accordance with your request I have made a series of experiments with your patent trap, and now beg to state the results obtained. I first tried the trap without the valve, and found that the gases passed through the water so that they could be detected by appropriate tests at the other side in the following times:—

Ammonia in 1 hour 30 minutes.
Sulphuretted Hydrogen in 20 minutes.
Chlorine in 10 minutes.

These observations amply confirm the statement of

Dr. Fergus that soluble gases pass freely through the water of an ordinary trap.*

"I next tried the apparatus with the valve placed in position, and in no case could any of the gases be detected in 20 hours. The effect of the valve, therefore, is to arrest completely the passage of gases through the trap.†

"I have also made a series of experiments with the Bower's patent trap which you sent me, and have found, much to my surprise, that it does not arrest the passage of soluble gases, all of those I tried being found at the opposite side within half an hour. The principle of the trap appears to be correct, and I expected that it would have acted efficiently.

"Yours truly,
"W. WALLACE."

I was not astonished at this result myself, as I considered it was a mistake to allow the gases to get free access to and so saturate the water in the trap. As the bottom part, C, of the Bower trap is made of glass, I wished to see how it would stand hot water, and caused

* In reference to Dr. Fergus's experiments in December, 1873, Dr. Wallace remarked then that the experiments were satisfactory as regards soluble gases such as those employed by Dr. Fergus, but gave it as his opinion that it was by no means proved that the germs of disease, or sewage gases in appreciable quantity, would pass through water in a trap. His own impression was that they would not, especially if the trap were efficiently ventilated. My own opinion expressed also at the time was in favour of the real value of water in a properly sealed trap, and especially if aided by ventilation of the outer side of the trap. In the last edition of his "Sanitary Engineering," Mr. Baldwin Latham says:—"When no displacement of the water in the trap takes place it is a good security against sewage gas." In connection with this a distinction must be drawn between water in a siphon trap and water in a large cesspool. The grease box or cesspool in connection with some scullery sinks, *e.g.*, throws off a most offensive smell, especially if the water is disturbed, quite independently of any gases diffused through the water. The value of Dr. Fergus's experiments and statements regarding danger from sewage gases, consists in his having been able to draw public attention to the liability of disease arising where sewage gases got free access into inhabited houses, &c., through corroded holes or leaking joints, &c., of water-closet soil-pipes.

† This "valve" was a *half* ball with a spindle.

one of my men to pour cold water into it first, then leaving said cold water in the trap, hot water was poured down from the top, A, when the bottom cracked and fell away, and the water falling out, nothing was left to keep the ball valve, D, in position, and so the trap was useless. I therefore feel justified in saying that instead of this, Fig. 279, trap being "the only

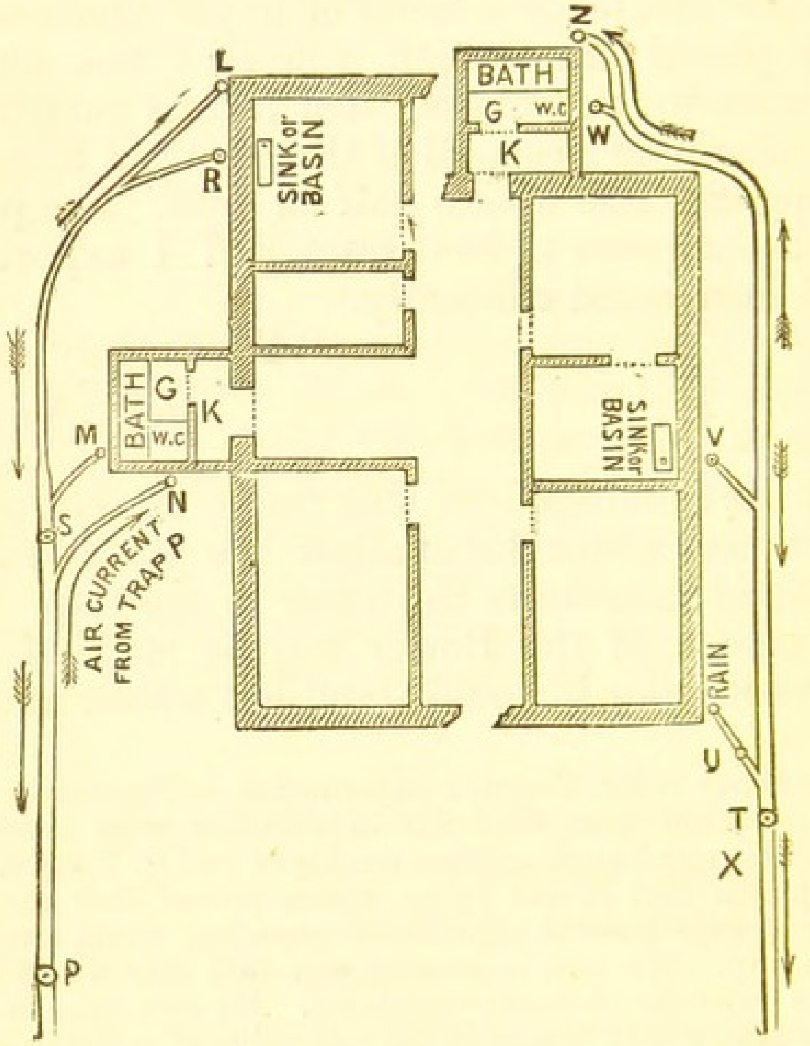


Fig. 280.
Ground Plan.

Fig. 281.
Ground Plan.

perfect trap," it is somewhat imperfect. The title "perfect" is a dangerous term to apply to sanitary fittings in this sublunary sphere; more than one appliance having come to grief to which it was attached.*

I may now proceed to explain what I have termed the Sectional or Detached System of House Drainage,

* A valve trap will do no good for a holed pipe beyond the trap.

to which reference was made some pages back. Figs. 280, 281, and 282 show plans of locking off, not only the sewer gas, but also the drain and soil-pipe gas, and other water-closet smells from the house. In this case *extra* precaution exists by having the water-closets erected in a special wing, say at the back of the house, and in the spaces marked G G. A covered or enclosed passage, with a door and window (or windows—one on each side), intervenes between the body of the house and the water-closets as shown at K K. While due provision is made for *necessary* ventilation of the passage or lobby K K, the inmates must, at the same time, be protected from cold, hence I object to the lobby K K being quite open or exposed to the weather. The joists of this lobby ought to be laid across it, and not with their ends to the wall of the main building, in order to prevent gases or impure air passing between the joists to main building. In cases where this extra precaution cannot be had owing to the house being already built, some such *arrangement of the pipes as shown above ought at all events to be adopted.* A, Fig. 282—or W, Fig. 281—is the patent 6-inch Fire-Clay Disconnecting Siphon-Trap, which locks off the drain and sewer gas, and at the same time allows a continuous current of fresh air to blow through the soil-pipe. It has also a peculiar drop, giving the cascade-like action specially recommended by Dr. George Buchanan of the Local Government Board. It is due to Dr. Fergus to state that the importance of making the water *fall* over a *sharp* edge—a special feature in my trap when patenting it in April, 1875—was firmly impressed upon my mind by a remark made by him bearing against the drain traps hitherto in use, in which the water was allowed to *glide* quietly into the trap and so leave the fæces stagnating for a long time on the surface. When beginning to manufacture the trap, Dr. Fergus particularly approved of only a slight or shallow dip being given to the "tongue" or dipping air-barrier. Some use revolving cowls upon the top of the soil-pipe to assist the up-current. In my own practice I prefer the fixed ventilator, B. C is a ventilator for ventilating the enclosure in which the water-closet is situated. The erection of this has given great satisfaction where done, and where considered necessary a fresh-air inlet may be made in the floor, or where most suitable. D, Fig. 282, shows position of one of my No. 2 Fixed Exhaust Ventilators upon the ridge of the house. It

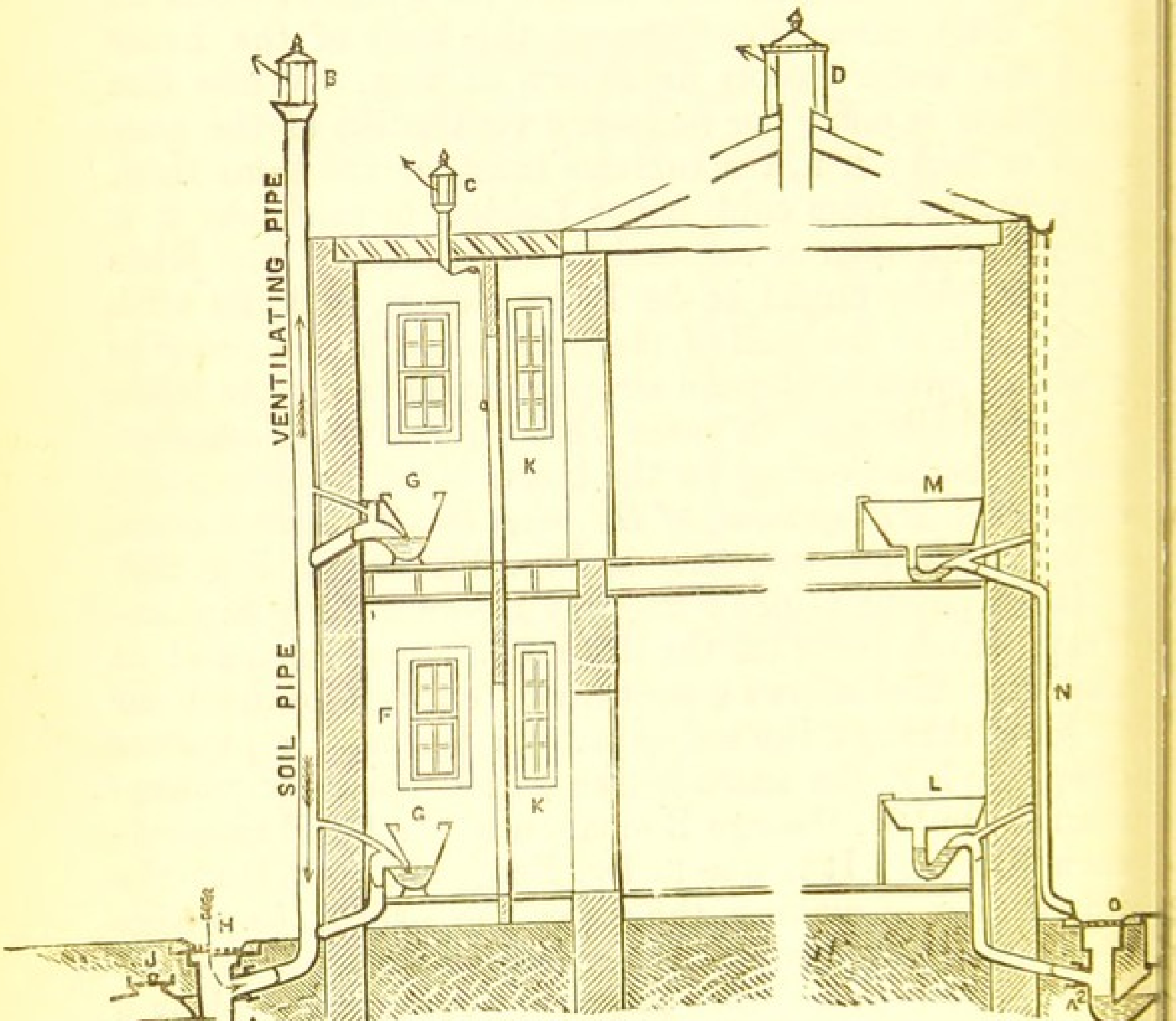


Fig. 282.—Elevation.

may ventilate the staircase. G G show different styles of the "Carmichael" Wash-down Closets, erected in special apartments projecting beyond the house, and with an intervening lobby. The house is supposed to have no drains inside of its outer walls. The branch air-pipe from the top of the out-go of the trap is shown branched directly into the soil-pipe for the lower closet as well as for the upper one; but in many cases it is better to carry up, say, a 2-inch lead pipe from the lower closet trap up past the upper closet and then branch it into soil-pipe as here shown in Fig. 282A, and also shown in Fig. 301, or else carry the ventilating pipe up through the roof by itself on the principle shown at A, Fig. 159. This, Fig. 282A, style of connecting the air-pipe has been in use in Glasgow, especially where the soil-pipe was inside and of iron, for sixteen or more years back. I show it in illustration, Fig. 69, of my patent of July 9th, 1878, but I was rather astonished to read some time ago of a person in the United States trying to patent it at the end of 1878 as a new idea of his own, his claim causing some sensation and annoyance there. An attempt was afterwards made to patent it in this country, but it was money wasted, I suppose, as I have never as yet heard any attempt to claim it here. Possibly the patentee, seeing it illustrated in my patent and published elsewhere long before his time, saw there was no use to try to claim it. Other ventilating-traps are put on at the foot of the other pipes, as at A², Fig. 282, and U and V, Fig. 281. By thus dividing the house drainage, as it were, into *sections*, only the *minimum* amount of sewage gas is allowed access to any particular pipe, viz.—what is bred in said pipe itself; hence I consider the plan shown in Fig. 281 much safer than the plan advocated by the Local Government Board.* X, Fig. 281, marks where the sewer may be ventilated from, *if desired*, by means of a special pipe carried up to above the roof, but many persons object to ventilate the public sewer up their private pipes.

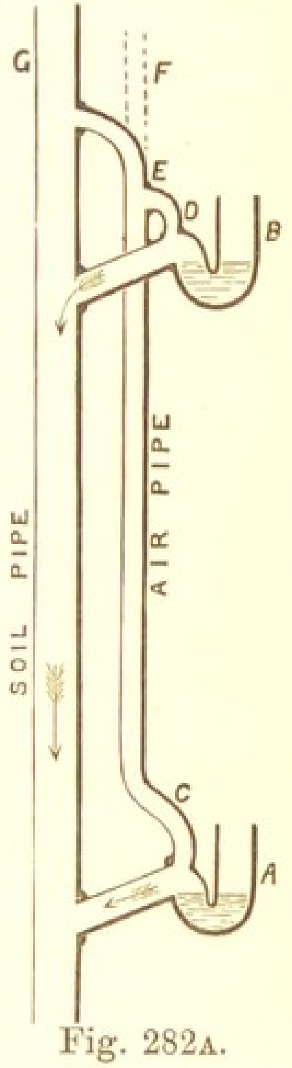

Fig. 282A.

* According to Clause 15, page 9 of the "Suggestions" by Mr. Rawlinson, C.B., Chief Engineering Inspector to the Local Government Board, lately published (1878), the style in Fig. 281 it seems may now be used.

When either the soil-pipes or other pipes with branches leading into the house are allowed to ventilate the common sewer, then the *maximum* amount of sewage gas and danger included is let on to the house. When the soil-pipe is allowed to ventilate the drain—and the Local Government Board appears to say that it should ventilate as long a portion of the drain as possible—then a *medium* amount of sewage gas and of danger included is let on to the house. But when even the drain is locked off from the house, as in Fig. 281, then supposing something went wrong, only a *minimum* amount of sewage gas can get access to the house, and so the *maximum of safety* exists within it.

Fig. 283 shows vertical section of one of my No. 2 traps (Fig. 272A) *in situ*, with the air-opening carried up to the surface to admit fresh air to the drain, soil, or waste-pipe, through the iron grating E, as also shown at G, Fig. 284. D, Fig. 283, is a plain 4-in. or 6-in.—according to size of trap, &c.—common fire-clay pipe with a branch, as at H. This side branch, H, is for a ventilating-pipe for the sewer to be attached when wished. By this arrangement, which is patented, but open to be freely used by all parties using my traps, the vertical opening, D, remains clear to be used for ready examination or cleansing of the *outer* side of the trap at a moment's notice and without disturbing the ground, by simply lifting the iron plate F and then the fire-clay lid G, beneath, the latter being made air-tight with a little lime or cement which is easily removed. In some cases a ring of india-rubber pipe has been used under G. A is a soil-pipe or drain-pipe on the house side of

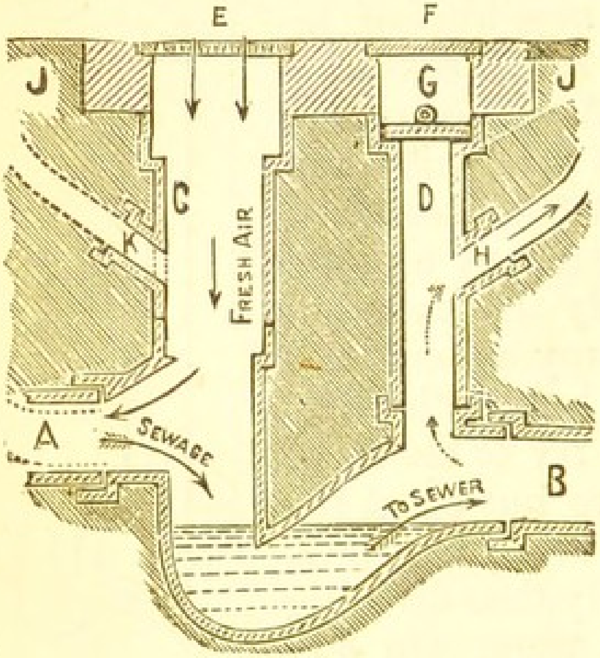

Fig. 283.

the trap, K may be a rain-pipe or fresh air inlet if E be a solid plate, as in Fig. 269A. So far as I am aware the arrangement on the outer side of the trap is unique for combined efficiency and simplicity, while the arrangement and practical working as a whole seems much better than where more cumbersome and very much more expensive appliances have been used, and with which the ground has to be opened before getting access to and seeing the outer side of the trap.

If wished, a movable metal grating, perforated or ribbed, or like Fig. 275, may be placed at the bottom of the pipe D, if any fear is entertained of rats from the sewer getting access to the pipe H.

Instead of setting the trap in the ground as in Fig. 283, it is often, especially where it is extra deep, placed inside a manhole, as shown in Fig. 283A. In this case the outer opening of the trap in the manhole is generally closed by having the lid cemented down under M; but if it is wished a short branch drain-pipe may be put in as per dotted lines at M, to ventilate the outer side of the trap by a strong iron pipe led up from the side of M. Many, however, may prefer to ventilate the drain beyond the trap from the point R on the *outer* side of the wall of the manhole. K in this sketch is the drain from the house, Q is the house side of the trap shown open, the arrow at Q indicating the direction of the fresh air which enters down through the iron grating L. In some cases it is not desired to have a grating at L, so a close iron plate may be put on at L, which is easily lifted when wished, and fresh air may be admitted into the manhole by a side air pipe at S or T, or as found most suitable.

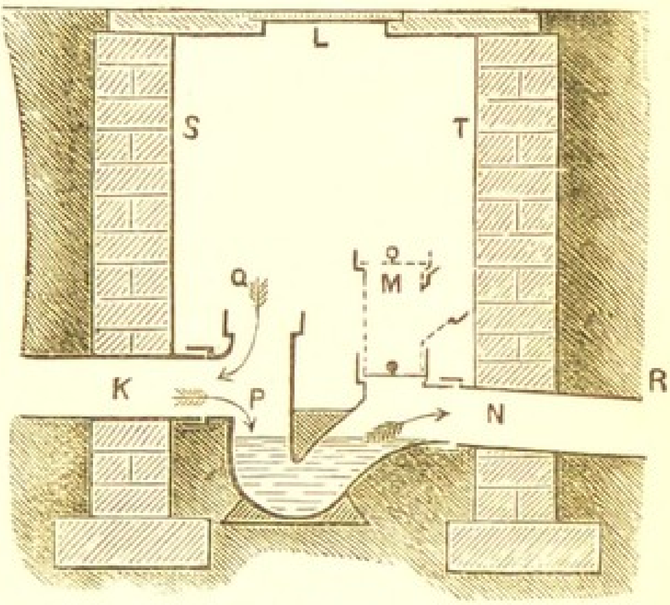

Fig. 283A.

Fig. 284 is another contribution towards a scientific

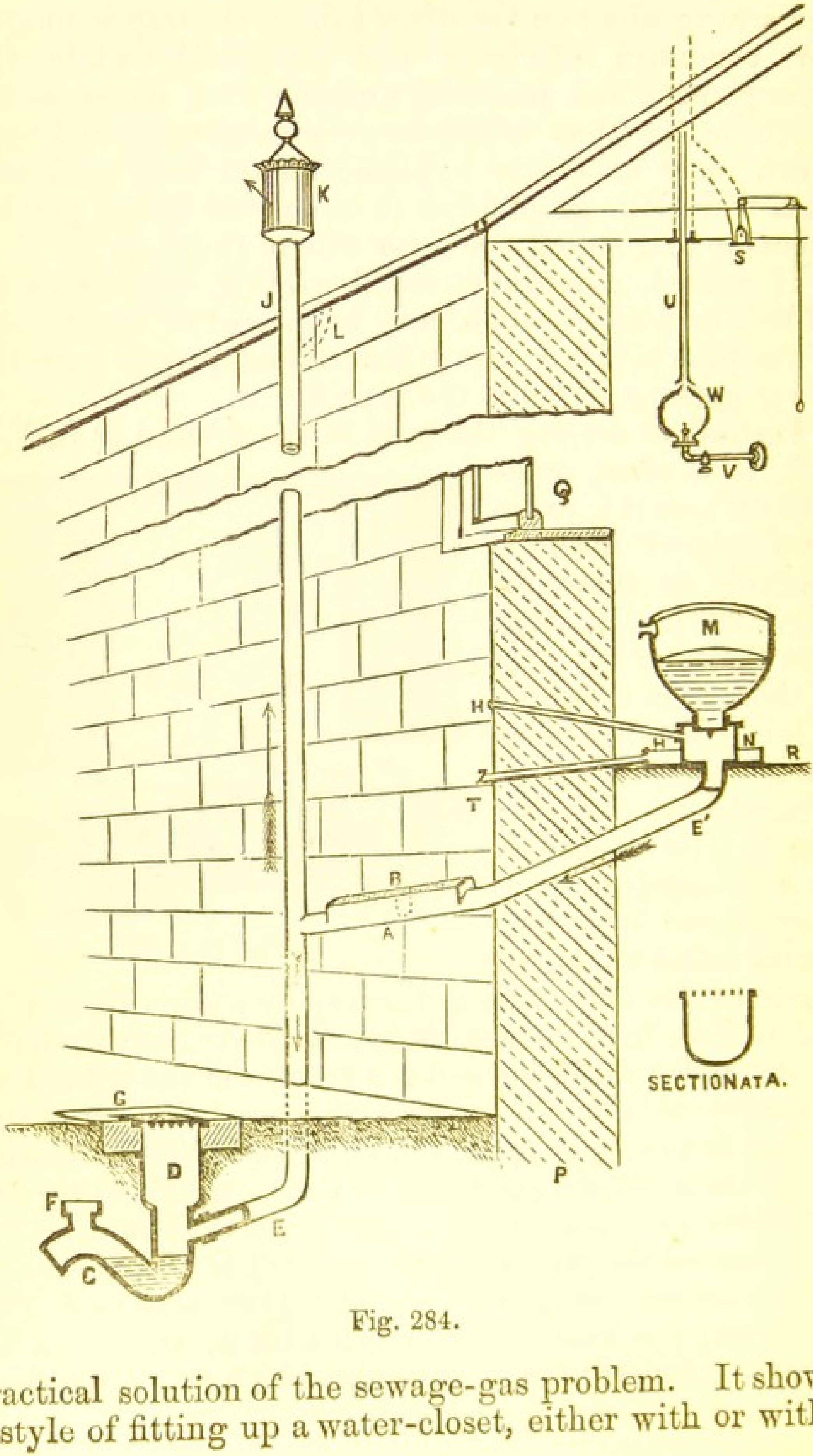


Fig. 284.

practical solution of the sewage-gas problem. It shows a style of fitting up a water-closet, either with or without a lead siphon-trap,* which for combined efficiency and simplicity is, some think, in advance of any plan yet published. The novelty or speciality in it—the open pipe A in the sketch—was suggested to me by a perusal, about ten years ago, of the article on "Sanitary Science," in Blackie's Encyclopædia, by Dr. Robert Bell, F.F.P.S., Glasgow. I never, however, worked the idea out thoroughly until January, 1879; but having once done so, I believe the plan may please some people. It is easily carried out in practice, and especially in new houses. My intention in 1874 was to lock off the drain from the soil-pipe and water-closet; but the intention now is to keep out, as far as possible, any gas that may be bred in even the soil-pipe itself from the water-closet. This is effected as shown in sketch.† C is one of my cascade-action ventilating drain traps. D is the fresh air entrance channel to the trap and soil-pipe E. This soil-pipe E being surmounted by one of my 4-in. induced-current ventilators K, a constant current of air is expected, and will generally be found to be passing up the soil-pipe. This up current will tend to draw in air from the open channel at A, at the end nearest the soil-pipe; while, if an opening existed in the branch soil-pipe E′, no bad air from the upright soil-pipe would get access to the house, but only through the short portion of branch soil-pipe, about 2 feet long or so, fresh air

* I have still a strong fancy for retaining the inside siphon-trap, and Mr. James Mactear, managing partner of St. Rollox Chemical Works, who experimented with water-traps, told me that he easily got the gases to pass through the water, but failed in all his attempts to get ferment germs to pass through. He hopes yet to manage the latter, but his failures hitherto show the value of water in keeping back germs and disease-breeders from the house or inner side of the water trap. The molecules of the gases may pass freely through between the molecules of the water, and the more readily in imperfectly ventilated pipes, but the germs, being many times larger, cannot get through in the same way. Experiments made by Dr. Neil Carmichael, and described to the Philosophical Society of Glasgow, in February, 1880, prove this, and see paper by Professor Tyndall, at page 99, vol. xxvii. of the Proceedings of the Royal Society (London), which he kindly drew my own attention to. See also page 243 of this book.

† This plan is best for closets where there are no room windows near or close above the open channel. Compare it with Fig. 264A.

pouring in from the end of A nearest the water-closet. Again, owing to the ventilating-pipe H, no bad air could gather in the branch soil-pipe. B is a swinging valve that might be put in if wished of tinned copper, but I consider it unnecessary. M is a Bramah valve closet, but Fig. 301 closet would be better. N is the lead safe, with safe pipe T, carried outside and with hinged valve at its outlet end. R is the level of the floor; Q is the water-closet window; S is a ventilating-shaft for the water-closet enclosure, which may be sur-mounted by a ventilator. The gas globe W and ven-tilating-pipe U are more necessary for rooms than W.-C.'s, but put in here merely to illustrate an idea. In some cases the pipe U might be allowed to blow off, as shown; in other cases it would be better to go out as a *small* tube by itself in order to keep up the heat, and so prevent tendency to down-draught.* Only one water-closet is shown leading into the upright soil-pipe, but several may be led into it, as in flatted houses or large private houses, and by carrying each branch soil-pipe, say, 3 feet or so along the wall, and leaving about 2 feet of it open at the top, as shown in section A of the sketch, then each water-closet is locked off from the soil-pipe, so far as the passage back of sewage gas into it is concerned, without interfering with the free passage outwards of the water and soil. J is the soil-pipe continued upwards above the roof, full diameter; L is a rain-water pipe, which in some cases may with perfect propriety be led into it, especially if no windows are near. Its worst effect is to tend to supply the venti-lator with air, instead of the air being forced to come from lower down. It is only ticked in as a suggestion, however, and people can please themselves. The top of the open channel pipe at A is covered with a perforated lead, zinc, or iron grating, as shown at "Section at A,"

* In the house I occupied in 1878 I used tubes to carry off the products of gas combustion at the sliding gasalier in the dining-room; the tubes working up and down with the gasalier. This kept the air of the room pure when the gas was lighted. A fixed tube served for the kitchen. Electric lighting may by-and-by obviate all this. I intend to refer to the ventilation of rooms, &c., more fully elsewhere.

which, while providing for perfectly free ventilation, at same time prevents snow or anything falling into and choking the channel. This grating also prevents the passage of soil down the pipe being seen by any person from a window upon a higher level. Dr. J. B. Russell, the able Medical Officer of Health for Glasgow, to whom I have shown this drawing, considers this new plan "as near perfection as can be." Some time ago, in conversing upon sanitary matters, he observed to me that what he wished with water-closets was that the soil should go slick down the soil-pipe, and as far off as possible, with one pull of the w.-c. handle; the difficulty with me, however, was to at the same time prevent the sewage gas from coming "slick up," but that objection is now removed.* The system, *which can also be used for waste pipes*, but *with a siphon-trap* at each sink, bath, or basin, &c., is open to the public to be freely used without any charge for royalty, and so those who fancy the plan are perfectly free to try it. Some may consider it serviceable for flatted tenements, such as we have in Glasgow, as it tends to isolate each house.

At page 382 of the *Sanitary Record* (London) for June 15th, 1877, reference is made to a paper communicated by Professor E. Frankland to the Royal Society, "On the Transport of Solid and Liquid Particles in Sewer Gases." In his paper Professor Frankland says, "It is, therefore, extremely improbable that the mere flow of foul liquid through sewers can impregnate the circumambient air with suspended particles;" but after explaining certain experiments he goes on to say, "Here, then, in the breaking up of minute gas bubbles on the surface of a liquid consequent upon the generation of gas within the body of the liquid, is a cause of the suspension of particles in the air. If, therefore,

* Fig. 284 is probably nearly perfect, as against mere sewage *gas*, but as against *dry infected particles*, the open channel, if on a soil pipe and near a window especially, looks to have an element of imperfection about it, hence many will prefer Fig. 282 style. It's awfully difficult to attain absolute perfection in this sublunary sphere; some have boasted of having managed it, but I could never see it as yet.

through the stagnation of sewage or constructive defects which allow of the retention of excrementitious matters for several days in a sewer, putrefaction sets in, then gases are generated, and the dispersion into the air of zymotic matters is very probable. It is of the greatest importance that foul liquids should pass rapidly and freely through drain-pipes and sewers, so as to secure their discharge from the system before putrefaction sets in." See pages 542—545 of the Proceedings of the Royal Society of London, for February 8th, 1877.*

One lesson to be drawn in practice from these experiments is that a siphon water trap with a small body of water in it, which can be often easily renewed, is safer upon a drain or at the bottom of a soil-pipe than a large pit cesspool, the influx of even clean water into which often merely dilutes the foul stagnant water, and stirs it up, causing it to throw off even more sewage gas bubbles than in the quiescent state.

"Flushing" drain-pipes with *foul* water has an element of evil in it, as said foul water leaves a dirty deposit upon the inside of the pipe, which after drying may allow disease particles to get loose. In this connection when a drain which has been choked is cleared, it should not only be well flushed with clean water and disinfecting liquid, say muriatic acid, but its interior should also be fumigated with the fumes of burning sulphur blown into it, as the flushing liquid may only cleanse the lower half of the pipe, and leave the top half still dirty. The neglect of proper flushing and fumigation may, in some instances, lead to development of cases of diphtheria, especially should children come under the influence of the atmosphere from the drying and stinking drain.

Amongst the pseudo-improvements in house drainage suggested within the last few years by non-practical men, I here give sketch of one that was highly puffed

* If sewage is really to be rapidly carried entirely away from the house sufficient water must be allowed to do so. Preaching as above does little in any good unless it can enlarge the paltry two-gallon water-flush for closets into four gallons, or more.

up in the professional journals about the beginning of A.D. 1880. In this case a disconnecting trap is put on at the bottom of the soil-pipe to lock off the sewer gases, rats, &c., but any good it could do in that respect is completely stultified by the air-pipe put in from the *outer* side of the trap and connected to the air-pipe of the soil-pipe *inside* of the house! How the genius of the author of this grand design managed to throw such a glamour over the brains of the critics as to cause them to praise up such an absurdity is a curious problem in our nineteenth-century journalism. It is only one, however, amongst various foolish plans that have been promulgated and extolled through the press, and it should serve as a lesson to the public not to take as gospel all that appears in print. It also suggests the question: Supposing the author of such a design were really entrusted with some large job where more elaborate combinations of pipes were used, how many dangerous mistakes might really be made? The only chance of good work from an amateur plumber is where the work is sublet by him to a properly qualified practical man, to whom, however, it might be better to go direct. There is not much to be gained by incompetent or nominal supervision, although really good and honest superintendence or inspection is worth paying for when required, as it often is.

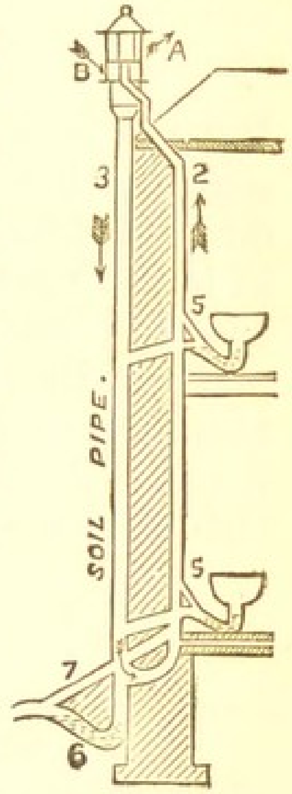

Fig. 284A.

# CHAPTER XXX.

## General Drainage and Ventilation.

Before bringing my remarks to a close I would add some further information relative to the proper laying down of drains within and around houses, &c., and also as to the ventilation of buildings. Wherever the drains are well laid, securely jointed, and properly trapped and ventilated, it is a great benefit to the house and also a great boon to the inmates; but if otherwise, the house is damaged, and, in the lower flat, the plaster on the walls may often be seen damp and bulged out in a

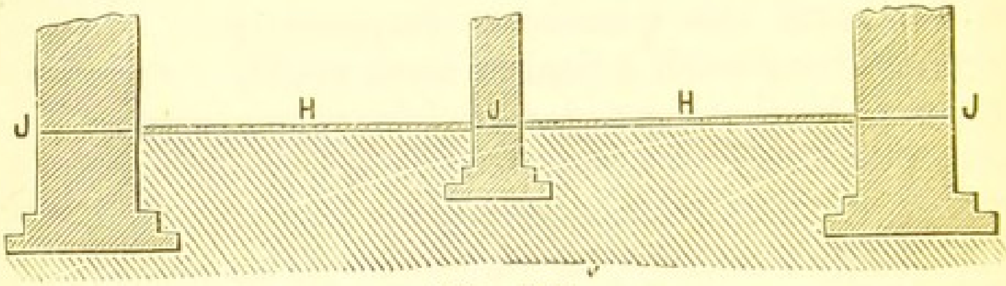


Fig. 285.

very unsightly manner for several feet up,* a signal that the house in that part at least is in anything but a healthy condition.

To prevent dampness in the lower flat and the damp

* In country houses, with the water supply derived from wells, disease and death are often produced owing to leakage from bad drains or dirty slops, &c., thrown on the ground getting into the wells. The water moving in a circle—well, cistern, stomach, drain; and well, cistern, stomach, drain, again, for so much of the same. In such circumstances people should be careful whom they invite to the house, for a diseased visitor might damage the whole family! Then, again, it is anything but a friendly act to invite a friend to stay at one's house where either the interior atmosphere or the water supply is polluted by the sewage. Town dungsteads used as manure on fields sometimes pollute the water supply. Dr. Ebenezer Duncan of Glasgow gives a very interesting and instructive example of this in the "Transactions of the Philosophical Society of Glasgow," March, 1881.

rising up the walls, the following plan ought to be strictly enforced by all authorities, viz. when the walls are being built to lay down a layer, a little broader than the wall, either of 4 lb. sheet lead, or of slates bedded in cement, or, especially for the outer walls, of Caithness pavement, said layer being put in either at the same level as the asphalt, as per Fig. 285, or otherwise as may be most suitable. In Fig. 285, H H is the asphalt, and J J J the layer of lead.* Above the asphalt a layer of Caithness pavement may be put down if wished, especially for the kitchen and lobbies: but where pavement is not wanted small wooden joists may be put in on the top of the asphalt, and then wooden flooring laid down, while the space between the underside of the flooring and the asphalt could easily be ventilated by holes cut through the outer walls and perforated iron gratings put in.† If the ground is very damp, or a spring exists about it, drain-tiles should be put in or other provision made to carry off the water, and the work so executed as that neither bad air nor rats can get into the house.

For general house use the spigot and faucet style of vitrified fire-clay drain pipe shown in Fig. 286, if good, makes a very serviceable pipe for ordinary purposes, if it is properly laid and securely and smoothly jointed. They are made in lengths about 3 ft. long or under, and may be had of various sizes, say from 4 in.

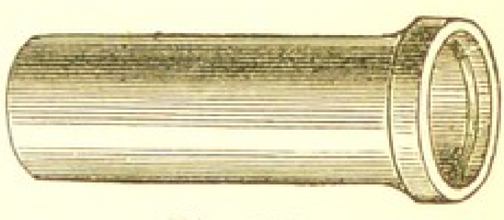

Fig. 286.

* Pettenkofer's experiments as to the permeability of walls, or the passage of air and gases through bricks, sandstone, concrete, &c., are worth remembering here. See p. 410 of the *Sanitary Record* (London) for December 28th, 1877. See also remarks on Ground Air and Dampness, by Dr. B. W. Richardson, in the Introduction to "Our Homes, and How to Make them Healthy," a capital book lately published by Messrs. Cassell, Petter, Galpin, & Co., London.

† Through and through ventilation, with a sufficient number of openings (more smaller openings are better than few large ones) is a great preventive of "dry rot;" currents of fresh air playing around wood being unfavourable to the growth of such fungi as the *Merulius lacrymans*.

in diameter upwards. The smallest size I would have for the main drain of a house is 6 in., which size, with a fall of 1 in. in 40, or more, will run off a great deal of ordinary house sewage and rain water. Nine inch diameter pipes are often used where 6-in. or at most 7-in. would serve far better and also be cheaper. One mode of jointing the pipes is to pack the joints well with clay. This often does pretty well, if properly done, where the ground is not very firm, as it allows the joints to yield a little without breaking; * but where the ground is solid, and the pipes can be laid down without fear of sinking then I prefer the joints made with either Roman or Portland cement, and plenty of it used.† Some use gascon or hemp; but the joint filled full of cement and cleaned flush inside does well. For all side connections I generally prefer branch pipes to be used, the branches being inclined to suit the run of the pipe, as per L, Fig. 307; the angular branch not being so apt to cause a chokage as the square one.

In practice I often found the plain round pipe Fig. 286, wanted something to enable a first-class job to be easily made, and also to prevent liability of disturbance of the pipes and breakage of the joints before they were set, from rolling of the pipe owing to its being round. To rectify this I invented and patented an improved fire-clay or stoneware pipe with a flat sole or feet, which flat sole prevents the pipe from rolling. Then in order to enable the bottom of the joint to be more easily and securely made, this flat sole projects a little beyond the faucet and a little back from its front edge,

* An objection to soft material for jointing is that it is boreable by worms or the roots of trees; in some cases the latter have completely filled up the pipe. In my practice I use Roman cement for jointing.

† If at all possible no drain-pipes should be laid down in the interior of a house. Where drain-pipes must pass through a house, some support the use of sufficiently strong iron pipes, the joints of which may be run with lead, while special eyes could be put in, say every eight feet or so, to serve as access openings; but for those who prefer the fire-clay pipe the improved pipe with rest, and with longitudinal access-openings at suitable distances, shown in Fig. 286A, or Fig. 286B, may be used, and the pipes laid upon and surrounded by concrete.

which allows the hand or tool to be got in *under the joint* and front of faucet, and so while easily putting in the necessary cement at the bottom to also wipe off the surplus properly to the edge of the faucet and so make a tight joint. This is found especially useful when the drain-pipes are laid upon either a stone, cement, or concrete bed. Further, where the drain-pipe is to be cemented or concreted either half-way up or all over, the style of the flat sole or rest allows this to be easily and well done. See other style of the pipe, Fig. 286B.

Again in laying down drain-pipes I often wished to be able to look along the inside of the pipes before they were covered in to see if they were all clear *inside*, but with the ordinary pipes below 9 in. diameter, although the usual round eyes the full size of the pipe might be put in, they were too small to let the head in, consequently to get over this objection, while patenting the above pipe with the flat raised sole or feet, I at the same time introduced and patented a *longitudinal* access opening, with longitudinal movable lid, which opening, while being the full breadth of the pipe at least, is made two or more times as long, and so allows the head to be got easily in to look along the inside of the pipe; a lighted candle being held down at another opening or down the cleansing eye of my disconnecting trap, the state of the interior of the pipe can be easily seen.

Should it be necessary to put in a rod or long cane to clear the pipe such can be far more easily put in into a longitudinal opening 18 inches or more long than into a round hole only about 6 inches diameter.

Figs. 286A and 286B give longitudinal and cross vertical sections of these improved pipes, which are supplied by Messrs. J. and M. Craig, of Kilmarnock, the makers of my traps, who are the sole manufacturers, but they have a number of agents and depôts throughout the kingdom so as to supply them readily. They received award of merit at the International Medical and Sanitary Exhibition, London, 1881, and from the Sanitary Institute of Great Britain, &c.*

* These pipes have been used *inter alia* by myself in work done for Messrs. Campbell Douglas and Sellars, Architects, Glasgow, as at

A, B, and D are views of the attached flat sole, which may extend along the pipe any length. C is a movable flat sole block, which may be used when the attached block is short, as shown at A. E is the iron lid for the opening which, in its place, may be made tight either

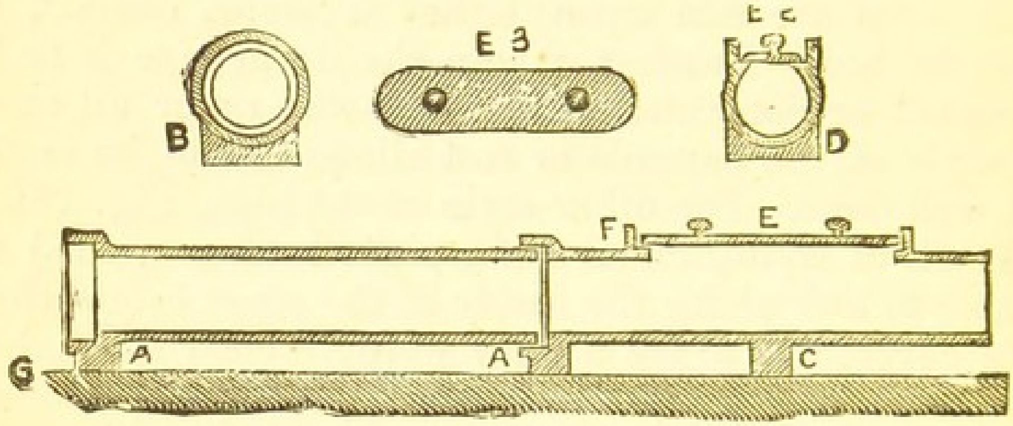

Fig. 286A.

with lime or Roman cement, as most suitable. When the pipe is not to be concreted below it, the earth is simply packed in under and around the pipe.

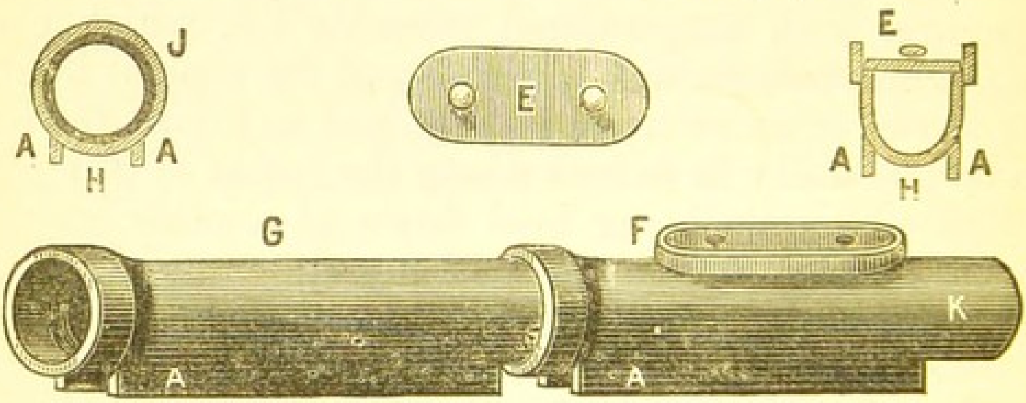

Fig. 286B.

In Fig. 286B two long ribs A A are used instead of the solid block. When wished and for greater strength, the space H between the ribs may be filled with Portland cement before laying. This is an extra strong drain-pipe, and very useful for laying on earth or soft ground.

Ach-na-Cloich on Lock Etive, and for Mr. John Honeyman, F.R.I.B.A., at Craigton Castle, Stirlingshire; likewise for Prof. James Thomson, F.R.S., Glasgow. They are also put in by Messrs. Watt and Wilson, with consent of the Architect, at the new Central Railway Station, Glasgow. Mr. Thomas Watson, Architect, Glasgow, is using them for the drainage of new Board Schools, and so at many other places.

Figs. 287 and 288 are vertical sections of square

Fig. 287.

Fig. 288.

fire-clay blocks suitable for either iron gratings or plates to be set into. The former is intended for level ground, or for asphalt or cement; the latter for gravel or grass. Fig. 288A is vertical section of square *iron* box frame which I often use in place of the fire-clay blocks; the margin outside of the grating being much less it looks neater. Fig. 289 is one of my square slop-

Fig. 288A.

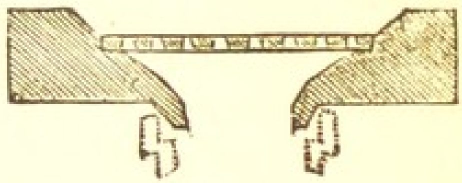

Fig. 289.

stones made of fire-clay, 1 ft. 6 in. across. It has a projection or pap at the bottom, to fit into the pipe, so as to prevent soakage of the ground. Fig. 290 is horizontal plan of one of the strong cast-iron gratings referred to at page 202 (and also shown in Figs. 287 to 291), the size in this case being taken as 10 in. (See p. 303.)

A very common practice exists regarding the drain-

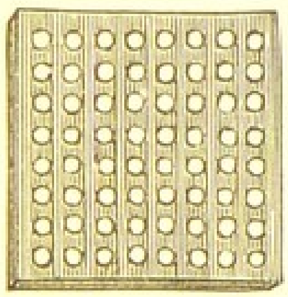

Fig. 290.

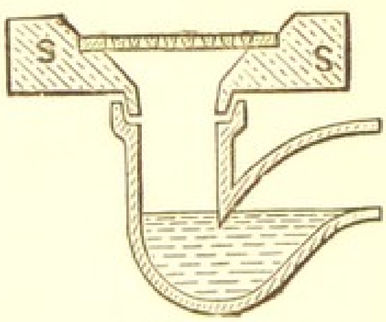


Fig. 291.

age of wash-houses—which I beg to condemn very strongly, especially where the wash-house is within the walls of the building. I allude to the use of those iron "bell traps" with the movable covers. They readily choke up, and so the cover is taken off, or lifted, to cleanse them out, when up comes a rush of sewage gas from the drain and passes up through the house. The covers are also often left off. None such should be put in, but, instead, a 4-in. fire-clay siphon-trap (the same shape as the plumber's lead one), with an iron grating, and slop-stone above it, as shown in Fig. 291, which combination I have termed "The Anti-Bell Trap."

Fig. 283A shows vertical section of a No. 2 Buchan's disconnecting trap placed inside a single manhole. I have done so as occasion needed for a number of years back. I have likewise used two manholes, as shown in Fig. 292, viz. one on the house side of the main trap and one on the sewer side of the trap. In this case the new access pipe shown in Fig. 286A was also introduced, the pipe on house side of trap having the access opening without the lid as seen at B, Fig. 292, so that in this case the access opening acts as the fresh air inlet to the drain as per the arrow T. The access opening beyond the trap has the lid on and cemented down as shown at H, but when desired the lid may be

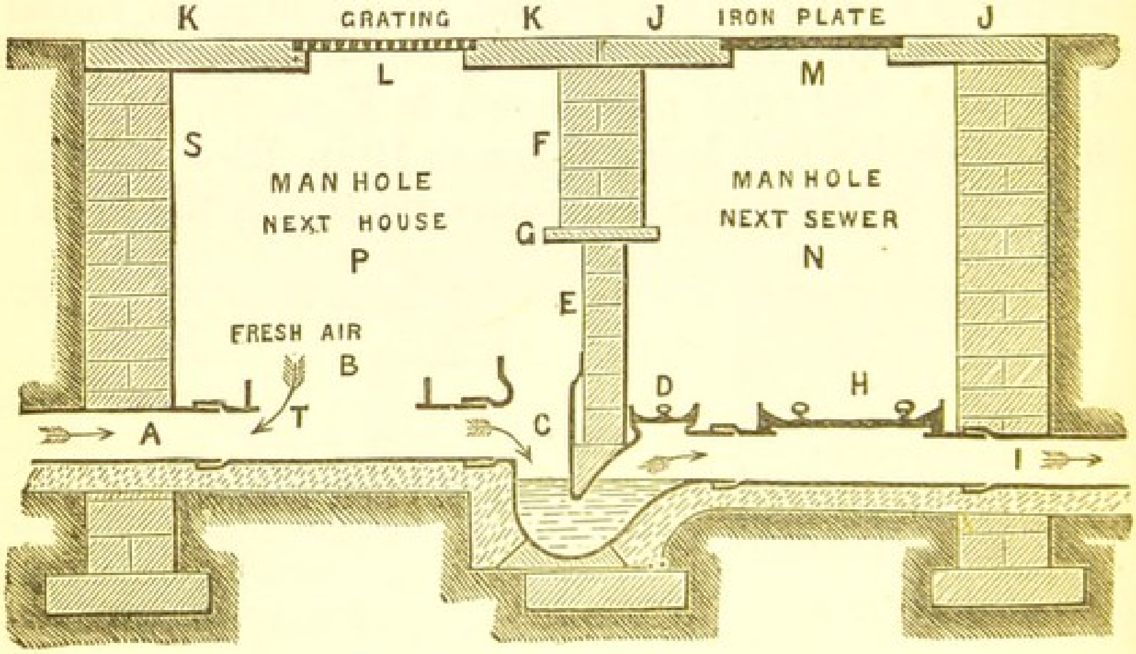


Fig. 292.

lifted to examine or clear the drain. The lids as sent out at first were of fire clay, but purchasers should insist on *iron* lids as being stronger. If it is wished to ventilate the sewer side of the drain this may be done at the branch or eye D; and as stated at Fig. 283A, if it is not wished to have an inlet grating right over manhole as at L, it may be placed at any convenient distance and an air pipe led to S on a similar principle to Fig. 293.

At one large mansion-house in Stirlingshire ("Craigton," near Fintry), where Fig. 292 style of fitting in the *main trap* has been adopted (in this case the trap is a nine-inch one), there are other fifty disconnecting ventilating traps on the branch drains, viz. 4 in. and 6 in., No. 2, so that supposing the trap C from any cause failed to lock off the sewer gas from the drain A, each branch trap would still act as a barrier to it getting into the house pipes. The air which enters at L and B after traversing the drain A goes up a special strong iron ventilating shaft carried above the roof and surmounted by one of my 10-in. Induced-Current Fixed Ventilators. The pipes were laid on a bed of concrete and after being jointed with cement were concreted half-way up, but any portion of drain passing inside any enclosure was concreted all over. All the traps were concreted to prevent leakage. The holes in walls through which either drain-pipes, or soil or waste-pipes, &c., passed were all made good with cement.* The work was done to order of Mr. John Honeyman, F.R.I.B.A., Glasgow.

Fig. 293 shows a modification of the fresh-air inlet to the ventilating trap when said trap is too near a door. It is also useful in preventing children dropping pieces of wood, &c., into the trap. In this case a branch pipe, C, is put in above the trap, and a pipe, D, joined to it and turned in any direction as most suitable. B is the iron grating for admitting fresh air, while the top of the trap is in this

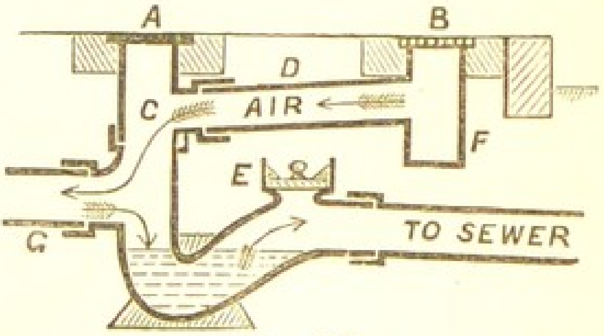

Fig. 293.

* This is an important point not only in order to prevent any gases or bad air getting into the houses along the outside of the pipes, but also to keep out rats or other vermin, should such visit the neighbourhood.

case covered by an iron plate, A. The grating, B, may also be set in plumb in face of a wall. In laying down drains it is well to be able to give them sufficient fall; an inclination of 1 inch to the yard serves pretty well, especially if the pipes are smooth inside and laid regularly, and all the joints well cleaned out in the inside with a scraper. This scraper—which may only be a half-circled piece of wood, about 1 in. thick, with a handle attached about 3 ft. long or so to suit the length of the pipe—must be so made as that its edge will not sink into the joint when being drawn across it. In some cases the sewer is so high that only a fall of 1 in. to the three yards or so can be given; in this latter case there is all the more necessity for first-class workmanship.

It is a good thing for the drains to flush them occasionally. Even where there is plenty of water many people who use water-closets, young females especially, are either so thoughtless—I will not say lazy—or afraid of the noise of the water running, that the soil is often several days in its passage from the water-closet to a few yards along the drain. I have often had to find fault with house servants and warehouse girls about this, as it does not give the water-closets fair play, while it turns the drain into a sewage-gas retort.

In examining the drainage of houses the smoke-test —with smoke-blowing machine, introduced by me about twelve years ago—when properly applied is very useful, and saves much time and expense. By it we have the senses of both smell and sight to go by. It is now referred to by the judges in our law courts as the proper test to be used in examining the drainage of houses, &c.

It is a very useful thing for the proprietors of houses and buildings to possess a plan of the drains. Many a pound would often be saved if a correct plan were forthcoming when wanted. Even when the work has been well done at first, inspection of the drains, &c., at intervals—say once a year—is to be highly recommended as a precautionary measure. When the work has been executed upon some of the improved plans herein described this inspection will be more easy.*

Between the house and the sewer a trap should always be put in when the drain is being laid, in order to keep back rats and sewer gas.† When this is not done at first, and the rats once get a footing in the house, it is often a difficult matter to get rid of them. Some try poisoning, but the stench that arises from off the dead carcases hid away under the flooring or at the back of the plaster, is rather a dear price to pay for that experiment. I was perfectly astonished to be told lately—end of 1878—that in a certain institution where the drainage was newly altered, there was no trap put on between the building and the sewer in street, but instead the drain was carried right through the building and a trap or traps put on at the back of the building! Supervision was surely needed here.

I have no hesitation in asserting that the inhabitants of our large towns and cities suffer far more from the evil effects of sewage and other gasses and impurities polluting the air, both inside and outside of their houses, than is generally understood.‡

* Some of my own customers are now having this done; *e.g.*, Mr. Fraser, of 2, Crown Gardens, has had his drains tested for several years now, before coming home from the coast. If anything wrong it was sorted; if nothing, it is satisfactory to know that.

† This has often been omitted even in cases where it would hardly be believed such was the case; *e.g.*, at the new University of Glasgow, built about seventeen years ago, no traps existed on the drains between the houses and the sewer until November, 1877, when I put in between thirty and forty of my disconnecting ventilating drain-traps. One of the inmates of Professor Gairdner's house felt the effects of the sewer air blowing into the house for several nights—the family having newly come to reside there—which led to an examination. The immediate cause of complaint was siphon action, a closet near by when let off emptying the siphon-trap of the bath owing to improper ventilation.

‡ A most important paper in connection with this subject was read before the Philosophical Society of Glasgow, in December, 1877, by Dr. James B. Russell, Medical Officer of Health, Glasgow, entitled "On the Comparative Prevalence of Filth-diseases in Town and Country," from which we draw the welcome intelligence for dwellers in towns that if the drainage and water supply of towns are properly carried out, and as with proper intelligent supervision they easily might be, then the disease and death-rate would fall very much. Even with all its drawbacks, Dr. Russell says, "that in regard to diptheria,

In the opening lecture of a series of "Lectures on Public Health,"* delivered in Glasgow in November and December, 1878, under the auspices of the Lord Provost and Magistrates, by Drs. J. B. Russell and Wm. Wallace, the former, when describing the effects of "Density of Population in relation to Death-rate" (see pp. 23 to 32 of lecture as published), shows that in a large and densely populated city such as Glasgow, three people die from pulmonary diseases for every single death from the same cause in the rural and less densely populated districts; this great difference in the death-rate being due to the bad effect of breathing impure air.† Bad air has also, whether directly or indirectly, a deleterious effect upon the digestive organs.

In a very interesting paper upon "Air and Water in relation to Public Health," read before the Philosophical Society of Glasgow, in Feb. 1875, Dr. William Wallace, F.R.S.E., F.C.S., says :—"The evil effects of breathing impure air—that is, air containing an abnormal quantity of carbonic acid, attended with a diminished quantity of oxygen ‡—are due primarily to an imperfect oxidation of the blood. This if continued long enough, produces a congested condition of the lungs, and often gives rise to various forms of disease of the respiratory organs." See also "Parkes' Hygiene," fifth ed. 1878, in connection with this subject, likewise the writings of Dr. Angus Smith. I may

enteric fever, and cholera, a citizen of Glasgow runs much less risk of dying of these diseases than an inhabitant of Caithness or Aberdeenshire, or almost any other rural district in Scotland you choose to name!" It seems from this that Nature will have it so that filth, even although mixed up and flavoured with the most stolid sanctimoniousness, will yet produce disease and premature death. Fast-days and prayers —with work undone and duties disregarded—being as much "vain oblations" now as they were two thousand years ago.

* I am glad to be able to state that the Glasgow authorities have published these important lectures in book form, including large diagrams, at the low price of one shilling. They may be had from Mr. James Maclehose, 61, St. Vincent Street, Glasgow.

† Is this our nineteenth-century tribute to the worship of Mammon or Moloch?

‡ The Black Hole at Calcutta proved how quickly in some cases under these conditions impure air could even kill.

here hint at the value of personal cleanliness—especially the frequent washing of the hands—as a health promoter, and also as a safeguard against contagion, especially to plumbers, nurses, and servants, or to any or all who handle the sick or what comes from them.

Among bad sanitary arrangements, a sewage-polluted water supply is a very dangerous and far too common cause of disease, and is to be held accountable for a large proportion of the deaths from preventible diseases. At pp. 350 and 351 of the *Sanitary Record* (London) for May 30th, 1879, will be found a summary compiled by Mr. Ernest Hart from government official documents, which gives valuable information upon this point.

The evil effects therefore producible from imperfect drainage should make it imperative upon our municipal authorities, and all concerned, to see that *when the house is building* the house-drains are in all cases properly laid. Instead of this being done, however, it would appear to be the rule that "what is everybody's business is nobody's;" † for not only in the commoner order of houses, but even in those of the higher class, so far as my experience goes, the character of the house-drainage is often most disgraceful, and the workmanship extremely slovenly—joints improperly fitted and only half made, pipes with a fall the wrong way, old pipes stuck in without faucets, &c., so that free exit into the house is allowed to both sewage water and sewage gas. A great point, therefore, in this business is to see that

* Since this was written, in 1876, considerable progress has been made. The study of hygiene and museums of sanitary appliances are now becoming quite popular. Parkes' Museum of Hygiene, London, is now in connection with the Sanitary Institute of Great Britain. The yearly congresses and exhibitions of the latter do a great deal of good. The sanitary associations started by the late highly respected Professor Fleeming Jenkin in Edinburgh, London, and other cities have proved highly useful. The demand for better sanitary work in houses has led to a movement for the registration of plumbers, inaugurated by the plumbers themselves at a national congress held at the International Health Exhibition, in London, in 1884, when the practical working out of the scheme was taken up by the Worshipful Company of Plumbers, London, and since then district councils have been formed throughout the kingdom, and a large number of both masters and men registered. The public authorities in various cities and towns are also now looking strictly after the drainage of new buildings.

there is *proper supervision*, so that good results may be secured.*

A gentleman, *e.g.*, may be looking out for a house for himself and family. He espies one newly erected, with a fine frontage, garden before the door, &c., and in a fashionable locality. Everything is nice and fresh-looking about it, so far as the eye can perceive, so he secures it and settles down. All goes well for a time; but by-and-by he begins to get fidgety, suspicious odours are occasionally felt,† some of the family too complain now and then of headaches, listlessness, &c.; the kitchen-maid comes in for a share of the blame and is told that she surely doesn't keep her portion of the house quite as clean as it might be; so that altogether our friend is not so comfortable in his new quarters as he expected. The summer is coming on, however, and off they all go to the coast; and if they have been fortunate in their choice of a residence there, all goes well. The season ends, however, and back they come; but after a time disease makes its appearance, and, happening to have a physician who likes to know the reason why, an examination is made as to its cause, when the gentleman discovers that his fine-looking mansion was in a fair way of proving to be a regular whited sepulchre, or rather a pest-house for himself and family, owing to the bad manner in which the drains had been laid. The fault being discovered, things are put right, however, by the floors being torn up and the drains relaid, &c., after which the house feels more comfortable and the general tone of health of the inmates is improved. But who was to blame for the purgatory that had to be

* In connection with this the classification and registration of houses, as of ships at Lloyd's, is an idea which might be advantageously taken up either by the Government or by municipal authorities. I threw out some hints upon the subject in the *Building News* for February 7th, 1879, which were commented upon in the public press. Coast houses should be examined each spring.

† The stages of sewage-gas poisoning may be designated as four, viz.—first, the odorous, or warning stage; second, the narcotic, or dangerous stage; third, the disease stage; fourth and last, death.

gone through before this took place? Each reader may answer that from his own point of view; but for my part—in a matter of such general and public importance as this, where the health of the community suffers, and where pounds have to be paid out to-day to repair what the shillings that ought to have been expended yesterday would have prevented—I think the law and the authorities are both at fault, when they allow such a state of matters to exist and such things to be done.

The Government of the country has managed to prevent the selling of adulterated coffee; but why cannot it do something more important still by preventing the erection of badly built houses, the putting in of fever-breeding drains, and the poisoning of the atmosphere of our towns? Good houses are as great a desideratum as good ships, while bad houses, leaky drains, and impure air cause far more deaths than rotten ships, only the work is done in a quieter sort of way.

Perhaps I am doing wrong in thus expressing myself, seeing that a great deal of work is got through, things having to be done twice over; but surely the great problem of the "struggle for existence" is capable of being solved in a better and nobler manner than this.

I would here say something about ventilation. Fig. 294 shows my Patent No. 1 Induced-Current Fixed Ventilator, for ventilating soil-pipes, drains, sewers, ships, workshops, mills, houses, &c., and for any air-exhaust purposes, where the top of the ventilating pipe stands up exposed. Fig. 294A shows a more ornamental and consequently more expensive style, marked as No. 1c on my list. Other styles may also be had, but the one ordinarily used in No. 1 style, is Fig. 294.

Fig. 295 shows the No. 2 style, with flat and generally square base A, it is generally used for the larger sizes; it is applicable to houses, halls, hospitals, churches, schools, mills, barracks, prisons, billiard-rooms, wash-houses, stables, &c., and is intended to be placed upon a square wooden frame or seat B, fixed either over the ridge as in Figs. 295 or 295A, or to one side of the ridge, but its *base* upon a level with the top of the ridge, as shown in Fig. 295c, so that the whole of the body of the ventilator may stand up above the ridge. The frame or seat when placed to one side of the ridge is generally so set to prevent its being seen; but to keep the seat so far below the ridge as that the ventilator would be lower

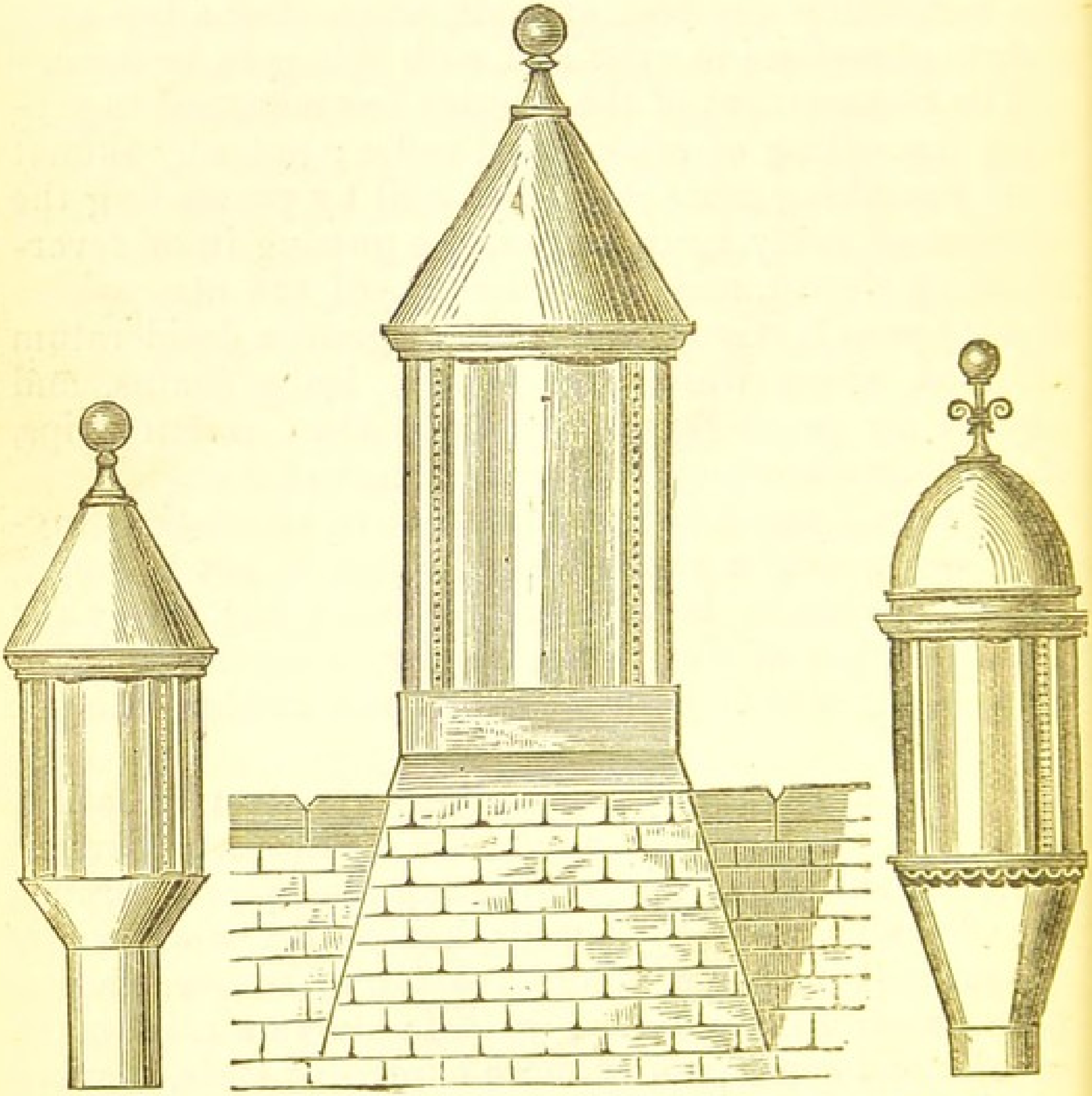

Fig. 294. Fig. 295A. Fig. 294A.

than the ridge would prevent the wind getting full scope to blow past the ventilator freely, and so hinder the ventilator from working as well as it would do if placed higher than the ridge.

Fig. 295A shows a No. 2 ventilator seated upon a rather more elaborate frame or seat than ordinary. Fig. 295D shows how an architect improved a No. 2

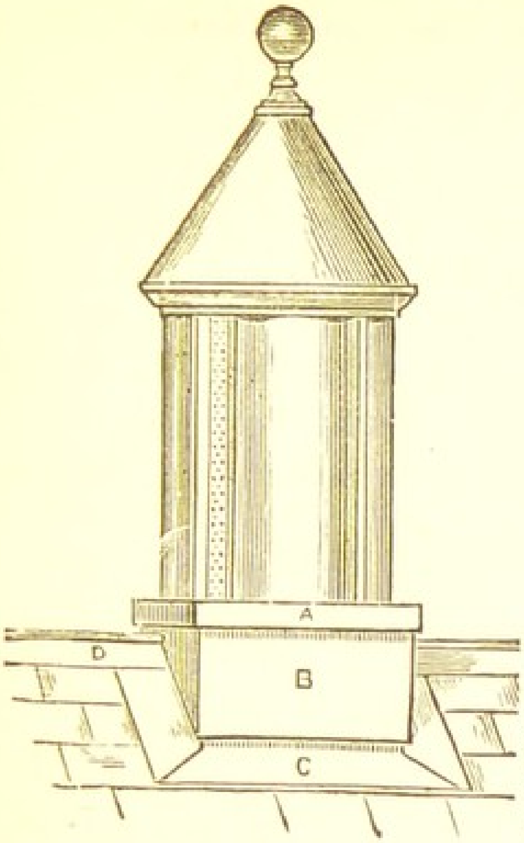


Fig. 295.

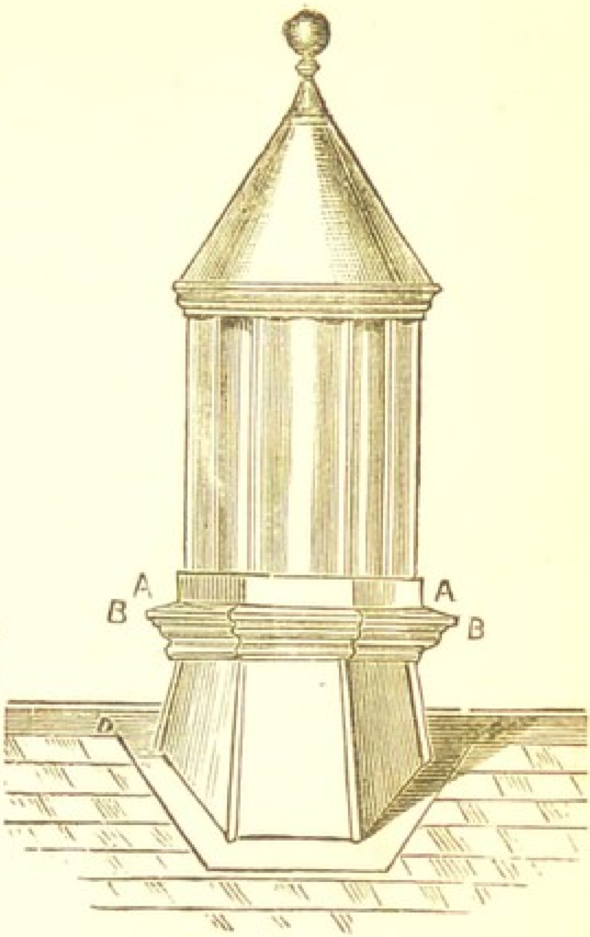


Fig. 295D.

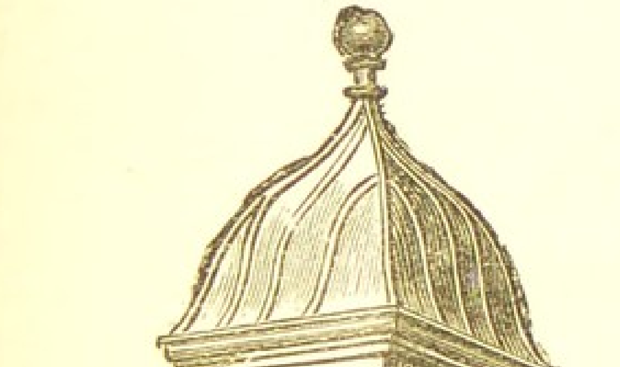


Fig. 295B.

Fig. 295C.

plain ventilator by seating it upon an octagonal frame and adding the mouldings B B. In Fig. 295, A is the base of the ventilator, from 4 to 6 inches deep according to size. This base slips down over and sits upon the wooden frame B, the part B being protected by lead or zinc; C is the lead or zinc flashings below and round the frame; D is the lead, zinc, or iron, &c., ridging.

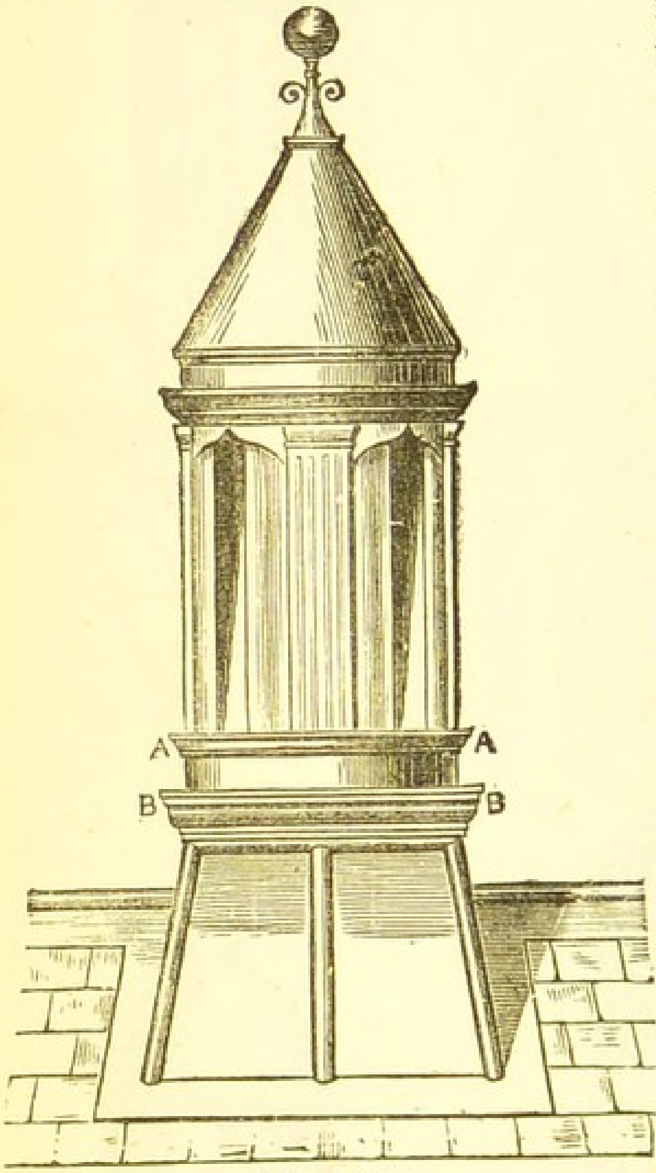

Fig. 295E.

Fig. 295B is one of my No. 3 ventilators *in situ;* the ornamental work at A A is extra to the ventilator and is added on in position.

Figs. 295C and 295G show some of my other styles, as does Fig. 295E. The latter is here shown with a round base; the round wood seat standing up inside of the base at A A from 4 to 9 inches or so higher than the top of the cornice B. The style mostly in use as yet with flat base is Fig. 295, the other styles being more expensive and no better as regards working power. A large demand has sprung up for the more ornamental styles, however.*

I had better give here a sketch explaining how the No. 2 and other styles of flat-bottomed ventilators are placed in position. In Fig. 296 we have therefore first an ordinary slated roof G G, up through the ridge of which the ventilating pipe H has to pass say 7 inches

* While some architects add their own outer casings.

above the ridge at M. This allows the pipe to stand up 3 inches higher than the top E E of the square wooden frame, of which F F are two of the sides (top and sides being made of wood 1 inch thick for a 2 feet diameter ventilator and less or more according to size for other ventilators). This pipe H is supported, where it passes up through the board E E, by a metal flange $1\frac{1}{2}$ in. or so broader than the pipe, soldered on below D. The wooden frame E F being fixed in position and the lead or zinc flashings put round it, the ventilator A A is lifted up (in Fig. 296 it is shown suspended over its seat) and lowered down over E E, F F, the width of the base B B being a little more than that of the frame or seat E E over all. The pipe C is also a little wider than the pipe H, so that H may slip up into C, the joint being made tight with red lead and hemp. The top of the base from C to B slopes a little down in order to allow the rain to run off easily, and so it is better to make the top of the wood at E E to slope a little too to suit.*

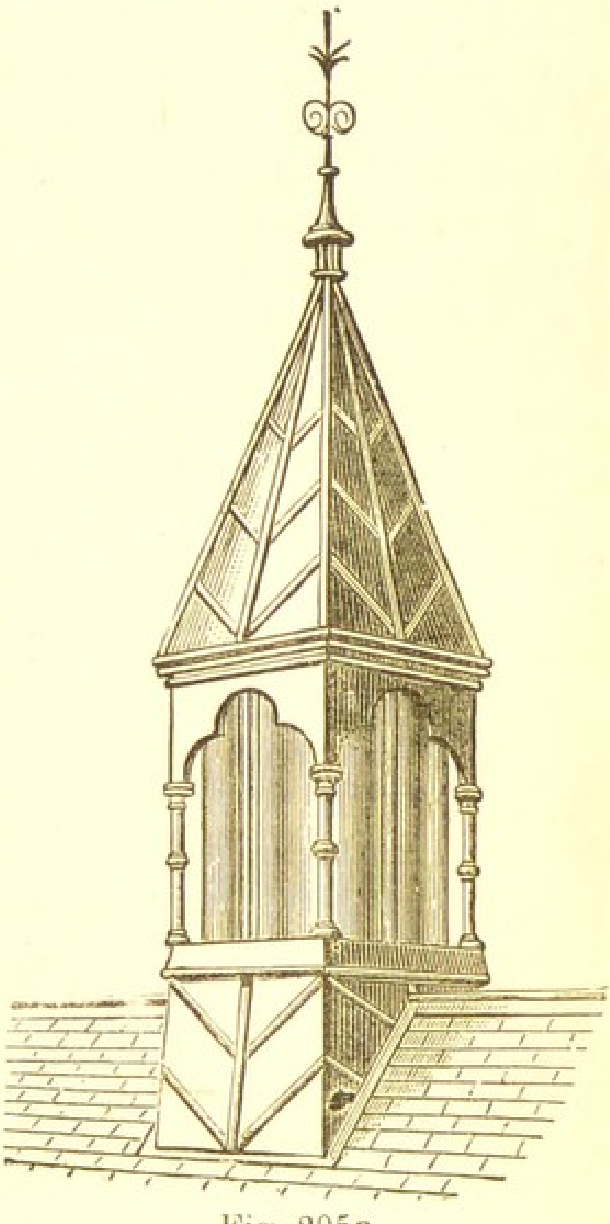

Fig. 295F.

L L is the ceiling line. At K, especially when the outlet ventilating pipe is metal, I recommend provision to be made to catch any drops of condensed vapour which in certain states of the atmosphere may be formed in tube. At J again, or where most suitable, a

* Fig. 295F shows my No. 12 ornamental Gothic ventilator.

valve may be placed to be worked say by a cord and pulleys, as sometimes too much air goes out when not wanted, as *e.g.*, when heating up an empty church, &c. Besides this hand-worked valve J, another self-acting or self-closing valve may also be placed inside the pipe H, which will allow passage to all air upwards or outwards but shuts against the passage of air downwards. This self-acting valve is most useful where the action of chimneys in cold calm weather, or where a certain direction of the wind, tends to produce an inclination to down-draughts. From entire liability to down-draught in unfavourable conditions there is no ventilator that I yet know of free. One kind will allow down-draught, even where there is wind, more readily than another. In some that I tested against my own, and which were *asserted* to be *entirely free from down-draught*, I found this not to be true; but, instead, they allowed down-draughts far more than mine, which latter were not warranted.

It is very amusing to think of the vast amount of nonsense that has been promulgated about "self-acting," or more correctly *wind*-acting, ventilators. Even scientific men certified to the wonders that could be worked in the ventilating way by merely clapping So-and-so's ventilator upon the roofs of the people's houses or halls, &c. The people believed and bought, but from this quarter and the other quarter murmurs arose that the public had been deluded, for Tom swore he had got cold from down-draught in the theatre—possibly he shouldn't have been there! Dick said he had got the same at the concert; but, worse than all, his wife got headache and rheumatism at the church from the persistent down-draught* of the ventilator on the roof. In these cases there were no self-closing valves or other such provision made, the patent ventilator was supposed to act as a charm and in fact to be a "perfect cure!" By-and-by people began to think and to experiment, when it was discovered that

* There are two kinds of down-draught to be guarded against, viz. the blow-down and the suck-down. See Valve-Boxes pp. 279, 280.

a wind-acting ventilator without wind to work it was at times something equivalent to a steam-engine with the fire out, and the coals done.*

Generally speaking in this country it seldom happens but that there is some wind to act upon a ventilator if it is so placed as to feel what there is. Where there are fresh-air inlets upon the windward side of a building the entrance of fresh air at these will help to cause the foul air to go out at the roof ventilator, and all the more easily in halls or churches, &c., where there are no fires. "Tobin's tubes" are largely used for fresh air inlets and work well, especially when the air is not too cold. Attempts have been made *to heat the incoming air* through these by gas and by hot water, without harming the air. In regard to the *heating* of buildings I have had a preference for a long time for the hot-water-pipe system, although my business has been more connected with the water supply fittings and the improved drainage of houses, &c., and latterly with their ventilation and that of public buildings. Some remarks follow here regarding ventilation, but I intend afterwards to publish a separate pamphlet on ventilation, dealing more fully with the subject.

Reference has been made to the complaints that had been made about the exhaust ventilators in the market not acting up to the pretensions of their vendors. In 1878 the Sanitary Institute of Great Britain offered the Medal of the Institute to the best acting ventilator sent in to be tested. To this invitation Messrs. Boyle, Lloyd, and Scott-Dunn responded,† but after testing their ventilators against plain pipes, the committee, consisting of Captain Galton, Mr. William Eassie, C.E., and Mr. Rogers Field, C.E., reported that they were unable to recommend the Medal to be given to either,

* A ventilator on a steamer when sailing might work well supposing no wind, owing to the motion of the vessel; but we can't send a house through the air like a ship through the water.

† Messrs. Boyle sent in their "Air-Pump" Fixed Ventilator; Lloyd's was also a fixed one, while Scott-Dunn's was a veering cowl.

as the experiments made by them at the Royal Observatory appeared to show that the only use of the cowls tested was to keep out the rain. The chairman, Dr. B. W. Richardson, in alluding to the experiments conducted at this time, said—"It turned out that many of the instruments and apparatus exhibited, and which had previously borne a high reputation for excellence, were found by the Council not to be able to stand the test."* The publication of this statement (the Report will be found published *inter alia* in the *Sanitary Record*, London, June 7th, 1878) fell like a thunderclap upon the ears not only of the prize-seekers, but also upon many of the general public. Although two months or so previously I had in the *Sanitary Record* published that in my opinion various ventilators were puffed up far above their real merits, I was not prepared to read that the only good they served upon the tops of pipes was to act as umbrellas, yet that virtually seems to have been the opinion enunciated by the judges of the Sanitary Institute. I consider this opinion has done a great deal of good, and has helped to bring out improved *systems* of ventilation as well as shown there was room for *better working appliances*. At same time, however, it has also done some harm by making many persons imagine that wind-acting ventilators were useless because the *wind* as the motive power was inconstant; but if that were really so, what, *e.g.*, would be the use of sailing vessels? How did they get on making the circuit of the earth, long before steam-engines were invented? And even now, it is found in practice that sailing vessels are still serviceable—getting along pretty well, and sometimes paying better

* Dr. Richardson himself had previously stated, that the introduction of Boyle's Ventilators had given us "perfect methods of ventilation." His candour under the circumstances is therefore all the more honourable to him. Real "perfection" to be got from an appliance with such a variable motive power as the wind is rather difficult. Good planning in the arrangement of both inlets and outlets is a great matter, so that each may help the other. Tobin's or other inlets without providing also good outlets is only half doing the work. Hence the introduction of my Anti-down-draught and Inspection Valve-Boxes shown at pages 279 and 280.

than steamers; the extra cost of the machinery and coals of the latter sometimes counteracting their benefits otherwise. Which is the same with the water-power or otherwise mechanically-worked ventilating engines or appliances; *people grudging the expense and attention required.* Under these circumstances therefore *wind-acting exhaust ventilators will continue to be used,* and the great question for the public is—which one, at a reasonable price, utilises the wind-power best, while at the same time having a good or at least passable appearance? The ignoring or acting upon some such ideas as these might have been one cause of the different action of the judges at a number of the late exhibitions where ventilating appliances were shown. *E.g.*, at Glasgow in 1880, at the International at London, 1881, and the Newcastle one in 1882, the wind-acting ventilators seem to have been rather pooh-poohed. What's the use of *them* when there is no wind? At the International Health Exhibition at London in 1884, and also at the International Exhibition at Edinburgh in 1886, as well as at other exhibitions, the judges did give awards to the wind-acting exhaust ventilators, so that judges can differ as well as doctors. At the Edinburgh Exhibition, *inter alia*, a silver medal—the highest award for such—was given to my ventilators, but I do not remember of any comparative testing being made there. At the London 1884 Exhibition tests were made of the wind-acting exhaust ventilators, but they were conducted inside a small room by blowing air on them from a hand-turned blower, which plan of testing I formally condemned before the awards were declared, and all the more because some of the London makers saw the *modus operandi* of testing before sending in their ventilators, while I and other provincial makers got no chance to do so. Some parties again sent in two ventilators, while I only got one sent in at the last moment. My ventilators got two medals, however.

As to whether or not a good ventilator is better than a plain open pipe I think the experiments made by Mr. S. S. Hellyer of London, and myself at Glasgow, settled that in favour of the ventilator. (*Vide* Mr. Hellyer's work already referred to, and the "Transactions of the Philosophical Society of Glasgow," April, 1879, p. 442.

Experimenting in August, 1878, upon an inhabited house with ventilators *versus* a plain pipe, the following shows the comparative amount of up and down draughts in each in one minute :—

| | Plain Pipe. | Boyle's 3 in. Air-Pump Ventilator. | Buchan's 4 in. I.-C. Fixed Ventilator. | Banner's Cowl. |
|---|---|---|---|---|
| Up | 30 ft. | 160 | 250 | 100 |
| Down | 40 ft. | 10 | None, but wavered. | 5 |

The Sanitary Institute of Great Britain were to make a new series of experiments with ventilators, but as yet I have not heard of the results being published.

Only experiments with full-sized ventilators *in position* can give fair play in judging as to their exhaust power and protection of the pipe they are on from down-draught, yet the following experiments with model will help to explain how a pipe surmounted with a ventilator may be better than a plain open pipe.

In Fig. 296A we have a plain U-shaped pipe open at both ends, while in Fig. 296B we have the same pipe surmounted by a ventilator on one end. In this case by blowing upon one end of Fig. 296A as per either of the arrows A or B, the air comes out of the end B, as indicated by the piece of cotton lying in the bottom at F rising up in or out of the end B; but if we blow in the direction of the arrows C or D, down-draught takes place and the cotton is sent out at the end E. Now try Fig. 296B with the ventilator on, and we find that, no matter in what direction the wind strikes the ventilator, there is always an up-current of air in the pipe towards it. This shows that a good ventilator may be made to serve the purpose of both an umbrella and a protection so far against down-draught as well as increasing the up-current.* As to a suck-

* I had a good proof of this about three years ago at Dalmuir, where I was executing some improvements in the drainage on account of an outbreak of gastric fever. At the manager's house the soil-pipe went up outside and was carried up full bore to act as a blow-off for

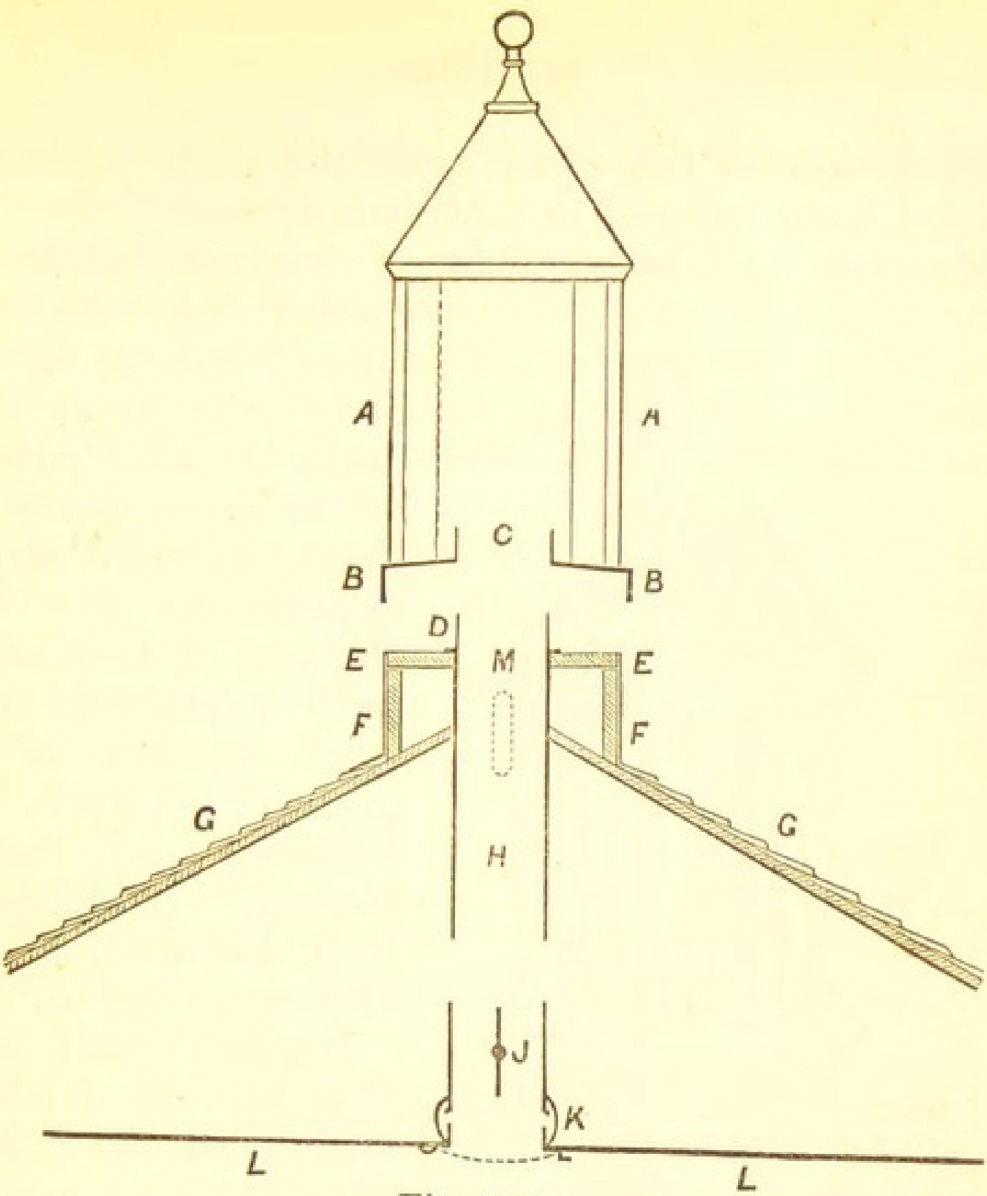


Fig. 296.

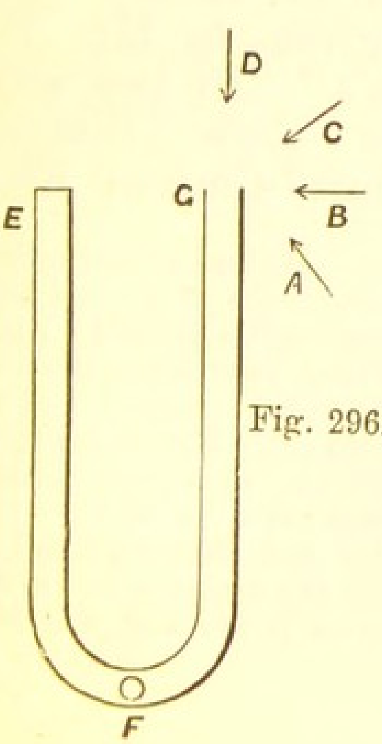


Fig. 296A.

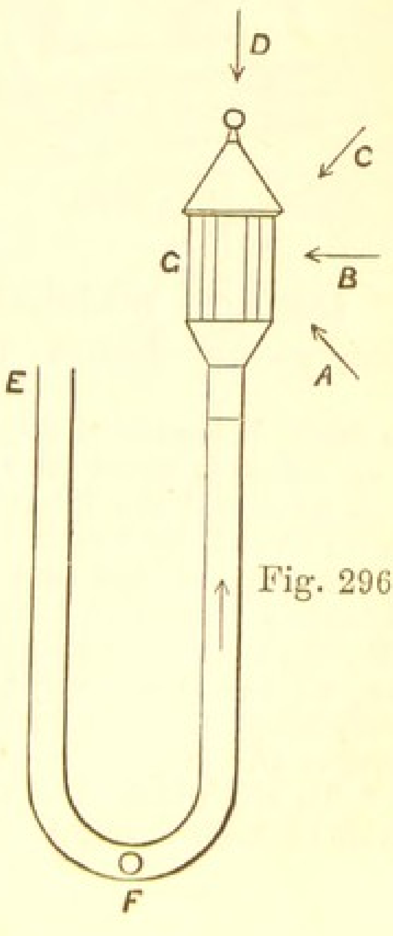


Fig. 296B.

down action in the pipe, especially when there is no wind, I have referred to that already.

Mention has been made of various experiments carried out with ventilators,* but so far as I know the most elaborately detailed *published* set of experiments were those conducted at great expense by Mr. S. S. Hellyer, of London, and fully explained and a large amount of data given in his work, "The Plumber and Sanitary Houses," published by B. T. Batsford, 52, High Holborn, London.

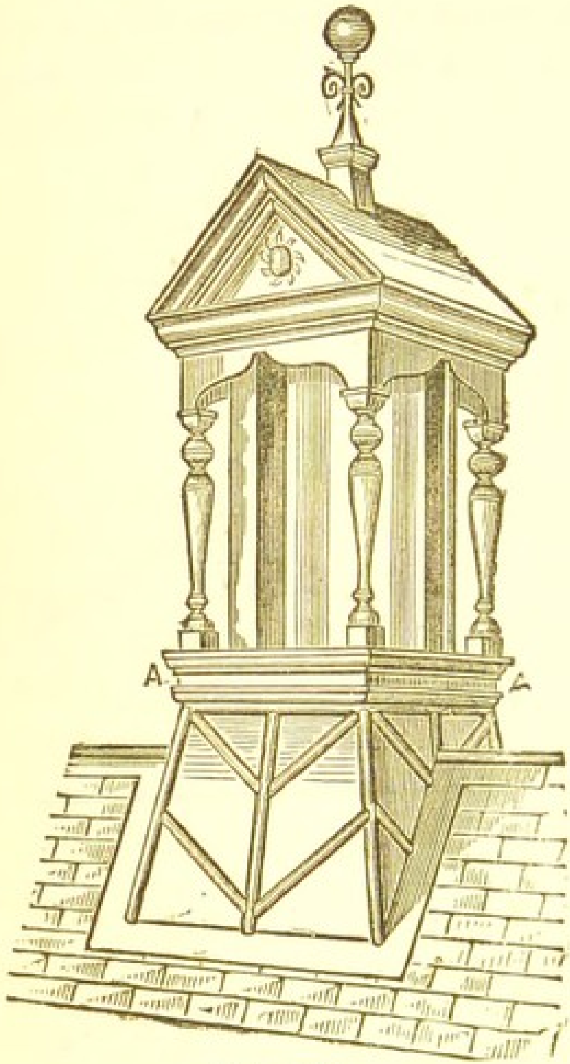

Fig 295G.

As the result of all the various trials he made with the principal ventilators or cowls in the market, he says:—"Taking all the tests into consideration the palm of victory must be given to Mr. Buchan's." In two series of testing matches his tables show that in twenty-one hours my new Induced-Current Fixed

the drain, but without any ventilator at first. Instead of acting then as an outlet it acted as an inlet, to the annoyance of the manager when he passed the intended air-inlet grating on the ground. I then put on one of my 9-inch Induced Current Fixed Ventilators upon the top of the soil-pipe and the air current went as desired and the manager's complaint ceased. Several months after Mr. James Deas, C.E., engineer to the Clyde Trust, examined the work, and certified that all was satisfactory; while several years after he told me that everything was still in good working order and they had had no fever in any of their houses since I had sorted the drainage in 1879.

* To see which had the strongest exhaust power and was least liable to down draught.

Ventilator excelled all the others—whether fixed, veering, or rotating—by about 94,000 feet. To certain interested parties who affected to disbelieve his data as published, Mr. Hellyer offered to repeat his experiments in their presence, but, although the proof o' the puddin' is said to be the preein' o't, they did not care to *taste*. Some of those tested were larger and much more expensive than mine.

Fig. 297 is new cross section of Figs. 294 and 295. There were a number of various styles of fixed ventilators in use long before this, as *e.g.*, Kite's with vertical angular plates in 1846, Wilson's and Finlay's

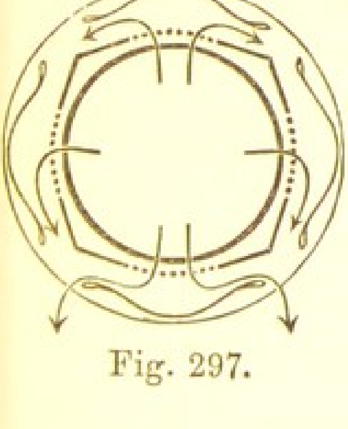

Fig. 297.

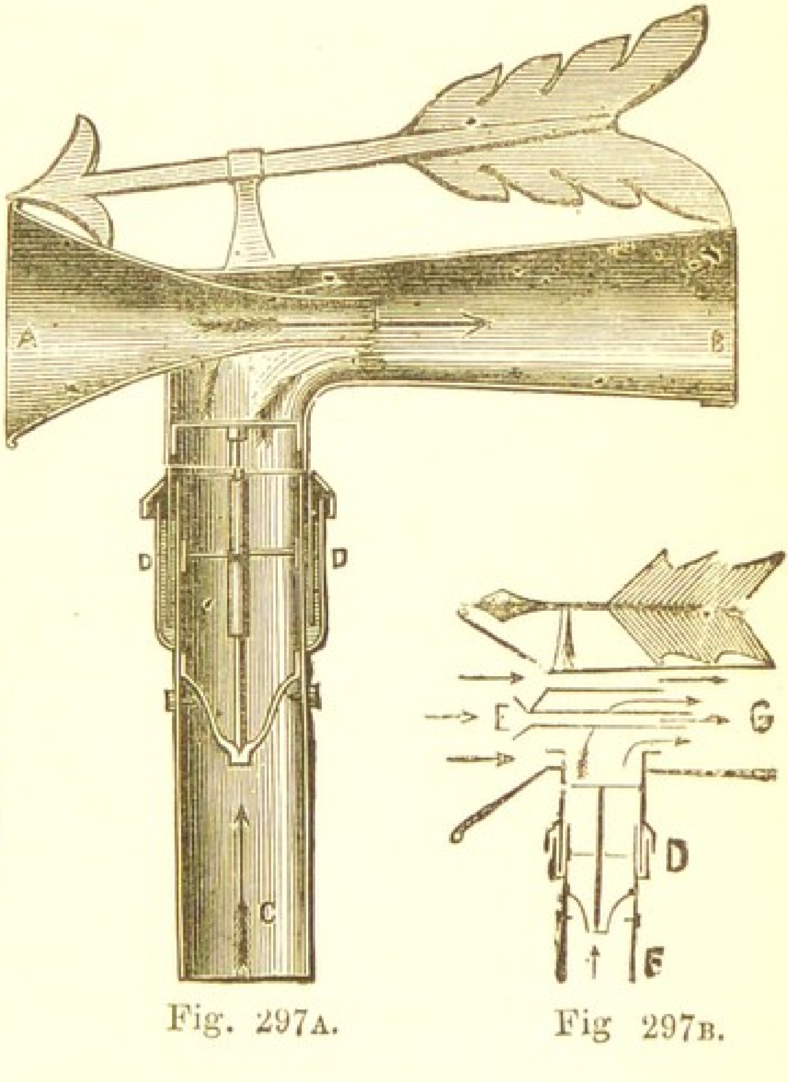


Fig. 297A. Fig 297B.

a few years after that, and Boyle's in 1872, formed of a series of vertical plates. Each has its own peculiarities, Boyle's to my mind being the most expensive and elaborate, although not the best working, so far as I can judge by experiments and data published.

The late Mr. Robert Boyle, the inventor of the "air-pump" ventilator, took great interest in the subject of ventilation. I had a visit from him in my own house in 1878, to see some experiments made with his own ventilator, in regard to its liability to down-draught. These experiments were published and explained at the time in the *Sanitary Record* (London) for April 5th, 1878, but as Mr. Boyle's experiments with me were made, so the firm said, "without our knowledge and sanction," and when he was not "an acting member of the firm,"* the experiments did not lead, as I wished them, to further experiments with if possible improved construction of this ventilator. I was therefore forced, in order to get the style and improvements I aimed at, to go on with my own "Induced-Current" Fixed Ventilator as an advance upon all that had preceded it. *Inter alia*, I wished Messrs. Boyle to supply me with their "air-pump" ventilator only 9-inch diameter in the body in place of 12-inch, for a 4-inch pipe, as in many cases I judged the 12-inch to be too large, and therefore an eyesore as well as an unnecessary expense. I could not get this from them, and therefore designed a ventilator to suit my own ideas with the result that Mr. S. S. Hellyer published that my 9-inch one at 25s. upon a 4-inch pipe excelled Boyle's 12-inch 42s. one by 11,772 feet in two hours, and again by 976 feet in twenty minutes. And with both on a U-shaped pipe pulling against each other, my small one in two hours pulled 2,468 feet down through the 12-inch "air-pump!"

I observed it stated lately that Boyle's was the first round fixed ventilator. I think that statement a mistake, as Finlay's, about ten years before Boyle's,

* At the time I failed to see what it mattered to scientific or practical experimentation whether or not Mr. Boyle had the "sanction" of his old firm to experiment. Had the experiments turned out successful no doubt the *firm* would then have been glad enough to hear all about them, and appropriate the honours. I think the "firm" made a mistake in objecting.

was round in section. I here show sections of Wilson's hexagonal one about 1856, Finlay's round one about 1860, and Boyle's 1872. I think the *round* ones allow the wind to embrace them too much, and so in my own one, as per Fig. 297, I have striven to give rather a

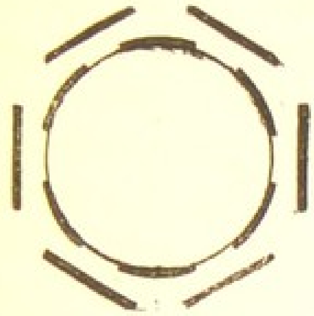

Fig. 297c.

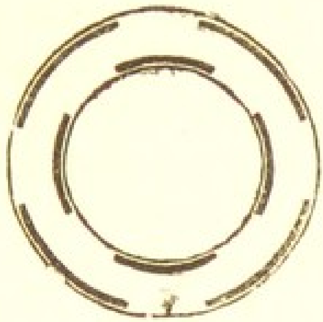

Fig. 297d.

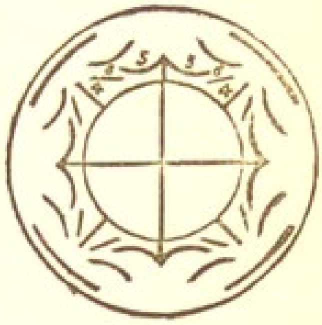

Fig. 297e.

*square* character to its section in order to allow the wind to flow readily past each side, and so discourage the encircling tendency.*

Figs. 297a and 297b are vertical sections of my patent glycerine-jointed veering cowl; but as my fixed ventilator acts better, I do not care about these or any other *movable* wind-acting exhaust ventilator.

Some further remarks upon wind-acting exhaust ventilators, and their application, will be found at page 278. As to entering upon the subject of *systems*† of ventilation I cannot do so fully here, but I may refer to the successful ventilation of apartments without any special exhaust appliance by utilising the chimney already there as the outlet. The plan I refer to was first shown to me by Councillor W. R. W. Smith, of Glasgow, in last decade, but whether he or Lord Kinnaird first suggested it I do not know. It was

* Boyle's is shown with four divisions in centre. I experimented with these in mine and considered them a useless waste of metal and money, at least for *exhaust* purposes.

† A good system with inferior appliances may be made to give a more satisfactory result than a bad system with better appliances; but the best result, of course, is attained by having both the system and the appliances as good as possible, and this does not necessarily mean the most expensive. I have come across some very expensive and pretentious failures where the best working appliance was the tongue of the vendor.

published from the latter in the *Building News* for November 8th, 1872.* It consisted in his plan of bringing down a pipe from near the ceiling to *above* the chimney-piece, where the pipe bent inwards to the vent. Mr. Smith's plan was to bring it down below the chimney-piece and then in; but as in both these cases, if there was a down-draught and a register grate in use there, the smoke could get up the ventilating-pipe and mark the ceiling, I, therefore, in those fitted up by me, carry the pipe down to within a foot or so of the floor, so as to prevent any smoke getting into the pipe. I have used this plan for rooms, which it ventilates very well, especially if a fire is on,† carrying off the heated air from the gas, &c. I have also used it for laundries with stoves, &c., the effect being that the laundry is made much more comfortable and healthy for the servant to work in, while the clothes dry in half the time and better than before the pipe went in.

I here, in Fig. 297F, give a sketch of one end of the apartment, showing position of fireplace and the outlet ventilating-pipe C. This pipe C is generally flat—say 9 inch × 2 inch, or thereby. Sometimes it is put in outside the plaster, again out of sight at the back of the plaster. The plan does best where there is a good going large clear vent. A valve-box may be put in at D.‡ Fresh air may be admitted into the room

* Messrs. Jas Combe & Sons, Glasgow, claim it for twenty-five years back. Mr. Hoey, Glasgow, is another claimant.

† The plan is not suitable for open fireplaces. An interesting paper, with diagrams, upon this subject was read to the Philosophical Society of Glasgow, on March 31st, 1880, by Mr. H. K. Bromhead, A.R.I.B.A., and published in the "Transactions." Some of my own remarks upon House Drainage and Ventilation will be found in the "Transactions," under dates March and April, 1879.

‡ This plan will work all the better, and more air may be carried off by the pipe C if there is a valve-damper, or door, upon the smoke outlet of the grate, which can be opened or closed as far as necessary to permit the smoke to get free exit and no more. Finlay's sliding-valve upon register grates is a good one for this purpose, while a screw handle, like a water crane, with suitable attachment at top of grate, would be a great improvement upon the present common style of smoke-door, which opens or shuts by jumps of a couple of inches at a time, or perhaps only stands at the shut or open, and to regulate which the hand or arm has to be put up the chimney. I am arranging

either at window between the sashes as at F,* which is often termed Dr. Hinckes Bird's style, a slip of wood as at G, about 3 inches deep, being put in along top of window to prevent air getting in there, or it may come in through one or more Tobin's tubes as at E. Again, instead of the fresh air coming in directly from the outside into the room or apartment, it may come in

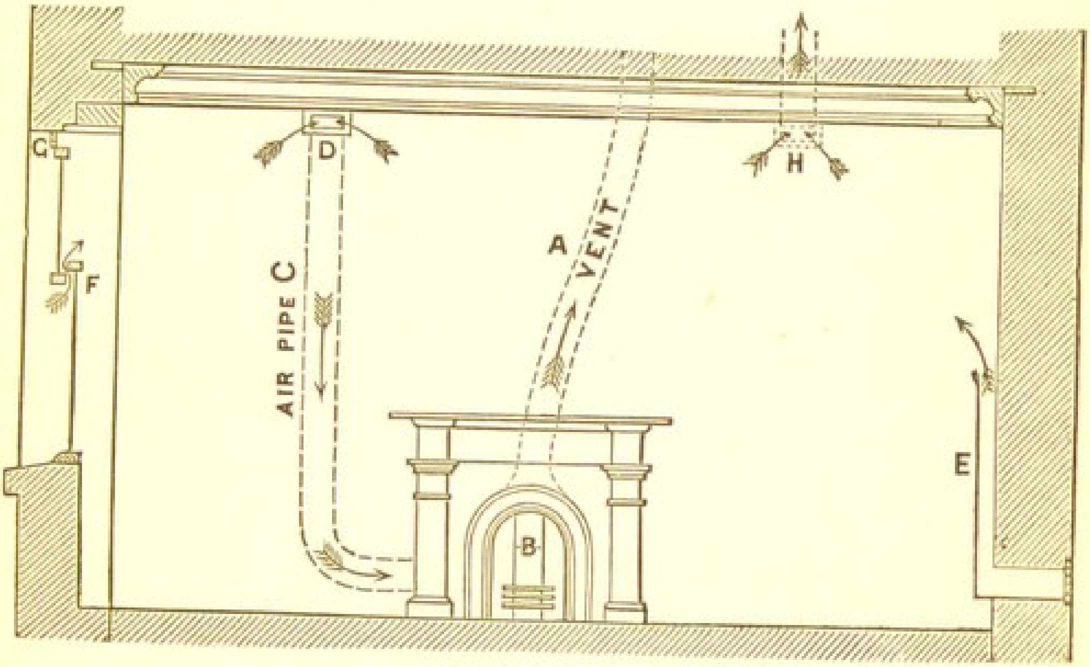


Fig. 297F.

from the lobby through Tobin's tubes. A Tobin's tube fixed up at the back of the door makes a good fresh-air inlet. When Tobin's tubes communicate directly with the outer air complaints are often made in cold weather of the incoming air being too cold.†

with Messrs. John Finlay & Co., Renfield Street, Glasgow, as to supplying such a valve-regulator on the grate as I refer to.

* A muslin or wire gauze screen to keep out smoke and dust would be useful here if attended to and cleaned occasionally.

† Reducing the amount of air let in sometimes stops the complaint. In other cases heating the air is the cure. Various plans of doing so are in use; one plan is by the use of gas heaters, which sometimes answer the purpose where there is a good-going vent or chimney handy into which a pipe can be led to carry off the bad air produced by the gas. Other plans are by the use of hot water pipes or hot water "radiators." For offices, and in some cases for rooms, many now use gas stoves in the fire-places. In those with a heating air chamber, the foul air from the gas is led off by an outlet near the bottom of the stove. I think those are healthiest, and especially for rooms, which

In regard to air-supply to rooms over doors, Professor James Thomson, of the University of Glasgow, designed various plans of doing so, and has had some of them in use for twenty years or more. I show in Fig. 297G

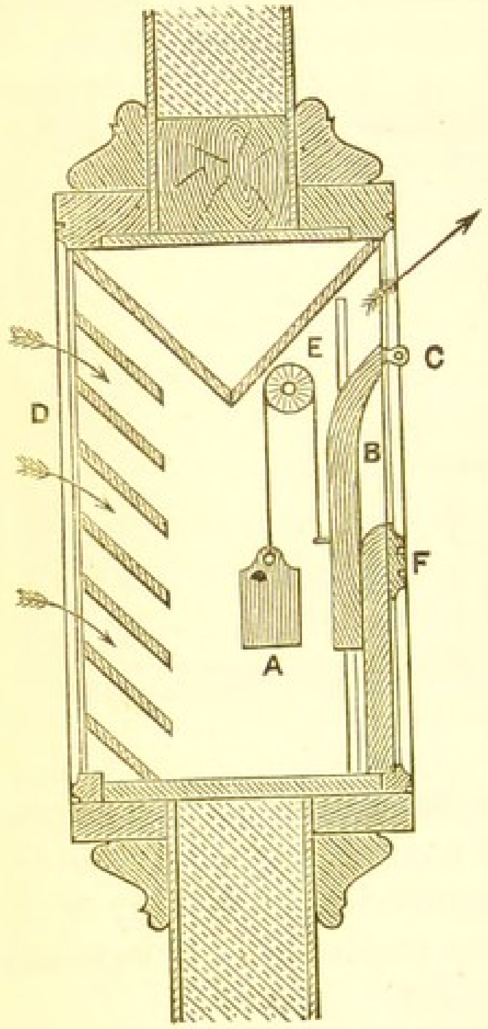


Fig. 297G

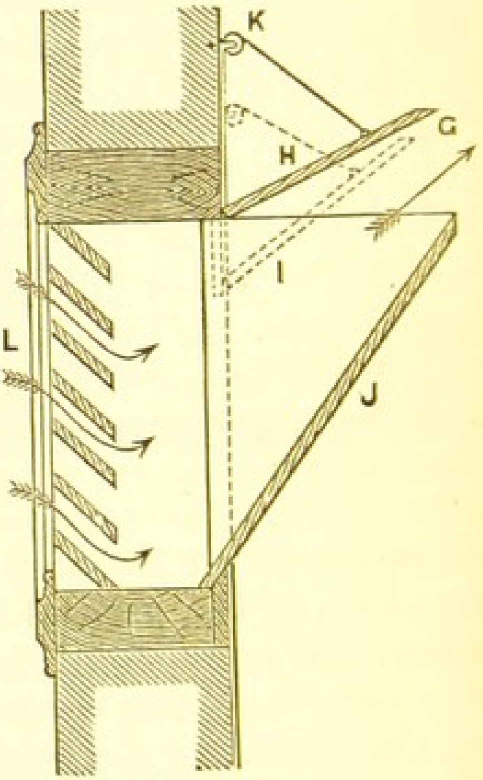


Fig. 297H.

one style of which he has kindly lent me the drawing, but the idea can be worked out in various ways, either simple or ornamental, as best suits the circumstances of the case. D, Fig. 297G, is on the outside of the room,

have no air chamber, and in which the foul air is led away from the top of the stove. Some of the gas companies now supply these stoves in both plain and ornamental patterns. Care should be taken to see that the vent goes well and that the vitiated air from the gas is not blown back into the room or office.

B is the vertical sliding valve above which the air enters the room, C is a metal eye by which the valve B can be raised and lowered, A is a balance weight. In front of E is shown the groove in which the valve works. F is wooden fixture. Fig. 297H is another style, L being outside of the room and J wooden board placed at an angle above the door inside of the room. This style at J may also be used in place of the louvre boards at L outside. The breadth of board J may be 18 inches or more, and height about 18 inches; each end of J is closed in. H is the valve on top, which may be regulated by a cord and pulley K. Instead of the back of valve being as high as top of J, it may be fixed or hinged down at I as per dotted line. The Fig. 297G style was used about thirty years ago, and any one is free to use the styles.

In admitting fresh air to any apartment care must be taken that it is so admitted as not to give the occupants cold. Too much of even a good thing may do evil. There is a sensible Spanish proverb which says, "Beware of a cold draught and an angry donkey."

In the case of schools and churches, short but large flushings between the lessons and sermons when the scholars and hearers are out is very good, especially if done quickly, so as to renew the air without giving time for the walls, &c., to cool. Amongst my disagreeable experiences has been that of hearing the "Word of God" preached in a stifling, or badly, or non-ventilated church. Few things are more incongruous or inappropriate.

H, Fig. 297F, is an outlet-pipe with valve, sometimes put in in place of the pipe C (but it may be put in and C too), to work when there is no fire on. It may deliver into outer air, lobby, or vent.

To lessen the current of air towards the fireplace and help to keep the room and people sitting in front of the fire warmer—especially on off-side from fire—it is a good plan to put in a large pipe from the outer air to front of fire, up through hearthstone say, and have a sliding or hit-and-miss valve on. This pipe must be put in so as to prevent any danger from red-hot cinders. I have this and the pipe C, Fig. 297F, also the wood slip G, in several of the rooms of my own house. As I write this, two gas lights have been burning in my dining-room for the last two or three hours, yet I find that, owing to the fire being on and the pipe C working, the atmosphere of the room feels quite good even upon going out to the fresh air and coming in again, whereas, with the valve D shut and the pipe C not working, the air of the room feels stuffy to me in half an hour or so after the gas is lighted.

The style of outlet-ventilation shown in Fig. 297F may be termed the aerial-siphon system of ventilation, the vent being the long leg of the siphon and C the short leg; the motive power is got by the weight or pressure of the atmosphere upon the top of C being greater than the weight of the warm air in the vent from the level of the top of C to the top of the chimney.

In addition to having the rooms of a house ventilated *per se*, the lobby and staircase should also be ventilated by a large special pipe surmounted by a ventilator as high as the ridge (or some other plan), which ventilating-pipe should have either a self-closing valve in it or one which can be closed and opened when wished.

Referring especially to the ventilation of schools, churches, halls, and other buildings, I stated several years ago, and I am of the same opinion still, that:—"From entire liability to down-draught in unfavourable conditions there is no wind-acting exhaust ventilator that I know of free." I have experimented with a number asserted to be quite free from down-draught, but they could not stand the test. They often allowed down-draught badly even under the same conditions as my own sucked up pretty well. The necessities of the case drove me, however, to invent and introduce some simple appliance which, while not marring the exhaust power of the ventilator, or impeding the outgoing vitiated air in any way, would prevent the down-draughts so often complained of, and which were alluded to on page 264. Another felt want was some easy and simple means *for seeing how the ventilation was going on.*

Both these important desiderata have been supplied by the introduction of my patent Self-acting Anti-down-draught and Inspection Valve-Boxes.

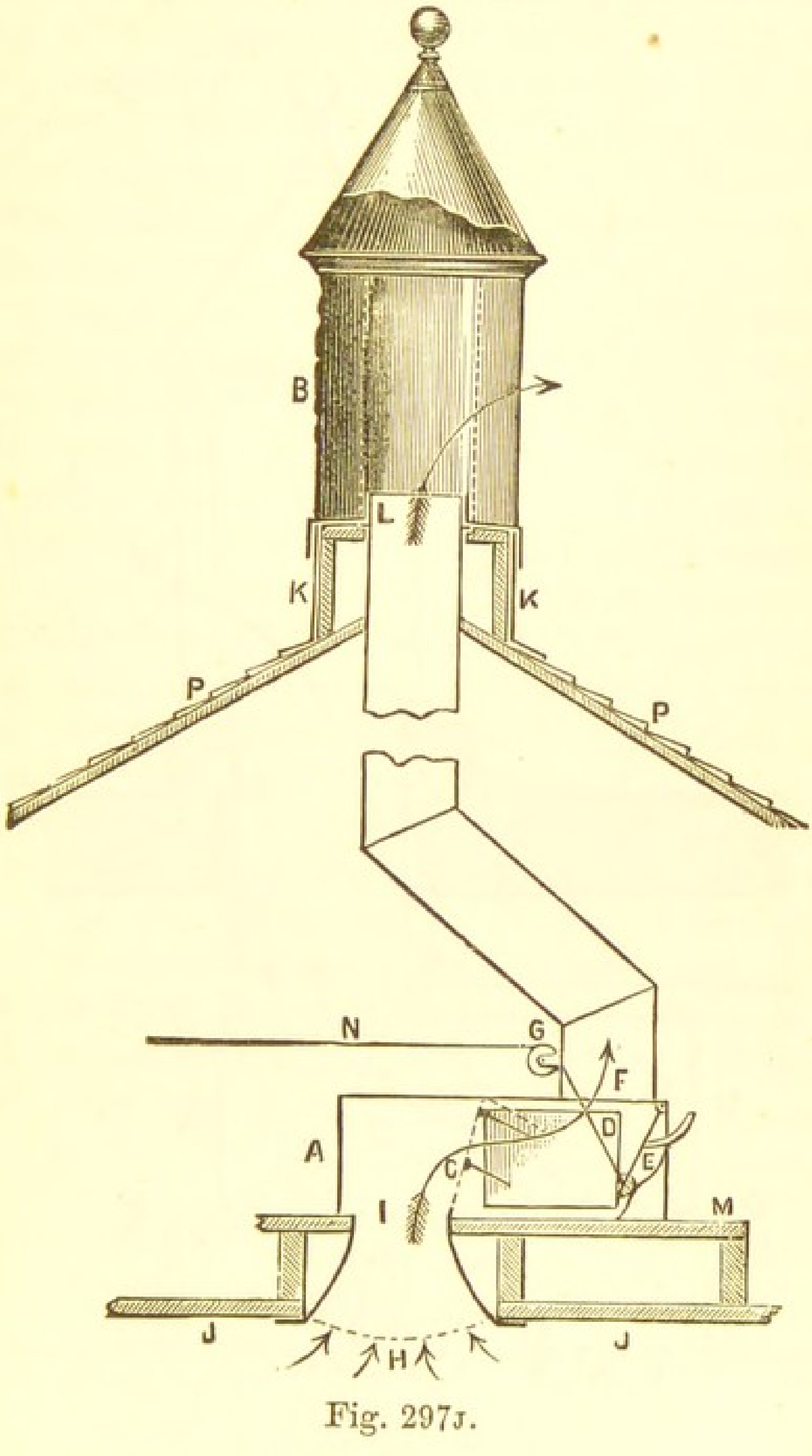


Fig. 297J.

I here give some diagrams to illustrate their application.

Fig. 297J shows a No. 2 Buchan's patent 20-in. or 22-in. Ventilator, B, seated upon a square wooden frame, K, above the ridge of a building, and with say, 12-in. outlet ventilating pipe, L, F, as for a small hall, led up from the top of the patent valve-box A, which is seated upon a wooden plank M that rests upon the ceiling

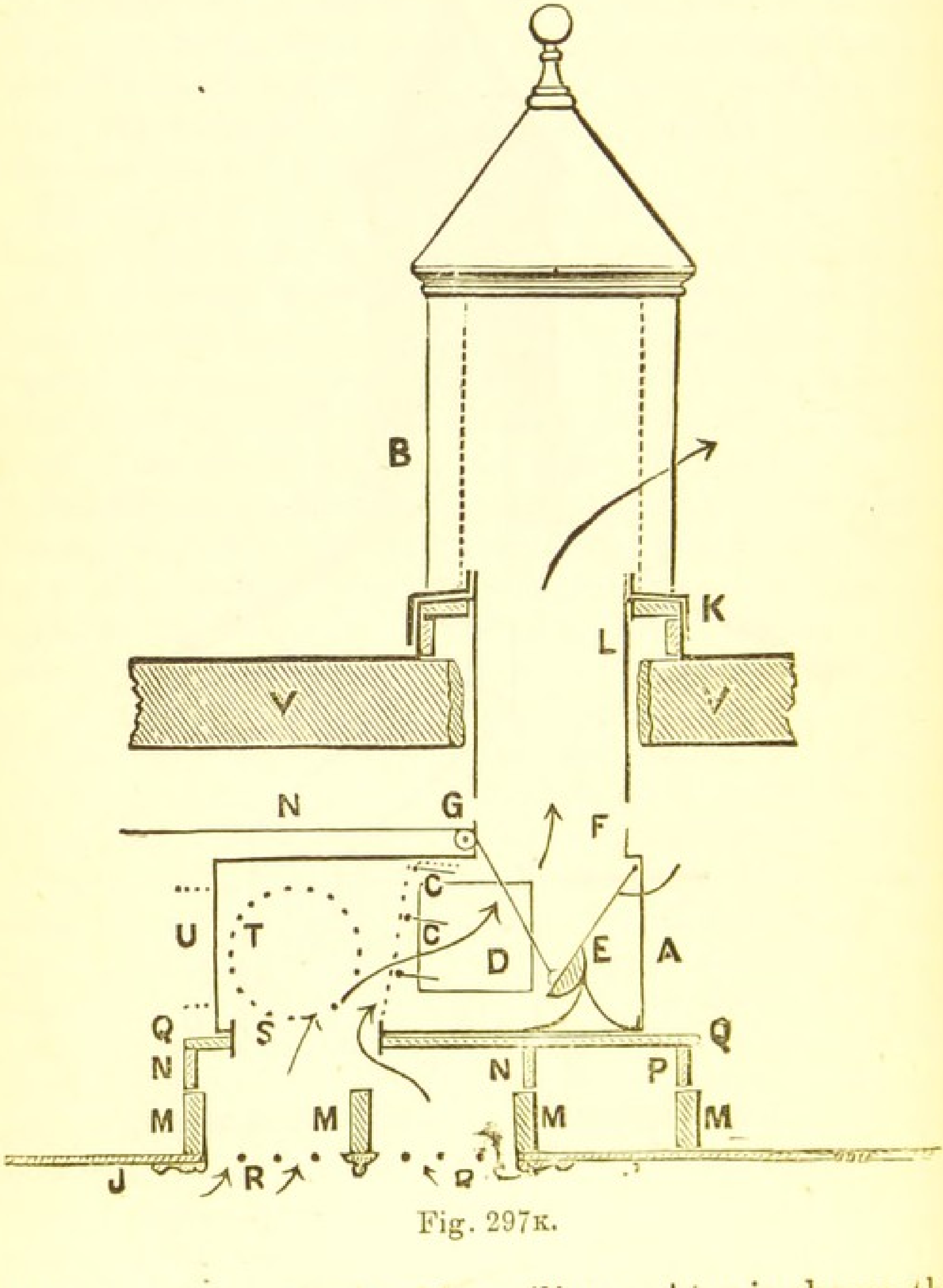


Fig. 297K.

joists as shown, J being the ceiling. At C is shown the position of the self-closing silk valves, which open with the slightest up-current of air, but shut down at once with the least temporary attempt at down-draught. D shows the position of panes of glass—one on each side of the box—for looking through to see how the valves work, &c. E is a loaded metal valve with pulley and cord, G, N, for closing the outlet ventilator when the building is being heated up, or for regulating or stopping the outgoing air when the ventilator is drawing up too much. The cord N should have an index-plate.

In the diagram the valve-box A is shown seated across the joists, and the pipe up from it bent to suit the valve-box outlet, or to bring part at L plumb above outlet through the ceiling as per H, I; but where the ventilator can be set a little farther along the ridge, then the valve-box may be turned a quarter round, when the pipe between F and L might be plumb.

Fig. 297K shows a 30-in. No. 2 Ventilator seated above the ridge V V, and with the outlet ventilating pipe F, L, 17 inches or 18 inches in diameter, carried up vertically from the valve-box to the ventilator. In addition to the air going away through R, R, S, into and through the valve-box, additional inlet pipes may be connected as indicated by the dotted lines at T and U. J J is the ceiling, N N are pieces of wood about 4 inches high placed on top of the ceiling joists for the wooden seat Q Q for the valve-box to sit on. Corresponding pieces of wood to N N are placed at each end of N N to form an air-tight box, so that the air passing in at R R through the open flower or openings in the ceiling cannot get away anywhere except up by the passage or opening S into the valve-box, and then through the pipe F, L, to the ventilator, B.

In the case of roofs open to the ridge (which have no flat ceilin g or horizontal joists like Figs. 297J and 297K) a modification of the valve-box—termed the "open-roof valve-box"—is used, and may be fixed, as here sketched at A A, Fig. 297L, a little below the ridge. B indicates either a wood board or two ribs of wood for the valve-box to sit on. Or instead of this, the box may be supported by two bands of hoop-iron screwed to the inside of the roof.

These self-acting valve-boxes have now been fitted up in many churches, schools, halls, mills, billiard-rooms, and other places. They are especially useful for hospitals, in preventing chills from down-draughts. Where they have been fitted up they have given *confidence* to those interested in their working to keep the ventilators open in all weathers, whereas without them the ventilators would be often kept shut when they should have been open, for fear of down-draught. Where they are fitted in they also prevent the ventilators being blamed for cold-air draughts in a church, school, or hall, when they do not deserve it.

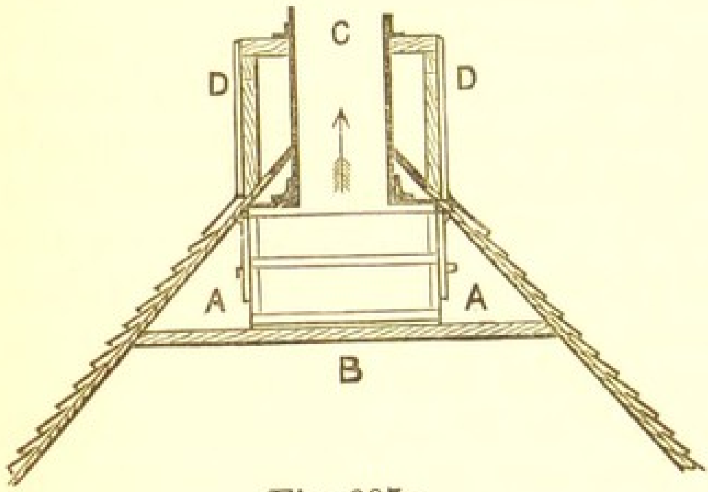

Fig. 297L.

I had an example of this in February last, in a new church which was opened for service before the plaster on the ceiling was dry. In this case the architects went up with me to the garret and looked through the inspection panes of the valve-boxes, when we found that the ventilator was drawing out the air all right at the rate of several hundred feet a minute. The cure for this complaint, therefore, was to heat up the church and exercise a little patience until the plaster dried. This prescription had the desired effect.

Another useful service these valve-boxes render is to prevent the smoke and soot, often flying about roofs, from getting into the building down through the outlet ventilating tubes.

In reference to the cry that has been got up lately in some quarters for mechanical ventilation to be used generally in the ventilation of schools, churches, and halls, &c., I consider this in thousands of cases would be a pure waste of money. It is not only more expensive at first, but it also means *continuous expense and attention afterwards;* whereas with the automatic ventilation carried out as indicated on pages 279 and 280, and with the ventilators and pipes of sufficient size, the outlay is not only cheaper at first, but there is no continuous outlay afterwards. In connection with this the architect, Mr. Lake Falconer, at the large public schools at Blairgowrie, Scotland (where my exhaust ventilators and valve-boxes were fitted up for the outlet ventilation and inlets provided on the Tobin's tube system in April, 1886) says, after two years' experience, that the ventilation has been most satisfactory in all weathers, and that they could not have had it better supposing they had gone to the great expense of providing mechanical ventilation.

Mr. J. Murray Robertson, F.R.I.B.A., architect, Dundee, who has fitted a large number of my ventilators upon his buildings, in some cases with the valve-boxes, considers mechanical ventilation to be seldom necessary, as he finds few cases where properly arranged automatic ventilation is not sufficient.

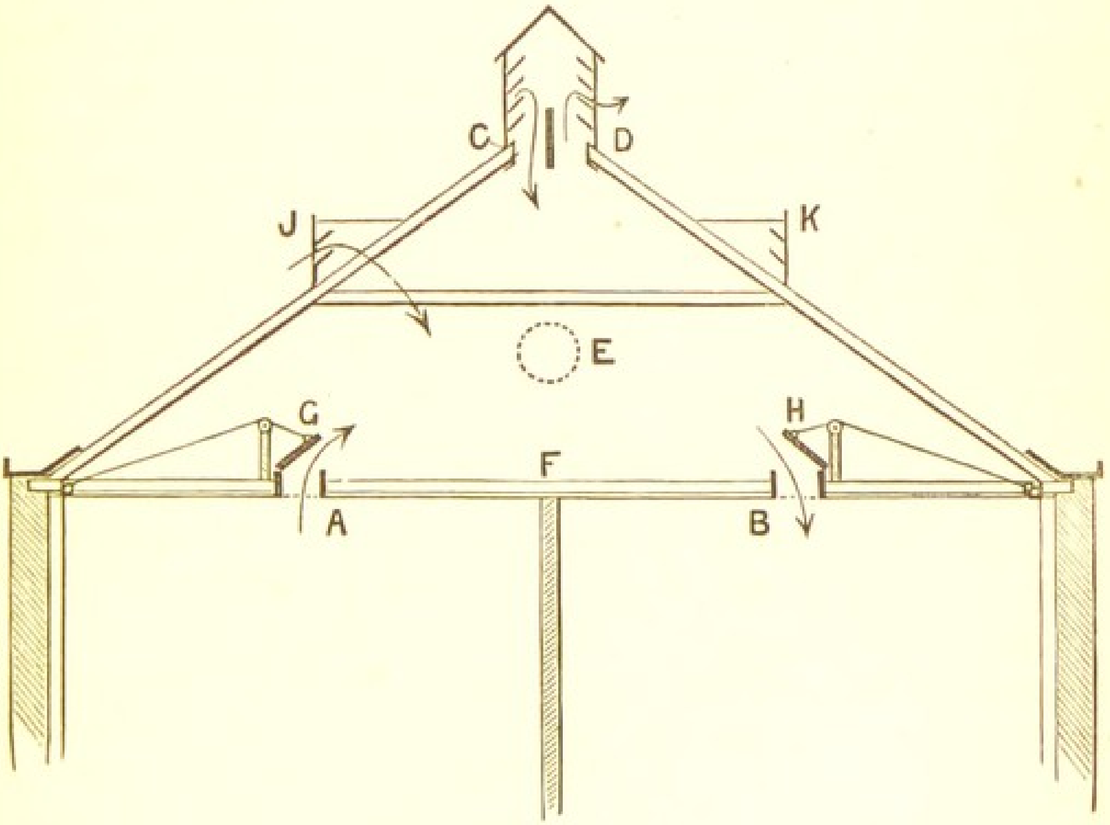


Fig. 297M.

Mr. John Honeymoon, F.R.I.B.A., also says:—"I agree with you that in the vast majority of cases automatic ventilation is best—proper provision being made for both inlet and outlet."

Some of the causes that have led to the cry for mechanical ventilation have been the existence of schools, churches, and halls, &c., without any means for ventilation at all. In other cases, what automatic ventilation there was, was too little, and not properly carried out; while many of the appliances put in did not act up to the pretensions of their vendors. To use such premises as a reason for the condemnation of automatic ventilation generally is absurd and also unfair to the public.

The above rough sketch in vertical section, Fig. 297M, will give an idea of some of the unsatisfactory ways in which automatic ventilation has been attempted to be carried out.* In this case A and B are two rooms, in a school say, with outlet ventilation openings in the ceiling. These openings have no pipes connected to them, but simply open into the garret F, from or through which the air, intended to come up the ceiling openings, is supposed to go out at the wooden louvre ventilator C D.† Instead of doing so as wished, however, the wind often blows in at the ventilator and down the openings in the ceiling, whereupon the wooden valves G H are shut and the ventilation

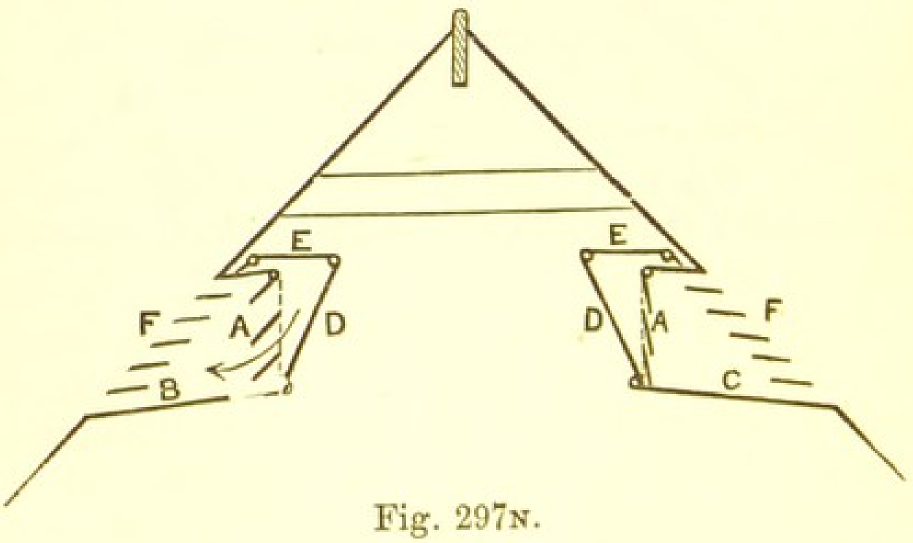


Fig. 297N.

* Thomas Tredgold made the mistake of advocating this plan about fifty years ago, and so has misled many.

† The louvre ventilators are generally good at *down*-draughts, and therefore often prove a nuisance.

stopped—perhaps when the school is full and the outlet ventilation most needed.

Instead of the louvre ventilator C D, another foolish plan, if possible worse than the foregoing, is to have two large openings in gables facing each other, as per E. A modification of this is to have the openings on the sides of the roof, as per J K, Fig 297M. I have often seen these boarded up after a time on account of the discomfort caused by down-draughts from them.

Improvements upon these latter have been brought out by Mr. John Honeyman, F.R.I.B.A., Glasgow, and myself, in which the down-draughts are prevented by

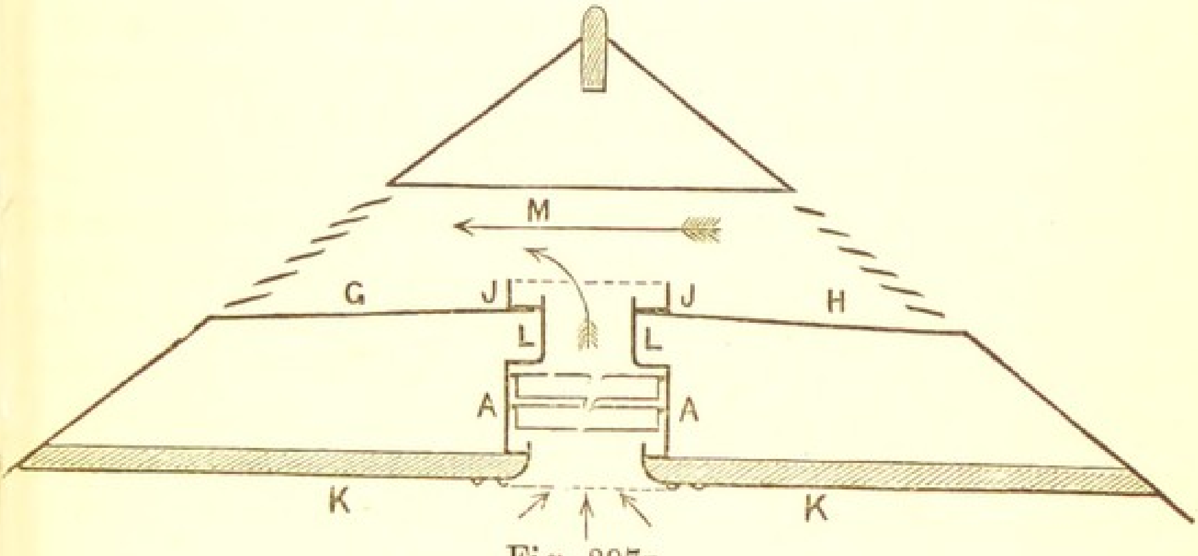


Fig. 297P.

self-closing valves. In Fig. 297N, two of my open-roof A.D. 1883 valve-boxes are seen, one fixed on each side of the roof, with both self-closing valves A and metal or wood valve D, worked by the cord E. When the wind blows against the C side of the roof it shuts the valves A there, and those on the lee side B may then open—if *pushed* open by outgoing air.

Another style is to form an open channel from side to side of the roof as shown at G H, Fig. 297P, and place in it one of the working sections of my 1883 exhaust ventilator, as shown at J, and between it and the ceiling, KK, place one of my 1883 valve-boxes AA, as shown at Fig. 297K, with any length of pipe, LL, as requisite. In this case, when the wind blows on side of roof at H, said wind blows through as shown by the arrow M, and draws the air out from the building as shown by the smaller arrow and darts. Down-draught is prevented by the self-closing valves in the valve-box AA.

Where sufficient air is coming in at the windows or air-inlets to cause a pressure of air out through the exit-ventilator JJ, this style of outlet-ventilation will sometimes serve pretty well, and may get the credit of *sucking out* the air, when, all the time, the air is merely being *pushed* out from below. In cold weather admission of too much cold air below is often objected to, and people like a ventilator that can draw out the air with the windows, &c., shut, just as they like a fire in a room to burn and the chimney to carry off the smoke well although the window is shut. Hence my recommendation of the system shown on pages 279 and 280. Of course, if air goes out air must come in, but people like it to come in insensibly, or without advertising itself too much.

Instead of having the two valve-boxes, as shown in Fig. 297N, for the open roof, some might prefer to carry a channel right across from C to B and place a double valve-box, as per Fig. 297Q, in its centre. The valves on A side are shown open, while the valves at B on windward side are shut. Mr. Honeyman's improvement upon this is to put a tube through, between B and A, to induce a current from the lee side.

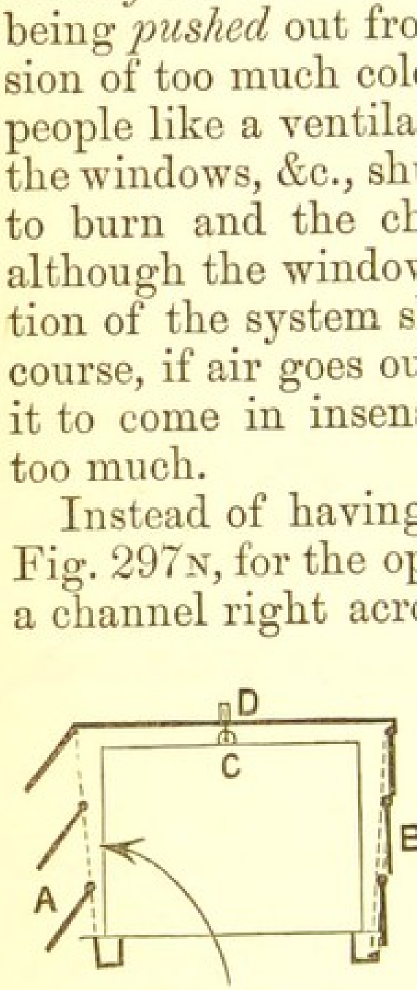

Fig. 297Q.

Figs. 297R show longitudinal and cross-sections of Mr. Honeyman's A.D. 1885 patent outlet ventilator, for placing inside a roof, below the ridge, with openings on each side of the roof. The wind entering from the side A closes the valves B B, and blows through the pipe D, and then the valves F F on the lee side of the roof may open and let the air from the inside of the building out. Mr. Honeyman has had these placed in a number of buildings, but I am sorry that, as yet, I have not had an opportunity to test their working, and especially to see what effect the tube D has in practice. A forced jet at a high speed would give considerable power to induce a current from behind it, but, except when the wind was high, where is the strong force for the jet to come from? Testing the outgoing air with the pipe D closed and open—other conditions being the same—would give the value of this pipe D. Mr. Honeyman says his valve-boxes have given most satisfactory results where they have been fitted up. This goes far to prove that self-acting valves are useful, and helps to justify my advocacy of their use for the last five years. Ventilating below the ridge without valves is bad.

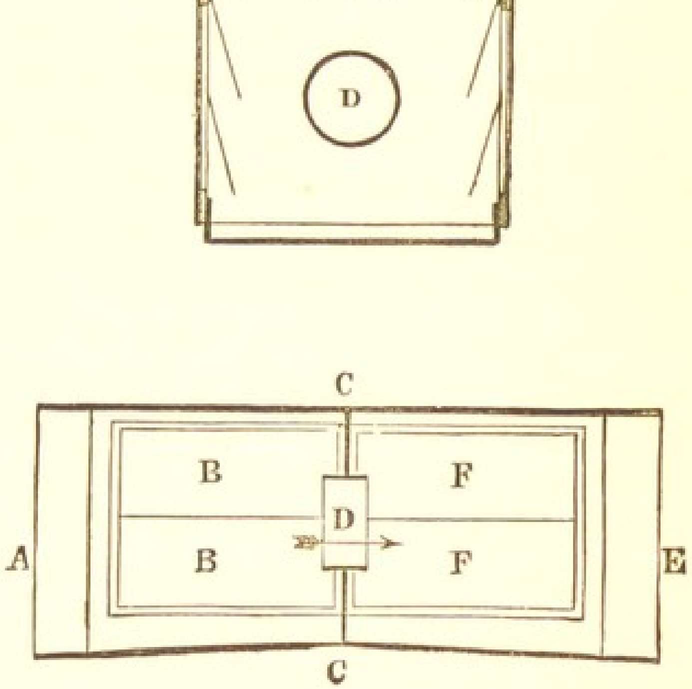

Fig. 297R.

Side ventilation-openings on the roof placed below the ridge in the position of J K, Fig. 297M, are so placed occasionally where it is not desired to have ventilators placed above the ridge, as shown on page 261; but I consider these ventilators placed on the sides of the roof, some distance below the ridge, as much inferior to those placed above the ridge, because with the former the wind can only act favourably upon them in a particular direction, whereas, when the ventilator is above the ridge, the wind may blow freely past it in all directions.

In my opinion, *ventilators have as good a right to be seen fully exposed upon a roof as chimneys.* Good ventilation is such an important factor in promoting health and comfort that it should not be shelved and neglected, as it has so often been. Instead, its necessity should be fully recognised, and ventilators should be prominently seen, it being the duty of architects to assist in making them presentable without marring their efficiency.

Hitherto it would often seem as if some people imagined that a ventilator worked all the better the uglier it looked, just as if an old iron scimitar, all jagged and rusty, were better than a first-class new steel sword. Designs, again, looking as if they were inspired by the cabbage-stocks in an old kail-yard, are open to improvement in more respects than one.

I may here condemn the practice of placing the fresh air inlets eight or ten feet high above the floor, or within a foot or two of the ceiling. This is absurd. The fresh air inlets should only be from about 4 feet to 6 feet above the floor, according to circumstances. It is a mistake to place them too high. In fact the fresh air might sometimes enter even at the floor level.

In connection with ventilation, the question is often asked, "What size of pipes and ventilators will be required for this church or that school?" &c. In answer to that, I have found it useful to draw up a printed formula, giving certain rules whereby the sizes of the pipes in connection with my ventilators may be got. In this connection it may be premised that as the sites and sizes of buildings are so various, it is difficult to publish a working rule suitable for all cases, more especially when *monetary circumstances* form a factor in judging. A building, such as a church, or a school, &c., freely exposed to the wind all round, and especially if on raised ground, will be well ventilated with about half the provision for outlet ventilation that would be required for a similar building if in a sheltered position, and with high buildings near or round it.

Upon this understanding it may be stated that for the outlet ventilation of churches, chapels, and halls, seated for say from about three hundred persons upwards, the rule may be to allow from half a square inch up to a square inch and a half of outlet for each person, the medium being one square inch of outlet for each sitter.

Another basis of calculation may be to allow from half an inch to one and a half square or superficial inches of outlet for each 120 cubic feet of space. It is generally better to have two, three, four, or more outlets in the ceiling than only one, and especially for long, low, and flat ceilings. A regulating valve is used to stop ventilation when heating up, &c. Where there are two or more branch pipes, the sum of their areas may with advantage be a quarter or so more than the area of the main outlet pipe.

For schools, the allowance for outlet ventilation should be much greater per head than above, as they are occupied for a longer time and daily, and by young growing persons. Hence, from two and a half to five square inches, or more, of outlet for each pupil is needed, and provision ought to be specially made to prevent down-draughts upon the heads and bodies of the children, as they often have not either the sense or the courage to complain themselves.

Police and law courts might rank like schools.

Hospitals, again, require far more outlet than the foregoing, viz. about sixty square inches for each patient.

For rooms in houses, &c., allow about ten square inches of outlet for the room, and then from two to four square inches more for each person in it.

Those interested in this matter may get copies of the formula, with further details, sent them free by applying to the author and sending stamped directed envelope.

I may add a word here about the ventilation of railway carriages, which, in my opinion, is generally done in a very perfunctory manner. Being a daily traveller by rail, I consider myself justified in objecting strongly to the vertical ventilating slits made in the tops of the carriage doors, and consider these have often hurt the health of railway travellers by the chills produced owing to the cold draughts blowing in through them.

The ventilators, in order to really act as outlets, ought to be placed on the *roof* of all carriages, as is *sometimes* done on first class ones, and have the necessary provision for closing them when wished. As passengers cannot amend this themselves, Parliament ought to force the railway companies to do it, and the directors and officials, with their wives and children, will reap the benefit as well as the general public. Perhaps some of the railway companies for their own credit will take the hint and improve matters without compulsion.

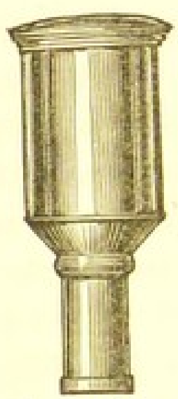

Fig. 297s.

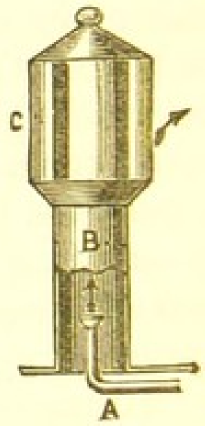


Fig. 297T.

Fig. 297s is sketch of one of my fixed exhaust ventilators for use on ships and yachts. After a comparative test, they were adopted by the engineers of the Clan Line of East Indian steamers for use on several of their vessels. They kept out the water better, and were less liable to down-draught.

Fig. 297T shows the application of a forced air jet, through the small jet tube A, for the purpose of increasing the out-current of air through the ventilator C in calm or close weather. The forced air jet may come from a fanner driven by steam, gas, or water-power, or by a falling weight, or from an air-pump.

I tried an experiment on the outlet ventilating pipe of a top flat room with a small 1 in. jet tube put in through the side of the outlet pipe and bent up, and blowing the air through the air jet pipe from my drain smoke-testing machine, worked by hand in the garret.

In this case a large fire was put on in the room, and the window and door shut tightly. The fire or vent then drew in part of its supply of air down from the ventilating pipe, but when the air jet was started, it beat the fire, and the air was drawn out from the room. This experiment was made to show the power of the air jet. A plan occasionally used to help the outlet ventilation in a vertical outlet pipe is to light one or more jets of gas in the pipe to heat the outgoing air. The gas-jets should be kept as far from top outlet of pipe as convenient. Hot water is sometimes used.

About ten years ago, when some unwell persons were complaining in one of the Glasgow newspapers about the pain they suffered on Sundays, owing to the clanging of so many of the church bells at once for a quarter of an hour at a time, a suggestion was made by me that the beadle should only pull the bell-rope for seven minutes at a time, and utilise the other seven in hoisting a weight to work a fanner, in the style above referred to, to improve the ventilation of the church. People prefer ventilating appliances with as little trouble as possible, however; so it is not to be supposed the beadles were at all thankful for the *latter* half of this suggestion.

Index-plates, telling when the cord-worked valve of the ventilator is "open" or "shut," should be fixed up to prevent persons shutting valve by mistake.

I intend to say more about ventilation in a separate volume at a future time.

At page 111 reference was made to certain water-closets not there described; the following diagrams give an idea of some of the styles referred to. The first three shown belong to the "Wash-out" style, and with a plentiful supply of water they may do well. Fig. 298 is a vertical section of Jennings' "Monkey" closet; the horn at B is intended to ventilate the soil-pipe to the outer air, of course. This closet, in one or two pieces, was patented by Mr. Jennings in August, A.D. 1852, but the horn B is a late addition. Fig. 299 is Woodward's "Wash-out" closet. Fig. 300, a newer design, is Bostel's closet brought out as an improvement upon Jennings'. It seems to me that the ventilating-horn C is in the wrong place. See page 298.

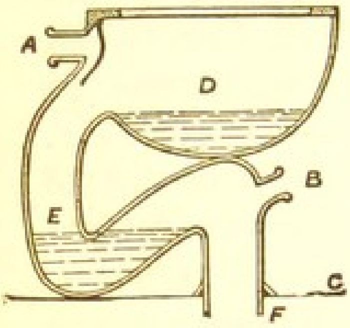


Fig. 298.

Fig 299.

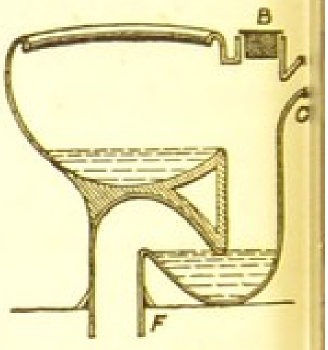


Fig. 300.

Another closet lately introduced, which reminds me of Fig. 170 minus the trap, is "Pearson's Patent Trapless Twin-basin Water-closet." I consider it very dear and little improvement upon Shank's closet in use long before it. I also consider the want of the trap a great source of danger, for if a piece of paper, &c., gets under the valve, especially when the water is off, there is nothing to prevent the pollution of the atmosphere of the house from the soil-pipe. I consider this "trap-less" closet much inferior to the old cheese-closet in use thirty or more years ago, and which also had two water receptacles, but, in addition, a lead water-trap underneath. Mr. S. S. Hellyer writes very strongly against the use of trapless closets.

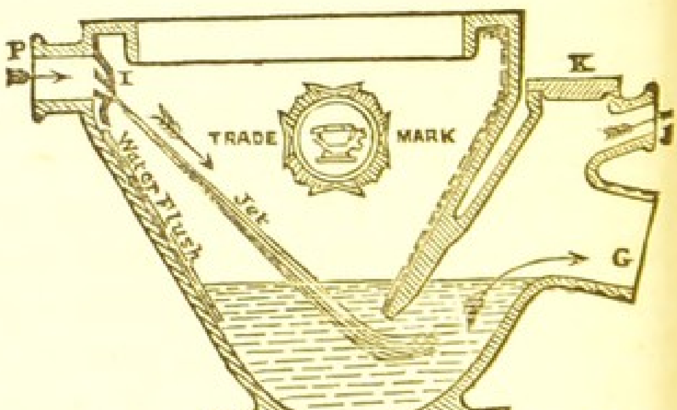


Fig. 300A.

Figs. 300A and 300B show vertical sections of two patterns of the wash-*down* (as distinguished from the wash-*out*) style of closet, invented by myself and patented in 1879.

It is known and registered as the "Carmichael Washdown Accessible Closet." Fig. 300A is sold as "No. 1002;" it is in one piece, and in the P-trap style. Fig. 300B is "No. 1003," in two pieces, and in the S-trap style. The flushing water enters the basin through

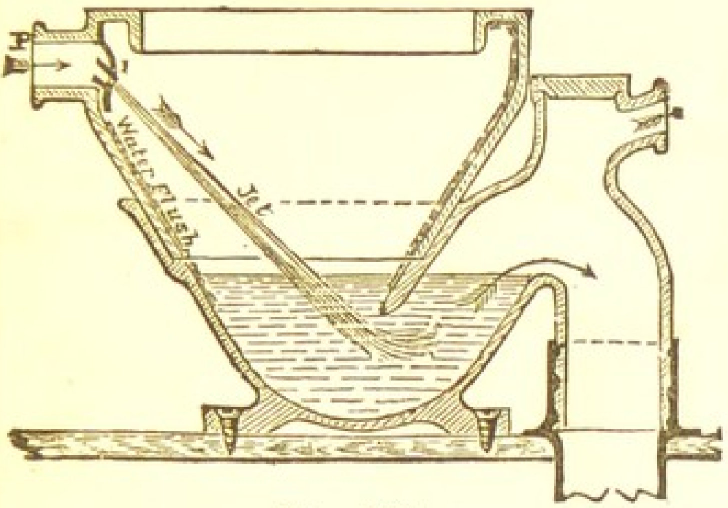

Fig. 300B.

my patent adjustable metallic jet-fan I, which, while allowing the water to flow all round the interior of the basin, also at same time produces a special water-jet, as shown in diagrams, which jet submerges and sends off the paper, &c. At first I tried a hollow-rim basin partly perforated instead of the metallic jet-fan, but, finding it required more water and was much more difficult to regulate for flushing, I have allowed it to drop, and the makers now only supply the metallic jet-fan with turn-down-rim style of basin or closet, as shown in diagrams. The closet may be had in four different styles, as ordered, viz., Nos. 1001 and 1003 in the S-trap style, and Nos. 1002 and 1004 in the P-trap style. Nos. 1001 and 1002 are each in one piece of earthenware, Nos. 1003 and 1004 in two pieces of earthenware. The latter style allows the basin considerable freedom to be turned round in the direction most suitable for the service or flushing pipe; but on account of the joint—which, however, is above the water, as seen in Fig. 300B—many prefer the closet in one piece. In many cases, as being more handy to use, I have a liking for the style in two pieces, and have it fitted up in my own house, for, when the basin and trap are well joined with either red lead putty, stucco, or cement, the two are virtually one. Then again if basin or trap gets broken of either Nos. 1003 or 1004, only a half-closet is needed to put things right, whereas, if either Nos. 1001 or 1002 are broken, a whole-closet would be needed. In setting the basin of either No. 1003 or No. 1004 the inlet-horn of the basin should not be placed right above or over the outlet of the trap, but somewhere opposite to it, as in Fig. 300B, or to one side (either right or left), as at C in Fig. 300C. Attention to this in setting allows the water-jet to submerge and send off the paper, &c., better. This closet is supplied best, I think, from a cistern overhead, and with a $2\frac{1}{2}$-inch or 2-inch valve and 2-inch, $1\frac{1}{2}$-inch, or 1-inch vertical down-pipe according to height of the cistern. The pipe next the valve should not be less than 2 inches diameter, and should have a very small air-pipe, $\frac{1}{2}$-inch diameter enough, and *no service-box*.

Some architects prefer a simple pull-down bell-pull cord and handle for letting on the water, as per F in Fig. 300C. I use this plan myself, and have fitted up many of these closets so.* In other cases the lifting handle at seat is preferred. As various medical gentlemen consider that the usual closets stand too high above the floor, the height of this one is only $15\frac{1}{2}$ inches.

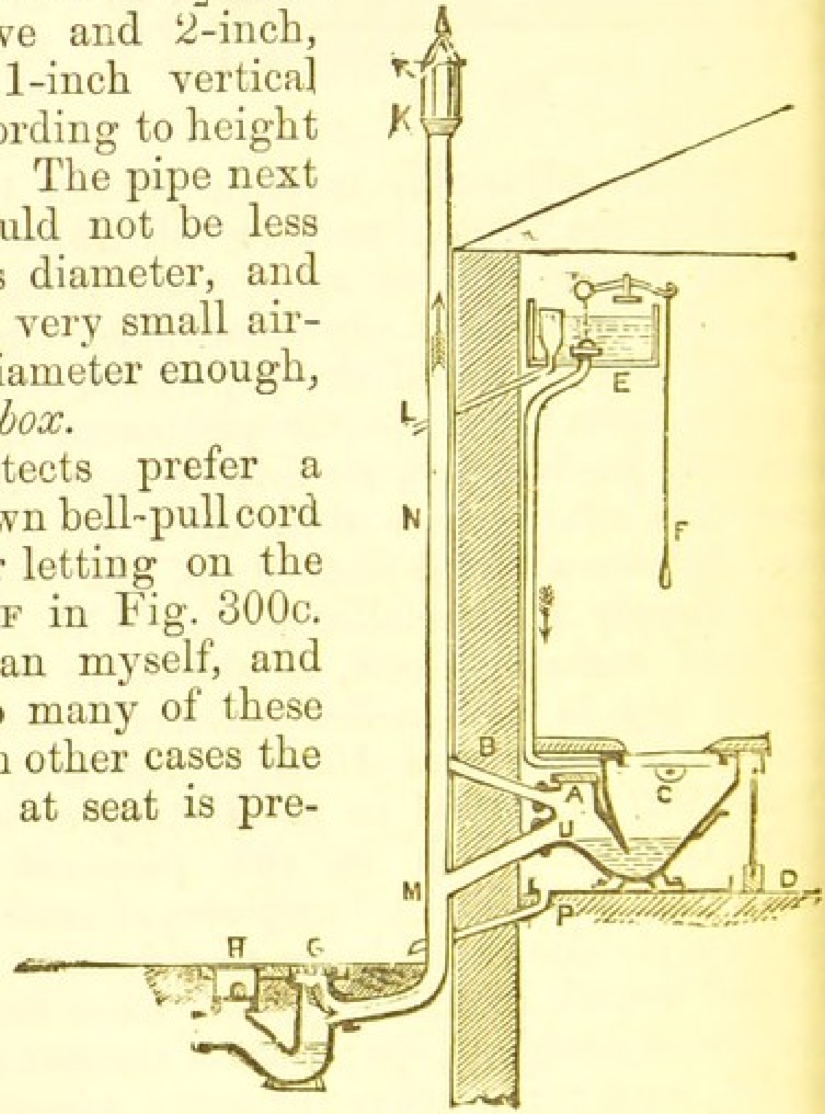

Fig. 300C.

* A check for the outer end of the lever to strike against is useful, to prevent it being pulled down too far. India-rubber or felt for deafening sound may also be placed under the closet if wished.

If wanted up to the usual height it can easily be set upon a small block of wood slightly larger than the earthenware sole of the closet. This wood may be placed under the lead safe, where a lead safe is used.

It is recommended to use this closet with the following sizes of valves and service-pipe from cistern, according to the height of the cistern above the water-closet, viz., about 6 feet or less above closet, a $2\frac{1}{2}$-inch valve and 2-inch service-pipe; about 8 feet above closet, $2\frac{1}{2}$-inch valve and $1\frac{1}{2}$-inch service-pipe; about 9 feet 6 inches above closet, 2-inch valve and $1\frac{1}{4}$-inch service-pipe; about 11 feet above closet, 2-inch valve and 1-inch service-pipe, with short tapered piece of pipe between valve and 1-inch, &c., down-pipe. A good size of small wood cistern, lined with sheet-lead, is 21 inches long by 11 inches broad and 15 inches deep all inside, or as much larger as desired. In towns, &c., where limited closet water-supply regulations are in force, either Ross's or other regulating valve of sufficient size may be used, or cistern with division and two common valves, or A. T. Bean's valveless waste preventer, or one of the siphon-action cisterns with 2 in. or $1\frac{1}{2}$-inch down-pipe. It is necessary that the water-flush of this closet should come quickly and with force, so that there be no waste of water. Two or three gallons coming *quickly* and with a good force will do more good than ten times as much coming slowly, while two short flushes are better than one long one.

Nothwithstanding the foregoing directions as to fitting up, the mistakes that various parties have made in fitting them are rather curious; *e.g.* one party had a $2\frac{1}{2}$-inch valve and 2-inch down-pipe from a small 2-gallon iron cistern, but only a 1-inch coupling between the valve and 2-inch pipe. Of course the flushing of the closet was a failure. I was appealed to to explain this, and desired the parties to take out the, in this case, stupidly small 1-inch coupling and use a 2-inch coupling. This was done, a 3-gallon cistern at same time being put in in place of the 2-gallon one, whereupon word came back that "now the closet works first-rate."

Anything new is sure to take a little time before the generality of workmen will properly master it, or get out of the old groove into a new one. In other cases many tradesmen take a pleasure in mastering anything novel.

A great many old pan closets especially—in some cases even Bramahs—have been taken out and replaced by these "Carmichael" wash-down closets. In some gentlemen's houses all the closets are "Carmichaels" in other cases only some of them. For their new premises,* the London Sanitary Protection Association (of which Professor Huxley, F.R.S., &c., is President), have adopted the "Carmichael" closet. It was fitted up by the North British Plumber and Sanitary Engineering Company, 4, Upper Baker Street, N.W., and Mr. W. K. Burton, engineer † (colleague with the late Mr. C. Innes, Secy. of the L.S.P.A.), wrote me that its working "is thoroughly satisfactory." It has been fitted up with a small siphon-action service-cistern and $1\frac{1}{2}$-inch service-pipe, the height being 6 feet above the closet. The cistern at one flush delivers $2\frac{1}{2}$ gallons of water in four seconds. "With these conditions the closet cleanses itself most thoroughly." Mr. Burton goes on to say very truly, "Much more care is necessary in fixing a wash-down closet than in fixing a valve one; but given the necessary care in fixing I must say I prefer the wash-down, and on the whole I have found none so satisfactory as your 'Carmichael.'" He also adds that in any case where he had come across a Carmichael closet not working satisfactorily, the fault lay *in the flushing* and *not in the closet.* With the adjustable metallic jet-fans there is no good reason why an ordinary plumber with the slightest gumption should not fit up the wash-down closets to work satisfactorily if he do so as directed, and makes the water-jet strike the centre. If in any case the plumber thinks the pipe he has put in is too large and allows too much water to come into the basin, he can easily sort that by cutting

* 1, Adam Street, Adelphi, London, W.C, † Now in Japan.

off 6 inches or so off the end of the pipe *next the basin,* and putting in a short piece of pipe $\frac{1}{4}$ inch or so less in diameter. In a number of cases I have a few inches of 1-inch pipe next the basin with a larger pipe behind and above it, and the flushing first-rate. It is easier contracting a too large pipe than putting in a larger pipe where too small a one has been put in at first.

A broad but shallow cistern, only a few inches deep, is not so good for flushing as a narrower but deeper one; *e.g.* a depth of water of 12 inches above the valve will give a good flush when only 6 inches would give an insufficient one, and even with twice the quantity of water.

The title "wash-down" is used to distinguish this style of closet from the "wash-*out*" styles shown in Figs. 298, 299, and 300. In the latter the water flows out sideways into the trap, the water in which is *out of sight,* while the pipe between the basin D and the top of the water in the trap at E, Fig. 298, is apt to get foul and furred where not seen. For this reason some prefer the "wash-down" to the "wash-out" style of closet. Dr. Neil Carmichael, in the important paper read by him to the Philosophical Society of Glasgow, in February, 1880, on "The Trap and Water-Closet System," says, "A basin with its outlet so curved as to form a siphon-trap, the deepest part of which *is seen* from the basin, the whole formed of one piece of glazed earthenware, fulfils all the conditions of a simple, clean, safe, and cheap water-closet." These principles, including the necessary flushing arrangement, will be found embodied in Figs. 300A and 300B.

There is a partial resemblance between Figs. 300 and 300A, in that both have access openings and lids with ventilating horns beneath, as at B and K, but in Fig. 300 both are upon the *house side* of the trap, while in Fig. 300A and B both are upon the *outer side* of the trap.

At the Philosophical Society's Exhibition, Glasgow, Oct., 1880, one of the two first-class sanitary medals awarded was to the "CARMICHAEL" CLOSETS.*

Since the last edition of this book was published, considerable improvements have been made by many makers in the appearance of the wash-out closets. This has been induced by the demand that has sprung up for exposed closets, *i.e.* without the usual wood casing in front of and around them; simply a narrow wooden lid, often hinged, so that the same appliance might serve both as closet and urinal, and sometimes as slop-sink also. Some of these exposed earthenware closets are highly ornamental. Fig. 300D is sketch of Twyford's "Unitas" wash-out closet, with the lid partly raised. Messrs. Doulton & Co., Shanks; J. & M. Craig, and many other makers are now making ornamental and improved styles of these closets. After a time a black looking deposit takes place below the water-line inside the closet; this can be rubbed off with muriatic acid.

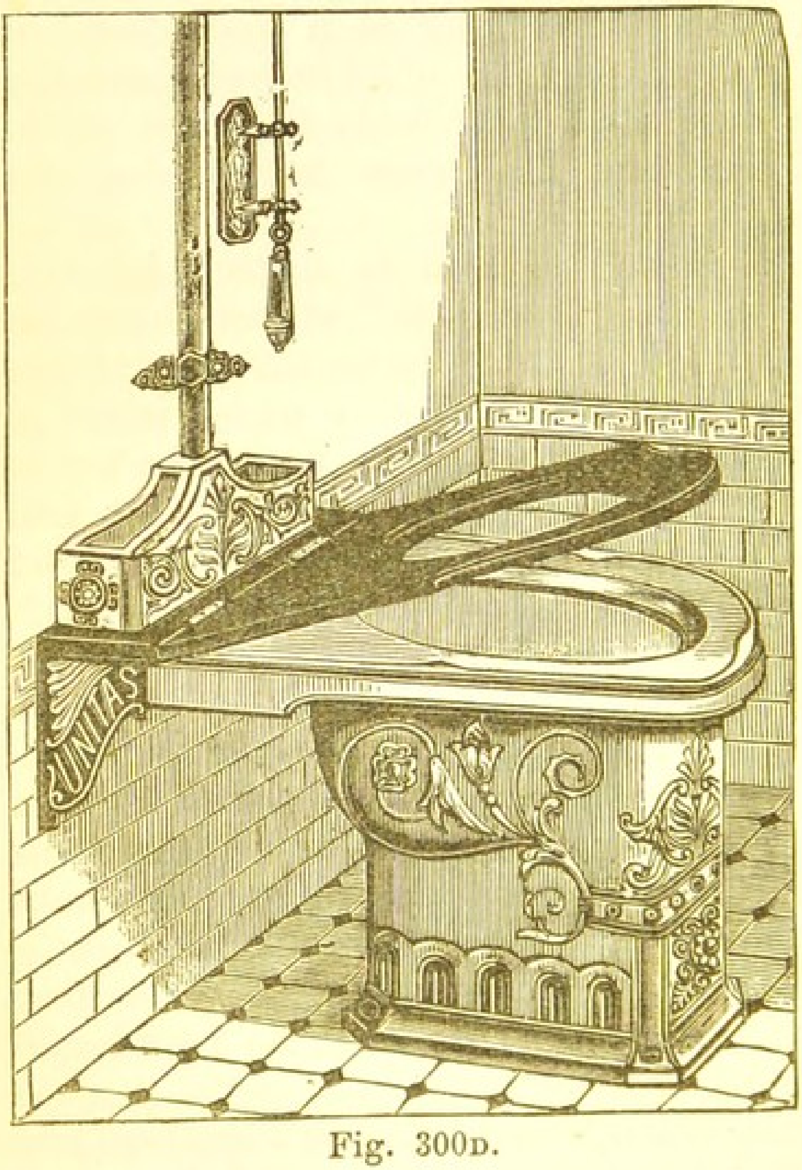

Fig. 300D.

* Messrs. Robert Brown & Son, Ferguslie Works, Paisley, Scotland, are the makers of these closets and supply them. A closet with valve on outlet, inside a side chamber, has lately been invented by a Mr. Buchan, in Edinburgh—the author has nothing to do with it.

A number of people have been advertising that by the use of their particular closet absolute freedom from sewage gas is guaranteed; but that is all nonsense, and highly misleading, for although a closet may be warranted, *per se*, to guarantee freedom from sewage, or *sewer* gas—which latter it may do all the more easily if the *sewer* gas is already locked off independent of it by a ventilating siphon-trap—*its* guarantee against *sewage* gas from the soil-pipe belonging to it is worthless, hence the proper fitting in, trapping and ventilation of the pipes and drains are of more importance than the use of a particular water-closet.

Fig. 301 shows in vertical section the general arrangements for providing, in a satisfactory, safe, and simple manner, for the water supply and drainage of a house. This diagram may be studied in connection with Figs. 272A, 281, 282, 282A, 283, 283A, 286A, 292, 293, 308, and 309, &c.

The trap marked $A^2$ $B^2$ shows how I have been in the habit of trapping off the soil-pipe from the drain, while at the same time providing for the proper ventilation of both soil-pipe and drain. This trap is the same as that shown at Fig. 272A. The size in this position is generally 6 inches, which size costs about nine shillings, 4-in. size less, and 9-in. more. C and D are two of my Induced-Current Fixed Ventilators.* E is the overflow pipe of the clean water cistern, with one of my self-acting block-tin bell traps in the cistern. K is one of my blow-in glycerine jointed cowls, shown here upon the supposed high-level inlet ventilating-pipe for drain. I have never as yet, however, required to put up this high-level inlet pipe so surmounted upon any of my jobs; although I have used a plain vertical inlet pipe 6 feet or more high. H is an overflow pipe for water-closet cistern. If the bell-trap is not used, it should have a hinged valve at its outlet end. G is clean cold water supply off the main to sink and bedroom on lower flats. On top flat the fresh water is shown from a cistern. J is a water-closet trap,

* Cost of these, according to size, from twelve shillings each upwards.

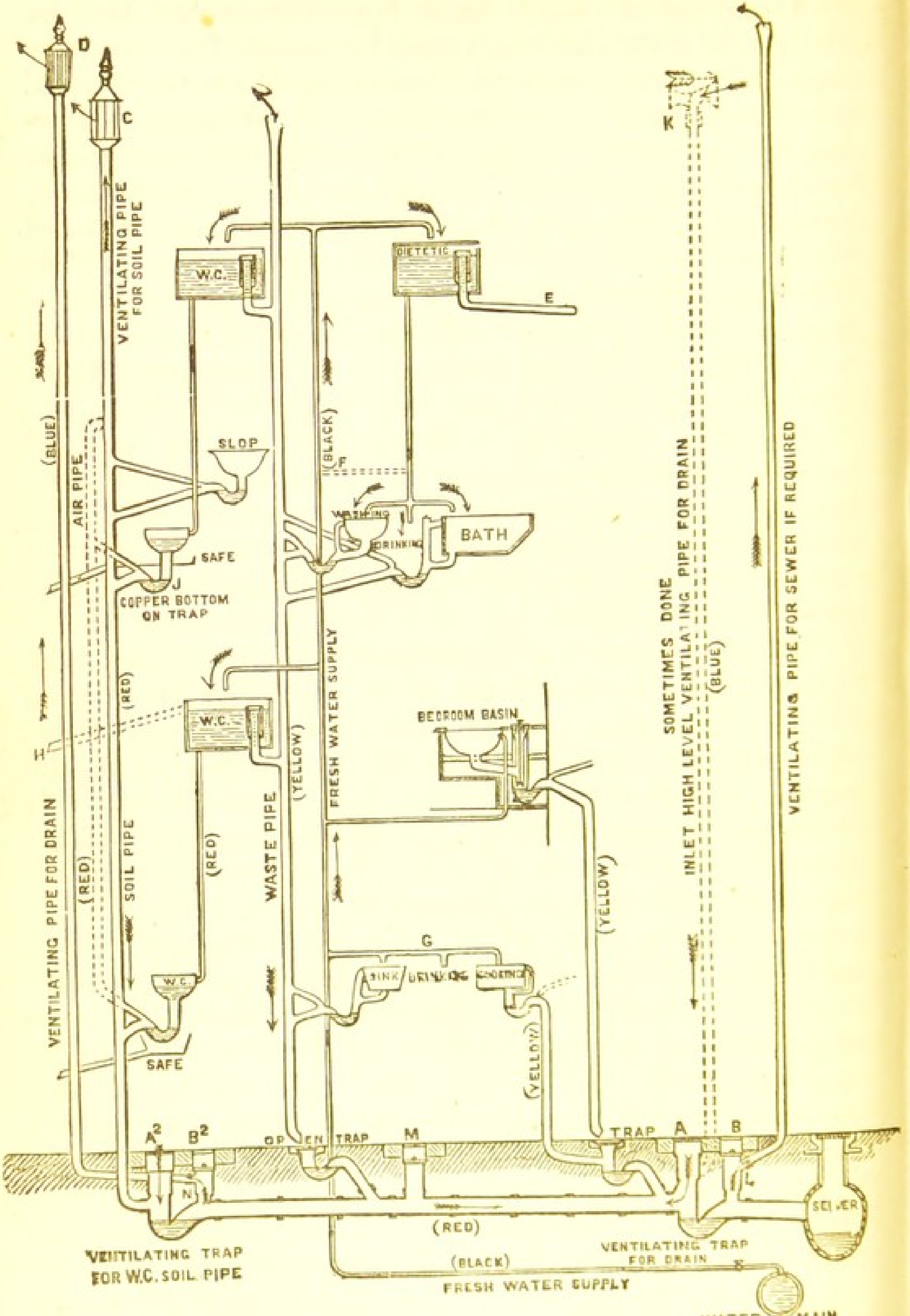


Fig. 301.

with the safe as usual *above* it, and upon the floor, but under the water-closet. This trap, J, may have a sheet-copper bottom added on it, to prevent it being holed by a lazy servant, say, poking it to get rid of something that should not have been put down. The trap A is the ventilating-trap dividing the house drain from the sewer; the opening at A is a strong perforated or ribbed iron grating—I prefer and use the former—for the admission of fresh air. It is easily removed in order to examine or clean the trap. B is the examination or cleansing eye on the outer side of the trap. It is covered by an iron plate, having a cemented-in fire-clay or iron lid beneath to prevent the sewer gas coming out. The ventilating pipe for the sewer, as at L—or for the drain as at N—is connected to and led off from the *side branch* attached to the vertical pipe. This plan, while allowing full and free scope for ventilation, provides for ready examination or easy accessibility at a moment's notice, without disturbance of or lifting the ground. The plan was patented by me, but is freely open to be used by all parties using my No. 2 ventilating traps. I do not here enter into the question or propriety of ventilating the public sewers up private pipes; I only here show what I consider the best mode of attachment when it is done. M is a cleaning or examination opening upon the drain, with iron plate and cast-iron lid underneath, the latter being cemented down. My patent pipe,* Fig. 286A, with the longitudinal access opening and lid, is in many cases the best to use for this. The space between pipe and surface of the ground may be built with bricks and cement, and have an iron plate on top like J, Fig. 303.

Instead of the kitchen sink discharging into a disconnecting siphon-trap, as into one of my No. 2 traps, it may discharge into one of my patent grease-traps manufactured by Messrs. J. & M. Craig, of Kilmarnock. Figs. 302 and 303 show different styles of fitting

* In "L'Hygiène dans la construction des habitations privées," published by Professor F. Putzeys, of Liège, assisted by Lieut. E Putzeys, these traps and pipes are illustrated and recommended, and so are my closets. My fixed ventila'o:s are also illustrated in three styles.

these grease traps in position. In Fig. 302 the grease trap is put in with its top on a level with the ground, as in private situations where persons do not walk over it. A is the inlet end of the trap, C the outlet end, B is

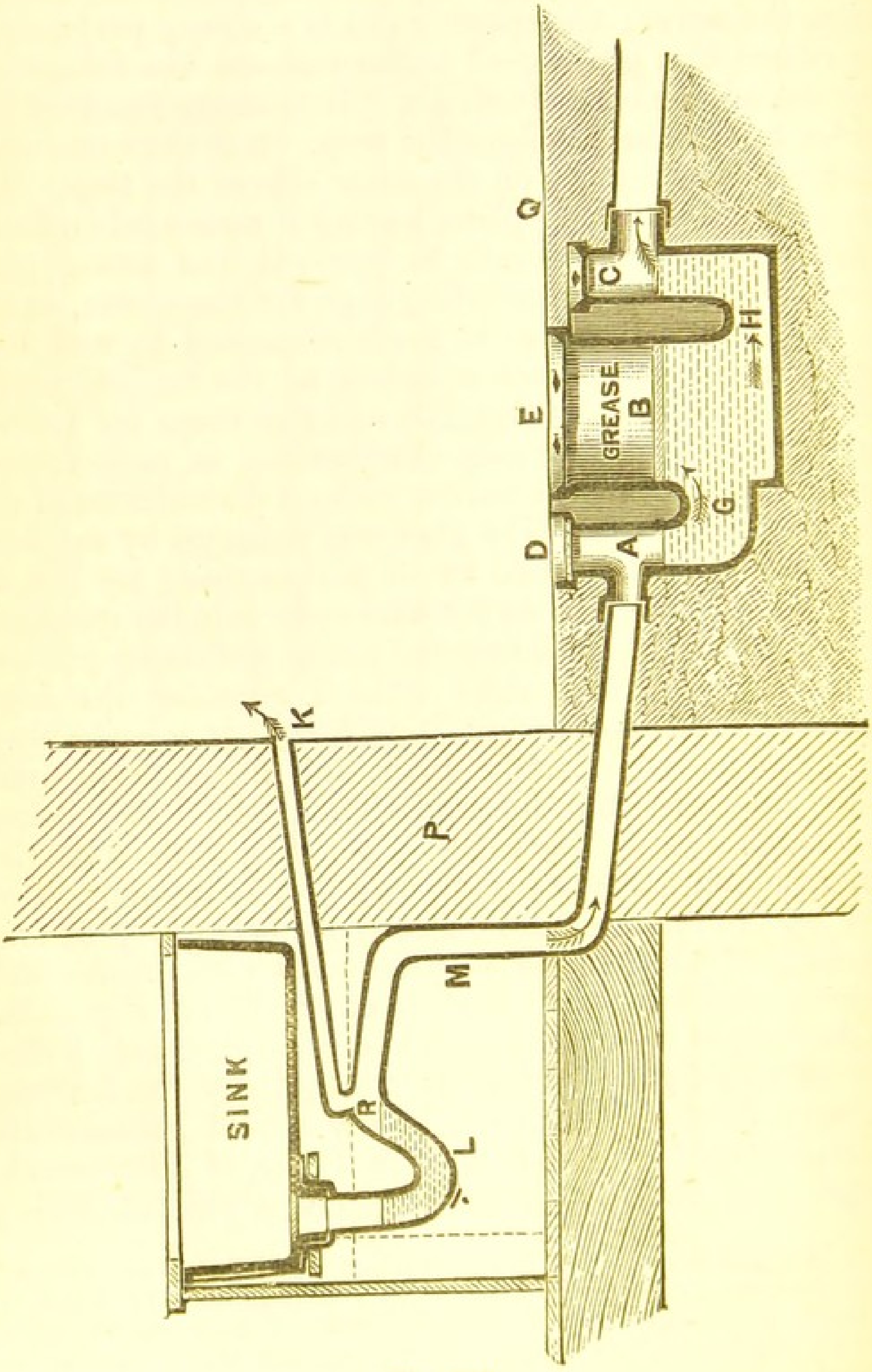


Fig 302.

the oval grease compartment where the grease lodges, and where it can be lifted out as necessary. In some cases once a fortnight, in others once a month, or once in three months. E is a portable lid over the grease chamber. Above C is a movable lid, sealed down with

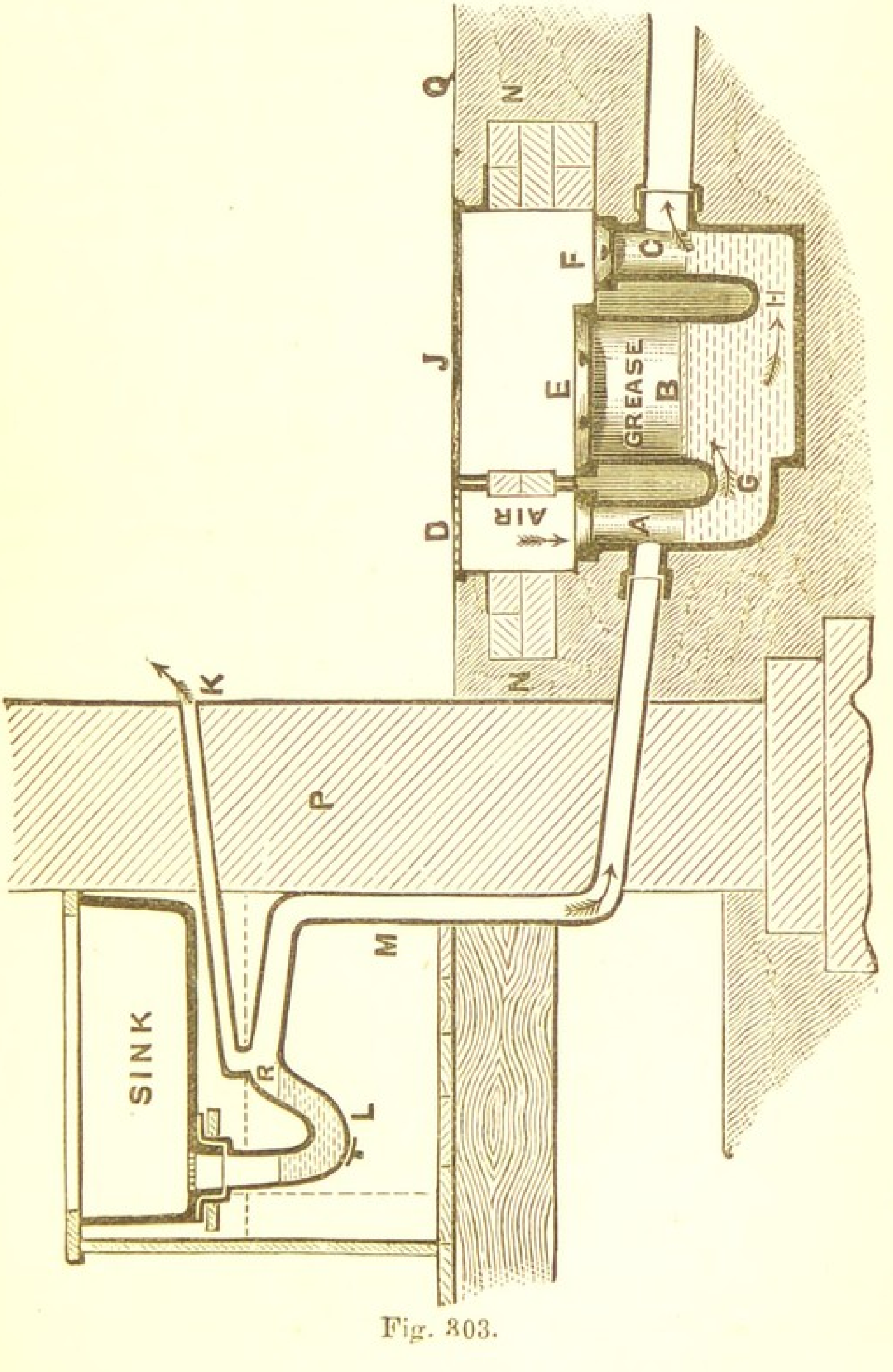


Fig. 303.

lime and Roman cement. It can be lifted when wished to get at the outer end of the trap. This is seldom necessary, however; D affords ready access at all times to the house end of the trap, and at D a small fresh air inlet grating may be placed. The fresh air entering at D goes up the waste pipe M and out at the air pipe K. Q, Figs. 302 and 303, indicates the level of the ground.

In Fig. 302 the grease trap is set some distance below the ground, and has a strong cast-iron plate J, 21 in. × 11 in., set in strong iron frame over the grease chamber, B; D is an 8 in. iron grating in iron frame. The small fire clay or iron access lid F is kept sealed down with lime and Roman cement on top. The lid E is loose. M is the waste pipe from the sink, K its air pipe, and L the lead siphon trap with a brass trap screw in its bottom. P is supposed to be the back wall of the house. This trap is made in two sizes, and is the best style of grease trap in the market. It has been in use for years at Balmoral Castle, the Highland residence of Her Majesty the Queen, and at many mansions, hotels, and private houses throughout the kingdom. Further information may be had from the makers.

Enamelled fire-clay sinks are now largely used. The white ones are the best. They are strong, about 2 inches thick, and clean looking, and can be had in various styles. If it is not intended to line them in with wood, the front part, or where exposed, may be enamelled as well as the inside. It makes a clean job to set them

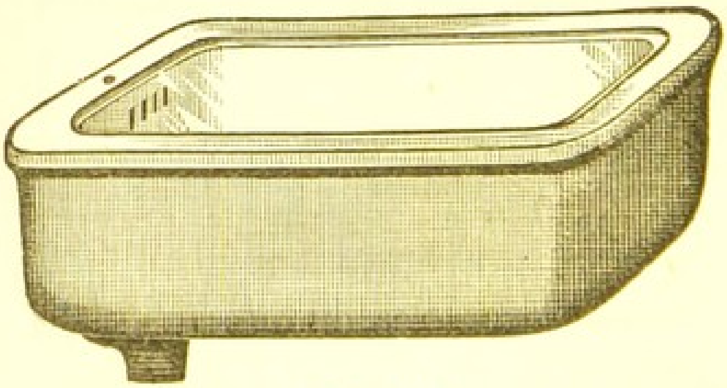

Fig. 304.

upon white enamelled bricks where they are exposed. Figs. 304, 305, and 306 show three different styles of these sinks, as made by Messrs. J. & M. Craig; the two latter with high backs, through which the hot and

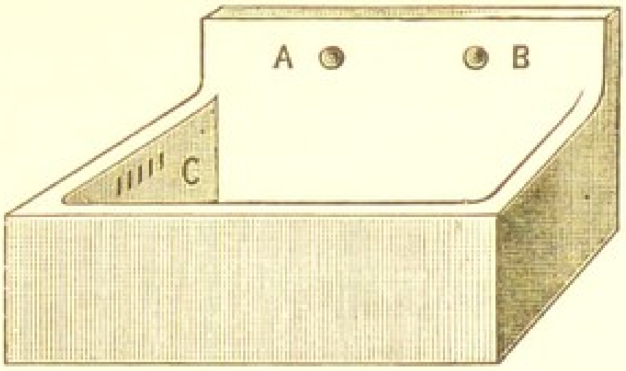


Fig. 305.

cold water cranes are often fixed, as indicated by the holes at A and B. It will be observed that while Fig. 305 is only raised along the back, Fig. 30 is raised both along back and one end, as if to be set in a corner.

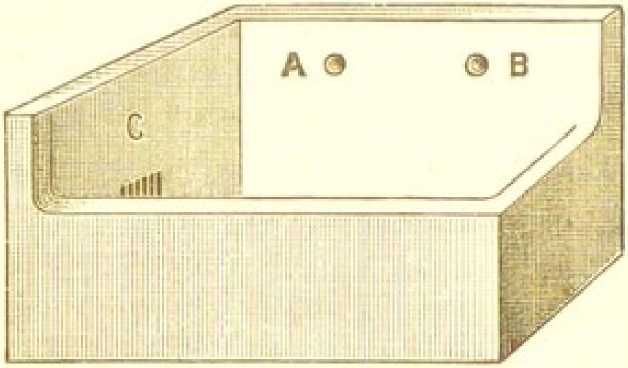


Fig. 306.

Fig. 307 shows one of my patent access pipes with a single branch L coming into it. The access pipe may

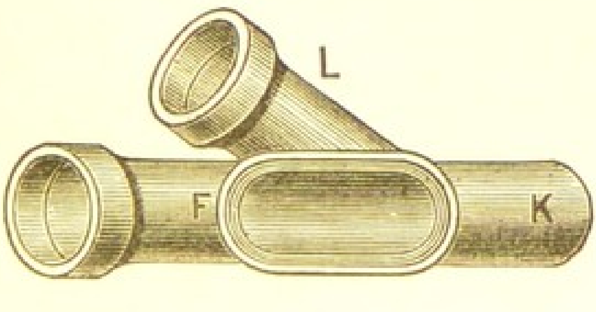


Fig. 307.

also be had with two branch pipes coming into it where required. It is very useful in practice to have these access-openings at the branches as well as at other parts of the drain. The longitudinal opening F is closed with an iron lid made tight with either Roman cement or lime. See back pages 248 and 250.

Fig. 308 shows a ground plan of the drainage of Armadale Castle, in the Isle of Skye, as altered and improved by me on the Sectional System in the spring of 1887, for the Right Hon. Lord Macdonald of the Isles. A, B, C, D, and E are closet soil-pipes inside of the house, with separate Buchan's 6 in. No. 2 disconnecting traps F, G, H, I and J outside for each. These latter traps have side fresh-air inlets as indicated, and as was illustrated on page 253. In the case of F trap the outside rain pipe "8" acts as the fresh air inlet. Where the drain pipes enter the house as at B, C, and D, they are laid on and surrounded by concrete, and have my access pipes with iron lids for easy examination, &c., when wished, without disturbing the pipes; most of the rain pipes are trapped at foot separately; but No. "11" trap serves for three rain pipes. The scullery sink has a Buchan's grease trap M set outside in the court, in style shown in Fig. 303. The other sinks are also trapped outside separately.

The drains going along the front of the house are kept distinct from those going along the back by the two 9 in. No. 2 Buchan's traps in the manholes. The fresh air enters each manhole from the side fresh-air inlet, and after passing along the inside of the drain goes up the two blow-off pipes, which are carried up above highest vents and each blow-off pipe surmounted by a No. 1, I. C. fixed ventilator. The traps marked "7" in front and "13" and "14" at back prevent bad air getting behind them. The soil-pipes A, B, C, D and E are each ventilated separately to above the roof. The blow-off pipe Z is 4½ inches diameter inside, and the other one 4 in. Both are of strong iron soil pipe pattern, and are red-leaded inside to prevent them rusting up. The outlet eye of the No. 2 trap in each manhole has a lid sealed down with lime and a little Roman cement on top, so that access to outer end of

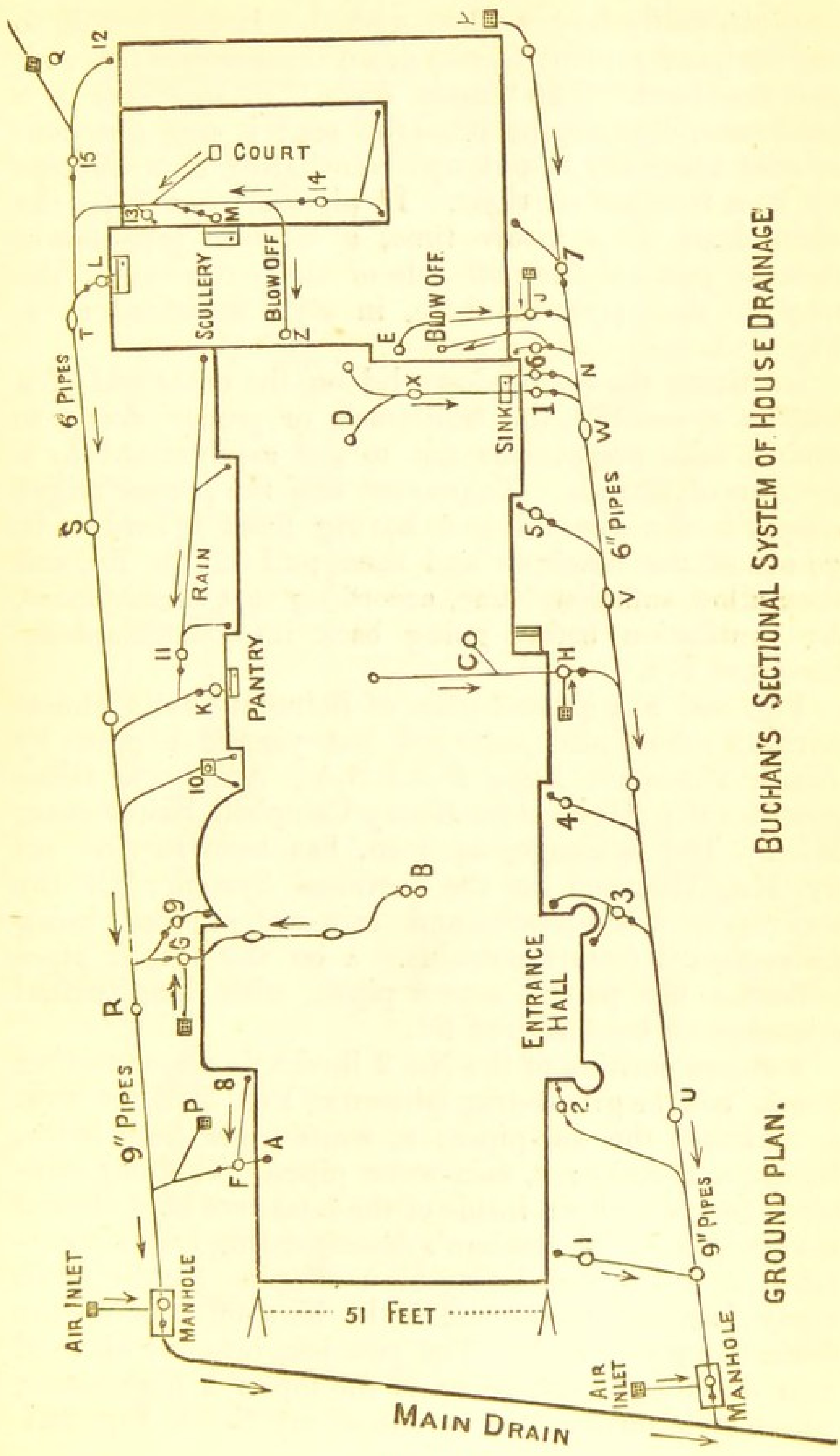
BUCHAN'S SECTIONAL SYSTEM OF HOUSE DRAINAGE
GROUND PLAN.
COURT
SCULLERY
BLOW OFF
BLOW OFF
SINK
PANTRY
RAIN
ENTRANCE HALL
6" PIPES
6" PIPES
9" PIPES
9" PIPES
AIR INLET
MANHOLE
AIR INLET
MANHOLE
51 FEET
MAIN DRAIN

Fig. 308.

trap can easily be got when wished. It does not do to use Portland cement to seal down these access lids as it gets too hard. The "main drain" in this case is a built one, discharging into the sea; it was not considered necessary to put up a ventilating blow-off pipe for it as it is not air tight. If pipes are put in for the main drain at a future time, a blow-off pipe might then be put up from off side of the outer eye of the trap in the upper manhole, in style indicated at M, Fig. 283A.

In lifting the sealed-down lid on the outer end of a trap *in a manhole*, the tradesman or person doing so should take precautions not to get asphyxiated by a rush up of bad air. To prevent this the person might simply loosen the lid, and, having fixed a cord to it, go out of the manhole and then pull off the lid, and then allow sufficient time, according to circumstances, for ventilation before going back into the manhole. See page 179.

Fig. 309 is a ground-plan of Belmont Castle, almost entirely rebuilt and enlarged last year from plans by James Thomson, Esq., F.R.I.B.A., Architect, Glasgow, for the Right Hon. Henry Campbell-Bannerman, M.P. The drainage, as seen, has been carried out by Mr. Thomson on the Sectional System; all the soil-pipes, waste-pipes, and rain-water pipes being disconnected from the drains. A on the 6-inch pipes indicates my patent access pipes, with longitudinal openings on top and iron lid.

B shows position of the No. 2 Buchan's disconnecting traps. C is the grease-trap (shown at Fig. 303) for sink. D indicates the soil-pipes; E, waste-pipes from baths, basins, and sinks; F, rain-water pipes. The four rain-pipes and their drain inside of the house are kept clear of sewage gas by the Buchan's disconnecting trap set outside. J is the ventilating blow-off pipe for the drain along front of house, and H the blow-off pipe for the drain along the back. The two join into one blow-off near H, which is carried up to the top of a high tower, where it is surmounted by one of my No. 1, Fig. 294,

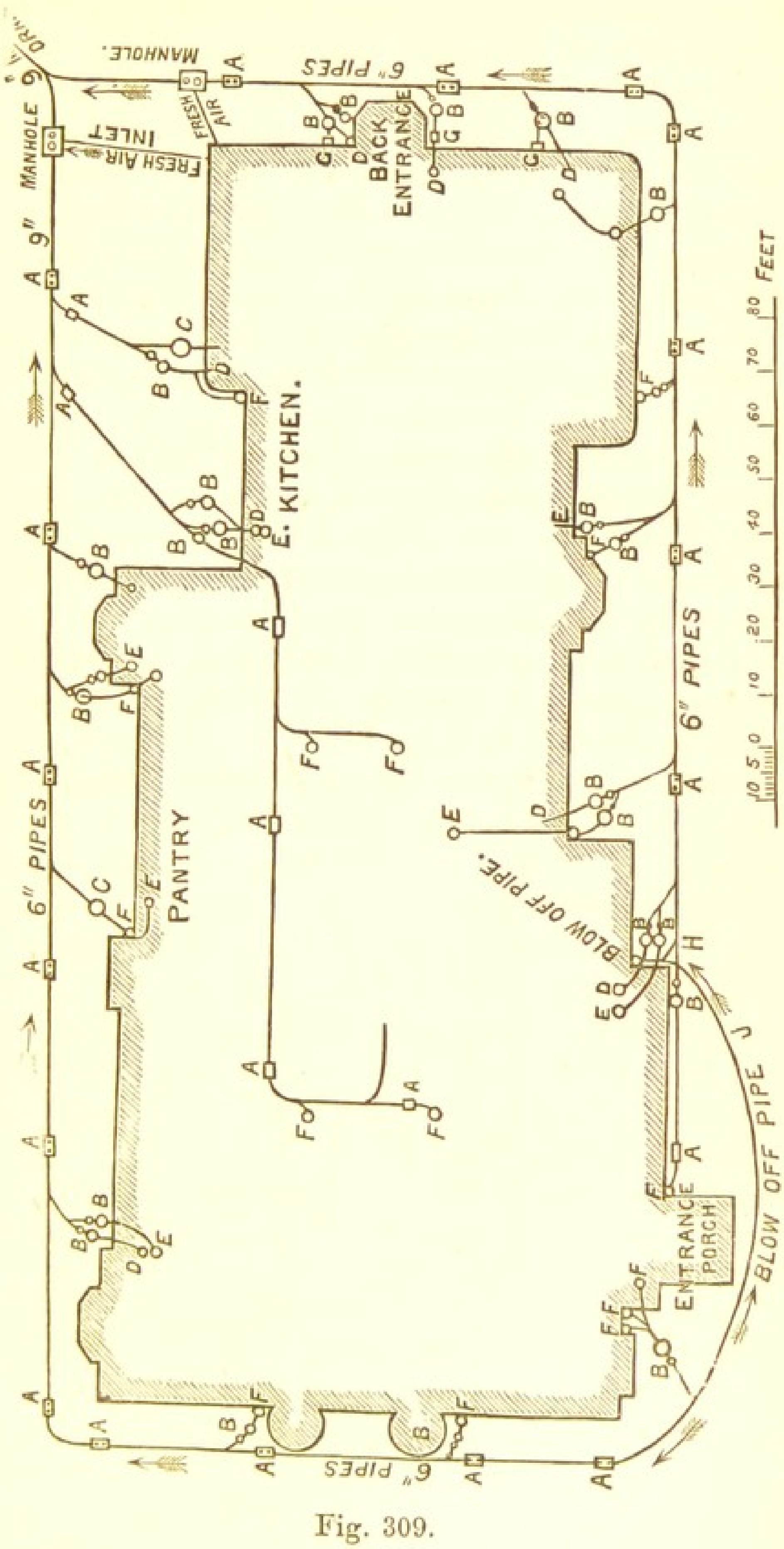
KITCHEN.
PANTRY
BACK ENTRANCE
ENTRANCE PORCH
MANHOLE
MANHOLE.
FRESH AIR INLET
FRESH AIR
9"
6" PIPES
BLOW OFF PIPE.
BLOW OFF PIPE J
10 5 0 10 20 30 40 50 60 70 80 FEET

Fig. 309.

fixed ventilators. There is a Buchan's disconnecting trap in each of the two manholes. There are access pipes every 40 feet or so on the main drain. Gartshore House, recently rebuilt by Mr. Thomson for Alexander Whitelaw, Esq., has its drainage on the Sectional System. Likewise Tulliechewan Castle, James Campbell, Esq., and Stracathro House, for James Alexander Campbell, Esq., M.P. Also Moy Hall, Inverness-shire, for the Mackintosh of Mackintosh, and many other mansions and houses, &c., throughout the kingdom.

In executing the drainage of Armadale Castle and Belmont Castle, the blow-off pipes of the drains are placed at the high end of the drains, so that the current of air through the pipes is generally intended to go in the opposite direction from the water.

In Figs. 310 and 311, however, the air and the water-currents are intended to both go in the same direction. C and D, Fig. 310, are blow-off pipes for the drains. The fresh air for C drain entering at the

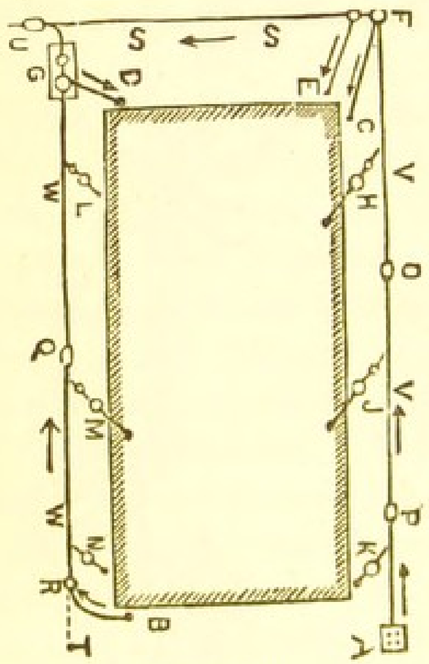

Fig. 310.

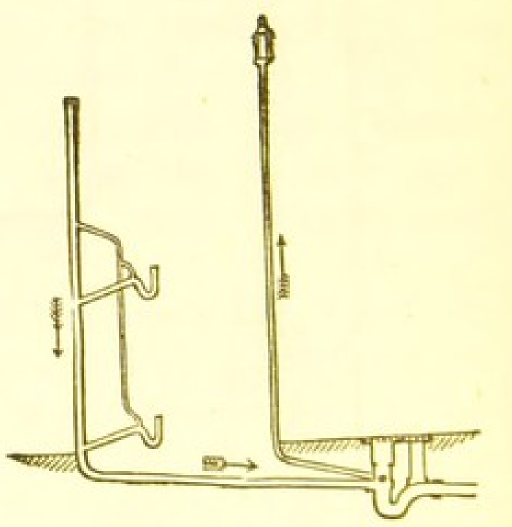

Fig. 311.

grating A on the ground, which may have a light self-acting valve under it, to let air in but none out. D has its fresh air inlet from the pipe B, whose top is 6 feet or more above the ground. Fig. 311 is from my patent of March 22nd, 1883. Several persons since then have published the same plan as novel and grand, but they were too late to claim it as new after the above date.

In the article on Sewerage in the new edition of the "Encyclopædia Britannica," Professor J. A. Ewing, F.R.S., illustrates the Buchan traps, and acknowledges the "excellent service to the cause of sanitary reform" by the disconnection and ventilation of house drains and soil-pipes which I have advocated.

Mr. A. Lindsay Miller, architect, Glasgow, says the introduction of the trap, shown on p. 218, and the system of ventilation inaugurated therewith, have done more for the advancement of house drainage than all other appliances put together.

Mr. James Sellars, I.A., architect of the buildings, etc., for the International Exhibition, Glasgow, 1888, permits me to state that his firm are in the habit of specifying Buchan's appliances for their drainage work, and did so for the Exhibition drainage; the main disconnecting trap specified for insertion on the drain between the public sewer and the buildings being a 15-inch Buchan's trap.

I here give some illustrations of the traps in two pieces. Fig. 312 shows a Buchan's trap, No. 2 style,

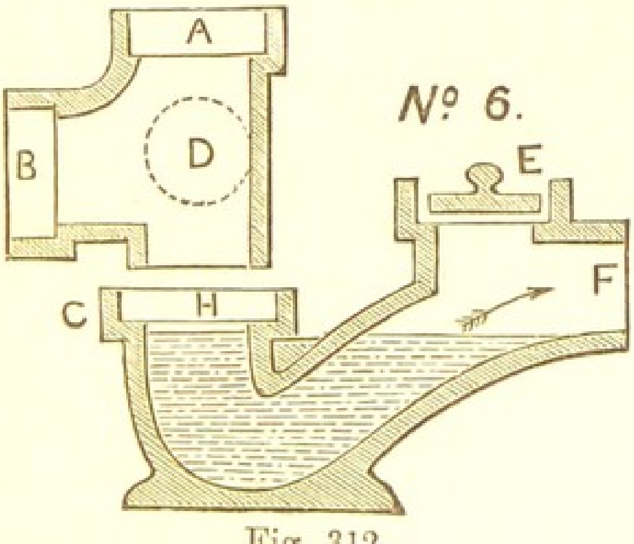


Fig. 312.

in two pieces—termed "No. 6"—with the well H of the trap the same diameter as the inlet branch B, and the outlet end F. The part A B, being movable, the branch inlet B can be turned round in any direction. Sometimes a second inlet branch is put on as indicated at D, which may be used either for water or air. In other cases there may be three or more inlets. In my own work I have seldom used more than one waste water inlet branch into the same trap, and especially for drains.

Where the drains have been deep I have sometimes made one main trap receive one or two side drains as well as the drain behind it, in order to have only one deep manhole, or save expense, &c. In the case of trapping and ventilating street sewers in sections, which may yet become much more common than at present, it might be often useful, to save expense, to use traps with two or three inlets, as indicated in my patent of A.D. 1883, and as illustrated farther on; only, of course, when the one trap is made to serve for two or more drains the aerial disconnection is not so complete as when each branch drain or branch sewer has its own trap.

Fig. 313 shows another idea of mine introduced

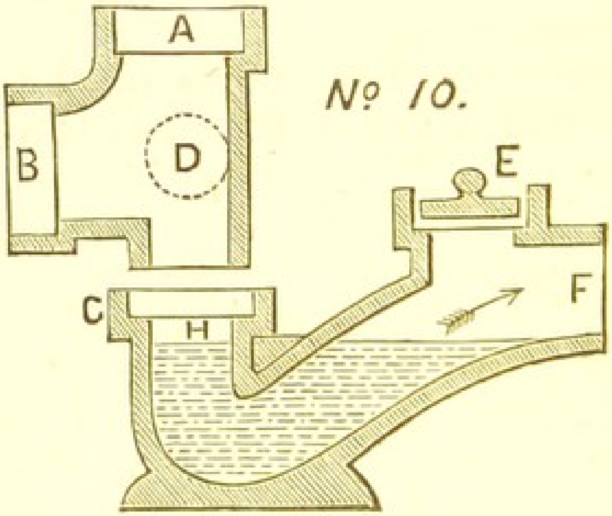


Fig. 313.

above ten years ago, viz. contracting the well H of the trap to about one-third or more less than the inlet and outlet. This is often done for sizes from 6 inches upwards, in order to make the trap more self-cleansing by having less surface of water at H. The value of having a small surface of water exposed in the well (H) of the trap is indeed strongly expressed in my patent of April, 1875, and see page 219 *ante.* The examination eye E on the outer end of trap is in my patent of May, 1877. This Fig. 313 trap is termed No. 10 Buchan's Trap.

There have been a great many traps sold by various manufacturers or sellers of fire-clay goods as Buchan's traps which were not such at all, and about as many misrepresentations or stories told about them, both by sellers and tradesmen buyers, in order to turn an honest penny or save a shilling, as would sink the *Great Eastern.* When personally unknown to the speaker the author has been told that certain traps on sale were Buchan traps, but on asking that they should be so styled in the invoice that was declined. The seller had no objection to speak what was not true, especially in presence of only one other person, but writing it was a different matter, disrespect for conscience being amply made up for by esteem for the pocket. Several firms had to pay damages and legal expenses for infringement and false representations. The real traps should have "Buchan's Patent" and "J. & M. Craig, sole Makers," stamped on them.

Fig. 314 shows vertical cross-section of my patent improved egg-shaped pipe with longitudinal ribs A A. The space between the ribs may be filled in with Portland cement or concrete for greater strength where the ground is soft, or an extra strong job wished. The intention of the egg-shape is to make the pipe more self-cleansing than the round ones, especially for sizes above 6 inches diameter.*

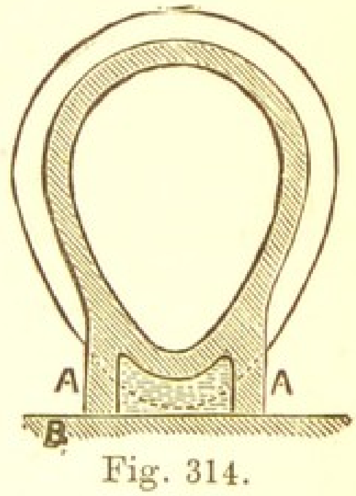

Fig. 314.

Fig. 315 shows longitudinal section of the improved pipe with raised bead A A, all around the spigot end of the pipe, for the

* Messrs. J. Finch & Co., 9, Buckingham St., Strand, W.C., are Messrs. Craigs' agents in London for the supply of the author's patent disconnecting traps and fittings, also grease-traps, and access and other pipes.

purpose of centring said spigot end better in the faucet of the next pipe, as shown at B B, and so leaving a more equal space all round for the cement. This pipe is also made and supplied by Messrs. J. and M. Craig, Kilmarnock. In jointing drain-pipes with cement, the joint would be more secure than it often is if it were more the practice to wash or brush the outside of the spigot

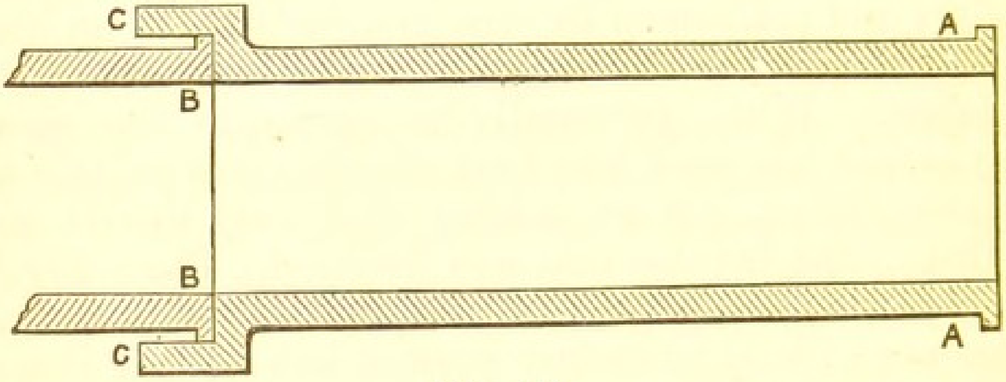


Fig. 315.

end of the one pipe and the inside of the faucet end of the other with a brush dipped in clean water; then before putting in the one pipe into the other, put a little cement into the inner end of the faucet at B B all round.

When the entering pipe is pushed home some of the

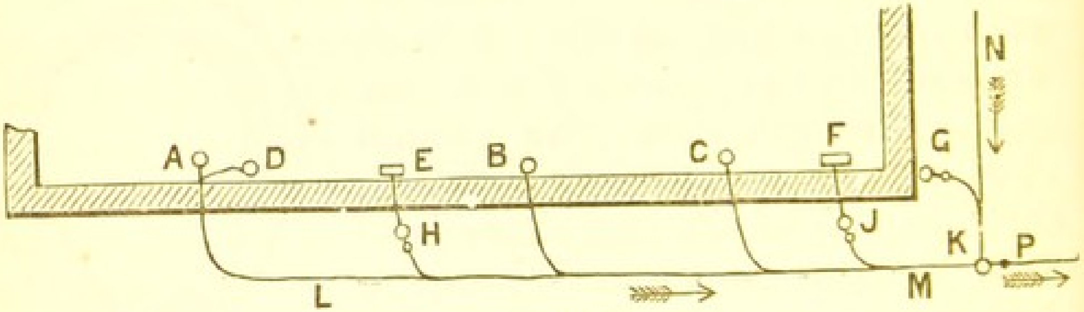


Fig. 316.

cement will likely protrude inside of the pipe; this is immediately scraped off, of course, with the scraper in ordinary use for that purpose, before the cement has got time to set or harden.

We have been illustrating how to execute drainage work in the way safest for the inmates of the house; Fig. 316 shows how the work should *not* be done if it can be avoided. In this case A, B, and C are water-closets, all with their soil-pipes in direct communication with the drain L M. D is a bath or basin, whose waste-pipe delivers into the soil-pipe of the closet A. E is a basin or sink, the waste-pipe of which is disconnected from the drain by the trap H. F is the kitchen sink with a grease-trap J. E and F are therefore all right, so is the rain-pipe G with its 4-in. Buchan's trap. K is a No. 2 Buchan's trap, with two inlets for the drains M and N and the one outlet P to sewer. Now this plan is partly right and partly wrong—what I condemn is allowing the smell of the drain to go up the soil-pipes A, B, and C, and especially when said soil-pipes are inside of the house, and permitting the smell from the closets A and B to get access to the soil-pipe of closet C, or the smell from closets C and B getting back to soil-pipe of closet A. In this case, should fever be in a house, it is more difficult to really isolate the patient than if each soil-pipe were disconnected and trapped outside, and the drain ventilated by a special blow-off pipe put up outside.

In regard to the position of the soil-pipe, viz., whether it is best to be placed outside of the house or carried up inside of it, there was a good deal of correspondence some years ago, many advocating the placing of the soil-pipe inside, so as to prevent it freezing in winter. I supported the idea that it is best for the safety of the inmates to be *outside*, and pointed out that it was not the *pipe* itself that got frozen up but *the water* that was in it, but which water, I observed, had no business to be in it, as it would likely be that proceeding from some leaking crane or other fitting which had no business to be leaking. Dr. B. W. Richardson, in *Good Words* for November, 1881, referred to my remarks upon this subject and also supported the outside position, such being also the best position in the opinion of the Local Government Board. I also pointed out that the emanations from an outside soil-pipe were both less in quantity and less dangerous, generally speaking, than those from an inside one ; but whether outside or inside

I approve, as far as possible, of the soil-pipe being disconnected at its foot by an outside trap and surmounted with a *fixed* induced current ventilator upon its top. The use of soil-pipe sweepers may come in vogue by-and-by. I invented one in 1877.

At some houses the foundation is only a foot or so below the service, in such cases the pipes may have to be laid some feet lower than the foundation, especially at their lowest part. In this case the pipe, if running parallel to the house, should if possible be kept several feet back, and the cutting while open should have its sides firmly supported by wooden uprights and struts, to prevent the ground falling in—in fact this is useful in all deep cuttings. Then as soon as possible after the pipes are laid, the ground should be filled in and firmly beaten down (but so as not to hurt the pipes) at least as high as to the bottom of the foundation, or a little above it, unless when the outer walls of the house are resting on the rock. I think it bad practice to have the foundation only one foot or thereby below the surface, especially where drains will pass near and at a lower level.

There has been considerable controversy as to the merits of the siphon *versus* the "D"-trap, for water-closets, &c. Some decry the D-trap altogether, on account of it being more dirty than the siphon-trap; others, keeping in view the effect of siphon action, consider the D-trap the safer of the two. This effect of "siphon action," it was asserted, could be obviated by proper ventilation on the outer side of the siphon-trap, and which ventilation not only prevented siphon action but also corrosion of the lead. These have been the ideas upon which I have all along acted myself. Foremost amongst the supporters of the "D"-trap is Mr. P. J. Davies, of South Kensington, London, who has both experimented and written much in connection with Plumbing. In the front rank of the opponents of the D-trap must be placed Mr. S. S. Hellyer, of 21, Newcastle Street, Strand, London, who brought out an improved form of the siphon-trap, termed by him the

"Anti-D-Trap," of which Fig. 317 shows vertical section. In regard to the question as to whether the D-trap or the ordinary siphon-trap is most easily cleansed, I consider that of much less importance than *the loss of the water-seal* by either; and in that relation a D-trap, which would retain its water-seal where a siphon-trap would lose it, is the better trap to use, as *e.g.* in a case where proper ventilation of the outer side of said ordinary siphon-trap was not allowed. In some such cases, as on the waste-pipes of wash basins, I have used a bottle-trap. A great objection against the D-trap is that its dipping foul-air barrier being out of sight, as in A, Fig. 318, it may be corroded and holed and so allowing foul air to pass unknown, and in a way

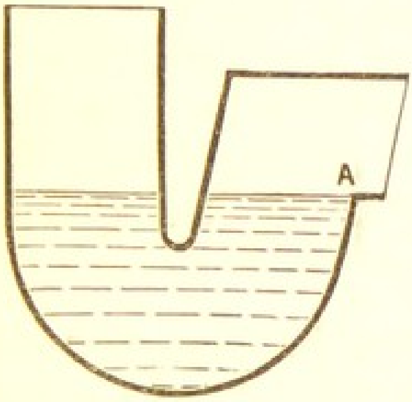

Fig. 317.

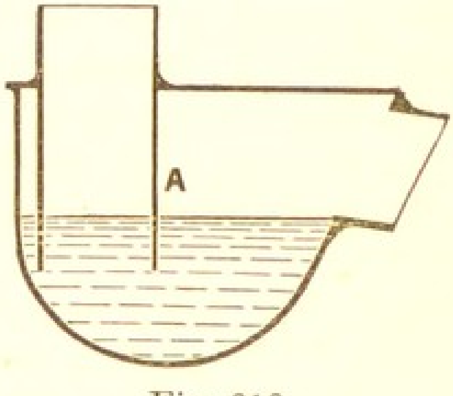

Fig. 318.

more difficult of detection than with the siphon-trap. Of course the application of the smoke-test, now in general use, should soon tell if the lead at A was holed, although it would give no warning, supposing the lead there were nine-tenths eaten through.

In Mr. Hellyer's "Anti-D-Trap" the outlet end of the trap is less in area than the inlet end. In his lectures on Sanitary Plumbing, as published in book form, Mr. Hellyer gives some very interesting tables, showing the quantity of water required to flush various closets, as also the effect of siphon action upon various forms of traps. The best one to withstand siphon action when unventilated was the full-sized D-trap, but a heavy discharge of water in that case might draw its sides together. This would not happen with the round bottle-trap, Fig. 319. Mr. Hellyer's "Anti-D-Trap" stood the tests very well, but the necessity for ventilating the outer side of the trap, especially where large discharges of water go down the pipe, was amply demonstrated. Instead of *contracting* the outer end of the siphon-trap to make it keep its water-seal better, I had a notion that enlarging it, as per Fig. 320, would tend to produce that effect, but I have not had opportunity to experimentally test the plan in a proper manner as yet, but it may be useful to record the idea here for future reference. Where the water turns over at D, the lower portion of the pipe or trap there might

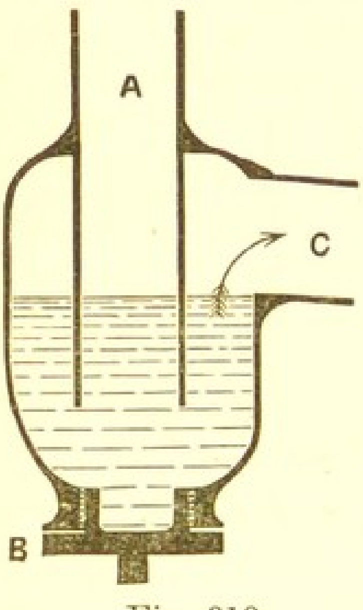

Fig. 319.

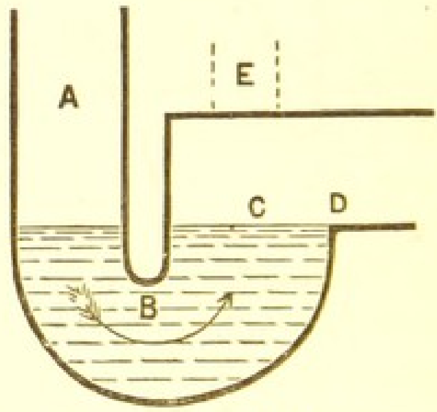

Fig. 320.

be flat, the section being something like the letter D on its face, so, ◠. It may be similar at B, but so, ◡.

The ordinary lead siphon-trap is generally badly made by its outer end having too much of a slope outwards, as per Figs. 169 and 179, instead of being shaped more like Figs. 229 and 234.

When it is wished to be so done, drains may be flushed automatically at certain intervals by a siphon-pipe having its upper end placed inside a cistern, which cistern is filled either by a ball-cock, turned upside down and with a ∩-pipe attached to it, or in place of the ball-cock a cottage closet-cock with lever may be used, and with a loaded copper ball in place of the iron weight; there being also a small regulating stop-cock branched off the side of the supply-pipe to the ball-cock. This small stop-cock is to allow the water to dribble into and fill up the lower portion of the cistern so far at the desired rate: when the cistern is so far—say three-quarters—filled by the small stop-cock, the rising water gradually raises the ball of the larger cock and opens it, which after running full bore for a minute or so charges the siphon. The siphon once started must be regulated to empty the cistern quicker than the supply-pipe can fill it, so as to allow the supply-cock to shut. A large regulating-cock on the supply-pipe to the cistern would therefore be useful. A $1\frac{1}{4}$-inch siphon-pipe would be a serviceable size. If the drain is flushed once a day, or only once in so many days, the best time to do it would be about 9 P.M., so as to have the drains clean during the night while sleeping. In some cases a rain-water flushing cistern would be useful, or Roger Field's automatic flushing tank.

I observed on page 504 of the *Building News* for October 27th, 1882, a notice with illustrations of a plan said to have been recently patented by Drs. Buxton and Ross for preventing water-pipes from bursting in frosty weather by simply placing a valve inside the cistern with air-pipe below it to allow the pipe to be emptied; but, as I observed on page 557 of same Journal, it seems to me that they are rather late in attempting to patent such a plan, as it has been already used for years back. It has been often in use in Glasgow upon service pipes from cisterns. The same plan was also in common use to allow the service pipes from fountain heads to be emptied when wished. I here, in Fig. 321, show some styles which have been in use for a long time in Glasgow, only whereas Messrs. Buxton and Ross use a *hinged* valve, it has generally been a *spindle* valve that I have seen, and with the air-pipe A connected below the cistern as at F; the air-pipe if put in as per dotted lines J being merely a modification. In place of the valve a stop-cock, as per C, was used, being sometimes placed inside the cistern and at other times outside at D. Upon shutting the valve or cock at cistern and opening the cocks G and H the service pipe was emptied of water, *i.e.* if the pipe had a gradual fall down to nose-cock. As the plan is old no one can patent it, but all may freely use it. It is not quite perfect, for sometimes when the cord L is let go during frosty weather the valve B will not fall, because the top

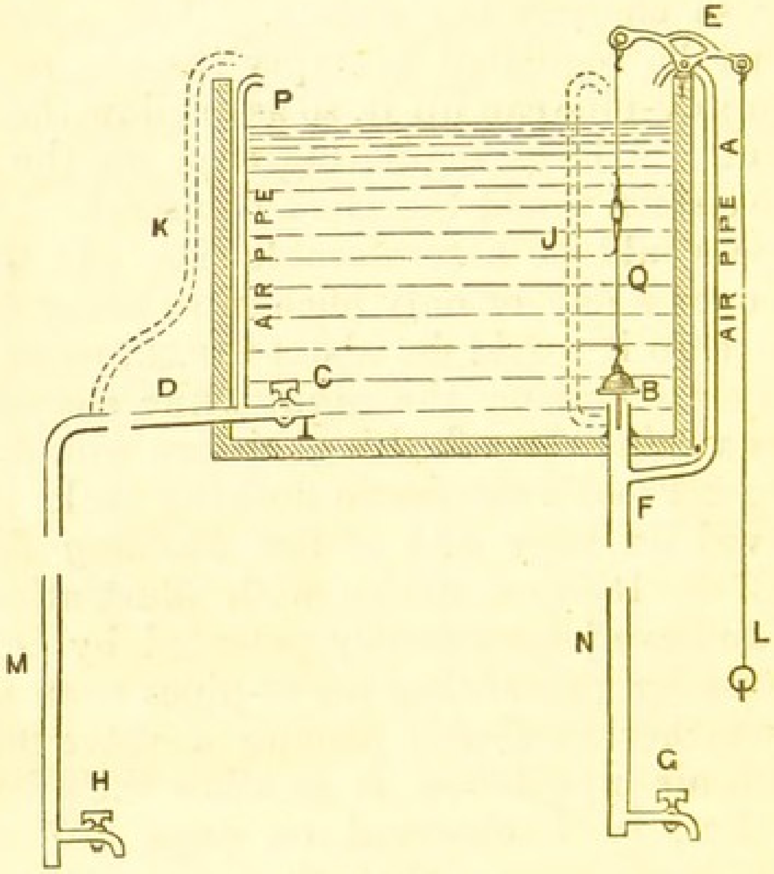


Fig. 321.

of the water has got frozen and holds the wire in its grasp.

I see Messrs. Buxton and Ross use electricity to set the valve working, but how this would serve in practice requires experience to tell. The air-pipes should be small, especially the pipe P, to prevent air getting in too freely to interrupt the flow of the water; in many cases the mouth of the air-pipe is squeezed close except a small hole one-eighth inch in diameter or so.

Fig. 322 shows a tube-cock for kitchen sinks, designed by John Dunbar, Hyde Park Street, Glasgow, with stop-cock with square head attached, to enable or permit a new washer to be put into the crane without turning off the water from any other crane or pipe in the building. Other makers in the past have supplied cistern ball-cocks with stop-cock attached or included in the design of the cock, which plan of crane is very useful, and although dearer at first pays in the long run, especially if the stop-cock ground-key part is good.

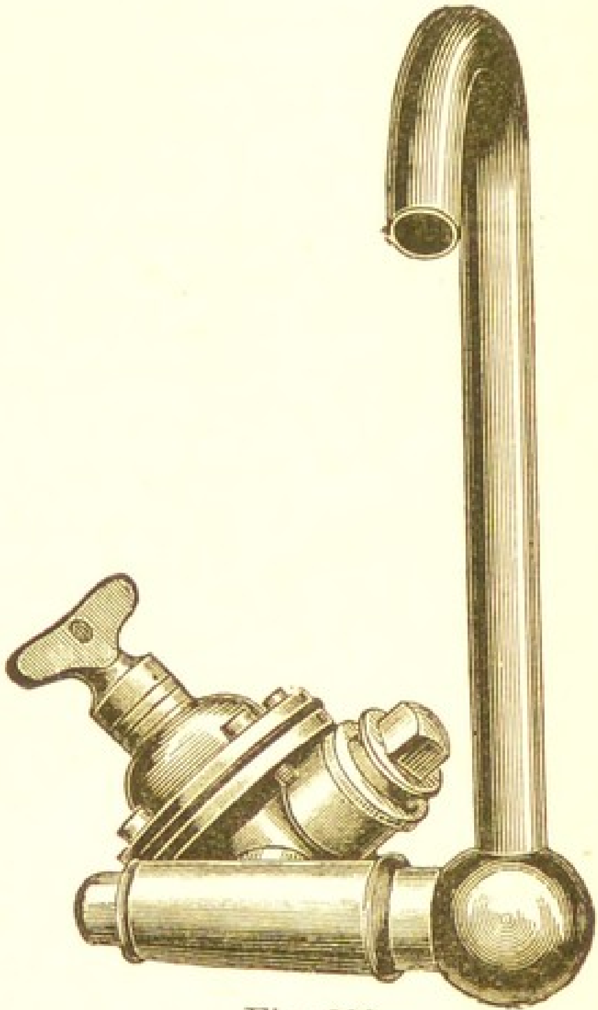

Fig. 322.

At page 268, when referring to work done by me at Dalmuir in 1879, I omitted to mention that I there introduced then the Sectional System of trapping and ventilating Street Sewers; *e.g.*, upon the bottom of a short branch sewer in one of the streets I put in one of my large disconnecting ventilating traps to lock off gases from the main sewer, and allow this branch sewer to be ventilated *per se*, the fresh air entering through the trap to lower part of the sewer; and one of my patent exhaust induced-current fixed ventilators being placed upon the top of a 4½-in. diameter iron pipe carried up above the chimneys from the top of the higher end of the sewer, a current of fresh air was thereby caused to flow through the sewer—the foul air blowing off high up above the roofs. The branch drains from the various tenements leading into the street sewer had my traps upon them, and the gutter gratings in street had also water-traps placed below them, so that no foul air could pass up through said gutter gratings.

Thousands of people have often been annoyed by the foul smells from the sewer coming up the untrapped gratings so often placed at the edge of pavements, and I believe many people have been poisoned thereby, and especially children, who will often be seen playing over them and inhaling the deadly fumes, all unconscious of their danger. The stink issuing from untrapped gratings at the edge of the pavement at some coast towns in summer is often most abominable; but whether in the town or at the coast this should be stopped, and no gutter gratings should be allowed in streets without having a proper trap below each.

Figs. 323 and 324 are vertical sections of two forms of "gully" or water traps in use for placing below gutter gratings in streets, &c. Both are generally round in the body. The former is sometimes styled a "Box-

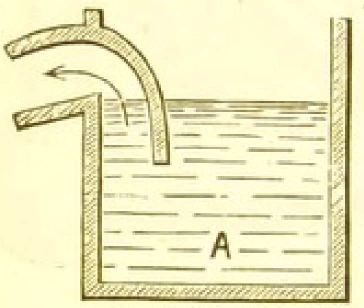


Fig. 323.

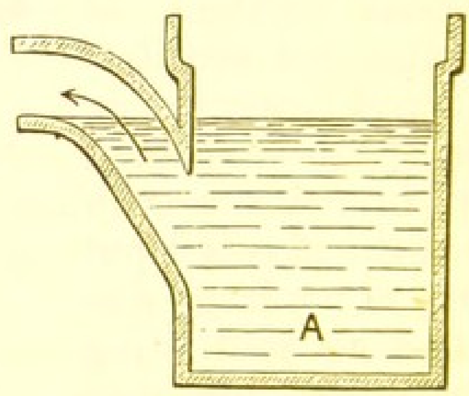


Fig. 324.

trap." A considerable amount of space exists in the bottom, A, of each trap, where sand, &c., may accumulate for some time without interfering with the working of the traps. The sand requires to be removed at intervals, of course, or else the trap would choke in the course of time.

Figs. 325, 326, and 327 show plans of the Sectional System of trapping and en ilating Street Sewers, as referred to in my patent of March 22nd, 1883. In Fig. 325 the pipe *d* and the two pipes *b b* indicate high level blow-off ventilating pipes for different sections of the sewer.

These pipes are supposed to be carried up to above the roofs of most convenient houses, the higher the better. In the drawing the air current and water current are shown as both going in the same direction, but where it is found to work better the air may be allowed to go the opposite way from the water. I show both

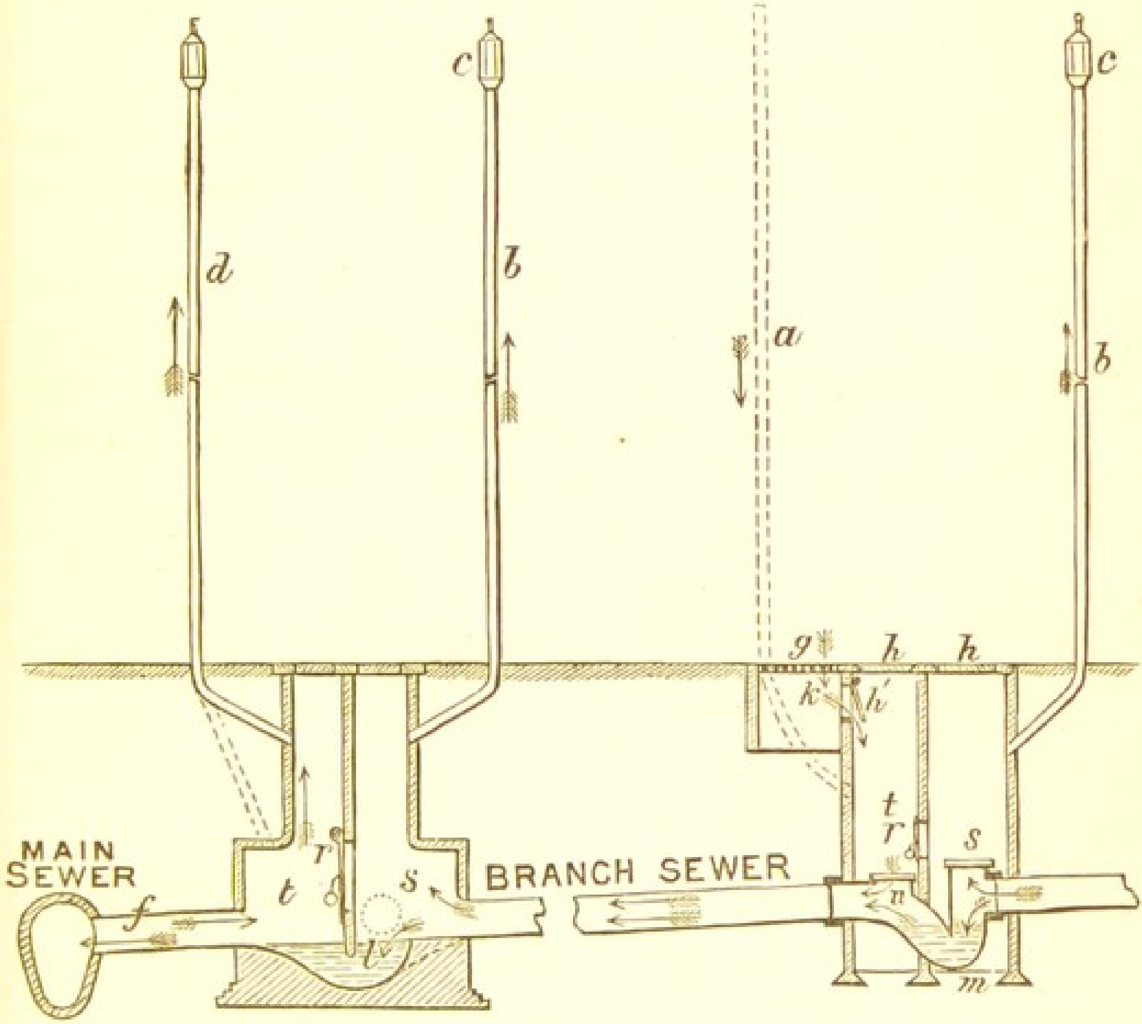


Fig. 325.

ways in my 1883 specification. In Fig. 325 the fresh air may either enter through a strong iron grating *g* (which may have or have not a self-closing valve *h*, to let fresh air in, but no foul air out) placed on the ground-level, or, where preferred, the fresh air inlet may be by a high-level inlet-pipe, as indicated at *a*, and which may or may not have an inlet cowl at top. One of my fixed induced-current exhaust ventilators *c* is shown as placed upon the top of the foul air outlet ventilating pipe *b*. The object of this system of trapping and ventilating street sewers is to prevent foul air from the sewers coming out at the street level. In case a trap should ever choke there is shown a valve *r*, which the rising water can push open and so get away. The dotted circle at *s* indicates a side street sewer coming into the trap, so that, as shown in Fig. 327, one trap may serve for three different street sewers all coming into one trap.

Fig. 326 is a ground plan of sewers showing a separate trap for each side street, as well as traps at any desired distance from each other on the main sewer, so

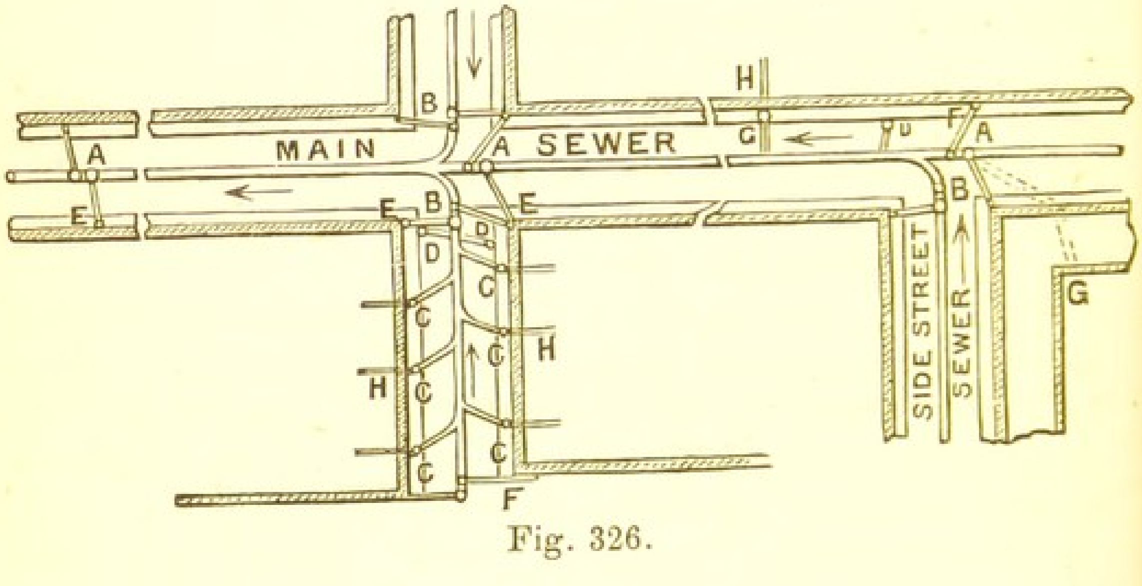


Fig. 326.

as to prevent smells from main sewer going up any of the side streets, as wished, and also prevent smells or air in the main sewer from going any farther along said main sewer than is desired. All the drains H from the houses, &c., are shown to have a main disconnecting trap C; D indicates trapped gully gratings, E blow-off ventilating pipes. G indicates that if wished a strong iron blow-off pipe may be put in through sunk flat or otherwise of a house or warehouse and carried up the back of said house to above the roof. I prefer, however, that the blow-off pipes for the sewers should not enter the inside of any building at all, and especially if that building is a dwelling-house.

Fig. 327 is a modification of Fig. 326, showing fewer traps on the sewer, and indicating that one trap may serve for two, three, or more streets. In this drawing

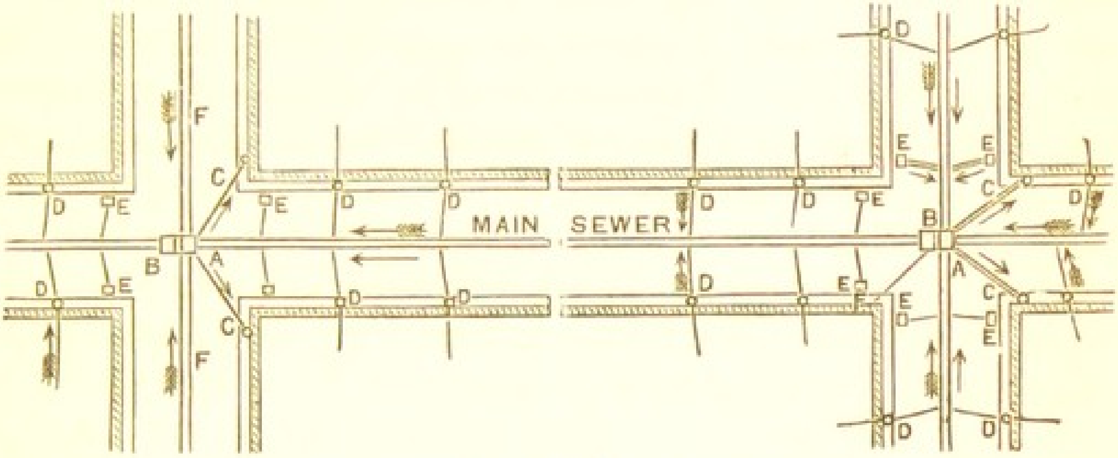


Fig. 327.

the ventilating air current is also shown as going in the same direction as the water, which would often be the best way, especially where there was not much fall and the water current strong.

This plan might often be best also where the prevailing wind blew in the same direction as the water went. In other cases, where the prevailing wind blew the opposite way from the water flow, then it might be better to make provision for the air current going in the opposite direction from the water flow. The arrows indicate the water-flow, the darts the air-currents.

D, Fig. 327, indicates Buchan's disconnecting traps put on between each house, &c.; and the sewer. E is gully trap at edge of pavement for the gutter water. C is blow-off ventilating pipe; A is Buchan's disconnecting trap in street in one of the styles shown in Fig. 325. B is the outer end of the trap. There are strong iron access covers at the level of the street, for access to either end of each trap. *g*, Fig. 325, shows the fresh-air inlet grating to one side of the access opening or manhole of the trap, with sand or rubbish pocket below the grating. In other cases either the usual strong open iron gratings may be used, or special gratings with rubbish catch-pit below, as shown in Figs. 328 and 329.

F, Fig. 327, indicates side street sewers going into the trap on the main sewer. Where there is sufficient fall, the water going into the trap from the sewer behind it and from the side sewers may be made to fall into the trap, but where there is not sufficient gradient for that, then this fall or cascade may be dispensed with. In the system above illustrated it is understood that while the fresh air may enter either from a low or high level, the foul air is to be blown off at as high a level as possible above the houses, &c., or above their chimneys.

So far as I am aware, the sectional system of trapping and ventilating street sewers has very seldom been adopted as yet. It is referred to in *The Builder* for April 28th, 1888, and following numbers. Mr. W. Santo Crimp, surveyor, has applied the system at Wimbledon, having recently isolated several miles of sewers in that district, where he found that the ventilating air current often went down hill with the water flow, as I had anticipated, and found in my own experience.

A short paper on "Ventilation of Street Sewers," read by me at the Sanitary Congress of the Sanitary Institute of Great Britain, held at Glasgow in September, 1883, will be found at page 264 of Vol. V. of "Transactions of the Sanitary Institute of Great Britain." In this paper I described three different improved ways of ventilating the street sewers, starting with the understanding that in each case the drains of all houses and other buildings were to be isolated from the sewer air by a proper disconnecting trap. This being done, the sewers, as they generally are, may then be ventilated by using the iron gratings in the middle of the street as inlets, and put up high-level blow-off ventilating iron pipes, with induced current fixed ventilators upon them, above the houses to act as outlets. These blow-off pipes may be attached at bottom to the outer eyes of my No. 2 traps, as shown at L, Fig. 301, and E, Fig. 273. The gully gratings at the edge of the pavement are to be trapped.

Another plan was to close up the ventilating gratings in the street, and have a number of high level ventilating pipes put up to above the roofs of the houses or other buildings, so many to act as inlets and so many as outlets.

The third plan was the sectional system of trapping and ventilating the sewers illustrated in Figs. 325, 326, and 327.

Figs. 328 and 329 show vertical cross sections and perspective view of patent ventilating iron gratings, with provision for preventing sand, stones, or sticks falling into or being put down the ventilating and

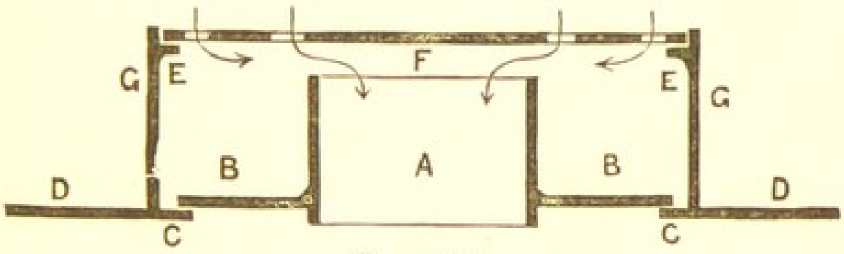

Fig. 328.

access shaft above the trap, and so falling into the trap. A is square or round opening for ventilation, situated right over the ventilating opening on the house side of the trap. The fresh air enters from the holes in the iron cover F, as shown by the darts. To get access to see, or cleanse out, the trap, the cover F is first lifted, and then the interior portion B B may also be taken out. G is the outer vertical casing of the iron frame, which may be either square, round, or longitudinal. D is the iron flange or sole. Iron framed gratings in this style may be made any size, say from 8 in. square or diameter and upwards for drains, and in stronger style and larger for sewers.

These iron gratings and frames may be had from Messrs. George Smith & Co., of the Sun Foundry, Glasgow, as also Fig. 330 style. In Fig. 330, which shows longitudinal vertical section of patent iron frame G G with movable iron lid K F, which lid or cover is half grating and half iron plate, there may be used a self-acting valve H, which is intended to let fresh-air pass freely into the drain or sewer, but to close against

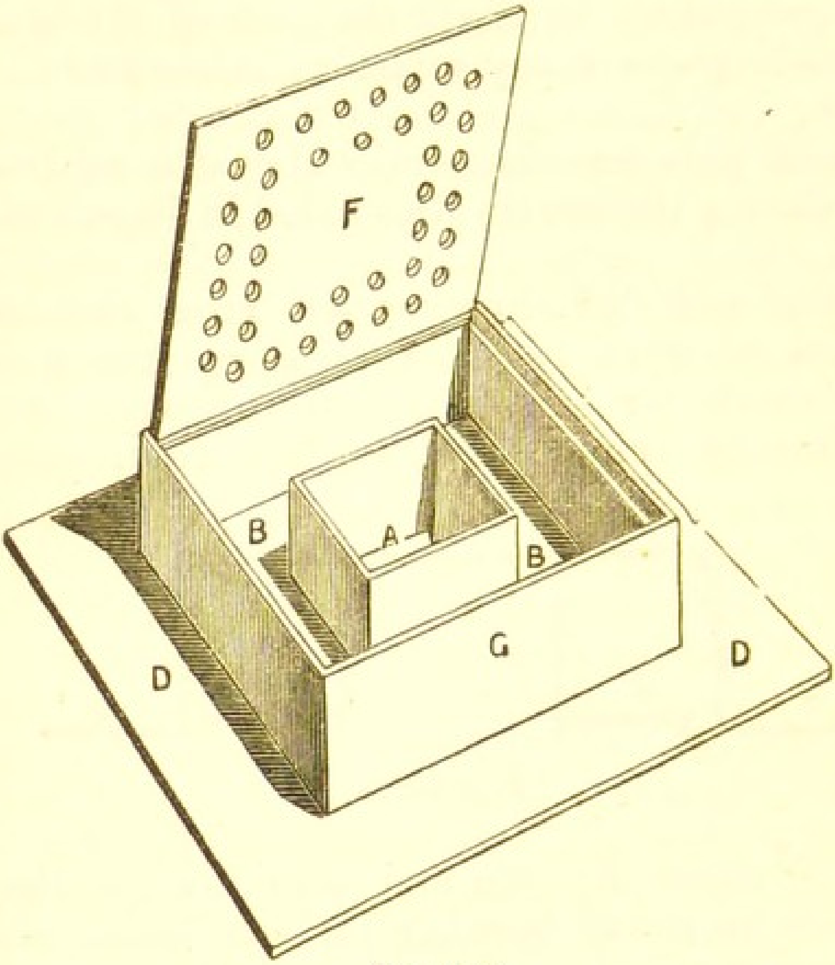


Fig. 329.

any air, fresh or foul, trying to get out. There may be an iron bottom B below the grating, either fixed or

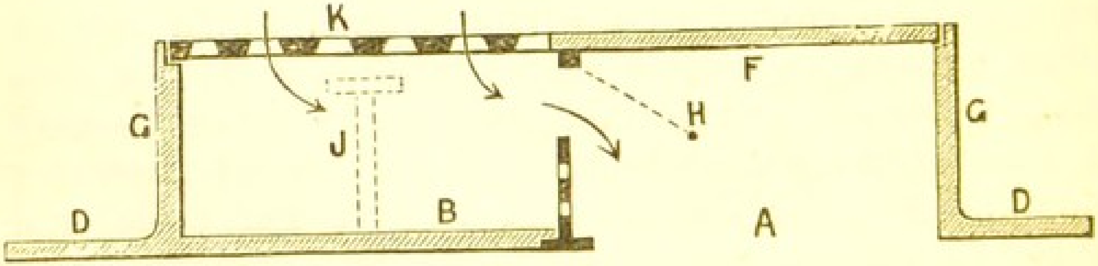


Fig. 330.

movable. If movable it may have a handle J. Or this bottom part B may be awanting and a deeper hole left in the ground. The top cover of the frame K F may be in either one or two pieces. The grating K is placed to one side of the opening A in order to prevent sticks, sand, or stones falling through the grating getting into the opening A. This style of grating and cover may be used above the traps or access openings of either drains or sewers. The breadth of Fig. 330 cover K F may only be about half its length.

I may here give some particulars of the origin and progress of the machine-applied smoke-test for drains. Up to about twelve years ago there was no recognised or known system in general use for examining defective drains except exposing them. It appeared to me that this state of matters was open to improvement, more especially as in houses I was examining myself I wished to know the state the drains and sanitary pipes were in without disturbing them. As I was aware, especially when the soil-pipes went up inside of the house, that a current of air generally passed into the drains from any opening made into them from outside of the house, especially if said opening were made or existed upon the inner side of a disconnecting trap, it occurred to me that if smoke were passed into the drain and the top outlet of the soil-pipe or other outlet pipes closed, that then, if leaks existed in the drains, &c., the action of the chimneys if fires were on would draw out this smoke into the house. Upon experimenting I found this to be the case. At first my *modus operandi* or style of applying the smoke into the drain was rather crude, viz. by suspending or placing burning straw or brown paper into the drain. I soon found this was not satisfactory enough, especially when placed down the ventilating eye on the house side of my disconnecting trap. I then tried cotton waste suspended, which was better, and did pretty well in some cases where the leaks were bad and a number of fires on in a house. It did not do so well, however, for empty houses I therefore got a fanner to blow air into the drain above the suspended cotton waste, and was considering how to improve this when I was called in to see if I could cure a plague of rats which infested Dr. Samuel Moore's house here, and which he had been fighting against with a fumigating machine by which the fumes of sulphur paper were blown into the rats' holes, and so scared them away for a time. I trapped and sorted the drains, and also discovered a passage or rat-run from the next house, and after closing up the hole in the gable with cement the rats disappeared; and as Dr. Moore had no more use for his fumigating machine I bought it from him, finding it would do very well for applying the smoke-test to drains with, only in place of using sulphur paper, which was expensive, I used the cotton waste I had been using before with some sulphur or brimstone mixed with it.*

Fig. 331 shows sketch of this fumigating machine; the material for fumigating with, or for producing smoke, being placed in the round vertical chamber. The fan is in the round side chamber with the nozzle. To this nozzle a piece of india-rubber tube, about $1\frac{1}{4}$-inch diameter, or so, is attached, for conveying the sulphur fumes or smoke into the place to be fumigated, or, as I used it, into the drain. The large driving wheel is attached to the spindle of the fanner by a band made of $\frac{3}{8}$ in. spliced hempen cord or rope.† This "Fumigator" was patented in 1871, April 28th, No. 1,137, by Mr. S. S. Bateson, of Mayfair, Middlesex, and the first duty of £50 was paid in 1874; but the £100 duty due at the end of the seventh year was

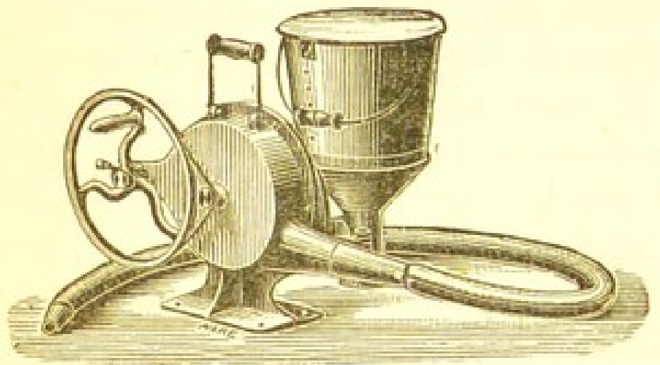

Fig. 331.

* The author did not patent this system of testing drains and soil-pipes by smoke, so that all and sundry may freely use it.

† I have found these hempen cords rather expensive, paying six shillings and nine pence nett the half-dozen for them, carriage extra. Mr. John Todd, rope manufacturer here, tells me he can supply them in quantities spliced, at about twopence each; but he recommends a round cotton rope band as better. It costs about threepence each.

not paid, and so on May 10th, 1878, the Patent was advertised in the Commissioners of Patents' Journal as void. The machine, as a producer of smoke for drain-testing, is open to improvement, as, in my experience, unless the waste is carefully manipulated, it sometimes goes into flame, and the result is invisible gas instead of visible smoke.* Mr. Bateson, in his A.D. 1871 specification, does not refer to his machine as a producer of smoke for testing drains, as we now do, but states that it was to fumigate or destroy vermin and noxious insects, or to disinfect sick-rooms or hospital wards, or to perfume apartments, halls, or theatres. He died in 1879. Shortly after I began to use the machine-applied smoke-test for finding out defects in the drains and soil-pipes, &c., of houses, the late Mr. Kenneth Macleod, Sanitary Inspector for Glasgow, recommended it, and one of his staff, Mr. James Dobson, invented a smoke machine of his own design for testing the drains of houses, and used it privately. The first application of the smoke-test by the Sanitary Department of Glasgow for the public, as recorded in the books, was on 20th February, 1882, several years after my introduction of it. Mr. Macleod had publicly recommended it, however, in 1880. Mr. Dobson, and Mr. Peter Fyfe, now the sanitary inspector for Glasgow, have lately patented a smoke-testing machine, which works by water-power. Fig. 332 gives sketch of this machine in the act of being used above a 6-inch Buchan's No. 2 disconnecting trap, to blow smoke into the house drain. E is the combustion chamber; K is the fanner; D, the blow-pipe from the fanner to the combustion chamber; Q is the water-cock for driving the fan; it is connected by means of a half-inch or three-quarter inch india-rubber

* It is somewhat heavy also, the smallest one I have, without its india-rubber tube, weighing about 37 lbs. Mr. Dobson's hand-worked machine, with india-rubber tube and wooden box to carry machine in, weighs 25 lbs. in all. Burn and Baillie's, with tube but without wooden box, weighs 27 lbs. Mr. Fyfe tells me they expect to produce shortly a new small water-worked machine, costing under £2, that will only weigh about 7 lbs. If so, it would be a boon to those using smoke machines, if this new one could be transformed into a serviceable hand-worked machine, to weigh 12 lbs. or less.

tube, attached at one end at z, and at other end to one of the cold water taps in the house.

Fig. 331 style of smoke machine, as also Fig. 333 style, require some person to drive them; but Fig 332, being driven by water, can be left for a consider-

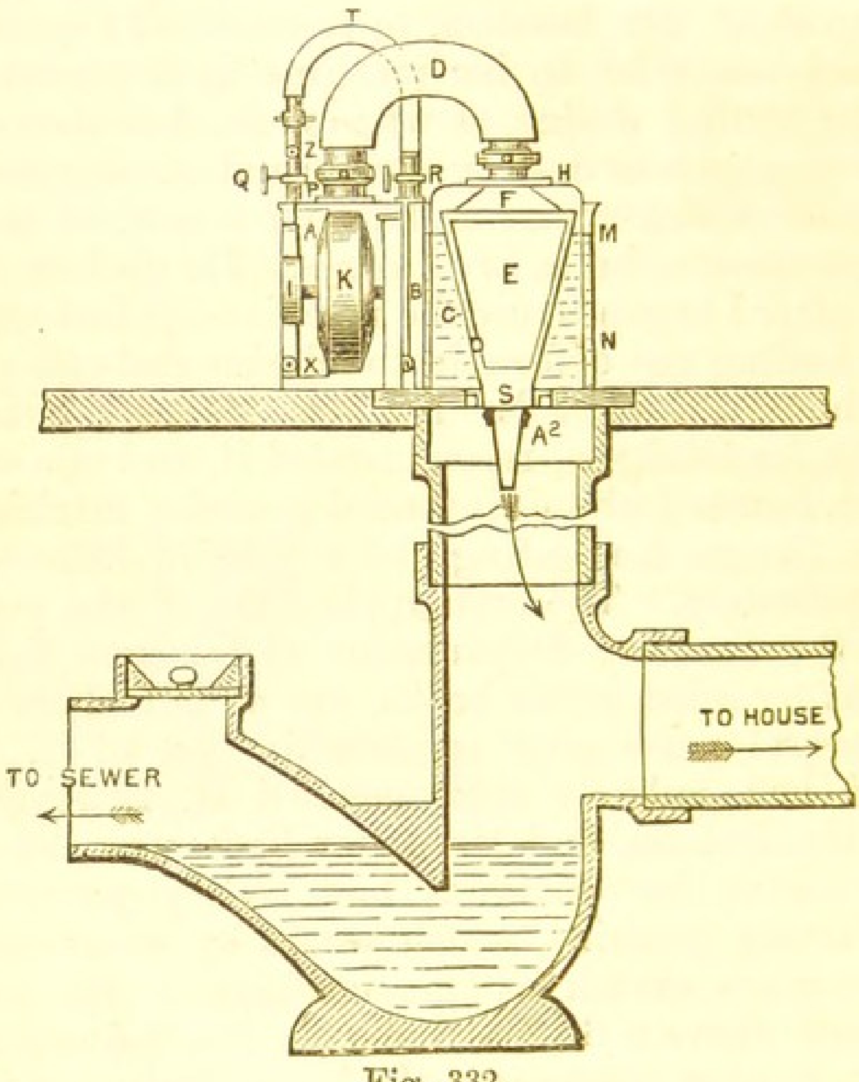


Fig. 332.

able time working away itself, wherever there is plenty of water with sufficient pressure — about 50 lbs. per square inch, or less does very well—to drive it. The amount of water used is not great, as it has to pass through a fine nozzle before impinging on the turbine I. The machine has also an injector arrangement, in order to put extra pressure on when wished. Further information will be got from the patentees.

Fig. 333 is a style of hand-worked smoke-testing machine, which I have used of late and think very highly of. It was patented in 1884, Oct. 23rd, No. 14,056, by Mr. Macdonald, of the firm of Messrs. Burn and Baillie, plumbers and brass-founders, Edinburgh. It is shown as seated upon the ground, and blowing

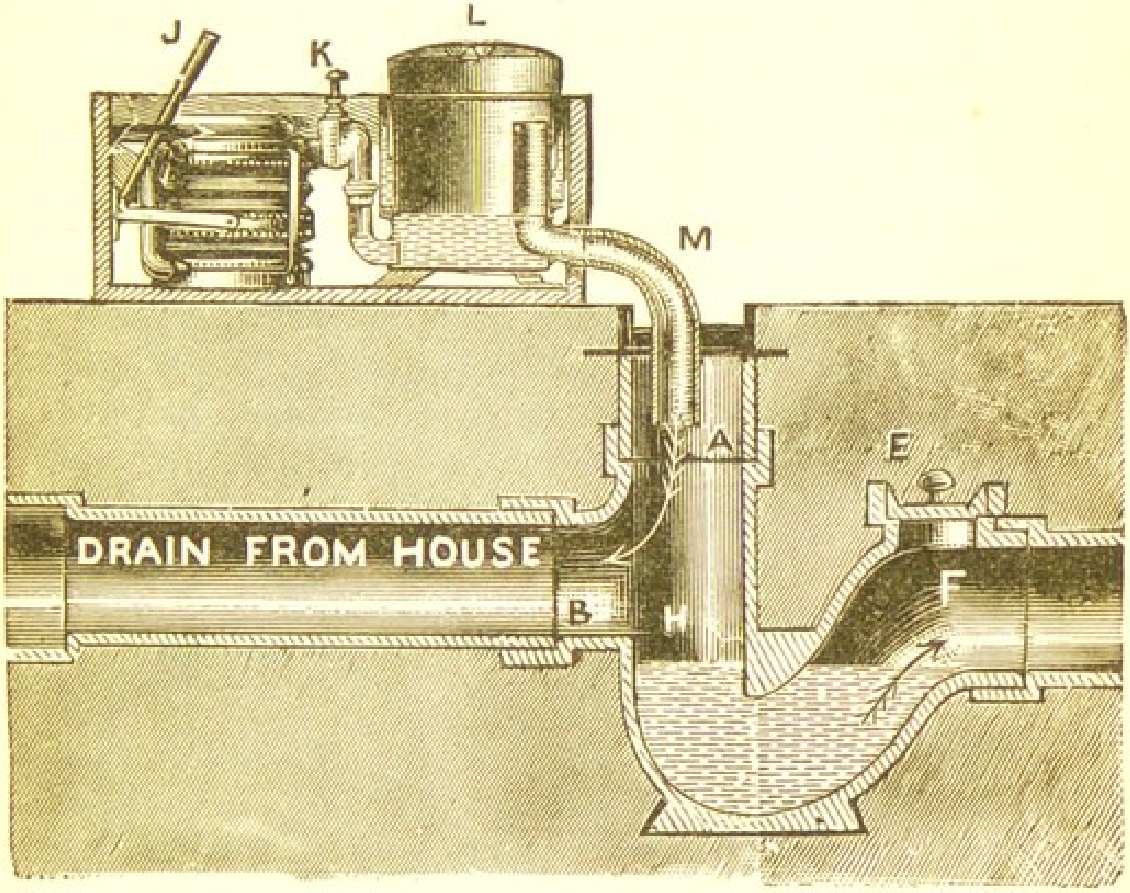


Fig. 333.

smoke through the tube M into the top of a Buchan's No. 2 trap, and from thence into the drains in or around the house. L is the cover over the combustion chamber, which chamber is filled with soiled cotton waste; J is the handle which works the bellows; K is a stop-cock for shutting when the bellows is not being worked, in order to prevent the smoke or heat from the combustion chamber getting back into the bellows. The outside of the combustion chamber is filled with water, and so a water-tight joint is formed when the cover L is put on.

A larger machine than either of the foregoing was patented in December, 1884, No. 16,952, by Messrs. John Watts & Co., of the Broad Weir Engine Works, Bristol, who, as I understand, were the original makers of the fumigating machine shown in Fig. 331. To those made by them they have for some years back applied the distinguishing registered title of "Asphyxiator," which particular title or name no one else can apply to smoke machines.

When smoke-testing the drains of houses the tradesmen or parties doing it must watch, and not asphyxiate or suffocate the baby or any of the other inmates of the house. The canary or parrot need not be killed either.

Fig. 334 shows the plug invented by Mr. Francis Botting, Sanitary Engineer, Baker Street, London, for

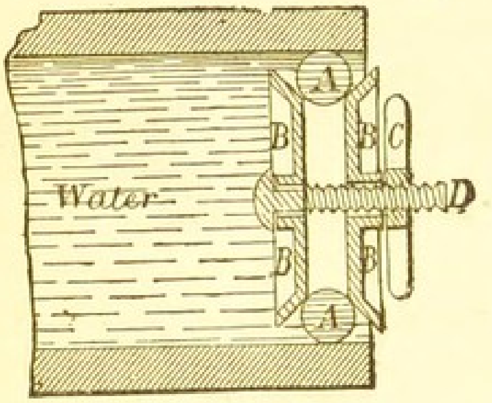


Fig. 334.

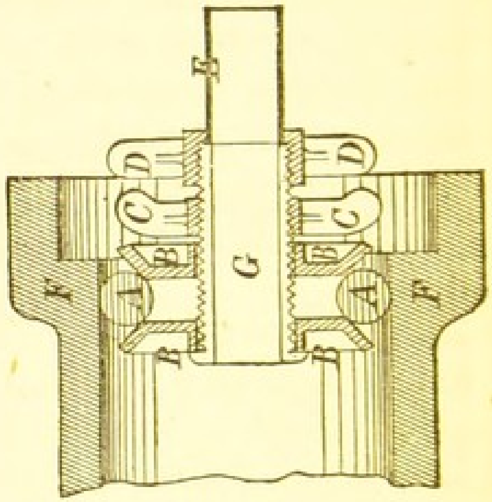


Fig. 335.

plugging up drain-pipes when either the water-test or smoke-test is applied. B B are two discs of either wood or iron, bevelled at the circumference, as shown. When these discs are screwed towards each other the solid ring of india-rubber A is pressed tightly against the circumference of the pipe, and so a tight plug is formed.

Fig. 335 shows a modification of this plug, suggested by the author, in which, instead of forming the screw of a solid bolt it is made of a tube G, through which the smoke from a smoke machine may be applied when testing the drains.

The use of peppermint and paraffine oil for testing drains has been tried, but as these tests only depend upon the sense of smell—of which sense various people are considerably deficient—the smelling test has had to give way to the smoke test, as the latter appeals not merely to the nose but also to the eyes.

The institution of vaccination by Dr. Edward Jenner in 1796, and the invention of chloroform as an anæsthetic by Sir James Y. Simpson in 1847, are instances among many of what has been done by members of the medical profession to prevent and palliate human disease and suffering. Perhaps some gracious historian in the next century will acknowledge that the introduction of the smoke test for drains by a tradesman was a step in the same direction.

In closing this chapter I may observe that, while not forgetting the early pioneers, led on by the veteran, Mr. Edwin Chadwick, C.B., sanitary literature within the last few years has been most abundant, and also quite popular; and what is better, the greater part of it has been useful, instructive, and very good. We have had the architect, the chemist, the engineer, and physician all vying with each other, as to who would do best. One pamphlet I especially esteem is "The Sanitary Work of an Architect," by Mr. Ernest Turner, F.R.I.B.A., London. Another interesting little work by an architect is "An Hour with a Sewer Rat," by Mr. G. G. Hoskins, F.R.I.B.A. Mr. Rogers Field, B.A., C.E.,* is well known both for his words and deeds in connection with sanitation, and in great measure in its relation to house drainage. Mr. S. S. Hellyer's "Lectures to Plumbers," and "The Plumber and Sanitary Houses," are books which all plumbers who can afford it should possess. Mr. Bailey Denton is another writer upon drainage whom I might mention. I have already referred to Mr. Baldwin Latham's standard work on "Sanitary Engineering." In the body of this work I have mentioned a number of well-known names—co-workers towards sanitary progress: to which I may add Drs. W. H. Corfield, C. A. Cameron, and Charles Cameron, M.P., Sir James Gowans, Lord Dean of Guild,

* Mr. Field, 5, Cannon Row, London, S.W., is the inventor of Field's flushing tank.

and Dr. Henry D. Littlejohn, Medical Officer of Health for Edinburgh, who have both done much towards improving the drainage of the capital of Scotland.* I may also mention Drs. E. T. Blake and David Page. Likewise Mr. Ed. C. Robins, F.S.A., who has delivered various important lectures in connection with the healthy and comfortable use of buildings; John Farquharson, architect, Haddington, who has been paying special attention to the improved ventilation of churches and schools; also H. P. Boulnois, C.E., Portsmouth, author of the "Municipal and Sanitary Engineer's Handbook"; and last, but not least, Dr. T. Pridgin Teale, of Leeds, with his amusing and yet highly instructive "Pictorial Guide to Domestic Sanitary Defects." †

The names of officers of health and sanitary inspectors throughout the kingdon are so numerous that I could not pretend to name them, but they have all

* I am indebted to the courtesy of Mr. John Cooper, Burgh Engineer and Master of Works, Edinburgh, for a copy of the "Memoranda" prepared and issued by the Dean of Guild Court of Edinburgh at the beginning of 1888, for the guidance of architects, builders and others, from which we learn that all the plans of new houses presented to the Court are carefully examined to see that they are in accordance with the regulations. They are very particular in regard to inspecting and testing the drainage, while a plan and record of the position and arrangements of the drainage system are preserved for future reference. On completion, a final examination is made before the building is certified as being fit for human habitation. Duplicates of these certificates can be had by the owners if they want them. Should the owner of any new, or structurally altered, building allow it to be occupied before it is certified, he is liable to a penalty not exceeding £5, with the addition of £2 for every day during which such occupancy shall continue. Before the drains of a building are covered up, twenty-four hours' notice has to be given to the burgh engineer. Sir James Gowans informs me, that although he had some little difficulty with architects and builders at the first, he finds they are now pretty willing to fall in with his suggestions. In Aberdeen, the surveyor informs me that they insist on all water-fittings, drainage, and ventilation being executed in accordance with the Town Council's printed regulations, and that houses, &c., are tested by the smoke test—first the drains and then the plumber's work. In many other cities and towns, the change that has taken place for the better has been very great during the last few years.

† I omitted to express my belief, on page 298, that Mr. John Honeyman, F.R.I.B.A., was the first to advocate the full exposure of closets.

been helping on the good work of the day. May they all reap their reward, and their country gratefully acknowledge it has been the better that they have lived.

In connection with sanitary improvements, I have somehow come into personal contact with very few of the clergy, although I am aware that many of them have been interesting themselves specially in this work. Chief among those I do know, the Rev. John Stark, of Duntocher, stands out in bold relief as an apostle of sanitation. He seems never to be weary of well-doing. Both young and old—and especially the former—have much to thank him for on account of what he has done for them. The old saying, "Mens sana in corpore sano"—a sound mind in a sound body—is getting transformed into, "Corpus sanum dat mentem sanum" —a sound body produces a sound mind. It is a mistake to boast of the mind being perfectly sound when the brain is diseased; or that the rising generation can grow up strong and healthy as they ought in unhealthy surroundings. Hence the demand for improved environment.

## CHAPTER XXXI.

### WATER REGULATORS OR GOVERNORS, AND GAS STOVES.

ATTENTION is here drawn to a new water regulator invented some years ago by Mr. William Foulis, Gas Engineer, Glasgow. The object of this regulator is to control the supply of water in mains so as to maintain a constant outlet pressure, under varying conditions of inlet pressure or outlet consumption. *E.g.* if the reservoir were 200 feet high above a certain district, then by the insertion of this new regulator the pressure could be reduced to only 100 feet, and so on as desired. A great improvement in these valves is that even the largest sizes may be worked by weights of a few pounds.

Fig. 336 is vertical section of one arrangement where F is the inlet, G the outlet from the governor, A is the valve, and B the piston attached to it, C is the pipe communicating with the arrangement shown in Fig. 337. The pressure on the top of the valve A balances the pressure under the piston B, and the valve adjusts itself until the balance of pressures is obtained. The inlet pressure acting on the bottom of the valve A and top of the piston B is neutralised, and has no influence on the action of the governor.

The means of obtaining the necessary pressure under the piston is shown in the arrangement in Fig. 337. It consists of an elongated piston or ram, P, about ½ inch in diameter and 6 inches long, working in a cylinder, G. In this ram a recess is cut. C is a pipe leading to the underside of the piston of the valve, F is a communication with the inlet of the valve, and

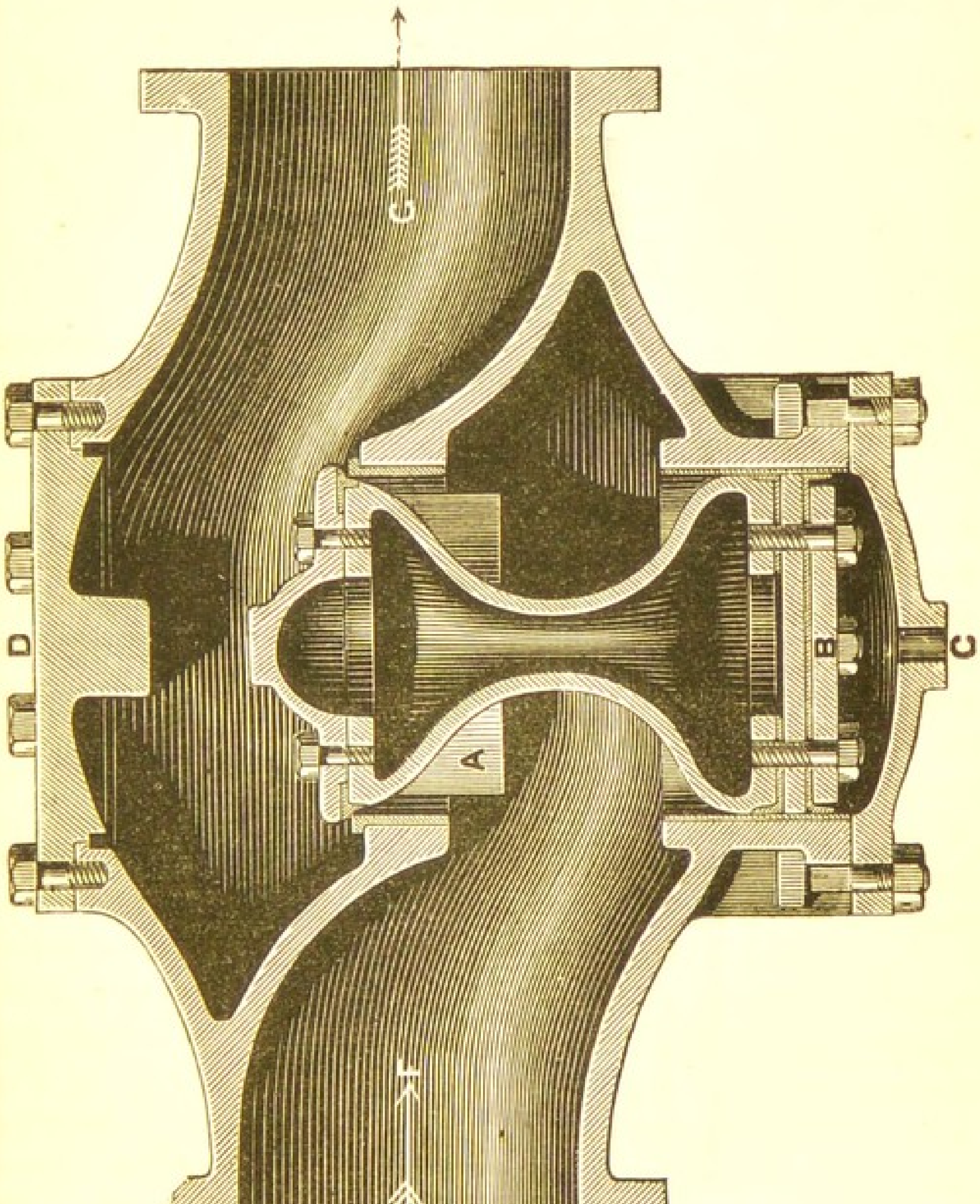


Fig. 336.

G communicates either with the outlet or above ground. A small hole, D, through the ram communicates the pressure to its underside. The ram is continued through the top of the cylinder, and may be loaded to any desired extent.

The regulating arrangement in Fig. 337 from its small size may be placed in any convenient position—*e.g.* in the pillar of a lamp as shown in Fig. 338—

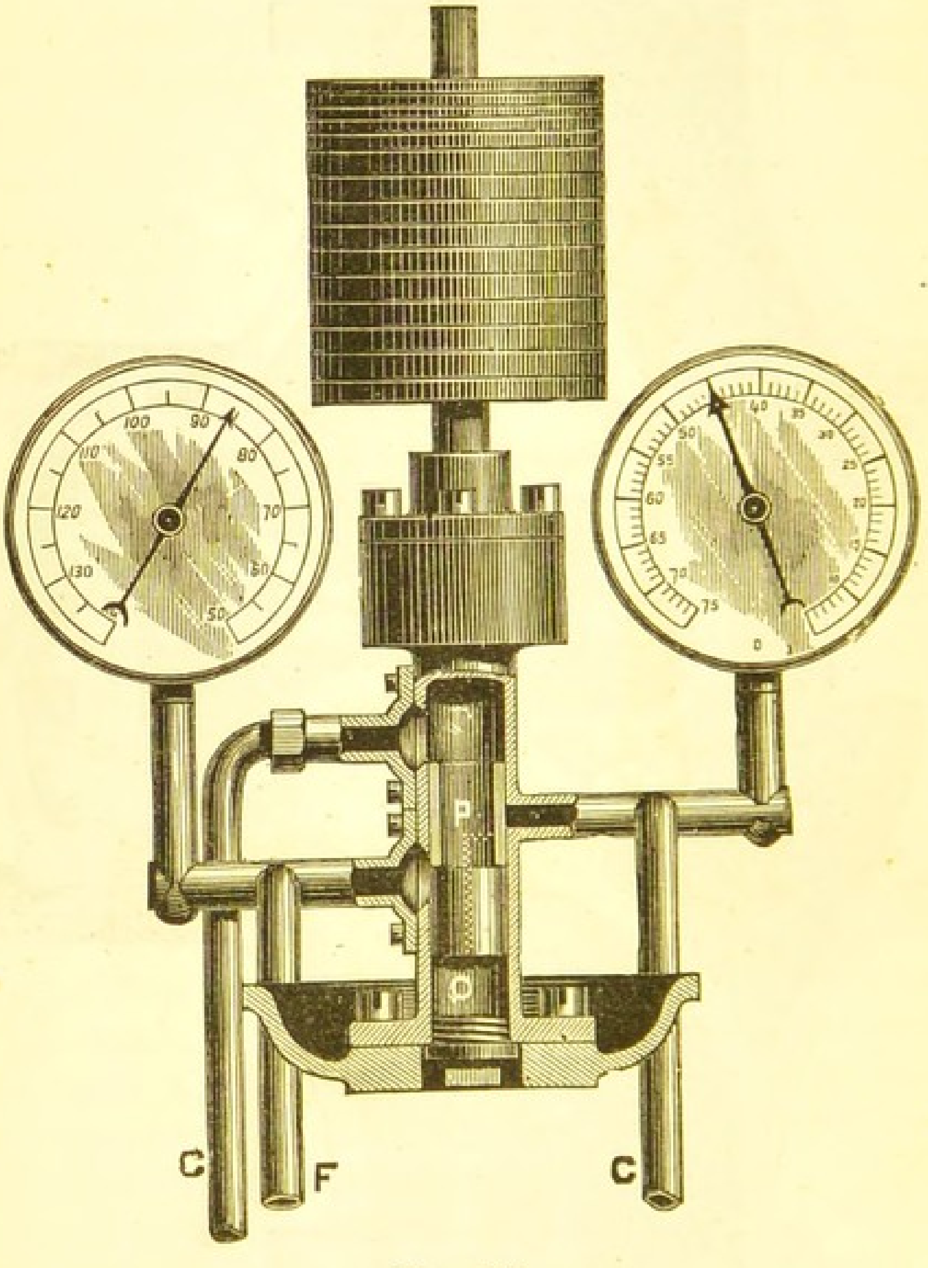


Fig. 337.

the governor itself being placed underground on the line of main, at any distance from the regulating arrangement. Such a regulator as above described should be very useful in a town or city with various levels, to prevent waste of pressure upon the low levels, and allow full pressure only for the high levels.

Fig. 339 is vertical section of a small-sized regulator, the intention of which is to reduce the pressure in service pipes to houses in cases where the pressure is stronger than is either necessary or is wanted, and so help to save injury to the pipes and fittings from extra high pressure.

I have not seen any of the large governors working yet, but I am told they are doing satisfactorily where

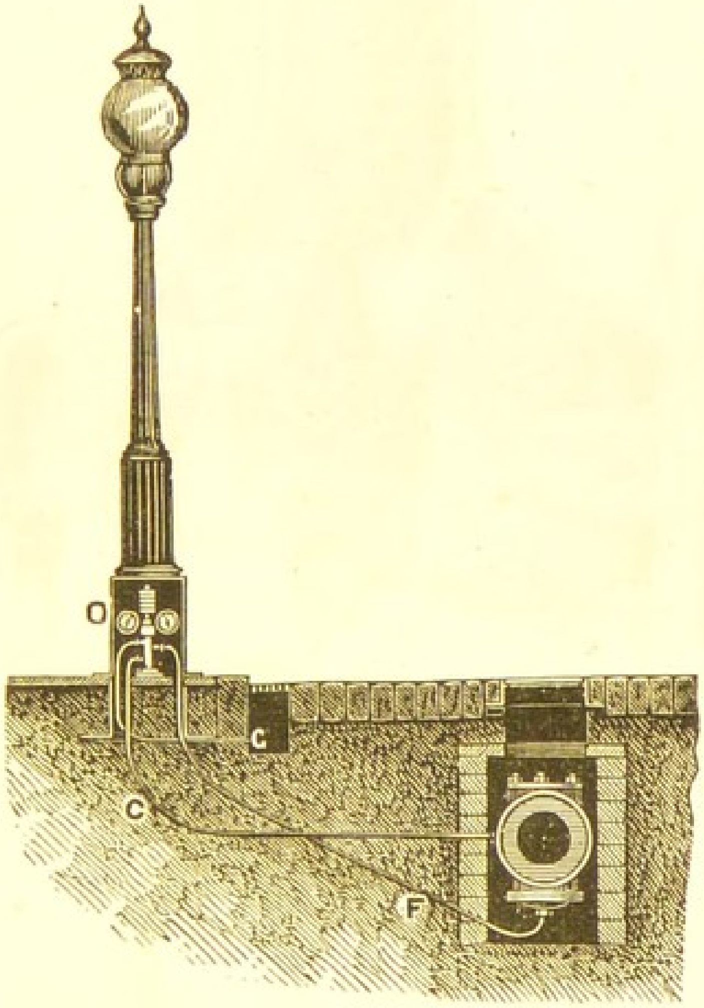


Fig. 338.

they have been applied. It will require some time to show their real value. I saw some experiments with the small one, Fig. 339, showing its action as a reducer of the pressure. Hitherto stop-cocks have been used, as per page 156, to serve at one and the same time as shut-off cocks and as regulators to check excessive outflow while the water was running; but these stopcocks, although half shut, did not reduce the pressure in any degree, when the water ceased running. If Fig. 339 would serve as stop-cock, regulator, and reducer of the pressure all in one, then its value would be greatly enhanced. It was suggested to try one

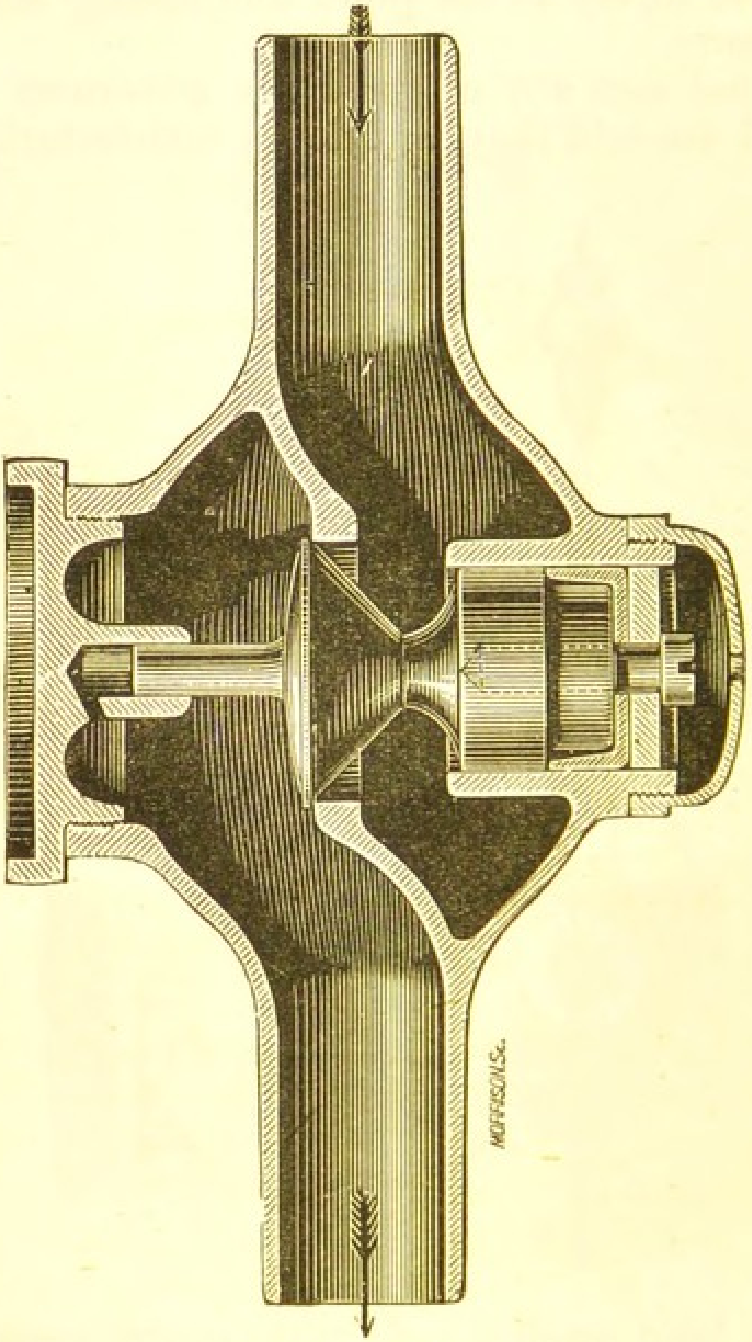

Fig. 339.

with a screw-down spindle attached, and also with an air vessel.

Fig. 340 is sketch of an improved Gas Stove—entitled the "Regenerator"—lately invented by Mr. Foulis. It is made in two styles as per vertical sections Figs. 341 and 342. The latter (the A pattern) has a heating air chamber, F, between the furnace or

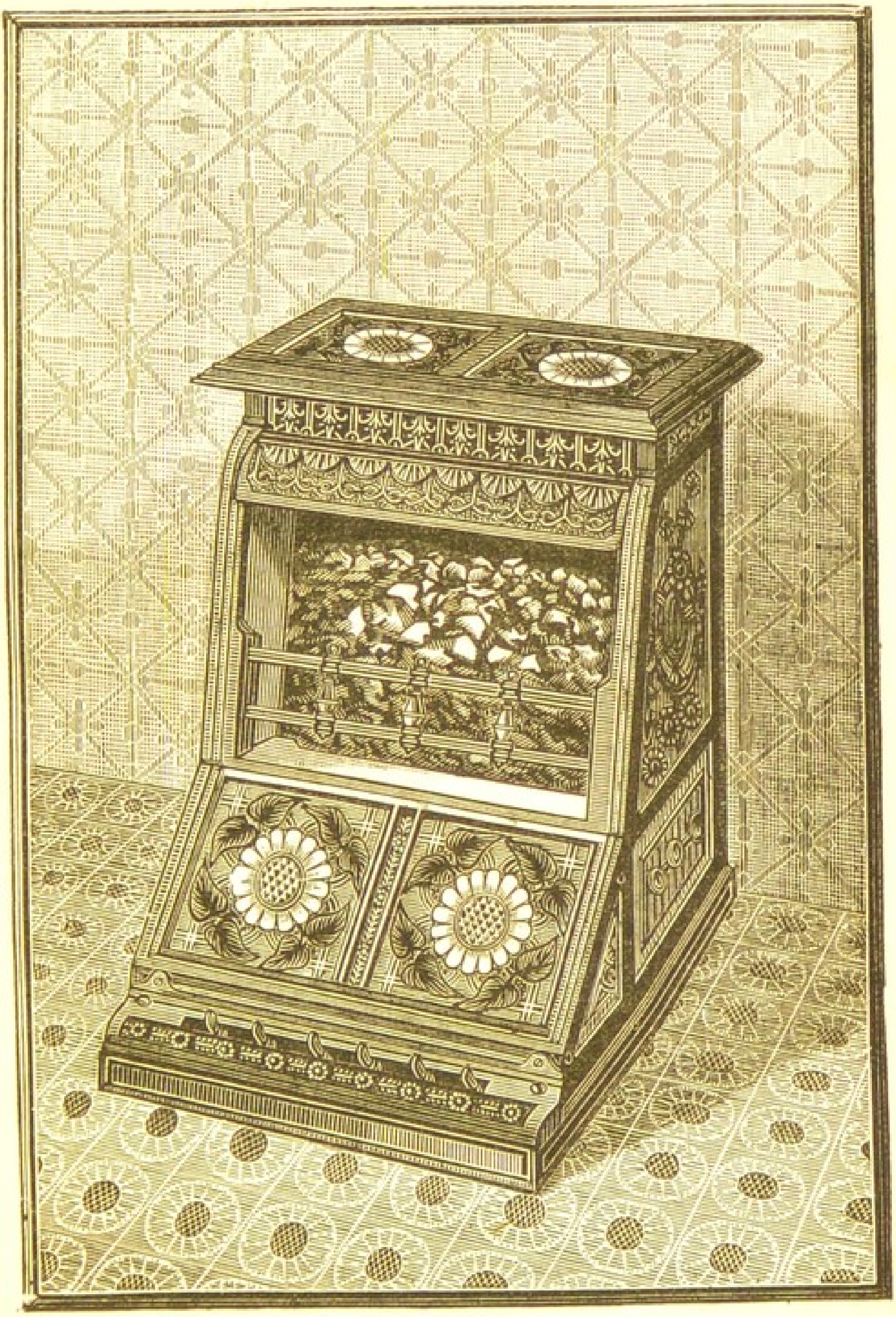

Fig. 340.

fire and the outer metal casing, which the former (the B pattern) wants.

In Fig. 342, it will also be seen that the outlet for the waste gas fumes is low down near the floor at E, whereas the outlet for the gas fumes in Fig. 341, is near the top at D. For this reason I prefer to use Fig. 341 style of stove, and especially where the vent or outlet pipe from the gas stove has not an exceptionally good up-draught. Fig. 341 is the cheaper style and I think the healthiest also.*

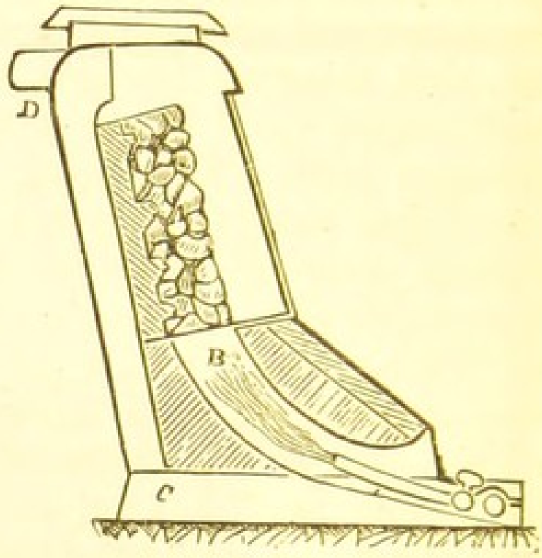

Fig. 341.

I put one of the Fig. 341 stoves into the billiard room of Mr. M. G. Neilson's house, Brentham, Pollokshields, N.B., and after it has been on for some time the room gets so warm that the gas has to be lowered. It was intended to put in two stoves, but I recommended that one should be tried first, which is found quite enough.

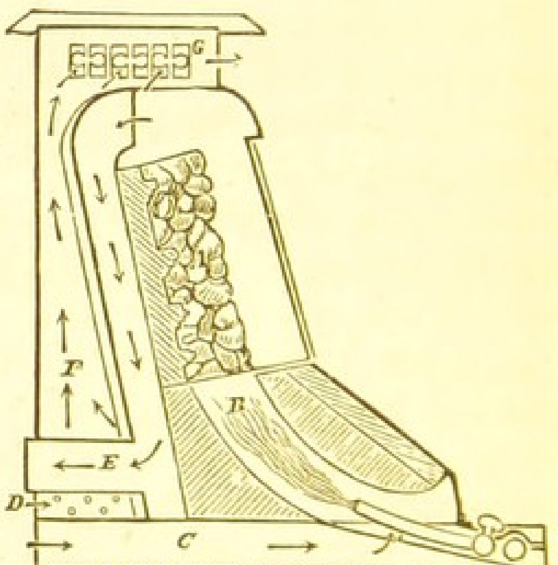

Fig. 342.

B in both figures is the combustion chamber into which the gas flames deliver. Above B there is an irregular fretwork of firebrick, which is intended to give the appearance of a bright coal or coke fire when the gas is lighted. As the combustion chamber B is surrounded with firebricks, a very strong heat is sent out after the gas has been on for some time.

* The makers are R. and A. Main, Gas Cooking and Heating Engineers, Argyle Works, Glasgow. Also the Carron Company.

When a gas stove is used in a room, there is much more necessity to provide outlet ventilation to carry off the v tiated air than with the ordinary open fire, for the latter has generally a large or wide opening into the vent, whereas the gas stove has generally only a small outlet equal to about a three inch or four inch diameter pipe. This being so, supposing a "Regenerator" gas stove to be fitted into a room in place of the register grate B shown in Fig. 297F, page 275, then have either one or two ventilating pipes put in as per the "Air-pipe C," which air-pipe C may either have its inlet opening at D as shown, or it may be above the ceiling—say in the centre of the room. In other cases the outlet may be by the pipe H, page 275, or its equivalent. A gas stove badly fitted into a room may make the room warm, but at same time it may act like a slow-poisoner, while a good gas stove fitted into a room that is sufficiently ventilated will make it warm, comfortable, and healthy.

It is often highly dangerous to leave a warm room and stand in the draught of the open outer door speaking to departing friends, and especially on a cold day. Many people have brought painful illness and even death upon themselves by so doing. Last spring a highly accomplished young lady friend of the Author's lost her life, after a few days' severe illness, in this way.

A great variety of gas stoves for heating and also for cooking are made by other makers, such as Thomas Fletcher, of Warrington; John Wright & Co., of Birmingham; Smith and Wellstood, Glasgow, &c., &c., while a number of the gas companies or corporations now show gas stoves at their offices.

## CHAPTER XXXII.

### Registration of Plumbers.

In closing this new edition of Plumbing, it will be both interesting and useful to give a short sketch of the rise and spread of the present great movement for the National Registration of Plumbers. The Worshipful Company of Plumbers of London has taken the lead in this, and spared neither money nor pains in striving to make it a success. The public start of the movement may be said to have taken place at the Congress of Plumbers from all parts of the kingdom, held at the International Health Exhibition, London, in October, 1884. This Congress was held to consider the best means for protecting the public, in regard to plumbers' work in connection with house sanitation, and also to consider what practical steps should be taken to raise the status of the trade.

The chairman of the meetings, at the "Healtheries," was the then Master of the London Plumbers' Company, who previously to this had been striving to do something to advance the craft for the good of the public, and amongst other things the suggestion was made to confer the membership of the Plumbers' Company, as a premium and diploma, on craftsmen who proved themselves worthy of it, and which diploma would be a means of letting it be publicly known that its recipient was a qualified and worthy plumber. This contained the germ of a good idea but was too local for general application, hence the necessity for something wider in scope.

Apart from this it was felt by a few who took an interest in plumbing work, that the great International Health Exhibition of 1884, in London, should be utilised in order to hold a National Congress of Plumbers at it to consider questions affecting the trade. Mr. Arthur T. Dale, of the *Plumber and Decorator*, London, wrote to me in the summer of 1884, asking me to use my influence in getting up a meeting of plumbers in London during the Exhibition, and after thinking the matter over it seemed to me that if anything really practical and *permanent* was to result from a meeting of plumbers at the "Healtheries," some influential local person or body must be got to take the lead in the proceedings. The only body that I knew that could properly do so was the Worshipful Company of Plumbers of London, so in June, 1884, I wrote to the Master of the Company, mentioning that it was desirable to have a Congress of Plumbers at London during the Exhibition, and asking him to lay the matter before his Company to see if they would agree to take part in the Congress. He entered heartily into the idea himself, and a special meeting of the Wardens' Court being called, the idea was approved of by it.* The Company thereafter proceeded to take active steps to get up and organize the proposed Congress, which was most successfully held in October, 1884, the Master and officers of the Plumbers' Company attending and taking the leading part at the meeting, which lasted two days.

The opening paper read was by Mr. Ernest Hart, on "The Regulation and Registration of Plumbers; Facts in support of the Extension of the Existing Statute Law as to House Drainage." There followed papers by Mr. William Eassie, on "The Technical Instruction of Plumbers," Mr. C. T. Millis, on "Technical Education for the Sanitary Plumber," and by Mr. J. W.

* I also communicated with a number of other master-plumbers in London and elsewhere—more particularly with Mr. P. J. Davies of London, and Mr. D. Emptage of Margate—who promised to aid the movement. The proposal was also ventilated and advocated in the Plumbing and Architectural Journals.

Clarke and Mr. E. G. Mawbey on the same subject. A discussion followed, in which a number of those present took part.* Other papers were read by or for Mr. W. R. Maguire, of Dublin; Mr. F. Wells, of Worcester; Mr. John Smeaton, of London; Mr. P. J. Davies and Mr. E. Knight, both of London; Mr. Robert Smith, of Bermondsey Square; Mr. H. Webb, of London; Mr. W. P. Buchan, Glasgow; Mr. W. Poole, of Norwich; Mr. David Emptage, of Margate; Mr. T. H. Court, of London; and Mr. J. Bailey, of Grantham.

The following were the Resolutions passed at the Congress:—

1. "That it is the opinion of this Congress that architects should not include plumber's work in the builder's contract."

2. "That in the opinion of this Congress it is desirable that the apprenticeship system should be continued, modified, if necessary, to suit the improved course of technical education."

3. "That this Congress is of opinion that in the event of the establishment of Provincial Boards of Examiners of Plumbing Work, such Boards—

(1.) Should be affiliated with a Metropolitan Board.

* A full account of the proceedings was published in book form—extending to 153 pages—by the Plumbers' Company. I see on page 41 that in reference to the value of water traps I am made to say, "In spite of the water, particles of gas remained which caused disease." That is nonsense. What I said was that, "In spite of the laboratory experiments—which showed strong gases passing through water—in practice a good water-trap prevented the passage through it of the particular germs which caused disease, and also of sewage air or gases to do any harm." (This corresponds with what I published in 1883, and which again appears in the foot-notes on pages 106 and 233 of this edition.) On page 87, again, I am made to say, "Some of the best plumbers in Glasgow, while condemning the use of iron for soil-pipes, invariably use heavy iron for other purposes. I have never, however, seen anything wrong with any of these iron pipes." This should read, "While condemning the use of light iron pipes for soil-pipes, invariably use heavy iron pipes for that purpose. I have never seen anything wrong with these heavy (about ¼-inch thick) iron soil-pipes." Should a new edition of these Proceedings be issued, the editor might kindly oblige by correcting these mistakes.

(2.) Should consist largely of trained working plumbers.
(3.) Should be in connection with Provincial Schools of Plumbing."

4. "That in the opinion of this Congress the registration of master plumbers and journeymen is expedient."

5. "That this Congress is of opinion that it is expedient that the system of sealing or marking lead and solder of standard weight and quality be revived by the Plumbers' Company, and that the Plumbers' Company should be requested to consider whether the materials used in plumbers' work as substitutes for lead are suitable, and whether standards of quality for such materials could be advantageously fixed on and verified by a recognised mark."

6. "That the Resolutions, Recommendations, and Conclusions set forth in the preceding papers be referred to the Plumbers' Guild, with a request that they will confer thereon with a view to take such action as may seem best."

The first of these Resolutions refers more to the London or English practice, as in Scotland it is customary to give the plumber's work directly to the plumber. The fourth Resolution, proposed by Mr. D. Emptage and seconded by Mr. Houghton, however, is the one we are particularly dealing with here.

At first this Registration was set a-going in the London district, but it soon overflowed that boundary and its aspirations became national. The Company, therefore, went out into the provinces, with the result that in Scotland, *e.g.*, the northern part of the kingdom has been laid out into six districts, viz. :—Glasgow and the West of Scotland; Edinburgh and the East of Scotland; Forfarshire, Fifeshire and Perthshire; Aberdeenshire, Kincardineshire and Banffshire; Inverness and the North of Scotland; Dumfriesshire, Kirkcudbrightshire and Wigtownshire.* The first District

* Each district council consists of an equal number of masters and men and also of public representatives. The latter generally including

Council in Scotland was the Forfarshire one, with its head-quarters at Dundee. The Glasgow and West of Scotland was established next at Glasgow, on January 9th, 1888, Sir James King, Bart., the Hon. the Lord Provost of Glasgow, in the Chair, and up to October, 1888, there have been sent into it upwards of 700 applications for Registration from both masters and men. The popularity of the National System of Registration was increased by the circulation of what is known as the Plumbers' Catechism—covering the whole question of Registration—prepared by Mr. A. M. Scott, secretary to the District Council for Glasgow and the West of Scotland.

In England, in addition to the head-quarters in London, District Councils have been established for Manchester and district; Lancashire, Cheshire, and North Wales; Northumberland, Durham, Westmoreland, Cumberland, and North Yorkshire; also in Sussex and the South of England.

Before the establishment of the various District Councils, a large number of plumbers were registered directly by the Plumbers' Company at London; such has been the case with a number of Irish plumbers.

At first, applicants for Registration were admitted on proof of having served apprenticeship, but it was intimated that after certain dates those applying would have to undergo examination in both the theory and practice of the trade. Technical Schools have, therefore, been inaugurated for the benefit of the younger members of the craft.*

the chief magistrates and the leading members of the architectural, medical, and engineering professions.

* The introductory lecture of the Glasgow classes which are under the control of the Glasgow and West of Scotland Technical College, was delivered by Mr. J. W. Clarke, Lecturer on Plumbing for the City and Guilds of London Institute, on October 10th, 1884, to a very large audience, Thomas Russell, Esq., of Ascog, one of the Governors of the College, in the Chair; there being present, amongst others, Alderman Knill from London, Past Master of the London Plumbers' Company, Professor Jamieson, M.I.C.E., Dr. Ebenezer Duncan, Mr. H. Dyer, C.E., and others. The local lecturer is Mr. David Fulton, R.P. The district council for Glasgow and the West of

Municipal Sanitary Authorities, Architectural and Sanitary Associations, and owners of property, have all evinced their sympathy with the movement; while the British Medical Association, at its annual meeting at Dublin, in 1887, passed a motion that in view of its bearing upon the health of the public the due Registration of Plumbers—in order to prevent incapable parties practising as plumbers—was a necessity. Up to date of publication of this edition about four thousand plumbers have been registered—about one-third being masters—all getting their diplomas from the London Plumbers' Company.* By-and-by, it is intended to ask Parliamentary sanction for this Registration of Plumbers in something the same way as is the case with the Medical Profession.

Scotland has given an endowment-grant of £20 to the class. Prizes are given by the City and Guilds of London Institute, and also by local parties for the best collection of illustrated notes handed in at the end of the session by pupils.

* Further information regarding registration will be got on applying either to the Council in the district or to the Worshipful Company of Plumbers, 1, Adelaide Buildings, London Bridge, London.

# INDEX.

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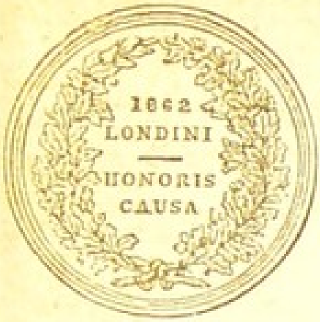


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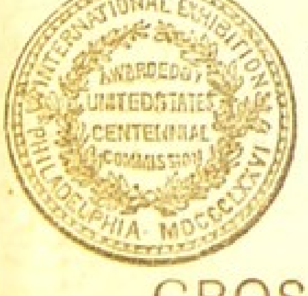


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