WEST PAKISTAN

BUILDINGS AND ROADS DEPARTMENT

OBAID-UR-RAHMAN ANSARI
BSc. Engg with HONOURS (civil)

SPECIFICATIONS

Vol. II

(Public Health Works)

1966

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بسم اللہ الرحمن الرحیم

PREFACE

1. The *ex*-Punjab Public Works Department has been executing building and road works on the basis of specifications drawn in A. D. 1936 and it was keenly felt that it should be revised to cope with the advance in building science.

For Public Health projects in the *ex*-Punjab Province the basis has been two specification pamphlets on water-supply pipe line and sewers. No specification existed in *ex*-Punjab Province for sanitation, plumbing, hot water-supply, gas fittings and pumping installation, etc.

For electrification of Government buildings specifications in the *ex*-Punjab Province were drafted in 1936, which were reprinted in A. D. 1948 without any change.

2. The *ex*-Sind Public Works Department has been following the Bombay Public Works Department Handbook.

3. On the unification of all Provinces in the West Pakistan into One Unit it was felt that specifications should be drawn out to meet the needs of the Buildings and Roads Department for the entire West Pakistan. As a result of this Buildings and Roads specifications have been drawn up. The book consists of three volumes as per details given below :—

VOLUME I—Contains specifications for Buildings and Roads including Concréte and Road Machinery.

VOLUME II—Contains specifications for Public Health including Machinery.

VOLUME III--Contains specifications for Electric Installations.

These publications together with other Technical Instructions issued from time to time will help Engineers to frame and execute projects expeditiously economically and efficiently. The specifications have been printed in loose sheets for facility of additions and deletions from time to time.

4. These books were originally compiled by Mr. Abdul Rawoof, Officer on Special Duty and vetted by Mr. A. G. Shaikh, Additional Chief Engineer, Southern Zone, Hyderabad, Mr. Abdul Samad Khan, Additional Chief Engineer, Northern Zone, Peshawar and Mr. Hamid-ud-Din, Director, Research and Co-ordination of West Pakistan Buildings and

Roads Department, Lahore and many others. My personal thanks are due to all concerned for this labour of love.

5. Any suggestions for improvement of the Specification Book should be received with thanks by the Chief Engineer, West Pakistan Buildings and Roads Department, Lahore.

MUHAMMAD INAMULLAH KHAN
I. S. E.

The 9th May 1956.

Chief Engineer, West Pakistan Buildings and Roads Department, Lahore.

VOLUME II

CONTRACT SPECIFICATIONS

CHAPTER NO. 1

Well Sinking

Protection during construction.

1. Wells to be fenced round during excavation and proper light including red traffic warning lights and watch arrangement will be made by the contractor without any claim or extra charges.

Excavation ordinary.

2. The excavation should be carried out up to Ground Water level and the construction work of Curb Steining should start from that level, unless sandy strata is met. (Refer excavation sewers Chapter 13 of this volume).

Islands.

3. Where it is necessary to sink a well in standing or flowing water, unless otherwise ordered by the Engineer-in-Charge an island of earth shall first be formed having a diameter of at least 10 feet more than the diameter of the well to be sunk.

The earth forming this island must be free from all stones bricks or hard material which is liable to impede the sinking of the well.

The island shall be brought up at least 12 inches above water level before the well curb is laid, and if the Engineer-in Charge shall so direct the sides of the island shall be protected from erosion by means of clumped store or gunny bags or balli piles and/or matting.

Curbs.

4. (a) *Wood n Curbs*--They shall be made of babul, tamarind, Jamun or other wood approved by the Engineer-in-Charge. They shall be made of two thicknesses of wood for well having diameter up to 6 feet, and three thickness of wood for wells having diameter more than 6 feet. They should be strongly dovetailed, dowelled together secured by iron bolts and other such arrangements as ordered by the Engineer-in-Charge. The curb shall be secured to the masonary by iron holding-down bolts, over the upper end of which an iron bond plate shall be passed and secured by spikes. Wooden Curbs may not be used for wells having more than 15 feet diameter. For diameters above 6 feet steel cutting edges will be fixed to the curb at the bottom. If a contractor can arrange R.C.C. Curbs in place of a wooden one for the same price, R.C.C. will be preferred and in that case, it will conform to the specifications as given below,

(*b*) *R. C. C. Curbs*—They shall always be cast-in-situ and made of 1 : 2 : 4 R.C.C. Reinforcement shall consist of either <-iron or M.S. round or combined. Bars less than $\frac{1}{2}''$ diameter should not be used in circumferential reinforcement. The spacing of bracket reinforcement shall not be more than 3 feet centre to centre in any case. In case of <-iron reinforcement, it shall consist of at least one circumferential ring in the cutting edge and two circumferential rings at the upper section. The brackets, if made of L-section shall be rivetted to the circumferential reinforcements as per design of Engineer-in-Charge. In case of M. S. Round Reinforcement, there shall be at least 2 rings of circular reinforcements in the cutting edge and 2 rings in the upper section of curb. The lower section of curb i.e., cutting edge shall in no case be less than 3″ and upper section shall be at least 3″ more than the outer diameter, of steining to provide a step of $1\frac{1}{2}''$ all round the perimeter.

In the case of rocky soil or extraordinary hard soil, in the cutting edge 'T' Section (with Arms vertical i.e., "⊢ Position) reinforcement be preferred, whose lower flange shall project outside the R.C.C. mass, to provide a sharp cutting edge.

Laying well curb.

(*c*) The well curb shall be laid perfectly true and level by means of a dumpy level or spirit level, as the Engineer-in-Charge may direct, before any masonry is started.

Tie rods.

5. Tie-rods shall be fixed to the well curb and shall be carried up (forming a continuous length) to the height specified or shown on the drawings.

The tie-rods which shall be in 10 feet lengths, unless otherwise specified, shall be joined at each bond ring by means of a bottle-nut 6 inches long, as shown in the sketch. Care will be taken that threads on opening edges are opposite.

Fixing tie-rods.

6. After the well curb has been laid truly level, the first length of tie-rods shall be plumbed truly vertical by means of plumb-bobs and the bond rings placed on the top to ensure the proper spacing.

They shall be guyed in position to prevent displacement during masonry work.

For subsequent lengths the tie-rods must be fixed in the same straight line parallel to the sides of the well, but on no account must be a plumb-bob used, in case the well has taken a tilt during sinking.

Steining.

7. It shall always be of water tight structure made either in Brick Masonry or Stone Masonry. Even in cases of hard soil where lining is not needed, steining must be taken to a depth of at least 8 feet below Ground Level for freedom from surface pollution.

Laying Brick work Masonry.

8. After the well curb has been laid truly level, the brick work shall be built truly vertical by means of straight edges and plum-bob at least 5 feet in length and fixed at four points round the steining.

As soon as length of one set of tie-rods is completed the next set of roads shall be fixed firmly in position by means of bottlenuts.

On no account shall brick bats be allowed to fall either inside or outside the well, but all bats chips etc., must be collected in baskets and be removed from the well.

Sinking.

9. No sinking shall be allowed to start, until a full length of masonry has been completed, the bond rings fixed in position and the masonry has been allowed to set for 20 days or such time as the Engineer-in-Charge may direct.

The contractor shall fix plumb-bobs (not less than four in number) to the inside of the steining of the well to ensure that the sinking proceeds evenly.

On receipt of instructions from the Engineer-in-Charge the contractor shall commence sinking the well and shall proceed without interruption working night and day if necessary until the well has been sunk to the required depth. The well shall be sunk truly plumb and vertical and should a well tilt or go down out of line, the contractor must take steps to put it right at his own expense, even if it be necessary to sink the well deeper than specified and no payment shall be made for any sinking below the specified depth and other works involved therein.

Plant.

10. The plant used shall be subject to the approval of the Engineer in-Charge. Should he provide steam winches, crab winches, steam boilers pumps and any tools and plants to assist

sinking of the well, along with the rent for the use thereof unless the machinery is to be agreed to be supplied on no rent basis.

West Excavation.

11. It shall be started at least at 3 different places near the inner perimeter of well and will be continued in either clockwise or ante-clockwise direction simultaneously from all the 3 places and then moving inward to central place. This is necessary for safeguard against improper settlement. It shall be done either by Manual Labour using "Charkhar Methed" or "Country Jams" or by means of "dredgers" and "Drivers". Payment of this shall be made either in cubic feet paying extra for sinking per rft. or gross rate of sinking per rft., as agreed upon.

It shall be definitely understood that the Engineer-in-Charge does not in any way bind himself to supply any of the tcol and plant for the sinking of the well and it is incumbent on the contractor to obtain from the Engineer-in-Charge in writing, before submitting his tender, what plant there is available and on what terms it will be lent.

Completion.

12. On completion of the sinking the masonry of the well shall be completed to the levels shown on the drawing and all bricks, rubbish or other stuff which may have fallen in the well shall be removed from the bottom of the well by the contractor at his own expense.

Measurement.

13. The quantities shown in the tender for the excavation are the quantities that will be paid for notwithstanding that the contractor may find it more convenient to take out the excavation at greater slopes than allowed in the estimate.

The sinking shall be measured per foot run from water level, to the bottom of the well curb, to the depth specified or as ordered by the Engineer-in-Charge in writing.

Rate.

14. The rate for sinking shall include all pumping, bailting excavation and other works required for the sinking of the well.

Puddling.

15. Good clay puddle should be provided in space between back of steining and excavated face to a depth of at least 10 feet, after complete sinking of well, or up to the bottom of steining whichever is less.

Parapet.

16. Leaving the required number of opening for drawing water which shall be at least 2½ feet wide, the lower part of which shall be rising above 1′ of platform level, the wall toping should be finished with a 13½″ thick and 3ft. high-water right parapet.

CHAPTER No. 2

TUBEWELLS

General.

1. The contractor shall execute the boring work in such a way that true and accurate particulars of depth, thickness and nature of the various stratas are accurately obtained, up to the satisfaction of Engineer-in-Charge. Failure of doing so will result in rescinding of agreement and other penalties as considered fit by the Engineer-in-Charge. The contractor shall have to observe all the precautionary steps, as deemed fit and given in writing by the Engineer-in Charge.

Water in Borehole

2. Borehole should be kept as full of water as practicable by the contractor, throughout the execution of work. It shall be the entire responsibility of contractor to ensure that no blowing of sand is allowed.

Collapse and failure of Borehole.

3. If during the course of operation or even after completion, the borehole collapses or fails due to any reason the contractor shall be responsible to do the job again without any extra or repayment.

Borehole casing pipes and equipments.

4. The contractor shall use mild steel pipes of size and diameter as instructed by Engineer-in-Charge and will be paid as per rate of diameter actually used. In case the pipes and other material are issued free of cost for use, contractor shall be responsible to ensure safe return and will have to make good all losses, fracture, damage, rust and theft at the prevailing market rate price or more as decided by the Engineer-in-Charge. In case, the boring pipe and other equipments, with the department for issue, are not available then all the requisite material shall be procured and arranged within a given time by the contractor at the rates to be settled with the Engineer-in-Charge in writing.

The contractor shall not be entitled to any extra claim or payment for the delay which may occur due to non-availability of the equipment and he is to arrange all the boring material and appliances himself.

Hand-boring material

In general, the following articles which are required for hand-boring operation, must be available with a contractor.

1. Boring pipes—Length and diameter as per requirement of work as ordered by the Engineer-in Charge.
2. R. S. Beams—10″ × 5″ × 14″ ... 4 Nos.
3. Teepoy with Clamps ... 1 No.
4. Bokies (sludger) of dia. as instructed by the Engineer-in-Charge ... 2 Nos.
5. Winch Crab ... 1 No.
6. Bokies (sludger for water sample) ... 2 Nos.
7. Excavator Bit (wooden or iron) ... 1 No.
8. Clamp of diameter suiting the boring pipe ... 2 Nos.
9. Screw Jacks (40 Tons) ... 2 Nos.
10. Wire Ripe $\frac{7}{8}$″ diameter ... As instructed.
    $\frac{1}{2}$″ diameter ... As instructed.
11. Rammer ... 1 No.
12. Crowbars 12′ long ... 2 Nos.
13. Crow bars 6′ long ... 4 Nos.
14. Pulley Block single ... 1 No.
15. Pulley Block double ... 3 Nos.
16. Pulley Block triple ... 3 Nos.
17. Pipe $1\frac{1}{2}$″ including Teepoy .... 1 Set.

In addition to above, other items as deemed necessary by the Engineer in Charge, shall be procured by the contractor for which he shall not be entitled for any extra payment or claim.

Boring by Spudding Machine and a Rotary Drill.

5. If spudding Machine or a rotary drill is available with the department, the contractor shall have to execute the boring operation utilising the machinery, the maintenance, running cost including salary of the operating staff and hire charges as determined by the Engineer-in-Charge shall be recoverable from the contractor.

A penalty of Rs 100 per day shall be charged from the contractor for keeping the machine idle, without any genuine reason and the decision of Engineer-in-Charge shall be final in this case.

6. The contractor shall keep accurate continuous record in ink on approved form in duplicate of the stratas met with reference to an approved datum line. He shall preserve two samples each weighing two lbs. of every stratum met separately for every 25 feet thickness of strata or the actual thickness of stratum, whichever is less, one sample being preserved in an approved wooden sample box and other in jute or gunny bags. In case, the record is wrongly maintained or samples improperly preserved the contractor shall have to do a fresh boring on another spot or pay liquidated damages as decided by the Engineer-in-Charge.

Record for Strata.

7. The contractor shall record daily the level of bottom of borehole and level of the surface of water standing in it. The record shall be maintained in ink in duplicate, one copy being supplied to Engineer-in-Charge after completion of work. The contractor shall not be entitled for any extra claim or payment for this work.

Record of Water Level and depth of Borehole.

8. The contractor shall take a sample of every water bearing stratum after continuous bailing for at least 2 hours or as directed by the Engineer-in-Charge and shall keep them in clean white glass or Quartz bottle with glass stopper and he shall be responsible for their safe delivery to the Engineer-in-Charge or his representative on the same day; for chemical and bacteriological analysis. If so desired by the Engineer-in-Charge, a duplicate set of water samples be procured by the contractor without any extra claim or payment.

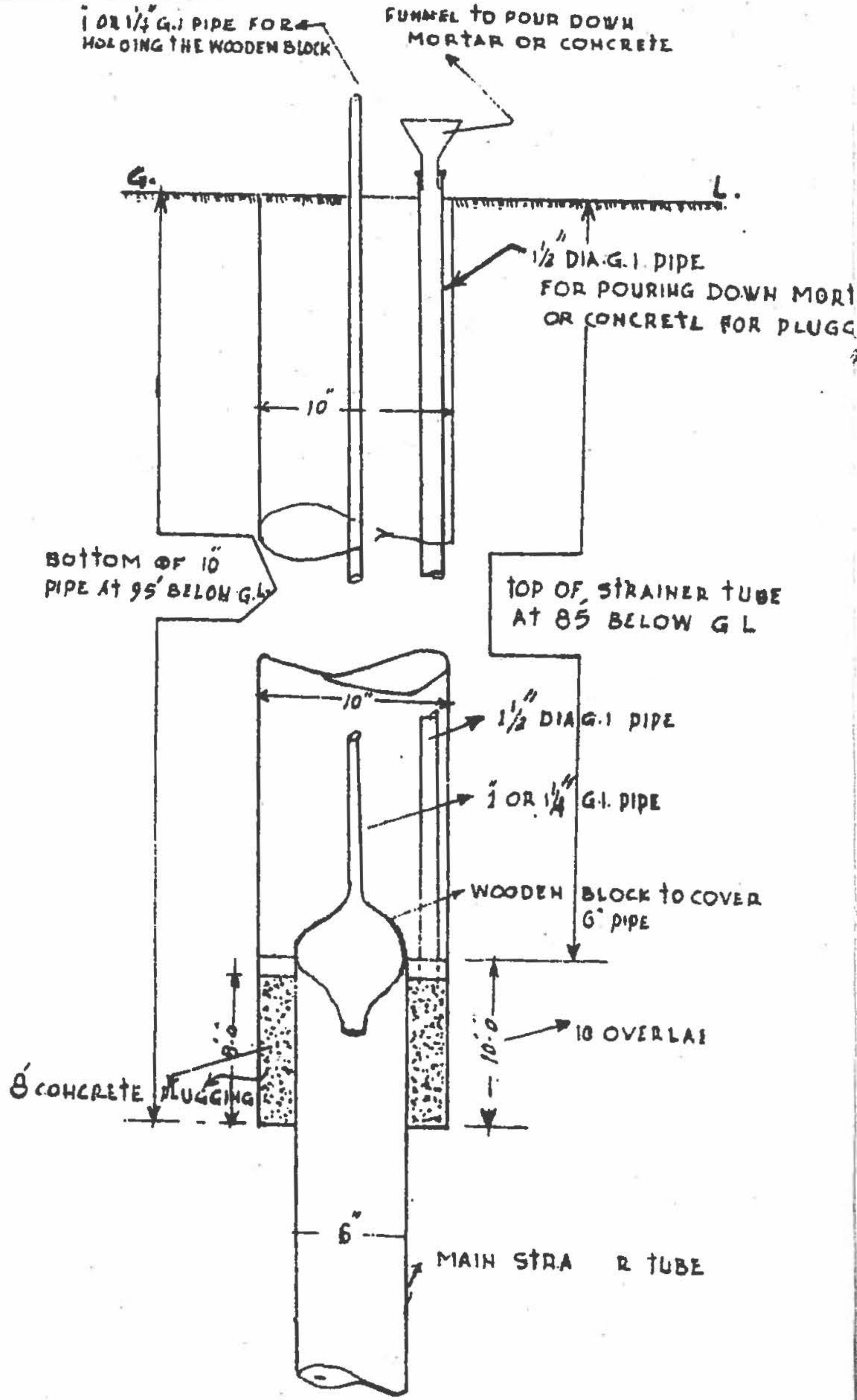
Sample of Water.

The contractor shall label the bottles showing the following information on the label :—

1. Name of place or institution (to specifically define the borehole location).
2. Date of start of work.
3. Name of contractor.
4. Date of sampling.
5. Total depth of borehole completed on the date of sampling.
6. Depth of strata from which water sample is taken.
7. Brief description of water bearing soil strata.
8. Depth of Ground Water.
9. How sample was taken.
10. Possibility of impurities reaching the water from cesspool, drains and cultivated land, etc., etc,

PLUGGING A COMPOUND WELL

WITH CONCRETE PLUG



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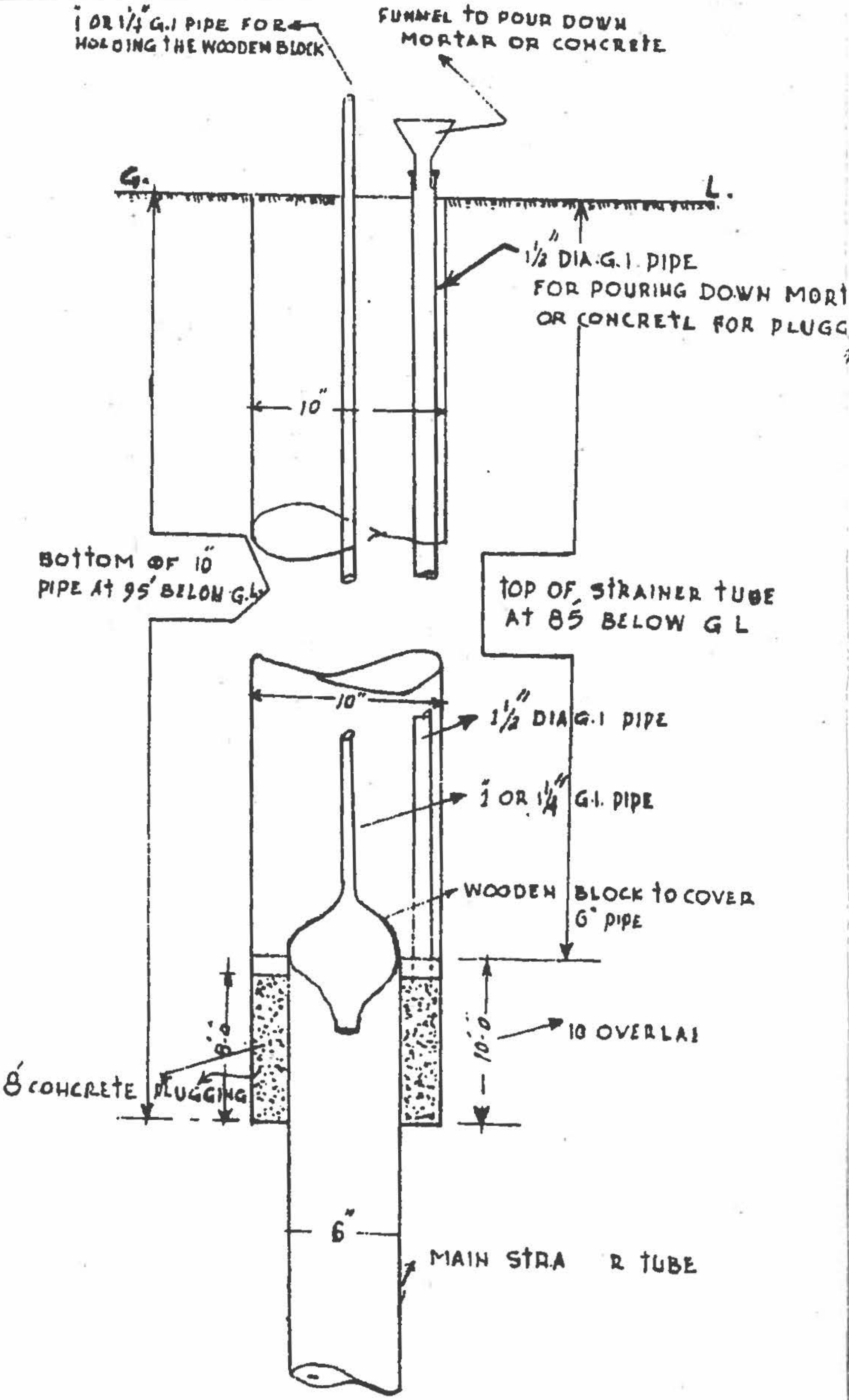

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11. General Remark (This shall include any special point needing the particular care of analyst).

Test for verticality of borehole.

9. The contractor shall carry out a test for the verticality of borehole as per method given in technical specification or as per satisfaction of Engineer-in-Charge, without any extra claim or payment. In case the verticality is defective for more than 1/12 of size of diameter of borehole, the contractor have not only to do the work again without any extra claim or payment but is also liable to a penalty not exceeding 10 per cent of the actual amount of work done, (on account of delay caused thereby).

Damage during lowering of Blind pipe and strainer.

10. The contractor shall be fully responsible for all the damage during lowering of Blind pipe and strainers. He shall have to provide all the safety devices up to the satisfaction of Engineer-in-Charge for the work and will get his such certificate and instructions in writing. He shall further have to get the orders of the Engineer-in-Charge or the Sub-Divisional Officer in writing before actual commencement of lowering work and all the pipes and strainer will be got approved each one of them being got initialled or punch marked by the Sub-Divisional Officer in token of acceptance. Divergence from any of the above instructions will result in rescinding of agreement and other penalties as deemed fit by the Engineer in-Charge (for specification of strainer refer to Chapter 4—Manual of Public Health Works).

Method of lowering Blind pipes strainers.

11. The contractor shall have to execute lowering operation by Manual or other method as instructed in writing by the Engineer-in-Charge or as described in Technical specifications para. 7 Chapter No 4·3.

Plugging compound well.

12. The joint between the top casing and the Blind pipe shall be rendered watertight by plugging the annular space to a distance of 10 feet with a sufficiently fluid mixture consisting of I part cement I part sand, and I part bajri or any other mix as determined by the Engineer-in-Charge. This plugging operation will be done by means of a funnel and 1½" G. I. Pipe It shall be ensured that the mix does not find its way in the borehole by using proper wooden block.

Shrouding.

13. Shrouding, if required by the Engineer shall be done by pouring bajri (10 40 meshes to an inch) from the ground in the annular space. The contractor is responsible for prevention of damage to the strainer and the Blind pipe (refer para. 17 and 18 Chapter 4·3 Technical Specifications).

Extraction of boring pipe.

14. Care shall be taken to see that during extraction the boring pipes, strainers, and Blind pipes are not damaged (refer para. 8 Chapter 4·3 Manual on Public Health Works.

Defective Tube-wells.

15. Eccentric and defective tube-wells shall be set right to the satisfaction of Engineer-in-Charge (refer para. 16 Chapter 4·3 Technical Specifications).

Strainers.

16. The strainers shall be of 1/8" brass sheet, with appurtures as determined by the Engineer-in Charge. They will be manufactured by Irrigation Tubewell Workshops at Sanda Kalan, Lahore or any other approved quality of strainers, as accepted by the Engineer-in-Charge, and shall be installed against aquepher as directed by the Engineer-in Charge.

CHAPTER No. 3

EARTHWORK FOR IMPOUNDIDG RESERVOIRS AND BUNDS

Earthen dams for large reservoirs

General description

1. The dam is to consist of an earthen embankment with puddle trench, or concrete and puddle trenches, arranged according to a selected design or as shown in the drawings.

Preparation

2. The following preparations should precede the commencement of the dam :—

The land taken up for the work should be properly demarcated and a plan and register kept on the work.

(The soil and other materials available for the embankment puddle trench, etc., and the sufficiency of the each description of material required, as well as the cost of carriage, should be considered, and the best selection consistent with economy determined.

The officer carrying out the work should provide himself with detailed drawings of the puddle trench, or concrete and puddle trenches, and a working section of the dam with the width marked at convenient intervals of height. If the hearting and casing of the dam are separately specified for, their respective widths shall be shown each such interval on the section).

Clearing site and preparing foundations.

3. The whole site must be cleared to the full width of the seat of the dam, of all tree, shrubs, grass, rubbish of all sorts, loose stones and soft stuff. All roots to be dug out and the loose surface soil to be scraped off till the firm natural soil is uncovered.

If the natural soil in any part of the base of the embankment is found to be compressible or to contain salts, or otherwise has a suspicious appearance, the order of the Executive Engineer should be obtained before commencing the embankment.

4. Where the line of embankment crosses the bed of a river or stream gravel, sand and all loose deposits are to be carefully removed down to solid and unyielding material.

All decayed and suspicious strata in the sloping river banks should be removed.

Disposal of excavated material.

5. The rock and debris excavated from the concrete and puddle trenches may be used, if suitable with the permission of the Excutive Engineer, in the construction of the outer slope of the dam.

Such material, if not fit for use, as well as other removed from the seat of the dam, shall be removed from the site of the work and deposited, outside the tank, in places, be approved by the Engineer-in-Charge where it will not interfere with the execution of the work.

The seat of the dam when thus cleared shall be watered and opened with a pick or harrow and all clods and lumps shall be broken. The new material is then to be mixed with the excavated soil and consolidated, as described hereafter to form the first layer of embankment.

Draining the base of dam in rear of puddle trench.

6. Provision should be made for draining the water leaking beyond the puddle trench, so as to prevent the saturation of the rear toe of the dam or the ground underneath or immediately beyond the toe. The base of the dam in rear of the puddle trench should as far as possible, be kept dry and firm. Otherwise the saturation, and occasionally also the unbalanced hydrostatic pressure resulting from it may lead to the movement of the subsoil, and slips and settlements in the rear slop of dam.

The leakage should be collected and led away, clear of the rear toe, by constructing drains at the ground surface below the dam, or by filling for at least 2 feet deep, the whole base of the dam in rear of (and from 5 to 10 feet clear of) the puddle trench with large rubble, gravel or other heavy material forming porous substructure. All pools and saturated subsoil close to the outer slope of the dam should be thoroughly drained.

The work should be carried out according to design or as shown in the drawings.

Puddle Trench

Excavation

7. A trench for the puddle is to be excavated along the centre line of the dam embankment to extend along the sides unless otherwise specified, up to a level of 2 feet above full supply level.

The lengths of trench opened out should be small which can be quickly filled in.

The excavation in all cases, and particularly in the rear bed, to be carried down to, and far at least 2 feet in depth, into solid rock, or 3 feet into hard earth or other water tight and impervious soil approved by the Executive Engineer. The excavation below the surface of the rock or the water tight subsoil may be narrower than the trench above, or carried down with slopes of about 1 to 1, as directed by the Engineer-in-Charge.

Size of trench.

8. The breadth of the puddle trench, unless otherwise, specified to be 1/10th the height of the dam + 3 feet. It may be gradually diminished from the centre to the end as the height of the dam diminishes. The minimum breadth should not be less than 6 feet.

The sides of the trench, when not otherwise specified, to be left vertical. When the excavation cannot stand with a vertical, face, the side slopes shall be as steep as they can stand, without shoring, for the period the trench is likely to remain unfilled.

Adequate shoring shall be restored to, when the depth of the trench exceeds 4 feet to prevent accidents due to collapse of sides.

Vertical steps longitudinally in the trench are to be avoided, level stages with steep inclines being preferable.

Springs.

9. All water met within the foundations must be collected in sumps; and pumped or bailed out, or otherwise conveyed out of the trench without being allowed to spread on the puddle as it is being laid.

All springs of consequence to be carefully plugged up or caulked before the puddle is laid.

Puddle

10. The trench, when ready is to be filled with good clay puddle made out of clean, tough and retentive clay of the best quality available near the site. The most suitable clay is of the description used for tile making. Soft, sludgy, peaty, sandy, salt or puffy clays should be rejected.

The clay is to be worked up to puddle before use by turning it over and over again with PHAWARAS watering and treading with men's feet into one plastic homogeneous mass of the toughest consistency.

Laying the Puddle

11. The bottom of the trench should be washed, if the excavation is in rock, before puddle filling is commenced. The bottom layers should be made of puddle tempered upon the surface and thrown or dashed into the trench in balls to fill in inequalities. The puddle should be worked up on the surface in the same way when the trench is deep or there is not enough room to work.

Generally, however, after the first few layers are laid the clay may be put on in the trench itself in layers not exceeding 9 inches in depth and then worked up with PHAWARAS and men's feet into stiff, dough-like mud. The layers of the puddle should be kept as level and uniform as possible.

If too much water has been used, the layers must be excavated and removed from the trench before another layer is laid upon it.

Puddle is never on any account to be allowed to dry; should the surface of puddle crack at any time, the cracked surface is to be dug up and the puddle remade.

On Sunday and holidays coolies should be specially employed tc keep the surface of puddle wet.

Ramming.

12. As the surface of the puddle layers dries up, it should be thoroughy consolidated with rammers. Before a new layer of puddle is laid, the surface of the previous layer, if not newly made, should be lightly sprinkled with water by means of watering pots.

When puddle is finished it should be atonce covered up in the work or when this is impossible with wet earth or grass.

The surface soil is to be removed on both side of the puddle trench for a breadth equal to that of the top of the trench, and for 2 feet deep, and refilled with selected clay or other material used for the hearting and consolidated in the same way.

The filling is to be carried up with the puddle wall to a height of 2 feet above ground level and joined with the hearting.

Concrete trench.

13. When the trench is filled entirely with concrete, or partly with concrete and partly with the work should be done according to design, approved by the Executive Engineer, or as shown in the drawing.

The concrete should be prepared and laid as in per specifications for concrete work.

Embankment

Construction of embankment.

14. The embankment is to consist of a water tight hearting of clay or clayey earth; with a casing both in front and back of clay mixed with MURAM or gravel, as directed by the Executive Engineer.

The clay hearting is intended to make the dam water tight and the casing to afford protection to the hearting against the effects of alternate saturation and dryness.

The casing both in front and back shall be 3 feet thick at full supply level measured at right angles to the slope, increasing at the rate of 1 foot for every 20 feet of vertical depth below that level.

Material.

The material for the hearting should be of the most clayey or retentive earth obtainable within one half-mile of the site, unless otherwise specified and, where possible the whole of the hearting should be made of same kind of material throughout to ensure equal settlement. It must be free of salts, large stone and rubbish of every kind.

The casing should be made of clay and MURAM or where good MURAM is not obtainable, of gravel and the proportion of two of clay to three of MURAM or gravel, unless otherwise specified. Preference should be given to a ready made natural mixture where available, such as clayey MURAM or gravel; or hard soil with a large admixture of KANKAR.

All stone which do not pass through a ring of $1\frac{1}{2}$ inch diameter to be rejected.

Forming embankment and consolidation.

16. The material, freed of all clods and lumps, shall be laid in continuous layers with a slight slope towards the centre, making a concave curve, the centre being 3 to 6 inches lower than the outwards edges.

The material shall be spread in even layers of 5 or 6 inches or such other thickness as will roll down to about 4 inches when finished. If a power roller is used, the thickness of the layer may be increased to 9 or 12 inches or as may be determined after actual trial.

All the earth used in the embankment should be such as naturally moist in itself or is made so before it is spread.

No watering should be allowed until the layer has been completely rolled.

Water should be sprinkled to sink about $\frac{3}{4}$ inch in depth into the completed layer just before the next layer is spread so as to ensure complete union between the two.

If the earth available is too dry for use it shall be moistened before being spread on the dam. This is done either by wetting the site of the barrow pits a few days previously and allowing the surface to dry before actual excavation or by heaping the dry soil in layers of about 12 inches, each layer being thoroughly soaked before the next is laid until the heap attains a convenient height. The heap is left in this state for a sufficient time till the clods have become exfoliated. The material is then mixed with PHOWARAS, carried to the dam and spread in the usual way. If proper supervision is available, there is no objection to making the heaps on the dam itself.

Note.—The use of soils which are moist by reason of the presence of salts should be avoided.

Rolling.

17. Rollers may be made of stone or iron, and of such a size and weight that they will give a pressure ¾ to ½ ton per foot length of roller. It is sometimes advisable to pass a light roller quickly over a newly spread layer in order to bring it to a surface before working a heavy roller.

To prevent the material sticking to the rollers, dry earth should be sprinkled on the surface before or during consolidation, as may be necessary. The rollers should be kept clean by means of suitable scrapers.

Ramming—In parts of enbankment where rollers cannot be worked on or cannot reach, the consolidation should be done with heavy rammers worked by lines of men moving in union backwards and forwards on the surface till the layer is thoroughly consolidat ed. When the consolidation is effected by ramming the materials should be spread in layers not exceeding 3 inch in thickness. Where manual labour is used for carrying the materials, the work-people should, as much as possible, be made to walk over the r. lled portion of the dam, but not in single file.

Allowance for settlement of earthwork.

18 In setting out the half widths of embankment, it is desirable to allow for the settlement of the materials, by adding unless otherwise specified, at the rate of 1 foot for every 24 feet of height of dam ; that is, the half widths calculated on the cross-section for a height of 24 feet above ground level should be actually set out at 25 feet above that level.

Junctions of earth work.

19. When new embankment are joined to old, the surface of old work is to be removed to a slope and the junction to be dug up 2 feet deep and both new and old stuff mixed and watered to the extent necessary for consolidation and rammed.

Protection after slope.

20. Where it is proposed to protect the outer slope of embankment with HARIALI or other binding creeping grass, the outer casing should be finished off with a top layer containing a sufficient admixture of soil favourable for the growth of grass.

21. No excavation shall be made on the inside of a dam nearer the toe of slope than twice the height of the dam opposite, not on the outside of the dam nearer than three times the height of the dam.

Borrow Pits.

Nor any excavation to be done within 100 yards of the dam to exceed 5 feet in depth without the special sanction of the Executive Engineer.

Care should be taken that no porous stratas are uncovered on the inner or tank side of the dam.

All pits should be arranged with a certain amount of regularity, having regard to the convenience of the work during the execution and to its safety and an appearance of finish after its completion.

Pitching

Stone Pitching.

22. The inner slope of embankment shall be protected with stone pitching from the level of 2 feet below the still of outlet sluices to 3 feet over the highest flood level, unless otherwise specified.

When circumstances permit, one rainy season should be allowed to elapse after constructing the slope, to allow for consolidation before pitching is commenced.

Stone.

23. The stone to be good, hard, quarry or boulder stone such as will not weather on the surface. It is to be roughly hewn or squarred with the hammer to ensure the stones fitting fairly one on the other so as not to expose the earthwork below.

Laying.

24. The stones are to be laid with their broadest faces downwards and firmly bedded on a layer of Muram, spauls or gravel at least 6″ in thickness.

They are to be packed against each other with the hammer or mallet so as to fit closely for at least 3″ in height and to lie generally perpendicular to the slope. No pinning is to be allowed between the sides of stones, and the use of chips should be confined to hollows and inequalities in the bed and for packing, after the stones are laid, on the surface to form a uniform slope.

The surface packing should not be allowed to proceed till the previous work is inspected and approved.

Size of stone—The depth of pitching, unless otherwise specified, to be 6″ at the bottom of slope, increasing uniformally by increments of about 3″ to 18″ at the highest flood level and again decreasing in the same way to 12″ at the top.

The top most courses shall consist of roughly dressed headers projecting 9" above the face of the pitching and shall be laid in a continuous level line.

Slope.

25. The face slope of the pitching when complete is to be that specified for the dam, so that the varying depths of the stone and the thickness of the Muram or gravel bending must be allowed for in the earthwork.

The surface of the work when complete shall be fairly uniform and left. clean of all refuse.

Specials forms of construction.

26. Deviations from the above general specification will be necessary to meet particular cases of material or construction which require special treatment.

Low Dams—The following modifications apply to low dams, generally, below 40 feet in greatest height :—

The material of the NALA bed on the downstream side of puddle or concrete trench may be left, if it is firm an unlikely either to compress or shift in case of leakage from spring. All vegetable soil and rubbish of every sort should, however, be removed.

A concrete trench is not necessary, the puddle wall be contined throughout.

Unless the subsoil is particularly porous, no special drainage works are necessary for preserving the outer slope of the dam in a dry rubber stone or large gravel for 2 or 3 feet, deep, and extending not less than 10 feet into the dam.

The pitching should not be less than 6 inches up to 5 feet below the highest flood level, nor less than 9 inches above that up to the top.

Mixture of materials for puddle.

27. Where good natural clay is not obtainable in sufficient quantity, soft, MURAM or sand may be mixed with it Gravel may be added to wet puddle clay, with the consent of the Executive Engineer, in proportions not exceeding 1 to 1 when it is necessary on economical grounds.

Black Soil—Puddle may also be made by mixture of soft MURAM or sand with black soil; 3 parts of pure black soil to 2 of sand or MURAM broken fine will make a good mixture, but the proportions should in each case be determined by experiment. The soil should be free from all impurities. All stones or unbroken lumps larger than a hen's egg and all grass or rubbish should be carefully removed.

28. Puddle may also be laid in the following manner:—

Laying Puddle.

After the bottom of the trench is filled for 2 or 3 feet with well-trodden clay, such as ball puddle, the remainder of the trench may be filled with thin layers wet clay and consolidated as on the embankment. The clay is thrown in layers of 3 or 4 inches and trampled and rammed dependence being placed on through ramming to ensure homogentity of the mass.

Mixture of materials for the Dam.

29. Pure black soil swells when wet and cracks when dry, should not be used for embankments, except in combination with some foreign material such as MURAM broken to small size, or with gravel or sand. Two or 3 parts of black soil to 1 of MURAM broken fine makes a good mixture. The exact proportions should be determined after experiment in each case.

When the mixture is made by the hand, the materials are to be placed clear of the work, the dry Muram and black soil are to be laid on each other in layers not more than 9 inches deep; they are then to be mixed with PHOWARAS by turning the stuff over and over.

The materials, when thoroughly mixed, are spread in a layer 12 inches thick or heaped in such layers, to a convenient height, each layer being soaked with water before the next is laid. The mass is left over for a time (usually one night). It is then mixed with PHOWARAS spread on the dam in layer and rolled.

The soaking should be such that the material when ready for use should be just damp enough to crumble easily in the hand. Great care is necessary to avoid both unequal moistening and the use of too much water.

Pitching.

30. Pitching on the large dams may also be constructed with a uniform thickness of not less than 12 inches. Where stones 12 inches thick are not obtainable or are very expensive to procure, smaller stones, but not less than 9 inches thick, may be used, in the latter case, rows of headers or the longest stones available are to be laid down in continuous horizontal lengths at intervals of 5 feet on theslope.

CHAPTER No. 4

Contract Specifications for (Rapid Gravity Filter Plant Pressure Filter and Softening Plant.

(Tenders)

Capacity.

1. The capacity of the filter plant shall be as per item—— and the plant shall be capable of being overloaded to the extent of 25 per cent.

Filter Media.

2. The filter media shall be coarse sand and local water borne bajri and shingle.

Velocities.

3. The following velocities shall not be exceeded :—

		Feet per second
Filter influent	...	2
Filter effluent	...	5
Wash water	...	12
Waste water	...	8
Filter to waste	....	15

Under drainage system.

4. The underdrainage system shall be of perforated pipes system.

5. The amount of waste water shall not exceed 5 per cent of the daily supply.

Quality of water.

6. The quality of water is as per Analysis . The filtered water shall be fit for (*i*) domestic

(*ii*) industrial

(*iii*) Boilers and laundries.

Note—The source of water-supply should be indicated. At least four samples in different seasons shall be analysed and the Analysis shall include test for Turbidity sizes of suspended impurities Chemical analysis, P. H. value biological analysis.

Specification plant.

7. The contractor shall quote for furnishing complete machinery and installations for filteration of required Million gallons per day, and shall include within this item—

(*a*) All Inlets and Outlets Valves to basins and filters, etc.

(*b*) All regulating the desludging mechanism of settling basin (type, whether horizontal and Vertical to be indicated).

(*c*) Coagulant feeding, mixing and floculating mechanism.

(*d*) Inlet system to the filter (excluding civil works).

(*e*) Underdrainage system of perforated pipe.

(*f*) Wash water system including compressors.

(*g*) Waste water system.

(*h*) Control apparatus for filters.

(*i*) Walkways, railing etc.

(*j*) All other mechanical and electrical equipments including starter, switch board, etc., to make the plant complete.

Drawing for civil work. 8. The contractor shall furnish the layout plan and drawings showing the required inner dimensions of setting basis filters units etc.

Electricity. 9. Electricity is available of AC/DC system 1/3 Phase 50/60 cyls.

Current. 10. The machinery piping shall be such as to withstand rough use of the plant and shall work satisfactorily in the atmospheric and water conditions of the place.

Test. 11. The filter plant shall pass and test of satisfactory working for at least one month after installation without giving any trouble.

12. The prices quoted shall be in Rupees for furnished, installed and tested equipment.

13. In case Civil works are not executed by the supplying firm his representative shall be present during the execution of the works to see that the Civil works suit the mechanical and other requirements of the plant and necessary anchor bolts and fitment are left in the Civil works and there is no necessity of subsequent dismantlement or alterations in the structure.

14. The work shall be done as per specification in Volume I and II.

The rates shall include Railway frieght, Sales Tax, octroi duties, and other incidential charges.

CHAPTER No. 5

CHLORINATION PLANT

Information to be supplied to Manufacturer of chloromenses.

1. The chemical and Biological Analysis of water as well as type of electricity supplied to the manufacturers. The point of chlorination and brief description of the water supply shall also be mentioned.

Specifications of Chlorination apparatus.

2. The chlorination plant for —— Millions Gallon water per day shall consist of Auxiliary tank valve, chlorine filter high pressure gauge, chlorine pressure, regulator, air outlet relief valve, acid trap, low pressure gauge, Chlorine meter, Chlorine control valves, chlorine line, services line, float well, mixing chamber, safety device, injector odour trap, Chlorine solution line, Stone ware cock, Solution line connection, Overflow pipe and all other equipment to complete a chlorination plant, and the contractor supplying the plant shall properly furnish, install adjust and test all the equipment thereof.

The prices quoted shall be in Rupees for furnished, installed and tested equipment.

In case Civil Works are not executed by the supplying firm, his representative shall be present during the excution of the works to see that the Civil works suit the mechanical and other requirements of the plant and necessary another bolts and fitments are left in the Civil works and there is no necessity of subsequent dismantlement or alterations in the structure.

General.

The work shall be done as per specification in Volume I and II.

The rates shall include railway frieght, sales tax, octroi duties and other incidential charges.

CHAPTER No. 6

SPECIFICATION FOR HYDRAULIC STRUCTURES (WATER RETAINING STRUCTURE) (WATER TANKS SUMP WELLS, TRICKLING FILTERS, PRIMARY, SOUND FINAL SETTLING TANKS WATER-SUPPLY FILTER, ETC.)

No. 6·1—Under ground and Surface Tanks.

Material. The materials, e.g. cement, sand and aggregate bricks and stones shall be free of deleterious material and for major jobs shall be tested with colour and petrographic tests.

Floor. 1. The foundation of the floor shall be firm, and free of all cavaties or a loose material shall and compressible soft stuff. All loose and soft material be removed, and any cavaties left shall be filled with lean concrete (1 : 7 : 20) or as instructed by Engineer-in-Charge.

Base concrete. 2. The soil shall be thoroughly compacted at the same time sprinkling water till the heal of shoe does not make any impression on it. A layer of 4″ to 6″ cement concrete 1 : 4 : 8 or an other mix shall then be laid as directed by the Engineer-in-Charge.

Top concrete. 3. A layer of 4″ cement concrete with 3/8″ aggregate, mix designed by water cement ratio method shall be laid in bays of sizes fixed by the Engineer-in-Charge. The mixes recommended are $1\frac{1}{2} : 2 : 3$ and $1\frac{1}{4} : 2 : 4$. The actual mix shall, however, be determined by the Engineer-in-Charge.

An admixture of pudlo or any other water proofing, material be used with cement, if directed; the proportions of admixture shall be as instructed by the Engineer-in-Charge.

Treacherous Soil. (*a*) *When the soil is treacherous the cement concrete slab shall be replaced by reinforced concrete designed in spans of 8′ × 8′ or other suitable dimension as directed.*

Floor below spring. level. (*b*) *The floor below the subsoil level should be designed to withstand the upthrust of subsoil water to minimize the thickness of reinforced concrete slab the up thrust should be counter acted by plain cement concrete 1 : 2 : 4.*

For laying concrete below water level see Specification No. 7·2, Vol. 1.

(c) The wall shall be designed to withstand the water pressure in order to reduce the wall thickness, it is permissible to backfill the wall, with earth in which case, the wall should be safe to withstand the earth pressure.

Walls.

The material of the wall shall be of impervious stone, brick or concrete blocks. The masonry shall be in cement mortar 1 : 3 and it is essential that more water than that necessary for hydration, or making a workable mix shall not be used:

The horizontal and vertical joint shall, properly be filled with cement mortar, without leaving any voids The brick should not be just with cement mortar. The bricks and concrete block shall be immersed in water for 12 hours before laying then in the masonry which shall be thoroughly cured for fifteen days.

(d) A core wall of impervious concrete may be used to render the structure water-tight if desired. It shall consist of (4½"—9") (as per design) water tight concrete filled between the front brick and back masonry laid with just sufficient water to make it workable, and for its hydration.

Core wall.

The concrete shall not be spongy.

(e) The internal wall shall be plastered with cement mortar (1 : 2 to thickness as ¾" (without the neat cement coat) with just sufficient water for hydration.

Internal Wall finished.

4. A water tight joint shall be made between masonry and concrete by forming a groove in the masonry and inserting top concrete of the floor in the masonry throughout its length 4½" deep and 6"—9" high forming a fillet at the junction. There shall be another groove to take back concrete 6" below the top fillet. (see attached figure).

Joint between masonry and floor.

5. No bay shall exceed 30′ × 30′. Expansion joints shall invariably be provided and water tightness ensured by filling the joint with a mixture of bitumen and sand (Bitumen 37 per cent saw dust or asbestos fibre 3 per cent and 60 per cent of fine river sand).

Expansion joint in the floor.

The mixture shall be finished proved to extend 3/8" over to the surface.

A layer of Asphaltic paper extending 6" on either side be laid below the top concrete in hot bitumen.

The construction joint in the base concrete shall break joint with the expansion joint, as per attached figure,

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~~In case of R C.C. slab a copper U plate shall be inserted~~ between the adjoining slabs.

Test for water tightness of masonry.

6. During the course of construction $\frac{3}{4}''$ pipe, 6″ long with a socket, at 3′ interval in either direction shall be built in the masonry and left $\frac{1}{2}''$with protruding. The pipe shall go up to the centre of the wall and will be paid separately.

After completion, the masonry shall be grouted with a grouting machine under pressure. If and when the cement mortar refuses to force its way into the masonry it be considered water tight.

Inlets and outlets.

7. For the inlets and outlets square opening shall be left in the masonry and the pipe after thoroughly cleaning it of rust be correctly placed in position after laying its base in water tight concrete as directed by the Engineer-in-Charge (usual mix $1\frac{1}{2}:2:3$ or $1\frac{1}{4}:2:4$) with $\frac{1}{4}''$ and 3/8″ coarse aggregate.

The opening shall then be filled immediately with the same concrete to ensure a water tight joint.

A joint of the bellmouth with the straight pipe shall be made as to come in the centre of masonry and it shall be made certain that the pipe joint does not leak, by surrounding it with dense concrete. For outlets and scour pipes, the Bellmouth shall be kept 3″ above the floor level, the top concrete being finished to form a stream lined joint.

TH
BITUMEN
SAW DUST
FINE RIVER SAND

The duckfoot bend shall be surrounded by water tight concrete of the same kind.

Test for watertightness.

8. After the masonry is completed the tank shall be filled with water to the full supply level and soacked for 48 hours. The water shall then be added to bring it to F.S.L. and observation made for 48 hours. The loss due to evaporation shall not exceed $\frac{1}{8}''$ in 24 hours. Leakage, if any, shall be closed as,—*vide* paragraph 11 above.

Roof.

(a) The roof of water level shall be insulated against heat to improve the quality of water R C.C. T; beam and hollow tile roof is recommended.

In case of Trusses, Shell or Dome type roof ceiling of celotex or jute cloth shall be provided.

Freeboard.

(b) A freeboard of at least 1 foot shall be provided below the beam or Arch spandrel,

(c) *Adequate ventilation shall be provided by mosquito proof* **Ventilation.** *Air vents of salt glazed stone ware concrete of any other type. For other specification refer to the chapter of Volume 1 and pipe work.*

No. 6·2—Underground on Surface. Tank of Reinforced Concrete.

Floor. 1. *Vide* paragraph, 1 of this Volume, Chapter 6·1.

Walls. 2. The walls shall be reinforced concrete whose mix shall be especially designed to ensure watertightness, and adequate strength. The sand and aggregate shall be tested for freedom from deleterious clayey matter by the sodium Hydroxide colour test and petrographic test.

The cover for reinforcement shall be 2 inches thick.

Stresses in Reinforced concrete. 3. *The reinforced concrete for wetted Area shall be designed for the following stresses.*

Concrete = 750 *lbs. per square inch and* 600 *lbs. per square inch in case of doubtful aggregate.*

Steel = 12,000 *lbs. per square inch.*

Modular = *Ratio* = 15.

For the roof work the usual concrete specification shall be followed. The concrete shall be vibrated by external vibration. Sliding forms shall be used, preferebly of steel.

Junction of the wall and floor. 4. No joint shall be left at the floor level.

Concreting to the floors and walls be done at the same time. 5. Concreting of the floor and walls shall be done in one continuous process if possible. The concreting of the wall shall be uniform throughout.

Construction, joint. 6. In case due to site conditions, a joint is to be left in the wall, then a 9″ copper plate shall be embedded $4\frac{1}{2}$ inches on either side of the joint in the middle of the wall. Before laying the next layer of concrete the laitance collected at the top shall be removed and the concrete roughened by wire brush. It shall then be painted with cement slurry (1 : 1) and the next layer of concrete be laid.

Expansion joint. 7. *See* Chapter 6·1, paragraph 10.

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INLET CONNECTION TO OVER HEAD TANK.

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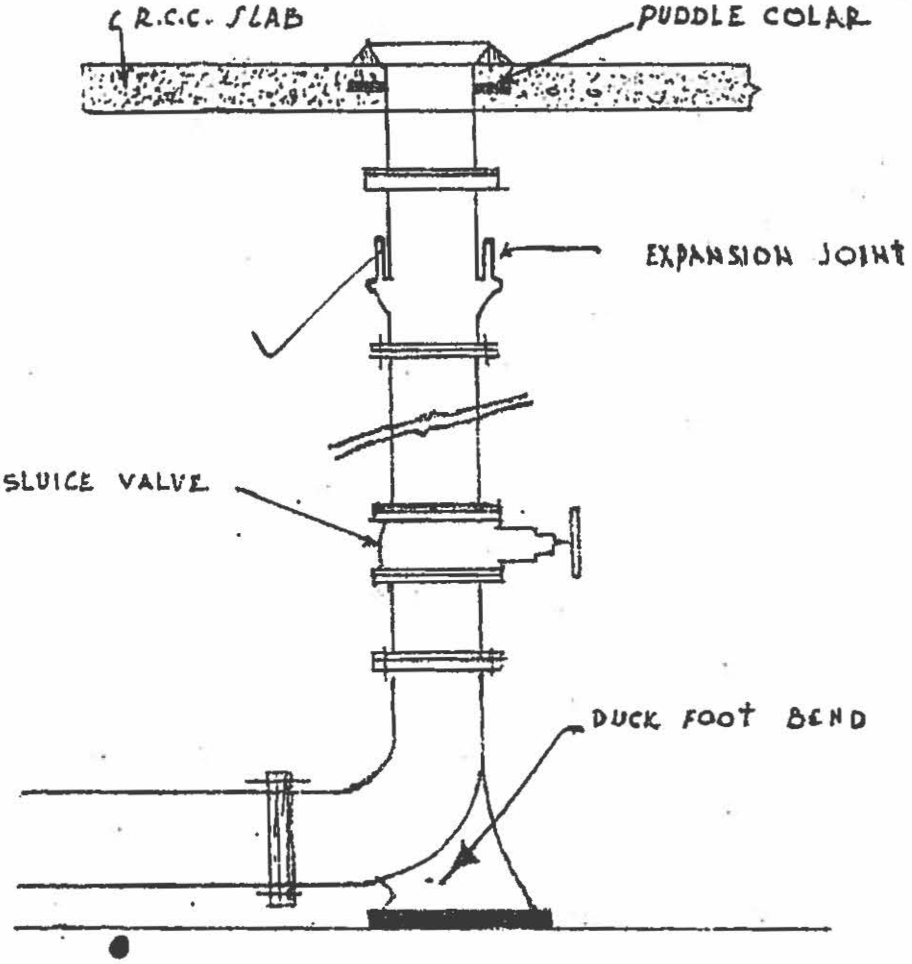

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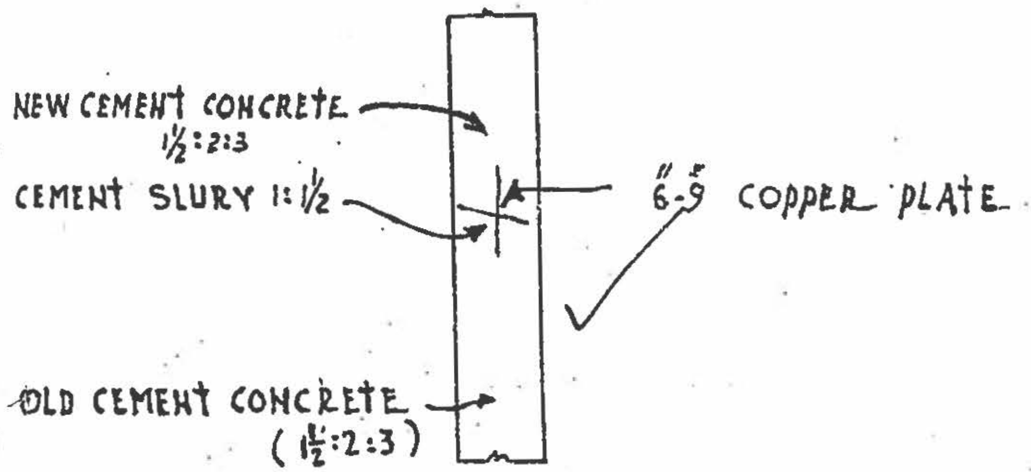

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INLET CONNECTION TO OVER HEAD TANK.

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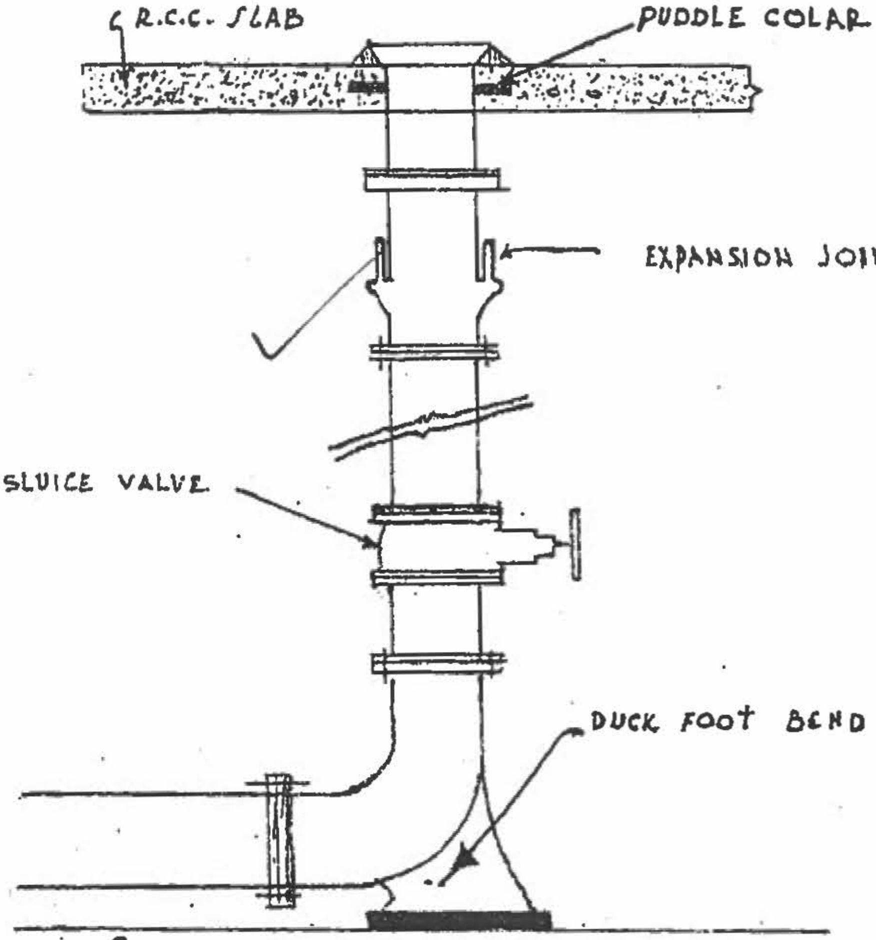

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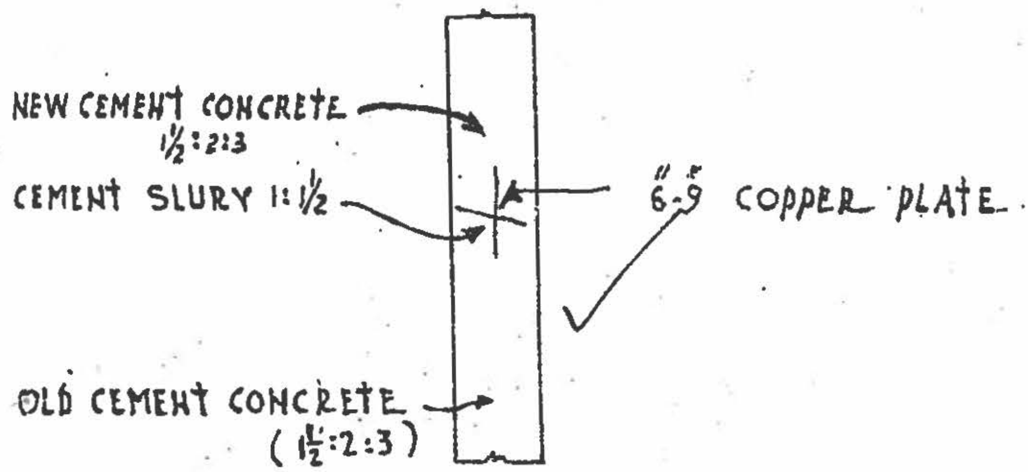

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8. Where directed by the Engineer-in-Charge, Pudlo or on any other water proofing material (I part admixture to 3 parts of cement) shall be used (However, this is no substitute for poor concrete mix or defective laying.

Use of water proofing admixture.

9. The walls shall be given a wash of cement slurry (with water proofer) to seal all surface irregularities.

Cement rendering.

10. Refer to Chapter No 6·, paragraph 11.

Water tightness of wells.

11. Refer to Chapter 6·1, paragraph 13.

Test for water tightness.

12. The inlets and outlets shall be built in simultaneously with the concreting, to ensure water tightness.

Inlets and outlets.

13. For other Specification refer to Chapter 6·1 and other chapter of this book.

Miscellaneous.

No. 6·1—*Overhead Reservoirs.*

(*a*) Masonry Tanks.

1. The work shall be done according to the Specification in Volume I and as per Chapter 8 for pipe work.

General

2. The centering for the bottom slab and roof shall be of steel (made of M S. plates, angle iron or Acrow Steel Shuttering).

Centering.

In case no Government centering is available, the contractor shall make arrangement for his own centering,—*vide* specifications in Volume I.

3. The walls shall be of Brickwork in cement mortar 1:3 with a core of R.C.C.

Walls of reservoir.

The R.C C. Core wall and the base slab shall be laid in one continuous operation to give a watertight structure.

The inner line of Brick shall be in cement mortar 1:3 and shall be $4\frac{1}{2}''$ or 3" thick as decided by the Engineer-in-Charge. The brickwork shall not be executed in excess of 3 feet above the concrete.

4. There shall be no construction or expansion joints in the base slab, its junction with the core wall and up-to 3 feet height above the concrete.

Joints.

It would be advisible not to have any joint in the core wall up to I foot above the full Supply level.

In case it becomes necessary to stop the work in the middle of the top of the concrete shall be brushed to remove laitance, before new concrete is laid, and then cement slurry of 1 : 1 cement mortar applied.

When a water tight joint cannot be ensured in this way, copper plate 9″ long shall be built to a depth of 6″ along with the lower concrete.

The top concrete shall then be laid after brushing away laitance as described above.

Free Board.

5. *A free board of at least 1½ feet shall be provided between full supply level and roof.*

Height of wall.

6. *In order to minimize the fluctuation in the pumping head the depth of wall shall not ordinarily exceed 12 feet.*

Ventilation

7. *The reservoir shall be ventilated through mosquito proofed ventilator in the roof.*

Inspection of Reservoirs.

8. *The acces to the water tanks shall be provided by a ladder with an easy slope on a spiral stair case. The Climbing shall be made easy by the provisions of hand rails if required.*

An inspection manhole with a water tight double locked cover of water tight pattern shall be provided in the roof. At least two manholes shall be provided in every compartment.

Foot steps.

9. The footsteps if required, shall consist of malleable cast iron or mild steel and shall be built in the inner lining simultaneously with the brickwork to ensure watertightness. The foot steps shall not be introduced afterwards unless specially premitted by the Executive Engineer.

Interwal Plaster.

10. The Internal walls shall be plastered with cement mortar 1 : 2 up to a thickness of ¾″ without neat cement coat (with admixture of 1 part of pudlo or any other waterproofer if directed by the Engineer-in Charge), with just enough water for hydration of cement.

Pipe work.

11. The pipes in the core wall or bottom slab shall be built simultaneously in the concrete with puddle collar welded to the pipe special as per fig—

An expansion joint shall be provided in the vertical piping to cater for the temperature variation. The design of the joint shall be supplied by the Engineer-in-Charge.

Pipe work. 12. The pipes shall preferably be flanged, with 1/8″ thick rubber insertion.

13. As soon as the Reservoir is completed and cured for 21 days it shall be kept constantly filled with water to ensure freedom from cracks and the roof shall be covered with wetted gunny bags. The test shall be taken after 7 days of first filling.

Test for water tightness. 14. After the Reservoir has been built and kept filled as above it shall be completely filled with water, and the level observed of 48 hours. The drop in level shall not exceed $\frac{1}{8}$ inch in 24 hours.

Leakage in reservoir. 15. The leakage shall be attended to,—*vide* paragraph 11 and 13 of Chapter 6·1.

No. 6·4—Steel Tanks.

General. 1. Steel Tanks sections are available from Messrs. Bredthwodth and Co. of England, which are welded together to form steel tanks.

The work shall be done as per specification of steel work, in volume I.

Painting. 2. The steel tanks shall be painted with rust proof paint, e. g., Angus Smith Solution, or any other paint approved by the Engineer-in-Charge.

Roof. 3. The roof shall be of A. C. sheets over steel or timber trusses, with the traingular portion protected by Mosquito proofing.

For other items refer to specification Buildings and pipe works.

CHAPTER No. 7

PIPE MATERIALS

No. 7·1—*General*

Pipe Material.

1. The pipes to be used in West Pakistan shall be manufactured from any of the following materials :—

(*i*) Cast Iron pipes—for all sizes Mains more than 3", internal diameter.

(*ii*) Galvanised Iron Pipe for internal work and distribution up to 3" i/d.

(*iii*) Mild Steel Pipes for hilly areas ;

(*iv*) Asbestoes Cement Pressure Pipes—for 3" and above.

(*v*) R. C. C. Pipes (Class B)—for mains above 4" i/d. (Gravity System), up to a maximum pressure of 50 feet.

(*vi*) Hume Steel Pipes—for pressure mains.

Preference to locally Manufactured Pipes.

2. As for as possible, the pipes that are locally manufactured with indegneous material conforming to the specifications as described in following sub-chapters shall be preferred.

7·2—*Cast Iron Pipes.*

Manufacture.

1. The pipes shall be either vertically cast or centrifugally spun from pig Iron or scrap and shall comply with B. S. S. 78 of 1938 and 12, 11 of 1945.

Metal.

2. The metal used for casting the pipes shall be a suitable mixture of pig iron and scrap and shall be remelted in the coupola or air-furnace, or may if approved by the Engineer-in-Charge be refined in a molten condition in a mixture of an active tipe. The pig iron shall be best tough grey foundry pig iron and the scrap shall be clean, unburnt and of good quality. There shall be no admixture of cinder iron or of any material calculated to render the metal inferior in quality, and the resulting casting shall not be white or vitreous on fracture.

The metal shall be tested as per test incorporated in B. S. S.

Mode of Casting.

3. *Vertically cast pipes*—(*a*) Straight pipes shall be cast vertically in dry sand moulds formed from turned iron patterns and in boxes accurately faced and jointed, and without the use of core nails, chaplets, or thickness pieces, or any other substitute therefor. They shall be cast with a head of metal

of sufficient volume to ensure soundess, tho head shall be afterwards cut off in a lathe and the finished pipe left with the length and shape required. Spigot and socket pipes shall be cast socket downwards.

When the size of special castings does not require the use of dry sand moulds and cores, they may be cast in green sand moulds with green sand cores.

The sand used in the moulds and cores shall be sufficiently fine and fresh to produce a smooth and regular surface. The cores shall be smoothly finished.

Where dry sand is used, the moulds and cores shall be properly back-washed carefully dried, and finished reasonably smooth.

The pipes shall not be removed from the moulds until cooling has proceeded so far as to prevent all risk of straining cracking or other injury consequent on their removal.

(b) *Centrifugally spun*—The pipe shall be Centrifugally spun in metal or sand moulds and the pipe, shall not be removed from the mould until a sufficient time has elapsed to avoid inherent strains or damage to the pipe during the process of handling and they shall be subjected to heat treatment after the withdrawal from the moulds. Pipes cast in sand would need not be subjected to any heat treatment.

Freedom from Defects.

4. The Pipes shall in all respects be sound and good castings, easily worked with a drill or file and shall be free from laps and other imperfections. They shall be neatly dressed and carefully tested so that no lumps or rough places are left on the barrels or sockets, and their inner and outer surfaces shall be smooth. The inner face of the socket shall be left reasonably square with the axis of the pipe.

Coating.

5. Each pipe, which has satifactorily withstood the foregoing tests and before it becomes affected by rust, shall be coated in the following manner.

The Pipe shall be uniformly heated by being immersed in hot water, the water being maintained at such a temperature and the pipe being immersed so long, that the pipe dries immediately upon removal or, alternatively, the pipe shall be uniformly heated in a stove where in the fumes of combustion do not come in contact with the pipe.

The hot pipe shall be thoroughly cleaned and then be coated by being completely immersed (except in the case of pipes which are to be only partially coated) in a bath containing a composition having a tar or other suitable base, and maintained at a temperature between 290° F; and 330° F, the proportions of the ingredients of the composition being regulated so as to produce a coating of the quailty hereinafter specified. When the pipe is removed from the bath it shall be properly drained, and the coating must fume freely and set hard within an hour.

On any pipes which are to be partially coated, the above composition, or other composition approved by the Engineer-in-Charge, may be applied to the surfaces to be coated by a brush or other suitable means. The surfaces upon which coating is not required shall be entirely free from the composition.

In the case of pipes intended for gas, the coating shall, except when otherwise specified, be applied only to the exterior of the pipe, and shall be carried up to a distance from the spigot end equal to one and a half times the depth of the socket ; the face of the socket shall not be coated.

The coating shall be smooth, tough and tenacious, sufficiently hard so as not to flow when exposed to a temperature of 145°F.* and not so brittle at a temperature of 32° F. as to chip off when scribed lightly with the point of a penknife.

The coating shall not be such as to impart taste to potable water passed through the pipe after reasonable flushing.

Any pipe which is imperfectly coated, or the coating of which does not fuse and set to conform to the quality as herein specified shall be recoated.

The machined surfaces of all pipes and turned and bored joints shall be entirely free from the coating composition and before they have become affected by rust, shall be coated with a mixture of white lead and tallow or other approved protective composition.

Tests.

6. Each straight pipe shall be tested for straightness regularity of thickness, and diameter by being rolled on a level iron gantry and by the use of suitable straight-edges, gauges and callipers which with the iron gantry, are to be provided and maintained in proper condition for the purpose by the Manufacturer.

Classification.

7. The Pipes are classified as "A", B, C & D standing a test pressure of 200 ft 400 ft. 600 ft. and 800 ft. of water head.

Thickness and weight of the pipe shall be as per table attached.

*If the Engineer-in-Charges specifies that the pipes are for use in, or transport through a tropical country, a temperature of 170°F shall apply.

TABLE 7-A FOR STRAIGHT VERTICALLY CAST PIPES

Nominal internal diameter of pipe	Gas				Water and Sewage				Nominal internal diameter of pipe
	Class A		Class B		Class C		Class D		
	Test pressure 200 ft. hd.		Test pressure 400 ft. hd.		Test pressure 600 ft. hd.		Test pressure 800 ft. hd.		
	Thickness	External diameter	Thikness	External diameter	Thickness	External diameter	Thickness	External diameter	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1½	0·35	2·20	0·35	2·20	0·35	2·20	0 35	2·20	1½
2	0·36	2·72	0·36	2·72	0·36	2·72	0·36	2·72	2
2½	0·37	3·24	0·37	3·24	0·37	3·24	0·37	3·24	2½
3	0·38	3·76	0·38	3·76	0·38	3·76	0·40	3·76	3
4	0·39	4·80	0·39	4·80	0·40	4·80	0·46	4·80	4
5	0·41	5·90	0·41	5·90	0·45	5·90	0·52	5·90	5
6	0·43	6·98	0·43	6·98	0·49	6·98	0·57	6·98	6
7	0·45	8·06	0·45	8·06	0·53	8·06	0 61	8·06	7
8	0·47	9·14	0·47	9·14	0·57	9·14	0·65	9·14	8
9	0·49	10·20	0·49	10·20	0·60	10·20	0·69	10·20	9
10	0·52	11·26	0·52	11·26	0·63	11·26	0·73	11·26	10
12	0·55	13·14	0·57	13·14	0·69	13·60	0·80	13 60	12
14	0·57	15·22	0·61	15·22	0·75	15·72	0·86	15·72	14
15	0·59	16·26	0·63	16·26	0·77	16·78	0·89	16·73	15
16	0·60	17·30	0·65	17·30	0·80	17·84	0·92	17·84	16
18	0·63	19·38	0·69	19·38	0·85	19·96	0·98	19·96	18
20	0·65	21·46	0·73	21·46	0·89	22·06	1·03	22·06	20
21	0·67	22·50	0·75	22·50	0·92	23·12	1·06	23·12	21
22	0·68	23·54	0·77	23·54	0·94	24·16	1·08	24 16	22
24	0·71	25·60	0·80	25·60	0·98	26·26	1 13	26·26	24
26	0·74	27·66	0.83	26·66	1·02	28·36	1·18	28·36	26
27	0·75	28·70	0·85	28·70	1·04	29·40	1·20	29·40	27
28	0·76	29·72	0·86	29·72	1·06	30·44	1·22	30·44	28
30	0·79	31·78	0·89	31·78	1 09	32 52	1·26	32·52	30
32	0·82	33·84	0·92	33·84	1·13	34·62	1·31	34·62	32
33	0·83	34·88	0·94	34·88	1·15	35·66	1·33	35·66	33
36	0·87	37·96	0 98	37·96	1·20	38·76	1·38	38·76	36
38	0·90	40·02	1·01	40.02	1·23	40·84	1·42	40·84	38
39	0·91	41·04	1·02	41·04	1·25	41·88	1·44	41·88	39
40	0·92	42·05	1·03	42·06	1·26	42·92	1·46	42·92	40
42	0·95	44·12	1·06	44·12	1.30	45·00	1 50	45·00	42
44	0·98	46·16	1·08	46·16	1·33	47·06	1·53	47·06	44
45	0·99	47·18	1·09	47·18	1·35	48·10	1·55	48·10	45
46	1·00	48·22	1·11	48·22	1.36	49·14	1·57	49·14	46
48	1·03	50·26	1·13	50·26	1·38	51·20	1·60	51·20	48

TABLE 7-B. STANDARD OF STRAIGHT SPIGOT AND SOCKET PIPES

Nominal internal diameter of pipe.	Gas						Water and Sewage						Nominal internal diameter of pipe.
	Class A			Class B			Class C			Class D			
	Length (Exclusive of depth of socket)			Length (Exclusive of depth of socket)			Length (Exclusive of depth of socket)			Length (Exclusive of depth of socket)			
	6 Ft.	9 Ft.	12 Ft.	6 Ft.	9 Ft.	12 Ft.	6 Ft.	9 Ft.	12 Ft.	6 Ft.	9 Ft.	12 Ft.	
						Weights							
in.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	in
1½	0 1 19	...	...	0 1 19	...	...	0 1 19	...	...	0 1 19	...	...	1½
2	0 2 4	...	...	0 2 4	...	...	0 2 4	...	...	0 2 4	...	...	2
2½	...	0 3 21	...	...	0 3 21	...	...	0 3 21	...	...	0 3 21	...	2½
3	...	1 0 17	...	...	1 0 17	...	...	1 0 17	...	...	1 0 22	...	3
4	...	1 2 3	1 3 25	...	1 2 3	1 3 25	...	1 2 7	2 0 2	...	1 2 27	2 1 1	4
5		1 3 36	2 2 6	...	1 3 26	2 2 6	...	2 0 15	2 3 2	...	2 1 17	3 0 13	5
6	...	2 1 24	3 0 21	...	2 1 24	3 0 21	...	2 2 27	3 2 7	...	3 0 12	4 0 5	6
7	...	2 3 26	3 3 13	...	2 3 26	3 3 13	...	3 1 19	4 1 22	...	3 3 11	5 0 2	7
8	...	3 2 11	4 2 16	...	3 2 11	4 2 16	...	4 0 25	5 1 26	...	4 2 24	6 0 15	8
9	...	4 0 20	5 1 17	...	4 0 20	5 1 17	...	4 3 23	6 1 21	...	5 2 8	7 1 1	9
10	...	4 3 14	6 1 7	...	4 3 14	6 1 7	...	5 2 26	7 1 23	...	6 2 0	8 1 26	10
12	...	6 0 5	7 3 8	...	6 0 25	8 0 18	...	7 3 0	10 0 5	...	8 3 4	11 1 19	12
14	...	...	9 2 2	...	...	10 0 11	...	...	12 2 25	...	...	14 1 8	14
15	...	...	10 2 3	...	...	11 0 16	...	...	13 3 23	...	...	15 3 9	15
16	...	...	11 1 18	...	...	12 0 27	...	...	15 1 19	...	...	17 1 18	16
18	...	...	13 1 21	...	...	14 2 5	...	...	18 1 12	...	...	20 3 4	18
20	...	...	15 1 14	...	...	17 0 3	...	...	21 1 2	...	...	24 0 19	20
21	...	...	16 2 12	...	...	18 1 11	...	...	23 0 4	...	...	26 0 9	21
22	...	...	17 3 7	...	...	19 3 12	...	...	24 3 3	...	...	27 3 24	22
24	...	...	20 0 26	...	...	22 1 24	...	...	28 0 11	...	...	31 3 9	24
26	...	...	22 3 2	...	...	25 0 21	...	...	31 2 17	...	...	35 3 24	26
27	...	...	23 3 22	...	...	26 2 27	...	...	33 1 23	...	...	37 3 19	27
28	...	...	25 0 17	...	...	28 0 5	...	...	35 1 6	...	...	39 3 22	28
30	...	...	27 3 24	...	...	31 0 8	...	...	38 3 6	...	...	44 0 10	30
32	...	...	30 3 16	...	...	34 0 23	...	...	42 3 13	...	...	48 3 9	32
33	...	...	32 1 2	...	...	36 0 2	...	...	44 3 22	...	...	51 0 11	33
36	...	...	36 3 7	...	...	40 3 18	...	...	51 0 3	...	...	57 2 26	36
38	...	...	40 0 13	...	...	44 1 21	...	...	55 0 15	...	...	62 2 12	38
39	...	...	41 2 11	...	...	46 0 4	...	...	57 1 27	...	...	65 0 18	39
40	...	...	43 0 14	...	...	47 2 19	...	...	59 1 18	...	...	67 2 21	40
42	...	...	46 2 21	...	...	51 1 24	...	...	64 1 5	...	...	72 3 26	42
44	...	...	50 1 16	...	...	54 3 12	...	...	68 3 12	...	...	77 3 24	44
45	...	...	52 0 7	...	...	56 2 23	...	...	71 1 23	...	...	80 3 1	45
46	...	...	53 3 2	...	...	58 3 27	...	...	73 2 13	...	...	83 2 13	46
48	...	...	57 2 26	...	...	62 2 21	...	...	77 3 22	...	...	88 3 14	48

TABLE 7-B. STANDARD OF STRAIGHT SPIGOT AND SOCKET PIPES

Nominal internal diameter of pipe.	Gas						Water and Sewage						Nominal internal diameter of pipe.
	Class A			Class B			Class C			Class D			
	Length (Exclusive of depth of socket)			Length (Exclusive of depth of socket)			Length (Exclusive of depth of socket)			Length (Exclusive of depth of socket)			
	6 Ft.	9 Ft.	12 Ft.	6 Ft.	9 Ft.	12 Ft.	6 Ft.	9 Ft.	12 Ft.	6 Ft.	9 Ft.	12 Ft.	
						Weights							
in.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	in
1½	0 1 19	...	...	0 1 19	...	...	0 1 19	...	...	0 1 19	...	...	1½
2	0 2 4	...	...	0 2 4	...	...	0 2 4	...	...	0 2 4	...	...	2
2½	...	0 3 21	...	...	0 3 21	...	...	0 3 21	...	...	0 3 21	...	2½
3	...	1 0 17	...	...	1 0 17	...	...	1 0 17	...	...	1 0 22	...	3
4	...	1 2 3	1 3 25	...	1 2 3	1 3 25	...	1 2 7	2 0 2	...	1 2 27	2 1 1	4
5	...	1 3 36	2 2 6	...	1 3 26	2 2 6	...	2 0 15	2 3 2	...	2 1 17	3 0 13	5
6	...	2 1 24	3 0 21	...	2 1 24	3 0 21	...	2 2 27	3 2 7	...	3 0 12	4 0 5	6
7	...	2 3 26	3 3 13	...	2 3 26	3 3 13	...	3 1 19	4 1 22	...	3 3 11	5 0 2	7
8	...	3 2 11	4 2 16	...	3 2 11	4 2 16	...	4 0 25	5 1 26	...	4 2 24	6 0 15	8
9	...	4 0 20	5 1 17	...	4 0 20	5 1 17	...	4 3 23	6 1 21	...	5 2 8	7 1 1	9
10	...	4 3 14	6 1 7	...	4 3 14	6 1 7	...	5 2 26	7 1 23	...	6 2 0	8 1 26	10
12	...	6 0 5	7 3 8	...	6 0 25	8 0 18	...	7 3 0	10 0 5	...	8 3 4	11 1 19	12
14	...	...	9 2 2	...	...	10 0 11	...	...	12 2 25	...	...	14 1 8	14
15	...	...	10 2 3	...	...	11 0 16	...	...	13 3 23	...	...	15 3 9	15
16	...	...	11 1 18	...	...	12 0 27	...	...	15 1 19	...	...	17 1 18	16
18	...	...	13 1 21	...	...	14 2 5	...	...	18 1 12	...	...	20 3 4	18
20	...	...	15 1 14	...	...	17 0 3	...	...	21 1 2	...	...	24 0 19	20
21	...	...	16 2 12	...	...	18 1 11	...	...	23 0 4	...	...	26 0 9	21
22	...	...	17 3 7	...	...	19 3 12	...	...	24 3 3	...	...	27 3 24	22
24	...	...	20 0 26	...	...	22 1 24	...	...	28 0 11	...	...	31 3 9	24
26	...	...	22 3 2	...	...	25 0 21	...	...	31 2 17	...	...	35 3 24	26
27	...	...	23 3 22	...	...	26 2 27	...	...	33 1 23	...	...	37 3 19	27
28	...	...	25 0 17	...	...	28 0 5	...	...	35 1 6	...	...	39 3 22	28
30	...	...	27 3 24	...	...	31 0 8	...	...	38 3 6	...	...	44 0 10	30
32	...	...	30 3 16	...	...	34 0 23	...	...	42 3 13	...	...	48 3 9	32
33	...	...	32 1 2	...	...	36 0 2	...	...	44 3 22	...	...	51 0 11	33
36	...	...	36 3 7	...	...	40 3 18	...	...	51 0 3	...	...	57 2 26	36
38	...	...	40 0 13	...	...	44 1 21	...	...	55 0 15	...	...	62 2 12	38
39	...	...	41 2 11	...	...	46 0 4	...	...	57 1 27	...	...	65 0 18	39
40	...	...	43 0 14	...	...	47 2 19	...	...	59 1 18	...	...	67 2 21	40
42	...	...	46 2 21	...	...	51 1 24	...	...	64 1 5	...	...	72 3 26	42
44	...	...	50 1 16	...	...	54 3 12	...	...	68 3 12	...	...	77 3 24	44
45	...	...	52 0 7	...	...	56 2 23	...	...	71 1 23	...	...	80 3 1	45
46	...	...	53 3 2	...	...	58 3 27	...	...	73 2 13	...	...	83 2 13	46
48	...	...	57 2 26	...	...	62 2 21	...	...	77 3 22	...	...	88 3 14	48

TABLE 7-A FOR STRAIGHT VERTICALLY CAST PIPES

Nominal Internal diameter of pipe	Gas				Water and Sewage				Nominal Internal diameter of pipe
	Class A		Class B		Class C		Class D		
	Test pressure 200 ft. hd.		Test pressure 400 ft. hd.		Test pressure 600 ft. hd.		Test pressure 800 ft. hd.		
	Thickness	External diameter	Thikness	External diameter	Thickness	External diameter	Thickness	External diameter	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1½	0·35	2·20	0·35	2·20	0·35	2·20	0 35	2·20	1½
2	0·36	2·72	0·36	2·72	0·36	2·72	0 36	2·72	2
2½	0·37	3·24	0·37	3·24	0·37	3·24	0·37	3·24	2½
3	0·38	3·76	0·38	3·76	0·38	3·76	0·40	3·76	3
4	0·39	4·80	0·39	4·80	0·40	4·80	0·46	4·80	4
5	0·41	5·90	0·41	5·90	0·45	5·90	0·52	5·90	5
6	0·43	6·98	0·43	6·98	0·49	6·98	0·57	6·98	6
7	0·45	8·06	0·45	8·06	0·53	8·06	0 61	8·06	7
8	0·47	9·14	0·47	9·14	0·57	9·14	0·65	9 14	8
9	0·49	10·20	0·49	10·20	0·60	10·20	0·69	10·20	9
10	0·52	11·26	0·52	11·26	0·63	11·26	0·73	11·26	10
12	0·55	13·14	0·57	13·14	0·69	13·60	0·80	13 60	12
14	0·57	15·22	0·61	15·22	0·75	15·72	0·86	15·72	14
15	0·59	16·26	0·63	16·26	0·77	16·78	0 89	16·73	15
16	0·60	17·30	0·65	17·30	0·80	17·84	0·92	17·84	16
18	0·63	19·38	0·69	19·38	0·85	19·96	0·98	19·96	18
20	0·65	21·46	0·73	21·46	0·89	22·06	1·03	22·06	20
21	0·67	22·50	0·75	22·50	0·92	23·12	1·06	23·12	21
22	0·68	23·54	0·77	23·54	0·94	24·16	1·08	24 16	22
24	0·71	25·60	0·80	25·60	0·98	26·26	1 13	26·26	24
26	0·74	27·66	0.83	26·66	1·02	28·36	1·18	28·36	26
27	0·75	28·70	0·85	28·70	1·04	29·40	1·20	29·40	27
28	0·76	29·72	0·86	29·72	1·06	30·44	1·22	30·44	28
30	0·79	31·78	0·89	31·78	1 09	32 52	1·26	32·52	30
32	0·82	33·84	0·92	33·84	1·13	34·62	1·31	34·62	32
33	0·83	34·88	0·94	34·88	1·15	35·66	1·33	35·66	33
36	0·87	37·96	0 98	37·96	1·20	38·76	1·38	38·76	36
38	0·90	40·02	1·01	40,02	1·23	40·84	1·42	40·84	38
39	0·91	41·04	1·02	41·04	1·25	41·88	1·44	41·88	39
40	0·92	42·05	1·03	42·06	1·26	42·92	1·46	42·92	40
42	0·95	44·12	1·06	44·12	1.30	45·00	1 50	45·00	42
44	0·98	46·16	1·08	46·16	1·33	47·06	1·53	47·06	44
45	0·99	47·18	1·09	47·18	1·35	48·10	1·55	48·10	45
46	1·00	48·22	1·11	48·22	1.36	49·14	1·57	49·14	46
48	1·03	50·26	1·13	50·26	1·38	51·20	1·60	51·20	48

8. The specials shall be as per British Standard Specification contained No. 78 and 1211.

Special.

9. The variation in the weight and thickness shall be between 1 to 7 per cent as stipulated in British Standard Specification 87 and 2‹1.

Tolerances

10. Where is it not possible to import specials or a few pipes, they shall be got locally manufactured and accepted provided they stand the tests pressure stipulated.

Locally Manufactured Specials.

TABLE 7-C SPUN PIPE

Nominal internal diameter of pipe	Class B, Test pressure 400 ft. head: Thick-ness	Exter-nal dia	Weight per ft. of barrel	Weigt of socket	Weight of spigot head	Class D, Test pressure 600 ft. head: Thick-ness	Exter-nal dia	Weight per ft. of barrel	Weight of socket	Weight of spigot head	Class D, Test pressure 800 ft. head: Thick-ness	Exter-nal dia.	Weight per ft. of barrel	Weight of socket	Weight of spigot head	Nominal internal diameter of pipe
in.	in.	in.	in.	lb.	lb.	in.	in.	lb.	lb.	lb.	in.	in.	lb.	lb.	lb.	in.
3	0·29	3·76	9·71	15	0·457	0·29	3·79	9·71	15	0·457	0·30	3·76	10·20	15	0·457	3
4	0 30	4·80	13 03	20	0·524	0·31	4·80	13·43	20	0·524	0·35	4·80	15·03	20	0·524	4
5	0·31	5·90	16·72	23	0·640	0·34	5·90	18·24	23	0·640	0·39	5·90	20·74	23	0·640	5
6	0·33	6·9[illegible]	21·18	29	0·820	0·37	6·98	23·60	29	0·820	0·43	6·98	27·18	29	0·820	6
7	0·34	8·06	25·33	35	0·934	0·40	8·06	29·57	35	0·943	0·46	8·06	33·74	35	0·943	7
8	0·36	9·14	30·50	42	1·065	0·43	9.14	36·15	42	1·065	0·49	9·14	40·91	42	1·065	8
9	0·37	10·23	35·10	51	1·188	0·45	10·20	42·34	51	1·188	0·52	10·20	48·58	51	1·188	9
10	0·39	11·26	40·91	58	1·308	0·47	11·26	48·94	58	1·308	0·55	11·26	58·85	58	1·308	10
12	0 43	13·14	52·74	69	1·522	0·52	13·60	65·64	80	1·575	0·60	13·60	75·28	80	1·575	12
14	0·46	15.22	65·53	92	2·070	0·56	15·72	81·93	107	2·135	0·65	15·72	94·54	107	2·135	14
15	0·47	16·26	71·63	100	2·207	0·58	16·78	90·68	118	2·280	0·67	16·78	104·17	118	2·280	15
16	0·49	17·30	79·49	109	2·340	0·60	17·84	99·83	126	2·420	0·69	17·84	TI4·20	126	2·420	16
18	0·52	19·38	94·65	130	2·620	0·63	16·96	119·33	152	2·700	0·74	19·96	137·26	152	2·700	18
20	0·55	21·46	110·99	148	3·290	0·67	22·06	138·31	171	3·390	0·77	22·06	158·21	171	3·3[illegible]0	20
21	0·56	22·50	118·58	158	3·460	0·69	23·12	1[illegible]9·37	182	3·550	0·80	23·12	172·33	182	3·550	21
22	0·58	23·54	128·52	188	3·620	0·70	24·16	158·49	217	3·710	0·81	24·16	182·53	217	3·710	22
24	0·60	25·60	144·76	210	3·930	0.74	26·26	182.26	242	4·030	0·85	26·26	208 45	242	4·030	24

No. 7·3—Galvanised Iron Pipes

General. 1. The pipe shall be the best G. I Pipes and shall be provided with sockets for jointing, screwed to fit the screw thread on the pipes. Pipes whose galvanising has been damaged should be rejected.

Other requirements. 2. The pipe shall comply with specification B.S.S No. 789 of 1938.

Specials 3. The specials shall normally be of G.I. manufactured to the same specification as the pipes but where those are not available, locally manufactured, Gun metal specials be used. It shall be ensured that the threads are not worn out, the fittings shall be tested by jointing at least 5 per cent the local supplies to straight pipes in pipe vices with sufficient pressure, to the satisfaction of the Engineer-in Charge. Defective fittings invariably crack on application of pressure. The fitting shall also be examined to detect blisters and minor cracks. The fitting shall also be hydraulically tested to a pressure of 100 ft. of water head.

Protection of Threads. 4. All straight lengths of pipes shall be protected with sockets and jute covering by the supplier. Pipes whose thread are not properly protected by the supplier shall be rejected.

General Pressure test. 5. The pipe shall be capable to withstand a pressure of 200 ft of water.

No. 7·4—Mild Steel Pipes

General. 1. The Mild Steel pipes shall comply with British Standard Specification No. 1387 of 1947 They shall be supplied with ordinary sockets.

Thickness and length of sockets. 2. The thickness and length of sockets shall be as per following :—

TABLE 7-D

STEEL TUBES AND TABULARS, B. S. S. 1387 : 1947

Nominal bore	Approx. outside diameter	Thickness						Ordinary sockets	
		Class A		Class B		Class C		Approx. outside diameter	Minimum length
in	in	S.W.G.	in.	S.W.G.	in	S.W.G.	in.	in.	in.
1/8	13/2 ...	15	·072	14	·080	12	·014	19/32 ...	3
¼	17/32 ...	15	·072	14	·080	12	·104	¾ ...	1
⅜	11/16 ...	15	·072	13	·092	11	·116	29/32 ...	1-1/8
½	27/32 ...	14	·080	12	·104	10	·128	1-3/32 ..	1-½
¾	1-1/16 ...	13	·092	11	·116	9	·144	1-11/32 ...	1-5/8
1	1-11/32	12	·104	10	·128	8	·160	1-21/32 ...	1-7/8
1¼	1-11/16	12	·104	9	·144	7	·176	2-1/32 ...	2-1/8
1½	1-29/32	11	·116	8	·160	6	·192	2-9/32 ...	2¼
2	2-3/8 ...	11	·116	8	·160	6	·192	2-25/32 ...	2½
2½	3 ...	10	·128	7	·176	5	·212	3-7/16 ...	2¾
3	3½ ...	10	·128	7	·176	5	·212	4 ...	3
3½	4 ...	9	·144	7	·176	5	·212	4½ ...	3¼
4	4½ ...	9	·144	7	·176	5	·212	5-1/16 ...	3½
5	5½ ...	...	...	7	·176	5	·212	6-1/8 ...	3¾
6	6½ ...	...	...	7	·176	5	·212	7¼ ...	3¾

Identification Colours : Class A, Brown; Class B, Yellow ; Class C, Green.

Tolerances (thickness) : Class A, welded, + 10—S. P. C ; Class B and C, Welded, 10 P. C., Classes B and C, seamless + 12¼ P. C.

Test. 3. The pipe shall be tested to the class of pipe for which it is required.

No. 7·5—Asbestos cement pressure pipes and Fittings

General. 1. Asbestos is available in large quantities in Pakistan and asbestos cement pressure pipes shall invariably be used provided they are locally manufactured in preference to C. I. and R.C.C. pipes.

Classification.

2. The pipes are classified as A, B, C, and D as per test pressures of 200, 400, 600 and 800 feet of head of water.

Material.

3. The pipes shall be composed of cement (*vide* Materials Chapter :—volume I) and asbestos fibres free from grit and organic fibre or loading. The finished fibre shall be such as to be cut and drilled.

Manufacture.

4. The pipes shall be centrifugally or by any approved means manufactured and shall be seemless and homogeneous.

The pipes when they are sufficiently set to permit handling shall be completely immersed in water not less than 7 days.

Joints.

5. The pipes are without sockets and the joints are made by the insertion of the 2 spigot ends in a collar made of asbestos cement, water tightness being secured by Rubber ceiling rings 1%of the joints shall be tested to the head specified and they shall withstand stipulated pressure when the pipes are set at the maximum angular deviation.

Asbestos Cement Sleeves.

6. The asbestos cement sleeves shall be made froml materials similar to the pipe and shal comply with the appropriate limits of tolerance.

C.I. Collar, saddles and Flanges. etc.

7. Cast Iron collars, saddles, flanges, etc., shall conform to the B.S.S. No. 321, General Grey Iron Castings (Grade A) in so far as workmanship tests are concerned.

Malleable C. I Collars, Saddles and Flanges. etc.

8. They shall conform to British Standard Specification No. 31, Block Heart, Malleable C. I. Castings, in so far as workmanship and tests are concerned.

Rubber Rings.

9. The rubber shall be from first wild on plantation type with extracts not exceeding 3·5 per cent by weight. The ring shall separately be volcanised in malds, the surface being plain finish and smooth and free from air mark or any other blemish. The ring shall be tested for permanent test, hard ness and water absorption and aging by the manufacture, according to British Standard Specification No. 486.

Thickness of pipe.

10. The thickness of pipe shall be as per this table.

Asbestos

TABLE 7-E

TABLE OF CLASSIFICATION AND DIMENSIONS

Nominal size of pipe	CLASS A			CLASS B			CLASS C			CLASS D			Nominal size of Pipe
	Test pressure 200 feet head			*Test pressure 400 feet head*			*Test pressure 600 feet head*			*Test pressure 800 feet head*			
	Thichness.	External diameter	Internal diameter actual	Thickness	External diameter	Internal diameter actual	Thickness	External diameter	Internal diameter actual	Thickness	External diameter	Internal diameter actual	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
2	0·39	2·76	1·98	0·39	2·76	1·98	0·38	2·76	1·98	0·45	2·76	1·86	2
3	0·40	3·76	2·96	0·40	3·76	2·96	0·50	3·76	2·76	0·55	3·76	2·66	3
4	0·42	4·80	3·96	0·47	4·80	3·86	0·61	4·80	3·58	0·66	4·80	3·48	4
5	0·46	5·90	4·98	0·55	5·90	4·80	0·70	5·90	4·50	0·78	5·90	4·34	5
6	0·49	6·98	6·00	0·61	6·98	5·76	0·78	6·98	5·42	0·90	6·98	5·18	6
7	0·53	8·06	7·00	0·66	8·06	6·74	0·87	8·06	6·32	1·03	8·06	6·00	7
8	0·57	9·14	8·00	0·72	8·14	7·70	0·96	9·14	7·22	...	...	...	8
9	0·60	10·20	9·00	0·70	10·20	8·62	1·05	10·20	8·10	...	...	...	9
10	0·64	11·26	9·98	0·84	11·26	9·58	1·16	11·26	8·94	...	...	...	10
12	0·68	13·14	11·78	1·00	13·60	10·60	...	...		...	...	...	12
14	0·78	15·22	13·64	1·15	15·72	13·42	...	...	...	...	...	...	14
15	0·84	16·26	14·58	1·23	16·78	14·32	...	...	...	...	...	...	15
18	1·00	19·38	17·38	1·47	19·96	17·02	...	...	...	...	...	...	18
20	1·10	21·46	19·26	1·62	22·06	18·82	...	...	...	...	...	...	20
21	1·16	22·50	20·18	1·70	23·12	19·72	...	...	...	...	...	...	21
24	1·30	25·60	23·00	...	...	...	...	...	...	...	...	...	24
27	1·47	28·70	25·76	...	...	...	...	...	...	...	...	...	27
30	1·63	31·78	28·52	...	...	...	...	...	...	...	...	...	30
33	1·80	34·88	31·28	...	...	...	...	...	...	...	...	...	33
36	1·95	37·96	34·06	...	...	...	...	...	...	...	...	...	36
40	2·01	42·06	37·86	...	...	...	...	...	...	...	...	...	40

Freedom from defects and permissible.

11. The pipe shall be free from defects and the turned ends of the pipes shall conform to the dimensions given in the Table as per paragraph 10 above.

Variation in Thickness and Diameter.

The thickness of the unturned barrels shall not be less than that specified for the turned ends of the pipes.

Permissible Variation in Thickness		Permissible Variation External Diameter at End
Thicknes	Permissible Variation	
in.	in.	in
Not exceeding 0·45 ...	± 0·04	$\pm\frac{1}{16}$
0·46 to 0·59 ...	± 0·05	
0·60 to 0·75 ...	± 0·06	
0·76 to 0·93 ...	± 0·07	
0·94 to 1·15 ...	± 0·08	
1·16 to 1·50 ...	± 0·09	
1·51 to 2·10 ...	± 0·10	

Length and Permissible Variation in Length.

12. The length of the pipes shall be in accordance with the following table :—

Nominal Size of Pipe	Length not exceeding
	ft. in.
Up to and including 3 in. diameter	9 10
Over 3 in diameter.	13 1½

A tolerance of minus ½ inch or plus ¼ inch shall be allowed on the length of an individual pipe, but the average length of the pipes shall be not less than the length ordered.

Test for straightness, Regularity of Thickness and Diameter.

13. The pipes shall be tested for straightness, regularity of thickness and diameter by being rolled on a level floor or gantry, and by use of suitable straight edges, gauges and callipers which shall be provided and maintained in proper condition for the purpose.

Ball or Plug Test.

14. The regularity of the internal diameter of every pipe shall be tested by a steel ball or suitable steel plug, which shall pass freely through the whole length of the pipe.

The diameter of the ball or plug shall be less than the actual internal diameter of the pipe by the amount given below:—

Nominal size of pipe	Diameter of Ball or Plug less than actual internal Diameter of Pipe by.
2 to 10 ...	0·1 in.
12 to 21 ...	1½ per cent
Over 21 ...	1 per cent

Bursting Test.

15. The minimum tensile strength of the material of the pipes shall be not less than 2,240 lb. per square inch with tested. (*See* Clause 4) for hydraulic pressure.

Hydraulic Test.

16. Every Pipe shall be tested, in the manner that the pressure shall be steadily applied by approved means and full pressure shall be maintained sufficiently long for proof and inspection and shall withstand the following hydraulic test pressures without showing any leakage, sweating or other defect of any kind. (*See* Clause 4).

The test shall be carried out by a competent workman in the presence, if required, of the Purchaser or his representative.

Class of pipe	Test Pressure in Feet Head of Water
A	200
B	400
C	600
D	800

Chapter No. 7·6—R.C.C. Pipes Collars, and Fittings.

Pipes.

The term pipe shall signify a hollow cylinder made of cement concrete of uniform internal diameter and thickness of wall through its length.

Collars.

2. The term 'Collar' shall signify the jointing pieces similar in construction to the 'pipe' described above except that it shall be of suitable short length.

3. This shall signify such 'Pipe' which have one end

5. Reinforced cement concrete pipes shall be classified as 'A', 'B', 'C', 'D' class as mentioned below :—

Class of Pipes	Pressure Condition
'A'	Non-Pressure. But will be tested to 15 feet head when fitted in the pipeline.
'B'	Tested to 75 ft. Water Head.
'C'	Tested to 150 ft. Water Head.
'D'	Tested to 200 ft. Water Head.

Reinforcement.

6. Reinforcing bars and wire in pipes and Collars shall be steel free from rust, scale, oil and grease and shall conform with B.S.S. No. 785 and 1144.

The amount of reinforcement required in Pipes and Collars shall be as per table given below :—

Diameter	Steel Reinforcement for Pipes				Steel Reinforcement for Collars			
	Spirals		Straight Rods		Spirals		Straight Rod	
	Guage	Weight per Pipe.	Size	Weight per Pipe.	Guage	Weihgt per Collar.	Size	Weight per Collar.
1	2	3	4	5	6	7	8	9
'A' Class Pipes and Collars								
Inches		lbs.		lbs.		lbs.		lbs.
3 ...	14	0·56	3/16"	2·80	12	0·07	3/16"	·36
4 ...	12	0·76	3/16"	2·94	12	0·10	3/16"	·43
5 ...	12	1·32	3/16"	3·03	12	0·16	3/16"	·52
6 ...	12	1·47	3/16"	3·25	12	0·24	3/16"	·60
7 ...	12	2·31	3/16"	5·25	12	0·27	3/16"	·67
8 ...	12	2·75	3/16"	5·35	12	0.34	3/16"	·75
9 ...	12	3·14	3/16"	6·4	12	0·39	3/16"	·80
10 ...	11	3·56	3/16"	7·0	11	0·42	4G	·90
12 ...	11	5·22	4G	10·2	11	0·85	4G	1·1
15 ...	11	8·16	4G	15·2	10	1·0	1/4"	1·3
18 ...	9	15·04	1/4"	16·0	9	2·28	1/4"	1·6

Diameter	Steel Reinforcement for Pipes: Spirals — Guage	Spirals — Weight per Pipe.	Straight Rods — Size	Straight Rods — Weight per Pipe.	Steel Reinforcement for Collars: Spirals — Guage	Spirals — Weight per Collar	Straight Rods — Size	Straight Rods — Weight per Collar
	1	2	3	4	5	6	7	8
				'B' Class Pipes and Collars				
3 ...	14	1·81	3/16″	4·67	12	0·31	3/16″	·5
4 ...	12	1·90	3/16″	5·0	10	0·33	1/4″	·5
5 ...	12	2·13	3/16″	5·25	10	0·35	3/16″	·5
6 ...	12	3·09	3/16″	5·25	10	0·39	3/16″	·6
7 ...	12	4·97	3/16″	5·83	10	0 56	3/16″	·8
8 ...	12	6·0	1/4″	6·0	9	0·85	1/4″	·8
9 ...	12	6·02	1/4″	7·6	9	0·73	3/16″	·9
10 ...	11	7·8	4G	8·5	8	1·05	4G	1·0
12 ...	11	12·48	4G	10·2	7	1·74	4G	1·1
15 ...	11	18·5	3G	12·1	6	2·13	1/4″	1·7
18 ...	9	33·62	3G	18·7	6	2·24	1/4″	2·3
				'C' Class				
3 ...	12	2·17	3/16″	4·67	10	0·35	3/16″	·5
4 ...	12	3·28	3/16″	5·0	9	0·51	3/16″	·53
5 ...	10	4·35	3/16″	5·25	9	0·63	3/16″	·57
6 ...	10	5·87	3/16″	5·25	8	0·74	3/16″	·65
7 ...	9	7.61	3/16″	5·85	8	0·88	4G	·8
8 ...	9	11·27	1/4″	6·0	7	1·31	4G	·85
9 ...	8	11·84	1/4″	7·0	7	1·46	1/4″	·9
10 ...	8	15·87	4G	8·5	6	1·05	1/4″	1·0
12 ...	7	24·16	4G	10·2	5	3·2	1/4″	1·1
15 ...	6	36·8	3G	12·1	4	4·4	1/4″	1·7
18 ...	4	66·31	3G	18·7	3	8·33	1/4″	2·3

7. The cement used in the manufacture of pipes, collars and fitting shall comply in all respects with the provisions of B.S.S. No. 12 for Portland cement ordinary as well as Rapid Hardenings.

8. The aggregate shall comply with the provision of BSS. No. 882. For Pipes and fittings up to 36″ nominal internal diameter including, the whole of the aggregate shall pass through a sieve having meshes not exceeding 1/2″ square, and for pipes and fittings above that diameter, through a sieve not exceeding ¾″ square.

Concrete.

9. The concrete for pipes and fittings made of normal or rapid hardening cement shall be composed of one part by volume of cement (Based on a density of 90 lb. per cubic ft. for normal setting & 80 lbs. per cft, for rapid hardening cement) and not more than 4 part by volume of aggregate. The whole shall be thoroughly mixed together first in a dry state and afterwards with a proper proportion of clean Water to ensure maximum density the mixing being done in an efficient manner by a mechanical mixer.

10. *Water and Consistence*—The water shall be clear and free from deleterious matter and in no case shall the water cement ratio exceed 0·55 by weight.

11. The concrete shall be used as soon as possible after being mixed and no material which has begun to develop a set shall be used in the work.

12. After the concrete has been placed in the mould and consolidated either by bumping and rolling or by spinning it shall not be disturbed during the period of setting.

13. *Concrete after placing*—Shall be protected during setting from harmful effects of sunshine, drying winds, cold, running water and shocks.

14. The pipes after setting shall be removed from the mould and kept submerged in pure clean water for at least 3 weeks. The pipes then be removed from the tank and kept wet for another 3 weeks.

15. The cover of concrete to all reinforcement shall be at least equal to the size of the aggregate *plus* 1/16″ with a minimum of ¾″.

16. All reinforcement shall be accurately placed and means be provided for maintaining its position during manufacture.

17. The main reinforcement shall be lapped or welded in such a way that such joints shall be equal to the strength of the bars used.

18. The mould shall be such that the form and dimensions of the finished work are accurate the surface and edges clean and true, the ends square with the longitudinal axis.

19. Tamping, pressure vibration, bumping, and rolling centrifugal action or other effective method shall be used to consolidate the material such that the finished work on breaking represent dense and homogenous concrete.

20. The nominal internal diameter, thickness & weight of different classes of Pipe shall be in accordance to the table given below :—

Serial No.	Bore Dia. of Shell	A N—n. Pressure		B—Tested to 75-Head		C—Tested to 150-Head		D—Tested to 200 Head	
		Thick-ness	Weight	Thick-ness	Weight	Thick-ness	Weight	Thick-ness	Weight
	Inches	Inches	lbs.	Inches	lbs.	Inches	lbs.	Inches	lbs.
1	3	1	14	1	14	1	14	1	...
2	4	1	18	1	18	1	18	1	....
3	5	1	21	1	21	1	21	1	10
4	6	1	25	1	25	1	25	1	...
5	8	1	32	1	32	1-1/2	50	...	95
6	9	1	36	1	36	1	...	1/5/8	...
7	10	1-1/8	42	1-1/8	42	1-1/2	60	...	62
8	12	1-3/16	54	1-3/16	54	1-1/2	70	...	...
9	15	1-1/4	71	1-1/4	71	1-7/8	114	...	92
10	18	1-3/8	95	1-3/8	95	2	114	...	...
11	21	1-3/8	108	1-3/8	108	...	...	...	...
12	24	1-1/2	121	1-1/4	121	...	...	...	...
13	27	1-7/8	155	1-7/8	155	...	...	...	...
14	30	1-5/8	158	1-5/8	158	...	...	...	...
15	33	1-3/4	180	1-3/4	180	...	...	...	...
16	36	2	248	...	...	...	...	...	...
17	39	2-1/6	298	...	....	...	...	...	...
18	42	2-1/4	344	...	...	...	...	...	...
19	45	2-3/8	400	...	...	...	...	...	...
20	48	2-1/2	455	...	...	...	...	...	...

Standard lengths A, B, C, Class

Pipes up to 9″ bore	= 5 ft.
Pipes of 12″ and 15″ bore	= 6 ft. or 8 ft. at option of the Contr.
Pipes over 15″ bore	= 8 ft.

Variation in thickness and weight of 'A' Class pipes. The pipes of 21″ bore and above, thickness may be slightly more than these specified with proportionate increase in weight.

Class of Pipes	Proportion by Volume		
	C	B	A
A	1	1	2
B	1	1	1
C	1	1	1
D	1	1	1

21. The internal diameter of any pipes throughout the effective length shall no where deviate from the nominal internal diameter by more than 1/8″ up to and including 19″ diameter and by 1/4″ up to including 48 inches diameter pipes.

22. The radial thickness of the wall of a pipe or fitting shall no where vary as under :—

Pipes Diameters Inches	Variation in Radial Thickness
3 to 18 ...	±1/16 inches.
20 to 36 ...	±3/32 inches.
38 to 48 ...	±1/8 inches.

23. The standard length of A, B, C & D Class pipes shall be as under :—

Diameter	Class of Pipes A, B, C & D.	
	Standard Length	Length
Up to 9 inches ...	6 ft.	
Up to 12-15 inches ...	6 ft. or 8 ft.	
Above 15 inches ...	9 ft.	

24. The internal diameter of the Socket or Collar of a pipe shall be such that minimum clearance between the inner surface of the Socket or Collar and the outer surface of the Spigot of the entering pipe, when the two pipes are placed concentrically shall be not less than the amount set in below for the appropriate diameter of the pipe :—

No.	Nominal Internal Diameter of Pipe	Minimum Clearance between Spigot and Socket or Collar
1	3 to 9 inches ...	3/8",
2	10 to :8 inches ...	5/8"
3	24 to 48 inches and above ...	3/4"

25. The standard length of Collars for Class A, B C and D. pipes shall be as detailed below :—

CLASS, A. B. C. and D.

No.	Nominal internal Diameter of pipe	Length of Collars
1	3 to 12 inches ...	6"
2	12 to 18 inches ...	8"
3	19 to 36 inches ...	9"
4	37 to 42 inches ...	10"
5	43 to 48 inches ...	12"

26. The thickness of the wall of a Collar or a Socket shall be the same as that of the appropriate diameter of pipe in the respective class.

27. All the pipes and fittings shall be tested for Hydraulic test, Absorption test, Crushing test, as per Appendix A with condition therein.

28.. Fractures or Cracks passing through the shall except that an end Crack not exceeding the joint depth or a fracture that at its deepest point does not exceed the depth of the joint or extend more than 10 per cent around the depth circumferance shall make the pipes liable to rejection.

29. Allowable fractures or Cracks mentioned above if exist in more than 5 per cent of the pipes, inspected shall make the supply liable to rejection.

30. Defects in the judgement of the Engineer that indicate imperfect mixing, placing and curing shall make the pipes liable to rejection.

31. Exposure of the reinforcement indicating misplacement of reinforcement shall make the pipes liable to rejection,

32. The supply of pipes or fittings shall be liable to rejection if they have not been allowed to mature under suitable conditions for a period of at least of 6 weeks.

33. Each pipe and fittings shall be impressed while being moulded with the day, month and year of manufacture e.g., 25th January 1955, or with other suitable means of indentification of date. The character shall not be less than 3/4 inch high and approximately 1/16 inch deep. Where Rapid Hardening cement has been used each pipe or fitting made from such material shall also be marked with the letter R.

34. The manufacturer of the pipe or fitting shall furnish a certificate, confirming the date of manufacture of the pipe or fitting comprising the order, in the form given below :—

CERTIFICATE AS TO COMPLIANCE WITH BRITISH STANDARD AND DATES OF MANUFACTURING OF PIPES FITTINGS

We hereby certify that the concrete pipes/fittings supplied by us to your order No and referred to in Delivery Note No. Comply with B.S.S. 556 : 1945 and were made during the month of

Signed.

Dated the

FIRM SEAL

35. The Engineer, or his representative shall at all reasonable times have free access to the place where the pipes and fittings are manufactured, for the purpose of examining and sampling the materials, pipes and fittings and for supervising the testing and marking.

36. The manufacturer shall provide free of charge every facility and all labour required for such examination sampling, inspecting, testing, and marking before delivery.

37. The manufacturer shall provide and maintain in good working order suitable convenient and accurate apparatus for testing sample pipes and fittings.

38. If the manufacturer fails to provide such said facilities at his work for making the standard prescribed tests embodied in B.S.S. the manufacturer shall bear the cost of carrying out the tests elsewhere deemed fit by the Engineer.

39. The pipes and fittings shall be made to this specification and B.S.S. and the manufacturer shall furnish a Certificate that the pipes and fittings have been made in all respects in accordance and comply with the requirements of this specification.

APPENDIX A

Tests for Pipes and Fittings

The pipes and fittings shall be subjected to the followings tests :—

Hydraulic Test—The Pipe shall with-stand an internal hydraulic pressure as per specification clause No. 5 applied on the barrel without showing sign of injury or sweating. The pressure shall be applied at a rate not exceeding 10 lbs. per sq. inch in 5 seconds, and full pressure shall be maintained for at least ½ minutes.

Absorption Test—From each pipe selected, a test piece of the full thickness of the pipe and approximately 4 inch square, all edges being broken shall be taken.

The test pieces shall be dried for 72 hours in a suitably ventilated drying oven the temprature of which as measured by a thermometer suspended centrally in between 185° and 204°F 85° and (95°C). On removel from oven they shall atonce be weighed and immediately submerged in water, the temperature of which is between 58° and 64°F (14·4° and 17·8°C) for a period of 10 minutes at the end of which time they shall be taken out immediately wiped with a dry cloth for a period of ½ minute, and again weighed They shall then be submerged in water again for a total period of 24 hours, at the end of which time they shall be taken out, wiped with a dry cloth and weighed. The increase in weight by absorption of water in first 10 minutes shall not exceed 2·5 per cent of the dry weight of the test piece, nor shall the total absorption exceed 6·5 per cent of dry weight.

Crushing Test—Each selected pipe shall be placed centrally between and with its longitudinal axis parallel too, two hard unyielding bearers of 6 inch width, with rubber packing 6 inch wide and 1 inch thick between the bearer and the pipe. The bearers shall extend the full length of the pipe. The total load shall be steadily and uniformily applied starting from zero at a rate not exceeding 112 lbs. per ft. out any sign of failure for at least 1 minute to a minimum load of 1350 lbs. per ft. length.

Sample for testing—(*i*) For Hydraulic Test 2 per cent of the pipe or fittings when the batch comprises 500 pipes or fittings or less and if the batch comprises more than 500 pipes or fittings 2 per cent of the first 500 and one pipe or fitting from every 100 or part thereof beyond this number. This applies to A and B class pipes only. Every 'C' class or 'D' Class pipe shall be tested to the required pressure.

(*ii*) *For absorption Test*—From each batch of 100 pipes or fittings or less number three pipes.

(*iii*) *For Crushing Test* - 2 per cent of the pipes when the batch comprises 500 pipes or less and if more than that 2 per cent of the first 500 and one pipe from every 100 or part thereof beyond this number.

Conditions—Should all the pipes selected as in (*i*), (*ii*), (*iii*) above, pass the test the whole of the pipes comprising the batch shall be deemed to comply with this test. If one pipe fails the purchaser or his representative may select from the same batch a further similar number for testing, and if all such further pipes comply with the test the whole of the pipes comprising the batch including these which have passed the test, shall be deemed to comply with this test. If any one of the pipes selected from the retest fail, then the whole of the batch presented may be rejected.

No. 7·7—Humesteel Pipes.

General. 1. In areas, were scale collects on Iron Pipes, Humesteel pipe shall be laid in preference to C. I. or steel pipe.

Description. 2. The humesteel pipe consists of steel pipes with lining of ¼″ to 1″ cement mortar lining inside and outside. The lining shall be centrifugally spun on the pipes.

Spigot and sockets ends. 3. The ends of the pipe shall be provided by welding M. S. Spigot and Socket ends to the C.M.S., care of the pipe to give a water tight metallic joint, which shall be protected by a concrete covering during laying.

No. 7·8—Large Mild Steel Mains

General. 1. Where the main size exceeds 30″ i/d M. S. Plates are fabricated into pipes by welding or rivetting.

Method of rivetting. 2. Internal rivets should always be counter sunk.

(*a*) *For low pressure Pipes*—Single rivetting with lap joints be adopted both for longitudinal and circular joints.

(*b*) *For High Pressure Pipes*—Single or double butt strap joints with multiple line of rivets be adopted. For circumferencial joints, single butt strap joints are quite efficient.

Plate Thickness. 3. The thickness of the plate shall be worked out both as to internal pressure and external pressure.

(*a*) For External Pressure.

$$T = d.\left(\frac{6}{E}P\right)^{1/3}$$

Where t = thickness.

d = Diameter of pipe in ft.

p = Uniform external pressure in lbs Square ft.

E = Modulas of elasticity in lbs. Square inch.

(*b*) For internal Pressure.

The thickness shall be worked out for hoop stress equal to twice the working pressure to allow for water hammer.

Supports for Pipes. 4. Where the pipes are resting above ground, they shall be supported on a footing of bricks or concrete at intervals of 20 ft. to 60 ft. as directed by the Engineer-in-Charge.

Expansion joints.

5. Expansion joints shall be provided at every 200 ft. which may be done by a flexible flanged coupling of such width or material thickness that it may be stretched or compressed in the direction of pipe axis the necessary stress relieving movement being thus allowed. Bends should be of long radius to avoid damage to the metal by flexure.

Painting.

6. Exposed pipes shall be painted with light colour bitumastic paint to reduce heat absorption.

Protective Coating.

7. Protective lining of cement monter. 1 : 1 shall be given inside the pipes as required by the Engineer-in-Charge.

APPENDIX

Pipe Lining and Protective Covering

Pipe Lining and Protective Coatings.

The A. W. W. A. specifications (1908) for bell-and-spigot cast-iron pipe and fittings required a coating inside and outside of coal-tar pitch varnish. Castings are heated to 300°F and then dipped for at least 5 min into vats containing the pitch and a small amount of oil also at about 300°F. A coating of about 1/32 in. is thus produced for a single dip. Asphalt is sometimes used in place of coal-tarpitch for dip-coatings. Coal-tarpitch coatings are more durable then asphalt coatings for underground water pipes after the pipes are in service, but they are more subject to damage in shipping and handling the pipes because the temperature range between the brittle and softening points of coal-tarpitch usually does not exceed 45°F, whereas asphalts have range of 120° to 130°F. Nearly all bell-and-spigot water pipes are furnished with dip coatings unless more effective coatings are specified. Flanged pipe is commonly furnished with dip coatings unless more effective coatings are specified. Flanged pipe is commonly furnished without coating.

Two types of interior linings for cast-iron pipe are being widely used for corrosion protection, *viz.*, special bitumeinous lining with inert fillers and cement linings. A well known example of the former type is Bitumastic Enamel, which consists of a coal-tar-pitch base and finely divided mineral fillers. When the enamel is applied at the foundry, the pipe is first coated by the regular dip method and after cooling is placed in a horizontal turning rig and revolved at high speed. A trough carrying the hot enamel is then inserted into the pipe and turned over, the coating being thus deposited on the pipe surface to a thickness of about 3/32 in. The susceptibility of this coal-tar-pitch coating to temperature changes is somewhat modified to suit particular climatic conditions by the use of a fluxing oil. For lining pipes in the field with Bitumastic, a portable rolling rig may be used, for reconditioning old pipes in place, the coating may be brushed on if the pipe is 30 in. or larger in size. In both cases, the pipe is first cleaned thoroughly, dried and then primed by brushing on a cold bituminous solution.

Fittings are lined by hand brushing. The temperature of molten lead used for joints should be kept less than 800°F to prevent injury to Bitumastic lining.

The American Standards Association tentative specifications (1930) for cement lining for cast-iron pipe call for minimum thicknesses of 1/8in. for pipes 4 to 12 in. in diameter and 3/16 in. for larger sizes. A satisfactory mortar may be obtained with 3 parts portland cement to 1 partsand. Pipe to be lined with cement should not be pre-coated with tar or asphalt and should be cleaned thoroughly. New pipe is cement lined at the foundry by the centrifugal process, the method being similar to that used in applying Bitumastic lining. Fittings are lined by hand brushing. When water is first applied to cement-lined pipe some free lime and other materials are leached out of the cement and cause hardness and alkalinity in the water. This effect usually lasts for only a few days but may continue if the water is soft and corrosive and result in the slow disintegration of the lining. Smaller pipes may be given hot tar dip coatings after the cement lining has set, but for larger pipes the expansion to the heat may result in breaking the bond between pipe and cement. Bituminous paint may be used with larger pipes.

Cement lining of small pipes in place (up to 12 in.) may be accomplished by the Tate Process, in which mortar dumped into a section of the pipe is shaped into lining by means of a mandrel which is pulled through the pipe. Pipes large enough for men to enter may be lined in place by hand or by a special centrifugal machine.

CHAPTER 8

Pipe Laying and Jointing

No. 8·1 *Excavation and Trenches for Pipe Work*

Alignments of trenches, cover, etc.

1. The lines of trenches for all pipe lines shall be carefully set out to suit the alignment of the pipe-lines. The trenches shall be carefully trimmed at sides and bottom so that the pipe lines, when laid (except where the trench is cut into rocky ground) shall rest on the natural bed of the trench throughout their full length. Shallow joint holes being left for the joints, where necessary. Where pipe lines are to be laid in the ground in the plains the depth of cover, i. e., the normal distance from ground level to the top of the pipe lines shall be kept at about 2′—9″ and shall never be less than 2′—6″ clear except when for any special reasons the Engineer-in-Charge directs in writing to the contrary. In the hills the depth shall normally be about 3′—0″ and shall never be less than 2′—8″, unless for any special reasons the Engineer-in-Charge may find it impracticable to do so. In special cases, for example where the subsoil is heavily impregnated with corrosive substance pipe lines may occasionally have to be laid on the surface, if traffic and other conditions permit. In such cases the pipes shall be supported on dwarf blocks of concrete, bricks or stone where necessary in the opinion of the Engineer-in-Charge at intervals of 8 to 10 feet.

Lengths of trenches, to be kept open.

2. Unless otherwise directed or permitted, not more than 100 feet length of any trench in built up areas or 300 feet in open country in advance of the end of the pipe line already laid shall be opend at any time and all work shall be done in open trench or excavation. No tunnelling shall be done except with the consent of the Engineer-in-Charge.

Timbering of Pipe Trenches.

3. Where necessary, the contractor shall support the sides of the pipe trench and other excavation by suitable timbering and the trench sides shall be close timbered wherever the Engineer-in-Charge may so desire, without extra cost. Ordinarily timbering shall be removed as the work proceeds and the trenches are filled up after due test but it may be necessary in certain cases to leave a certain portion of the timbering in the ground in which case the contractor shall be paid for the cost of such timbering at the rate provided in the contract schedule of rates ; but if the necessity for leaving the timber in has, in the opinion of the Engineer-in-Charge, arisen from carelessness or neglect or

lack of skill, on the part of the contractor, the timber so ordered by the Engineer-in Charge to be left in the trench shall not be paid for.

The kind and quality and dimensions of the timber used shall at all times be subject to the approval of the Engineer-in-Charge. The contractor shall furnish and maintain such planking, poling boards and wooden braces or struts as may be required to support the sides of the excavation and to prevent any movement of the ground.

The Engineer-in-Charge may order additional supports to be put in at the expense of the contractor and the compliance with such order will not relieve the contractor of his responsibility for the sufficiency or otherwise of such supports. Great care shall be taken to prevent voids occurring outside the poling boards but if voids are formed they shall be immediately filled and rammed to the satisfaction of the Engineer-in-Charge.

Removal of Timber.

4. The operation connected with the removal of timbering shall not endanger the pipe lines already laid, and other structures, buildings or property whether public or private. The right of the Engineer-in-Charge to order poling boards and struts, etc., to be left in shall not be construed as creating any obligation on his part to issue such orders and his failure to exercise his right to do so shall not relieve the contractor from any liability in respect of damage to persons or property occurring from or upon the work of laying the pipe lines, occasioned by negligence or otherwise arising out of a failure on the part of the contractor to leave in place in the trench sufficient timbering to prevent any caving in or moving of the ground adjacent to the bank of the trench.

Shoring up of buldings.

5. The rates included in the contract schedule of rates for pipe laying work are inclusive of all work required for shoring up of the buildings along or near the trench which are likely to be endangered by the execution of the work.

Opening out trenches.

6. In excavating the trenches the road metalling, stone or brick pavement, kerbing, turf, etc., shall be placed on one side and shall be preserved for reinstatement when the trench is filled up. The surface of all trenches through private property shall be restored and maintained to the satisfaction of the owner and if he is dissatisfied, to the satisfaction of the Engineer-in-Charge.

The contractor shall grub up and clear the surface over the trench but the cutting of any live fence or tree in the line of trench shall be done with the approval of the Engineer-in-Charge.

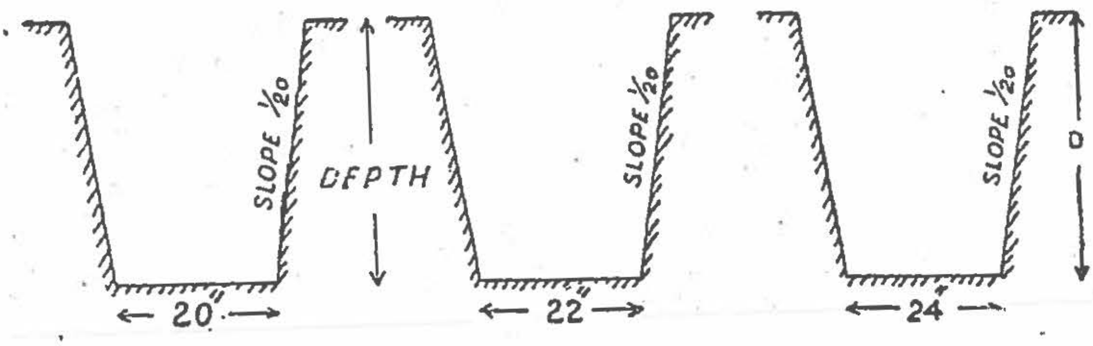
Removal of water from pipe trenches.

7. The contractor shall provide and carry out as part of the contract all pumping, bailing out or removing of water accumulated if trench during the execution of work in such a manner as will neither cause injuries to the public health nor to private property and no extra amount shall be payable for such work.

Width of trenches.

8. The maximum width of trenches for measurement purpose shall be taken as shown on the diagrams following :—

I	II	III
For pipe lines up to and Including $1\frac{1}{2}''$ i/d.	For pipe lines $2, 2\frac{1}{2}''$ and $3''$ i/d.	For pipe lines over $3''$ i/d.
$1 - 20'' + \frac{\text{DEPTH}}{10} \rightarrow 1$	$1 \leftarrow 22'' + \frac{\text{DEPTH}}{10} \rightarrow 1$	$1 \leftarrow 24'' + \frac{\text{DEPTH}}{10} \rightarrow 1$



If the actual widths of trenches are less than shown on the diagram above, the actual volume of excavation only shall be measured and paid for. If the actual widths are greater than those shown on the diagrams above, the widths to be measured for calculation of volume of excavation to be paid for shall be in accordance with the above diagrams.

Depth of trenches.

9. The trenches shall be dug to such depth as the Engineer-in-Charge or his authorised subordiate may direct from time to time but the normal cover shall be not less than $2\frac{3}{4}$ feet. The bottom of the trench shall be properly trimmed off to present a perfectly plane surface and all irregularties shall be levelled. Where rock and large stones or boulders are encountered, the trench shall be trimmed to a depth of at least 3 inches below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with stone broken to pass through a $\frac{1}{2}''$ screen and well rammed to form a fair and even bed for the

pipes. Joint holes shall be excavated to such dimensions as will allow the joints to be well and thoroughly caulked. Joint holes shall be paid for on the basic of actual measurement subject to the maximum dimensions being to the approval of the Engineer-in-Charge of the work.

It is to be clearly noted that should the contractor excavate any trench in good ground to a greater depth than that required, the extra depth will have to be filled up at the contractor's expense with such material as the Engineer-in-Charge may direct.

10. After the pipe have been laid, jointed and tested and proved to be water-tight, the trenches shall be refilled in the manner described below.

Refilling of trenches.

The first foot of filling material immediately above and around every pipe shall be put round the pipe or thrown into the trench until the same has been protected in the manner described above.

After the first one foot of material has been placed in position, the remainder of the material is to be put in and rammed in layers not exceeding 6" at a time and sufficient water shall be used in addition to aid the consolidation of the trenches.

Trenches shall be filled to their origin al surface, surplus material being removed by the contractor at his own expense after the trenches have finally settled. All kerbing and other surface work, paving and metalling shall be reinstated in as good condition as before disturbance or the execution of the work and any deficiency in the filling material or in the kerbing, paving and metalling, resulting from theft or any other cause whatsoever shall be made good by the contractor at his own expense. Before his final bill is paid the contractor shall make good promptly at his own expense any settlement that may occur in the surface of the roads, foot paths, yards, gardens, etc., whether public or private, caused by the trenches or other excavation not having been properly filled up and consolidated and he shall be liable for any accidents caused thereby. He shall also repair and set right at his own expense, any damage done to property and such work shall be carried out to the full satisfaction in all respects of the owner thereof.

Where sluice valves, air valves, etc., are to be fixed in the ground the depth shall be such as to leave the top of spindle caps not less than 6" below the surface of the road.

11. See excavation under Sewerage. Chapter 13 of this volume.

Excavation in deep tranches and below water level.

12. The various materials excavated to be separated and stacked, so that in refilling they may be again relaid in the same order, and thus the least possible damage be done to public roads, cultivated fields, etc.

Material excavated.

13. Necessary fencing, boarding, strutting, and watchmen shall be provided by the contractor at his cost without any extra payment. He shall further provide red flag in the day and red light in the night in the ends of excavated trench.

Lighting and Fencing.

14. The contractor shall provide all safety measures, as instructed by the Engineer-in-Charge for the protection of property and life from any accident and damage without any extra claim and even after all the safety measures, if any accident or damage occurs it shall be the entire responsibility of the contractor to make good any loss or stand to litigations.

Accidents and damage to the property and life.

No. 8·2—Laying and Jointing of C. I. Pipes.

Stacking of Pipes.

1. The pipes shall be laid out along the side of the trench, each pipe in its proper position for laying with an extra pipe after every 20′ to allow for cutting. Where the trench crosses a road or place where such distribution is inadmissible, the pipes shall be stacked in heaps at each end, sufficient to fill in the length. Small pipes below four inches diameter may be stacked in heaps at every 100 feet.

Preparation of Pipes.

2. The pipes before being laid shall be brushed throughout to remove any soil or stones that may have accumulated therein, the inside of the socket and outside of the spigot being carefully cleandd. For small pipes, they should be titled up to remove any accumulation.

Laying of the Pipes, Specials and Valves.

3. The pipes shall be lowered singly (or in pairs if the Engineer-in-Charge shall so direct in writing) into the trench and each pipe, before being laid, shall have all sand, dirt carefully removed from the inside thereof for which purpose proper brushes shall be used. care being taken that the coating is not

damaged. The pipes shall be slung and struck with a hammer and also carefully examined to see that they are free from cracks and other defects and after they are laid in the trench a strong plug shall be provided and fixed to each open end of the pipelines in order to keep them free from all extraneous matter. The pipes shall be properly driven home and joined together and shall be properly bedded throughout their whole length. All pipes shall be laid perfectly straight from bend to bend except where the Engineer-in-Charge shall deem it necessary that the pipes may be laid on the sweep according to the curvature table given in Table No. 2, at paragraph No. 16 of the specification. Pipe laying and jointing shall proceed from one end of each pipe line, but if such pipe line is intended to be laid in or on sloping ground, the starting point shall be at its lower end and the pipes shall be laid uphill with socket ends leading.

Where found necessary by the Engineer-in-Charge the contractor shall be required te provide and erect sight rails to enable the pipe line to be laid to correct lines, levels and gradients.

All tool marks on the sockets and also other marks and patches on the pipes shall be painted with pitch or tar to be provided free of cost by the Engineer-in-Charge before earth filling is done. Cost of labour in painting tool marks on sockets, etc., is included in the rate to be paid for jointing work, and no extra will be allowed. All sluice valves, air valves, hydrants and vertical branches shall be fixed perfectly vertical in all cases. All horizontal branches and trees shall be fixed perfectly horizontal.

Socketed joints.

4. The socket joints of the pipes and special castings shall be made with lead and best white Pakistani spun yarn. The joints shall be made by forcing the spigot end of one pipe into the socket end of the preceding one a gasket of spun yarn being then driven and caulked into the bottom of the joint to keep the pipes concentric. The gasket shall either be driven in complete rings, the length of yarn to form each ring being carefully measured and cut before hand to ensure a good fit or, better still a spiral coil of yarn shall be inserted. In the former case, care shall be taken that the joints of the successive rings do not coincide. Each ring shall be packed with a thin steel "yarning" tool and then lightly hand caulked to ensure that the yarn is solidly packed. No short pieces of yarn forming less than a complete ring shall be used.

The yarn shall be caulked to such a depth as to leave clear the following depths measured from the faces of the sockets given in the table No. 1 below for the lead joints:—

TABLE I

I/d of pipe	*Finished depth of lead joints*
2"	$1\frac{5}{8}$"
$2\frac{1}{2}$"	$1\frac{5}{8}$"
3"	$1\frac{5}{8}$"
4"	$1\frac{5}{8}$"
5"	$1\frac{5}{8}$"
6"	$1\frac{3}{4}$"
7"	$1\frac{3}{4}$"
8"	$1\frac{7}{8}$"
9"	$1\frac{7}{8}$"
10"	2"
12"	2"

Leading the Joint.

5. The lead for the joint shall be melted in a suitable lead pot in a special grate or "devil" or over a furnace provided close to the joint. The outer end of the socket shall then be closed either by means of a thoroughly kneaded clay gasket stifiened with a core of yarn in the case of small pipes, or by a hinged iron ring or by a clip or asbestos composition ring fitted over the spigot against the face of the socket and pulled up tight by a thumb screw at the top of the pipe, a small "pond" about 5 or 6 sqaure inches in area by about 1 inch in depth being formed in the clay at the summit of the pipe with an outlet into the top of the joint. The molten lead shall then be run into the joint either from a metal ladle or directly from the lead pot to completely fill up the joint in one operation. Care shall be taken to have sufficient molten lead in the pot for each joint before starting the operation. All partially filled joints shall be cut or melted out and the whole joints shall be refilled completely with lead at one running. To ensure that the joint is completely filled with lead the "pond" at the summit of the pipe shall be kept filled to the brim in course of pouring the molten lead.

The internal surface of the clay gasket or metal or asbestos ring shall be levelled off to leave a uniform fillet of lead projecting on the face of the socket all round to the extent of not less than 1/4 inch.

Before making any joint, care shall be taken to remove all thick bituminous material or coal tar from the spigot end and from the inside of the socket. Both shall be thoroughly cleaned and dried before the joint is made.

Caulking. 6. After the lead has solidified in the joint, the clay gasket or the ring shall be removed and the joint caulked by hammering up the face of the lead uniformly with a series of at least three special caulking chisels, the thicknesses of the caulking edges of which shall vary from a little less than 1/8″ to just under the width of the lead joint shall be set back by caulking, not less than 1/6th of an inch inside the face of pipe socket.

Each caulking chisel shall be kept perfectly true on the edges and the surface of the working face shall be formed at an angle of about 80° to 85° to the back of the tool.

The finished face of each lead joint shall be smooth and uniform all round and shall not show any tool marks.

The caulking hammer shall be of steel with hexagonal or octagonal face, weight 1½ lbs. with short wooden handle.

Flanged Joints. 7. These shall be made using 1/8″ rubber insertion jointing discs accurately cut. The bolts of the joints are to be tightened up systematically and uniformly in such a manner that the tension in all the bolts shall be similar and there shall be no tendency to distortion. No bolt shall be stressed beyond its elastic limit and no spanners other than British Standard pattern shall be allowed nor shall any appliance for lengthening the leverage of any spanner be permitted. All flanges with their bolts shall be painted with 2 coats of pitch or tar to be provided free of cost by the Engineer-in-Charge before the earth filling is done.

Bends. 8. All bends shall be properly fixed and secured in the trench so that no risk of movement thereof shall take place due to the thrust of the water. For this purpose a block of cement concrete (1 : 4 : 8 with brick ballast aggregate) length about 2 feet, depth equal to the diameter of the pipe and width being that of the excavation on that side of the bend, shall be provided on the outer side of each bend. Care shall be taken to ensure that each lead joint or flanged joint is fully exposed so that it can be caulked or re-caulked easily without interference due to the concrete blocks.

Testing. 9. After each section of the pipe line has been completed it shall be tested for water tightness before being covered in. This can be done by closing water. The pressure should then be raised by means of a valve, back flange, cap or plug and filling the pipe with water.

The pressure should then be raised by means of a small hand force pump till it registers 15 per cent above the highest working pressure in the section, and the test pressure should be ascertained by means of a reliable gauge. When the pipe is laid on any appreciable gradient, the test should be carried at the lower end of the section. Any leaking joints should be made good, and the above test re-applied until no further leaks are apparent.

10. TABLE SHOWING MINIMUM RADII OF CIRCLES OF CURVATURE TO WHICH B.S. SPECIFICATION, SPIGOT AND SOCKETED, CAST IRON PIPES WITH PLAIN SOCKETS FOR RUN AND CAULKED LEAD OF VARIOUS DIAMETERS SHOULD BE LAID

Internal diameter of pipe	*Laying length*	*Radius of circle of curvature.*
2″	6 ft.	150 ft.
2½″	9 ft.	216 ft.
3″	9 ft.	216 ft.
4″	9 ft.	216 ft.
4″	12 ft.	288 ft.
5″	9 ft.	252 ft.
5″	12 ft.	336 ft.
6″	9 ft.	252 ft.
6″	12 ft.	336 ft.
7″	9 ft.	290 ft.
7″	12 ft.	387 ft.
8″	9 ft.	329 ft.
8″	12 ft.	438 ft.
9″	9 ft.	367 ft.
9″	12 ft.	490 ft.
10″	9 ft.	406 ft.
10″	12 ft.	540 ft.
12″	9 ft.	490 ft.
12″	12 ft.	653 ft.

Use of old pipes

11. Old pipes, when used, shall be thoroughly tested for soundness and cracked portions cut out. Incrustation shall be scraped out, and all holes in pipe walls shall be thoroughly plugged up by screwed plugs and pipes tested under hydraulic pressure, equivalent to a head of at least 300 feet. The pipes shall then be dipped in hot Angus Smith's Solution and shall not be used before one week.

Turned and bored joints.

12. For turned and bored joints, the joints shall be carefully cleaned and then smeared with Russian tallow, the spigot end of one pipe being placed in the socket of the other and driven home by three or four blows of a wooden mallet. (The next pipe is sometimes slung on a rope and used for this purpose).

New flanged joints.

13. Flanged joints shall be made by painting the facing of the flange with red lead freely and bolting up evenly on all sides.

A thin fibre of lead wool may be very useful in making the joints water-tight, where facing of the pipes is not true.

Where packing must be used, it shall be of rubber insertion cloth, three ply, and of approved thickness. The packing shall be of the full diameter of the flange with proper pipe hole and bolt holes cut, and even at both the inner and outer edges.

Where the flange is not fully faced, the packing shall be of the dimension of the facing strip only. Its proper placing shall be tested before another pipe is joined on.

Weight of lead.

14. The weight of C.I. pipes of Class 'B' and that of lead required for jonting are given approximately in the table given below :—

TABLE 8-A

SHOWING WEIGHT OF C.I. PIPES AND THE MATERIAL REQUIRED PER JOINT FOR JOINTING THEM, AS PER BRITISH STANDARD SPECIFCATIONS

Dimensions of pipes in inches	Length of pipe in feet	Thickness of pipe in inches	WEIGHT OF EACH PIPE			Total depth of socket in inches	Weight of lead per joint in lbs.	Weight of hemp per joint in lbs.	Depth of lead in inches
			Cwt.	Qrs.	Lbs.				
1	2	3	4	5	6	7	8	9	10
3"	9'	0·38	1	0	17	3·0	4·5	0·25	2·00
4"	9'	0 39	1	2	4	3	5·5	0·38	2·00
5"	9'	0·41	2	0	4	3½	7·0	0·44	2·50
6"	9'	0·43	2	2	6	3½	8·0	0·44	2·40
7"	9'	0·45	3	0	9	4½	9·5	0 50	2·40
8"	9'	0·47	3	2	24	4	12 0	0·63	2 90
9"	9'	0·49	4	1	9	4	13·5	0 69	2·90
10"	12'	0·52	6	2	2	4	14·75	0·75	2 90
12"	12'	0 57	8	1	6	4	17·0	1·06	2·90
14"	12'	0·61	10	1	15	4½	21·5	1·38	3·25
15"	12'	0·63	11	1	21	4½	23·0	1·50	3·25
16"	12'	0·65	12	2	7	4½	24 25	1·63	3.25
18"	12'	0 69	15	0	5	4½	31·50	2·07	3·10
20"	12'	0·73	17	2	11	4½	34·50	2·25	3·10
21"	12'	0·75	18	3	25	4½	36 25	2·38	3·10
22"	12'	0 77	20	2	8	5	38·25	2·50	3·60
24"	12'	0·80	23	1	...	5	41·25	2·60	3·60
26"	12'	0·83	26	0	4	5	44·50	2 84	3·60
27"	12'	0·85	27	2	13	5	46·75	2·94	3·50
28"	12'	0·86	28	3	20	5	50·25	3·06	3·50
30"	12'	0·89	31	3	26	5	58·25	3·22	3·40
32"	12'	0·92	35	0	16	5	63 0	3·38	3·40
33"	12'	0·94	37	0	5	5	57·56	3·63	3·25
36"	12'	0·98	42	0	4	5	71·50	4·13	3·25

STAND

Nominal internal diameter
3"
4"
5"
6"
7"
8"
9"
10"
12"
14"
15"
16"
18"
20"
21"
22"
24"
26"
27"
28"
30"
32"
33"
36"
38"
40"
42"
44"
46"
48"

R JOINT ONS	
...nt ...p ...nt ...s.	Depth of lead in inches
	10
5	2·00
3	2·00
1	2·50
1	2·40
1	2·40
1	2 90
1	2·90
5	2 90
5	2·90
3	3·25
1	3·25
	3.25
	3·10
	3·10
	3·10
	3·60
	3·60
	3·60
	3·50
	3·50
	3·40
	3·40
	3·25
	3·25

TABLE 8-B
STANDARD WEIGHTS OF CAST IRON BENDS COLLARS, TAIL PIECES AND HYDRANTS

Nominal internal diameter	BENDS 90″	BENDS 45″	BENDS 22½″	BENDS 11½″	Collars	TAIL PIECES Flanged socket	TAIL PIECES Flanged spigots	Hydrants 3″ for all sizes	REMARKS
	C. Q. L.	C. Q. L.	C. Q. L.	C. Q. L.	C. Q. L.	C. Q. L.	C.Q.L.	C. Q. L.	
3″	0 1 13	0 1 18	0 1 18	0 1 18	0 1 4	0 0 27	0 0 18	0 2 18	
4″	0 2 4	0 2 5	0 2 5	0 2 5	0 1 14	0 1 8	0 0 25	0 3 9	
5″	0 2 27	0 3 4	0 3 4	0 3 4	0 2 7	0 1 23	0 1 8	1 0 8	
6″	1 0 4	0 3 27	0 3 27	0 3 27	0 2 23	0 2 7	0 1 16	1 1 8	
7″	1 1 2	1 0 27	1 0 27	1 0 27	0 3 7	0 2 18	0 1 25	1 2 7	
8″	1 3 0	1 2 6	1 2 6	1 2 6	1 0 11	0 3 11	0 2 14	2 0 7	
9″	2 0 7	1 3 14	1 3 14	1 3 14	1 1 0	0 3 26	0 2 26	2 1 13	
10″	2 2 22	2 0 25	2 0 25	2 0 25	1 1 14	1 0 18	0 3 16	2 3 4	
12″	3 2 1	2 3 23	2 3 23	2 3 23	1 3 27	1 1 17	1 0 14	3 1 25	
14″	4 1 23	3 3 22	3 3 22	3 3 22	2 2 16	1 3 10	1 2 8	4 3 3	
15″	5 0 27	4 1 25	4 1 25	4 1 25	2 3 6	1 2 26	1 2 24	5 0 25	
16″	5 3 0	4 3 17	4 3 17	4 3 17	3 0 8	2 0 19	1 3 16	5 2 23	
18″	6 3 20	6 0 13	6 0 13	6 0 13	3 3 3	2 2 20	2 1 1	7 1 19	
20″	8 2 13	7 1 25	7 1 25	7 1 25	4 1 6	3 1 24	2 2 21	8 2 19	
21″	9 3 15	8 1 6	8 1 6	8 1 6	4 2 13	3 2 27	2 3 17	9 1 8	
22″	11 2 1	9 1 0	9 1 0	9 1 0	5 2 3	4 0 24	3 1 16	10 3 27	
24″	13 2 23	10 2 27	10 2 27	10 2 27	6 0 16	4 3 2	3 3 13	12 1 13	
26″	15 2 21	12 1 3	12 1 3	12 1 3	6 3 27				These sizes will be special castings for which no standard weights are available.
27″	17 1 26	14 0 11	14 0 11	14 0 11	7 1 9				
28″	18 1 6	14 3 1	14 3 1	14 3 1	7 2 20				
30″	20 1 6	16 1 3	16 1 3	16 1 3	8 1 22				
32″	23 1 4	19 1 1	19 1 1	19 1 1	9 0 13				
33″	24 2 7	20 1 7	20 1 7	20 1 7	9 3 5				
36″	27 3 11	23 0 3	23 0 3	23 0 3	10 3 13				
38″	31 3 0	26 3 18	26 3 18	26 3 18	11 3 21				
40″	34 0 2	28 3 9	28 3 9	28 3 9	12 3 1				
42″	36 2 26	31 0 14	31 0 14	31 0 14	13 2 20				
44″	41 2 10	35 3 17	35 3 17	35 3 17	15 2 26				
46″	44 2 17	38 2 5	38 2 5	38 2 5	10 2 23				
48″	47 1 9	40 3 10	40 3 10	40 3 10	17 2 2				

TABLE 8-C

SHOWING STANDA·D WEIGHTS OF C. I. PIPE TEES AND ANGLE

Nominal internal diameter	3″	4″	5″	6″	7″	8″	9″	10″
				Cast				
	C. Q. L.							
3″	0 2 27							
4″	0 3 19	0 3 27						
5″	1 0 17	1 0 25	1 1 14					
6″	1 1 18	1 1 25	1 2 11	1 2 21				
7″	1 2 16	1 2 24	1 3 11	1 3 22	2 0 6			
8″	2 0 17	2 0 23	2 1 10	2 1 20	2 2 4	2 2 21		
9″	2 1 23	2 2 3	2 2 18	2 3 1	2 3 13	3 0 2	3 0 17	
10″	2 3 14	2 3 20	3 0 9	3 0 19	3 1 6	3 1 27	3 2 12	3 3
12″	3 2 7	3 2 17	3 3 3	3 3 18	4 0 1	4 0 23	4 1 7	4 1
14″		4 3 20		5 0 21		5 1 27		5 3
15″		5 1 13		5 2 14		5 3 21		6 0
16″		5 3 11		6 0 13		6 1 20		6 2
18″		7 2 8		7 3 10		8 0 17		8 1
20″				9 0 3		9 1 11		9 2
21″				9 2 20		10 0 1		10 1
22″				11 1 11		11 2 20		11 3
24″				12 2 25		13 0 7		13 1
26″						15 3 25		16 1
27″						16 3 11		17 0
28″						17 2 10		17 3
30″						20 3 13		21 1
32″								20 0
33″								
36″								
38″								
40″								
42″								
44″								
46″								
48″								

Nominal internal diameter	22″	24″	26″	27″	28″	30″	32″	33″
22″	14 3 12							
24″		16 3 2						
26″		19 2 4	20 0 10					
27″		20 1 20		21 0 25				
28″		21 0 22			22 0 24			
30″		24 3 8				26 2 0		
32″		26 3 1				28 1 24	29 0 1	30 2
33″		27 3 23				29 2 18	30 0 18	
36″		34 1 24				36 0 23	36 3 1	
38″		37 0 7				38 3 8	39 1 15	
40″		41 1 12				43 0 15	43 2 23	
42″		44 1 1				46 0 5	46 2 14	
44″		49 2 9				51 1 16	51 3 25	
46″		52 3 13				54 2 22	55 1 4	
48″		55 2 26				57 2 9	58 0 20	

TABLE 8-D

BRANCHES OF BRITISH STANDARD SPECIFICATIONS

LE

		OF			BRANCHES			
9″	10″	12″	14″	15″	16″	18″	20″	21″
		Iron		*Standard*			*Tees*	
3 0 17								
3 2 12	3 3 2							
4 1 7	4 1 27	4 2 27						
	5 3 3	6 0 4	6 1 9					
	6 0 25	6 1 25		7 0 10				
	6 2 25	6 3 26		7 2 11	7 3 0			
	8 1 23	8 2 25		9 1 11	9 2 7	10 0 19		
	9 2 17	9 3 27		10 2 7	10 3 4	11 1 16	11 3 6	
	10 1 7	10 2 18		11 0 26	11 1 23	12 0 8		12 2 22
	11 3 27	12 1 10		12 3 19	13 0 16	13 3 1		14 1 20
	13 1 23	13 2 27		14 1 8	14 2 6	15 0 20		15 3 11
	16 1 8	16 2 14		17 0 27	17 1 21	17 3 23		18 1 14
	17 0 21	17 2 1		18 0 13	18 1 8	18 3 10		19 2 2
	17 3 21	18 0 18		18 3 15	19 0 8	19 2 11		20 1 3
	21 1 0	21 2 12		22 1 4	22 2 1	23 0 8		23 3 8
	20 0 17	23 2 2		24 0 22	24 1 20	25 0 0		25 3 1
		24 2 21		25 1 15	25 2 12	26 0 21		26 0 22
		31 0 16		31 3 11	32 0 9	32 2 19		33 1 22
				34 1 19	34 2 18	35 1 0		36 0 4
				38 2 21	38 3 20	39 2 23		40 1 8
				41 2 6	41 3 6	42 1 17		43 0 23
					47 0 12	47 2 24		48 2 23
					50 1 13	50 3 26		51 3 5
					53 0 23	53 3 8		54 2 18

32″	33″	36″	38″	40″	42″	44″	46″	48″
29 0 1	30 2 11							
30 0 18		38 0 11						
36 3 1		40 2 26	41 1 25					
39 1 15								
		45 0 8		46 1 22				
43 2 23		48 0 0			50 0 16			
46 2 14		53 1 13			55 2 2	56 2 17		
51 3 25		56 2 18			58 3 12		60 3 8	
55 1 4								
58 0 20		59 2 10			61 3 4			64 1 0

TABLE 8-D—contd.

SHOWING STANDARD WEIGHTS OF C.I. PIPE TEES AND ANGLE

Nominal internal diameter	Sizes						
	3″	4″	5″	6″	7″	8″	9″
				Cast		Iron	
	C. Q. L.						
3″	0 3 10						
4″	1 0 1	1 0 13					
5″	1 1 1	1 1 13	1 2 4				
6″	1 2 0	1 2 11	1 3 3	1 3 21			
7″	1 2 26	1 3 11	2 0 2	2 0 21	2 1 13		
8″	2 0 6	2 0 18	2 1 10	2 2 1	2 2 21	2 3 20	
9″	2 1 9	2 1 22	2 2 14	2 3 5	2 3 26	3 0 25	3 1 21
10″	2 2 23	2 3 8	3 0 0	3 0 20	3 1 13	3 2 12	3 3 2
12″	3 1 8	3 1 22	3 2 15	3 3 7	4 0 1	4 1 1	4 1 26
14″		4 1 0		4 2 15		5 0 10	
15″		4 2 12		4 3 27		5 1 23	
16″		5 0 0		5 1 17		5 3 13	
18″		5 3 21		6 1 11		6 3 8	
20″				7 1 2		7 2 27	
21″				7 3 2		8 0 27	
22″				8 1 24		8 3 22	
24″				9 1 20		9 3 19	
26″						11 0 20	
27″						11 2 26	
28″						12 0 23	
30″						13 1 6	
32″							
33″							
36″							
38″							
40″							
42″							
44″							
46″							
48″							

Nominal internal diameter	Sizes						
	22″	24″	26″	27″	28″	30″	32″
22″	20 0 9						
24″		23 0 9					
26″		25 0 25	27 2 22				
27″		26 2 3		29 2 4			
28″		27 1 13			32 1 8		
30″		28 3 27				36 0 25	
32″		31 0 2				38 2 0	41 1 14
33″		32 0 26				39 3 15	42 3 9
36″		35 1 16				34 2 0	46 2 18
3s″		39 3 14				46 0 19	47 2 15
40″		41 1 22				48 2 9	52 0 1
42″		42 1 10				51 1 16	54 3 26
44″		44 3 27				54 0 10	58 0 11
46″		49 3 21				57 1 13	58 3 8
48″		52 2 6				60 3 5	64 0 0

TABLE 8-E

BRANCHES OF BRITISH STANDARD SPECIFICATIONS

OF				BRANCHES			
10″	12″	13″	15″	16″	18″	20″	21″
			Angle		*Branches*		
4 3 6 5 3 3	6 1 4						
6 3 9 7 1 9 7 3 21 9 0 18 10 1 14 11 0 5 11 3 19 13 0 25	7 1 12 7 3 12 8 1 18 9 2 20 10 3 20 11 2 11 12 2 8 13 3 5	8 0 3	8 3 18 10 0 1 10 3 1 12 0 6 12 2 21 13 2 11 14 3 20	10 1 27 11 2 21 13 0 26 14 0 1 14 3 20 16 1 14	13 2 0 15 0 2 15 3 0 16 3 5 18 1 11	15 3 11	7 1 23 8 1 25 20 6 6
14 3 23 15 2 24 16 1 12 17 3 10 19 1 12	15 2 1 16 1 2 16 3 19 18 1 18 19 3 24 20 3 19 23 1 13		16 2 12 17 1 14 18 0 3 19 2 4 21 0 11 22 0 7 24 2 4 26 1 14	18 0 26 19 0 8 19 3 4 21 1 20 23 0 11 24 0 16 26 3 9 30 2 17	20 1 12 21 1 2 22 0 4 23 3 8 25 2 21 26 3 6 29 2 25 33 2 26		22 0 5 22 3 23 23 3 1 25 2 6 27 1 16 28 2 2 31 1 23 35 2 8
			28 0 0 29 3 20	32 2 11 32 3 0 35 0 8 39 1 26 42 1 0	33 3 12 36 0 14 38 2 12 43 0 19 43 2 1		35 2 17 37 3 21 40 1 20 45 0 3 45 1 11

33″	36″	38″	40″	42″	44″	46″	48″
44 2 10	52 2 4 55 2 3	57 2 11					
	58 0 23 61 1 12 64 2 15 68 0 1 70 3 25		64 1 8	71 3 21 75 2 4 79 1 24 82 2 18	79 1 0	85 0 13	93 3 13

TABLE 8-E

SHOWING STANDARD WEIGHTS OF CAST IRON TAPER PIPES

Socket large end			Socket small end		
Internal bore		Weight	*Internal bore*		Weight
Socket end	Spigot end	Cwt. qrs. lbs.	Socket end	Spigot end	Cwt. qrs. lbs.
4	3	0 2 8	3	4	0 2 6
5	4	0 3 5	4	5	0 2 25
5	3	0 2 25	3	5	0 2 16
6	5	1 0 0	5	6	0 3 24
6	4	0 3 20	4	6	0 3 8
6	3	0 3 12	3	6	0 2 26
7	6	1 0 24	6	7	1 0 21
7	5	1 0 15	5	7	1 0 7
7	4	1 0 5	4	7	0 3 18
7	3	0 3 26	3	7	0 3 8
8	7	1 2 1	7	8	1 1 19
8	6	1 1 19	6	8	1 1 5
8	5	1 1 9	5	8	1 1 18
8	4	1 0 27	4	8	1 0 1
8	3	1 0 20	3	8	0 3 20
9	8	1 3 3	8	9	1 2 25
9	7	1 2 18	7	9	1 2 3
9	6	1 2 8	6	9	1 1 17
9	5	1 1 26	5	9	1 1 2
9	4	1 1 17	4	9	1 0 14
10	9	2 0 9	9	10	2 0 4
10	8	1 3 24	8	10	1 3 13
10	7	1 3 13	7	10	1 2 20
10	6	1 3 3	6	10	1 2 26

TABLE 8-E—contd.

WATER SUPPLY

Socket large end: Internal bore, Socket end	Socket large end: Internal bore, Spigot end	Socket large end: Weight, Cwt.	qrs.	lbs.	Socket small end: Internal bore, Socket end	Socket small end: Internal bore, Spigot end	Socket small end: Weight, Cwt.	qr.	lbs.
10	5	1	2	20	5	10	1	1	19
12	10	2	3	9	10	12	2	3	2
12	9	2	2	18	9	12	2	2	7
12	8	2	2	4	8	12	2	1	14
12	7	2	1	19	7	12	2	0	19
12	6	2	1	6	6	12	2	0	3
14	12	3	2	14	12	14	3	1	22
14	10	3	1	19	10	14	3	0	11
14	9	3	0	17	9	14	2	3	14
15	14	4	0	17	14	15	4	0	13
15	12	3	3	8	12	15	3	2	13
15	10	3	2	4	10	15	3	1	1
16	15	4	2	7	15	16	4	2	0
16	14	4	1	15	14	16	4	1	5
16	12	4	0	8	12	16	3	3	5
18	16	5	1	10	16	18	5	0	13
18	15	5	0	18	15	18	4	3	14
18	14	4	3	27	14	18	4	2	20
20	18	6	1	0	18	20	6	0	15
20	16	5	3	13	16	20	5	2	3
20	15	5	2	23	15	20	5	1	7
21	20	6	3	24	20	21	6	3	14
21	18	6	2	6	18	21	6	0	20
21	16	6	0	19	16	21	5	2	27
22	21	7	2	20	21	22	7	1	17
22	20	7	1	24	20	22	7	0	11
22	18	7	0	6	18	22	6	2	9

TABLE 8-E—concld.

WATER SUPPLY

Socket large end					Socket small end				
Internal bore		Weight			*Internal bore*		Weight		
Socket end	Spigot end	Cwt.	qrs.	lbs.	Socket end	Spigot end	Cwt.	qrs.	lbs.
24	22	8	1	27	22	24	8	1	9
24	21	8	1	2	21	24	7	3	9
24	20	8	0	6	20	24	7	2	5
27	24	10	3	18	24	27	10	3	4
27	21	10	0	16	21	27	9	2	18
27	18	9	1	17	18	27	8	3	4
30	27	12	3	10	27	30	12	2	25
30	24	11	3	12	24	30	11	2	16
30	21	11	0	11	21	30	10	2	[illegible]
32	30	14	1	17	30	32	14	1	7
32	27	13	2	1	27	32	13	1	[illegible]
32	24	12	2	5	24	32	12	1	[illegible]
33	32	15	1	12	32	33	15	1	[illegible]
33	30	14	3	8	30	33	14	2	[illegible]
33	27	13	3	24	27	33	13	2	[illegible]
36	33	16	3	22	33	36	16	3	4
36	30	15	3	23	30	36	15	2	16
36	27	15	0	11	27	36	14	2	[illegible]
40	36	19	2	4	36	40	19	1	[illegible]
40	33	18	2	7	33	40	18	0	[illegible]
40	30	17	2	8	30	40	16	3	[illegible]
42	40	21	3	4	40	42	21	2	[illegible]
42	36	20	1	20	36	42	20	0	[illegible]
42	33	19	1	24	33	42	18	3	[illegible]
48	42	25	2	8	42	48	24	2	[illegible]
48	40	24	3	8	40	48	23	3	[illegible]
48	36	[illegible]	1	25	36	48	[illegible]	[illegible]	[illegible]

1.

Jointing Joints.

joints.
be ligh
type t
ends o
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ness.
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joint i
shall b

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be allo
mixed
lubrica
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outsid

2.

Flanges.
shall b
flanges
and us
for scr
screwe
the fla

Weight		
wt.	qrs.	lbs.
8	1	9
7	3	9
7	2	5
0	3	4
9	2	18
8	3	4
12	2	25
11	2	16
10	2	1
14	1	7
13	1	11
12	1	2
15	1	10
14	2	19
13	2	23
16	3	4
15	2	16
14	2	20
19	1	11
18	0	14
16	3	26
21	2	15
20	0	1
18	3	15
24	2	27
23	3	10
22	0	24

No. 8·3—Laying and Jointing of G. I. and M.S. Pipes.

Jointing Screwed Joints.

1. All screwed joints, both internal and external, shall be examined before jointing, to ensure that the threads are perfect for the full depths of the joints. If there is any flow in the threads, the threads shall be lightly gone over with the stocks and dies of the correct type to suit the threads, before they are joind. The screwed ends of the pipes or specials to be jointed, shall be very slightly tapered so that as the joint is screwed up, the threads shall bind together more and more tightly to ensure water tightness. The jointing work shall be so arranged in the case of every joint that the two ends of pipes or specials joined thereby shall be equidistant from the middle of the socket and shall have a space of not more than about a quarter of an inch between them in the centre of the socket. Before any joint is made all burrs from the ends of the threaded joints shall be removed.

A few very thin strands of best quality country cotton yarn smeared over carefully with genuine Red lead shall be carefully wound in the grooves of the threads from end to end of the joint, if the screwed joint is a little slack, in order to ensure tightness. For this purpose, hemp or jute or any material other than that described above shall on no account be allowed to be used. A paste of genuine red and white lead mixed shall be lightly smeared over the threads to act as a lubricant and to make-up for imperfections in the threads when the pipes are screwed up.

Red and white lead paste is made by mixing together genuine dry red lead with genuine moist white lead and then thinning it out into a paste with genuine boiled linseed oil.

The pipes shall be screwed up tightly with pipe fitter's tongs or pipe wrenches to ensure that each and every joint is perfectly watertight against the test head of water.

No red and white lead paste or cotton yarn shall project outside the ends of the joints.

Flanges.

2. In the case of pipe lines laid in open country whether in trenches or on the surface, flanged joints shall be provided at intervals of not more than 500 feet. The flanges shall be screwed on to the pipes in the same manner and using the same jointing composition as already described for screwed joints so as to be water tight. All flanges shall be screwed home and the end of the pipe projecting in front of the flange faces shall be neatly cut off, filed and made perfectly

smooth and not to project ahead of the faces of the flanges so as not to interfere with the accuracy of the joints. Each flanged joint shall be made by inserting an accurately cut disc of tough multiply rubber insertion about 1/8″ thick of approved quality between the flanges. The inner diameter of this disc shall be 1/8″ larger than the bore of the pipe and its outer diameter 1/16″ less than the outer flange diameter. The bolt holes in the rubber insertion as well as in the flanges shall be drilled to template. The bolts and nuts for all flanged joints shall consist of British Standard mild steel, hexagonal, round and hexagonal. The bolts shall be pulled up gradually and evenly by the use of standard spanners, so as to ensure a perfect joint. They shall, however, not be over-strained by using spanners with undue leverage.

Long Screws and Unions.

3. Ground union couplings of a type to be approved by the Engineer-in-Charge shall be inserted where required to suit the exigencies of each particular pipe line. The same applies to long screws with back nuts, It shall be clearly understood that in both these cases the joints shall be carefully made and shall be fully water tight under the test head.

Bends, Tees and other Specials.

4. Bends, tees, reducers and other specials shall be provided and joined at points required by the Engineer-in-Charge.

All charges in direction shall be effected by means of bends wherever practicable and the use of elbows shall be restricted only to cases where there is no room for bends. In such cases moreover only "round" elbows will be allowed. Square elbows are positively forbidden to be used. When any change of direction is at an obtuse angle, springs or special easy bends shall be used. In any special case, however, where in the opinion of the Engineer-in-Charge it shall be impossible to provide a bend or bends, the pipe shall be bent very carefully, taking the utmost care not to distort the circularity of the bore or damage the metal of the pipe. In the case of galvanized pipes, heating of the pipe to bend it will destroy the galvanizing and therefore, in any such case a short length of British steam quality wrought iron or mild steel pipe of the same outer surface shall be carefully protected against corrosion by bituminous coating.

All specials such as tees, bends, reducers, sockets, etc., used in connection with pipe lines of British Standard water quality or steam quality screwed and socketed pipes shall in every case be of a quality description and specification at least equal to the pipes in connection with which they are intended to be used.

Starting point for Pipelaying.

5. Pipe laying and jointing shall proceed from one end of every pipeline, but if such pipeline is intended to be laid in or on sloping ground the starting point shall be at its lower end unless for some special reason the Engineer-in-Charge orders otherwise in writing.

For every long pipelines where more than one pipe laying gang is intended to be employed, pipe laying operations shall be allowed to be started at intermediate points to be selected by the Enginner-in-Charge.

Testing.

6. All pipelines in course of or after laying and jointing but before being covered, shall be tested hydraulically, using a test pump fitted with accurate pressure gauge to the approval of the Engineer-in-Charge to 400 feet head of water, or such other test head (atleast 50 per cent) above the working pressure as shall be fixed by the Engineer in-Charge to suit the particular conditions of the work. All pipes, specials and fittings with their joints shall remain perfectly watertight under the full test head for a period of not less than one hour after the whole length of the pipe line has been examined and demonstrated to be watertight.

Pipe attached to Walls or Ceilings

7. Every pipeline attached to walls, floors, roofs or ceilings shall be supported by galvanized holder bats placed securely into the walls, floors, roofs and ceiling at intervals not exceeding 8 feet throughout its length clear of the walls, floors, roofs or ceilings as the case may be as shall be fixed in writing by the Engineer-in-Charge for each particular case in order to facilitate periodical painting, coating or if necessary, provision of lagging materials thereto.

Sleeve Pipes.

8. Every pipeline laid through any walls, floors ceilings or roofs shall be arranged to pass sleeves pipes of ample diameter embedded therein to enable the pipelines to pass easily and freely therein. The length of every such sleeve pipe shall be of the full width or thickness of the wall and in the case of a roof, ceiling or floor, shall be at least $1\frac{1}{2}''$ longer than the thickness thereof and shall project to that extent above the upper surface thereof unless the Engineer-in-Charge orders to the contrary. Every sleeve pipe shall consist of a single length of British Standard water quality wrought iron or steel pipe or otherwise of a steel or wrought iron pipe not less than 1/4" thick to the approval of the Engineer-in-Charge.

No. 4·8--Laying and Jointing Asbestos Cement Pipes.

1. The joining shall be done by placing the rubber rings on the spigot ends after slipping the sleeves on them as shown in the figure which shall then be held by C. I. flanges firmly secured by bolts. Care shall be taken to see that all the bolts are equally stressed.

Jointing.

(*See* Fig. on opposite page).

2. The bends, Tees, etc., shall be of C.I without sockets and shall be jointed with straight pipes by means of C.I. Sleeve, with rubber rings and flanges as described above.

Bends, Tees, Flanges, etc.

3. C.I. Valves and specials shall be fixed to the pipeline by inserting C. I. spigoted toil pieces.

Fixing of Valves specials.

4. Ferrule connection shall be given by any of the following methods :—

Ferrule connections.

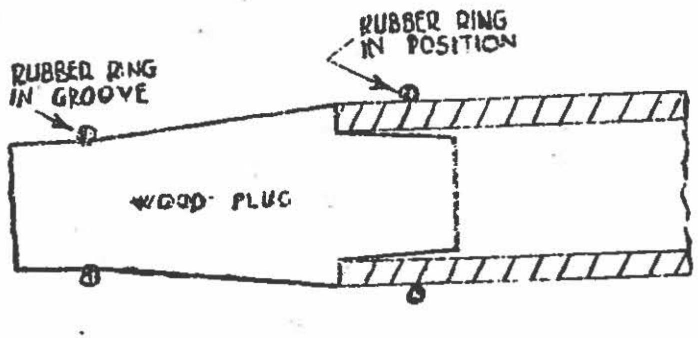
(1) Service connections to water mains shall be made either by drilling and tapping the main after the pressure has been shut off, or by the use of special tapping apparatus whereby the main can be drilled and tapped and the ferrule introduced while the main is still under pressure. The latter method shall be used for trunk mains or in other cases where it would be inconvenient to shut off the water while the connection is being made.

(2) In order to make a service connection to an asbestos cement water main, a malleable iron saddle piece with a flat boss shall be first bolted round the main with a rubber washer between the main and the boss. The boss and the pipe shall then be drilled and tapped together, giving a continuous thread through the boss and the wall of the main.

(3) *Cast Iron Collar*—A long collar which shall be short piece of cast-iron pipe by inserted into the run of the main. This shall then be drilled and tapped in the same manner as cast iron main.

No. 8·5—Specifications for Laying and Jointing R.C C. Pipes.

1. No pipes shall be lowered into the trench till the excavation of the trench is done fully in accordance with specifications for "Excavation in soil other than Rocky and trench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RUBBER RING IN POSITION
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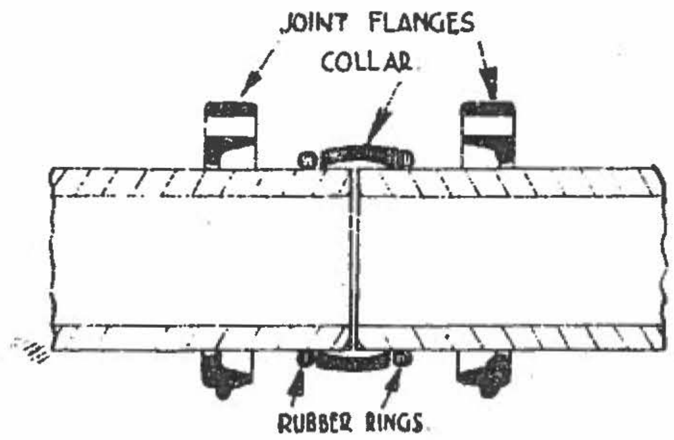
JOINT FLANGES
COLLAR
RUBBER RINGS

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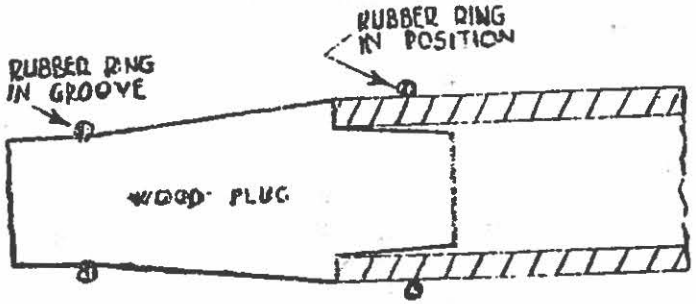
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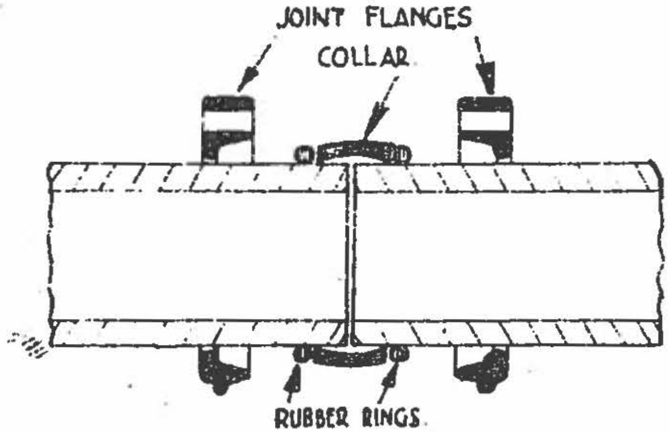
JOINT FLANGES
COLLAR
RUBBER RINGS

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in for Drainage and Water Works" or as per Excavation under other appropriate sub-head in accordance with the site condition and instructions of Engineer-in-Charge (Refer Chapter 13 of this volume).

2. The sight rails shall not be moved till the pipeline is laid and checked by the Engineer-in-Charge and his written order obtained for their removal.

3. Each pipe or special before being laid, shall be inspected with a view to see that it is free of cracks, obstructions and any offensive material inside.

4. The barrel of large pipes shall be cleaned of any debris, mud, stone pieces etc., with a wire brush and pumice stone.

5. The smaller pipe shall be titled up to remove accumulation of mud, stones, etc. If any debris refuses to fall down, a gunny bag tied to a rope will be passed through.

6. The pipe shall be laid in proper gradients and the centre line is to be straight or curved to proper radius true to the drawing.

7. All unnecessary bends or kinks in the vertical or horizontal shall be avoided.

8. When the pipe is to be laid without a cradle the earth forming the bed shall be carefully freed of stones, boulders or clods of hard earth.

9. The bottom of the barrel of the pipe shall rest wholly on the bed of the trench and no subsequent packing will be allowed.

10. If the excavated bed is too low, earth shall be thrown into the bottom and thoroughly rammed and a new bed shall be trimmed for the pipe.

11. Ramming earth beneath pipe length to raise the grade of the pipe shall not be allowed in any case.

12. Head holes wherever necessary of a length equal to at least double the length of the collar shall have to be dug out to enable the collar to be slipped completely to one side when the inner joint is being done. No extra payment shall be made for this excavation.

13. If concrete cradle is used, the thickness and other dimensions shall be as shown in the drawing.

14. The concrete for the full width of the cradle as per drawing shall be deposited continuously to the height of the outside bottom of the pipe. While filling the concrete on the

sides of the pipe to complete the cradle, the pipe shall be evenly bedded in the concrete so as to have a uniform support for its entire length and the concrete shall be tamped in such a manner as to avoid changing the position of the pipe.

15. Pipes previous to being lowered into the trench shall be fitted together dry on the surface and matched.

16. The pipe shall be placed in position in the trench and the loose collar shall be slipped over clear of the end of the pipe. The recess at the end of the pipe shall then be filled with a sufficient section of jute braiding dipped in bitumen. The next pipe shall then be brought forward against the first pipe until the plastic ring in the recess of the first pipe fits into the recess of the second pipe. The second pipe shall then be pressed tightly against each other by jacking with a jack of approved capacity and type. Before the collar joint is made, these pipe joints shall be verified and checked to see that there is no offset, i.e., that each pipe rests against the adjacent pipe truly in line.

17. The rope for cement joints shall be made of closely twisted gasket or hemp or jute of suitable diameter not less than 3/4 inches and or as directed.

18. After the pipe joints as detailed in para. 16 above the gradients shall once again be tested by means of sight rails and bonning rods and if found correct and true to drawing then only collar joint shall be made.

19. The collar shall then be set up actually over the joint, and brought into a concentric position over the pipe, by means of wedges driven at two or three places so as to ensure that there is an even jointing space all round. The intervening space shall be filled with a neat cement mortar (1 : 1) proportion. Angle iron collar supports shall be placed covering one end of the collar fully before the mortar is filled in from the other end.

20. The mortar shall be well pressed, rammed and caulked into the joints with properly shaped caulking tools and hammers. The mortar when so caulked shall not allow a pend knife to be thrust into it single handed.

21. The whole of cement used shall comply in all respect with the provision of the B.S.S. 12 for Portland cement (Ordinary).

22. No rapid hardening cement shall be used for caulking.

23. The mortar in the joint shall be beaten into a fillet of roughly 450 slope and this fillet shall not overlap the face of the collar. No trowels shall at all be used for making or finishing this fillet. The fillet may be rubbed very lightly with caulking tool to level the surface.

24. No surplus mortar or other foreign substance shall project into the pipe from the joints.

25. After the joints are made, the pipes shall be cleared from inside with a disc scraper attached to a rope or rod sufficiently long to pass the joints in a manner satisfactory to the Engineer.

26. For pipes larger than 21 inches in diameter, the joints on the inside shall be filled with cement mortar wiped smooth and flushed with the inside surface of the pipe.

27. The joints shall be covered with slightly moistened bag to guard against sun and when 4 hours old shall be packed with moist, sand or earth.

28. The joints shall be cured for 10 days after they are made. The part of the trench round about the joints shall be filled with earth and kept watered well throughout the curing period.

29. Where ground water is met with, flexible bituminous joints shall be made. A jute or oakum gasket shall be caulked in place to centre the joints and the hot bituminous filling at about 400° F shall be poured in the joint. A joint runner shall also be provided on one side before pouring hot bitumen.

30. All the joints shall be made in such a way as to render them watertight.

31. No back filling shall be allowed before the pipe line is tested and passed by the Engineer-in-Charge.

32. Water shall not be allowed to rise in or about the pipe before the mortar of the joint has thoroughly set.

33. The pipe lines shall be tested hydraulically with heads specified for particular class of pipes. For "A" Class mains the lower end of the drain will be closed by a properly fitted drain plug and the drain filled with water slowly to the required head of water which shall be the head due to the head manhole filled up to the top or 15 ft. whichever is less. Leakage exceeding 100 gallons per minute per day per inch dia. shall not be allowed. The leakage will be reckoned after the pipe line has been soaked for 24 hours. These conditions of leakage apply to 'A' Class main only. No leakage

in other classes will be allowed after soaking for 24 hours. For other classes, as directed by the Engineer-in-Charge and in accordance with the appropriate B.S.S.

34. The pipes after being laid may be tested by air pressure if thought proper by the Engineer-in-Charge. For this, the ends shall be closed with iron plate fitted with rubber packing rings and air pressure shall then be applied with an air pump. If the pressure remains constant at the required pressure for one hour, the pipe line shall be passed.

35. The contractor must give one of the two tests (*i.e.*) hydraulic or Air whichever is prescribed in the contract.

36. If the line is unable to stand the test the Contractor shall rectify and re-do if necessary the leaky joints at his own cost until the line is able to stand the test and approved by the Engineer-in-Charge.

37. The contractor shall provide all facilities for testing including provision of testing equipment and labour free of charge. In case, such facilities are not provided by the contractor the test shall be carried out at contractor's cost.

38. Walking on or working over the approved laid pipeline unless covered with earth to a depth of 12 inches shall not be allowed except as may be necessary in tamping and refilling.

39. Payment shall be based on the measurement along the centre line of the pipeline after it is land in position. The unit of measurement shall be one rft.

8.6—Disinfection of Water-supply main.

Ce eral.

1. In this country, disinfection of mains after laying has not been attended to so far but experiments and observations in many a countries have attributed some of the water borne epidemic outbreaks to this neglect. In the process of handling and placing it is inevitable that newly laid water mains will be polluted. The reasons of such pollution are careless storage on the street, before the trench is opened in the trampled mud in the bottom of the trench, polluted water which may run into the trench, shoes, overalls, etc., which workmen push into the open ends of the pipes and forget to remove them. Every care should be taken to safeguard against such practice.

Flushing or scraping.

2. Preliminarily each length of the pipes should be flushed or scraped to remove all accumulation of mud.

Disinfection.

3. Flushing or scraping does not wholly remove bacterial pollution and contamination. The disinfection should be carried out by any of the following methods,

I. *By adding chlorinated lime*—Chlorinated lime is dissolved in a water tank and is led into the mains along with water for a sufficient period to ensure complete freedom from pollution. In general, the following amount of chlorinated lime for each 12 feet length of mains will be sufficient.—

Diameter of mains in inches	4	6	8	10	12
Chlorinated lime in ounces	0·34	0·75	1·33	2·09	3·01
Chlorinated lime table spoon fulls	½	1	2	3	4

II. *By adding chlorine gas*—A special type portable apparatus is avaliable for this purpose. The new mains is tapped near the valve at the connetion to the old main and a ½″ gate valve is connected to a Corporation Cock. The gate valve is fitted with a stuffing box through which small silver tube will slide. The silver tube connects by means of a rubber hose to the chlorine tank. As the new main is filled the chlorine is fed into the main, Since the gas is injected into the main as a result of the tank pressure, the water pressure into the main must be kept at a minimum. While the chlorine is being applied, the water should be allowed to escape at the end of the main until an orthotolidine test shows a deep orange colour. Whether gaseous chlorine or chlorinated lime is used, the chlorinated water is allowed to remain in the main for 24 hours, after which the mains are thoroughly flushed.

By adding bleaching powder.

III. *By adding bleaching powder*—After the mains have passed the pressure tests, they shall be thoroughly scoured out ; and further to ensure that the pipe system is free from injurious matter, it shall be filled with solution of bleaching powder (Calcium Hypocholorite) or of Permagnate of Potash and allowed to remain for 24 hours. After the period, the system shall again be scoured out and filled with the water of supply main. Samples of water shall be taken to the Government Provincial Laboratory for medical test. The contractor shall provide the chemicals, etc., and make the necessary arrangement for these operations. He shall produce the report signed by the competent Medical or Health authority that the water is fit for human consumption. Should the report be not satisfactory, the operation shall be repeated again and again till a satisfactory report is obtained.

The contractor shall include in his rates of pipelaying all the expences to be incurred in connection with the chemicals and medical test and other operations described under this sub-head.

8·7—Laying C. I. Pipes Submurged under Water. A streamer Harbour.

1. A trench shall be dreged out in the channel bottom in which the pipes are to be laid. The dredged bottom shall be left irregular if necessary, concrete blocks will be placed to furnish a suitable foundation.

Dredging of trench.

2. A number of length of pipes will be joined together on a barge and then lowered to the trench. Divers shall make under water flexible joints as directed by the Engineer-in-Charge in a shallow water, a frame shall be set up over the pipe location and the connected pipe shall be lowered into the place.

Method of laying.

3. The joints shall in general, be flexible or ball type shown in the fig. on opposite page.

Types of Joints.

4. For flexible joints special pipes with plain spigot without head and special socket, containing an internal shoulder situated at half the socket depth, and an external flange, e.g., vertical cast pipes, spun pipes or metal pipes shall be used.

Pipes for flexible joint.

5. The joint shall consist of cast iron pressure ring, resistent rubber gasket laid tipped, bolts of special high tensile cast iron (16 tons to a square inch), and the joint shall be ordered with the pipes.

Flexible joint.

6. (1) Care should be exercised to see that the inside of the socket and all other parts are entirely free from foreign matter prior to assembly.

Method of Assembly.

(2) Slip cast-iron pressure ring over spigot end of pipe, so that ring flange is towards socket.

(3) Thread rubber ring over spigot end of pipe, taking care, when the rubber ring is fitted with lead tip, that lead is nearest the spigot end, so that cast iron pressure ring lead tip is fitted, the narrow face of rubber ring should be nearest the spigot end.

(4) Fit the special hooked bolts as shown and hold the hooked end in position until nut is hand tight. Tighten each

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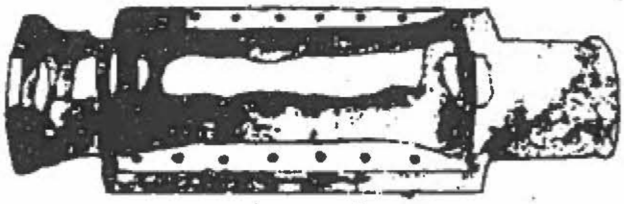

(PATENTED)

FIG — Empire Hatch-box

nut in turn steadily and evenly with the short spanner provided, using one hand only.

Even tightening oj bolts is very important

(5) After making the Joint, the exposed machined portion of the bolts shall be coated with a bitumen or non-corroding paint.

(6) A thin coating of graphite paste for lubrication of the rubber ring and of the spigot and socket joint faces shall be applied.

The joint shall be so made that the rubber gaskets but against the interval shoulder, while the back of the external flange is bevelled back to form a seating for the hook of the special bolts.

Floating Pipes—For floating pipes special floats manufactured by specialist firms shall be used on the pipe shall be laid on a pier made of wooden piles and bracings.

8·8—Use on Hatch box or door pipes, in mains

General.

1. To facilitate the descaling and cleaning of water mains, Hatch Boxes or Door Pipes shall be provided at every depression and also one or two hatch boxes per miles of flat pipe main and a flanged piece of 4 ft. length in every 600 to 800 ft. length of main. In cases where Hatch Boxes are very costly or not available, then only flanged pieces of 4 ft. length shall be provided throughout instead.

CHAPTER 9

9·1—PIPE SPECIALS

External Fittings (Specials)

1. (1) The valve shall withstand test pressure of 300 lbs. per square inch and shall operate satisfactorily with 150 lbs. per square inch, or working pressure of the main whichever is more.

Gate-Valve and Sluice-Valve.

(2) The diameter of the water way shall not be less than the pipe diameter.

(3) The gates in valves of 3 inches and below shall be of solid bronze.

(4) The gates in valves of diameter larger than 3 inches may have discs of cast iron but shall be proived with bronze rings.

(5) The valve seating thrust bearing, packing glands, gear spindles, wedging devices, guide rullers and indicator mechanism shall be of gunmetal.

(6) Valve stem, stem collars and nuts shall be made of manganese bronze having a tensile stress of 60,000 lbs. per square inch.

(7) Stuffing-box shall be packed with graphited hydraulic packing made of jute.

(8) Wrench nuts shall be of cast iron 2 inches square

(9) All ferrous parts of valve except finished or bearing surface shall have three coats of bitumastic pipe dip.

(10) All valves shall be of inside-screw type.

(11) Gears of large valves may be of cast iron or steel if enclosed in an oiltight cast iron gear case.

(*Figure on opposite page*)

(12) Valves 16″ in size and larger, designed to lie on their sizes with horizontal stems, will have tracks and rollers to carry the weight of the gate as it moves with the bonnet.

2. For cases, where a distribution system, receives supply by gravity or through pipes from a high pressure district, hand adjusted or automatic pressure reducing valves shall always be used to maintain constant pressure on down stream side of valves.

Pressure Reducing Valve.

Its structural specification shall be the same as for sluice valves and gate valves.

3. Check valves will be utilised in suction delivery lines of pumps, where flow in only one direction is required. They shall also be used in distribution system,

Check valve.

industrial fire supply into the Municipal distribution system. ~~They shall be of substantial construction and the loss of~~ head prescribed must be guaranteed by the suppliers. The gate or flap on the vane should be easily accessible for cleaning and repairs.

Air valves.

4. Air valves shall be placed at every summit in the pipe-line to permit the escape of air when the main is filled, and afterwards, if any, air is carried into the main They shall also be placed on longs stretches of nearly level main. They shall generally, be ball valves lighter than water, which close the air vent if air accumulates

Scour valves.

5. Scour valves shall be placed at the bottom of all depressions for emptying the main or letting out sediment.

Reflux valves.

6. These are flap valves which shall be placed on ascending parts of the main. They shall open in the direction of flow but automatically close if a burst occurs and the water flows back. (They diminish the damage which may occur at a burst by the escape of water.)

Safety of relief valves.

7. These shall be at the downstream ends of long length of mains, or where water hammer may take place, so as to reduce to the normal on any excessive pressure that may occur.

Fire hydrants.

1. Fire hydrants shall be :—

(*i*) Post type with a vertical barrel extending 2 to 3 feet above the ground surface.

(*ii*) Flush type in which the top of the barrel is under ground in a box whose cast iron cover is flush with the ground surface.

2. The design shall be such that permits ready removal of the valve without excavation and that the valve remains closed in case of damage to the top of barrel.

3. The size of the hydrants shall be 3 inches for single hoze connection, 4 inches for two hoze, 5 inches for three hoze 6 inches for four hoze connection.

4 The friction losses shall be 1 lbs. per square inch for 250 gallons per minute stream.

5. In case of post-hydrant the barrel connection, (which shall, always be flanged shall be 2 inches above ground surface,

6. All dydrants shall be provided with drain valve, to completely drain the hydrant on closure of the main valve.

7. The dydrant shall be capable of lubricating during the service.

8. Barrel hydrant, heads valve gate and nozel cap shall be of cast iron

9. Outlet nozel, valve seat, drain valve, stuffing box glands, and gland box, hut and operating stem shall be of bronze or any other incorrosive metal.

The main valve shall be faced with rubber or leather and in the case of slide gate tube shall have barrel rings.

10 All exposed surfaces shall be painted with bitumastic paint in three coats, to distinguish from private hydrants. The capacity of hydrant shall be given at hydrant top and nozel cap.

11. All hydrants, shall be inspected annually, opened and closed, lubricated repacked and repaired if necessary.

(See attached figure.)

9·2—Internal Fittings (Specials)

Taps, valves and mixing valves

General.

1. The terms taps, valves and cocks shall be applied to fittings which control the flow of liquid or gasses. The term cock, bib-cocks and stop cock shall be classified as screw down valves. Cocks have an internal plug, a quarter turn of which shall or close the line. They shall be used to control domestic gas-lines at gas outlet points as on coolers and for emptying holers.

The term cock has been applied to brass screw-down valves up to 2 in. size as used in domestic hot and cold water systems. The term shall include fitting of cast-iron or gun-metal controlling large mains.

Definitions.

2. (*a*) *Bib tap.*—A draw off tap with a horizontal inlet and free outlet.

(*b*) *Hose tap.*—A bib tap with a screw or union on the outlet for the attachment of a flezinle.

(*c*) *Pillar tap.*—A drew of tap with a vertical inlet and a horizontal free outlet.

(*d*) *Globe tap.*—A draw off tap with a horizontal inlet and a vertical free outlet.

(*e*) *Stop valve.*—A valve with suitable means of connection for insertical free outlet,

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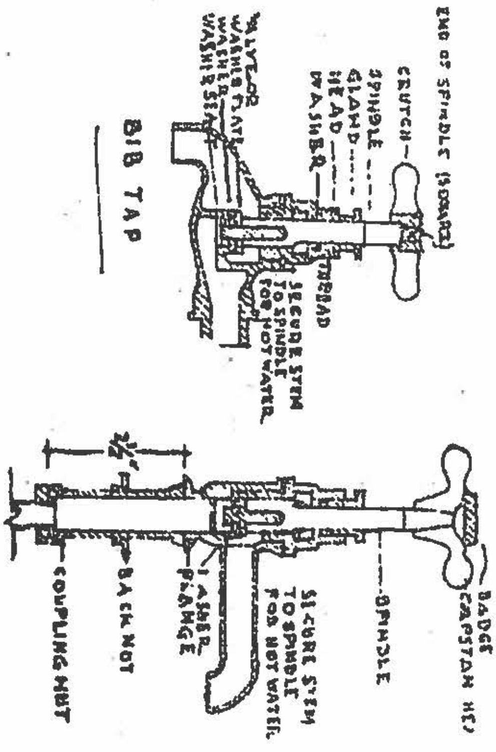

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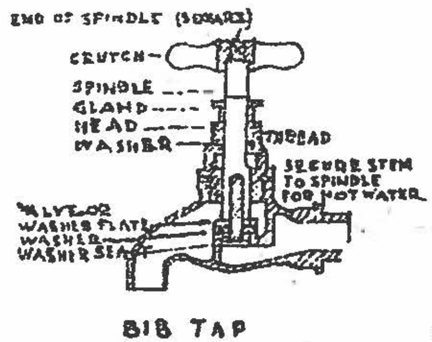
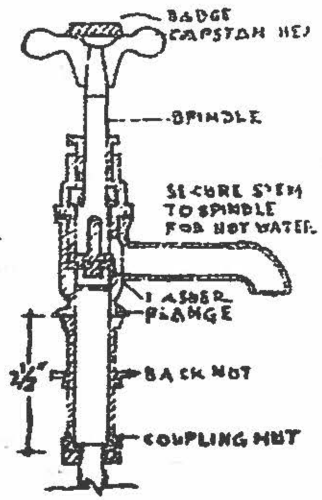


BIB TAP



PILLAR VALVE

(*f*) "*Screw down*" *tap or stop valve.*— A tap or stop valve closed by means of a disk carrying a renewable non-metallic washer which shuts against the water pressure on a seating at right angles to the axis of the screwed spindle which operates it.

Specifications.

3. The bokies and heads of taps shall be of brass or gunmetal or hot pressings of brass or manganese bronze. Castings shall be from metal poured into moulds whilst hot pressings shall be metal pressed between dies. Pressings shall be smoother and shall present a better appearance.

Spindles, glands, crutches, washer plates an nuts shall be of brass or manganese.

Taps shall have crutches or capstab leads as required by Engineer-in-Charge, in the latter being marked hot or cold. The tap shall be fitted with an easily clean cover of pressed sheet metal threaded for attachment to the head.

The water way shall not be less than the areas of a circle equal to the nominal size of a tap.

The stem of the washer plate (some times called a jumper shall be loose when used on main supplies, where the pressure should be sufficient to lift the valve from its seating when spindle pressure be released.

A tap on low pressure mains or distributing pipes served by cisterns shall have a fixed jumper secured to the spindles by a grub screw.

Bib Taps.

4. Bib taps shall be used only over sinks to fill and cistern or buckets and hospital baths. They shall be generally in sizes of $\frac{1}{4}''$, $3/8''$, $\frac{1}{2}''$, $\frac{3}{4}''$, $1''$, $1\frac{1}{4}''$, $1\frac{1}{2}''$, and $2''$. The inlet shall be horizontal and shall alway be with tail having external parallel thread.

Pillar taps.

5. These shall be draw off taps with a vertical inlet and horizontal outlet, the nose of which shall be down to give a vertical discharge. There shall be a flange on the base of the body which shall rest on the top of a bath roll or lavatory shelf, beneath this it shall be square in section fitting the tap holes. From the square portion there shall be a tail $2\frac{1}{2}''$ long screwed with a parallel thread, riding on which be a backnut for tightening to the ware.

The service pipe, according to material, shall be connected to the tail with a lead to iron union, copper to iron union or malleable iron to iron union.

Pillar taps are made in sizes $\frac{1}{2}$", 3/4" and 1".

6. (These are for use in baths and similer apparatus).

Globe Taps.

These are made in sizes $1\frac{1}{2}$", $\frac{3}{4}$", and 1".

The inlet shall have an internal thread, shall be usually connected to a bent tail pipe which passes through, and should have a union below, the tap hole.

Stop valves.

Stopvalves—Stopvalves shall be not made in sizes $\frac{1}{4}$",3/8", $\frac{1}{2}$", 5/8", $\frac{3}{4}$", 1", $1\frac{1}{4}$", $1\frac{1}{2}$" and 2". (They are intended for the isolation of pipe lines and individual service connections to sink lavatories, baths and w. c. cisterns when they facilitate repair and replacement of washers)

Their tails shall be made for lead pipe connections with external parallel threads or with one end having external threads and the other having internal thread as directed by Engineer in-Charge.

Self Closing Taps.

8. These shall be used in factories and schools to avoid waste of water, and shall be fixed vertically or horizontally. They shall be such that when the button heads is depressed the water flows and when the hand is removed the spring control causes the head to rise and water is shut off.

These taps shall be used for low pressure service only except where directed otherwise by the Engineer-in-Charge in writing

Special Non-Splash Taps.

9. Taps shall be so designed that the washer can be charged without turning off the stop cocks on the supply pipe. They shall be on both screw down and revolving nozzle principles.

Supply Fittings

10 These shall both hot and cold service and have a single discharge nozzle. (They are suitable for baths, lavatory basins and sinks when wall fixing is desirable wall fixing assists pre-fabrication).

They shall usually have swivel arm discharge pipes, (these being useful for the supply to double sinks from one central fitting) except when directed otherwise.

Finish.

11. Tap and valves shall be plated with nickel or chromium (the latter is preferable but should not be used in laboratories and other places where acids are used)

Globe Valves.

12. These shall be similar in construction to stop taps but they have stronger spindles and gunmetal to gunmetal seatings, or asbestos renewable disc to gunmetal seating, instead of the washer, washer plates, nut and stem. The ends of these valves shall be screwed internals for iron and they shall not usually be made with tails for lead.

CHAPTER 10

CLEANING OR SCRAPING OF WATER MAINS (CONTRACT SPECIFICATION).

Necessity.

1. Nearly all types of water mains are affected by the passage of time. Vegetables and animal growth, inside rusting and corrosion and other impurities deposited on the inside of mains which gradually go on decreasing the water passage area and discharge of main. This necessitates the occasional cleaning of mains.

Interval of cleaning or scraping.

2. In general, cleaning or scraping of mains shall be done once a year. This period can, however, be changed by the Engineer-in-Charge, as per conditions of different places and quality of water.

Methods of cleaning.

3. (i) *By discharging water under high pressure*—Water under high pressure, 200 P.S.I. in general, shall be passed through the mains in cases where rusting or other such effects are not much predominant.

(ii) *Mechanical Process*—There are two different types of machine which should be utilized.

(a) Hill hodgman or other make pipe Cleaning Machine:— (Fig. on opposite page).

(b) Turbine Pipe Cleaning Machine :— (Fig. on opposite page).

Operation of cleaning or Scraping (Machanical process).

4. All the tapping ferrules, hydrants, tees, valves other such things shall be removed so that there is no obstruction the pipe clearance. In place of valves, etc., Straight length of pipes shall temporarily be fixed.

The hatch boxes shall be opened up or flanged piece removed. The scraping or descaling machine as described above shall then be inserted. Sufficient amount of water for operation of machine shall be passed. In case, where water passage sufficient pressure can not be used, a cable should be passed by means of a special carrier. The machine shall then be carried through the main and the sufficient quantity of water, as already allowed will take away the scrapped dirt, etc., which ultimately be carried to the surface by means of a specially inserted vertical pipe at the other end.

Proving the clear diameter.

5. Having thus isolated the main, a cable shall then be drawn through with the aid of drain rods or a cord attached to a wood and rubber piston forced through the main by water pressure and a prover

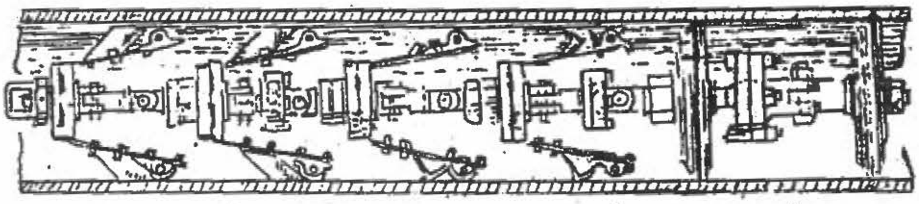


FIG. 260 — Hill-Hodgman Pipe Cleaning Machine.

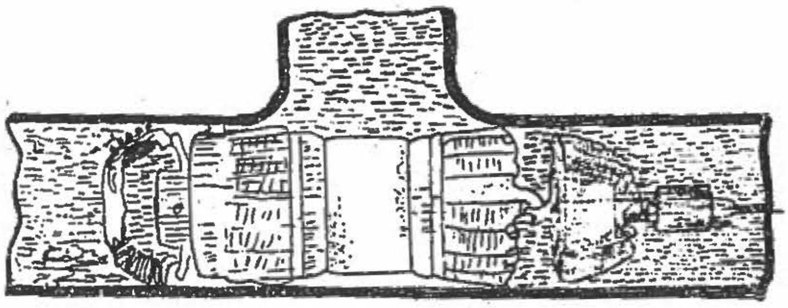


Fig. — Turbine Pipe Cleaning Machine.

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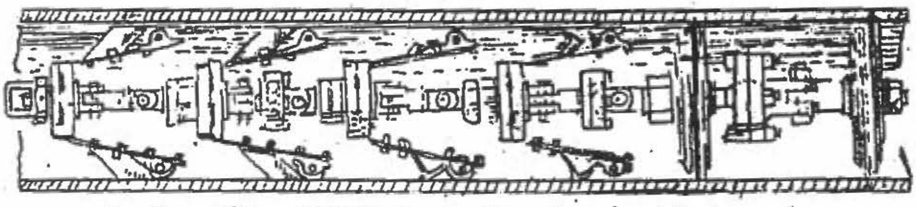


FIG. 260 — Hill-Hodgman Pipe Cleaning Machine.

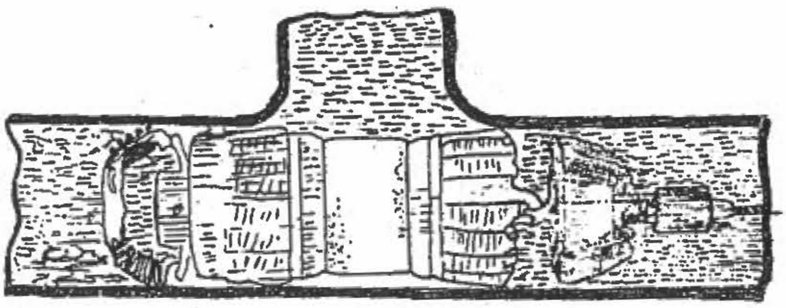


Fig. — Turbine Pipe Cleaning Machine.

with over sized rubber washers or plangers be passed through the pipe. (This method shall be used, where the head is insufficient to drive the scaper, say under 15′ head. The prover indicates the largest diameter of the lining scraping machine, which can be used, and also discovers the position of any obstructions in the main). The prover which shall be slightly less in diameter than the pipe under treatment, shall consist of a hardened steel cylinder centrally held in the pipe by flat steel springs.

The Contractor, Overseer incharge, should follow the main line with sounding rod setethescope in hand, stopping now and then and detecting (other the scraper has struck or not.) When a solid obstruction is met with the scraping machine can be heard coning against it with a dull thud.

When this dull thuds is noticed the pipe track shall be opened and the pipe is struck with a few blows of sledge hammer. However, in cases, where these blows proves in effective, a whispt hay shall be inserted at the hatch box. When it reaches the scraper, it shall form a species of packing and the extra pressure thus generated will make the scraping machine to move. If all these methods fails, then the pipe shall be cut open to remove the cause of obstruction.

It shall be the duty of the Sub-Divisional Officer to see that the correct bore test as above is carried out in his presence.

Scraping operation in mains. Not provided with hatch boxes, or flange pieces.

6. (The only difficulty lies in insertion of machine, which is to be overcome by cutting the pipe length piece, completing the operation as above and then after completion, filling in a flanged piece of 4′ length or a hatch box.)

CHAPTER 11

SPECIFICATIONS FOR WATER SERVICE METERS

CONTRACT

(*i*) Meters for all types shall withstand a pressure of 150 lbs. per square inch.

(*ii*) The measuring chambers and cases of all meters shall be of bronze or nonferrous metal.

(*iii*) The outer cases of disc meters of 2 inches and smaller size meters shall be of bronze

(*iv*) Large meters made of cast iron shall have pretec tive coating of bronze.

(*v*) Gear trains and strainers shall be of nonferrous metal and measuring disc and wheels be of vulcanized rubber.

(*vi*) The registration of new meters shall be accurate within normal test flow limits in table given below to 1·5 per cent for disc meters and to 3 per cent for other types.

(*vii*) The registered flow at minimum test flow shall be not less then 95 per cent of the actual flow of all times.

(*viii*) The pressure loss at the upper normal test flow limit shall not exceed 15 lbs. per square inch for meter of up to 1 inches size and 20 lbs. per square inches for vane disc, current and compound meters and 4 lbs. per square inch for fire service meters.

(*ix*) The ratings of meter shall be in imperial gallons unit with least count of 10 gallons.

(*x*) The meters shall have removable strainers which could be easily cleaned, without interrupting services for more than 15 minutes.

(*xi*) The meters shall have necessary isolating valves for the purpose of cleaning strainers.

(*xii*) The connecting ends of the meters shall be of the union or flange type.

(*xiii*) All meters shall be supplied with one spare and a set of bearing.

(*xiv*) The meter shall be capable of being lubricated without dismentlement.

TABLE 11-A

TABLE 11-A

TEST FLOW LIMITS FOR COLD-WATER SERVICE METERS (IN GALLONS PER MINUTE)

Size	Disc metres		Current metres		Compound metres		Fire service metres	
	Normal test flow limits	Minimum test flow	Normal test flow limits	Minimum test flow	Normal test flow limits	Minimum test flow	Normal test flow limits	Minimum test flow
⅝	1 to 20	¼	...	...	...	...	...	...
¾	2 to 30	½	...	...	...	...	...	...
½	3 to 50	¾	...	...	...	...	...	...
1-½	5 to 100	1½	12 to 100	7	2 to 100	½	...	...
2	8 to 160	2	16 to 160	10	2 to 160	½	...	...
3	16 to 300	4	24 to 350	15	4 to 320	1	8 to 400	2
4	28 to 500	7	40 to 600	20	6 to 500	1½	8 to 700	2
6	48 to 1,000	12	80 to 1,400	30	10 to 1,000	3	16 to 1,600	4
8	...	...	144 to 2,500	50	16 to 1,600	4	28 to 2,800	7
10	...	...	224 to 3,800	75	32 to 2,300	8	48 to 4,400	12
12	...	...	320 to 5,800	100	32 to 3,100	14	48 to 6,400	12
1[illegible]	...	...	400 to 11,500	150	...	...	...	...

CHAPTER 12

12·1—WATER SUPPLY PUMPS

12·1—*General*

General Specification.

1. The various parts of the pumps coming in contact with water to be supplied from rivers / lakes / Tube-wells in West Pakistan conforming to the analysis if supplied by the Engineer-in-Charge, and if not supplied then clean water with a small percentage of fine silt shall be guarenteed safe by the manufacturers against abnormal wear in tropical climates, due to the abrasive action of silts and other impurities usually found in this area.

The wearing parts of the pumps, i.e., wearing rings impellers or bearings and shafts shall be of substantial construction and capable of being easily dismounted for the purpose of examination and replacement. In this respect horizontal spilt casing shall be preferred.

In the absence of specification of the position of pump with respect to the highest and lowest water level on the suction sides the suppliers will be free to propose and position of pumps on the suction side where the pumps would work most efficiently.

In the case of self-priming position a sluice valve of proper construction on the suction side, of corrosion proof material, shall be supplied with the pumps to isolate it for purposes of repairs. Special tools for dismentling the pumps and for replacement of spaces shall be supplied along with the pumps.

The pumps shall be rated for continuous running at least 16 hours a day.

2. Complete instructions for erection, maintenance, dismentling and normal repairers along with necessary sketches drawings and exploded view all written up in English and Urdu would be supplied free of charge with every machine.

Performance curves connecting discharge with a head, efficiency and horse power drawn, on the same X and Y axis on the same graph sheet shall be supplied and their accuracy with respect to individual machines guaranteed.

All guarantees will be deemed to be held valid only when 10 per cent of the price is kept in deposit with the Government for a period of six months after the installation of the machine during which period all the guarantees except that against abnormal wear will be specified by the manufacturer

3. *The pump shall stand the test enumerated in the following paragraphs :—*

During the whole period of the test careful observation shall be made in regard to :—

(a) *Serious shock, hammering or vibration occurring.*

(b) *Bearings running cool and with proper lubrication.*

(c) *Stuffing boxes and water sealing devices operating satisfactorily and not allowing any leakage of air into the pump.*

(d) *In the case of centrifugal or axial floow pumps, rubbing of the rotor occurring against the casing or neck rings.*

(e) *The reliable and satisfactory action of hydraulic balancing device, if used.*

(f) *The prevention of any escape of water between the pump and the point of measurement of discharge.*

(*i*) *Elements of* operating conditions—*Three main elements of operating conditions are :*

(a) *The quantity of water delivered by the pump in a given time.*

(b) *The total head.*

(c) *The speed.*

The speed shall always be maintained as nearly constant and as nearly equal to the specified speed as possible. If the prevailing suction and delivery heads under operating condition are not the correct specified heads then if possible, these heads shall be brought to the specified values by suitable methods applicable to the local conditions of installation. Throttling by a valve is the most feasible means to raise the head in case the operating head is less than the specified value, but should it be found necessary to insert a throttle valve in the suction, line this shall not be fitted closer to the pump than ten times the diameter of the suction pipe.

Each of the various measurements for a given run shall whenever possible be computed by averaging a series of instantaneous readings taken simultaneously at equal time intervals. A note shall be made of extreme fluctuations at any instant. A sufficient number of readings shall be taken in making an observation, so that the addition or elimination of a single reading representing a maximum swing of the instrument shall not affect the average by more than 1 per cent, (*ii*) Mechanical and hydraulic conditions—(*a*) *The pumping unit shall be in the best possible mechanical condition with all bearings, stuffing boxes and internal running clearances properly adjusted.*

All air leaks in the suction pipe shall be eliminated and the pump shall be free from foreign matter.

Note—*Special care is necessary to avoid the formation of air pockets in the suction pipes. Such pockets formed by conical reducing pieces can be avoided by putting all the taper on the bottom of the reducer, keeping its top horizontal.*

(b) Hydraulic condition—*Unless otherwise specified, the temperature of the water during the test shall not cxceed 85° F. The water to be handled shall be reasonably free from air, gases/or suspended solids.*

(c) Duration of test—*The duration of the test shall be sufficient to secure accurate and consistent check result. To verify the mechanical condition of the pump it shall be run continuously for not less than one hour and not more than six hours. Where a specification covers a range of performance, a minimum of five tests shall be made to define points approximately equidistant on the characteristic curve.*

(*iii*) Measurement of speed and discharge—*The speed of the pump shall be accurately measured by a revolution counter or an accurately calibrated tacheometer.*

The discharge shall be measured by 'V' notch method as directed by the Engineer-in-Charge.

(*iv*) Method of measuring head—(*a*) *The standard method of measuring head shall be to employ a water column or gauge glass giving a direct reading of surface elevation. Where this cannot be used, indirect methods may be employed, such as the use of a mercury or other fluid gauge or a Burdon type gauge.*

When water columns are used, care shall be taken to avoid errors due to the difference between the temperature of the water in the gauge connection and that of the water in the pump by frequently draining the connection or determining the necessary correction.

(b) Gauges and connections—*Where accuracy is specially desired, and when the head against which the pump is operating is 50 feet or less, it is recommended that water or mercury manometers be used instead of Burdon type gauges. When Burdon type gauges are used, it is recommended that drain cocks be placed immediately below the gauges and that frequent tests be made to determine whether the pipe connections of the gauge are filled* *with air or water. With any form of gauge care shall be taken to eliminate any leaks (even if small) in the connecting piping, and to avoid the trapping of air in the connecting pipe or hoses.*

Gauges shall be calibrated prior to and after the test and when calibrated and used, shall be in an upright position. On no account shall any Burdon type gauge be fixed so that any strain is placed on its case, as its readings may thereby be seriously affected.

Connections for the gauges shall be made on the suction and delivery pipes in position free from likelihood of the gauge readings being affected by curvature, restriction, rotation or impact effect of the stream lines, and shall be as short and direct as possible. Connections to taper pipes and bends are undesirable, and connections to the top side of a pipe shall be avoided, as air frequently collects there. The suction gauge connection shall be placed at a distance of one to one-half pipe diameter from the inlet flange, and the delivery gauge connection at a distance of one to four pipe diameters from the outlet flange. If a valve is used for the throttling the discharge, it shall be placed downstream of the delivery gauge connection at a distance not less than three pipe diameters. The end of the connecting tube or pipe shall be flush with the inside of the conduit in which the pressure is to be measured and shall have its axis at right angles to the direction of flow.

(c) Limit of accuracy of total head measurement—*With the above precautions and provided the head to be measured is reasonably steady, an accuracy may be expected within 1·0 per cent.*

(v) Measurement of power input—(*a*) Classes of measurements—*Measurement of power input to the pump, that is the brake horse-power (B. H. P.) of the pump, falls into two general classes, Some measurements are those which in themselves determine the actual power or torque delivered to the pump and are therefore made entirely during the test, using some form of transmission dynomometer. Other measurements are those which involve measurement, during the pump test, of power input to the driving element and the previous or subsequent determination of the relation of the power input to the power output of this driving element under the identical conditions of the pumps test, thus by calibration deriving the efficiency of the driving element.*

(b) Corrections and Allowances—*The power delivered to the pump shaft when directly connected shall be the power output of the driving element. When not directly connected, corrections shall made for the losses between the driving element and the* *pump. In the case of a belt drive the allowances for belt losses shall be taken as* 5 *per cent unless an accurate determination of such losses is made, on unless otherwise agreed between the parties concerned.*

(c) Electrc motor and instruments—*If a dynamometer motor, or a transmission dynamometer, is not available, the preferred method of determining power input to the pump shall be the use of a direct connected calibrated electric motor, provided the calibration tests of this motor are made with ever care and are frequently rechecked. Curves shall be made up from the calibration tests translating kilowatts input into brake horse-power out-pur. Power input to the motor during a pump test shall then be measured in a manner exactly similar to the calibration tests, and the corresponding power output as shown on the calibration curve shall be taken as the power input to the pump.*

Electrical instruments shall be calibrated, if required, immediately prior to the tests by the National Physical Laboratory or other approved authority.

Should question arise as to the accuracy of the motor efficiency or electrical instruments, these shall be re-calibrated immediately following the pump test.

(*vi*) Calculation of results, Water Horse-Power—*The water horse-power is found from Equations* 1 *and* 2:

$$W.\,H.\,P. = \frac{Q \times H}{8{\cdot}828} \;\ldots\ldots\; \textit{Equation } 1.$$

$$W.\,H.\,P. = \frac{G \times H}{3{\cdot}300} \;\ldots\ldots\; \textit{Equation } 2.$$

where W. H. P. = *Water horse-power,*

Q = *Discharge in cubic feet per second.*

G = *discharge in imperial gallons per minute.*

H = *Total Head' in feet of water standard density.*

Efficiency—*The efficiency of pump is the ratio of the water horse-power output to the brake horse-power input, or,*

$$\textit{Percentage efficiency} = \frac{W.\,H.\,P.}{B.\,H.\,P.} \times 100 \;\ldots\ldots\; \textit{Equation } 3$$

where the values have been determined as described.

(*vii*) Tolerances—(*a*) General—*In all commercial acceptance tests of pumps, a certain tolerance shall be allowed the manu-*

facturer on his guarantees to cover in accurancies of the equations for discharge, errors of observation and unavoidable minor in accuracies of the instrument emloyed.

(b) Tolerance on discharge and Head—*The tolerance shall be the probable attainable accuracy as per appropriate B. S. S. or as specified by the Engineer-in-Charge.*

(c) Tolerances on pump efficiency—*The tolerance on pump efficiency shall normally be 2·5 per cent when the discharge is determined by any of the standard method.*

E. G. should be guaranteed efficiency be 5 per cent and the tolerance + 2·5 per cent, the limiting efficiencies allowabl would be 48·75 per cent and 51·25 per cent.

No. 12·2.—Water-supply Pumps—Centrifugal Pumps.

Casing.

1. The casing shall be of volute type with end section and tengential delivery unless directed, otherwise by the Engineer-in-Charge. He should be of substantial construction and shall have a pedestal cast integrally with the pump.

Impeller.

2. The impeller shall be of cast-iron or Bronze and shall be fitted with easily renewal cast-iron seating rings, fitted to the casing adjacent to the eye of the impeller. The blades shall be designed for efficient performance.

Stuffing Box.

3. This shall be easily accessible for inspection and shall have clear water seal so arranged to present in gross of air into the pumps through the stuffing box.

Shaft.

4. The shaft shall be of substantial construction adequately supported by bearings of appropriate design being so placed as to avoid vibration in the shaft at any speed.

Accessories.

5. 1 Foot valve.
1 Gate valve.
1 Check valve.
1 Flexible coupling.
1 Priming funnel.
1 Pressure gauge including cock.
1 Depression water indicators.

Motor.

6. A.C. Electric motor 440 volt, 3 phase 50 cycles water proof with tropical insulations Horizontal speed 1400—3000 R. P. M.

Upto 10 H. P. Squirell cage and above that slipring motors shall be provided.

Ampere and Volt mctor shall be supplied.

7. (*a*) For Squirell cage motor :—

Starter.

Star delta motor protection switch, sheet steel clad equipped with overload and short circuit releases provided with one hand lever, and warning light and an automatic electric cut out (Switch).

(*b*) For Slipring Motor Oil drawn starter shall be provided Red warning light shall be provided. In both cases diagram shall be supplied.

8. (*a*) One set of bearings.

Spares.

(*b*) Spare motor.
(*c*) Starter winding.
(*d*) Starter contract.

(*e*) Four sets of brushes in case of slipring motor. The brushes for above 15 H. P. Motor shall be liftable.

The motor shall be capable of continuous running for 16 hours and complete accessories, spare parts and set of tools, for erection maintenance, repair and dismantling shall be supplied with the motor.

Diesel drive.

9. Where diesel power drive is required as stand by the motor will be connected to the pumps through V or flat belt, with suitable pulleys for the engine and the pumps.

The engine shall have all standard equipment, and shall include all flywheels, air filter, fuel tanks, fuel filter head starting cravel with supporting shield (exhaust), silencer, foundation parts, casing for valve gear one complete set of tools consisting of spares, socket, wrenches, socket oil can, screw driver, round pliers ignition paper, one set of spares consisting one locking for valve lever, one gasket between injection valve piston ring, circlip for piston pins, lock sheet for connecting rod, packing for cylinder head.

Temperature and oil gauge and other necessary suitable equipment necessary for erection, dismantling, inspection and repair and maintenance, shall also be provided.

The fuel and oil consumption shall be stated.

Complete instructions including erection diagram for erection, dismantling, repair and running of the installation written up in English and Urdu shall be supplied free of cost.

Diesel engine.

10. This shall be watercooled horizontal slow speed (Max. 1,000 R. P. M.) high compression with precombustion chamber, single cylinder for stroke, single acting type with forced feed lubrication and shall be capable of with standing abnormal wear for 10,000 hours. The engine shall be rated for continuous running for 16 hours a day, accessories spare parts and for running 10,000 hours, shall be provided together with tools and instructions for erection, dismantling, repair, inspection and maintenance together with spare part list.

The engine shall have all standard equipment and shall include all flywheels, air filter, fuel tank, fuel filter, head starting crank with supporting shield (exhaust), silencer, foundation parts, casing for valve gear, one complete set of spares, consisting of socket, wrenches, socket oil car, screw driver, round pliers, ignition paper, one set of spares consisting one locking for valve lever, one gasket between injection valve, piston ring, circlip for piston pins, lock sheet for connecting rod packing for cylinder head.

Temperature and oil gauge and other necessary suitable equipment necessary for erection, dismantling inspection, repair and maintenance.

The fuel and oil consumption shall be stated.

Complete instructions including erection diagram for erection, dismantling, repair, and running of installation written up in English and Urdu shall be supplied free of cost.

Information to be supplied to the Manufacturers.

11. (1) Discharge in gallons per minute.

(2) Lift above well.

(3) Suction lift maximum and minimum.

(4) Analysis of water, if any.

(5) A diagramatic sketch of the pump house may be supplied to the firm, who would submit detailed drawings for lacation of various units.

No. 12·3—Water Supply Pumps—Vertical Bore Hole Pumps.

Casing.

1. The pump shall be of single or multistage types depending upon delivery head, with high grade cast iron with axially and radially curved diffusers cast, or of the casing the individual stages

being held by steel through bolts, the pump being of substantial construction and the component parts being strictly interchangable.

Driving Shaft.

2. The driving shaft will be of substantial constructions and adequately supported by intermediate gunmetal bearing (shaft sleeves) of appropriate design being so placed as to avoid any vibration in the shaft at any speed. Calculation for placing with respect to size, eccentricity and strength shall be submitted. The bearings shall be forced lubricated by oil being capable of lubrication from the working platform from which the prime mover is located. The Thrust bearing for driving shaft shall either be located next to the pumps or at the floor level and will be of substantial construction and calculation for the size thereof shall be submitted.

Depth gauge.

3. Depth gauge together with indicator clock calibrated in feet of water with necessary fittings will be supplied with the pump.

4. These shall be of high grade tensile steel of substantial construction.

Shaft column pipe.

5. One suction pipe of steel.

Accessories.

Two Foot valve.
One Gate valve.
One Check valve.
One Pressure gauge with cock.
One set of pipe.
One water level depth gauge with foot air pump and sufficient length of pipe.
One set of tools.
One set of the impellers of bronze, 1 set neck bearings, 1 set of distance brushes of bronze, 1 set of rubber lined bearing.

Electric Drive.

6. Vertical AC Hollow shaft electric motor, with non-reverse brake, drip water proof, tropical insulated, Robust construction to with stands and storm.

Winding ...	... 400 volts delta.
Voltage	... 400/440 volts.
Frequency ...	... 50 cycles/sec.
Speed	... 1450/1700 rpm.
Out put at 113 degrees F	To be stated by supplier.
Listed output ...	To be stated by supplier.

The motor shall be squirel cage up to 10 BHP above that slipring.

Starter.

7. (*a*) Starter for squirel cage motor.

Motor protection switch, sheet steel clad equipped with overload and short circuit releases provided with one hand lever, and red warning light.

(*b*) Starter for slipring motor.

One oil drum starter.

One motor protection switch, sheet steel clad, with overload, short circuit and no volt release, and red warning light.

Spare parts.

8. *Spare parts*—(*a*) One set of bearings.

(*b*) Spare motor.

(*c*) Starter winding.

(*d*) Starter contract.

(*e*) Four sets of brushes in case of slip ring motor.

The brushes for above 15 H. P. motor shall be liftable.

Diesel drive.

9. Where diesel power is required the motor will be connected to the pump through a gear head and clutch box allowing the motor to run the pump with gear in the neutral. The gear will have a horizontal cone through a clutch to the diesel prime mover. The gear ratio will be such as to enable the pump to run at appropriate speed for the engine.

Diesel engine, Accessories spare parts.

10. Same as for centrifugal pumps.

Information to be supplied to the Manufacturers.

11. (1) Discharge in gallons/minute.

(2) Lift above well.

(3) Suction lift maximum and minimum.

(4) Analysis of water, if any.

(5) A diagramatic sketch of the pump house may be supplied to the firm, who would submit detailed drawing for location of various unit.

(6) The diagram shall include the sketch of borehole showing diameter and its divergence from the vertical line.

No. 12·4—Water supply pumps—Submersible pumps.

General.

1. These pumps shall not be used in case the horse power of the motor exceeds 10 B. H. P. or where there is a liability of the constant drop in voltage, and where the water has appreciable silt contents.

2. This shall be only used with AC, 3 phase, 50 cycles maximum speed 3000 R. P. M. seamless steel rising main.

3. Special cable length—

Accessories

Two cable connectors.

Twenty cable clamps.

One set of mounting clamps.

One gate valve.

One pressure gauge with cock.

One depth gauge complete with foot pump and air line.

One bend size.

One adopter flange non-return valve.

One non-return valve to be lifted at above ground level.

One water level safe quard complete with low tension transformer driving electrode and cable.

One automatic star delta starter, oil immersed cast iron clad with no volt releasc and overload releaser, includ-ing built in a meter.

One set of spare parts.

Information to be supplied to Manufacturers.

4. Same as chapter 12·2 and 12·3.

CHAPTER 13

EARTHWORK

13·1—*Earth work for sewers manholes, junctions, Chambers, Flushing Tanks, Drains in ordinary soil above subsoil water level.*

Alignment and grade.

1. The sewers are to be laid to the alignment and gradients shown on the drawings, but suject to such modifications as shall be ordered the Engineer-in-Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cuttings or gradients of the sewers shown on the plans and sections shall be permitted except by express direction in writing of the Engineer-in-Charge.

Setting out sight rails.

2. The sewers shall be constructed and laid with a true grade and in straight lines between curves as shown on the plan. The sewers shall be laid and constructed to their proper levels by the aid of suitable boning rods and sight rails which shall be fixed according to the requirements of the Engineer-in-Charge at intervals not exceeding 50 feet, and also by levelling along the invert line of the sewer by means of accurate "Dumpy" or other levelling instruments. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor who shall also provide and maintain suitable levelling instruments and equipment and shall set out the positions and levels of the sewers and other works according to the drawings and with any instructions he may receive from the Engineer-in-Charge from time to time during the progress of work throughout. He shall also provide, at his own cost and charge all labour and materials necessary to enable the Engineer-in-Charge or his staff to check the level and dimensions of the works whenever the Engineer-in-Charge or his staff require him to do so. All sight rails and posts shall be of well seasoned deodar timber of ample size and strength. The rails and boning rods shall be suitably planed accurately and no warped or otherwise defective or damaged sight rails or boning rods shall be allowed. The sight rails shall be secured to the posts by heavy wrought steel clamps to the approval of the Engineer-in-Charge and in such manner that they shall be fixed immovable to the correct line and level. All boning rods and sight rails shall have the centre line accurately marked thereon by a thin saw cut and shall be painted black and white to the requirements of the Engineer-in-Charge. All boning rods shall be suitably shod with iron. At least four separate sight rails shall always be maintained incorrect level and

alignment along the line of sewer at every place where construction work is proceeding and the alignment and level of the sight rails shall be checked by level and line at least twice every day to ensure that no disturbance or interference of the alignment and levels has taken place. Wherever required, the Contractor shall erect and maintain such additional sight rails as the Engineer-in-Charge shall direct. The Contractor shall, at all times, see that his workmen or other unauthorized persons are not allowed, accidently or otherwise, to tamper on interfere with sight rails or other alignment or level marks.

All bends and curves shall be set out mathematically in a manner to be approved by the Engineer-in-Charge and the Contractor shall provide, and maintain for the purpose such additional sight, rails posts rails, rails and other wrought and rough timber work also lines, steel wire and other articles as the Engineer-in-Charge shall require from time to time.

Excavation to be done in oppen cutting.

The excavation for sewers and works shall be done in open cutting unless the permission of the Superintending Engineer for the ground to be tunnelled is given in writing. Where sewers have to be constructed along narrow passages, the Superintending Engineer may order the excavation to be made partly in open cut and in such case, the excavated spoil shall be removed at once so as not to block up the passage, and shall be brought back later on for refilling the trench or tunnel.

Length of Excavation.

4. The excavation shall be made in such lengths and of such widths as shall, in the opinion of the Engineer-in-Charge, enable the sewer to be properly constructed. Unless otherwise permitted by Engineer-in-Charge, not more than 60 feet of any trench in advance of the end of the built sewer shall be open at any time and unless written permission to the contrary is given by him the trench shall be excavated to its full depth for a distance of at least 16 feet more than the minimum length of sewer permitted to be laid in it.

Opening out trenches.

5. In excavating the trenches, etc., the soling, road metalling, pavement, kerbing, etc., and turf is to be placed on one side and preserved for reinstatement when the trench or other excavation shall be filled up.

Before any road metal is replaced, it shall be carefully shifted. The surfaces of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-Charge and of the owners of the roads or other property traversed and the Contractor shall not cut or break down live fence or trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-charge shall order to the contrary.

The Contractor shall group up and clear the surface over the trenches and other excavations of all trees, stump, roots, and all other incumbrances affecting the prosecution of the work and shall remove them from the side to the approval of the Engineer-in-Charge. The Contractor shall keep all excavated spoil sprinkled with water during the execution of the work so as to prevent any dust nuisance.

Obstruction of roads.

6. The Contractor shall not occupy or obstruct by his operations more than one-half of the width of any road or street and if insufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Engineer-in-Charge in writing before closing and road to vehicular traffic and the foot walks must be kept clear at all times.

Removal of filth.

7. All night soil, filth or other offensive matter met with during the execution of the works, immediately it is taken out of any trench, sewer or cesspool, shall not deposited upon the surface of any street or where it is likely to be a nuisance or passed into any swere or drain but shall be at once put into carts and removed to a suitable place to be provided by the Contractor.

Excavation to be done to proper depths.

8. The trenches shall be excavated to such depth that the sewers shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given on the sections. In bad ground the Engineer-in-Charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with concrete, broken, stone, gravel or other materials. For such extra excavation and concrete, broken stone gravel or other materials, the Contractor shall be paid extra at the rates laid down for such work in the Schedule if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavates the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-Charge, the extra depth shall have to be filled up with concrete at the Contractor's own costs

and charges, to the requirments and satisfaction of the Engineer-in-Charge.

Refilling.

9. After the sewer or other work has been constructed and proved to be watertight, the trench or other excavation, shall be refilled. The utmost care shall be taken in doing, this, so that no damaged shall be caused to the sewer and other permanent work. The filling in the haunches and up to two and a half feet above the crown of the sewer, manhole, junction chambers and other work shall consist of the finest selected materiál, placed carefully in 6″ layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 6″ layers with material taken from the excavation, each layer being watered to assist in the consolidation, unless the Engineer-in-Charge shall otherwise direct.

New surfacing Materials.

10. In the event of the surfacing materials excavated from the trenches and other excavations being insufficient to restore the surfaces to the satisfaction of the Engineer-in-Charge, the Contractor shall made up the deficiency with materials equal in quality to that which was removed and if the old materials are unsuitable or worn out or damages, the Contractor shall supply new material in their place without extra charge.

Restore settlements and damage.

11. The Contractor shall, at his own costs and charges make good promptly during the whole period the works are in hand, any settlements that may occur in the surfaces or roads berms, footpaths garden, open spaces, etc., whether public or private, caused by the trenches, or by his other excavation and he shall be liable for any accidents caused thereby.

He shall also, at his own expense and charges, repairs and make good any damage done to buildings and other property. If in the opinion of the Engineer-in-Charge, he fails to make good or to pay and satisfy the expenses of making good such works with all practicable despatch, the Engineer-in-Charge shall be at liberty to get the work done by other means and the expense thereof shall be paid by the Contractor or deducted from any money that may be or become due to him or recovered from him any other manner according to the law of the land.

Disposal of Surplus earth

12. The Contractor shall at his own costs an charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus spoil shall be immediately removed, the surface property restored and the road way and sides left clear.

Timbering of sewer trenches.

13. The Contractor shall at all times support effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in all loose or sandy strata and below the surface of the sub-soil water table, without any extra cost. It is intended that all timbering, shall be removed as the work proceeds, except timber sheeting against which concrete is placed, which shall not be removed unless specially permitted by the Engineer-in-Charge. Such sheeting will, however, not be paid for when left in position unless the same was specially order in writing to be left in by the Engineer-in-Charge to protect the sides of the trenches and other excavations as provided for below. The Engineer-in-Charge may require any portion of the timbering, piling or sheeting to be left in the ground in order to protect the sides of the trenches or other excavation by an order, in writing to the Contractor, detailing the quantity of timber and other material to be left in and the place thereof. Such timber and other material will be paid extra at the rate as provided in N. S. T. or as determined by the Engineer-in-Charge. In soft or water-logged ground, the Contractor shall close drive the timber sheeting or piling with tongue and grooved or other joints of approved type to such depth below the bed level of the under-side of the sewer and other work as shall be required by an order in writing of the Engineer-in-Charge and no extra shall be payable to the Contractor for such extra work.

All timbering, sheeting and piling with their whaling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse, or subsidence of the walls of the trench shall take place. When timbering or sheeting is withdrawn, it shall be done gradually and carefully to avoid falls and subsidence and all cavities shall be solidly filled in. In case of timbering or sheeting left in place, all cavities behind such sheeting shall also be solidly filled in as directed by the Engineer-in-Charge.

The Contractor shall be held accountable and responsible for the sufficiency of all timbering, sheeting, and piling used and for all damages to persons or property resulting from the improper quality, stength, placing, maintaining or removing of the same.

Shoring of buildings.

14. The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to person or property resulting from any accident to any of such building.

Removal of water from sewer trenches.

15. The Contractor shall at all times during the progress of the works keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to the public health nor to public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

He shall from time to time forward in writing in advance to the Engineer-in-Charge, particulars of his arrangements for dealing with storm water and sub-soil water in order to push forward the progress of the work but the approval of the Engineer-in-Charge to any such proposals shall not relieve the Contractor of any of the full responsibilities imposed uponhimin this specification as regards to the work. The Contractor shall at all times provide adequate plants and materials, labour, fuel, lubricants, spare parts and all other contingent items, stores and accessories, for keeping all trenches and works de-watered in a safe, proper and effectual manner necessary for the prosecution and completion of the work without incurring any risks of damage to neighbouring buildings, property and structure.

The Contractor, in carrying out the de-watering of the trenches and excavations shall take adequate precautions to ensure that under no circumstances shall the sandy bottom of trenches below sub-soil water level be allowed to "blow", thereby endangering building and other structures in the vicinity of the work and the Contractor shall be held fully and wholly responsible for all damages done to buildings and other property resulting from his de-watering and pumping operations. If he fails to make good or to pay and satisfy the expenses of making good damages or works with all practicable despatch, the Engineer-in-Charge shall be at liberty to get the work done by other means or to pay the cost of the said damages deducting the amount expended from any money that may be or become due to the Contractor or the promoter may recover the same from him in any manner according to the law of the land. It is made absolutely clear that nothing extra shall be paid to Contractor for all operations connected with de-watering.

Widths and depths of trenches for sewers and manholes.

16. The maximum width of trenches in respect of which payment will be allowed for excavation will be as follows :—

(*a*) Trenches not exceeding 7 feet in depth 20 inches plus external diameter of barrel for pipe sewers; and six inches plus, maximum external overall diameter or width of sewer ; and six inches plus maximum external overall diameter or width of sewer for brick or concrete sewers constructed in situ,

(*b*) trenches exceeding 7 feet and not exceeding 15 feet, 24, inches plus external diameter of barrel for pipe sewers; and twelve inches plus maximum external over all diameter or width of sewer for brick or concrete sewers constructed in situ,

(*c*) trenches exceeding 15 feet depth 27 inches plus external diameter of barrel for pipe sewers and eighteen inches plus maximum external over all diameter or width of sewer for brick or concrete sewers constructed in situ.

The cross sections of trenches to be excavated below the level of the crown of the barrels in the case of circular sewers of all classes and below the intrados of the covering arches of egg-shaped sewers shall be trimmed accurately to the exact cross section of the sewers to be laid or constructed therein and no earth filling shall be permitted between the sides of cradle or envelope and the trench sides below the horizontal diameters or springing of the covering arches of the sewers as the case may be.

If any excavation is carried out at any point or points to a greater width than the specified cross-section of the sewer with its envelope, the same shall be filled with concrete by the contractor at his own expense and charges to the requirement of the Engineer-in-Charge.

The minimum widths of trenches down to the crowns of the barrels, for pipe sewers and drains not over 18 inches in diameter shall be such as to give a clearance of 8 inches on each side of the barrel of the pipe, and for those of large diameter, of 9 inches on each side of the barrel of pipe and all such trenches shall have a clear width at the bottom equal to the width of the cradles of the sewers to be laid in them. The minimum clear width of trenches for other sewers shall be the greatest external width of the structures to be built therein.

Where a manhole or the foundation thereof extends beyond the exterior lines the sewer or its foundation, the minimum excavation is earth required for the same shall be that contained in a prism with vertical sides and a horizontal section equal to the smallest rectangle which will enclose such manhole and its foundation.

The minimum dimensions of the excavation in earth for brick work and for concrete flushing tanks, junctions with junction chambers, storm water overflows and similar works shall be such as to give a clearance inside the sheeting or timbering of one foot on all sides above the foundation, but in all such cases the excavation shall be large enough to include the foundation for the structures as shown on the drawings.

The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewers, manholes and other works in certain lengths to be specifically laid down by him, where, on account of bad ground or other unusual conditions, he considers that such increase widths are necessary in the interests of the work.

17. The contractor shall provide at his full cost charges, all necessary safety arrangements and proper watch, e.g., road closure boards, red flags during day time, red light during night time, fencing etc., etc., as per instructions satisfaction of Engineer-in Charge, on the open trench. Failure to do so all the arrangements shall be provided otherwise at Contractors full expense he shall further be rendered liable to any penalty or rescinding of agreements as deemed fit by the Engineer-in-Charge.

13·2 CUT AND COVER METHOD OF EXCAVATION TUNNEL

1. As per paragraph 3 of Chapter 22·1 of this volume.

General.

2. This type of excavation hereby called 'Cut and cover' system may be permitted for strong hard homogenous clayey formations which are not liable to collapse under normal working conditions.

Formation of soil.

This work shall not be permitted in running sand.

In weaker foundations consisting of mixtures of clay, and sand, which although may be able to stand up unsupported initially, are nevertheless, liable to give way if exposed to atmospharic exposure for a little time, the roof shall be protected by adequate timbering or shoring as to roof and wall.

3. Irrespective of the type of alluvial strata, if the tunnel is subjected to any sort of traffic, it shall be adequately protected by roof and wall timbering and shoring.

Tunnel under Traffic.

4. Normally the length of Tunnels shall not exceed 17 feet. This case may be exceeded in case of sewer of considerable depth under cross roads, or street junctions, if absolutely essential, provided that the tunnels are driven carefully and in such a manner that there is no danger of collapse of the overlying strata on the side and so long as the Executive Engineer, has satisfied himself clearly and fully before hand for each particular case that such tunnel cannot be avoided in the interest of work and that the method to be followed of driving such tunnel and of shoring or timbering the floors and roofs are such that no risk of collapse or of damage to life and limb will be incurred.

Length of Tunnel.

5. The tunnel shall be driven as rapidly as possible from both ends work being continued during holidays and also so for as possible at night time. As soon as any tunnel is fully driven the sewer therein shall be rapidly completed and empty space over the each packed soiled with fine sandy material as rapidly as possible commencing from the centre, wherever it is practicable to do so.

Tunnel in strong hard clayey formation not liable to collapse.

6. When vehicular traffic will pass over the tunnel in the above case, the tunnel shall be arched by adequate layer of five shingle.

In hard soil without traffic.

The posts and walling board shall be kept as short as possible.

7. The roof shall be adequately protected in case of traffic above a weaker formation by a sufficient polling board, depending upon type of soil.

Tunnel in strong hard clayey formation under traffic and weaker starta.

The polling boards and struts shall be in short lengths say 3 to 5 feet and shall be so erected and fitted that each frame setting with its struts and polling boards, can be slackened and removed easily without interfering with the timbering on either side.

The polling boards shall be independently wedged in position so that they can easily be drawn singly by slackening the wedges.

The polling board in successive setting shall break joints.

The sole plate of the roof frame shall be bedded in stong solid clayey ground to obviate the ground giving way.

The width of tunnel shall be carefully maintained, and the height above the top of the sewer up to tunnel roof shall not be less than 4 feet clear.

The side of tunnel shall be adequately supported, if required by frame consisting of vertical posts on walling, 8″ × 3″ or 9″ × 3″, spaced from 3 to 6 feet apart depending on local condition and held together by struts 5″—6″ round or square. Behind these vertical polling board 1″—1½″ thick planks shall be fitted and wedged in as sufficiently near as desirable.

A lower frame or another set of polling board held by vertical wallings or posts and adequately strutted shall also be fitted if essential.

The timbering work shall be carried out expenditiously and accurately as the work proceeds. Timber shall be withdrawn as the construction work is built, and filling carried out simultaneosly.

8. All other work shall be done as per Chapter No. 13·1 of this volume.

No. 13·3—*Excavation for Sewers and Drains below sub-soil water in ordinary clayey soil.*

1. When the depth of excavation is not more than 6 feet below the sub-soil water level the excavation or up to the water level be done as describe in Chapter 13·1 with necessary timbering and shoring if required.

Excavation in ordinary water-logged soil other than running sand up to spring level.

The width of excavation shall be at least 3″ wider than the width of the trench required at bottom.

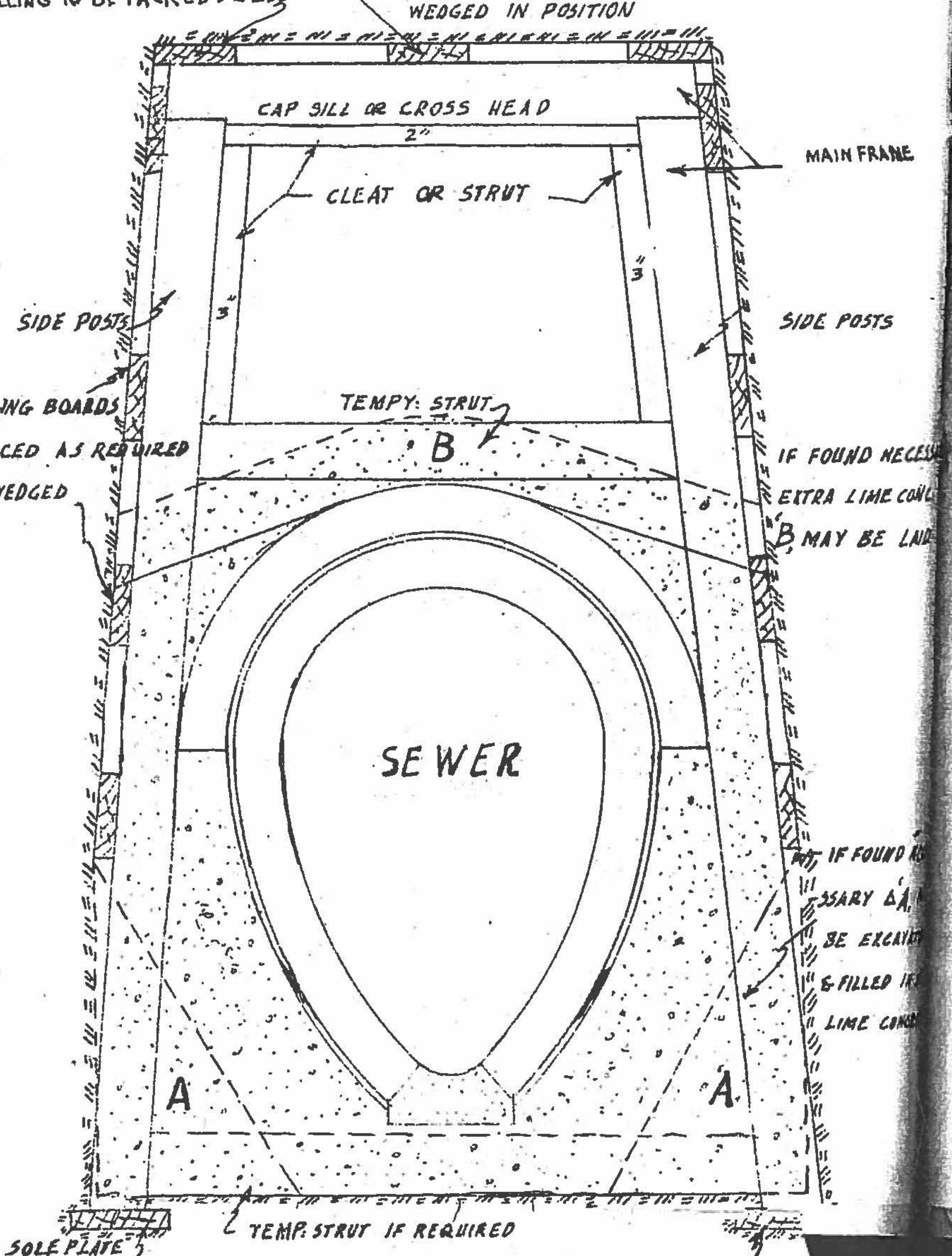
2. Iron corrugated sheets or closed timbering shall be driven after leaving a bench of 2 feet on either side, and excavation in between carried out by means of jhams and tobas (divers) or by means of mechanical grabs.

Excavtion below water.

LAHORE SEWERAGE SOS

FIG: 3. SHEWING TIMBERING OF HEADINGS IN HOMOGENOUS GROUND.

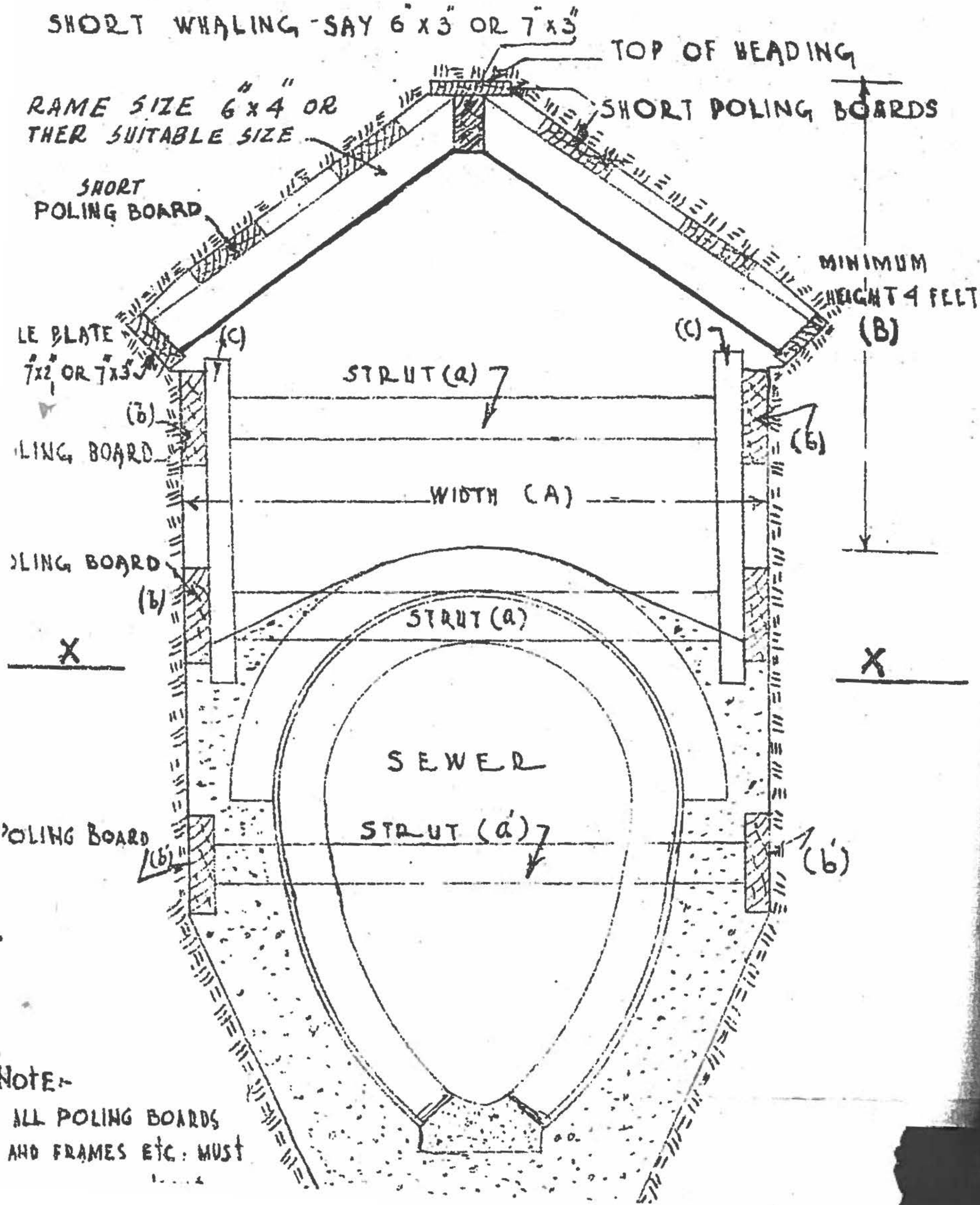
NOTE:-
CLEARANCE ABOVE TOP OF SEWER IN HEADING MUST BE SUFFICIENT TO ENABLE WORK TO BE CARRIED OUT IN A PROPER MANNER AND FOR THE BACK FILLING TO BE PACKED SOLID.



NOTE :- (1) THE MAIN TIMBER FRAMES DEPICTED ARE SPACED FROM 2 TO

LAHORE SEWERAGE 505

FIG.-2. DEPICTING SECTION OF TUNNEL HEADING IN STRONG HARD GROUND IN WHICH THERE IS RISK OF PIECE OF ROOF FALLING

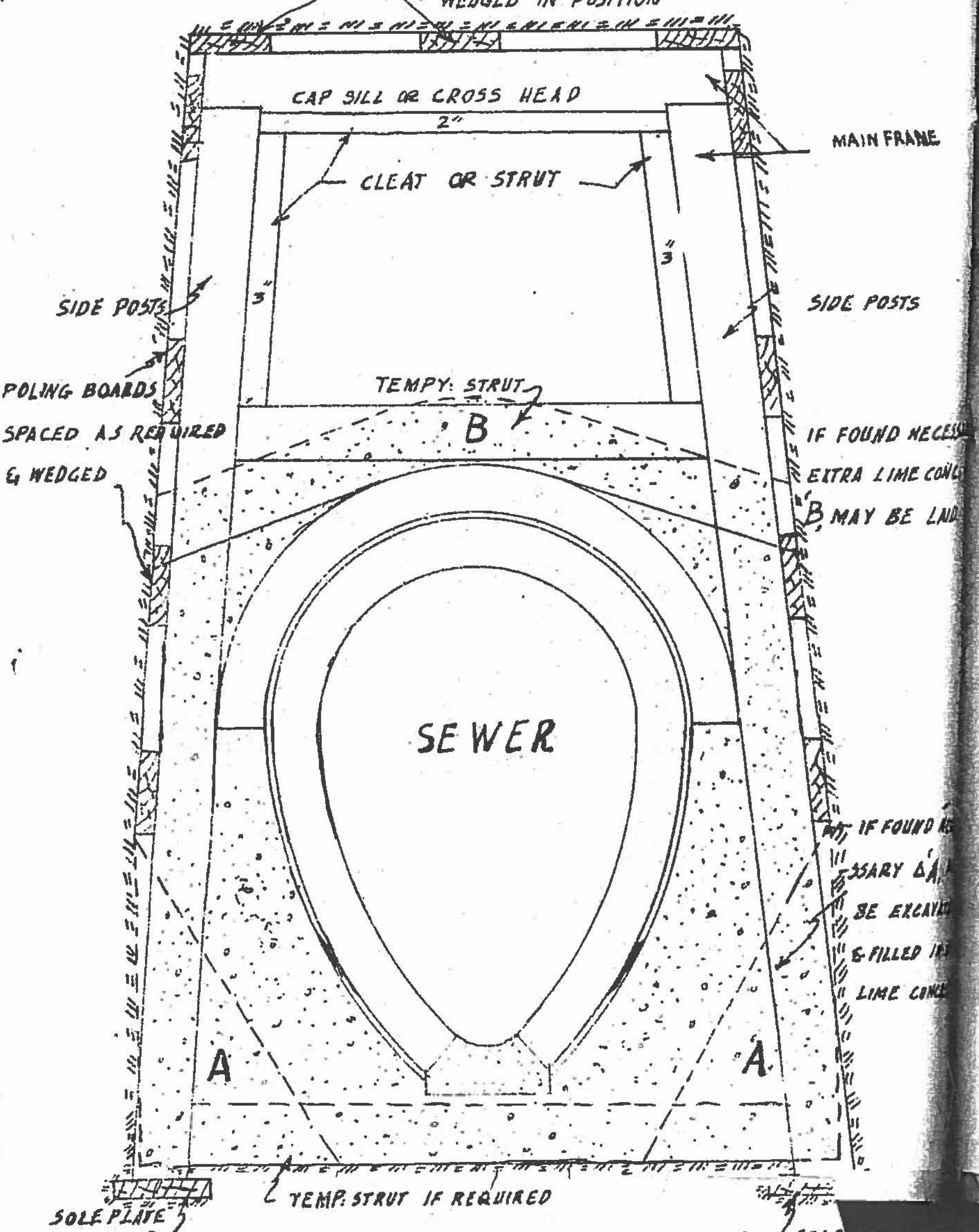


NOTE:-
ALL POLING BOARDS AND FRAMES ETC: MUST

LAHORE SEWERAGE 505

FIG: 3. SHEWING TIMBERING OF HEADINGS IN HOMOGENOUS GROUND.

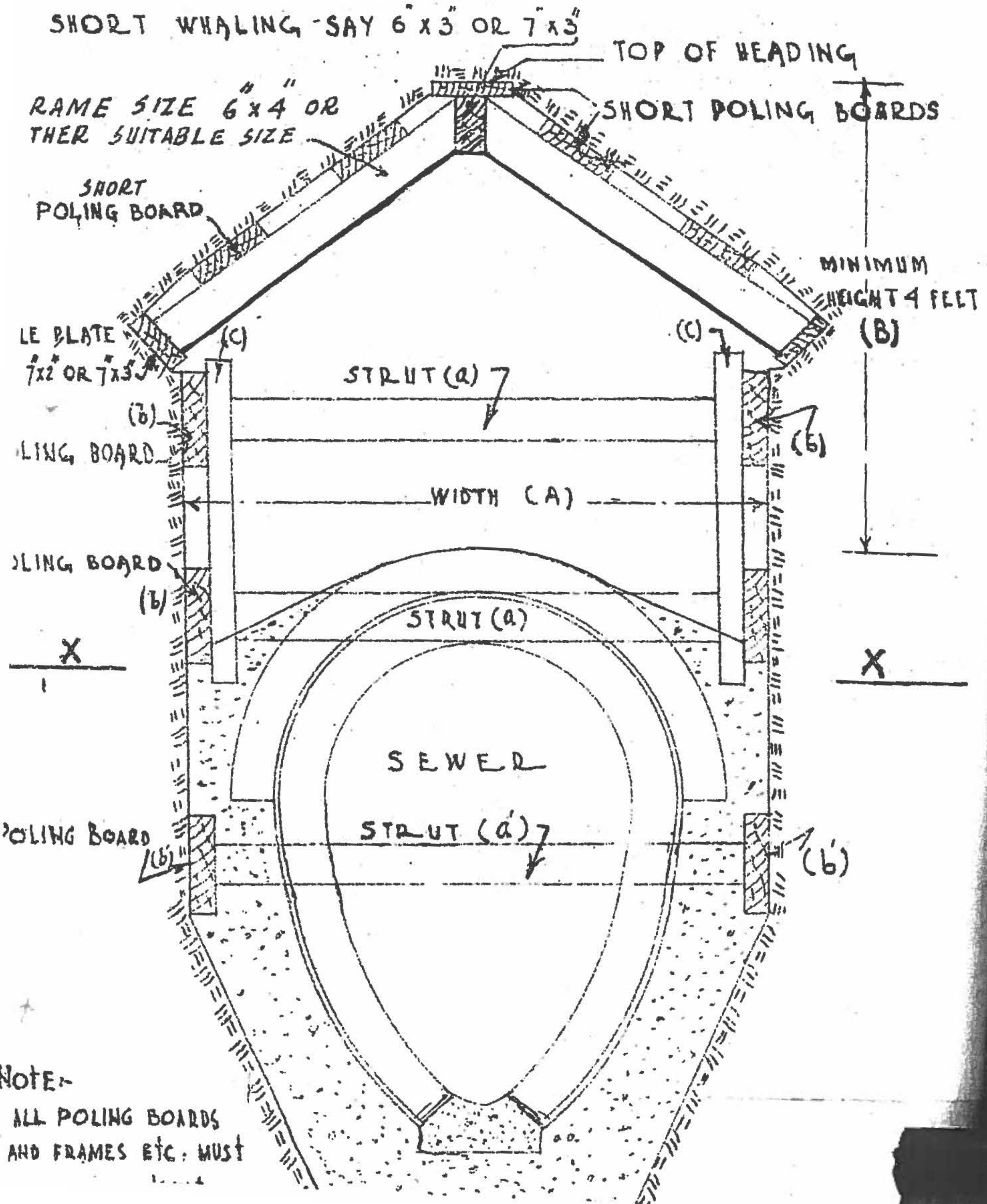
NOTE:-
CLEARANCE, ABOVE TOP OF SEWER IN HEADING MUST BE SUFFICIENT TO ENABLE WORK TO BE CARRIED OUT IN A PROPER MANNER AND FOR THE BACK FILLING TO BE PACKED SOLID.



NOTE :- (i) THE MAIN TIMBER FRAMES DEPICTED ARE SPACED FROM 2 TO

LAHORE SEWERAGE 505

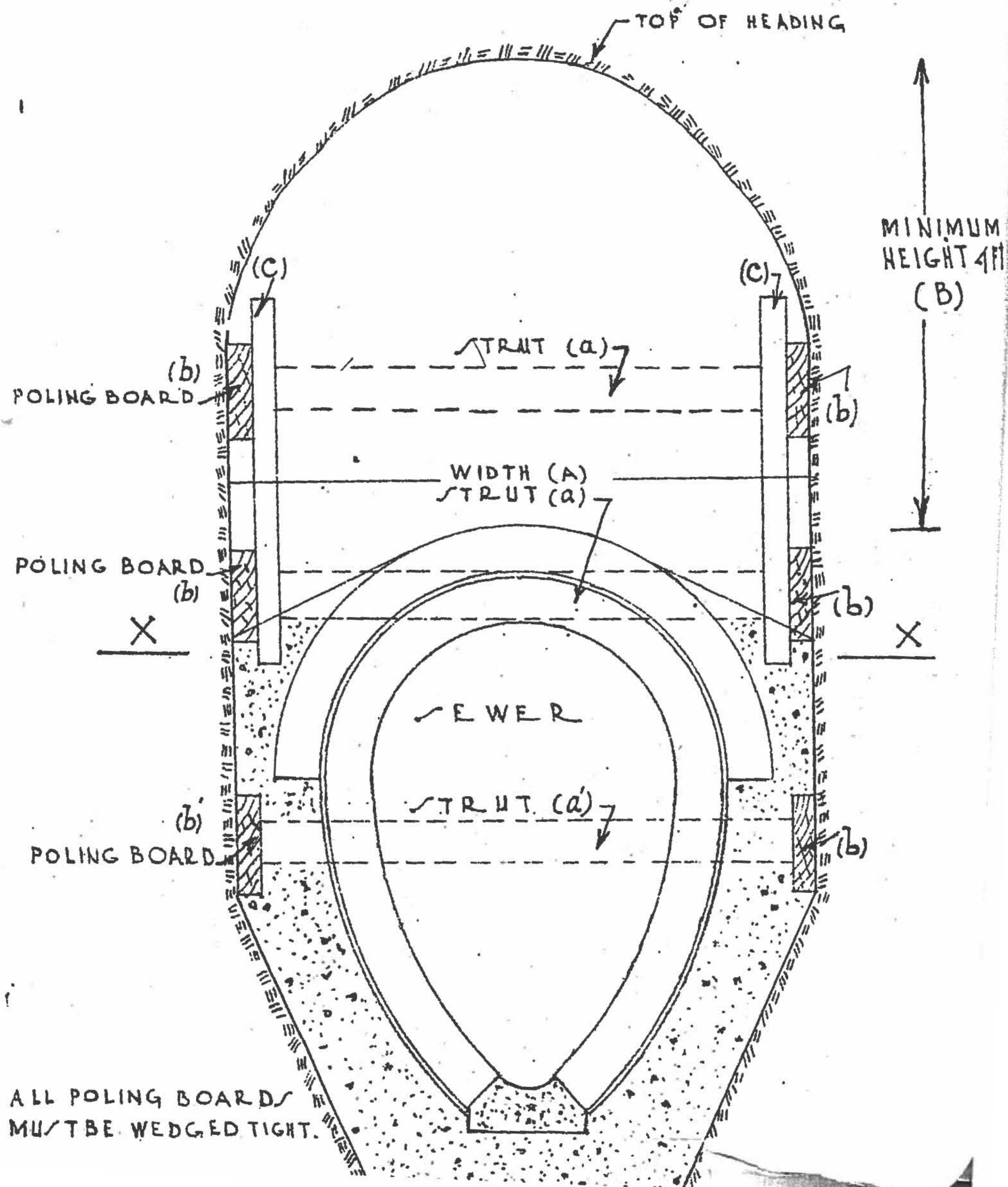
FIG.-2. DEPICTING SECTION OF TUNNEL HEADING IN STRONG HARD GROUND IN WHICH THERE IS RISK OF PIECE OF ROOF FALLING



NOTE:-
ALL POLING BOARDS
AND FRAMES ETC. MUST

505 LAHORE SEWERAGE

FIG: 1. DEPICTING SECTION OF TUNNEL HEADING IN STRONG HARD GROUND IN WHICH THERE IS NO RISK WHAT SO EVER OF ROOF GIVING WAY.



The lower stage timbering or sheeting be lowered as excavation proceeds and under no circumstances, it shall be less than 1 foot lower than the bottom of the trench.

Security of sides of trenches.

3. It shall be ensured that the timbering and sheeting in both the upper and lower stages is strong and does not give way, care being taken that the spoil earth is placed at a distance of at least 5 feet away from the edges of the trench and that the trenches are not disturbed by traffic and impact on the sides.

Watch.

4. As per paragraph 17 Chapter 13·1 of this volume.

Protection to property.

5. The trenches shall be at a safe distance from valuable buildings so that line drawn from the bottom of the trench at an angle of 45° does not cut the foundation or the ground at a distance of less than 5 feet. In case, this cannot be done by altering the alignment, the timbering shall be left in the trench as a safe guard, unless decided otherwise by the Engineer-in-Charge in writing.

6. No cut and cover method shall be allowed in this case.

For depth exceeding more than 6 feet below the sub-soil water.

Well point pumping.

7. The sub-soil water level shall be depressed to a depth of excavation by constant pumping from a line of 3″ pipes bore with 3 feet strainers on either side of the trench driven to a depth of 3-4′ below the required trench depth by means of water jet method.

The bore pipes shall be at a distance of 5′ or as directed by Engineer-in-Charge from the sides of trench and shall be 10 feet part, inter-connected by piping on each side as well as other side.

De-watering.

8. The de-watering shall be done by unchokable pumps of a robust type powered by two alternative sets of prime movers. These shall be stand by pumps as well.

Constant De-watering.

9. It shall be ensured that the trench remain de-watered constantly (without interruption during day and night) till the sub-soil construction is completed, to avoid accidents.

The cost of de-watering is included in the rate of failure to maintain adequate pumping plant and timber shoring material would result in rescinding of agreement.

10. In all other works, specification as given,—*vide* Chapters 13·1 and 13·2 of this volume will be applied.

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13·4—EXCAVATION IN RUNNING AND ABOVE SUBSOIL WATER

General.

1. Running sand saturated with water behaves exactly like water and cannot stand to any slope. Dry sand assumes. A slope of 1½ to 1.

Extreme care.

2. Whenever running sand is encountered, extreme care shall be taken during excavation to avoid accidents by keeping the sand dry. The spoil shall be kept at a distance of 10 feet from the edge of trench and after giving minimum slope of 1½ to 1 to the slope of bank.

Security.

3. As per paragraph 17, Chapter 13·1 of this volune.

Open Area.

4. In open area the excavation shall be done to a slope of 1 in 1 and consolidating the side slopes with a slurry of clay being poured on them throughout the length.

In congested areas proximity to buildings.

5. In congested areas with valuable building property, it shall be ensured that the line of 45 degrees the horizontal from the bottom of the trench does not cut either the foundation or the ground at a distance of within 5 feet of any tall structure (30 feet of higher).

In case it does, sheet piling or timbering shall be left in the trench, as a safeguard.

Excavation in congested area.

6. In congested areas the excavation shall be done by driving the close timbering of mild steel sheet piles throughout the depth, adequately supported by wales, posts and shuttering and excavation proceeded. The depth of the sheet piling shall be maintained at 2½ feet below the excavation at all times.

Width of Trench.

7. The width of the trench shall be at least 4 feet more than the width of the pipe or sewer.

8. In all other respect the work shall be in accordance with the Chapter 22·1 and 22·3. No cut and cover method shall be permissible.

13·5—EXCAVATION IN RUNNING SAND BELOW SUBSOIL WATER LEVEL.

General.

1. Running sand saturated with water cannot stand to any slope and behaves exactly as water and great care shall be exercised in excavation to avoid accidents. The aim shall be to render the trench completed dry and maintain it in that condition till work under water is completed to avoid caving in of sides.

Open Country

2. In open country the work shall be executed by completely keeping the trenches dry up to the foundation level.

Side slope above sub-soil water level and spoil banks.

3. It shall be ensured that the side slopes above the sub-soil water level are adequate and spoil banks are at a safe distance from the trench with adequate slope in a dry condition.

De-watering.

4. The foundation shall be kept dry by constant pumping from a system 3″ bores with 3 feet strainers driven at a distance of 5 feet or as directed by Engineer-in-Charge from the trench it shall be ensured that the pumping is without interruption, adequate stand by pumps and primovers (alternative, Service of power if necessary) so that there is no caving in of the sides. The depth of the bores shall not be more than 3 feet below the excavation.

Care of trenches depth.

5. In case of greater depth another system of the bore shall be driven in the side slopes to depth 3 feet below the excavation, after excavation up to the first stage is completed.

The second bore system shall be similarly operated, simultaneously closing the first system. Some precautions apply to this case.

Excavation in congested area.

6. Where it becomes essential to lay pipe and sewers in congested areas, and result of trial bores indicate existence of running sand saturated with water, great care shall be exercised in excavation under the sub-soil water as per instructions full satisfaction of the Engineer-in-Charge.

Closed fitting mild steel sheet pipe.

7. Closed fitting mild steel sheet pipe shall be used in the above case.

Width of trench.

8. The width of trench shall be at least 6 feet more than the width of the pipe or sewer, so as to leave it undisturbed during extraction of the pipes.

Depth of piles.

9. The depth of piles shall be at least more than $2\frac{1}{2}$ feet below the excavation depth.

Only quick acting light hammer shall be used whilst driving or extracting the piles.

Proximity of property.

10. Where valuable building property exists, and where a like drawn at an angle of 45 degrees to the horizontal cuts either the foundation or the ground within 5 feet of the outer edge of foundation the sheet piles shall be left in the trench,

11. The supporting system to the piles, e. g., wales and struts shall not be removed till refilled material is sufficiently compacted. Where sheet piling is proposed to be removed the struts shall only be removed after the refilling material has attained compactions.

Supporting system to the piles.

12. All other excavation work shall be done as per previous Chapters 13·1 to 13·4 of this volume. All those specifications will be considered applicable to this case.

No. 13·6—EXCAVATION IN HARD ROCK BY BLASTING DRILLING OR WEDGING OR BARRING AND TRENCHING FOR DRAINAGE AND WATER WORKS.

1. The general specifications in soil other than rocky shall be complementary to the following :—

2. Rock wherever used as the name of an excavated material shall mean boulders exceeding 8 cubic feet in volume or sold ledge rock which in the opinion of the engineer, requires for its removal drilling and blasting or wedging or sledging or barring.

3. No soft or disintegrated rock which can be removed with a pick no loose, shaken or previously blasted rack or broken stone in rock fillings or elsewhere, nor rocks exterior to the maximum limits of measurement allowed which may have been previously loosened in excavating for water pipes, or other purposes and which, by means of such loosening, may fall into the trench will be measured or allowed.

4. Disintegrated lime stone, shall soapstone, slate, hardpan, fire-clay, cemented gravel, macadam pavement, and boulders less than 8 and more than 1 cubic feet in volume shall not be taken as "Rock".

5. In rock the trench shall be carried if required to a level 6 inch below the invert grade of pipe sewer when no under drain is required if an under drain is required the trench shall be carried to the depth and width required by the underdrain and grave or broken stone refilling, as shown in the drawings.

6. In case of masonry sewers the rock shall be excavated to the depths required for the foundations and to a width 6 inches greater on each side than that of the masonry. The minimum dimensions of the excavation in rock for a manhole catch-basin, flush-tank or other special structure shall be those of a prism with vertical sides and a horizontal section 6 inch wider on each side than the smallest rectangle which will enclose such structure and its foundation,

7. Rock shall shall be stripped in sections which, unless otherwise permitted shall be not less than 50 feet in length, and the Engineer shall then be notified in order that he may measure it. Rock blasted before such measure is made, will not be paid for.

8. The quantity of excavation to be paid for shall be the rock lying within "lines of Excavation" indicated on the drawings. Wherever deemed necessary by the Engineer and ordered in writing additional rock excavation shall be performed and will be measured to the lines stipulated by the Engineer and paid for.

9. All blasting operations shall be conducted in strict accordance with existing ordinances and regulations relative to rock blasting and the storage and use of explosives.

10. Any rock excavation within 5 feet of a water or gas mains less tnan 36 inches in diameter and within 10 feet of a water or gas mains 36 inches or more in diameter shall be done with very light charges of explosive and the utmost care should be taken to avoid disturbing the mains.

11. All exposed sewers and special structures shall be carefully protected from the effects of blasts and any damage done to them by blasting shall be promptly repaired by the Contractor at his own expense. Sufficient warning shall be given to all persons in the vicinity of the work before blasting. The site of the blast shall be covered with heavy timbers, blasting mats or other devices to prevent damage by flying rock. The time of blasting and the number and size of charges shall be satisfactory to the Engineer. The blasting shall be done only by experienced men.

12. The contractor shall, further, be answerable for any accident or damage caused by blasting or improper storage of explosives.

13. Where there are no local ordinances governing blasting the storage of explosives, all blasting supplies shall be stored in a manner approved by the Engineer, and a Watchman shall be stationed at all times, at the places of storages. In no case shall caps or other exploders be kept at the place where dynamite or other explosive is stored.

No. 13·7—Trench excavation by Machinery for Drainage and Water Works

(Corallary to the General Specifications of Excavation in ordinary soil other than rocky)

In using machines for excavation, due regard should always be given to the probable quantity of work to be done. It is not advisable to secure and use a machine for the sake of very short piece of work.

Among the different types of machines which are available for trench work may be mentioned machines in which Buckets are raised and lowered by machines of Cables, such as the ordinary Cableway and the Carson, Pottor and More Trench machines; Trench diggers like the Buckey Traction Digger; the steam shovel with or without extra long dipper arm, and either moved on tracks or traction wheels upon the surface of the ground; Clam-shell and Orange-Peel Buckets operated by Derricks or locomotive Cranes are also useful upon large work and wide trenches and scrapers drawn by horses have been used to a limited extent upon sewer work.

Carson Trench Machines—It should be used for ordinary soil comprising of quicks and soft mud, exceeding 12 feet in depth for economy.

For ordinary Sewer construction, the Six-Bucket Single Track machine should be used. If the trench is very wide, or the excavation is exceedingly hard, the double-Track machine would be most convenient and should be used.

During the excavation work, the lower Track should be laid before the excavation for the section being worked, is finished.

The whole work Backfilling, Laying, and Excavation should be divided into six sections. A total length of 288 feet should be operated at a time.

The tubs should be so arranged as to be hoisted six at a time out of a total of 18 tubs furnished.

The tubs should have a nominal capacity of 5·50 cubic feet each.

The machinery along with manual labour should be so employed as to at least give an average of 2,700 cubic feet of excavation a day in 8 hours of working.

Potter Trench Machine Type—In this case, a Track should be laid on the ground over which a Bucket-Machine is to be operated by cables.

The Excavator and Conveyor Type should be equipped with an orange, Peel or Clam-Shell Bucket.

The whole machinery should be provided with at least 12 Buckets of varying capacity, varying from $\frac{1}{4}$ to 1 cub-yard.

Cableway Type—This should be exclusively employed on sewer trench excavation.

The towers provided should be light capable of being easily moved with relatively short cableway not over 300 feet in length.

It should be provided with a tub varying from $\frac{1}{2}$ to $1\frac{1}{2}$ cub. yards in capacity.

The hoisting, swinging should be effected in such a manner as not to hit or knock the timber sheeting.

Steam Shovels Type—It should not be employed for ordinary trench excavation.

It should be used where deep excavation is the real motive.

The nominal capacity of Steam Shovel should vary from 1,000 to 1,500 cubic yards per day of excavation.

Such steam shovels should not be employed where the trench excavated is through paved streets.

The steam shovel should better be used for making the first cut for deep trenches of large dimensions.

Endless Chain Machines Type—These should be adopted for relatively shallow trenches through virgin soil where bracing is not necessary and where pipes, conduits crossing the trench are not encountered.

This should not be employed in sandy soils and especially where there is considerable ground water.

These should be employed where the excavation of trenches is required to a precise grade regardless of the inequalities of the surface over which it passes as in the case of water-supply.

These should be adopted where there is scarcity of labour.

Buckey traction Ditcher Tpye—This type of machine should be emplyoyed in excavation trenches of relatively narrow width specially for laying drain tiles to a maximum depth of 12 feet.

Derricks and Cranes Type—These are usually employed to lift buckets which have been filled by labourers in the track and dumping the material in windrows along the trench.

This should be used on large works for economy.

The length of boom should not exceed 30 feet.

Excavation Bucket Type—This should be employed in a loamy or sandy soil.

The banks of trench excavated by such machine should be trimmed by manual labour.

The length of trench should be divided into sections of 10 feet each.

Excavation within 6-12 inches of sub-grade should not be carried to avoid settlement and incorrect elevation.

No. 13·8—Rock Excavation by blasting

(*Corallary to the general specifications of Excavation in Hard rock by blasting, drilling, or wedging or barring an or trenching*).

1. Blasting shall only be carried out at certain special times to be jointly agreed to by the contractor and the Engineer, and an area of 200 yards radius from the firing point is to be specially flagged out and all workmen excluded therefrom at least 10 minutes, before the hour for firing, a warning bell being sounded for the purpose.

2. A subordinate on behalf of the Public Works Department is to be in special charge of each set of operations, and will be held personally responsible for proper conduct of the operations.

3. A properly appointed agent on behalf of the contractor shall personally superintend the firing and not more than six holes at a time shall be set off. A count shall be kept of the blasts, if these do not tally with the number fired the difference indicates misfires, in which case no person shall be allowed to return to site of firing for at least half an hour after firing, when the misfire shall be carefully looked for.

4. On detection, the hole containing the unexploded cartridge should be marked immediately with a ring of red paint and a new should be put down by the side of it, not nearer than 2 feet to blow it out at the next firing. The old hole must be left absolutely.

5. All drill holes should be thoroughly cleaned before loading.

6. When the hole has been drilled to its full depth, it should be plugged with a wooden plug to prevent entrance of dirt or water.

7. Where water or dirt have found their way into the hole it should be cleared out with compressed air or steam.

8. The size of cartridges used for the drilled holes shold be such as to fit in the holes all round without leaving a space on its sides.

9. Explosives shall not be broght on to the works in quantities exceeding the requirement enougn for the particular amount of firing to be done and any surplus explosiues left when all the holes have been charged, must be carefully removed at least 1,000 feet from the firing point.

10. The names of the resposible agents entrusted with the blasting operations should be carefully registered by the Engineer.

11. Dynamite should be kept dry until used, if exposed to damp, it becomes most dangerous. It shall not be exposed to the direct rays of the sun and should not be placed near fires, stoves steam pipes of heated metal.

12. Frozen dynamite is a most dangerous substance, none but the most experienced men should, therefore, handle it in a frozen state. It should be thawed by placing the cartridge in a pan floating in warm water.

13. A wooden tamping rod should be used to puse the cartridge home. No metal rod or rammer shall be used in tamping or brought to the site of blasting work.

14. The charge should not be removed nor poundod, but passed firmly into place.

15. Dry earth should be used for tamping, if water is used, great care should be taken to press the cartridges into contact with each other.

16. The dynamite is to be exploded by means of a detonator pinched on to a fuse by means of special nippers and let into the primer or cartridge.

17. All fuses must be cut to the length required before being inserted into the holes.

18. A service supply should be store by the subordinate incharge in an expense magazine, to be built by the coutractor at departments expense not nearer than a quarter of mile to his work.

CHAPTER 14

CIRCULAR SEWERS.

No. 14·1—SALT-GLAZED STONEWARE SEWERS

(a) *Materials.*

1. Stoneware pipes shall be of best quality stoneware or fire-clay, salt-glazed, thoroughly burnt throughout the whole thickness, of a close and even texture, free from air blows, fire blisters, cracks and other imperfections, and the surfaces external, and internal shall be smooth and perfectly glazed.

2. A piece of stoneware pipe, about 2 inches square from any part of the pipe, shall not absorb, after 48 hours immersion in water, more than 4 per cent of its own dry weight of water.

3. The stoneware pipe shall be capable of resisting a bursting pressure of 30 lbs. per square inch, without showing sings of leakage.

4. The breaking weight of stoneware pipe shall not be less than 1,700 lbs., applied by means of a lever or otherwise to the centre of a flat board of hard wood, of the same length as the pipe, laid along the top of the pipe throughout its length exclusive of the socket. The pipe, when subjected to this test, should be supported on a similar flat board underneath, the socket overhanging, and a layer of felt being laid between the boards.

5. The thickness of the stoneware pipes shall not be less than one-twelfth of the internal diameter and of the fire-clay pipes not less than one-tenth, and shall be uniform throughout the body of the pipe. The socket shall be made in one pipe with the pipe. The cross section af the pipes at right angles to the axis shall be a circle and the ends square tc the axis. The pipes to be used for straight drains shall be straight longitudinally and those used for curved drains shall be segments of a circle in plan, and when laid and jointed in position shall form a drain free from any obstruction.

6. The depth of the socket should not be less than 1½ inch for all pipes under 9 inches in diameter, 2 inches for 9″ inch pipes, and 2½ inches for all sizes over 12 inches. The internal diameter of the socket should be sufficiently large to allow a joint of ¼ inch all round the outside of the pipe intended to enter it, so that a caulking of tarred gasket may be inserted.

7. To test the freedom, of the material of which the pipe is made, from lime, pulverize a small pieco of the pipe, weigh

Note—Fireclay pipes, though less brittle than stoneware pipes, are not considered, for thickness. as strong or as durable as the latter. They also usually possess greater and boil in hydrochloric acid; subsequently wash on a filter and dry, nothing any loss in weight. If there is no loss in weight, then the material may be considered free from lime.

8. Stock sizes should only be used, with 4" minimum diameter and 24" maximum diameter.

9. The following Tables I and II gives the details of the dimensions of glazed stone ware pipes :

COMPARATIVE TABLES OF STANDARDS

TABLE I

British Standard Salt Glazed Ware Pipes

1	2	3	4	5	6	7
Int. dia. of pipe.	Minimum Mean thickness of barrel A	Minimum Mean thickness of socket B	Minimum internal depth of socket C	Minimum jointing space D	Length of grooving on spigot E-1 ½C	Minimum depth of grooving F
ins.	ins.	ins.	ins.	ins.	ins.	ins.
3	7/16	7/16	2	5/16	3	1/16
4	½	½	2	3/8	3	1/16
5	9/16	9/16	2¼	7/16	3/8	1/16
6	8/5	5/8	2¼	7/16	3/8	1/16
7	11/16	11/16	2¼	7/16	3/8	1/16
8	11/16	11/16	2½	½	3¾	1/16
9	¾	¾	2½	½	3¾	1/16
10	13/16	13/16	2¾	5/8	4-1/8	1/16
12	1	1	2¾	5/8	4-1/6	1/16
13	1-1/10	1-1/10	3	5/8	4⅛	1/16
14	1-3/16	1-3/16	3	5/8	4½	1/16
15	1¼	1¼	3	5/8	4½	1/16
18	1½	1½	3	5/8	4½	1/16
21	1-5/8	1-5/8	3¼	¾	4-7/8	1/16
24	1-3/4	1-3/4	3½	¾	5¼	1/16
27	1-7/8	1-7/8	3½	¾	5¼	1/16
30	2	2	3½	¾	5¼	1/16
36	2½	2½	3½	1	5¼	1/16

TABLE II

RANIGUNGE OR JUBBULPORE STANDARD SALT-GLAZED WARE PIPES

1	2	3	4	5	6	7
Int. diameter of pipe	Minimum mean thickness of barrel A	Minimum mean thickness of socket B	Minimum internal depth of socket C	Minimum jointing space D	Length of grooving on spigot E-1½ C	Minimum depth of grooving F
ins.	ins.	ins.	ins.	ins.	ins.	ins.
3	7/16	7/16	1¾	5/16	3	1/16
4	½	½	1⅞	3/8	3	1/16
5	11/16	11/16	1½	7/16	3	1/16
6	⅝	⅝	2	½	3	1/16
7	¾	¾	2	½	3	1/16
8	7/8	7/8	2	½	3	1/16
9	7/8	7/8	2	½	3	1/16
10	7/8	7/8	2	½	3	1/16
12	1	1	2	½	3	1/16
15	1¼	1¼	2¼	½	3¼	1/16
18	1½	1½	2½	½	3½	1/16
21	1-3/8	1-3/8	2½	⅝	3½	1/16
24	1½	1½	2½	¾	4½	1/16

Junctions for House drains in the line of the sewer.

9. Junctions (usually of 4″ i/d to serve ordinary small houses, and of 6″ i/d, 7″ i/d, 8″ i/d or 9″ i/d for large premises) should be provided in every line of sewer to serve existing buildings and premises. These junctions should be inserted at the same time as the sewers are built and the position of each junction shall be fixed most carefully so that it will suit the outlet drain discharging or to discharge from the premises to be connected.

All junctions should be of the pattern given in figure which is known as the *cured oblique* and the angle of the branch with the main pipe should be 45°. This type of junction is much better than 45° branch junction which makes a sharp angle with the main pipe instead of a gradual curve as shown on Figure No. I. The same junctions can be used on either side, i. e., as left handed and as right handed junctions. When laying these junctions the branch should be tilted a little, Usually a slope of about 1 in 15 to 30 is given so as to give a good fall into the main sewer from the branch.

The branch socket should be closed by a glazed ware stopper or cap set in a weak lime mortar sufficiently strong to prevent any leakage through the branch, but sufficiently weak to enable the stopper to be easily removed when it is required to connect up the house drain to the branch. Another method is to order the makers to form a solid cap in one piece with the socket of the branch. This is grooved to enable the cap to be cut off easily.

Another method is to make a glazed ware cap separately and fit it over the branch socket with a permanent cement joint as shown in *figure*—

The flat end of the cap can then be removed easily at a later date to connect on the house drain by cutting along groove.

It should be noted that junctions are only to be left to connect up to branch drains from *existing buildings*.

10. *Saddle junctions for house drains.*—When a new drain connection has to be made to an existing sewer and there is no suitable junction available in the sewer, resort has to be made to cutting a rounded hole carefully in the glazed ware pipe sewer and inserting a saddle junction piece over it as shown in *figure*.

Saddle piece fitted to main sewer pipe—

This is somewhat unsatisfactory as it is difficult to make a good tight joint between the saddle piece and the main sewer. In all cases where this has to be done, an oblique saddle piece must be provided as shown in *Figure No.* 4 not a right angled or direct saddle. Great care must be taken to ensure that the hole in the sewer is cleanly cut to the correct size so as not to obstruct the flow and all broken pieces must be removed from the inside of the sewer. In addition, the saddle must be carefully and effectivly jointed so that the junction of the branch with the main sewer absolutely water and gas tight and it should be carefully tested to ensure this before refilling.

Junctions of house connection drains with sewer at Manholes.

11 Wherever possible, branch drains from buildings and other premises should enter the sewer at a manhole instead of through junctions or saddles on the line of the sewer as described in paras. 9 and 10 hereof and the latter are only provided in order to avoid an excessive number of manholes which are expensive to construct and maintain. Wherever junctions of branch drains enter at manholes, they must discharge in a stream line direction into the main sewer through curved branch channel bends suitably arranged. *The inverts of these branch channels must lie above the tops of the half round main channels of the sewer shown in attached figure:—*

This means that when any house connection drain or any other drain from any premises enters a sewer at a manhole there is no need to cut the half round glazed ware invert channel of the main sewer. The invert of the house connection drain must be invariably above the top of this half round channel of the sewer. Hence no special channel junction is to be provided to take any house connection drain into the sewer and all that is required is that suitable branch channel bends either half round or three quarter round as laid down in Table 7, page 13 of British Standard Specification No. 539-1937 shall be provided and laid to proper curvature to give a stream line flow over the lip of the half round glazedware channels forming the line of sewer in manhole.

As house drains may enter a sewer at all sorts of angles at manholes, Table No. 7 of page 13 of the British Standard Specification No. 539-1937 which is copied below gives detail of eight special $\frac{3}{4}$th branch channel bends for left hand fixing and eight special $\frac{3}{4}$th branch channel bends for right hand fixing and great care should be taken to select and order the correct fixtures. For large sewerage schemes, the choice is simplified as one can order one or more complete sets of 16 fittings suitable for 4″ and 6″ branch drains in the first instance and then replenish the stock as they are used up.

Table 7—Dimensions of Branch-channel bends (see figure on opposite page)

I/d	B. S. Designation	Projection	Angle of projection
inches		inches	Degrees
...	Al. Ar ...	12	10
...	BL. BR ...	12	30
	CL. CR ...	12	50
4" and 6"	DL. DR ...	12	70
	EL. ER ...	12	90
	FL. IR ...	12	115
	GL. GR ...	12	140
	HL. HR ...	12	165

Normally, half round branch channel connections, otherwise the given in *figure* and Table above must be followed throughout in cases where house connection are taken into manholes.

12. *Channels for main and branch sewers in manholes*—The channels in manholes for the main and branch sewers shall consist of socketted, half round, straight channels and channel bonds to suit the course of the sewers. Branches for branch sewers (as applied to drain connections for buildings) shall be made by inserting half round channel junctions at 45° while half round straight channel tapers shall be laid in the manholes in cases where there are various channels above described are socketted and their designs are covered by the British Standard Specification No. 539-1937, from which the following details have been taken :—

(A) BRITISH STANDARD SOCKETTED HALF ROUND CHANNELS

Table 1 page (9) B. S. S. No. 539-1937		Table 2 page 9 B. S. S. No. 539-1937	
Straight		*Tapered*	
i/d	Length excluding Socket	Smaller and socketted i/d to i/d	Smaller ends socketted Length excluding Socket
inches	inches	inches	inches
Up to including 6"	24"	3" to 4"	24"
7" to 10" inclusive. ...	24" to 30"	4" to 6"	
12"	24", 30" and 36"	6" to 9"	
		9" to 12"	

(B) BRITISH STANDARD SOCKETTED HALF ROUND CHANNEL JUNCTIONS AT 45°,—*VIDE* FIGURE No. 7

TABLE No. 3—Page (10) or B. S. S. No. 539—1937

	i/d of branch	Length excluding socket
inches	inches	inches
4″	3″ and 4″ ...	24″
6″	4″, and 6″ ...	24″
9″	4″, 6″ and 9″ ...	24″
12″	4″, 6″, 9″ and 12″ ...	24″

(C) BRITISH STANDARD SOCKETTED, HALF ROUND CHANNEL BENDS QUARTER CIRCLE (90 DEGREES)

TABLE No. 4—Page (11) or B. S. S. No. 539—1937

i/d	Short		Medium		Long	
	r	a	r	a	r	a
inches	inches	inches	inches	inches	inches	inches
3	3½	5	5	7½	...	...
4	3½	5	6	7½	8½	10
6	6	7½	7½	9	9	10½
9	...	...	8½	10½	...	...
12	...	...	10	12	...	...

(D) BRITISH STANDARD SOCKETTED HALF ROUND CHANNELS, 1/8TH CIRCLE (135 DEGREES)

TABLE No. 5—Page (12) or B S S. No. 539—1937

i/d	Short	Medium	Long
	r	r	r
inches	inches	inches	inches
3	10	15	...
4	10	15	20
6	15	18	21
9	...	21	...
12	...	24	...

FIG. NO.7

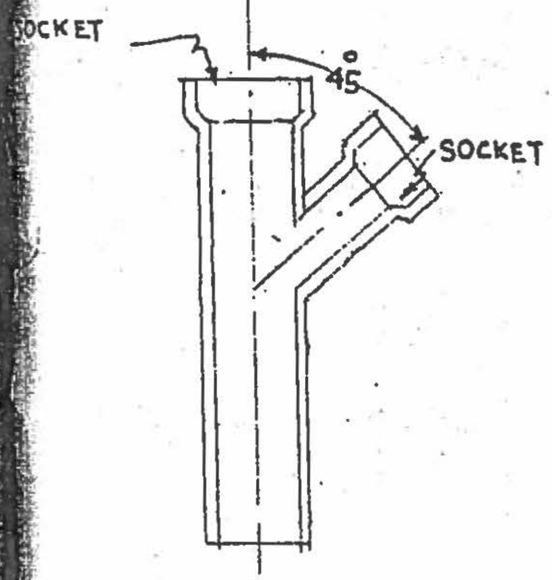


FIG. NO. 9

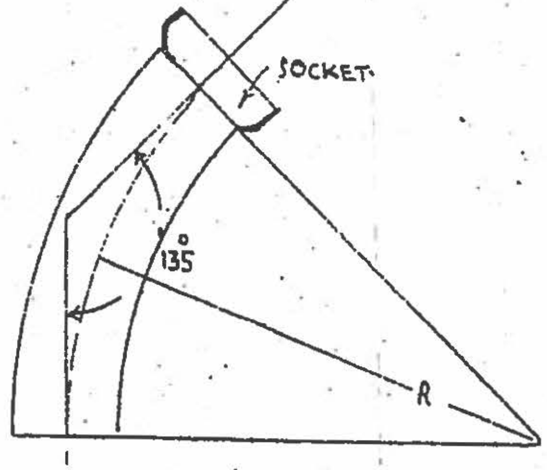


FIG. NO. 8

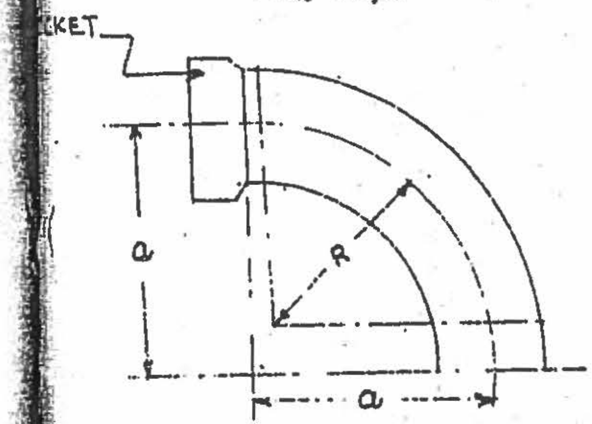
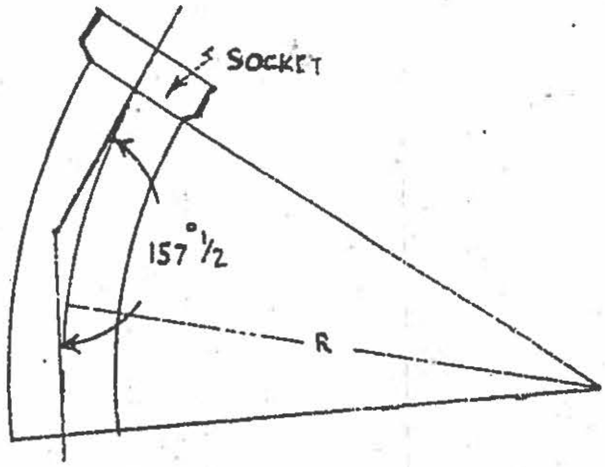
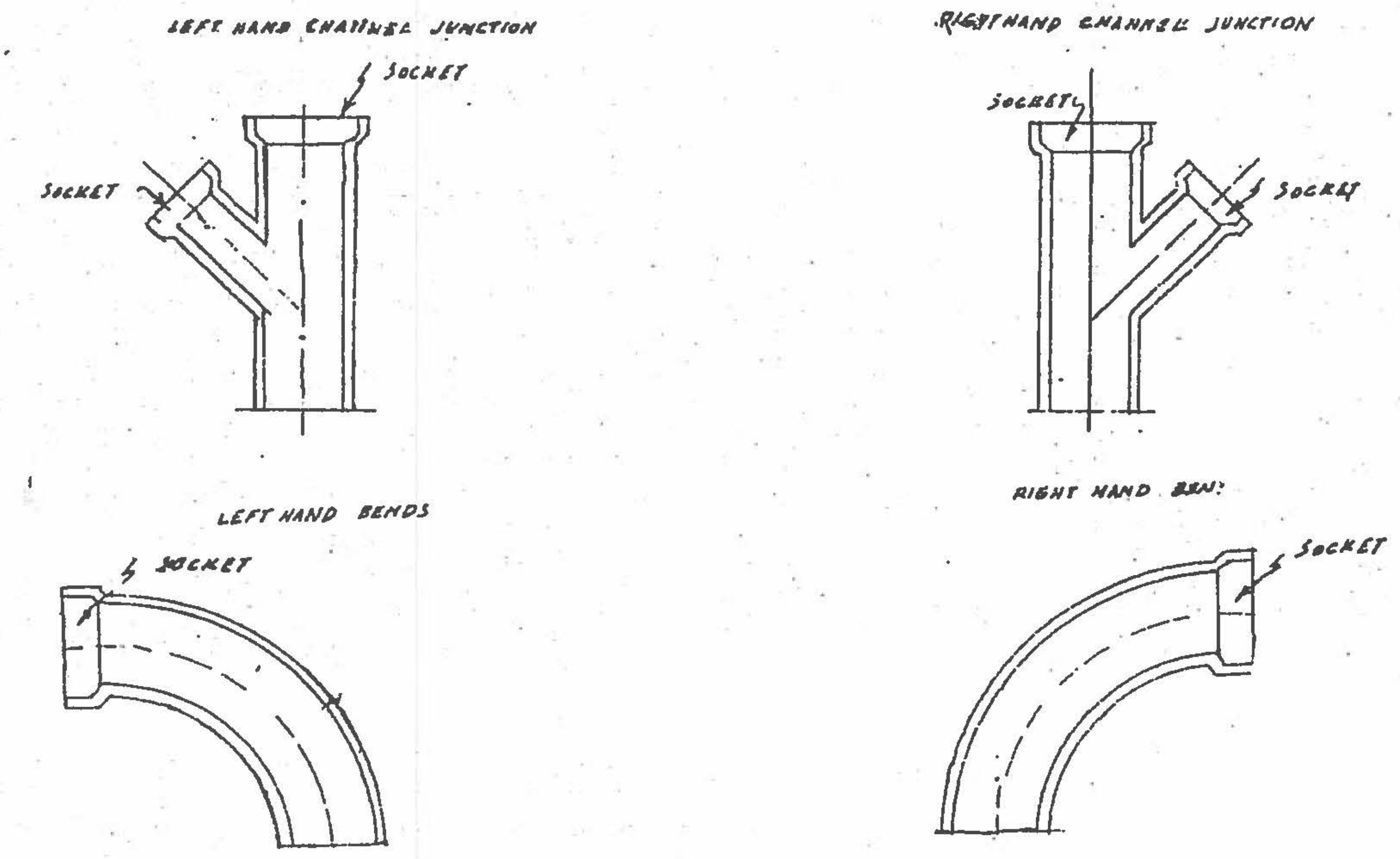


FIG. NO. 10




LEFT HAND CHANNEL JUNCTION
SOCKET
SOCKET
RIGHT HAND CHANNEL JUNCTION
SOCKET
SOCKET
LEFT HAND BENDS
SOCKET
RIGHT HAND BEN
SOCKET

(E) BRITISH STANDARD SOCKETTED, HALF ROUND, CHANNEL BENDS.
1/16TH CIRCLE (157 DOGREES)

TABLE NO. 6—PAGE (12) OF B. S. S. No. 539-1937

i/d in inches	r in inches
3	30
4	30
6	36
9	42
12	48

The channel junctions and channel bends described in this paragraph can also be obtained in sizes (diameters) other than those contained in the Tables at (A), (B), (C), (D) and (E) given above. Care must be taken to see that all the channels are properly socketted throughout, that the next channel is properly socketted with the *chute* (if any) or the adjacent sewer pipe at the downstream end of the manhole while at the upstream end of the manhole the spigot and of the first pipe of the next section of the sewer must be properly fitted into the leading socket of the channels. It is always advantageous to order adequate number of straight channels of short length so as to avoid cutting so far as practicable.

It should be clearly noted that channel junctions and channel bends are made to different patterns for right hand and for left handed use and great care must be taken in ordering these, to indicate whether left or right hand is required. The sketches below indicate what is a right hand channel bendand a right hand channel junction and also a left hand channel and a left hand channel junction respectively.

Figure are given on the opposite page.

Drain chutes.

13. These chutes consist of an expanding mouth and facilitate the insertion of cleaning appliances into small sewers while working in a confined space such as a manhole. Drain chutes should only be provided on sewers not larger than 9″ i/d for these size of sewers a chute should be fitted to form the first section of the sewers at the downstream end of each manhole. This is

roughly sketched in *figure* on opposite page locally through approved firm.

Socketted drain chute as per Doulton's Fig. 151.

The face of the rectangular expanded portion of the chute should coincide with the inner face of the downstream wall of the manhole and a relieving arch should be turned over it in the wall.

Tumbling Bay junctions.

14. *Tumbling Bay junctions*—These are required for drop manholes. They are not standardised and is to be adopted as per figure.

Attached figure illustrates a section through a manhole in front of which a tumbling bay is provided showing the position and layout as the tumbling bay. A 1/8th (45°) Standard Socketted Bend should be fitted at the bottom of the fall of the tumbling bay into the manhole as shown of the sketch. This should be carefully jointed with the socket of the leading channel in the manhole.

Laying and Jointing Stoneware Pipes

Laying of glazed stoneware spigot and socket pipe sewers.

15. A layer of cement concrete or lime concrete of such thickness and description as shall be laid down in the Schedule or shown in the drawings or as may be directed in writing by the Engineer-in-Charge, shall be laid along the bottom of the trench, the surface being formed evenly to the required gradient. Bricks shall be laid on the bed, one behind each socket to raise the pipes so that the outside of the sockets shall be about an inch above the bed. The pipes shall be laid with sockets forward beginning at the lower and they shall be kept in alignment with small props of cement mortar.

Laying of patent glazed stoneware pipes.

16. In cases where patent stoneware pipes are to be used for which no clearance is needed on the underside, the lime concrete or cement concrete bed shall be from 4″ to 6″ thick as shall be laid down in the Schedule or directed in writing by the Engineer-in-Charge and the pipes shall be laid direct upon it, socket holes of sufficient depth being cut into it so that the pipes shall be supported throughout their full length.

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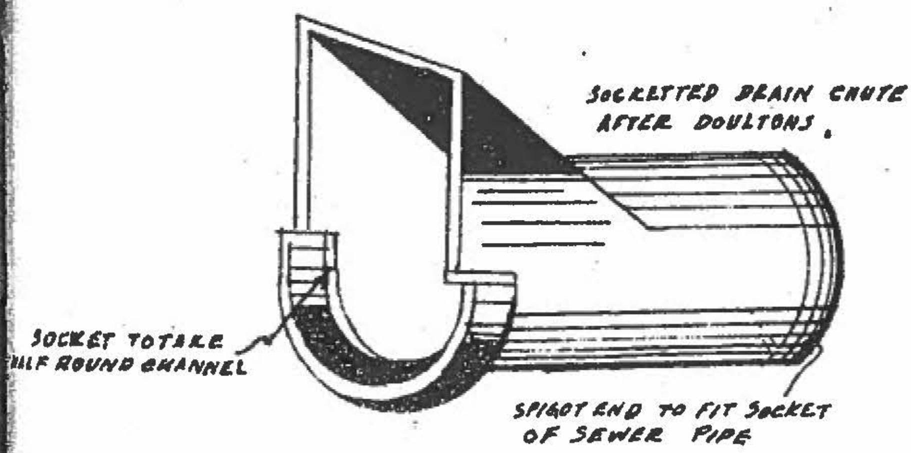

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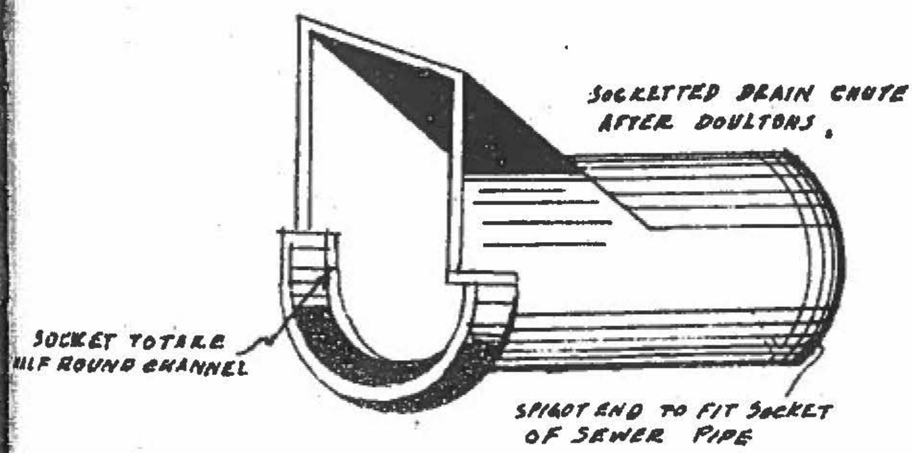

SOCKETTED DRAIN CHUTE
AFTER DOULTONS.
SOCKET TO TAKE
HALF ROUND CHANNEL
SPIGOT END TO FIT SOCKET
OF SEWER PIPE

17. After the joints and pipes have been proved to be water tight they shall be bedded in cement or lime concrete as shall be laid down in the Schedule or shown on the drawings or as shall be directed by the Engineer-in-Charge, to the extent of one half of the external diameter, the concrete being made to slope towards the sides of the foundation already laid, as shown on the detailed drawings.

Concrete to be placed round pipes.

In all places where the sewers have less than four feet or more than twelve feet of cover and in other cases where the Contractor shall be given instructions in writing by the Engineer-in-Charge to that effect, they shall be surrounded with six inches of lime concrete or cement concrete as shall be directed and the cost of such concrete shall be included in the rates of the Schedule.

18. The Engineer-in-Charge may increase or diminish concrete around the sewers both as to quantity and quality or to omit the same entirely, according to the nature of the ground that may be revealed when the sewer trenches are opened out, and the Contractor shall be entitled to be paid only for the actual quantity and description of such concrete as he actually places in the work, in conpliance with the Engineer-in-Charge's written orders.

Engineer-in-charge may order concrete to be increased or diminished.

19. The pipes shall be laid with sockets facing against direction of the flow. No pipes which are cracked or defective shall be used in the work and before the spigot end of a pipe is laid into the preceding socket, the socket and spigot ends shall be made perfectly clean inside and out after which a ring of tarred hemp gasket of quality and description to be approved by the Engineer-in-Charge shall be placed over the spigot. The spigot end of the pipe shall be placed concentrically into the preceding socket, care being taken that the inverts of the pipes form a continuous line to the correct alignment and grade and that the spigot end is in contact with the back of the socket all round. The tarred hemp gasket shall be gently forced to the back end of the socket, and caulked with a hand wood tool keeping the spigot concentric with the socket with an equal spianular space left for the joint all round. The joint shall then be formed by carefully packing a stiff mortar composed of one part of Portland cement to one part of coarse, clean washed sharp, siliceous sand into the joint. For this purpose the jointer shall be equipped with suitable wooden jointing tools and a

Jointing of glazed spigot and socketted pipes.

pair of rubber gloves on his hands and he shall force the mortar into the joint all round therewith taking great care to ensure that the joint is completely filled with the mortar in such a manner that it shall be absolutely watertight against an internal hydraulic pressure of 8 feet head of water, after the joint has thoroughly set.

Each joint shall be completely filled with mortar packed homogeneously and solidly, extending from the tarred hemp gasket at the back of the socket up to the external face of the socket and the face of the joint shall be finished off smooth projecting at an angle of 45 degrees with the longitudinal axis of the sewer as soon as possible.

If the Engineer-in-Charge shall direct the omission of the tarred hemp gasket, the joint shall be well filled thoroughly with a stiff cement mortar paste consisting of one part cement mixed with one part of clean washed sand and finished off as described above, care being taken that the inside of the pipe shall be thoroughly wiped out with a mop or scraper. There must be no round edge of pipe projecting inside or any fin or lump of cement, but the inside shall be left perfectly smooth and clean.

The cement must be spread out in a layer 6 inches thick on a dry floor for nine days to be air slaked before use in the joints so that there may be no risk of cracking the pipe sockets.

As soon as the joint has set sufficiently hard, it shall be covered with a sack which shall be kept wet continuously; until the concrete envelope of the sewer has been laid and set and the filling in over the sewer is taken in hand.

All joints shall be exposed and space left all round for inspection by the Egineer-in-Charge and testing, and the necessary staging for the protection of the exposed sewer and for handling of excavated material shall be provided; also a suitable ladder affording easy access for inspection at every place where work is being carried out. The inside of the sewer must be left absolutely clear in the bore and free from cement mortar or ather obstruction, throughout its entire length.

Jointing of patent glazed stoneware pipes

20. The joints of all patent pipes shall be made strictly according to the instructions of their manufactures and to the approval of the Superintending Engineer. A sample of any patent pipe which the Contractor may propose to use, shall be submitted to the Engineer-in-Charge and his approval thereto shall be obtained previous to its use.

Testing of glazed stoneware pipe sewers.

21. After sufficient interval has been allowed for the joints to set, the pipes will be tested under a head of at least 2½ feet of water and in no case under a head greater than 8 feet of water above the top of the pipes. Any defective or leaking spigot and socket joints shall be cut out and made good and in the case of any patent joints that may be defective and cannot be remade, they shall be entirely surrounded with cement—sand grout consisting of one part cement to one of sand. This shall be allowed to set before the sewere is filled in. A strong colouring shall be added to the water used for testing of patent pipes in order that any leakages may be more easily detected.

Junctions for house connections.

22. Junctions for house drains shall be 4″ and 6″ and for other larger buildings may also be 9″. They shall be inserted when the sewers are laid wherever directed by the Engineer-in-Charge and shall be formed with oblique angled curved junction pipes inserted in the sides in the direction of the flow and tangential with the main pipes. The ends of the curved pipes are to radiate to the centre when they are struck. They are to be laid at a sharp inclination with the sewer, as shall be directed from time to time by the Engineer-in-Charge.

The sockets of the junction pipes are to be stopped off by means of solid caps or light stoppers of stoneware or moulded concrete 1 : 2 : 4 : fastened in place by a fillet of weak cement mortar or by a bituminous composition joint so that no ground water can leak into the sewer and also that no sewage can escape into the ground. This must be done at all junctions left, whether the connections are expected to be made at once or not.

Sewers to be kept clean, etc.

23. The interior of each sewer shall be kept clean of all dirt, cement and superfluous materials of every descriptions as the work proceeds.

Backfilling.

24. The trenches for the sewers shall be backfilled as already described in. No walking on or working upon the completed sewer shall be allowed untill the trench has been backfilled to a height of at least 2 feet.

Dewatering trenches.

25. As per para. 19, Chapter 14·2.

14·2 PLAIN AND REINFORCED CONCRETE PIPE SEWERS

Material.

1. All plain and reinforced cement concrete pipes to be used on the work shall comply generally so far as the concrete part of the same is concerned, with British Standard Specification No. 556-1934 for cement concrete Cylindrical Pipes and Tubes (not reinforced). The bar and spiral reinforcements in the pipes shall comply with the British Standard Specification No. 785-1938 for Rolled Steel bars and hard drawn steel wire for concrete reinforcement except to the extent that the Superintending Engineer, Public Health Circle, shall permit the relaxation thereof. The quantity and details of reinforcement and also the thickness of the shell and details of spinning and manufactnre of the pipes shall be subject to the approval of the Engineer-in-Charge. All pipes and specials shall be cured by immersion under water for at least 28 days before despatch from the place of manufacture.

Earth-work.

2. For earth-work see Chapter 22.

Cradle of sewers.

3. Laying and jointing of plain and reinforced concrete pipe sewers.

Plain and reinforced concrete pipe sewers shall be laid on a bed of lime concrete or cement concrete or reinforced cement concrete cradle as shown on the drawings or as shall be otherwise directed in writing by the Engineer-in-Charge from time to time. The lime concrete or cement concrete shall be laid generally in accordance with the specifications laid down in Chapter 14 of this volume. In the case of reinforced concrete cradles, the concrete for the full width of the cradle shall be deposited continuously to the height of the reinforcement and then the reinforcement shall be immediately placed in position, after which the remainder of the concrete shall be laid to complete the cradle accurately to template and inconformity with the Contract drawings. Alternatively the reinforcement may be placed in position before the concrete is laid.

The work of constructing the cradle shall be carried out in a continuous operation so as to ensure proper bond between the concrete and the reinforcement and between the concrete above and below the reinforcement.

When any new concrete is jointed to old concrete, the old concrete must be propely raked back and roughened and the joint made in a manner to be approved by the Engineer-in-Charge in all respects.

The invert of the reinforced cradle shall be left about ½" lower than the finished level throughout and after the reinforced concrete pipe sewer has been laid and levelled thereon, the space between the underside of the pipes and the invert be filled with one part of the cement and one and a half parts of sand, in such a manner that no void shall be left and that the pipes shall rest throughout their lenth and breadth on the cradle so that the load of the pipes and the superimposed load of earthfilling shall be evenly distributed on the cradle. The con tractor shall take great care to see that no dirt, earth or other foreign material is allowed on the surface of the cradle or of the pipe resting thereon and shall provide the necessary grout holes and channels in the work to ensure positively that the grout fills all cavities and spaces between the pipes and their cardles and shall do all other acts and carry out all other work and operations required to satisfy the Engineer-in-Charge in all respects that the pipes are fully supported on their cradles in the manner described above. Should the Engineer-in-Charge find that the grouting is not being carried out to give the above requirements, the Contractor shall without any extra charge whatsoever comply with all further directions and instructions of the Engineer-in-Charge to ensure that the pipes are properly supported by the cradles even though such directions or instructions of the Engineer-in-Charge shall entail a different method of carrying out the work.

The reinforced cradle be allowed to set for at least 3 days before any pipe is placed on it and the Contractor shall take due care in setting the pipe on the cradle that no damage to the cradle shall occur. If any damage shall occur, the cradle shall be rectified to the satisfaction of the Enginee-in-Charge and any particular case where the damage has affected, in the opinion of the Engineer-in-Charge, the structural strength of the cradle. The Contractor shall cut out the damaged portion of the cradle and replace it at his own costs and charges to the satisfaction of the Engineer-in-Charge. In case the Engineer-in-Charge shall require a layer of gravel, broken stone or broken brick balast to be laid beneath the foundations of the sewer, the Contractor shall supply and deposit the gravel broken stone or broken brick ballast as required by the Engineer-in-Charge, in layer not exceeding six inches thickness each of which shall be well rammed and consolidated to the required levels and grades before the cradle is constructed.

No pipe or the cradle therefore shall be laid or placed till the alignment of the sewer and its-levels and gradients have been carefully checked and tested with the trench excavation and found correct.

4. The jointing for the pipes shall be made by a loose collar and shall give a minimum caulking space to the satisfaction of the Engineer-in-Charge. The collars shall be specially roughened inside for a better grip.

Joints.

The two adjacent pipe ends will be so designed and manufactured that when butted together concentrically a dowel will be left between the two ends. Into this dowel cement mortar 1 : 1½ (one part cement : one and half parts fine aggregate) shall be filled and then between the ends, paste of cement mortar of the same proportions will be placed, the space remaining between the pipe ends and the collar being then caulked with cement mortar of one part of cement mixed with one and a half parts of fine aggregate and so that an even space appears all round the external diameter of the pipes. Every joint shall be finished off smooth inside and shall be perfectly tight against an internal pressure of water equal to 20 feet head and also against all leakage of ground water into the sewer.

5. The interior of the sewer shall be cleared of all dirt, cement mortar and superfluous materials of every description as the work proceeds.

Interior of sewer to be kept clean.

6. The Engineer-in-Charge shall have power to vary the concrete in the cradle or surrounded under or round the sewer both as to quantity and quality or to omit the same completely according to the nature of the ground that may be revealed when the sewer trenches are opened out and the Contractor in such case shall be entitled to be paid only for the actual quantity and description of such concrete as he actually places in the work with the Engineer-in-Charge's written orders.

Engineer-in-charge may order concrete to be increased or diminished.

7. After a sufficient interval has been allowed for the joint to set, the sewers will be tested under a head of at least 4 feet and in no case under a greater head than 20 feet of water above the tip of the pipes. In addition, the sewers shall be examined for leaks of ground water making its way through the walls and joints. The Contractor shall make the sewers water-tight against the ingress of ground water from outside and also against the leakage of water from the inside of the sewers at the test heads specified above to the full satisfaction of the Engineer-in Charge. All defective or leaking pipes or joints shall be cut out and replaced and made, good by the Contractor at his own costs and charges or in the case of any joints that may be defective and cannot be remade, they shall be entirely surrounded externally

Testing of plain and reinforced concrete pipe sewers.

with cement concrete and cement sand grout (1:1) to render the joints watertight and this should be allowed to set before the sewer is filled in. A strong colouring should be added to the water used for testing of pipes in order that any leakages may be more easily detected.

Junctions for house connections and branch sewers.

8. Junctions for house drains and also for branch sewers of smaller size ranging from 4″ and 6″ diameter upwards shall be inserted when the sewers are laid wherever directed by the Engineer-in-Charge. For large sewers these shall be fitted at angles ranging from 30 degrees to 45 degrees with the centre line of the main sewers as shall be ordered by the Engineer-in-Charge, while for smaller pipe sewers they shall be formed with oblique angled, junction branches inserted in the sides, in the direction of the flow, and tangential with the main pipes. The ends of the curved pipes shall radiate to the centre whence they are struck and they shall be laid at a sharp inclination with the sewer.

The sockets of the branches on the junction pipes shall be stopped off by means of a light stopper of stoneware or moulded concrete (1:2:4) fastened in place by a fillet of weak cement mortar or by a bituminous composition joint so that no ground water can leak into the sewer and also so that no sewage can escape into the ground. This must be done at all junctions left, whether the connections are expected to be made at once or not.

Dewatering of excavations.

9. The Contractor shall keep all excavation for sewers and manholes and all other works absolutely and continuously clear of all water down to a level below the bottom of the excavation and below the lowest part of the foundations of the work to be carried out and shall construct manholes and other works without allowing any water to rise in the excavation made for the said works. He shall moreover continue full pumping operations and shall keep the excavation for each manhole or other work free of water until the manhole or other work is completed and passed and if any defect or defects are found in the said work subsequently, the Contractor shall carry out all dewatering and pumping operations required to make the defect or defects good to the satisfaction of the Engineer-in-Charge.

REINFORCED CONCRETE SEWERS, JUNCTIONS, STORM OVERFLOWS AND ORTHER WORKS CONSTRUCTED *in situ*.

Inverts.

10. Inverts of reinforced concrete sewers, junction chambers and other works constructed *in situ* shall be formed between transverse templates and shall be screeded. These templates shall be accurately made and placed at such close intervals as the Engineer-in-Charge shall approve. Unless otherwise shown on the drawings layer of cement mortar not less than ½ inch thick shall be spread evenly and to a smoothly finished surface upon the concrete of the inverts as soon as such concrete is in place. Where radii of inverts are too short for screeding between templates, the inverts shall be shaped by means of suitable forms which shall be removed as the concrete has sufficiently set and if required by the Engineer-in-Charge the surface of the inverts shall be floated or trowelled to a smooth finish. The concrete for inverts shall be deposited continuously for their full cross section and for such longitudinal distances as the Engineer-in-Charge shall approve. Where inverts are required to be lined with brick masonry or other material such work shall be laid at such times and in such manner as shall be directed by the Engineer-in-Charge. Inverts shall be carefully protected against injury during progress of the works.

Sidewalls.

11. Concrete in the side walls of sewers, junction chambers and other work shall be deposited continuously to the height directed by the Engineer-in-Charge and for such longitudinal distances as may be convenient and approved by him. If the sidewalls are required to be lined with brickwork or other material such work shall be carried out in a manner to be approved by the Engineer-in-Charge.

Roof and archwork.

12. Concrete in the roofs or arched work of sewers, junction chambers-manholes and other works shall be deposited continuously for the full depths and widths of the roofs and for such longitudinal distances as may be convenient and approved by the Engineer-in-Charge. The outer surfaces of roofs and arched work shall be left with an excess of mortar and finished true and smooth. If the roofs are required to be lined with brickwork or other material, such work shall be carried out in a manner to the approval of the Engineer-in-Charge.

Filling in.

13. The refilling in of trenches and other excavations shall be carried out in the manner directed in this specification.

Bulk heads.

14. Temporary wooden bulk heads shall be used while depositing concrete for sewers and other works at such intervals as may be required for convenient working. These bulk heads shall be of a design and shape and shall be so fixed and secured as shall be approved by the Engineer-in-Charge and shallnot be removed till the concrete has set sufficiently to hold its shape.

Reinforcements.

15. Where shown on the drawings or where directed by the Engineer-in-Charge, concrete sewers junction chambers, overflow chambers and other works shall be reinforced with metal of the dimensions and shapes shown and of a quality and in the manner herein-before specified, to the requirements of the Engineer-in-Charge.

Branches.

16. Connections and branches for lateral sewers and drains shall be provided by the Contractor and built in where shown on the drawings and also where directed in writing by the Engineer-in-Charge. Such connections and branches shall be closed with suitable plugs as already described herein for brick sewers.

Minimum length of invert.

17. Unless otherwise permitted or ordered by the Engineer-in-Charge, not less than 16 feet of foundation of invert for a concrete or reinforced concrete sewer shall be built in one operation.

Dewatering of trenches and excavations.

18. As per para. 9 above.

14·3 Cast iron sewer and rising main construction

Laying of cast iron pipes.

1. In trenches where cast iron sewers are to be laid the ground shall be excavated exactly to the required alignment, depth and grade and holes are to be taken out where the joints occur so that the barrels of the pipes may be on a solid bed throughout. In laying spigot and socket pipes, the socket shall be kept up-hill and socket must always terminate the line of drain in such a position as to exactly receive the invert channel in each manhole. To produce this result, a pipe must, if necessary, be cut.

Jointing.

2. All spigot and socket pipes and specials shall be joined by forcing the spigot home into the socket which must be centered so that the joint is an even thickness all round. The joint shall be filled with lead wool forced and caulked into the socket, ring by ring, till it is half full, after which the joint shall be run with molten lead in sufficient quantity as that after being caulked solid, the face of the lead shall be recessed about 1/6th of an inch inside the face of the socket, which shall be painted with a coat of hot melted bitumen to protect all tool marks.

Flanged cast iron pipes and specials shall be properly faced and the joints shall be made by inserting a washer of soft lead or other approved material between them.

Testing.

3. All cast iron pipe sewers shall be subjected to a hydraulic test of not less than 30 feet head all cast iron rising mains shall be tested to a hydraulic test of 100 feet head. They shall be absolutely tight under these test heads.

Dewatering of Trenches.

4. As per para. 9 of Chapter 14·2.

14·4 CONSTRUCTION OF MANHOLES

General.

1. The Contractor shall build and construct the various manholes in the position shown upon the drawings or where otherwise directed by the Engineer-in-Charge and in accordance with detailed drawings supplied by him from time to time. The floor shall be constructed in salt glazed ware bricks or cement concrete and the sidewalls of cement concrete and brick-work as laid down in tne drawings and proper channels shall be formed across them to lead the sewage from one sewer to the other without interruption to the flow and all pipes required for branch sewer house connections and ventilation purpose shall be built in the walls as shall be directed by the Engineer-in-Charge. Relieving arches should be provided to prevent any load on the pipes. All ladders and iron steps as shall be required by the Engineer-in-Charge shall also be provided and built into the brickwork while the walls are being constructed. All manholes shall be lined with machine pressed bricks on their inner faces to the requirements of the Engineer-in-Charge.

Manholes to be watertight.

2. Where shown on the drawing or otherwise directed by the Engineer-in-charge the inside of all manholes shall be rendered with cement mortar composed of one part of cement to $1\frac{1}{2}$ or two parts of sand as shall be laid down in the Schedule or shown on the drawings not less than half an inch in thickness and worked to a polished face and they shall be absolutely watertight. In places where no rendering is ordered the joints shall be carefully smooth finished internally.

Shaping of manhole inverts.

3. In the case of manholes on small pipe sewers of concrete or glazed stoneware the channels shall be formed of half round pipes bedded in cement mortar and shaped to fit the ends of the sewers. Where practicable in the opinion of the Engineer in Charge there shall be fall of not less than $1\frac{1}{2}''$ in each manhole, but in flat areas where it is not feasible to enforse this provision, the Engineer-in-Charge shall amend or reduce the fall to be allowed in each manhole. In manholes on brick or concrete sewers proper grooves shall be formed in the brickwork or concrete to enable a dam for flushing or other purposes to be formed in the sewers at any time.

4. As per para. 9 of 14·2.

Dewatering of excavations.

14·5 Construction of Flushing Tanks

General constructions.

The Contractor shall build the various flushing tanks in the position shown on the plans or where directed by the Engineer-in Charge, in accordance with the detailed drawings to be supplied by him.

The floors shall consist of concrete and the sides shall be of brickwork in cement mortar as specified, Galvanised wrought iron or malleable iron steps, shall be built in where necessary, while the walls are being constructed. The insides of the flushing tanks shall be rendered with cement mortar composed of one part of cement and $1\frac{1}{2}$ or two parts sand as shown in the Schedule or in the drawings, being not less than half an inch thick and finished to a polished face which shall be absolutely water tight.

Each tank shall be fitted with an automatic siphon with trapped outlet of pattern and size to be approved by the Superintending Engineer before they are placed on order.

Water-supply connections.

2. As supply of water from the City Waterworks system shall be laid on to each flushing chamber by means of a connection of suitable size and a suitable disconnecting gulley and meter chamber with cast iron hinged. Locked lid shall be provided and constructed in connection therewith.

The covers of flushing tanks shall be similar to those laid down for manholes and they shall be set to correct levels and alignments on a layer $\frac{1}{2}''$ thick of cement sand mortar (1 : 2).

Dewatering of excavations.

3. As per paragraph 9 of Chapter 14·2 of this volume.

14·6 VENTILATION COLUMNS

General.

1. All ventilation columns shall be of cast iron or heavy mild steel with ornamental cast iron bases of such diameter, height and description as shall be approved by the Superintending Engineer.

The columns and bases shall be made in the best and most workmanlike manner. The columns shall be of the best grey metal, free form cold shuts, blow holes and other imperfections. The castings, being left smooth and clean on the surface.

Painting and erection.

2. The columns and bases of cast iron shall be coated by heating and immersion with Dr. Angus Smith's composition inside and outside. New and all steel pipes shall be coated by heating and immersion with a hot bitumastic composition approved by the Engineer-in-Charge, inside and outside. The columns after erection, shall be painted with 2 coats of bituminous solution of colours to be approved by the Engineer-in-Charge and a heavy copper cage shall be provided and fixed on the top of each column. The short lengths of iron concrete or stoneware pipes connecting the ventilation columns to the manholes shall be laid and jointed according to the specifications for the laying and jointing of cast iron, concrete or glazed stoneware sewers, respectively.

14·7 MANHOLE COVERS AND FRAMES.

Design and manufacture.

1. The manhole and flushing tank covers and frames shall be 22 inches diameter clear opening heavy doubled seated "Conical" pattern 5" depth, of a design to be approved by the Superintending Engineer, weighing about five cwts, each. They shall be of the best foundary grey metal, tough and close grained and the samples of the metal shall be submitted to the Engineer-in-Charge and his approval in writing obtained there to before the covers and frames are manufactured. The covers and frames are to be coated with Dr. Angus Smtih's composition applied by heating them when new and before any rust has appeared on them and dipping them while hot into the heated composition. The covers and frames shall be clean moulded accurately made and fitted in a workman-like manner, the surface being smooth and even. "Rocking" covers will not be accepted.

Setting.

2. All manhole frames shall be set level to correct alignment and levels, embeded on a layer of cement sand (1 : 2) mortar to the satisfaction of the Engineer-in-Charge in all respects.

3. For back lanes and streets, light pattern manholes, (weight ·75 cwt. to 1·5 cwt. according to traffic) of an approved design shall be used as directed by the Engineer-in-Charge.

CHAPTER 15—BRICK SEWERS.

15·1—*General*

Bricks for sewers, junctions, manholes, etc.

1. All bricks to be used on the sewers, manholes, junctions and all other permanent works shall where so specified in the schedule be moulded and machine compressed in accurate metal moulds, and shall be of special quality. The bricks shall be manufactured of clay which has been carefully weathered, worked, pugged and tempered; they shall be hard burnt throughout, true to shape, homogeneous in texture, free form flaws, nodules of kankar or other blemishes, with sharp-edges and unform in size. Every brick must be thoroughly well burnt throughout in a "Bull" Kiln, to a deep red colour and shall give a clear ringing sound when struck. Unless otherwise specified or required by the Engineer-in-Charge, bricks shall measure 9″ × $4\frac{3}{8}$″ × $2\frac{3}{4}$″ so that every four courses laid shall measure one foot in height but bricks 3″ thick may be used for engineering work in order to reduce the number of joints.

Bricks to be used for arches, barrels, circular and egg-shaped sewers, circular shafts, bullnozing, plinths, string, courses, cornices, etc., shall be specially moulded and machine pressed accurately to shape and no cutting of bricks for arch or radiated work will be permitted.

All first class bricks on removal from the kiln shall be properly sorted and arranged in stacks containing 2,000 bricks each. Each stack shall contain 2 rows of bricks arranged so that at least one end of every brick is visible. No bricks shall be removed from the site of kiln to the works unless the stacks in which they were placed have been passed by the Engineer-in-Charge or his assistant. Although bricks shall have been passed at site of kiln or elsewhere they shall be liable to rejection thereafter at any stage even after they have been built into the work, if they are found not to comply in all respects with this specification.

No brick shall absorb more than 12 per cent by weight of water after being perfectly dried then boiled for 20 minutes and then allowed to cool in water. A sample brick shall be supplied to the Engineer-in-Charge and no bricks shall be ordered until his approval in writing has been given thereto.

Puddle Clay.

2. Puddle clay for clay concrete and other purposes shall consist only of selected clay derived from a source and of a quality to be approved in writing by the Engineer-in-Charge. The clay before use shall be fully weathered in the sun, all roots, leaves and other

organic impurities being removed and all hard lumps being fully disintegrated. The clay shall be well wetted, trod out, tempered and worked with spades to the entire satisfaction of the Engineer-in-Charge before being utilized on the works.

Timber for shoring, trench timbering, moulds, centring and other temporary works.

3. All timber and wood work to be used for shoring, trench timbering, moulds, centring, etc., shall either be of deodar or some other wood to be approved by the Engineer-in-Charge. It shall be of the best quality of its kind, well seasoned, sound, free from sap wood, knots, shakes and all other defects.

Cement rendering and plastering.

4. The mortar to be used for rendering or plastering shall be composed of one part of cement to two parts of clean washed, sharp siliceous sand or of other proportions as laid down in the schedule and ordered by the Engineer-in-Charge. It shall be mixed as in the case of cement and shall be gauged in small quantities so that none may be allowed to go off or become partially set before use. The rendering shall be applied only after the underlying surface has been thoroughly roughened (or the joints raked out to ½" depth in the case of brick work) and kept thoroughly wet for 24 hours before application of the rendering and no hollow spaces shall be left under the rendering, which shall be well keyed into the underlying material.

The rendering shall be finished with a floator trowel to an even polished surface and must be protected from the sun and rain, by shelter or awnings to be erected in advance.

The rendering shall be kept wet by sprinkling an ample supply of water while it is setting for a period of not less than ten days.

Should the Engineer-in-Charge require any special water proofing treatment to be carried out to the rendering, either by the addition of "Pudlo" "Tricosal." "Sika" or other material or by subsequent treatment with silicate of soda or both, the water proofing materials will be supplied free by the Engineer-in-Charge at his stores, to the Contractor but the Contractor shall transport the materials, to the work, use them in the work to the directions of the Engineer-in-Charge supplying labour and tools therefore at his own expense and charges and no extra rate for water proofing work shall be allowed.

Brick pitching and paving.

5. Brick pitching and paving shall be laid in panels in diagonal, herring bond, or such other bond as the Engineer-in-Charge may from time to time direct. The bricks to be used for flat brick pitching

shall be without frogs and shall have a true, smooth surface on the exposed face.

If pitching laid in lime or cement mortar is to be pointed in cement mortar, the joints shall be raked out the same day: Where no pointing is specified, the joints of all such pitching are to be nearly finished off as specified in specifications of pointing, the day after the bricks are laid and before further work is started.

The joints of all pitching and paving whether laid with bricks on flat or on edge dry or in lime or cement mortar, shall not exceed 3/16″ in thickness.

No extra shall be payable for or in respect of any special bonding, cutting, wastage, scaffolding, curves, cambered or other special work in connection with pitching or paving work to be carried out. The rates of the schedule cover all wastage, slopes and changes of slopes, curves, irregular areas and other special work required and include for the cost of pitching and paving work of all discription both on the flat and on the slope at all angles required.

Fixing manhole cevers, penstocks, shutters, steel windows, step irons and other fittings.

7. Where labour rates only are provided in the schedule for the fixing of penstocks, irons, step valves, manhole covers, ventilation shafts steel windows and other fittings as shown on the drawings or described in the schedule. The rates payable for such fixing shall include all cutting away or into of brickwork, concrete, masonry or stone work, the provision and fixing of holding down bolts and holdfasts therefore to the requirements of the Engineer-in-Chage. The grouting in or setting of the fittings, holdfasts and holding down bolts in 1 : 2 cement sand grout or mortar and the subsequent making good of the brickwork, concrete, masonry or stone work to the full satisfaction of the Engineer-in-Charge.

CHAPTER—15·2

BRICK WORK SEWER CONNECTION

Workmanship.

1. All bricks for the internal rings shall be sound well picked, compressed and machine moulded as laid down previously in this Specifications. They shall be radiated for all arches and other curved work. The courses shall be kept parallel to the gradient and all bricks must be fully embedded in the mortar, no grouting is being permitted. The joints on the face of the work are not to exceed 3/16th of an inch in thickness and are to be cerefully and neatly pointed flush unless intended to be rendered in which case the joints shall be raked out ready to receive the plaster. All curved work shall be suited to template and centres as shall be laid evenly and uniform to the correct curvature. All cavities behind the sidewalls shall be filled in and rammed and consolidated very carefully before the covering arch is constructed. All arched work shall be formed upon properly and accurately constructed centers, great care being taken in keying in the arch.

Collar Joints.

2. In single brickwork the internal surface of the concrete envelope shall be neatly and accurately rendered in 1 : 2 or 1 : 3 cement sand mortar not less than ½ inch thick. In other work, a cement-sand 1 : 2 or 1 : 3 collar joint not less than ½ inchin thickness shall be formed round the inner layer of brickwork. The end of each section of brickwork shall be properly racked back to form a key for the succeeding work.

Invert Blocks.

3. Invert blocks shall be specially moulded and lipped at the joints. They shall be laid true to line and at proper inclinations and shall be joined in 1 : 1 cement sand morotar, no joint being greater than ¼ of an inch in thickness, or they may be constructed *in situ.*

Removal of Centering.

4. After the covering arch has been turned, and before the nentering is removed, the trench shall be filled in to a height of at least 2¼ feet above the Crown, and properly consolidated as specified. No centering shall be removed without the sanction in writing of the Engineer-in-Charge or his representative. On the removal of the centering, the inside of the brickwork shall be thoroughly cleaned, and pointed, if not intended to be plastered, so that the work may be left with an even surface.

Junction Block.

5. Connections with house drains shall be made by means of 4″ to 6″ diameter stoneware, fire-clay or moulded cement-concrete (1:2:4) junction blocks as shall be required by the Engineer-in-Charge.

For very large buildings, 9" diameter still large blocks shall be provided if required by the Engineer-in-Charge and the detailed design of all junction blocks shall be subject to his previous approval. The sockets of the junction blocks shall be subject to his previous approval. The sockets of the junction blocks shall be stopped by means of a light concrete (1 : 2 : 4) or stone ware stopper fastened in place by a fillet of weak cement mortar or by a bituminous composition joint so that no ground water can leak into the sewer and also that no sewage can escape into the ground. This must be done at all junctions left, whether the connections are expected to be made at once or not.

Sewers to be watertight.

6. All sewers shall be absolutely watertight when submitted to a head of water of the height of the road or ground level above the sewer or such other head not exceeding the height of the road or ground level above the sewer as shall be given in writing by the Engineer in Charge to the Contractor from time to time.

Rendering.

7. In case, sewers are intended to be provided with a coat of cement redering such rendering shall consist of one part of cement to $1\frac{1}{2}$ or two parts of sand by volume, as shall be laid down in the schedule or shown in the drawings, not less than half an inch in thickness and worked to a polished face to the requirements of the Engineer-in-Charge.

Dewatering of trenches.

8. As per para. 9 of Chapter No. 14·2 of this volume.

15·3—CONSTRUCTION OF BRICKS SEWERS BELOW SUBSOIL WATER LEVEL.

Depth of foundation upto $2\frac{1}{2}'$ below sub-soil water level.

1. Upto $2\frac{1}{2}$ feet depth below the sub-soil water level, egg-shaped Sewers may be adopted as directed by the Engineer-in-Charge without any pumping operations. The excavation shall be done as per Chapter 13 of volume.

Base.

2. The Sewers shall be given a base of lean concrete 1 : 6 : 12 or Bricks laid under water by means of cribs with openable bottom

3. The Sewer construction shall start from the tail and upwards.

Invert.

4. Precast invert blocks in cement concrete $1\frac{1}{2}$: 2 : 3 (on any other water proof mix as fixed by the Engineer-in-Charge) shall be properly laid on the base and work executed as per Chapter 15·2.

5. With depths greater than $2\frac{1}{2}$ feet below sub-soil water only circular form of sewer shall be adopted.

Depth greater than $2\frac{1}{2}$ feet. Below sub-soil waterlevel.

6. A six to nine inches layer of cement concrete 1 : 6 : 12 or bricks shall be laid under water, by cribs as directed by the Engineer-in-Charge.

Base.

7. The Cradle concrete of 1 : 2 : 4 (or any water proof fixed by the Engineer-in-Charge (shall be deposited on to the base by means of false bottom buckets till the lowest point of the brick work is reached.

Cradle concrete.

8. Mild Steel Semi-Circular forms shall be placed exactly at the centre of the cradle and the rest of the concreting laid on the sides.

Circular Formwork.

The rest of the work shall be done as per Chapter No. 14 of this volume.

9. In greater depths than mentioned in para. 5 *i.e.*, more than 6 feet below the sub-soil level be kept depressed up to the desired level by well point pumping (refer Chapter 13) and sewer constructed as per paras 5—8.

Depth greater than in para. 5.

Note—It is desirable to execute the work entirely in dry condition.

CHAPTER 16

Sump Wells, Screening Chambers and Pump Houses

16·1—Sump Wells and Pump House

Sump Well.

1. (The Sump Wells, walls and floors shall be designed to counter the upthrust of sub-soil water.) The plugging shall be done by concrete 1 : 2 : 4 or any other mix determined by the Engineer-in-Charge using rapid hardening Alumina cement or plain concrete. The concrete mix shall be designed for optimum water cement ratio, and the mix designed to ensure water tightness. No friable and deleterious materials be used in concrete. The rates provided are for ordinary cement. Extra payment shall be made for the cost of water proofer or rapid hardening cement.

To counter the upthrust the concreting shall be done with a positive pressure of water.

2.30

(*The depth of concrete shall be 144/62·5 times the head of sub-soil water. In case the depth is excessive an R. C. Slab be laid on to the base concrete for the balance of upthrust after allowing for the concrete depth*).

The base concrete shall be covered by 4″ cement concrete $1\frac{1}{2}$: 2 : 3 or any other mix as directed by the Engineer-in-Charge the entire top concreting being done in one operation.

A slope shall be given towards a sump which would house the strainer of suction pipe.

Bubbling of foundation concrete.

2. In case water oozes out from the foundation 2″ G. I. pipes shall be erected vertically in the concrete. The water level in the pipes shall be allowed to assume its natural level. The bottom concrete shall be impregnated with cement slurry 1 : 1 through these pipes with sufficient pressure till the foundation concrete is sealed.

Walls.

3. The wall shall be of first class Brick or cement masonry in cement 1 : 3 or cement blocks 1 : 3 : 6 (with a $4\frac{1}{2}$″ core wall of cement concrete $1\frac{1}{2}$: 2 : 3 reinforced if necessary). The walls shall be plastered with $\frac{3}{4}$″ thick cement plaster 1 : 2 (without heat) cement cast with an admixture of water proofing material as directed by the Engineer-in-Charge.

Steps.

4. The steps shall be of malleable cast iron or mild steel, built simultaneously with the masonry. Under no circumstances the steps shall be allowed to inserted in the masonry afterwards.

5. After completion of the wet well it shall be filled with water up to the full supply level.

Impermeability Test.

The drop in level shall not exceed 1/8th of an inch in 24 hours.

In case this test fails the walls and foundations shall be grouted with cement slurry at the expense of the contractor.

Roof.

6. In case the collecting sump, and screening chamber are located in populous areas they shall be covered with roof with manholes, and adequate ventilation provided.

7. All other work shall be done as per Volume I, Chapters 8, 6 and 1 of this volume for pipe work, Hydraulic Structures and well sinking, respectively.

No. 16·2 Sewage Screens

(a) *Fixed Screens*

Fixed screens.

1. For small plants (up to a sewage discharge of 1 million gallons) fixed screens shall be employed fixed in grooves of channel iron built in masonry at angle of 30 to 45 degrees to the vertical.

Course gratings.

2. The course gratings shall be of opening of 2″ × 2″ and shall be installed before the pumping station.

Bar Screens.

3. The bar screens shall be employed before treatment works with openings of $\frac{1}{2}'' \times \frac{1}{2}''$.

Duplicate screening chamber

4. The screening chambers shall be always in duplicate to facilitate repairs.

Coating of Screens.

5. The screens of mild steel bars and sections shall be coated with two coats of bitumastic point or Dr. Angus Smith Solution.

Openings for hand operated Screens.

6. The area of openings below the flow line shall be thrice the area of inlet sewer for combined sewer and $1\frac{1}{2}$ times for sanitary sewer.

(b) *Mechanically Operated Screen for large disposal plants*

Mechanically operated Screens.

7. For mechanically operated screens the opening shall be only 25 per cent excess of the cross section of sewer below the flow line.

Specification for Mechanical Screens.

8. The contractor shall furnish all materials for and shall properly install, adjust and test mechanically operated screens, at the locations shown on the drawing or as directed by the Engineer-in-Charge.

Included in this item are all structural steel, walkways the rake, carriageway which travels between two guides, the guides, the bolt, the roller chain and all mechanism control apparatus, electric work including motors, anchor and foundation bolts, electric connections and all other appertunances which are necessary for complete installation.

In general these shall be furnished and installed under this item complete equipment for——Nos. Screening chambers Railing pipework, excavation, masonry and concrete and reinforcing steel will be paid for under the appropriate item.

While the detailed specification describe the mechanism and equipment of Simplex screen, the use of approved equal mechanism and equipment made by others will be permitted subject to the approval by the Engineer-in-Charge and variations as may be required in the Engineer's judgment to permit the use of approved equal mechanism and equipment by other.

The bidder shall state, what make of mechanism and equipment he proposes to furnish and install, if awarded contract; and upon the award of the contract, the successful bidder will be required to furnish and install the make so named in his proposal.

Where the civil works are done by another agency the supplying contractor shall depute a representative during construction that civil works suit the mechanical, electrical and other requirements of the equipment, and that foundation and anchor bolts and other necessary items are built in the civil works without resource to dismantlment.

Civil work.

9. The Civil works shall be executed as per Volume I, Chapter 8·6 of this volume for Hydraulic Structures and pipeworks.

CHAPTER 17

17·1—SURFACE DRAINAGE & STREET PAVEMENTS.

Surface drains.

Punjab Standard Type drains.

1. Punjab Standard type drains shall be made of cement concrete 1 : $2\frac{1}{2}$: 5 mixture. House connection drains, type I drains, type II drains, type III drains and inverts of drains of large sizes and of sewers shall be laid in situ in length not exceeding 4 feet, separated by vertical expansion joints not less than $\frac{1}{8}''$ width formed by accurately shaped metal templates. The exposed surfaces of all inverts and drains including side slabs and bull-noze shall be formed by applying a thin skin of about $\frac{1}{4}''$ thick of 1 : 1 cement sand mortar immediately after the concrete has been placed and screening the same to clean smooth finish. The slabs for the side walls shall be moulded separately and shall be laid in 1 : 2 cement sand mortar on the lime concrete backing, previously prepared, not less than 14 days after being made. All joints being carefully struck perfectly clean and flush with the faces of the slabs.

The preparations of the trench, aligning, and grading, shall be carried out in the same manner as required for sewers.

No extra shall be payable for curves, bends, falls, junctions, inlets, outlets, and all other special work in connection with the drains and the cost of all such special work is included in the rates as given in the schedule.

Girders crossing for 1, 2, 3, drains.

2. The girder crossings across street shall be formed by removable flats and angle fixed in the angle iron frame Two flat iron hold fasts $2'' \times 2'' \times \frac{1}{4}''$ shall be embedded in concrete 1 : 2 : 4 and shall be bolted with the angle iron seats.

Side slopes above connected.

3. The side slopes shall be laid in herring bone pattern either flat or on-edge as directed, in first class bricks. The base shall be of clay puddle lime cement concrete as specified, and the rate shall include a thin layer of plaster underneath the bricks. Any special cutting or curved work, boundry corners, curves, slopes and changes of slopes, cambers, cutting shaping and wastage of bricks to fit irregular area and all other special work is also included. There shall be layer of mortar $\frac{1}{4}''$ thick below the brick and the joints struck flush and smooth. All profiles and strips shall be provided by the contractor at his own costs. Unless cement pointing is required by the

Engineer-in-Charge, the external surface of the joints shall be struck flush as the work proceeds and left perfectly flushed and smooth.

4. They are of R. C. C. slabs 6" thick as per drawing.

Crossings over drains above type 3.

Connection with sewers.

5. The surface drains are connected with sewers through gully grating,—*vide* Chapter 14 of this volume.

House Outlet connections.

6. These are made by forming Purnalas and making Khurras of the size at the heads of House connections with size of Khurra as specified and this item includes all cuttings and order work as required by the Engineer-in-Charge.

Curb and channel Drains.

7. Curb and channel shall be formed on both sides of the Road way and the foot-path as per sketch This is connected to sewer by gully grating as directed by Engineer-in-Charge.

Testing of Drains.

8. After the drain is completed they shall be tested for flow by fitting them upto the connected section.

Reimbursement.

9. The reimbursement is laid in bricks in cement mortar 1 : 5 on both sides of the roads sloping towards the drain 1/8" in 9" and is laid on specified thickness of base concrete. The rates shall include any strips, sides and edging of narrow width area to be passed with dry bricks on edge or flat. The rates also includes all extra works involved in laying narrow strips 3", 4½" or 9" in width along sides of the drains and for all curves, bends, slopes and changes of slopes, and other work involving added labour and material for irregular areas, cutting, fixing and wastage of bricks required for such works. No extra amount will be payable for any special difficulty or complicated item required during execution.

The rate includes a layer of at least 1/4" thick mortar underneath and the bricks embeddod therein.

All joints between the bricks and along outer end and inner side of the reimbursement shall be completely filled with mortar.

10. The House walls shall be protected by a 3" or $4\frac{1}{2}$" thick Tega (i.e., brick on end) laid in cement mortar projecting to a maximum height of not more than 6" above the drain and the rates shall include all excavation, cutting and wastage of bricks. The external surface of the joints must be flushed as the work proceeds.

Tega.

11. Three inch or as specified lime or cement concrete shall be provided under reimbursement and Tega and paid separately.

Foundation for reimbursement and Tega.

his own ...

17·2—Street pavement

Paving on dressed earth.

1. The street pavements shall be in flat bricks or brick on edge as specified laid in ordinary bounded courses or herring bond pattern and laid to template over rammed and dressed earth to correct longitudinal and cross slopes (Minimum cross slope 1/24) as required by the Engineer-in-Charge. The joint shall be thoroughly filled with dry sand grouting, which shall be applied to a thickness of not less than $\frac{3}{4}''$ over the surface and brushed into the joints. All joints shall be fully filled with sand.

Paving on concrete base.

2. The paving shall be laid on concrete base if provided after the concrete has set on a minimum curing period of 7 days, and in case of lime concrete when it has been thoroughly compacted.

Joints, cutting of Bricks and laying.

3. The rates for the above two items shall include all special bonding, corner, curves, longitudinal and cross slope cambers, cutting shaping and wastage of bricks to fit irregular areas and special work.

In item 1 the rate also include a layer of mud plaster not less than 3/8'' laid to correct template, and bends underneath the bricks which should be carefully set in the plaster.

It item 2 the rate include a layer of mortar not less than 1/4'' thick under the whole of the flooring or paving into which the bricks shall be carefully set or embedded.

The joints in item 1 and 2 shall be fixed with a maximum width not exceeding 3/16th of an inch, all bricks shall be laid with the best side exposed and the rates cover the cost of cutting and dressing the bricks where necessary to ensure good bond and specified fine thickness of joints.

Cement pointing.

4. The external surface of the joints shall be struck flush, unless the Engineer-in-Charge orders for cement pointing.

Dressing of surface of streets.

5. The surface of street to receive flooring and paving shall be properly dressed and trimmed, and the rate shall include sectioning to correct cross and longitudinal slopes, cambers, ramming consolidation and smooth finishing of the surface prior to pavement.

CHAPTER No. 18

SEWAGE PUMPING SETS

18·1—*General*

General Specifications for sewage pumps.

1. The various parts of the pumps coming in contract with sewage shall be guaranteed safe by the manufacturers against abnormal wear in tropical climates due to grit, acids or other corrosive materials present in normal sewage of Pakistan towns (Normal water supply—20 gallons per head and ash is used for cleansing utensils).

The wearing parts of the pumps, i. e., wearing rings impellor bearings and shaft shall be of substantial construction and capable of being easily dismantled for the purpose of examination and replacements. In this connection horizontal split casings will be preferred.

The vanes and other passages in the impeller and the casings shall be guaranteed free against clogging by colloidel materials, small rags or other fibrous articles as well as *small solids up to 2 inches size* (This last condition in italics shall apply to pumps with suction and delivery of sizes six inches and above).

In the absence of specification of position of pumps with respects to the highest and lowest water level on the suction side, the suppliers will be firee to propose a position where the pumps would work most efficiently.

In case of a self priming position is proposed, a sluice valve of proper construction on the suction side of corrosion proof material will be supplied with the pump to isolate it for the purpose of repairs. Special tools for dismantling the pump and for replacement of spares ahall be supplied with the pump.

Spare parts for a normal running of 10,000 working hours will be supplied along with the pump.

The pumps shall be rated for continuous running of at least 16 hours a day.

Complete instructions regarding installation, maintenance, dismantling, and normal repairs along with necessary sketches and drawings and exploded view all written up in English and Urdu would be supplied free of charge with every machine.

Performance curves connecting discharge with a head, efficiency and horse power drawn on the same X and Y axis and on the same graph sheet shall be supplied and their accuracy with respect to individual machines guaranteed.

All guarantees will be deemed to be held valid only when 10 per cent of the price is kept in deposit with the Government for a period of six months after the installation of the machine during which period all the guarantee except that against abnormal wear will be deemed to be held good. For guarantee against abnormal wear will be specified by the manufacturers and will be in no case less than 10,000 working hours.

The pumps shall stand the test enumerated in the following paragraphs.

Testing of sewage pumps.

Purposes.

1. A pump test is made :—

(*a*) To determine whether the pump will deliver at a specified discharge against a specified head when running at a specified speed.

(*b*) To determine, at the same time, the power absorbed by the pump in doing such work.

(*c*) To determine the pump efficiency.

General Precautions.

2. During the whole period of the test, careful observation shall be made in regard to :—

(*a*) Serious shock, hammering or vibration occuring.

(*b*) Bearings running coal and with proper lubrication.

(*c*) Stuffing boxes and liquid sealing devices operating satisfactorily and not allowing any leakage of air into the pump.

(*d*) In the case of centrifugal or axial flow pumps, rubbing of the rotor occurring against the casing or neck rings.

(*e*) The reliable and satisfactory action of a hydraulic balancing device, if used.

(*f*) The prevention of any escape of liquid between the pump and the point of measurement of discharge.

Speed.

3. The speed shall always be maintained as nearly constant and as nearly equal to the specified speed as possible. If the prevailing suction and delivery heads under operating conditions are not the correct specified heads, then, if possible, these head shall be brought to the specified values by suitable methods applicable to the local conditions of instalation, Throttling by a valve is the most feasible means to raise the head in case the operating head is less than the specified value, but sholud it be found

necessary to insert a throttle valve in the suction line, this shall not be fitted closer to the pump than ten times the diameter of the suction pipe.

Readings.

4. Each of the various measurements for a given run shall whenever possible be computed by averaging a series of instantaeneous readings taken simultaneously at equal time intervals. A sufficient number of readings shall be taken in making an observation, so that the addition or elimination of a single reading representing a maximum swing of the instrument shall not affect the average by more than 1 per cent.

Mechanical and Hydraulic conditions.

5. The pumping unit shall be in the best possible mechanical conditions, with all bearings, stuffing boxes, and internal running clearances properly adjusted.

All air leaks in the suction pipe shall be eliminated.

Unless otherwise specified, the temperature of the liquid during the test shall not exceed 85°F. The liquid to be handle shall be reasonablly free from air and gases.

Duration of test.

6. The duration of the test shall be sufficient to secure accurate and consistent check results. To verify the mechanical condition of the pump, it shall be run continuously for not less than one hour and not more than six hours. Where a specification covers a range of performance, a minimum of five tests shall be made to define points approximately equi-distant on the characteristic curve.

Measurement of speed.

7. The speed of the pump shall be accurately measured by a revolution counter or an accurately calibrated tacheometer.

Discharge.

8. The discharge shall be measured by V Notch method or as directed by Engineer-in-Charge.

Measurement of Head.

9. The standard method of measuring head shall be to employ a liquid column or gauge glass giving a direct reading of surface elevation. Where this cannot be used, indirect methods may be employed, such as the use of a mercury or other liquid gauge or a Bourdon type gauge. It is recommended that liquid or mercury manometers be used in preference to Bourdon type gauges when the head to be measured is 50 feet or less.

NOTE—Special care is necessary to avoid the formation of air pockets in the suction pipes.

When using liquid columns for the measurement of head care must be taken that any correction necessary on account of the specific gravity of the liquid or liquids is made and that the head is stated in feet of water of standard density. When this is done, the horse-power calculations are correct whatever may be the specific gravity of the liquid pumped.

Gauges, Precautions and Connections.

10. When liquid columns are used, care shall be taken to avoid errors due to the difference between the temperature of the liquid in the gauge connection and that of the liquid in the pump by frequently draining the connection or determining the necessary correction.

When Bourdon type gauges are used, it is recommended that drain cocks be placed immediately below the gauges and that frequent tests be made to determine whether the pipe connections of the gauge are filled with air or liquid. With any form of gauge, care shall be taken to eliminate any leaks (even if small) in the connecting piping, and to avoid the trapping of air in the connecting pipe or hose.

A sealing arrangement should be fitted at the point where the gauge connection is taken from the main so as to prevent sewage entering and clogging the connecting pipe and the Bourdon tube of the gauge. The seal may be a liquid or flexible diaphragm type, and the gauge should be checked with the sealing device fitted to it.

Gauges shall be calibrated prior to and after the test and when calibrated and used shall be in an upright position. On no account shall any Bourdon type gauge be fixed so that any strain is placed on its case, as its readings may thereby be seriously affected.

Connections for the gauges shall be made on the suction and delivery pipes in positions free from likelihood of the gauge readings being affected by curvature, restriction, rotation or impact effect of the stream lines, and shall be as short and direct as possible. Connections to taper pipes and bends are undesirable and connections to the top side of a pipe shall be avoided, as air frequently collects there. The suction gauge connection shall be placed at a distance of one to one half pipe diameter from the inlet flange, and the delivery gauge connection at a distance of one to four pipe diameters from the outlet flange if a valve is used for throttling the discharge, it shall be placed downstream of the delivery gauge connection at a distance not less than three pipe diameters. The end of the connecting tube or pipe shall be flush with the inside of the conduit in which the pressure is to be measured and shall have its axis at right angles to the direction of flow.

Measurement of power input.

11. Measurement of power input to the pump, that is, the brake horse-power (B.H.P.) of the pump falls into two general classes. Some measurements are those which in themselves determine the actual power or torque delivered to the pump and are, therefore, made entirely during the test, using some form of transmission dynamometer. Other measurements are those which involve measurement, during the pump test, of power in put to the driving element and the previous or subsequent determination of the relation of the power in put to the power out put of this driving element under the identical conditions of the pump test, thus by calibration deriving the efficiency of the driving element.

If a dynanometer moter, or a transmission dynamometer, is not available, the preferred method of determining power input to the pump shall be the use of a direct connected calibrated electric motor, provided the calibration tests of this motor are made with very care and are frequently rechecked. Curves shall be made up from the calibration tests translating kilowatts in-put into brake horse-power out put. Power in put to the motor during a pump test shall then be measured in a manner exactly similar to the calibration tests, and the corresponding power out put as shown on the calibration curve shall be taken as the power input to the pump.

Electrical instruments shall he calibrated, if required, immediately prior to the tests by the National Physical laboratory or other approved authority.

Should question arise as to the accuracy of the motor effeciency or electrical instruments, these shall be recalibrated immediately following the pump tests. Such recalibrations, however, shall not be unreasonably demanded if reliable recent calibrations are available.

Calculation of water power and efficiency.

12. The water horse-power is found from Equations 1 and 2.

$$\text{W.H.P.} = \frac{Q \times H}{8{\cdot}828} \qquad \text{.. Equation 1.}$$

$$\text{W.H.P.} = \frac{G \times H}{3300} \qquad \text{.. Equation 2.}$$

Where W.H.P. = water house-power,
Q = discharge in cubic feet per second,
G = discharge in Imperial gallons per minute,
H = 'Total head' in feet of water.

Efficiency—The efficiency of a pump is the ratio of the water horse power out put to the brake horse-power input, or,

$$\text{Percentage efficiency} \frac{\text{W.H.P.}}{\text{B.H.P.}} \times 100\text{—Equation 3.}$$

Where the values have been determined as described.

The tolerances in efficiency and discharge head shall be 2·5 per cent.

Data to be supplied to the suppliers of pumps by Engineer-in-Charge.

(*a*) Drawings where sketch of the pumping installation is supplied to the supplying firms by the Engineer-in-Charge and the latter shall supply detailed drawings showing the best location of the various units and changes, if any, required to be made in the civil works.

(*b*) Drawing of existing suction and delivery pipes, if any.

(*c*) In case of existing installations the chemical and biological lists of sewage.

(*d*) The minimum and maximum discharge and heads to which the pump will be subjected to.

(*e*) Atmoshpheric data showing annual minimum and maximum temperatures, freedom or otherwise from sand storms, etc.

(*f*) Type of installation that is horizontal vertical dry or wet.

(*g*) The daily dishcarge curve of the pumping station if any for purposes of the planning the size and number of the pumping units.

18·2
SEWAGE PUMPS
Centrifugal Pumping Sets.

Impeller.

1. The impeller shall be of cast iron or bronze and shall be fitted with easily renewable cast iron seating rings, fitted to the casing adjacent for efficient performance. The pump shall be non-clogging type below 7 cusecs.

Stuffing Box.

2. This should be easily accessible for packing and shall have clear water seal so arranged to prevent ingress of air into the pump through the stuffing box,

Shaft.

3. The shaft shall be of substantial construction adequately supported by bearings of appropriate design being so placed as to avoid vibration in the shaft at any speed.

Accessories.

4. 1 foot valve.

1 gate valve.

1 check valve·

1 flexible coupling.

1 priming funnel.

1 pressure guage including cock.

1 depression water indicator.

1 suction guage including cock.

Motor.

5. A. C. horizontal electric motor, 440 volt, 3 phase 50 cycles, drip water proof with tropical insulations speed 1,400—3,000 rpm. Up to 10 BHP squirrel cage and above 10 BHP where slipring motors shall be provided.

Ampere and volt meters shall be supplied.

Starter.

6. (*a*) *For squirel cage motor*—Protection switch, star delta sheet clad equipped with overload and short circuit release and red light warning provided with one hand lever and an automatic electric cut out (switch).

(*b*) *For slipring motor*—Oil drum starter and one motor protection switch, sheet clad, with overload, short circuit and no volt release and red warning light and an automatic electric cut out (Switch).

Electric Spare.

8. Spares for motor shall be supplied as under :—

(*a*) One set of bearings.
(*b*) Spare rotor.
(*c*) Starter Winding.
(*d*) Starter contact.
(*e*) Four sets of brushes in case of slip ring motor.

The brushes for above 15 H. P. motor shall be liftables.

The motor shall be capable of continuous running for 16 hours complete accessories, spare parts and set of tools for erection maintenance, repair and dismantling shall be supplied with the motor.

Diesel Driven

9. Where diesel power drive is required as stand by the motor shall be connected to the pump through vee belt with a suitable vee pulleys for the engine and the pump.

The fuel and oil consumption shall be stated.

Complete instructions including erection diagram for erection, dismantling, repair and running of installation written up in English and Urdu shall be supplied, free of cost with every machine.

Diesel Engine

10. This shall be watercooled, a horizontal slow speed, (Max 600 RPM) high compression with pre-combustion chamber, single cylinder, four stroke, single acting type, with forced feed lubrication and shall be capable of standing abnormal wear for 10,000 hours. The engine would be rated for complete continuous running for 16 hours a day. Accessories and spare parts for running 10,000 hours shall be provided together with tools and instructions for erection, dismantling, repair, inspection maintenance and spare parts list. The engine shall have standard equipment including fly wheels, air filter, fuel cock, fuel filter, head starting crank with supporting shield, exhaust, silencer, foundation parts, casing for valve gear, one complete set of tools consisting of spares, socket oil can, screw driver, roundplier, ignition paper, one set of spares consisting one lockring for valve lever, one gasket between injection valve, piston ring, circlip for piston pin lock sheet for connecting rod, packing for cylinder head, Temperature and oil guage, and other necessary suitable equipment necessary for erection, dismentling, inspection, repair and maintenance.

18·3—SEWAGE PUMPS

VERTICAL PUMPING UNITS.

Design.

1. For discharges below the 7 cusecs, the pump shall be of non-clogging type and above that of the axial flow tppe unless otherwise specified by the Engineer-in-Charge.

Driving Shafts.

2. The driving shafts will be of substantial construction and adequately supported by intermediate bearings of appreciate design. The bearings shall be so placed as to avoid any vibration in the shafts at any speed. Calculation for placing these bearings with respect to size, elasticity and speed of shafts

will be submitted along with the tender. The bearings shall be force lubricated, capable of being lubricated from the working floor on which the prime movers are located. The thrust bearing for the driving shafts shall either be located next to the pumps or at the floor level, and will be of substantial construction. Calculation for size thereof shall be submitted. Bearings shall preferably be of tapered roller type.

3. Suspension pipes, if any, shall be of S. M. Steel.

Suspension Pipes.

4. Sealing of pumps shall be with clean water and cost of provision of tube shall be included in the tender.

Sealings of Pumps.

5. 1 flexible coupling (for electric drive only).

Accessories

1 sluice valve on suction side.

1 sluice valve on delivery side.

1 elongated spindle for sluice valve on suction side with headstock and indicator.

1 elongated spindle for sluice valve on delivery side.

1 non return with lever and counter weight.

1 set of impellers.

Spare Parts.

1 set of liner plates.
1 pump shaft of SM-steel, set of pump bearings.
2 intermediate bearings.

1 vertical A.C. electric mortor with squirrel cage rotar drip water proof with tropical insulation.

Electric motor

Winding	... 400—440.
Voltage	... 400/440 Volts.
Frequency	... 50 cycles
Speed	... 1,250—1,450 rpm for small sets, and 800—1,000 rpm for large sets motor, above 10 BHP slip-ring motor shall be provided.

NOTE—The motor shall be capable of continuous working for 16 hours. Complete accessories for running 10,000 hours, set of tools for erection, maintenance and repairs and dismantling shall be supplied with the motor.

Starter.

(*a*) for squirrel cage star data starter motor protection switch, sheet steel clad equipped with overload and short circuit releases provided with one hand lever a red warning light and on automatic electric cut out (switch).

Slipring motor.

(*b*) for oil drum starter. motor protection switch, sheet steel clad, with over-load short circuit and no volt release, red warning light and on automatic cut out.

Spare parts for motor.

8. (*a*) One set of bearing.

(*b*) Spare rotor.

(*c*) Starter winding.

(*d*) Starter contact.

(*e*) Four sets of brushes in case of slipring motor. The brushes for above 15 H.P. motors shall be liftable.

The lubrication oil consumption shall be stated.

Complete instructions including erection diagram, for erection, dismatling, repair and running of the installation written in English and Urdu shall be supplied free of cost.

Diesel drive.

9. Where diesel power drive is required as stand-by the motor will be connected to the pump, through a vee belt with suitable vee pulleys for the engine and the pumps.

Diesel Engine.

10. This shall be water cooled cold starting horizontal slow speed high compression with precombustion chamber single cylinder, four stroke, single acting type with forced feed lubrication and shall be capable of with standing abnormal wear for 10,000 hours. The engine shall be rated for continuous running of 16 hours a day. Complete accessories, spare parts and tools for running 10,000 hours shall be provided together with instruction notes for erection, dismatling, repairs, inspection and maintenance together with spare parts lists.

The Engine shall have all standard equipment, which shall include all flywheels, air filter, fuel tank, fuel filter, hand starting crank with supporting shield, exhaust silencer foundation parts, casting for valve gear, one complete set of tools consisting of spares, socket wrenches, socket oil can, screw divers round pliers, ignition paper, one set of spares consisting of lock ring for valve lever, one gasket between injections valves, piston ring circlip for piston pins, lock sheet for connecting rod, packing for cylinder head temperature and oil guages, and other necessary suitable equipment necessary for erection, dismantling, inspection repair and maintenance.

The fuel oil consumption shall be stated.

Complete instruction including erection diagram, spares for erection, dismantling, repair, and running of the installation written in English and Urdu shall be supplied free of cost.

11. (*a*) Discharge in gallons per minute.

Information to be supplied to manufacturers.

(*b*) Suction lift maximum and minimum.

(*c*) Delivery head.

(*d*) Analysis of sewage, if any.

(*e*) Diagramatic sketch of the pump house may be supplied to the firm who would submit detailed drawings for location of various units, for best performance.

CHAPTER 19

SEWAGE PURIFICATION WORKS

19.1—*General.*

The work shall be done as per specifications in Volume I and II.

The rates shall include railway freight, sales tax Octroi duties and other incidental charges.

19. 2—SEWAGE PURIFICAL PLANT.

Specifications for Primary Settling Tanks

General.

1. The sedimentation tank shall be circular. continuous flow with scrapers (as sludge is required to be removed very frequently 8 to 12 times a day to prevent the sewage from getting septic).

The sedimentation tanks shall have a flat slope towards the centre, which shall be determined by the Engineer-in-Charge.

Sludge removal mechanism.

2. The sludge removal mechanism shall include structural steel, walkways, sludge collecting mechanism, control apparatus, diffusers, all electrical work, anchor and foundation bolts, governor, collector ringsfor electrical connections and the other appertenances, which are necessary for the complete installation.

In general they shall be furnished and installed under this item complete equipment for——Nos. primary settling tanks each having a concrete floor with a centre supporting Pier.

The tanks shall have an internal diameter of———feet and a side sewage depth of———feet and with the flow sloping in the manner shown on the drawings.

Railings, pipe work, weirs, embankment, concrete and reinforcing steel shall be paid for under the appropriate items of this specification (if executed by the bidders).

If Civil Works are not executed by the suppliers, the firms representative shall be present during construction to see that they are executed to suit the requirements of the mechanism.

While the detailed specifications describe the mechanisms and equipment of the Dorr Company (Type 'A') and the mechanisms and equipment of the Link-Belt Company, (Type 'B'), the use of approved equal mechanisms and equipment made by other will be permitted, subject to the approval by the Engineer-in-Charge of such changes and variations from the detailed specifications and plans as may be required, in the Engineer-in-Charge judgement, to permit the use of the 'approved equal' mechanisms and equipment made by others.

The bidder shall state, in his proposal from, what make of mechanism and equipment he proposes to furnish and install if awarded the contract; and upon the award of the contract, the successful bidder will be required to furnish and in stall the make so named in his proposal.

Both mechanisms and equipments shall be of the same design and construction and shall be made by the same manufacture, unless otherwise instructed and approved by the Engineer-in-Charge.

"Type 'A' Sludge Removal Mechanism"—Each sludge removal mechanism shall consist of a central driving mechanism which rotates the supporting drum or cage and arms. There shall be four arms to which are attached blades so arranged that they will scrape the sludge, which settles the bottom, at the centre of the tank.

A *diffuser* shall be furnished and installed on the central pier of the tank. It shall be designed and constructed to carry and support the driving mechanisms and to withstand the full torsion of the force of rotation. This diffuser shall be of welded steel construction.

The control mechanism shall consist of a stationery cast iron-turn table base, bolted to the diffuser on a central concrete pier. A step bearing shall be provided on the turn-table base, carrying the turn-table top, to which the centre drum or cage shall be attached. An internal gear shall be cut integrally with the turntable top, and shall be rotated by two trains of gears mounted on the slow speed shaft to the drive unit. The drive unit pinion shall be free to float for centralizing the load from the internal gear. The turn-table shall rotate cn steel balls running in an oil bath, and shall bo provided with a felt saal. A dust shield shall be provided on the outside of the turn-table base and top.

The steel centre cage shall be hung from the turn-table top. The case shall supoort and drive the rotated arms and shall be of sufficient strength to withstand the full force of rotation. A rotating influent well shall be attached outside the cage.

The clarifier mechanism shall be firmly grouted to the centre pier.

Suitable provision shall be made for lubrication of all bearing or other moving parts as required by means of accessible grease fittings.

Type 'B' Sludge-Removal Mechanism—Each sludge removal mechanism shall consist of a bridge pivoted at the centre of the tank supporting a Link-Belt Straight line sludge collector which consists of two parallel endless strands of chain to which are attached flights at intervals of five feet. Separate driving motor shall be used to drive the bridge and the sludge collector. The collector shall deliver the sludge to a sludge copper covered by a steel plate which rotates with the bridge.

The revolving frame structure of each collector shall be constructed of structural steel throughout, and shall be substantial and stiffened. The frame shall be pivoted at the centre, being supported on a ball bearing centre piece which shall be mounted on the central supports. This frame shall be provided with a suitable walkway.

The straight line collector, consisting of a double strand of Promal chain, shall be suspended from the revolving bridge. The collector chains shall have an ultimate strength of not less than 14,000 lbs. The links shall be made from Promal iron, which shall have an average ultimate strength of 70,000 lbs. per square inch, and a Brinnell Hardness Number of not less than one hundred seventy through the entire section of the test bar. Attached to the chains at interval, of approximately five feet, shall be 3/16″ by 6″ steel flights sliding on steel tracks suspended from the bridge. A rubber skirt shall be provided along the full length of the back truss so that sludge is moved from all points in the tanks.

Anti-friction helical gear reducers in cast iron, oiltight housings, driven by motors of ample horse power, shall be provided to rotate the bridge and to move the collector. A pocketed drive wheel mounted on a shaft shall rotate the bridge at a speed of six feet per minute at the periphery. A galvnized chain lying in the effluent through shall be picked up by wheel revolves. A sprocket, with break pin hub, mounted on the shaft, shall propel the sludge collector at a speed of one and a half feet per minute. The bearings of the straight line collector shall be of the babbitted peak-cap type to prevent accumulation of set led solids on any part of them and shall be water lubricated. The sprockets shall be made of a special grade of iron, cast in chills with the sprocket teeth accurately formed and grounded smooth to mesh neatly with the chain.

The contractor shall have the manufacturer of this equipment to furnish with the said equipment, the influent diversion funnel and base at the centre of the tanks; the steel covered plates for the sludge hopper with the sludge plow, and the electrical current collectors.

3. The sludge pumps shall be of required capacity against a head of centrifugal type (non-clogging type) driven by A.C. electrical motor of non-inflammable pattern.

Sludge Pump.

9. The type of electric current, phase and voltage shall always be stated.

Type of electric cover.

10. For Civil Works specifications in Volume I (Building) Pipework Chapter 8, Hydraulic structure Chapter 6 excavation Chapter 13 and well sinking Chapter 1 of this volume shall apply.

Civil Works.

11. The contractor shall be supplied with the following information :—

(*a*) Population for which Sewage disposal work is to be designed.

(*b*) The water consumption.

(*c*) Type of Sewers, *i.e.*, separate, combined or partially combined.

19·3—*Trickling Filters*

1. The filtering media shall consist of hard stone, clinker, coke, coal or slag according to local conditions as approved by the Engineer-in-Charge. The medium shall have a large surface area as the efficiency of oxidation depends upon the biological films which coat the medium. The two general conditions are that (*a*) the filtering material shall be relatively uniform in size and must be free from fine particles which fill up the spaces between the specified sizes of the material; and (*b*) a reasonably durable material should be used to prevent breaking up of the media and consequent formation of fine particles.

Filtering Media.

The filtering media shall be stone ballast or brick ballast graded from 6″ to 1″ from coarse at the bottom to fine at the top.

The recommended grading is :—

2 feet ..	6″ to 3″
Middle core varying from 3 feet to 5 feet ..	1½″ to 1″
Top 12″ ..	1½″ to 1″.

2. Circular shape shall be adopted unless the land is limited.

Shape of filter.

Walls. 3. The walls shall be of bricks, stone, concrete or R. C. C. as decided by the Engineer-in-Charge, plastered inside with $\frac{3}{4}''$ thick cement mortar 1 : 2 without neat cement coat.

Under drains. 4. The filter shall be provided with concrete floor (4″ thick $1\frac{1}{2}$: 2 : 3 : top slab) sloping 6″ in 100 feet towards the periphery from the centre (in case of rectangular tank from one side to another).

The method of laying under drains from the centre to external peripheral channel is considered to be the best for the purposes both of drainage and aeration. With this arrangement the ends of all the under drains can be got at and cleaned whenever necessary. (*The most economic construction for general purposes is cross-flow under drains in which the drains are parallel discharging to a channel which is equal in length to one quarter of the circumference of the bed and in which the fall of the floor is in the same direction as the fall of the land. It is believed that such an arrangement requires a minimum length of drains for the degree of drainage and aeration obtained.*)

The under drains shall be made in bricks, tiles or concrete half pipes without joints as directed by the Engineer-in-Charge.

Distribution Mechanism. 5. The dosing system shall be continuous and at rapid rate to avoid fly and odour, and the application shall be arranged to keep the whole of medium wet at all times. The minimum capacity of dosing tank is $\frac{1}{2}$ gallon per cubic yards of the filter.

Specification distribution system. 6. The distribution system shall be such as to require minimum attention and consuming a few inches of hydraulic Head without recourse to mechanical or electrical power.

The cotractor shall furnish all materials and shall properly install, adjust and test the distribution system as directed, which shall have a working head of 3″ with Mercury Seal, frictionless type, with all moving points being accessible without the necessity of dismantling the machine, and shall include ball bearing, at the head of the pillar carrying the moving parts, fitted with hydraulically braced copper ferrules headed inside and out side in the same operation, with a rustless finish on the spray arm.

In general, they shall be furnished and installed under this item complete equipment for the——Nos. trickling filters of—diameter with a centre supporting pier. The depth of the filter at the sides shall be——and the floor shall be sloping outward as shown on the drawing.

Railings, pipe work, weirs, excavation embankment concrete and reinforcing steel shall be paid under the appropriate item of the specification if excavated. The firms representative shall be present during the construction of civil works if executed by any other agency to see that the construction suits the mechanical requirements. The detailed specification described above is of Messrs. Ames Cresta, the mechanism and equipment made by others will be permitted subject to the approval of the Engineer-in-Charge of such changes and variations from detailed specifications and plans as may be required in the Engineer-in-Charge judgement to permit the use of 'approved equal' mechanism of equipment made by others.

The bidder shall state, for in his proposal form, what make of mechanism and equipment, he proposes to furnish and install, if awarded the contract; and upon the award of the contract, the successful bidder will be required to furnish and install the make so named in his proposal.

Both mechaninsms and equipments shall be of the same design and construction and shall be made by the same manufacture, unless otherwise instructed and approved by the Engineer-in-Charge.

Civil Works.

7. The contractor shall be supplied with the following information :—

(a) Population for which sewage disposal is to be designed.

(b) The water consumption.

(c) Type of sewers; separate combined or partially combined.

19·4—Activated Suldge Process.

Aeration Machinery.

1. The contractor shall furnish all materials for and properly install, adjust and test—Nos. Aeration Mechanism of the Aeration tanks. Included in this item shall be all structural steel, walkways, control apparatus, the stationery cylinder or up take tube revolving disc. fitted with vanes designed to throw a thin sheet of sewage across the surface of the tank, driving shaft and worm gear electrical work including motors and starters and other appertenance which are necessary for the complete installation.

In general, these shall be furnished and installed under this item complete equipment for Aeration tanks each having a hopper concrete floor with a central supporting pier. The aeration tanks shall be——feet square and the depth of sides shall be——feet and the centre——feet, as shown on the drawings.

Railings, pipework, weirs excavation, concrete and rein forcing steel shall be paid for under appropriate items of executed by the supplying firm.

While the specifications described above are for the simplex Aeration of Ames Cresta the use of 'approved equal, mechanism made by others will be permitted subject to the approval as the Engineer-in-Charge of such changes and variations from the detailed specifications and plans as may be required in the Engineer's judgement to permit use of the epproved equal mechanism and equipment by others.

The biddar shall intimate in his proposal form what make mechanism and equipment, he proposes to furnish and install, if awarded the contract ; and upon the award of the contract the successful bidder will be required to furnish and install the make so named in the proposal.

The prices quoted shall be in rupees for furnished, installed and tested equipment.

In case civil works are not executed by the supplying firm his representative shall be present during the execution of the works to see that the civil works suit the mecahnical and other requirements of the plant and necessary anchor bolts and fitment are left in the civil works and there is no necessity of dismantlement or alterations in the structure.

Sludge Pump.

2. For pumping activated sludge non-chockable centrifugal pump of robust make capacity——— gallons per minutes against a head of —————powered by AC/DC flameproof motor shall be used and the contractor shall quote in rupees the cost of all mechanism, walkways, railings, anchor bolts, all electrical work including starters and other necessary appertenances to complete the work installed as shown on the drawings or directed by the Engineer-in-Charge.

The works of railings, pipework weirs excavation, concrete and reinforcing steel shall be paid from under appropriate items.

In case civil works are executed through any other agency, the suppliers representative shall be present during the construction to see that the works are executed to suit the mechanical, electrical and other requirements.

The cost of furnishing, installing and testing shall be given in rupees.

Final settling Tanks.

3. The design and mechanism of the final settling tanks shall be similar to the preliminary settling tanks and all clauses of Volume I, Chapter 8, 6, 13 and 1 of this volume shall apply in this case.

Information to be supplied to the manufacturers of the plant.

4. The following information shall be supplied to the manufacturers by the Public Works Department :—

1. Amount of influent during various months of the year.
2. Ultimate population to be served.
3. The Chemical Composition and Biological Oxygen demand.

19·5—*Sludge Disposal*

Mechanism of sludge digesting tanks.

1. The contractor shall furnish all materials for install adjust and test——units of single stage tanks diameter——and capacity——cubic feet with stirring apparatus consisting of screw pump situated near the top of vertical upward tube extending down nearly to bottom deflector blade situated about 1/3rd the depth of the tank. The roof shall be domical and of floating type of one buoyant ring with sufficient slope on the dome to lead all gasevolved up to the water surface. The floating proof shall not make any difference in the gas pressure for removal of sludge or supernotent. The whole installation shall be water end gas proof. The heating shall be by a gas fired boiler. The sludge pump shall be of intermittant type working 5 minutes in an hour. No stirring shall be required to be done for a period of 4 hours prior to withdrawal. The motor for driving shall be of flame proof type.

Included in this item shall be all structual steel, walkways, sludge collecting mechanisms, control apparatus, diffusers, electrical work as specified, anchor and foundation bolts, governor, collector rings for electrical connections and the other appertenances which are necessary for the complete installations.

In generalthese shall be furnished and installed under this item complete equipment for——units gas digestion with brick, stone, concrete or R.C.C. walls with floor sloping in the manner described. The digesting tanks shall have an internai diameter of——and the height at sides shall be——feet and at the centre——feet.

Railings, pipework, weir, excavation, embankment, masonry, concrete and reinforcing steel will be paid for under appropriate items if executed.

While the detailed specifications described in the mechanism of Pruss single stage digestor the use of 'approved equal' mechanism and equipment made by others will be permitted subject to the approval by the Engineer-in-Charge of such changes and variations from the detailed plans as may be required in the Engineer-in-Charge's judgement to permit use of the 'approved equal' mechanism and equipment made by others.

The bidder shall state, in his proposal form, what make of mechanism and equipment he proposes to furnish and install, if awarded the contract, and upon the award of the contract, the successful bidder will be required to furnish and install the make so named in his proposal.

Both mechanisms and equipments shall be of the same design and construction and shall be made by the same manufacturer, unless otherwise instructed and approved by the Engineer-in-Charge.

In case the civil works are executed by agency different from the supplying firm, their representative shall be present during construction to see that it is executed to the mechanicals and electrical and other requirements of the machinery, and that foundation bolts and other equipment necessary to be built in is done without recourse to any dismantlement.

CHAPTER 20

HOUSE CONNECTION FOR WATER SUPPLY

20·1—*General*

Service Connection for 2" and below.

1. Service pipes of less than 2 inches bore shall be conected to mains by means of right-angled screw-down ferrules of nonferrous metal; but the ferrule itself shall not be of more than 1 in. bore. 1 in. and ¾ in. ferruless shall not be used in mains of less than 4 in. bore. The main is drilled and tapped and the ferrule screwed in; this shall be done by a tapping under pressure machine which obviates any interference with the use of the main or as instructed by the Engineer-in-Charge.

Service Connection for above 2".

2. Service pipes of 2 in. bore and upwards shall be connected to special branch pipes which have to be inserted into the line of the main. (Special branch pipes should also be used for service pipes of less than 2-in. bore if the main is not much greater than that of the service pipe).

Precautions against contamination during connection.

3. Precautions against contamination of the main must be taken when making a connection, and where any risk exists, the main must be subsequently sterlized as described in Chapter 8 of this Volume.

Surface Box.

4. A surface box, mounted on a guard pipe, shall be fixed over the underground stop-valve to give access for operating the latter. The limited space provided by this arrangement will not permit the repacking of the stop-valve, gland or other repairs to be carried out without excavation, which is necessary to give adequate space and to obviate the danger of contamination of the interior of the stop tap by any local filth. The guard pipe shall by supported on bricks, or as directed and must not rest on the supply pipe.

Entrance of service of pipe to building.

5. The service pipe shall pass into or beneath the building at a depth, below the external ground level of not less than 2 ft. 6 in. and as its point of entry through the structure shall be accommodated in a sleeve which should have previously been solidly built in. The space between the pipe and the sleeve shall be filled with bituminous or other suitable material for a minimum length of 6 in. at both ends.

Fixation of meters.

6. If the service is to be metered, the meter may be provided and fixed by the Department or as decided. It shall be fitted between two stop-valves and with unions to facilitate the necessary periodic changing of the meter. If the meter is fixed underground, a suitable brick chamber shall be built, large enough to include both meter unions, and covered with an iron surface box. If the meter is fixed inside the building, a rigid shelf shall be provided for its support in such a position as to facilitate the reading of the meter dial, and the meter must be so disposed as to ensure correct working of the mechanism, that, is, normally with the inlet and the outlet horizontal and the dial facing upwards. If fitted in an exposed position, the meter must be protected against frost.

Stop valves.

7. (*a*) A stop-valve shall be provided in the service pipe in an accessible position inside the building, as near as practicable to the point of entry of the pipe, so that the supply may be readly shut off in case of trouble and for repairs. A draining-tap shall be provided just above this stop-valve to enable the service piping in the building to be emptied of water when the stop-valve is shut and the piping from the stop-valve down to 2 ft. below ground level shall be lagged with insulating material. Another stop-valve shall be provided near the point where the service pipe enters private land from the street. It shall be fixed preferably in the street close to the boundry so as to be accessible to authorized employees of the department without their having to enter on private property, but the requirements of the local body, if any, in this respect should be ascertained.

(*b*) In flats ande tennts supplied by a common service pipe, a stop-valve shall be fixed to control the branch to each separately occupied part.

Invisible piping.

8. Where invisible pipe is required, ducts or chases in wall for piping shall be provided during the building of the walls. If with the permission of the Engineer-in-Charge, they are cut in existing walls, they shall be finished sufficiently smooth and large enough for fixing the piping. In the case of lead pipes the joints may be wiped outside the duct, and the pipes cased back into the duct after jointing.

Piping in wooden floor.

9. (*a*) When piping laid in wood floors has to cross through the joint, it should cross as near the supports as possible. Joint should not be cut or bored except with the permission of, and as directed by the Engineer-in-Charge.

(*b*) Piping laid in notches or holes should not be subjected to external pressure, and should be free to expand and contract without noise due to friction on the wood.

Draw-of taps.

10. Draw-off taps not forming an intergral part of an appliance shall be screwed into suitable pipefittings so as to provide for ready removal, for repair or replacement. The fittings or the pipe immediately adjacent thereto, shall be firmly secured to a suitable support so as to prevent strain on the pipe and its joints when the tap is operated.

Sterlization of pipes and cisterns.

11. The cisterns and pipes shall first be filled with water and thoroughly flushed out. The cistern shall then be filled with water again, and a sterlizing chemical containing chlorine added gradually while the cistern is filling, to ensure thorough mixing, sufficient chemical shall be used to give the water a dose of 50 parts of chlorine to one million parts of water. If ordinary 'bleaching powder' is used the proportions will be 1·5 lb. of powder to 1,000 gal. of water; the powder shall be mixed with water to a creamy consistency before being added to the water in the cistern. If a proprietary brand of chemical is used, the proportions shall be as instructed by the Engineer-in-Charge. When the cistern is full, the supply shall be stopped and all the tap on the distributing pipes opened successively, working progressively away from the cistern. Each tap shall be closed when the water discharged begins to smell of chlorine. The cistern should then be 'topped up' with water from the supply pipe and with more sterlizing chemical in the recommended proportions. The cistern and pipes shall then remain charged for at least three hours unless otherwise directed by the Engineer-in-Charge, where upon a test shall be made for residual chlorine ; if none is found, the sterlization must be carried out again.

Finally the cistern and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

20·2—Semi-Rotary Pumps

Description.

1. The semi-rotary wing piston and the suction divider shall be of brass each provided with two free fitting hinged flap valves. The wing piston shall be cast integral with the operating spindle. The clearances between the wing piston and the interior of the pump body shall be adequate but not excessive

and suitable for cold or for hot water as may be required. The suction divder shall be a close fill to the interior of the pump body with a packed groove in rubbing contact with the central cylindrical portion of the wing piston. The suction divider shall be removable and located in the body by a steady pin. A screwed drain or frost plug shall be fitted to the cover of the pump at the lowest position immediately above the suction divider.

Body.

2. The body shall be a sound casting of iron or brass with oval inlet and outlet flanges with two bolt holes. The back of the body shall be provided with a pair of integral vertical legs each with one bolt hole and with a central bross bored to form a bearing for the inner end of the operating spindle. The interior of the body the spindle bearing and the cover joint face shall be smoothly machined. The inlet and outlet flange joint face shall be machined or ground to a level surface and shall be reasonably parallel to each other and at right angles to the vertical axis of the pump. In the case of brass bodies the outer rim of the body shall also be machined.

Cover.

3. The cover shall be a sound casting, the central inner portion of which shall project to form a spigot in the bore of the body. A central outer projection shall form the housing and stuffing box for the outer and of the operating spindle. The inner face of the cover shall besmoothly machined and its spigot shall be machined to fit the bore of the body; the joint face shall be machined and the central hole for the operatings pindle bored. In the case of brasspumps the outer rim of the cover shall also be machined to match the outer rim of the body. The central outer projecton shall be counter bored to form a stuffing box the exteror of which shall be threaded. The stuffing box, shall be provided with a machined all-over loose gland ring to fit the stuffing box and with an internal threaded gland nut wth a central hole to clear the spindle. The stuffing box shall be packed with suitable sping packing.

Wing piston.

4. The brass wing piston shall be a sound casting with cast-in steel spindle, its contact surface shall be a free rubbing fit to the body cover sand suction divider- The spindle ends shall be machined with the piston at the one setting. The valve seats shall be machined or ground flat wherein contact with the valves. The brass flap valves shall be provided with free fitting non-ferrous pivot pins securely clenched and the valves machined or ground flat where in contact with the valves seats,

5. The brass suction divider shall be a sound casting machined a close fit to the body and cover and shall be provided with a packing groove and suitable packing strip wherein contact with the central cylinderical machined surface of the wing piston. The valve seats shall be machined or ground flat where in contact with the flap valves. The brass flap valves shall be provided with free fitting nonferrous pivot securely clenched and the valves machined or ground flat where in contact with the valve seats.

Suction divider.

6. The end of the steel spindle shall be smoothly machined to fit the bearing in the central brass of the body. The outer end of the spindle shall be smoothly machined and shall terminate in a taper equal for the operating handle and a threaded portion provided with a hexagon nut to secure the handle when in place. The outer end of the spindle shall be a free fit in the stuffing box of the cover.

Spindle.

7. The inlet and outlet flanges shall be ovel and interchangeable with two bolt holes and threaded internally B.S.P. taper to B.S. 21 of parallel to B. S. 84 : 1940 and the joint surfaces shall be faced flat. The flanges shall be bolted in place on the pump body each with an unpierced joint gasket or a stout paper or card diaphragm to protect the internal mechanism of the pump while in transit or in store.

Mating flanges.

NOTE—*It is incumbent on the manufacturer to supply joint qaskets. Before connection to section or delivery piping the protective diaphragms need removal and a central hole must be cut in blank gaskets.*

8. The operating handle centre shall be a well annealed malleable iron casting or a mild steel forging at the option of the manufacture of adequate strength with an internal tamper square fitting the corresponding spindle square with a tang of ciruciform cross section. The wooden handle extension shall be circular in cross section and well shaped for hand grip reinforced with an external steel tube ferrule at the tang end. The handle extension shall be of sound well seasoned timber turned all over and free from knot or shake. The tube ring ferrule shall be securely driven on, and the tang centre securely driven into the wooden extension.

Operating handle.

9. After assembly each finished pump shall be subjected by cold water hydraulic test to a pressure of 50 lb. per sq. in. without showing signs of porosity or other leaks.

Hydraulic pressure test.

10. When tested with clean cold water, without priming and with a pump clean, dry unoiled and without foot valve or strainer, the pumps shall give the following minimum suction heads :—

Suction performance.

Symbol	Size inlet and outlet bores	Vacum inches mercury
	inches	inches
B. S. 0 ...	½	10
B. S. 1 ...	¾	12
B. S. 2 ...	1	15
B. S. 3 ...	1¼	15
B. S. 4 ...	1¼	18
B. S. 5 ...	1½	18

11. Under the conditions of 3 ft. suctions and 15 ft. delivery heads when tested with cold water the pump shall give the following minimum discharges when operated at the stated double strokes per minute :—

Discharge performance.

Symbol	Size inlet and outlet	Double strokes per minute	Gallons per hour
B. S. 0 ...	½	60	90
B. S. 1 ...	¾	50	130
B. S. 2 ...	1	45	190
B. S. 3 ...	1¼	40	260
B. S. 4 ...	1¼	35	340
B. S. 5 ...	1½	30	380

General Instructions for Service Pipe And Service Connections

1. Piping outside buildings should be laid underground with a cover-measured from the top of the pipe to the surface of the ground of not less than 2 ft. 6 in. Outside piping should only be allowed above ground in exceptional circumstances, and then it should be efficiently lagged with waterproof insulating material and provision should be made for draining the piping of water in frosty weather (but no draining tap should be fixed underground because of the danger of contamination).

2. As far as practicable, the underground service pipe should be laid at right angles to the main and in approximately straight lines to facilitate location for repairs.

3. Water for drinking or for culinary purposes should not pass through any cistern, and therefore, taps supplying water for these purposes should be on branch pipes connected, directly to the service pipe.

4. A service pipe should not be connected into any distribution pipe; such connection might permit the backlow in certain circumstances of water from a cistern into the service pipe with consequent danger of contamination. If might also result in pipes and fitings being subjected to a pressure higher than that for which they were designed, and in flooding from over flowing cistern.

5. A service pipe should not be connected into the delivery pipe from any pump, except where the pump is arranged solely as a booster pump on a by-pass round a stop valve on the service pipe.

6. Cold water piping should be so located as not to be liable to heating by too close proximity to hot water piping or tanks where this is not practicable, both cold and hot water piping should be lagged with insulating material.

7. The rising pipe to the storage cistern, if any, or any feed cistern should be taken as directly as possible to the cistern and should be fixed to the internal walls. near a chimney flue if possible (but not so near as to cause undue heating of the water) and away from windows or ventilators.

8. Piping should be so located that it is no unduly exposed to accidental damage, and fixed in such positions as to facilitate cleaning and avoid accumulations of dirt.

9. All pipework should be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly it is usually possible to arrange it in or adjacent to cupboards recess, etc., provided there is sufficient space to work on the piping with the usual tools. Piping should not be buried in walls or solid floors. In suitable cases, piping may be burried for short distances provided that adequate protection is given against damage by frost or otherwise and that no joints are buried. If piping is laid in ducts or chases, these should be roomy enough to facilitate repairs and should be so constructed as to prevent the entry of vermin. To facilitate, removal, pipe casing floor boards covering piping should be fixed with screws or bolts.

10. When it is necessary for a pipe to pass through a wall or floor, a sleeve should be fixed in for reception of the pipe and to allow freedom or expansion and contraction and other movement. Piping laid in wood floors should, where possible be parallel with the joists.

11. Piping inside buildings should not be attached to external wall, of the building if this can be avoided ; where this cannot be avoided the piping should be attached by brakets which prevent contact between the piping and the wall, or wooden battens or other insulating materials should be interposed the piping and the walls. Piping should be insulated from the brackets unless they have low heat conductivity or are themselves insulated from the wall. Piping should be adequately supported ; lead and lead-alloy piping should be supported continuously or at frequent intervals.

12. In large buildings a sufficient number of stop-valves should be fixed on branch pipes, and to control groups of ball-valves and draw-off taps, so as to minimize interruption of the supply during repairs. All such stop-valves should be fixed in accessible position and may be of the gate type to minimize loss of head by friction.

13. In buildings where it is desirable to have some means of identifying the use of the various pipes, conducts, ducts and cables, the pipes, etc. should be painted with different.

CHAPTER 21

House Drainage and Connection for Sewers

General.

1. (*i*) *Manner of Running Pipes*—Horizontal drain and waste pipes shall be carried with a minimum fall of $\frac{1}{2}''$ per foot for pipes 4" diameter and smaller; pipes larger than 4" shall have a fall of at least $\frac{1}{4}''$ per foot.

Drain lines shall be laid true to grade and alignment.

Changes in direction shall be made with curved fittings or bends having a long sweep or with Y branches and $\frac{1}{8}$ bends. All junctions shall be made with Y branches.

All vertical soil, waste, and vent pipe stacks shall be arranged as directed and straight as possible. They shall stand free from the walls an even distance from the walls.

(*ii*) *Traps*—All traps shall be set perfectly true and level. No fixture shall have more than one trap. The trapped waste from fixture shall not connect with the inlet or house side of the trap of an adjoining fixture.

(*iii*) *Roof Joints*—Where plumber's pipes pass through the roof, water-tight roof joints shall be made round the pipes by means of heavy sheet-copper or sheet-lead flashings with funnels slipped over the pipes.

(*iv*) *Floor joints of water-closets and slops-inks*—Floor joints of stoneware of water closets having the trap above the floor and of slop sink trap standards shall be made with brass floor plates. The lead bends coonnecting the outlets of the fixture with the soil pipes shall be securely soldered to the brass floor plates, and the fixtures shall be firmly set on the plates and a plastic composition used to tighten the joints (no rubber washers for floor joints shall be permitted).

(*v*) *Floor and ceiling joints*—Wherever pipes pass through floors, ceilings walls, or partitions the pipes shall be enclosed in short sleeve pipes, where necessary, to prevent damage to plaster, etc. The holes and air channels shall be properly closed and the pipes provided with extra cushions.

(*N.B.*—In hospitals the floor shall be kept as free from encumbrances as possible. Plumbers, pipes shall not be taken through the floors when they can be taken through walls. Fixtures which leave the floors free shall be selected when suitable ones are available.)

Soil and vent pipe

2. The soil and vent pipe system shall be per chapter 22 of this volume.

3. (*i*) *House Drains*—House drains shall connect with the lateral sewers at a points not less than 8 feet outside the walls of the buildings. Where the drain passes through the wall, a relieving arch shall be built over it to prevent breakage in case of settlement. House drains' shall be of extra havy cast iron only.

Arrangement of drainge system.

The minimum inclination shall be $\frac{1}{4}''$ per foot; but pipes 4″ and smaller shall have a greater fall, where obtainable.

A sufficient number of brass clean-outs shall be provided at traps, bends, junctions, etc., to permit ready access for cleaning. These clean-outs shall be scaled with approved sealing composition when screwed up.

(*ii*) *Size of main house drain*—Shall be 4″ to 6″, according to the number of fixtures connected with it.

(*iii*) *House trap and fresh air inlet*—If the house drain is specified to be disconnected from the sewer, a suitable intercepting trap shall be provided at least of 8″ and as for as possible away from the building. Inlets and outlets shall be provided on one of the three methods as prescribed in the bye-laws of the London County Council, as may be specified in each case. The fresh air inlets shall not be less than 4 inches diameter and its effective area shall be at least equal to the combined sectional area of all the drains ventilated by it at the point. It shall be located at least 15 feet from any window unless specially permitted otherwise in each case.

If, however, the house drain is specified not to be disconnected from the sewer the intercepting trap and the fresh-air inlets specified above shall be omitted. In this case, there must be an inlet on the sewer within 300′ of that end of the house drain which is furthest from the sewer.

Soil and waste pipes shall always be extended the full size up to the roof and shall terminate at least 3′ above the caves. All such pipes smaller than 4″ shall be enlarged from a point below the roof by a suitable increaser.

All soil and waste pipes shall be carried vertically upward as straight as possible. Necessary offsets on the vent extensions shall be made at an angle of at least 45° to the horizontal.

Pipe extensions above the roof shall left fully open and protected with a copper wire dome. They shall not be capped with either cowls, return bends, or ventilating caps.

Soil and waste pipes shall have proper fittings or branches for the fixture connections.

Fittings, which shall not be used, are the short quarter bends, double tubs, the common offsets, fittings, bends and saddles.

Waste pipes shall be taken as directly as possible through an external wall of the building and shall discharge in the open air into a channel leading into a trapped gulley grating at least 18 inches away, unless one pipe system is adopted.

For the waste from kitchen sinks efficient flushing rim gullies shall be provided, unless one pipe system is adopted.

Gullies. 4. These shall have traps suitable to the situation and fixed as described below:—

Each gulley trap shall have one C. I. or R. C. 1. Grating 6″ × 6″ and one C. I. Cover and Frame 12″ × 12″. Gulleys shall be fixed on concrete foundation 1 feet square and not less than 6″ thick. After fixing and testing gulleys and branch drain, and after permission has been given to concrete round the pipe the gulley is to be completely built in concrete forming a square 1½′ wide and level with top edge of gulleys. A brick curb in cement mortar about 3″ high from the ground level is then to be built round top edge of gulley rendered in ½″ cement plaster, in such a manner that surface water may not be allowed to enter the gulley.

Surface drain. 5. These shall built in 1st class B.B. in cement mortar, cement plastered ½″ thick to the inside on the top, and to the sides carried down 3″ below the ground level on the outside or built in C.C. blocks (1:2:4) or in C.C. cast in situ.

The drains shall be provided with 4″ thick foundation in concrete 1:7:20. Or as ordered by Engineer-in-Charge. Keeping the top level, they shall be given a uniform slope from the starting point to the discharging point according to the available fall. The top of the drain shall always be kept 3″ above the ground level, so as not to admit storm water from the surrounding area into it.

Test. 6. House drains and each drain connection from W. C. pan or gulley shall also be put to water test and treated in this respect similar to the pipe work in the main drains as described in sub-head "Sewers".

House sewers. 7. (*i*) *Material and size*—House drains shall be 4″ dia. stoneware or concrete pipe or made of other materials as mentioned under sub-head "Sewers" but if they pass through pipe to B. S. S. No. 78, Class B or B. B. S. 1211/45, Class B or R. C. C. pipe. Cast-iron pipe shall be of the plain spigot and socket type jointed with tarred spun yarn packing in half the depth of the jointing space and the rest of the space filled in with molten lead and properly caulked and finished. After test, the pipe shall be encased in cement concrete (1:2:4) 6 inch thick alround.

Note—C. I. Specials shall also conform to B. S. S. No. 78, Class 'B' and shall be provided with strong brass nuts, bolts, and felt washers of approved design and shall be properly coated with Angus Smith Solution.

Inepection Chambers.

8. Inspection chambers shall be provided at all bends or changes of gradients and shall have C. I. manhole covers of light pattern and 1½' dia. (weight 42 lbs. out of precast R.C.C. as directed by the Engineer-in-Charge.

Oblique junction.

9. The branch sewer, may be connected to the main house sewer, through oblique junctions as directed by the Engineer-in-Charge.

The oblique junctions may also be adopted in connecting individual houses to the street sewer at the discretion of the Engineer-in-Charge.

Sewer connections.

10. House sewer shall connect to the main sewer either at a manhole or by means of oblique jonctions pipes, and if a drain is at right angles to the main sewer a stoneware or R. C. C. bend shall be inserted next to the junction. The house sewer shall be disconnected from the main sewer by means of a disconnecting trap. These fittings shall be arranged in accordance with an approved method or as shown in the detailed drawings, or as the Engineer-in-Charge may direct.

Disconnecting trap.

11. Disconnecting traps, shall comply with the following principles :—

(*a*) The trap shall be free of all angles, corners and places where filth can accumulate.

(*b*) A free way shall be made for the discharg to pass through the trap without undue friction, and the traps shall be so made as to form a water seal of at least three inches depth.

(c) The body section of the trap shall be smaller in area than its inlet section so as to hold as small a quantity of water as possible.

(d) The minimum sized trap shall be used consistent with the circumstances.

(e) The inlet side of all traps shall be open to the atmosphere.

Air vents.

12. The inlets of disconnecting traps shall be connected to the atmosphere by means of a fresh air inlet or by some alternative method shown in the detailed, drawings, or as ordered by Engineer-in-Charge.

The head of the main drain shall be ventilating by means of a soil pipe extension or by meams of a ventilating shaft.

CHAPTER 22

House Plumbing Installations

No. 22·1—Material

Cast iron pipes and fittings.

1. Cast iron pipes for soil waste and ventilating purposes shall be according to B.S. 416 and fittings shall be as per B.S. 1130.

The locally manufactured pipes shall comply with the requirements given below :—

(*i*) All cast iron pipes and fittings shall be truly cylinderical, of the clear internal diameter as specified, of a uniform thickness, smooth and with strong and deep sockets, free from flaws, air bubbles, crackes, sand-holes and other defects. They shall not be brittle but shall allow of ready cutting, chipping or drilling.

(*ii*) For underground use, the thickness and weight of cast iron pipes shall not be less than those shown in the following table :—

Internal diameter	Thickness of metal not less than	Weight per 6 ft. length (including socket and beaded spigot or flanges, the socket not less than 3/8" thick) not less than
		lbs.
3"	5/16"	110
4"	3/8"	160
5"	3/8"	190
6"	3/8"	230

(*iii*) Where used above ground the thickness and weight shall be—

Internal diameter	Thickness of metal not less than	Weight per 6 ft. length (including socket and beaded spigot or flanges, the socket not to be less than ¼" thick) not less than
		lbs.
3½"	3/16"	48
4"	3/16"	54
5"	¼"	69
6"	¼"	84

(*iv*) All cast iron pipes and fittings shall be treated with two coats of Angus Smiths composition or the Bower-Barft process or Macarlaine's glass enamel or other approved means of preventing oxidation before use.

Asbestos cement pipes

2. The asbestos cement soil waste and ventilating pipe and fitting shall comply with British standard specifications No. 582.

(Asbestos is found in abundance in Baluchistan and as far as possible locally manufactured pipes shall be used).

Wrought iron and steel pipes.

3. Wrought iron or steel pipes shall not be used for carrying the discharge from water closets, urinals or slop sinks.

All wrought iron and steel pipes shall be of the best quality with heavy shoulders and smooth interior water way screw jointed and either galvanized or otherwise suitably coated. The weight shall not be less than the following:—

1½″ pipe	..	2·68 lb. per foot.
2″ ,,	..	3·61 ,, ,, ,,
3″ ,,	..	7·54 ,, ,, ,,
4″ ,,	..	10·66 ,, ,, ,,
5″ ,,	..	14·50 ,, ,, ,,
6″ ,,	..	18·76 ,, ,, ,,

The threads of traps and fittings shall be tapped so as to give a uniform fall to the branches of one-fourth inch to the foot for pipes four inches or larger in size, and of one-half inch for smaller sizes.

In the wards and work-rooms of hospitals, all pipes of iron or steel shall either be porcelain or vitreous enamelled or shall be left rough and receive, after fitting, two coats of approved enamel paint.

Brass pipe.

4. All brass pipes shall be thoroughly annealed seamless drawn brass tubing of standard iron pipe gauge. Its weight shall average as follows:—

1½″ pipe	..	2·84 lb. per foot.
2″ ,,	..	3·82 ,, ,, ,,
3″ ,,	..	7·92 ,, ,, ,,
4″ ,,	..	11·29 ,, ,, ,,

Brass soldering fermules or flanged thembles.

5. All soldering ferrules shall be of heavy cast or drawn brass or else of brass pipe of iron pipe size.

Brass flanges and sockets.

6. For the connection of all stoneware water-closets with the soil pipe extra heavy brass flanged pipes or socketed pipes as necessary, shall be used.

Brass clean outs.

7. All clean-outs in the drainage system shall be closed with brass (not iron) screw caps. All brass screw caps shall be extra heavy and not less than ⅛″ thick, and shall have a flange of not less than 3/16″ in thickness. Each screw cap shall have a solid square or hexagonal nut not less than 1″ high, with a minimum diameter of 1½″. The body of the clean out ferrule shall at least equal in weight and thickness the caulking ferrule for the same size of pipe. The engaging parts of the screw cap shall not have less than six threads and shall be of iron pipe size and tapered.

Brass floor flanges.

8. Where specified extra heavy brass flanges shall be used.

Copper flashings.

9. Copper flashings and copper tubing for the inside connections of rain water down pipes and weight shall not be less than 11 Gauge.

Lead pipe.

10. Lead pipe shall only be used for short branch soil and waste or vent connections. All such lead pipe shall be the best quality drawn pipe and weight shall not be less than as given below—

1¼″ pipe	...	2½ lb.	per foot.
1½″ ,,	...	3 ,,	,, ,,
2″ ,,	...	5 ,,	,, ,,
3″ ,,	...	6 ,,	,, ,,
3½″ ,,	...	6.5 ,,	,, ,,
4″ ,,	...	7.4 ,,	,, ,,
5″ ,,	...	9.2 ,,	,, ,,
6″ ,,	...	11 ,,	,, ,,

Lead flashings.

11. Sheet lead for flashings shall be of at least 6 lb. weight per square foot.

Traps.

12. Lead traps shall be of the same weight and thickness as specified for lead pipes.

Brass traps shall be of heavy brass and made particularly smooth on the inside. They shall have all waste and vent connections screwed.

Stone wa:e traps shall be used for water closets, urinals and slop sinks.

Iron traps shall correspond in weight to the extra heavy cast iron pipes specified. The iron traps for house drains shall be provided with two clean-out openings closed with brass screw caps at least 2″ in diameter, Cast iron trap standards may be used for slop sinks if porcelain lined or enamelled on the inside. They shall be provided with a 2″ brass screw cap inside of trap.

Flushing pipes.

13. Flush pipes connecting the flushing cisterns with the water-closet, urinal and slop sink bowls shall be of G. 1. The size of flush pipes shall be as follows—

Height of cistern above pan	...	2′	4′	8′	12′
Diameter of flush pipe	...	$2\frac{1}{2}$″	2″	$1\frac{1}{2}$″	$1\frac{1}{4}$″
Diameter of flush valve	...	2″	$1\frac{1}{2}$″	$1\frac{1}{2}$″	$1\frac{1}{4}$″

For urinals, the diameter of the flush valve shall be $\frac{1}{4}$″smaller.

Pipe supports.

14. Supports for iron soil, waste and vent pipes shall be heavy galvanized, improved pipe hangers fastened to the walls with expansion bolts or hung from iron beams by means ef pipe clamps.

Brass pipes shall be supported in brass pipe hangers or pipe hold-fasts.

Pipe supports shall be secured to brick and stone walls or to marble-work, by expansion bolts, and to wood work by large screws.

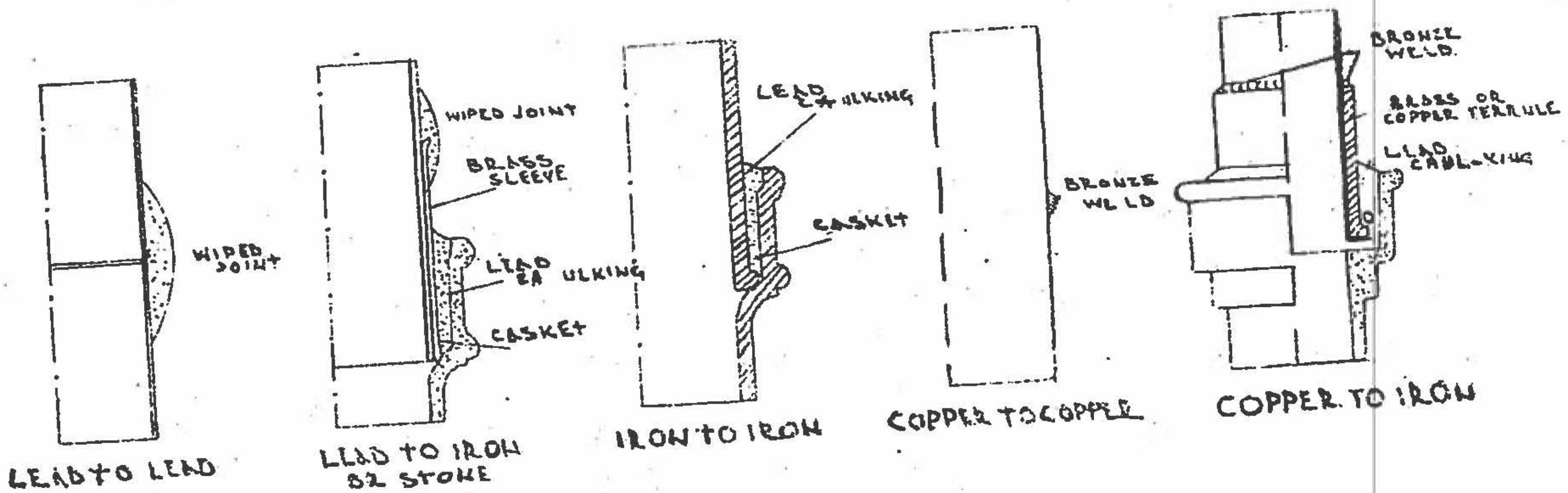
No ordinary soil-pipe hooks shall be used for fastening or supporting pipes. Vertical lead pipes where permitted shall be supported by metal tacks screwed to woodwork. Horizontal lead pipes shall be continuously supported on boards and not with hooks or nails.

Wood work.

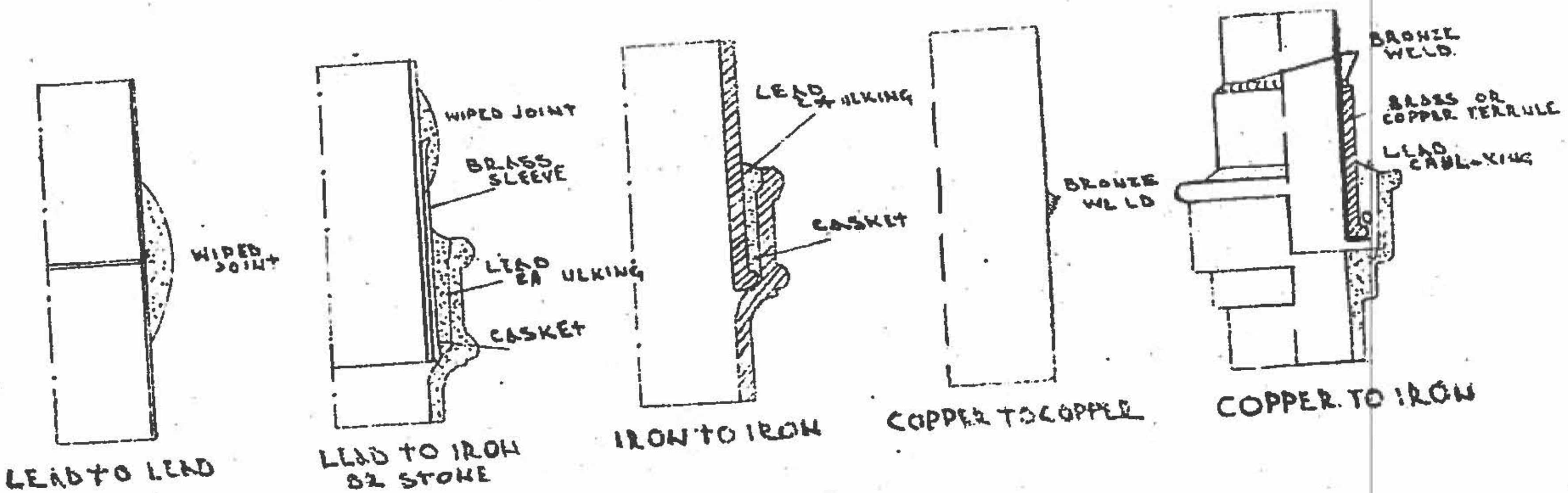
15. Exposed wood work in connection with plumbing work shall be of well seasoned kiln-dried close jointed, cabinet finished wood work.

Water-closet seats shall be strongly made and well-framed guaranteed not to warp or crak or open in the joints, and shall have a highly polished surface.

Note—Wood work must receive proper attention by keeping it well varnished or polished, so as not to expose the grain to water.



JOINTS IN SOIL PIPES



JOINTS IN SOIL PIPLS

16. ~~Marble shall not be used for floor drains, or in urinals~~ for patients or the public or in kitchen scullery or pantry sinks in any position in which it is liable to absorb urine or any foul waste. Marble, where specified, shall be first quality blue veined Italian marble free from stains or defects.

Marble.

All marble work shall be sharply moulded and shall be well fitted and perfectly set. All exposed surfaces and edges shall be well-polished.

No. 22·2—Jointing of soil and waste pipe

Asbestos cement pipe.

1. The joints should be made with a gasket of tarred yarn caulked to about 1 in. in depth and filled and pointed with a stiff mortar with one part by volume of portland cement and two parts of sand. These are usually jointed with spigot and socket joints in which the space between socket and spigot is first caulked with tarred yarn to a depth of 1 in. to 1½ in. (depending on the size of pipe) and then filled with molten lead. A form of fibrous lead is obtainable which shall be caulked into the socket instead of molten lead. Where cast iron pipes are to convey hot discharges, the joints should be caulked with yarn as above and filled with cement mortar made with equal parts of sand and portland cement, mixed to a stiff paste and well-temped.

Joints in cast from Pipe.

2. Joints in cast iron pipes and fittings shall be caulked joints made with a gasket of hemp, or oakum and molten lead. The amount of lead in each joint shall be not less than the following :—

WEIGHTS OF LEAD AND GASKET FOR PIPE JOINTS

Diameter of pipe	Lead	Gasket
Inches	lb.	lb.
2	2·[illegible]	0·125
3	3·5	0·1[illegible]0
4	4·5	0·170
6	6·5	0·200
8	9·5	0·200
10	13·0	0·250
12	15·0	0·250
14	18·0	0·375
16	22·0	0·500
18	26·0	0·500
20	33·0	0·[illegible]25

3. All joints shall be made perfectly air and water tight. Joints between iron and vitrified pipe shall be made with pure neat cement mortar.

Joint between iron and stoneware.

4, Joints of brass pipe and fittings shall be screw joints. The pipe shall be screwed up to the shoulder of the fitting and in all exposed or plated work no threads must show beyond. No slip joints or couplings in brass pipes excepting flush pipes shall be permitted. All threads on brass pipes shall be same as iron pipe threads.

Brass pipes

5. (*i*) Joints of lead pipes (whether for supply soil, waste or vent) shall be solder wiped joints.

Lead pipes.

(*ii*) Joints between lead and brass shall be wiped joints

(*iii*) Joints between lead pipe and wrought iron pipe fittings shall be made with heavy brass soldering ferrules, screwed to the iron pipe fittings.

(*iv*) Joints between lead pipe and cast iron pipes shall be made with heavy brass soldering ferrules or flanged thimbles. The ferrule or thimble will be passed over the end of the lead pipe and securely soldered thereto at its upper end while at the other end the lead is well-dressed orver it. It will then be inserted in the socket and caulked with lead in the usual manner.

Where it is required to join lead pipes to the spigot of iron pipes of fittings the joints shall be made with brass sockets. The sockets shall be caulked to the iron pipe and jointed to the lead pipe by solder wiped joint.

Where the cast iron pipe or fitting is flanged, heavy brass floor flanges shall be used and balted to the flange. The floor flange shall be jointed to the lead pipe by a solder wiped joint.

(*v*) Joints between lead pipes and stoneware traps and pipes shall be made one of the first two methods specified for jointing lead and cast iron except that the joint between brass and stoneware shall be made with neat cement.

The most usual joint for jointing straight lengths branch connections or lead pipe to brass fittings, is the wiped soldered joint, made with plumbers solder. An alternative method is the lead burned joint. This is made by fusing the lead together by means of an oxy-acetlyene flame, and building up the joint with a filling stick of lead. (This method is often used for pipes which will have to convey acid, such as waste pipes from chemical laboratories.

Pipe supports.

6. (*i*) Bracket School board—*A bracket made in halves, with a vee joint at the front and a screw behind the pipe to join the halves.*

(*ii*) Holder-bat—*A bracket made in halves, with bolts and nuts for joining the halves and with provision for building in or screwing to the structure.*

(*iii*) Pipe Ears—*Two wings cast integrally with a pipe socket and provided with holes to take fixing nails or screw.*

Drainage pipes shall be supported and held in place by the supports specified above.

All pipes shall be so supported that they are held 2" from the wall to permit of painting, inspection of the joints and cleaning.

Lead pipes shall not be fixed with iron hooks.

Where pipes ears are used they shall be blocked off at least 1" from the wall by short pieces of iron pipes.

Design considerations.

7. *General*—Atmospheric conditions are likely to cause corrosion, particularly in external pick-work and all pick-work should be arranged to give free access to the full surface, so that a protective coating shall be applied when required. This can be facilitated by avoiding re-entrant or internal angles of the structure and using projecting fixings. The clearance between the surface of the pipe and the surface of the structure should not be less than $1\frac{1}{4}$ in., except in the case of lead pipe, which shall be close to the structure.

Where pipes carry hot discharges, the fixing should allow for movement caused by expansion.

Where it is necessary to avoid sound transmission, fixings should be provided with a sound absording packing.

Where pipes pass through walls or floors, a layer of heavy hair felt, or pipe sleeves of cardboard, millboard, asbestos cement or other suitable material shall be provided and shall extend through the full thickness of the wall or floor and be secured against movement. Sleeves shall be fixed during the construction of the building in order to avoid unnecessary work, and to ensure a sound job.

Expansion.

8. The movement caused by temperature changes in pipe work (within the scope of this specification) required special consideration in the case ef lead pipes, which when of 2 in. internal

diameter or more, shall have expansion joints on straight runs or pipe at intervals of not more than 10 feet. Such expansion joints shall be of the spigot and socket type.

The socket shall be made with an expanding metal and be 4 in. to 5 in. deep. One pair of lead tacks shall be fitted to the socket end, which shall be kept clear of the base of the sockets by $\frac{3}{4}$ in. 1 in. to allow for expansion. The joints shall be made gas-tight by means of rubber or asbestos rings and subsequent sealing with a lead cap.

9. (*a*) For cast iron pipes (see B. S. 416)—

Type of fixing.

(*i*) Cast iron sockets with ears.

(*ii*) Cast iron, wrought iron, malleable iron or steel holder bats.

(*iii*) Similar holderbats with ears for nailing or screwing to the structure.

(*b*) For wrought iron or mild steel pipes (see B.S. 1994)—

(*i*) Malleable iron school board pattern brackets for building-in.

(*ii*) Similar brackets of fixing for with screw.

(*iii*) Malleable or wrought iron pipe rings, with either back plates, lugs or girder clips.

(*c*) For asbestos cement pipes (see B. S. 528)—

(*i*) Galvanized wrought iron brackets with cast iron brasses having ears for nailing or screwing to face of structure.

(*ii*) Galvanized wrought iron brackets with shanks or spikes for driving into brick-work.

(*iii*) Galvanized iron, wrought iron or steel holderbats for building-in.

(*d*) For copper pipes (see B. S. 1494)—

(*i*) Brass or gunmetal holderbats for building in.

(*ii*) Similar holderbats with cars for screwing to structure.

(*iii*) Copper saddle clips.

Note—Iron or steel supports are not recommended for copper pipes but if used they should always be insulated from the pipe by special lines.

(e) For lead pipes—

(i) Double or single cast lead tacks, soldered to the pipe. Either type may be fixed to the structure with galvanized nails, nails with lead dipped heads, or brass screw (see Fig.).

(ii) Milled lead tacks which are similar to cast tacks, and shall be of sheet lead weighing not less than 6 lb. per square feet for pipes up to 2 in. diameter or 8 lb. per square feet for pipes of bigger diameter. They shall be fixed similarly to cast tacks, but the nai's or screws shall pass through both the lead and solder (see Fig.).

(iii) Continuous support shall be provided for horizontal piping by means of light wood battens, to prevent sagging between fixings. Horizontal pipes up to 2 in diameter shall be fixed on pipe, rails hollowed out to receive the pipe (see Fig.) which should be fixed to the rail with milled lead tacks and screws, or other suitable means.

Spacing of Fixing.

10. The spacing of fixings shall not exceed those shown in table given below.

TABLE SHOWING MAXIMUM SPACING OF PIPE FIXINGS.

Material of Pipe	Diam of pipe	Max. spacing of pipe fixings — In vertical runs	In horizontal runs
*Cast iron ...	All sizes ...	10 ft. ...	5 ft
*Asbestos cement ...	All sizes ...	10 ft. ...	10 ft.
*Wrought iron, mild steel or copper- heavy gauge	1 in. ...	10 ft. ...	8 ft.
	1¼ in. ...	10 ft. ...	9 ft.
	1½—2 in. ...	12 ft. ...	10 ft.
	2½—3 in. ...	15 ft. ...	12 ft.
	4 in. ...	15 ft. ...	13 ft.
*Copper light gauge ...	1 in. ...	8 ft. ...	6 ft.
	1¼—1½ in. ...	10 ft. ...	8 ft.
	2 in. ...	10 ft. ...	9 ft.
	2½—4 in. ...	12 ft. ...	10 ft.
*Lead-fixed with single lead tack	All sizes ...	2 ft. ...	...
Lead fixed with double lead tack	All sizes ...	3 ft. 4 in ...	...

*One fixing must be provided for each fitting.

11. If fixings are not built into the wall, the joints shall be raked out sufficiently to enable hard-wood plugs to be driven firmly into them, which shall then be sawn off flush with the required face line. The ground pipe rail or pipe board on which the pipe work is to be fixed should be nailed or screwed to these plugs or fixing.

Plunging and grounds.

In fixing the pipes suitable bobbins or blocks should be used to keep the pipe work at the requisite distance from the wall.

12. All fixing shall be carefully aligned and spaced built-in fixings shall be secured with cement mortar.

Fixing.

13. Pipes embedded in floors and walls shall be so fixed as to allow for any movement due to expansion or contraction. If in an exposed external wall, the pipe should be securely bound with canvas backsd hair felt. This method is recommended for protecting all embeded pipe work where it is desired to provide a cushion for expansion and to reduce noise transmission.

Embedded pipes.

14. It shall be ensured—

Workmanship.

(*a*) that the pipe brackets, clips, etc., are socurely fixed;

(*b*) that the fixings are correctly spaced;

(*c*) that the pipe is protected where necessary by a non-conducting covering; and

(*d*) that embedded pipe work is properly protected before sealing in.

Internal pipe work—*The driving or spliting of plugs grounds may cause the fixing to become loose, and prompt attention should be given to repairing and refixing.*

External pipe work—*The fixings of external pipes may become loose if the joints in the wall are allowed to deteriorate, and careful maintenance of the pointing around wall fixing is important.*

Painting—*Fixings made of iron and steel (particularly the latter) require the protection af paint against corrosion Non-ferrous metals containing copper should be similarly protected to prevent materials being stained.*

No. 22·3.—Trapping and Ventilation

Definitions

1. (*i*) Trap—*A fitting or part of an appliance or pipe, arranged to contain water and prevent the passage of air. An integral trap is one formed in an appliance during the manufacture.*

An attached trap is a separate fitting which is connected to the waste outlet of the apaliance.

(*ii*) Water seal—*The depth of water which must be removed from a fully charged trap before air can pass.*

Crown (of trap) The topmost point of the inside of a trap out let.

(*iii*) Ventilating Pipes (including antisy phonage pipe)—*A pipe for admitting air to a drainage system or serving to relieve air in the system. The term antisyphonage is derived from one of the functions of a ventilating pipe namely to prevent loss of water from trap caused by fluctuations in air pressure.*

A drainage ventilating pipe *is one which connects a drainage system to open air.*

Note—*A main soil stock may perform the triple function of collecting and conveying discharges, action of a drain ventilating pipe, and acting as a main trap ventilating pipe.*

A main trap-ventilating pipe (antisyphonage pipe) *is one which receive a number of branch trap—ventilating pipes. A branch trap ventilating pipe (antisyphonage pipe) is one which has one end connected to the system adjacent to the trap of an appliance and the other to a main trap ventilating pipe of a drain ventilating pipe.*

Purpose of trapping and ventilation pipes.

2. (*a*) Purpose of Trapping—*The entry to the building of foul air must be prevented. This is accomplished so far as entry through pipes is concerned by installing suitable, and suitably sited traps.*

(*b*) *Purpose and advantages of Ventilating pipes—The main purpose of a drain ventilating pipe is to ventilate a drain in order to prevent undue concentration of foul air. The main purpose of a trap ventilating pipe is to avoid loss of water in trap seals caused by syphoning and to prevent admission of foul air to the building caused by back pressure.*

Incidental advantages derived from ventilating pipes are—

(*i*) *The air in all branch pipes is constantly renewed.*

(*ii*) *Deposition of solids on the internal surface of the pipes may be reduced as the drying resulting from* *the renewal of air causes a shrinkage of deposits and consequent flaking.*

A drain ventilating pipe should always be incorporated in a drainage system. Trap ventilating pipes may be omitted in certain causes.

Traps selection and depth of seal.

3. (*a*) General considerations—*Traps should always be of a self-cleansing pattern. A trap which is not an integral part of an appliance should be directly attached to it, and the pipe bore should be uniform throughout and of smoothing surface.*

It is preferable that traps for use in domestic waste installations and all traps elsewhere which are convenient of access, should be fitted with cleaning eyes. The fitting of a cleaning eye and plug should not cause obstruction of the water way.

(*b*) *Selection of traps for various purposes—*

Integral traps are dealt with in Chapter on Sanitary installation. The following factors should receive consideration. In relation to attached traps.

(*i*) *Minimum internal diameters are—*

Drinking fountains	1 *in.*
Lavatory basins	$1\frac{1}{4}$ *in.*
Bidets	$1\frac{1}{4}$ *in.*
Bar wells	$1\frac{1}{4}$ *in.*
Domestic sinks and baths	$1\frac{1}{2}$ *in.*
Shower bath trays	$1\frac{1}{2}$ *in.*
Hotel and canteen sinks	2 *in.*
Urinals (with not more than 4 feet of channel drainage)	2 *in.*

(*ii*) Depth of seal—*Water seals should conform to the following :—*

(*i*) In the two pipe system—*If the internal diameter of the trap is $2\frac{1}{2}$ in. or more it should have a 2 in. water seal. If the trap has an internal diameter of less than $2\frac{1}{2}$ in. it should have a $1\frac{1}{2}$ in. water seal.*

(*ii*) In the one pipe system—*If the internal diameter of the trap is 3 in. or more it should have a 2 in. water seal. If the trap has an internal diameter of less than 3 in. it should have a 3 in. water seal.*

4. (*a*) General consideration—*To be effective, a ventilating system must be such as to ensure a free circulation of air through the pipes forming the drainage system. The drain ventilating pipe and the main trap-ventilating pipe (anti-syphonage pipe) should be so arranged and of such bore as to meet this requirement under all working conditions.*

Ventilating pipes, general consideration diameter, layout, etc.

(*b*) Internal Diameter—(*i*) *The drain ventilating pipe should be of not less than 3 in. diameter. When, however, it is used as a soil stock, the upper portion which does not carry discharges should be of not less diameter than the remainder.*

(*ii*) *Subject to a minimum of 2 in. the diameter of the main trap-ventilating pipe should be determined by the number of traps ventilated, and its total length.*

(*iii*) *A branch trap-ventilating pipe on a waste pipe in thetwo pipe system should be not less than two-thirds the diameter of the branch waste ventilates, subject to a minimum of 1 in. diameter.*

(*iv*) *A branch trap-ventilating pipe on a soil pipe in the two pipe system should be not less than 2 in. diameter.*

(*v*) *A branch trap-ventilating pipe on a waste pipe in the one pipe system should be of not less than two-thirds the diameter of the branch waste ventilated, subject to a minimum of 1 in. diameter.*

(*vi*) *A branch trap-ventilating pipe on a soil pipe in the one pipe system should be of not less diameter than 2 inches.*

(*c*) Layout and position of connecting—(*i*) General—*Trap-ventilation pipes should be so laid that water cannot be retained in them.*

(*ii*) Main trap-ventilating pipes—*The upper end of the main trap-ventilating pipe should be continued to open air above roof level as a separate pipe, or it may be connected to the main soil and/or waste pipe at a point above the flood lavel of the highest appliance connected to the system. The bottom end of the main trap-ventilating pipe should be carried down to join the horizontal drain, at a point where air relief can always be maintained. Alternatively it may be connected to the vertical main soil and/or waste pipe at a point below the lowest soil or waste connection thereto aud where air relief can always be maintained To maintain a cleansing and flushing action at the bottom end of the main trap-ventilating pipe under the alternative scheme discussed above, a bath or lavatory basin should be connected to it just above the level of its connection to the main soil and/or waste pipe.*

(*iii*) Branch trap-ventilating pipes—*Branch trap-ventilating pipes must connect to the main ventilating pipe above the level of the free edge of the appliance and should be connected to the top of the branch waste pipe between 3 in. aud 18 in. from the crown of the trap measured along the pipe. The lower limit is to prevent the deposit of solids in the mouth of the branch trap-ventilating pipe. The upper limit is to allow for wall thickness.*

(*d*) Permissible cmission of trap-ventilating pipes—*Having regard to the variable conditions which may be encountered, it is impracticable to define precise general rules for such permissible exceptions, but the following notes are given for guidance.*

Subject to compliance with the requirements as given above separate branch trap-ventilating pipes may be ommitted—

(*i*) *Where the main soil pipe and/or waste pipe acts as a trap-ventilating pipe for the highest connection.*

(*ii*) *Where a waste appliance discharges through a short separate waste pipe to an open gully or to a hopper head or to a waste stack of larger diameter.*

(*iii*) *Where a soil appliance discharge by a shor separate branch drain pipe to a manhole.*

(*e*) Access—*Facilities should be provided for the removal of obstructions (such as rust) wherever they may collect, e.g., at the base of a main trap-ventilating pipe.*

(*f*) Termination of high vent pipes—*A high vent pipe should in all cases be taken to a point up the level of the eaves or flat roof and not less than 3 feet above the head of a window within a horizontal distance of 10 feet, from the vent pipe.*

The open end of every ventilating pipe should be protected by means of a wire balloon or loud.

Inspection and testing

5. *Testing for stability of trap seals in soil and/or wast system :—*

(*a*) *A soil and/or waste pipe system should, under test withstand any condition of discharge of its appliances which can occur in practice, without any trap losing more than 1 in. of its seal and without waste from one appliance being forced up into another. The tests should be designed to make full allowance of the maximum suction and pressure effects which may occur.*

(*i*) *In large installation when sufficient appliance are discharged together.*

(ii) *In large installations when sufficient appliances are simultaneously discharged to stimulate. peak conditions.*

(b) *The following test is suggested for investigating the seals of water-closet pans...*

Six pieces of newspaper measuring about 8 in. × 6 in. to be laid flat, one by one over the water surface and the pan subjected to the normal flush, followed by a two gallon pail of water.

(c) *When testing the seals of traps fitted to abolutionary appliances, the latter should be filled to overflow level and allowed to discharge in the normal way.*

(d) *Tests similar to the above should also be carried out by discharging some appliances while others are empty, with plugs out.*

(e) *Each test should be carried out at least three times and the maximum loss of seal in any of the test should be taken as the significant result.*

No. 22·4.—Access

Definitions.

1. Access cover—*A cover or door which is fixed to a flat face, cast or seated on to the pipe or fitting The face may be square, rectangular or oval in shape. The cover should be of the same shape as the face and held down by gunmetal set-screw. see fig. 7.*

Cleaning Eye—*An access opening in a pipe arranged to facilitate the cleaning of obstructions and fitted with a threaded cap or plugs, see fig. 8.*

Joints.

2. All access points shall be provided with gas-tight and water-tight jointing rings.

Design consideration.

3. *General*—Sufficient access should be provided to enable all pipe-work to be cleared. Vertical pipe work is not so liable to obstruction, but suitably spaced access points should be arranged. Where there is a change of direction, means of access should be provided at the bend. Solid matter may build up, and provision should be made for clearance. Where there is a series of bends of which the contained angle lies (between 90 and 120, means of access need be provided only) at alternate bends.

The following clauses give the most likely points at which obstruction may occur and where access is most likely to be needed.

Water closets and urinals.

4. Water closets, bed-pan washers slop, sinks and other similar appliances are particularly prone to obstruction in or near the traps through misuse, and the provision of adequate access is of importance.

Urinal connections should be provided with access at the branch connection to a vertical pipe, and also at a point near the connection to the trap outlet. When the diameter of the pipe is greater than 2 in. access to the trap shall be omitted as obstruction can be cleared by the removal of the grated outlet, unless otherwise directed by the Engineer-in-Charge.

Waste pipes from ablutionary fitments.

5. Waste pipes of small bore, used for branch connection from ablutionary fitments and sinks, are liable to collect solid matter. Single branch pipes seldom become obstructed, so that, except in the case of sinks, additional access is needed only under exceptional circumstances, as when runs are long or where there are several bends. Where a sink waste pipe is directly connected to a main pipe, access should be provided at the connection of the trap to the waste pipe.

Vertical soil waste and vent piper.

6. When the vertical soil, or waste pipe is connected otherwise than directly into a manhole, an access point should be provided immediately above the surface of the ground to enable the drain to be rodded.

Caste iron ventilating pipes should be provided with means of access at the ground level for the removal of rust. Asbestos cement, lead or copper ventilating pipes need not be provided with such access if they are suitably protected with a guard at the outlet end.

Branch connections.

7. It is desirable that branch connections on vertical pipes should be provided with access covers at the junctions. Main branch connections serving subsidiary branches should have means of access at the point of connection to the main pipe, with additional access at the extreme end of the main branch.

Waste pipe branches, serving more that one fitment, should be provided with means of clearance at their extreme end.

8. Traps up to and including 2 in. diameter sha[ll]
shall be provided with cleaning eyes

Access.

9. (*a*) Rectangular access doors shall have an opening equal in width to the full diameter of the pipe and a length at least equal one and a half times the width. The internal face should be shaped to form a true completion of the bore of the pipe. To opening shall be made gas-tight and water-tight with good quality rubber washers, and the access doors firmly secured with gunmetal set screw.

(*b*) Oval access doors shall have an opening area of not less than the cross-sectional area of the pipe to which they are fitted. Their internal faces shall be shaped to form a true completion of the bore of the pipe. The openings should be made gas-tight and water tight with good quality rubber washers, and the access doors firmly secured with gunmetal set-screws.

Cleanining eyes.

10. The collar or socked forming a cleaning eye shall not project into the pipe bore. It is preferable that traps for use in domestic waste installations, and all traps elsewhere which are convenient should be fitted with cleaning eyes.

Prevention of foreign matter.

11. To prevent the entry of foreign matter during storage and transport, all open pipe ends connection openings and access openings should be temporarily plugged. All access doors and cleaning eyes shall, at the time of installation be finally fixed and sealed ready for testing. Cure should be taken that all access points are fixed in accessible positions.

Every care should be taken to protect the work and prevent the entry of foreign matter into any part of the system and openings shall, therefore, the kept sealed.

Inspection and testing.

12. (*a*) Access fittings shall be examined to see :—

(*i*) that the internal face truly completes the internal bore ;

(*ii*) that there is no obstruction in the pipe bore.

(*iii*) that the cover and caps or plugs are well-jointed.

(*b*) Inspection shall be carried out to ensure that the access points are accessible.

(*c*) When completed, the installation shall be tested the satisfaction of the local authority concerned.

(*d*) Little maintenance should be required other than periodical inspection to reveal whether any washers, beddings or packing require replacing or any caps or plugs easing.

Screw caps plugs require occasional easing to prevent seizure.

No. 22·5—Inspection and Testing of Installation

Cement.

1. Work shall be inspected during installation, and tests applied are complied on completion, care being taken that all work which is to be encased or concealed is tested before it is finally enclosed.

Pre-assembled units shall be tested at the work or place of fabrication, and carefully inspected for damage on delivery at the site.

Pipe system should be tested for gas-tightness and for hydraulic performance.

Tests.

2. (*a*) *Air Test*—The air test shall be applied by inserting expanding rubber testing plugs in the lower and upper ends of the soil and ventilating pipes and sealing the upper plugs with small quantities of water.

The testing plug at the upper end of the ventilating pipe shall be fitted with a tee-piece (preferably with a cock on each branch), one branch of which is connected by a flexible tube to one leg of a manometer previously charged with water.

Air pressure shall then be introduced into the system through the other branch of the tee-piece until the desired pressure is shown on the manometer scale. The pressure applied should be equal to 2½ inch. water gauge for a two-pipe system, or 4 inch. water guage for a one-pipe system, and shall remain constant for a period of three minutes to probe the soundness of the installation.

Alternatively, the air pressure shall be introduced into the system by passing the flexible tube of the manometer through the water seal of the trap of the sanitary appliance, the test being carried out as described above.

(*b*) *Smoke test*—The smoke test shall be applied at the foot of the pipe by pumping smoke into the system with the aid of a smoke machine. When the smoke emerages from the top of the ventilating pipe a plug should be inserted at this point and sealed with a small quantity of water. Any defect may then be observed. Alternatively, instead of using a smoke pumping machine a smoke rocket may be inserted at the foot of the pipe.

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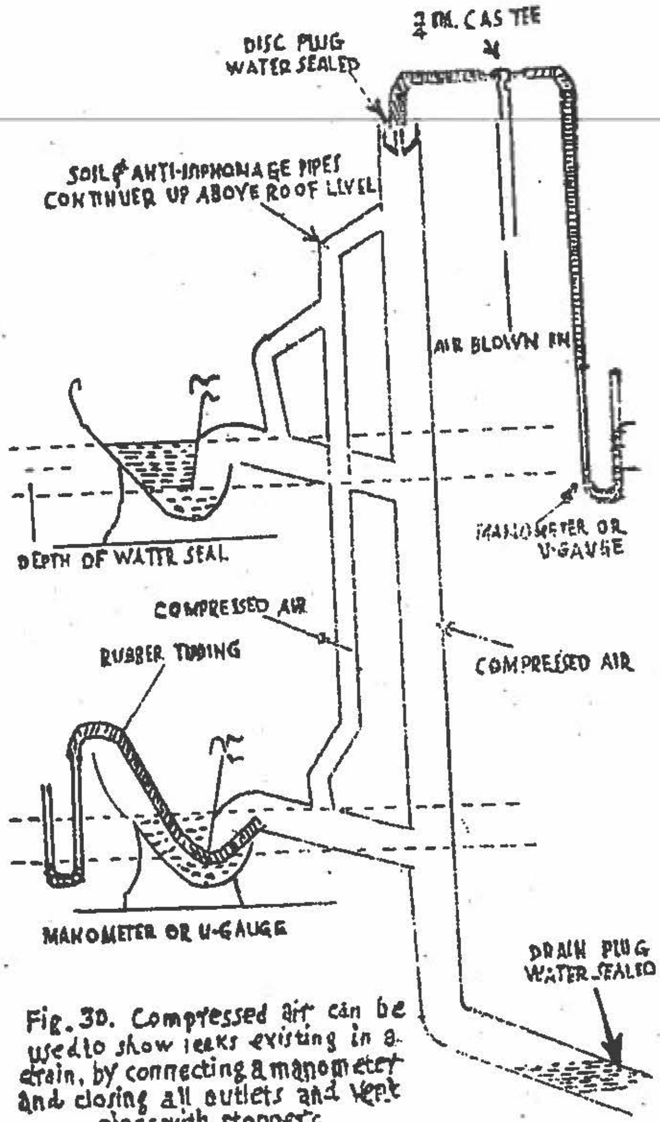

Fig. 30. Compressed air can be used to show leaks existing in a drain, by connecting a manometer and closing all outlets and vent pipes with stoppers.

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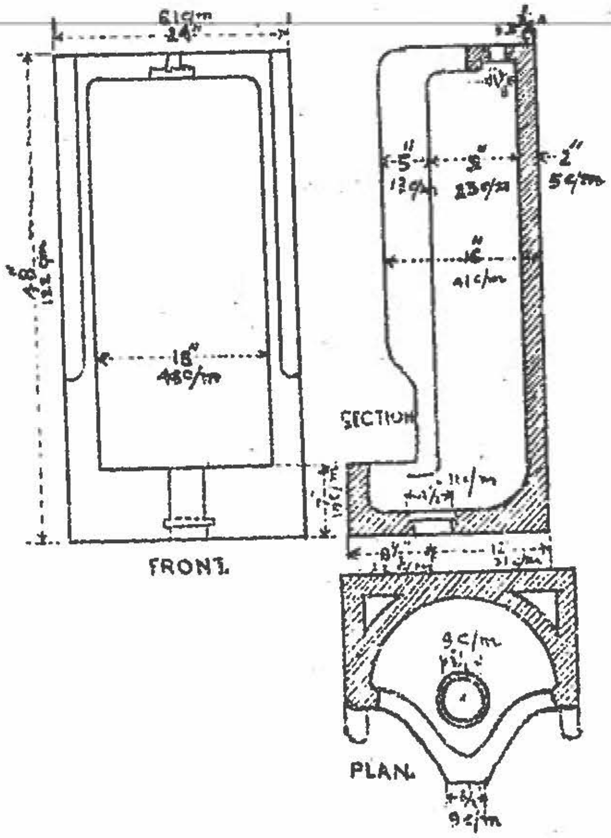

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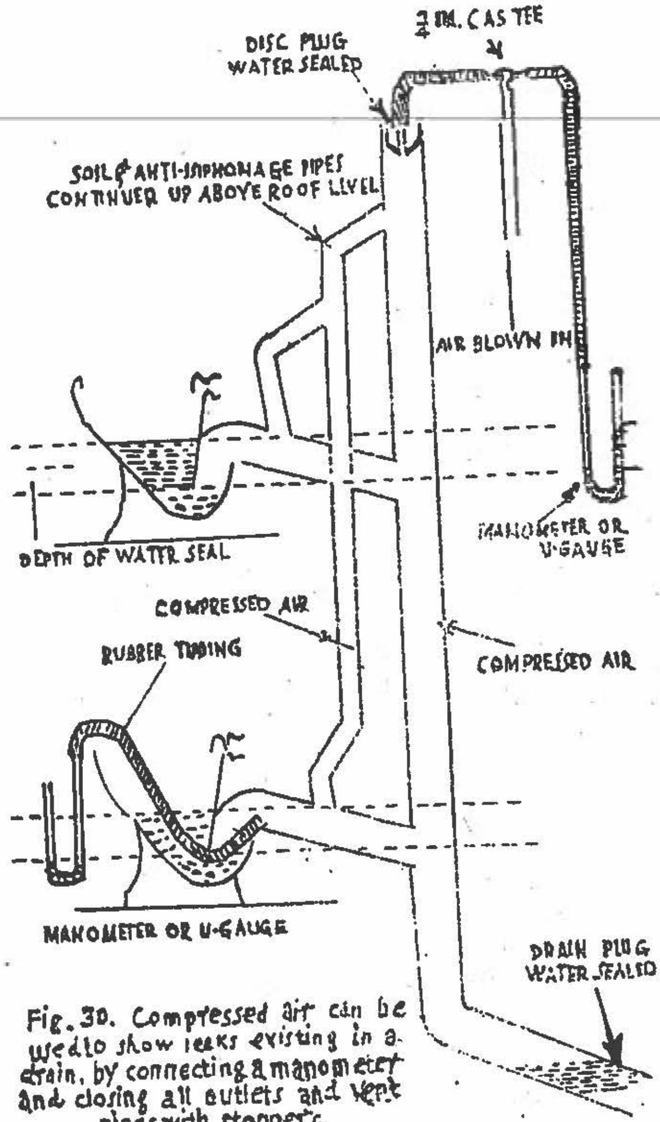

Fig. 30. Compressed air can be used to show leaks existing in a drain, by connecting a manometer and closing all outlets and vent pipes with stoppers.

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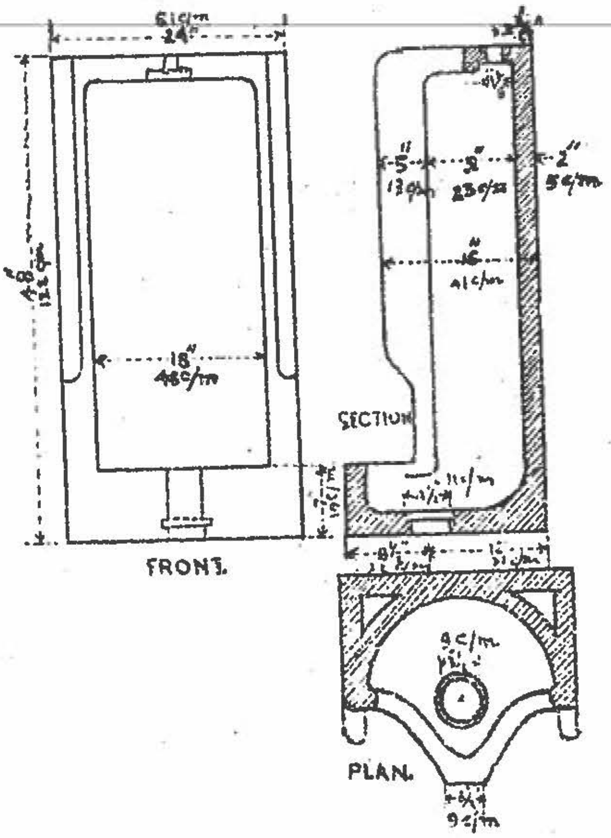

SINGLE URINAL

(*c*) *Water test*—A test may be applied by charging with water the pipe to be tested. It is necessary to seal all openings affected by the test and provide support to the plugs used as stoppers. The water test shall be applied before the appliances are connected and may be carried out in sections so as to limit the static head to 15 feet.

(*d*) *Hydraulic Performance*—Discharge test shall be made for all the appliances, singly and collectively. Obstruction in any of the pipe lines should be traced and the whole system examined for proper hydraulic performance, including the retention of an adequate water seal in each trap.

Any defects revealed by the tests should be made good, and the tests repeated until a satisfactory result is obtained.

No. 22·6.—Maintenance of Plumbing System.

Periodic Cleaning.

1. Periodic cleaning of waste pipes, overflow pipes, traps outlet gratings and integral overflows is desirable to maintain efficiency.

When access caps are removed care should be taken to renew any damaged packings and washers before replacement.

Painting.

2. Iron work should be repainted when necessary to protect it from corrosion.

Internal pipework External Painting.

3. Internal Pipework—*The drying or splitting of plugs and grounds may cause the fixings to become loose, and prompt attention should be given to repairing and refixing.*

External Pipework—*The fixings of external pipes may become loose if the joints in the wall are allowed to deteriorate, and careful maintenance of the pointing around wall fixings is important.*

Painting—*Fixings made of iron and steel (particularly the latter require the protection of paint against corrosion. Non ferrous metals containing copper should be similarly protected to prevent the materials being stained.*

Seals in Traps.

4. *The seats of waterclosets and other fittings shall be tested once every three months, as described in paragraph* 5 (b) *and* (c) *of Chapter* 22·3 *of this volume or as directed by the Engineer-in-Charge.*

CHAPTER. 23.

SANITARY FITTINGS MATERIAL

General

1. The sanitary fittings or parts thereof, shall be as far as possible, of Pakistani Manufacture wherever possible conforming to the specification described hereafter.

European type water closet, with high level cistern.

2. (a) The material of the W. C. shall be of fire clay, or stone ware, or earthenware of durable non-absorbent material, with porelain enamel, imperishable, leadless or any other durable glaze finish, without any decoration and shall present minimum fouling surface with a water pool of good depth with effective seal not less than 2" or a specified on the Engineer-in Charge. There shall be no sharp angles, but the surface shall be so rounded as to be easily cleaned. The closet shall be of syphonic action, syphonic jet, or improved wash down type, as directed by the Engineer-in-Charge. The closet shall not be enclosed. Ordinarily the closet shall be pedestal type.

In schools and public institutions, the pan shall have access eye just behind the seat.

(b) *Trap*—The trap shall be thoroughly self cleaning with a minimum water seal of 2" and made of the same materials as the pan.

(c) *Seat*—The seat shall be of hardwood, treated to prevent absorbtion, or of backlite of highly finished, hinged and fixed to the closet itself by substantial pillar hinges, protected against corrosion. The pillar bolts should have lead washers by nuts of self held securely type against the underside of the pan seat lugs. The seat should have rubber buffers securely fixed to the underside to prevent damage to the pan, and where a cover flap is provided, this should have rubber buffers.

(Damage to W. C. pans is frequently caused by the exposed screws or worn rubber buffers. This can be avoided by using a solid type of buffer).

Hardwood inseats are not recommended because the joint between the inset and the pan forms a grime trap and particular care is required to ensure that it is kept clean and free from contamination.

(d) *Flushing Cistern*—The cisterns shall be of 3 gallons capacity made of C. I. or porcelain waste preventing, efficiently covered, without aperture and prefectly mosquitio proof. The interior of the cistern shall securely protected against rust by paint of flawless vitreous enemal to prevent staining of the bowls. The outside shall be similarly painted. The cistern shall be perfectly plain with round corner without ornamentation, panalling or moulding.

The inlet to the pipe shall be controlled by ½" copper ball valve and ½" stop cook. There shall be ¾" mosquito-proof overflow pipe discharging in a visible position outside and an external wall without being connected to a soil or waste pipe. The cistern shall be silent filling.

The cistern shall be supported on M. S. or C. I. cantilever bracket, and painted with approved enemal paint with 4" support in the wall. The flushing cistern (bracket) shall ordinarily be placed at a height of 4' above floor or as per directions of the Engineer-in-Charge.

(e) *Chain Handle*—The flush shall be operated by pulling a chain handle preferably by a thin-rod with as few joint as possible.

(f) *Flush Pipe*—The flushpipe shall be 1¼" G.I., painted wish approved aluminium paint.

(g) *Soil Connection*—Ordinarily the closet shall have trap above the floor and the connection with the soil pipe through an external wall.

(h) *Size of Closet*—Ordinarily, the closet shall be 15" For school, nurseries, 24", 12" and 10" be adopted as per instruction of the Engineer-in-Charge.

This specification provides w. c. pans of the following materials and weights:—

Material		*Weight in lb.*
Caneware No. 1	...	24
Caneware No. 2	...	28
Earthenware	..	24
Fireclay	...	45
Heavy earthenware	...	32
Stoneware	..	45
Vitreous china	...	32

IMPORTANT DIMENSIONS

No.	*Important Dimensions.*	*"S" trap*	*"P" trap.*
1.	overall height ...	16 in.	16 in.
2.	distance from end of		
3.	trap to floor ...	$\frac{3}{4}$ in.	...
4.	overall length ...	$20\frac{1}{2}$ in min.	$20\frac{1}{2}$ in min.
5.		25 in max.	25 in max.
	angle of outlet ...	180°	104°
6.	floor fixing holes ...	Two $\frac{1}{4}$ in. diameter.	Two $\frac{1}{4}$ in diameter.

The great variation in overall length is because of the different materials specified. Earthenware W. Cs. are made $20\frac{1}{2}$ in. long whilst heavy fireclay are 25 in long.

3. (*a*) Water Closet (Pan).

European Water closet low down flushing Cistern.

The W. C. shall be of Syphonic type with large water area and deepseal, the cleaning being effected by syphonic action. It shall have a low-trap at the floor line so that the closet cannot be untrapped by the emptying water or slips in the pans.

The syphonic action by atmospheric pressure on the water area induced due to evacuation of the air in the trap through the flush pipe of the low down cistern. The basins may have one or two traps.

(*b*) Flushing Cistern (Lowdown).

Note—Syphonic Closets shall not be used for external W. C., for schools, factories and their Public buildings.

(*c*) In all other aspects the closets shall be as described in para. 2 above.

European water closet for Hospital Wards.

4. The water closets shall not be of the pedestal type but of brackets corbel type so that the floor below shall be left free for cleaning.

The supporting brackets shall be of procelain enamel or enemal cast iron, and shall have perfectly plain and rounded corners to facillatate cleaning.

The seat shall be of non-absorbant type, without the front portion and the bowl capable of being adjusted accordingly.

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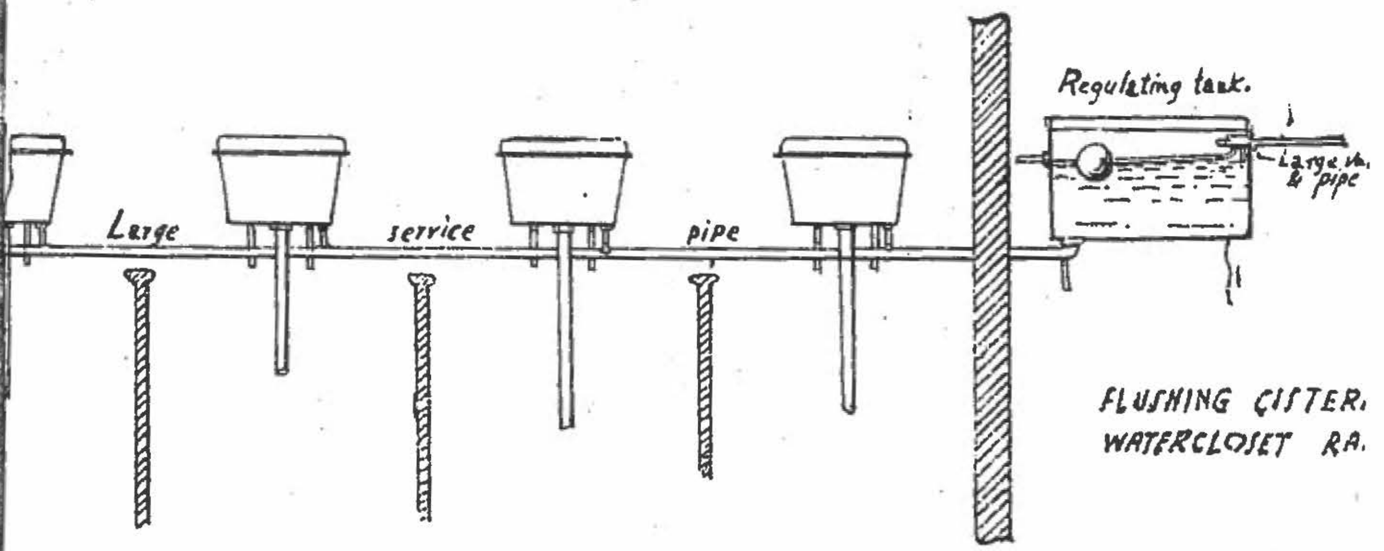

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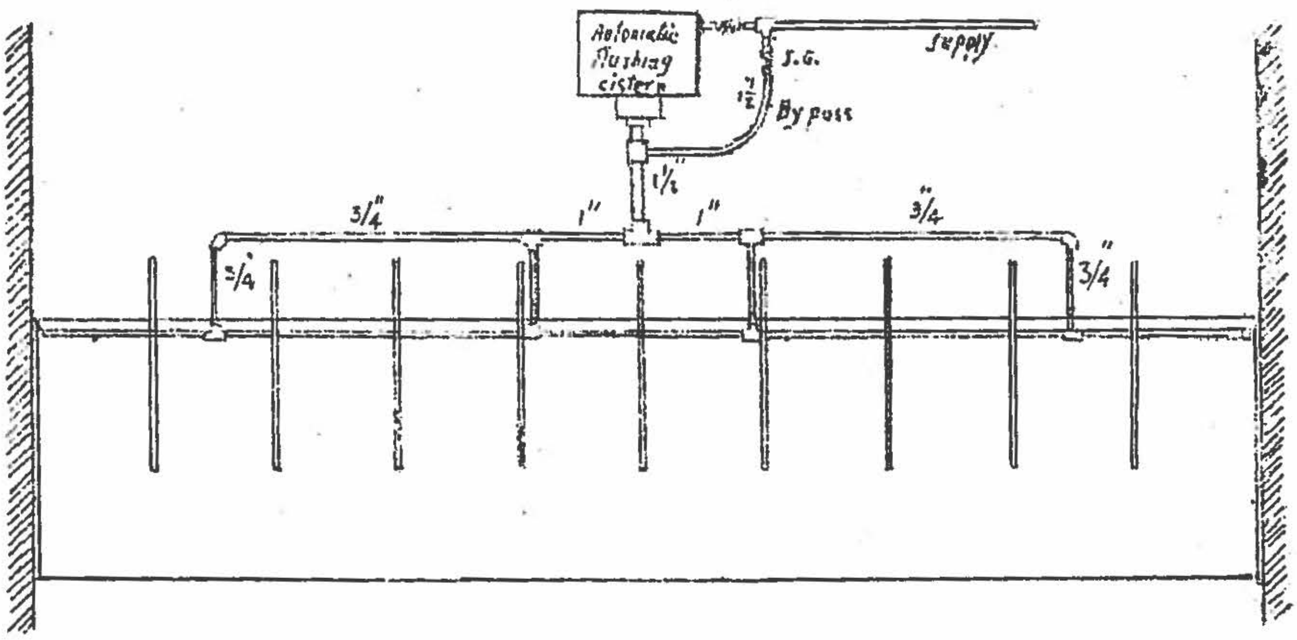
WATERCLOSET RA



AUTOMATIC FLUSHING OF
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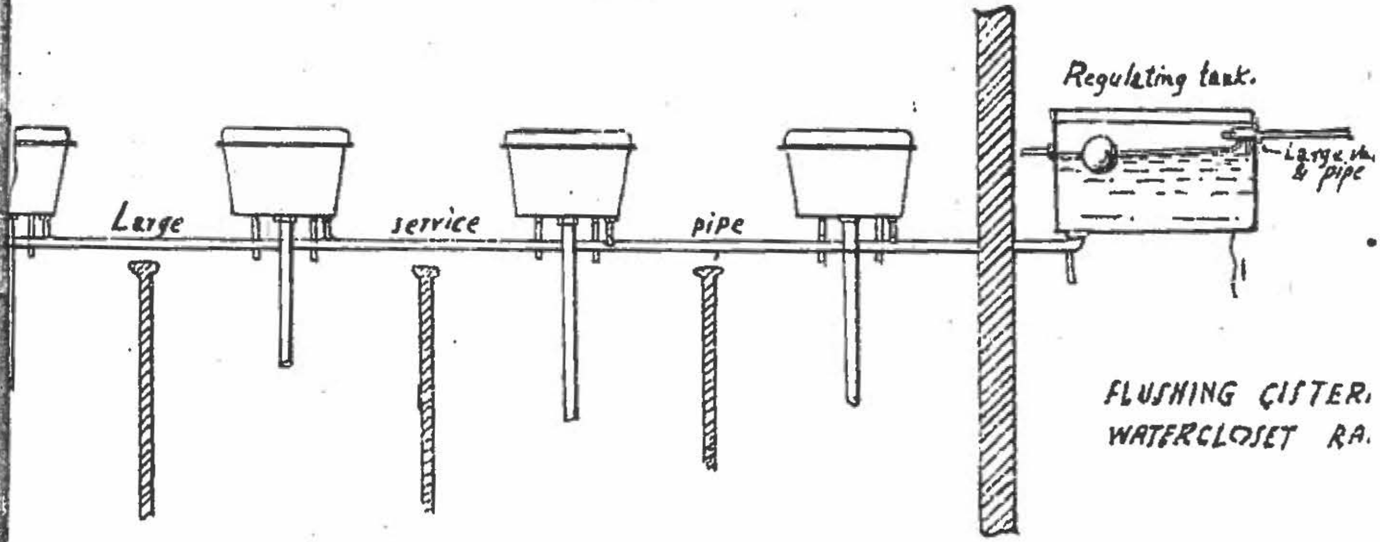

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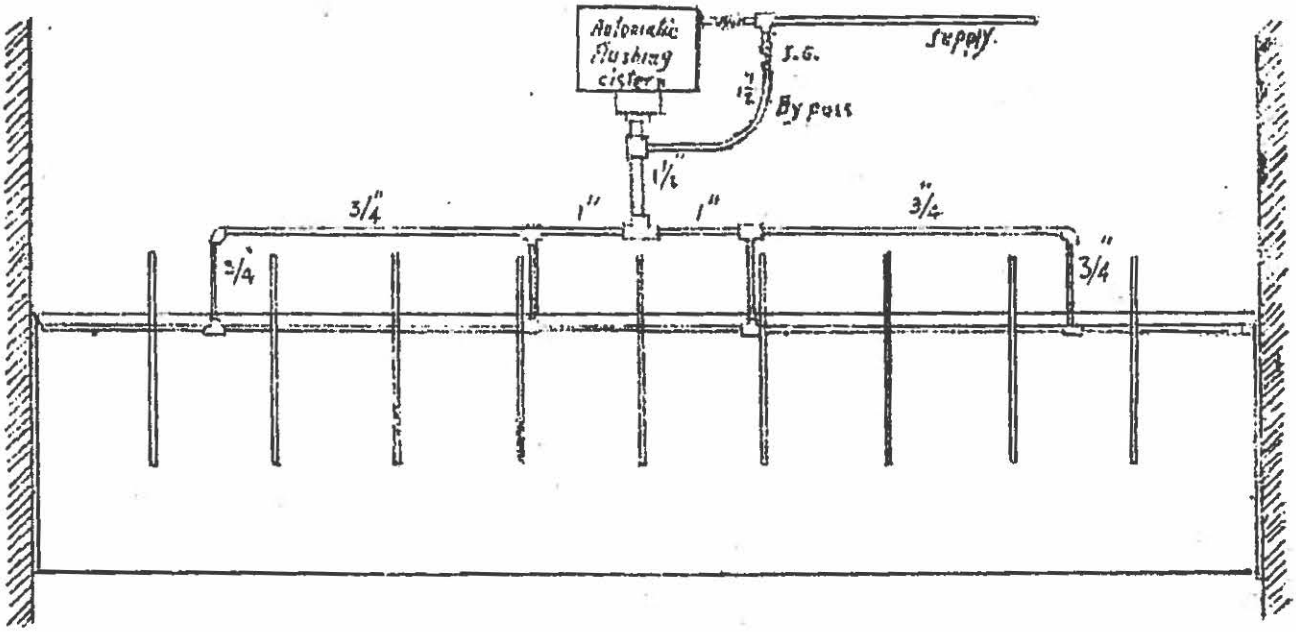


AUTOMATIC FLUSHING OF
URINAL RANGE.

In the case of mental patients wooden seat shall be omitted and the flush shall be operated by push button necessitating valve cistern or by automatic flushing cisterns.

In all other aspects the closets will be as per paragraphs 2 and 3 above.

Plugging water Class Squatling Type

5. (*a*) The pan shall be of fireclay, stoneware, earthenware, stainless steel, or any other non-absorbant material with 4" diameter C. I. trap and 2" bent arm.

The surface shall have a hard durable glazed finish with minimum of fouling area and a seal depth greater than 2". The outlet shall be placed well back and the pan shall be sufficiently long to prevent urine from splashing out and shall preferably be without shield.

The pan shall have integral flushing rims.

(*b*) *The Squatling plate*—shall be of a non-absorbant acid resisting material of the same finished and in one piece with the pan.

(*c*) *Foot Rest*—shall preferably form part of the plate.

(*d*) *Flushing cistern*—shall be of 3 Gallons Capacity of C. I. or any other approved material, painted inside and outside with approved enamel paint with ½" copper ball, a valve and an additional ½" stop cock, fixed on M. S. or C. I. or concrete Cantilever brackets.

(*e*) *Flushing arm*—The flush pipe shall be 1¼" C. I. pipe painted with approved aluminium paint on the exposed surface.

(*f*) *Fixation of Water Closets*—The W.C. shall be embedded in lieu or lean cement concrete, faced with ¾" cement plaster 1:2 rendered with neat cement.

The pan shall be sunk in the floor, sloping towards the pan from all sides. For upper storeys, a step-up platform shall be provided.

The pan outlet making joint with the trap shall be of the design without shoulder and collar so as to make a sound water tight joint with the trap.

Note—White glazed earthen ware foot treads of the required finish and design and 12" × "6 in size shall be provided to pans not manufactured with integral tread. If these are not available , foot tread (in fine cement concrete (1:2-4), with 3/4" stone ballast and ½" drain, semi-circular grooves cut in diagonally both ways and finished with 2½" cement plaster (1:2) with 1/8 inch cement floating coat on all surface shall be provided.

6. Ranges of closets shall consist of a continuous apparatus provided for a number of seats and having a common discharge pipe. They shall be of strong glazed stoneware with rim flushed hopper basins and cleaned by a combined flushing and syphonage action. The necessary flushing tank of the proper capacity shall be included with the apparatus. This type shall be used in factories, etc., where the closets are used by careless or neglectful people.

Range of closets.

In other cases wash down closets with water preventing flushing cistern may be fixed. But to avoid numerous ball-valves and overflow pipes, a common large supply pipe with a branch into the bottom of each flushing cistern is carried along underneath the cisterns connected with a regulating tank, with large supply pipe and ball-valve fixed; level with the flushing cistern. The supply pipe and ball-valve shall be large, in case two or more flushing cistern should be emptied simultaneously. When the closets are used in quick succession, as in schools this system has great advantages, and always be adopted unless otherwise directed by the Engineer-in-Charge.

7. (I) *Connection between trap and closet*—(*a*) If the trap is of stoneware, it shall be connected with the water closet with 1:2 cement mortar joint.

Connection of water closet with soil pipes.

(*b*) If the trap is of C. I. it shall be connected with gaskets and 1:2 cement mortar joint.

(*c*) If the trap is of lead, it shall be connected with a stoneware pipe by a brass socket piece, stone ware into brass being cemented and the brass into lead being soldered or jointed by any other approved means.

(II) *Connection between trap and soil pipe*—(*a*) If the trap is of stoneware and the soil pipe is of C. I. then it shall be connected through a lead pipe piece or C. I. piece, the joints between stone ware, and C. I. piece be as per 1 (*c*) and 1 (*b*) as above respectively.

(*b*) If the trap is of C. I. it shall be connected with C. I. soil pipe with ordinary lead metallic joint through a C. I. connecting piece.

It is not desirable to have a stoneware connecting piece going through the walls to avoid shrinkage of floor where either the joints become defectly or sockets of pipe become cracked. It is best to connect the trap by an integral C. I. pipe piece with the stack having a cleaning eye.

8. The slop sink shall consist of a strong rim-flushed basin with trapped outlet, and be provided with a flushing cistern. A hinged brass grid with supply valves over for filling pails will be found an additional advantage. Such a grid should be hinged through the sides and not the rear, so that it can be removed for cleaning when requird.

Slop sink.

Slop sink for hospital shall be of a special kind, as in addition to being the receptacle for slopes they must be suitable for the washing out of bed-pans, etc., and must also have special flushing pipe of orifices and special flushing cisterns. A supply tap from which water for dietetic uses is withdrawn shall never be fixed over a slop-sink. Any tap required should be placed over a draining sink to one side.

9. A bed-pan washer is an enclosed cabinet with a sealed door, for cleaning bed-pans. It shall be of stone ware or fireclay, or durable earthen ware with imperishable leadless glazed finish. It should be fitted with hot and cold water jets controlled by valves externally fitted; steam jets may be fitted when required. Ventilating connections are provided to maintain the cabinet at atmospheric pressure and for exhausting foul air.

Bed-pan sink

10. Bidets shall be of, white porcelain enamelled and with horizontal inlet to flushing rim, standing waste and overflow and as cending spray or jet.

Bidets.

The hot and cold supplies shall be controlled by a mixing valve, so that any desired temperature may be obtained from the jet. By passing heated water through the hollow rim it may be warmed—thus facilitating use without a wooden seat.

11. The best urinals are made of enamelled fireclay with curved back and sides, with a flushing rim or rose supplied from an automatic tank. They shall be made in as few pieces as practicable. The sides forming the divisions should stop short of the channel so that the latter may be cleaned from end to end. Ranges in which each stall is provided with its own outlet tend to complicate the drainage and increase the number of traps. In any case the outlet and grating should be of gun-metal, and the latter should be hinged or only screwed down.

Urinals. (General description).

Urinals ranges can be supplied with end screens, and the outlet may be at any convenient part of the range. Flushing cisterns for urinals are best made of similar material to the range, and the distributing pipes shall be of polished copper. When ordering urinal ranges, a sketch should be supplied giving net overall dimensions, to avoid fitting on site. Positions of outlets should also be shown, together with any returned ends or screens.

When single stall urinals are used they are best made as a complete unit, so that there are no joints exposed to corrosive action. Such urinals may be either 18 in. or 24 in. wides. Various other patterns of equal merit are obtainable, as well as those angular shape for fitting in corners. Twin basin placed along a wall (instead of complete ranges) are sometimes preferred, on the ground that by the use of such patterns space is saved in the apartment.

Single-basin urinals are of the flat back or angle description with rim flush to front as well as back. The outlet should be fitted with a loose grating to enable the outlet pipe to be cleaned.

The discharge from a urinal should be directly into a drain or soil pipe, or a connected direct to drain.

Urinals should be flushed by an automatic or hand pulled cistern, which contain one gallon per urinal stall or basin.

Specification for Indian type Urinals.

11. (*a*) These shall be squatting type with white glazed *tillin*, 4 high for front and side Walls. The channel, if separate, shall be of superior quality white glazed fireclay with circular projection for fitting in trap. The latter shall be $2\frac{1}{2}''$ to $3''$, depending on the number of seats. The inlet end of the trap shall be provided with C. P. brass discharge of removable type. The urinal slabs shall be of the design with back flush.

The flushing cistern shall be of cast iron, automatic type. The capacity of the cistern shall be according to the number of stalls to be flushed. A connection from the flush pipe shall be provided with spreader (one to each seat) to flush the front.

Floor trap.

11. (*b*) These shall be of self cleaning design, provided with 1″ puff pipe. The specifications for these shall be the same as for M. C. I. Soil, waste and vent pipes.

(*c*) These shall be of white glazed fireclay and of the following dimensions :—

European type stall urinals.

Height from treads to top of Division ... 1′—6″.

Width centre to centre of Divisions ... 2′—0″.

The urinal range shall be provided with automatic or hand pulled flushing cistern in white glazed fireclay, of the capacity according to the numbers of stalls to be flushed. The flush pipe and spreader shall be C. P. brass. The trap shall be proper C. I. urinal trap 2½″ to 3″ depending on the number of stall in the range and approved by the Engineer-in-Charge.

Sinks.

12. (*a*) General—Apart from the types of sink specially described in sub-clauses (*c*) to (*k*) below, there are three general types, namely the sink with integral drainer (or drainers the sink without drainers and the tub-and-sink set. The tub portion of this set shall conform to the specifications as given for tubs and the sink portion shall be as described in para. (*b*) below. Where the drainers are not integral with the sinks, they may be added.

The sink should be so fixed as the drain to the outlet.

The height from the floor to the top of the front edge of the sink with integral drainer should be 3 Ft. and where separate draines are used, the height should be reduced accordingly.

In food preparation rooms, canteens, hospitals and other institutions, sinks shall be fixed 3 in. clear of the walls to facilitate cleaning.

(*b*) *Domestic sink*—(waste appliances). A domestic sink should be of glazed ceramic ware of or earthenware with imperishable leadless glazed finish or stainless steel as specified. An integral draining board may be incorporated. The overflow shall be usually combined with the waste and be of the open weir type, and the plug for the waste outlet be secured by a chain.

Dimensions. B. S. 1206: 1945 covers Fireclay Sinks.

This specification covers for white glazed inside and out fireclay sinks only, in the following types and sizes:—

(I) Reversible sinks without shelves with overflow at end.

(*i*) 30 in. by 18 in. deep overall dimensions; weight 130 lb.

(*ii*) 24 in. by 18 in. by deep overall dimensions; weight 112 lb.

(II) Sinks with back shelves $4\frac{1}{2}$ in. wide with overflow in back centre.

(*i*) 30 in. by 21 in. 10 in. deep overall dimensions; weight 165 lb.

(*ii*) 24 in. by 21 in. by 10 in. deep overall dimensions; weight 1:7 lb.

It is stipulated that the bottoms of sinks shall fall to the outlet and that the thickness of the ware shall be $1\frac{1}{2}$ in.

(III) The domestic sinks may be of the following materials and of the type as directed by the Engineer-in-Charge.

(*i*) Porcelain enamelled cast-iron.

(*ii*) Porcelain enamelled pressed steel.

(*iii*) Stainless steel.

(*iv*) Monel Metal and specifies the following types :—

(*i*) Single sink, 24 in. long by 18 in. wide.

(*ii*) Single sink with back ledge, 24 in. by 21 in.

(*iii*) Combined sink and draining board 42 in. by 18 in.

(*vi*) As type C with back ledge, 42 in. by 21 in.

(*v*) Combined sink and draining board and work slab, 73 in. by 18 in.

(*vi*) As type E with back ledge, 73 in. by 21 in.

Tap holes in the back ledge shall be $1\frac{1}{8}$ in. square set at 45 degrees and spaced at 7 in. between centres.

The size of sink bowl in all cases shall be 21 in. by 15 in. by 8 in. internally.

The overflow from the ware sink shall be of the weir type and the waste fitting (which is normally $1\frac{1}{2}$ in. diameter shall be slotted to receive it basins, and water is held in the sink by a rubber or vulcanite plug fixed in the waste when required. The waste fitting flanges shall be $3\frac{3}{8}$ in. diameter, the tail $3\frac{1}{2}$ in. long, screwed $1\frac{1}{2}$ in. B. S parallel thread and the siding flange or backnut shall be $3\frac{1}{4}''$ in. dia. The overflow slot shall be 3 in. by $\frac{3}{4}$ in. Out-lets shall be trapped and connected to waste pipes, soil or gullies as described by the by-laws or as instructed by the Engineer-in-Charge. Where considerable washing up has to be done, sinks should discharge into grease traps. Waste holes shall be rebated or bevelled and are made to receive the waste fittings previously described.

On reversible sinks waste holes shall be formed centrally on the bottom and 6 in. from the overflow and end and on shelved sinks centrally with centre $7\frac{1}{2}$ in. from back.

(IV) Taps usually have $\frac{3}{4}$ in. diameter inlets, but $\frac{1}{2}$ in. is satisfactory for ordinary domestic purposes. They shall be according to B. S. 10 10 : 1944

(V) Draining boards shall be applied on one or both sides of sinks, as directed by the Engineer in-Charge and according to B. S. 1226 : 1945.

This specification is for draining boards may be of any of the following materials as directed by the Engineer-in-Charge.

(*i*) Asbestos cement 3/8 in. thick.

(*ii*) Cast iron porcelain enamelled-3/16 in. thick.

(*iii*) Fireclay 1 in. thick.

(*iv*) plastic 1/8 in. thick for moulded types ; 3/16 in. for laminated types.;

(*b*) Pressed sheet steel, porcelain enamelled, 18 B. W. G.

(*vi*) Stainless steel 20 S. W. G.

(*vii*) Wood (beech, elm, freijo, irokeo, hajarrah, mahogany, plane, sycamore, teak, yellow birch) $1\frac{1}{4}$ in. thick, nominal.

(*b*) Monel metal.

The standard lengths are 18, 21, 24, 25, 27, 30, 33, and 36 in. long from outer end of sink to end of board and widths are 18 in. and 21 in.

The board shall be tapered if necessary to ensure that water shall be discharged into the sink.

Teak draining boards shall be provided for domestic use, as they minimise breakage of crockery.

(*e*) *Bed-pan sinks*—(Soil Appliances) A bed-pan sinks a sink fitted with water jets for cleansing bed-pans and urine bottles and shall be provided with a flushing cistern.

It shall be if glazed fireclay or other durable, impervious, corrosion-resisting material and consists of one or two compartments, and in the latter case, one compartment shall have a flushing rim for cleaning, whilst the other be used as a scalding sink, the two compartments having a common outlet. A scrubbing slab shall be attached to form combined bed pan and macintosh sink. Jet controls shall be capable of operating by foot, knee or elbow.

(*d*) Cleaner's bucket sinks. (Waste Appliances). A cleaners bucket sink shall be made of ceramicware; or stoneware without imperishable leadless finish. If glazed shall have a high back to protect the adjacent wall finish from splashing.

Hot and cold water supplies should be provided, when directed, the taps being mounted either through holes in the high back or on the wall above the sink. The taps should be so arraged as to enable them to discharge simultaneously into a bucket, and to allow the latter to move freely without damage to the sink or to the taps. Where pressures are low, the taps should be of 3/4 in. size, so that bucket may be filled quickly.

The front edge of the sink should be protected by a teakwood pad and a removable non-corrodible grating resting across the sink, should be provided on which buckets may be rested.

A grated outlet and a trap with an accessible cleaning eye shall be provided.

The sink shall be fixed on the floor. Where this is impracticable, it shall be supported on brackets fixed to the wall as low as possible.

(*e*) *Crockery sinks*—(Waste appliances). A crockery sink may be constructed of teak, joined in a mixture of red and white lead. The sides are held together with long galvanized iron bolts, and the base should be screwed to the sides, with brass screws. Alternatively stainless steel or brass may be used.

(*f*) *Macintosh sinks*—(Soil Appliances). A macintosh sink is a combination of sink and slab for cleaning waterproof draw sheets for bed, and should be provided with a flushing cistern. It shall be made of glazed fireclay, or stoneware and shall be provided with a hand spray attached to flexible tubing.

(*g*) *Pantry sinks*—(Waste Appliances). A pantry sink is a small sink for washing silver and glass ware, and is constructed of such materials as will minimize damage. Aluminium shall not be used for pantry sinks, owing to the possibility of damage to silverware due to chemical action.

(*h*) *Slop sinks*—(Soil appliances). A slop sink shall be of glazed fireclay, and be fitted with a trap, a flushing rim and upstanding skirting. A hinged metal gritlle should be provided above the flushing rim, and a hardwood is set on the front edge of the rim. The sink shall be fitted with a flushing cistern for effective cleansing, and with taps to discharge hot and cold water over the sink. The taps shall be so arranged as to enable them to discharge simultaneously into a bucket and to allow the latter to be moved free without damage to the sink or to the taps.

(i) *Utensil sinks*—(for large kitchens). (Waste Appliances). A utensil sink is a large sink for the cleansing of cooking utensils. It shall be made of galvanized or hard waring and corrosion-resisting metal, with an outlet in the base, a useful size being about 36 in. × 24 in. × 18 in. Both supply and waste pipe connections should be rather large than those used on most other types of sink to enable quick changes of hot water to be made.

(j) *Vegetable sinks*—(Waste Appliances). A vegetable sink is a sink for washing vegetables by hand. It shall be made of a fireclay, stoneware or earthen wood of a size sufficient to deal with the amount of vegetable to be prepared and washed. It shall have a standing waste outlet for running water and shall be fitted with a perforated guard around the waste, or removable basket or cage, to reduce the amount of solid matter passing through the waste pipe.

Wash-tubs.

13.. These shall be provided in schools, institutions, country houses and laundry washtubs. These tubs shall usually be of size 21 in. × 19 in. × 13¼ in. and it is recommended to provide a good number to meet the requirements of various laundry operations.

Bath-tub.

14. (a) *General description*—These shall generally be made of cast iron (porcelain enamelled) and enamelled fireclay. A good bath shall be free from angles and corners, have an incorrodible surface, shall not absorb an undue amount of heat, and shall be durable and light. When the bath has to stand with one or two both ends against a wall, it shall have these edge let into the wall, and the exposed side and end, or ends enclosed by porcelain enamelled cast iron or polished marble panels, which shall form almost dust-tight joints with the walls and floor. (Such baths, with rims of special shape are now procurable, and may be commended for their hygienic qualities). The panels shall be constructed for easy removal for access to the wasts and service pipes.

A notable development in the design of porcelain enamelled cast iron baths is "one piece" fixture having the aprons down to the floor on which it is bedded in cement. It is made in three forms (1) *with aprons at front and one end to fit in an angle* (2) *with aprons at front and ends fitted between walls,* (3) *with aprons at front and both ends, to fit against a back wall. This pattern of bath being only* 18 *in. high, is of particular service for invalids and aged people. The fittings are of the standard independent type, with combined or independent overflow, as the tap trap has to be fixed below the floor level; a dspth of approximately* 6 *in. should be allowed for the purpose.*

Baths shall have a large outlet, 2 in. diamter at least, to enable the bath to empty quickly, and to provide a good flush for the drains.

Bath traps frequently form part of the outlet, and this arrangement is serviceable in that only a small area of the connections if exposed to fouling on the inlet side of the traps.

(*b*) *Shower Baths*–The primary consideration in the fixing of a shower baths is the provision of hot and cold water mixer which is gradual and positive in its regulations and by which the user cannot scald himself, provided both hot and cold supplies are constant. The supplies should be of sufficient size to prevent a lower "draw off" checking the flow into the mixer. (Improved makes of shower bath apparatus are obtainable with mixing valves as small as 3 in. diameter which will also supply direct to the bath itself).

When baths have non-removable panels such as a bath and panel cast in one piece an access floor shall be made either behind or under the bath.

Hand grip shall preferably be provided.

Special types of baths are available for use in mental institutions, hospitals, schools, and maternity centres etc.;

(*c*) *Bath fittings—*(*i*) *General—*Most baths are fitted with pillar valves, or a combined supply fittings, fixed through the roll, or with bib cocks discharging over the bath roll. In some cases, the combined supply fitting also incorporates a hand shower, which forms a very useful addition to the bath.

As fireclay baths have solid rolls a supply fitting which discharges over the roll must be fitted above.

(ii) *Types of overflow*—Where globe valves are fitted, the bath should always be provided with an overflow at a lower level than the valve outlets, so that the valves cannot be submerged in dirty water. Except where globe valves are fitted, an overflow is hardly necessary to a bath fixed in a private house but in schools, barracks and similar buildings, an overflow to each bath in necessary.

Another type of bath overflows is the combined standing waste and overflow, which should be removable so that it can be thoroughly cleaned. When this type of fitting is used, the end of the bath is often recessed so that the overflow is out of the way of the bather's feet.

All baths should be fitted with a waste having a $1\frac{1}{2}$ in. or 2 in. bore with a brass or enamelled cast iron trap fixed immediately beneath the waste outlet.

(*d*) *Ordinary baths*—(*i*) These shall be of cast iron, porcelain enemelled inside. The outside shall be painted as desired by the Engineer-in-Charge. The general size, unless otherwise ordered, shall be.

Lengths	...	6′ 0″.
Width	...	2′ 6″.
Height	...	1′ 11″.

The bath shall be provided with $1\frac{1}{2}''$ trap, overflow and anti syphonic arrangements and connected to the waste and antisyphonic stocks on the outside wall. Waste water may be allowed to discharge overflow trap, if so desired by the Engineer-in-Charge. The bath shall be fitted with 2 C P. Pillar cocks and C. P. Chain with a plug 2 control cocks $\frac{1}{2}''$ shall be provided with each bath.

This specification is for cast iron rectangular (magna) and tub pattern (perallel) baths to be adequatly and evenly coated internally with procelain enamel and painted externally with one priming coat of rapid drying paint.

The rectangular or manga pattern is suitable for enclosed baths whilst the tub pattern is for non enclosed baths.

(ii) Dimensions—*The principal dimensions according to B. S.* 1198 *are* :—

	(Magna)	Pattern rectangular	tub (parallel) pattern
	in.	in.	in.
Length overall ...	66	72	66
Width overall ...	28	28	29
Depth inside at waste ...	17½	17½	17
Height overall—exclusive feet and waste ...	18	18	17½
Height overall—with feet for 1½ in. seal trap ...	23	23	22½
high overall for 3 in. seal trap top holes (13/8) in. square) centred.	24½	24½	24
On roll—Hole distance apart	7-1/8	7-1/8	7-1/8
Waste hole-2¼ in.clear diameter distance from edge of roll at tap and to centre of waste hole)	11¼	11¼	10
Overflow centre-distance below top edge ...	4	4	3½
Capacity ...	26 galls	28 galls	27 galls

The fall along the bottom from head end to outlet should be adequate for complete emptying. –

The feet shall be suitable (a) *for baths with traps having* 1½ *in. seal and* (b) *for baths with traps having* 3 *in. seal.*

√ *(iii)* Roll—*The rolls at ends sides defined in the B. S., the rectangular bath having a roll demanding a cement fillet between the top edge and the wall and the tube bath a turned over roll designed to discharge splashings on to the floor. For this reason the roll should be kept clear of the wall.*

√ *(iv)* Outlets—*Bath outlets may be rebated or tapered to receive the outlet piece. The latter comprises a Chamfered flanges* 2-7/8 *in. diameter with tail,* 1-3/8 *in. long screwed at end B. S.* 1½ *in. parallel thread and having an integral grating and riding flange* 2-7/8 *in. diameter for tightening to the bottom of the bath.*

√ *(v) Overflows*—The overflows holes on rectangular baths are 4 in. from top of bath to centre and on tub baths 3½ in. from top to centre.

Holes on bath are 1¾ in. in diameter and are intended for 1¼ in. overflows although 1 in. diam. is frequently used.

A grating is fixed in the overflow hole and to it is attached a brass bend $2\frac{1}{4}$ in. long from centre to tail. The tail is screwed $1\frac{1}{4}$ in. out so that connection may be to iron, copper or lead pipes.

When overflows discharge directly through walls they should have light copper flaps at the outlet end to prevent draughts. Care should be taken in painting exposed overflows in order that the flap do not become jammed.

(*vi*) *Water Taps*—Water taps for baths are usually 3/4 in. diam. and the tap holes on baths are made to receive 3/4 in. pillar valves.

Pillar and globe valves are suitably for baths and are defined in B. S. 1010.

Pillar tap—"A draw off tap with a vertical inlet and a horizontal free water outlet".

Globe tap—"A draw off tap with a horizontal inlet and a vertical free water outlet".

(*d*) *Bath for hospitals*—Baths for patients shall be solid porcelain ware, or of best quality enamelled iron with roll rim, and shall not be fixed to the floor. They shall be so set as to stand everywhere entirely free from the walls at such a distance from the walls at the foot or sides as to enable the attendant to pass round them. Each bath shall be supplied with hot and cold water taps with detachable handles or keys accessible only to the attendants. A combination nozzle suitable for attaching a rubber hose and hand spray or better one of the anti-scald pattern valves should be supplied.

Showers.

15. (*a*) *Delivery apparatus*—(1) A shower head shall consist of a corrosion resisting cast or fabricated sheet metal rose having perforations, or of some other device to break up the water into a fine spray, such a device shall be adjustable so as to give varying degrees of spray.

(*ii*) Perforated tubes shall be used instead of shower heads or in combination with them, when directed by the Engineer-in-Charge.

(*iii*) A shower may be over or at shoulder height or, in the case of a foot bath, at knee level. Showers may be arranged singly or in groups to spray water from more than one direction.

(*b*) *Methods of control*—(*i*) Individual control for domestic use.

(*i*) As shower may be arranged for cold water supply only, each shower head being controlled with a screw-down stop valve, or a non-concussive spring valve. The latter shall be capable of being operated by hand or by foot.

(*ii*) A shower may be arranged for hot and cold water supplies blended manually by means of a mixing valve, a thermostatic mixing valve, a thermostatic blender or a breeching fitting.

Note—Unless precautions have been taken to ensure equal pressures of both hot and cold water at the valve (when in use), back-flow may occur in one direction or another with consequent risk of scalding or unsatisfactory blending.

(*ii*) *Combined control by attendant and user for schools institutions, etc.*—(*i*) A shower shall be supplied with hot and cold water already blended by an attendant. The user then controls the volume of blended water.

(This method saves piping and fittings, but does not permit the user to control the temperature).

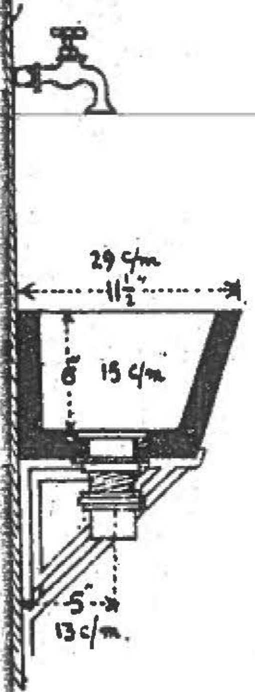
(*ii*) As an alternative, the attendant may control the maximum temperature of the water and the user may then reduce the temperature to his liking by adding cold water. This method is not economical of piping and fittings but permits the user to control the temperature.

(*iii*) *Control by attendant for schools, institutions, etc.*—Shower heads or perforated tubes may be arranged along a corridor, and the temperatures and flow of the water control by an attendant. This enables graduation of the temperature to be made throughout the corridor so that the user may pass successively through increasing and decreasing temperatures.

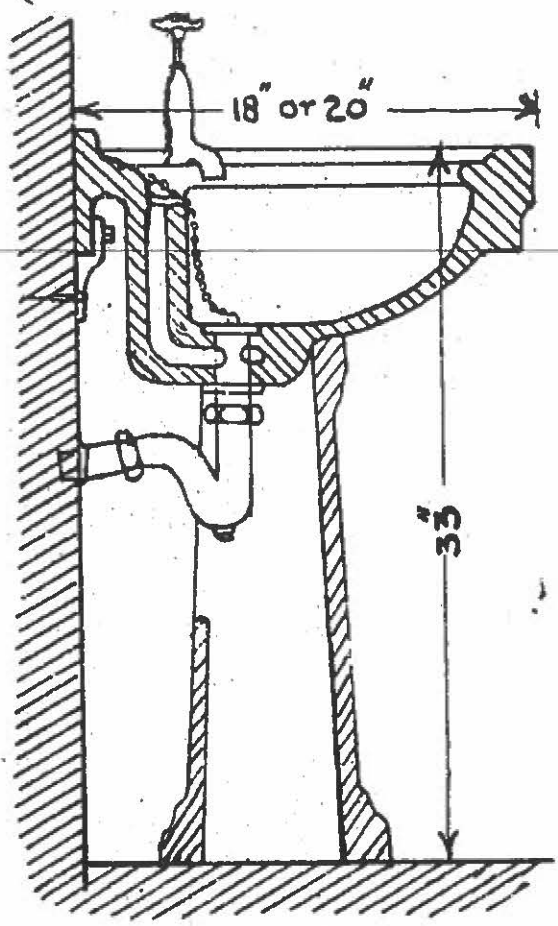
Lavatory Basins (Wash hand Basins.)

16. (*a*) Lavatories shall be provided with overflows that are readily accessible, whilst the waste outlets shall be large enough to effect a rapid discharge. The most common fault of lavatories is that in many cases no provision is made for cleansing their overflows, which shall always be avoided.

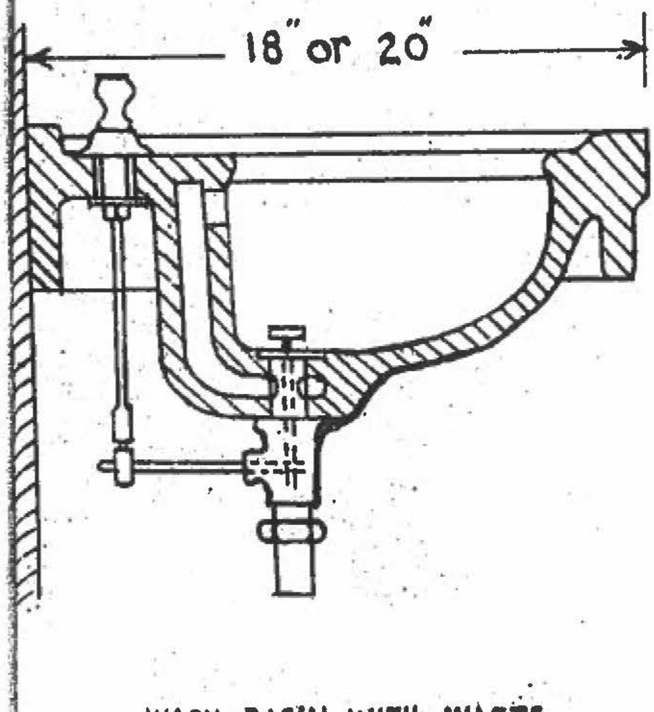
For schools, lavatory ranges shall be constructed with continuous waste in the form of a channel let into the floor, and trapped. An alternative arrangement is the provision of a horizontal waste pipe connecting the traps of the entire range. The spray principle of continuous troughs in glazed fireclay erected against walls or in islands providing double ranges (similar to that shown in Fig. attached) shall be applied in factories.



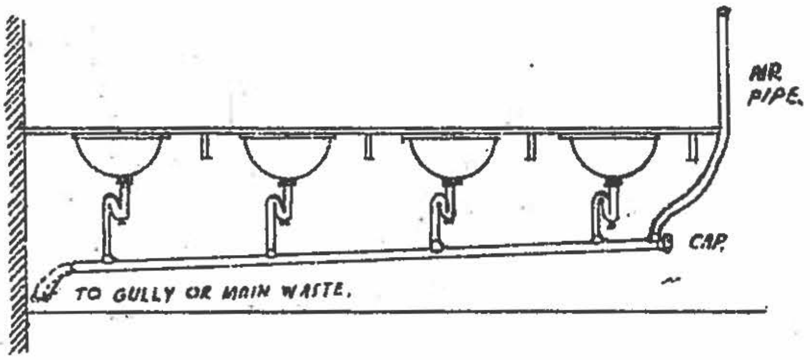
TINOUS TROUGH
H BASIN



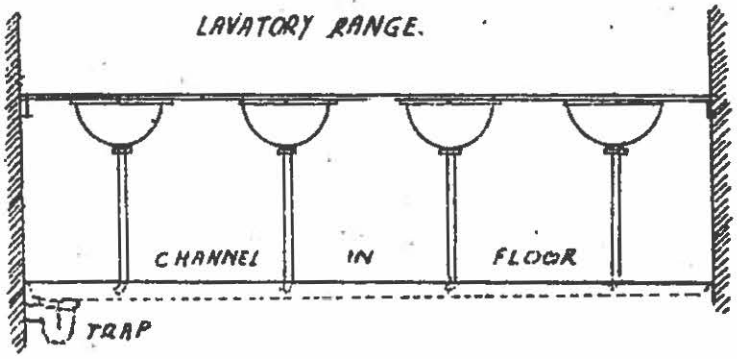
PEDESTEL WASH BASIN WITH
SECRET OVERFLOW.

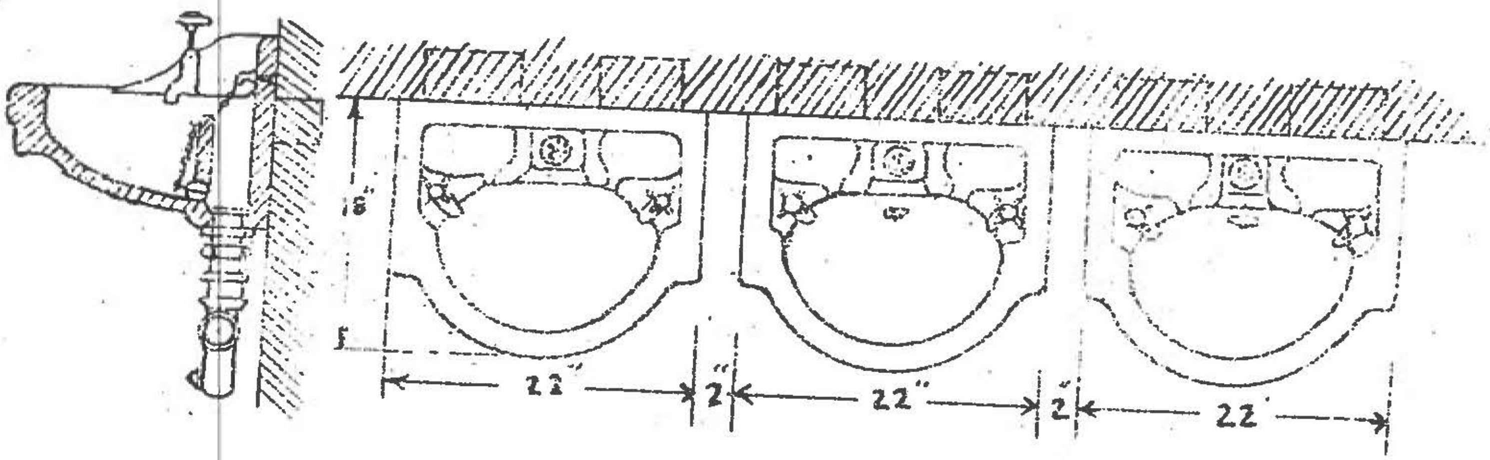


WASH BASIN WITH WASTE
AND OVERFLOW FITMENT.

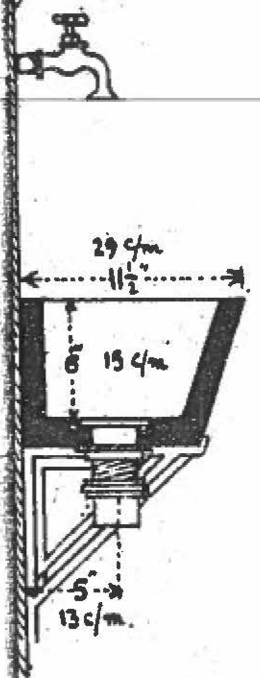


WASTE-PIPE ARRANGEMENTS FOR LAVATORY RANGE.

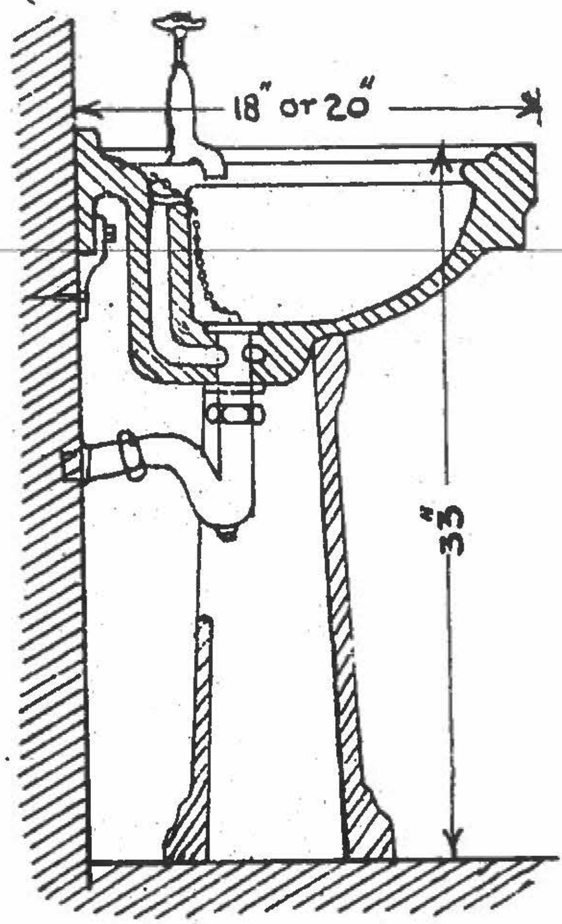




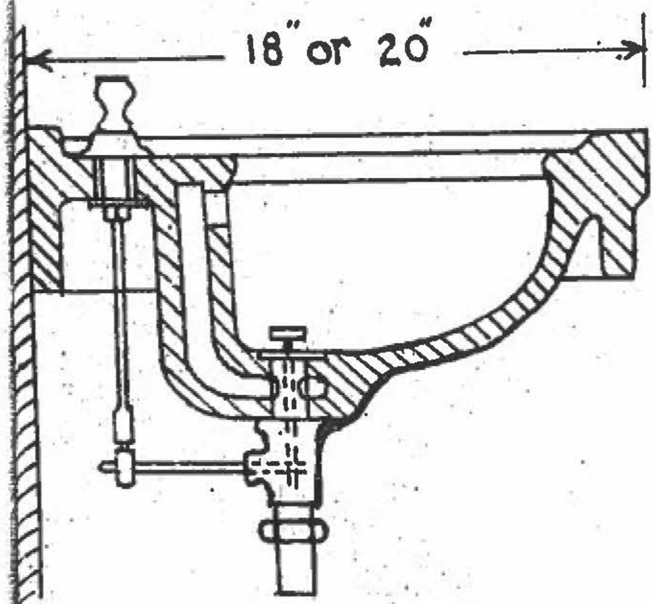
SCHOOL LAVATORY RANGE WITH HORIZONTAL WASTE PIPE



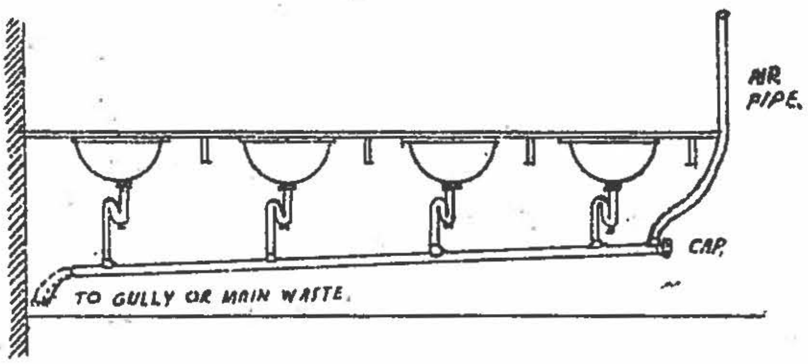
TINOUS TROUGH
H BASIN



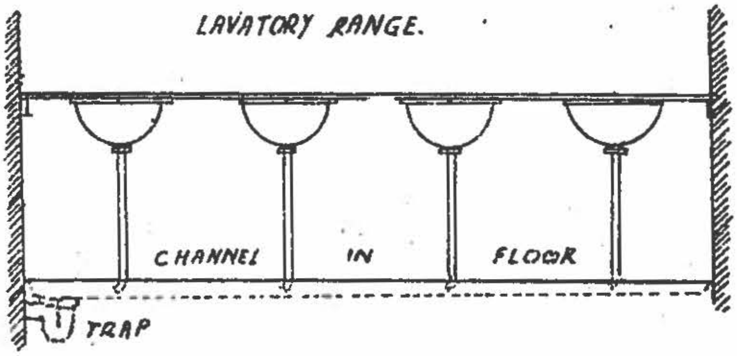
PEDESTEL WASH BASIN WITH SECRET OVERFLOW.

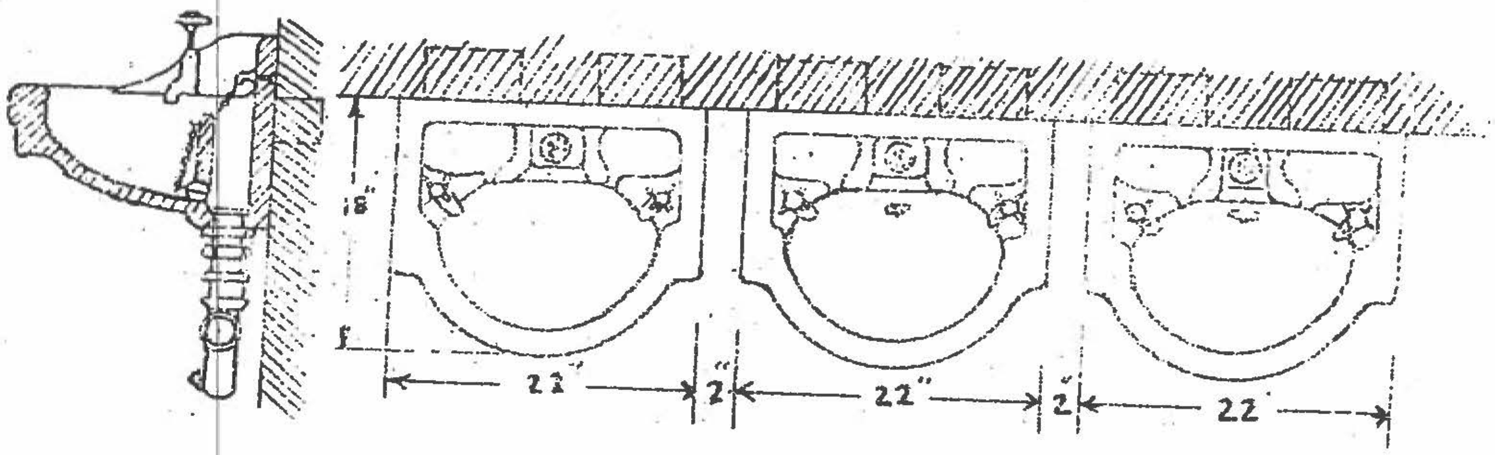


WASH BASIN WITH WASTE AND OVERFLOW FITMENT.



WASTE-PIPE ARRANGEMENTS FOR
LAVATORY RANGE.





SCHOOL LAVATORY RANGE WITH HORIZONTAL WASTE PIPE

With this pattern the tap over the trough has a rose nozzle so that users wash in a continuously running shower thus preventing the reuse of dirty or contaminated water.

Lavatories with secret overflows should more or less, be avoided from a sanitary standpoint, unless fitted with waste and overflow fittings that may be removed for cleaning.

The type of lavatory illustrated in Fig.—has a weir overflow and is perfectly sanitary, and in addition, the method of supporting the basin upon enamelled fireclay pedestal is commendable. Some type of lavatories have overflow chambers large enough for insertion of the hand for adequate cleaning.

(b) *Principal Dimensions and Weights*—They shall be as per following, unless ordered contrary by the Engineer-in-Charge.

	Minimum weights 22 *by* 16 *in. overall in lb.*	Minimum weights 25 *by* 18 *in. overall in lb.*
Earthenware ...	24	30
Fireclay ...	45	58
Heavy earthenware ...	32	40
Stone ware ...	32	40
Vitreous china ...	32	40
Tap holes (1/1/8 in. sq).	inches	inches
centres of tap holes ..	16	19
Centre from back ...	5-1/2	5-1/2
Outlet centre from back	7	7
Height of top of basin above floor. ..	31	31

(*c*) Ordinarily the lavatory basins shall be of the following specifications.

Specification for lavatory basin—This shall be ordinary type of glazed earthen ware the slotted pattern approved by the Engineer-in-Charge. It shall be fixed in rolled steel Joint cantilever bracket or C. I. 4 inch built into wall and the plaster of the rear wall be cut to overhang the top edge of the basin. The size of basin will be 25″ × 18″ unless other size is asked for, 2 lead ·onnection pipes with wiped soldered joints and 2 control in stop cocks ½" dia. shall be used for controlling water-supply to the two chromium plated, pillar valve of ½" dia. The 1¼" malleable iron trap or chromium plated brass of approved design shall be fixed on the brass of the basin by means of wiped solder joints and each waste shall have an M. I. Union as well as a puff pipe dia. terminating with a brood perforated cap screwed on to it on the outside of the wall or to the on stack, if one is proposed for the purpose. The ¼" dia. waste pipe shall terminate in a gully trap/or be connected to the waste such as required in the circumstance.

Drinking Fountains

17. A drinking fountain shall be made either for wall or for pedestal mounting.

(*a*) To supply drinking water inlet form at low velocity to enable the user to drink direct from the jet.

(b) To supply drinking water to a vessel.

In other case the receiving bowl should be large enough to prevent spillage, and in type (a) the nozzle should be so designed and so placed as to prevent contamination. A self-closing non-concussive water valve, with controlling stop valve, should be fitted. The waste pipe from the bowl should be trapped. Type (*b*) is to be depracated unless a separate drinking vessel is provided for each person.

Wash-tubs (Wash-appliance)

18. A wash tub should be of ceramic wares or stoneware and is similar to a sink, but of greater depth and provided with sloping front. In domestic premises, wash tubs should have open weir overflows but these are not required, in laundries, wash-houses etc. where there is floor drainage.

Storage cistern.

19. The cistern shall be of G. I. or Mild steel plates rivetted or welded together and rendered preferably water tight and painted inside and outside with and anti-corrosive, bitumastic, paint.

Cisterns shall be placed in a well-lighted and ventilated place, easily accessible, and protected from extremes of heat and cold.

A storage cistern shall be which is completely closed up and similar to a hot water cylinder. It is connected directly with the service pipe, and is under hydraulic pressure.

When a building is big and large quantities of water is required it is not desirable to concentrate the supply, but it shall be disposed, about building in quantities according to the require-

P. 744

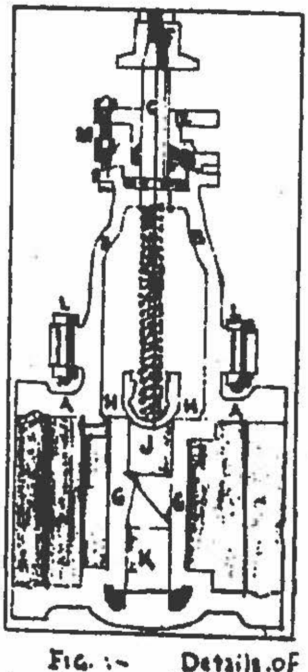
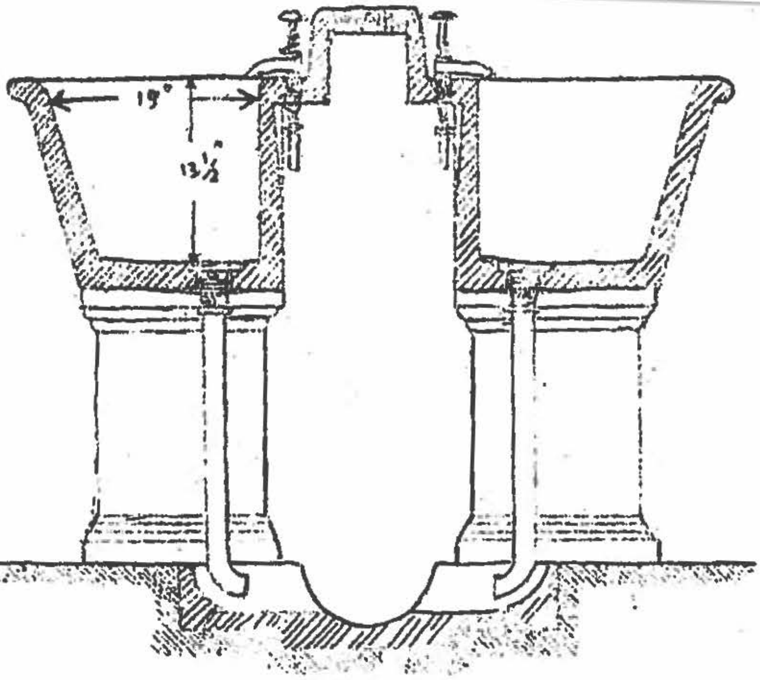


Fig. :- Details.of inside-screw.type gate valve.



WASHTUBS.

P.744

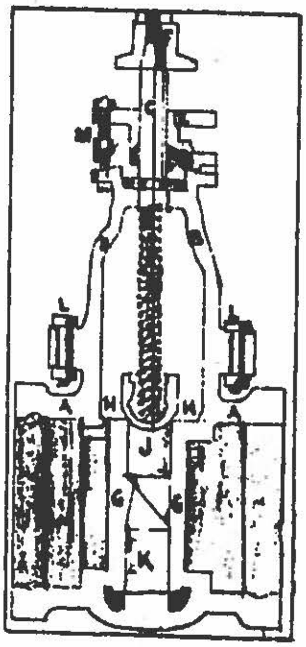
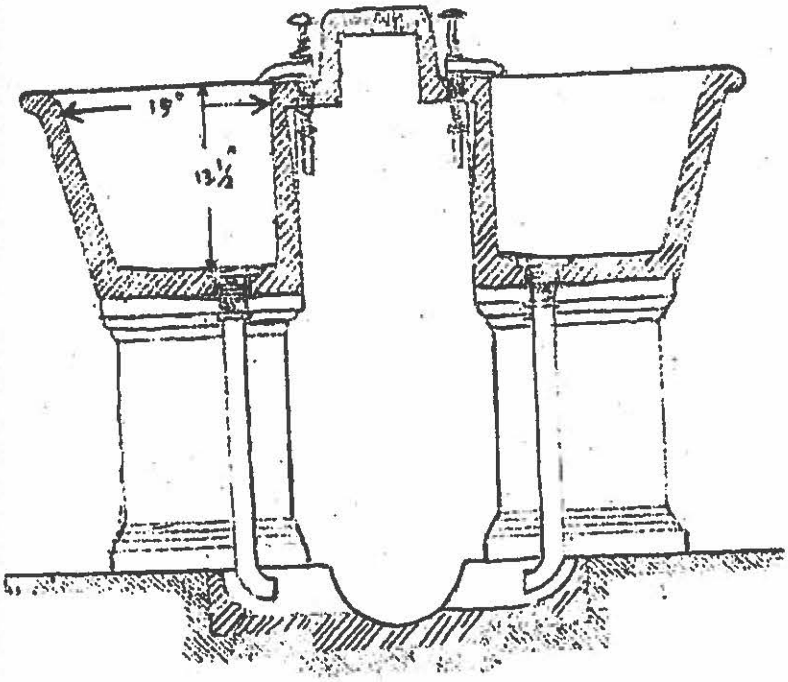


FIG. :- Details of inside-screw type gate valve.



WASHTUBS.

ments, of that part of the building where the cistern is required. This system has many advantages, of which the following are the principal one. Failure of one cistern from any cause does not interfere with the whole supply; the weight is distributed so that the ordinary walls are of sufficient strength; undue pressure in pipes supplying apparatus in the lowest parts is required, and pipe lines are simplified and shortened. Separate cistern shall be of course, provided for water-closet urinals and slop-sinks when these appliances are not flushed by waste-preventing cisterns, but it is imperative that each cistern in the series should have its own inlet with all ball valve to prevent stagnation of water.

Service Pipe.

20. Service pipes are generally of lead. In connection with certain waters it is necessary to use piping with a pure tin lining. If galvanised iron piping is used it shall be strong ("water strength)." The sizes of the pipes shall be regulated by head or vertical depth below cistern of the principal draw off—the greater the head the smaller the diameter necessary.

All principal service pipes shall have stopcocks fixed as near to the cistern as possible for shutting the water off in case of accident. They shall be what is called "full-way" and of the screw-down pattern.

Taps shall be of the screw-down type so as to prevent concussion in the pipes as much as possible where it is liable to occur; this may be remedied by carrying the service pipe past the tap about a couple of feet and turning it up vertically with a stopped end so as to form an air vessel.

Overflow pipes.;

21. The overflow pipe of a bath and lavatory basin shall be capable of taking the discharge of the both taps full on ;- that of cisterns of carrying off the flow from the ball-valve when held down to the farthest extent.

Overflow pipes from closet, basins, baths lavatory basins and sinks shall be connected with the outlet pipe of each apparatus (above the trap) except where the Engineer-in-Charge requires other methods. These from cisterns should terminate with a short end through an outer wall.

Lead Pipes.

22. All lead pipes to be hydraulic drawn, and of equal substance throughout. All connections to be made with a plumber's whiped solder joint, or by any other approved method. All pipes to be of

the full bore throughout, and to be of not less than the following weights per yard run :—

	½ in.	¾ in.				
	lb.	lb.	lb.	lb.	lb.	lb
Light ...	3½	5	7½	8	10½	14
Medium ...	4½	5½	8½	10½	14	18
Cistern Series ...	4½	7	10½	13	18	21
Strong ...	6	9	12	16	24	30

Overflows, wastes from safes, and air pipes to be of light piping; waste pipes to be of medium weight, and all supplies to be strong. Or as required by the Engineer-in-Charge.

Fixing of lead pipes—When not supported on bearers, all lead pipes are to be fixed with strong lead tacks, soldered on; two pairs to every 10 ft. length in pipes of and exceeding 2½ in. diameter and not less than three tacks to every 12 ft. length in pipes of 2 in. bore, with not less than two screws, nails, spikes, or wall-hooks to each tack. Pipes of smaller bore when not supported on bearers to be supported by a sufficient number of wall hooks lead clips. etc, to prevent them bulging or sagging.

Looking glass.

23. It shall be of size specified and at least 1/8″ Belgium or any other approved make, with brass screws for fixing shelf shall be provided where specified.

CHAPTER 24

Hot Water Supply

24·1. *Boilers*

General.

1. The boilers shall be of an adequate capacity (Refer Public Works Department Manual Public Health Works) Chapter No. 25.

The construction shall be as stipulated below :—

(*a*) *Small domestic hot water supply boilers for solid fuel.* (Also refer B. S. S. 758)

This specification covers cast iron and steel boilers with a heating surface of not more than 5 square feet and not less than 3 square feet, and may be regarded as applicable to both direct and indirect hot water supply boilers.

(*b*) *Cast iron boilers for central heating and hot water supply.* (Also refer B. S. 779).

This specification is restricted to cast iron boilers with a heating surface exceeding 5 square feet and use on installations where the working head of water does not exceed 120 feet.

A direct hot water-supply boiler which is ordered to this B. S. must comply with the general requirements and with these specially set out for hot water-supply boilers.

An indirect hot water-supply boiler which is ordered to this B. S. must comply with the general requirements and with those specially set out for hot water heating boilers.

(*c*) *Riveted steel boilers for hot water central heating and hot water supply.* (Also refer B. S. 780).

This specification is applicable to riveted steel domestic hot water boilers designed for operation at a working pressure not exceeding 150 feet head.

(*d*) *Welded steel boilers for hot water central heating and hot water-supply.* (Also refer B. S. 855).

This specification is applicable to welded steel domestic hot water boilers with a heating surface exceeding 5 (five) square feet and for operation at a working pressure not exceeding 150 feet head.

Boiler Mountings.

2. (*a*) A domestic hot water-supply boiler shall be provided with a relief valve, thermometer and emptying cock with a house union. When a range or back boiler is used, a relief value and emptying cock with hose union should be supplied.

(*b*) An indirect domestic hot water-supply boiler with a heating surface of 50 square feet and over should be provided with an altitude gauge.

(*c*) Temperature regulators should be provided on all boilers with a heating surface of 5 square feet and over. For boilers up to 50 square feet of heating surface, the temperature regulator shall be of a simple type unless otherwise specified as, for example, that which controls the opening of the ashpit, damper. For boilers above 50 square feet of heating surface, the temperature regulator shall be of a type capable of operating the boiler dampers, ashpit damper and check draught damper.

(*d*) All automatically fired boilers such as gas, oil, electric or stoker-fired boilers must be provided with safety controls in compliance with respective British Codes of Practice.

(*e*) Thermometers, relief valves and altitude should comply with the requirements for these items as set out in B. S. 779.

Stoking Tools.

3. (*a*) *For solid-fuel fired independent boilers* : shovel, slice, bar or poker, clinker tool, flue brush and scraper.

(*b*) *For domestic-boilers of under 5 square feet heating surface* : shovel and slice bar.

(*c*) *For oil-fired and gas-fired independent boilers* : brush and scraper.

Test for Boilers.

4. (*a*) A test should be made under the normal working head with all mountings and connections complete. The test pressure shall be maintained for 30 minutes, after dealing with all weak joints, defective mountings and pipe connections disclosed by the initial application of the test.

(*b*) Hot water test shall be carried out for at least two hours, during which time the boiler shall be maintained reasonably close to the maximum working temperature.

(*c*) After test (*b*) the temperature shall be allowed to fall to cold condition and the boiler shall remain filled in such condition for a further period of three hours.

During tests (*b*) and (*c*), the boiler and mountings shall again be closely examined for leakages and other defects, and where these occur they shall be corrected and the test repeated.

Where plastic thermal insulation for the boiler is used, the above tests shall be applied before the insulation work commences.

No. 24·2.

Storage Vessels and Electric Heaters.

Storage Vessels.

1. The vessels shall conform to the Specification as given below :—

(*a*) *Copper Cylinders for domestic purposes*: (For details refer B. S. 669).

Copper cylinders for sizes between 20 and 100 gallons capacity in three grades according to the maximum working head with which they can be used.

(*b*) *Galvanized mild steel cisterns, takes and cylinders:* (For details refer B. S. 417).

Galvanized steel (riveted or welded) cylinders and take for sizes up to 100 gallon capacity.

Electric Heaters.

2. The electric Heaters shall be as given below :—

Thermostatically-controlled thermal storage electric water-heaters with copper containers from 1½ to 100 gallon capacity. (For details refer B. S. 843).

Mountings.

3. For the purpose of this sub-code, mountings must include thermometer and emptying cocks. The thermometer shall be fitted near mid-storage position of all vessels of 500 gallon capacity or over.

The thermometer shall be of such a type and so fitted as to permit it to be readily replaced without emptying the vessel. It shall be so placed as to be easily readable and shall indicate the temperature of the water in degrees Fahrenheit.

An emptying cock shall be fitted to each vessel which cannot be emptied from the boiler or calorifier, or where more than one vessel is connected to the boiler or calorifier with isolating cocks.

Electric immersion heaters.

4. Where immersion heaters are fitted to hot water storage vessels, the connections shall comply with appropriate British Standard. Where a group of two or more heaters are used these should be mounted on a removable flanged plate. (For details See B.S. 1556, 'Electric immersion heaters for domestic hot water-supply,' and Code 324·202).

5. When all connections are completed the storage vessel shall be tested as follows:—

Tests.

(*a*) A test shall be made under normal working head with all mountings and connections complete. The test pressure shall be maintained for 30 minutes, after dealing with all weak joints, defective mountings and pipe connections disclosed by the initial application of the test.

(*b*) A hot water test shall be carried out for at least hours, during which time the temperature of the vessel shall be maintained reasonably close to the maximum working temperature, as directed by the Engineer-in-charge.

(*c*) During tests (*b*) and (*c*) the vessel and mountings should again be closely examined for leakages and other defects, and where these occur they shall be corrected and the test repeated.

No. 24·3 Pipe Work

1. G. I. pipes shall be used. (*vide* chapters 7 and 8 of this volume).

Pipes.

2. Full-way gate valves may be used for regulating and normal control purposes, but are not considered satisfactory for positive isolation purposes on domestic hot water installations.

Valves and cocks.

Full-way cocks must be provided for effecting the positive isolation of any circuit or appliance of a domestic hot water installation. For sizes over 2 in. such cocks must be of the lubricated plug type.

A clear indication shall be given on the cock of its position, open or shut, *e. g.*; a cross-cut on the square parallel to the cock port.

Isolating cocks shall bear a warning notice 'CLOSE SLOWLY' to avoid damage due to 'water hammer.'

Keys for cocks shall be supplied, and shall be of wrought iron or mild steel, forged to shape and of a length equal to five times the nominal bore with a minimum of 5 in.

3. These fixtures should meet the requirements of B. S.

Taps.

4. These fixtures should be of the same material as that used in the pipework installation, and should be fitted with control valves with an air cock.

Drying coils.

Towel rails.

5. These fixtures shall be of solid drawn brass or copper tunes not thinner than 18 S. W. G. highly polished and assembled to give a smooth surface of a rustless character which cannot damage fabrics where the towel rail is supplied as a separate appliance it shall be provided with control valves and an air cock. All towel rails should be provided with a top stay support of equal finish to the towel rail.

The design should be such that there are not less than two rails in the vertical plane.

Mixing valves and water blenders.

6. (*a*) It is imperative that, in all cases where manually operated mixing valves and thermostatic water blenders are used, the hot and cold water supplies serving such fittings shall be taken from a cistern or from cisterns at approximately the same level.

(*b*) *Manually operated mixing valves*—These valves must meet the requirements of B. S. 1415. They may be used wherever a supply of mixed hot and cold water is required to a single appliance, but they shall not be used to control the water-supply to more than one appliance, i.e., wash basin, bath, shower etc.

When used as recommended above (i.e. to serve individual appliances) the normal provision of stop taps only for repairs and rewashering, etc., is necessary.

(*c*) *Thermostatically operated mixing valves* —These valves shall meet the requirements of appropriate B. S. In order to obviate the risk of scalding, they shall be used wherever a single mixing valve is required to control the supply of mixed hot and cold water to a range of appliances, *i.e.*, wash basins, baths, showers, etc. Their use on a range of showers, however, does not preclude the necessity of providing for each shower fitting means for the individual control of the flow of water.

A thermostatically operated mixing valve shall be fitted with a graduated temperature scale and with provision for controlling the mixed water to a predetermined temperature with a maximum 'below scalding' point. Stop taps and dirt strainers shall be fitted to both the hot and cold water supplies to each mixing valve.

(*d*) *Thermostatic water blenders*—These items may be used in suitable cases as an alternative to thermostatic mixing valves, but care should be taken in their selection to ensure that they give the required accuracy of control over water temperature. They may also be used to control the hot supply to manually operated mixing valves, thus giving constant supply of hot water at a safe temperature.

Waterblenders shall always be fitted with stop taps and check valves on both the hot and cold water-supplies.

(*e*) Combined Taps the type of water mixing fitting which has a common water outlet, but entails the operation of separate cocks on the hot and cold water-supplies (and therefore does not comply with above British Standards), should not be considered as a meeting the requirements of this code for a mixing valve or water blender.

Pipework, Installation (General).

7. (*a*) Storage vessel connections shall conform to the requirements of B. S. 417, for steel and B. S. 699, for copper vessels.

(*b*) Isolating cocks must not be inserted in the primary flow and return mains of single boiler and storage vessel installations.

(*c*) Cleaning facilities for primary circulation pipes of a direct system shall be provided by means of the use of tees with plugged outlets at changes of direction in combination with union connectons.

(*d*) Tees shall be of the long sweep pattern axcept where non-circulating branches are taken off a circulation main, in which case square tees may be used. Long sweep tees should be fitted in such a manner that air cannot be trapped in the upper part of the tee.

(*e*) Elbows should not be used as fittings except in non-circulatory branches. Bends are preferable wherever practicable.

(*f*) Any galvanized pipe bent in the fire shall be re-galvanized inside and out.

(*g*) Where horizontal pipes reduce in size towards an air vent, an eccentric reducing fitting shall be fixed so that the top of the smaller pipe is in level with the larger one. Bushes shall not be used.

(*h*) Gradients on all pipe runs for both primary and secondary circulations shall not be less than 1 inch in 20 feet.

(*i*) Concealment of pipes shall be effected by the provision of properly designed chases or ducts, fitted with easily removable covers. Pipe must not be solidly built into walls or plaster.

(*j*) The practice of running domestic hot water-supply pipes (which are subject to frequent expansion movements) under floors by means of notching of floor joints shall be avoided, but where this is unavoidable each notch shall be lined with felt.

(*k*) Clearances between pipes and building structure shall be in accordance with the following :—

(*i*) 3/4 inch minimum clearance between the surface of insulated or uninsulted pipe and the finished surface of wall partition or ceiling.

(*ii*) 3 inch minimum clearance between the surface of insulated or uninsulated pipe and the finished surface of floor.

(*l*) Expansion loops shall be provided wherever the pipe expansion cannot be taken up by changes in direction. The loops shall be properly formed from mild steel or copper pipe. The location of the loops should be carefully related to the position of the fixed points or anchorages of the main concerned, to ensure that the expansion is totally comulative at the loop position. Each expansion loop shall be associated with two fixed points, one on either side. Care shall be taken to ensure that the expansion loops are, wherever practicable, in the same horizontal plane as the pipe run and that airlocks cannot occur. The crest of the loop should be separately supported by a suitably designed bracket.

PIPE FIXINGS, SUPPORTERS, ETC.

(*a*) Pipe fixings and suports should be arranged at interval not greater than shown in Table 24-A but care should be exercised that each support takes its due proportion of the pipe weight.

Cast iron pipes shall be supported at intervals not greater than these given in the table for wrought iron pipes, but each separate length of pipe shall have at least one support arranged near the joint so that undue strain is not placed upon the joint.

(*b*) All pipes should be supported so as to allow free movement for expansion and contraction, particularly at the ends of long runs where a change of direction takes place.

Table 24-A. *Intervals between pipe supports—*

(*a*) Wrought iron pipes Heavy gauge copper pipes Mild steel pipes.

Size of pipe	intervals for vertical runs	Intervals for horizontal runs
(in.)	(ft.)	(ft.)
½	8	6
¾	10	8
1	10	8
1¼	10	9
1½	12	10
2	12	10
2½	15	12
3	15	12
4	15	13

(*b*) Light gauge copper pipes.

Size of pipe	Intervals for vertical runs	Intervals for horizontal runs
(in.)	(ft.)	(ft.)
½	6	4
¾	8	6
1	8	6
1¼	10	8
1½	10	8
2	10	9
2½	12	10
3	12	10
4	12	10

(c) Sleeves for pipes passing through floors shall finish just clear of the floor as so to permit of the floor plate covering it. Sleeves shall be fitted to pipe at point where the pipes pass through the walls, floors and ceilings, to allow movement of the pipes without damage to the building fabric. The overall length shall be such that the sleeves project 1/16 inch beyond the finished thickness of the wall or partition.

(d) Generally; single pipe below **3** inch diameter should be supported from walls by schoolboard pattern brackets of malleable iron, stamped steel, or wrought iron, for wrought iron and mild steel tubes, and of gun metal or brass for copper tubes. The brackets shall have properly formed shanks for building-in, or back plates drilled for screwing to wood fixings. Pipe rings shall be in two halves secured by a set-screw so that the pipe can be inserted in the bottom half of a ring after the bracket is fixed and set in position. The two halves shall be provided with a registering device and there shall be a clearance of not more than 1/8 inch between the ring and the pipe. Care should be taken to ensure that the axis of the pipe is parallel with the axis of the pipe ring.

(e) Built-in brackets shall not be used for walls less than 6 inch thick. In such cases, wherever possible, the pipes shall be supported from the roof or ceiling or from the floor. Where this is not practicable, the brackets should be of the wood-fixing type secured to the well wall by expanding plug or similar device.

(f) For bath and plaster walls where it is found impracticable to support pipes in any other manner than from the wall, care should be taken to ensure that the brackets are screwed to the timber quartering or studs. The screws used for fixing shall be of sufficient length to penetrate through the plaster and into the timber deep enough to provide a stout fixing.

(g) Where pipes are fitted in trenches or pipe ducts, and in all cases where pipes of 3 inch diameter and above are used the support shall be chosen or specifically designed for the particular requirements of the installation. The following points shall receive special attention.

(i) The pipes shall be spaced in the trench or duct in a manner which will permit subsequent access to any pipe for maintenance without disturbance of the remaining pipes.

(ii) Allowance shall be made for movement of a pipe due to expansion or contraction; provision for guiding such movements shall be made and for countracting any tendency of a pipe to lift off brackets or rollers.

(*iii*) Where a common pipe hanger is used for two or more pipes, provision shall be incorporated for the unequal pipe movements which may arise due to expansion.

(*iv*) Damage to pipe insulating covering due to movement of the pipe shall be prevented.

(*h*) Where structural steel joists are the only means of support for pipe hangers, the drilling of the structural steel work must be avoided whenever possible by the use of special girder clips securely bolted round the joists. The hangers shall be articulated to allow free movement.

Where drilling of the structural steel for the passage of pipes or their support is unavoidable, prior permission should be obtained from the Engineer-in-charge.

Emptying pipes and drains.

9. (*a*) A hot water-supply installation must be provided with facilities for emptying the system.

(*b*) A single direct boiler and storage vessel installation must be provided with and emptying cock connected to the boiler and wherever practicable, with an emptying pipe continuing so as to discharge over in nearest gulley or sump in the boiler house or to a convenient and conspicuous discharge position outside the building.

(*c*) A single indirect boiler and storage vessel installation must, in addition to the requirements of (*b*) for the boiler be provided with an emptying cock to cylinder and, where practicable, with an emptying pipe continuing so as to discharge over the nearest gulley or sump in the boiler house or the convenient and conspicuous discharge position outside the building. The two emptying pipes can be married together if convenient.

(*d*) An installation with two or more (boilers or calorifiers) and storage vessels in parallel must be provided with an emptying pipe (with cock) connected to each boiler and storage vessel.

(*e*) An emptying pipe with cock must be connected to the lowest point of each section of the circulation mains for which isolation control has been provided.

(*f*) Where a pipe dips to local trenches and rises again, a tee with 1/2 inch, outlet plugged off shall be fitted at the lowest point in the dip, arranged so that the plug is readily accessible.

(*g*) Wherever practicable the separate emptying pipes from boilers (or calorifiers); storage vessels and circulation mains shall be brought into a common discharge pipe which shall be continued so as to discharge over the nearest gulley or sump in the boiler house or calorifier chamber. (A semi-rotary hand pump, with by pass and cock, should be fitted in the main emptying pipe if the discharge gulley or sump is above the 'empty' level of the boiler or calorifier.

Joints for galvanzied pipes and fittings.

10. (*a*) *Screwed joints.*—Screwed joints shall be screwed British Standard pipe thread, clean threaded and pulled up tightly (see B. S. 21). Caulking shall not be permitted. Joints shall be made with good quality jointing compound and, when parallel threaded fittings are used, with fine stranded hemp, the hemp being wound on to the pipe thread to ensure tightening when the joint in screwed up. Pipes shall be well reamered before screwing, care being taken not to damage the internal galvanizing. All surplus hemp and jointing compound shall be cleaned off the pipe joint after completion.

(*b*) Flanged joints shall be made by screwing drilled flanges on to the end of the pipe as for screwed joints. Drilling and dimensions of flanges shall be in accordance with British Standard tables.

Flanges shall be of wrought or cast iron or mild steel and shall be faced full width of the flange. The end of the screwed pipe shall finish flush with the face of the flange. The two flanges forming a joint shall be flush with one another all round when in position and all bolt holes shall be in correct alignment with those on the mating flange. The joint between the flanges shall be made with a good quality jointing material and, where necessary, jointing compound arranged to fit snugly concentric with the pipe bore and in no way obstructing the pipe bore. The flanges shall be bolted together with British Standard mild steel hexagonal bolts and nuts complete with washer under nut. When fitted and pulled up tightly, the bolts shall project not less than one thread through the nuts.

(*c*) *Long screw connectors*—Are not considered to be a satisfactory jointing for domestic hot water installations and therefor shall not be used.

(*d*) *Unions*—Shall consist of two screwed halves, with ground spherical-faced or cone-faced joint between faces, and one face at least shall be bronze. Flat-faced unions employing leather or similar non-metallic washers shall not be used.

(*e*) *Iron pipe with lead pipe*- Joints between iron pipe and lead pipe shall be made in accordance with the requirements as directed by Engineer-in-Charge. 'Pipework above ground.'

(*f*) *Welded joints*—Fusion welding shall not be undertaken on galvanized pipe. Where bronze welding is undertaken, such welding shall be in accordance with the appropriate B. S.

Location and Identification of cock and valves.

11. (*a*) All valves and cocks should be fitted in such a manner that they are accessible for operation and maintenance. Where they are located in chases or trenches, removable access covers should be provided.

(*b*) Where stop taps are provided for the control of individual draw-offs, they shall be located within 18 inch of the draw-off, and where control stop taps are required for a group of draw-offs the pipe-work shall be continued to within 18 inch of each individual draw-off.

Each individual float for a range of basins must be controlled by a stop tap and the individual outlets on the float should be within 18 inch of the taps.

(*c*) Every circulation isolating cock shall be provided with a non-corrodible label of size not less than 3 inch × 2 inch × 16 s. w. g. The cock duty or the reference number should be marked in plain block letters.

Identification of pipes.

12. All pipework should be painted or otherwise provided with identifications legends in accordance with B. S. 617. Identification of pipes, conduits, ducts and cables in building.

24·4 *Thermal Insulation.*

General.

1. (*a*) All thermal insulating materials shall be delivered to the site in a dry condition and housed in a dry store until drawn upon for use.

(*b*) In view of the importance now attached to the efficiency of thermal insulation, the installation of such be entrusted only to operatives skilled in the work.

(*c*) All insulating material, however fixed, shall be in close contact with the surface to which it is applied, and all joints shall be sealed, after ensuring that edges or ends of any section butt up close to one another over the whole surface to be insulated. Edges or ends shall be cut or shaped at site where necessary.

(*d*) Each pipe shall be insulated separately. It is not good practice to marry together adjacent parallel pipes with insulating material.

(*e*) In the case of vessels having a diameter of 4 feet or over, or a length or height greater than 6 feet, non-corrodible supporting bands not less than 1 inch wide shall be provided aftar the insulation has been applied and painted.

Asbestos fibre and jute wrapping, only shall be used in Pakistan being locally mined.

2. *Flexible insulating materials*—

Application.

(*a*) These materials are usually applied in blanket or strip form built up if necessary to the required thickness, and held in position with galvanized lacing wire not thinner than 20 S. W. G.

(*b*) For application to boilers, cylinders, etc., flexible insulating materials shall be securely stitched or stabbed as is necessary to maintain uniform thickness, and held in position with galvanized wire not thinner than 20 S.W.G., which in the case of mattresses having an outer cloth envelope is accomplished by securing to non-corrodible hooks fastened to the envelops.

Insulation of flanges, valves, special fittings, removable covers, etc.

3. At flanges and valves, the insulation shall be cut back to leave access to bolts, etc.

The flanges and valves themselves shall be enclosed in flexible mattresses wired on, or provided with flange or valve boxes enclosing granular type insulation.

All fittings on boilers or vessels shall be kept free of insulation, and the adjacent insulation shall be finished around such fittings to allow easy access and romoval.

Bolted ends or removable chests on vessels shall be provided with specially formed insulating blankets or mattresses arranged for easy removal. Where flexible material is used for such purposes it shall be securely stitched or stabbed as necessary to maintain uniform thickness, and the same degree of insulation must be maintained as in the adjacent work.

CHAPTER 25

Gas Plant and Laboratory Fittings

No. 25·1—General

General.

1. Gas for schools, colleges and hospitals may be obtained from netural Gas companies, sludge digestion tanks or from (sewage disposal) institutional, gas plant, fuelled by coal, charcoal wood, oil or petrol.

For sludge digestion tanks refer to chapter 19 of this volume.

The institutional plants are described in this chapter which may be of the Mansfield type fired by coal wood and oil or Aerogen plant worked with Petrol.

No. 25·2—Mansfield Type Gas Plant

Producer.

1. The producer plant is manufactured in the sizes, *viz.*, B-90 cubic feet per hour and C-250 cubic feet per hour.

Specification for producers.

2. *B Type or C Type*—The producer shall be manufactured by Mansfield and Sons Liverpool, described as under or any other 'approved equal' accepted by the Engineer-in-Charge and shall consist of a robust fire box with fireclay sides, heating chamber with fireclay, lining and slag-wool insulation protected with cast iron casing with a sight plug, a retort of cast iron with a lead seal bonnet, oil syphon chimney, water seal, hydraulic syphon, syphon box, test bend with test cock and all other equipment to make the installation complete.

The manufacture of gas is as per para 4 below.

The quotation shall always be in Rupees at P. W. D. godown (Name of Railway Station) including railway freight, sales tax, insurance, etc., and shall be delivered in the P.W.D. godown sound condition.

The installation shall be done under the supervision of the supplier's representative and tested and the cost of testing shall be included in the contract.

Capacity ..	B type ..	90 cubic feet/hour.
	C type ..	150 cubic feet/hour.

3. The storage of oil shall be in steel tanks with at least ... weeks capacity at a suitable height.

~~4. The method of gas making is as follows :—~~

Manufacture of Gas.

A fire is lighted in the firebox, either wood or coal being used as fuel, and a steady heat is maintained until the retort, which is shown suspended inside the producer fireclay lining, is heated to redness. (The progress of this heating may be watched through the sight plug). As soon as the retort is sufficiently hot for gas-making, the bonnet sinks into the molten lead at the top of the retort and an automatic gastight joint is made. The other end of the bonnet is sealed by water.

The oil from which gas is to be made is stored in a small tank fixed at a suitable height in the gas house so that it will run by gravitation through a supply pipe to the producer. At the end of this pipe and immediately over the oil syphon of the producer is a small cock by which the flow of oil into the producer is regulated. When oil is ready for gas making, the oil cock is turned on and a stream of oil flows through the oil syphon into the red-hot retort. It is immediately "cracked" or turned into a permanent gas. The size of the stream of oil is adjusted until the gas is suing from a test cock provided for the purpose, is the correct colour in accordance with directions for working. Gas-making will continue as long as the retort is kept at the correct temperature and the oil is allowed to flow into it. When the gasholder has risen to the desired height, the oil is turned off and gas making ceases. The main valve to the gasholder is closed and the bonnet is lifted out of the molten lead, so that the retort can be cleaned when it is cold. There is no necessity for purification, as the oil from which gas is made does not contain impurities which occur in coal gas.

Gas holder.

5. *The gasholder shall consist of an inverted bell suspended by means of weights and chains in a tank of water. As the gas is made the gasholder bell raises in the water, and as the gas is consumed it descends. The pressure of the gas is regulated by means of balance weights. To increase the pressure balance weights are removed from the chains and to reduce the pressure the weights are replaced.*

For high pressure gasholder the bell shall have a concave top on to which water can be pumped.

Type of oil Gasholder

6. *A complete gas-making plant consists of a producer which makes the gas, connecting ppies and valves, and a gasholder in which the gas is stored.*

When oil-gas is being produced it is essential that there should be as little pressure on the retort as possible. To provide for this, balance weights are placed on the chains of the gas-holder until it is almost counterbalanced and does not throw a pressure of more than half an inch of water.

It follows, therefore, that it is not possible to produce efficiently and consume gas from the same gasholder at the same time.

(*i*) Simplex Type—*The simplex type is the simplest plant. It consists of a producer, connecting pipes and a gasholder which is counterbalanced when all the weights are then taken off the chains. This shall be used for elementary laboratories where no elaborate furnace or blowpipe appliances are required, and where it is not inconvenient to discontinue the supply to the laboratory while gas is being made. It is usual to order a plant of this type such capacity that one days gas making will be sufficient for three or four days consumption.*

The simplex type is made in the following sizes :—

Capacity of gas-holder cubic feet	Producers	Number	Code word	Approximate Weight tons.
500	1B	866	Spatoso	5
1,000	1C	167	Spatroth	8

(*ii*) Duplex Type—*This is similar to the simplex type but has two gasholders, one of which is counterbalanced to half inch water pressure for gas making, while the other has the balance weights removed to throw two inches water pressure for consumption at burners.*

In this manner a constant supply of gas is available for the burners at two inches pressure during gas-making. The connecting pipes are so arranged that gas can be made into either or both gasholders. Gas can thus be made daily without interfering with the consumption. It is recommended for elementary

The duplex type is made in the following sizes :—

Capacity of gas-holder cubic feet	Producers	Number	Code word	Approximate Weight Tons
500	2B	1,583	Stelkunst	10
1,000	2C	1,585	Stelnetz	17

(iii) Intensive Type—*This is similar to the simplex type, but is provided with our high pressure gas holder, which obviates the removal of balance weights. During gasmaking the water in the concave top of the gas-holder is allowed to run down into the tank. After gas is made, water is pumped from the tank on to the concave top of the gas-holder by means of a hand pump. A pressure of eight inches of water is thus easily maintained for consumption, giving all the advantages of being able to use more elaborate gas burners, blowpipes, furnaces, etc. This is recommended where a continuous supply of gas throughout the week is not necessary.*

The intensive type is made in the following sizes :—

Capacity of gas-holder cubic feet	Number of Producers	Number	Code Word	Approximate Weight Tons
1,000	1C	2,132	Strikles	10¾
2,000	2C	2,133	Strimpello	18¼
3,000	3C	846	Spastoio	26
4,000	4C	931	Spealhol	32
5,000	5C	932	Speelkas	39

(iii) Auxiliary Intensive Type—*This type is intended for laboratories of importance where it is necessary to have a constant supply of gas at the pressure required by the burners both day and night. Gas is made into a small gas-holder which is permanently balanced at the low pressure required for gas making. As the gas is made, it is forced by means of a gas engine and compressor into the storage gas holder which is permanently weighed to a pressure of about eight inches of water. With gas at this pressure experiments of any magnitude can be conducted. It is well known that all atmospheric burners work better at a* *higher than at a lower pressure. This type is the most perfect and up-to-date oil gas plant for laboratory purposes.*

The auxiliary intensive type is made in the following sizes:—

Capacity of High-pressure gas-holder Cubic feet	Capacity of Low-pressure gas-holder Cubic feet	Number of Producers	Number	Code word	Approximate weight Tons
2,000	200	2C	837	Sparviere	22½
3,000	300	3C	838	Spasimato	30
4,000	400	4C	839	Spasimava	36
5,000	500	5C	840	Spasmata	43
6,000	500	6C	841	Spasmatis	49
8,000	750	8C	842	Spasme	58
10,000	1,000	10C	843	Spassahaft	76

Specification for Gasholder.

7. The gas holder tanks shall be constructed in the specification of hydraulic structure chapter 6, Pipe work chapters 7, 8 and 9 of this volume and usual building specifications of Volume I.

The gas bells shall be of M. S. Sheets rivetted with counter-sunk heads or welded, designed to withstand pressure of 100 lbs. per square inch and must be perfectly leak-proof for water and gas. The tanks must be waterproof. All structural street work shall be as per relevant chapter of Volume I. The pulleys shall be of cast iron.

Specification for Producer house.

8. The chamber housing producers shall be well ventilated and chimney from the producer taken sufficiently high, it shall be constructed to the corresponding specification as given in Volume I.

Piping.

9. The pipes shall be covered with two coats of bitumastic paint inside and outside and the pipes and valves shall be of specifications as per Chapter 7 of this volume

Size of pipes.

10. The size of pipe shall be calculated from the following table.

TABLE

Sizes of pipes	Cubic feet per hour.
2 Inch diameter pipe will supply ...	750
1½ ,, ,, ,, ,, ,, ...	300
1¼ ,, ,, ,, ,, ,, ...	160
1 ,, ,, ,, ,, ,, ..	90
¾ ,, ,, ,, ,, ,, ...	40
½ ,, ,, ,, ,, ,, ..	24
3/8 ,, ,, ,, ,, ,, ...	12
¼ ,, ,, ,, ,, ,, ..	6

No. 25·3—Aerogen Petrol Gas-Generator

General.

1. Where electricity and petrol are cheap, Aerogen gas plants may be installed.

Description servicing.

2. *The generator is available in nine different sizes from the smallest, with an output of 200 cubic feet per hour to the No. 15 size which has an output of 5,500 cubic feet per hour. Figures given as per table below will enable the Engineer in-Charge to decide which size of plant will serve his requirements, but should any doubts exist, the makers may be requested to advise regarding the most economical size for any given requirements.*

In each size of plant the principles of control and operation are the same.

Fuel for approximately 20 hours continuous running at the maximum output, is carried in a tank fitted with a constant guage and a filler plug of ample size. An adjustable fuel metering device delivers fuel at a controlled rate to a rotating Archimedian Spiral running in a water seal in the pump case.

Gas is delivered under pressure to the gas holder which is fitted with mercury switch controlling the motor. Gas pressure may be adjusted to a maximum of 6 inches water column in the case of the three largest sizes of generator and 5 inches in the case of the smaller ones.

The generator is fully automatic in operation, stopping and starting with the rise and fall of the gas holder. All demands are met instantaneously, the motor being switched on when the contents of the gas holder are becoming low, and off when the gas-holder is full.

The proportion of gas to air is always stable and is quite unaffected by load changes or climatic conditions. By varying the rate of flow of fuel, the mixture can be controlled. This adjustable mixture control enables the requirements of any particular manufacturing process to be met.

TABLE FOR AEROGEN GAS PLANT (ELECTRICALLY DRIVEN)

Code word	Size	Capacity Bunsen Burners	Capacity cubic feet per hour	Approximate overall dimensions: length	Approximate overall dimensions: width	Approximate overall dimensions: Height	Packed shipment (approximate cubic feet)	Weight of generator Less Fuel and Water	Weight packed	Size of motor	Gas main pipe
	No.							cwt.	cwt.	H. P.	
Elduo ...	2	40	220	5′ 1″	3′ 0″	4′ 3″	95	4¾	7	¼	1″
Eltres ...	3	60	300	5′ 4″	3′ 4″	4′ 8″	130	5½	9½	¼	1¼″
Elquattuor ...	4	120	600	5′ 8″	3′ 7″	5′ 0″	145	6½	11½	¼	1½
Elquinque ...	5	180	900	6′ 2″	4′ 2″	5′ 9″	170	7	14	1/3	2″
Elsex ...	6	240	1,200	6′ 4″	4′ 5″	6′ 0″	200	10½	17	1/3	2″
Electo ...	8	350	1,750	6′ 10″	5′ 4″	7′ 0″	240	15	24	½	2½
Eldecem ...	10	450	2,250	7′ 6″	5′ 6″	8′ 2″	300	16	25½	½	2½
Elunodecem ...	11	550	2,750	7′ 6″	5′ 9″	8′ 2″	350	16½	27	½	2½
Eduodecem ...	12	700	3,500	11′ 0″	5′ 4″	8′ 4″	390	17	29	(2) ½	3″
Elquatdecem ...	14	900	4,500	12′ 0″	5′ 6″	9′ 0″	430	20	30	(2) ½	3″
Elquindecem ...	15	1,100	5,500	12′ 6″	5′ 9″	9′ 0″	475	22	32	(2) ½	3″

The portable electrically driven generator

3. In cases where the amount of gas required is small, the Portable Electrically Driven Generator is strongly recommended. The maximum output is 100 cubic feet per hour, sufficient for 20 bunsen burners working simultaneously.

Portable elecuric generator

Being very light in weight (56 lbs. empty), it can readily be transported to wherever gas is required provided that a mains electricity point is available.

It is intended that the motor be switched eff when gas supply is not required. However, should the motor be left running when no gas is being used, no patrol will be consumed nor will any gas be generated.

Air from a blower is fed direct to the carburettor which, being of simple design and robust construction, needs no attention.

The overall dimensions are : --

Length : 1'-9" Width : 1'-11'. Height : 2'-0"

The approximate shipping space is 7 cubic feet.

4. The generator is designed for use where no electricity supply is available. The principle of operation is the same as that of the Electrically Driven Generator except that motive power is derived from falling weights which are re-wound by hand through suitable gearing.

Aerogen weight driven generator.

Five different sizes or generator are available, having maximum outputs ranging from 100 to 850 cubic feet per hour.

With any plant either 6" × 6" or 8" × 8" pulley blocks can be supplied and if the 8" × 8" size is specified, the driving weight should be increased by about 25 per cent. The table below gives the amount of driving weight required for each of the various sizes of generator

When the generator is on full load, the weights descend at the approximate rate of 6 feet per hour if 6" × 6" pulley block are fitted, or 4 feet per if 8" × 8" pulley blocks are used. The effort required to re-wind the weights is not very considerable.

8" × 8" pulley blocks are recommended for those installations requiring at uninterrupted gas supply for long periods without re-winding.

TABLE FOR AEROGEN WEIGHT DRIVEN GENERATOR

Code Ward	Size	Capacity in Laboratory Bunsens	Driving Weight with 6×6 pulley blocks approximate	Approximate dimensions: Length	Width	Height	Packed shipment (approx.) cu. feet	Weight nett	Weight packed for shipment
			Cwt.					Cwt.	Cwt.
Duo ...	2	20	9	3′ 4″ ×	2′ 0″ ×	5′ 0″	55	3	6
Tres ...	3	40	12	3′ 4″ ×	2′ 0″ ×	5′ 0″	64	3½	6½
Quattuor ...	4	70	16	4′ 0″ ×	2′ 4″ ×	6′ 8″	73	4½	9½
Quinque ...	5	100	20	4′ 2″ ×	2′ 8″ ×	6′ 8″	96	6	10½
Sex	6	170	30	4′ 8″ ×	2′ 10″ ×	7′ 0″	102	6½	11

5. Aerogen gas is generated from highly volatile petrol of the special Boiling Point group, which have a specific gravity of 0.68 to 0.72. The petrol, which is marked under various trade names, is universally obtainable. The gas has a calorific value of 300 B.T.U's. per cubic feet, or 8,250 calories per litre. Five hundred cubic feet of gas is obtained from one gallon of fuel, or 3 cubic metres of gas per litre.

Gas generation.

Aerogen gas is safe ; it is non-poisonous and has only a slight odour in its unburnt state. The products of combustion are carbon dioxide and water. Aerogen petrol gas has been applied to almost every industrial and domestic operation suitable for coal gas, and has many applications where its superiority as regards cleanliness, absence of toxics and ready control of mixture strength, make it preferable to coal gas.

6. Installation of any of the plants is relatively simple matter and full instructions be always obtained with every machine. In cold climates, for correct carburation, it is advisable to instal the plant in a heated building.

Installation and servicing.

A minimum of servicing attention is required. In the case of the standard electrically driven generator, occasional inspection of the water level and of the electric motor brush gear, together with periodic greasing at each of the four grease cups provided, are all that is necessary.

The weight driven plant is much the same, except of course that there is no electric motor to require attention, and additional grease cups are to be found on the pulley blocks.

The portable electrically driven generator and the portable automatic electrically driven generator require virtually no servicing, except perhaps, for very occasional inspection of the water level in the air holder in the case of the latter.

No. 25·4—Gas Fittings

1. The bunsen burners shall be of plain air slide type on cast iron stand and shall be of the diameter of tube outside as below. The burners tube shall be of brass, it shall have adjustable gas injector and air sleeve.

Bunsen Burners.

Diameter of tube outside.	*Oil gas per hour cubic feet.*
3/8″	1
7/16″	1·5
½″	2
5/8	3
3/4	4

2. A well-designed bunsen, giving a very high temperature flame with 50 to 60 per cent more power than an ordinary bunsen of the same size.

Registered Bunsen burner.

Diameter of tube outside	*Oil Gas per hour cubic feet.*
$\frac{1}{2}''$	2
$\frac{5}{8}''$	3
$\frac{3}{4}''$	4

3. Drip-proof, rustless, and one of the most powerful burners ever designed in proportion to their size.

Standard rose bunsen of Brass stands.

These burners are specially designed for wet, dirty work and are proof against drip, wet and dust.

Diameter of flame	*Oil Gas per hour cubic feet.*
$2\frac{1}{2}''$	3
3''	5
4''	7.5

4. This well known burner gives a very high power flame. Any clogging up of the grid at the mouth of the burner, is easily dealt with, as the head is detachable.

Meker Burners.

Meker Burner No.	*Oil Gas per hour cubic feet.*
1	2
2	3.5
3	6
4	9

5. A cheap, simple, and indestructible burner for small laboratory work. The flame of these burners is shorter, more compact and higher in temperature than an ordinary Bunsen. They are made in cast iron or brass.

Argand Bunsens.

Diameter of horizontal tube.	*Oil gas per hour cubic feet*
$\frac{1}{2}''$	2

6.

Standing Boiling Burners.

Diameter across support for vessels.	*Oil gas per hour cubic feet*
$5\frac{1}{2}''$	6
7''	7·5
8''	10

Drip-proof high power burners.

7. These burners are generally used under vessels either fixed or supported on wrought-iron stands. The burners themselves are very small in proportion to the power and the size of vessel they will heat. The bottom of the vessel should be about 2 inches clear above the top of the burner.

Size.	*Oil gas per hour cubic feet.*
Small	13
Medium	20

Special high power burners.

8. These burners are the highest power for their size which it is possible to make.

Size across gauze	*Oil gas per hour cubic feet*
$2\frac{3}{4}''$	13
$4''$	20

Injector furnace.

9. This furance speedily attains very high temperatures. Starting all cold, with the 2 lb. size, a crucible full of ordinary iron wood screws can be fused to a solid button in 25 minutes.

To take crucible No.	*Capacity lb. Iron.*
00	1/3
1	2

Oil gas per hour cubic feet varies with work done.

Combustion Furance No. 1

10. This will heat an iron tube of $\frac{3}{4}''$ to 1 in diameter to its softening point in ten minutes, using a small foot blower, or it will heat the same tube to redness without a blast, the same burner being applicable for either draught or blast.

For draught or blast, with adjustable flame length.

Length inches.	*Oil-Gas per hour cubic feet.*
12	
18	Varies with work done.
24	

With fixed length of flame, without blast.

12	12
18	18
24	24

Combustion Furance No. 2.

11. *For organic analysis*—The special points about this furance in which it differs from all other are,—the burners are outside and in front of the furnace, and clear from all falling dirt. There is no iron-work to rust, the whole of the

metal used being brass.

Length inches	*Oil Gas per hour cubic feet.*
12	8
18	12
24	16
36	24

Reverberatory Gas Furnaces. For crucible Mufles. Cupels, etc.

One of these furnaces will do most of the general work of an ordinary laboratory. They work perfectly with chimney draught to a bright red—about the fusing point of fine silver. With a blast they will work up to the fusing point of cast-iron. The furnaces can be made to take either two muffles at once, a number of crucibles, trays of cupels, or one muffle and crucibles or cupels at the same time.

The opening may be either at the side of the top, the furnace working either way equally we'l.

G. L. C. Muffle Furnace.

13. This is used for tempering, hardening, analytical work, enamel work assaying, testing work, etc., at temperature up to 1,000°C.

This furnace is intended for use at all temperatures up to 1,000 degrees C. It will be found suitable for many kinds of laboratory and experimental work such as testing material at high temperatures assaying, heat treatment of steel, enamel work, china and glass heating and analytical work, etc.

The temperature in the muffle will be found very uniform with a maximum variation of 5 degrees C.

Revised. Pattern Blow pipe.

14. A strong serviceable blow pipe for workshop use, designed to meet the demand for a cheap, and at the same time, efficient article.

Total length 13 inches.

Universal Blow pipe.

15. This shall be on stand, with Swivel point and bent Air Inlet.

The smaller size requires a gas supply from a 3/8 inch pipe and the larger from a ½ inch pipe.

The L. T. Blow pipe.

16. An excellent blow pipe, supplied with six different jets similar to that illustrated. These jets can easily be changed with one hand, simply by removing the bayonet fixed cap, at the butt of the burner, withdrawing the jet; and replacing by the jet of the required size.

17. This shall be with cover for evaporating Corrosive Liquids.

Sand Bath for Laboratory use.

Size of bath, clear inside, 12 inches square. The back is opened to fit against a wall with a flue, a cock in each burner controls the temperature in any part.

Oil Gas per hour cubic feet—6.

18. Size 5 inches wide, 5 inches high, 8 inches deep, clear inside measure.

Drying Oven.(with water Jacket)

This is made of heavy copper throughout, riveted and seamed, and designed for heavy continuous work. Hanging door two sliding shelves of copper plate over the water filling hole, of tinned copper, hammered and polished.

Complete with burner and copper stand.

Oil Gas per hour cubic feet—4.

19. Specially designed for the various conditions required in the Chemical Laboratory, and also for pharmacentical use, bottle and power drying, etc.

Drying and Sterlizing Ovens

In ordering, the required maximum temperature must be specified.

Sterilising, and drying oven for breweries and bactriological work, working up to 400 degrees Fah.

Size clear inside, 9 inches high, 9 inches wide, 7 inches deep.

Oil Gas per hour cubic feet—10.

20. The use of Patent Solid Webs for conducting the heat of the burner to the water renders it possible to construct very powerful and efficient water heaters of an exceedingly small size, This pattern is only 14 inches wide and 6 inches high over all. It will deliver one quart of water per minute, heated from 60 deg. to 125 deg. Fah. (scaling). It is free from drip or mess, and is also free from smell.

Patent Instantaneous water Heater.

This pattern has the Water Tubes fitted with plugs at both ends to allow for the entire coil to be cleared inside from all deposits caused by hard or dirty water. -

Special pattern for use with hard water.

Oil Gas per hour cubic feet—12.

21. Ring Burners.	Small, 2 diam. (Powerful vertical flame.)	Small, 2″ diam. Side Outlets giving spreading flame.	Medium 5″ diam.	Largo 8″ diam.

22. Several types of water heaters are available including the Instantaneous Boiling Water Heater, The Bath Gas Water Heater, The Multi Point and The Storage Gas Water Heater.

Water Heaters.

This model raises water temperature 40 F. per gallon per minute.

Overall height 22″, Diameter $6\frac{1}{4}$″. The burner is lighted automatically when Hot tap is used.

Hot and Cold taps are provided and Hot and Cold mixing is incorporated.

White porcelain enamel and chromium plated finish.

23. Brass gas trees.

One way ¼″	Two way ¼″	Two way ¼″	Three ways
Lever Handle, with Base Plate for Bench Fitting.	Straight Outlets. ...	Splayed outlets ...	Straight Outlets
Two way ¼″ Tap on Top for Flame Jet.	One way ¼″ Wall Fitting	Two way ¼″ Wall Fitting.	Fully Wall Fitting.

24. The internal gas pipes shall be of galvanized iron laid and fixed according to the specification in chapter 7, 8 and 9 of this volume and painted with an aluminium paint of a colour to distinguish it from water-supply and drainge piping.

CHAPTER No. 26

SCHOOL FURNITURE LABORATORY—TABLE AND FITTINGS

26. 1—*Chalkboard*

Material.

1. The chalkboard shall be of seasoned deodar wood free from rots, shakes, blemishes, etc. up to fulll satisfaction of Engineer-in-Charge.

Finish.

2. *Woodwork*—All exposed woodwork, except that forming a writing surface, shall be finished by one of the following methods: as decided by the Engineer-in-Charge.

(*i*) One coat of sealer and one coat of clear cellulose varnish.

(*ii*) One coat of synthetic resin lacquer.

(*iii*) Two coats of synthetic resin lacquer.

(*iv*) Two or more coats of french polish finished with one coat of copal or shellac varnish, as directed by Engineer-in-Charge.

Writing surfaces.

3. The writing surface of wooden chalkboard shall be flat, reasonably hard and shall be finished with a paint which will provide a 'matt' or non-reflective surface. The writing surface of chalkboard using fabric for this purpose shall be left in the 'as made' condition.

Writing surfaces shall be either black or green, the latter being B.-S. Colour No. 225, Light Brunswick Green, B. S. 381-C. Special rulings. *e g.* squares of music staves, shall be supplied if so ordered.

General

4. All exposed arrises and corners shall be softened. The finish of all surfaces shall be smooth durable, and reasonably proof against stains, damp, and heavy wear and tear.

No. 26·2—*Handicraft and Woodwork Room Furniture*

Scope

1. This specificatian provides for the following furniture for handicraft rooms :—

(a) Dual carpentary bench without cupboards. (Fig. 1).

(*b*) Dual carpentary bench with cupboard and removable tool-racks. (Fig. 2.)

(*c*) Metal work bench with drawers. (Fig. 3.)

Size and Dimension.

2. The size shall be as per drawing. These sizes are subject to a tolerance of $+\frac{1}{8}$ in. Certain limiting dimensions which relate to finished sizes after processing are specified in the constructional requirements.

Material.

3. The timber used in the construction of handicraft workshop room furniture shall be shisham where members are specified to be of hardwood. The timber shall be free from large or loose knots, shakes or other defects. Other species of hardwood, or softwood of good commercial quality, may be used for other parts. All timber used shall be dried to a moisture content of not more than 15 per cent or less than 8 per cent.

Finish.

4. (*i*) *Woodwork*—All woodwork shall be left in its natural colour and shall be clean, smooth and free from surface irregularities.

General—All exposed arrises and corners be softened. The assembly of all articles shall be such as to provide rigidity, and adequate strength to withstand heavy wear and tear. Any applied decorative finish shall be subject to the approval of the Engineer-in-Charge.

Carpentary Bench without Cupboards.

5. Carpentary benches shall be made in the following sizes or as directed by the Engineer-in-Charge.

Reference number	Length of top overall	Width of top overall		Height	
	ft.	ft.	in.	ft.	in.
C. B. 1	5	2	4	2	4
C. B. 2	5	2	4	2	6
C. B. 3	5	2	4	2	8
C. B. 4	5	2	6	2	4
C. B. 5	5	2	6	2	6
C. B. 6	5	2	6	2	6

6. *Sizes*—Carpentary benches with cupboards shall be made in the following sizes or as directed by Engineer-in Charge.

Dual Carpentary each with Cupboards.

B. S. reference	Length of top overall	Width of the overall		Height	
	ft.	ft.	in.	ft.	in.
C. B. 1C ...	5	2	4	2	4
C. B. 2C ...	5	2	4	2	6
C. B. 3C ...	5	2	4	2	8
C. B. 4C ...	5	2	6	2	4
C. B. 5C ...	5	2	6	2	6
C. B. 6C ...	5	2	6	2	8

7. Each vice shall be fixed by recessing its back face into the bench top, the vices being secured by not less than four screws. The inside jaw of the vice shall be set on the apron piece and inset into the bench top, so that the top of the metal jaw will be not less than $\frac{1}{2}$ in, nor more than $\frac{5}{8}''$ below bench top. A backing block of suitable dimensions shall be inserted between the underside of the bench top and the vice. The metal jaws shall be faced with hardwood linings $\frac{3}{4}$ in. thick $\times$ 12 in. long, which shall be attached by counter sunk head screws. The top edges of these linings shall be level with the bench top. On the outer lining and additional filled shall be screwed to the wood lining and this shall be flush at the top and of sufficient thickness to cover the outer metal jaw.

Carpenters Vice.

The vices shall be 7 in. wide and shall have a minimum opening of 8 in. when fully extended. They shall have malleable cast iron jaws and a mild steel screw mechanism not less than $\frac{3}{4}''$ in diameter. Instantaneous closing releases shall be fitted only when specially ordered.

8. Metal work benches shall be made in two lengths, viz. 9 ft. and 12 ft. overall, each of which shall be 3 ft. Wide $\times$ 2 ft. 6. high overall.

Metal work Bench with drawers.

No. 26·3—Science Room Furniture

Scope. 1. This specification provides for the following types of furniture for science room :—

(*a*) Type 1 benches supported upon cupboard/drawer units.

(*b*) Type 2 benches supported on normal leg and drawer framework.

(*c*) Demonstration benches, comprising two or more cupboard/drawer units, a knee-hole and cupboard unit and a 4-drawer unit, constructed as a composite assembly.

The sizes of the articles covered by this standard shall be as shown in the figs. 1—3.

Material 2. The several materials used in the construction of science room benches shall comply with the relavant requirement stated below:—

Timber—Hardwood comprising shisham or deodar except that bench tops shall be of shisham. The timber shall be free from large or loose knots, shakes or other defects. Other species of hardwood, or softwood of good commercial quality, may be used for wholly concealed parts. All timber used shall be dried to a moisture content of not more than 15 per cent or less than 8 per cent.

Plywood—Plywood shall be of good commercial quality, faced, where exposed, with a timber matching that used in the construction:—

(*a*) Cellulose varnish synthetic resin lacquer. These, materials shall be of good commercial quality possessing a hard and durable finish which shall resist scratching and abrasion.

(*b*) *Woodscrews*—All woodscrews shall comply with the requirement of B. S. 1210. Glue and adhesives. These materials shall comply with B. S. 754 or with B. S. 1204 or B. S. 1444.

Sinks. 3. Sinks shall be of glazed fireclay, of the laboratory pattern, with a vulcanite standing waste, and a vulcanite waste outlet fitting.

Finish. 4. (*a*) *Woodwork*—All exposed woodwork, except bench tops of shisham shall be finished by one of the following methods:—

(*i*) One coat of sealer and one coat of clear cellulose Varnish.

(*ii*) Two or more coats of french polish finished with one coat of copal or shellac varnish.

ham bench tops shall be finished by the application of ed oil rubbed well in, or by paraffin wax ironed well in.

b) *General*—All exposed arises and corners shall be ed. The working surface of all articles shall be reason- ard. The finish of all surfaces shall be smooth, durable asonably proof against stains, damp and abrasion.

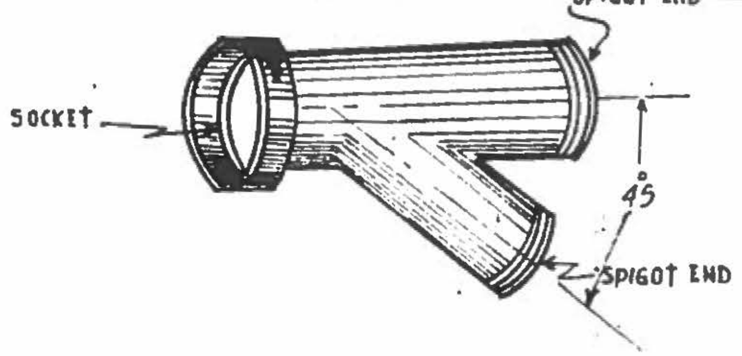
The specification provides for the supply and fitting of gas and water taps, sinks and waste fittings, if included in the item.

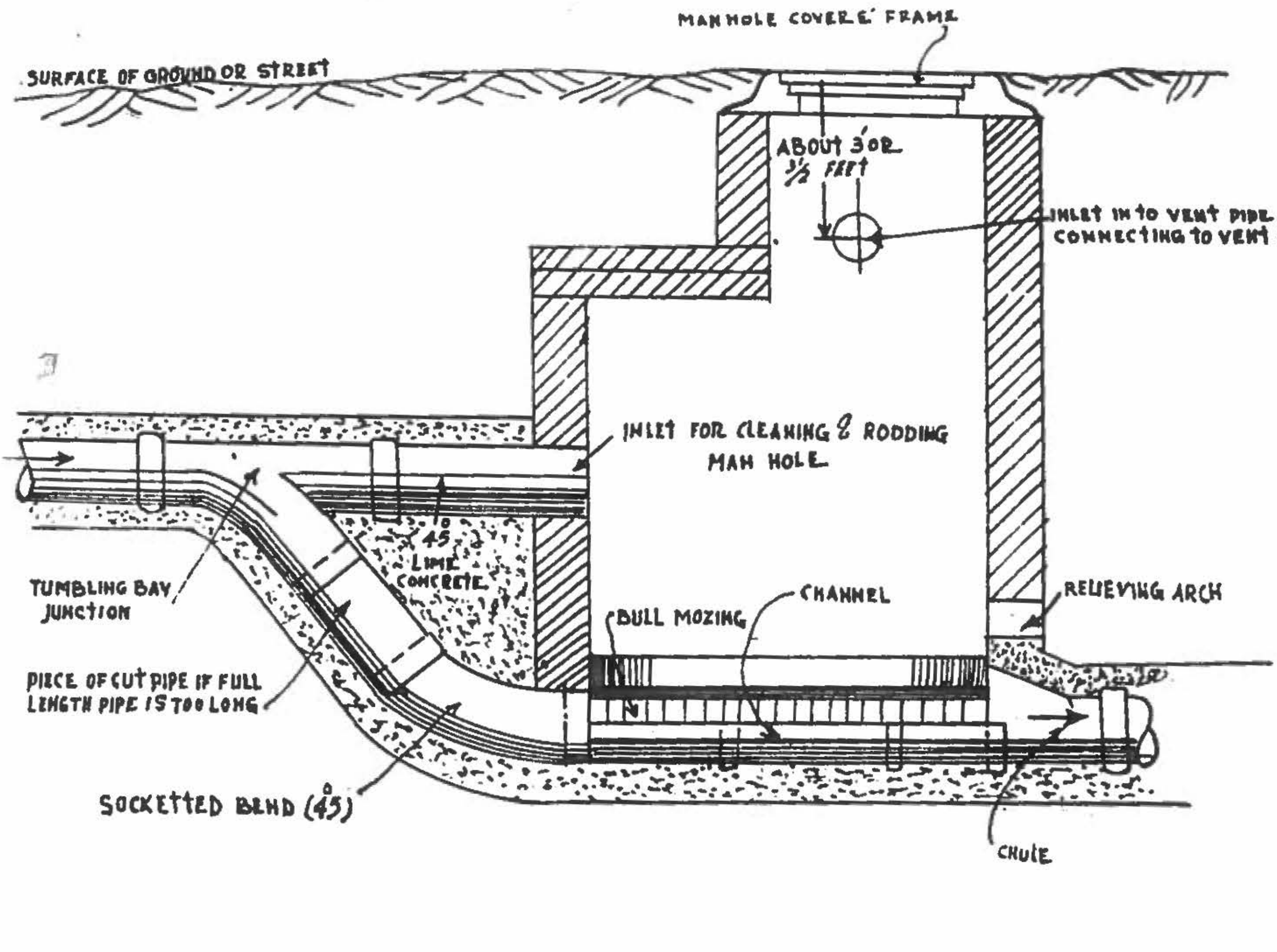
As per drawings fume cupboard shall be provided rds. with one or two way taps and sliding glass cover, and smoke shall be led by to a height of 3 feet above roof.

he laboratories shall be well ventilated by exhaust fans.

e laboratory fittings shall be connected with stone- ware sewers only. S. C. C. or brick sewers shall be avoided.

FIG NO 13


SPIGOT END
SOCKET
45°
SPIGOT END


MANHOLE COVER & FRAME
SURFACE OF GROUND OR STREET
ABOUT 3' OR 3½ FEET
INLET IN TO VENT PIPE CONNECTING TO VENT SHAF,
INLET FOR CLEANING & RODDING MAN HOLE
45°
LIME CONCRETE
TUMBLING BAY JUNCTION
BULL MOZING
CHANNEL
RELIEVING ARCH
PIECE OF CUT PIPE IF FULL LENGTH PIPE IS TOO LONG
SOCKETTED BEND (45°)
CHUTE