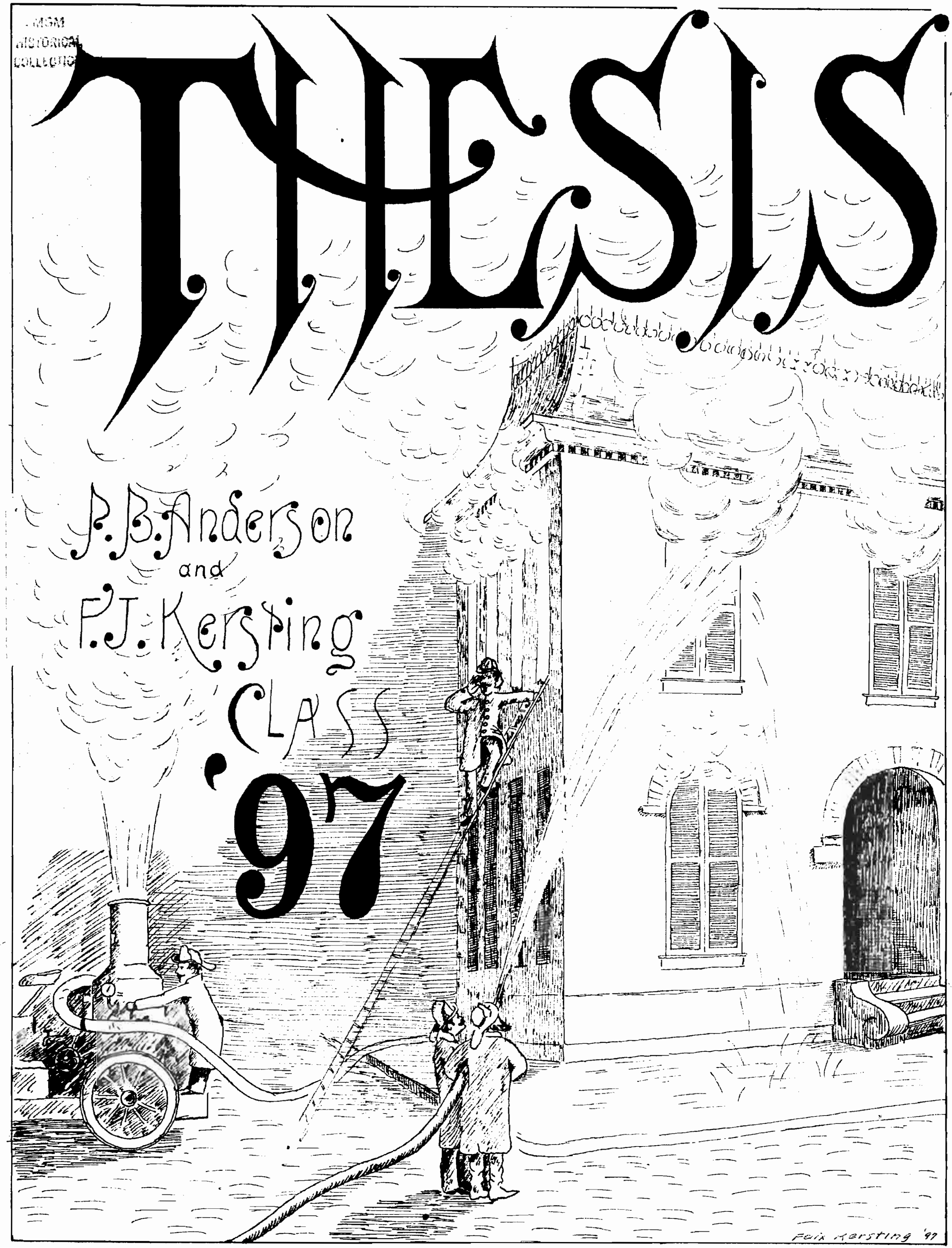
1897

# Water supply of Rolla, Missouri

Perry B. Anderson

Felix John Kersting


MGM HISTORICAL COLLECTION
THESIS
P. B. Anderson
and
F. J. Kersting
CLASS
'97
Felix Kersting '97

# WATER SUPPLY

OF

# ROLLA, MISSOURI.

# A R G U M E N T.

-----------ooOoo-----------

An essential feature of a prospering town is a system of water supply, to protect property from losses by fire and to furnish water for domestic use.

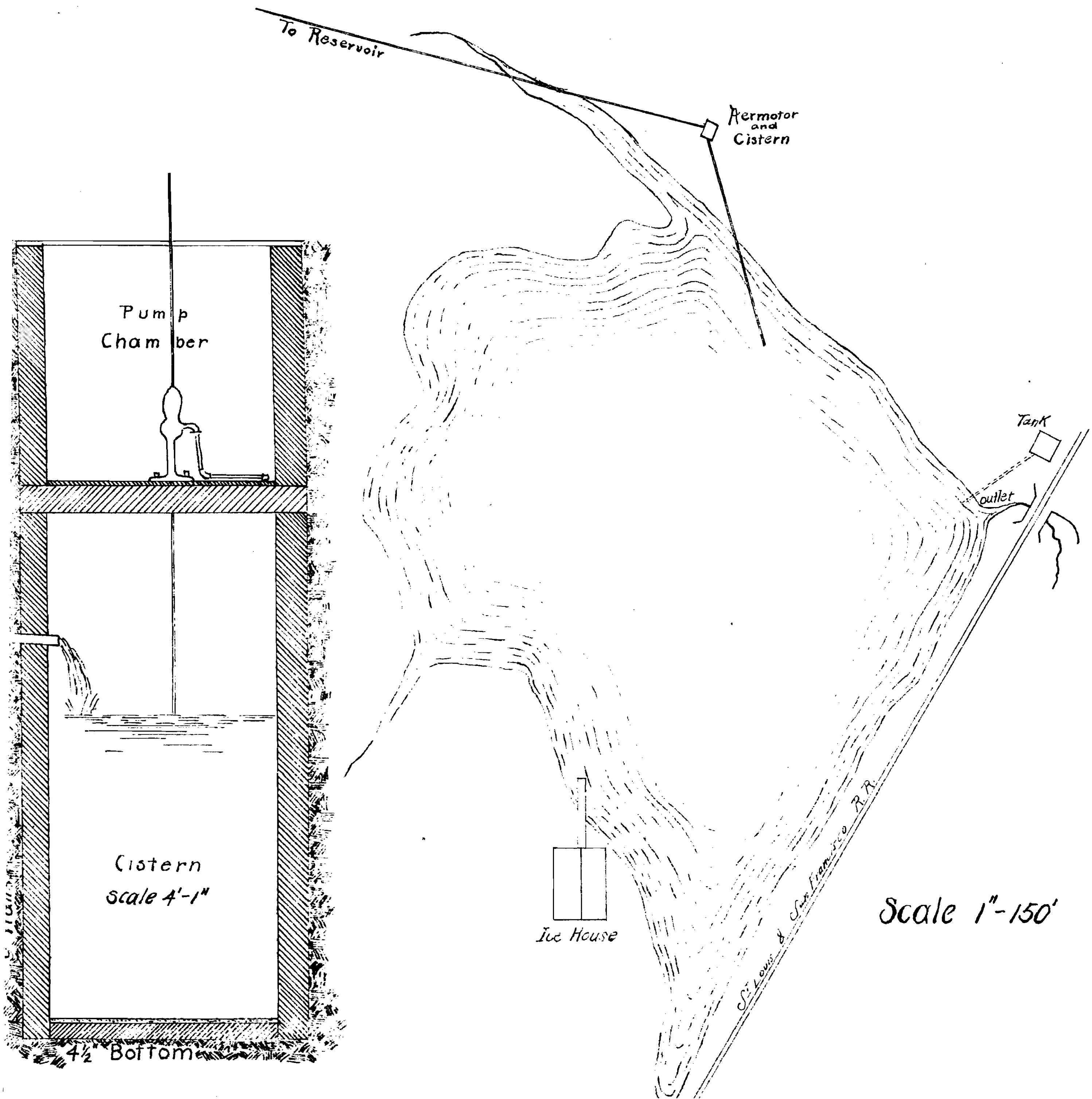
Rolla, a town of about fifteen hundred inhabitants, is without a proper water supply, in consequence of which it has suffered many losses to property, which could have been averted, or at least diminished, had the proper protection been at hand.

At present the only fire protection the business part of the town has, is derived from one large cistern placed on the principal street, while the protection for the residence portion, is derived from private cicterns. The quantity of water in these cisterns is dependant on the amount of rainfall, which in this region is very uncertain; therefore, when there is the greatest demand for water in these cisterns, the quantity may be insufficient to meet the necessary requirements.

Hence the reason for selecting this subject for our thesis.

Plate I

# Lake Frisco



# S O U R C E.

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The only source of water supply for Rolla, which can be taken into account, without involving undue expense, is a lake situated about a half mile north of town, known as Lake Frisco. The area drained by this lake is about 100 acres and its contents at low water, approximately 7,000,000 gallons.

These figures are based upon a survey and soundings made two years ago; but it is safe to say, that during the greater part of the year the contents range nearer the 15,000,000 mark.

This water will require filtering before sufficiently pure for household use.

# F I L T E R.

------------OOO------------

The filter is to be of the gravity type. The filtering material is to be of sand, gravel, broken stone, charcoal and coke. This will necessitate two tanks, one large one, and one small one. The large tank will contain:-

One 10" layer of 2" broken stone,

" 6" " " ordinary gravel,

" 8" " " fine sand.

The small tank will contain:-

One 3' layer of loose coke, and

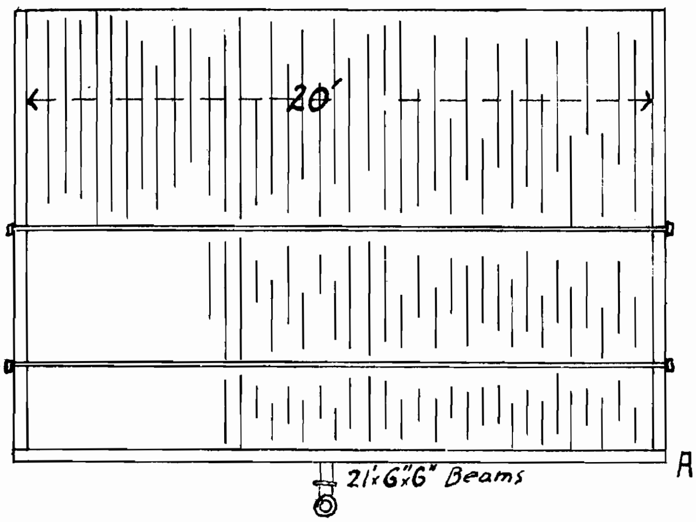
" 2" " " fine charcoal.

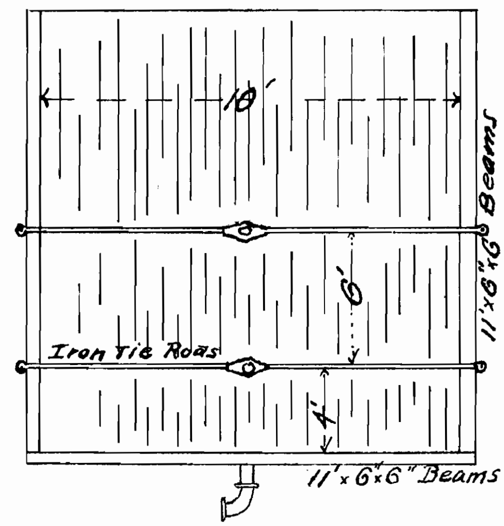
From all the data available we calculate that a filter made as described above, will have a capacity of 200 gal. per sq.ft. per day.

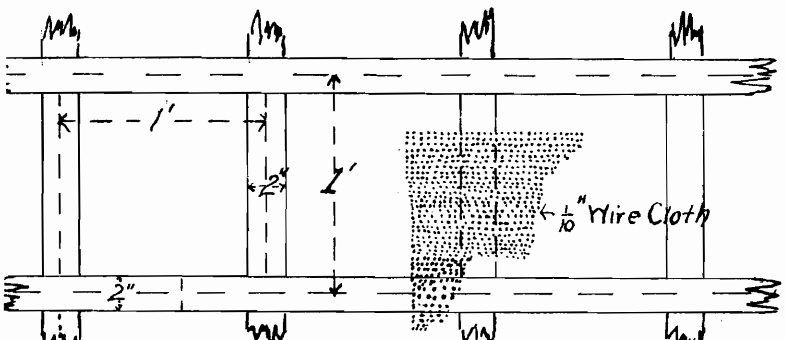
Allowing 24.8 gal. per capita as daily consumption, or a total of 1500 X 24.8 = 37200 gal. daily, we dimension our filters as follows:-

Plate A

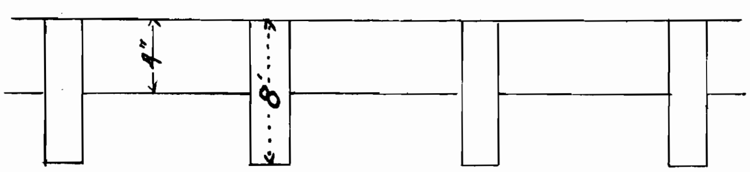
# FILTER

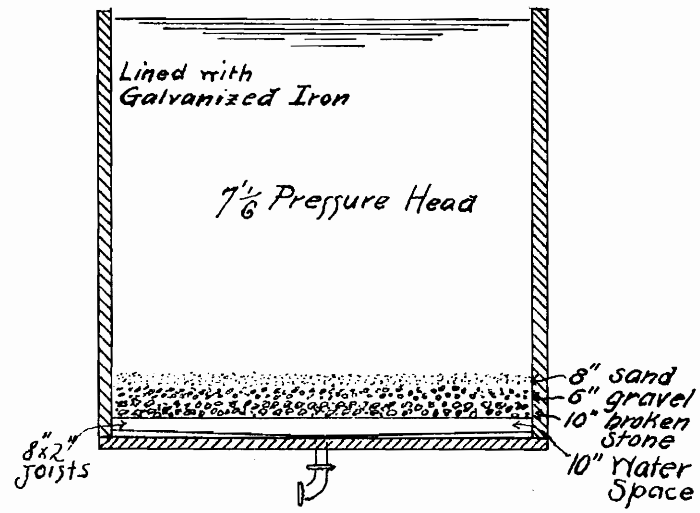


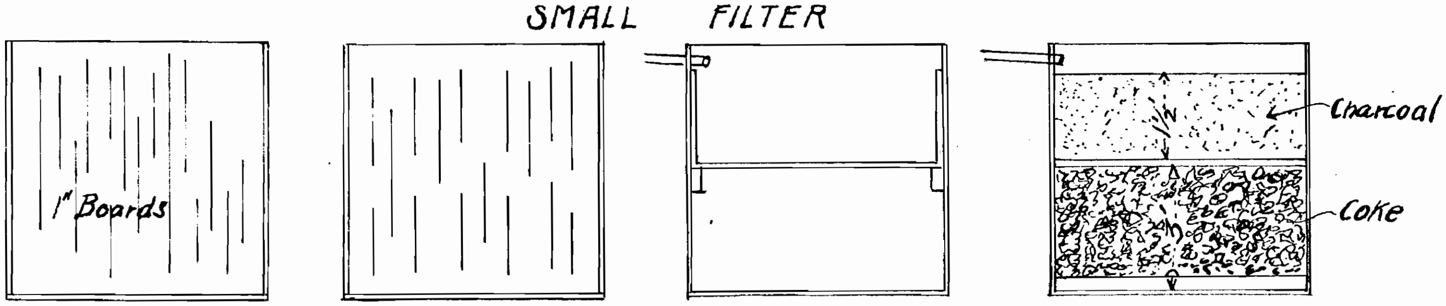



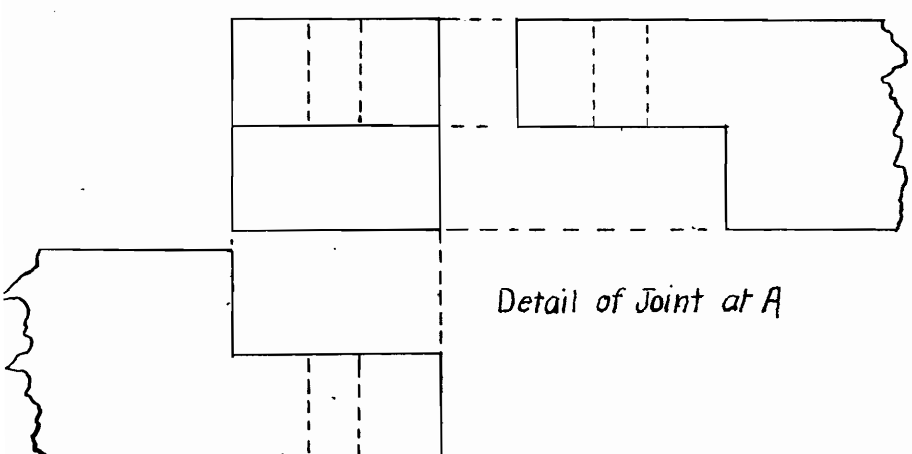

Detail of Floor System



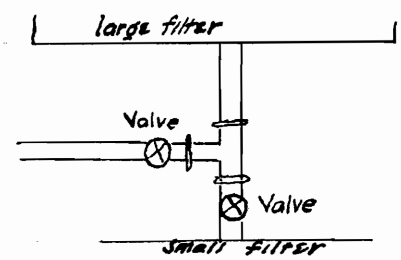




## SMALL FILTER



Detail of Joint at A




connection between large and small Filters

Large tank 37280/200 = 186 sq.ft. are necessary for bottom area. Dimensions 20'X 10'X 10'. This will leave a pressure head of 7' above filtering material.

Small filter, 6'x 6'x 6'.

We estimate 37280 gal. as sufficient for average daily consumption. In order to provide for any consumption above the average, the water will pass from the filter into a reservoir, which will contain a sufficient amount of filtered water to meet any demand.

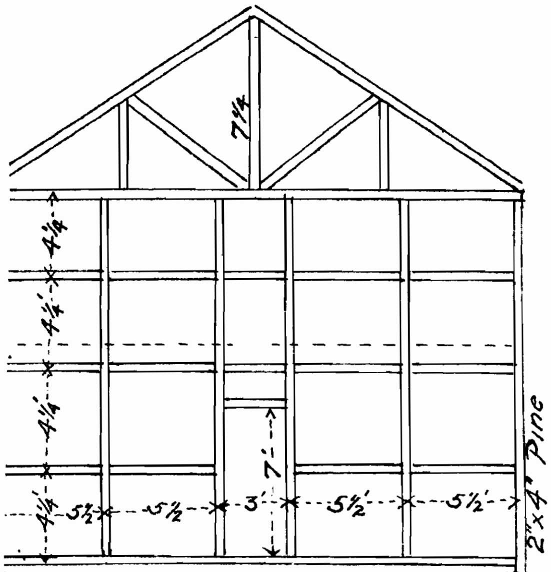
Amount of filtering material required, with above dimensions, will be as follows:-

| | | |
|---|---|---|
| 2" Broken stone | 6. | cu.yds. |
| Gravel | 3.75 | " " |
| Sand | 10. | " " |
| Charcoal | 2.7 | " " |
| Coke | 1.5 | ton. |

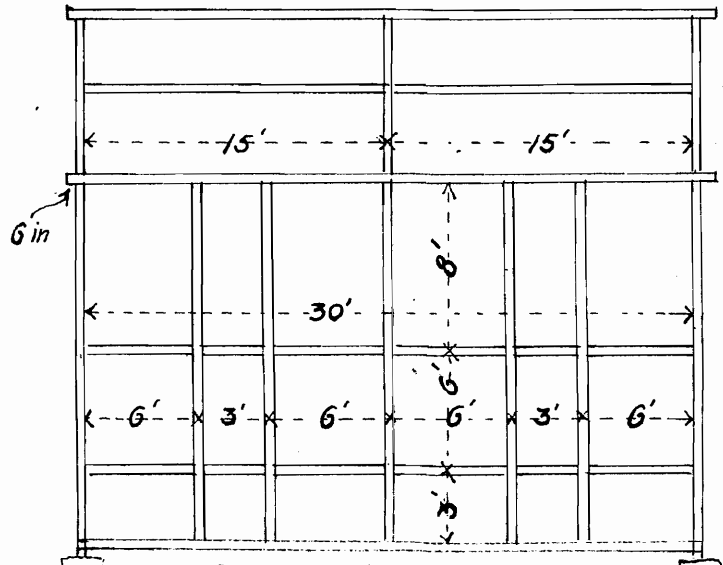
Only sand which will pass through a #30 (900 mesh) seive shall be used in this filter. For our purpose 5 cu.yds of sand will be ample, but allowing 50% of the ordinary sand as too coarse - to pass through seive - we estimate amount of

Plate B.

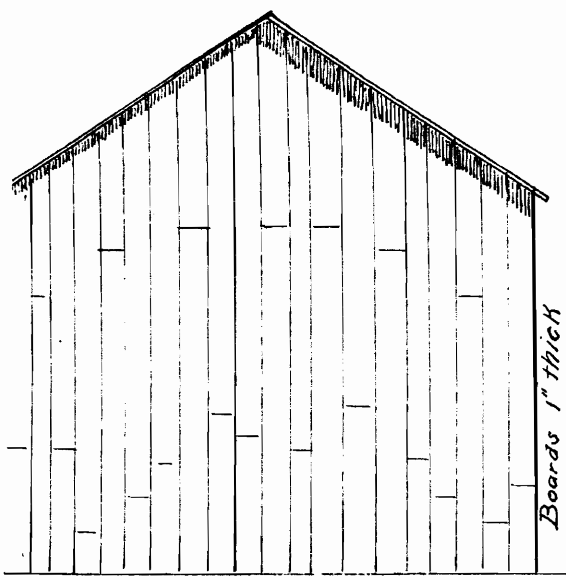
# DETAILS FOR
# FILTER SHED



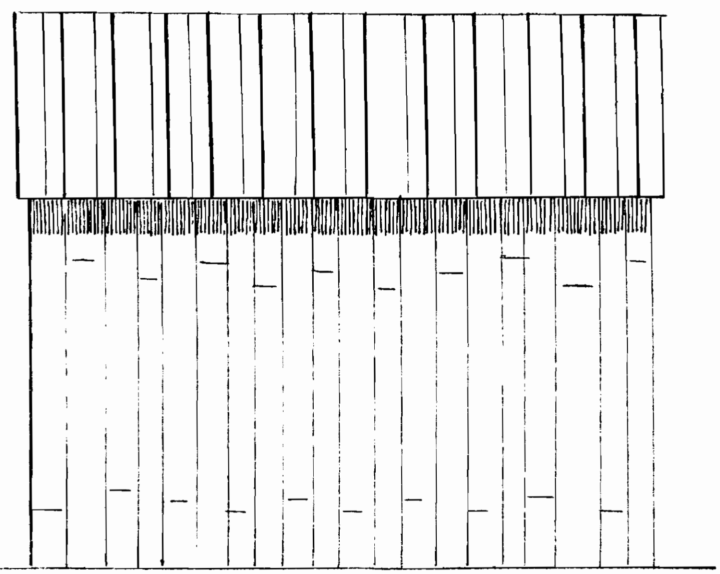

West Elevation



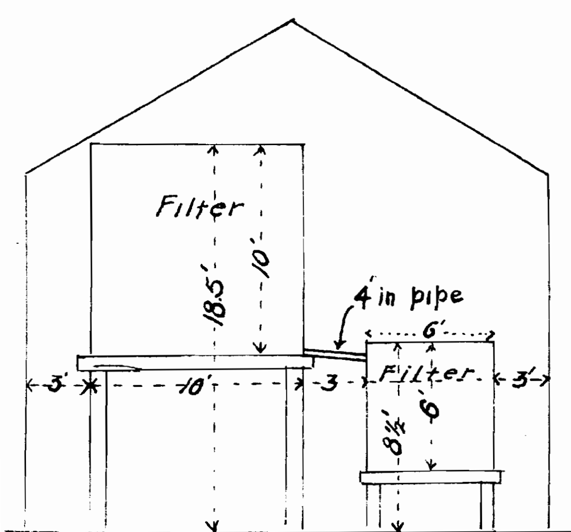

South Elevation




East Elevation



North Elevation




Cross Section

Detail of Roof

Scale 10'-1"

sand bought as 10 cu.yds. Both tanks are to be lined with galvanized iron. Filtering material in each tank rests upon wire cloth which is supported by 2"x 3" wooden joists, placed one foot apart, c to c supporting 2"x 4" stringers placed one foot c to c, and arranged as shown on Plate A.

The tanks are covered by a shed which is shown in detail on Plate B.

## METHOD OF CLEANING TANKS.

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To clean the filter it will be necessary to scrape off from 1/2" to 1" of the sand of the top layer. The remaining sand should then be stirred so that it will not clog up and become too compact for the ready flow of water. When the sand has been scraped off to a depth of about 4", new sand should be added until the layer reaches its original thickness. The sand which has been scraped off may be washed and again used.

This operation of cleaning should be performed about once every two weeks, or at least once a month. The charcoal and coke need not be cleaned so often as the sand but should be taken out and washed about every six weeks.

# P O W E R.

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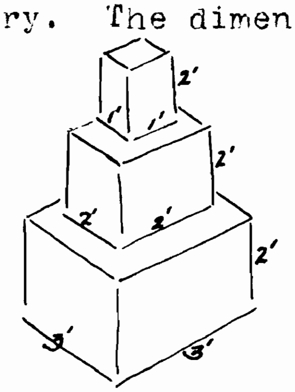
The pumping from the lake to the reservoir will be done by a wind mill, having a 16 ft. aermotor on a 100 ft. steel tower. The situation of wind mill is shown on Plate 1. The properties of this wand mill are here given:-

| | |
|---|---|
| Weight of 100 ft. tower | 5750# |
| " " 16 " aermotor | 2200# |
| Capacity of wind-mill | 1470 gal per hr. |

The corner posts of the tower are to anchored in brick masonry. The dimensions are given in sketch.




Dimensions of excavations are 4'x 4'x 6' = 3.55 cu.yds or, total excavations for anchor posts = 14.20 cu. yds.

Allowing 500 bricks to one cubic yard; the four foundations require 4.16 cu.yds., or 500 x 4.16 = 2080 brick.

# C I S T E R N.

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The water is pumped to reservoir from a cistern situated immediately below the aermotor. The dimensions of excavation for this cistern are 8'x 8'x 20'= 47.5 cu.yds.

The walls are to be of brick, 9" thick and laid in Louisville cement mortar. Inside dimentions are 6'x 6'x 20'. The floor for pump will be placed 14' from bottom and made of 2"x 8" joists placed one foot apart and covered with board flooring. 50.sq.ft., will be required for joists and 36.sq. ft.,for flooring (B.M.).

Number of bricks required for lining= 8000. Water is conducted to cistern from the lake through a 4" cast iron pipe which makes connection with cistern as shown on Plate 1.

The pipe extends into lake 100' and at the end is provided with a screen. Slope of pipe= .4' in 100'.

Trenching for this pipe equal 31 cu.yds. This pipe is provided with a gate as shown on Plate 1.

## R E S E R V O I R.

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The site of reservoir is shown on Plate 3. Its elevation is 90' above low water mark of lake. Dimensions of reservoir:-

Bottom 20'x 20', Slope of sides 2'.1, Top 60'x 60', Depth 10' making a net capacity of 23480 cu.ft., or 129022 gallons.

Reservoir is to be made partly by excavating and partly by banking -- 7' of excavation will yield about enough material for 3' of banking which is to be 4' broad on top.

The bottom and sides of the reservoir are to be lined with puddle made up as follows:-

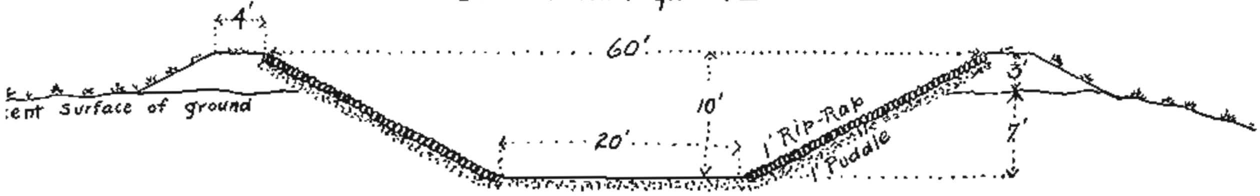
| | |
|---|---|
| Coarse gravel | .75 cu.yds., |
| Fine " | .26 " " |
| Sand | .11 " " |
| Clay | .15 " " |
| Total | 1.26 " " (Fanning) |

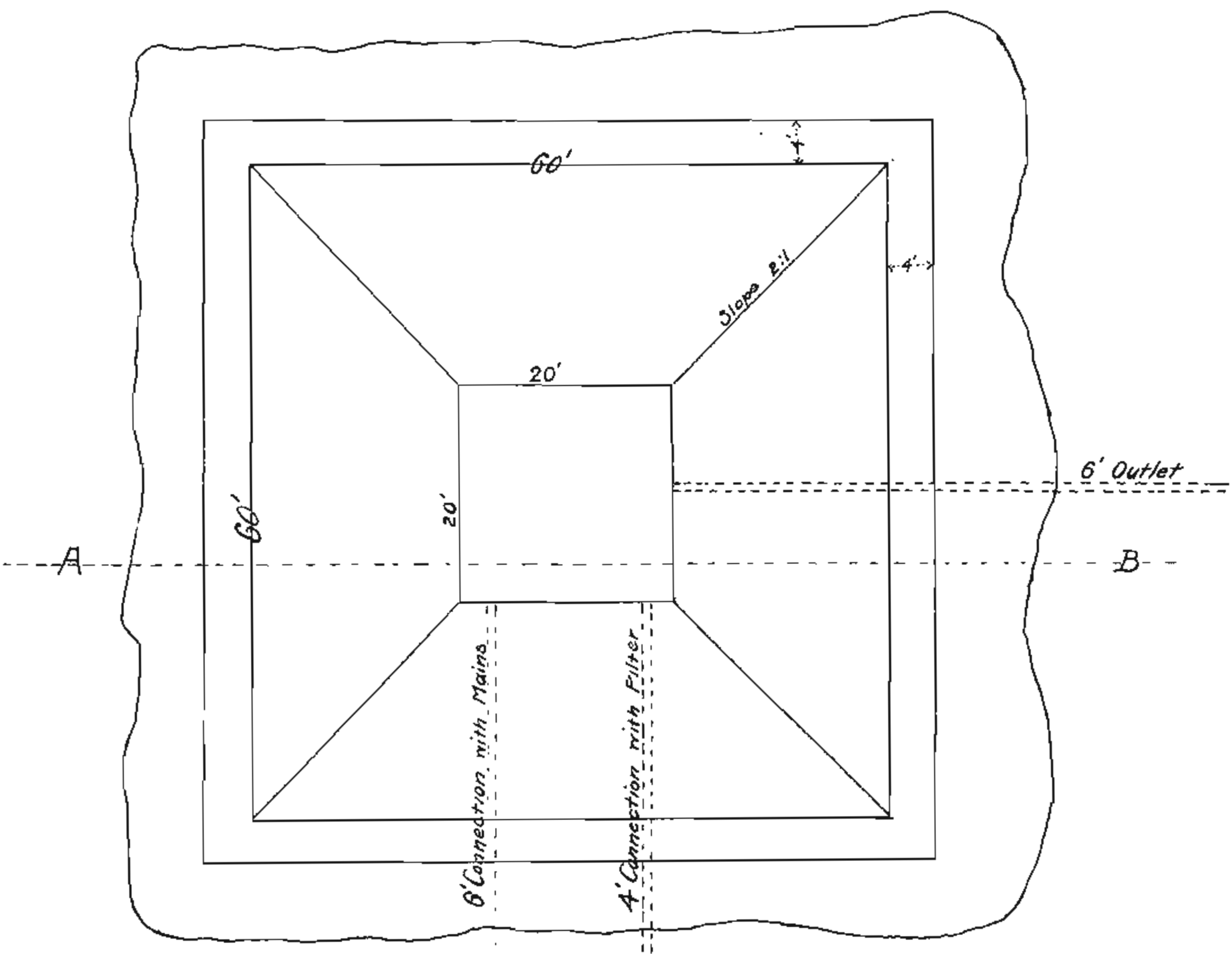
Total amount of puddle required 160.9 cu.yds. or

# Reservoir

Scale 16'-1"

Section through A-B



96 cu.yds. of coarse gravel,
33 " " " fine "
14 " " " sand and
19 " " " clay.

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L A Y I N G P U D D L E.

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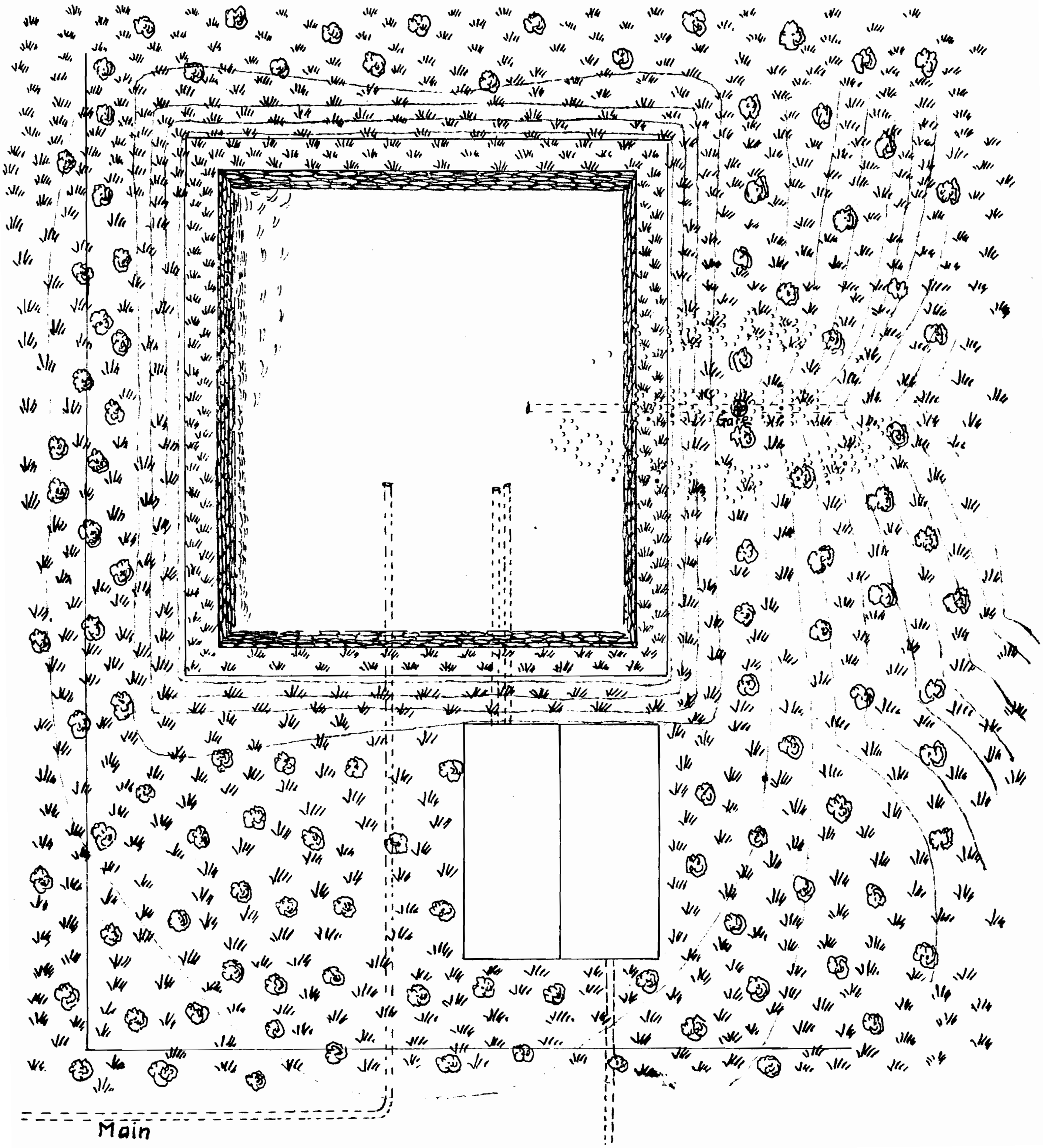
Gravel is to be spread on in layers of 2" thickness. Clay is evenly spread on over gravel and lumps broken. The sand is then spread on the clay and the whole thoroughly mixed by passing a harrow over it. After this, is done, it must be rolled with a heavy roller, the layers having first been moistened, just so they will mix well under the roller and become a compact mass. The next layers are put on in the same mannerruntil the required amount of puddlehas been put in place. (Fanning)

Rip Rap is placed on top of puddle on slope walls. In this rip rap, stones must not be less than 4" thick and 12" long. They are to put in place by hand,making a uniformly sloping bank; careful attention being paid to the selection

# Topographical MAP

Reservoir and Filter House



and placing of stones at all angles. (Baker.)

An outlet pipe is placed on the north side of the reservoir for the purpose of discharging all the water when cleaning becomes necessary.

Connections for all pipes are shown on Plate 2.

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## P I P E S.

The pipe is to be made of cast iron, part of it being 6" in diameter and the remainder 4".

The plan of the pipe line is shown on Plate 3.

| | |
|---|---|
| Total length of 4" pipe required | 14494' |
| " " " 6" " " | 4265' |
| Total length of pipe required | 18759' |

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## G A T E S.

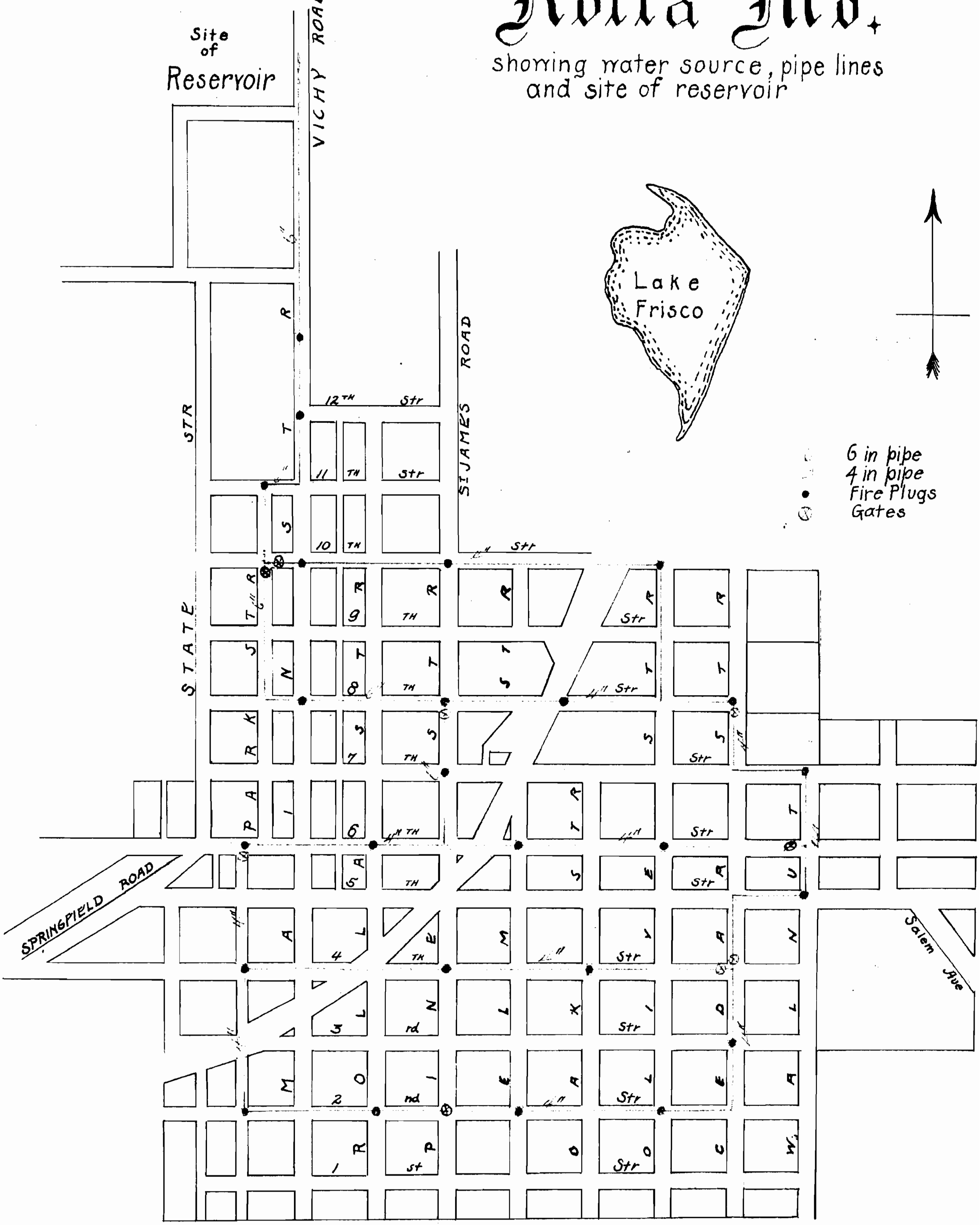
A number of gates will be placed on line so that a portion of the line may be cut out and be repaired without interfering with the flow of water in the remaining portion.

The position of these several gates are shown on Plate 3.

*Plate III*

# MAP of Rolla Mo.

showing water source, pipe lines and site of reservoir



## H Y D R A N T S.

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In all there will be 25 hydrants, their positions being shown on Plate 3. It will be noticed that, in case of fire in any block, water can be drawn from two hydrants simultaneously

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## T R E N C H I N G.

Dimentions of trench for pipe line are 1.5'x 2'x 18759' equal 3130 cubic yards.

FILLING OF TRENCH: After pipe is laid in position, the dirt is to be filled in around it and tamped, so as to give a good solid bearing for the line.

The dirt in the upper portion of the trench need not be tamped. This also applies to the trench joining lake and cistern.

## HEADS AT ELEVATED POINTS OF TOWN.

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In finding elevation of different points on streets along which the pipe line is laid, the following data was obtained. The elevation of the B.M. at the School of Mines being taken as reference:-

| POINTS. | ELEVATION. | HEAD. |
|---|---|---|
| B.M. at School of Mines. | 1138.23 | 32.85 |
| Site of Reservoir | 1171.08 | |
| B.M. at Lake | 1084.06 | 87.5 |
| Sixth and Pine | 1089.7 | 81.38 |
| Sixth and Olive | 1096.6 | 74.48 |
| Second and Cedar | 1093.61 | 78.4 |
| Eight and Cedar | 1106.6 | 65.4 |

Elevations were taken at intersection of streets, and at mid-point of blocks. The notes given above are selected as being most elevated points in the city.

TABLE SHOWING LOSS OF HEADS DUE TO FRICTION.

| POINT | HEAD | LOSS | REMAINING HEAD. |
|---|---|---|---|
| Eight & Pine | 64.09' | 1.56' | 62.53' |
| " " Cedar | 65.4' | 5.' | 60.' |
| Sixth " Pine | 81.38' | 1.83' | 79.55' |
| Second and Cedar | 78.4' | 12.21' | 66.19' |
| School of Mines | 32.85' | .6' | 32.25' |
| Sixth & Olive | 74.48' | 3.67' | 70.81 |

## E S T I M A T E   O F   C O S T   O F   S Y S T E M.

-----------ooOoo-----------

### COST OF GRAVITY FILTER.

| | | | | |
|---|---|---|---|---|
| 6 cu.yds.of broken stone | at | .75 | per cu.yd. | 4.50 |
| 3.75 cu.yds. of gravel | " | .75 | " " | 2.81 |
| 10 " " Sand | " | 1.75 | " " | 17.50 |
| 2.7 " " charcoal | | | | 2.70 |
| 1.5 ton of coke | | | | 11.00 |
| Wire cloth | | | | 53.90 |
| Galvanized iron lining | | | | 68.60 |
| Lumber (Labor ect.) | | | | 69.00 |
| Lumber for shed (Labor ect.) | | | | 83.75 |
| One 16' Aermotor ) | Capacity 1470 gal. | | | 125. |
| ) | per hour. | | | |
| " 100' Steel Tower ) | | | | 360. |
| " Pump (Combined air chamber & head) | | | | 15. |
| Foundation for tower | | | | 16.64 |
| Laying foundation | | | | 6.24 |
| excavating for same | | | | 4.26 |
| " " cistern | | | | 14.25 |
| Walls for " | | | | 70. |

| | | |
|---|---|---|
| Lining the cistern | | 24. |
| Lumber for pump platform | | 1.07 |
| Excavating and banking reservoir | | 233. |

COST OF PUDDLE.

| | | | | | |
|---|---|---|---|---|---|
| 96 cu.yds. of coarse gravel | at | .75 | per cu.yd. | | 72. |
| 33 " " fine " | " | .75 | " | | 24.75 |
| 14 " " sand | " | 1.75 | " | | 24.50 |
| 19 " " clay | " | .40 | " | | 7.60 |

COST OF LAYING PUDDLE.

| | | |
|---|---|---|
| Cost of Rip Rap (Laying ect.) at 1.50 per cu.yd. | | 174.37 |
| 14494' of 4" cast iron pipe | | 2524. |
| 4265' " 6" " " " | | 1079.20 |
| 10, 4" gates at 6.30 | | 63. |
| 5, 6" " " 11.60 | | 58. |
| Five 6" Hydrants at 29.40 ) | Freight | 147. |
| ) | incuded. | |
| Twenty 4" " " 20.40 ) | | 408. |
| 3211 cu.yds. of trenching | | 802.75 |
| Lead and packing for 4" pipe | | 310.17 |
| " " " " 6" " | | 148.42 |
| Laying 18759' of pipe at 10¢ per ~~xx~~.ft. | | 187.59 |
| Freight on above ) | Pipe ect. 30¢ per 100<br>Lead ect. 25¢ " " | 1132.46 |
| Total cost | | $8408.59 |

The prices given above on hydrants, pipe, gates, aer-
motor ect., are catalogue prices.

Prices on masonry, building, &c., are prices as obtain-
ed from Rolla contractors.

P. B. Anderson.
Felix J. Kersting

A D D E N D A.

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## ADDEND~~A~~um "A".

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Another possible source for water supply is a spring situated about a mile-and-a-half south east of the business part of the town.

The flow of the spring was measured and found to be 18 gallons per minute, or, 1080 gallons per hour, which would be sufficient for a maximum daily consumption of 17 gallons per capita.

## P O W E R.

Eighteen gallons equal 2.41 cu.ft.,discharge per minute. 2.41 cu.ft., equal 150.625 pounds. 165 ft.,is the difference of elevation between water in cistern, at spring and reservoir.

150.625 x 165 = 24853 ft.pds.,or, about 3/4 horse power required.

Therefore the wind mill of the foregoing estimate would furnish enough power for pumping. The capacity of the wind mill against a head of 165 ft. is 1030 gallons per hour,which would supply water enough for a maximum daily consumption of 16.5 gallons per capita.

## P I P E   L I N E S.

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The distributing mains of this system would be the same as in the first system. The 1700 feet of pipe conveying water from Lake Frisco to the Reservoir would not be needed; but, as the spring is 4920 feet from the nearest main, 4920 — 1700 = 3220 ft., would be the additional length of 4" pipe needed.

### C O S T.

| | |
|---|---|
| Cost of first system | $8408.59 |
| Deduction (Filter, gates &c.) | 306.96 |
| | $8101.63 |
| Additional cost for extra pipe, trenching &c. | $924.86 |
| Total cost | $9026.49. |

The advantage of this system lies in the purity of the water, which would dispense with the use of a filter.

The disadvantages are

1st. Increase of cost,

2nd. It furnishes only 16.5 gallons per capita per diem.

3rd. The discharge at this spring was measured within a week after heavy rains; and data as to its uniformity of flow were not available. It is very probable that the discharge in dry weather will fall short of this.

# A D D E N D U M

B

# ADDENDA "B".

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The following is a commendable design of a system where water for fire protection of the business part of town alone is desired.

The design is based upun the method of obtaining high pressure by means of compressed air.

## -- S O U R C E.--

Water will be taken from the mill pond, which is situateon 7th and Oak streets.

## -- P L A N T.--

The plant will be situated on the bank of this pond near the 8th str. side, and will consist of two tanks 8' dia. and 30' long.

These tanks are connected with an air compresser as shown on Plate 1. When the compressor is in operation air is drawn out of one tank and forced into the other which is filled with water, thus forcing this water out at a high pressure. The mains also act as a reservoir, supplying water immediately, when a hydrant is opened. While air is being drawn out of one tank to be forced into the other, water from the pond rushes into the first tank to take its place. Thus each tank is alternately filled with air and water, as a continuous pump. A water guage is fixed at the side of each tank so that the height of water is known at any time.

To illustrate: Suppose a fire alarm to be sounded and the attendant finds tank B filled with water. He must first start the compressor*, then open valve B and turn valves A and A' to the right and left respectively as far as they will allow. When the water in tank B has dropped to the bottom of guage and that in A has risen to the top, valve B is closed and B' opened; valves A and A' are then reversed, that is, turned to the left and right respectively. This operation can be repeated as many times as necessary.

---PRESSURE.---

The pressure in the tanks can be computed by the formula

$$\frac{p_1 + 14.5}{2\,v} = \frac{p_2 + 14.5}{v_1}$$

Allowing 100 pounds as pressure on the water just as it leaves the tank we have

$$\frac{p_1 + 14.5}{22500} = \frac{114.5}{11250} \quad \text{Therefore } p_1 = 214.5$$

will be the pressure per square inch on sides of tank. This will require thickness of metal to be $\frac{1}{2}$ inch.

* As A is full of compressed air when tank B is full of water, valve B is to be opened before compressor is started. The air in tank A gives the required pressure in pipes while compressor is being started.

---P O W E R.---

A small gasoline engine of 3/4 horse power will furnish sufficient power for operating the compressor. Compressor used will be same as shown in Fig. 6, Page 11, Merrill Mfg. Co's Catalogue. The engine and compressor combined is shown on page 18 same catalogue.

---M A I N S.---

Pipes are to be 6" in diameter and of cast iron. They will be laid on the following streets:

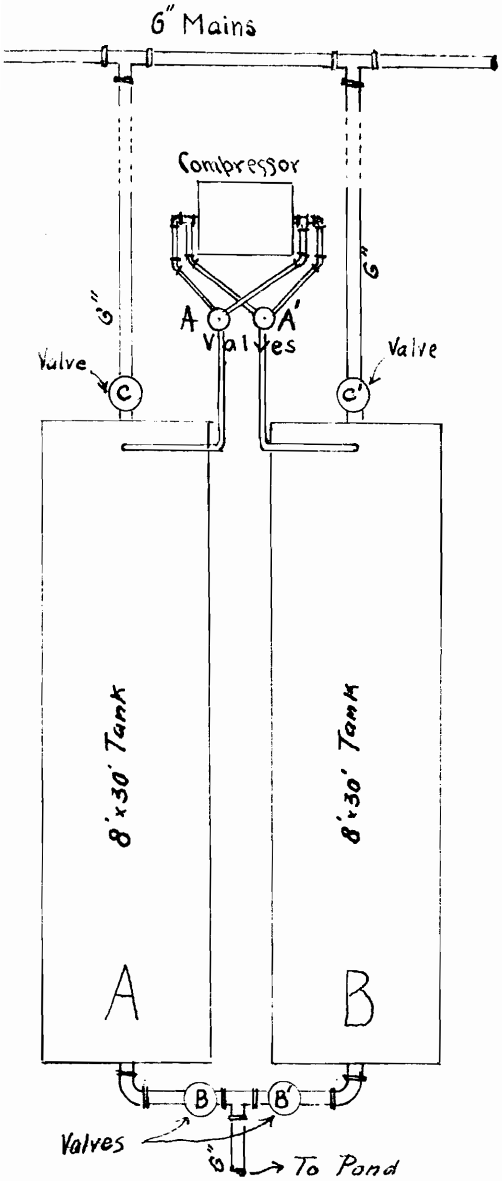
8th, from pump house to Pine; Pine, from 8th to 6th; 7th, from Pine to Elm. This will require 1600 ft. of pipe.

---H Y D R A N T S.---

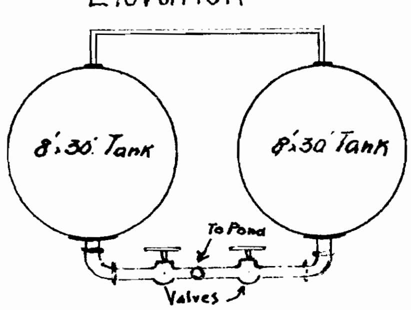
Hydrants will be distributed as follows: 8th & Elm, 8th & Pine, 6th & Pine, 7th & Pine, 7th & Elm.

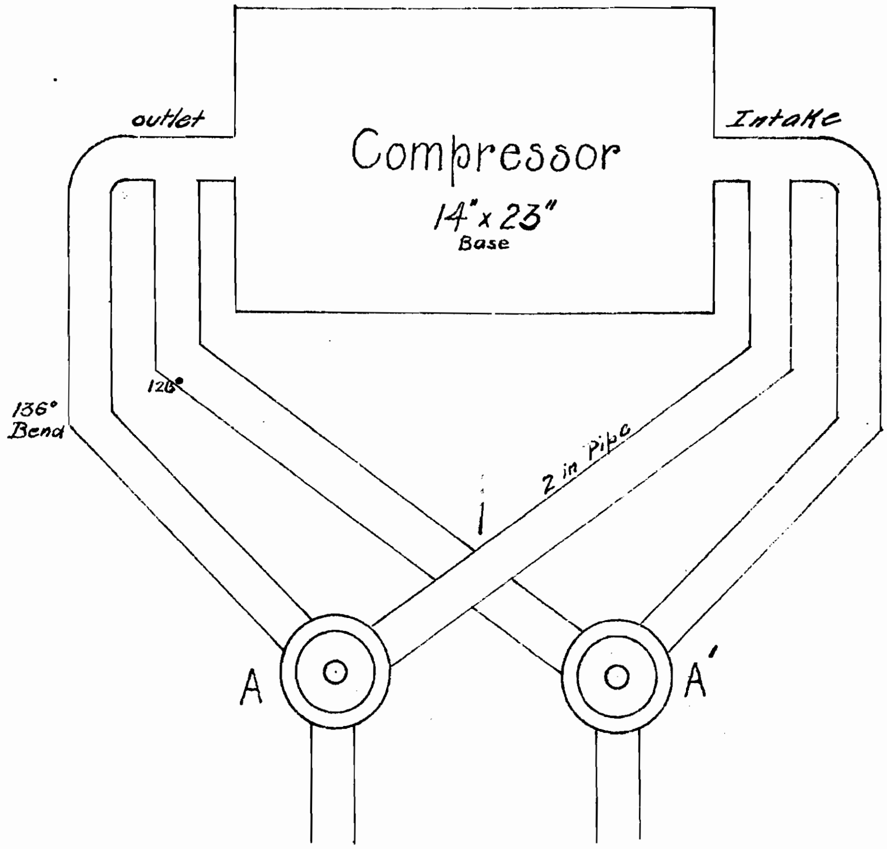
Addenda B
Plate I

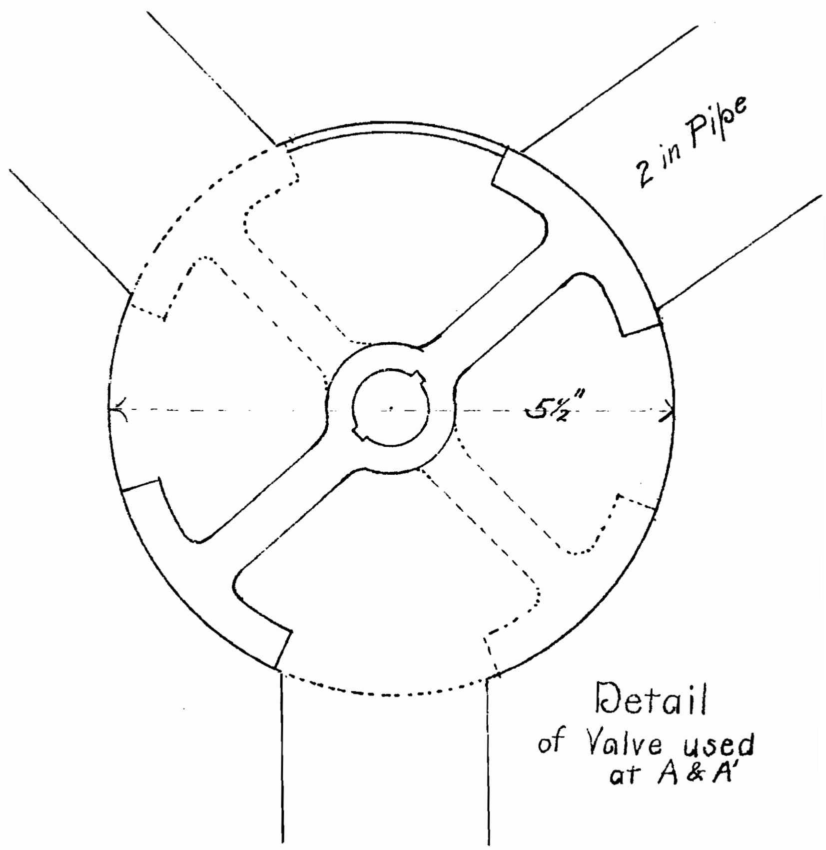
Plan



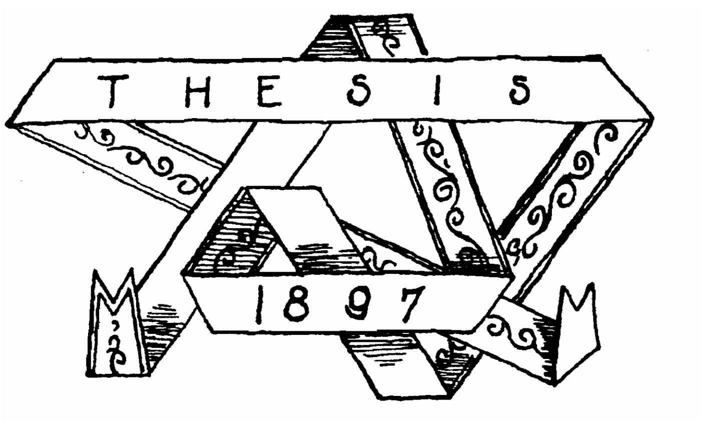

Elevation




Detail of Valve used at A & A'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