Drainage work and sanitary fittings / by William H. Maxwell.

ST. BRIDE'S PRESS PUBLICATIONS, No. 10.

DRAINAGE WORK

AND

SANITARY FITTINGS.

BY

WILLIAM H. MAXWELL,

Engineer and Surveyor's Offices, Leyton Urban District Council.

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THE ST. BRIDE'S PRESS, LIMITED,
24 BRIDE LANE, FLEET ST., E.C.

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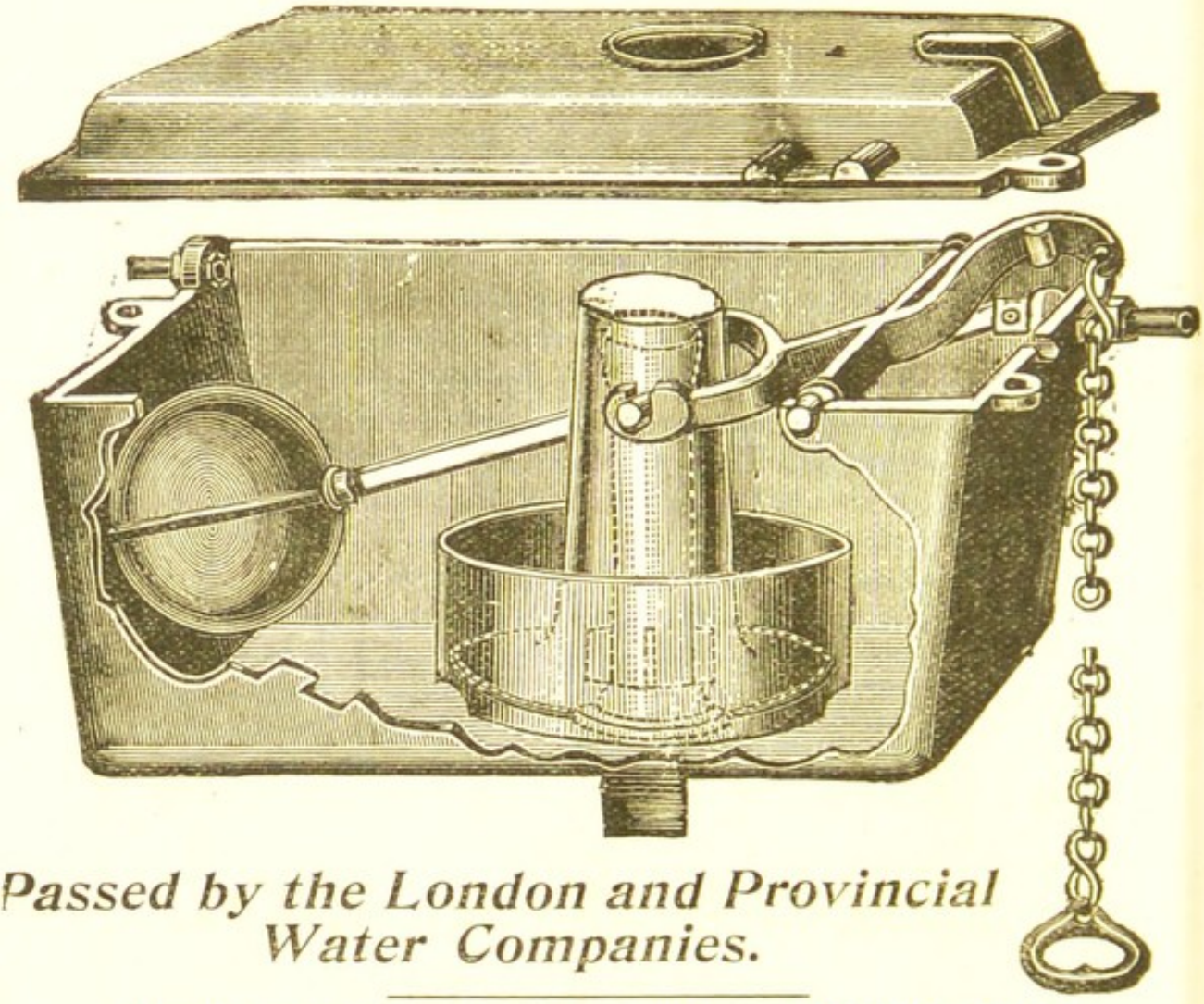

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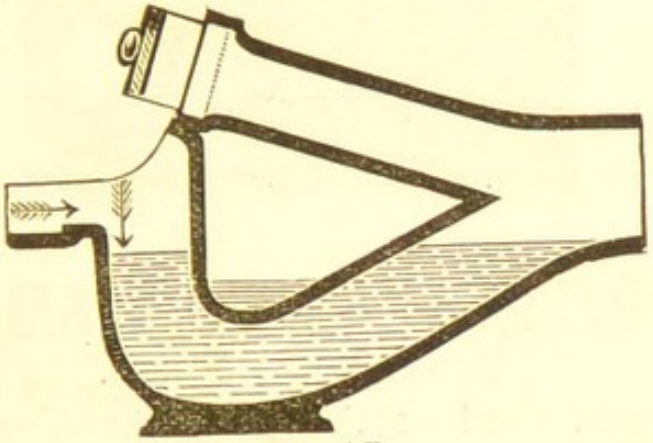

FIG. 37B

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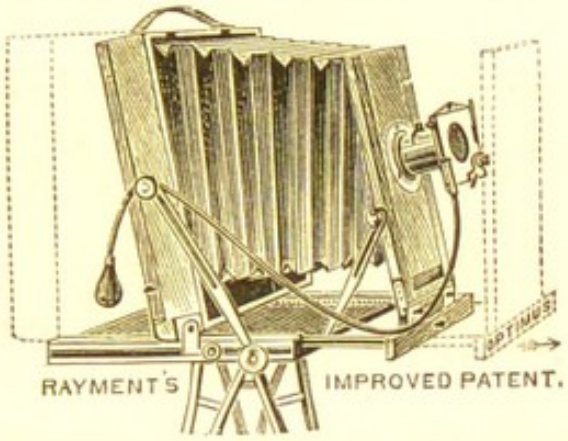

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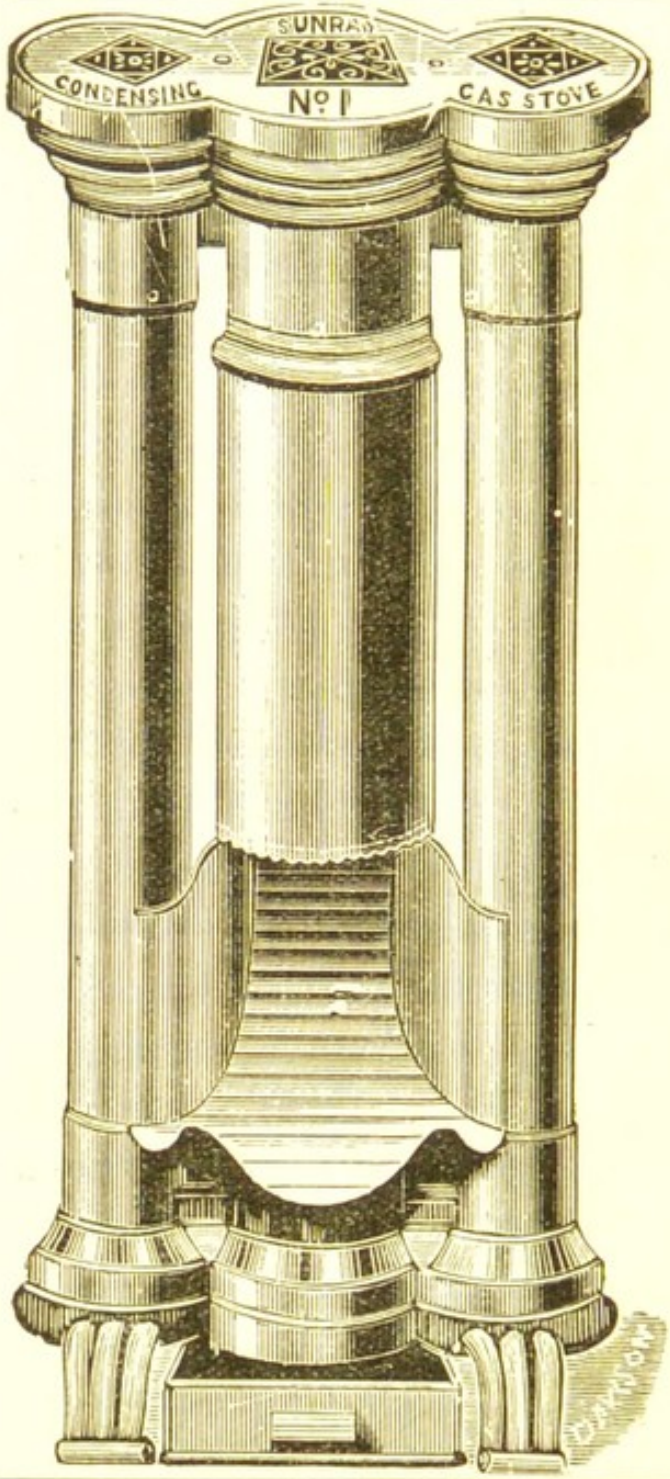

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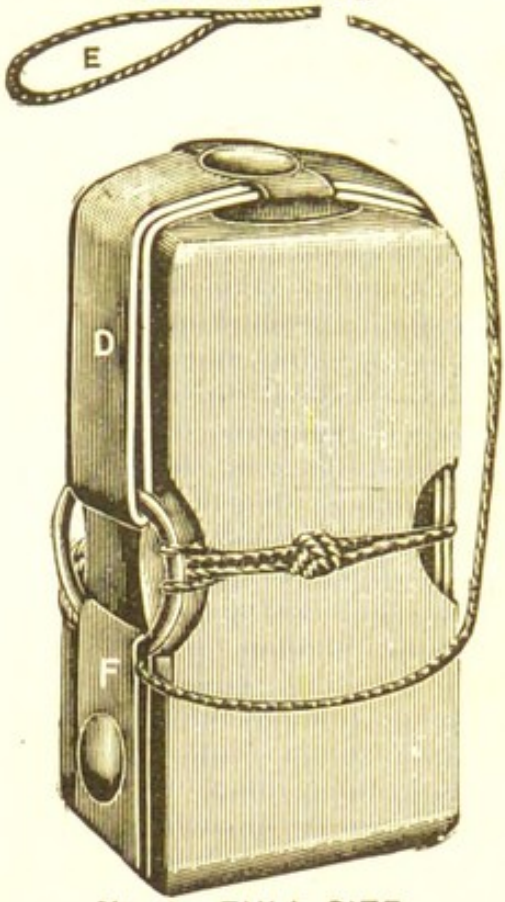
THE "RAPID" DRAIN-TESTER,

INSTANTANEOUS and SELF-ACTING.



No. 1.—FULL SIZE.
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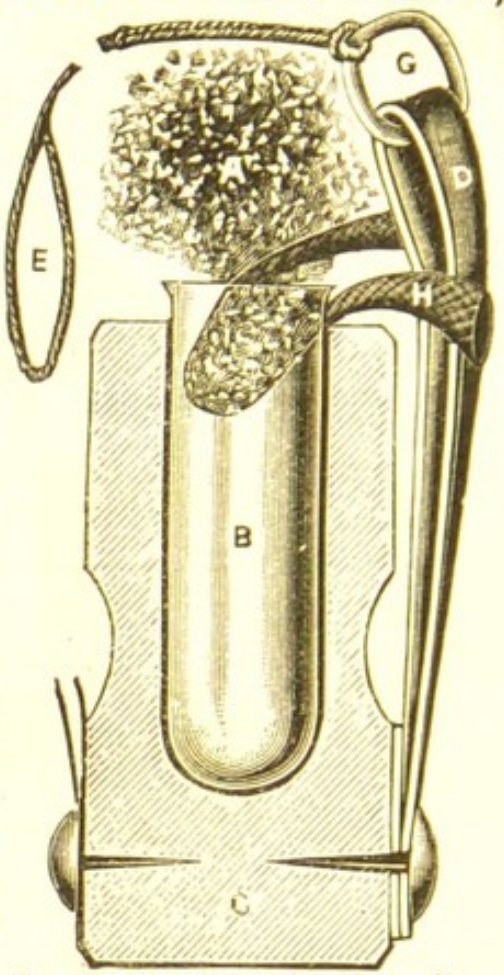
A Special Chemical.
B Glass Tube.
C Wooden Case.
D Elastic Rubber Band.
E Cord Holder.
F Paper Attachment.
G Brass Coupling Ring.
H Tape Ejecting Chemical.



No. 2.—Section showing discharge of Tester in Drain.

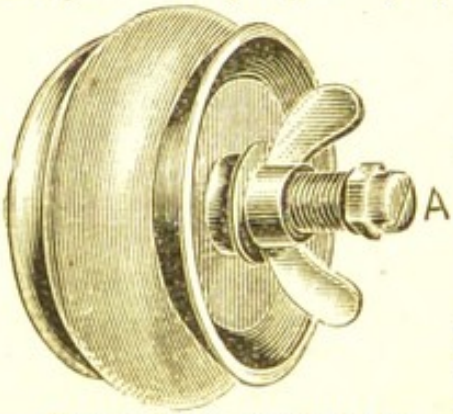
DIRECTIONS FOR USE.—Hold the Cord E; place the Tester in a W.C. pan; flush it into drain with a pail of water, when it will at once discharge itself, as *shown in Fig. 2.*

Prices: 1s. each, 9s. per doz. Special Price for 1 Gross Lots.

IMPROVED DRAIN PLUGS, WITH GUN-METAL BOLTS

FOR APPLYING THE "WATER" TESTS TO DRAINS AND SOIL PIPES.

They are easily adjusted, light, and portable



Drain Plug, ready to be inserted in Drain Pipe.

PRICES.

Plug for		each.
3in.	drain ..	7s.
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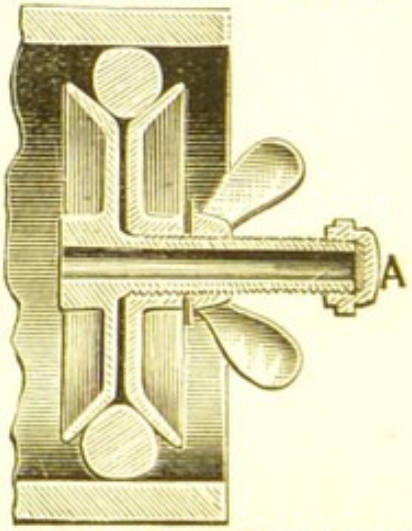

Section of Drain Plug shown in Drain Pipe.

BANNER SANITATION Co., 24 Craven St., Charing Cross, W.C.

Banner's Patent Exhaust Ventilators,

FOR PRIVATE & PUBLIC BUILDINGS.

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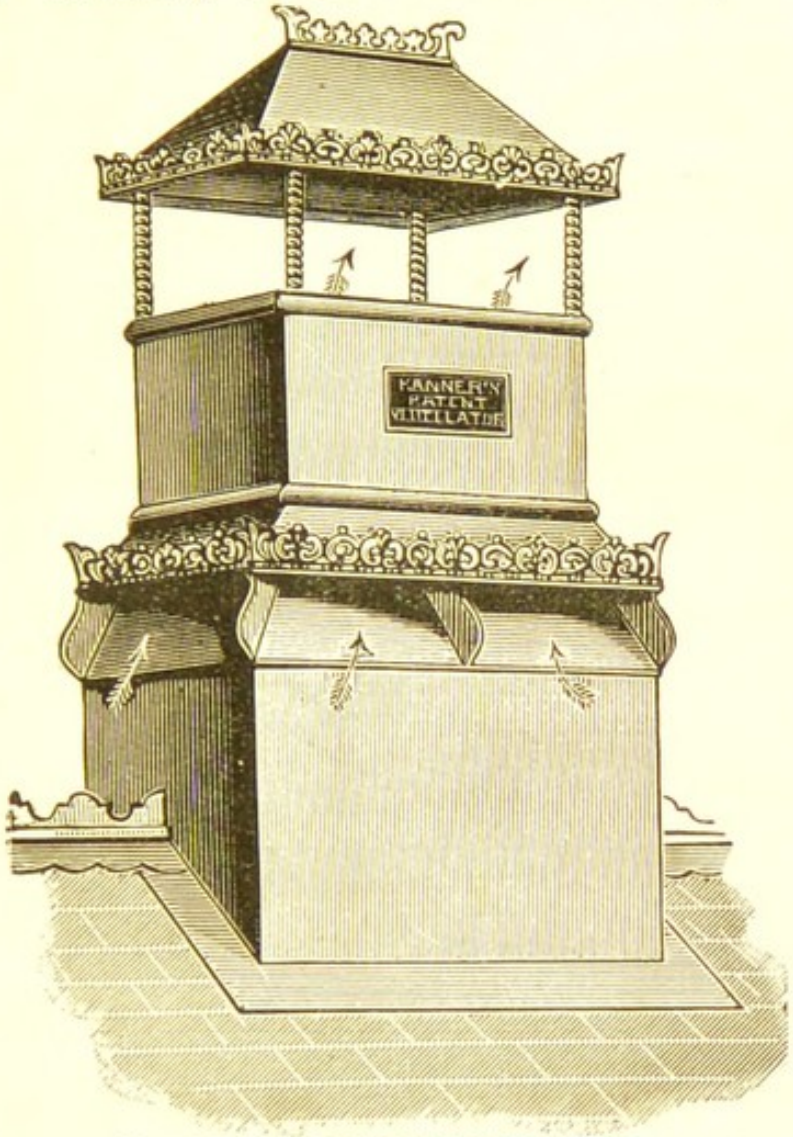

No. 33 D.—ROOF VENTILATOR.

DIMENSIONS.	INTERNAL OUTLET.	BASE OUTSIDE.	PRICES.
No. 33 C. Turret Ventilator	6in.	10in.	£2 2 0
,, ,, ,,	9in.	14in.	3 10 0
,, ,, ,,	12in.	18in.	5 10 0
,, ,, ,,	18in.	27in.	10 0 0
No. 33 D. Roof Ventilator	7in. × 5in.	11in. × 9in.	2 2 0
,, ,, ,,	10in. × 7in.	15in. × 12in.	3 10 0
,, ,, ,,	14in. × 8in.	20in. × 14in.	5 10 0
,, ,, ,,	20in. × 14in.	29in. × 23in.	10 0 0

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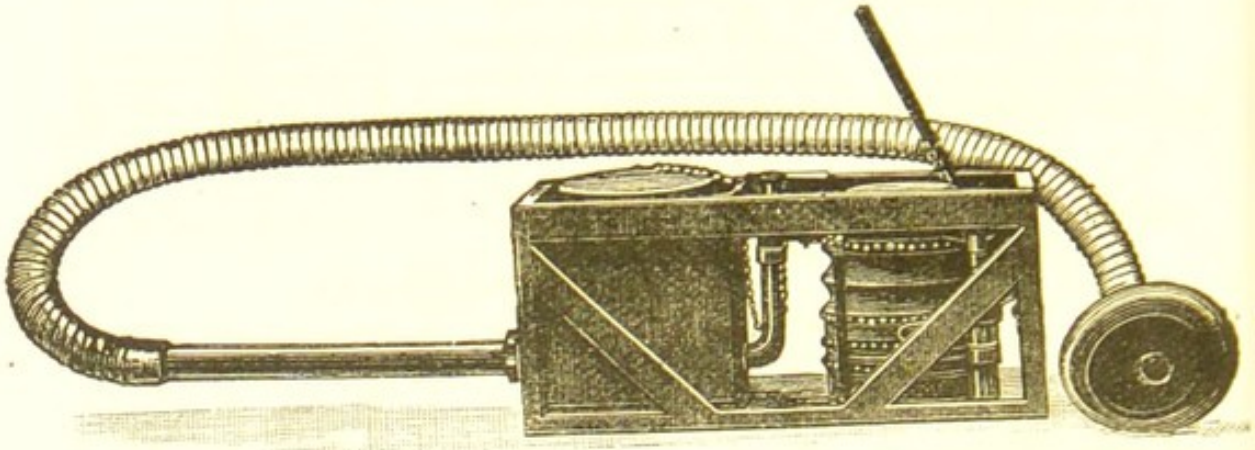
"Eclipse" Patent Drain-Tester.

This is the ONLY SMOKE GENERATOR, of any description whatsoever, which supplies a positive test to Drains.



IT consists of a double-action Bellow covered with specially-prepared leather, and, a copper cylinder or vessel with an outer casing, which latter is filled with water.

In this casing a cover or float is placed, which rises and falls with the action of the bellows. The hose must be connected to the drain or pipe to be tested, and all openings, such as ventilating pipes, plugged. A few strokes of the bellows will raise the float, and if it remains stationary the drain will prove tight. If the float falls a leak exists, and may be traced by using the Smoke-Test.

A great advantage in using these Machines is that the operator can ascertain whether the drain is tight or not, without leaving the apparatus. This apparatus is invaluable to Plumbers, Builders, Inspectors of Nuisances, Sanitary Inspectors, &c.

PRICES.

Machine & Tube (WITHOUT PLUG), 84/- Deal Painted Case, 10/-

Plugs extra, as under.

IMPROVED EXPANDING PLUGS FOR DRAIN TESTING.

Made in four sets, as under:

Size **A.**—3in., with extra Rubber Rings for 3½in. and 4in. 7/0
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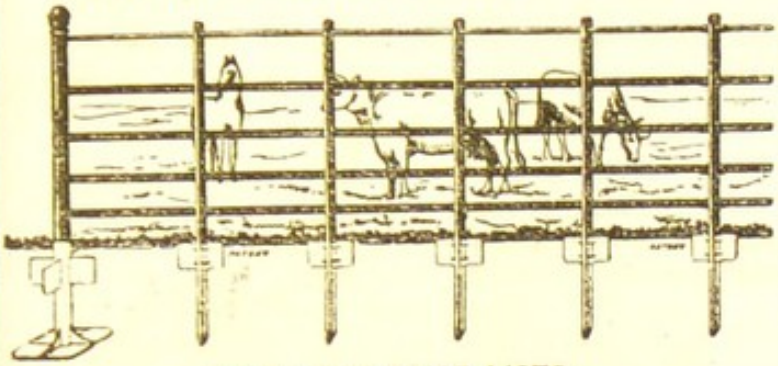

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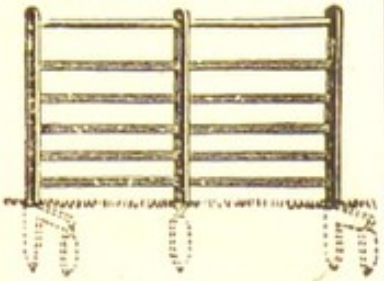

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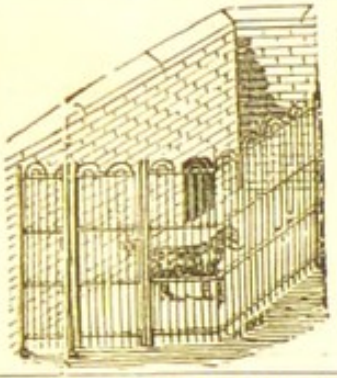

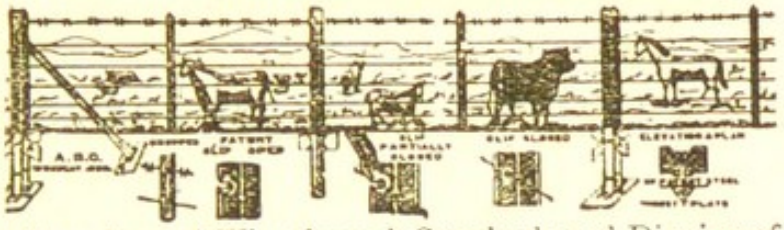

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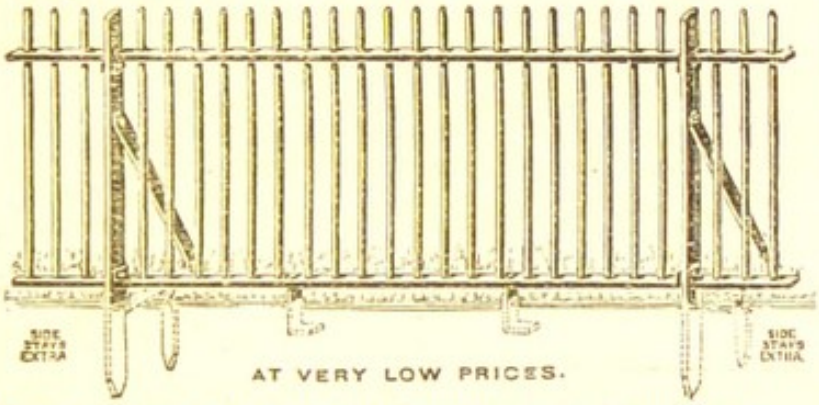

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From 1s. 3d. per gallon, Carriage Paid.

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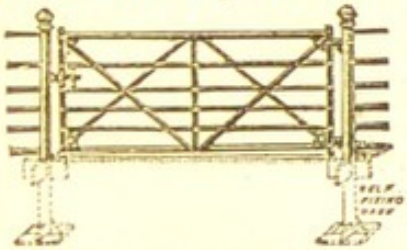

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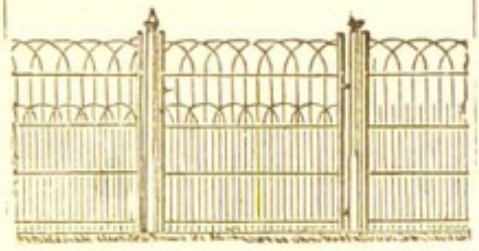

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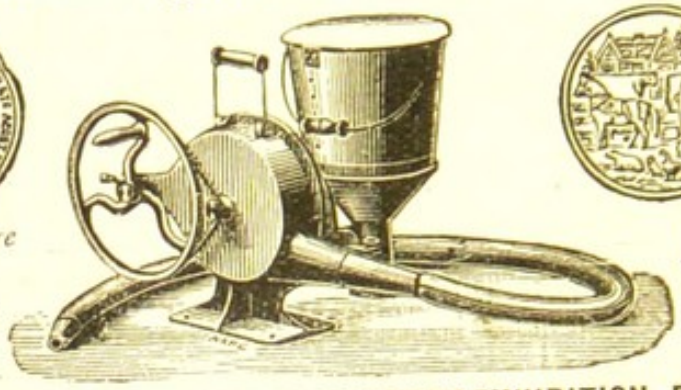

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CERTIFICATE OF MERIT SANITARY EXBHIBITION, BRIGHTON, 1890.
CERTIFICATE OF MERIT SANITARY EXHIBITION, NOTTINGHAM, 1892.

FOR APPLYING THE SMOKE TEST TO DRAINS, FOR DISINFECTING PURPOSES, FOR THE DESTRUCTION OF VERMIN IN HOLES.

The "ASPHYXIATOR" is universally acknowledged to be the only reliable machine by which the smoke-test can be applied to drains. It is used by Sanitary Authorities, Sanitary Associations, Unions. Medical Officers of Health, Architects, Plumbers and Builders throughout the United Kingdom and abroad. The "ASPHYXIATOR" is also applicable for disinfecting purposes.

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66 & 68, CHESTNUT ROAD, TOTTENHAM, N.,
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We have pleasure in informing you that the "ASPHYXIATOR" you sent has proved a most effective drain-testing machine, and having had it in use now some years, we consider it thoroughly reliable and far superior to rockets. It has also the advantage of being very easy to work. Yours truly,

(Signed) HENRY KNIGHT & SON.

SANITARY INSPECTOR'S OFFICE, TOWN HALL, GRIMSBY,
April 21st, 1893.

Gentlemen,

I have much pleasure in testifying to the efficiency of the "ASPHYXIATOR" supplied by you for us in our Sanitary Department here. It is certainly the best drain-tester extant, and from my personal experience of the use of the machine I strongly recommend it to Sanitary Authorities as a reliable method of testing drainage. Faithfully yours,

(Signed) HENRY F. MOODY, Assoc. San. Inst., Sanitary Inspector.

Descriptive Circular, with Testimonials, Price List of Machines, Fumigating Materials, and full instructions for use, Post Free on application to the Manufacturers,

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CHEAPEST and BEST made.

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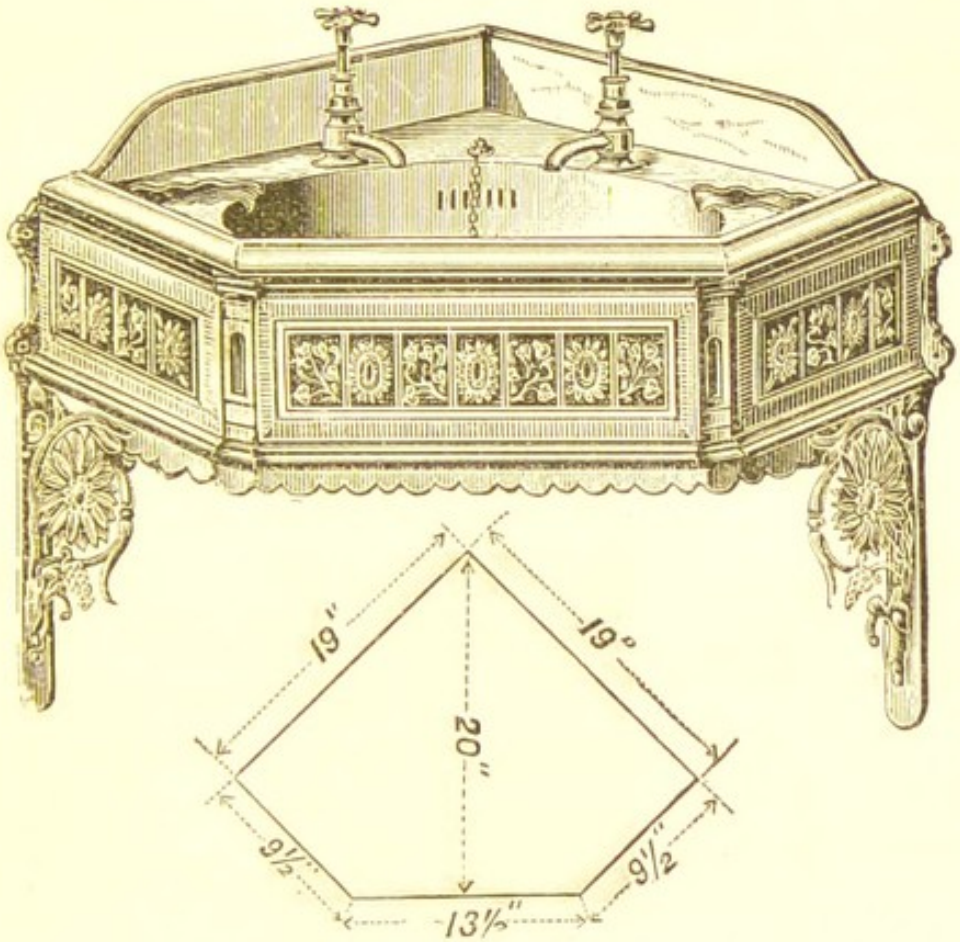

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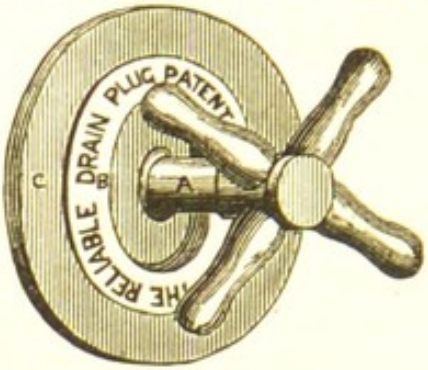

THE ESSENCE OF SIMPLICITY AND PERFECTION.

Fig. 1.

Fig. 1 shows an elevation of the "Reliable" Plug.
Fig. 2 represents the Plug inside a Drain Pipe.

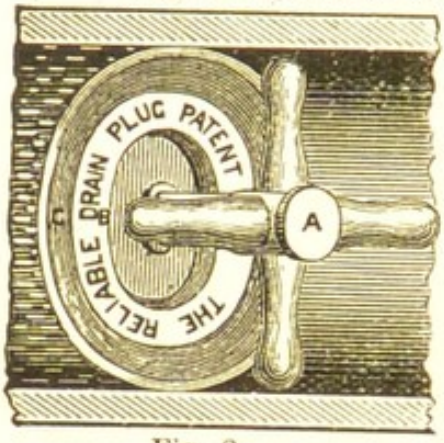

Fig. 2.

Fig. 3.

Fig. 3 shows the Plug with Capstan Handle removed.
Fig. 4 is the section of the Plug inside a Drain Pipe.

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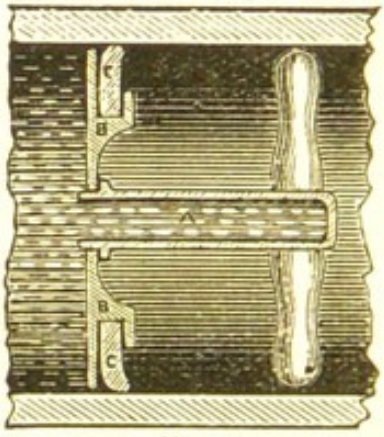

Fig. 4.

A is Capstan Handle.

B the double flanged plate carrying the rubber flange C.

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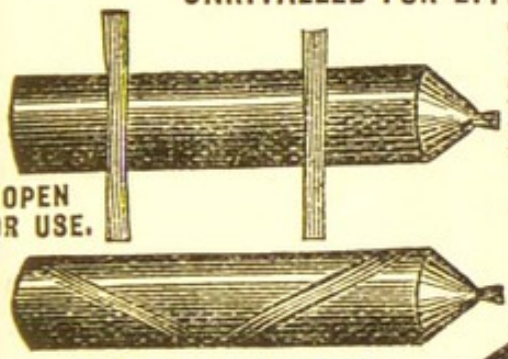

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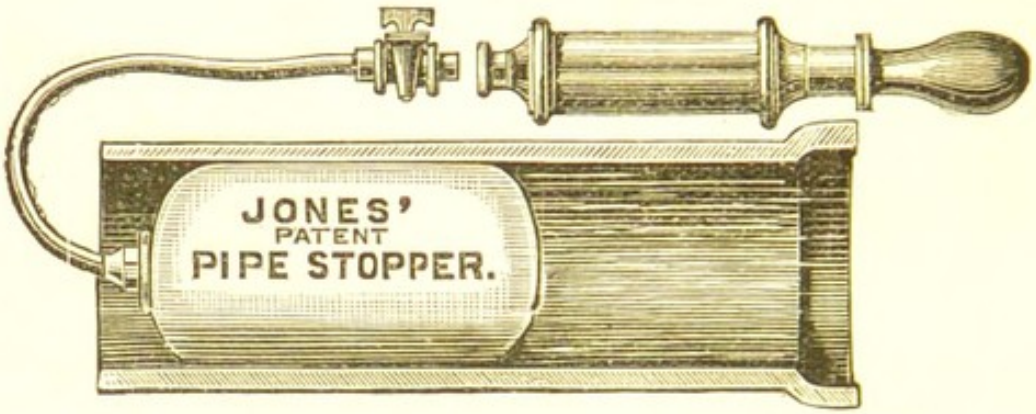

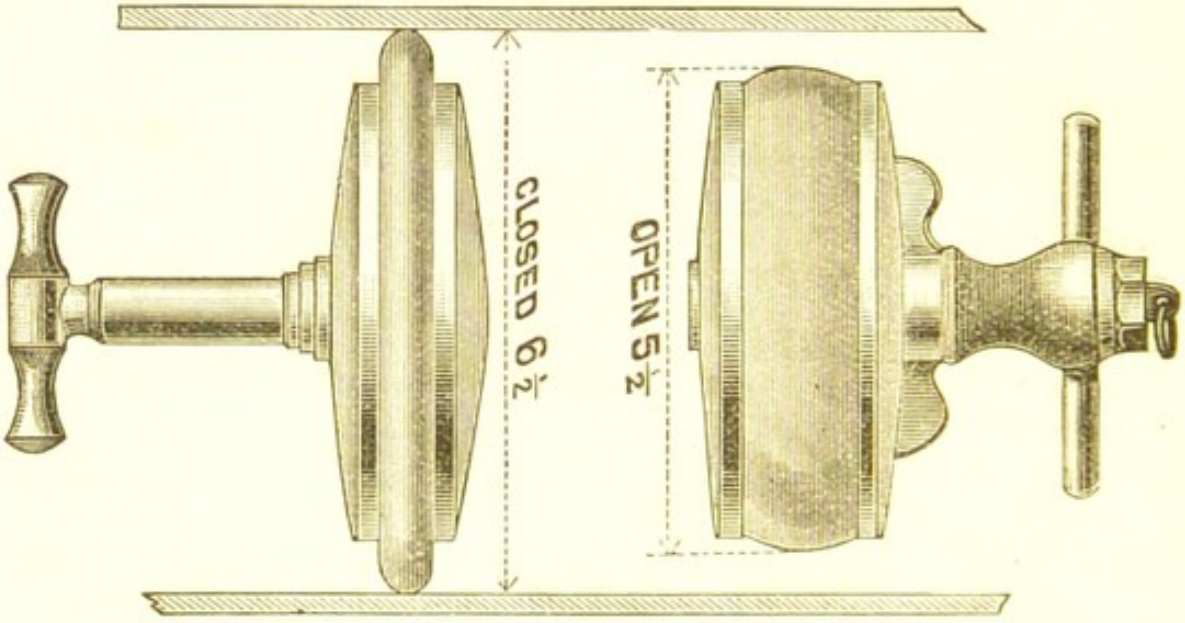

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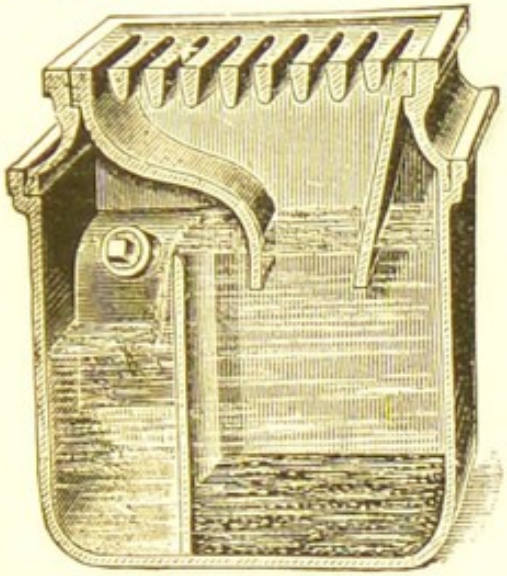

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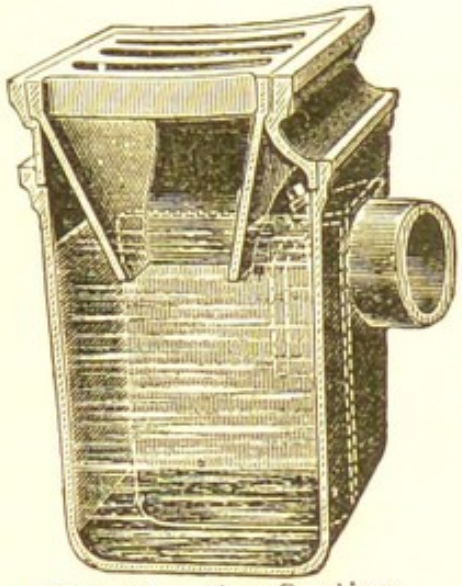

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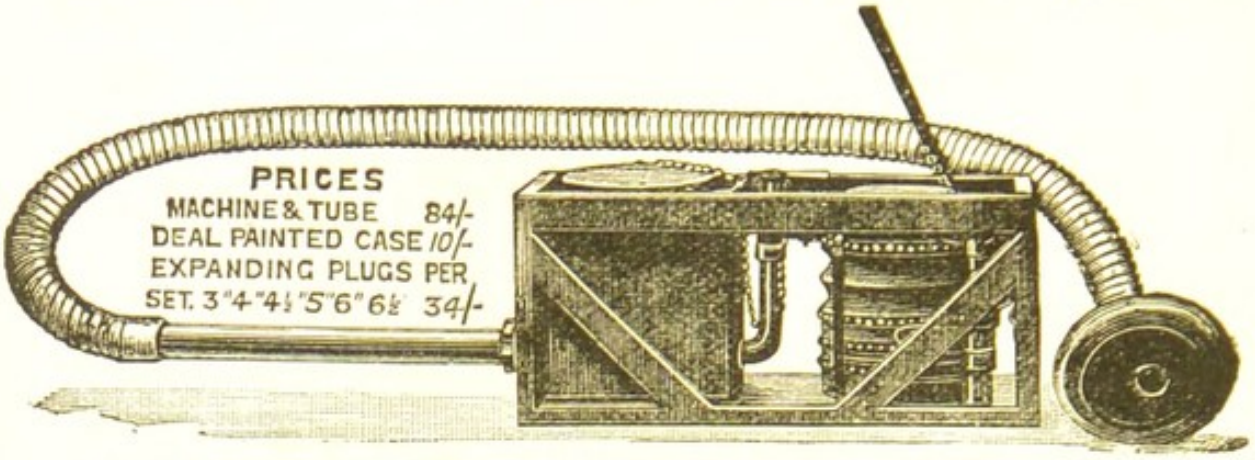

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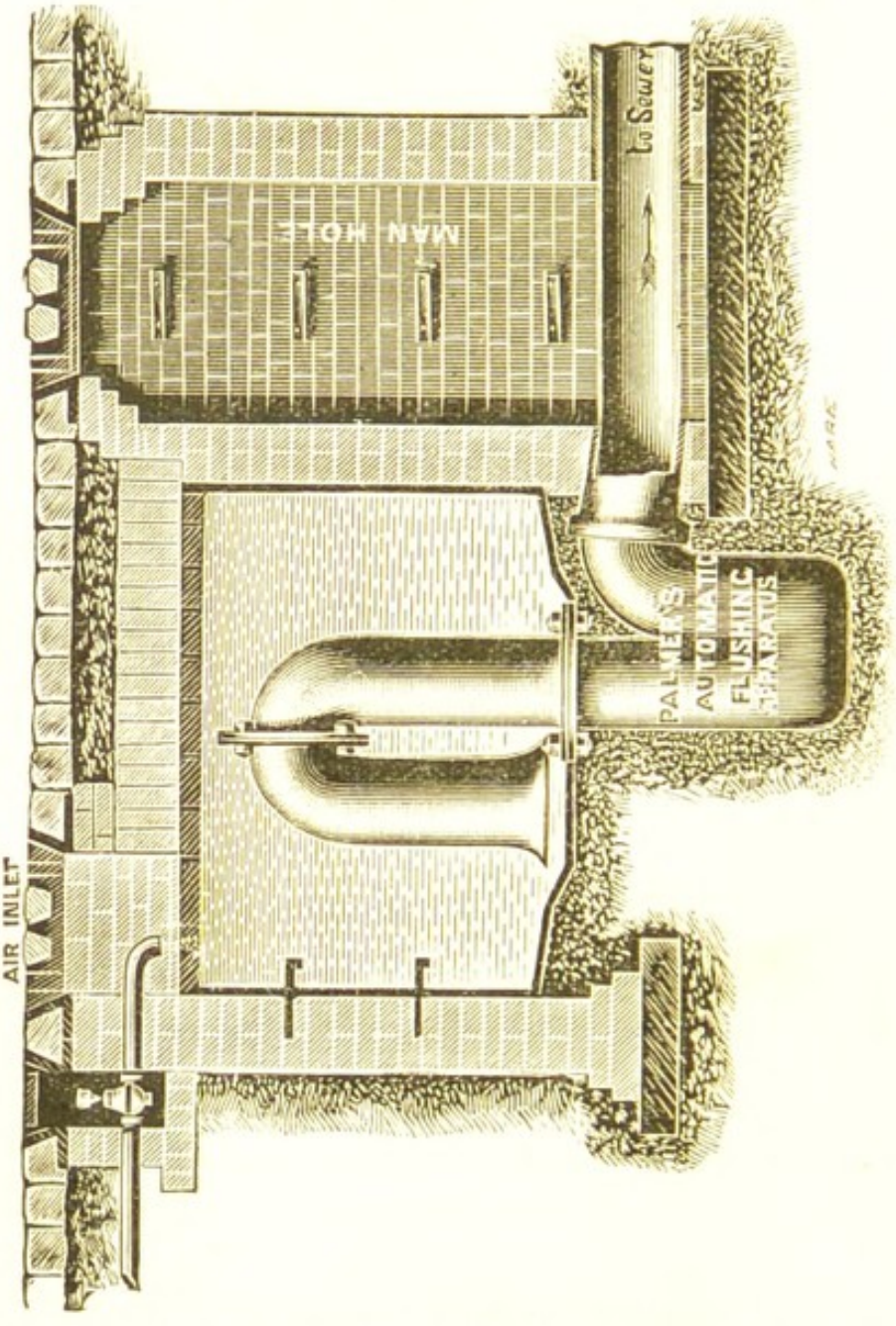

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DRAINAGE WORK

AND

SANITARY FITTINGS.

BY

WILLIAM H. MAXWELL,

Engineer and Surveyor's Offices, Leyton Urban District Council.

Reprinted from

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AND MUNICIPAL AND COUNTY ENGINEER."

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PREFACE.

The special object of this little work, which is prepared from articles which have already appeared in THE SURVEYOR AND MUNICIPAL AND COUNTY ENGINEER, is not so much to set forth original matter, but rather to bring together in a condensed and handy form, chiefly for the use of students, the main points connected with the construction, examination and testing of drainage works.

With this in view, and as illustrations of constructional details are much more readily understood than long written descriptions, I have specially prepared the drawings necessary to illustrate the subject somewhat fully.

The outline diagrams of sewers are intended to give at a glance the proportional carrying capacity, and easy means of calculating the sectional area, hydraulic mean depth, &c., of the three forms of sewers (circular, egg-shaped and ovoid) under various conditions—full, half full, &c.

The work has been made more complete by the addition of much useful matter at the end—*viz.*, Hydraulic Notes, a Synopsis of the Local Government Bye-Laws as to Drainage, &c., of New Buildings, and the Sections of the Public Health Act, 1875, which relate specially to sewerage and drainage.

It is therefore hoped that it may also prove to be a handy little book for the use of the young architect or engineer, who has to design, and the builder, who now has to execute, the drainage of his buildings under the closest supervision and in strict accordance with the most modern principles, as has been my endeavour herein to briefly explain.

WILLIAM H. MAXWELL.

TOWN HALL, LEYTON, E.

CONTENTS.

CHAPTER I.

PAGE

General Remarks.—Sewage Removal and Disposal—Water-Carriage System—Conservative System—Necessity of Careful Supervision to ensure Good Work—Legal Definition of "Drain," "Sewer"—Essential Points for Good House Drains—Common Defects in House Drains 1

CHAPTER II.

Materials for Drainage Works.—Lime, Cement, Mortar, Concrete, Proportions of—Brick Drains and their Various Forms: Square, Circular, Ovoid and Egg-Shaped—Stoneware Pipes: The Essentials of a Good Sound Pipe and Unsuitability of Earthenware Pipes—Cast-Iron Pipes: Treatment to Prevent Rust 6

CHAPTER III.

Various Kinds of Joints in Drain Pipes.—Ordinary Spigot and Socket Joint—Stanford's Patent Joint—Doulton's Self-Adjusting Joint—Archer's Patent Air and Water Tight Joint—Hassall's Patent Safety-Jointed Pipes—Patent Paragon Pipes—Sykes' Patent Screw Joint—Patent "Double Seal" Jointed Pipes (Tyndale's Patent) 10

CHAPTER IV.

Intercepting Traps.—Definition of—"Mason's" or "Dipstone" Trap—The Drain Siphon—The Croydon Trap—Buchan's Trap—Winser's Trap—Sykes' Patent Interceptor—The Proper Size of Intercepting Traps—Flaps to Prevent Back Flow—Ball Tide Valve 17

CHAPTER V.

PAGE

DISCONNECTION AND VENTILATION OF HOUSE DRAINS.—Special Necessity for "Disconnection" in towns badly sewered—The Object of Disconnection—Disconnection dispensed with in well-sewered districts if the house drains are outside the building—Thorough Ventilation Necessary to Prevent Formation of Injurious Gases—Hornsey Local Board and Intercepting Traps—Manholes and Inspection Chambers: The Details of their Proper Construction—Alternative Arrangement in Lieu of Brick Manhole—Ventilation of House Drains, the Necessty for and Effect of—Various Methods of Arranging *Inlets* and *Outlets*—Mica Valves—Copper-Wire Guards for Ventilation Pipes—Proper Size of Ventilation Pipes—Rain-Water Pipes as Ventilators, and the Proper Treatment of 24

CHAPTER VI.

THE LAYING OF DRAINS.—Level of "Outfall" the First Consideration—Proper Connection of Branch Drains—V Junctions—Mr. Latham's Rule for Forming Junctions—Preparing Trench and Gradient with Boning Rods—Concrete—Method of Laying the Pipes—Construction of Drains unavoidably under Houses—Pipe Jointing—Precautions in Applying the Hydraulic Test—On the Setting-Up of "Sight Rails" 35

CHAPTER VII.

DISCHARGE FROM SEWERS, FLUSHING, CESSPOOL SYSTEM, &c.—Proper Fall of Drains: Maguire's "Decimal" Rule—Eytelwein's Formula—Notes on "Hydraulic Mean Depth" and "Mean Velocity" in Sewers—Ready Means of Calculating Sectional Area of Flow, Wetted Perimeter and Hydraulic Mean Depth—Flushing and Cleansing of Drains—Cesspool System, Solids Intercepting Chamber and Polarite Filter for Rural Districts 41

CHAPTER VIII.

PAGE

ON THE TESTING OF DRAINS.—General Remarks—Testing always Necessary for a Thorough Examination —"Water Test," and the Method of its Application —Drain Plugs—India-Rubber Bags—Examination of Old Drainage Systems—Smoke Test and its Application—Common Defects as Revealed by Smoke Test—Smoke Rockets—Chief Points to Note when Examining the Sanitary Condition of a Building 49

CHAPTER IX.

GENERAL RULES REGARDING HOUSE DRAINAGE . . 56

CHAPTER X.

USEFUL HYDRAULIC MEMORANDA 61

CHAPTER XI.

SYNOPSIS OF THE LOCAL GOVERNMENT BOARD MODEL BYE-LAWS (UNDER 157TH SEC. OF PUBLIC HEALTH ACT, 1875) AS TO THE SANITARY CONSTRUCTION AND DRAINAGE OF NEW BUILDINGS 64

CHAPTER XII.

SECTIONS OF THE PUBLIC HEALTH ACTS HAVING SPECIAL REFERENCE TO SEWERAGE AND DRAINAGE . . 66

DRAINAGE WORKS AND SANITARY FITTINGS.

CHAPTER I.

GENERAL REMARKS.

Sewage Removal and Disposal—Water-Carriage System—Conservative System—Necessity of Careful Supervision to ensure Good Work—Legal Definition of "Drain," "Sewer"—Essential Points for Good House Drains—Common Defects in House Drains.

Although this little work has been written more particularly for the use of the student, yet it is hoped that it may be of interest and utility to all connected with, or interested in, sanitary engineering work.

The sanitary excellence of any district depends mainly upon the complete and speedy "removal" and "disposal" of all waste and excrementitious matters from among its population. This important work may be most conveniently considered under three headings, namely:—

(1) House drainage
(2) Sewerage (*i.e.*, a system of sewers) } Removal
(3) Sewage disposal

the first of which ("removal") forms the subject of our present consideration.

The business of the "removal of excreta" is carried out on one of two systems—either on the "conservative system" or on the "water-carriage system."

The "conservative system" in its various forms (*e.g.*, cesspool, midden, dry earth, and pail) having proved itself quite unsuitable for use in large

centres of population, is now rapidly giving place to the "water-carriage system." As an instance of this, it may be mentioned that Manchester was originally a privy and midden town, and in 1871 the pail-closet was adopted, but now it is being converted into a water-closet town.

In any arterial system of drainage, however, it is of the greatest importance that all house drains and sewers be well constructed, of sound material, well ventilated and flushed, and that the sewage at the outfall be disposed of in the best possible way.

All drainage works require very careful consideration, and to guard against inferior workmanship close supervision and testing is necessary, for on the efficiency of this work depends to a large extent the health of the community. Persons living in insanitary houses are especially liable to such diseases as typhoid, &c.; their standard of vitality is gradually lowered, and thus they become more and more susceptible to any of the very numerous maladies afflicting mankind.

A "drain" legally means any drain of, and used for the drainage of, one building only or premises within the same curtilage.

A "sewer" is a drain receiving the drainage of two or more buildings (*see* Public Health Act, 1875, sec. 4; also Public Health Act [Amendment] Act, 1890, sec. 19).

Some of the most essential points for a good system of house drains are as follows:—

1. The house drain should be constructed with such fall, even gradient and smooth bore, that all sewage may be rapidly carried away to a common "outfall."

2. It should be constructed of *sound* materials and workmanship, and should be able to stand the

hydraulic test when complete, so that under no circumstances could drain air or sewage leak therefrom.

3. House drains should be properly intercepted from the public sewer, so that no sewer air may pass into the house drain.

4. That there be thorough ventilation in every part of the house drainage system is also most im-

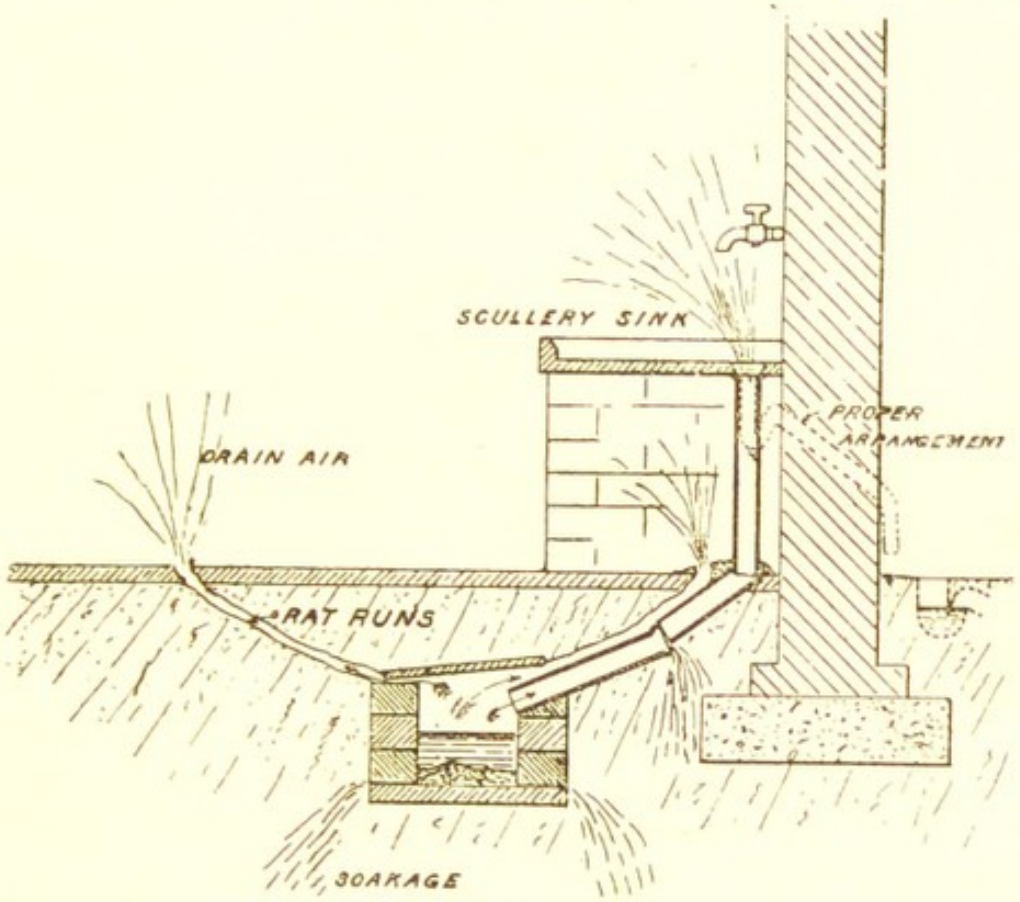

FIG. 1.

portant, and this should be carried out so as to give rise to no nuisance under any circumstances of wind or temperature.

In house drainage work some of the most common defects met with are briefly these:—

1. Old, defective, square brick drains, instead of suitable-size stoneware salt-glazed pipes.

2. A very common fault is that drains are often constructed much too large for the work they are likely to be called on to perform, therefore they very rarely get a thorough flushing.

3. Insufficient fall; bad and uneven gradient; pipes laid on unfirm ground with very defective

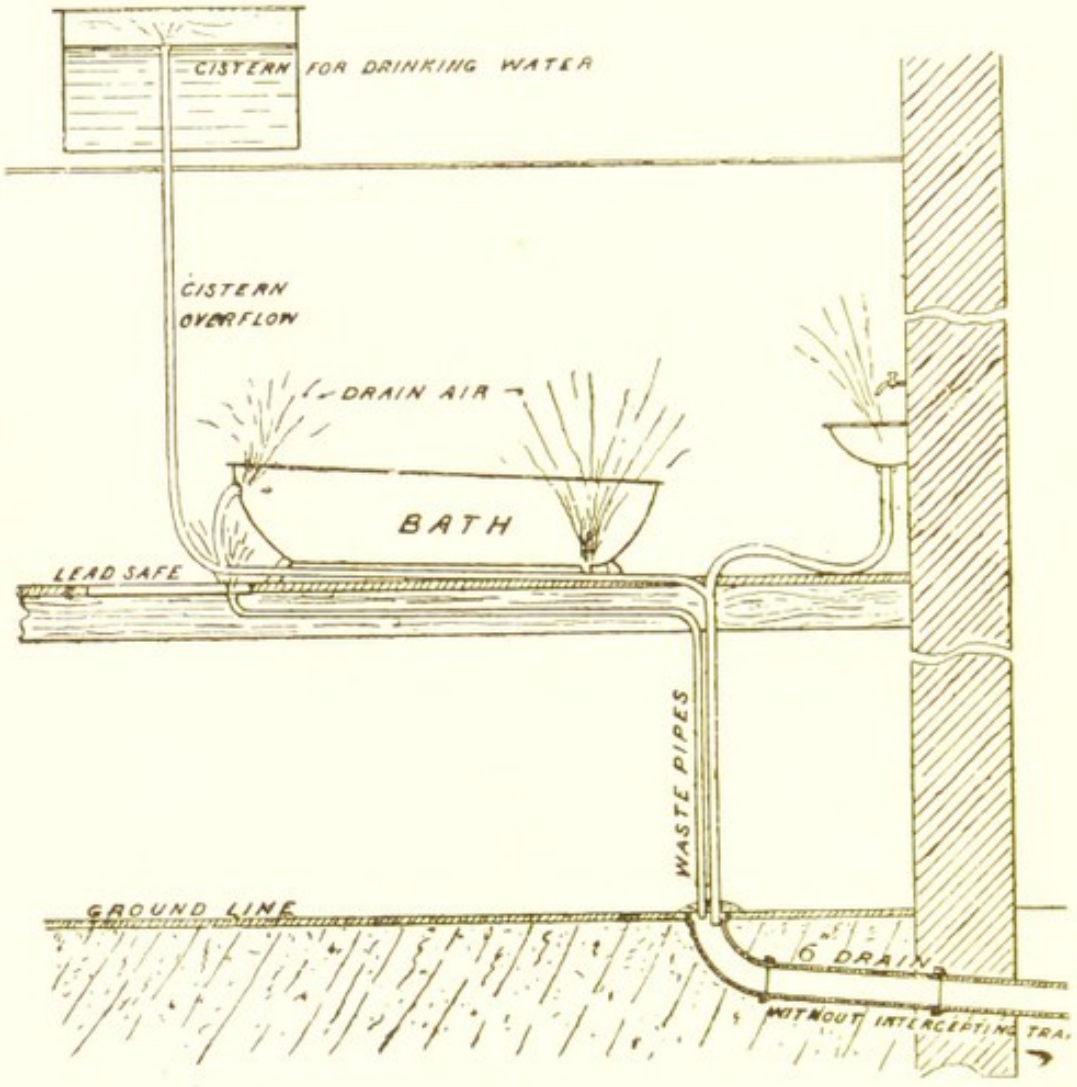

FIG. 2.

joints (perhaps only of clay or mortar, instead of cement), the earth all round soon becoming sodden with soakage from the defects.

4. Drains are frequently found laid in a most un-

desirable winding course, instead of in straight lines, and often connect directly into a large cesspool or sewer without an intercepting trap, and totally unventilated (except through defects).

5. From these bad drains rats generally burrow their way through the floors and into the houses, thus making direct communication, and thereby

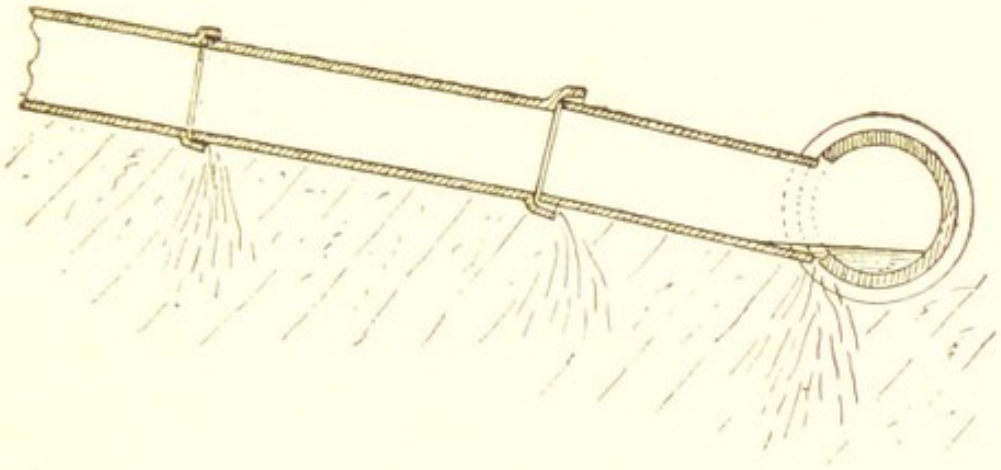

Fig. 3.

ventilating the sewers into the house (*see* Figs. 1, 2 and 3).

6. Bath wastes, lavatory wastes, and overflow pipes, are more frequently than not (especially in old buildings) found to communicate directly with the drains, thus actually "laying on" sewer air to the unfortunate inmates.

7. Butt joints (Fig. 3), no socket to pipes, and the square connection of branches to the main, are also defects often met with.

CHAPTER II.

MATERIALS FOR DRAINAGE WORKS.

Lime, Cement, Mortar, Concrete, Proportions of—Brick Drains and their Various Forms: Square, Circular, Ovoid and Egg-Shaped—Stoneware Pipes: The Essentials of a good sound Pipe and Unsuitability of Earthenware Pipes —Cast-Iron Pipes: Treatment to Prevent Rust.

Lime, Cement, and Mortar.—Mortar for drainage works should in all cases be capable of setting in water. Portland cement and blue lias lime make good hydraulic mortar. The proportions of cement, or of lime to sand, should not exceed $2\frac{1}{2}$ of clean sharp sand to 1 by measure of ground Portland cement or lias lime. These should be thoroughly mixed together, but too much water in mixing is to be avoided.

Portland Cement is made from an argillo-calcareous deposit which is calcined at a high temperature and afterwards ground to a fine powder. Good cement should be finely ground, weigh not less than 112 lb. per striked bushel, and be of a grey or greenish-grey colour. It should set perfectly hard under water in seven days, and should then be capable of bearing a tensile strain of about 500 lb. on a cross section of $1\frac{1}{2}$ square inches. The longer Portland cement is in setting the stronger will it be, and, if kept dry, it improves by age. No cement which has once commenced to set should be re-used.

Concrete.—Concrete should be made with Portland cement, with blue lias or other equally good hydraulic lime, and be gauged in the proportion of 1 part by measure of cement to 6 parts by measure of gravel and sand. The whole—cement (or lime), gravel and

sand—should be thoroughly mixed by being twice turned over in a dry state on a clean timber stage, and then be wetted by sprinkling with water before being placed in the work. In making mortar and concrete it is of great importance to use clean materials; the water used should also be fresh and clean. Concrete which has become set should not be re-used except as ballast; and any set surface should be thoroughly cleaned and wetted before an additional layer is put on, so as to secure perfect cohesion.

Brick Drains were very common a few years ago, but are now being speedily abolished. A great objection to their use is the want of smoothness of bore, aggravated by the uneven decay of the bricks. With brick drains there is always considerable leakage passing off into the surrounding subsoil, and oftentimes the sewage remains stagnated and decomposed in the drains, giving off injurious gases. I have met with brick and stone drains so leaky as not to require any "outfall"! These drains are variously shaped, but I think the worst form of all is the square one, the sides of which are usually of brick and the top and bottom of flat stones. The best forms of brick drains are "circular," "ovoid," and "egg-shaped," of which the last is the most modern and the best, there being less friction on the flowing sewage in this case. As brick drains are very perishable, the bricks in time crumbling away and thus causing leakage, bricks for this purpose should be of the hardest and most durable kind; and the joints, being very numerous, require to be set in good hydraulic cement. The invert, or lower portion of a sewer, should be formed either with specially-made stoneware invert blocks, cement concrete, or of Staffordshire blue bricks. For circular

and egg-shaped sewers the bricks should be specially moulded to suit the radius lines the beds must take in the work. All bricks should be hard, well burnt, sound, well shapen, of uniform size, should give a metallic ring when struck together, and be free from fire cracks, lumps of lime, or other imperfections. In brickwork no broken bricks, bats (except as closers) or place bricks should be allowed. Good bricks should not absorb more than one-sixth of their weight of water. All bricks should be thoroughly wetted before use.

Stoneware Pipes.—A house drain should be constructed of stoneware pipes, salt glazed, perfectly smooth inside, of true circular section and thickness of material, straight in the direction of their length, with whole sockets of proper depth, and free from any cracks, blisters, sand holes, or other defects. These pipes properly laid on a 6-in. bed of concrete, well jointed in Portland cement, and surrounded with 6 in. of concrete if the drain must unavoidably pass under a house, will fulfil all the requirements of a good and efficient drain. Stoneware pipes up to 18 in. diameter are the most suitable for sewers and drains, but above this size brick sewers become the best and cheapest. Pipes of 12 in. in diameter or greater should be at least one-twelfth their diameter in thickness.

Few *earthenware pipes* stand the necessary heat for thorough vitrification and yet retain their shape; and the internal bore is not so smooth as that of the stoneware pipe. This is important, as all drains should be self-cleansing; earthenware pipes are therefore not desirable for drainage work.

Cast-Iron Pipe Drains are now often used instead of stoneware pipes. They should always be used when the course of the drain is through made or

unfirm ground, as they are more rigid, there are fewer joints, and they can be made absolutely water-tight. In order to prevent them from rusting, all iron pipes should receive some such treatment as the "Bower-Barff" or Dr. Angus Smith's for the prevention of oxidation. The inside of all cast-iron pipes should be carefully examined before laying, to

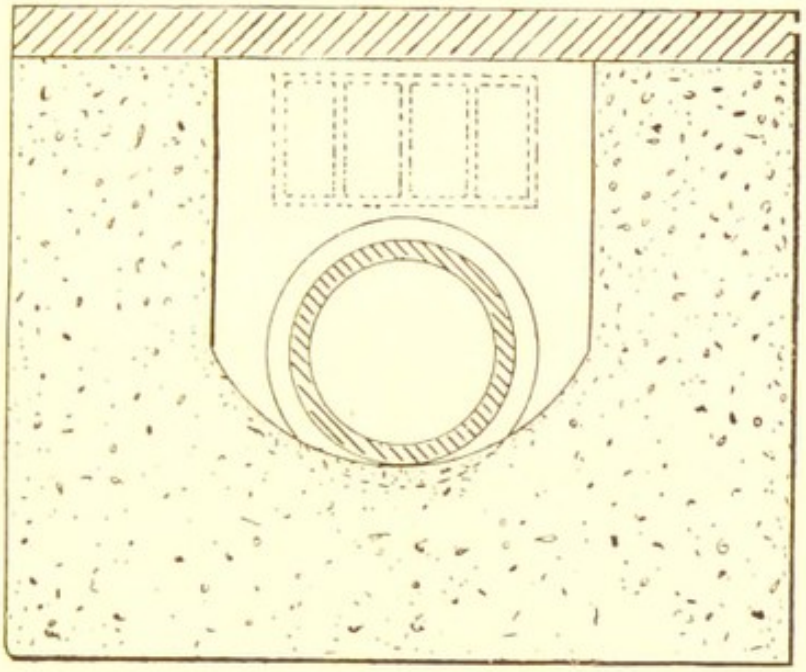

FIG. 4.

see that there are no projections. The pipes should be jointed with molten lead well caulked into the joint. When passing under houses they should be fixed in a concrete or brick trench and covered with iron gratings or flagstones. Sometimes they may be fixed on basement walls, but in either case should afford every convenience for inspection and repairs.

CHAPTER III.

VARIOUS KINDS OF JOINTS IN DRAIN PIPES.

Ordinary Spigot and Socket Joint—Stanford's Patent Joint—Doulton's Self-Adjusting Joint—Archer's Patent Air and Water Tight Joint—Hassall's Patent Safety-Jointed Pipes—Patent Paragon Pipes—Sykes' Patent Screw Joint—Patent "Double Seal" Jointed Pipes (Tyndale's Patent).

Fig. 5 gives a section of the *Ordinary Spigot and Socket Pipe*, with cement jointing, with or without tarred gasket. Pipes with extra-long sockets are

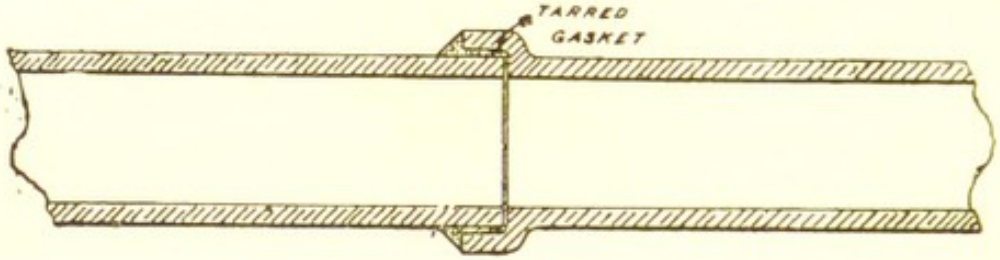

FIG. 5.

made for use in wet ground. Clay joints should under no circumstances be permitted.

Fig. 6 is a section of *Stanford's Patent Joint*,

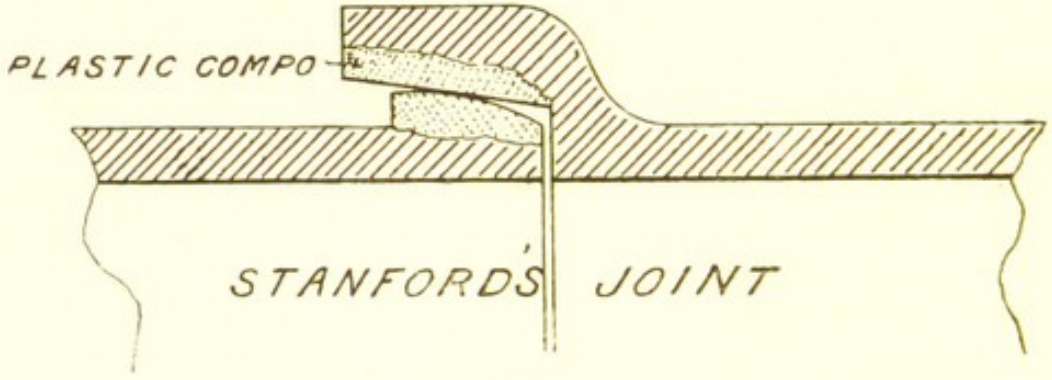

FIG. 6.

which is used in order to get a perfectly close joint between the lengths of socket pipes. This is ensured by casting upon the spigot and in the sockets

of each pipe rings of a durable material (a mixture of coal-tar, sulphur and ground pipes), which when put together fit mechanically, so as to form a water-tight joint without the aid of cement. In putting such a joint together the spigot and the collar should be greased with Russian tallow and resin, the pipe forced home by means of a lever acting on a short board laid across the collar. In Stanford's joint the composition on the spigot is rounded, so as to give the joint a little play and permit it to fit closely should the pipes not be laid quite straight or should they sag after laying.

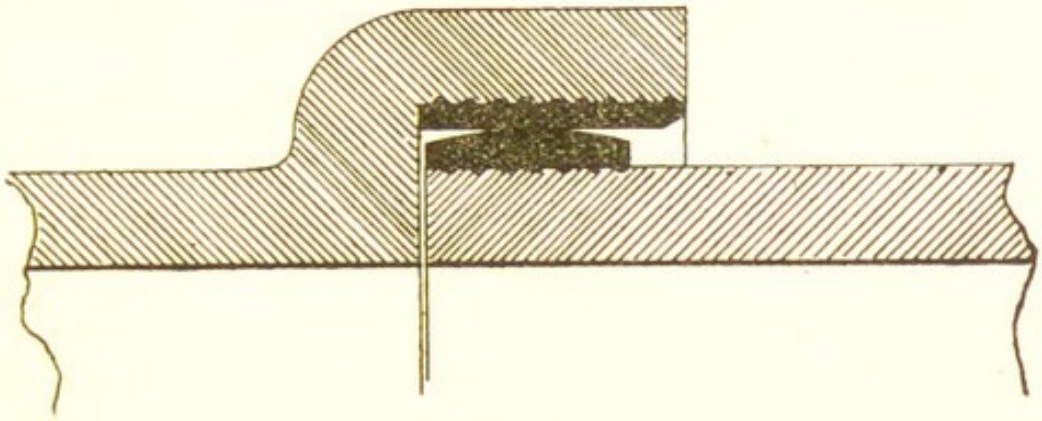

Fig. 7.

Doulton's Self-Adjusting Joint is shown in Fig. 7. It is a good form, and is of the same type as Stanford's. It is simple and very easy to joint. This joint is only supplied upon selected pipes of the best stoneware. A modified form of this joint is also manufactured - it consists in lining the socket with compressible material, and thus affording an elastic seating for the spigot.

Archer's Patent Air and Water Tight Joint (Fig. 8) is formed by an annular space between spigot and socket, into which liquid cement is run by a hole in the collar of the socket. A second hole in the collar, close to that by which the cement is poured

in, permits the escape of air driven out by the cement. The pipes must, of course, be laid with these holes upwards. A little clay smeared on the end of spigot or shoulder of socket prevents the liquid cement from flowing into the pipes.

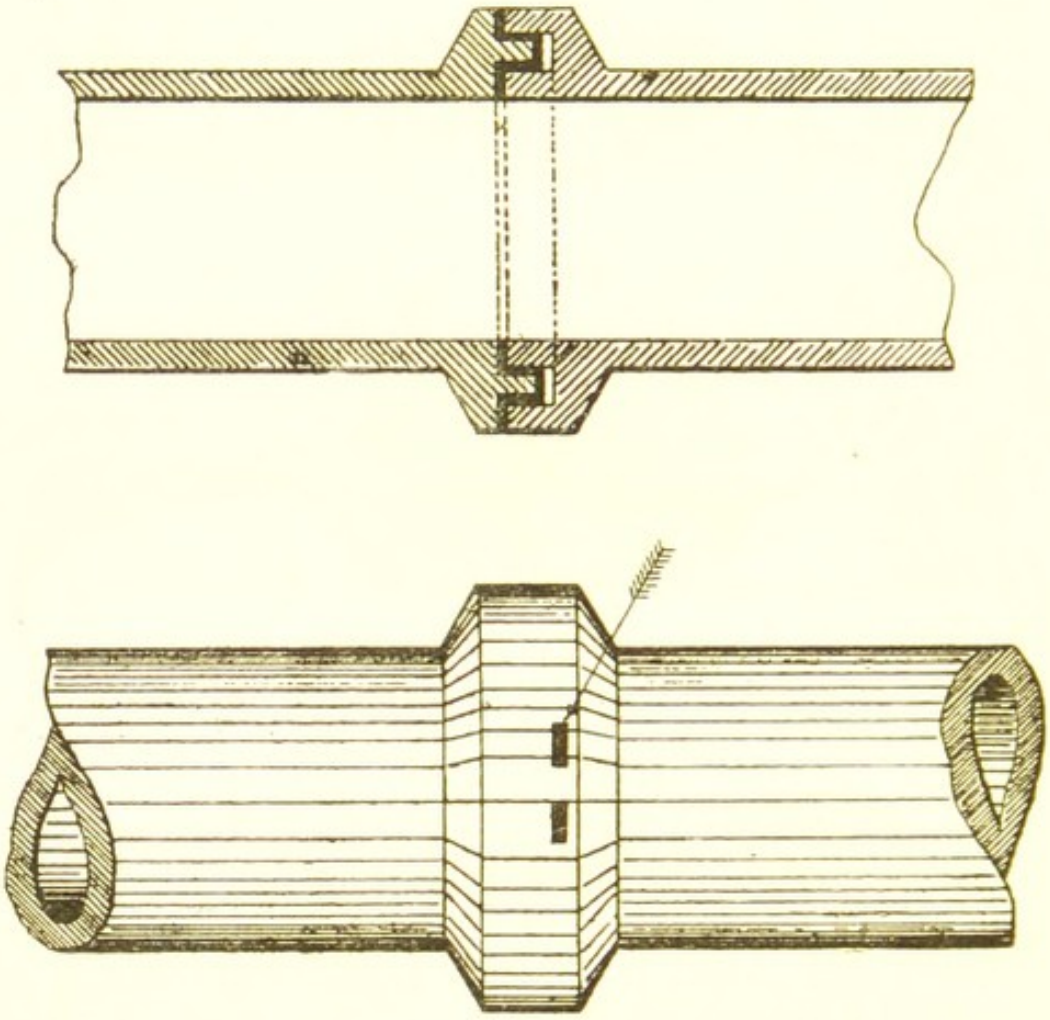

Fig. 8.

Hassall's Patent Safety-Jointed Pipes (Fig. 9) can be used with advantage. The joints may be described as follows: Two bands of special bituminous material are cast on to the spigot end of the pipe about $1\frac{1}{2}$ in. apart, and corresponding rings of the same tough mixture are cast inside the pipe socket, also about $1\frac{1}{2}$ in. apart. These two sets of rings, when

the pipes are together form an annular space round the whole joint of the pipe, which is filled, through a hole provided for the purpose (*A*), with liquid

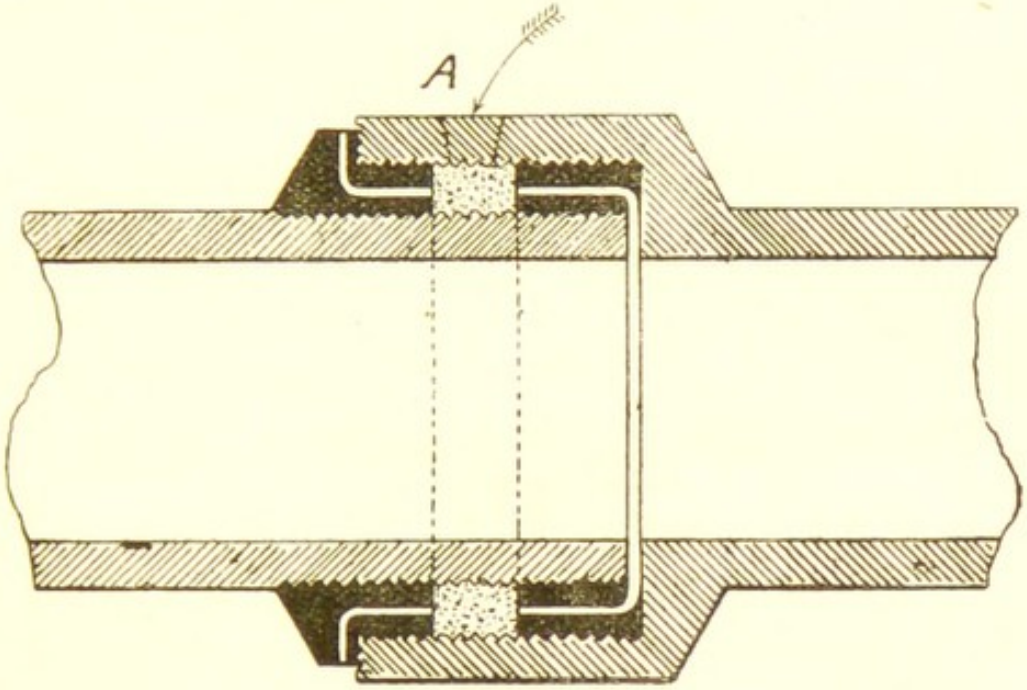

FIG. 9.

cement, which travels completely round the pipe, driving before it any air, water, grit or dirt, that is

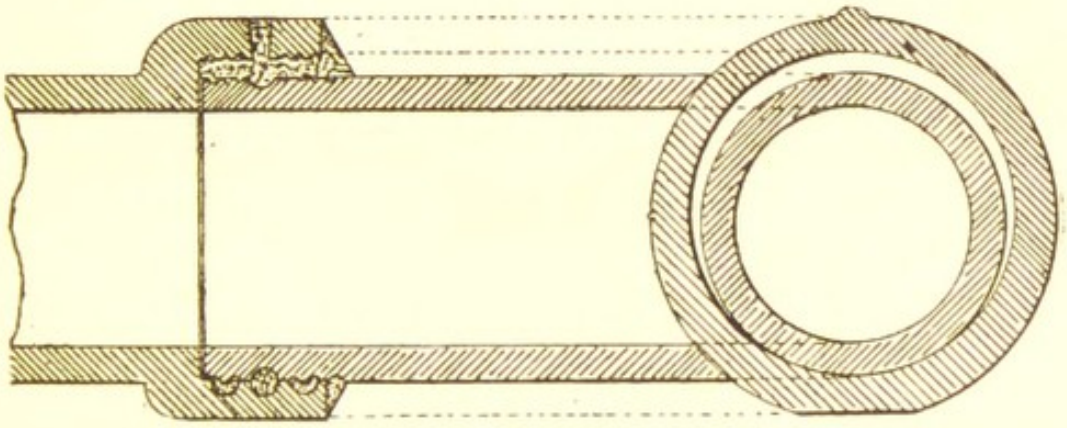

FIG. 10.

in the space. This also tests the joint, for should there be any leakage it will appear during this operation. When the cement has set this joint

hermetically closes the pipes and prevents the possibility of any leakage, and from its double bearing lessens considerably the chances of any settlement*

Patent Paragon Pipes (Fig. 10).—The sockets of the patent Paragon pipes are made eccentric to the pipe, so that when laid the spigot rests on the socket and has a solid bearing thereon and cannot drop, thus maintaining a true invert. The pipes are made in three forms, varying in depth of socket.

Sykes' Patent Joint (Fig. 11) is made by casting on the

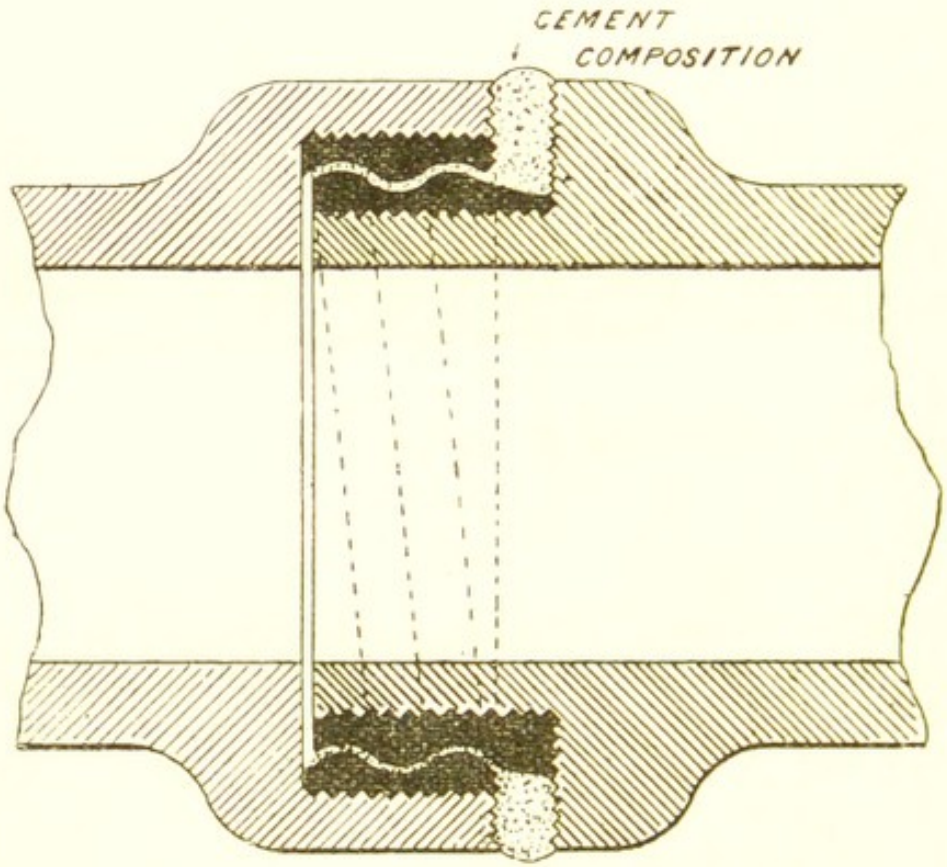

FIG. 11.

spigot and in the socket male and female threads to form a screw joint. A strong rim or collar is also formed on the pipe. In jointing the pipes a fillet of cement composition is put against the shoulder of the

* Boulnois' "Municipal and Sanitary Engineers' Hand-Book."

rim, and on screwing up is compressed between the rim and end of the socket. By the great pressure applied the superflous cement composition is forced into the space left by the play or clearance in the thread, and thus forms an effectual seal which will resist great pressure and makes a substantial and absolutely gas and water tight joint. The threads are so formed that during the process of screwing they have a certain amount of play, which admits of the adjustment of the joint and gives the required flexibility without affecting the level of the invert of the sewer. An important feature in the

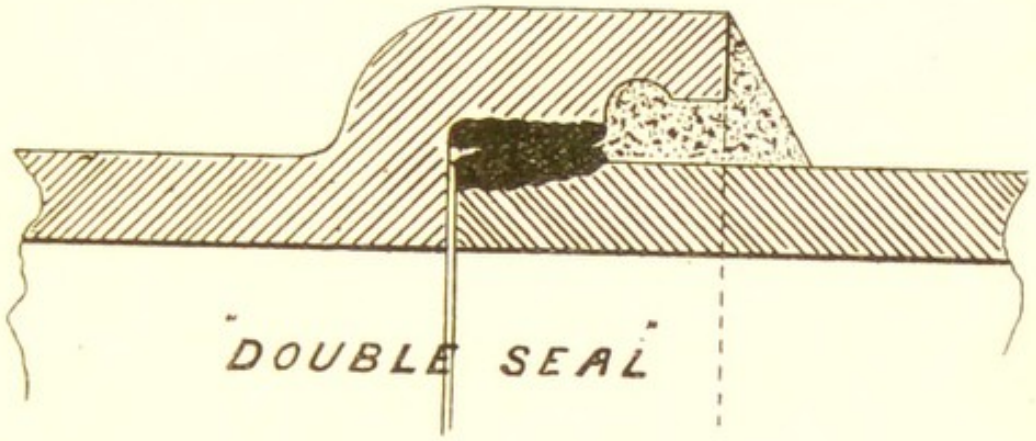

FIG. 12.

effectual making of this joint is the cement composition, which is said to possess advantages superior to those of Portland cement, and is at the same time equally durable and strong. It is mixed on the works, and applied to the pipes in a mastic state of the consistency of glaziers' putty. It is said to be water and acid resisting, slightly elastic, and imperishable. The pipes, it is stated, have been subjected to severe tests under the most trying conditions, and stood a hydraulic pressure of 140 lb. on the square inch, which equals a column of water nearly 323 ft. high—a pressure never likely to

operate in a sewer. They are manufactured by the Albion Clay Company, Limited, Blackfriars, E.C.

The Patent "Double Seal" Jointed Pipes, Tyndale's patent (Fig.12), are manufactured by Mr. Jennings, Stangate, London, of the best selected Dorsetshire clay. The method of jointing is similar to that of the "Stanford joint," but the pipes have a deeper and under-cut socket, so that after the pipes have been laid and tested the additional security of a fillet of cement may be added for the purpose of ensuring a more perfect and permanent connection. These pipes have been selected by her Majesty's War Department for re-drainage works at the Tower of London and other Government works, and in 1891 were awarded the medal of the Sanitary Institute.

CHAPTER IV.
INTERCEPTING TRAPS.

Definition of: "Mason's" or "Dipstone" Trap—The Drain Siphon—The Croydon Trap—Buchan's Trap—Winser's Trap—Sykes' Patent Interceptor—The Proper Size of Intercepting Traps—Flaps to Prevent Back Flow—Ball Tide Valve.

Intercepting Traps is the name given to those traps used for disconnecting the house drain from the main sewer. Some of the various forms met with are—

The "Masons'" or "Dipstone" Trap (Fig. 13), which

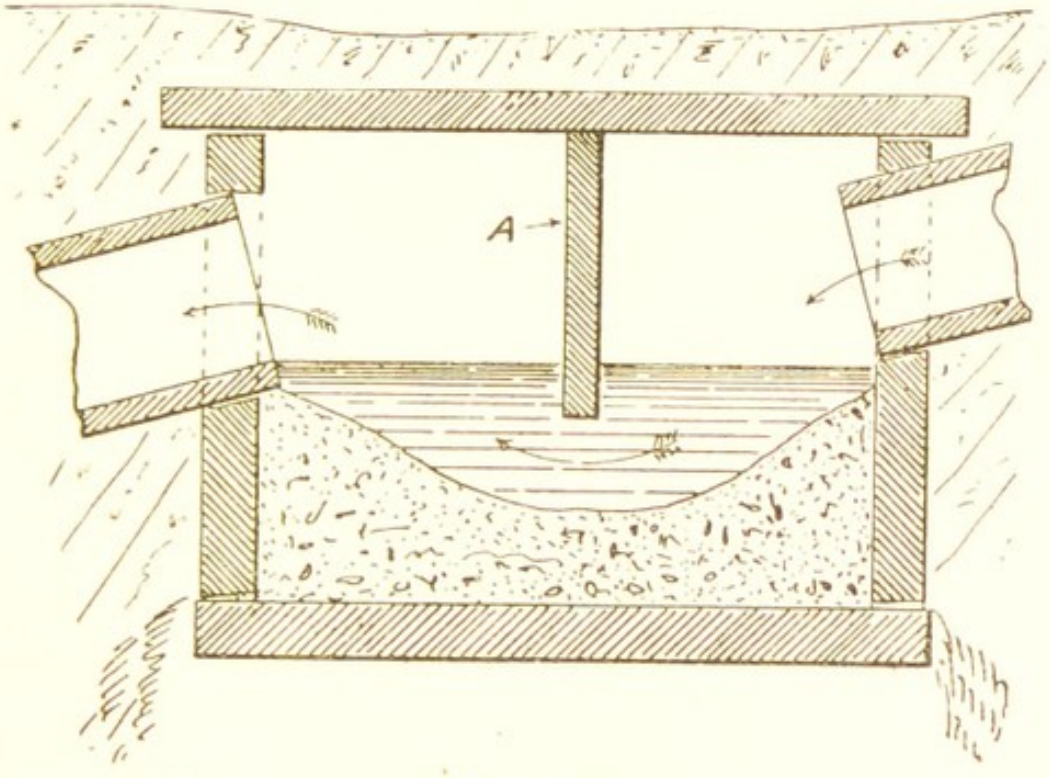

FIG. 13.

is a device designed with the intention of trapping, but is now quite out of date, its form being bad for many obvious reasons. The "dipstone" (*A*) often

slips down, thus making the passage of foul air an

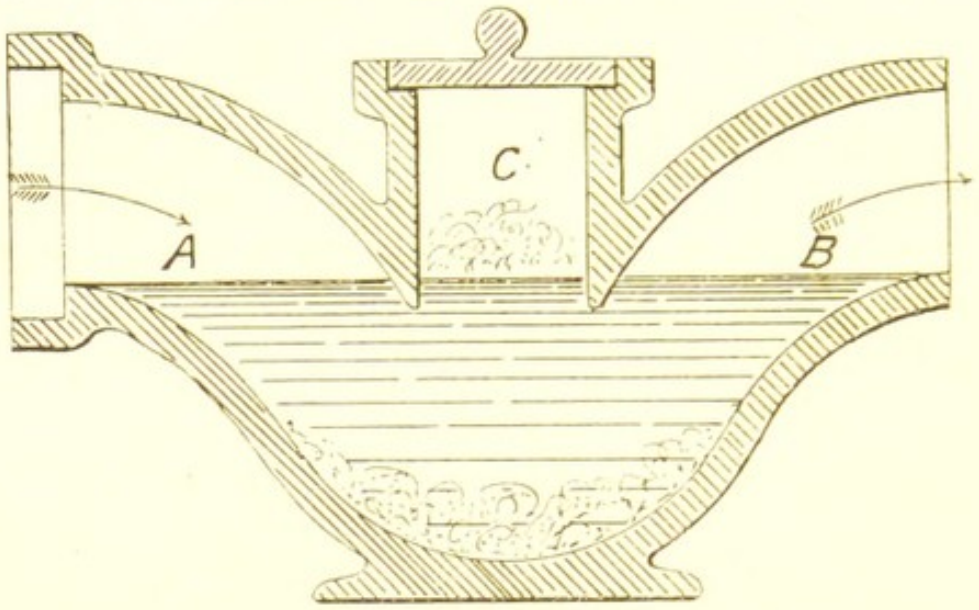

FIG. 14.

easy matter. The trap is by no means of a self-cleansing form, and there is always a large collec-

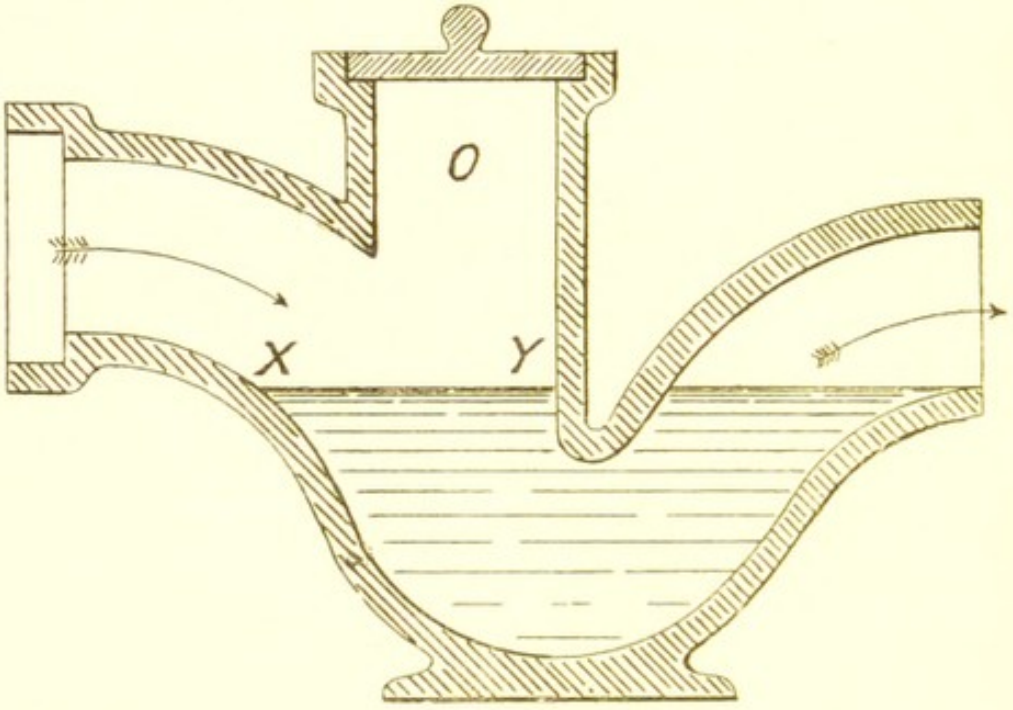

FIG. 15.

tion of filth at the bottom, as in sketch (Fig. 13).

The Drain Siphon (Fig. 14) or running trap is also a very bad form of trap, though preferable to the above. It is not self-cleansing, the flow of water through it being very sluggish; this results from having its inlet *A* on same level as outlet *B*; there should be at least 3 in. difference between these levels, in order to form a good cascade for keeping it clean.

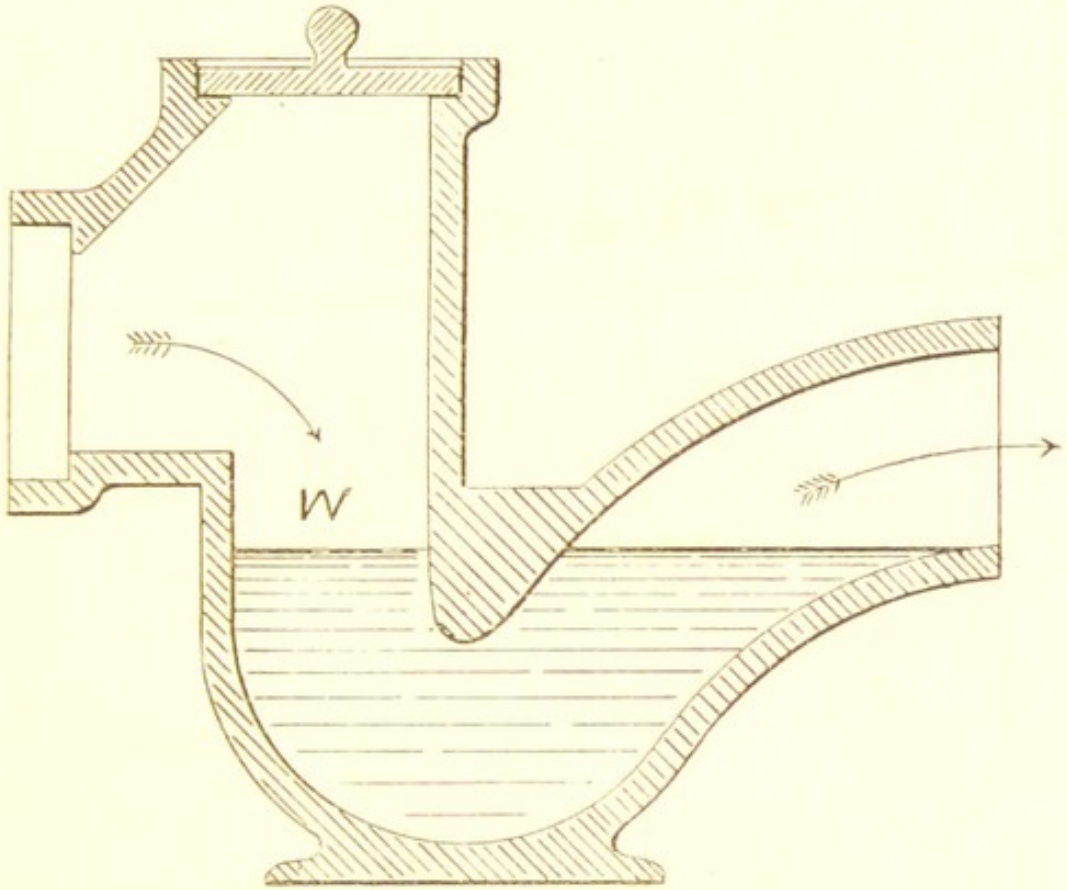

Fig. 16.

The solids either stand at *A* till a subsequent flush moves them forward or they work up into the compartment *C*, or collect in the bottom of the trap. This form of trap also holds far too much water to be properly flushed.

The Croydon Trap (Fig. 15), though possessing more good points than the last described, still is not a form to be recommended, as the inlet and outlet are again

nearly on the same level. There is a large water surface, *X Y*, which is objectionable, and the part *O* becomes a collecting place for filth.

Buchan's Trap (Fig. 16) is a much improved design. It has 3 in. difference between inlet and outlet, thus forming an excellent cleansing cascade action, which in all traps, as before stated, is an essential detail. The surface of the water at *W* is small, and the rapid flow through the trap breaks up and drives before it all fœcal and other matter.

Winser's Intercepting Trap is one of the best

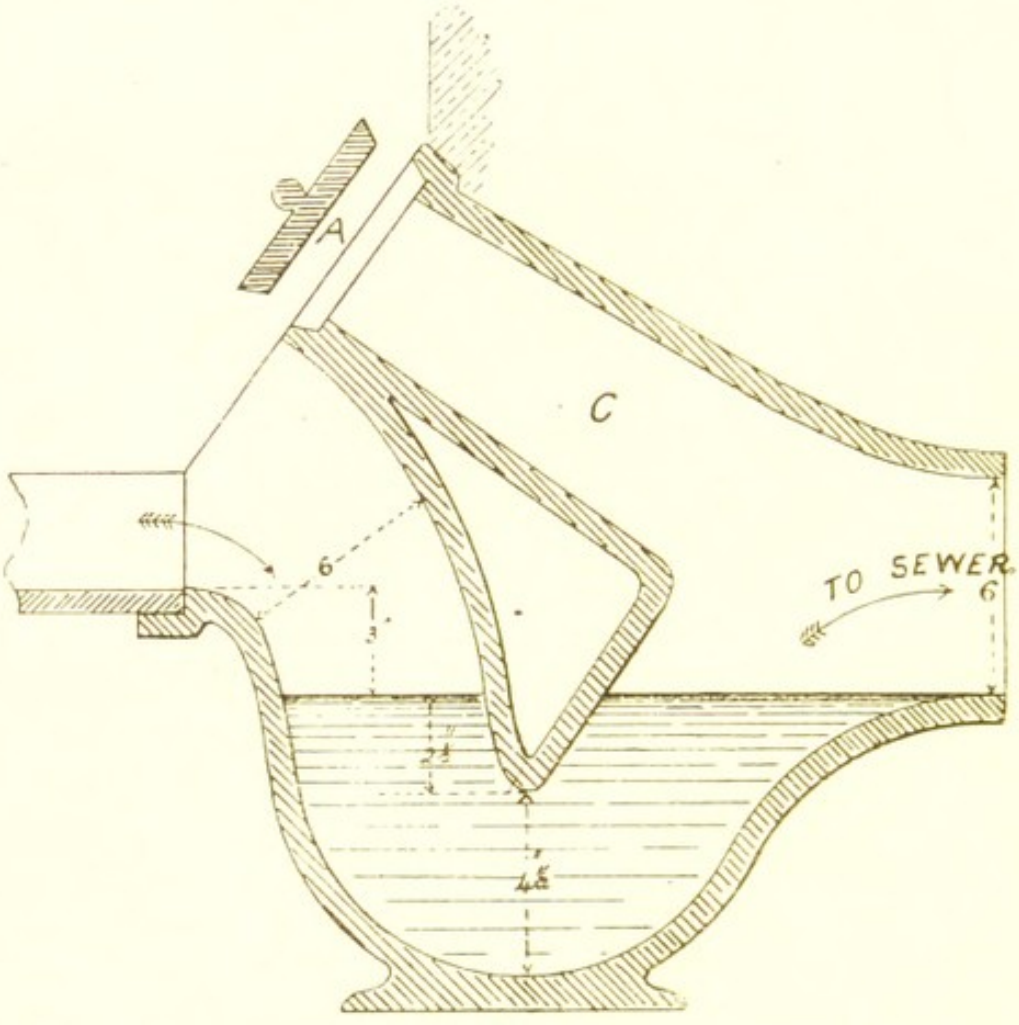

FIG. 17.

modern forms, and is especially adapted for a brick

manhole. It has a 3-in. cascade action. In Fig. 17 at *C* is a cleansing branch, fitted with a movable cap *A* with Stanford joint, so that rods may be passed down the drain toward the sewer.

The Sykes' Patent Interceptor (Fig. 18) which is now being introduced into the market has several very good and original points about it. Besides possessing all the advantages of a good *self-cleansing* trap, it gives ample means of access for the purposes of inspection and rodding the drain, and also provides a connection for a sewer ventilator, which latter

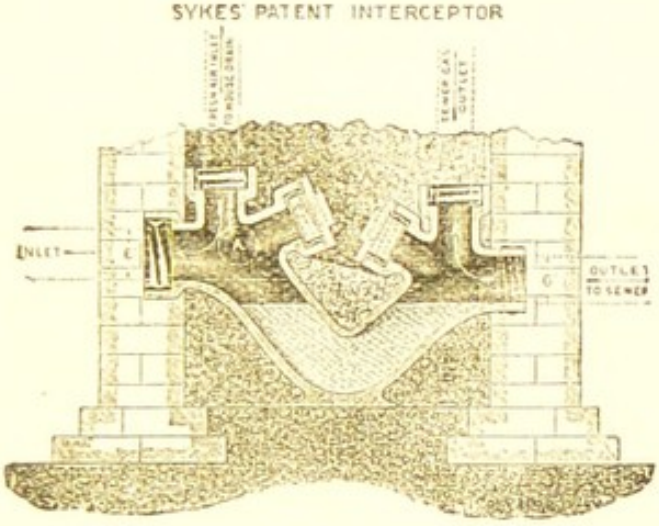

Fig. 18.

point especially adapts it for use wherever the principle of making each house ventilate the sewer is carried out. If, however, the "sewer-gas outlet" is not used, it can be effectually closed with a screw plug supplied with the trap. There is also a connection for the fresh-air inlet to the house drain provided near the inlet of the trap. The interceptor is entirely sealed up, so that no drain or sewer gases can escape into the manhole, thus rendering an absolutely *airtight* manhole cover unnecessary, and the usual "open channel" is also dispensed with—

two points which go to counteract the extra cost of this form of interceptor. The method of fixing and the sectional form of the interceptor may be seen from the accompanying illustration. It is fitted with Sykes' patent screw joints (already referred to), and is manufactured by the Albion Clay Company, New Bridge-street, E.C.

The size of an intercepting trap should be less than that of the drain with which it is connected. It is a common fault to find traps used which are too large. If the trap be kept smaller in bore than the drain there will be a greater scour through it, but for practical reasons it should not be less than 4 in. diameter. All connections between pipes of different sizes should be made with taper pipes made for the purpose. When size of pipe is—

4 in.,	size of	intercepting	trap	should be	4 in.
6 in.,	,,	,,	,,	,,	4 in.
9 in.,	,,	,,	,,	,,	6 in.
12 in.,	,,	,,	,,	,,	9 in.

Flaps are sometimes fixed over the outlets of house drains with the intention of preventing a back flow of sewage in time of flood, &c., but they are not very effectual, as the numerous articles which float down the house drain get fixed between the flaps and their seating, and thus often keep them open.

The Ball Tide Valve is a better contrivance, and is sometimes substituted for a flap in sewers which are liable to flooding. The ball hangs clear of the sewage flow, but is carried up into its seating by the rise of the sewage water in the sewer. Although the sewage cannot very well clog and prevent its proper work, yet it is advisable to use these appliances only where absolutely necessary, it being almost impossible to get any piece of mechanism to

work continuously without periodical inspection and cleansing. This valve should be as near the sewer as possible and in an accessible position. Couzen's patent gully for flooded cellars is a useful contrivance of this class. In this appliance any back pressure of water raises a copper ball against an india-rubber seating, and thus forms a seal.

CHAPTER V.

DISCONNECTION AND VENTILATION OF HOUSE DRAINS.

Special Necessity for "Disconnection" in towns badly sewered—The Object of Disconnection—Disconnection dispensed with in well-sewered districts if the house drains are outside the building—Thorough Ventilation necessary to prevent formation of injurious gases—Hornsey Local Board and Intercepting Traps—Manholes and Inspection Chambers: The details of their proper construction—Alternative Arrangement in Lieu of Brick Manhole—Ventilation of House Drains, the Necessity for and Effect of—Various Methods of arranging *Inlets* and *Outlets*—Mica Valves—Copper-Wire Guards for Ventilation Pipes—Proper Size of Ventilation Pipes—Rain-Water Pipes as Ventilators, and the Proper Treatment of.

The Disconnection of the House Drain from the public main sewer or from a cesspool or other outfall is illustrated by the accompanying Figs. 19 and 20. Sometimes simply an intercepting trap is fixed, but in all good work a proper manhole built in brick and cement, with an open channel and intercepting trap as shown in Fig. 19, should be built at *A*.

In towns should the drains pass under the houses, and *especially if the sewers are not well constructed and ventilated*, disconnection of the house drain is particularly necessary in order that the water seal of the traps connected with the internal sanitary fittings of the house may be relieved from the pressure of the sewer-gas, which oftentimes is sufficiently great to force through the seal and thus enter the house.

Of course the idea of disconnecting the house drains from the main sewer is to prevent the

passage of sewer gas and disease germs through the drains from house to house. Where the sewers are not ventilated and the house drains are not intercepted typhoid fever is said to be more prevalent, those towns, therefore, showing a higher death rate.

In the case of a new or developing district all drains may be kept entirely outside the house, and the intercepting trap may be dispensed with altogether; in fact, soil pipes if properly jointed may be carried to ridge of roof and made to ventilate the sewers. The best way to be freed from sewer gas is to *thoroughly ventilate*, and thus prevent anything in the form of injurious gases being generated. To ensure this a continuous current of air should be always passing through the drains from end to end, and no air in any part of the pipes should be allowed to stagnate. The principle of trapping is opposed to this, and therefore is not a good one. The Hornsey Local Board recently passed a resolution in favour of abolishing the intercepting trap, and asked the Local Government Board to allow them to expunge the bye-law making the provision of the trap compulsory. The Local Government Board, however, refused to assent to the application.

In Fig. 19 an interceping trap is used to trap off the main, and the fresh air enters the house drain at the manhole *A*, and passes out at *B*, thus making a continuous circuit of fresh air in these drains.

Wherever there is a bend in the course of a drain there should be an inspection chamber built, so as to afford means for inspection and cleansing with rods, &c., should it be necessary; but a system of drainage properly laid down on scientific lines will be found to give little or no trouble to anyone.

All manholes and inspection chambers should be built of non-absorbent material (white-glazed bricks

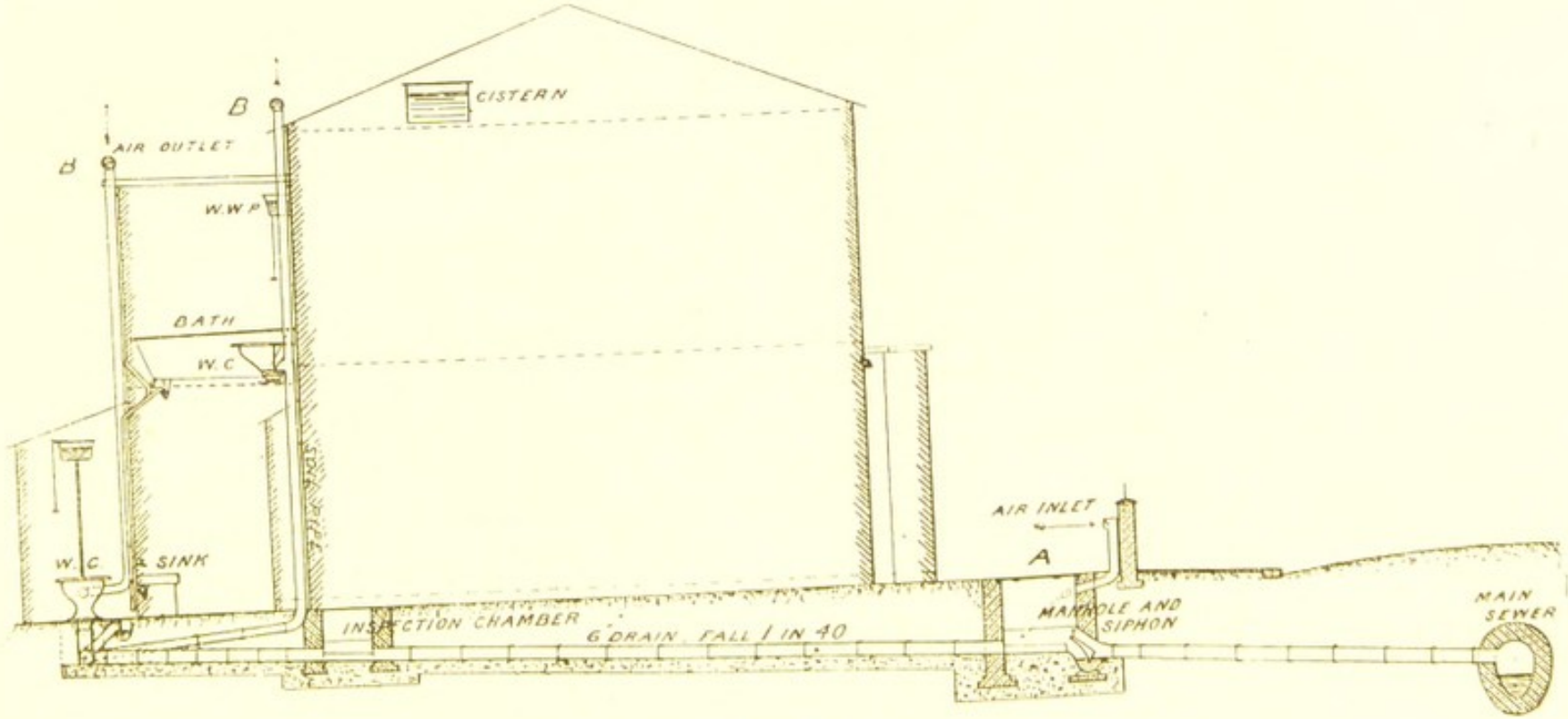
B
CISTERN
B
AIR OUTLET
W.W.P
BATH
W.C
W.C
SINK
AIR INLET
A
INSPECTION CHAMBER
6" DRAIN FALL 1 IN 40
MANHOLE AND SIPHON
MAIN SEWER

FIG. 19.

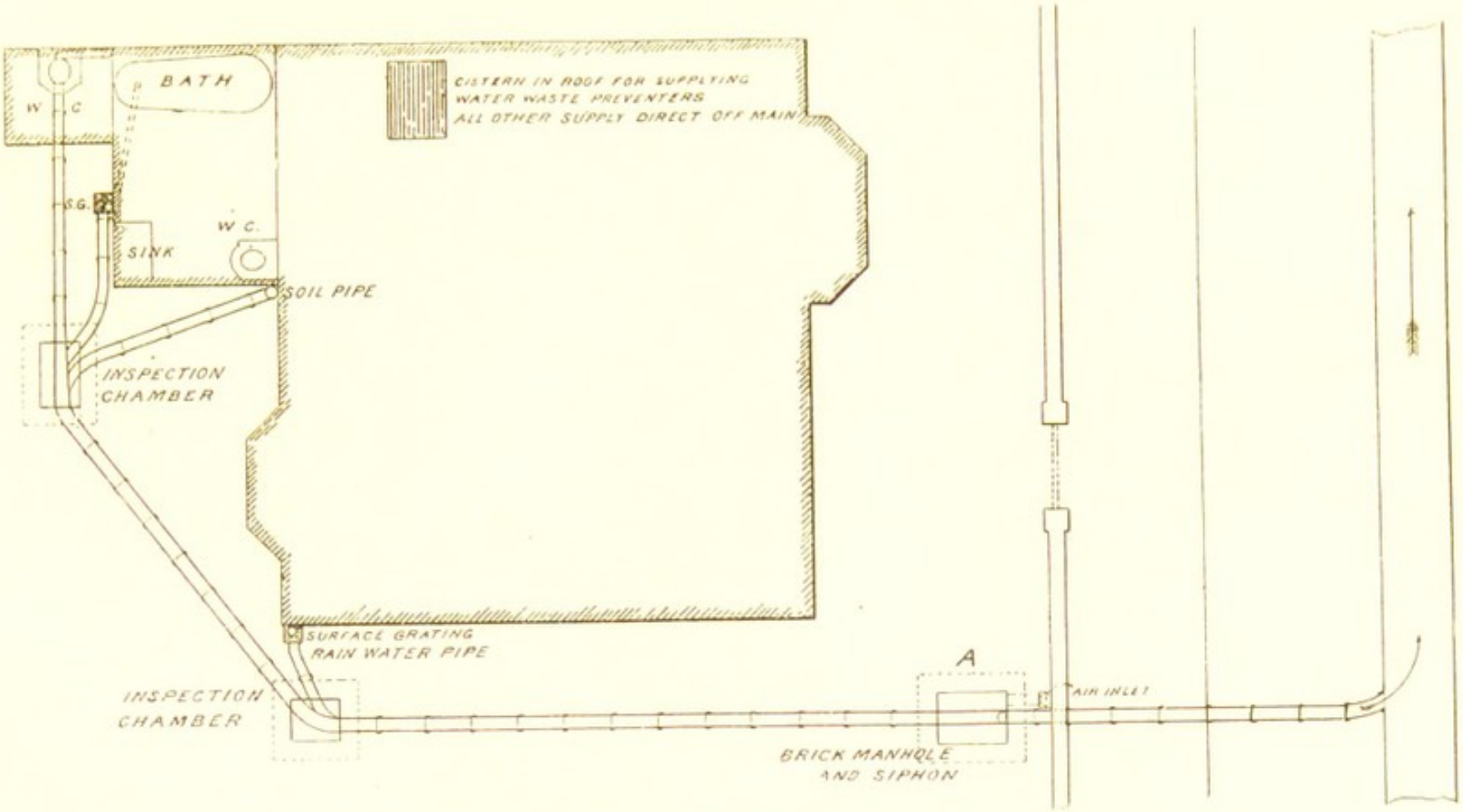
BATH
W C
S.G.
SINK
W C.
CISTERN IN ROOF FOR SUPPLYING
WATER WASTE PREVENTERS
ALL OTHER SUPPLY DIRECT OFF MAIN
SOIL PIPE
INSPECTION
CHAMBER
SURFACE GRATING
RAIN WATER PIPE
INSPECTION
CHAMBER
A
AIR INLET
BRICK MANHOLE
AND SIPHON

FIG. 20.

are best), so as to prevent the absorption of foul liquids, &c. The open channel should be of white-glazed stoneware and the brickwork set in Portland cement. Manholes, of course, should be watertight, like the drains.

Figs. 21, 22 and 23 illustrate the details of the construction of a manhole 3 ft. by 2 ft. 6 in., in brick and cement, with intercepting trap. For the sake

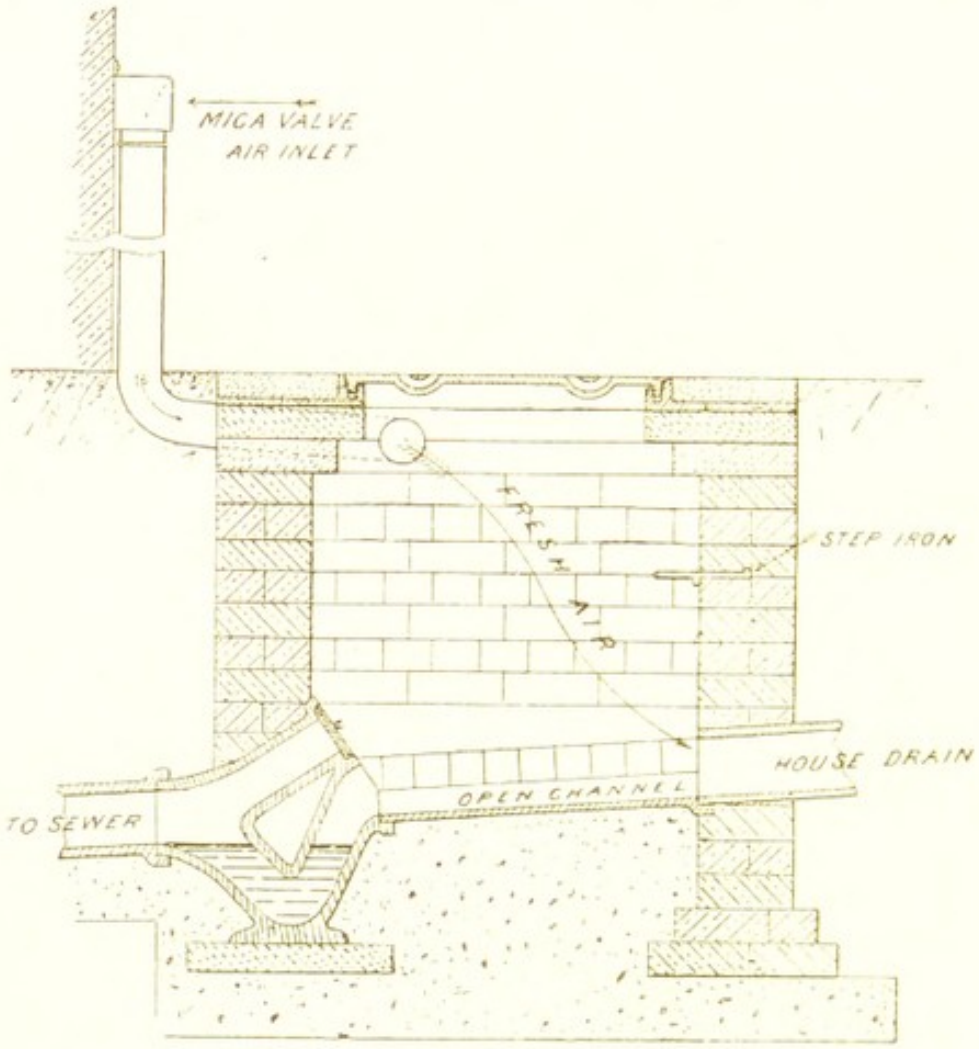

Fig. 21.

of clearness the branch drains are not shown in the section. If it is necessary to have the iron cover made airtight, it should be set in Russian tallow

and screwed down, and an alternative 6 in. air inlet may be arranged as in Fig. 21 and carried to a height of about 7 ft. above the ground level against some neighbouring wall, and fitted with a mica valve at top to guard against any back draught.

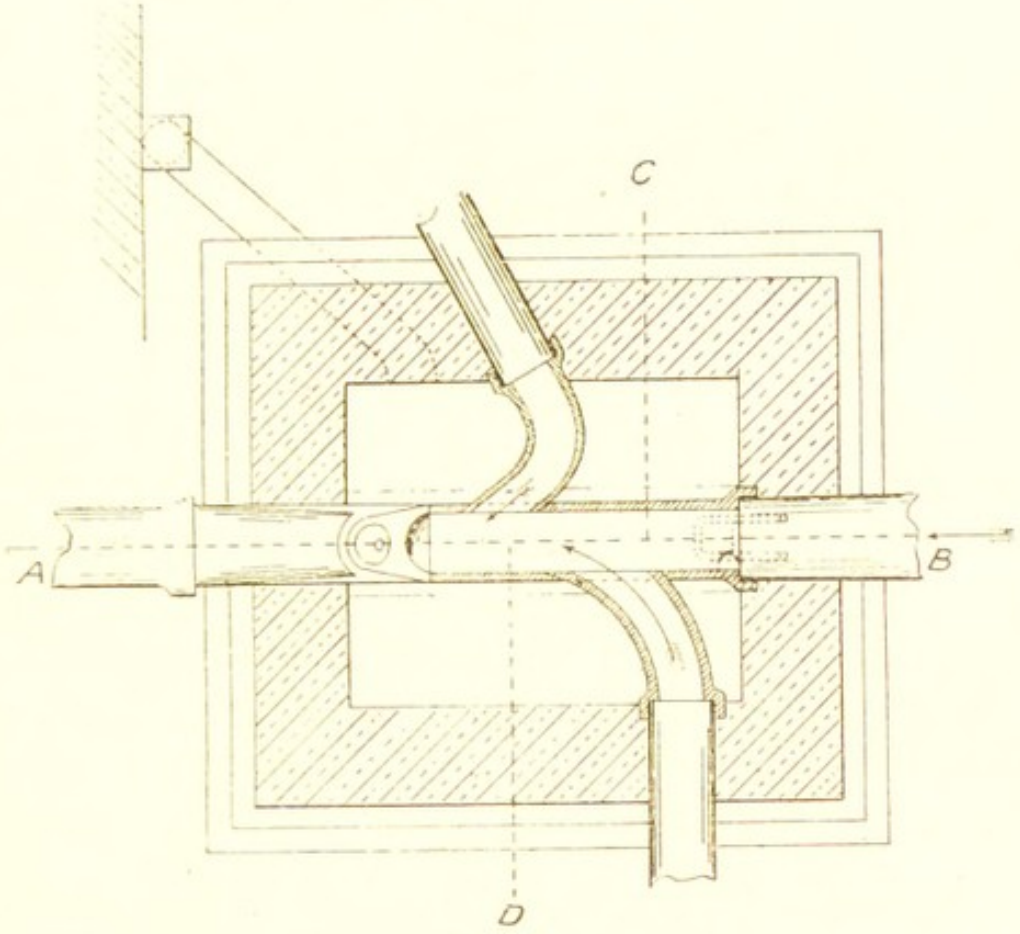

Fig. 22.

Where a manhole, &c., as above described would be too expensive, an arrangement as illustrated in Fig. 24 may be used as an alternative; but, of course, is not so good as the manhole, not affording equal facilities for inspection and for plugging the drain when a test is required.

THE VENTILATION OF DRAINS.

Oftentimes the ordinary builder does not see the

necessity for a continuous current of fresh air flowing from end to end of all drains, and for various

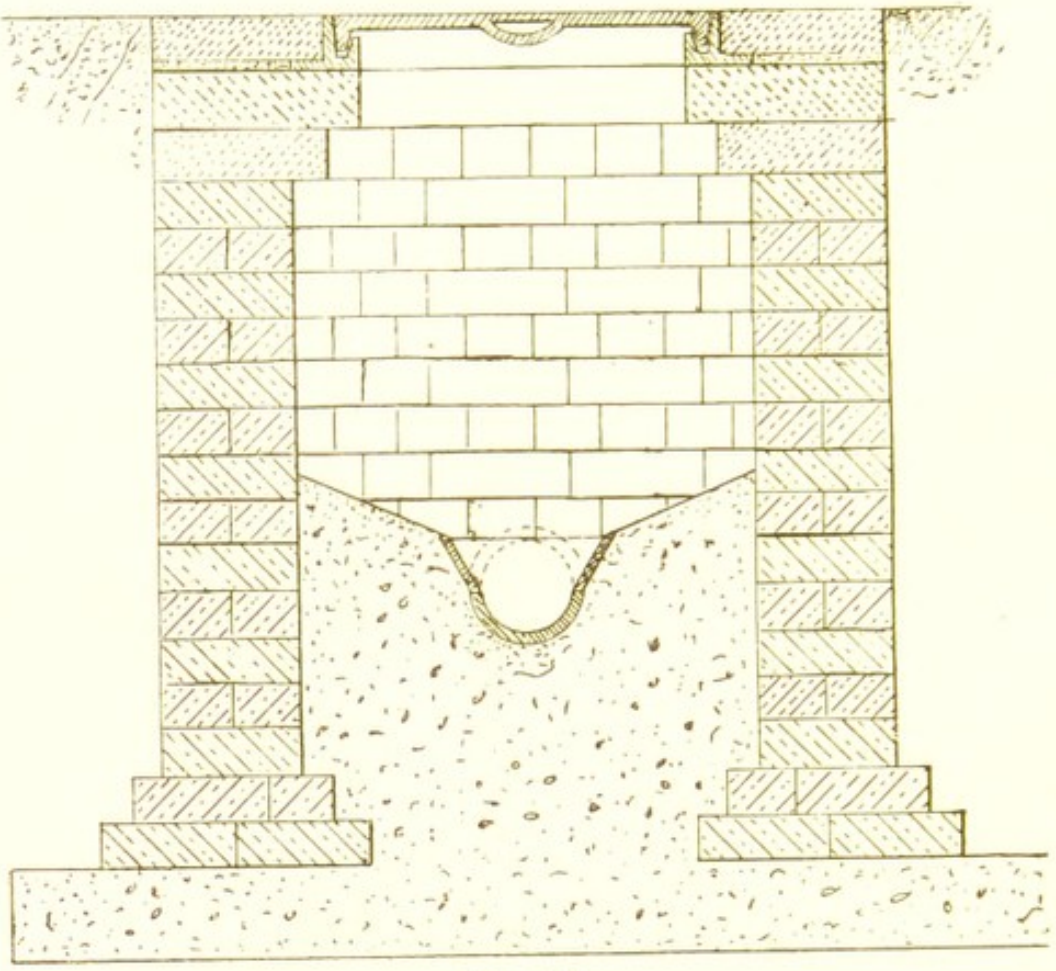

FIG. 23.

other reasons he frequently tries to evade this import-

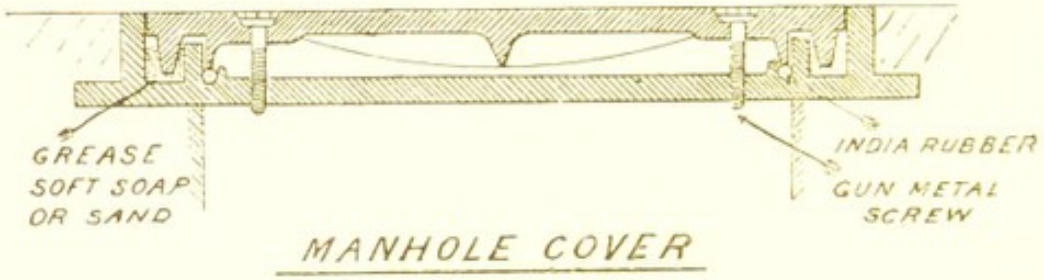

FIG. 23A.

ant detail, unless it is absolutely insisted upon. Without such ventilation no amount of "trapping" will

effectually exclude foul gases from our dwellings. By a thorough system of ventilation all gases formed in the drains are carried away, the sewage becomes oxidised, and further decomposition is pre-

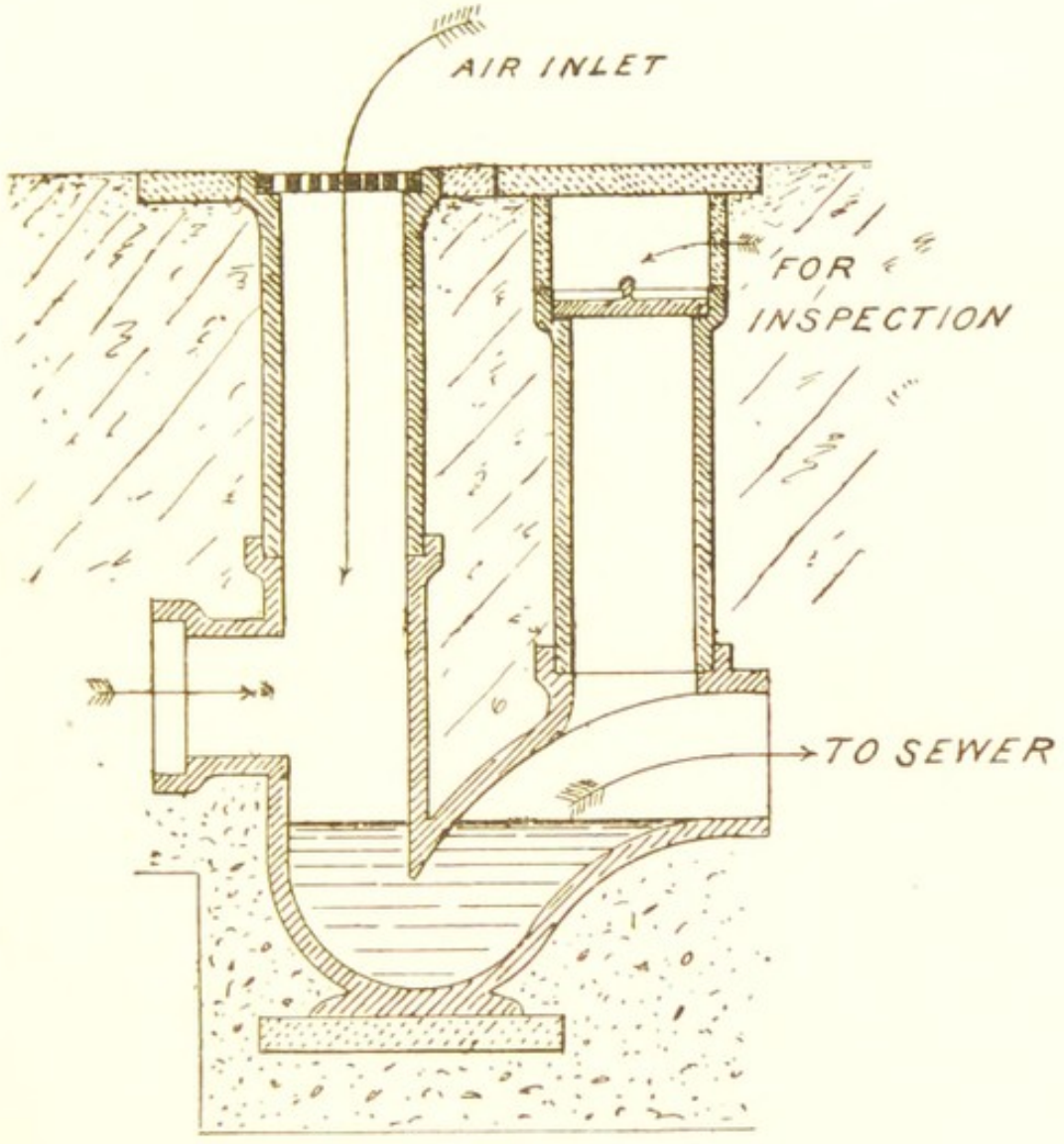

Fig. 24.

vented. Two openings at least are necessary for ventilation—*viz.*, an *inlet*, which is best arraged as low down as possible,, and an *outlet*, which should be carried by a straight pipe to the ridge of the roof.

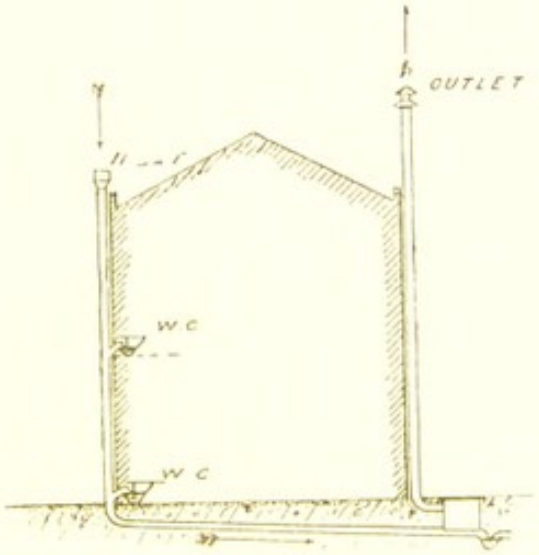

Fig. 25.

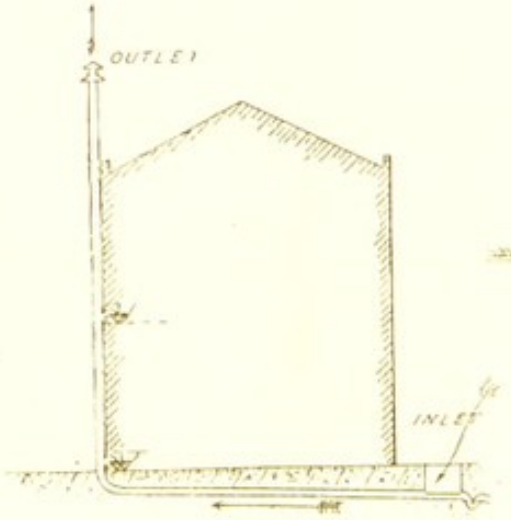

Fig. 26.

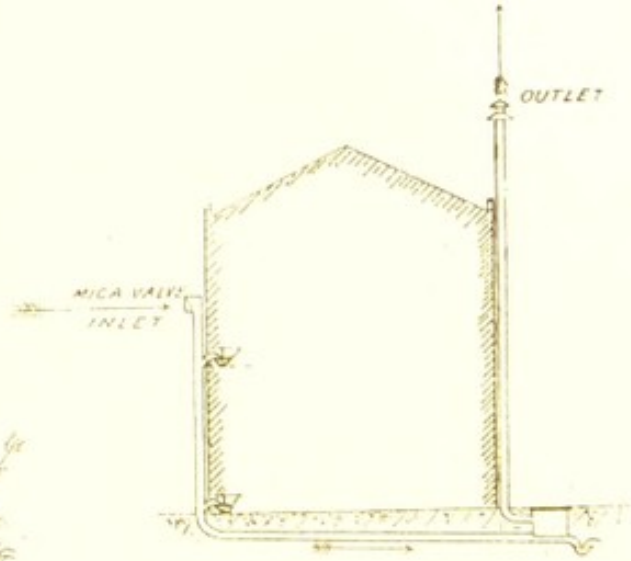

Fig. 27.

Figs. 25, 26 and 27 show the various methods of arranging inlets and outlets, the exact position of which, however, depends on the special circumstances of each particular case, but care should be taken to select a place for the inlet where it will not get blocked with rubbish, or where any back draught would not be a nuisance. A mica valve (Fig. 28) may be used if the inlet must unavoidably

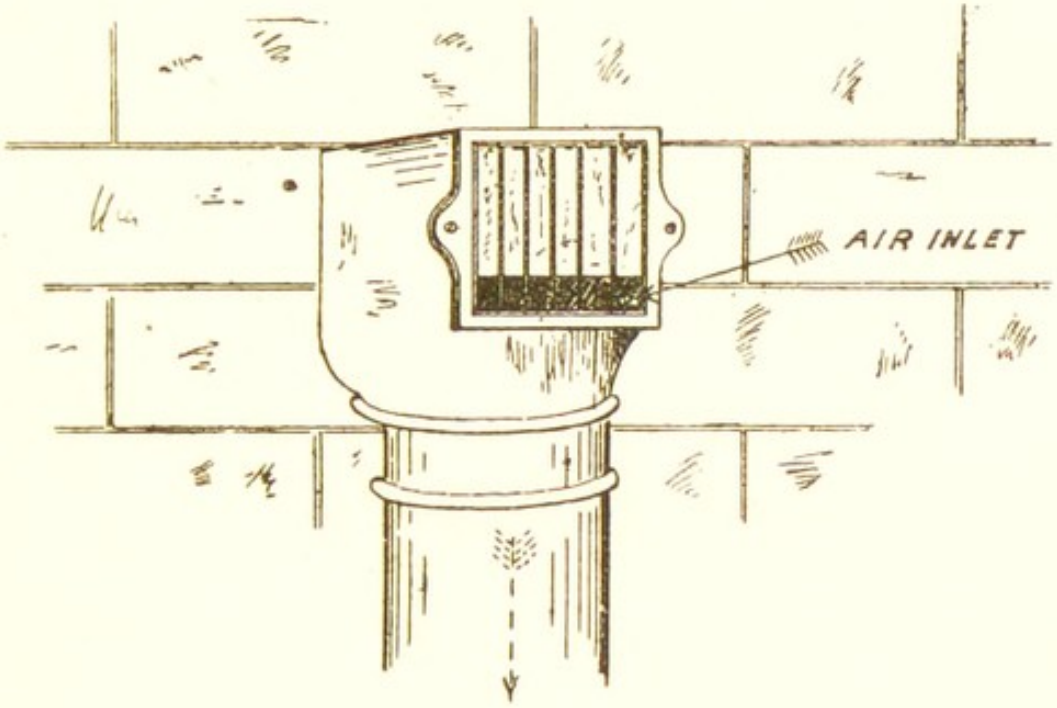

FIG. 28.

be fixed near a window, door, or footpath, to minimise the effects of any air blowing back from the drain, as the valve is thereby temporarily closed. These valves require attention and are not recommended except in these special positions. Outlets should also be fixed away from chimneys, windows, or other openings, and should stand alone in order that the air may blow freely across the top, thus creating an ascent in the pipe. The best finish for the top is a copper-wire guard to keep out birds, &c.

Ventilating pipes should not diminish in size as they go up, but should be continued to ridge of roof the *full size* of the soil pipe, and should not be less than 4 in. in diameter. Avoid all sharp bends or angles of any kind.

Rainwater pipes should never be used for ventilating the drains, as they usually terminate in such places as would admit drain air into the house. All rainwater pipes should discharge in the open air with a proper shoe over the water seal of a gully trap.

In ventilating drains it is advisable, where possible, to so arrange that the current of air passing through shall flow in the same direction as the sewage. The arrangement sketched in Fig. 27 would be found to work more satisfactorily than that in Fig. 26.

CHAPTER VI.

THE LAYING OF DRAINS.

Level of "Outfall" the First Consideration—Proper Connection of Branch Drains—V Junctions—Mr. Latham's Rule for Forming Junctions—Preparing Trench and Gradient with Boning Rods—Concrete—Method of Laying the Pipes—Construction of Drains unavoidably under Houses—Pipe Jointing—Precautions in Applying the Hydraulic Test—On the Setting-Up of "Sight Rails."

When designing a system of house drainage one of the first considerations is the level of the "outfall," as this will decide the gradient of the drains flowing into it. Branch drains should enter the

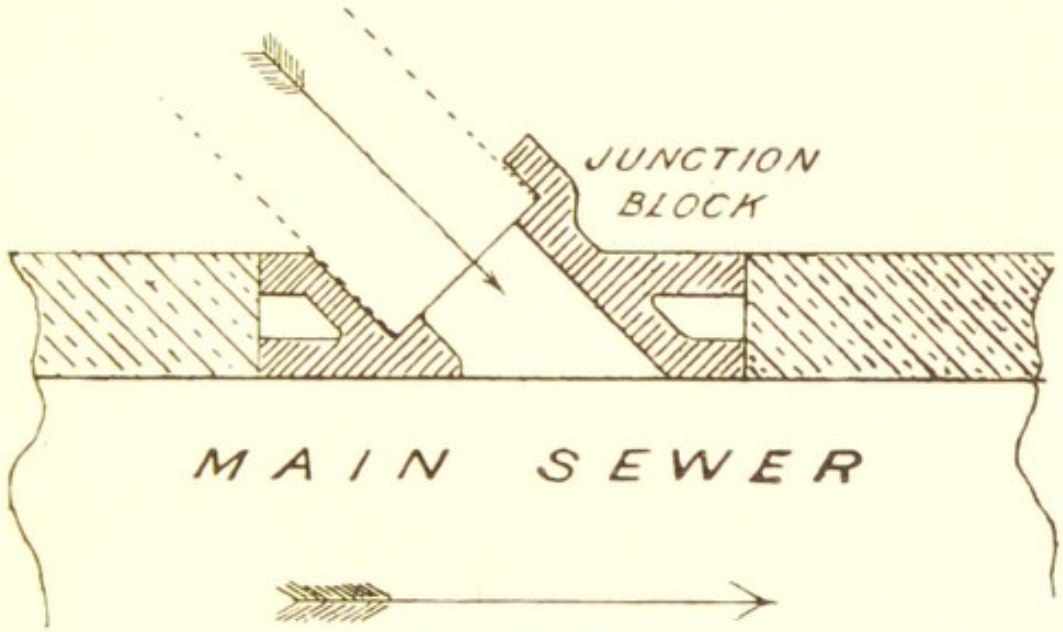

FIG. 29.

sewer at about two-thirds of its height above the invert; if a connection is made lower than this there will be danger of its becoming blocked. The house drain should connect with the main sewer by

means of a V junction, and not a square one. Oftentimes in jerry work a mere hole is cut in the side of the sewer, and the house drain simply stuck through (*see* Fig. 3). Mr. Baldwin Latham gives the following rule for forming bends and junctions: "The centre from which a branch on a main is struck must be upon a line at right angles to the centre line of the main pipe, the inside of the main pipe meeting the inside of the branch at a tangent on a radius line from which it is struck; the ends of all curved pipes must be in the direction of the radius of the curves with which they are described."

In connection with the *laying* of a main, the first thing is to excavate the whole trench to the required depth in as true a line throughout as possible. The bottom should be well rammed and leveled to the required gradient. Pegs should be set up at each end and boning rods used to obtain a proper gradient throughout. If the ground is not of a sound and firm nature at least 6 in. of good concrete should first be put in the trench, and the pipes then laid. Each pipe should be carefully examined before laying, as the hydraulic test soon reveals any weaknesses or bad joints. A hollow space should be cut out under each socket in order that the body of the pipe may rest on the bottom of the trench. Concrete may also be packed along the sides of the pipes to support the body of same. The pipes should be laid with their sockets toward the head of the drain.

Drains ought never to be constructed under a house, but occasionally, as in the case of a terrace house, this is unavoidable; in such cases, however, special precautions should be taken and the drain should be encased in good Portland cement concrete. Iron pipes (water main strength) may be

used with advantage, the joints being run in with molten lead and caulked home.

Portland cement (used neat) is the proper material for jointing stoneware pipes. Each pipe requires to be carefully wiped out after the joint is made to remove any ridges of cement which may be projecting inside. Pipe jointing requires to be done by men accustomed to the work; the ordinary mason on first trial is not as a rule very successful in making absolutely sound joints such as are required to stand the hydraulic test. A stoneware drain, when properly laid with good materials, will stand several feet head of water. Even after the hydraulic test has been applied and the pipes passed as sound, conconsiderable damage is frequently done by the workmen carelessly throwing in stone and other material, and also by ramming. I have found it a good practice to keep the drain full of water until the trench is filled in, when any lowering of the water shows that damage has been done to the pipes.

On the Setting up of "Sight Rails" for Laying Sewers. — From the section, prepared from levels previously taken along the line of the proposed new sewer, suppose we find that:—

1st.—*At B the top edge* of the "sight rail" is required to be 12·10 (height of invert of sewer above datum) plus 10·00 (length of boning rod to be used); that is 22·10 above datum.

2nd.—*At C the top edge* of the "sight rail" is required to be 11·09 (height of invert of sewer above datum) plus 10·00 (length of boning rod); that is 21·09 above datum.

Suppose, also, the height of the nearest Ordnance Survey bench-mark to work from in order to obtain the above heights to be 20·50 above datum, as at *A* for example, then the proper staff readings neces-

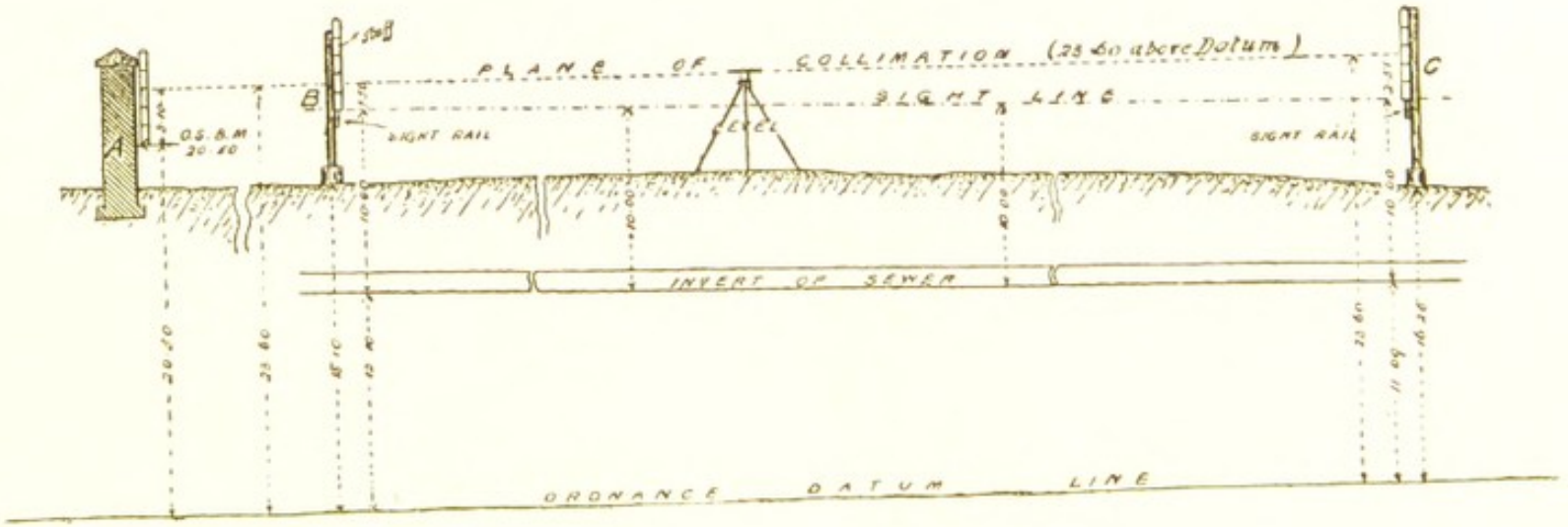
PLANE OF COLLIMATION (23.60 above Datum)
SIGHT LINE
A
B
C
O.S.B.M
20.10
SIGHT RAIL
LEVEL
SIGHT RAIL
INVERT OF SEWER
ORDNANCE DATUM LINE

FIG. 30.

sary to obtain these heights of 22·10 and 21·09 at

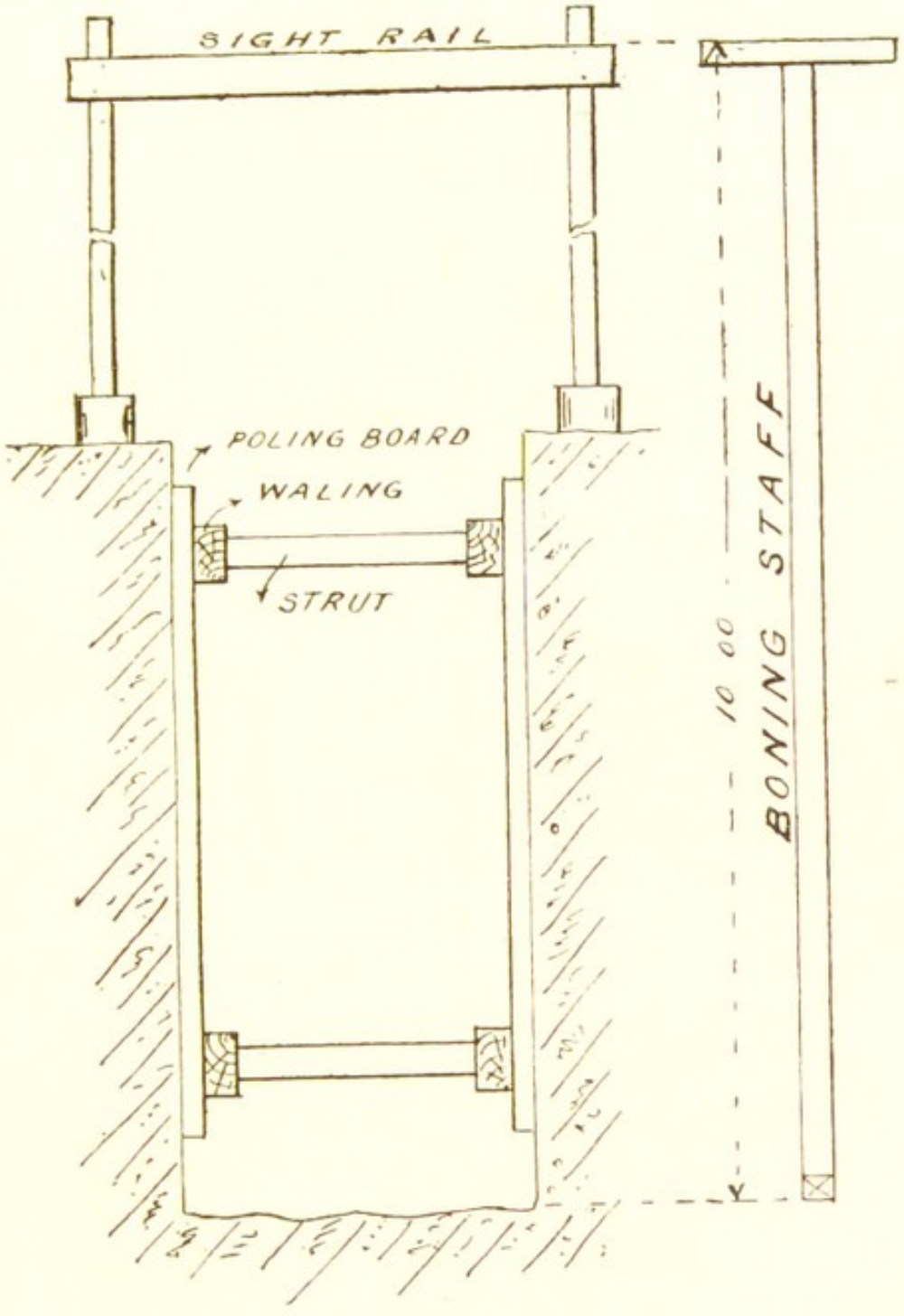

FIG. 31.

B and *C* respectively are obtained as follows: —

B.	20·50	height of O.S.B.M. on brick pier at A
Add	3·10	staff reading ("back-sight") on B.M.
	23·60	height of plane of collimation above datum
Minus	22·10	height at which sight rail is required to be fixed, as ascertained above from the section.
	1·50	staff reading at B.*
C.	23·60	height of plane of collimation
Minus	21·09	height at which sight rail is to be fixed
	2·51	staff reading at C (mark the foot of the staff and fix sight rail as at B).

To obtain the exact position of the invert at any point between *B* and *C*, hold up the boning staff so that its top edge, when sighted, coincides with the top edges of sight rails *B* and *C*, when the position ofits foot represents the required level of the sewer invert at that particular spot.

* The levelling staff is moved up and down the posts supporting the sight rail until this reading is obtained, when the position of the foot of the staff is marked on both posts and the sight rail fixed in position, its top edge coinciding with the mark as shown in the sketch.

CHAPTER VII.

DISCHARGE FROM SEWERS, FLUSHING, CESSPOOL SYSTEM, &c.

Proper Fall of Sewers: Maguire's "Decimal" Rule—Velocity of Flow—Eytelwein's Formula—Notes on "Hydraulic Mean Depth" and "Mean Velocity" in Sewers—Ready Means of Calculating Sectional Area of Flow, Wetted Perimeter and Hydraulic Mean Depth—Flushing and Cleansing of Drains—Cesspool System—Solids Intercepting Chamber and Polarite Filter for Rural Districts.

The Fall of Drains necessary in order that they shall be self-cleansing is as follows:—

4-in. pipes should have a gradient of 1 in 30
6-in. " " " " 1 in 40

Maguire's "decimal" rule is, however, one easily remembered:—

Pipe.	Gradient.	Velocity in feet per minute about
4 in. =	1 in 40	278
6 in. =	1 in 60	279
9 in. =	1 in 90	279

The Velocity of Flow in drains should not be less than 3 ft. per second, and by careful planning a much faster flow than this can generally be obtained. A very useful rule for the calculation of the discharge from drains and sewers is that of Eytelwein. It is as follows: "Multiply the hydraulic mean depth in feet by twice the fall in feet per mile; take the square root of the product and multiply it by 55; the result is the mean velocity of the stream in feet per minute."

Note.—This rule gives rather less than the actual discharge, but in calculations for any extensive scheme it is, of course, safer to be under the actual quantity than to be in excess of it. Kutter's formula gives results nearer the actual discharge.

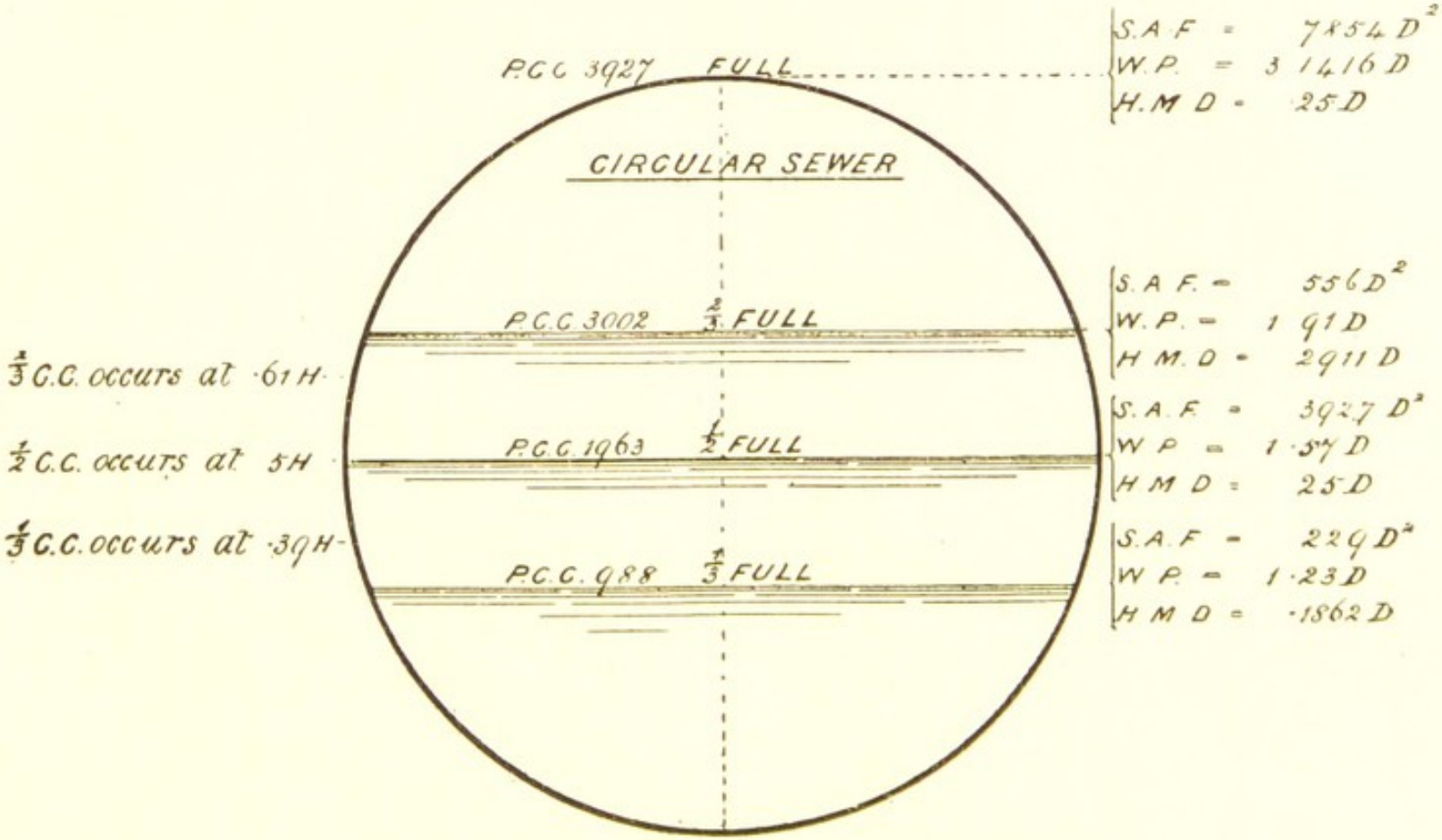
P.C.C 3927 FULL
S.A.F = 7854 D²
W.P. = 3 1416 D
H.M.D = ·25 D
CIRCULAR SEWER
P.C.C 3002 ⅔ FULL
S.A.F. = 556 D²
W.P. = 1 91 D
H.M.D = 2911 D
⅓ C.C. occurs at ·61 H
P.C.C 1963 ½ FULL
S.A.F = 3927 D²
W.P = 1·57 D
H.M.D = 25 D
½ C.C. occurs at 5H
⅓ C.C. occurs at ·39 H
P.C.C. 988 ⅓ FULL
S.A.F = 229 D²
W.P = 1·23 D
H.M.D = ·1862 D

FIG. 32.

The formula is:—

$$Q = A \sqrt{x \times 2f} \times 55$$

Where Q=the discharge in cubic feet per minute.

A=the sectional area of sewage flow

x=hydraulic mean depth.

i.e., $\frac{\text{Sectional area of sewage flow.}}{\text{wetted perimeter.}}$

f=fall in feet per mile.

55=a constant.

The hydraulic mean depth of a circular sewer flowing full is equal to one-fourth of the diameter.

For circular pipes, the H.M.D. when flowing full is the same as when flowing half-full.

The mean velocity of flow in circular sewers is the same when flowing half-full as when flowing full.

The mean velocity of an egg-shaped sewer flowing two-thirds full is always greater than the mean velocity of same sewer flowing full.

For the purpose of calculating the sectional area of flow, the wetted perimeter and the hydraulic mean depth required for the use of the above formula, the following diagrams of the various forms of sewers give the necessary decimal equivalents,* which are of very easy application and will be found convenient for ready reference and use.

The abbreviations used in the diagrams are:—

C.C.=Carrying capacity.

H.=Height.

D.=Diameter or width at springing.

P.C.C.=Proportional carrying capacity (the width, D, at springing of the arch=1 in each case).

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* Slagg, "Sanitary Work"; Olive, "Discharges of Circular and Egg-form Sewers"; Flynn, "Hydraulic Tables."

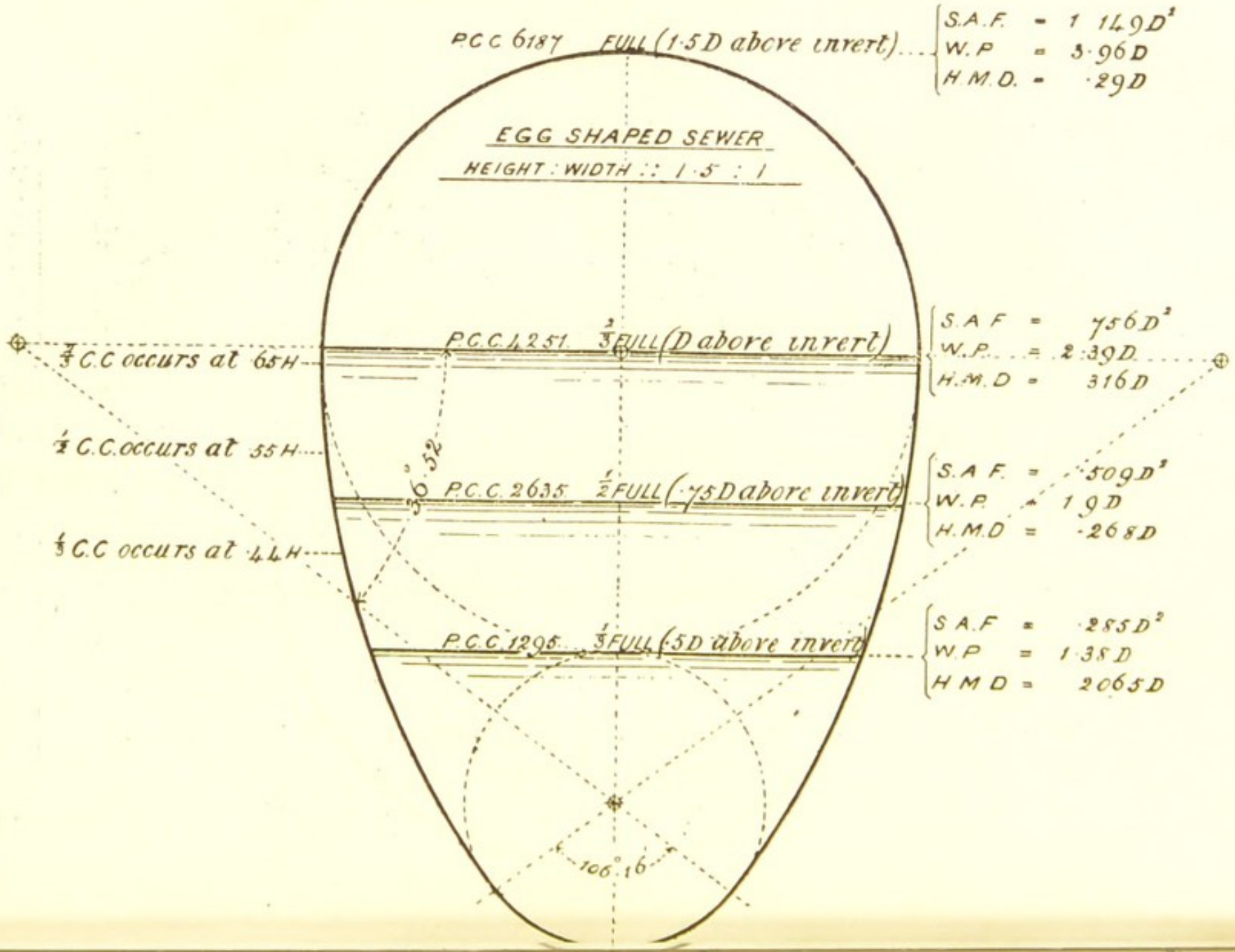
P.C.C 6187 FULL (1·5D above invert)
S.A.F. = 1 149D²
W.P = 3·96D
H.M.D. = ·29D
EGG SHAPED SEWER
HEIGHT : WIDTH :: 1·5 : 1
P.C.C 4251 ⅔FULL (D above invert)
S.A.F = ·756D²
W.P. = 2·39D
H.M.D = 316D
⅔ C.C occurs at 65H
½ C.C. occurs at 55H
⅓ C.C occurs at 44H
52°
P.C.C. 2635 ½FULL (·75D above invert)
S.A.F. = ·509D²
W.P = 1·9D
H.M.D = ·268D
P.C.C 1295 ⅓FULL (·5D above invert)
S.A.F = ·285D²
W.P = 1·38D
H.M.D = 2065D
106° 16'

FIG. 33.

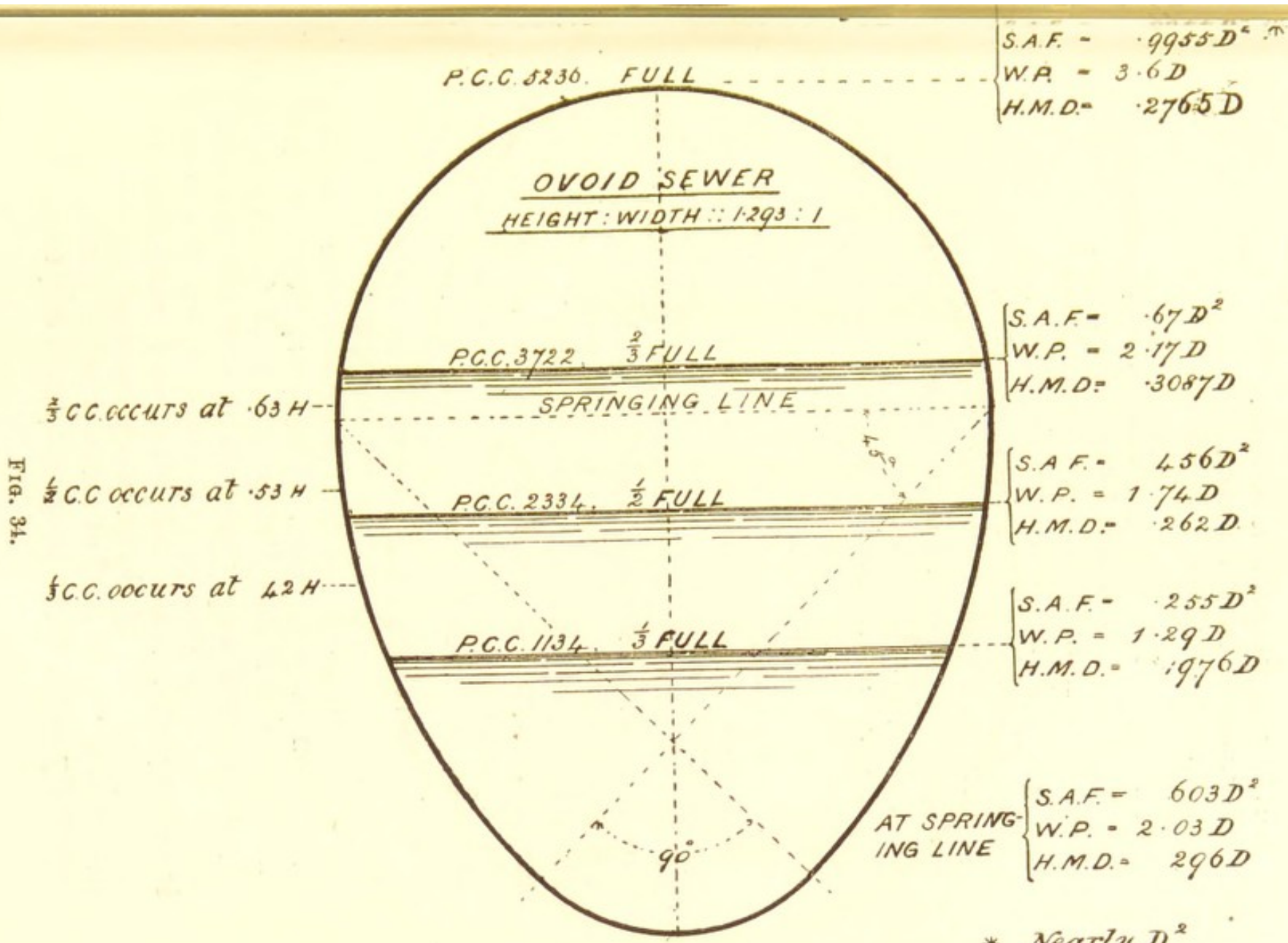
OVOID SEWER
HEIGHT : WIDTH :: 1·293 : 1
P.C.C. 5236. FULL
S.A.F. = ·9955 D²
W.P. = 3·6 D
H.M.D. = ·2765 D
P.C.C. 3722. ⅔ FULL
S.A.F. = ·67 D²
W.P. = 2·17 D
H.M.D. = ·3087 D
⅔ C.C. occurs at ·63 H
SPRINGING LINE
½ C.C. occurs at ·53 H
P.C.C. 2334. ½ FULL
S.A.F. = ·456 D²
W.P. = 1·74 D
H.M.D. = ·262 D
⅓ C.C. occurs at ·42 H
P.C.C. 1134. ⅓ FULL
S.A.F. = ·255 D²
W.P. = 1·29 D
H.M.D. = ·1976 D
AT SPRINGING LINE
S.A.F. = ·603 D²
W.P. = 2·03 D
H.M.D. = ·296 D
90°
* Nearly D²

Fig. 34.

S.A.F.=Sectional area of flow.
W.P.=Wetted Perimeter.
H.M.D.=Hydraulic mean depth.

Flushing and Cleansing of Drains.—If, in designing any scheme of drainage, the engineer, owing to the circumstances of the case, cannot obtain sufficient fall to keep the drains clear, then some special means of flushing must be resorted to, such as the erection of a good automatic flushing-tank, which will give the necessary flushing, say, once or twice a day. The illustration Fig. 35 gives a section of Mr. Roger Field's flushing-tank as made by Messrs. Bowes, Scott & Read, of Westminster, which is now very generally used and is found to be a very useful appliance. The tank is discharged automatically by means of a siphon, and is fed by a small and continuous stream of water from a tap at *A*. The contents are discharged suddenly with great rapidity into the drain, thus driving all deposit before it. The size of the tank, of course, should be proportional to the length of drain to be flushed, bearing in mind also the amount of fall the drain possesses. These flushing tanks may also be obtained at a cheaper rate made of galvanised iron.

The Cesspool System.—Hitherto no mention has been made of the well-known cesspool, which has been so favourite a resource in rural districts to fall back upon in past years. Cesspools, although permitted by the Public Health Act, 1875 (sec. 23 and 25), ought never to be made use of, however well constructed. The *principle* of the cesspool is a most insanitary one, as the collection and stagnation of large quantities of decomposing sewage is sure to result in a "nuisance" at some time or other, more especially so when the long-postponed emptying day

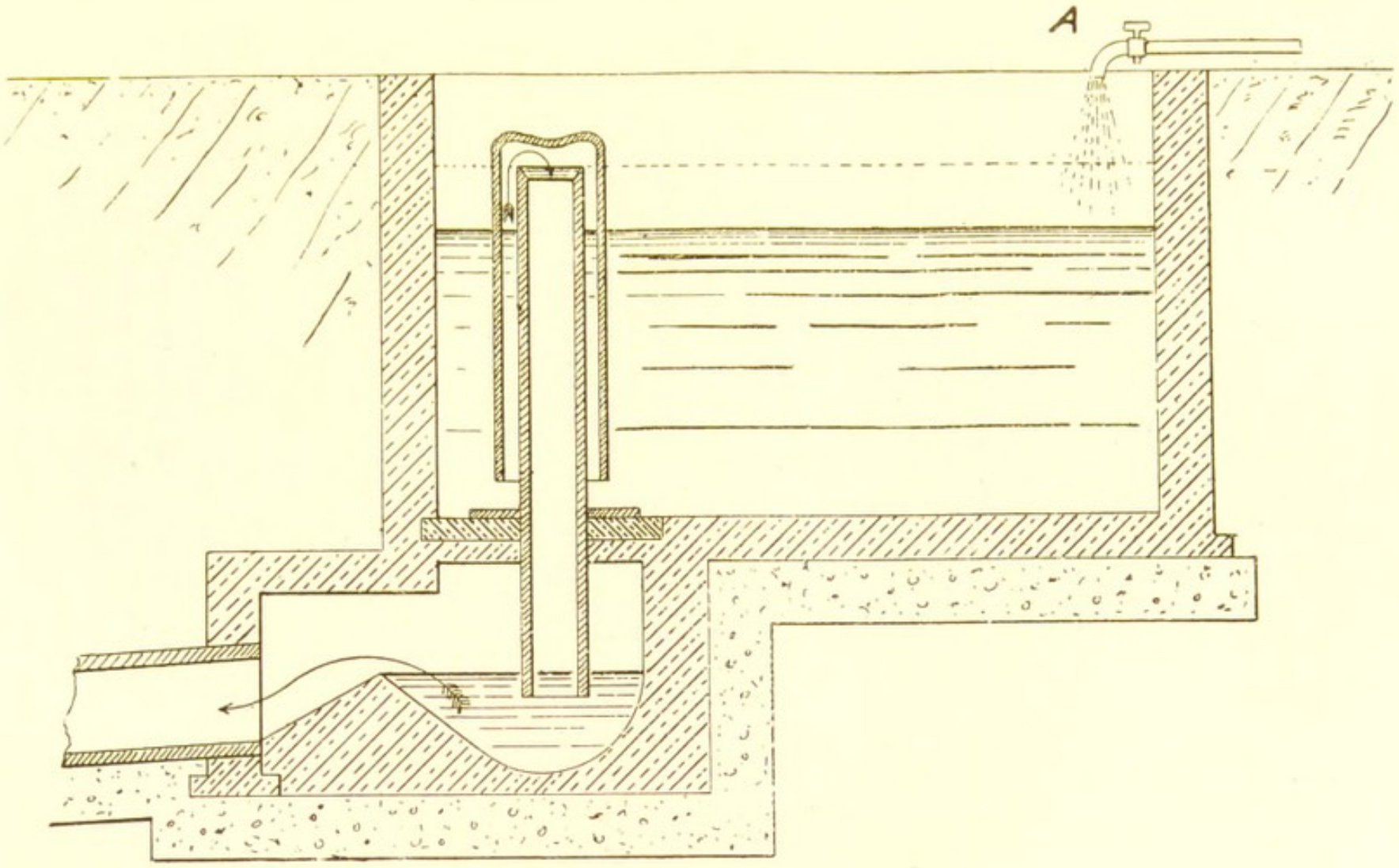

FIG. 35.

comes, giving rise to smells not only "offensive" but "injurious" to the public health.

The practice of building leaky cesspools, which "require no attention" but permit of the soakage of the sewage into the neighbouring earth, is a most dangerous one, as the local springs and water sources are almost sure to be thereby badly contaminated. Typhoid fever is particularly well known to be conveyed throughout whole districts from this cause alone, carrying off its numerous victims, or leaving others, who, although surviving the disease, yet find themselves to be considerably weaker constitutionally than they were prior to the attack.

In districts where there are no sewers a small *solids intercepting chamber* may be constructed, as shown in Fig. 36, having the bottom smoothly

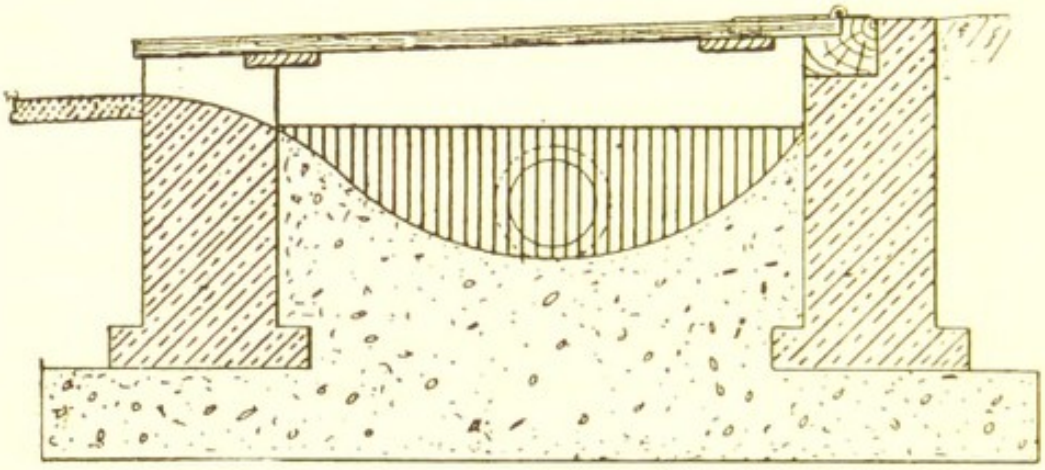

FIG. 36.

cemented, from which the solids may be easily and regularly scooped out and carried away or used on the land. The effluent may be passed on to a small polarite filter-bed, after leaving which it is fit to be turned into any natural watercourse.

CHAPTER VIII

ON THE TESTING OF DRAINS.

General Remarks—Testing always Necessary for a Thorough Examination—"Water Test," and the Method of Its Application—Drain Plugs—India-Rubber Bags—Examination of Old Drainage Systems—Smoke Test and Its Application—Common Defects as Revealed by Smoke Test—Smoke Rockets—Chief Points to Note when Examining the Sanitary Condition of a Building.

"The reliable and successful drain-tester must possess a certain amount of inventive ability and be of ready resource; above all, he must have great patience, and must find out everything for himself as indicated by the tests, and not take anything for granted; and information given to him by those who profess to know should be gratefully received; but, at the same time, he should satisfy himself of its accuracy and value."*

The only reliable method of making a thorough examination of the *workmanship* connected with the drainage of a building is by the careful application of suitable "tests." However experienced an engineer may be, he cannot ascertain much by mere inspection, except as to the general arrangement and design.

Most sanitary authorities now have bye-laws preventing drainage works being covered in until they have been tested and passed by an efficient officer. All drains should, however, be again tested when the house is occupied, and should afterwards (if possible) be tested annually, especially if any part of the drain runs under the building.

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* *Sanitary Record*, April 15, 1893.

The "Water Test."—When the cement is properly set, and before any earth is filled in, every new drain should be tested with water pressure, the pipes and joints should be able to bear a pressure of at least 5 ft. head of water. This test is applied by stopping the lower end of the drain (just above the "intercepting trap") with a drain plug or air bag. *Drain plugs* can be obtained with rubber bands, which can be expanded or contracted by means of a thumb-screw arrangement to fit the drain. *The india-rubber* bags are inflated with a small hand

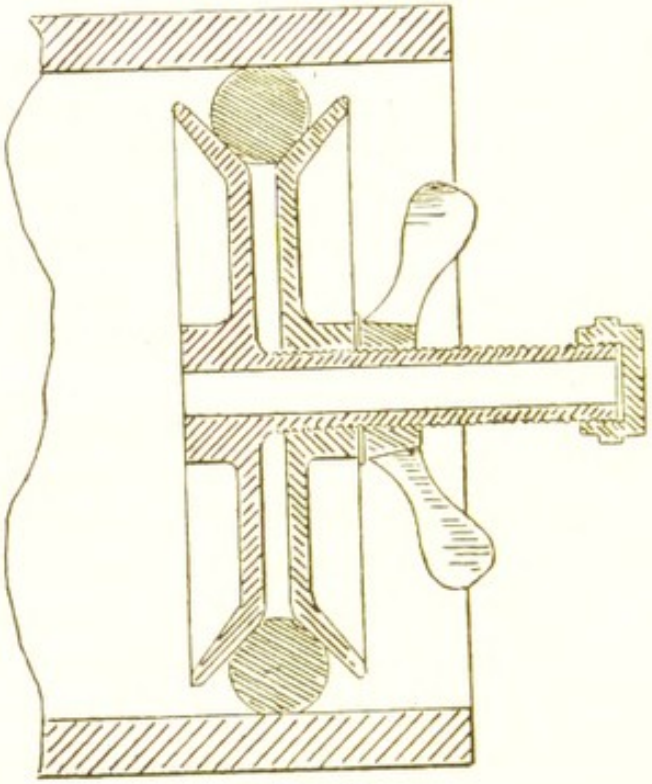

FIG. 37.

air-pump after being inserted into the drain. These bags are particularly handy, because of their portability. The drain, having been properly plugged, should next be filled with water to the level of the top of the lowest gully trap (or to the level of the highest if the lower ones can be plugged), and the level

noted by a mark or other method (care, of course, being taken to stop any further inflow of water). If the water remains at an uniform level for a reasonable time (say about two hours) the drain is sound. The water should be retained in the pipes till after the "filling in" is completed to make sure they are not disturbed by careless workmen. The drain inspector should, however (if he does not see the pipes being filled), see the *discharge* of the water on removing the plug, in order that he may be sure that all the pipes were fully charged and that the test was a fair one.

When the system of drainage is a large one, and cannot be tested at one time, it should be done in sections, the plug being inserted at the inspection chambers.

If a branch drain communicates with a gully at a lower level than others on the main pipe, the lower gully may be plugged, so that the test may reach to the highest parts of the drain. Circular gullies are much preferable to the ordinary square ones, as they are easily plugged and more self-cleansing.

When a portion of a drain is required to be tested and covered in before the whole can be laid, a bend and two lengths of pipe may be temporarily fixed in order to obtain the necessary head of water.

When testing new drains the inspector should also note the arrangement and size of the drain, the gradient, and the inside of the pipes, as far as possible, to see that they are clear of pieces of cement or other rubbish.

The proper examination of an old drainage system is a matter of much greater difficulty, and often requires more time and labour than is generally at first anticipated. No such examination can, however, be considered *complete* until every

drain, branch, soil, ventilating or waste pipe has been *traced and tested from end to end.* For this work the "*smoke test*" will be found most serviceable; it reveals defects which inspection alone could not detect, and is particularly helpful in tracing the course of the drains. The absence of smells is no guarantee that the house is free from sewer gas or that the drains are sound. If smoke escapes it is clear that the drain is defective and that drain air escapes also.

When about to apply the *smoke test*, first close

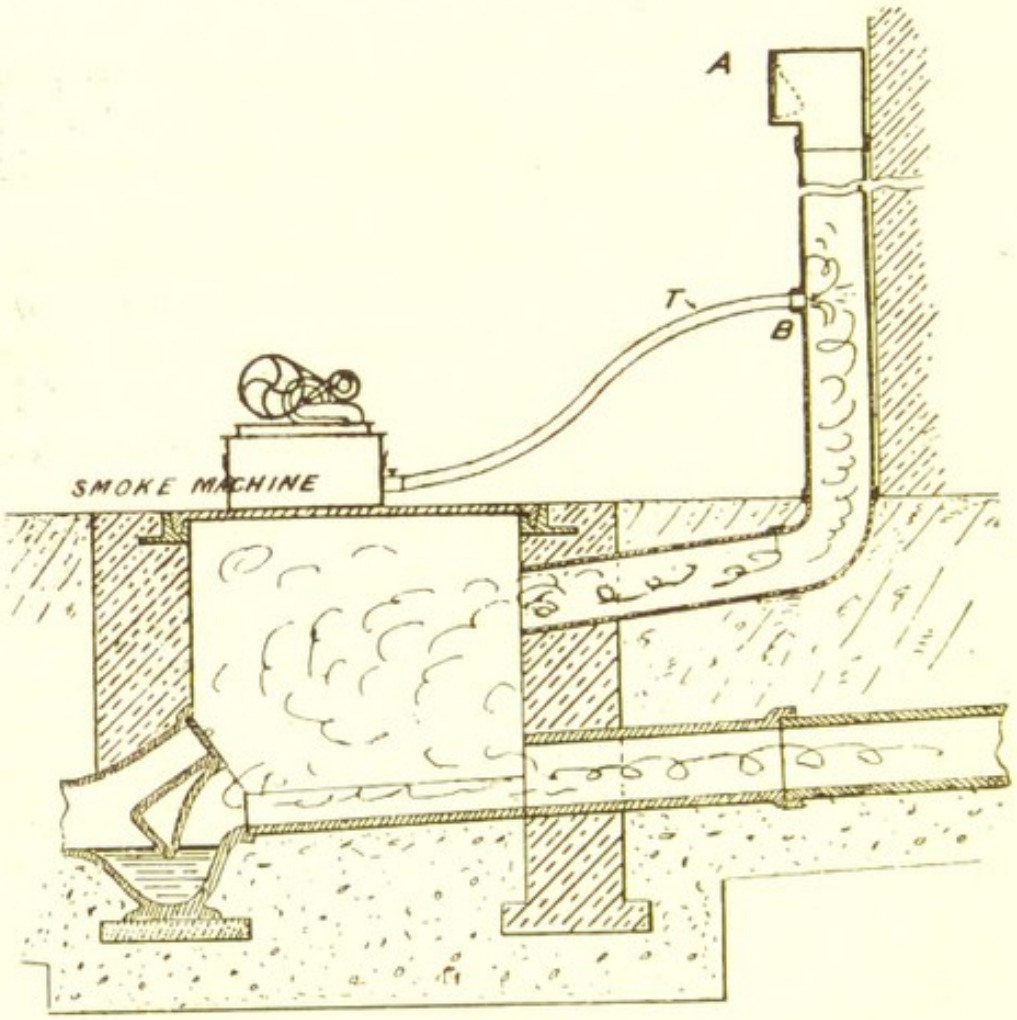

FIG. 38

all the doors and windows, and if the drain has an

intercepting trap the smoke machine should be applied there, or, if more convenient, it may be applied to a gully, the water seal being removed for the purpose with a syringe or damp cloth. A method which I have found very convenient is to have a small hole (about 2ft. from the ground) cast on the air inlet pipe at the manhole and fitted with a screw cap. The india-rubber tube, *T* (having a ferrule with thread at its end), may be screwed on as at *B*, thus making an easy and quick method of connection, as no gullies or manholes need be interfered with. The mica valve air inlet *A*, which is best kept about 7 ft. from the ground, would, of course, be stopped with a damp cloth or stiff clay in the usual way.

If there is no intercepting trap, the drain should be plugged off from the main sewer or the smoke will be driven away into the latter, and the house drain will not be undergoing a reliable test. The cotton waste or tobacco cloth being well alight and made to *smoulder* properly, an assistant may be left to work the asphyxiator at a moderate and uniform speed.* Whilst the drain is being filled with smoke make a sketch plan of the building, and mark on it the position of all gullies, soil pipes, ventilating and waste pipes, also the course of the drain when it has been ascertained. In order to confine the smoke under pressure in the pipes, stop down all ventilation pipes, soil pipes, or mica valves, with clay or a damp cloth after the smoke has been seen to issue freely from them.

During the examination take note of all the sanitary fittings—*e.g.*, waterclosets, sinks, baths, wastes, &c, and make sketches of important details. Also take note of any leakages of smoke there may

* If it is worked too fast the cloth will be made to blaze instead of to *smoulder*, and then little or no smoke will be produced.

be; these often appear in a few minutes from the commencement of the test. A few of the more common defects met with are: Soil pipes fixed inside houses, defective joints in soil pipes and drains, soil pipes or ventilating pipes badly placed and having numerous bends, cellar drains not disconnected, waste pipes not properly trapped, rain-water pipes connected directly into the drains. In testing, care should be taken that the smoke has actually passed into every branch drain and that it is close up to the top of every "fitting." To ascertain this, the water may be temporarily removed from a trap, which is quickly and easily done with a syringe.

In difficult positions, where the circumstances prevent any other method, it is necessary sometimes to apply the smoke test from the roof, either at a soil pipe or ventilation pipe.

For testing short lengths of pipe "smoke rockets" are useful, owing to their portability.

When the test and examination are completed all traps should be re-charged, ventilating pipes unstopped, and any apparatus or fittings interfered with replaced as found.

The following is a brief summary of the chief points upon which to obtain information when examining the sanitary condition of a building:—

Obtain a plan of the drains, if possible, or obtain information from any person acquainted with the drainage arrangements of the place.

Ascertain if there are rats in the house or if there are bad smells.

Note the position and course of the drains.

Also the position, arrangement, and soundness of soil or ventilating pipes.

Are there any privies or cesspools near the building,

or gullies in the scullery, basement or cellars, or *any* drain under the house?

If there is a well near, take a sample of the water for analysis.

Examine all rain-water tanks.*

Ascertain position of the outfall of the drain, whether into a sewer or cesspool.

Examine and note particulars of cesspools (if any); is it leaky or likely to contaminate water sources?

Of what material is the drain constructed? Is it sound, properly laid, with good gradient, true in line, and properly ventilated?

Are there inspection chambers at all bends in the course of the drain?

Is there a thorough system of ventilation for the waterclosets?

Notice the position of the closets, the form of apparatus, the force of the flush, safes and overflows, and if flushed by separate cistern disconnected from domestic supply.

Examine all cisterns, note the arrangement of the overflow, if fitted with a cover, and if the cistern is in an easily-accessible place.

Examine and trace all waste pipes, noting if they are properly trapped, fitted with back air pipes, and discharged over gullies outside the building.

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* I once found a waste pipe from a chemical laboratory connected into a rain-water tank, the water of which was used for domestic purposes. This, of course, was most dangerous.

CHAPTER IX.

GENERAL RULES REGARDING HOUSE DRAINAGE.

1. Drains should be set out true in line and gradient from point to point, and laid with best stoneware salt-glazed socketed pipes (not earthenware or fire-clay), jointed in Portland cement, on a 6-in. bed of concrete.

2. Drains should not be constructed under any building except in cases where any other mode of con-

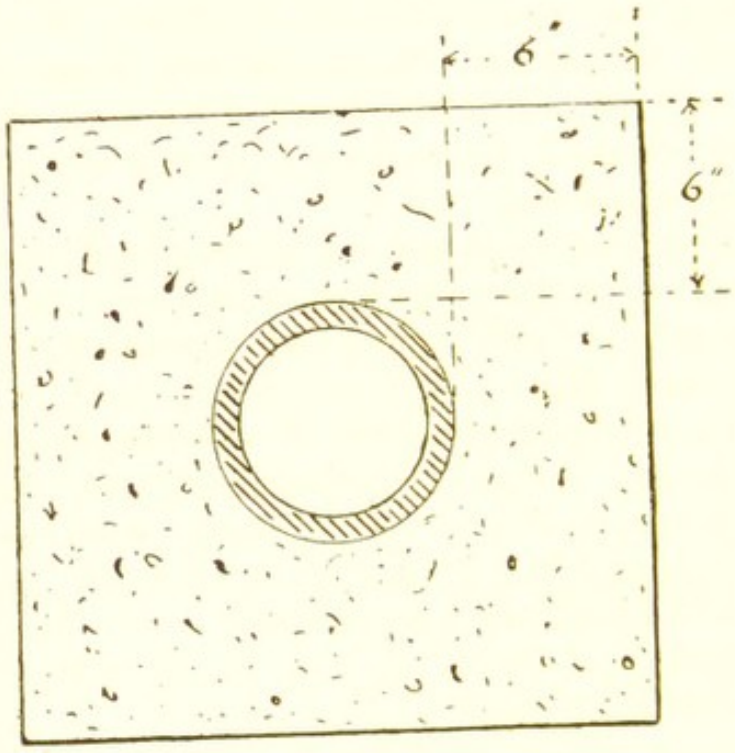

FIG. 39.

struction may be impracticable, and in such cases should be surrounded with concrete.

3. Drains should have as good a fall as possible,

never less than 1 in 60; it is desirable to obtain 1 in 40 wherever possible. If a sufficient fall cannot be obtained, one of Field's automatic flushing tanks should be fixed at the head of the drain.

4. The jointing of the pipes should be executed with great care, in neat *cement*. Each pipe should be jointed separately. It should be seen that no cement is left projecting inside the drain, and that the joint is good all round. Sometimes tarred gaskin is used to prevent the entrance of cement into the pipes; Hassall's patent joints are good where running water or sewage has to be contended with.

5. When the pipes are laid (having allowed time for the cement to set—*viz.*, from one to seven hours) they should be tested by filling them with water. The water should be retained in the pipes till the "filling in" is completed, so that any fracture caused by careless workmen, ramming, &c., may be at once observed.

6. Where drains pass through walls it is important to turn relieving arches over them in case of settlement in the wall, which would in all probability fracture the drain.

7. Pipes should in no case be cut for the purpose of forming junctions with branch drains, but these should always be made with proper junction pipes. All right-angled junctions should be avoided. Junctions should be V-shaped, and inspection chambers, with covers, should be provided at all junctions and bends.

8. Dummy junctions (for future branch drains) should be closed with proper discs solidly jointed.

9. Where bends or junctions occur in the length of the drain a small extra dip may be given, to counteract the effects of friction.

10. When a drain varies in size—*e.g.*, when a 4-in. is increased to a 6-in. pipe—the proper taper pipe, made for the purpose, should always be used.

11. It is well to have siphons a size smaller than the pipes in front of and behind them; this will increase the scouring effect through the siphon.

12. There should be *no* entrance into the drain by gullies, soil pipes, &c., inside the house.

13. House drains should be properly disconnected from the main sewer by a suitable intercepting trap (having a good cascade action), built in a manhole of brick and cement, with open white glazed channels and cast-iron airtight cover. Manholes, of course, should be outside the building, but the exact position must be guided by circumstances.

14. At least two openings (one at manhole and another at head of drain) should be provided for the thorough and continuous ventilation of the drains.

15. Rain-water pipes should never be used for the purpose of ventilating drains, but should be disconnected at the foot and made to deliver in the open air over a properly-trapped gully.

16. When drains pass near trees and shrubs special care should be taken in the jointing to prevent the roots entering and stopping the drain.

17. The site of a building should be underdrained with agricultural pipes, to carry off all subsoil water, and the floors of the basement afterwards concreted and asphalted. This subsoil water should not be discharged into a soil drain, neither should the water of the areas around the house, except in cases where any other method is impracticable, and then the subsoil drain should be effectually disconnected from the house drain by interposing a suitable trap.

18. The overflow of any well, cistern, or rain-water tank should not under any circumstances be

directly connected with a soil drain, but should discharge, first of all, in the open air over a gully trap.

19. In re-laying the drains of an old building, where brick or stone drains obtain, the whole of the brick or stone work should be removed, together with all sodden earth ; and fresh gravel, or other clean material, should be thrown in and well rammed.

20. The waste pipes or overflows of all closet trays, bath wastes, lavatories, sinks, cisterns and cistern trays, should always deliver themselves in the open air. Cistern overflows are now required to discharge as "warning" pipes by most water companies.

21. It is very important and necessary that all

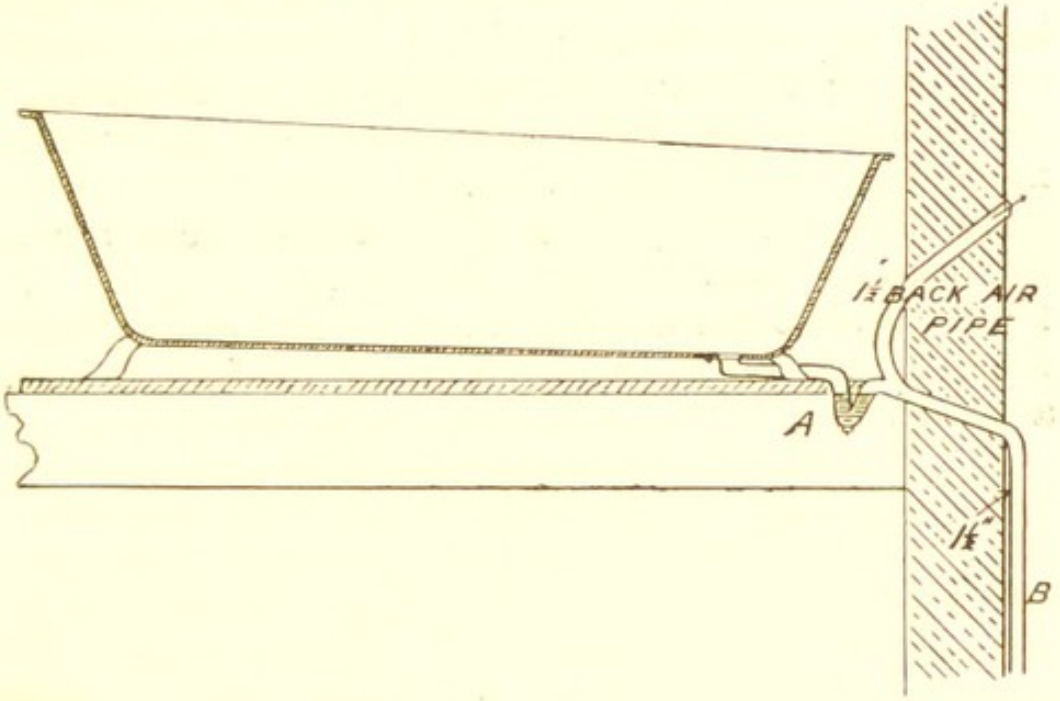

FIG. 40.

bath, sink or lavatory wastes, although discharged over an open gully, should be properly trapped *immediately under the fitting*, as at *A* in Fig. 40. If the vertical drop of the pipe *B* is very great, it will

also be found necessary to put a back air pipe to prevent siphonage of the trap (*see* Fig. 40). These are important details in plumbing which are frequently ignored.

22. Soil pipes should have air and water tight joints, be fixed outside the house, carried up full size without bends to ridge of roof, away from dormer windows, skylights or chimney stacks, and be protected with a wire cap on top.

23. Waterclosets should be confined to one part of the house, and built over each other as much as possible, projecting out from the house in an annex; or better if kept outside altogether. They should never be permitted to remain in the centre of a house. Closets should be provided with an inlet and an outlet for free ventilation. All seats should be hinged, and risers are better done away with altogether; they are not necessary with an improved modern basin, and the space under the seat is much more likely to be kept clean.

24. The use of grease traps for scullery sinks, cannot, as a rule, be recommended, as they require for their effectual working more attention than they are likely to get, and oftentimes, therefore, become a nuisance.

CHAPTER X.

USEFUL HYDRAULIC MEMORANDA.

Freezing point of water under one atmosphere ... ... = 32 deg. Fah. (0 deg. C.)

Boiling point of water under one atmosphere ... ... = 212 deg. Fah. (100 deg. C.)

British standard temperature of water ... ... = 62 deg. Fah.

Point of maximum density of water ... ... = 39·2 deg. Fah. (or 4 deg. C.)

Water expands from 8 to 10 per cent. in freezing. This expansion is almost irresistible, hence the bursting of water pipes, &c., during frosty weather.

Weight of 1 cubic foot of pure water at 62 deg. Fah. = 62·5 lbs. = ·0278 ton.*

1 cubic foot of water = 6·25 gallons.

1 gallon = 10 lbs. = ·16 cubic foot = 277·274 cubic inches.

224 gallons = 1 ton = 35·9 cubic feet.

The average annual rainfall for England is usually taken at 30 inches.

Rainfall in inches × ·52 = gallons per square foot.

1 inch of rain over 100 square feet of surface = 52 gallons.

1 inch of rain over an acre of surface = 100 tons of water (approximately).

1 inch of rain over an acre of surface = 3630 cubic feet of water.

1 inch of rain over an acre of surface = 22650 gallons.

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* In 1890 the Board of Trade fixed the weight of water at 1 cubic foot = 62·2786 lbs. at 62 deg. Fah. barometer, 30 in. of mercury.

"*Hydraulic Mean Depth*" in sewers $= \frac{\text{Sectional area of flow.}}{\text{Wetted perimeter.}}$

The H.M.D. of a circular sewer when flowing full is the same as when flowing half full—*viz.*, one-fourth of the diameter in each case.

In designing a system of sewers for any district the following are some of the chief points to be taken into consideration :—

Area of the district to be drained.

The nature of the ground the sewer is to be laid in, a careful inspection, and sections should be made so as to secure the best route and fall obtainable.

The present population, the probable future population, and sewage flow therefrom.

NOTE.—The population generally equals about five times the number of dwelling houses, and the quantity of sewage may be reckoned at about 30 gallons per head per twenty-four hours (varying according to locality).

The amount of rainfall likely to enter the sewers must also be taken into account. This will vary as the nature of the soil and as the paved surfaces, but if the "separate system" of drainage is carried out in the district it is usual to admit into the sewers only the rain water from the rear of buildings.

From careful considerations and calculations in respect to such points as the above is deduced the proper size and fall of the sewer necessary for the district to be drained.

The Areas of Circles are to one another as the squares of their diameters ; therefore an 18-in. sewer is $\left(\frac{18^2}{9^2} = 2^2\right)$ four times more capacious than a 9-in. sewer.

To find the quantity (in gallons) of water contained in a pipe :
(Diameter in inches)^2 × ·034 × length in feet.

To find the weight of water contained in sewers in lbs. per foot run :—
(Diameter in inches)^2 × ·34.

To find the pressure in lbs. to be overcome in raising water by pumping :—

(Diameter of pump barrel in inches)^2 × ·34 × vertical height in feet.

To find contents in gallons of a rectangular tank or cistern :—

Length × breadth × depth × 6·25.

N.B.—Dimensions in feet.

The pressure on the side of a tank containing any liquid is equal to the weight of a column of the liquid, whose base equals the area pressed, and whose height equals the depth of the centre of gravity of the area pressed below the surface of the liquid.

EXAMPLE.—The dam of a reservoir is 300 yards long ; the rectangular face exposed to the water slopes downwards at an angle of 45 deg. What is the total pressure on the dam when the water is 20 ft. deep?

Length of sloping side of reservoir = $\sqrt{20^2 + 20^2}$ = 28·2842712 ft.
∴ Area of side pressed = 28·2842712 × 900 ft. = 25455·84408 square feet.
Depth of centre of gravity of "area pressed" below surface of water = 10 ft.
1 cubic foot water = 62·5 lb.
∴ Total pressure = 25455·84408 × 10 × 62·5 = 15909902·55 lbs. = 7102·6 tons.

The Centre of Pressure on the side of a tank of water is two-thirds depth of water from its surface.

To find the pressure in lbs. per square inch of a column of water :

Height in feet × ·434.

The Atmospheric Pressure = 15 lbs. per square inch = 34 ft. head of water = $\frac{34 \text{ ft.}}{13{\cdot}6}$ = 30 inches of mercury (the standard height of the mercurial barometer).

N.B.—13·6 is the specific gravity of mercury.

CHAPTER XI.

Synopsis of the Local Government Board Model Bye-Laws (under 157th Sec. of Public Health Act, 1875) as to the Sanitary Construction and Drainage of New Buildings :—

No new building to be erected on a site filled up with any material impregnated with fœcal, animal or vegetable matter.

The whole site to have a 6-in. layer of cement concrete.
NOTE.—This is to resist the rising of ground air and damp.

Every wall of a new building must have a proper damp-course of sheet lead, asphalte, slates laid in cement, or other durable material impervious to moisture.

There must be sufficient open space about buildings to secure free circulation of air and ventilation of the building. The depth of space at the rear of buildings is regulated by the height of the building.

The subsoil of the site of a new building (if the dampness of the site renders such a precaution necessary) must be drained by means of suitable earthenware field pipes, but such subsoil drain is not to communicate directly with any sewer, drain or cesspool.

Every building must be efficiently spouted to keep it dry.

House drains to be of good sound glazed stoneware socketed pipes, of not less than 4 in. diameter, to be laid *in* concrete, to have proper fall and watertight joints. No right-angled drain junctions to be used.

Drains are not to pass under houses, unless any other mode of construction is impracticable, in which case they must be imbedded in concrete, and be ventilated at each end. All inlets to drains (except ventilation openings) to be trapped.

House drains to be effectually trapped from the main sewer, and to be effectually ventilated by means of at least two untrapped openings—one at ground level on house side of the intercepting trap, the other carried off head of drain to the ridge of roof.

No inlet to drains (except for waterclosets) to be within the building.

NOTE.—There must therefore be no communication between the soil sewers or drains and any gullies which may be placed in cellars.

Soil pipes to be 4 in. diameter, untrapped at bottom, continued upwards (without bends) full bore to ridge of roof for ventilation.

Waste pipes to discharge in the open air over a channel leading to a trapped gully grating at least 18 in. distant.

Slop-sinks to be treated as waterclosets.

Waterclosets or earth closets to have at least one side an external wall, to have a window of not less dimensions than 2 ft. by 1 ft., opening directly into the external air and to be provided with *additional adequate means of constant ventilation.*

Water supply to watercloset to be distinct from that for domestic use; watercloset to have a flushing apparatus and a self-cleansing basin. The old-fashioned "container" and "D trap" are prohibited.

NOTE.—The conclusion arrived at by the special committee of the Sanitary Institute on the quantity of water required to flush a watercloset is that the flushing apparatus should be "so constructed as to discharge *not less than three, nor more than three-and-a-half* gallons of water at each flush."—"Transactions of the Sanitary Institute, Vol. xiv.—The maximum fixed by the Metropolis Water Act, 1871, and adopted in the majority of other cities and towns is 2 gallons. In Carlisle, however, the amount is unlimited, but must not be *less* than 2 gallons.

Notice of the commencement of works, and of the covering up of sewers, drains or foundations is to be given to the surveyor who is to have free access to the works at all reasonable times.

In default of such notice the work may be cut into, laid open, or pulled down; and any work done in contravention of these bye-laws may be removed, altered or pulled down.

The usual penalty for each offence against any of the foregoing regulations is *five pounds*, and a further penalty of *forty shillings* per day in the case of a continuing offence.

CHAPTER XII.

Public Health Act, 1875.

The sections of the Public Health Acts having special reference to *sewerage and drainage* are as follows:—

Sec 4.—"*Drain*" means any drain of and used for the drainage of *one building only*, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings, or premises occupied by different persons, is conveyed.

"*Sewer*" includes sewers and drains of every description, except drains to which the word "drain" interpreted as aforesaid applies, and except drains vested in or under the control of any authority having the management of roads and not being a local authority under this act.*

NOTE.—The above definition of a "drain" is extended by sec. 19 of the Public Health Acts (Amendment) Act, 1890, which states as follows: Where two or more houses belonging to *different owners* are connected with a public sewer by a single private drain, an application may be made under sec. 41 Public Health Act, 1875, and the local authority may recover any expenses incurred by them in executing any works under the powers conferred on them by that section from the owners of the houses in such shares and proportions as shall be settled by their surveyor or, in case of dispute, by a court of summary jurisdiction, or, in an urban district, as private improvement expenses. For the purposes of this section the expression "drain" includes a drain used for the drainage of *more than one* building.

Sewers Vested in Local Authority.

Sec. 13.—All existing and future sewers within the district of a L. A.,† together with all buildings, works, materials and things belonging thereto,

Except

(1) Sewers made by any person for his own profit, or by any company for the profit of the shareholders; and

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* For useful information and summary of law cases on the difficult question of "Combined Drainage" see paper of Messrs. Blair and Godfrey, reported in THE SURVEYOR, vol. vii., p. 47.

† In the following sections L. A. means "Local Authority."

(2) Sewers made and used for the purpose of draining, preserving or improving land under any local or private Act of Parliament, or for the purpose of irrigating land; and

(3) Sewers under the authority of any commissioners of sewers appointed by the Crown,

shall vest in and be under the control of such L.A. Provided that sewers within the district of a L. A. which have been, or which may hereafter be constructed by, or transferred to, some other L. A., or by or to a sewage board or other authority empowered under any Act of Parliment to construct sewers shall (subject to any agreement to the contrary) vest in and be under the control of the authority who constructed the same or to whom the same have been transferred.

Power to Purchase Sewers.

Sec. 14.—Any L. A. may purchase or otherwise acquire from from any person any sewer, or any right of making or of user or other right in or respecting a sewer (with or without any buildings, works, materials, or things belonging thereto) within their district; and any person may sell or grant to such authority any such sewer right or property belonging to him; and any purchase money paid by such authority in pursuance of this section shall be subject to the same trusts (if any) as the sewer right or property sold was subject to. But any person who, previously to the purchase of a sewer by such authority, has acquired a right to use such sewer shall be entitled to use the same, or any sewer substituted in lieu thereof, to the same extent as he would or might have done if the purchase had not been made.

Maintenance and Making of Sewers.

Sec. 15.—Every L. A. shall keep in repair all sewers belonging to them, and shall cause to be made such sewers as may be necessary for effectually draining their district for the purposes of this act.

Powers for Making Sewers.

Sec. 16.—Any L. A. may carry any sewer through across or under any turnpike road, or any street or place laid out

as or intended for a street, or under any cellar or vault which may be under the pavement or carriage-way of any street, and, after giving reasonable notice in writing to the owner or occupier (if on the report of the surveyor it appears necessary), into through or under any lands whatsoever within their district. They may also (subject to the provisions of this act relating to sewage works without the district of the L. A.) exercise all or any of the powers given by this section without their district for the purpose of outfall or distribution of sewage.

Sewage to be Purified before being Discharged into Streams.

Sec. 17.—Nothing in this Act shall authorise any L. A. to make or use any sewer, drain or outfall for the purpose of conveying sewage or filthy water into any natural stream or watercourse, or into any canal, pond or lake until such sewage or filthy water is freed from all excrementitious or other foul or noxious matter, such as would affect or deteriorate the purity and quality of the water in such stream or watercourse, or in such canal, pond or lake.

NOTE.—The Rivers Pollution Act, 1876, makes further provision for the prevention of the pollution of streams, but in practice its object is frequently defeated, as the words "the best practicable means" for making effluents innocuous oftentimes form an effectual refuge for the offenders.

Alteration and Discontinuance of Sewers.

Sec. 18.—Any L. A. may from time to time enlarge, lessen or alter the course of cover in or otherwise improve any sewer belonging to them, and may discontinue close up or destroy any such sewer that has in their opinion become unnecessary, on condition of providing a sewer as effectual for the use of any person who may be deprived in pursuance of this section of the lawful use of any sewer. Provided that the discontinuance, closing up or destruction of any sewer shall be so done as not to create a nuisance.

Cleansing Sewers.

Sec. 19.—Every L. A. shall cause the sewers belonging to them to be constructed, covered, ventilated and kept so as not to be a nuisance or injurious to health, and to be properly cleansed and emptied.

Map of System of Sewerage.

Sec. 20.—An *urban* authority *may*, if they think fit, provide a map exhibiting a system of sewerage for effectually draining their district; and any such map shall be kept at their offices, and shall at all reasonable times be open to the inspection of the ratepayers of their district.

Power of Owners and Occupiers within District to Drain into Sewers of Local Authority.

Sec. 21.—The owner or occupier of any premises within the district of a L. A. shall be entitled to cause his drains to empty into the sewers of that authority on condition of his giving such notice as may be required by that authority of his intention so to do, and of complying with the regulations of that authority in respect of the mode in which the communications between such drains and sewers are to be made, and subject to the control of any person who may be appointed by that authority to superintend the making of such communications. Any person causing a drain to empty into a sewer of a L. A. without complying with the provisions of this section shall be liable to a *penalty not exceeding twenty pounds*; and the L. A. may close any communication between a drain and sewer made in contravention of this section, and may recover in a summary manner from the person so offending any expenses incurred by them under this section (*see* also Public Health [Amendment] Act, 1890, secs. 18, 19).

Use of Sewers by Owners and Occupiers without District.

Sec. 22.—The owner or occupier of any premises *without the district* of a L. A. may cause any sewer or drain from such premises to communicate with any sewer of the L. A. on such terms and conditions as may be agreed on between such owner or occupier and such L. A., or as in case of dispute may be settled, at the option of the owner or occupier, by a court of summary jurisdiction or by arbitration in manner provided by this act.

Power of Local Authority to Enforce Drainage of Undrained Houses.

Sec. 23.—Where any house within the district of a L. A. is without a drain sufficient for effectual drainage, the L. A. shall, by written notice, require the owner or occupier of such house, within a reasonable time therein specified, to make a covered drain or drains emptying into any sewer which the L. A. are entitled to use, and which is not more than *100 ft.* from the site of such house; but if no such means of drainage are within that distance, then emptying into such covered cesspool or other place not being under any house as the L. A. direct; and the L. A. may require any such drain or drains to be of such materials and size, and to be laid at such level, and with such fall, as on the report of their surveyor, may appear to them to be necessary. If such notice is not complied with, the L. A. may, after the expiration of the time specified in the notice, do the work required, and may recover in a summary manner the expenses incurred by them in so doing from the owner, or may by order declare the same to be private improvement expenses. Provided that where, in the opinion of the L. A., greater expense would be incurred in causing the drains of two or more houses to empty into an existing sewer pursuant to this section, than in constructing a new sewer and causing such drains to empty therein, the L. A. may construct such new sewer, and require the owners or occupiers of such houses to cause their drains to empty therein, and may apportion as they deem just the expenses of the construction of such sewer among the owners of the several houses, and recover in a summary manner the sums apportioned from such owners, or may by order declare the same to be private improvement expenses.

Power of Local Authority to Require Houses to be Drained into New Sewers.

Sec. 24.—Where any house within the district of a L. A. has a drain communicating with any sewer, which drain though sufficient for the effectual drainage of the house is not adapted to the general sewerage system

of the district, or is, in the opinion of the L. A., otherwise objectionable, the L. A. may, on condition of providing a drain or drains as effectual for the drainage of the house, and communicating with such other sewer as they think fit, close such first mentioned drain, and may do any works necessary for that purpose, and the expenses of those works, and of the construction of any drain or drains provided by them under this section, shall be deemed to be expenses properly incurred by them in the execution of this act.

Penalty on Building House without Drains in Urban District

Sec. 25.—It shall not be lawful in any urban district newly to erect any house, or to rebuild any house, which has been pulled down to or below the ground floor, or to occupy any house so newly erected or rebuilt, unless and until a covered drain or drains be constructed, of such size and materials, and at such level, and with such fall as, on the report of the surveyor, may appear to the urban authority to be necessary for the effectual drainage of such house; and the drain or drains so to be constructed shall empty into any sewer which the urban authority are entitled to use, and which is within *100 ft.* of some part of the site of the house to be built or rebuilt; but if no such means of drainage are within that distance, then shall empty into such covered cesspool or other place, not being under any house, as the urban authority direct. Any person who causes any house to be erected or rebuilt, or any drain to be constructed in contravention of this section shall be liable to a penalty not exceeding *£50*

Penalty on Unauthorised Building over Sewers and under Streets in Urban District.

Sec. 26.—Any person who in any urban district, without the written consent of the urban authority—

(1) Causes any building to be newly erected over any sewer of the urban authority; or,

(2) Causes any vault, arch or cellar to be newly built or constructed under the carriageway of any street, ...

shall forfeit to the urban authority the sum of £5 and a further sum of *40 shillings* for every day during which the offence is continued after written notice in this behalf from the urban authority; and the urban authority may cause any building, vault, arch or cellar erected or constructed in contravention of this section to be altered, pulled down or otherwise dealt with as they may think fit, and may recover in a summary manner any expenses incurred by them in so doing, from the offender.

The following brief summary is intended for use as an index to those parts of the Public Health Acts relating specially to *Drains* and *Sewers* :—

SUBJECT.	Public Health Act, 1875. Number of Section.	Public Health (Amendment) Act, 1890. Number of Section.	Public Health (London) Act, 1891. Number of Section.
Power of L.A. to enforce drainage of undrained houses, or may make them as Private Improvement Expenses ...	23, 24	—	—
Drain connections with sewers, L.A. to make same	21	18, 19	—
"New Buildings" to be effectually drained, £50 penalty	25	—	—
Opening and examination of drains by Sanitary Authority	41	—	40
Drains, &c., to be properly kept	40	—	40
Penalty for injuring drain, &c., so as to cause nuisance, £5	—	—	15
Improper construction of drain, and liability of workman	—	—	42
Drains when nuisances, abated summarily	91	—	2
Drains in cellars or underground dwellings	72	—	96

SUBJECT.	Public Health Act, 1875. Number of Section.	Public Health (Amendment) Act, 1890. Number of Section.	Public Health (London) Act, 1891. Number of Section.
Drains connected with bakehouses (*see* Factory and Workshop Act, 1878, sec. 3; also Factory and Workshop Act, 1883, sec. 15)	—	—	—
Power of Sanitary Authority to make bye-laws enforcing drainage of lodging houses	90	—	94
Penalty for running gas washings into drain or stream, £200	68	—	52
Penalty for running chemical refuse, water above 110 Fah., &c., into sewers or drains, £10...	—	17	—
Entry on premises to examine drains...	41, 105	—	40
Power to make bye-laws as to drainage of buildings	157	23	39
Sewers, drains, cesspools, stagnant water in cellars, &c., if kept so as to be injurious or dangerous to health	47, 91	—	2
Sewers vested in the L.A.	13	—	—
Power of L.A. to purchase sewers ...	14	—	—
Maintenance, making and cleansing of sewers by L.A.	15, 19	—	—
L.A. may carry sewers across any public or private (with notice in latter case) lands within their district ...	16	—	—
Alteration and discontinuance of sewers	18	—	—
Urban authority may keep map of system of sewerage	20	—	—
Persons within district entitled to drain into sewers	21	18, 19	—
L.A. may enforce drainage of undrained houses, and connection of same to any sewer within 100 ft.	23	—	—

SUBJECT.	Public Health Act, 1875. Number of Section.	Public Health (Amendment) Act, 1890. Number of Section.	Public Health (London) Act, 1891. Number of Section.
L.A. may require house to be drained into new sewers	24	—	—
Penalty on building house without drains in urban district, £50	25	—	—
Unauthorised building over sewers, £5 penalty	26	—	—
Persons outside district permitted by arrangement to drain into sewers of L.A.	22	—	—
Local authorities may agree as to combined sewerage of adjoining districts	28	—	—

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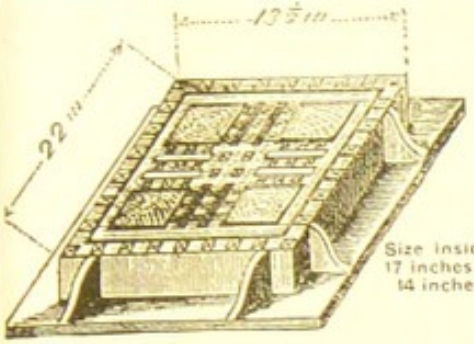

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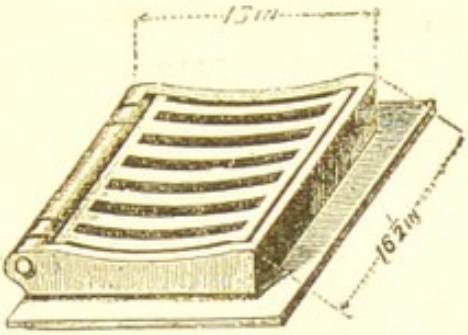

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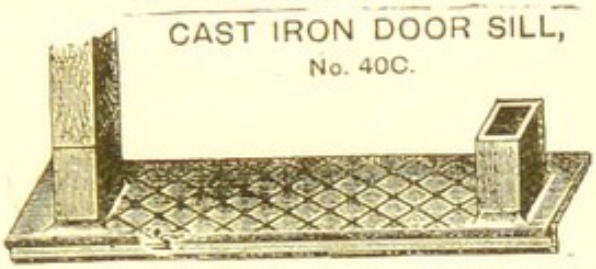

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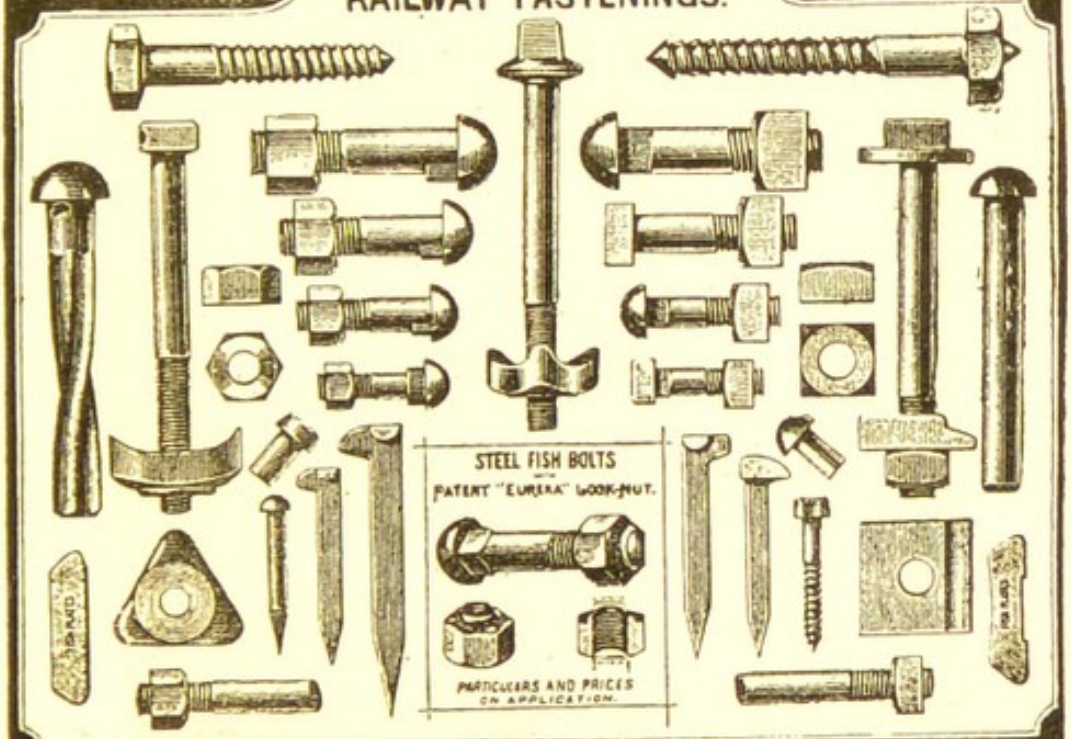

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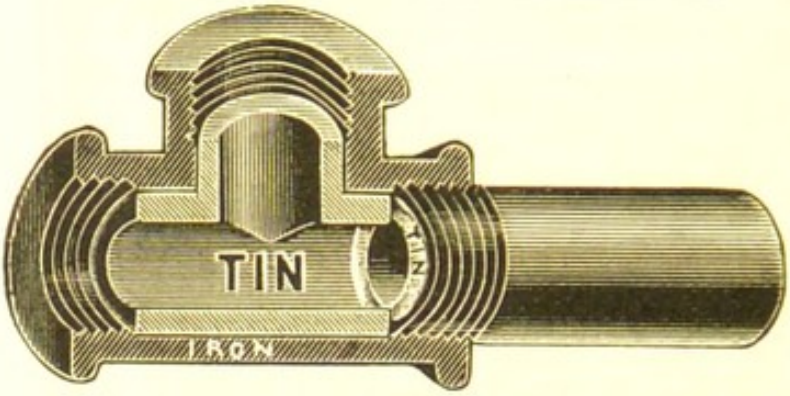

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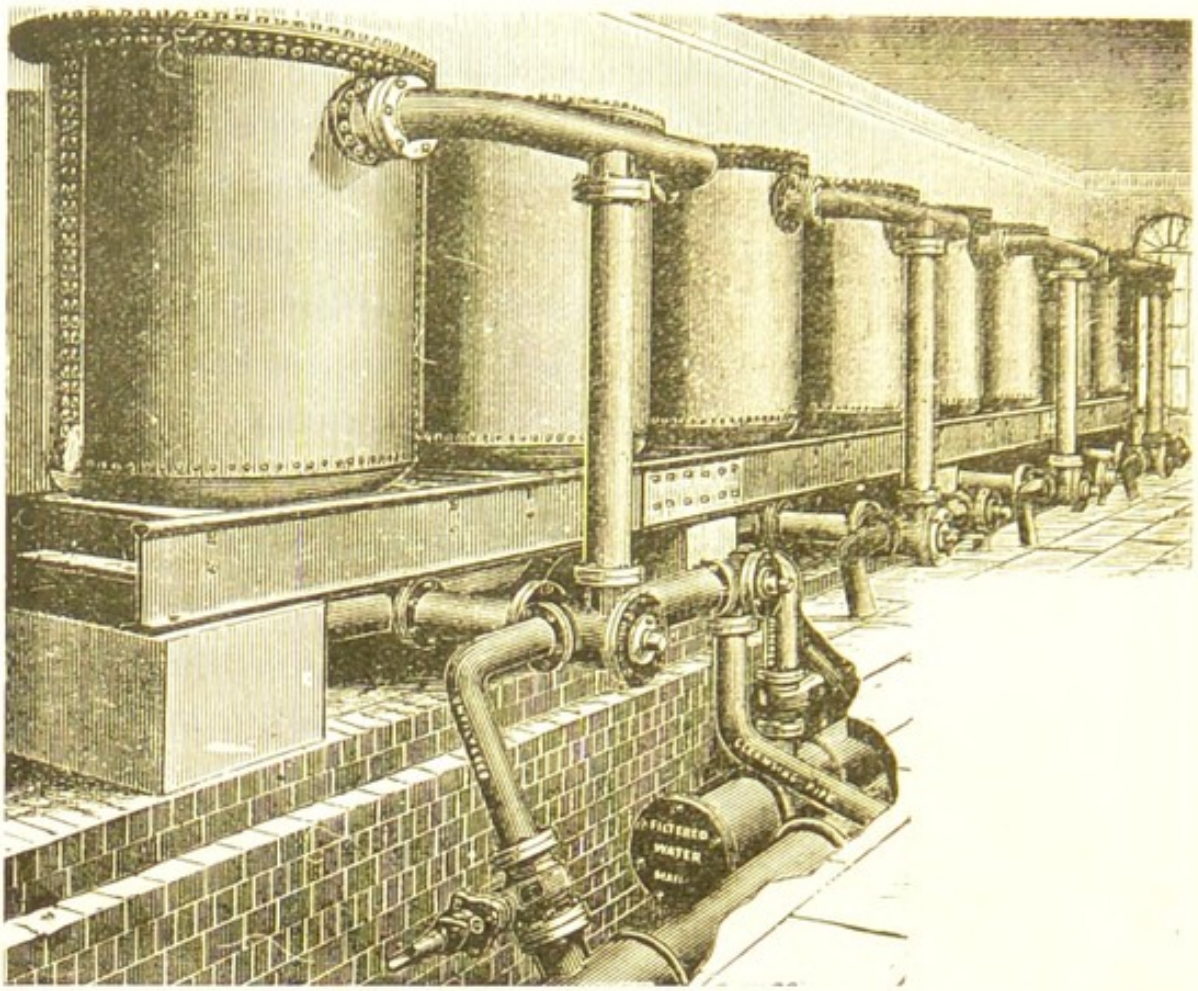

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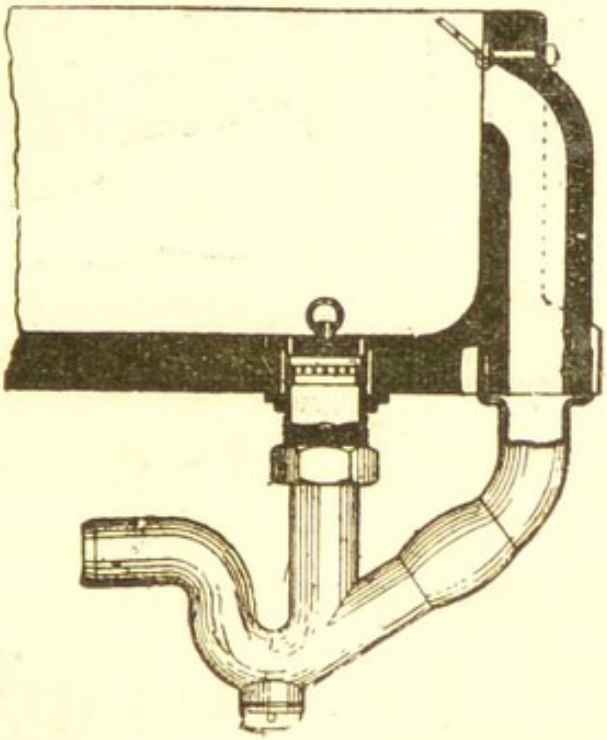

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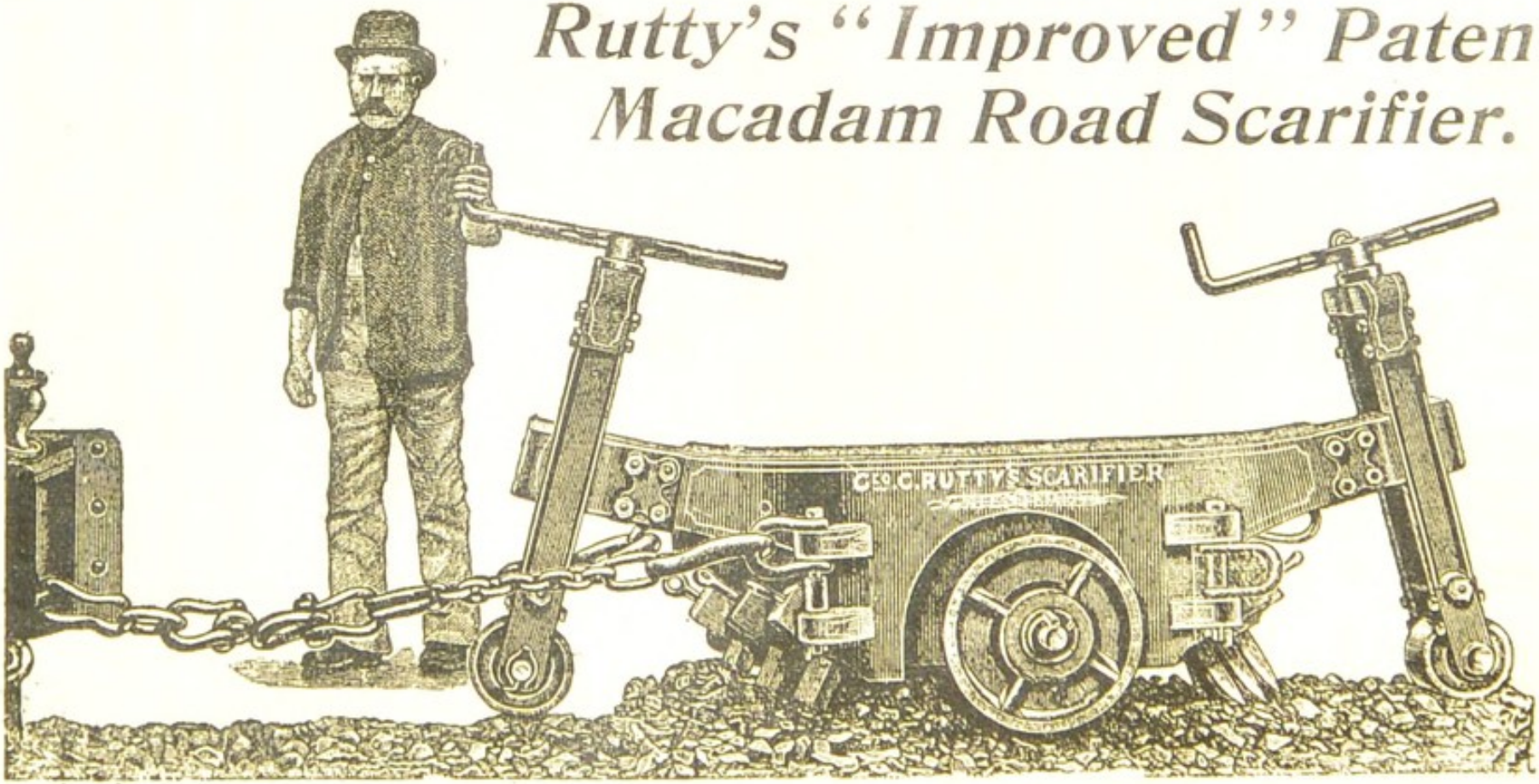

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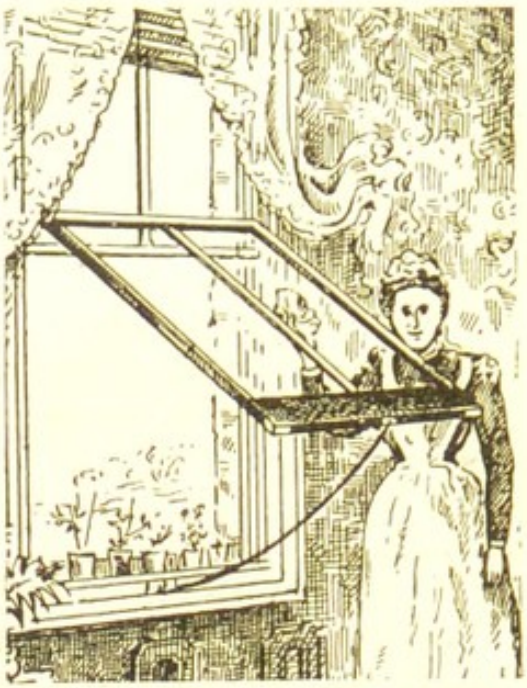

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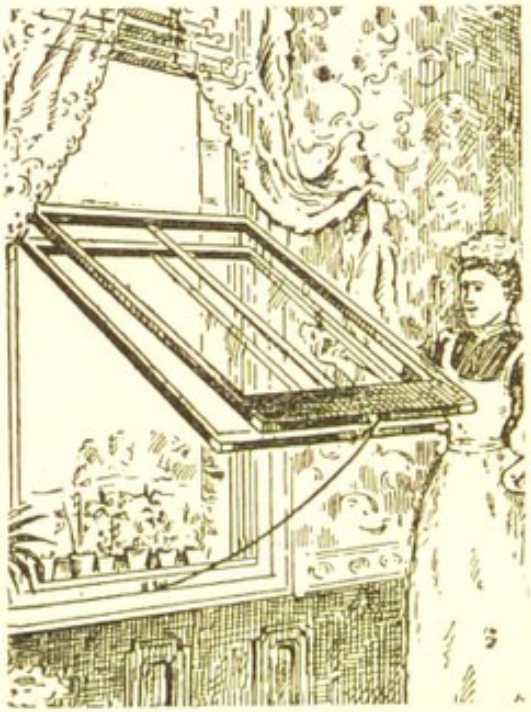

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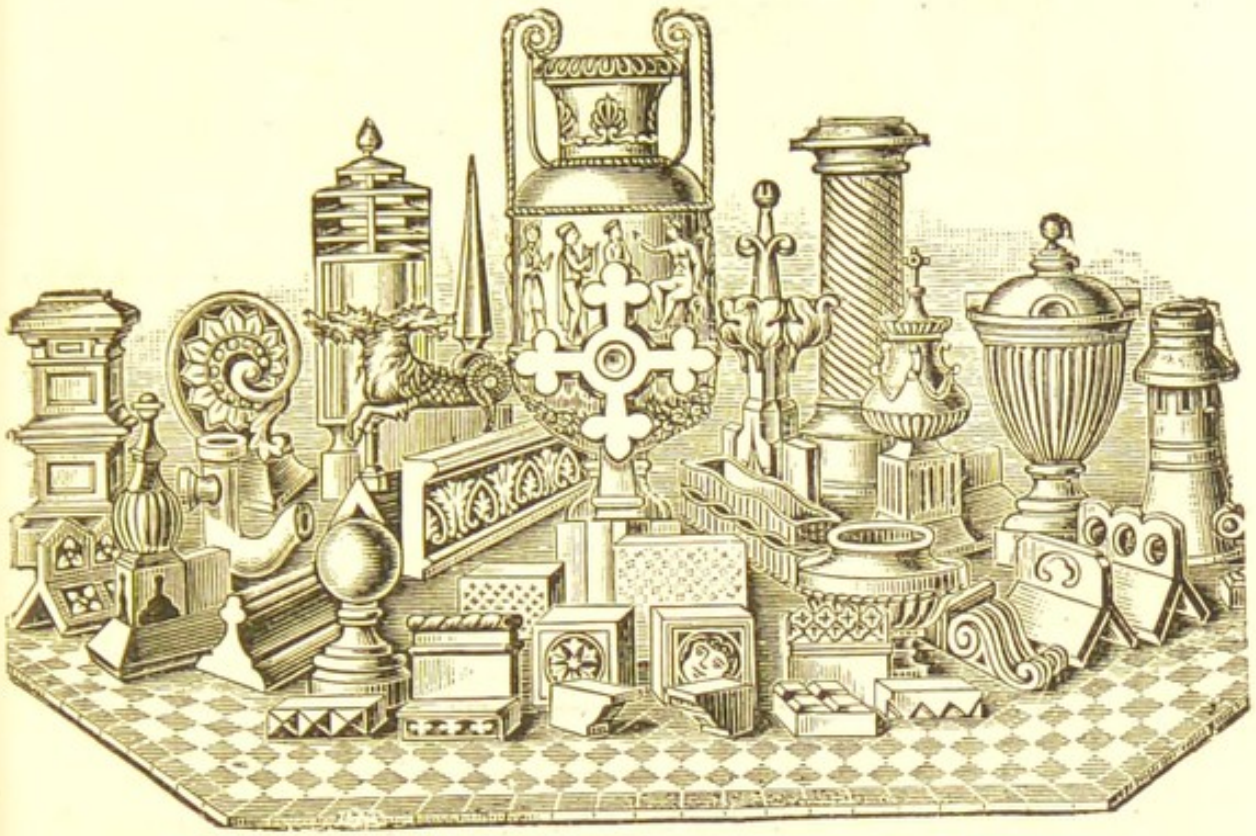

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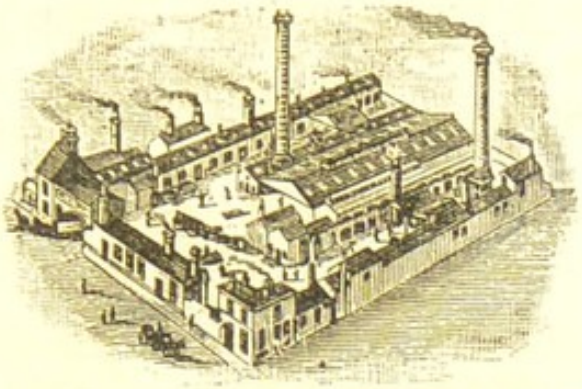

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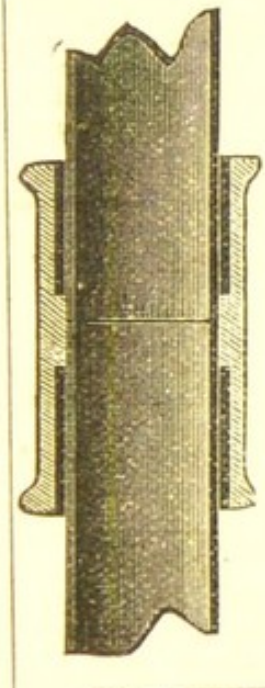

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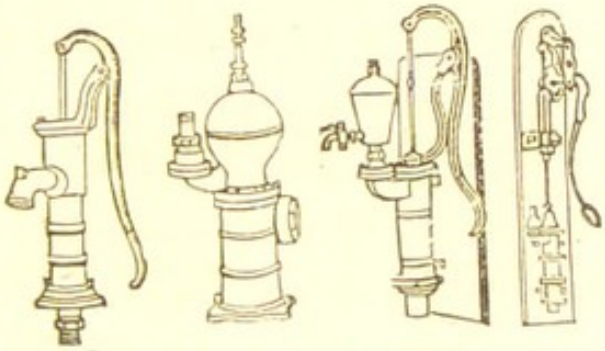

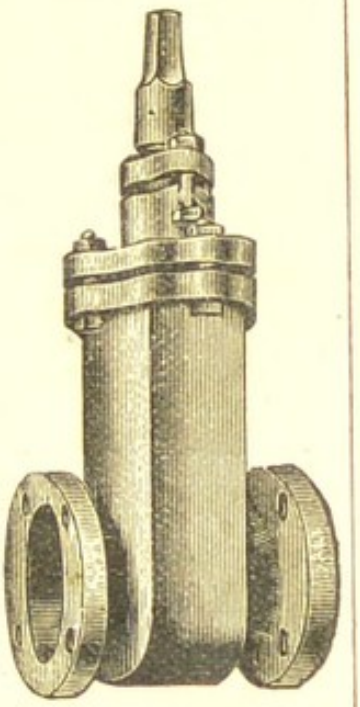

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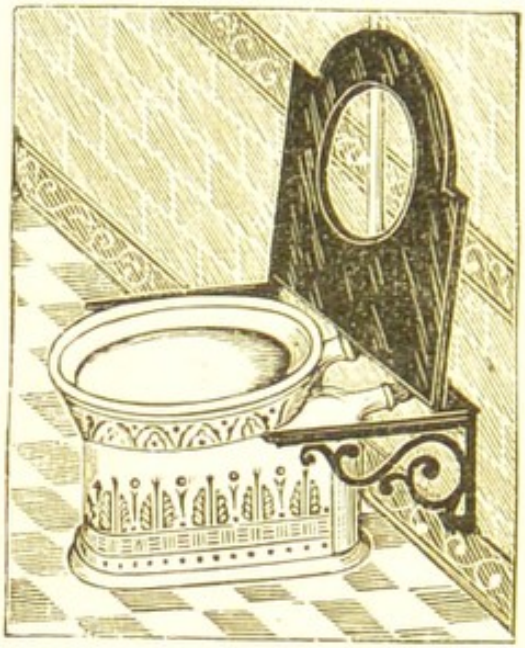

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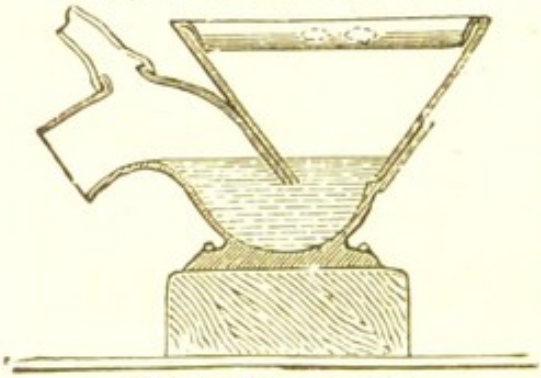

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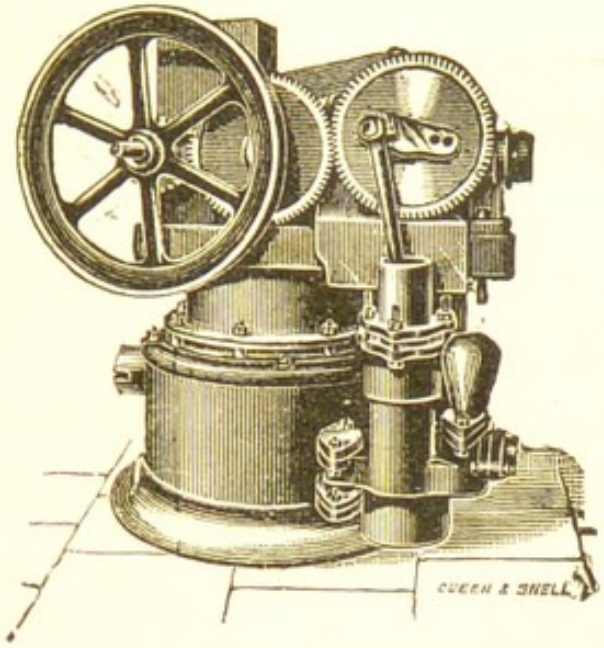

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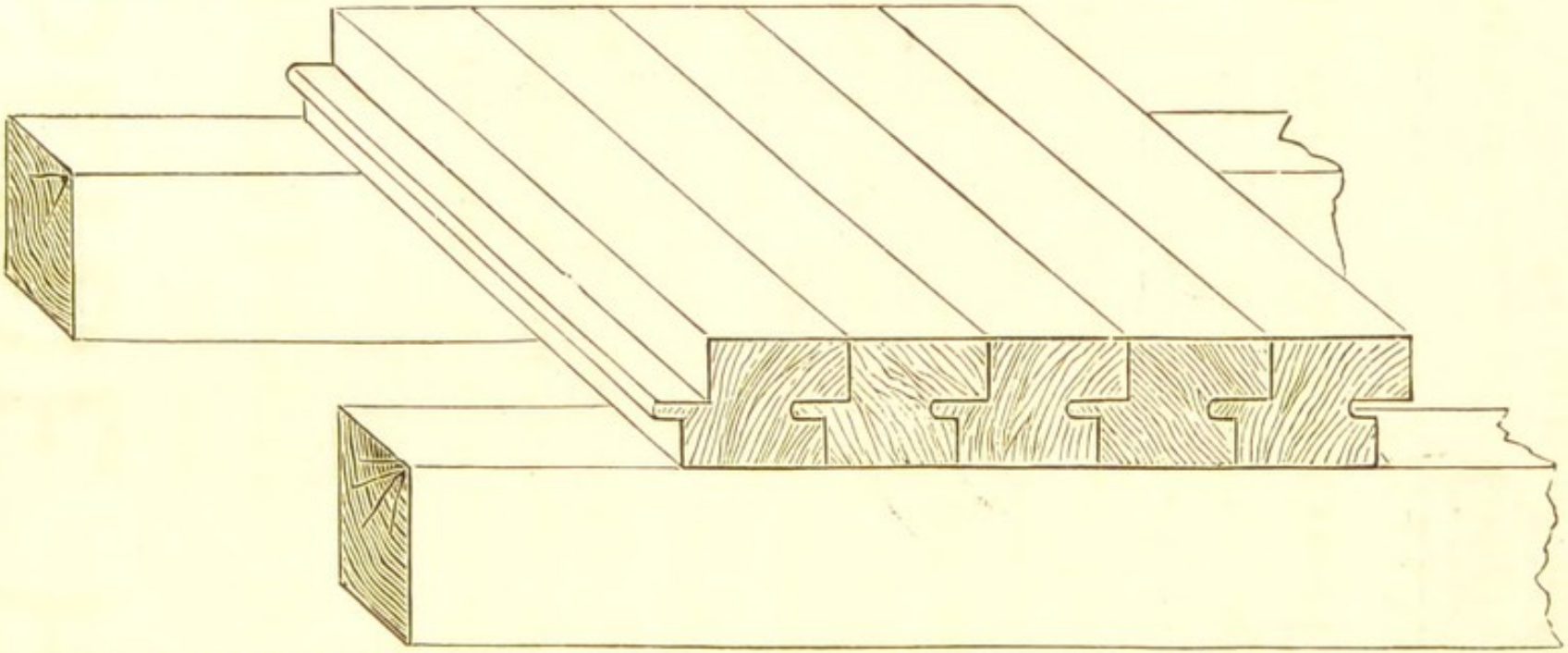

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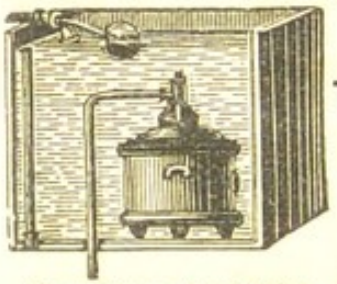

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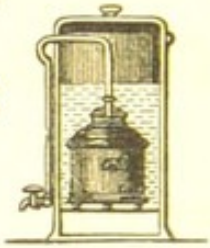

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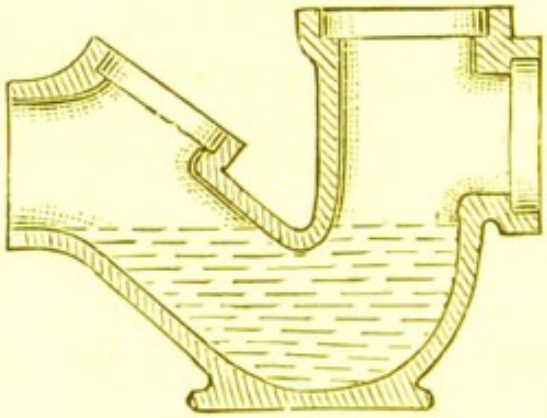

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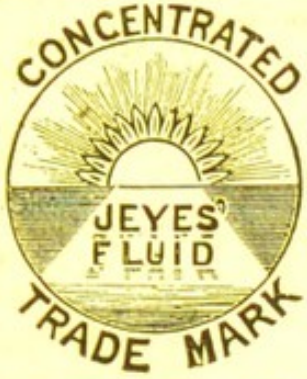

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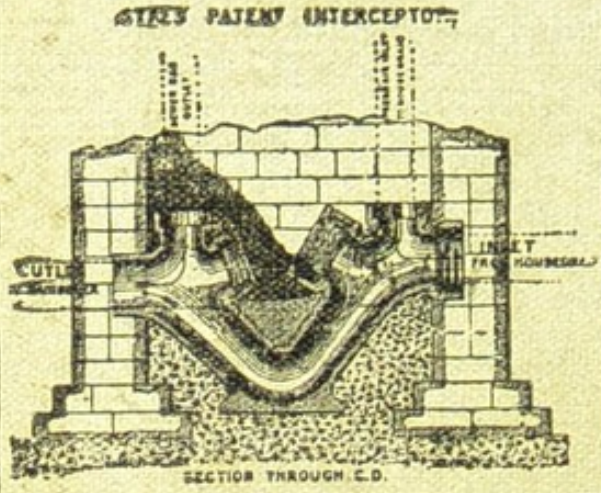

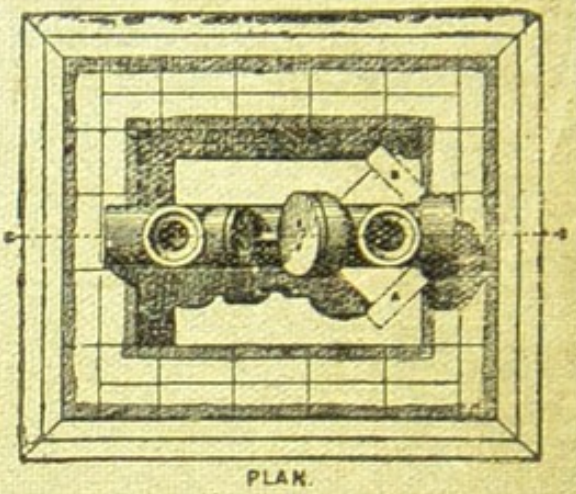

NOTE.—If the Sewer Gas outlet is not used, a Screw Plug can be inserted and closed with our India-rubber Washer or with grease.

IMPROVEMENTS.

Dispensing with open channel, which is often choked with solids.

In case of a stoppage the Chamber cannot fill with Sewage; a man can therefore enter and unstop the drain.

Provision for ventilating Public Sewer (which may or may not be used).

The pressure of gas is taken off the sewer side of the Interceptor, whereby the water seal cannot be forced.

The Interceptor is sealed up, which prevents the escape of gases in the Chamber.

Provision for the admission of fresh air to the house drain.

By confining such fresh air to space in the pipe we insure a current; by the old system it enters the Chamber, diffuses itself and becomes foul, and the current destroyed.

The use of screw stoppers which cannot be blown out.

The screw stoppers can be taken out of the Inspection Arms and the respective drains cleansed.

The inlets A and B are made with a shoot into the Interceptor, thereby thoroughly flushing same by the roof-water during a storm.

By confining the liquid to the Interceptor no sewage can escape to permeate the surrounding subsoil.

Concentration of all parts in the Chamber, where they are easily accessible, and where full control is obtained over the system.

Price delivered to any part of United Kingdom, 4in 16/6, 6in. 22/6, 9in. 38/6.
Side Inlets, 2/- each extra.

ALBION CLAY CO., LIMITED,

Albion Works. Woodville Burton-on-Trent,

OR 18 NEW BRIDGE STREET, BLACKFRIARS, E.C.