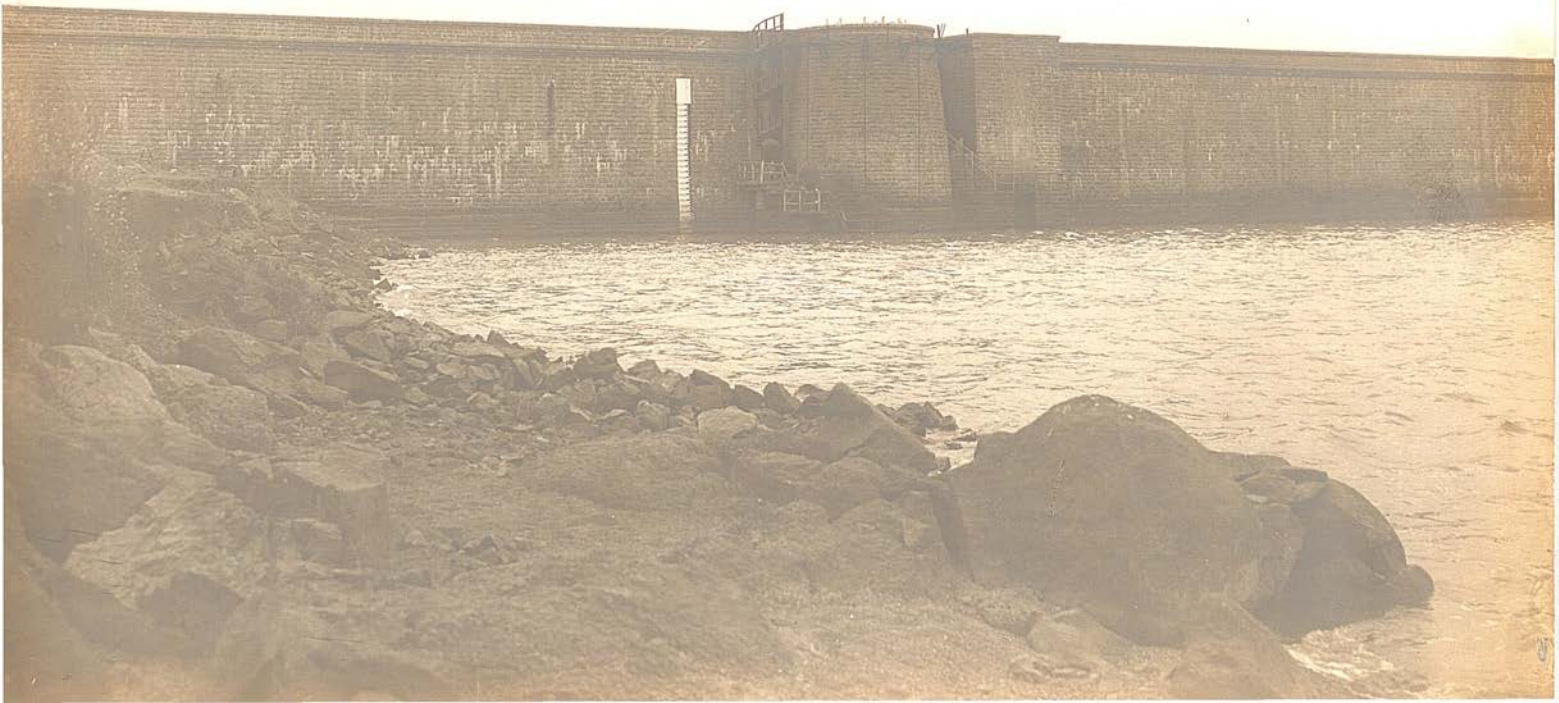
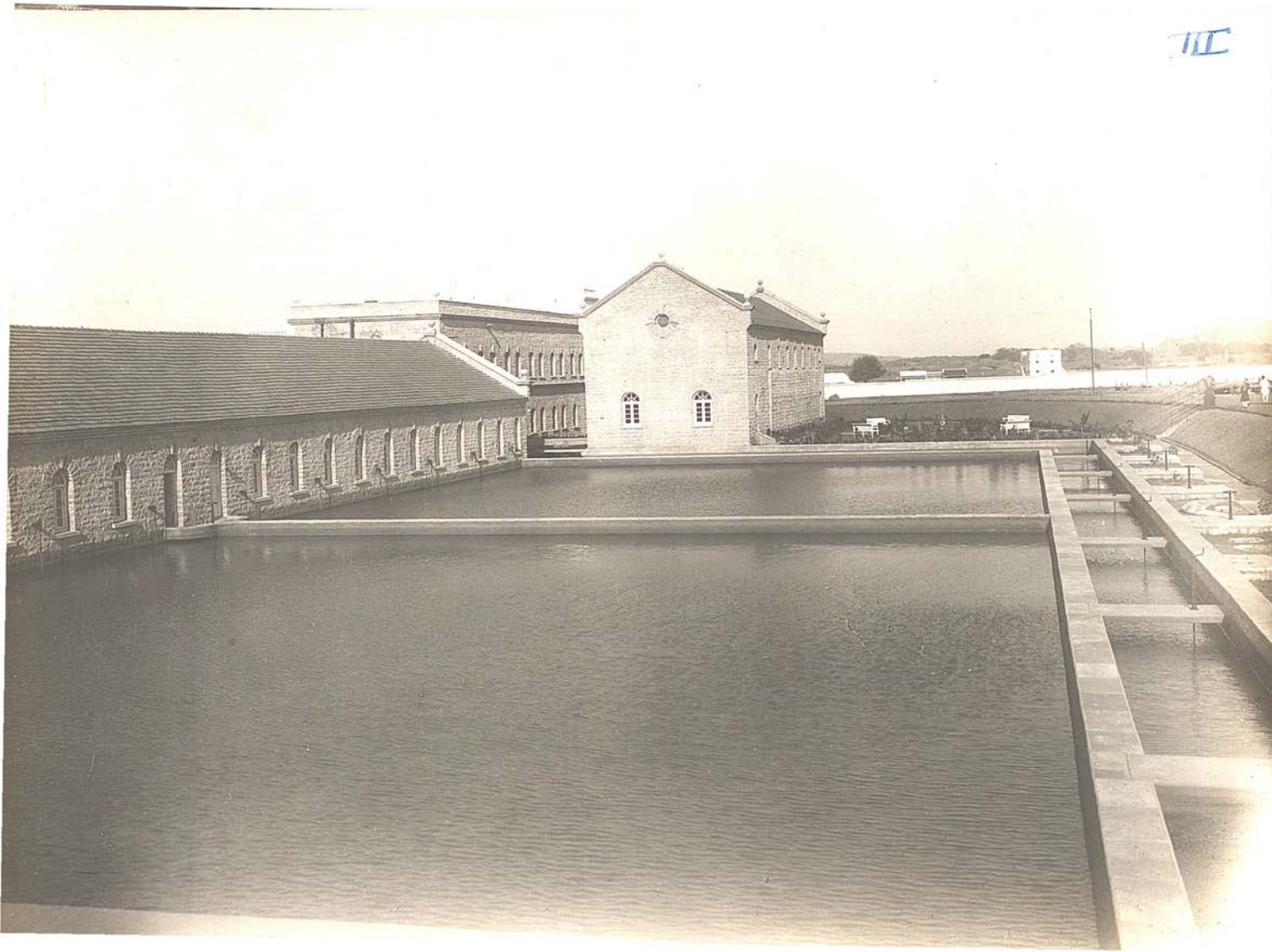
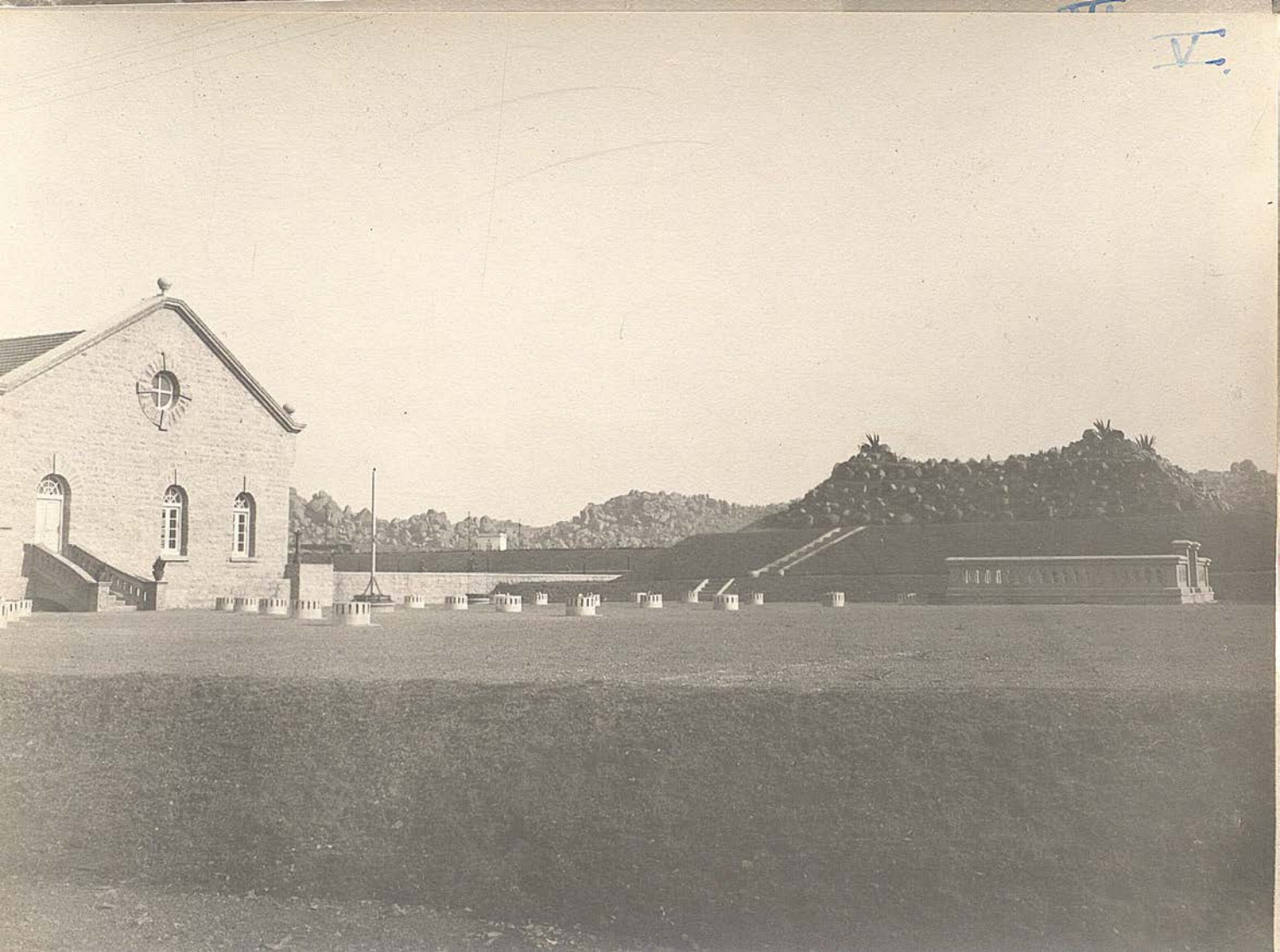
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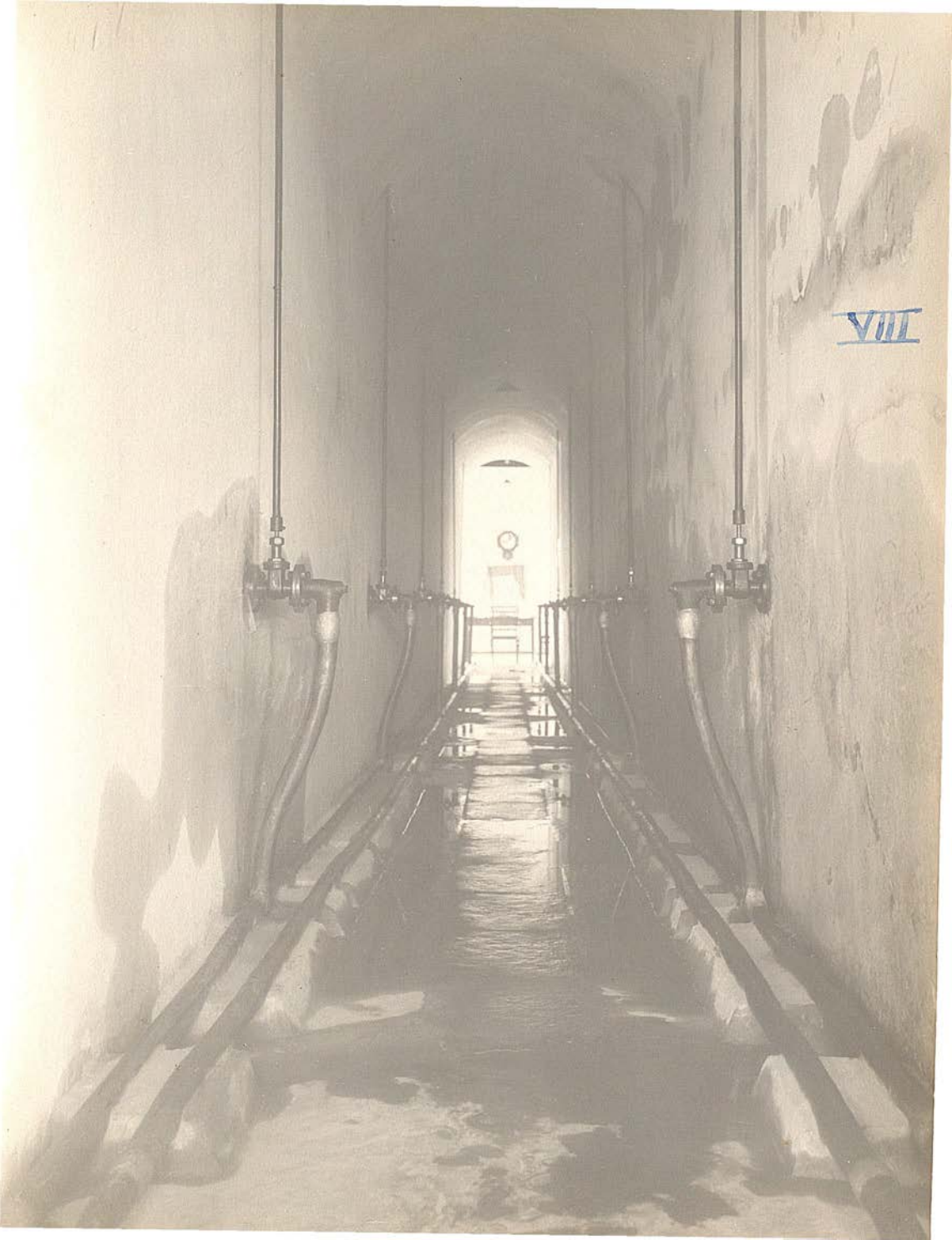

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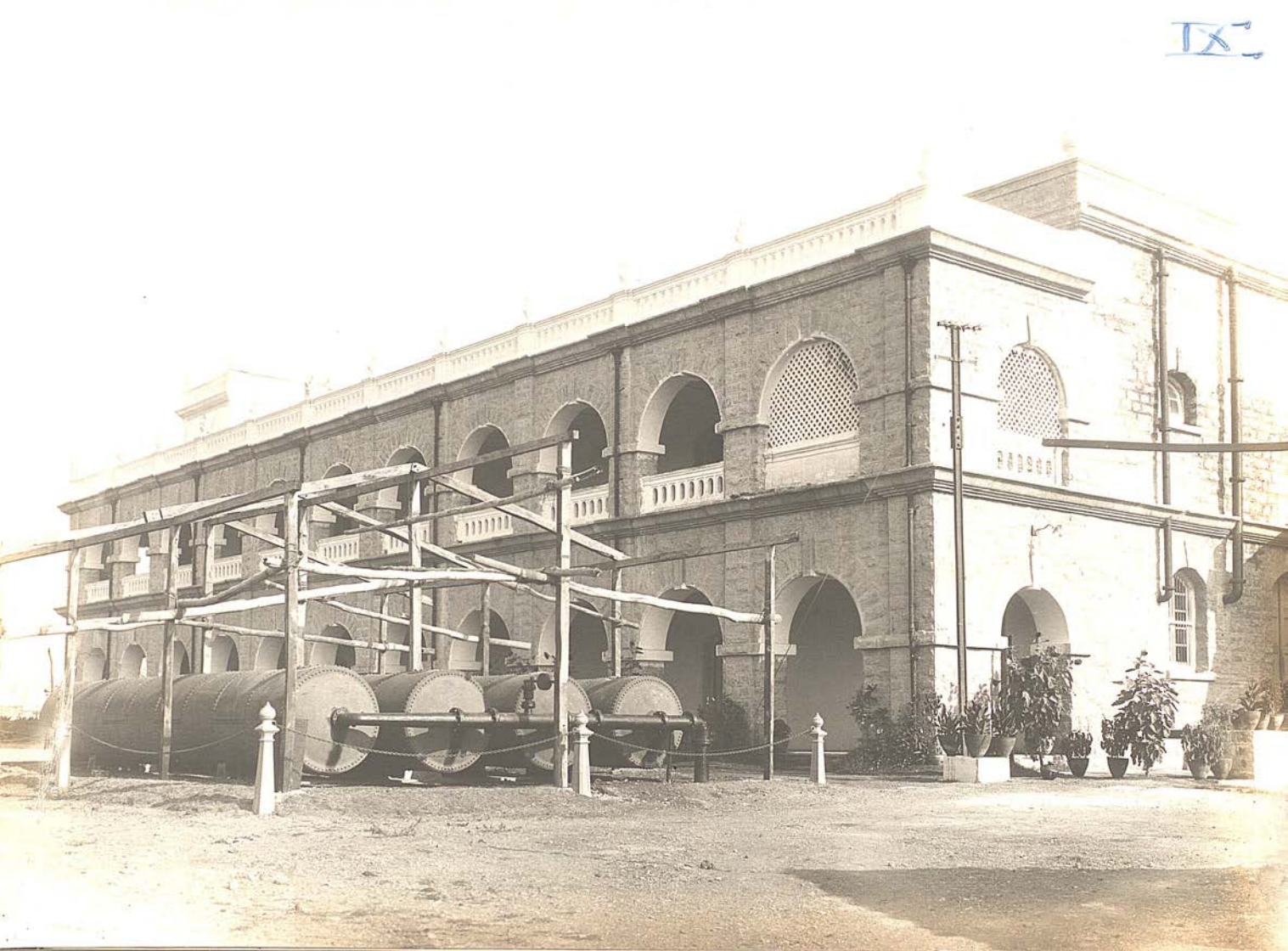


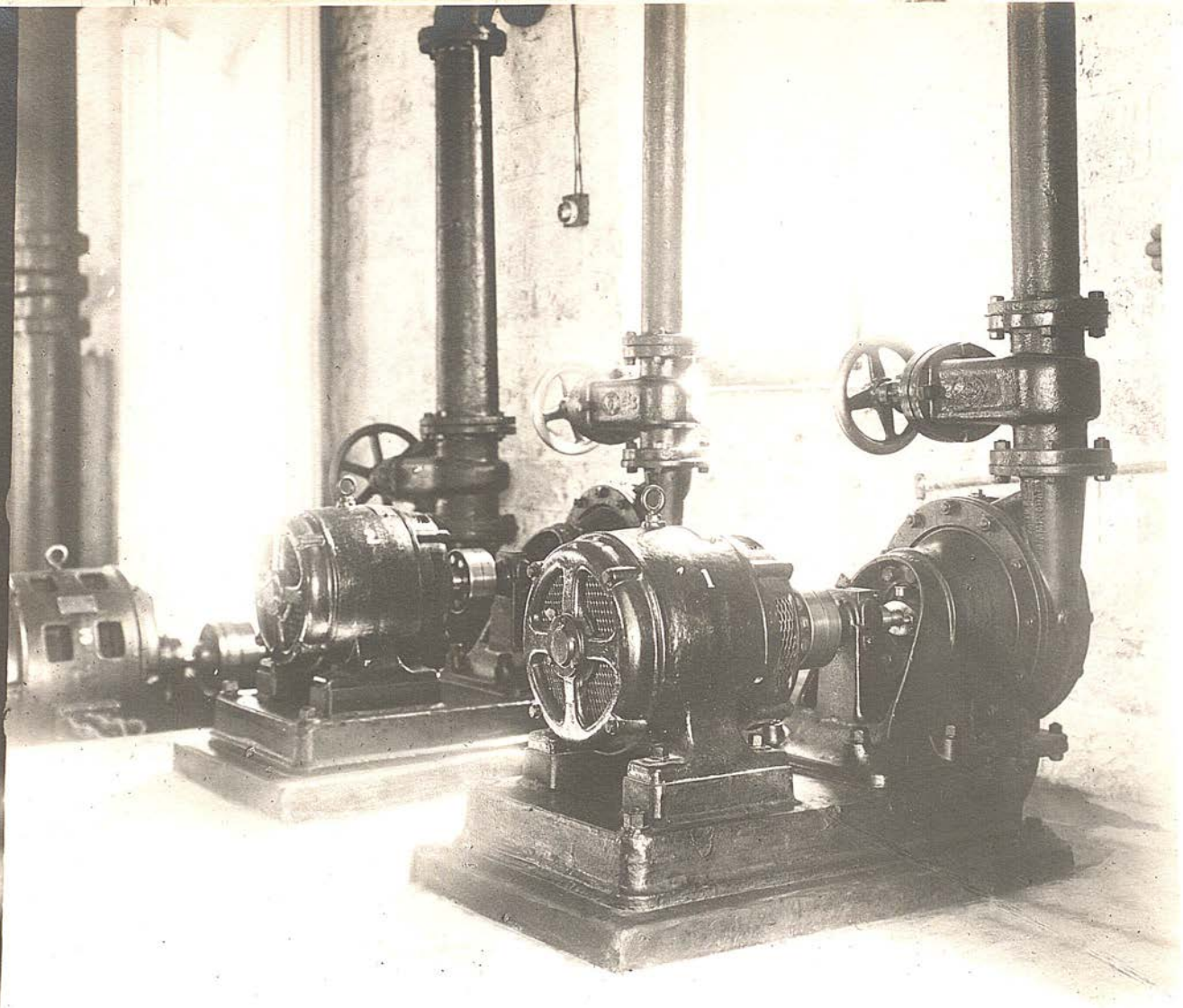
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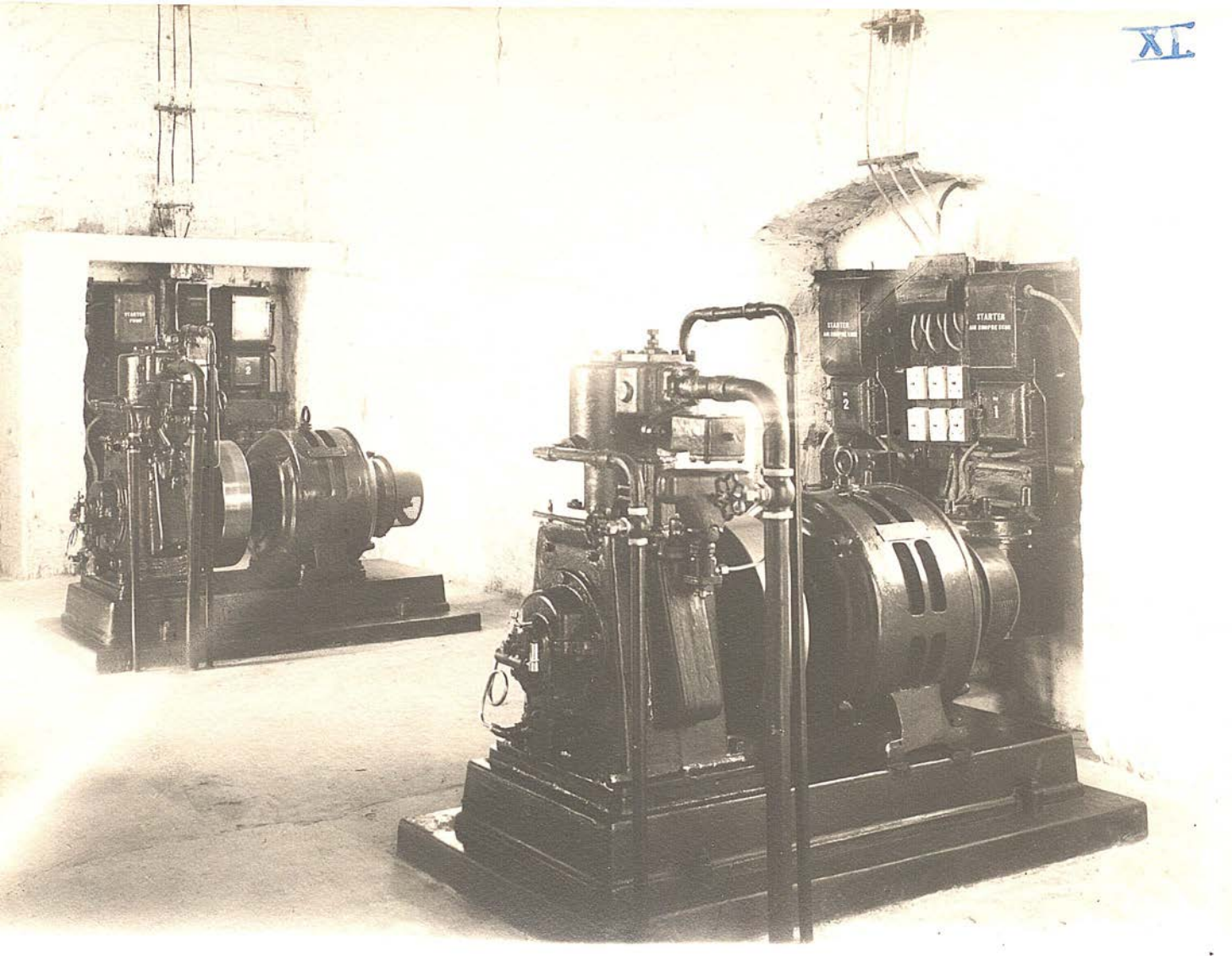





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Th. Sect

Thesis submitted for Degree of D.Sc.

Degree of D.Sc. conferred

12th July, 1923.

RAPID OR MECHANICAL FILTRATION

IN INDIA

WITH PARTICULAR REFERENCE TO

THE DESIGN & CONSTRUCTION

OF THE

NEW WATER PURIFICATION PLANT

AT

HYDERABAD, (DECCAN).

EX BIBL. UNIV. EDINBURGEN

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Water Purification in India
with particular ref. to the
Design & Construction
of the
New Mechanical Filtration Plant
at
Hyderabad, Deccan.

21/10/32.

INTRODUCTORY:-

The numerous advantages to be obtained from the adoption of the "Rapid" or "Mechanical" Filtration Plant are being more and more widely recognised, as can be seen from the large number of Plants of this nature which are being installed throughout the world in preference to the older and more generally known type of "Slow Sand" Filter.

MECHANICAL FILTRATION:-

Before proceeding with a detailed account of the Design and Construction of the Hyderabad Plant, it will not be out of place to indicate briefly the action of a Mechanical Filter, in contradistinction to the well known Slow Sand type.

The essential feature which distinguishes "Mechanical" from "Slow Sand" Filtration is of course the extremely rapid unit filtering speed of the former when compared with the latter. In a Slow Sand Filter a downward speed of say 2½ gallons per square foot of sand bed area per hour is regarded as good, whereas in a Mechanical Filter a speed of 100 gallons per square foot, or even over this is possible in many conditions,- a speed however of say 75 to 80 gallons per square foot being considered as a fair average working speed under general conditions.

For a Plant of any given capacity the saving of Filter Bed area is obviously enormous when Mechanical Filtration

is

is adopted. These results are only rendered possible and practicable by the adoption of the following features which may be said to be common to all Rapid Filtration Plants. These are all based more or less on the same broad principles, and only differ in the Mechanical and other means by which these principles are carried into practical effect.

1st.- A very careful Chemical Treatment of the incoming crude water, which must be kept under constant observation and analysis.

2nd.- A Mechanical System whereby the Filtering Medium may be very rapidly and economically cleansed without removing it from its place in the Filter Bed.

Dealing briefly with the subject of Chemical Treatment, it may be remarked that it is quite exceptional, especially in the Tropics, for a Natural Water to be entirely suitable in all respects, and without any treatment whatever, for use either as an Industrial or a Town Supply. The purpose for which it is intended decides the treatment to which it must be subjected to render it suitable for use. In connection with certain Industrial processes it is quite possible to have a water which requires the removal of say only one of its impurities and the presence of the others having no deleterious effects, whereas the same water used for another process might require the removal of all or other of the impurities. Again the same water might require quite different treatment to render it safely potable, but in addition to this its condition as regards Bacteriological contamination would also become one of the first importance.

Mention might also be made of the remarkable Bacteriological results obtained in this type of Filter, simultaneously with the Chemical Purification mentioned above. These results are obtained generally without the use of Chlorine in any form as a sterilising agent, although in most Mechanical Plants provision is made for the addition of chlorine to the purified

wate

water as an extra safeguard to the users, should necessity arise.

As a detailed discussion of the Chemical Treatment is not intended, the subject is not considered here at such great length as its importance in connection with "Mechanical Filtration" would naturally warrant.

Hyderabad Filter Plant.

The present paper does not aim at a discussion of the merits of "Rapid" as against "Slow Sand" Filters, nor does it consider the relative advantages and disadvantages of the various types of Filters of the former description now installed by the different Makers and Patentees. It confines itself chiefly to a somewhat close description of the Rapid Filtration Plant recently completed and brought into entirely successful operation at Hyderabad, (Deccan).

The Works are of some magnitude for this class of Purification Plant, being at the time of their design the largest of their kind in the country, and comparing favourably with any in the United Kingdom. Many very interesting problems presented themselves for solution in the course of the design, and several entirely new features were introduced into the Plant, the magnitude of which, being very much in excess of anything hitherto attempted in the country, involved an entirely fresh design in all its details.

GENERAL ARRANGEMENT.-

The general arrangement of the Plant may be clearly understood by a preliminary study of the following Ferro Prints, which are direct copies of the drawings prepared by the State from the detail drawings supplied to them showing clearly in all respects the actual requirements of the Filter Plant. They are of interest as being the actual working drawings to which the Masonry Work was constructed. They show a certain amount of extra architectural embellishment, but are for all practical purposes, merely reproductions of the various drawings sent to the State to enable them to prepare the masonry work.

The plant will be described in detail from the actual original drawings prepared in Calcutta, so that it will be sufficient to enumerate these ferros very briefly.-

Drawing

Drawing No.331/7.- General Arrangement of the whole Plant to 1/16" to the foot.

Drawing No. Nil.- Elevations - Sections along Filter House, Engine House, and Coagulating Tank.

Drawing No.365/12.-Elevations and Sections.

Drawing No.327.- Various Cross Sections.

Drawing No.338/9.- Chemical House Plan and Sections.

Drawing No.365/10.- Chemical House and Engine House Cross Sections.

Drawing No.364/11.- Plans, Elevations and Sections of Office Building.

Drawing No.326/5.- Coagulating Tank Sections.

PATH OF WATER THROUGH PLANT.-

Before giving a closely detailed description of the Plant itself, and going carefully into the various reasons for adopting the present design, it is advisable to indicate briefly the path of the water through the plant.

The General Arrangement Plan Drawing No.331/7, will illustrate the following :-

Water enters from the Conduit on the left, passing through a large sluice gate, and enters the Steadying Chamber from which it is discharged over the weirs into the Mixing Troughs. An underground connection between the Steadying Chamber and the Float Chamber of the Chemical Measuring Gear maintains the water level in the latter at the same level as the former. The Mixing Troughs discharge into a Distribution Chamber running across the ends of the Filter House and the Coagulation Tanks, and thence along the back of the Coagulating Tanks.

Drop Valves admit the water to the Coag. Tanks, through which it passes slowly to the Filter Inlet Pipes and Valves. It then passes downwards through the Filter Beds, and

and into the Pure Water Channel, which in turn discharges into the Pure Water Reservoir.

DESIGN OF THE PLANT.-

A. CAPACITY.

The Plant is designed for a total future maximum capacity of 24,000,000 gallons per 24 hours, (continuous working).

At present however the Filter Units, and Coagulating Tanks have been constructed for only half of this supply. All the other portions however are complete, so that when the final full supply is required, those portions at present omitted may be added without interruption of the supply.

B. SOURCE OF SUPPLY.

A Dam at GANDIPET some 11 miles distant impounds about 35 months supply on full capacity. From here the water is led to the Filter Plant by means of a Masonry Conduit, constructed for the most part underground. A section of this culvert is given below together with a memo of the calculations involved. The design and construction of this conduit was carried out entirely by the State Engineer.

C. DATA SPECIFIED.

For the purposes of the design of this Filter Plant data was provided by the State as under :-

(1) Particulars relating to the Cross Section and design of the Conduit.

(2) The present and the future capacity of the Plant.

(3) The reduced levels of the Culvert at the point of its entry into the area reserved for the Filter Plant.

(4) The reduced level of the water in the Culvert at the above point, when flowing with its maximum designed capacity.

(5) The reduced level of the water in the Clear Water Tank after its passage through the new Filter Plant.

(6) A site plan of the area reserved for the Filter Plant, showing location of the incoming Conduit, approximate desired location of the outgoing supply pipes, and the Spot Levels over the whole area.

DATA ASCERTAINED.-

The nature and condition of the water to be treated, both from a Chemical and Bacteriological standpoint is of course the chief determining factor in the design of any Filter Plant.

Accordingly a complete series of tests was carried out over a period of twelve months to establish these characteristics at various periods of the year.

COAGULATION BY ALUMINA SULPHATE.-

A consideration of the results of these tests showed that the degree of impurities in the water, as also its hardness, remained fairly constant throughout the year. It was found that a coagulation period of not less than 3 hours, and a minimum dose of ·3 grains of Sulphate of Alumina per gallon of crude water would give the most economical distribution of these two factors in view of the objects to be attained, viz:-

1st. That the efficiency of the Filters should be a maximum when judged by,-

(a) Purity of Effluent.

(b) Period between successive cleansing of the Filter Beds.

(c) Economy in use of Wash Water.

2nd. That the combined capitalised cost of Chemicals, together with the cost of providing Coagulating Tanks of the capacity determined should be a minimum.

Under

Under actual working conditions the dose of Sulphate of Alumina found necessary is (SEE APPENDIX) grains per gallon of crude water.

The Plant has been supplying water to the town of Hyderabad for 15 months, and the effluent has been ascertained to be of a uniformly high degree of purity.

HARDNESS.-

It was also found that provision must be made for the reduction of temporary and permanent hardness by means of Sodium Sulphate.

STERILISATION.-

More as a matter of wise precaution than from real necessity, provision was made for the addition of Chlorine in the form of a Chloride of Lime. It is usually found that the degree of purity obtained in the passage through the Filter is such as to render the use of Chlorine unnecessary.

APPLICATION OF CHEMICALS.-

During the normal operation of the plant this is of course in the hands of the Officer in Charge, who must be continually testing the incoming Crude Water, and also the outgoing Pure Water. Upon these tests he bases his estimate of the actual amount of each chemical required for the particular period to ensure the safety and potability of the Filtered Supply.

PRELIMINARY DESIGN.-

Having regard to the foregoing data, the main elements of the design were then decided.

A. FILTER UNITS.- (MAXIMUM FIGURES)

Total Supply per 24 hours day	=	24,000,000 gallons
" " " one hour	=	1,000,000 gallons
" " " second	=	44.5 cu.ft.

The present supply as mentioned was to be half the above,-

Supply per 24 hour day	-	12,000,000 gallons
" " one hour	-	500,000 gallons
" " second	-	22.25 cu.ft.

While

While the above were specified as being the maxima at which the plant should ever be used, it was understood that normally the flow would be somewhat less than this, viz. 20,000,000 gallons per 24 hour day.

(Normal Figures)

Total Supply per 24 hour day	-	20,000,000 gallons
" " " one hour	-	833,333 gallons
" " " second	-	37.1 cu.ft.

The present supply being again half the above,-

Supply per 24hour day	-	10,000,000 gallons
" " one hour	-	416,666 gallons
" " second	-	18.55 cu.ft.

For purposes of design it was therefore decided to proportion the whole of the Plant to the larger figures, with the single reservation, that the extra 4,000,000 gallons per day be regarded as an overload on the 20,000,000 gallons per day, and not likely to occur except for more or less limited periods during times of excessive demand for water.

This effected a considerable reduction on the total sand area to be provided.

From long experience in India it is found that under usual conditions it is not advisable to run the beds at a speed much in excess of 75 to 80 gallons per sq. ft. per hour.

In the present case however conditions were very favourable owing to the long period of preliminary storage in the Reservoir, resulting in a water of comparative purity throughout the year, and even at its worst, of very much greater purity than the majority of other Plants in India are called upon to deal with.

Under these circumstances it was considered safe to run at not more than 100 gallons per sq.ft. per hour for normal conditions, and at about 115 gallons per sq.ft. per hour under overload conditions.

The total area of sand required was thenfound to be about $\frac{1,000,000}{115}$ = 8695 sq. feet.

The

The largest unit up to this time that had been installed in India was 18'-0" x 10'-0" = 180 sq.ft. The adoption of this size in the present case would have involved too many small units, each of which would have required a complete set of the necessary operating gear.

It was therefore decided to adopt a larger unit viz. 20'-0" x 18'-0",- area = 360 sq.ft.

A total of 24 such units was decided on, giving a sand area of 8640 sq.ft. and resulting in the following speeds of Filtration,-

Normal Maximum,- $\frac{833,333}{8,640}$ = 96.4 gals per sq.ft. per hour.

Overload Maximum,- $\frac{1,000,000}{8,640}$ = 115 " " " "

The number of 20' x 18' Units for present use = 12
" " " " " " future " = 24.

B. COAGULATING TANKS.-

As mentioned above the period of Coagulation was fixed at 3 hours, this resulting in a capacity of 3,000,000 gallons for future supply. and 1,500,000 " " present " .

C. ARRANGEMENT OF PLANT.-

It was now possible to commence the rough layout of the Plant, bearing in mind the site plan provided, the capacity of the Coagulating Tanks, the number of Units, the location of the Inlet and Outlet, and also the necessary Chemical House, Measuring Gear House, Pump House, Workshop, Offices, Overhead Tank, and other portions of the Plant to be provided for, and of which mention will be made later.

It was not possible conveniently to place all the units in one house in one line as this resulted in too long a Filter Building. In addition to which the units

at

at the far end would have been inconveniently remote from the other portions of the Plant. Two lines of 12 Units each appeared to give the best result, and this was adopted.

The next step was to decide whether the whole of one line, or the half of each line should be built at present. Both arrangements have something in their favour, but the question of Coagulating Tanks decided it in favour of the former.

As will be seen from the Drawings, all the units in one line are fed from a common channel behind their house, which channel receives its water from the Coagulating Tanks behind.

It is necessary to clean out these Tanks at intervals, as they collect the sludge precipitated by the Alum. In a continuous running Plant like the present, it is necessary to clean the tanks out without interfering with the operation of the Plant. It is thefefore necessary to sub-divide the tanks into two or more compartments and arrange matters, so that one may be closed down, emptied and rapidly cleaned, while the other compartments are still in operation.

Had half the units been built in each line at present, this would have involved doubling the subdivision of the tanks, as each tank behind six units would have required sub-division in itself. The tanks as actually arranged for are therefore the full length of the Filter House, and have one centre partition at right angles thereto. The mean size of each of the 4 compartments is about 120' x 102' x 10' = say 750,000 gallons, or a total of 3,000,000 gallons, i.e. 3 hours storage.

The next step was to consider the best method of leading the incoming water to the Coagulating Tanks present and future. Many arrangements were tried, but that finally adopted appears to offer the most advantages.

LEVELS.-

The establishment of a complete set of water levels at all points throughout the passage through the Plant now called for attention. The whole design in this case was much

much complicated by the fact that only 8'-0" was allowed for the total "loss of head" from the surface of the incoming water to the surface of the water in the Pure Water Reservoir. This was the maximum figure which could be obtained from the State, as the whole Water Supply Scheme, of which the Filter Plant was a part, had already been designed allowing for this loss only.

As figures of 12'-0" & 14'-0" are quite the common practice for this class of Filter, it will be seen that the design was much influenced throughout by this restriction.

The allocation of this 8'-0", so that the necessary flow would be maintained, and yet leave sufficient head where required for the "Measuring Gear", "Filter Head", and the "Outlet Control Gear", required a considerable amount of adjustment, as such a low head as 8'-0" had never been used before.

The chief "loss" is the "Filtering Head" itself, which is the difference in level between the water surface in the Filter Unit, and the water surface in the Inspection Box after its passage through the Filter. Experience and experiment have shown that the minimum figure for this purpose to ensure satisfactory results in working is 6'-0", and as it was not considered advisable under any circumstance to reduce this, 6'-0" was adopted, leaving only 2'-0" for all other losses.

One of the features of Rapid Filtration is the accurate Chemical Treatment of the water. Automatic means are provided to measure accurately the flow of water into the Filter Plant, and to add to the water the predetermined dose of each Chemical Reagent in strict proportion to the amount of Crude Water passing the Measuring Gear. As the available head was so small much serious consideration was given to this portion of the Plant with a view to reducing the loss of head here to a minimum.

The usual type of Measuring Gear involves passing the water over a Weir or Notch having a free fall. With the volume

of

of water to be treated this necessitated either a narrow Weir with a big loss of head, or a shallow wide Weir with a small loss of head, and a corresponding loss in total vertical movement of the free surface of the water above the Weir between maximum flow and zero flow. In a gear of this type the operation of the chemical valves is dependent on this vertical movement.

Calculations were therefore made for two other alternative types of gear, and rough designs prepared, with the object of deciding whether or not it were possible to obtain a gear of greater accuracy and sensitiveness than would result from one of the shallow wide Weir type.

First a Venturi Tube was examined. With the restricted head available only small velocities were obtainable in this type of gear, and the variations between the surface levels in chambers connected to the large and small diameters were so small as to give it no advantage over the Weir type. This was especially noticeable on the lower limits of the discharge curves. While the adoption of this type of gear would not have been impossible, it did not compare favourably with the shallow Weir type, either in simplicity of design, efficiency, or first cost, and it was therefore abandoned.

Secondly a Drowned Weir was tried. At first sight this appeared very advantageous, as a Weir of moderate width and suitable depth could be obtained with comparatively small variation in the up and down stream surfaces. It was also abandoned on account of the practical difficulties of working a gear which would accurately operated by two water surfaces each of which was subject to vertical, as well as relative movement. Another objection was the absence of reliable experimental data applicable to a Weir of the size and type considered, which would also have introduced further inaccuracies into the operation.

When the water is discharged from the Inspection Box to the Pure Water Channel, another drop is necessary to obtain the necessary motion for the operation of the Outlet Control Gear

Gear of each Unit.

The three chief losses were therefore established as under.-

Measuring Gear.-	Depth of Weir	=	9"
	Drop below lip of Weir to surface of water in Mixing Trough	=	6"
Filtering Head.-		=	6'-0"
Outlet Control Gear.-	Depth of Weir	=	5"
	Drop below Weir	=	3"
	Total loss	=	7'-11"
	Balance		1"
	Loss allowable	=	8'-0"

This figure of one inch only was obviously quite inadequate to take the water round the Plant and into the Pure Water Reservoir, but on examination of the cross section of the Conduit and the figures for its design, it appeared possible to obtain another 5" head, without serious infringement of the conditions laid down by the State that 8'-0" only could be allowed.

As the matter was one of the importance, the permission of the State was obtained for this extra figure of 5", thus making the total head available for all other losses 6". Under the heading of "Main Conduit" full particulars are given of this extra 5" head.

In the event of course of the State's refusal of this 5", it would have been necessary to pare down slightly the main losses given above to obtain at least 6" for the purpose of taking the water round the plant.

MAIN CONDUIT.-

Before giving the table of actual reduced levels as finally established throughout the Plant for purposes of the final design, it is necessary to examine the section and design of the Main Conduit.

A Cross Section of this is given on Drawing No.44/15,988, and the calculations upon which its design was based are also shown thereon. These are exactly as supplied by the State for guidance in the design of the Filter Plant.

From these figures it will be noted that "Max Water Level" +1751.91 is shown at 4'-6" above the Invert, and the discharge is finally assumed by the State to be 27,243,000 gallons per day at this level.

With the limited loss of head available it was obvious that the water would require to be "banked up" in the Conduit at its discharge end for all conditions of flow except the maximum, as the shallow main Weirs must be so fixed as to take the full supply at the maximum level. At intermediate rates of flow, the level of the natural free surface of the water in the Conduit, if not banked up, would fall lower than the lip of the Weir itself.

It was therefore decided to discharge the Conduit into a large steadying Chamber, on the far side of which would be fixed the main Weirs. The total depth of the above had been fixed at 9", so that even in the event of the total cessation of flow in the Conduit the water level at its lower end could not fall below the lip of the Weir,- except of course by the operation of the cleaning pipes and valves provided.

The level shown viz. + 1751.5 was adopted as the maximum to be allowed in the chamber, when discharging the full 9" above the lip of the Weir, the level of which thus was fixed at +1750.75.

A fresh calculation on the same lines as followed by the State will show that the free flow through the Conduit with a water level of +1751.5 will be about 24,000,000 gallons.

A further rough calculation showed that to obtain a flow of 20,000,000 gallons,- the normal capacity,- another reduction of about 5" on the water level in the culvert was required.

As 5" was all that was necessary to complete the diagram

of levels satisfactorily, it was finally decided to bank up permanently in the Conduit to + 1751.5 as mentioned above, for 24,000,000 gallons flow, and to utilise this 5" to increase the available loss of head to 8'-5". The level of the water in the clear water channel was thus fixed at + 1743.09.

The entry of the Conduit to the Chamber is controlled by a large Gate Valve, and a suitable overflow is provided above this with a lip at such a level as not to interfere with the full flow to the Filter. It discharges to a suitable drain as soon as the level rises over its lip, which might arise either from accidental or malicious tampering with the valves at the Dam, thus causing serious flooding of the Plant, or from the total or partial closing down of the sluice gate above mentioned should this become necessary for any urgent reason.

With a lead of over 10 miles and a fall of only 1 in 5000, the time taken for water to flow from the Dam to the Filters would be about six hours, so that control at the inlet end of the Conduit would be quite useless in case of emergency at the Filter Plant.

FINAL LEVELS.-

The following are the reduced levels of the water surfaces at all chief points throughout the Plant.-

Steadying Chamber	+ 1751.5
Top of Mixing Trough	+ 1750.25
Foot " " "	+ 1750.0
Coagulating Tanks	+ 1749.9
Filter Beds	+ 1749.75
Inspection Box	+ 1743.75
Clear Water Channel	+ 1743.09

STEADYING CHAMBER.-

As shown on Drawing Nos.44/10,429 and 44/10,420 this is rectangular in section, and increases in a distance of 25 feet from

from 5'-0" wide by 4'-1" deep, to 31'-0" wide by 6'-0" deep. It then runs parallel for 10'-0" on this latter section. The velocity of approach to the Weirs is thus reduced to $\frac{44.5}{186}$ = .24 feet per second on future overload maximum discharge.

MAIN WEIRS.-

There are two Main Weirs, each of which is 10'-6" wide by 9" normal depth. One Weir only is in operation at present, the other being built into its permanent position and then closed with a temporary wall, which can easily be removed when necessary to bring the second twelve Filter Units into operation.

The details of the design of the Weir, which is of gunmetal screwed into a massive Cast Iron Frame, are clearly shown on Drawing No.44/10,424.

The width of the Weir was determined as 10'-6" as under.

Maximum capacity as above = 24,000,000 gallons
= 44.5 Cusecs.
∴ For one Weir capacity = 22.25 "

Using Francis' Formula as modified by Smith,

$$Q = 3.29 \left(1 - \frac{h}{10}\right) h^{\frac{3}{2}}$$

From which l = 10.5 feet = 10'-6" each.

The subject of the flow over these Weirs is ~~gain~~ again taken up in detail in connection with the design of the "Chemical Measuring Gear", a description of which follows.

MIXING TROUGHS.-

Each Weir discharges into a separate Mixing Trough, 15'-0" wide and 102'-0" long. These are shown on Drawing No.44/10,429 in plan, and on Drawing No.44/10,418 in Section. They are built in masonry, and are provided with a series of low diagonal baffle walls throughout their length. These ensure the ~~through~~ thorough mixing of the Chemical Reagents which

which are added to the Crude Water during its passage down the Mixing Troughs. The water is discharged from the latter into the Distribution Channel. Owing to the baffle walls it is impossible to compute exactly the flow down these Troughs. A fall was given of 3" in 102 feet, i.e. 1 in 408, and it was roughly estimated that a flow of about 1.5 feet per sec. would be obtained, allowing for the fact that the baffle walls would be entirely submerged.

In Photograph No.2, it will be seen that the baffle walls near the Weir are actually submerged, although the latter at the time was running only partially filled. The floor of the trough was made + 1749 at the top end, and + 1748.75 at the lower end. The area of section of the Trough is 15 x 1.25 = 18.75 sq.ft.

If the above velocity of 1.5 ft. per sec. were obtained the discharge of each Trough would be = 18.75 x 1.5 = 28.125 cusecs. This appeared to provide ample margin, as with the limited head available no risks could be taken of banking up the water at any point in its passage through the Plant. In practice the Mixing Troughs are found to serve the intended purpose very effectively.

DISTRIBUTION CHANNEL.-

This runs across the end of the Filter House, (present and future), and the side walls of the Coagulating Tank. With a sharp 90° bend it then runs along the back wall of the Coagulating Tanks. The Mixing Troughs discharge into it as shown, on Drawing No.44/10,429, and the water thus passes to the various 30" diar Drop Valves which control its entry to the Coagulating Tanks.

At present only one half of this Channel is constructed, but provision is made so that in future the remainder may be added and the temporary wall blocking the unfinished end removed with a minimum of interference with the operation of the Plant.

The

The areas provided, viz. 43 sq.ft. on the side of the Coagulating Tanks, and 40 sq.ft. along the back of the latter, allow for a maximum velocity of .52 ft. per second, which will obviously involve an almost negligible loss of head.

30" DROP VALVES.-

Three of these are provided to give entry to each of the Coagulating Tank Compartments. The Valves were designed especially to give a minimum of obstruction to the water, and are shown in detail on Drawing No.44/10,334.

In the event of either compartment being shut down for cleaning, it is necessary to run the full supply for the 12 Filter Units through one set of three Valves. With the comparatively clean water available for this Plant, the deposition of sludge will be small, so that the above contingency does not often occur.

The maximum flow is, as noted above, 22.25 cusecs maximum for twelve Units, i.e. 3.71 cusecs for each 30" Valve. The full bore area of each Valve is 4.55 sq.ft. so that the velocity of passage is .815 feet per second on normal duty, and 1.63 ft. per second on double duty. The Valves as will be seen run completely submerged, being operated by an extension of the screwed spindle to a suitable standpost above.

A free fall of .115 feet will produce a velocity of 2.72 feet per second, so that allowing for losses due to Inlet, Friction, and Outlet, say 40%, it was considered safe to estimate this loss as not exceeding 1½ inches through the Valve on double duty. Similarly when on normal maximum duty the velocity being .815 ft. per second, the loss of head between the Channel and the Coagulating Tanks would not exceed ½".

COAGULATING TANKS.-

These are fully illustrated on Drawing Nos.44/10,429 & 44/10,423. Each compartment of the Tank at present constructed is

is roughly 120 feet, by 104 feet, by 10 feet mean depth. This gives a capacity of about 750,000 gallons, which is equivalent to,-

$\frac{2 \times 750,000}{416,666}$ = 3½ hours on 10,000,000 gallons per day

$\frac{2 \times 750,000}{500,000}$ = 3 hours on 12,000,000 " " "

On the rare and widely separated intervals when one compartment is closed down the above periods would be halved, i.e. 1½ hours, and 1¾ hours reaction period. No evil effect will accrue from this temporary decrease of the coagulating period, the result being that for a short time extra duty is thrown on the Filter Units themselves. Under normal conditions of working the Coagulating Tanks perform a function of almost equal importance to the Filters themselves, most of the heavy sediments being precipitated here before the water reaches the sand beds, which otherwise would foul with such rapidity under the high rate of flow per square foot as to render it impossible to operate the Plant economically.

It will be noted that floor of the Coagulating Tanks is arranged in a series of ridges and valleys in Cross Section, and also that it has a fall from the Filter House end towards the Inlet end. Each valley is made with a trough 1'-6" x 1'-9" along its length, and each trough leads to a 12" diar Sludge Pipe. This passes through the back wall and discharges to a drain running along outside the wall. Each of the 4 pipes per compartment is controlled by a 12" Sluice Valve operated from above by a suitable spindle and Headstock.

A periodical flush through these Valves one at a time tend to remove the sludge and increase the periods between the complete closing down of the compartments for thorough cleansing.

The water enters the Tank through the various openings shown at floor level along the back wall of Tanks which also supports the Distribution Channel above.

After passing slowly through the Coagulating Tanks the water enters the Collecting Chamber running along the back

of

of the Filter House. From this channel each of the Filter Units draws its water as described below.

By Author ?

An interesting innovation was introduced in the design of this Channel. The usual practice is to control the entry of the water into the channel by means of Valves and Pipes set into the wall, or by means of Sluice Gates let into the wall and operated by hand when necessary to isolate one of the compartments. In the case of a large Plant such as the present this would have involved many such Valves or Gates placed along the whole length of the dividing wall. One or two openings of larger capacity would not have been permissible as this would have tended to cause "short circuiting" of the water across the Tank, certain portions of which would have remained practically stagnant once the flow had established itself across the tank.

To avoid this, no opening at all was made in the division wall, but the top of it was dressed off as shown in Section to form in effect a submerged Weir the full length of the Filter House. The lip of the Weir was made 3 inches below the normal level of water in the Tank, i.e. +1749.65. Under a flow of 12,000,000 gallons,- the maximum for each pair of compartments - this gave a rate of flow of $\frac{22.25}{245}$ = .091 cusecs per foot of Weir, and .182 cusecs when one compartment is taking the full supply.

The head in front of the Weir having been fixed at 3" = .25 foot, assume the loss of head .05 ft i.e. h = .25 and h^1 = .2

Q. then becomes = $\frac{2}{3} \times \frac{1}{2} \times 1 \sqrt{64.4 \times .05} (.25 + .1)$

$$\left(\text{i.e.} = \frac{2}{3} \; k \; b \sqrt{2 g (h - h^1)} \left(h + \tfrac{1}{2} h^1 \right) \right)$$

from which Q = .21 cusecs.

The actual max. flow as above is .182 cusecs, from which it is seen that the loss of head at this point under normal conditions will be less than ½". This being so, there would

be

be no virtue in calculating exactly what the loss of head will be to a fraction of an inch.

On Drawing No.44/10,494 will be seen the detail of a balanced Baffle Gate inserted in the Collecting Channel where the division wall joins it. This, in conjunction with the above submerged Weir, constitutes the innovation already mentioned. Its action is as follows. When working normally with both compartments in operating, it is locked along the channel and is inoperative, the water level in the channel being uniform throughout. When one compartment is to be shut down, its 30" Drop Valves are closed, the other Valves remaining full open as they usually are. The whole supply then passes into the other compartment, and flows over the Weir into the Collecting Channel. The Baffle Gate is now gently moved round to restrict the flow to the other half of the channel. As the Filters themselves are set to maintain a constant flow of water, it is obvious that the level in the channel behind the six Filters affected will begin to fall. The Gate is locked in such a position that the loss of head in passing it is just sufficient to keep the water level in the channel slightly below the lip of the Weir. The compartment to be cleaned is now thoroughly isolated, and the Sludge Valves are opened full.

After cleaning, the compartment is again filled by opening the 30" Valves gradually. During the filling period of course the whole Plant willrun at a somewhat reduced total capacity, unless extra water is admitted at the Dam, the latter course however not being an advisable one on account of the length of the Conduit, and also on account of the trouble involved in resetting the Valves correctly at the Dam.

The design of the various walls in the Coagulating Tank calls for no special comment. These walls are built in accordance with the usual practice and have always answered the purpose required very effectively.

FILTER UNITS.-

As already stated there are in all 24 Units each 18'-0" x 20'-0", half this number being at present constructed. They are arranged in two rows of 12 each, in two separate houses, so designed however that the centre wall is common to both houses when the second battery of 12 Units is installed. The masonry filling in the arches in this wall will then be demolished, and the two houses will become one. Each house is 36'-0" wide x 249'-0" long inside walls. The construction is very clearly indicated on Drawing Nos.44/10,417 and 44/10,429.

The speed of filtration under the various conditions has already been given. The action of the Filter in operation is now examined in considerable detail.

INLET GEAR.-

This is shown on Drawing No.44/10,572.

A hand wheel on the centre line of each Unit is operated from the platform running along the back of the Units, and through suitable shafts and gears controls the special 9" x 9" x 12" T Shaped Valves, full detail of which is shown on Drawing No.44/10,393. This Valve is located below the water level in the Collecting Channel, and from it two 9" pipes passing through the back wall of the Filter, lead to the combined Inlet and Waste Troughs. Under normal conditions the pipes are made somewhat smaller in diameter, but as the head was limited the pipes were increased to 9". This results in a velocity of 2.36 ft. per second through the 12" opening, and of 2.09 ft per second through each of the 9" openings when passing the maximum quantity of 1.85 cusecs per Unit.

Allowing for losses of entry & exit, and pipe & valve friction, it was estimated that a maximum differenee of head of 3½ inches between the water levels in the Collecting Channel and the Filter Unit would be ample to maintain the desired flow.

Inlet

INLET AND WASTE TROUGH.-

Drawing No.44/10,317 shows the construction of these troughs, which are made up of pressed steel.

The design is based on the following conditions:-

The lower portion is curved to admit of the easy settlement of the sand after washing. During this process the upward rush of water carries the whole of the sand bed upwards in suspension, the upper layers of water being thus highly charged with floating particles of sand. When the rush of washing water is stopped the latter immediately settle downwards forming a smooth top surface on the now purified sand bed. This is of great importance as most of the work in the Filter is done on the "Carpet" formed on the top surface of the sand.

The upper portion of the trough is formed of pressed steel lip pieces which recede inwards and finish in an adjustable vertical edge. The water flowing inwards over these lips is steadied and most of the sand in suspension is deposited and slips back before the wash water is discharged over the lip of the Weir. The loss of sand to waste is thus reduced to an almost negligible percentage.

The loose strip, having its top edge planed true is provided so that after the troughs are connected up into place and the end pipes built in a rapid and accurate adjustment can be made, ensuring that the discharge over the lip into the trough is uniform at all points.

When washing the Unit, the Inlet Valve mentioned above is closed, and the Waste Valve at the front of the Filter is opened. The flow of water over the lips is 2,880 gallons per minute when washing. This will be referred to again. The total length of lip in one Unit being 40'-0", the flow per foot of width is 72 gallons per minute, and the corresponding "head" over the lip is 1¾ inches. It is most essential that this water is carried away by the waste pipes at such a rate that the depth of water remaining in the

trough

trough can not rise high enough to interfere with the free flow of the Weir along its whole length. When this point has been neglected it is found that the major portion of the water discharged from the trough is drawn from the front area of the filter where the flow is rapid, while at the back, owing to the trough being full the flow is correspondingly sluggish.

The special tapering pipes shown on Drawing No.44/10,318 were designed to facilitate the exit of the waste water. The top edge is level and as low as possible to prevent the entry of air, the section being the full size of the trough, and running gradually into a pipe of 9" diameter. These pipes from each of the troughs are connected to a three way valve, 9" x 9" x 12", identical with that already described on the Inlet pipes. A vertical 12" pipe discharges into the drain running along the front of the Filters.

When in operation the water level in the Unit is + 1749.75, the lip of the trough being + 1748.5. The waste valve is closed and the inlet is open, the water flowing into the trough and rising from it into the Unit with a minimum of disturbance.

FILTER BEDS.-

The details of these are clearly shown on Drawing No.44/10417. As already mentioned each bed is 20'-0" x 18'-0" giving an area of 360 sq. feet of sand, the top surface of which is 15 inches below the lip of the Waste Trough, and 30" below the normal working level of the water in the Filter.

The sand bed itself consists of a layer 2'-2" thick of carefully graded sharp quartz sand, screened through a 30 mesh, and retained on a 40 mesh brass wire seive. This rests on a series of layers of sharp quartz pebbles, the top layer being 1/8" to 1/4" by 4½" thick, the next layer 1/4" to 1/2" by 4½" thick, and the lower layer 1/2" to 3/4"

by

by 3" thick. The total depth of the Unit from the platform level, which is 12" above the working level of the water, to the centre line of the Collector Tubes is 6'-8".

COLLECTOR SYSTEM.-

The whole of the bottom of the Unit is covered by a system of pipes as shown on Drawing No.44/10,417. Each tube is 1½" in diameter, and is perforated along its lowest point with a series of 3/16" diameter holes 3" apart. The tubes are spaced 6" apart, and are coupled in pairs into a "T" piece screwed down into a large "Header" of rectangular section 14" x 5" inside. Two such Headers, each 17'-9" long lie across the floor of the Unit. Details of Headers and Strainers are shown on Drawing Nos.44/6651 and 44/6652. They are coupled by 8" pipes leading from below to a common pipe 10" diar. which passes through the front wall of the Filter. The system is so designed and proportioned that the whole area of the bed is uniformly served during each of the three processes to which it is subjected, viz. I Filtering II Aeration and III Washing.

As mentioned above the total wash water discharged into the Filter is 2,880 gallons per minute per Unit. The total number of 3/16" diar holes per Unit is 2,664, giving an area of discharge of .51 sq.ft., and resulting in a velocity of flow through the holes of 15 feet per second. This will involve a loss of head of about 10 feet.

The normal downward flow is only 96.4 gallons per sq.foot per hour, resulting in a velocity of .5 feet per second through the 3/16" holes. The loss of head here is negligible.

The resistance to the passage of the air used before washing is also negligible.

OUTLET CONTROL GEAR AND INSPECTION BOX.-

In front of each Unit is arranged an "Inspection Box", shown in detail on Drawing No.44/10,416. It serves the main

main purpose of containing the Outlet Control Gear upon which the regulation of the discharge from the Unit is dependent.

It will be seen on Drawing No.44/10,417 that the 10" pipe referred to above on passing through the front wall of the Unit is connected into a "T" pipe having to the left a 10" branch to which is connected the 12" Wash Water Main running along the Waste Trough below and passing under the Inspection Box. A 10" Sluice Valve controls the flow from the wash main. Another branch 9" diar leads to the Inspection Box, the water passing through a 9" Sluice Valve just outside the latter, and discharging through the 9" Double Beat Outlet Control Valve into the Inlet Chamber of the Inspection Box. In this Chamber is located the Bye-pass Valve 8" in diar, by means of which it is possible to discharge the effluent from the Filter into the Waste Trough below. This is necessary when starting up the Unit after washing,- a short period being required to allow the "Carpet" on the top surface of the sand to form a new. When this Valve is closed the water passes through the openings shown into the lower portion of the Float Chamber, and thence into the Weir Chamber,- lined with white glazed tiles, so that the purity of the water discharged over the Weir into the Pure Water Channel may always be under observation. A horizontal Cast Iron Plate in the Float Chamber divides the latter into two portions, in the upper of which is located the Float 2'-6" diar. The plate is perforated so that the water in which the float rests is perfectly quiescent, and the height of its surface over the lip of the Weir is the "Head" causing flow. See Dr.No.44/10,426 & 44/10,430.

The function of the Outlet Control Gear is to preserve at all times a uniform rate of discharge from the Unit.

The total "Filtering Head" is 6'-0" as already noted, this being the vertical difference in level between the normal working level of the water in the Units and the Float Chamber. If no Outlet Control Valve were interposed the discharge from the Filter would be that due to 6'-0" head,

decreased

decreased of course for the various losses involved. The actual discharge required however can be obtained with only a fraction of this head until such time as the "Carpet" has become almost impervious to the passage of the water. At the commencement of a run, immediately after washing, the resistance of the "Carpet" is small. It gradually increases until the Unit is again ready for washing, so that some form of Control Gear is obviously necessary to ensure a uniform rate of discharge at all times.

In the present instance the action of the Control Gear is as under :-

The Double Beat Control Valve opens downwards, its spindle passing up through the long cast iron bracket lying diagonally across the top of the Inspection Box. It is pinned as shown to the end of a horizontal lever whose fulcrum is beyond the vertical spindle of the float. The latter is also pinned to this lever as shown. Any vertical displacement of the float is therefore transferred to the valve spindle, and is at the same time increased fourfold. The float spindle passes down through the float as shown, but is not attached to it, the weight of the valve and lever being transmitted to it by means of the adjustable nut working on the screwed portion of the spindle.

The valve opening is carefully adjusted by means of this screw and nut until the desired flow is obtained over the Weir, the discharge of which for various depths is known. As the "Carpet" becomes more and more impervious the loss of head in the Filter increases, so that the "Available Head" causing flow through the valve is diminished. The float then tends to fall, but in doing so it opens the valve by an amount four times as great, thus allowing more water to pass. By this means the flow at the end of a run is maintained within a few per cent of the maximum at the commencement of the run.

The actual details of the design are given below.

Under

Under ordinary conditions, where the total head through the Filter Plant is not limited, the usual practice is to have the discharge Weir or Notch in the Inspection Box comparatively deep, say 9" or even more. The float is then arranged directly over the valve and is mounted on the same spindle, so that the fall of the float produces the same increment of opening in the valve. With the deep Notch or Weir it is still possible to arrange matters so that the percentage variation at beginning and end of the run is small.

In the present case however the Weir had been fixed at 5" maximum depth, and a variation of even ½" in the head over the Weir would produce a serious variation in the diacharge.

The max. flow per Unit	=	1.854 cusecs
Velocity of flow in 9" pipe	=	4.21 feet per sec.
Filtering Head	=	6'-0"
When sand is clean say the total losses in the Filter	=	1'-0"
"Available Head" therefore	=	5'-0"
The velocity of "free fall" corresponding to 5'-0"	=	17.9 ft. per sec.
Actual velocity produced say 60% of 17.9	=	10.74 " " "

To keep the flow constant it is therefore necessary to choke down the velocity from max. 10.74 ft. per sec. to 4.21 ft per sec.

With a Double Beat Valve,- each opening 9" diar,- a lift of 1⅛" is necessary to give full area of pipe through the valve. This condition must obtain at the end of the run, whereas at the beginning the valve would, from a consideration of the above, be closed down to say 3/8" opening to give the necessary throttling effect. This would involve a variation of some 3/4" in the level of the water over the Weir, which is obviously too great.

The first arrangement tried to overcome this defect was to increase the diameter of the valve, and thus reduce the lift required to give "full bore" through a 9" pipe. The large diameter required to obtain a satisfactory result involved

involved the introduction of a very large and costly valve. The present arrangement was therefore devised, and the variation in head reduced to something of the magnitude of $\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$".

The discharge Q per inch width of Weir is,-

Q for 5" deep = 4.47 cu.ft. per min. (Tabulated)

" " $4\frac{7}{8}$" " = 4.30 " " "

" " $4\frac{3}{4}$" " = 4.14 " " "

∴ say Q for $4\frac{13}{16}$" deep = 4.24 " " "

approx. Percentage variation is therefore of the magnitude of

$$100 - \frac{4.24}{4.47} = 5\%.$$

To ensure as far as possible the steady working of the valve both the upper and the lower seats were made 9",- the details of the design being clearly shown on Drawing No.44/10439. This eliminated the unbalanced load which is usually present in valves of this type due to one seat being slightly larger than the other.

The float itself was also made with an excess of weight so that it held the valve under strong control. Ballast is added to sink it to the level shown in the drawings.

To prevent the water level in the Filter from falling much below the lip of the Waste Trough, the Outlet Control Valve is connected by means of a loose link and levers shown on Drawing No.44/10,417 to the Float inside the Filter. The action of the valve as described above is unaffected by this safety gear which would only come into action in the event of some accidental and incorrect manipulation of the Bye-pass or Inlet Valves. If the water was allowed to fall below the Waste Trough the "Carpet" would be destroyed by the impact of the water falling from the trough, or if the water ran right out, it would be necessary to "tune" the Filter up again before it could be brought into operation.

The main float in the Inspection Box is, as noted, loose on its spindle. The object obtained by this modification

of

of previous practice is that the float inside the Filter when in operation is relieved of the necessity of carrying the main float which would otherwise remain suspended from the lever above it when the water in the Inspection Box was run to waste. As made, the main float settles down on the cast iron plate leaving its spindle free.

The Weir is similar in construction to the main Weirs already described, its width being determined as 25 inches, using the same formula as already quoted for the main Weirs. A table of discharges, worked out to this formula for various heights and widths being available, it was found to be of great service in the proportioning of the Weirs.

As a matter of interest Barnes formula (vide "Barnes Hydraulic Flow Reviewed") was used to check the Weirs. In the present case, using $Q = 3.324\ H^{1.49}\ L^{1.11}\ (L - 2H)^{-.11}$, the following results were obtained,-

"Head" over Lip of Weir = .1 foot, Q = .2218 cusecs
" " " " " = .2 " , " = .6174 "
" " " " " = .3 " , " =1.1200 "
" " " " " = 5 inches" =1.8064 "
" " " " " = .5 foot " =2.3684 "

For a depth of 5" the Francis formula gives a discharge of 1.85 cusecs, which does not differ much from 1.8064 given by Barnes. The formulae as derived by the latter Authority are undoubtedly more accurate than any hitherto evolved, but they are somewhat laborious in practical application.

AERATION OF FILTER BED.-

When the "Carpet" becomes so impervious that the Unit concerned can not maintain its full supply, it becomes necessary to close down and cleanse the Filtering Medium. The Inlet to the Filter is closed, and also the Sluice Valve outside the Inspection Box. The Waste Valve is then opened and the water in the Filter allowed to run to waste down to the lip of the trough.

The

The first part of the cleansing process is the thorough aeration of the Filter bed by the passage of a strong reverse current of compressed air through the collector tubes and upwards through the Filter. This has the effect of very thoroughly loosening the accumulation of extraneous material deposited among and upon the sand particles. The introduction of such a large volume of air to the Filter bed causes the level to rise and there is a considerable flow into the waste trough.

It has been found in practice that the volume of air normally required for the efficient aeration of a Filter bed is from 3 to 4 cubic feet of free air per square foot of sand bed per minute, and that a period of about three minutes suffices for the efficient loosening of the slimy deposit from the sand.

In the present case it was assumed that 3½ cu.ft. would be required, and the total volume of air was therefore 18' x 20' x 3 x 3.5 = 3,780 cu.ft. per Unit per cleansing.

In Photograph No.IX will be seen the four Horizontal Cylindrical Air Receivers in which are stored compressed air at 80 lbs gauge pressure. Drawing No.44/10,074 shows the detail of the construction of these Receivers which were designed specially for the purpose. The total capacity of the four Receivers is over 1000 cu.ft. this being equivalent to over $1000 \times \frac{95}{15}$ (abs. pressure) = 6333 cu.ft. of free air. The pressure required to force the air through the bed is slightly less than 5 lbs (20 lbs. abs), so that it is not possible to run the receivers right down to atmosphere. The amount of free air left in the receivers is therefore about $1000 \times \frac{20}{15}$ = 1,333 cu.ft. making the air available for use 6333 - 1333 = 4,000 cu.ft. against the figure 3,780 cu.ft. determined above.

The Receivers are charged by a small Compressor 6" x 7", doing about 50 cu.ft. of free air per minute. In the first instance, owing to the impossibility of importing a suitable compressor on account of War conditions then prevailing, a

belt

belt driven Compressor of this size was designed and built specially. Details of this are shown on Drawing Nos.41/10,694

At a later date it was replaced by the direct coupled motor driven set shown on Photo No.XI.

The time taken to charge the receivers after a run is therefore about $\frac{4000}{50}$ = 80 minutes.

The discharge from the Compressor is led by a suitable pipe to the 6" Air Main. A safety valve is provided at the receivers and is set to 80 lbs. The 6" air main runs from the Receivers underground to the Filter House, passing over the Distribution Channel, and being carried along the front of the Filter Units just under the Operating Platform. This main is controlled by a valve just inside the Filter House. Beyond this again is placed a Pressure Reducing Valve, also specially designed and made for the purpose and shown in detail on Drawing No.44/10,598. This valve automatically reduces the pressure of the air as it passes to the Filter beds to slightly over 5 lbs per sq, inch. Beyond this again is placed another Safety Valve (Dead Weight Type) set to about 7/8 lbs per sq. inch. The object of the latter is to prevent the accumulation of high pressure air in the main in the Filter House due to leakage in the Reducing Valve, and the Stop Valve just mentioned, during periods between the washing of Units. This is an extra, and very necessary safeguard against the possibility of pressure air forcing its way past any of the Stop Valves which control the admission of air into the individual Units, and passing thence through the Collector System and upwards through the Filtering Medium, the "Carpet" on the top surface of which would be immediately ruptured and necessitate the closing down of the Unit and re-tuning of the bed. Air is admitted to each Unit by the 4" right angle valve under the Operating Platform. The horizontal branch of this valve leads to the Air Main, and the vertical branch to the T piece already mentioned on the end of the 10" pipe leading from the Collector System.

Wash

WASH WATER SYSTEM.-

On the completion of the aeration of the bed the Air Valve is closed and the Wash Water Valve is opened. This admits a strong flow of pure water which passes upwards through the Collector System and carries off the now loosened impurities from the sand and pebbles to the Waste Trough.

Normally an average rate of flow of 8 gallons per sq.foot of sand bed for three minutes is sufficient to complete the cleansing process.

In this case therefore the water required per Unit per minute = 20' x 18' x 8 = 2880 gallons, i.e. 2880 x 3 = 8,640 gallons total per wash. The 12" Wash main already mentioned carries this water from the Overhead Tank to the Filter Units.

FILTER OPERATING PLATFORM.-

Along the front of all the Units runs a platform, part of which is the top of the front wall of the Filters, and the remainder overhanging the Inspection Boxes below. The original intention was to carry the latter on Cantilever Brackets from the Filter wall, but this was modified as shown on Drawing No.44/11,660, and the overhanging platform made of reinforced concrete. Columns support the platform at intervals along the front of the Filters.

The operation of the Filters is carried out entirely from this platform to which, by means of extended spindles, lead the valves for Wash Water, Air, Waste, Byepass, and Pure Water. Each spindle passes through a C.I. Headstock, and is fitted with a suitable polished handwheel and nameplate. Details of the Headstocks, Handwheels and Nameplates are shown on Drawing Nos. 44/10,282 . The Inlet Valve, as already mentioned, is operated by means of the hand-wheel on the back wall of the Filter House. (In later Plants this wheel has also been placed on the front platform, an extended shaft leading across the Unit from its present position.)

A neat handrailing is run round the Units, and also along the

The Overhead Tank also supplies the necessary pure water to the Chemical House for the preparation of the solutions, and washing out of the tanks and chemical pipes.

A distance piece was provided for each of the Wash Valves to limit its opening so that it was impossible to obtain an excessive rush of water upwards through the bed. Should this occur it is liable to disturb the various layers of pebbles and sand, which become mixed up. Sand is thereby later carried into the Collector tubes and finds its way into the Inspection Box, while the efficiency of the sand bed is impaired by the presence in it of large pebbles Should this occur it is necessary to remove the contents of the Unit, re-grade the whole, and re-lay in correct layers.

The Suction pipe to the Pumps filling this Tank is led from the Pure Water Reservoir as shown on Drawing No. $\frac{44}{11,618}$ to the Pump House under the Tank, which is thus filled with Pure Water as required both for the purposes of washing, and for the High Level area supply just mentioned. Temporary belt driven Centrifugals, see Drawing Nos.14/10,778 and 14/10,780, were first installed. These were replaced later by the motor driven direct coupled sets shown on Photo No.10.

PURE WATER RESERVOIR.-

This is shown on Drawing No.331/7 and also on Photo No.5. The dimensions are 216' x 58' by 7'-0" deep, giving a capacity of 540,000 gallons. The Pure Water Channel in the Filter House discharges directly into the side of the Reservoir with practically no loss of head on account of the ample area of the former.

GAUGE BOARD.-

Drawing No.44/10,553 shows a gauge board placed in the Filter House. This may be seen on Photo No.4.

A mercury column with a plate suitably marked indicates the water level in the Overhead Tank.

ROOF STRUCTURES.-

The Filter House, and also the Chemical House are covered by Tiled Roofs carried on Steel Trusses and timber purlins and rafters. These were designed as part of the Plant, and the steelwork supplied from Calcutta, the timber and tiles being obtained at site.

CHEMICAL HOUSE.-

This is situated on the other side of the Mixing Troughs from the Office Building as shown on Drawing Nos.44/10,429 and contains:-

(1) The Measuring Gear Room

(2) The Chemical Storage and Mixing Tank House

(3) The Chemical Storage Room,

the former at the "Inlet" End and the latter at "Filter" end of the building.

SUPPLY OF CHEMICALS.-

Under "Data ascertained" it is noted that provision must be made for :-

(1) Alum

(2) Soda

(3) Chlorine

These are applied as required, and in the form of liquid solutions.

The design of this portion of the Plant is based on the following figures and considerations.

From previous experience it was found that it was necessary to provide chemical gear of such capacity as to be able to add to the Crude Water a volume of solution of not less than one gallon per 1,000 gallons of Crude Water for each chemical. As the total final capacity of the Plant was rated at 1,000,000 gallons per hour, this involved 1,000 gallons per hour of each solution.

The Chemical House and Gear are made suitable at present for

for the whole supply, and need no modification when the future Units are constructed. At present the flow of Chlorine solution is 1,000 gallons per hour, the strength of the solution being half that finally to be adopted, while the flows of Soda and Alum solutions are each 500 gallons of full strength per hour.

CHEMICAL STORAGE TANKS.-

Four tanks are provided for each Chemical solution, so that each tank may run for six hours. Two tanks must therefore be filled during each 12 hour shift. Each tank must thus have a capacity of $\frac{24}{4} \times 1000 = 6{,}000$ gallons. The dimensions adopted were 10'-0" x 10'-0" in plan, with a mean depth of 10'-0" of solution, giving a capacity of slightly over 6,000 gallons. When the solution is running at half capacity at present the tanks concerned will each carry a 12 hour supply instead of six hours.

The arrangement and construction of the tanks is clearly shown on Drawing Nos.44/10,418 They are of masonry and are arranged in two groups of six, one group on each side of the centre passage. A platform runs along between the tanks at a level of + 1766, the top of the tanks being at + 1768. The tanks are filled and operated from this platform, access to which is obtained by means of the staircase shown in the Chemical Storage room. A small hand crane was designed and fitted to lift the chemicals from the ground floor level to the platform level. This is shown on Drawing No.25/10,535. The alleyway between the tanks and below this platform contains the various chemical pipes and valves, and leads from the Chemical Storage room to the Chemical Measuring gear room. Two tanks on each side and adjacent to the latter are for Chlorine, the remaining four on the far and near sides being for Alum and Soda respectively.

Each pair of tanks is served by a common Mixing Box placed on the front wall over the common dividing wall. This

is

is made of masonry and is of capacity sufficient to carry a full charge of chemical. Details are shown on Drawing No.44/10,418. In each corner is an Outlet Valve as per Drawing No.44/10,508 which admits the solution to either tank as required. A swivel valve admits pure water to the Mixing Box. The whole of the water required to fill the Chemical Tanks is passed through the Mixing Boxes and the chemicals washed down therefrom into the Tanks.

The bottom of the Tanks is sloped towards the centre and at the front of the "Vee" is placed the Outlet Pipe, which runs through the wall and is controlled on the outside by means of gunmetal valves, the spindles of which run up to the platform above for convenience of operation. A Strainer is fitted on the inner end of the Outlet Pipe as shown on Drawing No.44/10,432. Along the front of the tank inside is constructed a waste channel at the end of which is placed a waste valve for use when cleaning out the tanks. The waste from these valves runs into a drain in the alleyway as shown.

For purposes of aeration, the Soda and Alum Tanks are each provided with an air pipe which runs along the bottom of the "Vee" and is connected with the Air Main between the Receivers and the Filter House.

A stirring gear of timber was also designed for agitating the above tanks,- see Drawing No.44/10,648.

These Storage Tanks are built so that there is always sufficient head available for them to empty themselves through the pipes provided, and at the rate required, into the Chemical Measuring Gear. These pipes are of lead, and are provided with suitable joints for cleaning out if required. Each line of pipe is also connected to the Pure Water Supply System so that a rapid scour through may be given at intervals.

It is unnecessary to give details of the calculations made for the various systems of piping all round the Chemical House.

House. Each pipe was proportioned so as to give the required flow under the heads available.

In operation these tanks are carefully calibrated. The required amount of chemical is added to give the desired strength of solution, and the Chemical Measuring Gear is set to pass the necessary amount of solution per hour.

The layout of the Piping for the Chemical House is shown on Drawing No.44/10,443.

CHEMICAL MEASURING GEAR.-

The arrangement and details of this very important apparatus are fully shown on Drawing Nos.44/10,433, 44/10,434, 44/10,435, 44/10,436, 44/10,437, 44/10,438 and 44/10,431.

An underground pipe connects the Float Chamber with the Steadying Chamber above the Weir, and the rise and fall of the Float operates the Module Valves by means of the vertical rack on the Float Spindle, and the toothed sector on the cross shaft. The motion of the float is magnified by the larger diameter of the sectors which carry the Module Valves, the motion of the latter being as $\frac{8}{6}$ times greater than that of the float. This was considered desirable on account of the comparatively shallow weir, more accurate adjustment of the flow being possible with the longer valves.

The three chemical supply pipes from the Storage Tanks lead each to a separate compartment in the large Slate Tank containing the Module Valves. The flow of solution is adjusted by means of the Ball Float Valves, of the double beat type. The floats themselves are adjustable so that valves may be set to keep the level of the solution in the compartments at any desired constant height above the orifices of the Module Valves. The action of the Module Valves is such that when the float falls the valves are lowered into their seats thus restricting the orifice. When the water in the Steadying Chamber falls to the lip of the Weir, and the flow becomes zero, the Module Valves seat themselves and shut off the supply

of

of solution entirely. Full details of the calculations made to determine the proportions of these valves are given below. In actual operation the valves are found to answer very closely to the calculated capacities. Provision as noted above is made to adjust the head in the compartments, so that within the limits of variation of flow which are liable to occur in actual operation of the Plant it is possible to obtain very exact adjustment of the flow of solution in proportion to the actual amount of water entering the Plant.

At present one Module Valve only in each of the compartments is in operation. The other two are disconnected from their sectors and rest in their seats.

The solution is caught below the slate tank in suitable cups, and led thence by means of lead pipes to the points of its application. The soda is added to the crude water just below the Weir, and the Alum about half way down the Mixing Trough. The Chlorine is led to the Filter House and is added to the pure water channel at the third Unit down the house.

DESIGN OF MODULE VALVES.-

The flow over the Weir was first calculated for each inch of height over the lip from zero to 10", using the Francis Formula as modified by Smith, viz., $Q = 3.29(1-\frac{h}{10})h^{\frac{3}{2}}$. In the following table,-

Column No.1.- Shows inches of head over the lip of the Weir.

" No.2.- Shows discharge over one Weir in cusecs.

" No.3.- Shows discharge over one Weir in gallons per hour.

" No.4.- Shows required flow of Chlorine solution in cusecs.

" No.5.- Shows required flow of Soda and Alum solutions per valve in cusecs.

" No.6.- Shows area in sq. inches required in Module Valve to give flow of chlorine shown in No.4.

Column

Column No. 7.- Shows area in sq. inches required in Module Valve to give flow of Soda and Alum shown in No.5.

" No. 8.- Shows diameter in inches of pin of Module Valve for Chlorine.

" No. 9.- Shows diameter in inches of pin of Module Valve for Soda and Alum.

" No.10.- Shows area in sq. inches of Section of Pin for Chlorine.

" No.11.- Shows area in sq. inches of Section of Pin for Soda and Alum.

Column No.2 is obtained from above formula.

" No.4 is 1/1000 of the total flow of cride water, or 1/500 of the flow over one Weir as given in Col. 2. As already noted the full flow of Chlorine is at present allowed for, the solution being half final full strength.

" No.5 is half of Col. No.4, as two valves are installed, and full strength of solution is used, one valve at present being inoperative.

" Nos.6 & 7 are obtained by dividing Cols. 4 & 5 by 5.7, this figure being the assumed velocity of flow in feet per second through the orifice under a head of 18" in the Chemical Tanks. The velocity due to free fall of 18" would be 9.82 feet per second. Making due allowance for loss of head due to friction, and other causes it was estimated that this would actually be reduced to 5.7 ft. per sec. Adjustment of the ball floats is also available to vary slightly the head of 18" so that it is possible to obtain actual flows in close agreement with the theoretical. The areas required are converted to sq. inches.

" Nos.8 & 9 are obtained by assuming that the minimum diameter of the pins is $\frac{1}{8}$", their areas being given in Cols 10 & 11. When the pins are right down, the pin diameter must be equal to the diameter of the orifice to give zero flow, therefore it is next necessary to determine the maximum size of each orifice. For a flow of 10" on the Weir areas of 1.32 and .66 sq. inches are necessary, but the minimum diameter of the pin, viz. $\frac{1}{8}$" is present in the orifice so that its area must be added to the above, giving 1.32 + .0123 = 1.3323 sq. inches for Chlorine and .66 + .0123 = .6723 sq. inches for Soda and Alum. The diameters corresponding to these areas are 1.3" and .925" respectively. These figures therefore appear at foot of cols. 8 & 9.

The intermediate areas of pin section at each level of flow are obtained by subtracting the required area from the above areas of the orifices, and the diameters are obtained from these areas.

The

The pin diameters given in Cols. 8 & 9 will be found to agree with those shown on the detail Drawing of the Valves, see Drawing No.44/10,438.

1	2	3	4	5	6	7	8	9	10	11
10"	26.12	588,000	.05224	.02612	1.32	.66	⅛"	⅛"	.0123	.0123
9"	22.2	502,000	.0446	.0223	1.125	.562	.514	.374	.2073	.1103
8"	18.7	421,000	.0374	.0187	.945	.472	.702	.504	.3873	.2003
7"	15.3	344,200	.0306	.0153	.772	.386	.845	.603	.5603	.2863
6"	12.18	274,000	.02436	.01218	.615	.307	.955	.681	.7173	.3653
5"	9.22	207,600	.01844	.00922	.465	.232	1.050	.749	.8673	.4403
4"	6.61	149,000	.01322	.00661	.334	.167	1.128	.802	.9983	.5053
3"	4.31	97,200	.00862	.00431	.2175	.1087	1.190	.845	1.1148	.5636
2"	2.36	53,200	.00472	.00236	.1192	.0596	1.241	.882	1.2131	.6127
1"	0.906	20,400	.001812	.000906	.0458	.0229	1.278	.908	1.2865	.6494
o"	Zero	0	0	0	0	0	1.30	.925	1.3323	.6723

Full details for the installation of the gear will be found on Drawing No.44/10,433.

PHOTOGRAPHS.-

To illustrate the Plant as actually completed the following eleven photographs will be of interest.-

No.1.- The Dam at GANDIPET, from which the culvery brings the water to the Filter Plant.

No.2.- Looking up the Mixing Troughs. The right Trough in partial use at time of taking the photo. In the background the large Steadying Chamber from which lead out the Weirs. In the background the small house covering the large Sluice Gate, beyond which again is the overflow (not visible). Note the chemical pipes coming along the ledge on the right, and leading to the right hand Mixing Trough. On the right the Chemical Storage Tank, and Chemical Measuring Gear building. On the left the Pump Room, Office etc., building with tank overhead.

overhead.

No.3.- View from the corner of the Coagulating Tanks. In the background the two buildings mentioned above in No.2, and on the left the Filter House. Note the Inlet Valve Operating Gears in wall of Filter House. Also the Baffle Gate handle at end of partition wall. On the right note the Distribution Channel bringing the water from the Mixing Trough, and across the Channel note the slabs carrying the operating handles for the 30" Drop Valves. Behind this again on the right, note the Sludge Valve operating gears. On the right also note the slope where the ground had to be dressed down to accommodate the Plant.

No.4.- View (in the Filter House) along the top of the Filter Units. On the right note the Inlet Valve operating Handwheels in the wall, and on the left the Operating Hand Wheels for the control of the Filter. The lower level of the House in front of the Filters does not show. In the background is the door leading to the Pump House, and Chemical House, and on the end wall is the Gauge Board.

No.5.- Outside end view of the Filter House, showing in the front of it the ventilators for the underground Storage Reservoir from which lead the town mains. The end wall of the Coagulating Tank shows on the right of the House.

No.6.- Chemical Measuring Gear, showing the slate tank in three compartments, with the inlet pipes leading in from the Chemical Storage Tanks. Note the toothed rack and quadrant on the right leading down to the float below, and the various quadrants from which are hung the long needle valves. The ball floats can be seen inside the Slate Tank. The graduated scale may be seen on the right, the pointer being attached to the rod from the float.

No.7.- View along top of Chemical Storage Tanks. The Mixing Chambers may be seen on either side with their Valve Handles,

and

and the operating rods leading to the Outlet Valves in the passage below are also clearly shown.

No.8.- View along the lower passage between the Chemical Storage Tanks. Note the Lead Pipes leading along on each side and the Outlet Valves on either side.

No.9.- Outside view of the Office, Pump House, Workshop, etc. Building, showing the Tank on top and the pipes leading up into the latter. In the foreground are the four long Cylindrical Air Receivers.

No.10.- View of the direct coupled electrically driven Pumping Sets.

No.11.- View of the direct coupled electrically driven Air Compressors.

WORKING DRAWINGS.-

The following is a list of the various Working Drawings referred to in the foregoing paper. They are arranged in the order in which they are mentioned in the context.-

44/15,988 - Cross Section of Conduit
44/10,429 - General Arrangement of Filter Plant
44/10,420 - Building Cross Sections Sheet No.1
44/10,424 - Detail of Weirs
44/10,418 - Building Cross Sections Sheet 5
44/10,334 - 30" diar. Drop Valve
44/10,423 - Building Cross Sections Sheet No.2
44/10,421 - " " " " No.3
44/10,494 - Baffle Plate Valve
44/10,417 - Filter House Cross Sections.
44/10,572 - Filter Inlet Valve Operating Gear.
44/10,393 - 9" x 9" x 12" Stop Valve.
44/10,317 - Waste Trough.
44/10,318 - Special Taper Pipes.
44/6,651 - Detail of Headers.

44/6652 - Detail of Strainer Tubes

44/10,416 - Filter Outlet Control Gear. Inspection Box Details.

44/10,426 - Details of Filter Outlet Control Gear, Float etc

44/10,430 - Details of Filter Outlet Control Gear. Rods and Levers.

44/10,439 - Filter Outlet Control Gear, Main Valve.

44/10,074 - Air Receivers

44/10,694 - Arrangement of 6" x 7" Air Compressor

44/10,598 - Reducing Valve

44/11,660 - Filter Platform Details

44/10,282 - Handwheels and Nameplates

44/10,299 - Headstocks

44/10,427 - Ladders & Pipe Supports

44/11,618 - Pump Suction Pipes

14/10,778 - Plan of Temporary Pump

14/10,780 - Elevation of Temporary Pumps

44/10,553 - Detail of Gauge Board

25/10,535 - 5 Cwt Jib Crane

44/10,508 - Details of Sludge and Mixing Box Valve

44/10,432 - Chemical Tank Outlet Pipe & Strainer

44/10,648 - Agitation Gear

44/10,443 - Plan of Chemical House Piping

44/10,433 - Chemical Measuring Gear. General Arrangement. Sheet 1.

44/10,434 - Chemical Measuring Gear, Slate Tank. Sheet No.2

44/10,435 - Chemical Measuring Gear. Sheet No.3

44/10,436 - Chemical Measuring Gear. Details. Sheet No.4.

44/10,437 - Chemical Measuring Gear. Sheet No.5.

44/10,438 - Chemical Measuring Gear. Valve Details.

44/10,431 - Chemical Measuring Gear Inlet Valve.Sheet No.7

GUARANTEED EFFICIENCY OF FILTER.-

The following is the guarantee under which the Filter Plant was undertaken.-

I. Suspended Matter.-

The removal of suspended matter from the Raw water as examined by the usual analytical methods will be 100%.

II. Colour.-

The Filtered water will be clear of colour to such extent that a Platinum wire of 1/25 inch diameter shall be discernable to a person of normal vision when placed at a depth of 6 feet in the filtered water at mid-day.

III. Taste & Odour.-

The filtered water will be free from taste and from odour when heated to 37^{0} Centigrade.

IV. Residue of Coagulant.-

The Filtered water will not contain a residue of any coagulant added to the crude water that can be detected by ordinary chemical analysis, unless the public Analyst is satisfied that such is harmless to the consumers.

V. Total Bacteria.-

The number of bacteria per cubic centimeters of the Filtrate as counted by usual standard laboratory practice, will not exceed 150, irrespective of the number present in the crude water at any time or season.

VI. Faecal Bacteria.-

The Filtrate will be purified bacteriologically so that no typical bacteria of sewage can be detected in 40 cubic centimeters of the Filtrate when examined according to the standard set by the Sanitary Commissioner with Government of India.

APPENDIX.

The following notes are based on a visit to the Plant in December 1922 :-

A. The whole of the plant continues to operate in the most satisfactory manner, all portions of the gear and fittings functioning correctly and as designed.

B. The Turbidity of the Crude Water entering the plant throughout the year is not excessive, varying from 50 to 100 depending on the Season.

C. The Pure Water discharged from the plant is perfectly clear and fulfils entirely the guaranteed degree of purity specified before the construction was taken in hand.

D. No trace of Chlorine is to be found in the Pure Water as it leaves the Pure Water Reservoir.

E. The Coagulating Tanks are cleaned out about once in six months. During this process the Baffle Gate and Weir already described act exactly as designed.

F. The average length of run of each Filter Unit between periods of cleansing is from 24 to 30 hours, although cases have occurred where it has been possible to run the beds to about 160 hours.

G. The following table shows the total number of gallons passing through the plant per month, and the actual amount of Alum added to the crude water :-

Month	Total Gallons	Total Alum.	Grains of Alum per gallon of crude water.
1921		Tons. Cwts.	
November	106,000,000	6 - 18	1. 0 Gr.
December	27,000,000	1 - 17	1.07 "

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Month.	Total Gallons.	Total Alum.	Grains of Alum per gallon of crude water.
1922.		Tons. Cwts.	
January	40,000,000	2 - 0	0.77 Gr.
February	72,000,000	5 - 3	1.12 "
March	220,000,000	5 - 2	0.36 "
April	220,000,000	5 - 13	0.41 "
May	247,900,000	7 - 3	0.455 "
June	274,200,000	5 - 3	0.295 "
July	260,000,000	14 - 4	0.855 "
August	228,600,000	18 - 11	1.27 "
September	240,300,000	15 - 3	0.99 "
October	240,900,000	12 - 9	0.81 "
November	248,500,000	11 - 17	0.75 "

From these figures it will be observed that the plant was supplying about 9,000,000 gallons per day in June, and about 900,000 gallons per day in December. The former figure approaches closely the maximum for which the plant was designed to run as already described.

During November and December 1921, and January and February 1922 the conduit was under repair and considerable quantities of extraneous impurities were unavoidably introduced. This resulted in a somewhat higher consumption of Alum per gallon than would normally have been required.

The dose of Alum, it will be noticed, falls appreciably in the hot weather months, being a minimum of .36 grains per gallon in June just before the beginning of the Monsoon. This is the result of the

longer period of undisturbed settlement in the Storage Reservoir prior to admission to the plant. No surface water has, of course, been added to the Reservoir during this period of dry hot weather.

Immediately the Monsoon breaks the turbidity of the crude water increases, and the dose of Alum rises, being a maximum in August. It then falls away gradually until November, and in the absence of extraneous causes to prevent it the expectation is that it will drop in the first half of 1923 to a figure somewhat lower than that recorded for June 1922.

H. The Alkalinity of the water during the above period was fairly constant, being about 18 to 19 parts per 100,000 $CaCO_3$.

J. During this period Chlorine has been added to the water during some months, but not with any degree of regularity. It has now been decided to make the addition of chlorine a regular part of the treatment of the water, the proposed dose being about .2 parts per million.

K. It will be observed that hitherto it has not been found necessary to add Soda to the crude water, although when the preliminary experiments were made, it was indicated that there was a strong possibility of its being required. The portion of the Chemical Gear, and the Mixing Tanks for this Reagent have therefore not been in use up to the present.

L. The monthly expenditure for Establishment at the plant amounts to about Rs1,100/-. This is inclusive of the Supervisor, Chargemen, Fitters, Blacksmith, Coolies,

Gardeners, Storekeeper, Watchmen, Messengers, and Sweepers, - about 50 people in all.

A similar plant in England would probably be run with about $\frac{1}{5}$ of this establishment as regards numbers.

M. The monthly cost for Chemicals, and Stores generally amounts to approximately Rs 2,000/-. This varies of course considerably per month to month, but this figure may be taken as a fair average.



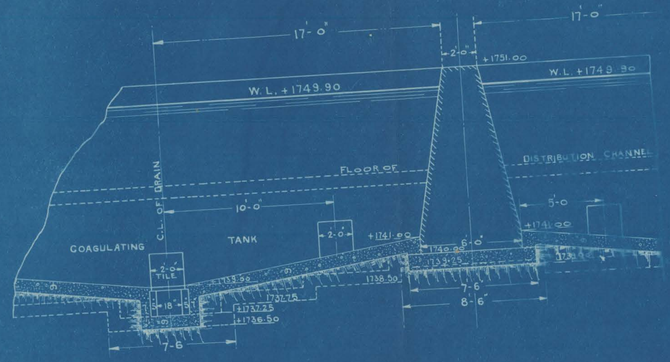
HYDERABAD NEW WATER WORKS

BUILDING CROSS SECTIONS

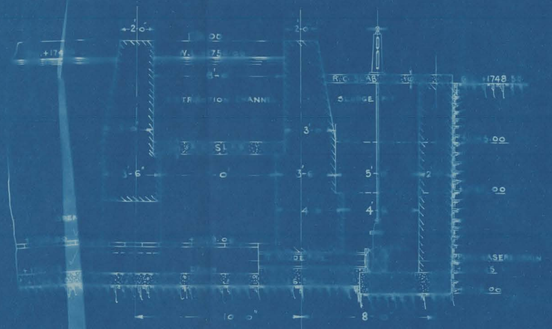
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DRAWING Nº 326/5

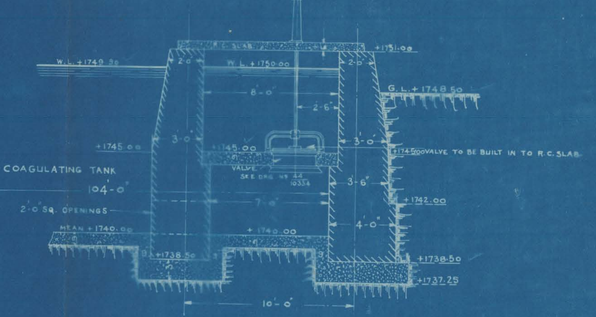
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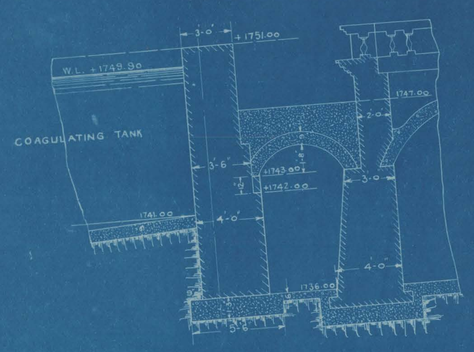
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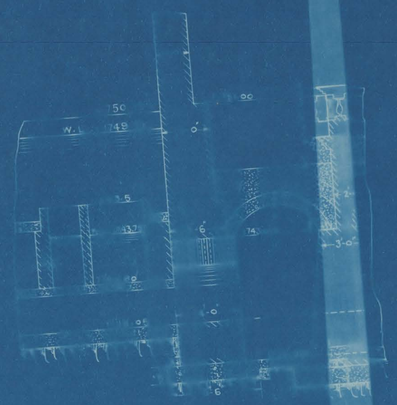
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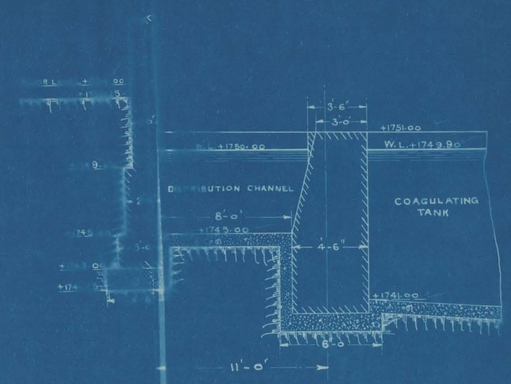
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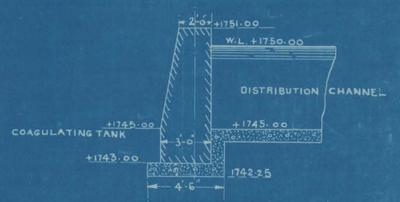
SECTION ON M.M



SECTION ON Q.Q.



SECTION ON R.R.



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HYDERABAD NEW WATER WORKS

BUILDING CROSS SECTIONS

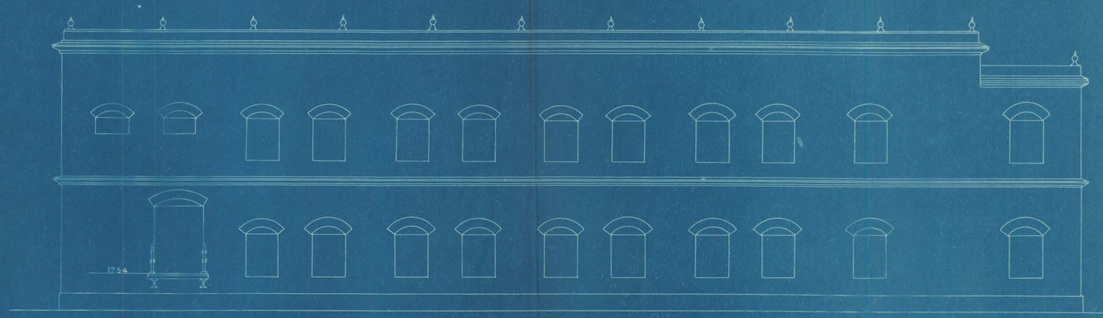
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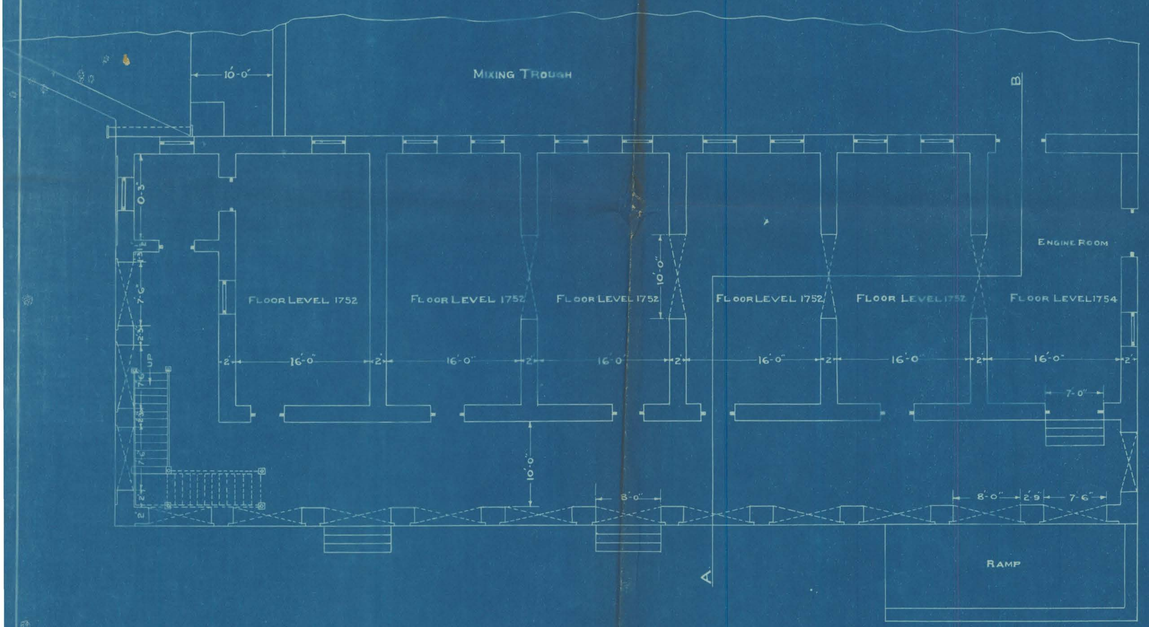
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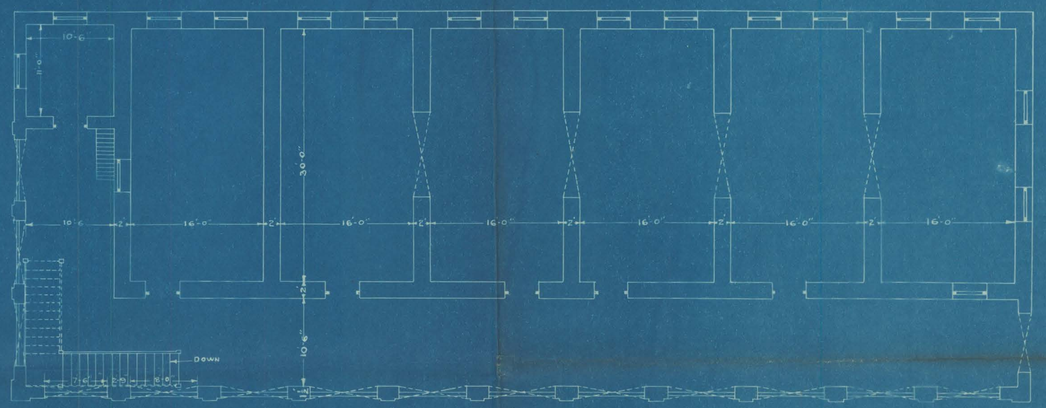
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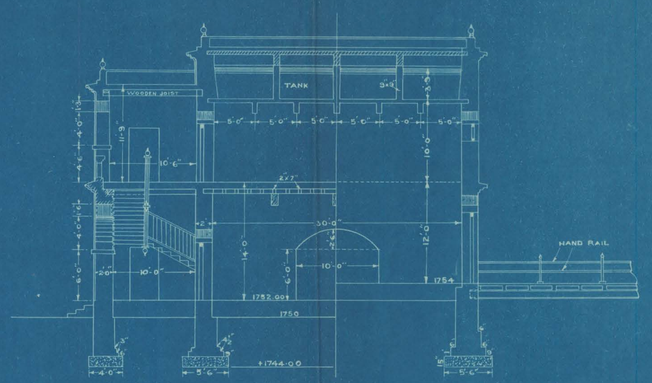
PLAN OF GROUND FLOOR.



PLAN OF 1ST FLOOR



SECTION ON A. B.



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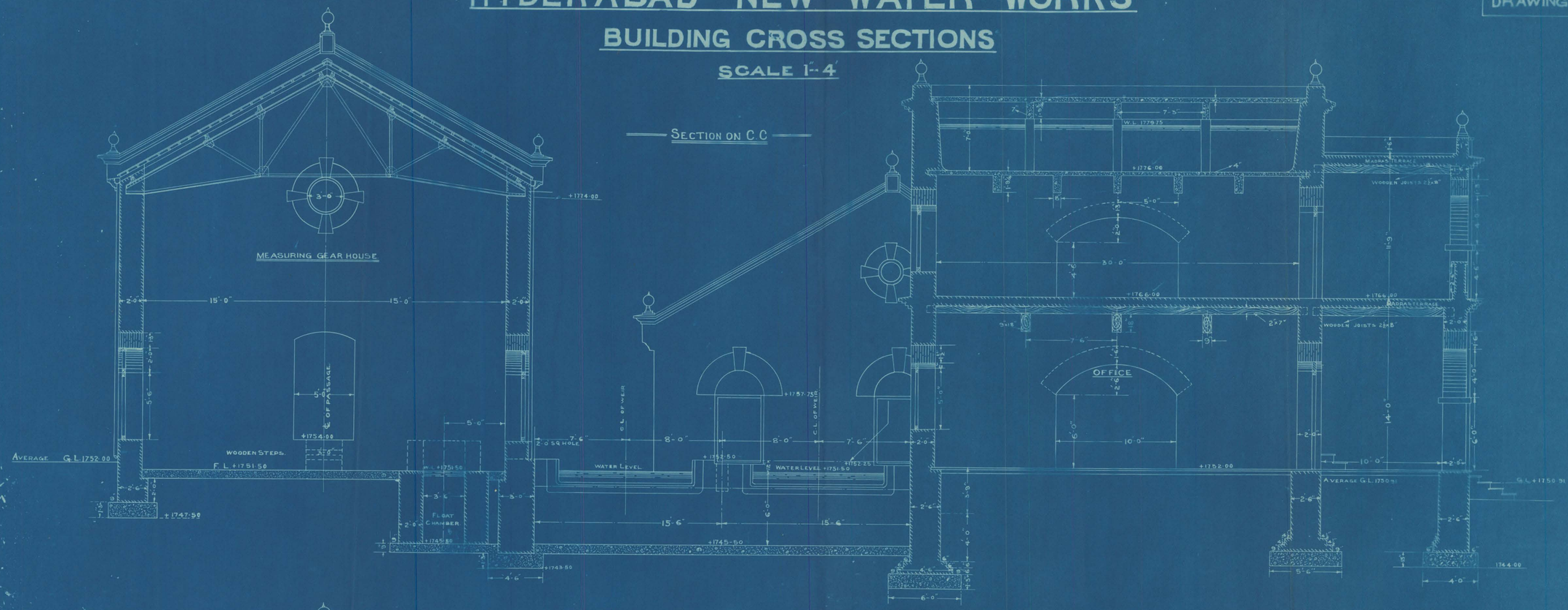
HYDERABAD NEW WATER WORKS

BUILDING CROSS SECTIONS

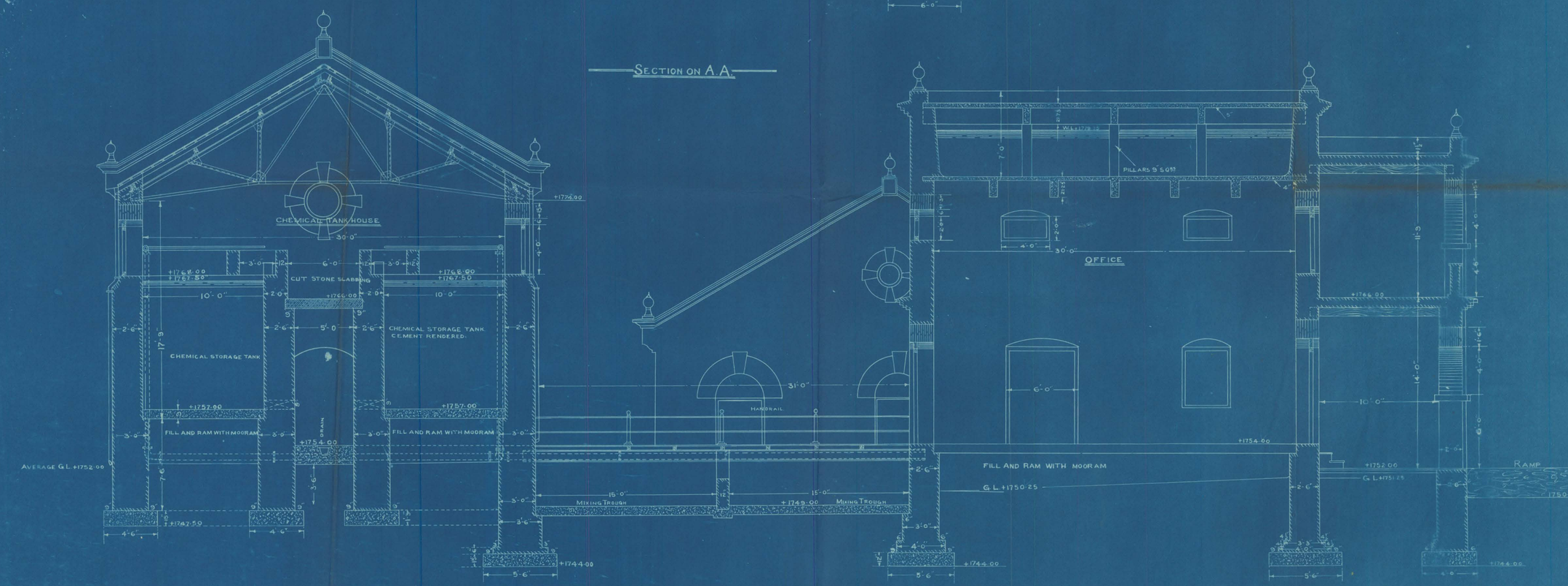
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CONTRACT No. 2
DRAWING No. 363/10

SECTION ON C.C



SECTION ON A.A



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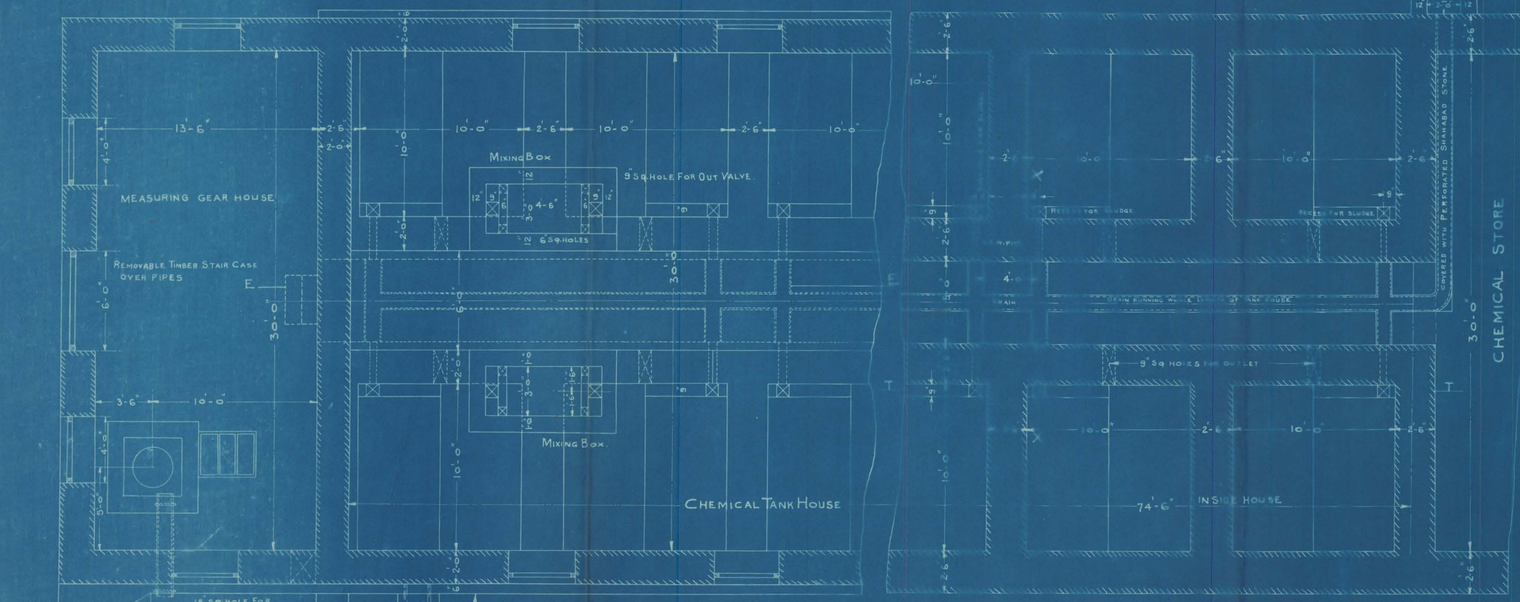
HYDERABAD NEW WATER WORKS

BUILDING CROSS SECTIONS

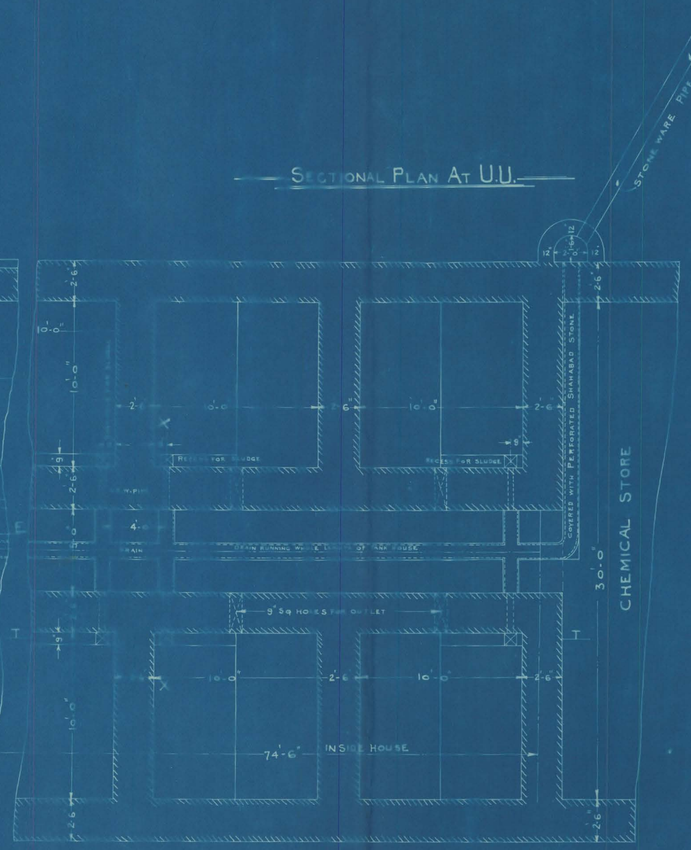
SCALE 1-4'.

CONTRACT Nº 2
DRAWING Nº338/9

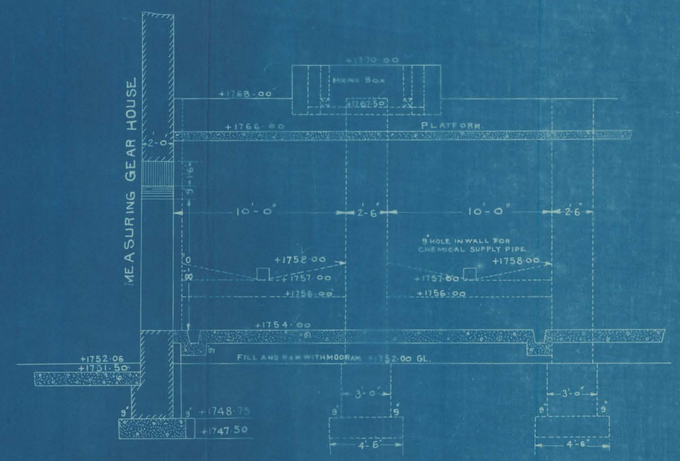
PLAN



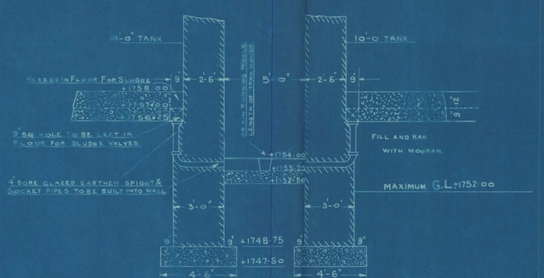
SECTIONAL PLAN AT U.U.



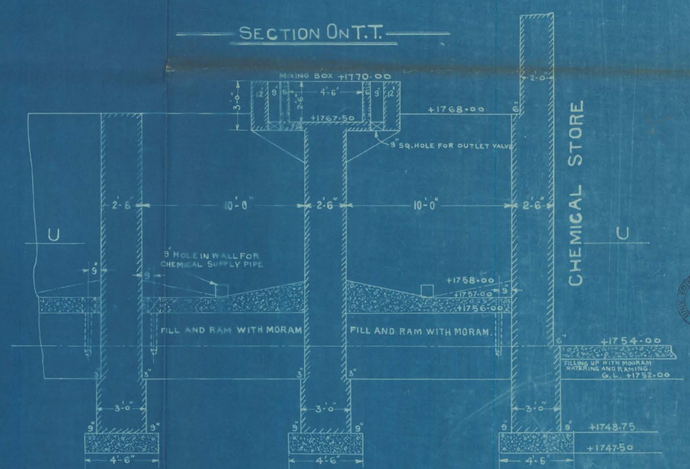
SECTION ON E.E.



SECTION ON X.X.



SECTION ON T.T.



TRACED FROM FERRO SUPPLIED BY THE STATE

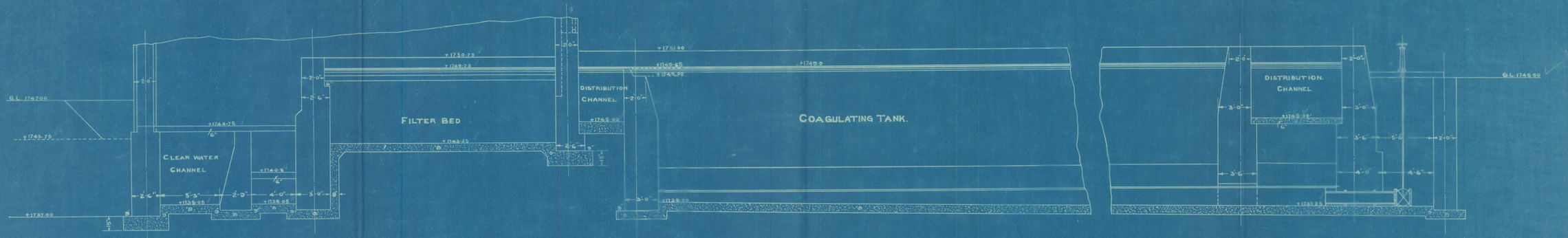
HYDERABAD NEW WATER WORKS

BUILDING CROSS SECTIONS

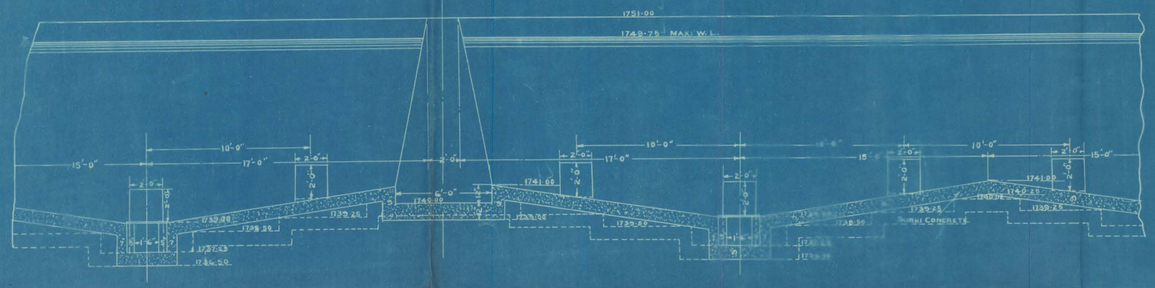
SCALE 4'= 1"

CONTRACT Nº 2
DRAWING Nº 327

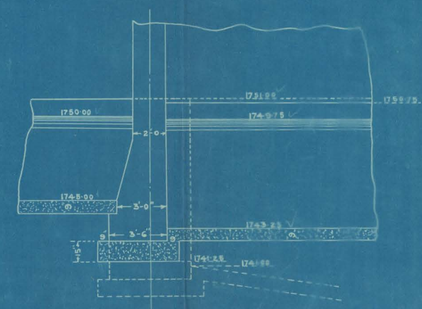
SECTION ON G. G.



SECTION ON K. K.

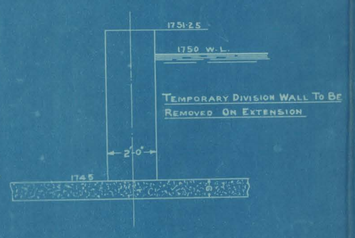


SECTION ON Z.Z.



SECTION ON S. S.

SCALE 3/16-1'

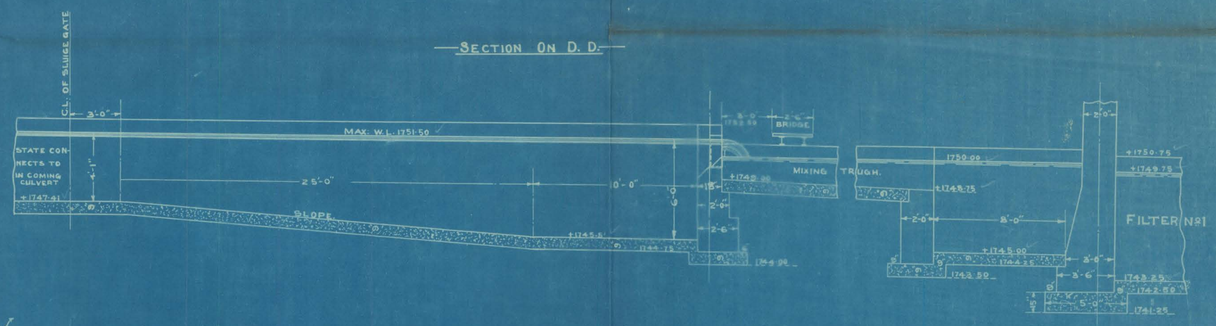


SECTION ON V. V.

SCALE 3/16-1'



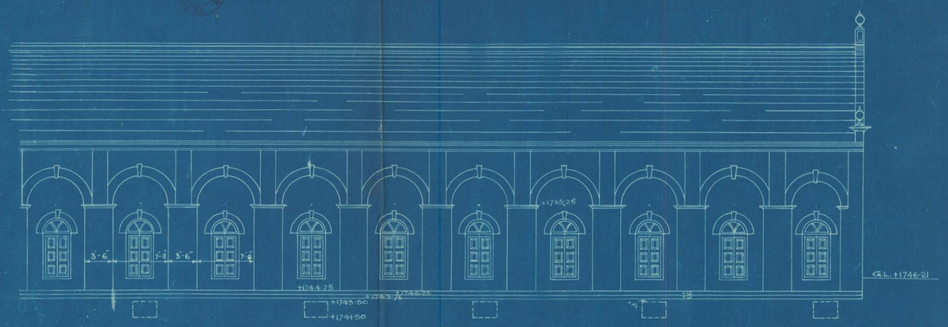
SECTION ON D. D.



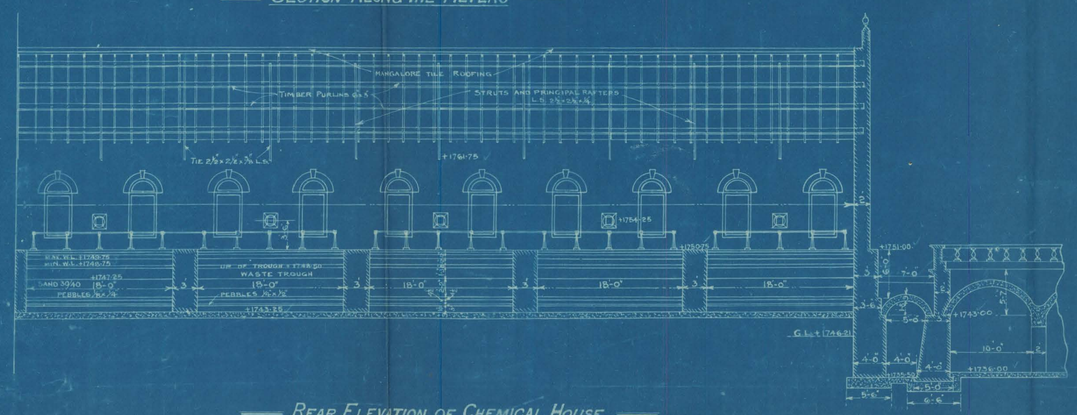
TRACED FROM FERRO SUPPLIED BY THE STATE

WORKS —
HOUSE —

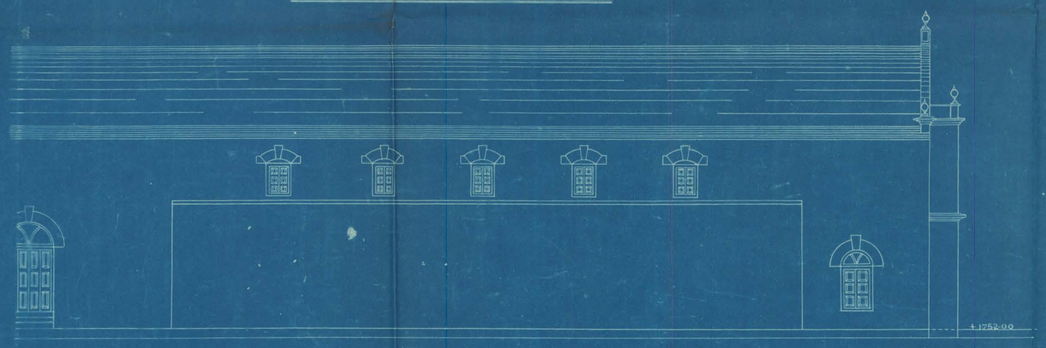
CONTRACT No 2
DRAWING No 365/12



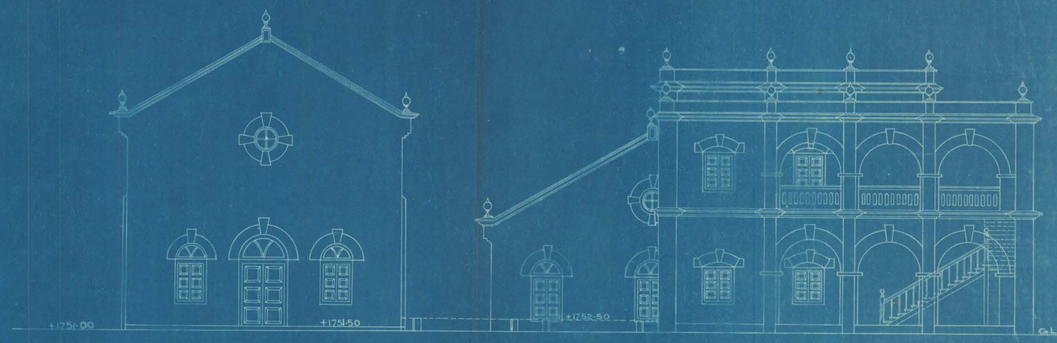
— Section Along The Filters —



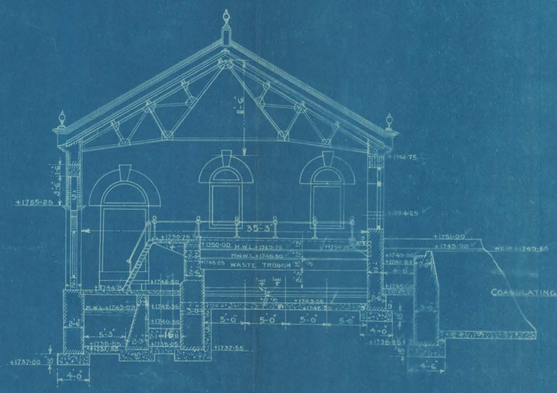
— Rear Elevation of Chemical House —



— End Elevation of Measuring Gear Room, Filters & Engine House —



— Cross Section of Filter House —



— End Elevation of Engine, Filter & Chemical House —
— (Avoiding Balancing Tank) —



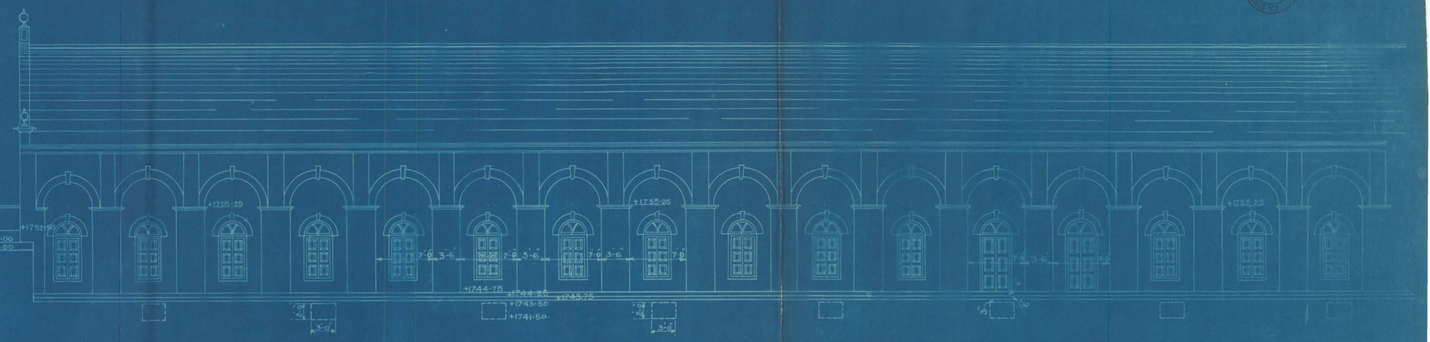
HYDERABAD NEW WATER WORKS

ELEVATIONS & SECTIONS OF THE FILTER HOUSE

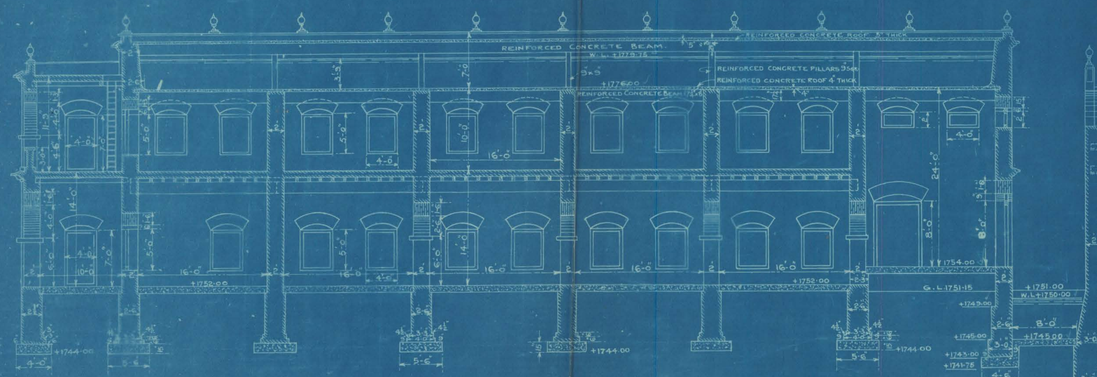
SCALE 8'=1'



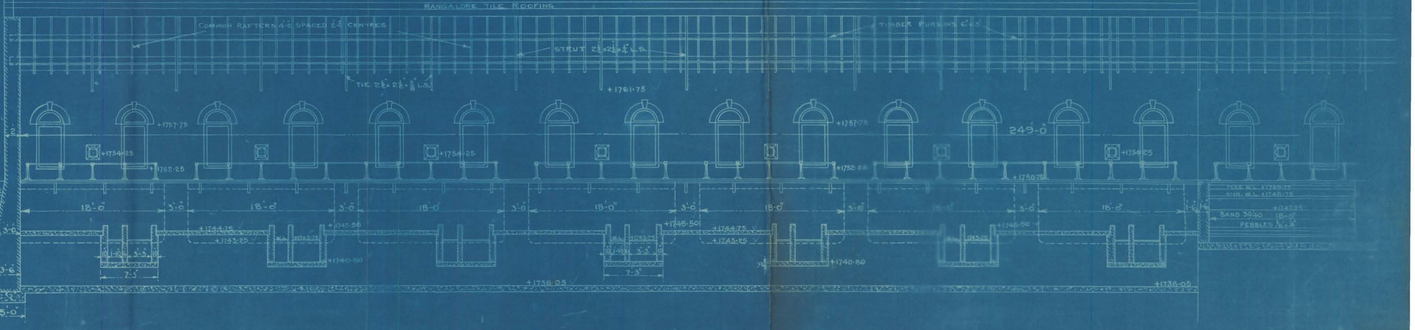
FRONT ELEVATION OF OFFICE, ENGINE & FILTER HOUSE



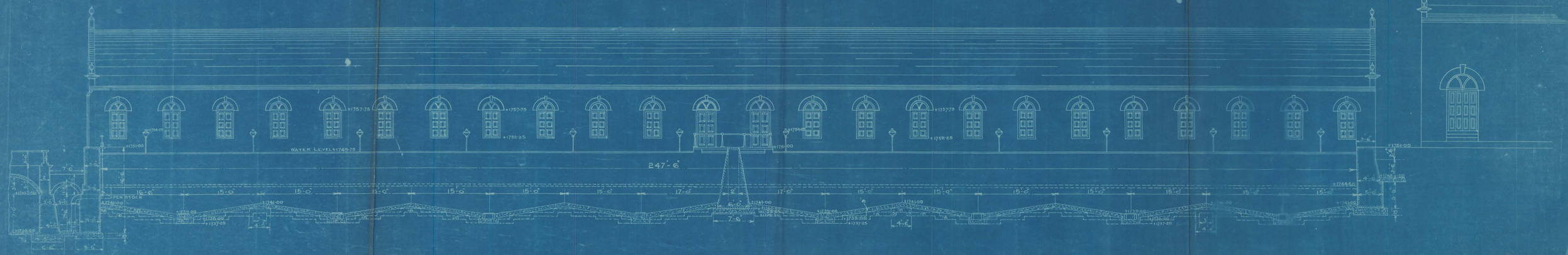
LONGITUDINAL SECTION ALONG THE ENGINE HOUSE



SECTION ALONG THE SLUDGE DRAIN



SECTION ALONG THE COAGULATING TANK & SHEWING THE REAR ELEVATION OF THE FILTER HOUSE



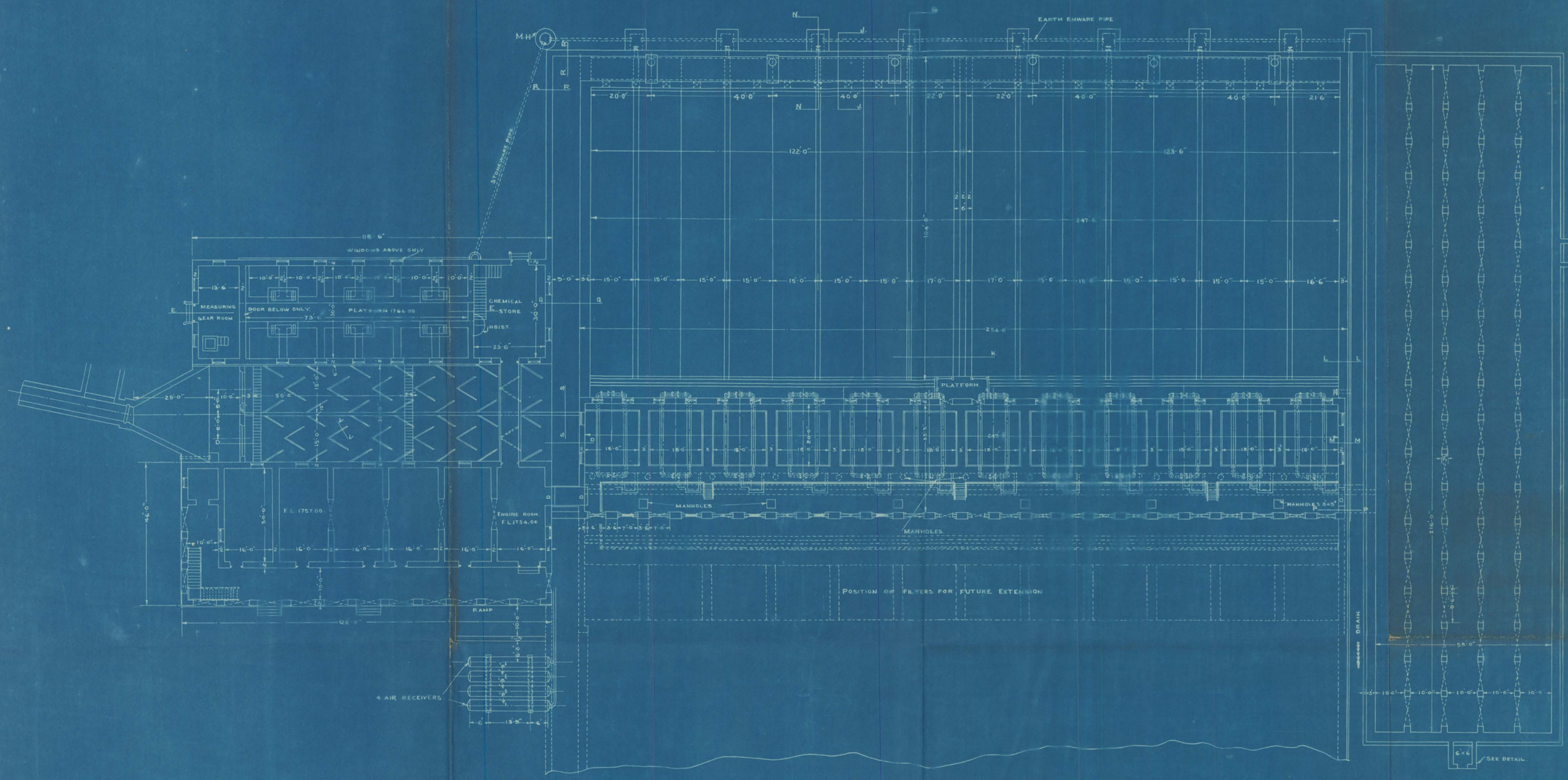
TRACED FROM FERRO SUPPLIED BY THE STATE

HYDERABAD NEW WATER WORKS

GENERAL ARRANGEMENT OF FILTER PLANT

SCALE 16'=1"

CONTRACT Nº 2
DRAWING Nº331/7



JESSOP & CO. LTD
ENGINEERS
CALCUTTA

TRACED FROM FERRO SUPPLIED BY THE STATE

TOP OF SLATE BOX

3"

18"

3"

1/16 RUBBER (18) 6"×3½"

3/8" 1¼" 3/8"

½"

1" 3/16

3½"

3" ½" DIA.

G.M. (1)

(4) ⅜" RIBS.

MAX. LEVEL OF CHEMICAL.

(17)

½" DIA.

3/16"

(2) G.M.

1¼" DIA.

2" BORE.

1"

3"

(3) 1⅞" DIA. × 3/16" RUBBER

G.M.

⅞" DIA.

⅜" SCREW

3½"

G.M. 45°

(5)

7/16"

2¼"

4½"

G.M. ⅜" DIA. PIN 1½" LONG (6)

G.M. ¾" DIA.

2¾" DIA.

5/16"

(4)

5⅝"

2" BORE.

WIPED JOINT MADE AT SITE

2" LEAD PIPE

1/16" 1/16"

1¼"×¼"

10¾"

G.M. (8)

1"

¼" PLUG (19)

G.M.

16 GAUGE (20)

COPPER FLOAT.

(9)

½" SCREW

G.M.

2"

2" DIA. WASHER

1"

(10)

BRAZE

9" DIA.

NOTE:- FLOAT TO BE LOADED TO FLOAT AT THIS LEVEL

ELEVATION.

3-OFF THUS

RUBBER WASHERS 1½" DIA × 1/16" (16)

A

G.M.

M.S.

(7) G.M. ⅜" PIN

½" DIA. G.M. (11) ⅜" DIA.

5/16" DIA.

(12) 5/16" G.M.

3/16" THICK

G.M. (13)

1/16 RUBBER (16)

⅜" DIA.

5/8" G.M. NUT (15)

5/8" BOLTS 2¾" LONG. (14)

PLAN.

6"

HOLE FOR 5/16" BOLT

4½" CENTRES

FLANGE "A"

—3 SETS REQ'D—

NOTE:-

ALL PARTS MARKED G.M.
TO HAVE FOLLOWING COMPOSITION:-

COPPER	86	PARTS
TIN	3	"
ZINC	2	"
LEAD	9	"
	100	

SHEET No 7

HYDERABAD

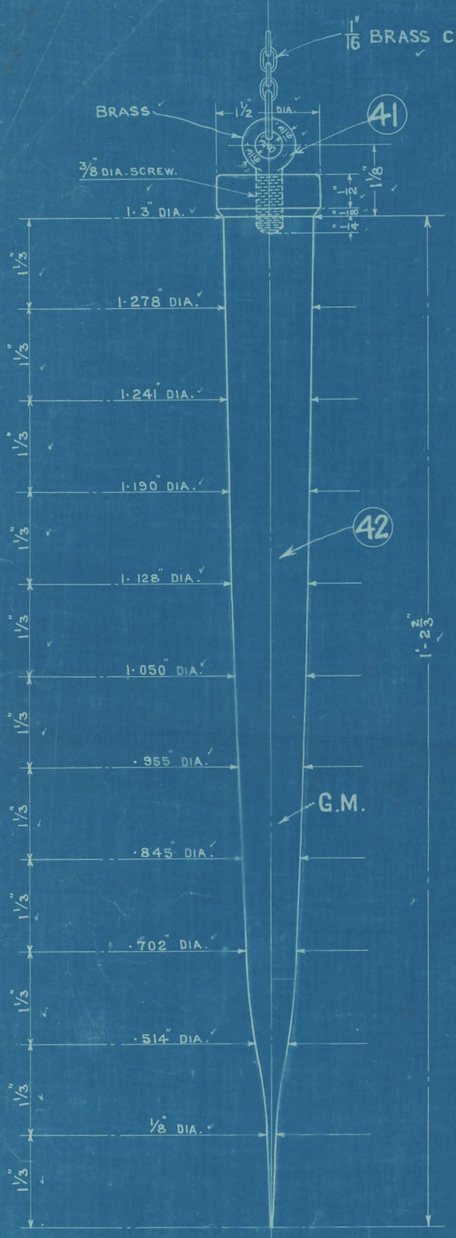
CHEMICAL MEASURING GEAR

INLET VALVE

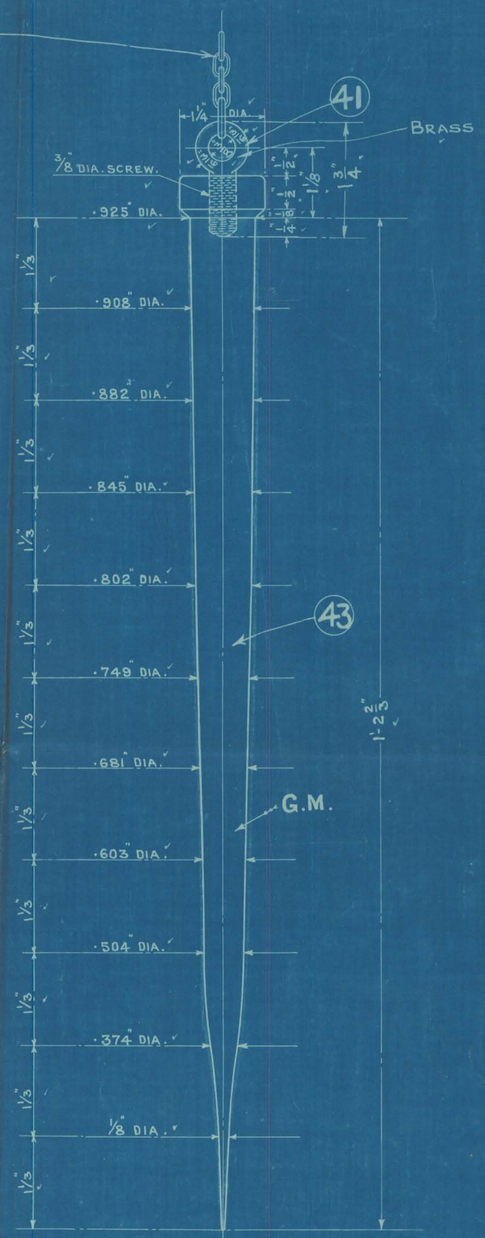
SCALE FULL SIZE.

11-10-17

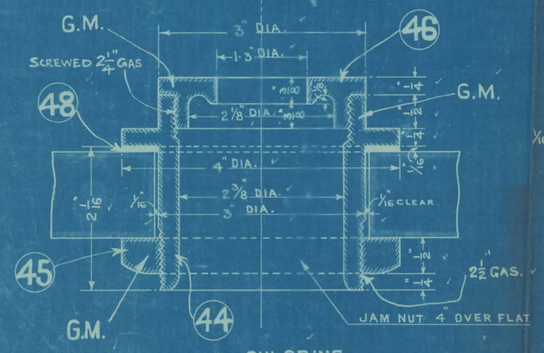
DRAWING No 10,431/44



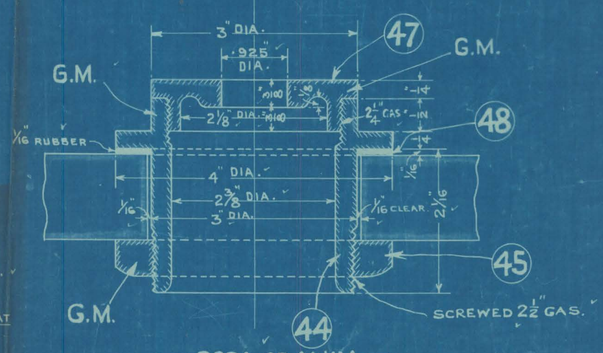
— CHLORINE —
— NEEDLE VALVE —
— 1-OFF —



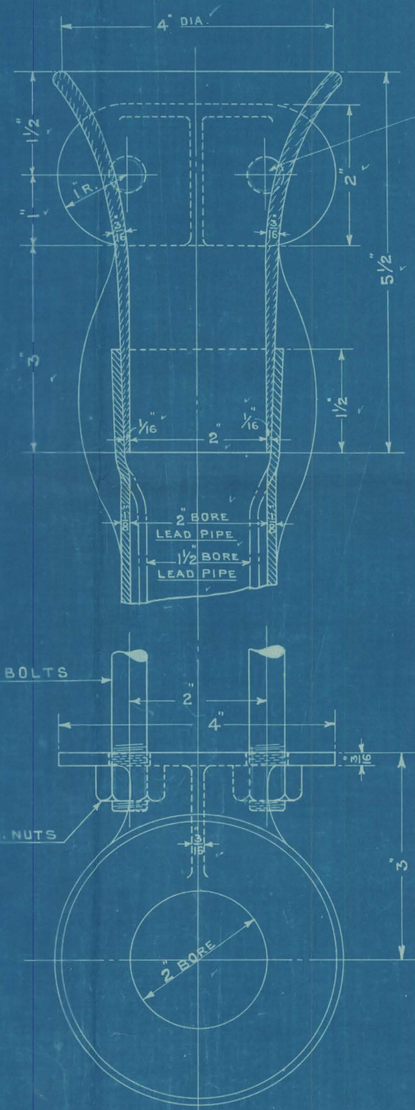
— SODA OR ALUM —
— NEEDLE VALVE —
— 4-OFF —

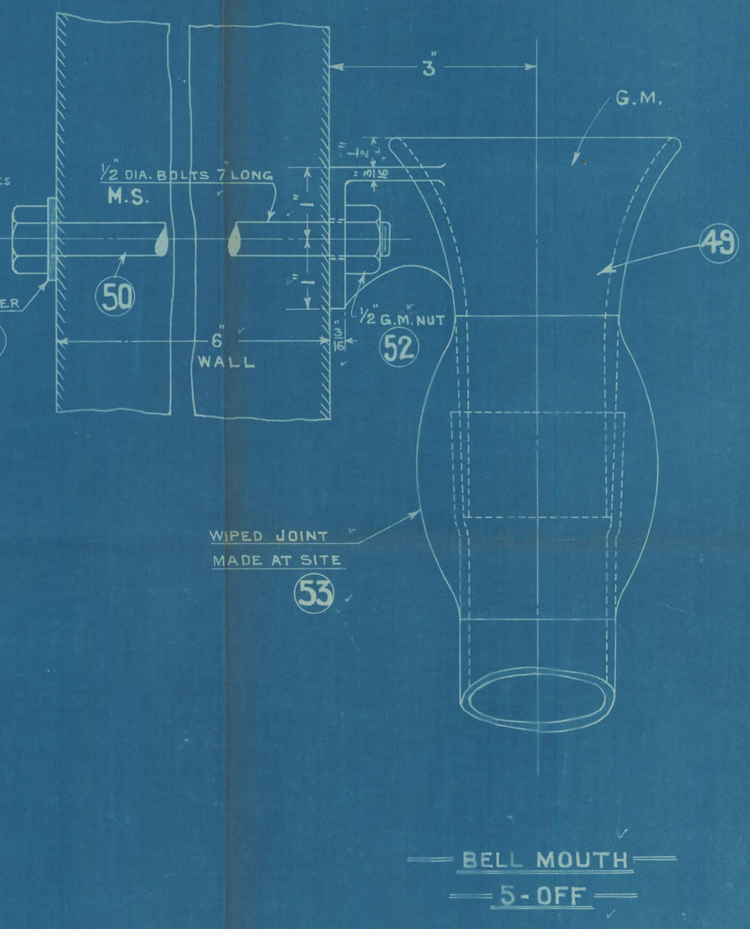


— CHLORINE —
— NEEDLE VALVE SEAT —
— 1-OFF —



— SODA OR ALUM —
— NEEDLE VALVE SEAT —
— 4-OFF —





— BELL MOUTH —
— 5-OFF —

NOTE:-

ALL PARTS MARKED G.M. TO CONTAIN:-

COPPER	86 %
TIN	3 %
ZINC	2 %
LEAD	9 %
	100

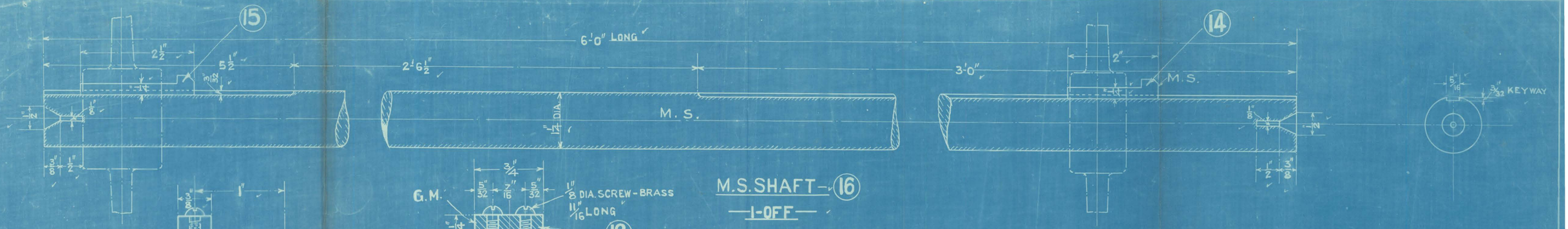
HYDERABAD
CHEMICAL MEASURING GEAR
DETAIL SHEET No 6
FULL SIZE

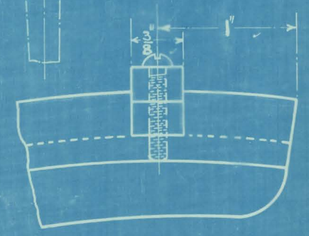
1-11-14

16004
A.R. Banerji
Jan 1911

44

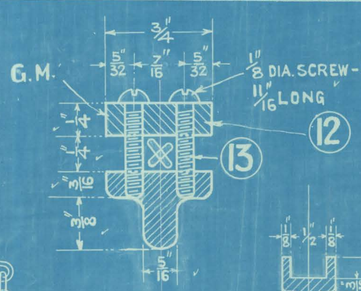
DRAWING No 10438





DETAIL OF CHAIN LOCK

5-SETS



SECTION THRO. A.A.

M.S. SHAFT — 16

— 1-OFF —

BRIGHT ALL OVER

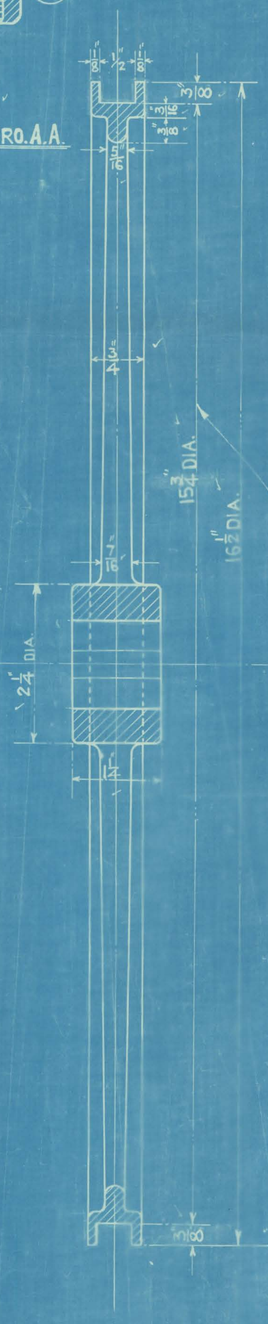
NOTE:- KEY WAYS FOR BOTH SETS OF QUADRANTS MUST BE IN SAME LINE. THUS:



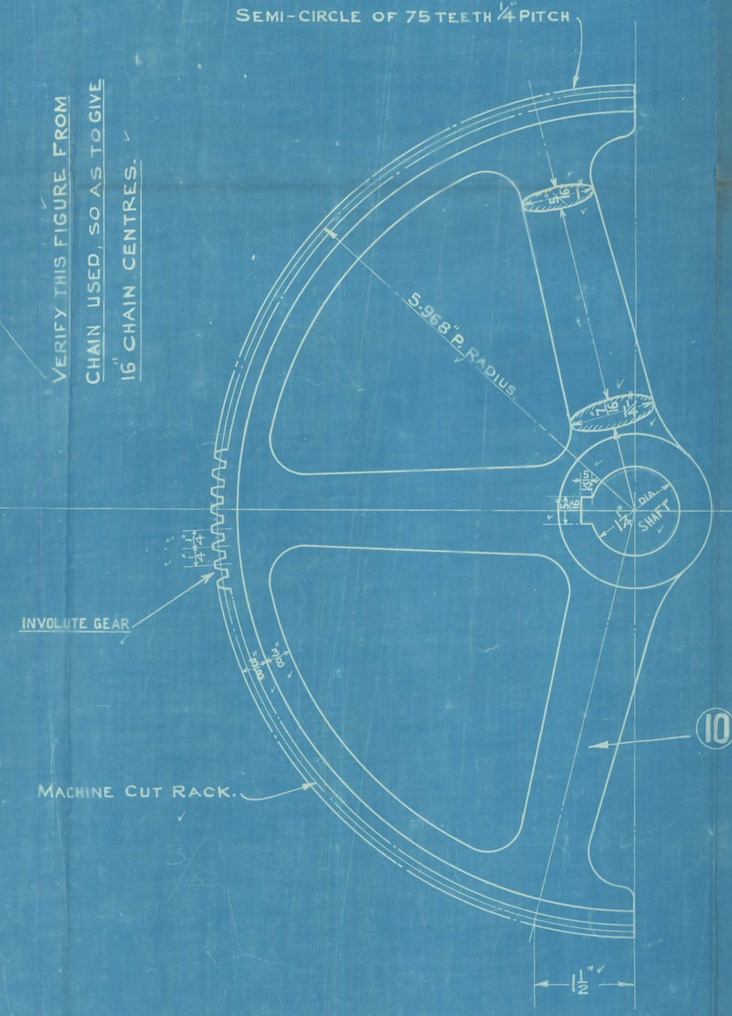


G.M. QUADRANT FOR CHAIN

— 5-OFF —

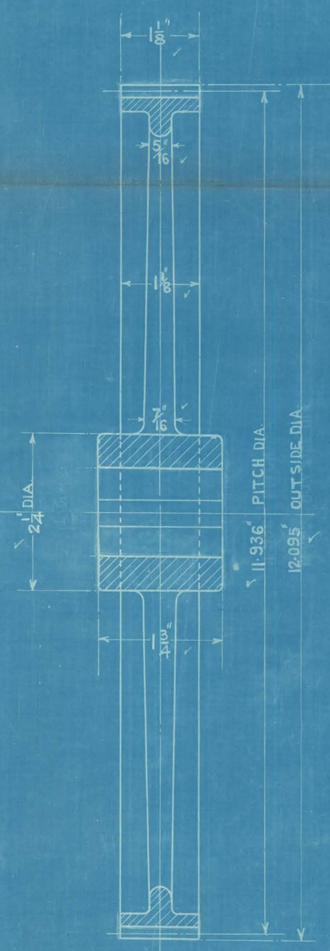


VERIFY THIS FIGURE FROM CHAIN USED, SO AS TO GIVE 16" CHAIN CENTRES.



G.M. QUADRANT FOR RACK

— 1-OFF —



NOTE:-

ALL PARTS MARKED G.M. TO CONTAIN:-

COPPER	86 %
TIN	3 %
ZINC	2 %
LEAD	9 %
	100

NOTE:- KEY WAYS IN ALL QUADRANTS MUST BE DEAD CENTRAL AS SHEWN

Our No. 1600 X
Work Done at Hyd
Checked by Chandler
Checked by Clyde
Date 10.12.17

DRAWING No. 44 10437

HYDERABAD.

CHEMICAL MEASURING GEAR

DETAIL SHEET No. 5

SCALE FULL SIZE

1-11-17

FOR RACK DETAIL SEE DRG. Nº 44/10435.

FOR DETAIL OF QUADRANT SEE DRG. Nº 44/10437.

1" DIA. CORED HOLE FOR 3/4" DIA. RAG BOLT 12" LONG.

3/8" BOLTS

4'-4"

3-6" WELL

1/8" SQR. RACK.

1'-9"

1'-9"

1" DIA.

3/8" RIB.

6" DIA.

1 1/4" DIA. SHAFT

C.I. CROSS BEAM

1-REQD

1 1/2" DIA.

3/8" DIA. PIN

TAPPED FOR 3/8" DIA. PIN.

3/8" DIA. PIN.

3/8" DIA. BOLTS X 1 1/2"

PART DETAIL OF CROSS BEAM

1 1/4" DIA.

TAPPED FOR 1/2" DIA. PIN

5/8 JAM NUT

1/2" DIA. G.M. NUT

M.S. 1/2" DIA. BOLT X 2 3/4" LONG

1/8" RUBBER

1/4" SLATE

C.I. BRACKET

1-REQD

1/8" CLEAR.

1/8" CLEAR.

1/4" DIA.

3/8" DIA. BOLTS

ONE WEIR

HEAD OVER WEIR	
10"	588000
9"	502000
8"	421000
7"	344200
6"	274000
5"	207600
4"	149000
3"	97200
2"	53200
1"	20400
0	NIL

GALLONS PER HOUR

CENTRE LINE OF FLOAT.

℄ OF FLOAT.

M.S. 1/4 DIA. SET SCREW 3/4" LONG.

THIS INDICATOR PLATE TO BE WELL FINISHED - THEN ENGRAVED CAREFULLY & LINES & LETTERS FILLED UP WITH SEALING WAX. TO BE A FIRST CLASS JOB

G.M. INDICATOR

1-REQD

M.S.

G.M. INDICATOR PLATE

1-REQD

M.S. PIN - 4 REQD

M.S. PINTLE - 2-REQD

5/8" DIA. JAM NUT.

G.M. ROLLER

4-REQD

NOTE:-

ALL PARTS MARKED C.M. TO CONTAIN:-

COPPER	86%
TIN	3 %
ZINC	2 %
LEAD	9 %
	100

HYDERABAD

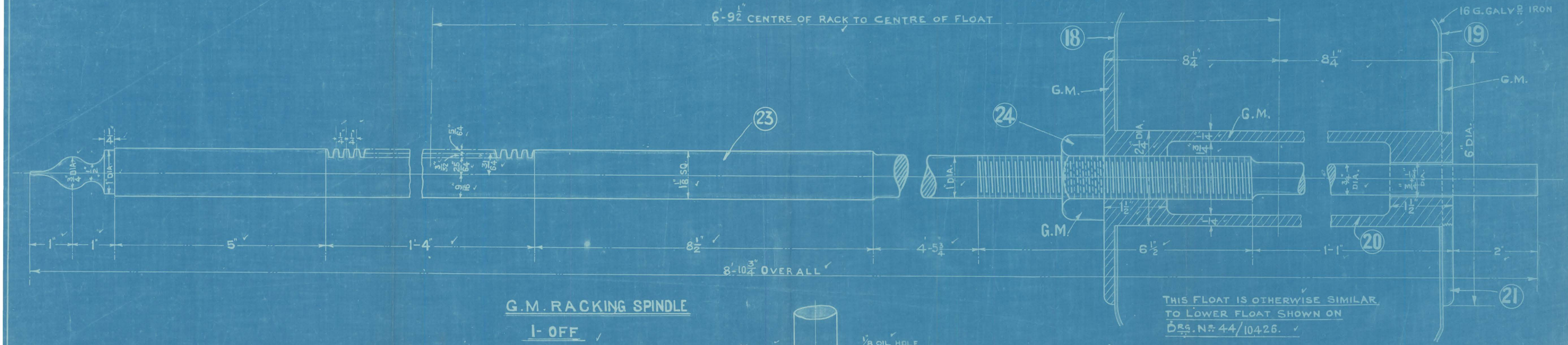
CHEMICAL MEASURING GEAR

DETAILS SHEET Nº 4

HALF & FULL SIZE

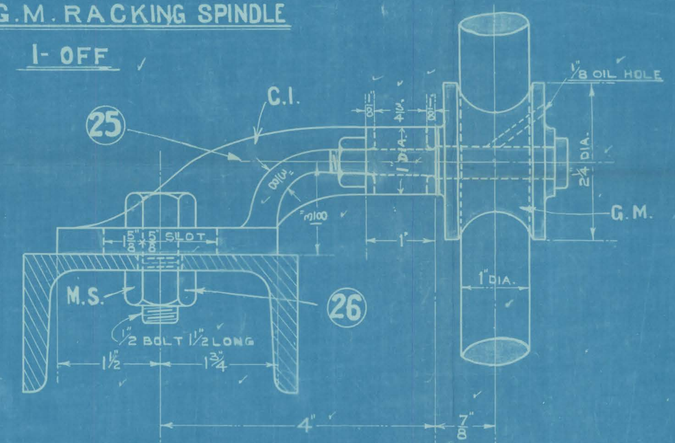
1-11-17

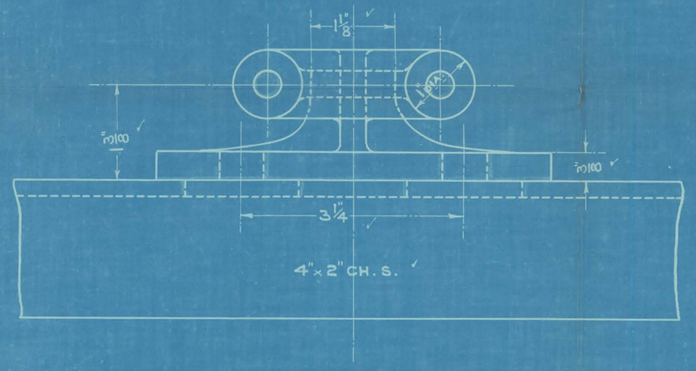
DRAWING Nº 44/10436

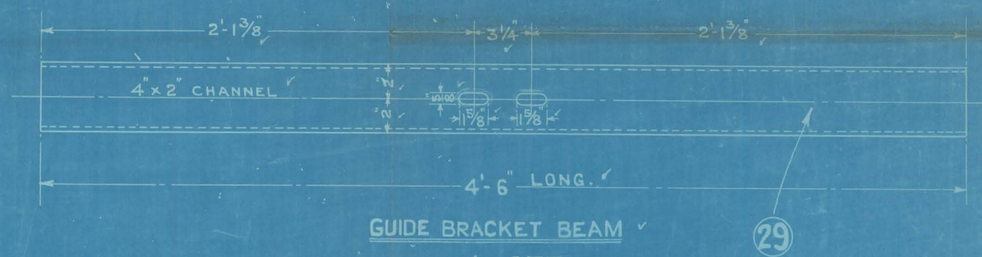


G.M. RACKING SPINDLE

1- OFF

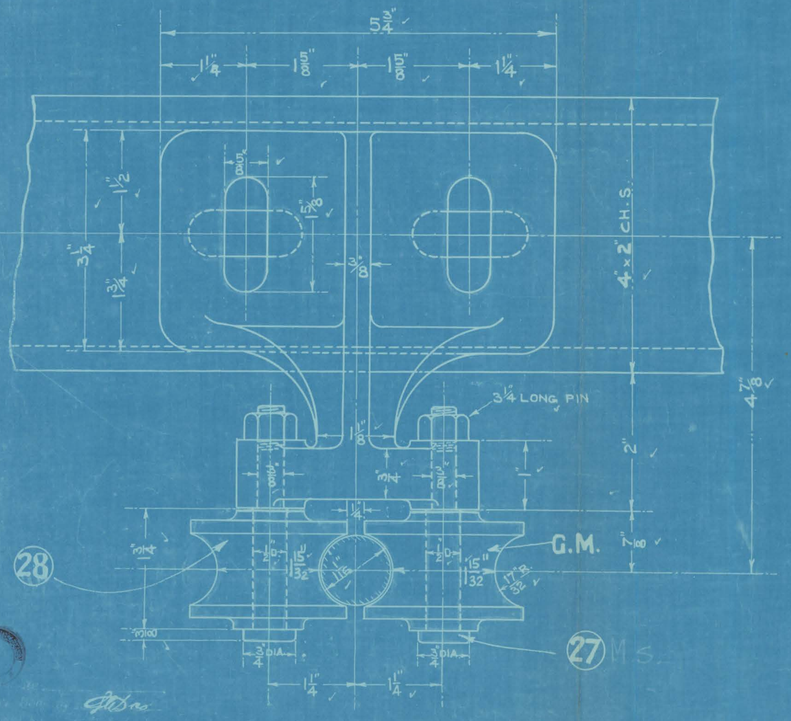






GUIDE BRACKET BEAM

1- OFF



C.I. BRACKET

1- OFF

PARTS OF FLOAT 2'-6" DIA.

17 — FLOAT SIDE — GALV.D IRON
18 — FLOAT TOP — " "
19 — FLOAT BOTTOM — " "
20 — FLOAT SLEEVE — G.M.
21 — FLOAT BOTTOM WASHER PLATE — G.M.
22 — FLOAT PLUG & FIXING — G.M.

Note.
All parts marked Gunmetal must contain:—

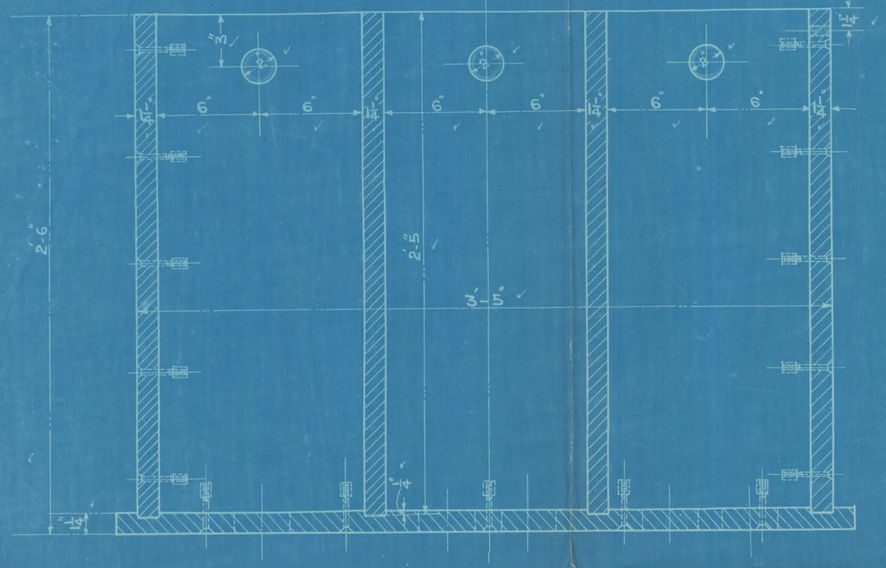
Copper	86%
Tin	3%
Lead	9%
Zinc	2%
	100.

HYDERABAD
CHEMICAL MEASURING GEAR
DETAILS SHEET No. 3

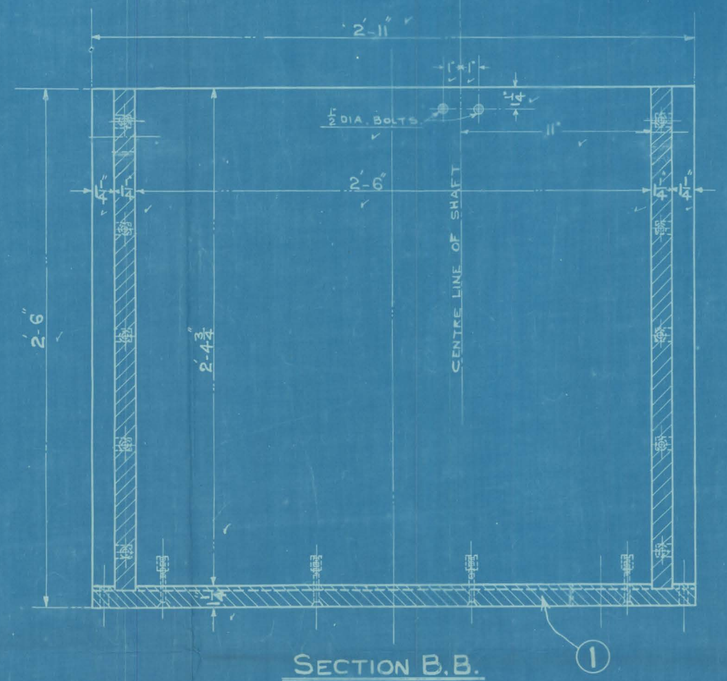
SCALE FULL SIZE

1-11-17

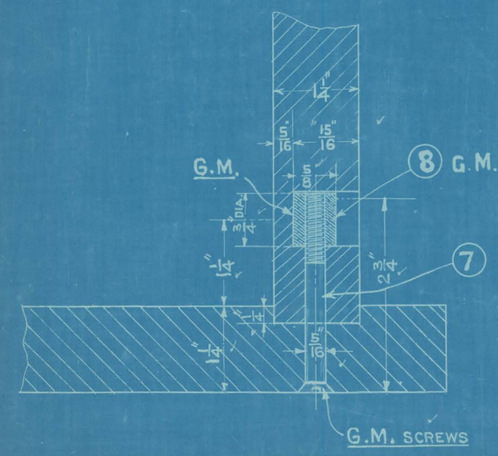
DRAWING No. 44/10435



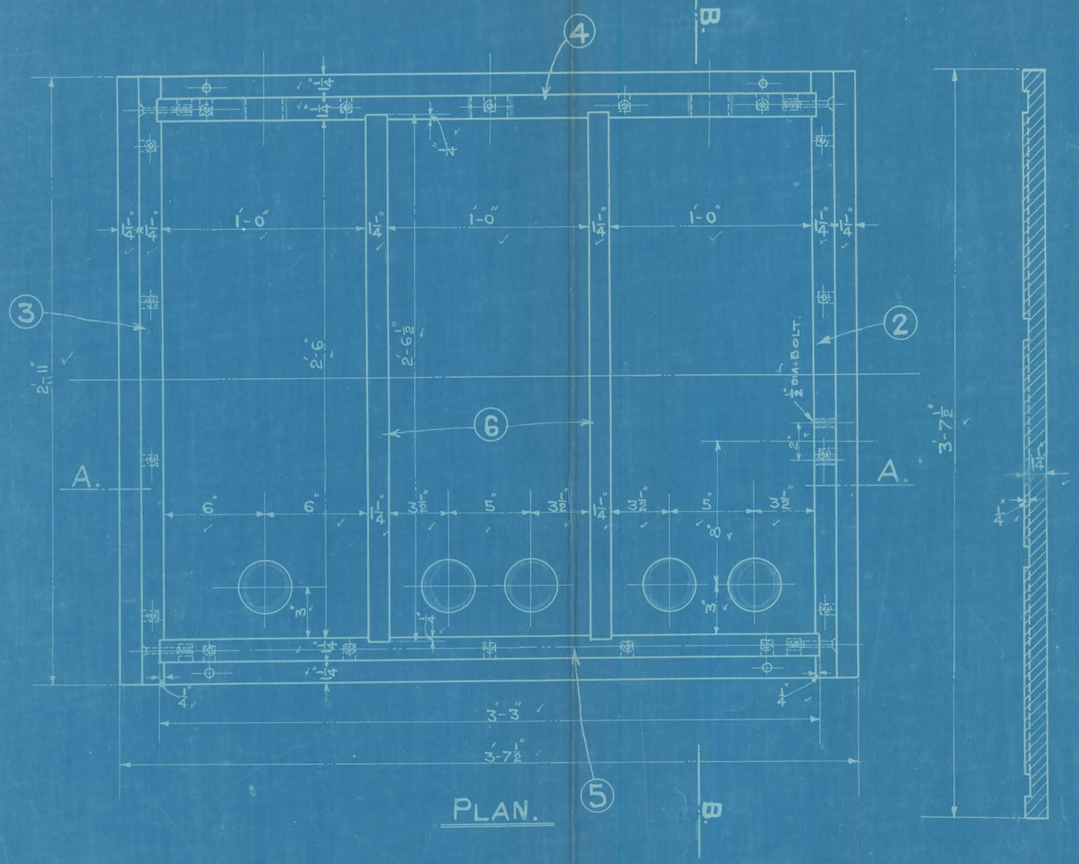
SECTION A.A.



SECTION B.B.

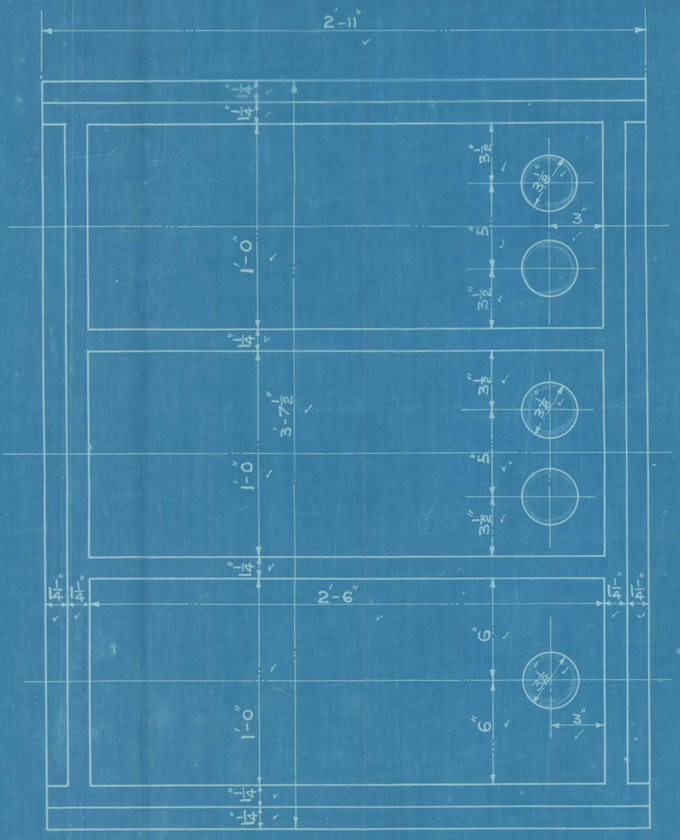


DETAIL OF JOINT SCREWS.
38-OFF THUS.



PLAN.

1-REQ'D THUS.



PLAN OF BOTTOM SLATE.

SHEET No. 2

HYDERABAD

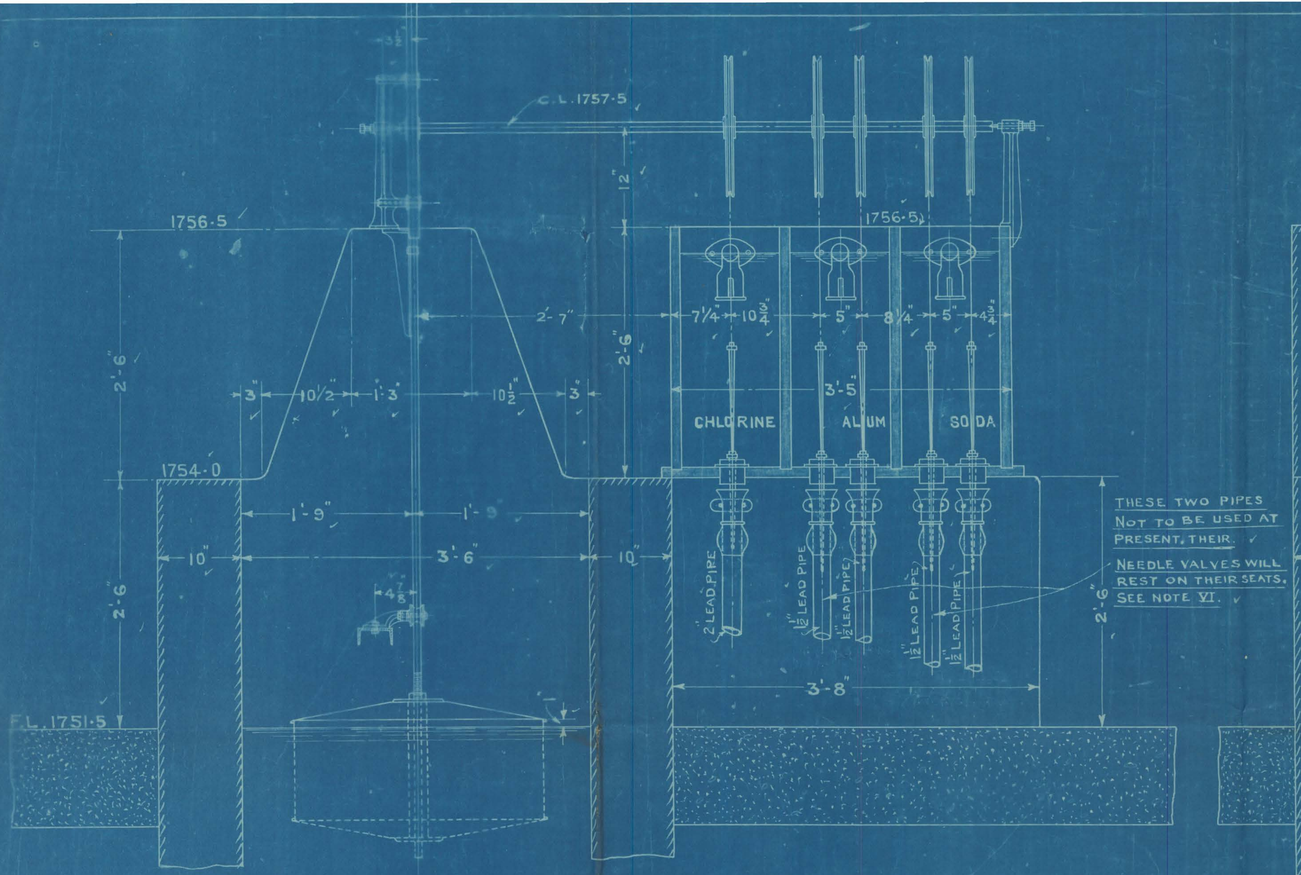
DETAIL OF CHEMICAL SLATE TANK

SCALE 3" = 1 FOOT.

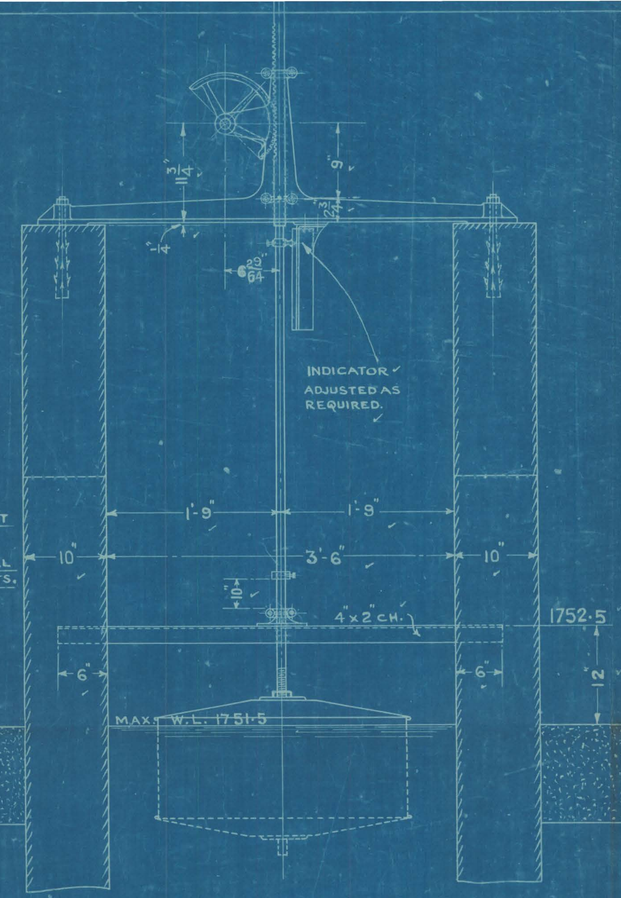
1-11-17

1600x

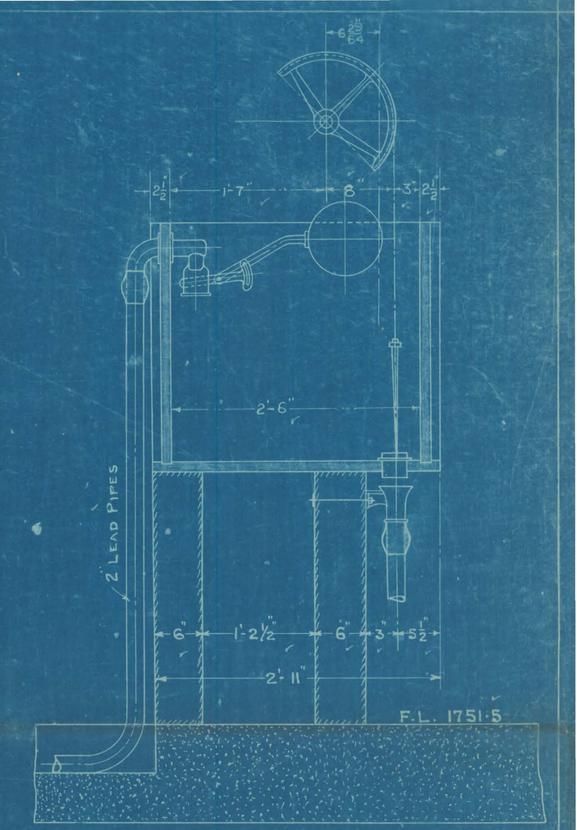
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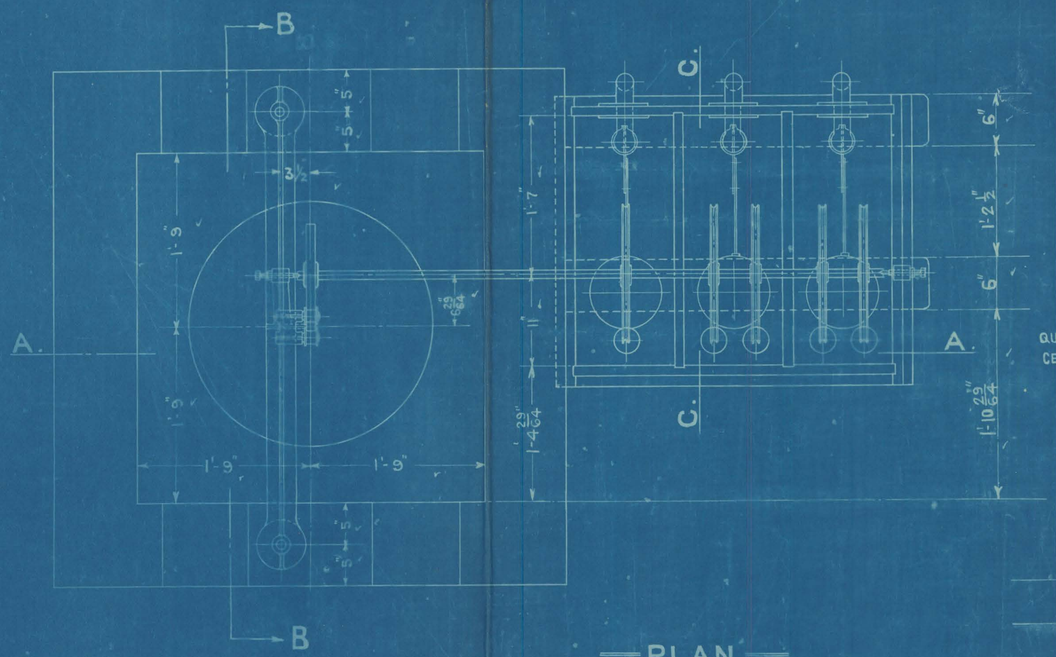
SECTION A.A.



SECTION B.B.



SECTION C.C.



PLAN

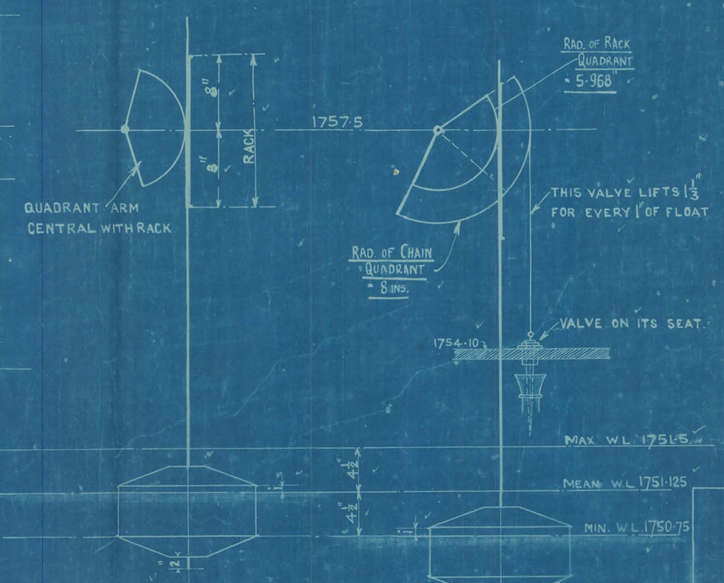


DIAGRAM A.
→ FLOAT IN MEAN POSITION.
FOR ADJUSTMENT OF RACK, QUADRANT, & FLOAT.

DIAGRAM B.
FLOAT IN LOWEST POSITION
FOR ADJUSTMENT OF NEEDLE VALVES.

NOTE IN ADJUSTMENT OF MEASURING GEAR:

I. ASSEMBLE WHOLE GEAR SO THAT FLOAT SUPPORTS WHOLE WEIGHT OF RACK ROD, QUADRANTS, CHAINS AND NEEDLE VALVES.
II. LOAD FLOAT SO THAT IT FLOATS 1" OUT OF WATER AS SHEWN.
III. ADJUST NUTS ON FLOAT SPINDLE SO THAT WHEN WATER IS AT LEVEL 1751·125 (MEAN LEVEL) AS PER DIAGRAM A", RACK IS CENTRAL WITH QUADRANT, AND END OF SPINDLE IS 2" BELOW BOTTOM OF FLOAT.
IV. NOTE THAT CHAIN QUADRANTS ARE TO BE EXACTLY IN LINE WITH RACK QUADRANT.
V. ADJUST LENGTH OF CHAINS AND LOCK ON QUADRANTS SO THAT VALVES ARE JUST ON THEIR SEATS WHEN FLOAT IS AT 1750·75 AS PER DIAGRAM B.
VI. NOTE THAT ONLY ONE VALVE IS AT PRESENT TO BE USED IN EACH OF THE SLATE CHAMBERS SO THAT ONE VALVE IN THE ALUM AND ONE VALVE IN THE SODA CHAMBERS WILL NOT BE CONNECTED-UP (AT PRESENT) TO THEIR QUADRANTS, BUT WILL BE LEFT IN THEIR CLOSED POSITION. WHEN FUTURE EXTENSION IS MADE, THESE TWO VALVES WILL BE COUPLED-UP TO THEIR QUADRANTS, AND THE GEAR READJUSTED TO SUIT.
VII. WHEN FLOAT IS AT 1750·75 ADJUST INDICATOR ON SCALE TO ZERO.
VIII. TWO MAIN 10'-6" WEIRS ARE BEING SUPPLIED AT PRESENT. THESE WILL BE BUILT-IN AND ADJUSTED CORRECTLY, BUT THE ONE NEARER THE OFFICE BUILDING WILL BE TEMPORARILY CLOSED-UP INSIDE ITS C.I. FRAME SO THAT IT CAN BE BROUGHT INTO USE ON FUTURE EXTENSION WITHOUT INTERFERING WITH THE FLOW OVER THE OTHER WEIR.
IX. NOTE THAT THE QUANTITIES ON THE INDICATOR SCALE WILL REQUIRE TO BE DOUBLED WHEN BOTH 10'-6" WEIRS ARE BROUGHT INTO OPERATION.

NOTE ON CHEMICAL SOLUTIONS:

I CHLORINE — ONE VALVE TO PASS A MAXIMUM OF 1000 GALLS. OF SOLUTION PER HOUR. AT PRESENT CHLORINE SOLUTION WILL BE HALF STRENGTH OF THE FINAL SOLUTION.
II ALUM — SODA.
AT PRESENT ONE VALVE FOR EACH, FLOWING AT 500 GALLS. PER HOUR. (MAXIMUM) IN FUTURE THE STRENGTH OF SOLUTIONS WILL BE AS AT PRESENT, BUT TWO VALVES WILL BE FLOWING FOR EACH SOLUTION, GIVING A TOTAL FLOW OF 1000 GALLS. PER HOUR FOR EACH SOLUTION.

SHEET Nº 1.

HYDERABAD

CHEMICAL MEASURING GEAR

GENERAL ARRANGEMENT

SCALE 1½"-1 FOOT

1-11-14

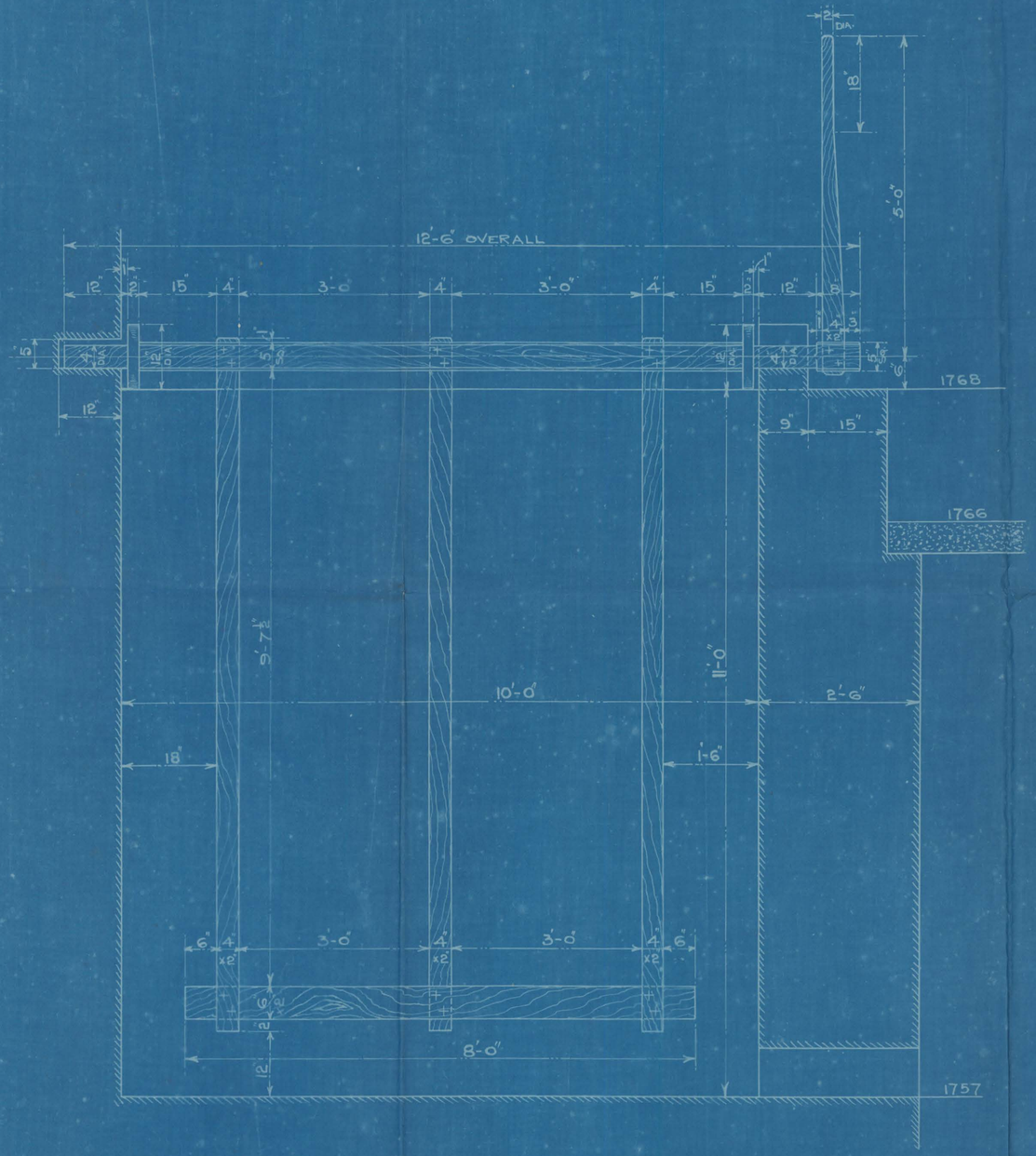
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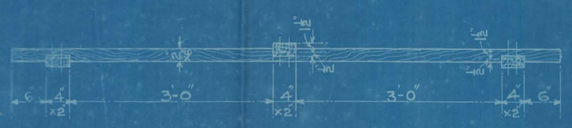
HYDERABAD

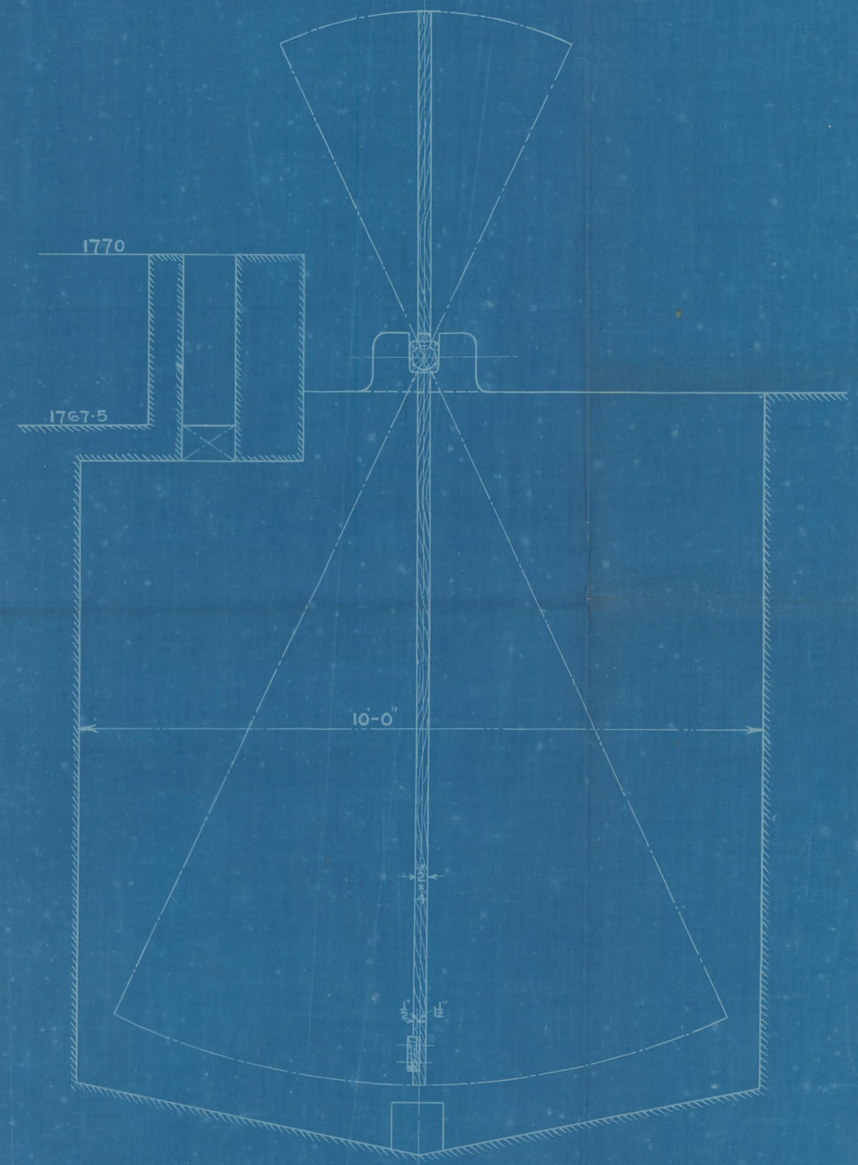
PLAN OF CHEMICAL HOUSE PIPING

SCALE 1/8 = 1 FOOT

DRAWING No 10443





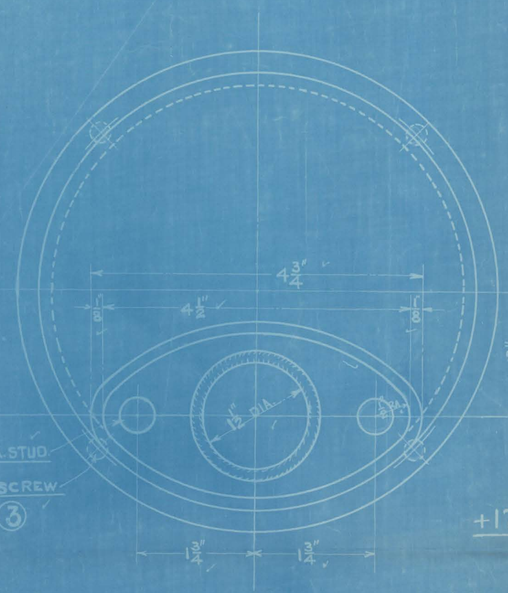


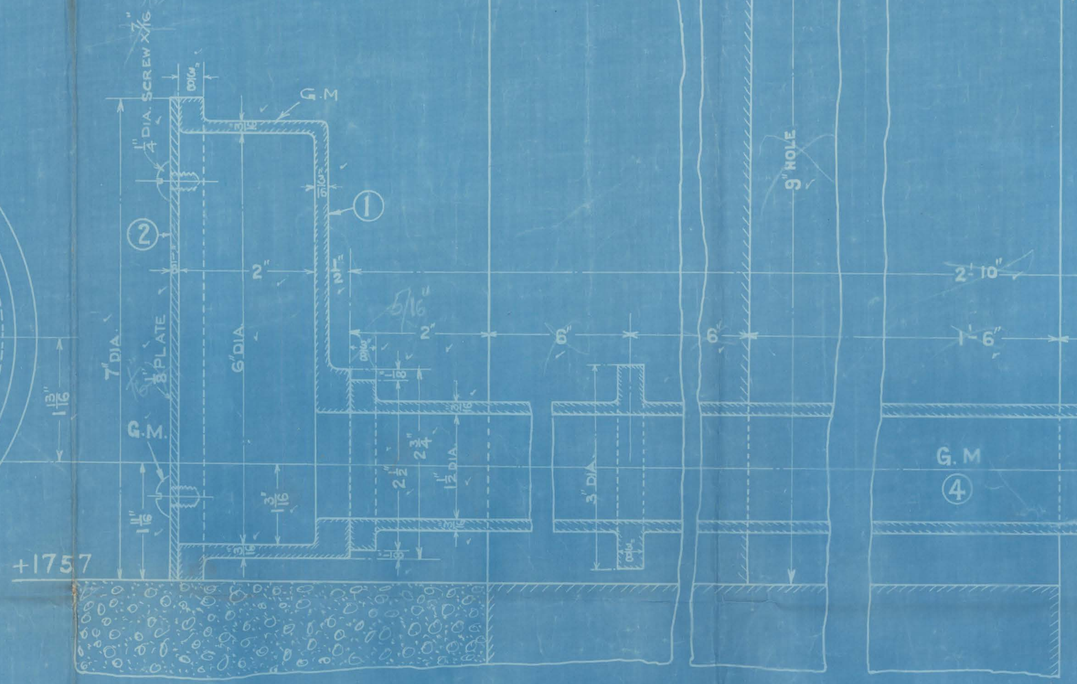
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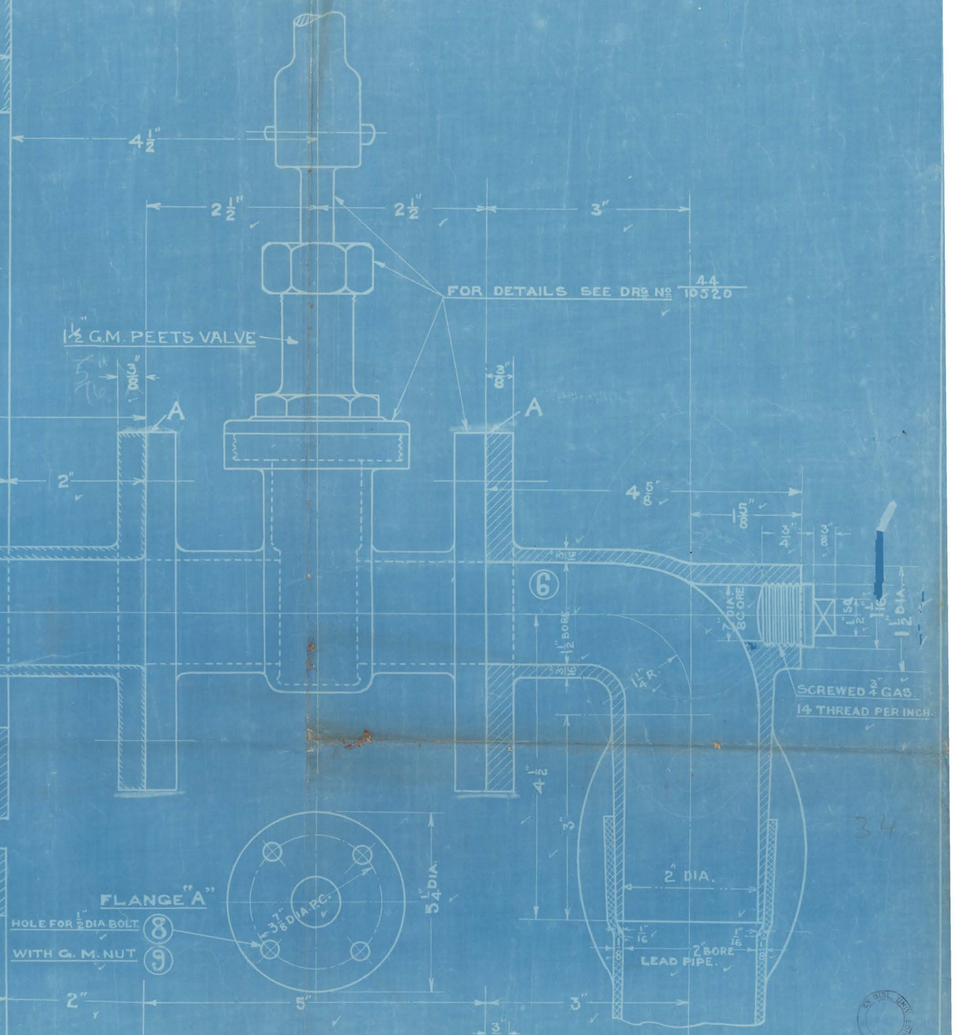
AGITATION GEAR

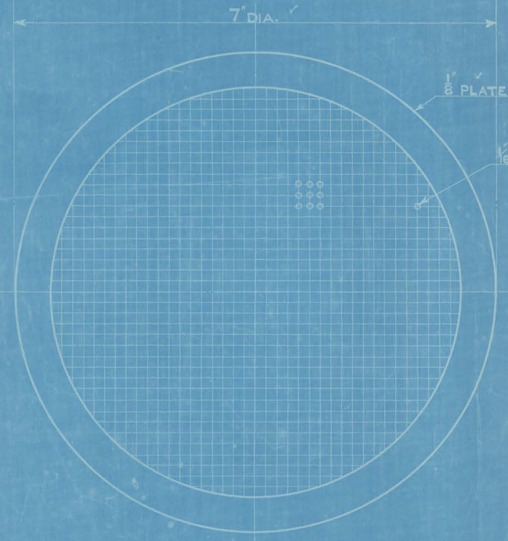
SCALE 1" = 1 FOOT

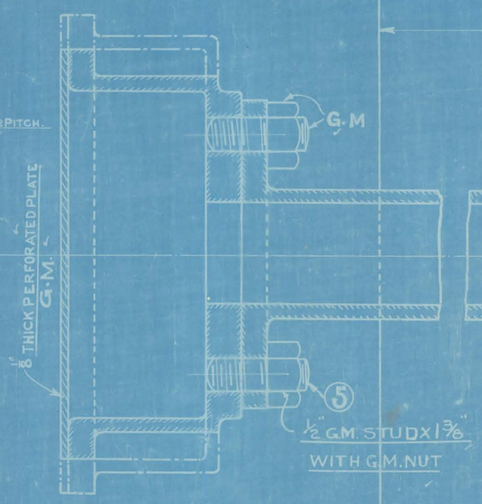
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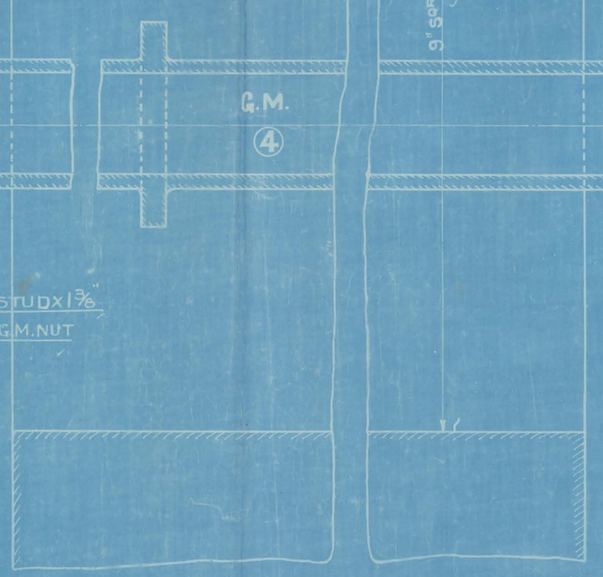


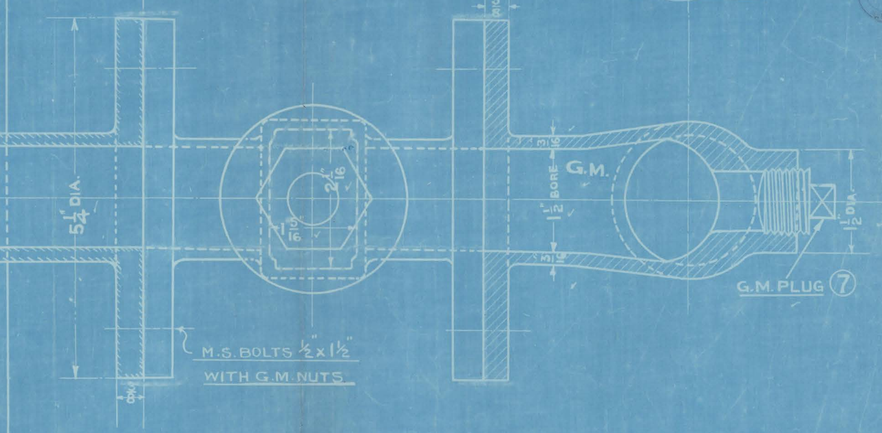












NOTE

ALL PARTS MARKED G.M. TO HAVE THE FOLLOWING COMPOSITION:—

COPPER	86 PARTS
ZINC	2 "
TIN	3 "
LEAD	9 "
	100

12 SETS REQUIRED

HYDERABAD

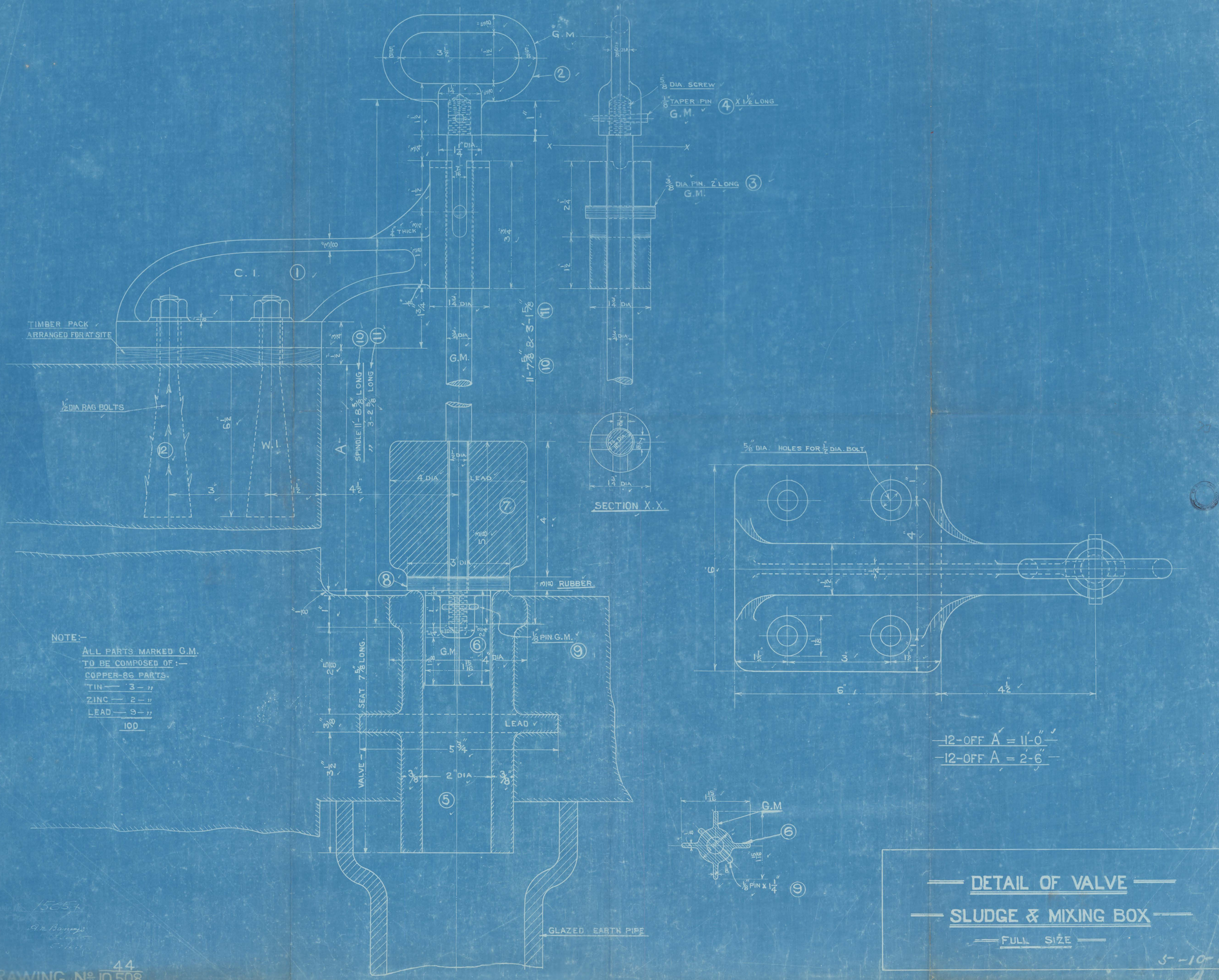
CHEMICAL TANK OUTLET

DETAIL SHEET No.

SCALE FULL SIZE.

DRAWING No. 44/10432

11-10-17



NOTE:-

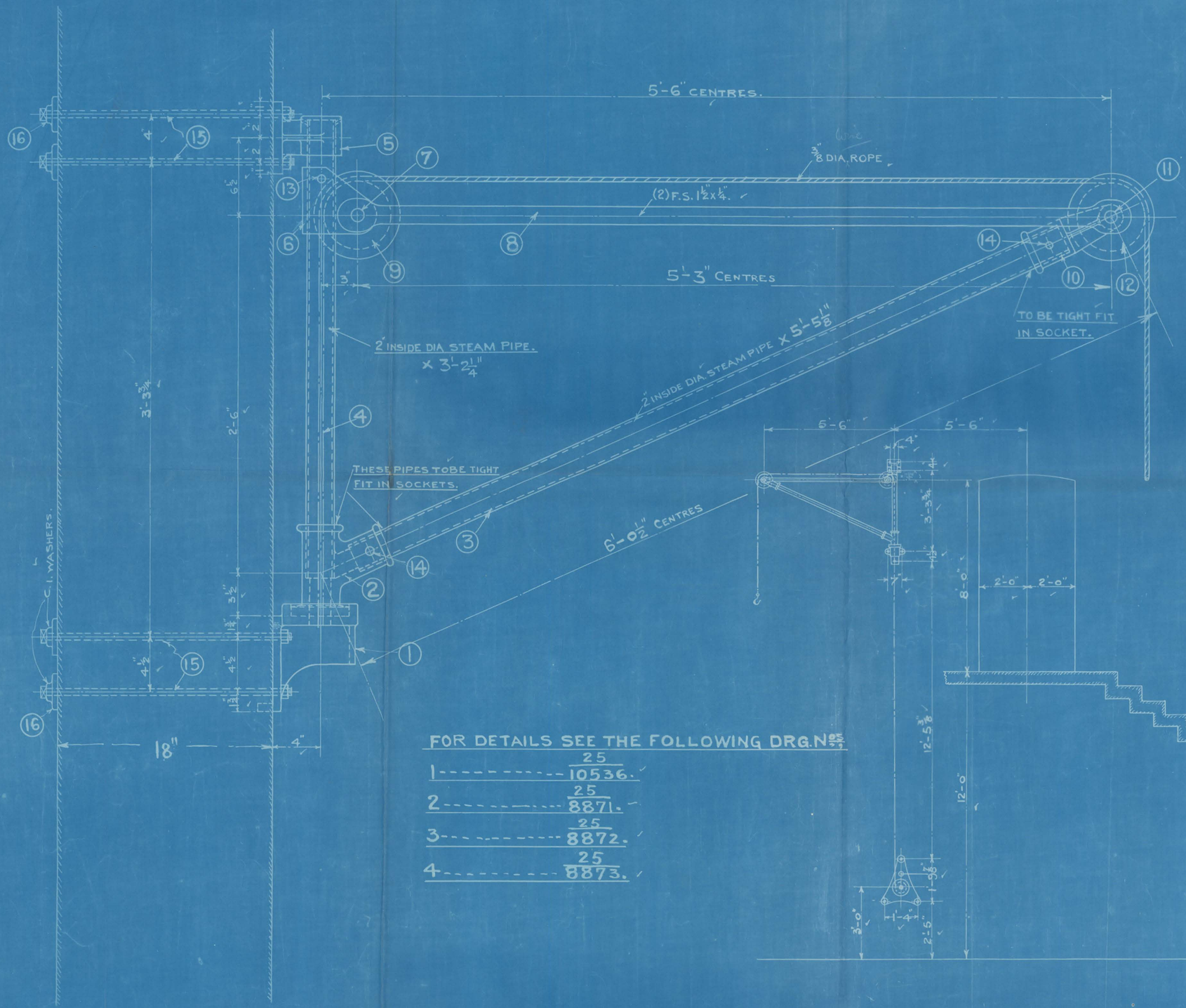
ALL PARTS MARKED G.M.
TO BE COMPOSED OF:—
COPPER-86 PARTS.
TIN — 3 —"
ZINC — 2 —"
LEAD — 9 —"
100

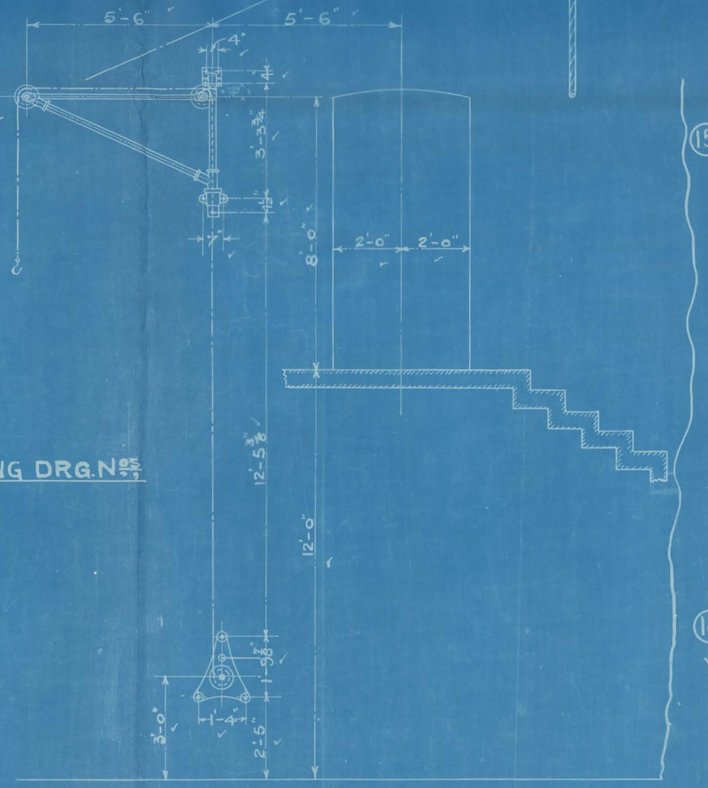
DETAIL OF VALVE
SLUDGE & MIXING BOX
FULL SIZE

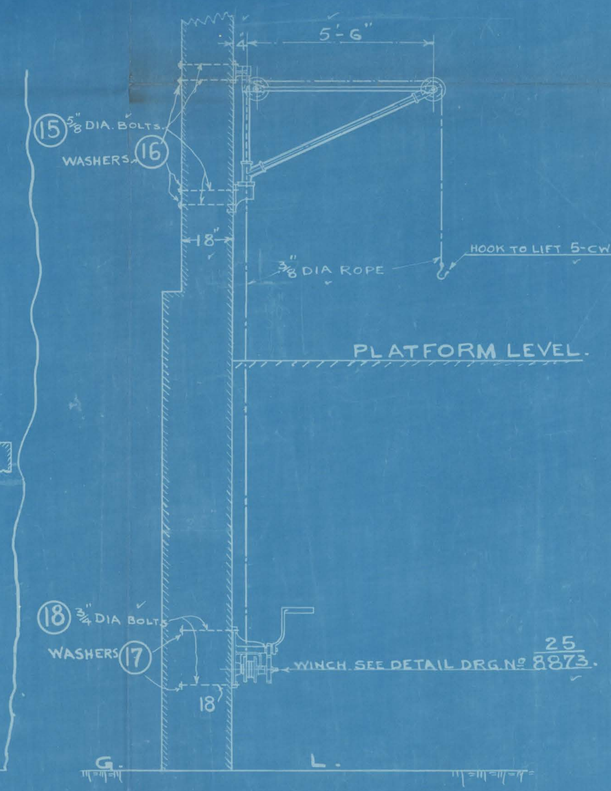
5-10-1

1565
G. R. Barnes
Engr.
Salem

DRAWING No. 44
10,508







FOR DETAILS SEE THE FOLLOWING DRG. Nos.

1	25/10536.
2	25/8871.
3	25/8872.
4	25/8873.

Order No. 1603X.
Work Done by Stratton
Traced by
Checked by
Etc.

DRAWING No. 25/10535.

5-CWT. SWING JIB CRANE.

ARRANGEMENT & DETAIL.

SCALE - ½" & 3" - 1 FOOT.

17-10-17.

DESIGNED & CONSTRUCTED
ON PATERSON SYSTEM
BY
JESSOP & Co LTD
ENGINEERS
CALCUTTA. 1914.

LAMP NOT SUPPLIED BY JESSOP & Co LTD

6 B — 6 1/4" — 5 5/16" — 1/4 BRASS SCREW
1 OFF THUS
1 OFF OPP. HAND

6 C — 4 1/2" — 3 17/32" — 1/4 BRASS SCREWS
1 OFF THUS
1 OFF OPP. HAND.

6 D — 3 3/4" — 2 21/32" — 1/4 BRASS SCREWS
1 OFF THUS
1 OFF OPP. HAND.

9 — 1/4 OUT SIDE DIA. GLASS TUBE 3'-5 LONG

WALL SPIKE 3/8 X 6

1/8 BRASS PLATE 16X10 LETTERS ENGRAVED & FILLED WITH RED SEALING WAX.

5'-2"

ADJUST BRASS PLATES AT SITE AFTER FIXING BOARD IN POSITION, SO THAT TOP OF MERCURY IS AT "5" ON PLATES WHEN 5'-0" OF WATER IN OVERHEAD TANK.

ENGRAVED BRASS INDEX PLATES 1-OFF RIGHT HAND 1-OFF LEFT.

NOTE:- GOOD FINISH REQUIRED FOR THESE BRASS PLATES

HOLES FOR 1/4 BRASS SCREW.

6 A.

ENGRAVED & FILLED WITH RED SEALING WAX.

1/8 THICK BRASS PLATES.

NOTE:
TEAKWOOD GAUGE-BOARD (5) AND STRIPS (4) TO BE POLISHED AND FINISHED IN A WORKMANLIKE FASHION.
THE WHOLE OF THIS GEAR TO BE A FIRST-CLASS JOB.

PAINT BLACK UNDERNEATH TUBE

PRESSURE GAUGE

NOTE

BRASS STRIP 1/8 X 3/16

1/4 BRASS SCREW

3/4 X 5/16 STRIPS 3-1 LONG

2'-8"

HOLES TO SUIT 1/4 BRASS SCREW

ENGRAVED & FILLED WITH RED SEALING WAX.

1/8 THICK BRASS PLATES

ENGRAVED BRASS INDEX PLATES
1-OFF RIGHT HAND 1-OFF LEFT

NOTE: GOOD FINISH REQUIRED FOR THESE BRASS PLATES

GLASS TUBE 1/4 OUT SIDE DIA. 3'-5" LONG.
G.M.
HEX.
MERCURY 1 1/2
1/4 OUT SIDE DIA. COPPER TUBE
SOLDERED IN
RUBBER WASHER 3 DIA. X 1/16
1/4 BRASS SCREW
LUGS FOR SCREWING DOWN TO BOARD
2 1/2" GAS

G.M. MERCURY CUP

PAINT WOODWORK 3 FACES BLACK UNDER TUBE.

ONE REQD.

2 OR 8
17
G.M.
3/8 GAS
COPPER PIPE
15
16
5/16 OUT SIDE DIA. X G-10"
BRASS
GAS PIPE.

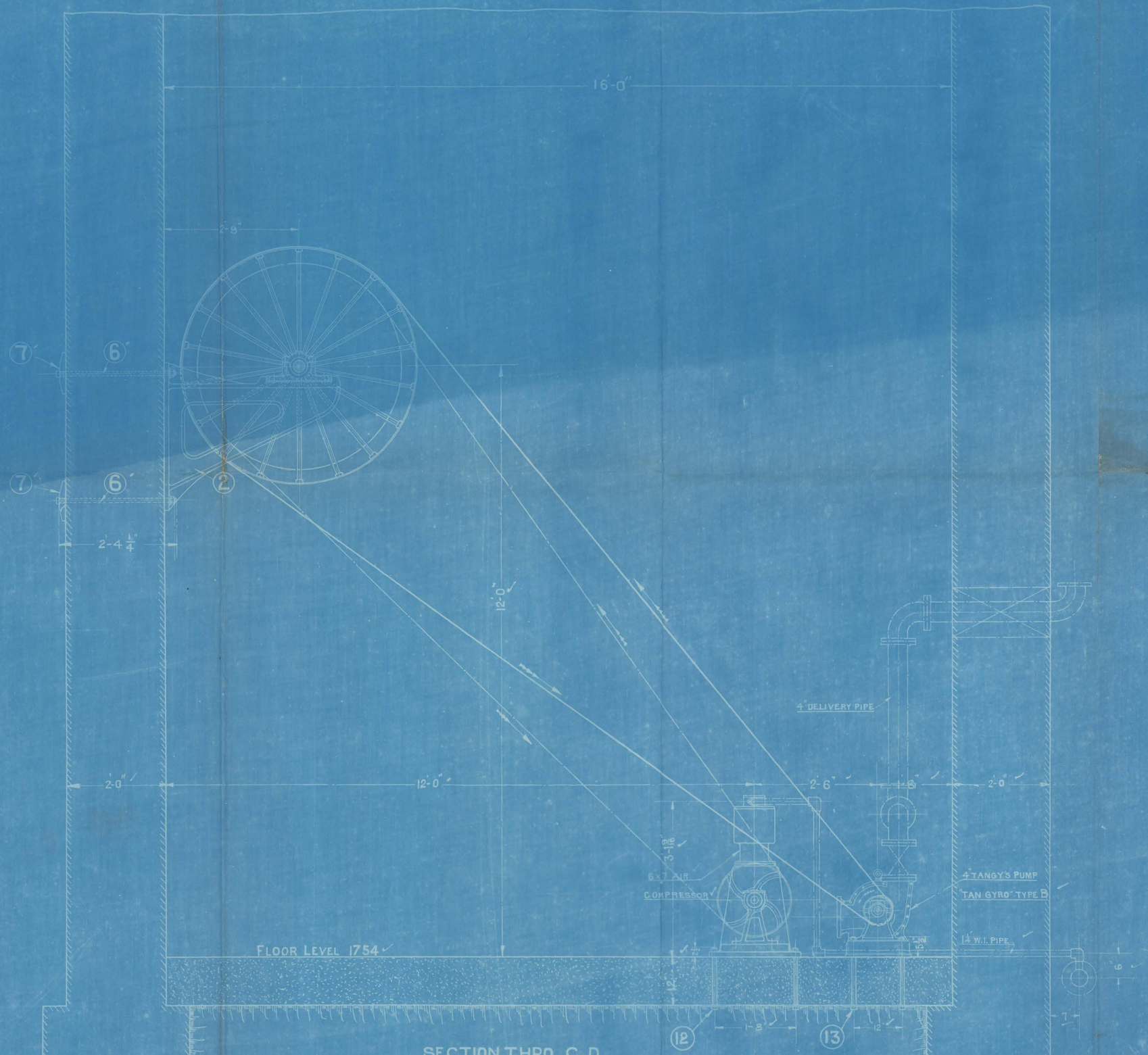
PIPE TO PRESSURE GAUGES 2-OFF
" " MERCURY CUP 1-OFF

GAUGE BOARD FOR FILTERS

SCALE 1/2 & FULL SIZE

20-10-14

DRAWING No. 44/10553

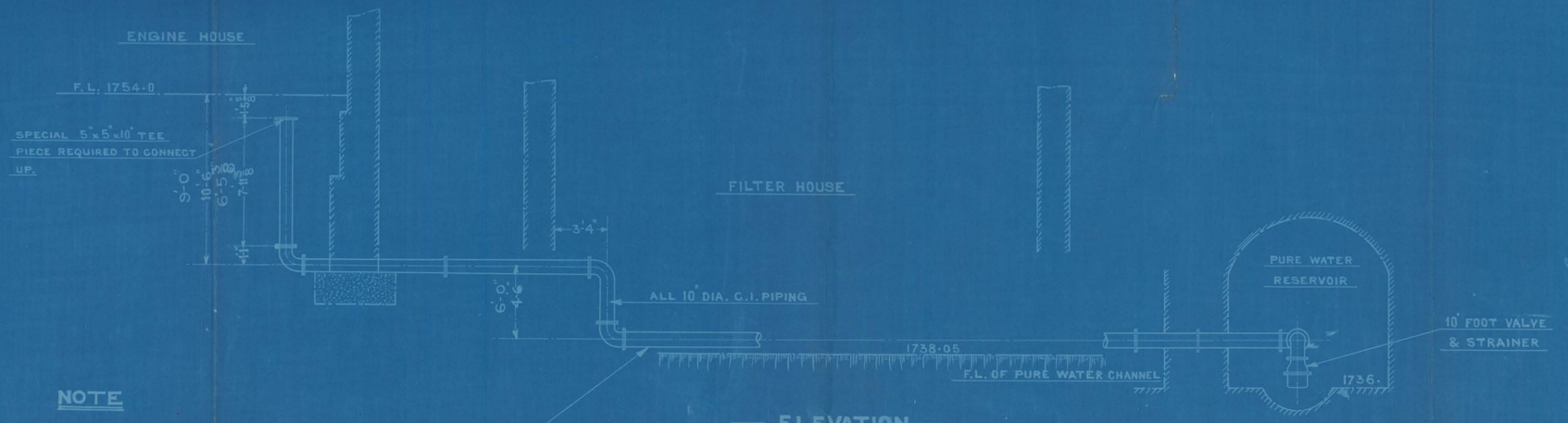


SECTION THRO. C. D.

HYDERABAD
TEMPORARY PUMPS
END ELEVATION

SCALE 1=1 FOOT.

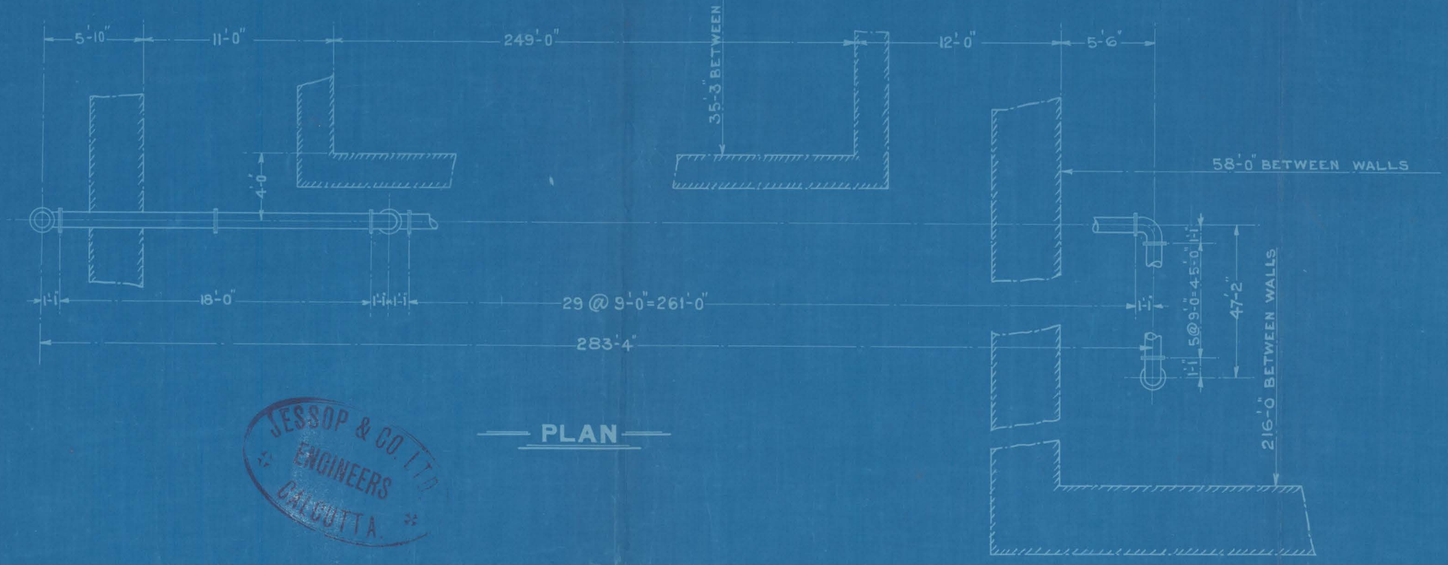
DRAWING No. 10780



ELEVATION

NOTE

THIS PIPE MAY BE BURIED IN EARTH AT PRESENT JUST OUTSIDE THE FILTER HOUSE WALL, BUT WHEN FUTURE HOUSE IS ADDED, THE PIPE SHOULD BE LAID IN AN ACCESSABLE COVERED TRENCH



PLAN

JESSOP & CO. LTD. ENGINEERS CALCUTTA

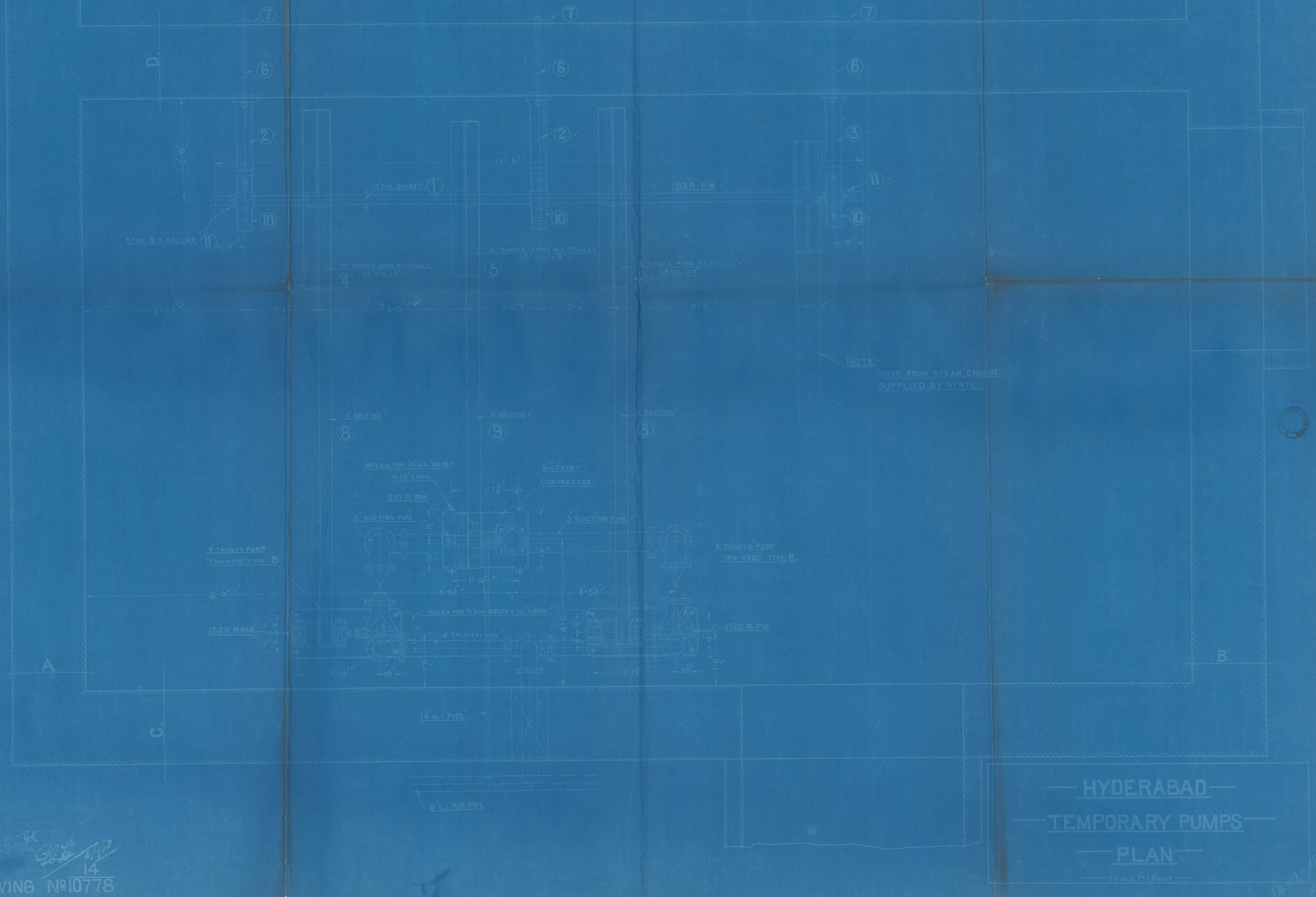
HYDERABAD

ARRGT OF PUMP SUCTION PIPING

SCALE 1/4" = 1 FOOT

M. K. Ali 13/11/18

DRAWING No. 44/11,618



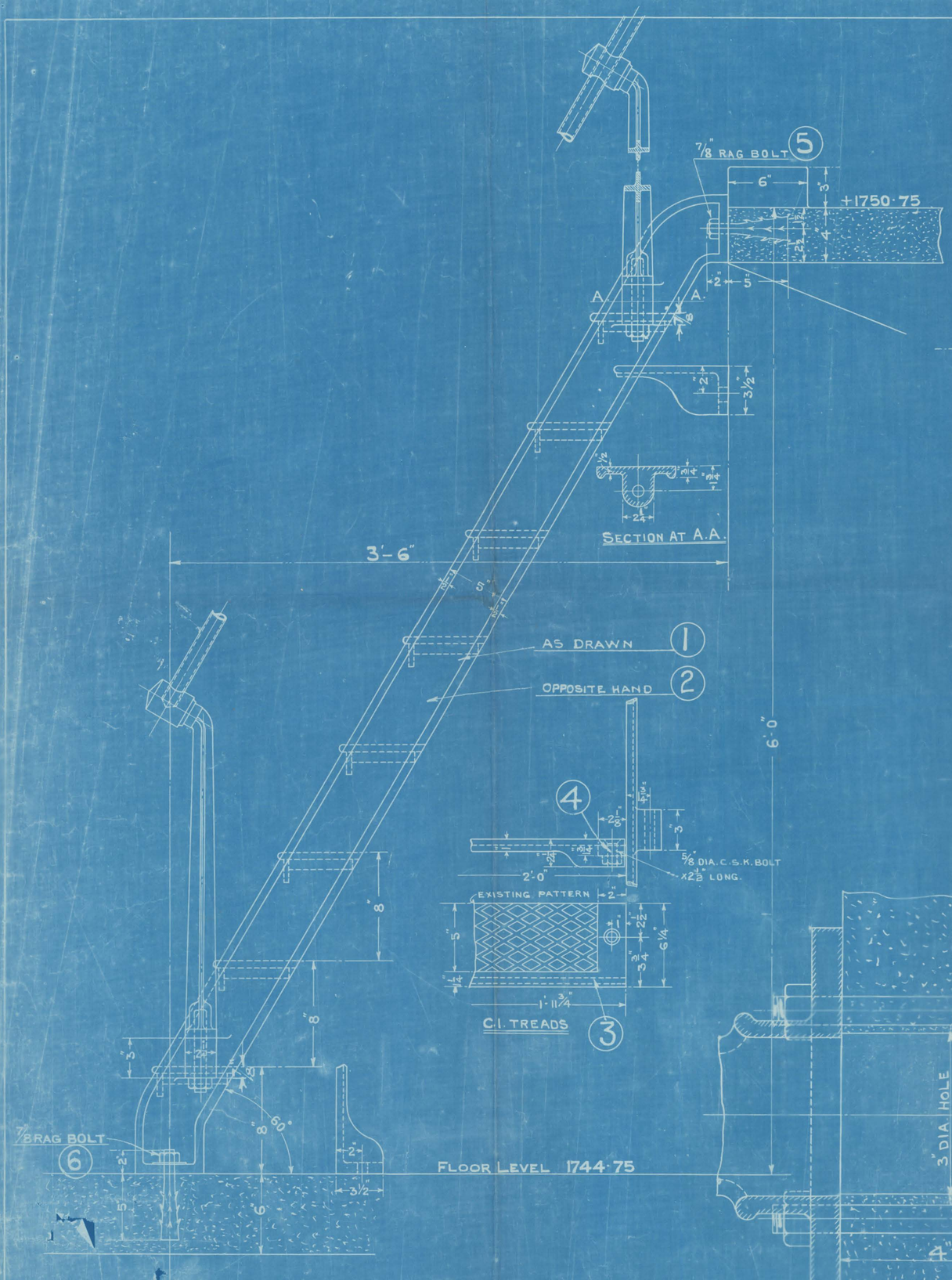
HYDERABAD

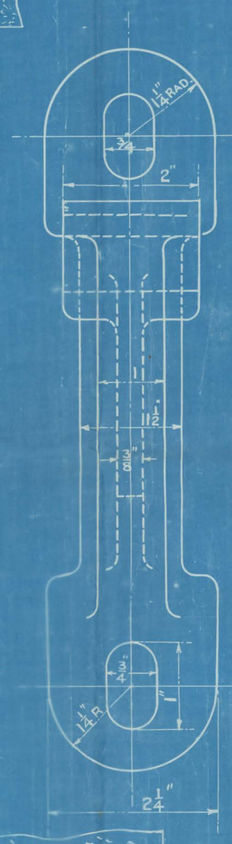
TEMPORARY PUMPS

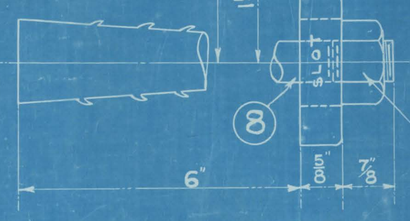
PLAN

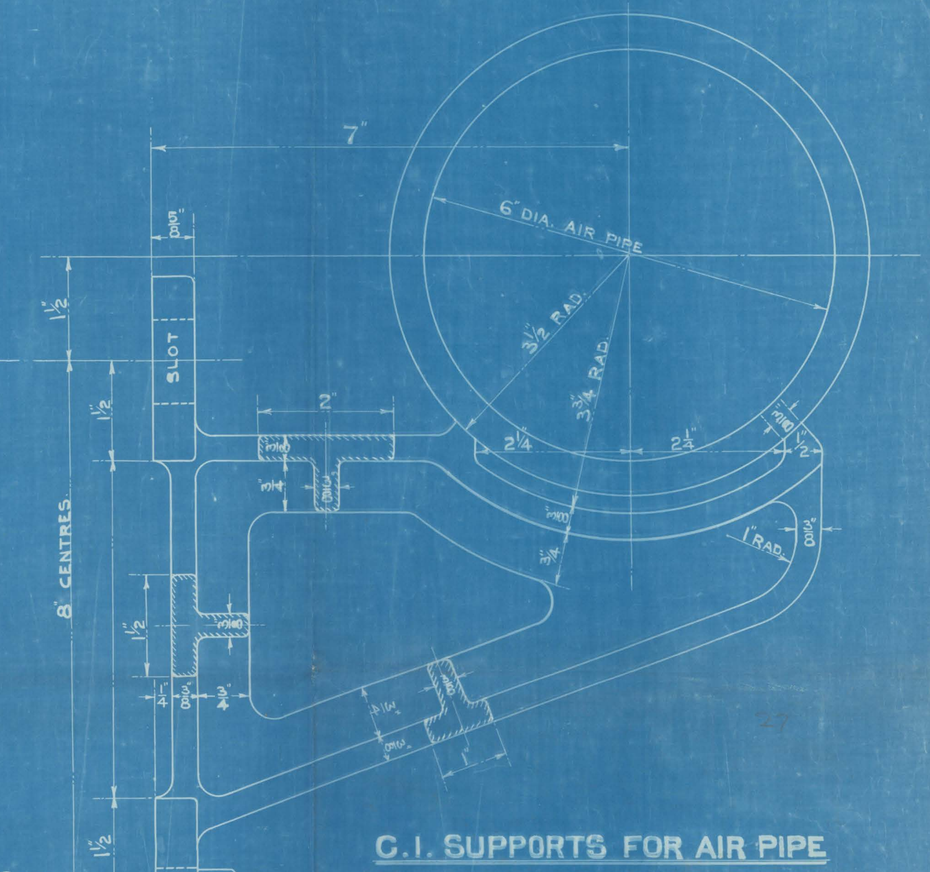
SCALE 1"=1 FOOT

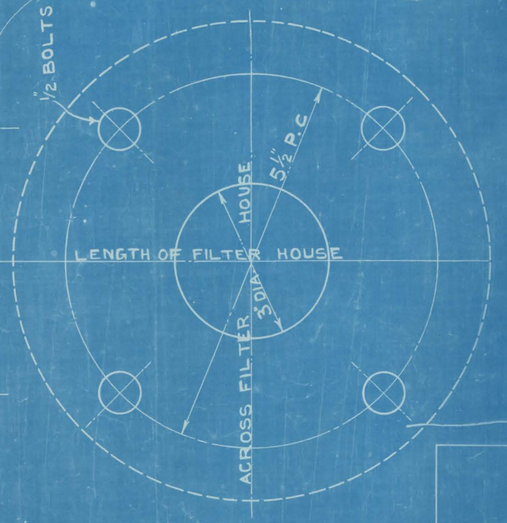
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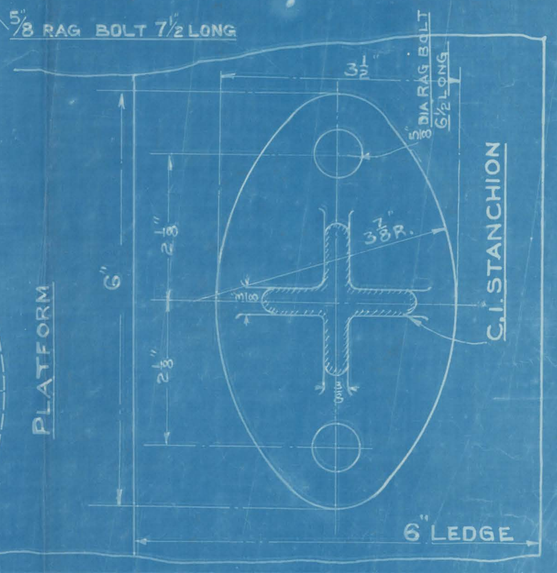












DETAIL OF C.I. STAIR

3 - OFF

PLAN

DETAIL OF FOOT OF HEADSTOCK FOR ALL VALVES.

C.I. SUPPORTS FOR AIR PIPE

FULL SIZE

7

HYDERABAD

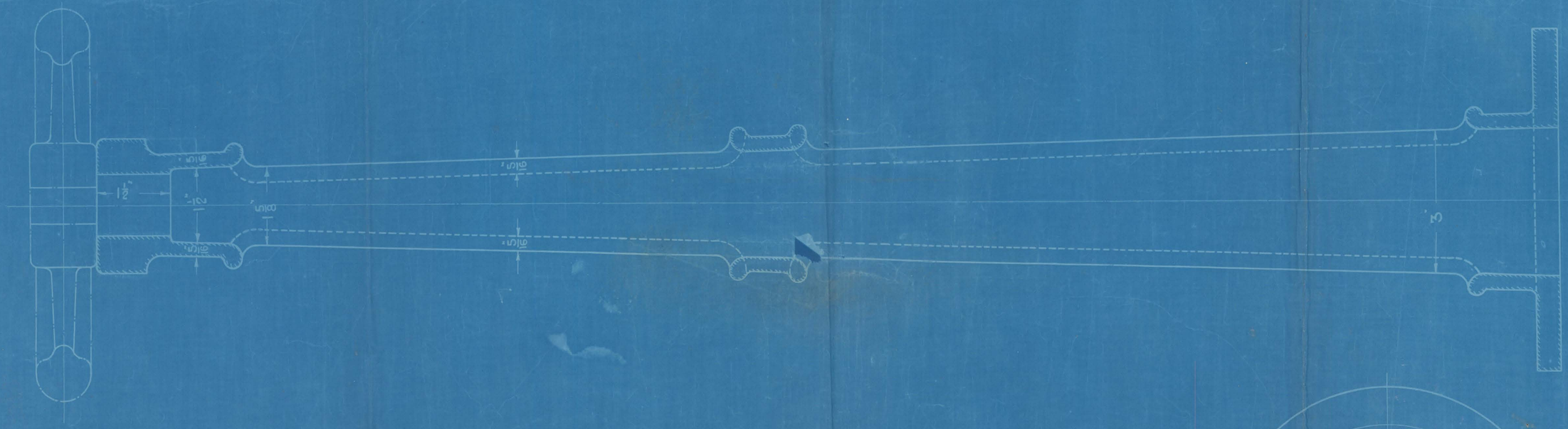
DETAIL OF LADDER & PIPE SUPPORTS

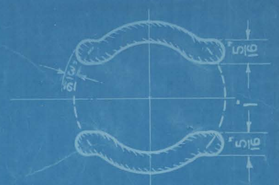
SCALE 3" = 1 FOOT

0917 W.P.F.

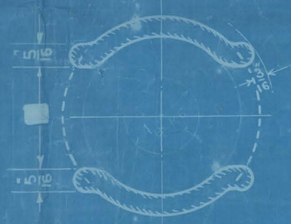
DRAWING No. 10,427

44

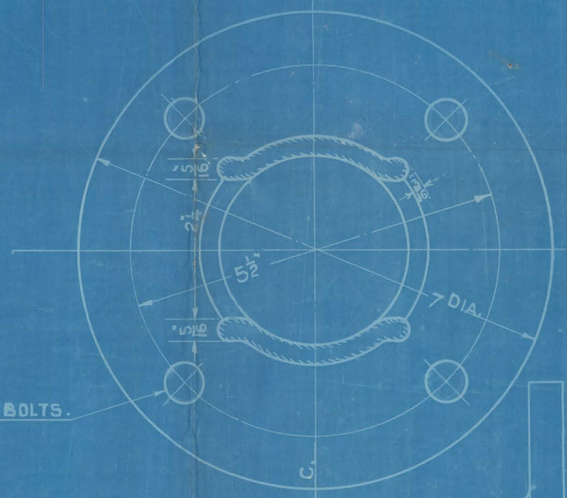




— SECTION THRO. A.A. —

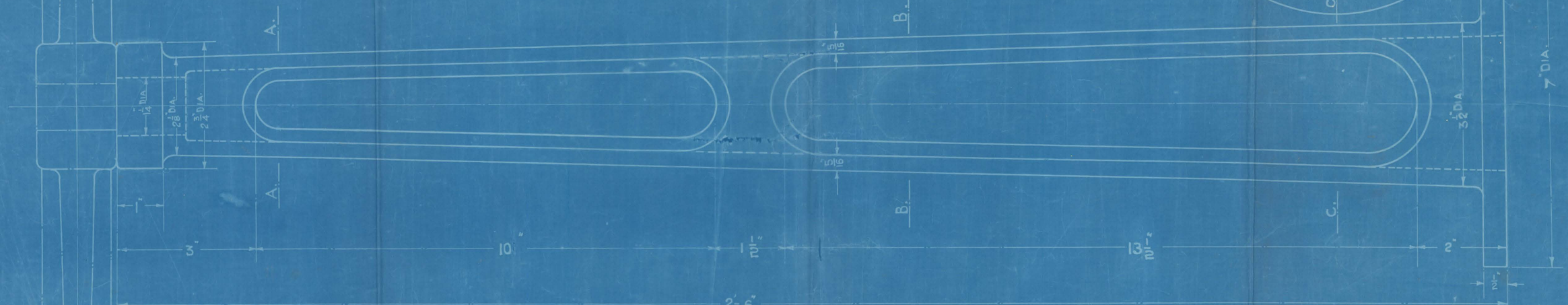


— SECTION THRO. B.B. —



— SECTION THRO. C.C. —

1" DIA. BOLTS.



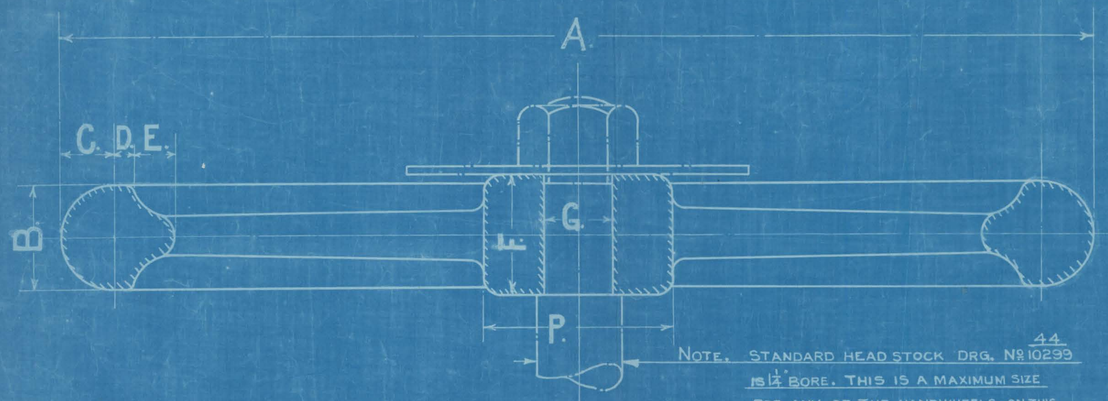
2'-6"

— HEADSTOCK —
— FOR —
— FILTER VALVES. —
— FULL SIZE. —

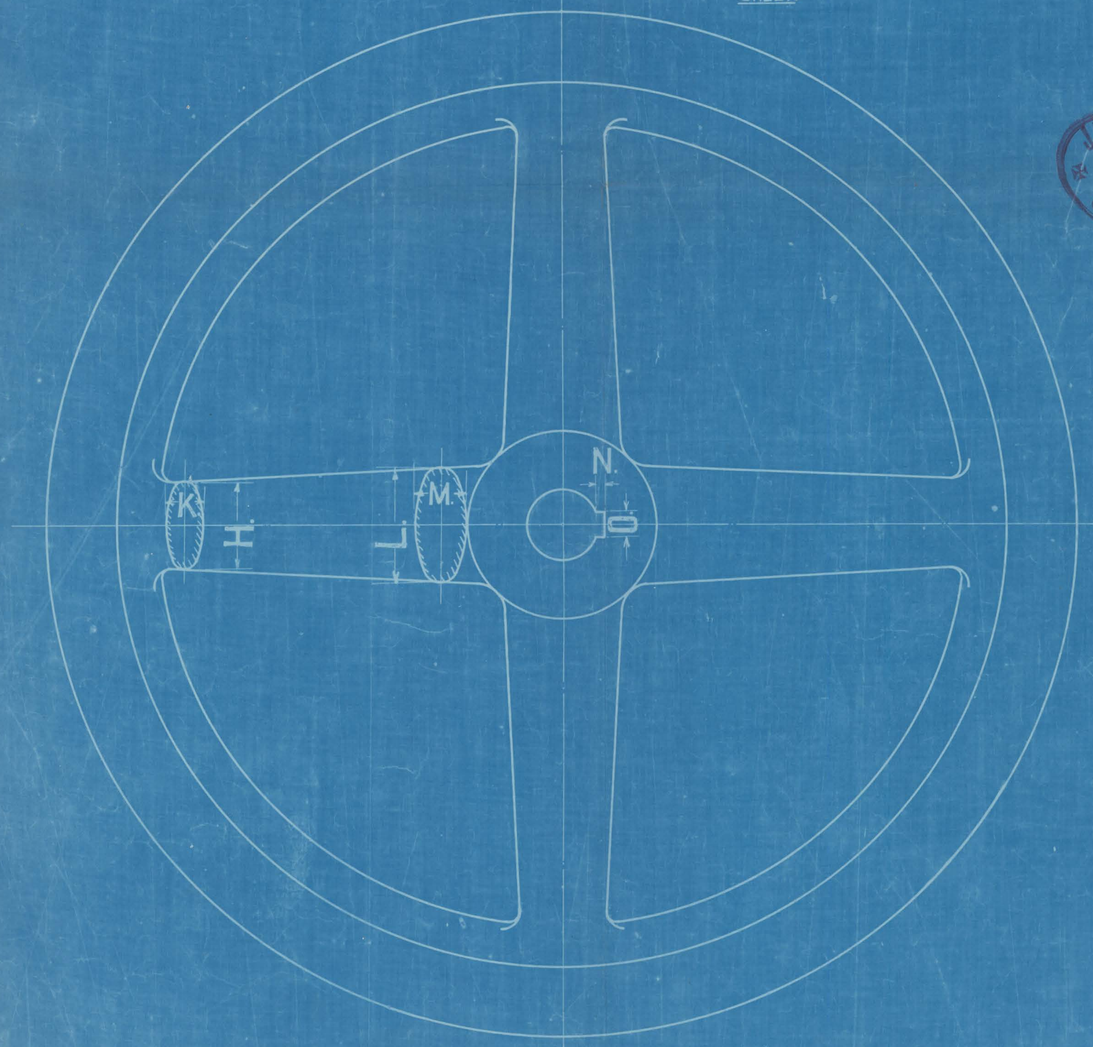
A. H. HALDER
del

DRAWING No 44/10.299

3-8-17



NOTE. STANDARD HEAD STOCK DRG. Nº 44/10299 IS 1¼" BORE. THIS IS A MAXIMUM SIZE FOR ANY OF THE HANDWHEELS ON THIS SHEET.

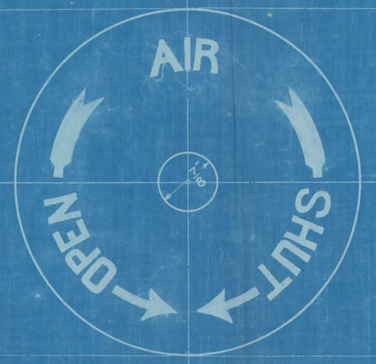


C. I. HANDWHEEL

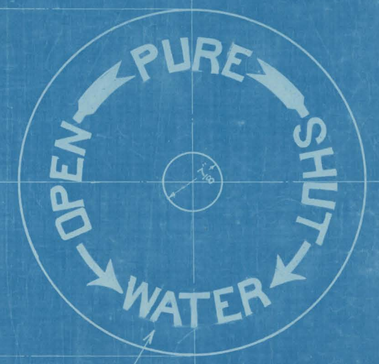




MARK. (5)



MARK. (6)

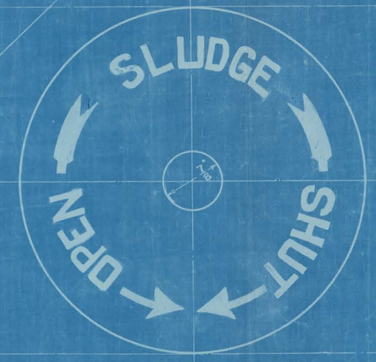


MARK. (7)

NOTE.
THESE LETTERS TO BE CUT OUT & FILLED UP WITH RED SEALING WAX.



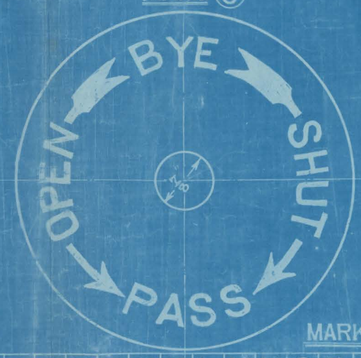
MARK. (8)



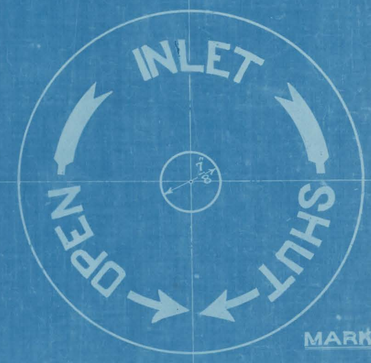
MARK (9)



MARK (10)



MARK. (12)



MARK. (11)

G. M. INDEX PLATES.

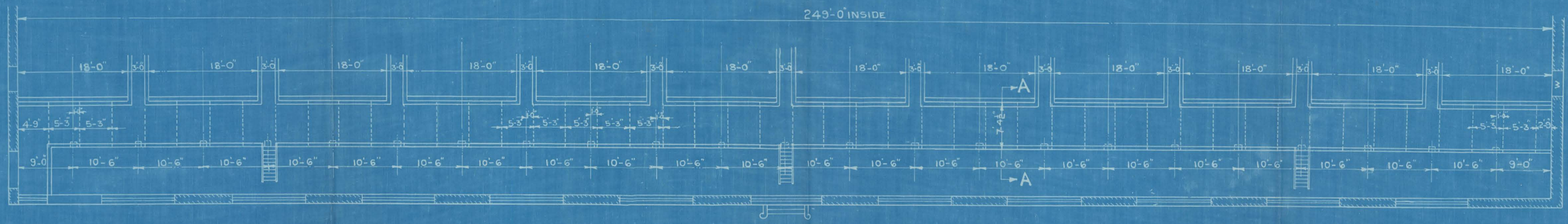
A	B	C	D	E	F	G	H	K	L	M	N	O	P	MARK.
8"	1 1/8"	9/16"	5/32"	13/32"	1 3/8"	3/4"	7/8"	3/8"	1 3/8"	1/2"	3/32"	3/16"	2 1/2"	(1)
10"	1 1/4"	5/8"	3/16"	7/16"	1 1/2"	7/8"	1"	7/16"	1 1/2"	9/16"	3/32"	3/16"	2 5/8"	(2)
12"	1 1/4"	5/8"	3/16	7/16"	1 1/2"	1"	1 1/8"	1/2"	1 5/8"	5/8"	1/8"	1/4"	2 3/4"	(3)
15"	1 1/2"	3/4"	1/4	1/2"	1 3/4"	1"	1 1/4"	9/16"	1 3/4"	11/16"	1/8"	1/4"	2 3/4"	(4)

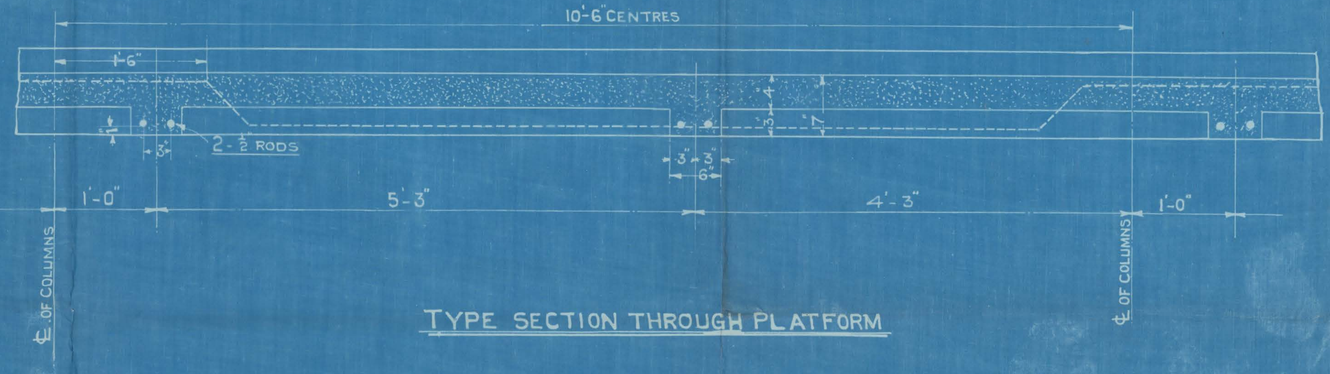
STANDARD HANDWHEEL

SCALE FULL SIZE

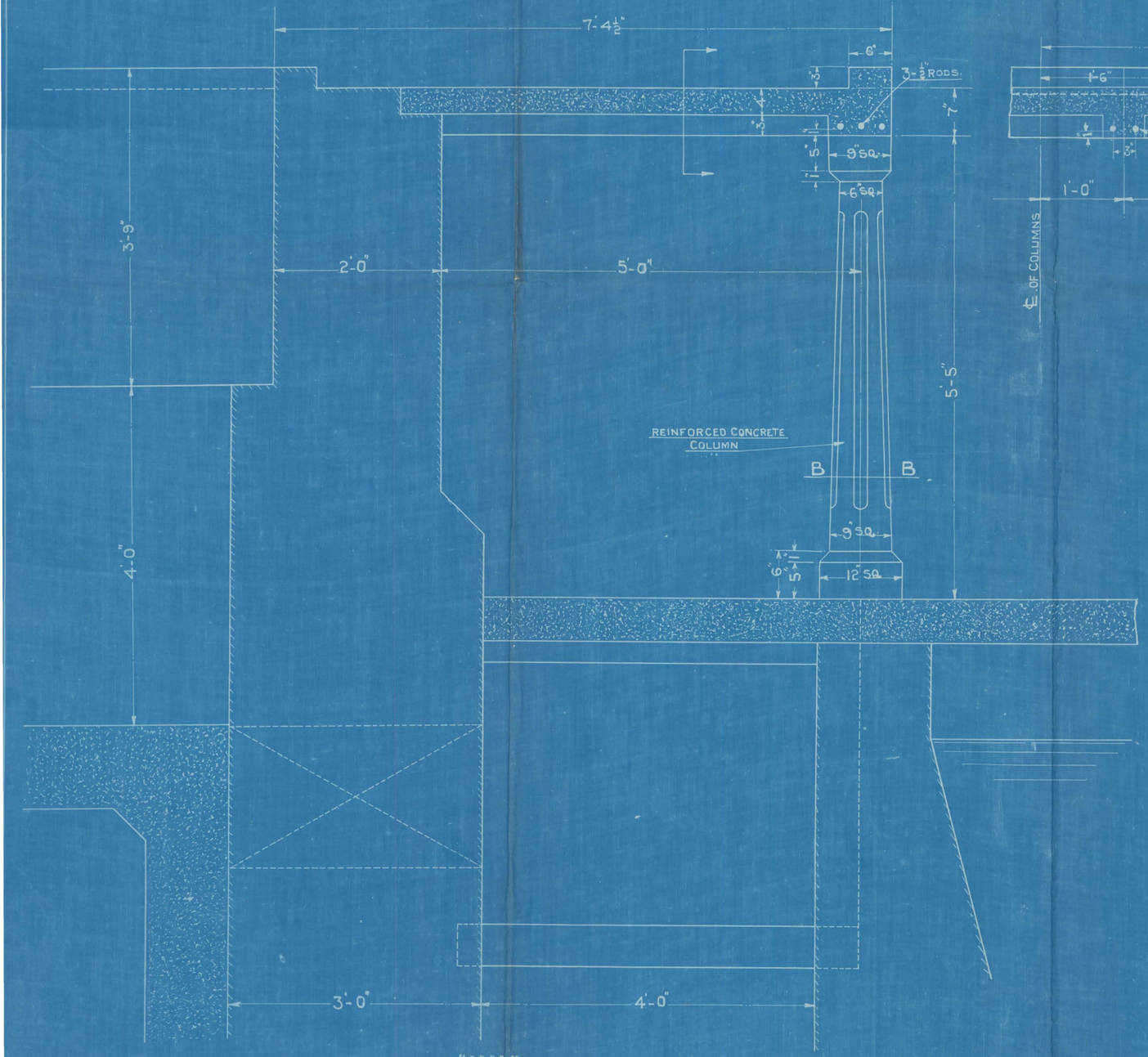
18-8-14

DRAWING Nº 44/10282





TYPE SECTION THROUGH PLATFORM



SECTION "A" "A"



SECTION B.B.

HYDERABAD

PLATFORM DETAILS

SCALE 1½" = 1 FOOT

DRAWING Nº 44/11,660

A-12-18.

NOTE:-

VALVE PARTS 8 & 9 } OF G.M.

VALVE SEATS 10 & 11 }

JESSOP & CO. LTD. ENGINEERS CALCUTTA.

Note:

This valve is designed to reduce pressure from 100 lbs. □" to 3-4 lbs. □".

Pressure on H.P. side may vary from 0 to 100 lbs □".

L.P ranges from 3 to 4 lbs. □" minimum to 6 to 7 lbs. □" max.

Strength of spring = 31.6 lbs. per inch.

6" PRESSURE REDUCING VALVE

— FULL SIZE —

31-11-14

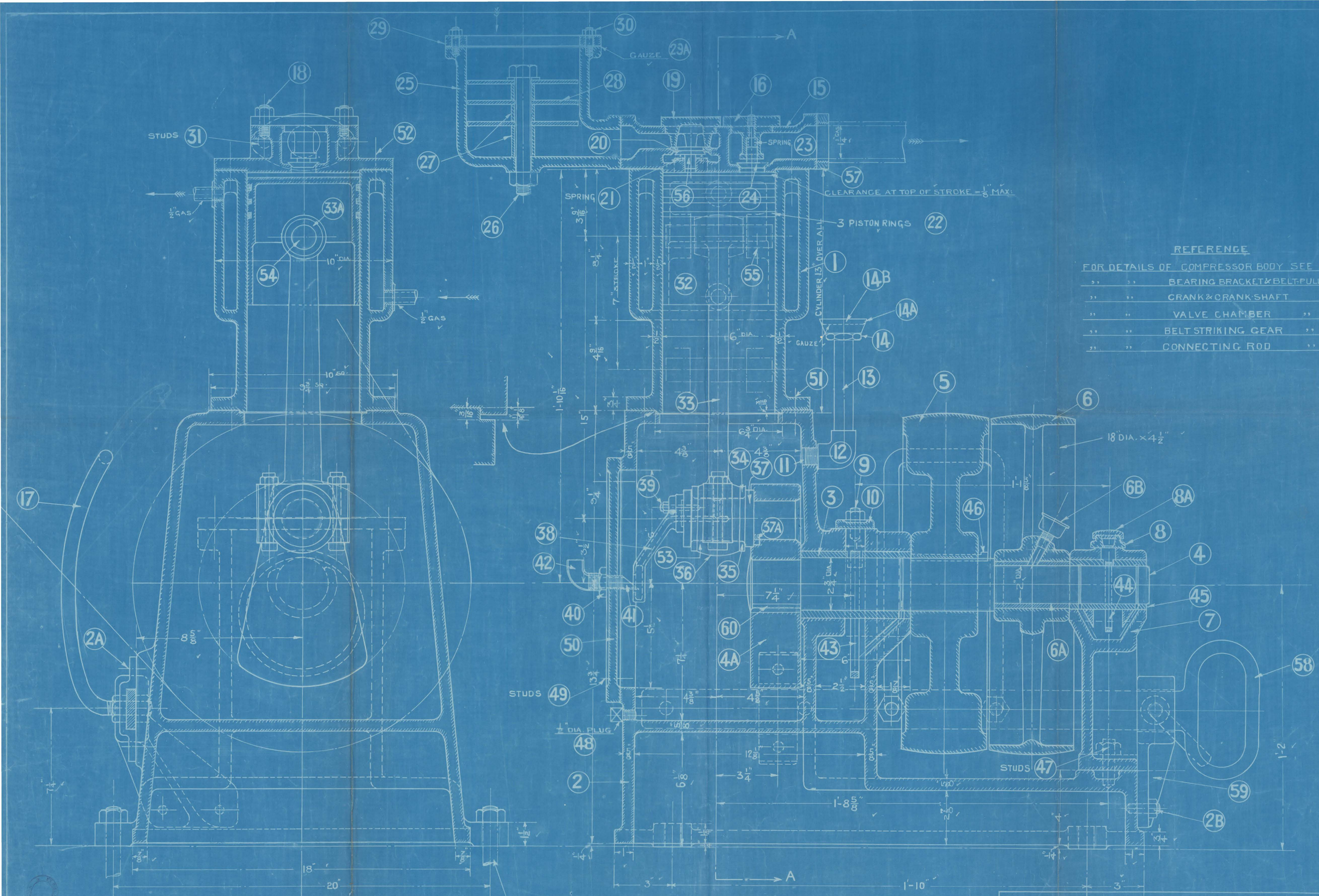
Job No. 1558 X

Drawn by Gupta

Traced by M. Ford

Checked by

DRAWING No. 44 / 10598



REFERENCE

FOR DETAILS OF COMPRESSOR BODY SEE DRWG			4/10695
,, ,,	BEARING BRACKET & BELT-PULLEY	,,	4/10696
,, ,,	CRANK & CRANK-SHAFT	,,	4/10697
,, ,,	VALVE CHAMBER	,,	4/10698
,, ,,	BELT STRIKING GEAR	,,	4/10699
,, ,,	CONNECTING ROD	,,	4/10700

—6"×7" AIR COMPRESSOR—

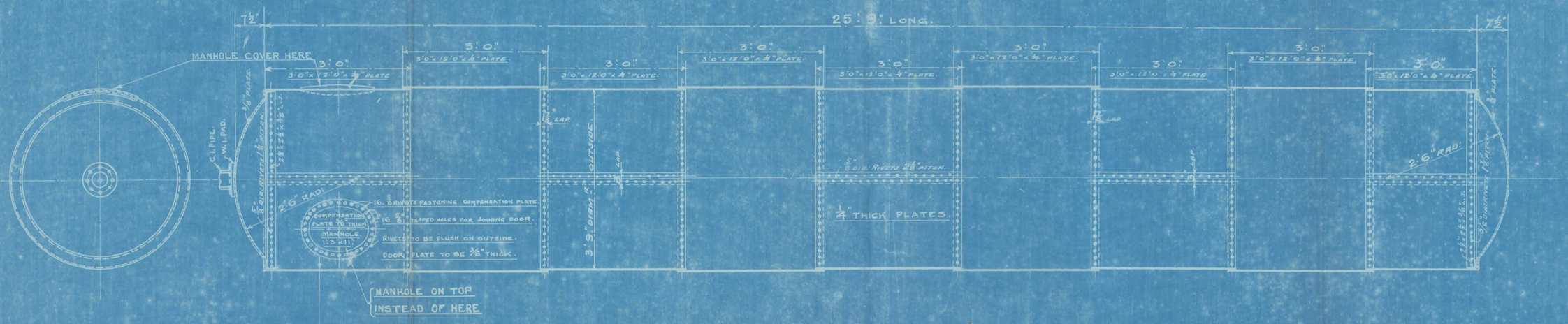
—GENERAL ARRANGEMENT—

—SCALE HALF SIZE—

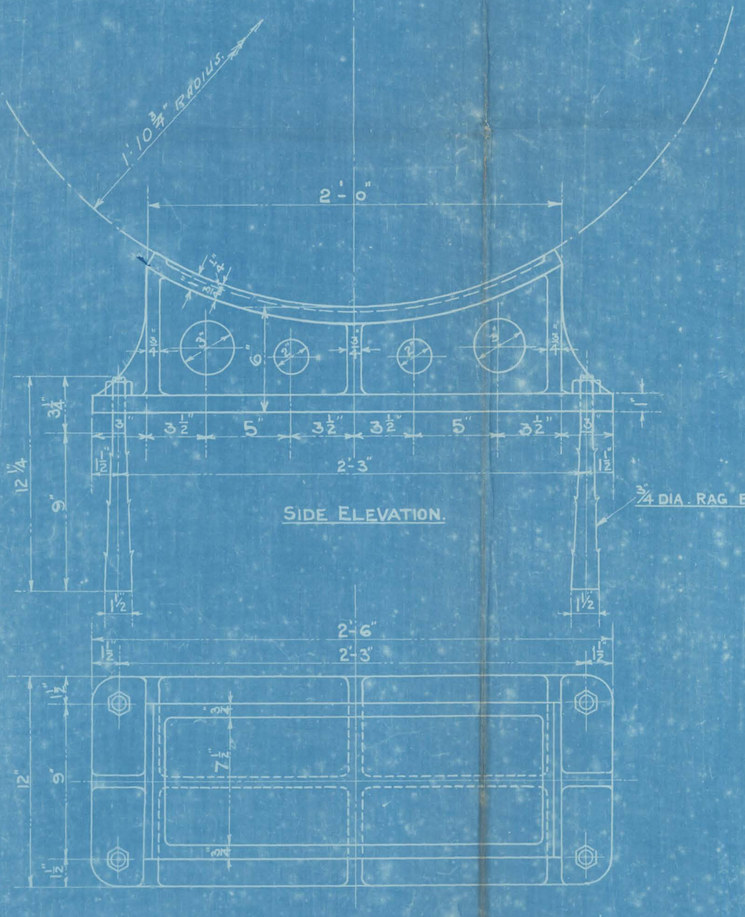
1675 K
Khangaon
20.12.17

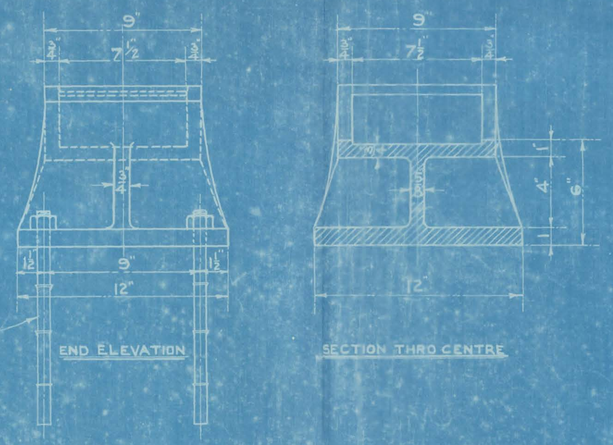
DRAWING No 4/10694

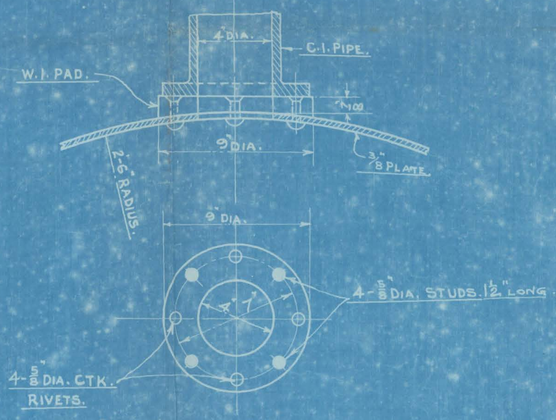
20-12-17

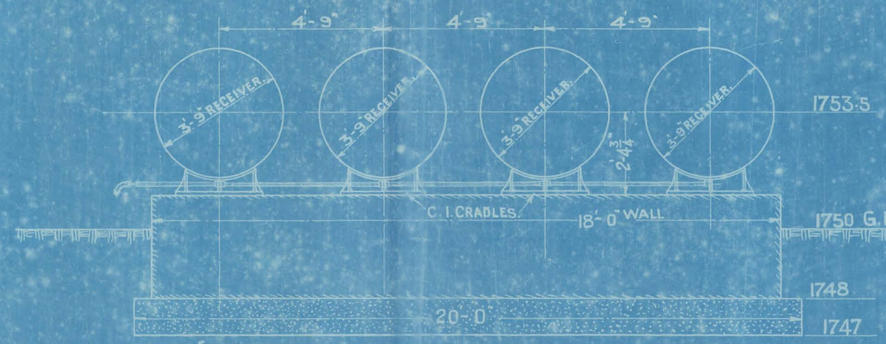


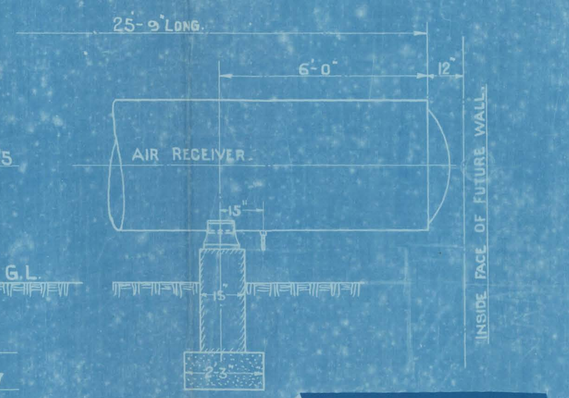
4-REQD







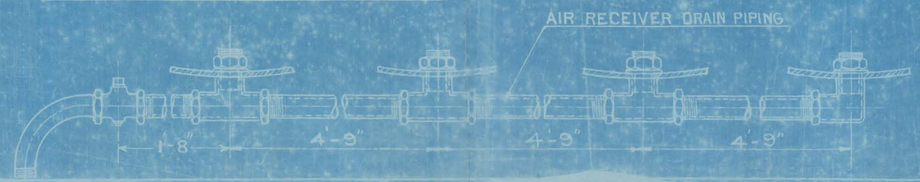




NOTE.

RECEIVERS TO WORK AT ABOUT 80 lbs. □"

—"— "—BE TESTED TO 100 lbs. □"



4-AIR RECEIVERS

SCALE 1" & 3"-1 FOOT

— HYDERABAD —

0917 WPE

Amir Hussain
R.S.E.
15.5.17.

44

DRAWING No 10.074

TAPPED HOLE FOR 3/8" SET SCREW x 5/8" LONG

8-5/8" STUDS

A. A.

12"

6 7/8" 5 1/8" 10" 7/8" 10"

WALL

HOLING THUS

7/8" 5/8" 7/8"

G.M.

8-5/8" DIA. BOLTS x 2 5/8"

8-5/8" DIA. STUDS x 2 1/4" LONG

C.L. OF FILTER

9" C.I. SLUICE VALVE HERE

12 3/4" P. DIA.

14 1/2" DIA.

9" DIA.

14 1/2" DIA.

10 1/2" DIA.

14 3/4" DIA.

14 1/2" DIA.

12 3/4" P. DIA.

9" DIA.

1'-4"

C.I.

G.M.

NOTE:- THIS VALVE HAS 1 1/4" DROP

DRAWING No 44/10439

—HALF PLAN—

DETAIL OF ROD SEE DRG. No 44/10430.

8 7/8" OVER WINGS

5/8" PIN x 2 1/2"

9 1/2" DIA.

9" DIA.

6 1/2" DIA.

6 1/4" DIA.

8 1/2" DIA.

9 1/2" DIA.

10" DIA.

4-3/8" SET SCREW 7 1/2" P.C.

2 3/4" DIA.

1 3/4" DIA.

1" DIA.

6 1/4"

6 3/4"

14" DIA.

10 1/2" DIA.

9 1/2" DIA.

8 7/8" OVER WINGS

9" DIA.

7 1/2 C.C.

No 8-5/8" STUDS x 2" LONG

3/8" SET SCREW

8 1/2" DIA.

12 3/4" P. DIA.

THESE G.M. RINGS EXACTLY SAME AS ABOVE SPLIT

—SECTION A.A.—

1 1/2"

NOTE:- ALL PARTS MARKED G.M. TO CONTAIN :—

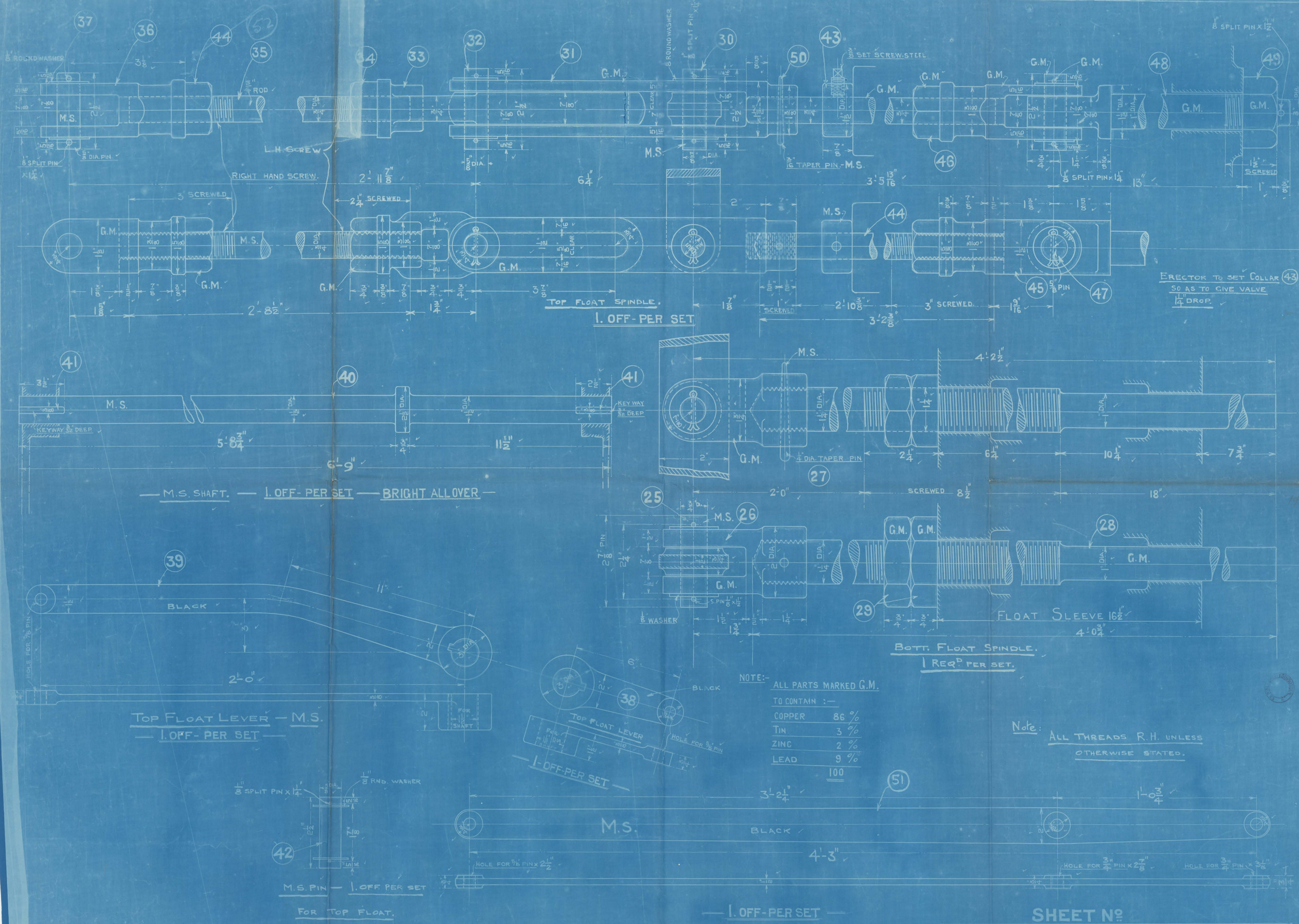
COPPER	86 %
TIN	3 %
ZINC	2 %
LEAD.	9 %
	100

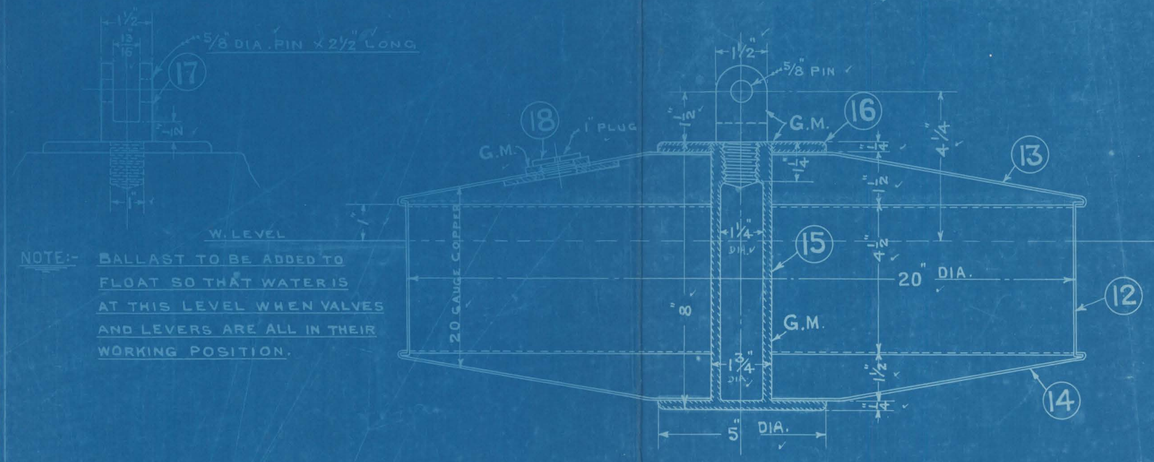
12-SETS REQD.

SHEET No

—9" DIA. OUTLET CONTROL VALVE—
—FOR 20'-0" x 18'-0" FILTER—
—FULL SIZE—

18-10-44


37
36
44
52
35
8 ROUND WASHER
3⅛"
ROD
M.S.
8 SPLIT PIN
¼ DIA. PIN
1¼"
L.H. SCREW
RIGHT HAND SCREW.
3" SCREWED
G.M.
M.S.
G.M.
1⅛"
2'-8½"
2'-11⅞"
2¼" SCREWED
G.M.
34
33
32
31
G.M.
8 ROUND WASHER
8 SPLIT PIN x 1½
30
50
M.S.
6¼"
TOP FLOAT SPINDLE.
1. OFF-PER SET
43
⅜" SET SCREW-STEEL
G.M.
3/16" TAPER PIN.-M.S.
G.M.
G.M.
G.M.
46
3'-5 13/16"
48
49
8 SPLIT PIN x 1¼
13"
G.M.
G.M.
SCREWED
1"
2"
M.S.
44
1⅞"
1" SCREWED
2'-10⅜"
3" SCREWED.
3'-2⅜"
1 9/16"
45
⅜" PIN
47
ERECTOR TO SET COLLAR 43
SO AS TO GIVE VALVE
¼" DROP.
41
3½"
M.S.
KEYWAY ⅜ DEEP
40
41
KEY WAY
⅜ DEEP
5'-8¾"
¾"
11½"
6'-9"
— M.S. SHAFT. — 1. OFF-PER SET — BRIGHT ALL OVER —
M.S.
4'-2½"
G.M.
¼ DIA. TAPER PIN
27
2'-0"
SCREWED 8½"
18"
25
M.S.
26
G.M.
G.M.
28
G.M.
S.PIN 1⅛ x ½
⅛ WASHER
1¾"
29
FLOAT SLEEVE 16½"
4'-0¾"
BOTT. FLOAT SPINDLE.
1 REQD PER SET.
39
BLACK
11"
2'-0"
HOLE FOR ⅝ PIN
TOP FLOAT LEVER — M.S.
— 1. OFF-PER SET —
6"
BLACK
38
TOP FLOAT LEVER
HOLE FOR ⅝ PIN
— 1-OFF-PER SET —
NOTE:- ALL PARTS MARKED G.M.
TO CONTAIN :—
COPPER 86 %
TIN 3 %
ZINC 2 %
LEAD 9 %
100
Note: ALL THREADS R.H. UNLESS
OTHERWISE STATED.
⅛" SPLIT PIN x 1¼"
⅛" RND. WASHER
42
M.S. PIN — 1. OFF PER SET
FOR TOP FLOAT.
51
3'-2½"
1'-0¾"
M.S.
BLACK
4'-3"
HOLE FOR ⅝ PIN x 2½"
HOLE FOR ¾" PIN x 2⅞"
HOLE FOR ¾" PIN x 3⅛"
— 1. OFF-PER SET —
SHEET No.
9"-OUTLET CONTROL VALVE FOR 20'x18'-FILTER
— DETAILS OF OPERATING GEAR —
— SCALE HALF & FULL SIZE —
DRAWING No 44/10430

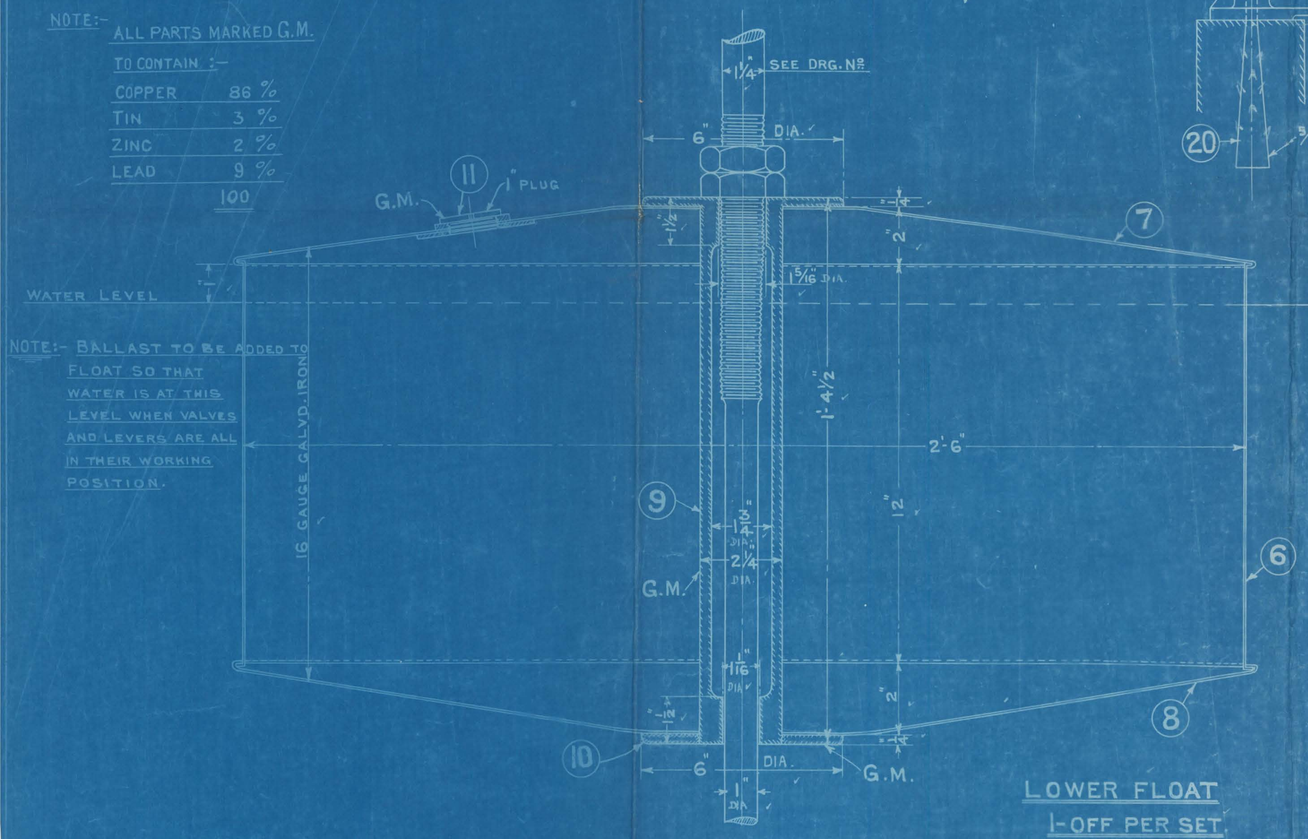


NOTE:- BALLAST TO BE ADDED TO FLOAT SO THAT WATER IS AT THIS LEVEL WHEN VALVES AND LEVERS ARE ALL IN THEIR WORKING POSITION.

UPPER FLOAT

NOTE:- ALL PARTS MARKED G.M. TO CONTAIN :-

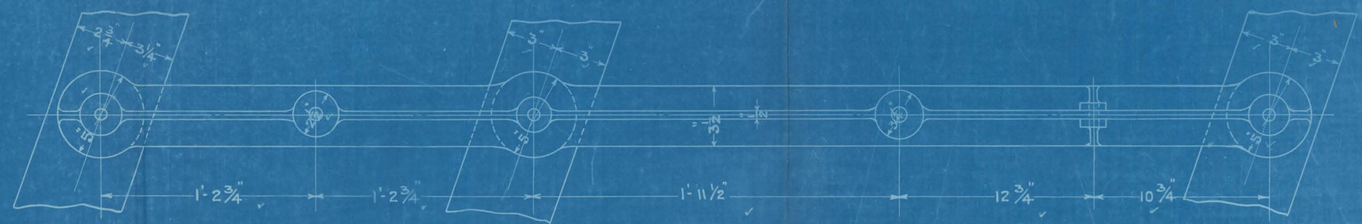
COPPER	86 %
TIN	3 %
ZINC	2 %
LEAD	9 %
	100



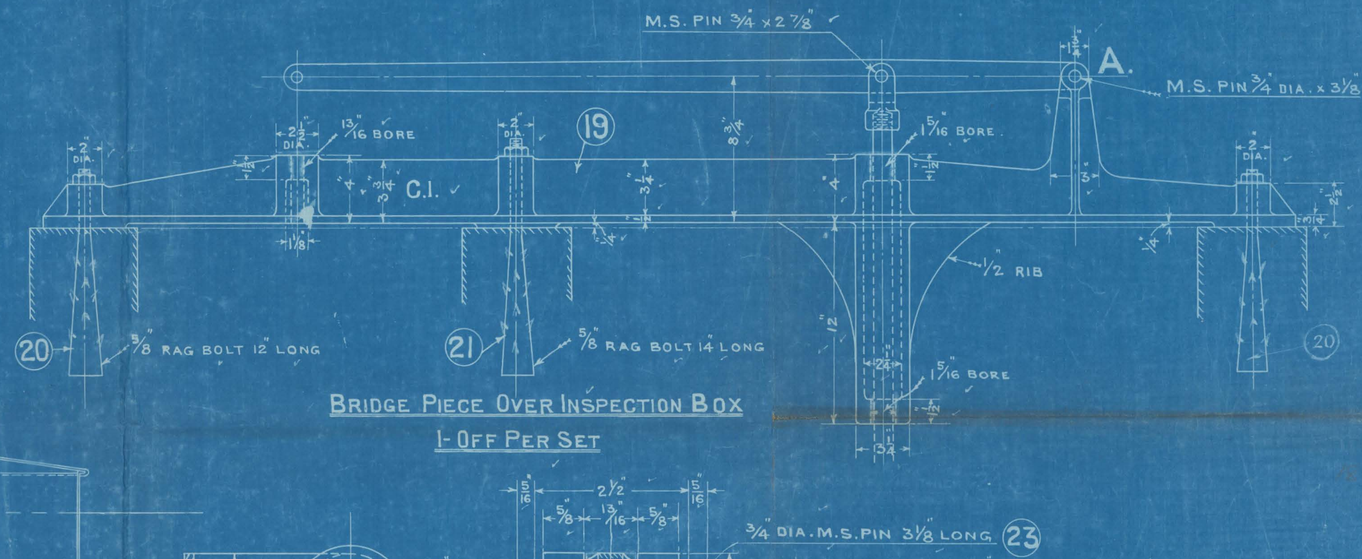
NOTE:- BALLAST TO BE ADDED TO FLOAT SO THAT WATER IS AT THIS LEVEL WHEN VALVES AND LEVERS ARE ALL IN THEIR WORKING POSITION.

LOWER FLOAT

1-OFF PER SET

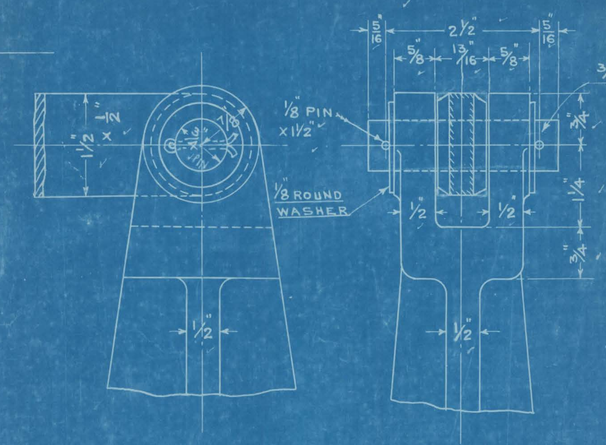


PLAN

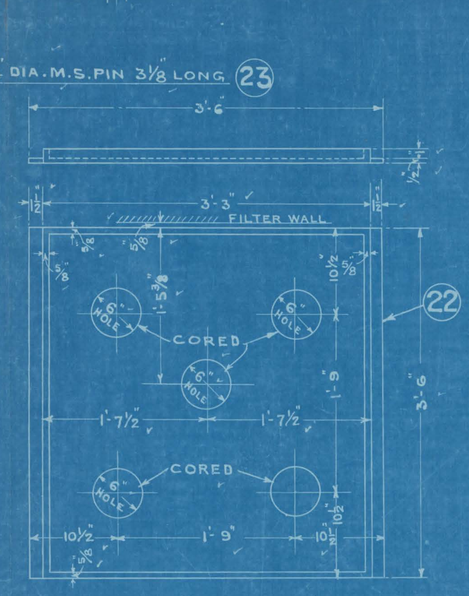


BRIDGE PIECE OVER INSPECTION BOX

1-OFF PER SET



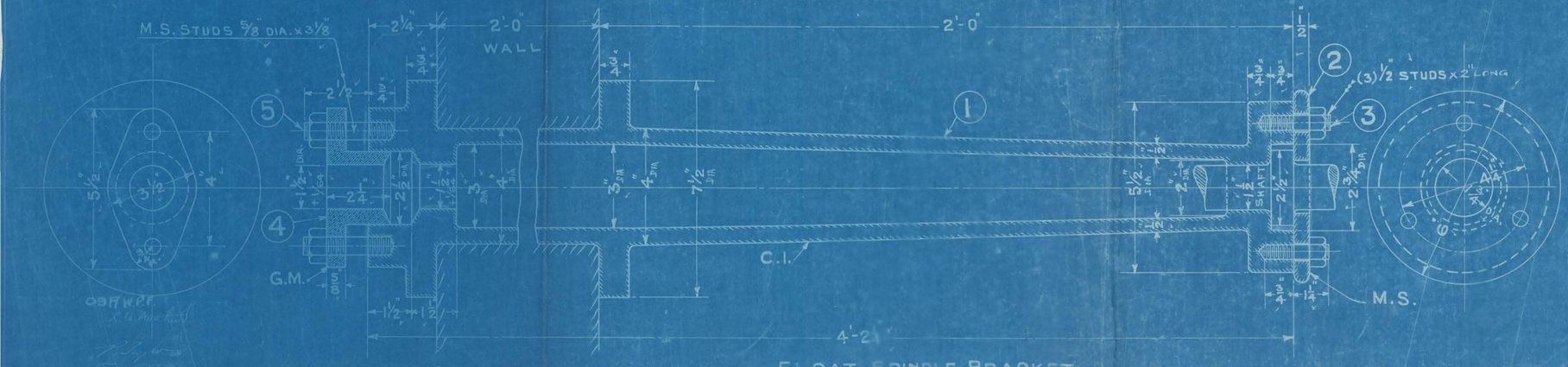
DETAIL AT A.



DETAIL OF BAFFLE PLATE

1-OFF PER SET

BUILT INTO WALLS



FLOAT SPINDLE BRACKET.

1-OFF PER SET.

SHEET Nº 1

9"-OUTLET CONTROL VALVE FOR 20'x18'-FILTER

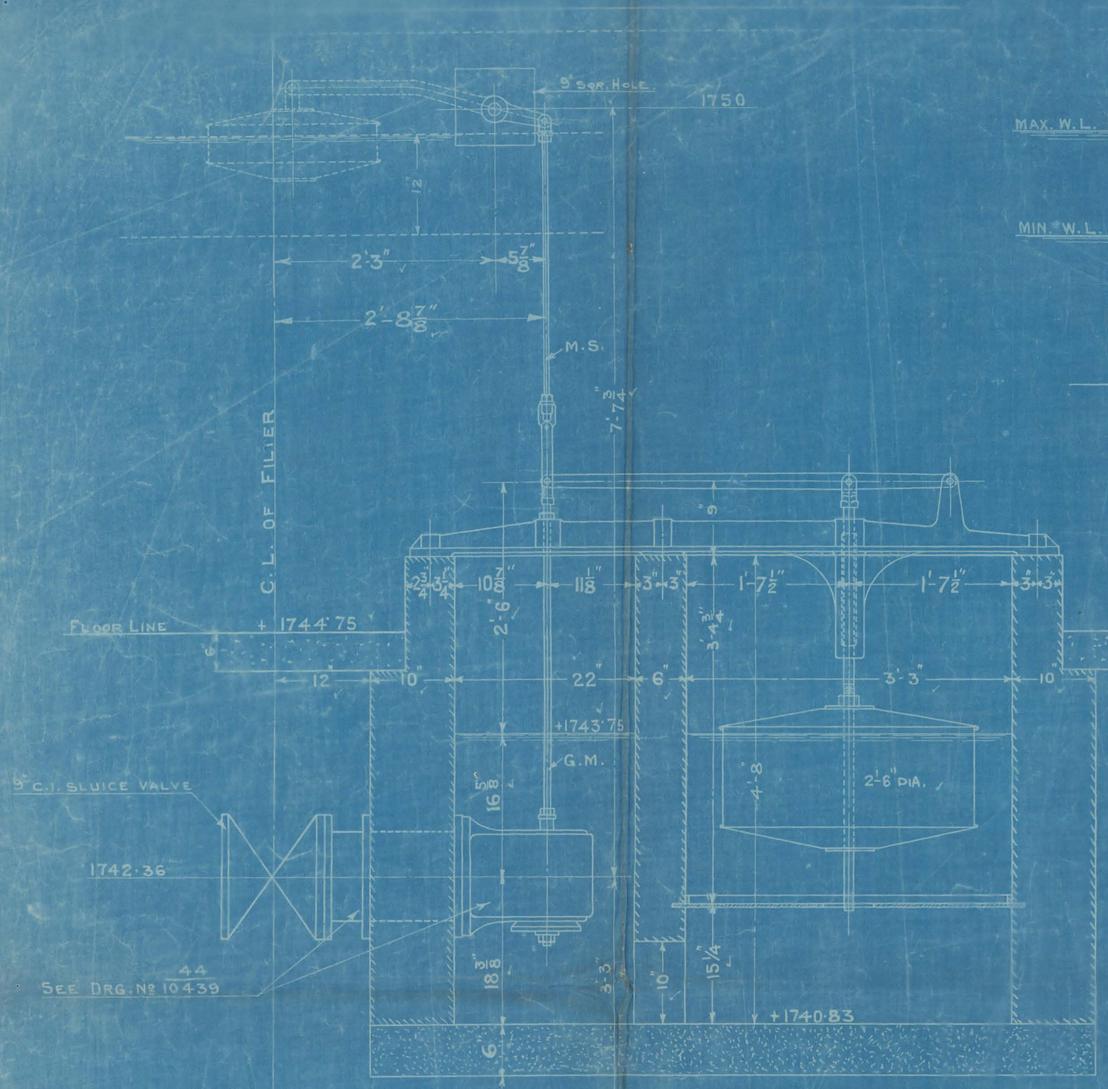
DETAILS OF OPERATING GEAR

SCALE HALF SIZE

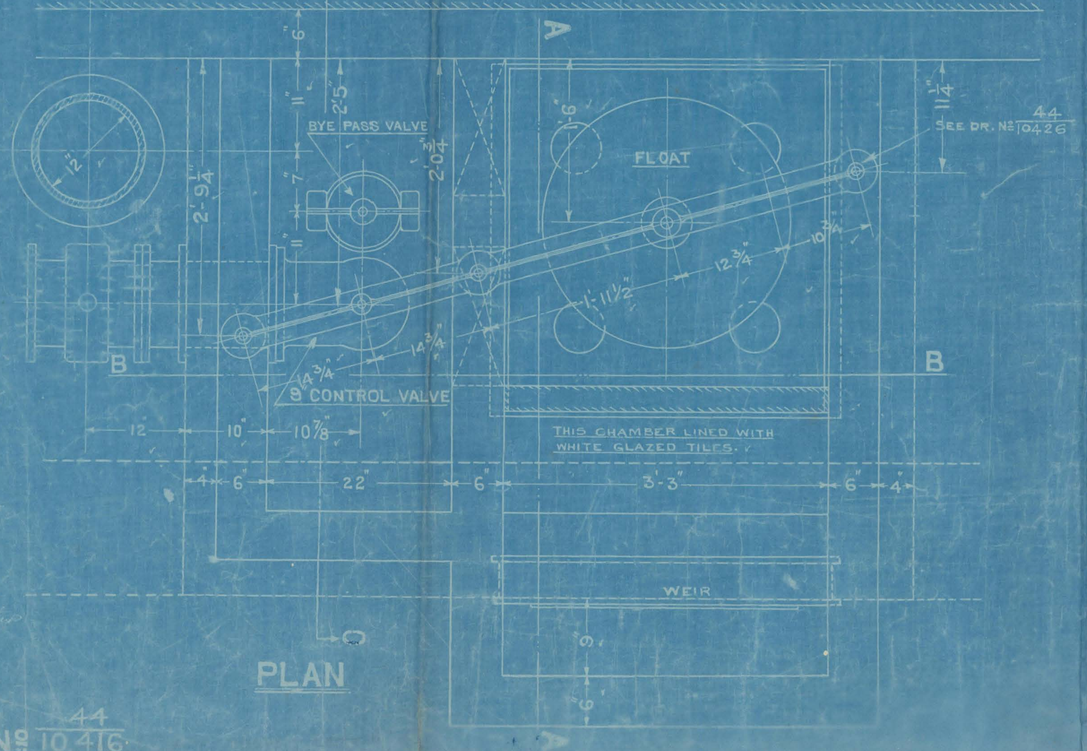
10-9-17

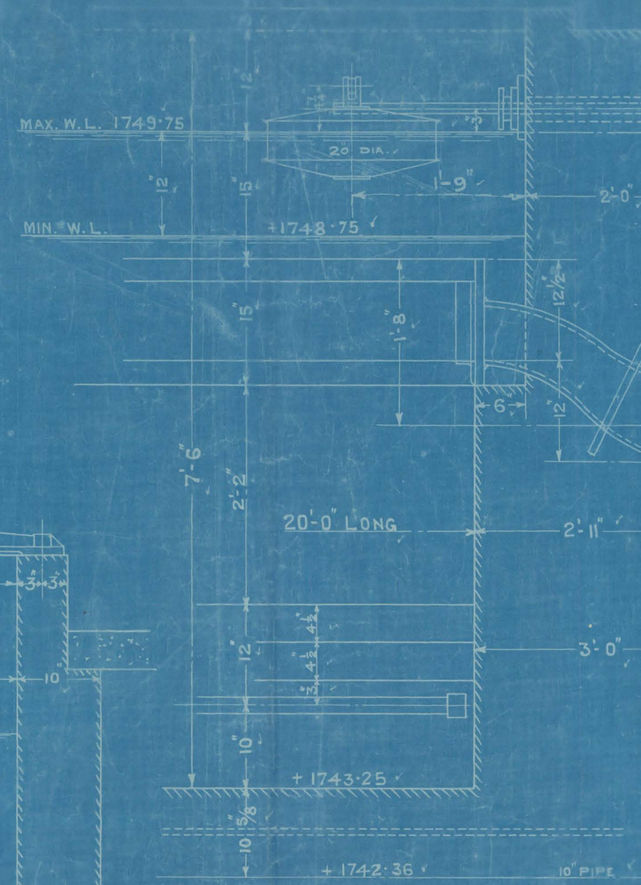
DRAWING Nº 44/10426

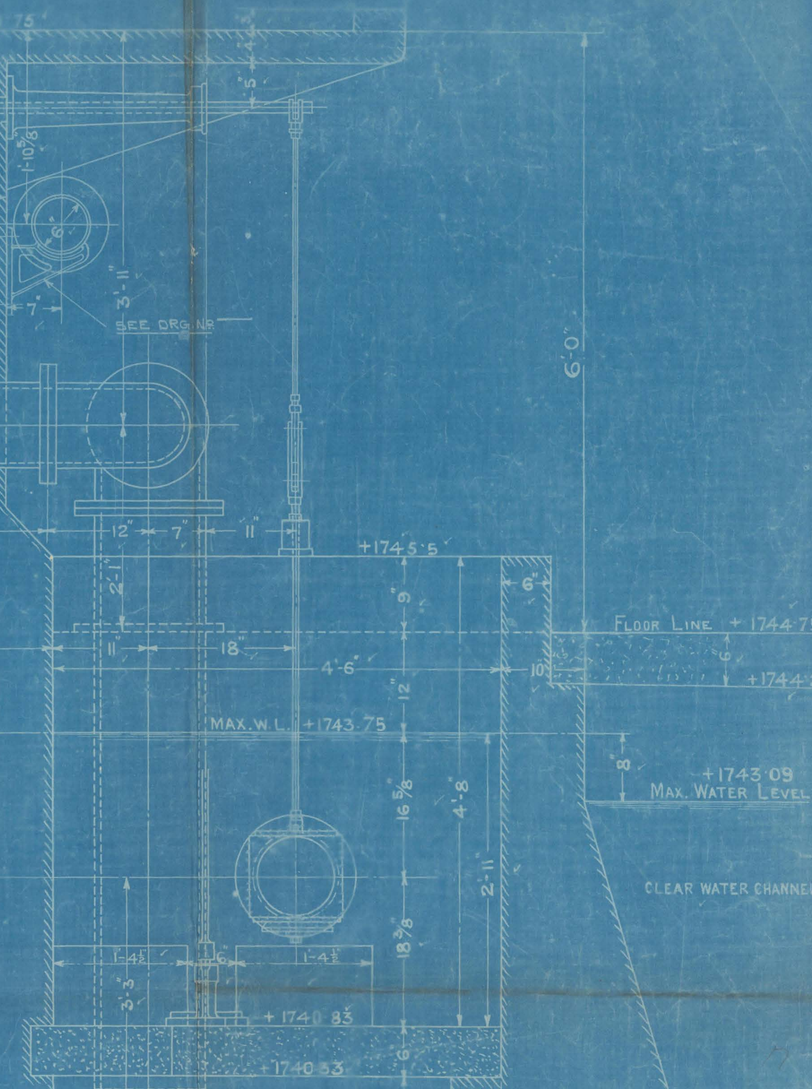
SECTION C.C.

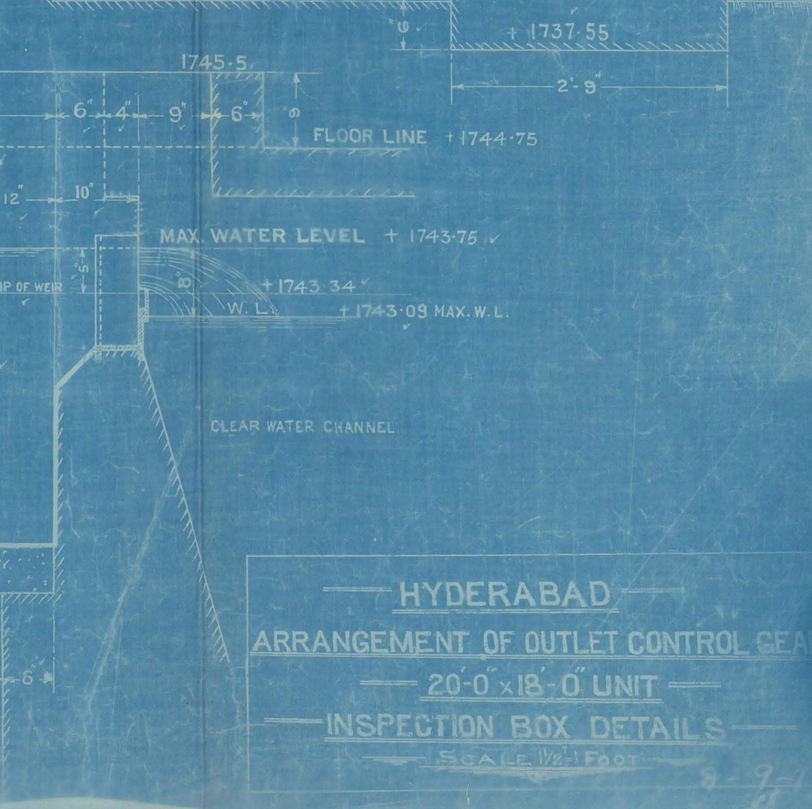


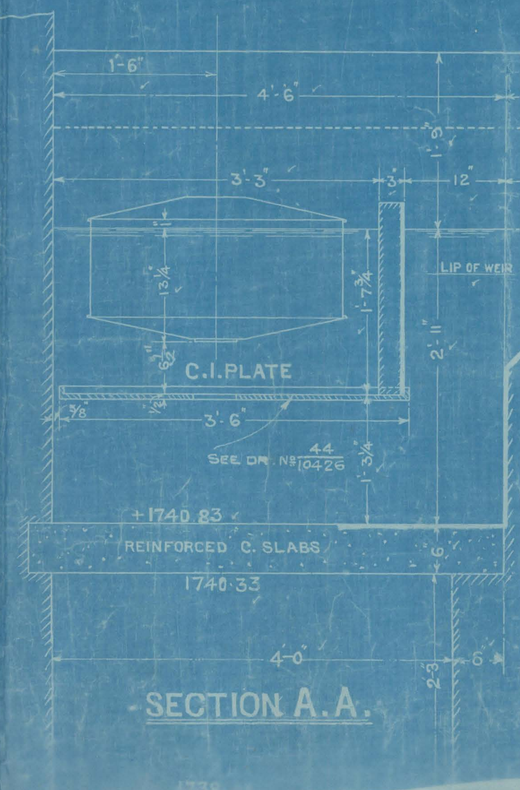
SECTION B.B











SECTION A.A.

HYDERABAD

ARRANGEMENT OF OUTLET CONTROL GEAR

20'-0" x 18'-0" UNIT

INSPECTION BOX DETAILS

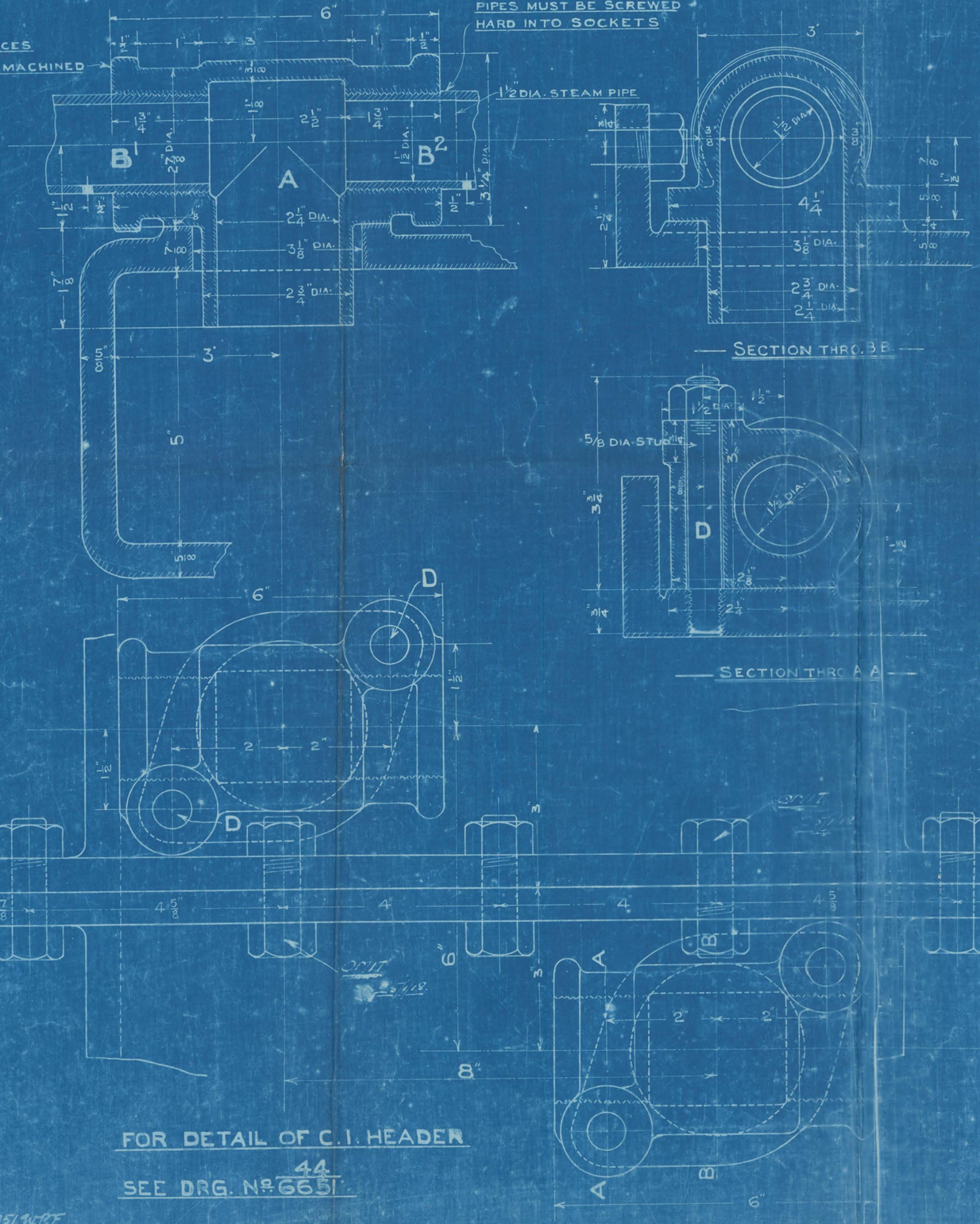
SCALE 1½"-1 FOOT

0917 W.P.F.

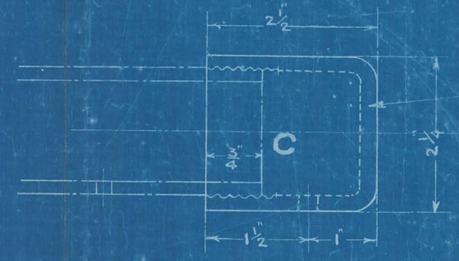
DRAWING Nº 44/10416

NOTE
THESE FACES
MUST BE MACHINED

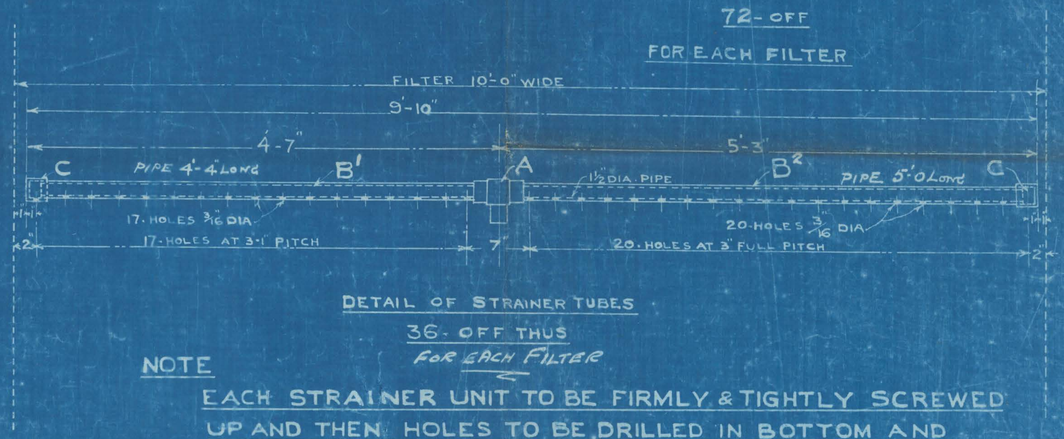
NOTE
PIPES MUST BE SCREWED
HARD INTO SOCKETS



FOR DETAIL OF C.I. HEADER
SEE DRG. No. 44/6651



DETAIL OF PLUG
72- OFF
FOR EACH FILTER



DETAIL OF STRAINER TUBES
36- OFF THUS
FOR EACH FILTER

NOTE
EACH STRAINER UNIT TO BE FIRMLY & TIGHTLY SCREWED UP AND THEN HOLES TO BE DRILLED IN BOTTOM AND THESE PIPES HAVE TO BE DISPATCHED IN THEIR SEPARATE UNITS & NOT TO BE DISMANTLED

JESSOP & CO LTD
ENGINEERS
CALCUTTA

ORDER No.	No. OFF	PURCHASER
06968 W.P.F.	72 OFF	CHITTAGONG
09751 W.P.F.	72 OFF	MUZAFFARPORE

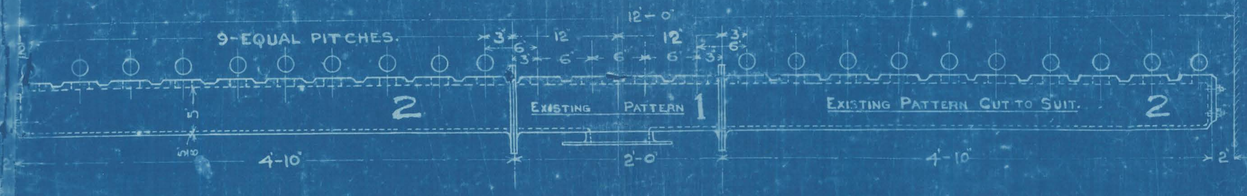
MUZAFFARPORE MUNICIPALITY

DETAIL OF STRAINER TUBES

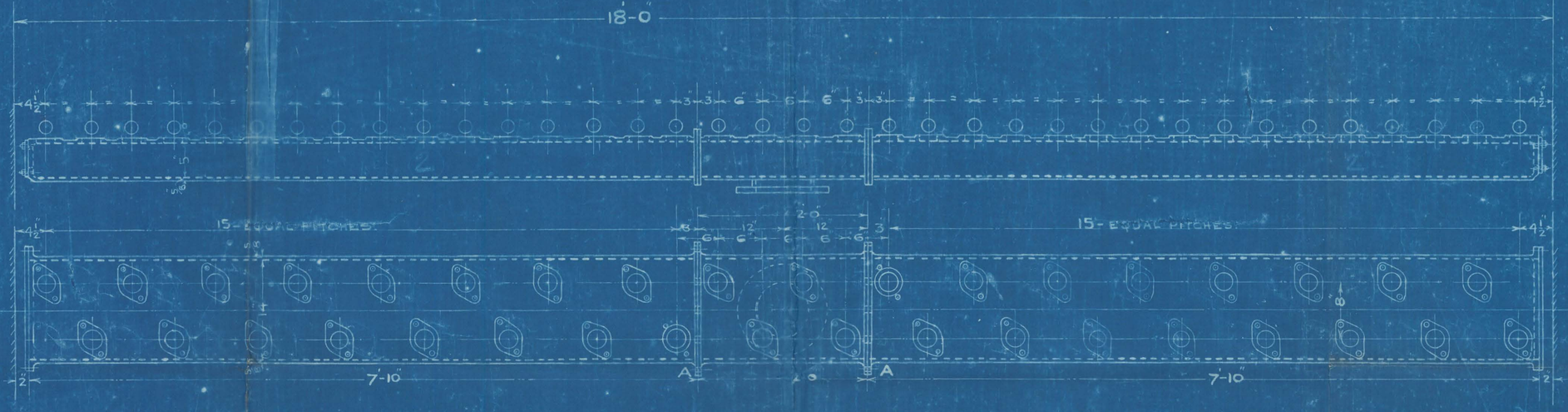
FULL SIZE

09751 W.P.F.
Sch.
Jura.
4-1-16

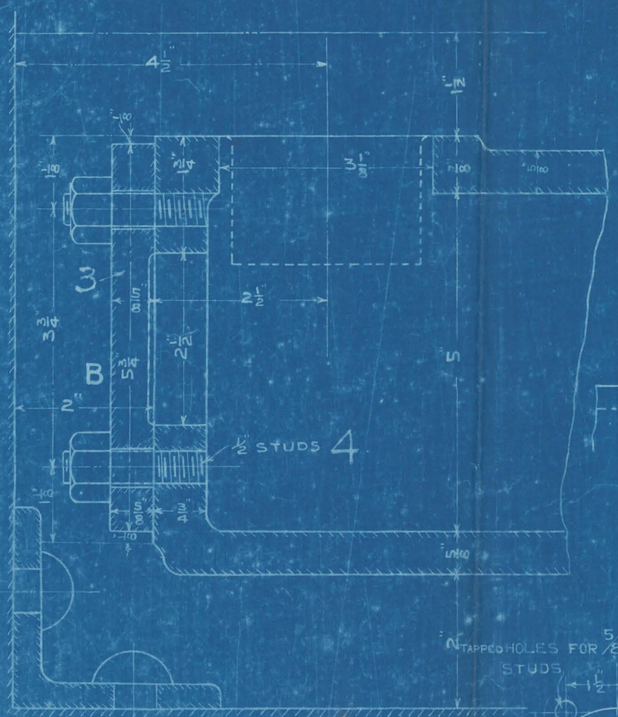
DRAWING No. 44/6652

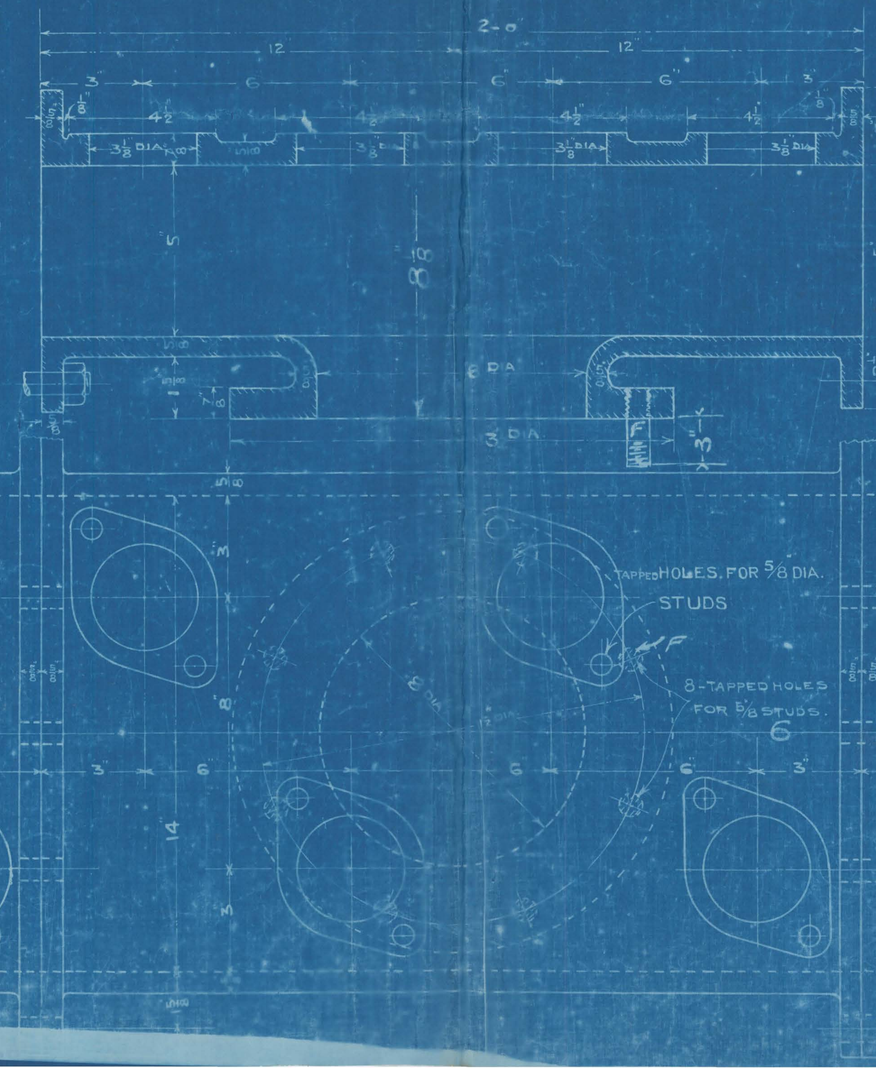


ELEVATION OF HEADER FOR 12×10 FILTER.



JESSOP & CO LTD
ENGINEERS
CALCUTTA

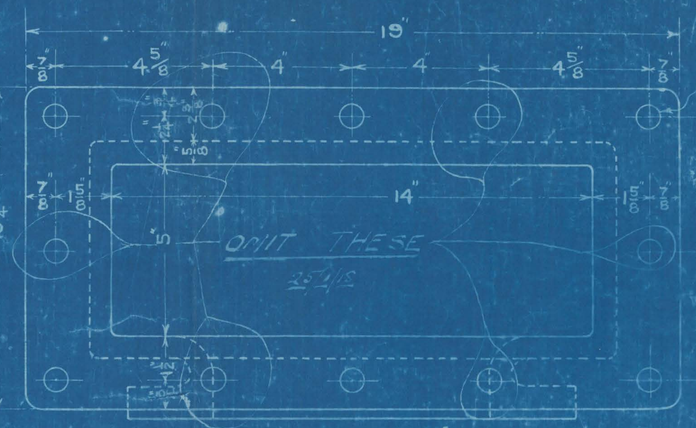




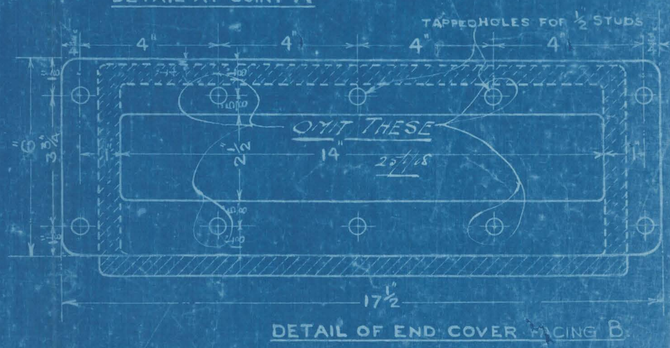
DETAIL SHEWING END CLEARANCES

ORDER Nº	Nº OFF	PURCHASER
06968W.PF.	2 OFF	CHITTAGONG
09751W.PF.	2 OFF	MUZAFFARPORE

09751-WPF.



DETAIL AT JOINT A



DETAIL OF END COVER FACING B.

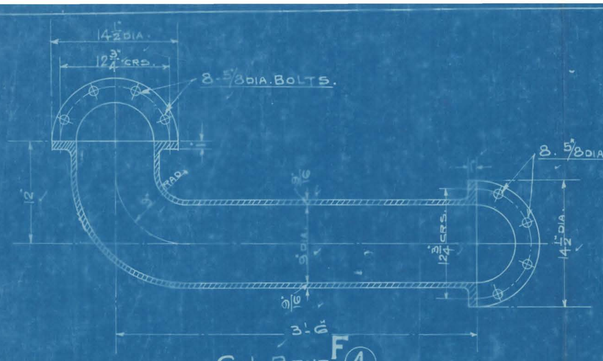
MUZAFFARPORE MUNICIPALITY

DETAIL OF C.I. HEADER

SCALE 1½ & 6"=1FT

44

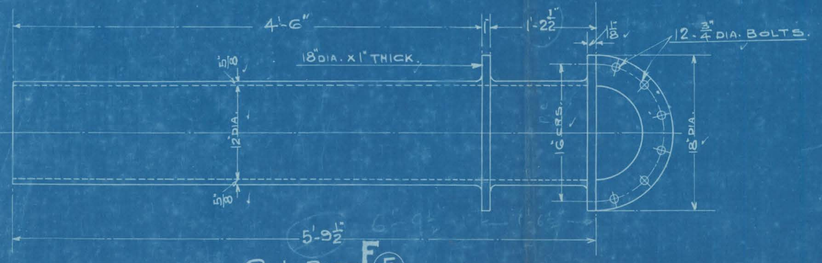
DRAWING Nº 6651



C.I. BEND. F(4)

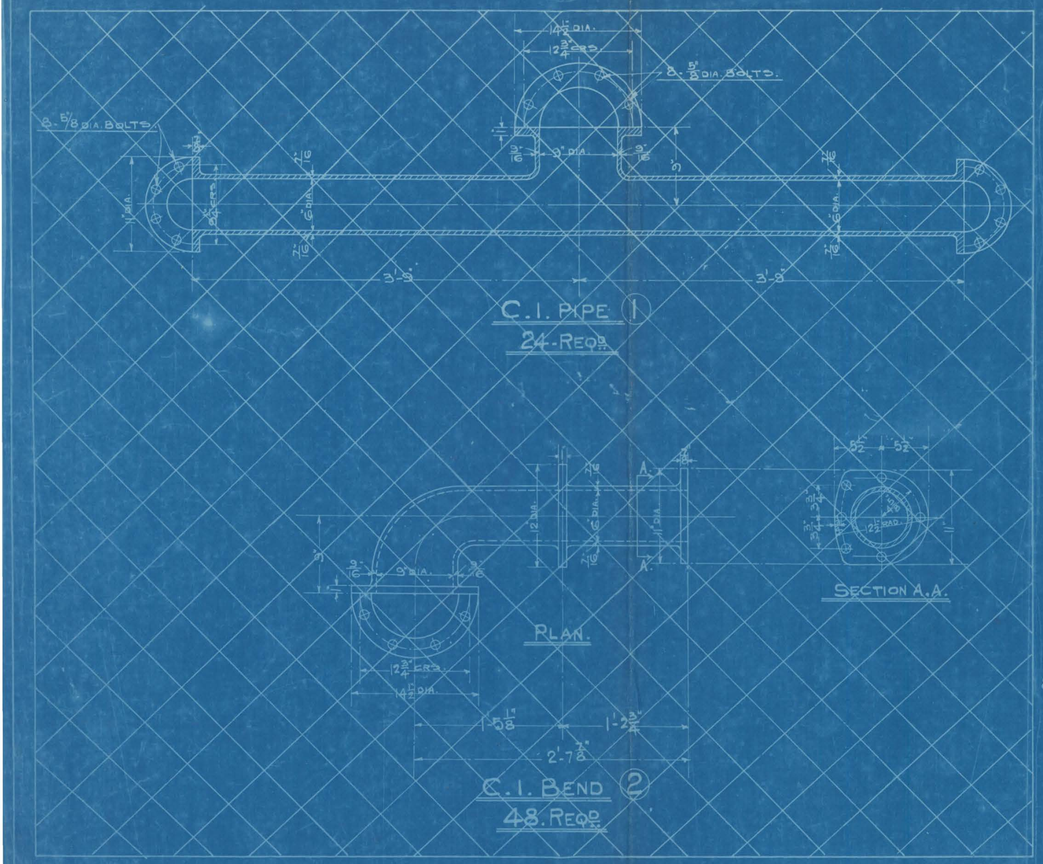
24-REQD.

300 LBS. APPROX. WEIGHT.



C.I. PIPE F(5)

12-REQD. 520 LBS. APPROX. WEIGHT.



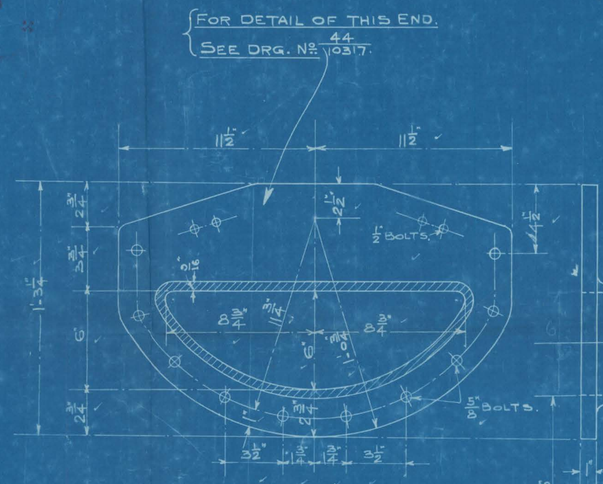
C.I. PIPE (1)

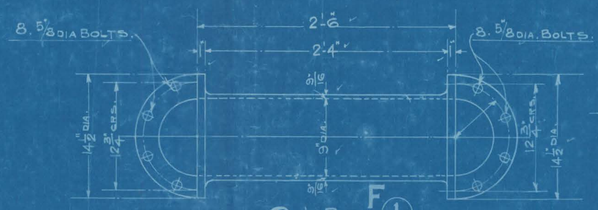
24-REQD.

C.I. BEND (2)

48. REQD.

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ENGINEERS
CALCUTTA

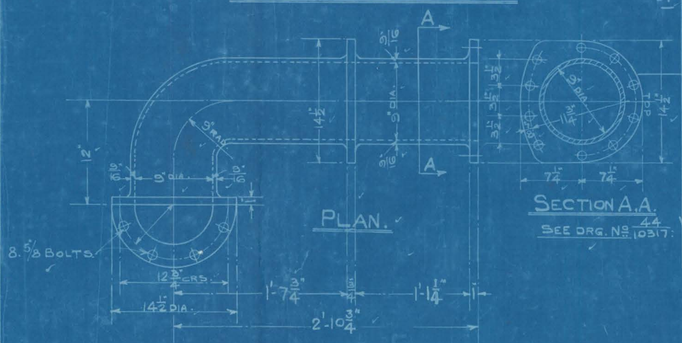




C.I. PIPE F(1)

24-REQD.

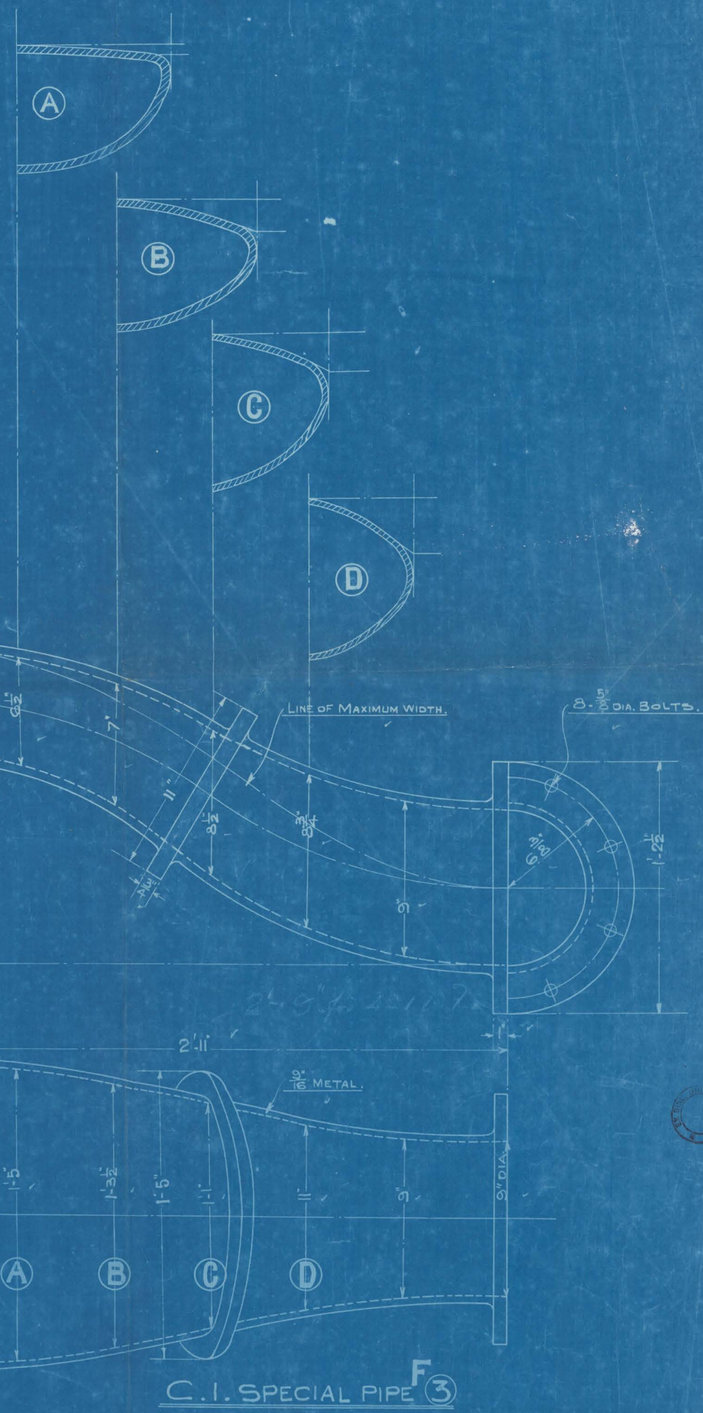
170 LBS. APPROX. WEIGHT.



C.I. BEND, 12- OFF AS DRAWN MARKED F(2)

12- OFF OPPOSITE HAND " F(2A)

280 LBS. APPROX. WEIGHT.



C.I. SPECIAL PIPE F(3)

24. REQD.

300 LBS. APPROX. WEIGHT

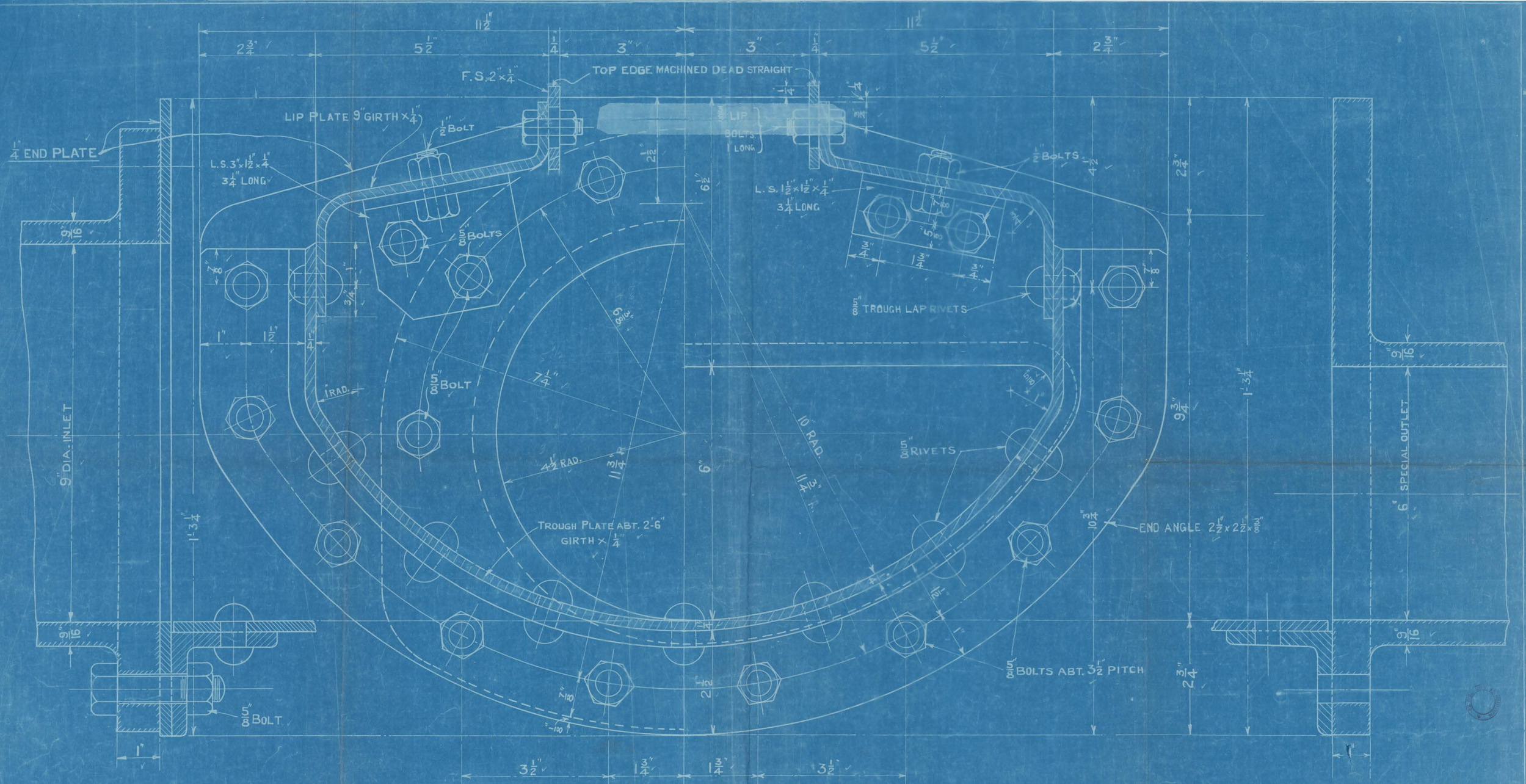
—HYDERABAD.—

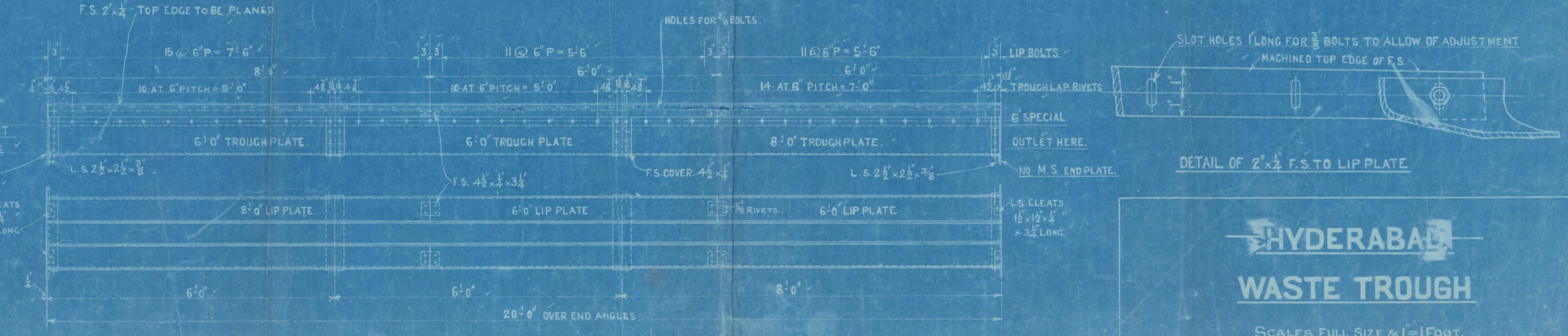
—WASTE C.I. SPECIALS.—

—SCALES 1" & 3" = 1 FOOT.—

0917 WFF
14/11/17
4-4

DRAWING No. 10318





WASTE TROUGH. — ALL HOLES FOR ⅝" RIVETS UNLESS OTHERWISE SHOWN.

24 - REQUIRED.

DETAIL OF 2"×¼" F.S. TO LIP PLATE

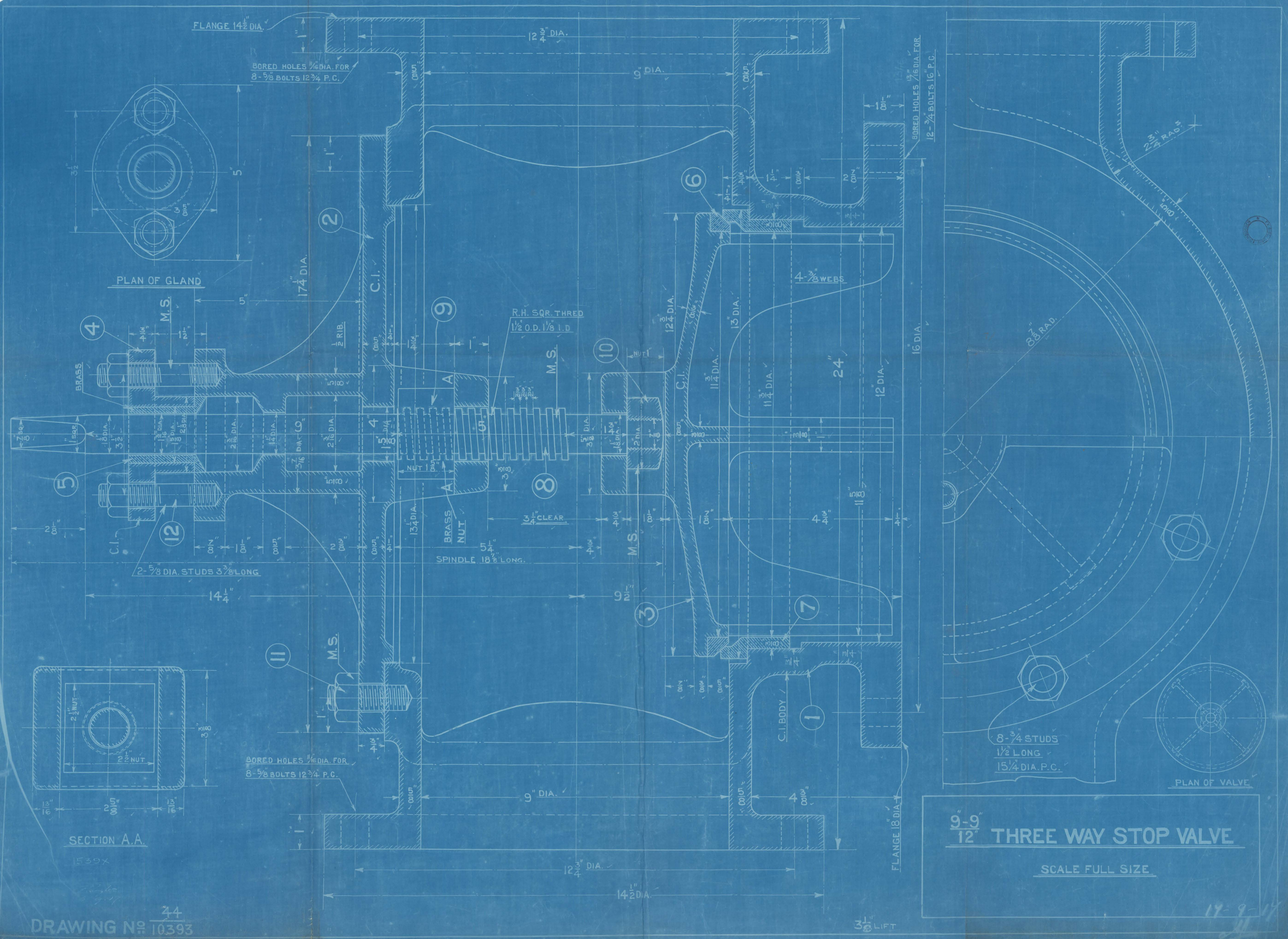
HYDERABAD

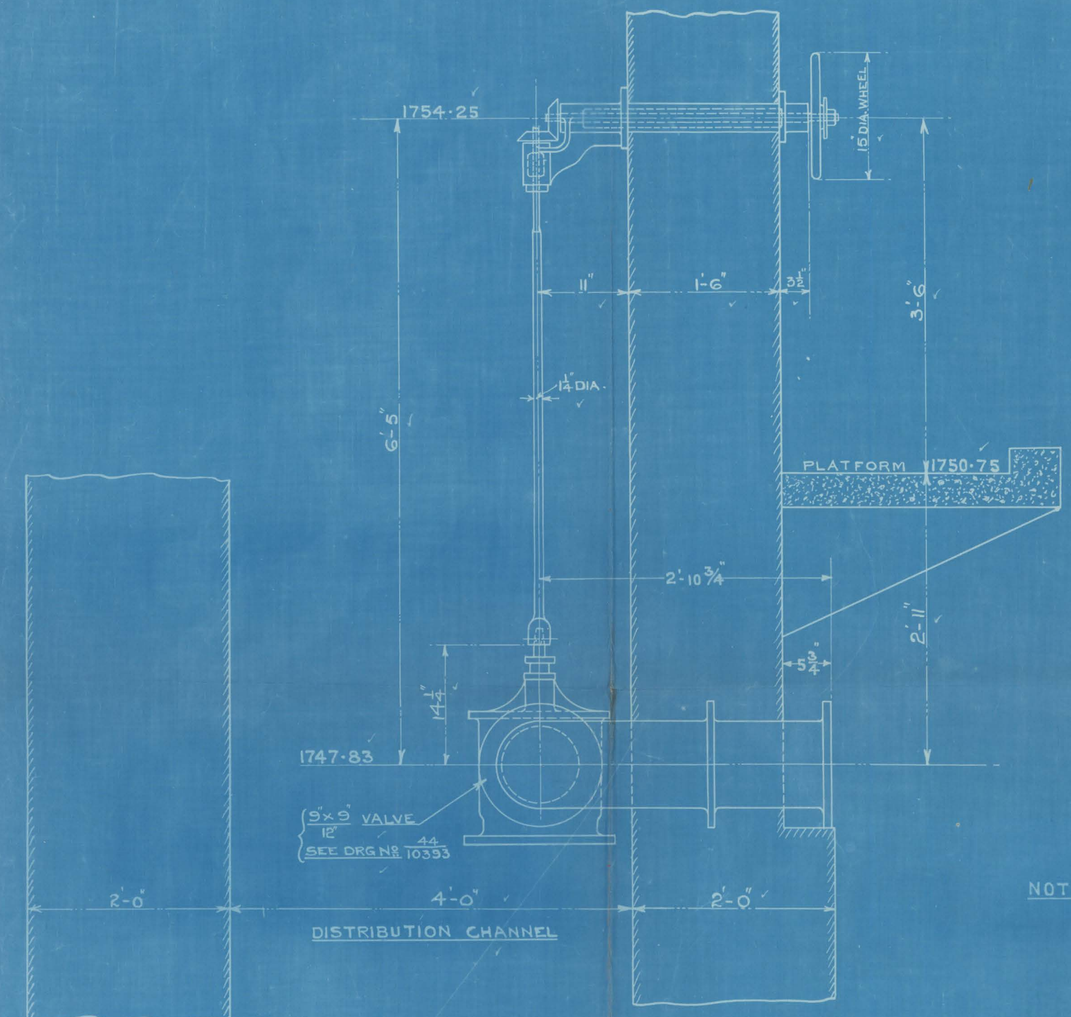
WASTE TROUGH

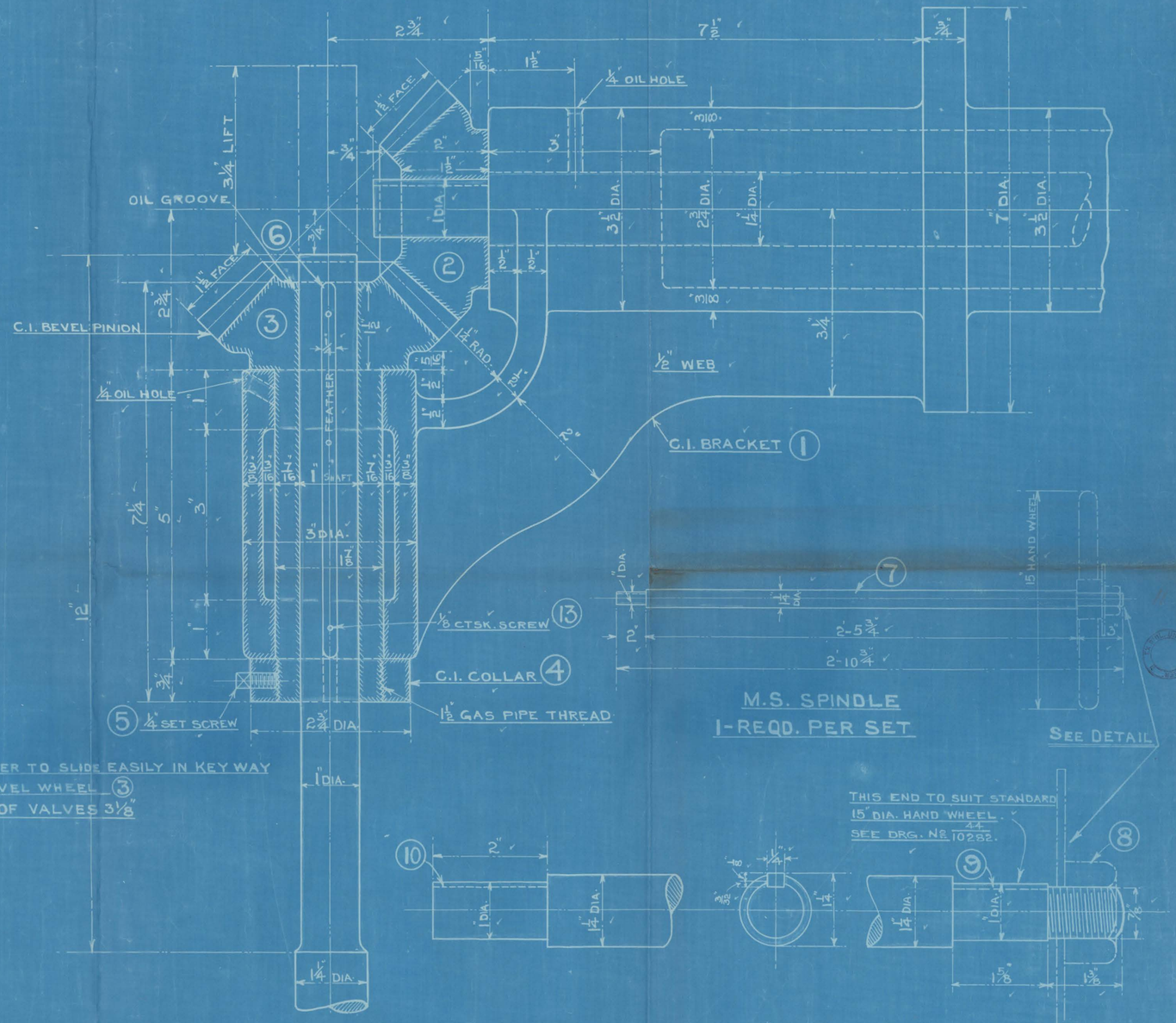
SCALES FULL SIZE & 1"=1 FOOT.

DRAWING No. 44/10317

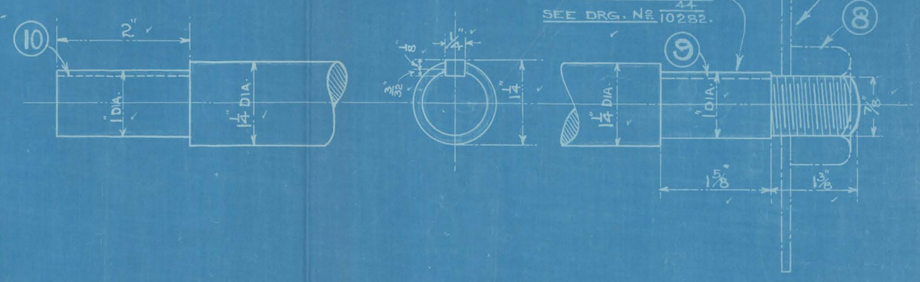
16-8-17

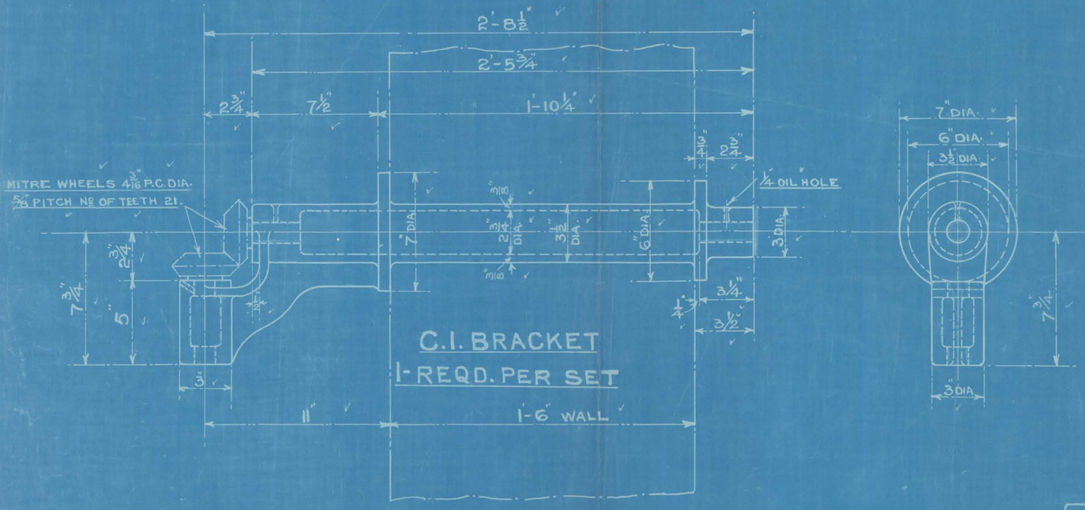

FLANGE 14½ DIA.
BORED HOLES 1/16 DIA. FOR 8-5/8 BOLTS 12¾ P.C.
12¾ DIA.
9" DIA.
PLAN OF GLAND
M.S.
C.I.
BRASS
½ RIB.
R.H. SQR. THRED 1½ O.D. 1⅛ I.D
NUT 1"
BRASS NUT
SPINDLE 18⅞ LONG.
3¼" CLEAR
2-⅝ DIA. STUDS 3⅜ LONG
14¼"
9½"
4-⅜ WEBS
BORED HOLES 13/16 DIA. FOR 12-¾ BOLTS 16" P.C.
16" DIA.
12" DIA.
24"
C.I. BODY
SECTION A.A.
BORED HOLES 1/16 DIA. FOR 8-5/8 BOLTS 12¾ P.C.
9" DIA.
12¾ DIA.
14½ DIA.
FLANGE 18" DIA.
3⅛ LIFT
2¾" RAD.
LOAD
8⅜" RAD.
8-¾ STUDS 1½ LONG 15¼ DIA. P.C.
PLAN OF VALVE
9"-9" 12" THREE WAY STOP VALVE
SCALE FULL SIZE
DRAWING No 44/10393

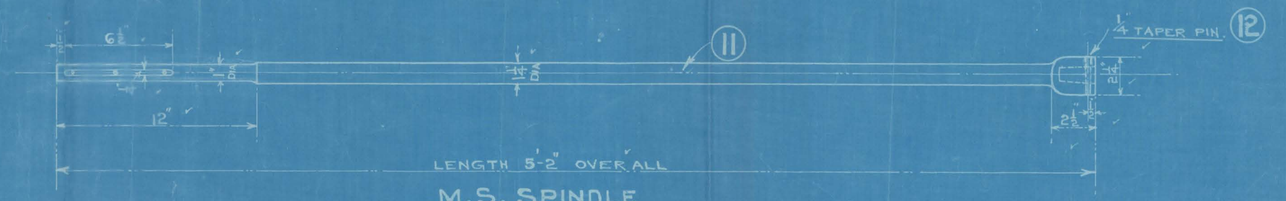


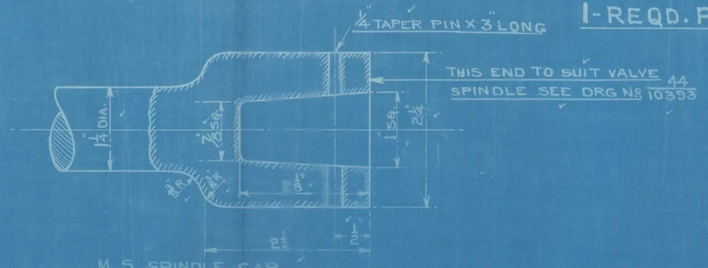


NOTE:-
FEATHER TO SLIDE EASILY IN KEY WAY OF BEVEL WHEEL (3)
LIFT OF VALVES 3⅛"









12-SETS REQ^RD

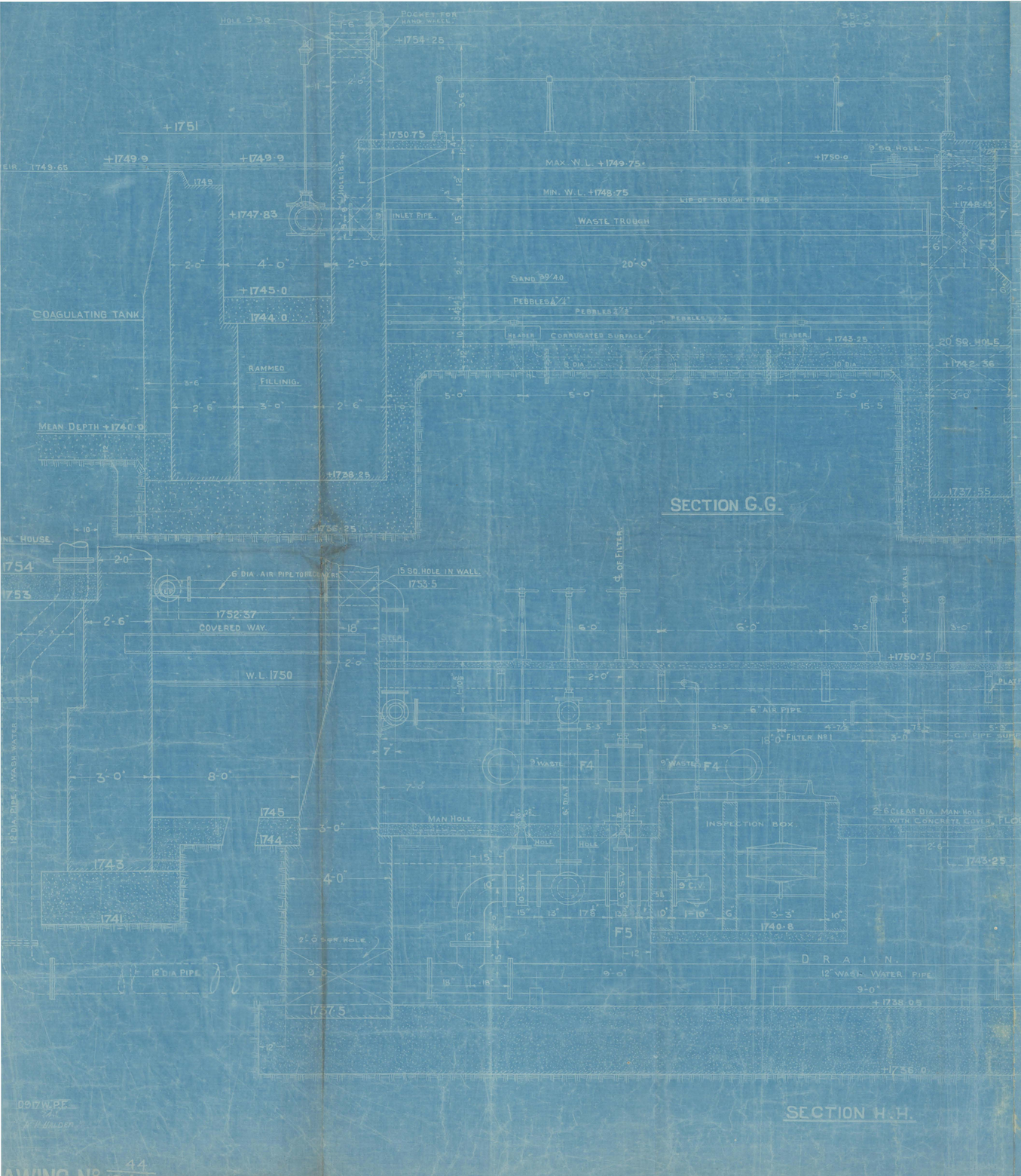
DRAWING Nº 44/10572

HYDERABAD

DETAILS OF INLET VALVE OPERATING GEAR

SCALE ½" & 3" = 1 FOOT.

1-11-47



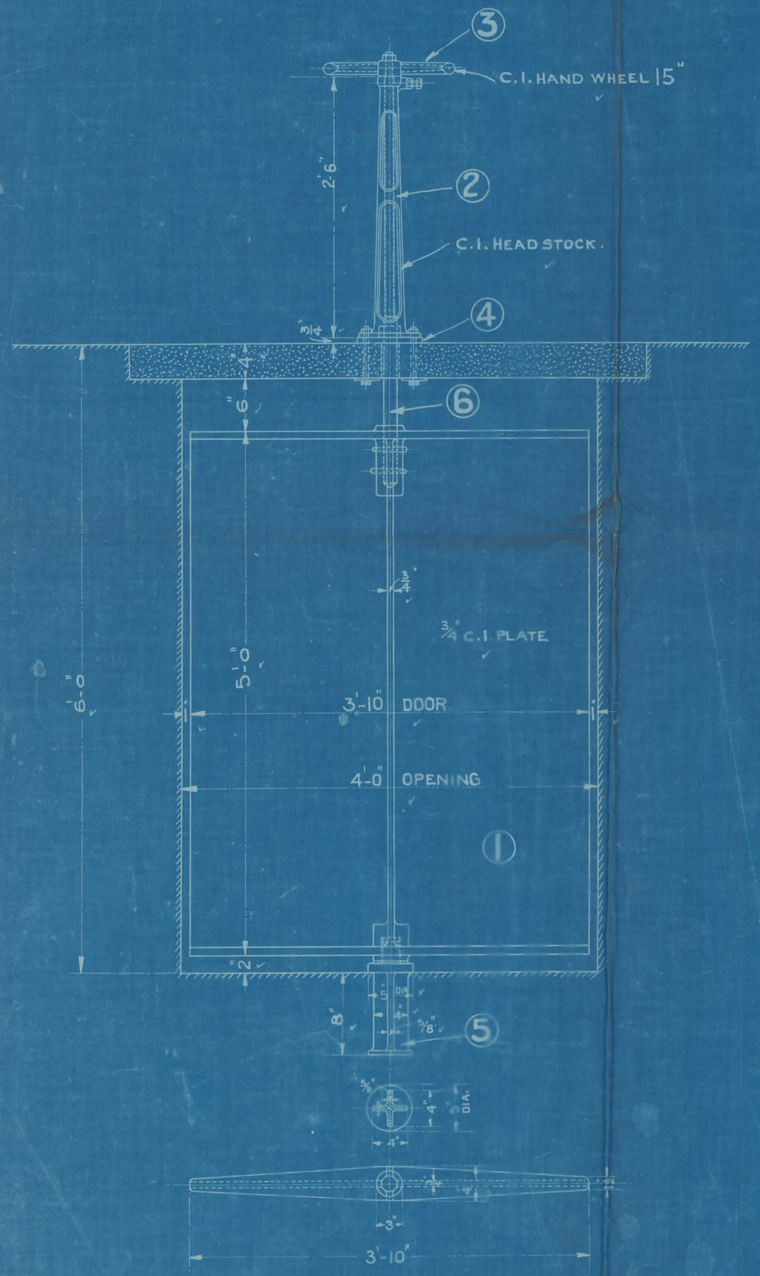
—HYDERABAD—

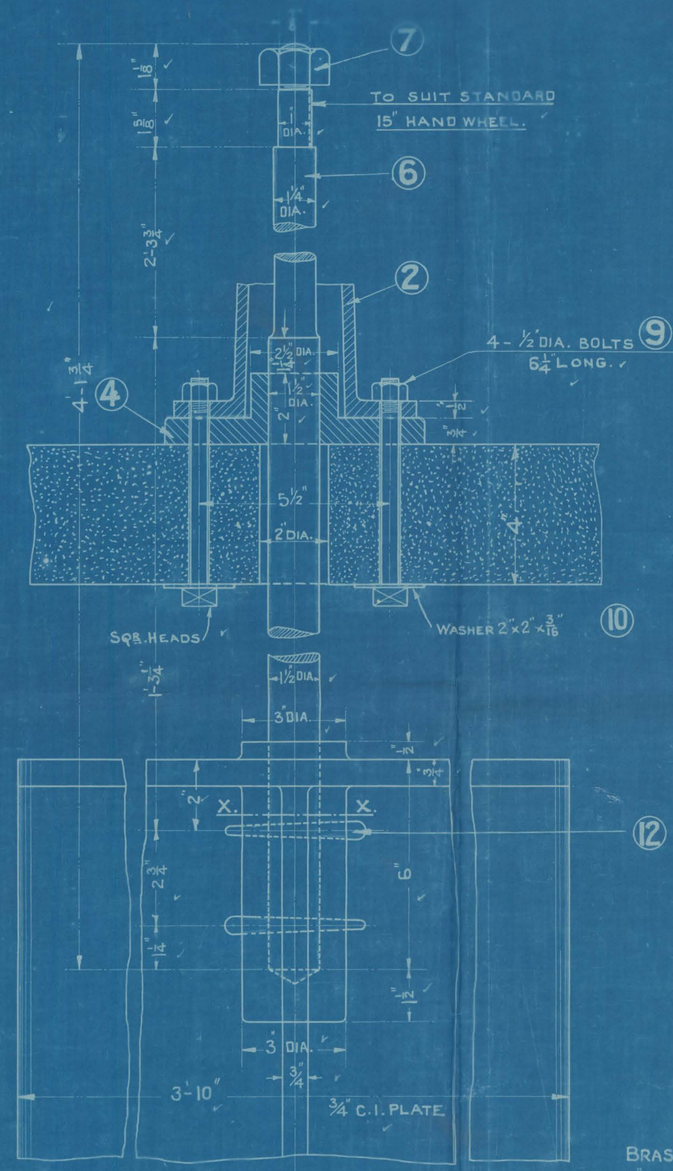
FILTER HOUSE CROSS SECTIONS

SCALE 8FT 1 FOOT

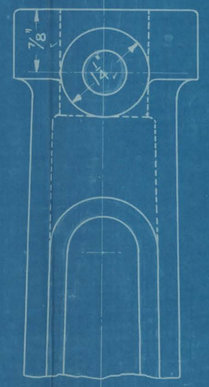
0917 W.P.E.
A.P. WALKER

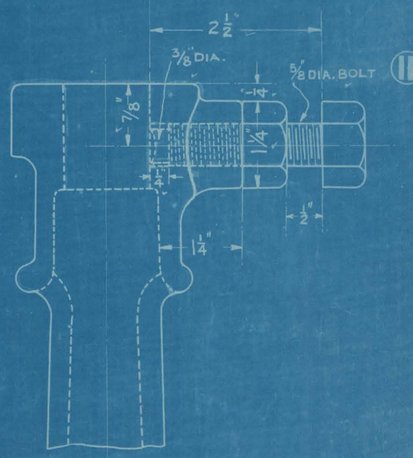
DRAWING No 44

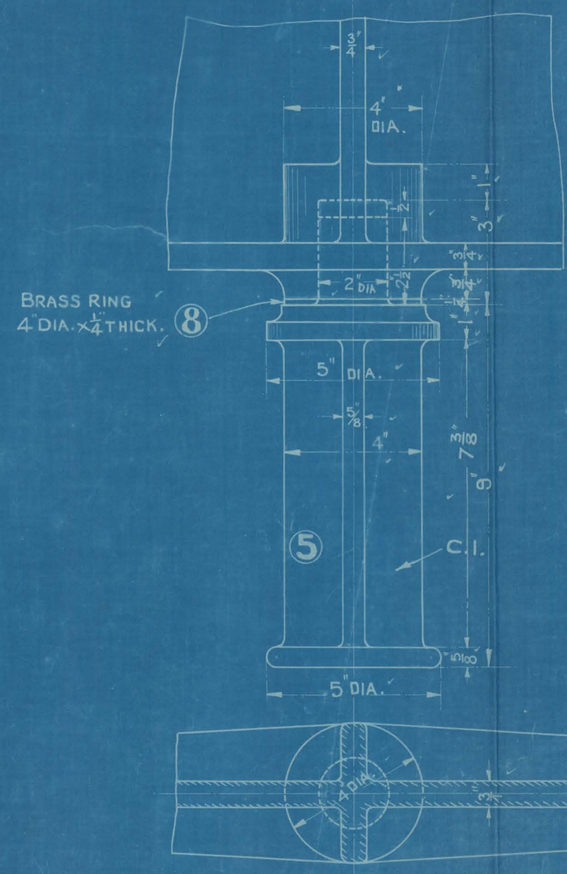












1563X

D.J. Linder. 28.9.17

DRAWING No. 44/10494

1-OFF.

BAFFLE PLATE VALVE

FOR

DISTRIBUTION CHANNEL

SCALES 1" & 6" = 1 FOOT

1-10-17

MEASURING GEAR HOUSE

+1774

2'-0" 18" 15'-0" 15'-0" 18" 2'-0"

℄ OF PASSAGE. 5'-0"

1754

NOTE:- WALL OF FLOAT CHAMBER TO BE BUILT UP TO 1751·5 AT PRESENT. DETAIL OF MEASURING GEAR IS SHOWN ON SEPARATE DRAWINGS.

5'-0"

+1753·0 G.L.

WOODEN STEPS

3'-0"

F.L. 1751·5

W.L. +1751·5

2'-6" 2'-0" 4'-6" 4'-0"

1749

1747

FLOAT CHAMBER 18" 3'-6" SQR. 2'-0"

3'-0"

8" C.I. PIPE

M

1745·5

1744·5

1742·5

NOTE:- THIS WEIR TO BE BUILT INTO PLACE AT PRESENT, AND BRICKED UP WITH A TEMPORARY WALL INSIDE C.I. FRAME. ON INSTALLATION OF FUTURE FILTERS WALL WILL BE REMOVED.

C.L. OF WEIR C.L. OF WEIR

2" 8" SQR. HOLE.

7'-6" 8'-0" 8'-0" 7'-6"

+1752·5 +1752·5

WATER LEVEL WATER LEVEL +1751·5"

12" 18"

+1750·75 G.L.

15'-6" 15'-6"

6'-0"

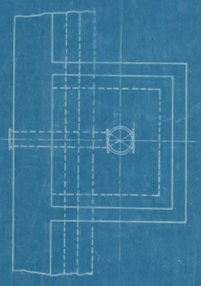
2'-0" 2'-6" 5'-0" 5'-0"

6" SLUDGE VALVE

6" SLUDGE PIPE

1745·5 1744·5 1742·5

SECTION C.C.



SHEET Nº 3.

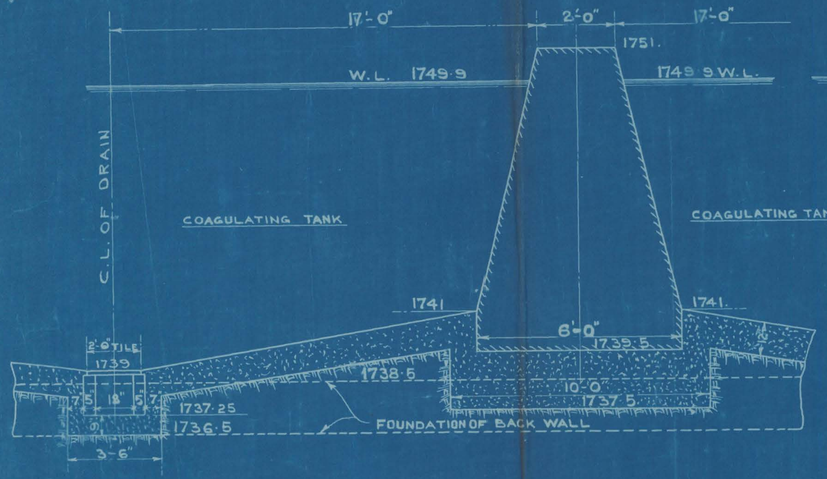
HYDERABAD

BUILDING CROSS SECTIONS

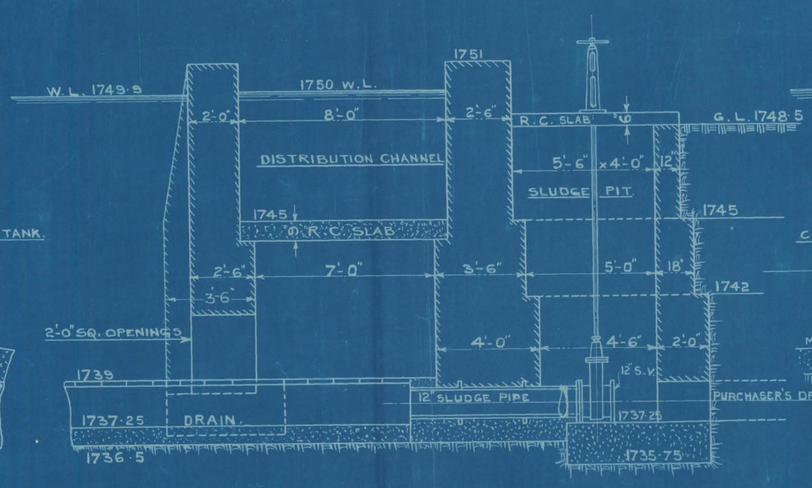
SCALE 8' - 1 FOOT

0917 W.P.F.

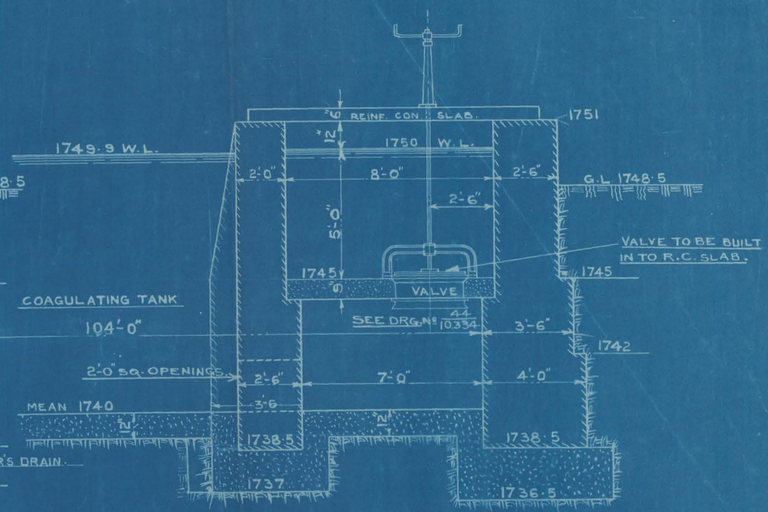
DRAWING Nº 44 / 10.421



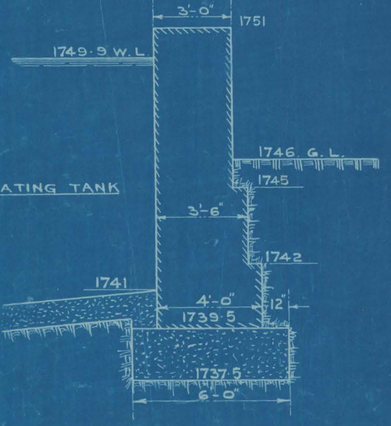
SECTION K.K.



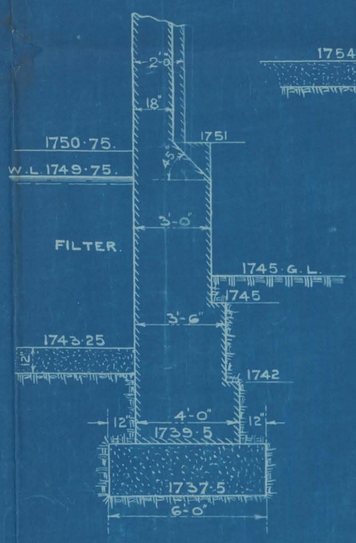
SECTION N.N.



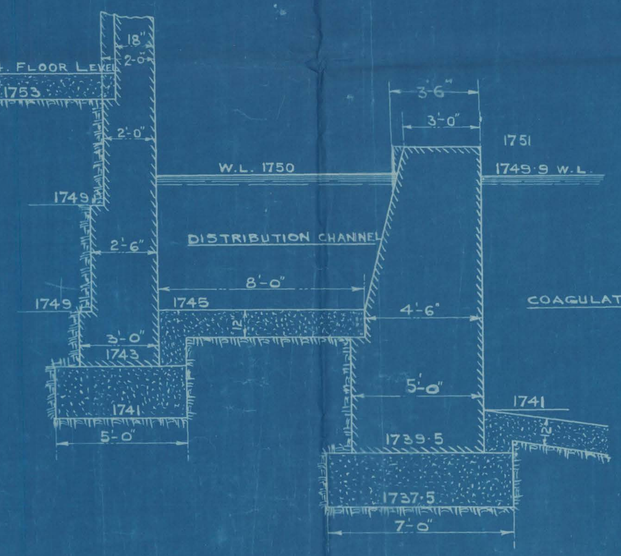
SECTION J.J.



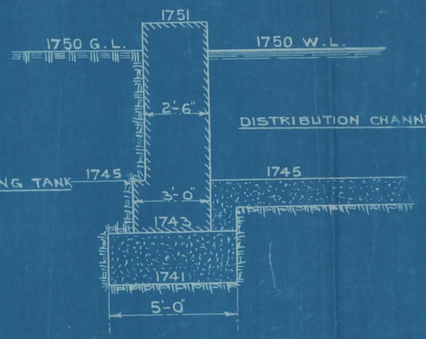
SECTION L.L.



SECTION M.M.



SECTION Q.Q.



SECTION R.R.

0917 WPF
T.A.R.

DRAWING No 44/10.423

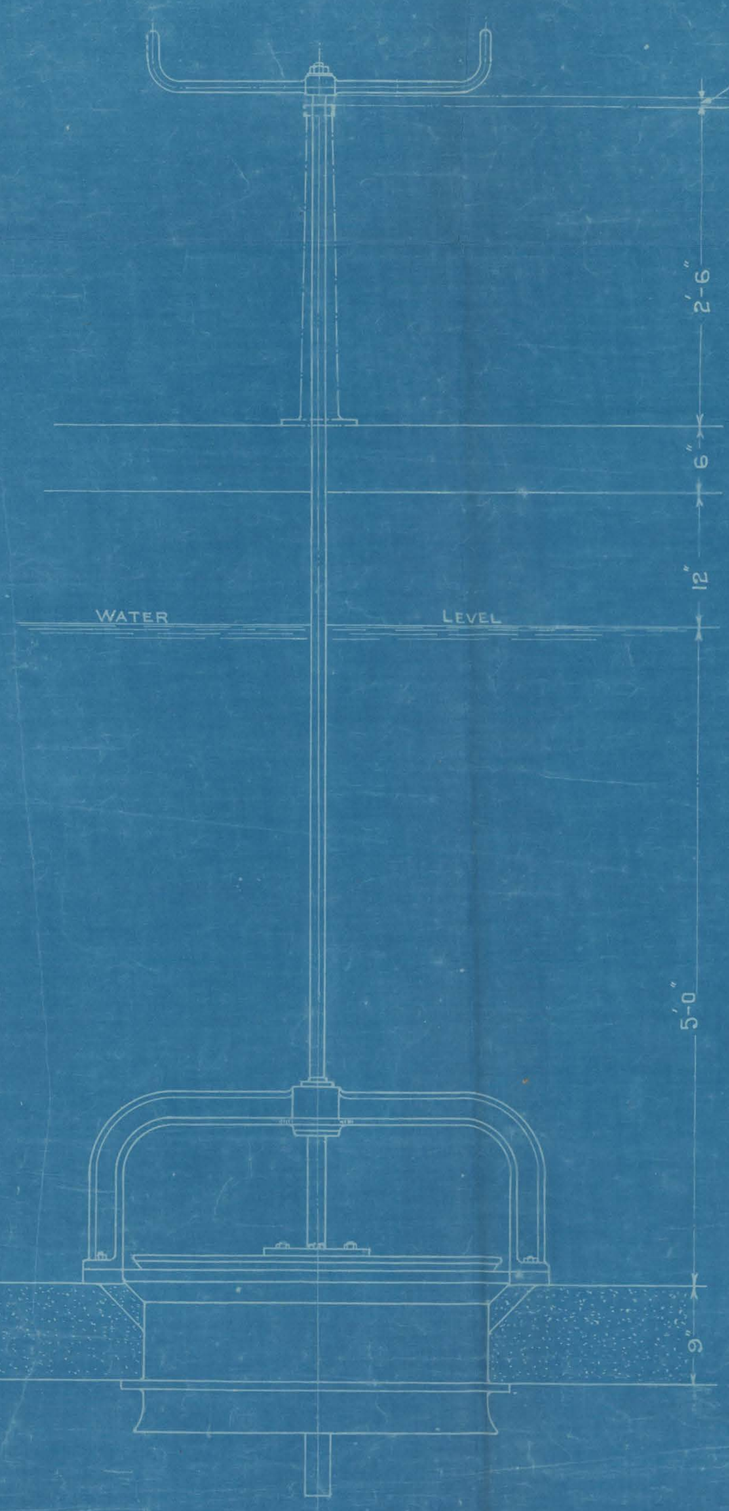
SHEET No 2

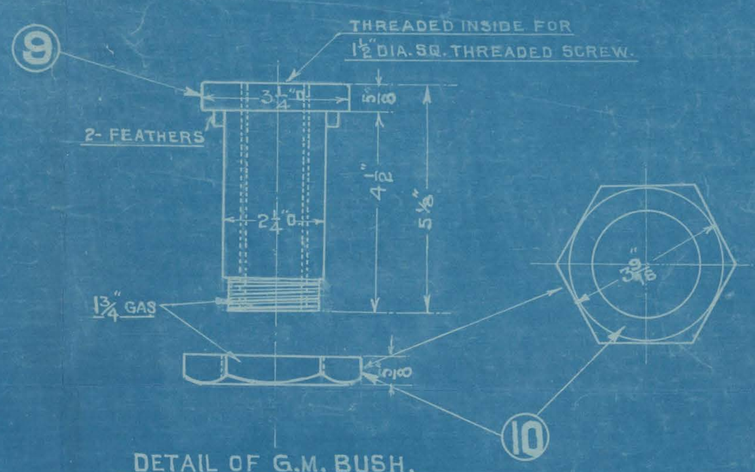
HYDERABAD

BUILDING CROSS SECTIONS

SCALE 3/8-1 FOOT

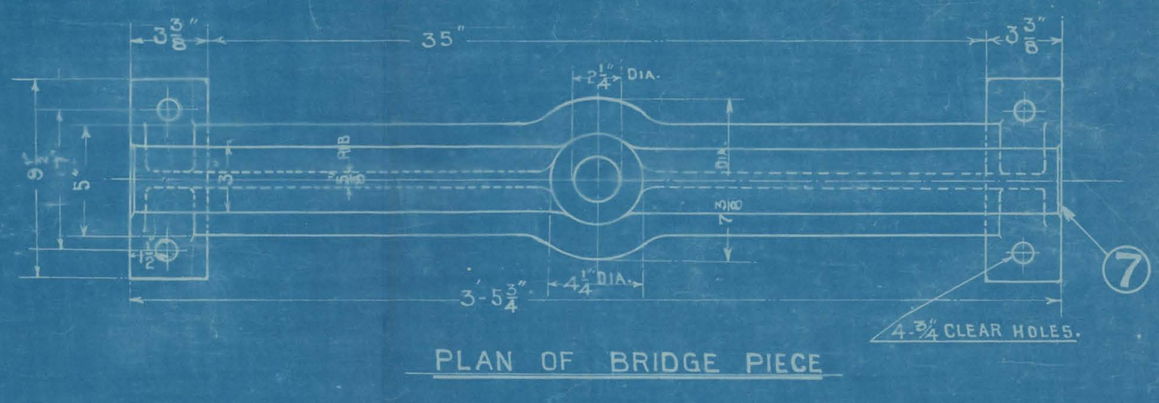
8-9-17.



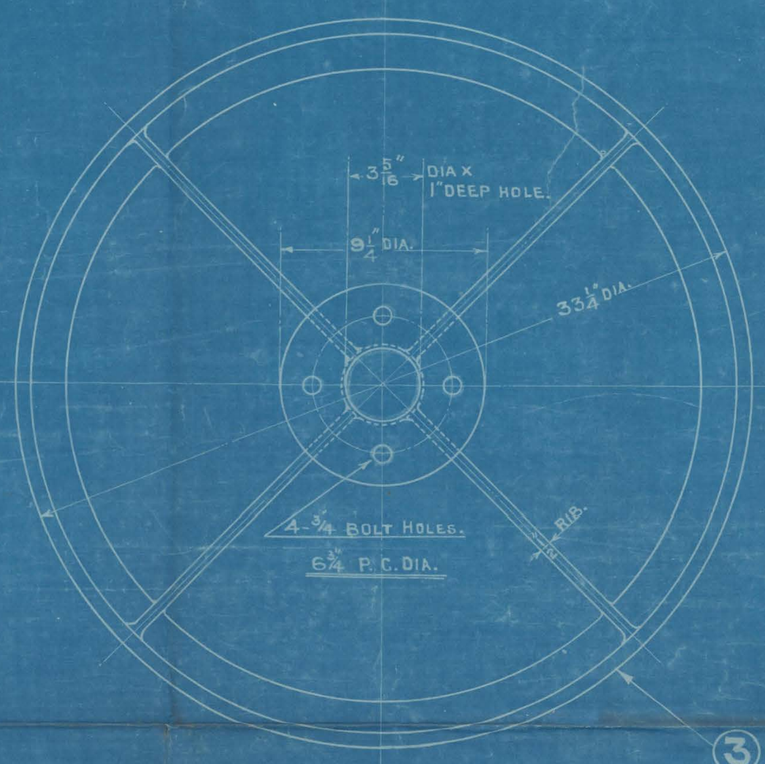


DETAIL OF G.M. BUSH.

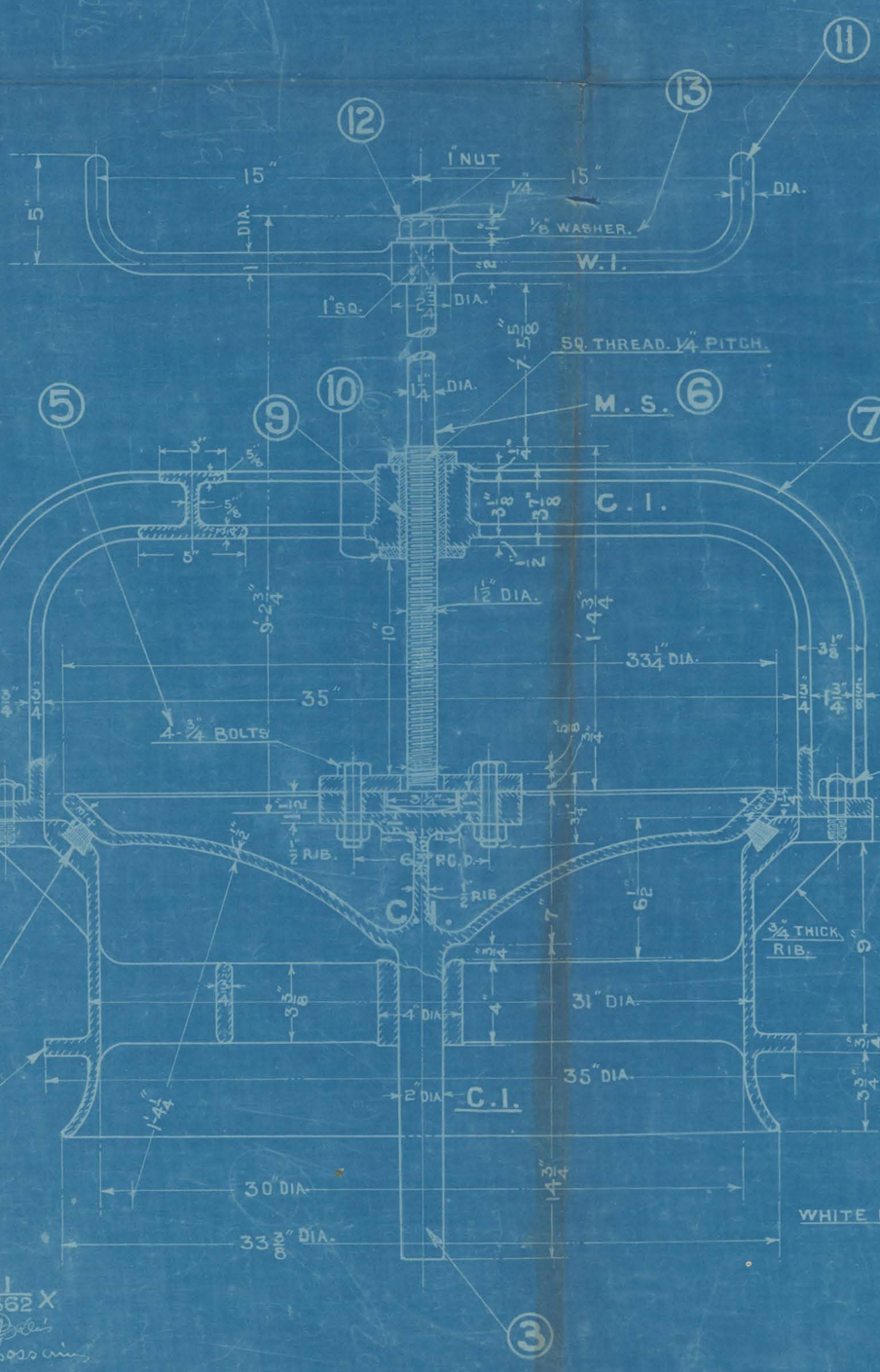
HALF SIZE.

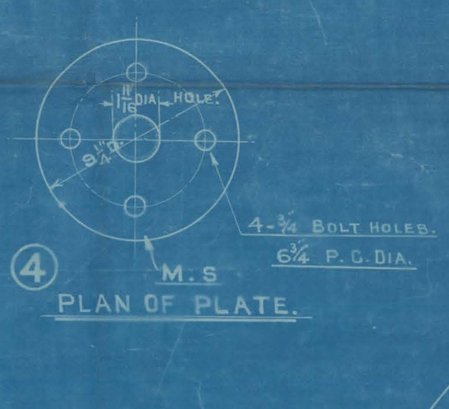


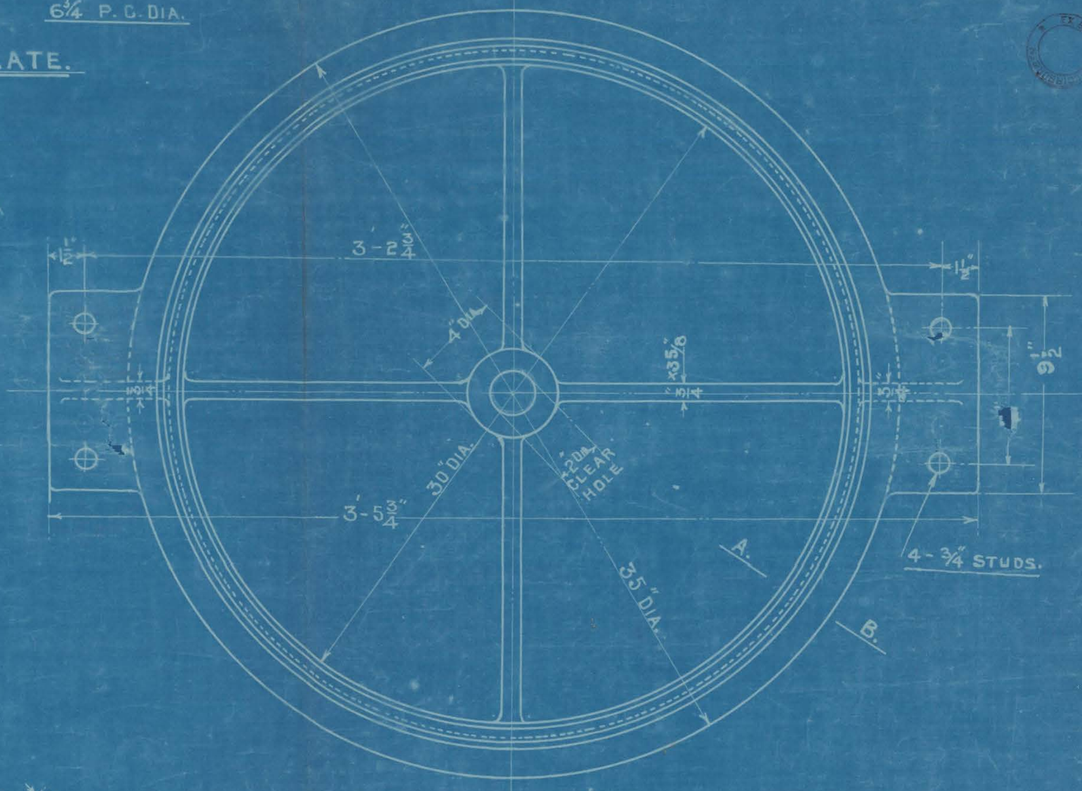
PLAN OF BRIDGE PIECE



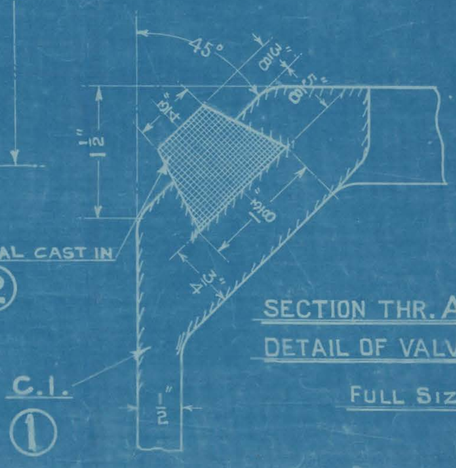
PLAN OF VALVE.







PLAN OF VALVE SEAT.



SECTION THR. A.B.

DETAIL OF VALVE SEAT.

FULL SIZE.

30" DIA. OUTLET VALVE

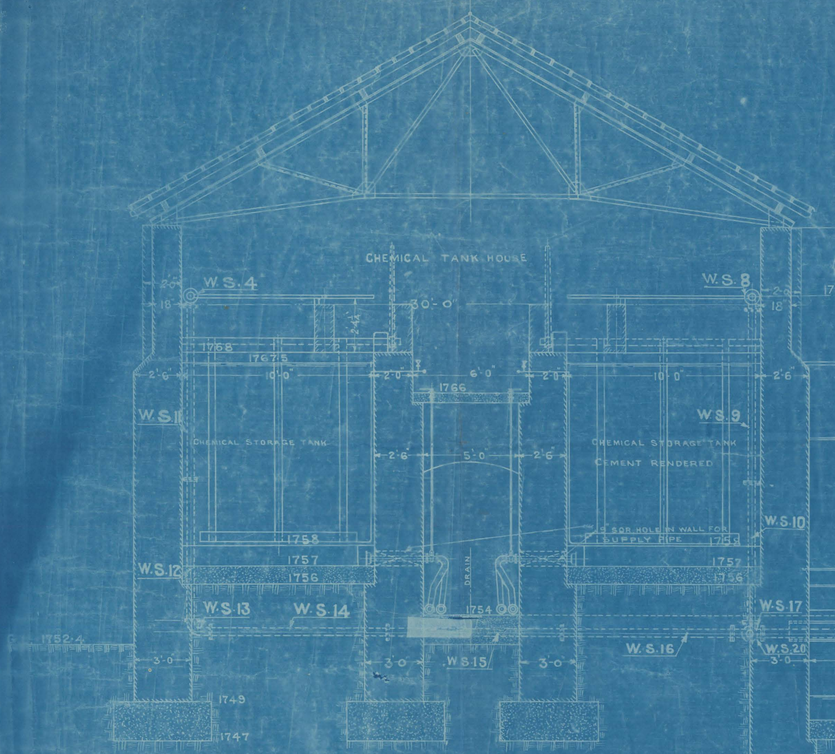
SCALE 3" = 1 FOOT

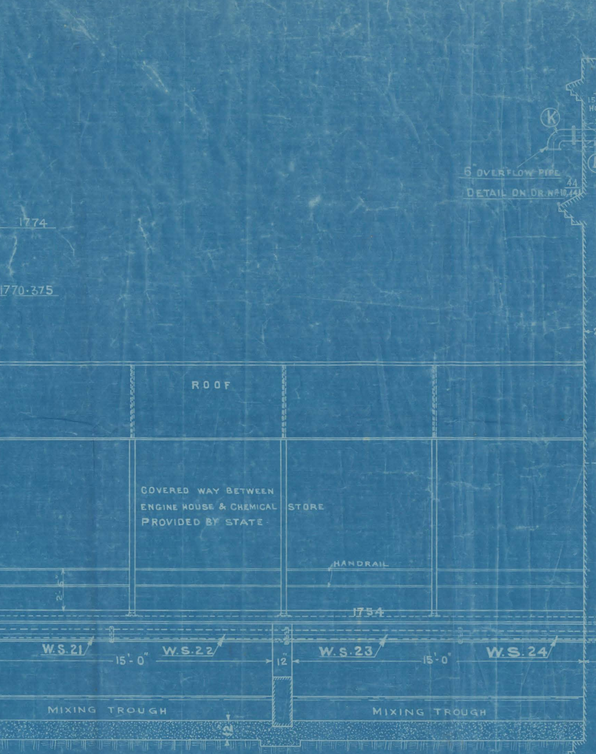
1/1562 X

J. Boss & Co.

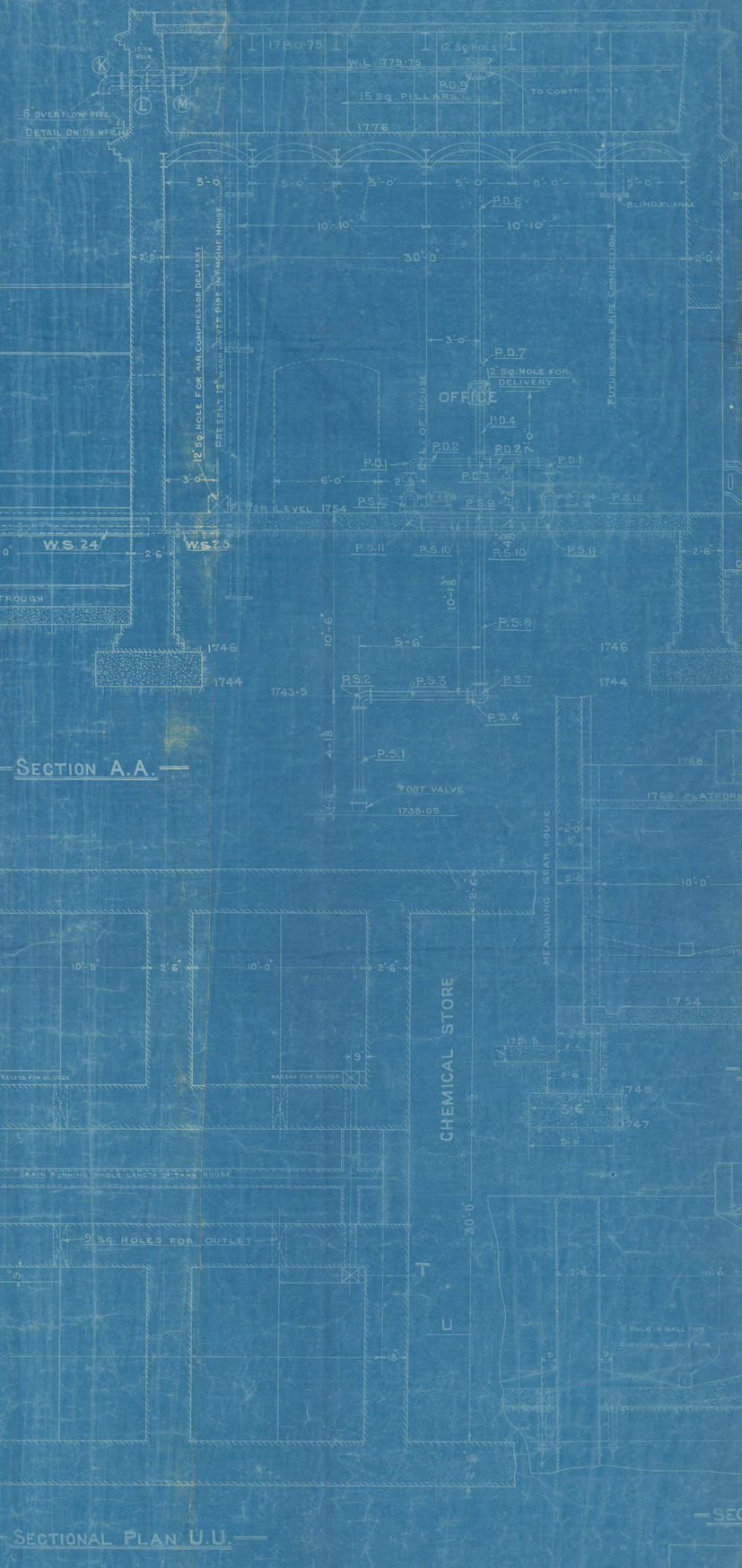
DRAWING No. 44/10,334

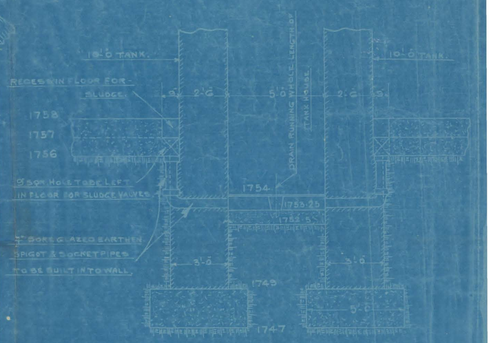
30-8-14



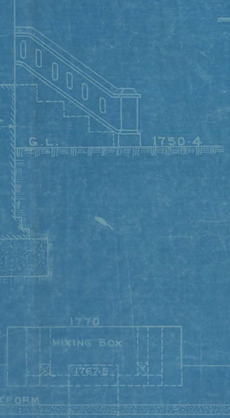


— SECTION A.A. —

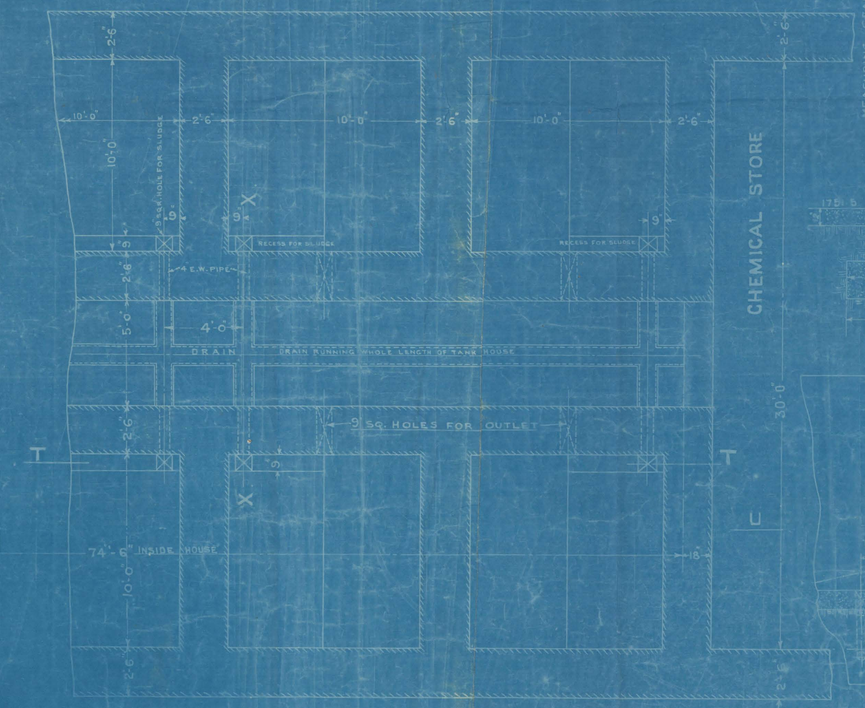




— SECTION XX —



— PLAN —



— SECTIONAL PLAN U.U. —

— SECTION E.E. —

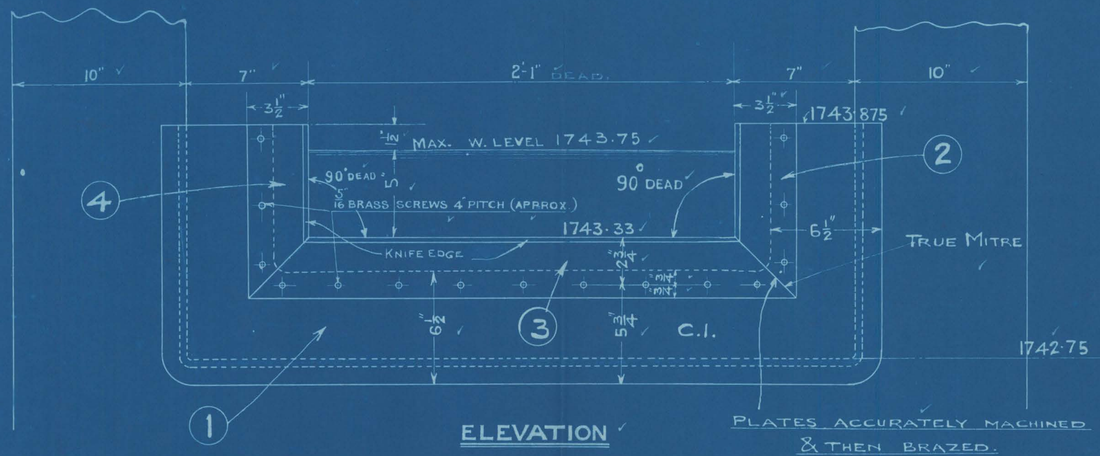
— SECTION T.T. —

SHEET No 5

— HYDERABAD —

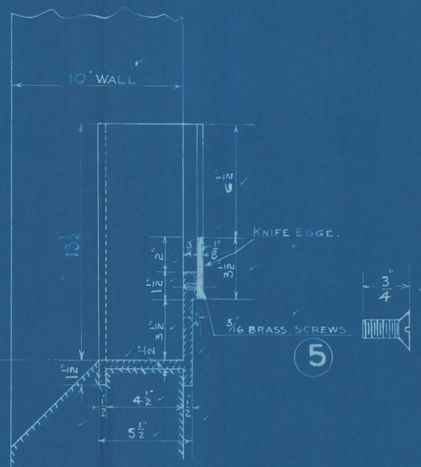
— BUILDING CROSS SE

MINING No 1041B

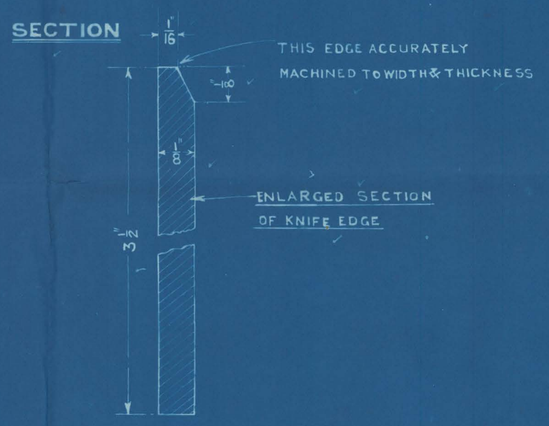


ELEVATION

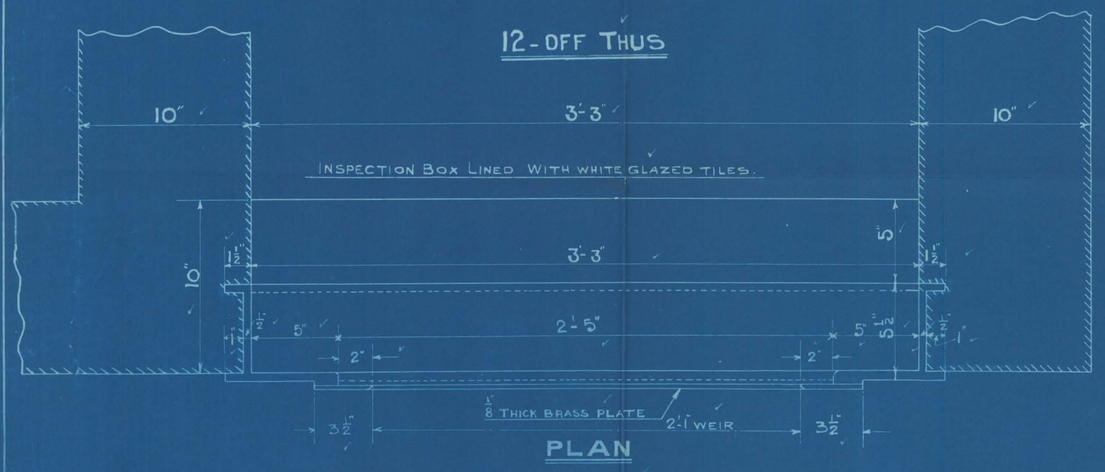
PLATES ACCURATELY MACHINED & THEN BRAZED.



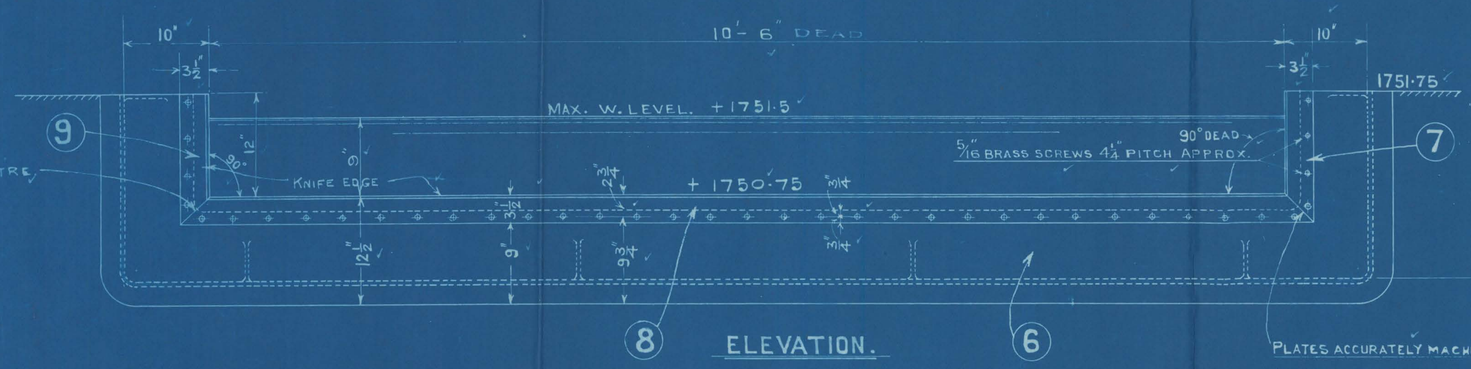
SECTION



12-OFF THUS



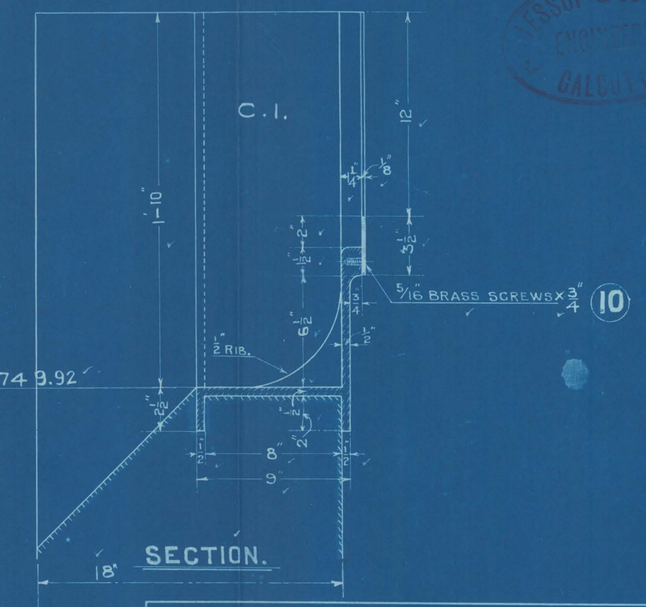
PLAN



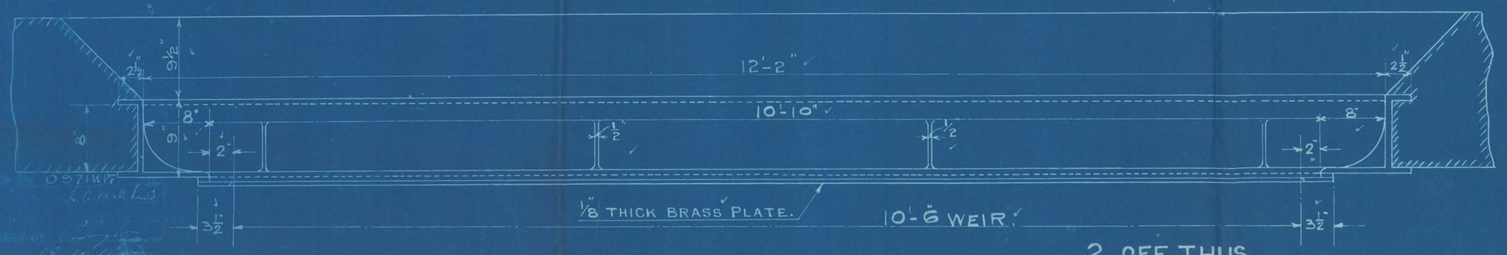
ELEVATION.

MAIN WEIR.

PLATES ACCURATELY MACHINED & THEN BRAZED



SECTION.



2-OFF THUS

PLAN.

HYDERABAD

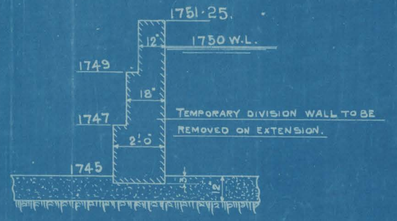
DETAIL OF 2'-1" & 10'-6" WEIRS

SCALE 1½" & 3" = 1 FOOT.

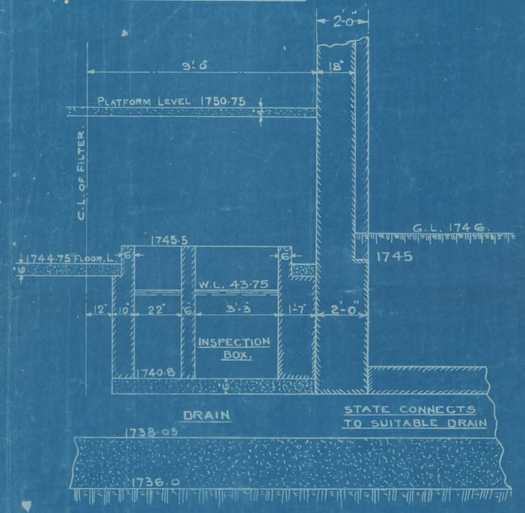
8-9-14.

DRAWING No. 44/10,424

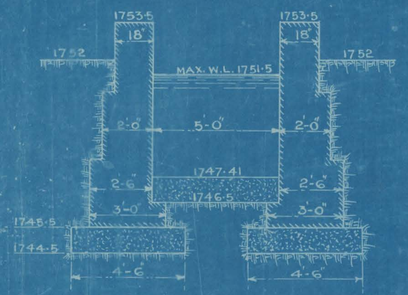
JESSOP & CO LTD ENGINEERS CALCUTTA



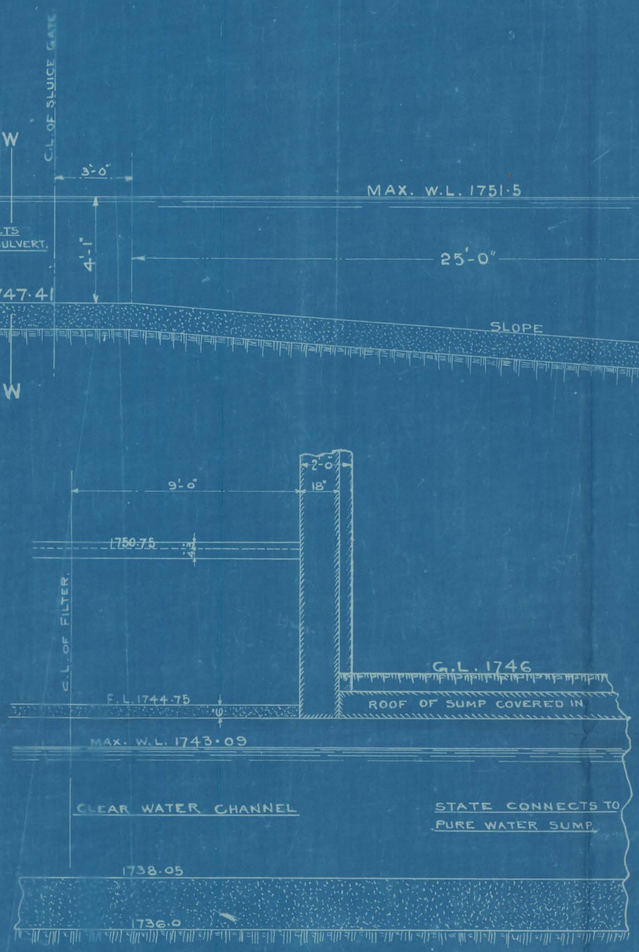
SECTION S.S.



SECTION O.O.

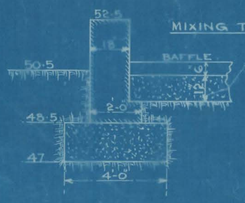


SECTION W.W.

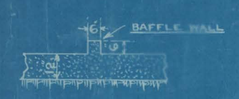


SECTION D.D.

SECTION P.P.



SECTION F.F.



SECTION V.V.

SHEET No. 1.

HYDERABAD.

BUILDING CROSS SECTIONS.

SCALE 1/8 = 1 FOOT.

8-9-44

Drawing No. 44/10420

DISCHARGE

GRADE = 1 IN 5000

AREA OF CROSS SECTION = 19.632 SQ.FT

WETTED PERIMETER = 11.85'

∴ H.M.D. = 1.656'

1 BY BAZINS FORMULA.

$$V = \sqrt{\frac{2G}{U}\,RS}$$

WHERE $U = D\left(1+\frac{B}{R}\right)$

$= \cdot 003\left(1+\frac{\cdot 1}{1\cdot 656}\right)$

$= \cdot 003181$

= 2.58 PER SEC.

∴ Q = A.V = 19.632 × 2.58

= 50.6 CUSECS

= 27,324,000 GALS PER DAY.

2 BY BARNES FORMULAE

(A) FOR DRESSED MASONRY IN CEMENT.

$V = 109.7\,M^{\cdot 713}\,i^{\cdot 483}$

$= 109.7 \times 1.656^{\cdot 713} \times \left(\frac{1}{5000}\right)^{\cdot 483}$

= 2.57' PER SEC

(B) FOR NEAT CEMENT.

$V = 136\cdot 3\,M^{\cdot 635}\,i^{\cdot 484}$

$= 136.3 \times 1\cdot 656^{\cdot 635} \times \left(\frac{1}{5000}\right)^{\cdot 484}$

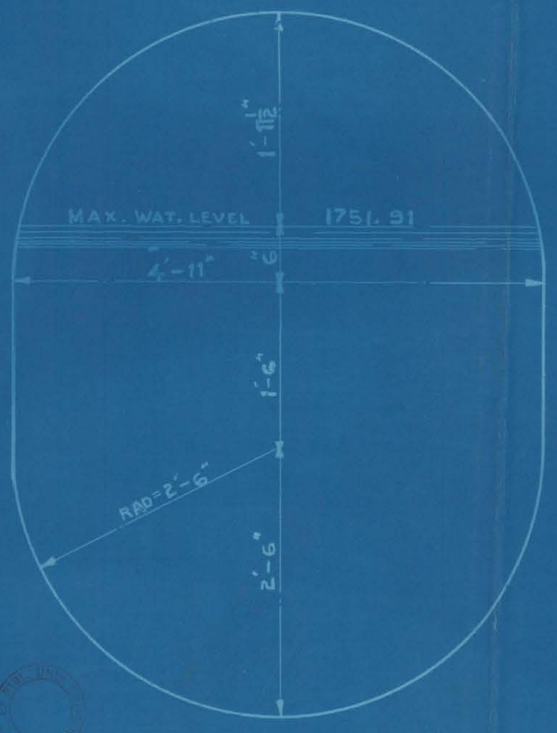
= 3.04' PER SEC

TAKING THE MEAN OF (A) & (B) MINUS 5%

V = 2·66' PER SEC.

& Q = 2.66 × 19.632 = 52.2 CUSECS.

= 28,188,000 GALS. PER DAY



INVERT LEVEL AT FILTER HOUSE = 1747.41

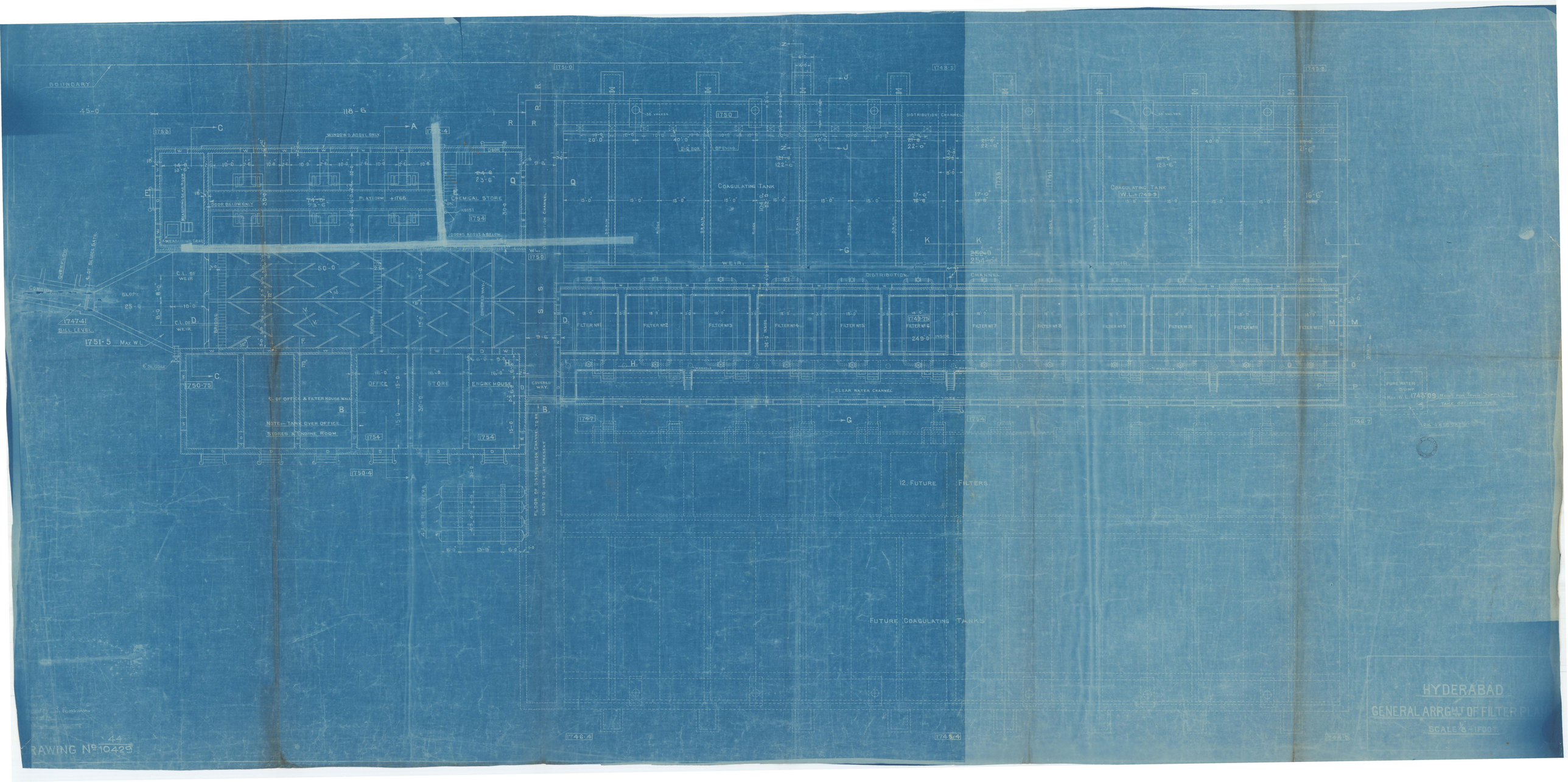
NOTE:

THE CONDUIT WILL BE FINISHED UP IN CEMENT PLASTER, IT IS THEREFORE PROBABLE THAT THE DISCHARGE WILL APPROXIMATE (B) TO BEGIN WITH. I.E. V = 3.04' PER SEC BUT AS THE WATER IS UNFILTERED AND DRAWN FROM A LARGE IMPOUNDING RESERVOIR THERE MAY BE SLIGHT GROWTHS LATER ON WHICH WILL PROBABLY REDUCE THE DISCHARGE TO THAT GIVEN BY (A) I.E. V = 2.57 & Q = 27,243,000 GALS. PER DAY.

HYDERABAD
FILTER PLANT
CROSS SECTION
OF
CONDUIT
SCALE 1" = 1 FOOT

Order No.
Work Order
Traced by Sultan Ali B.
Checked by R.A.M.
Date 1·7·22

DRAWING No. 44/15,988


BOUNDARY
45-0
118-6
WINDOWS ABOVE ONLY
DOOR
PLATFORM +1766
CHEMICAL STORE
HOIST
1754
DOOR BELOW ONLY
MEASURING SCALE ROOM
MEASURING GEAR
DOORS ABOVE & BELOW
OVERFLOW
C.L. OF SLUICE GATE
CONDUIT
SLOPE
25-0
1747-41
SILL LEVEL
1751-5 MAX W.L.
C.L. OF WEIR
50-0
BATTERS
OFFICE
STORE
ENGINE HOUSE
C.L. OF OFFICE & FILTER HOUSE WALL
NOTE:- TANK OVER OFFICE, STORES & ENGINE ROOM
AIR RECEIVERS
FLOOR OF DISTRIBUTION CHANNEL TO BE LAID TO HERE AS PRESENT
COVERED WAY
DISTRIBUTION CHANNEL
W.L. 1750
1751-0
1748-5
1745-8
1750
30 VALVES
DISTRIBUTION CHANNEL
2-0 SQR OPENINGS
COAGULATING TANK
WEIR
DRAIN
RISER
FILTER Nº1
FILTER Nº2
FILTER Nº3
FILTER Nº4
FILTER Nº5
FILTER Nº6
FILTER Nº7
FILTER Nº8
FILTER Nº9
FILTER Nº10
FILTER Nº11
FILTER Nº12
249-0 INSIDE
CLEAR WATER CHANNEL
HANDRAIL
WARNING
12. FUTURE FILTERS
FUTURE COAGULATING TANKS
PURE WATER SUMP
Max W.L. 1745-09
Mains for Town Supply to take off from this
24" D.I. Q.P. WATER
1747
1754
1746-7
1746-4
1745-4
1745-8
HYDERABAD
GENERAL ARRGT OF FILTER PLANT
SCALE 8 = 1 FOOT
44
DRAWING Nº 10429