REPORT OF THE PASADENA
MUNICIPAL LIGHTING WORKS .

THESIS CLASS 1911.

THROOP POLYTECHNIC INSTITUTE.

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I.

GENERAL STATEMENT.

A proposal was made by Mr. Thum to President Scherer that certain of the students of Throop Polytechnic Institute be given the task of making a report on the Municipal Lighting Works of Pasadena. For expenditures in connection with such a report Mr. Thum very kindly offered to deposit a certain sum with the Institute. This offer was taken under consideration by the Faculty, and upon investigation of the time at the disposal of the various students, the problem was placed before the Senior Class as an elective subject for a thesis.

This offer the Senior Class was very glad to accept, and work was commenced at the beginning of the second semester of the year 1910-1911. A rough outline of the various items to be taken up in such a report was furnished by Prof. Sorensen and later suggestions were made by Dean Damon. As actually accomplished, the work covers a detailed description of the plant and distribution system with drawings and maps, an appraisement of the property, a summary of segregated costs, capacities, etc., a statement of the general methods employed in financing public utilities, various suggestions as to possible improvements, and a partial description of the accounting system in use by the Municipal Lighting Works.

The figures found in the summary may be considered as accurate to within five per cent. of the cost of the plant altho sufficient time was not available for a detailed study of this phase of the problem.   The idea has been rather to obtain data from which rough estimates of similar equipment could be made.

II .
FUEL OIL SYSTEM.

California Crude Oil is used for fuel. Delivery is made in tank cars on a siding of the Salt Lake Railway adjacent to the building. A re-enforced concrete oil reservoir 38 feet in diameter and 12 feet deep is situated 150 feet from the main building. A discharge box receiving oil from the car is situated between the rails of the siding. This is so placed that it will fill the storage tank to a height of 6 ft. by gravity. To empty the car it is necessary therefore to pump the remaining oil into the building against the line pressure and thru the overflow back to the storage tank.

Oil is drawn either from the main reservoir or from the small tank shown in the drawing of the oil system. This small tank also receives the overflow from automatic by-pass valves situated on the pressure line supplying the burners. The reservoir and tank contain steam heating coils by means of which the oil is heated in cold weather. Two jet pumps drain the tanks of any water which may collect in the bottom. The valves for the interconnection of the several pipe lines running to the tank are situated in a pit lined with concrete. A 2½ inch suction line extends to the building and a 2 inch suction line then supplies each pump.

There are two sets of Snow duplex steam pumps, two pumps in each set, which force the oil into the pipe line passes thru two heaters where it is warmed by exhaust steam from each pump set. The pump sets are connected in parallel so that either set may be used.

An automatic by-pass valve keeps the oil pressure constant. The oil piping from the heaters to the burners is insulated with magnesia covering. A special furnace has been installed in one of the Babcock & Wilcox boilers and the burner for this boiler is supplied thru a Worthington meter, in order to determine the fuel consumption of this boiler. All the oil used by the furnaces is measured by a meter in the delivery pipe of the oil pump.

III.
BOILERS.

The steam boilers for the plant are placed in the South end of the building in a row in line with and parallel to the engines, but not separated from them by any partition.

The boiler equipment consists of four, one hundred fifty boiler horse-power, [1] Babcock & Wilcox boilers and one three hundred horse-power Sterling boiler. Each boiler has a superheater and is provided with a safety valve, water column, steam gauge, blow off pipe and all other necessary appliances.

All of the boilers are of the water tube type and are among the best for steaming capacity and efficiency and are also easy of access to inspect and clean.

The boilers are fired with California Crude Oil, which is supplied by the system described above. This fuel requires special furnaces to obtain a complete combustion, and thus a maximum heat with a minimum amount of fuel.

The furnaces used under two of the B & W boilers are of the ordinary coal grate type, with the grates covered with one layer of brick closely laid over all the surface, excepting near the back end, where the burner is placed . In front of the burner is a triangular shaped space in which many small holes are left for the admission of air from beneath the grate.

. . . .

Note: 1. A boiler horse-power is equal to three engine horse-power with better compound condensing engines, but equals only one-half horse-power with a non-condensing engine.

A third B & W boiler is equipped with an American furnace, which admits air to the fire-box by passages thru the heated walls of the furnace, so that heated air is supplied to the furnace and greater economy is obtained .

The furnace in the fourth B. & W. boiler is a modification of those in the first two described. The change has been made in order that a Ruggles burner can be used. The air to the fire is admitted from beneath the grates thru a large square hole in the center of the grate.

The Hammel burner and furnace is used under the Sterling boiler. This furnace resembles the furnace under the first two B and W. boilers so closely that it needs no further description.

The gasses from the furnaces pass over the water tubes twice and also over the superheater tubes before leaving the boiler. From the boiler they may be by-passed directly to the stacks or around the vertical water tubes of the economizer and then to the stacks. There are three smoke stacks of riveted sheet steel. The smallest stack is three feet in diameter and seventy five feet high and the large stack for the other three B. & W boilers is four feet in diameter and eighty five feet high, while the Sterling boiler has a ninety foot stack.

The connection of each boiler is shown in the drawings, and consists of a feed water pipe inlet at the front of the steam drum, a water column, a blow off pipe, connected to the mud drum at the rear of the boiler and the steam connections which are on top of the steam drum. The steam connection is made near the middle of the boiler, and the first supply branch goes to the steam pump auxiliaries, while the main steam supply passes thru a large pipe to the steam headers. The pipe is bent into a semi-circle to provide for expansion, as are many of the other large steam supply pipes. (See drawings).

There are two steam headers, each of which can be used from any boiler, in case of repairs being necessary to the other header. One is a twelve inch and the other is an eight inch pipe. The twelve inch header extends anly as far as the No. 2 engine unit where the eight inch header joins it and extends to No, 3 engine unit where it is again reduced to five inches, and extends to the low pressure cylinder of No . 3 unit, so that live steam may be used in the low pressure cylinder when necessary. All steam pipes and steam drums are covered with magnesia pipe covering.

IV.

FEED WATER SYSTEM.

The feed water is pumped from the hot well by duplex steam pumps thru two Goubert single flow closed heaters to the Green economizers, and then to the boilers. The heaters are supplied with exhaust steam from the feed pumps and No. 1 oil pump. The water from all traps except No. 1 and No. 3 unit receiver traps,is piped to the hot well. Triplex wet air pumps discharge the condensed steam into the hot well. Makeup-water is taken from the circulating water before it goes to the cooling tower. The Green economizers are equipped with motor-operated scrapers. There are two economizers, one in each of the B. & W. boiler stacks. The Sterling boiler has no economizer.

CONDENSING AUXILIARIES.

Wheeler surface condensers are used on all three units. These are connected to the low pressure cylinders thru oil separators. No. 1 and 2 condensers are interconnected so that they can be connected in case of a break down on either set. No. 3 is not connected with either of the others.

No. 1 circulating pump is driven by a 15 H.P. 200 volt motor. No. 2 & 3 are driven by 35 H. P. motors. Triplex wet air pumps are used on No. 1 & 2, each of which are driven by 5.5 H. P. motors. No. 3 wet air pump is a single cylinder double acting piston pump geared to a 7.5 H.P. motor. The circulating water runs to the cooling tower.

This is a wooden structure 34 ft. wide by 60 ft. long and 35 ft. high, placed on a cement reservoir. Suspended lath are used to break up the falling water. Galvanized iron side boards are put around the edge of the reservoir to catch all water spray. The makeup water is supplied from the City maine or from a well 120 ft. deep situated in the building, from which the water is drawn by a deep well direct acting steam pump.

V.
PRIME MOVERS.

The power plant is equipped with three engines, each of different capacity. They are arranged in a row north and south and are numbered from the south end.

Number one unit is a 300 hp. cross-compound, four valve Fleming engine, which runs at 190 r. p. m. with 180 lbs. steam pressure. It has rotary valves that are made quick acting by a link motion and closely approximate the quick closing of a Corliss valve.

The steam admission is controlled by an inertia govenor in the fly-wheel. It is very quick acting, so that good s peed regulation is obtained even with a variable load. The valve gear bearings are lubricated by means of grease cups, which are screwed into each one of the important bearings .

The main shaft bearings are oiled from cups, placed above them. The crank pins are oiled by the splash from the oil in each crank case.

All of the waste oil from the bearings runs into tanks in the base of the engine and it is then drained into the oil filter as often as necessary.

The cylinders are each supplied with oil by a small plunger pump geared to the valve rods by a ratchet and wheel. They are also equipped with hand pumps for emergency.

No. 2 unit is in every way similar to number one. It is a 450 hp. cross-compound four valve Fleming engine, and has the same equipment as number one, but runs at only one hundred fifty revolutions per minute.

Number three unit is a cross-compound high-speed Hamilton Corliss engine, running at 120 revolutions per minute. It has rotary valves, which are operated on the inlet side by Corliss valve gear and on the exhaust by a link motion. It is governed by a fly- ball governor thatis connected to the shaft by a belt. The low pressure cylinder is also controlled by means of rod connected directly to the governor and better speed regulation is thus obtained.

The lubrication of nearly all of the bearings is accomplished by an oil system operated from an oil tank by gravity feed. From the bearings the oil drains into a filter that is placed in the basement . It is then pumped back into the overhead tank by a cog-wheel pump driven by a onehalf horse-power motor or by a piston pump operated by the eccentric rods of the engine.

The cylinders are supplied with oil by ratchet pumps and emergency hand pumps in the same manner as the other engines.

Each of the engines has a receiver to conduct the steam from the high to the low pressure cylinder. In number one and number two engines, it is only a large horizontal pipe, but in number three engine it is enlarged into a vertical tank, which is also equipped with reheater coils, suplied with steam from the inlet side of the high pressure cylinder.

A steam separator is placed just above the throttle valve of each engine to drain out water that collects in the pipes.

In each exhaust, there is an oil separator to remove the cylinder oil from the steam. The oil thus separated is drained into a tank and is then blown outside of the building by steam pressure.

The waste water from the floors and from number one and number two receivers is drained into sumps in the basement and that from the steam lines is removed by traps, which are connected to the steam header and the steam separators.

Foot note:

The general arrangement of the power house is not in accordance with good engineering practice. The boiler-room, engine-room, and switch-board apparatus are not separated from each other by walls, so that dirt and grease collect on all the appratus, making it unsightly and increasing the danger of break-down of electrical equipment.

The relative position of the boilers and engine is also faulty in regard to making extentions. Good practice seems to show that with such arrangement of boilers, it would be better to have placed the line of engines at right angles to the firing aisle of the boiler-room, so that a minimum amount of steam header would have been necessary at the beginning and also in all extentions. The fault is, however, due to lack of foresight at the beginning.

VI.

GENERATORS.

No. 1 generator consists of a Crocker Wheeler 200 K. V. A. 2300 volt, 60 cycle, revolving field alternator direct connected between the high and low pressure cylinders of the engine. No. 1 exciter consists of a Crocker Wheeler 17½ K. W., 125 volt direct current generator belted to the fly wheel of No. 1 unit.

No. 2 generator consists of a Crocker Wheeler 300 K. V. A. 2300 volt, 60 cycle alternator of design similar to the No. 1 unit. No. 2 exciter consists of a Westinghouse 50 K. W. 125 volt direct current generator belted to the fly wheel of No. 2 unit.

No. 3 generator consists of a Westinghouse 883 K. V. A., 2300 volt, 60 cycle alternator of the revolving field engine type. No. 3 exciter consists of a Westinghouse 50 K. W. 125 volt direct current generator belted to the fly wheel of No. 3 unit.

MACHINE LEADS, ETC.

Connecting each machine to the board is a lead covered cable paralleled with three rubber covered cables tied in at each end. The lead cables are of capacity equal to the machine ratings only. The peak being of short duration, it has been found advisable to overload the units for this part of the load and the additional conductors are hence required.

The exciter leads are carried along with the rubber covered cables on knobs suspended from iron straps and brackets across the ceiling of the condenser pit to the wall.

The lead-covered-cable terminals consist of lead sleeve pot heads filled with Ozite compound. Before entering the oil switch, in the case of No. 1 and 2 units, the leads are first connected to a potential transformer used in synchronizing, then pass thru two current transformers for a watthour meter, then thru two current transformers supplying three ammeters, one for each leg, are then connected to two potential transformers supplying the above watthour meter and finally pass thru explosive fuse blocks.

The leads from No. 3 unit are first connected to a potential transformer used in synchronizing and then to two potential and two current transformers supplying a watthour meter before passing to the oil switch.

The oil switches for No. 1 and 2 units are General Electric, 300 amp. 2500 v. double throw, triple pole, while for No. 3 unit there is a Westinghouse 480 amp. 2500 v.double throw three pole oil switch.

SWITCH BOARD.

The switch board is largely of standard dimensions, a part being made up for special apparatus.

From left to right the first six panels control the distribution of commercial power and lighting . Three panels were originally equipped with one 150 amp. ammeter, three plug receptacles for reading current in any phase, one eight point plug receptacle for reading the voltage of any phase on the bracket voltmeter, and one double throw three pole Westinghouse oil switch equipped with a two leg primary auto trip. Originally a watthour meter with a separate set of current and potential transformers was mounted at the rear of each one of the distribution panels. As each generator is equipped with a watthour meter it has been found advisable to cut the watthour meters on the distribution panels out of service at the station and place them elsewhere on the system. At present some of the circuits have but one current transformer and no potential transformers . This, however, does not interfere with good service to any extent as the distribution system is checked as to balance at frequent intervals by test instruments. As a matter of fact, it would appear that such an expense is entirely unwarranted, a watthour meter on each generator being ample for recording the station output, and one current transformer and ammeter being ample for indication of the circuit loads.

The next panel controls No. 2 and 3 exciters and is equipped with two 600 amp. ammeters, one 300 v. voltmeter, two field rheostats, one six point plug receptacle for obtaining voltage reading on either bus, and two double throw three pole knife switches. Also in connection with the voltage regulator there is a equalizer rheostat on No. 2 exciter, one six point plug receptacle for connection of the regulator to either exciter bus, and two special plug receptacles connecting a current transformer on either main bus to the compensating winding of the voltage regulator. There is a six point plug receptacle on the first distribution panel connecting the potential transformer on either main bus to the potential winding of the regulator.

Adjacent to the exciter panel are the control panels of No. 3, 2 and 1 generators respectively.
These panels are equipped with suitable ammeters, voltmeters, wattmeters and field ammeters. Field rheostats, potential running and synchronizing plug receptacles, double throw field switches with discharge contacts, oil switches and watthour meters for each machine are also mounted on the panels. Above the No. 2. panel a synchroscope and frequency indicator are located.

The remaining panels are for the control of the series arc and incandescent lighting, there being six arc circuits and two series tungsten circuits with a control panel for each.

Constant current transformers supply these circuits with single phase alternating current. On No. 1 arc panel the main switch for the arc bus is located. This switch is double throw, three pole for connection to either of the main busses and is fitted with two leg primary auto trip coils. All energy delivered to the arc bus is recorded by a suitable watthour meter. Each arc panel is equipped with one single throw two pole oil switch for connection from the arc bus to the transformer, two line plugs for connection of the transformer to the line, one shortcircuiting plug for use during the daytime, one Westinghouse round pattern ammeter with 10 amp. scale and connected to a two to one current transformer in the line, and one set of cartridge fuse blocks. Two single throw three pole oil switches connecting the house transformers to either main bus are also located on the lower part of No. 1 arc panel. Electrostatic ground detectors are mounted on No. 1 and 6 arc panels for convenience in locating trouble.

No. 7 series tungsten panel is equipped with a 10 amp. G. E. ammeter, five plugs for connection of both tungsten circuits in series to one regulator or to No. 7 circuit alone, one single throw, two pole oil switch, cartridge fuse blocks, and a watthour meter. No. 8 tungsten panel is equipped with a Westinghouse arc ammeter with a 7 amp. scale, a two pole oil switch, line and short circuiting oil switches. This circuit is connected to a double throw knife switch for the connection of No. 7 and 8 circuits in series.

There are two banks of transformers for the supply of 440 volts for the station auxiliaries, each bank being of sufficient capacity to carry the station independently of the other. These transformers are protected by explosive type fuse blocks.

The outgoing arc circuits are carried to the exit tower in special lead covered duplex cable. The outgoing commercial circuits are carried to the tower in regular lead covered three conductor cable, the ends being sealed with suitable pot heads filled with Ozite compound.

VII.

DISTRIBUTION AND MAPPING.

In mapping the 2200 volt distribution system the simple method of following out each individual circuit from the station to the ends of all its branches was employed. By this means it was found feasible for several men to work at the same time, there being no danger of repetition.

An endeavor was made, at the same time as the map was being taken of the primaries, to obtain also an approximation of the transformer capacity per customer. This item was found to vary thru a wide range. Transformers of too great or small capacity were often installed on account of having none of proper capacity in stock. Others have simply fallen heir to an abnormal load where a large number of customers have been taken on in one section or block. There transformers will no doubt be replaced by transformers of greater capacity as soon as they can be secured.

The map shows very clearly the methods used in securing the best possible voltage so far as the primaries are concerned. Most of the secondary circuits are broken into sections, one for each transformer, but in a few instances where two transformers are on the same primary circuit the secondaries have been paralleled. By this means a smaller sized conductor may be used for the line between the two transformers, which will still take care of a concentrated load shifting anywhere between . A single transformer of equivalent capacity would necessarily require secondary conductors of capacity equal to the full load of the section, while with two transformers paralleled the thing may be accomplished with conductors of capacity equal to one-half the full load of the section . The added cost of transformers for such an arrangement in most cases renders it uneconomical however.

This method accomplishes no improvement in voltage regulation. The smaller transformers have a poorer regulation on the contrary.

As may be seen from the map there is opportunity for interconnection on the Orange Grove Avenue circuits, the three sections coming together thru strain insulators. In case of trouble it would be a very simple matter to tie across and feed back to any desired point on either the Wilson ave., Raymond Ave., or Pasadena Ave. circuits.

The street lighting is accomplished partly by clusters and largely by series arc and incandescent circuits. The incandescent lighting is confined to the so called close in section, the arcs being used in the outlying districts.

Poles of various lengths are in use, in some cases the City lines running under and in others running over the lines of the competing company. In all cases possible, the City lines are run on the side of the street opposite the telephone. Six pin cross arms are used thruout where there is primary distribution or a prospect of any in the future. In general the pin next to the street is reserved for an outgoing street lighting circuit, the remaining two on that side of the pole and the middle pin on the property side of the pole being reserved for primary distribution. The two remaining pins on the top arm are used for returning arc or incandescent lighting circuits. Where exception has been made and secondary circuits have been run on the upper cross arm, they are kept on the opposite side of the poles as far as possible.

At each light on the series street lighting circuits the line is broken with a strain insulator , this method being much more satisfactory than tying to double grooved insulators. The strain insulators used are of the goose egg porcelain type while the standard double petticoat glass insulator is used entirely for primary and secondary distribution.

From an examination of the loads on a large number of transformers in various parts of the City, the average transformer capacity per customer of the moderate means class was found to be .4 kilowatt. Sufficient time was not available for an accurate determination of the number of lamps per kilowatt of transformer capacity. A more desirable figure to be obtained is the number of kilowatts of lamp installation per kilowatt of transformer capacity. This is more preferable on account of the use of carbon, tantalum and tungsten lamps.

VIII.

AN OUTLINE OF THE VARIOUS METHODS OF FINANCING MUNICIPALLY OWNED PUBLIC UTILITIES.

There may be said to be four general methods of financing municipally owned utilities. In this paper these divisions are made on the basis of depreciation charge and bond retirement.

Municipally owned utilities are assumed to be constructed from moneys obtained thru the sale of bonds. These bonds are retired one or more at a time at the end of each half year, or according to some similar arrangement. On those bonds an interest is paid regularly which decreases in amount after the retirement of each bond.

In the case of a utility the funds for the payment of these retiring bonds and accrued interest are expected to come from the proceeds of the utility. In this respect a utility differs from other municipal projects such as parks, etc. where the bonds are paid off from the taxes directly. It might also be said that a municipally owned utility differs from a privately owned public utility in that there is no stock on which a profit has to be made and there is no profit over and above interest which has to be made on the investment of bond money.

The theoretically correct method of operating a municipally owned public utility would be to eliminate the retirement of bonds, the money obtained thru their sale being considered as a permanent investment on which a regular rate of interest should be paid. This is very evident when it is noted that if the bonds are retired from the profits of the business, this money invested is earning its regular interest plus the amount necessary for retirement of the bonds. For instance, consider a bond issue on which an interest of 4% is charged and 2½% of the issue is retired each year. It is very evident that this money is actually earning a total interest of 6½% which is very high for such an investment. In other words, under present economic conditions it is necessary for money obtained and used in this way to earn a higher rate of interest than would seem to be justifiable. These bonds, if considered as permanent investment could of course be sold and exchanged by the owner as any other stock. This method seems to be rather impractical at present as money cannot be obtained readily without a promise of repayment.

This same point may be applied in a greater degree to privately owned corporations where, say 60% of the property is constructed thru the sale of bonds. The business in such a case would be expected to earn sufficient funds for the payment of bond interest, bond retirement, and profit in addition. On the face of it this is found to necessitate rates which are unfair to the consumer. In this case the bonds should represent a permanent investment and on this part of the investment only such profit should be allowed as would correspond to the difference between the standard rate of interest and a fair profit for the particular business involved.

It is quite possible that a rate of interest somewhat higher than 4% should be paid on bonds issued as permanent investment, but the rate should not be as high as that resulting from the present conditions.

The four methods of depreciation charge referred to are as follows:

(1) A depreciation charge may be made on the basis of the life of the plant and the allowable reissue of bonds at the time of plant replacement, which will keep the bonded indebtedness up to the original issue.

(2) A depreciation charge may be made on the basis of the life of the plant as in a privately owned corporation, the plant earning sufficient funds for bond interest and retirement, thus becoming a self maintained institution paying off its own debt. Accompanying the retirement of the bonds the rate to consumers could be gradually reduced as the amount of interest would be correspondingly lessened.

(3) The depreciation charge may be incorporated in the regular maintenance and operation accounts, the condition of the plant being constantly maintained up to at least 75% of the initial value. The only essential difference between this method and the foregoing is in the accounting.

(4) A compromise could be made between any of the foregoing and a portion or all of the depreciation fund applied to extentions, the expectation being that money needed for replacement may be obtained thru mortgages on the extended property.

Private corporations often use a method similar to the third given above. A regular sum is deducted each month from the gross receipts, called a depreciation charge. From this sum such current replacements as properly come under this charge will be paid. The surplus in this depreciation fund will then be either deposited in a Bank at compound interest, or, as is more generally the case, will be invested in the business in the form of extensions. The assumption is that at any time when a large renewal is to be made, this property acquired by the depreciation may be mortgaged for a sum which, together with the interest which has accrued from the depreciation fund invested in the business, will be sufficient to cover the demand.

The Municipal Lighting Works of Pasadena employs a method coming under the fourth class. For the first five years, expenses of depreciation are to be carried by the operation accounts. All surplus funds which would otherwise be applicable to a depreciation fund are used in extensions. At the end of the first five years of the plant's existance a sinking fund will be started for the purpose of renewals principally at the station. As in the private corporations before spoken of, additional money may be obtained at any time thru mortgages or bonds issued on the extensions made from the depreciation fund. The arrangement is particularly suitable for power and lighting systems in the early stages of developement.

Towns not possessing charters are subject to the general laws of California in the conduct of projects of municipal ownership. These laws differ widely in different States. Their specifications are very indefinite and inadequate as a general thing and a great deal of improper administration has taken place as a result. For example in the State of California the law states that municipalities floating bonds for municipal water works shall expend the money obtained from the sale of these bonds for the particular purpose given out at the time of the bond election. The law also states that this money shall be turned into the general water works fund of the municipality. The Board of Trustees directing the affairs of the Town have absolute control over this fund and there is no direct means of preventing them from making an improper expenditure of a portion of the bond money.

Another example of poor arrangement in the same State is the power of the Board of Trustees of an unchartered town to assign bills against the City to any department. For instance cases havebeen noted in which drayage for City parks has been charged against the Water Works department.

From an inspection of the books of Towns managed in this way it is absolutely impossible to obtain a fair idea of the operating economy of their various departments.

In the same State it is impossible for a Town,not having a charter which provides otherwise, to borrow money on extensions to Municipal projects made from surplus earnings. Obviously this is unfair and a serious handicap in competition with private companies.

IX.

DISCUSSION OF GENERAL CONDITIONS.

- ELECTRICAL -

In the original plans there was no provision made for extended commercial service such as is now being rendered. Hence there are many obstacles in the path of a proper developomont to meet present and future demands. The present administration is also under the embarrassment of a rate to consumers which renders improvements and extentions very limited.

As to the apparatus at the station, the generators are in first class condition. No. 3 machine was injured in installing but was repaired in such a way that its value was not seriously impaired. The additional generator leads, elsewhere spoken of, would undoubtedly be safer if run in a more substantial manner. The pot head cable terminals should be supported in a position more suitable for connection to the switches. This would require a little more room but good service calls for opportunity for easy inspection and cleaning at all times.

The watthour meter equipment for each distribution circuit was put in as a check on the house meter readings . In some towns it is necessary to separately check each circuit in this way as a protection against theft, but in Pasadena conditions have been found so favorable that the investment for watthour meters has proven unnecessary. They have, however, been used to good advantage on other parts of the system.

The wiring on these panels has been left in rather poor order but will no doubt be straightened up eventually.

The lines leave the station thru a tower at one corner of the building. In all, there are fourteen circuits which make their exit from this point. A much metter method and one which is at the present time being carried out is to carry the lines out thru conduit to a distributing rack.

The arc circuit wiring is cramped for the same general reason as is all the rest of the station . The real evil of these cramped conditions lies in the difficulty of frequent inspection and the accompanying danger of burn outs or other interruptions. There is a considerable amount of bare copper exposed such as disconnecting switches fuses etc. which if there were more room, could be placed in safer positions.

The distribution system is limited due to the same change of policy as is the station, The copper is small on all the original lines. It has been necessary to pull in new lines and parallel in some cases, and to run new circuits and separate old ones in others. A chart is kept at the office by which, knowing the location of the consumer, bulbs of the proper voltage rating may be furnished to him. The voltage difficulty is in this way very satisfactorily taken care of.

The arc lights used in street lighting are designed for 60 cycle current . There is consequently more or less difficulty in obtaining satisfactory operation from them with the 50 cycle current now used by the Municipal Lighting Works. From a general observation of their operation in various parts of the City and an inquiry into the additional cost of upkeep it appears unjustifiable to make renewals until the lamps have served a reasonable life.

GENERAL.

The Municipal Lighting Works of Pasadena was started primarily for street lighting purposes. The rates offered by the sole company in the City were considered too high for the service rendered. A bond issue sufficient for the establishment of such a Street lighting plant was authorized and the plant was then constructed. After some months of operation the economy was found to be such that, on the basis of the rates offered by the lighting company, the city could no longer afford to operate the system. However, as the City could not, by law, enter into any contract of more than one year's duration, it was thought advisable to take on a commercial lighting and power load, and thereby bring the cost of operation of the City plant down to a paying basis. To do this, another bond issue was necessary. An additional unit and boilerswere added at the plant and the distribution system was installed. A base rate of eight cents was selected as a tentative offer to the public. The administration changed hands at about this time with a change of policy, or rather, an increase in the intended size of the business. Another extension of the plant and distribution system was soon set on foot, by the authorization of a third bond issue. A reduction to seven cents was made, and another was promised as soon as sufficient load could be secured to justify it. A campaign to secure the requisite number of subscribers by a specified date resulted in the establishment of a five cent base rate September 1, 1910. Before this time the competing company had first made a flat rate to all light users. Legislation by the City Council prevented the continuance of this method after a few months, however, enforcing sale thru meters. During the existence of the seven cent rate offered by the City for the period Dec. 1, 1909, Aug. 31, 1910, the competing company made a rate of six cents. A corresponding cut to four cents followed the second drop by the City. To meet the demands of the public for new service connections etc. additional funds over and above the proceeds of the 1909 bond issue became necessary . A part of the necessary amount for these additional extensions was obtained from the monthly surplus earnings which would otherwise have been applied to a depreciation or renewal fund. This action was justifiable as the City will have the right to issue more bonds at such a time as renewals of size too large to be taken care of by operation, become necessary, for the value of the light plant will at that time be sufficiently greater.

During the year 1906-1907 an amount for additional extensions was also borrowed directly from the general tax fund. The City charter of Pasadena requires that all funds necessary for the retirement of and payment of interest on all bonds for the business year must be on hand at the beginning of that year. This applies to all departments. Hence the bonds issued for the establishment of the lightplant are taken care of in the above way from the general tax fund. As a rule the light plant is expected to return this amount to the general tax fund during or at the end of the year. The remaining part of the necessary amount for extensions above spoken of was obtained thru the application of a part of the net receipts, over and above operation, to new construction. There was a consequent inability to return the proper amount to the general tax fund.

The light plant therefore has become indebted to the City treasury for these amounts, three in number, which aggregate about $80,000. Judging from the present rate of extensions necessary to supply demands for service, it will be necessary toborrow money in the same way during the year 1910-1911. It may also be necessary, as in the year 1906-1907 to borrow an additional sum from the general tax fund, over and above that necessary for retirement of and interest on the bonds. These loans have been made with no interest charge and no definite date of settlement, as there is an understanding that settlement will be made as soon as a sufficient decrease in the demand for extensions takes place.

Foot note: It is evident from the foregoing statements that the Municipal Lighting Works of Pasadena has developed under rather unfavorable conditions. From a small street lighting plant its scope has grown to one with the expectation of serving the entire City with light and power. The financial needs of the plant have consequently undergone corresponding changes. At the present time there is no adequate or systematic arrangement for extension funds. If the present rate of growth of the City of Pasadena be continued, a corresponding developement of the Lighting Works will undoubtedly call for a rate of extensions too great to be taken care of by surplus earnings such as are being obtained at present.

Bond elections as a rule require regular political campaigns to insure their success. These campaigns are expensive and wasteful. A bond issue is always necessary to start such a Lighting Works Department, and to establish the entire street lighting equipment. The following methods for obtaining extension funds for commercial light and power would probably relieve some of these difficulties. A rate would be charged to patrons of the municipal plant which would ordinarily net sufficient earnings for this purpose, any extraordinary demands being met by either loans from the general fund or bond issues. Extensions from tax funds place the burden on all residents whether they use electricity or not. That portion of the extension funds necessary for street lighting should, of course, be drawn from the tax fund. But residents not using electricity should not have to pay a part of the bills of those who do. Furthermore, patrons of the City plant should not have to pay for the street lighting equipment alone , as is the case where the entire bond issue is retired from surplus earnings, unless a sufficiently high rate is charged for street lighting.

That original share of the bond issue chargeable to commercial lighting and power should then be taken care of by the plant after which, if some adequate arrangement for depreciation has been made, the rates could be lowered. The plant would then be self maintained and clear of debt.

At the present base rate the Pasadena Municipal Lighting Works receipts net about 10% over and above regular operation charges. Under present management sufficient repairs are charged to operation to make a 4% depreciation charge probably ample. Bond interest and retirement amount to 6½ % . It appears from these figures that the present rate is too low to carry out such a method. In order that the plant may continue in operation it will be necessary at more or less frequent intervals to issue more bonds. It will also be necessary to consider the 2½ % necessary for bond retirement as a partial depreciation charge .

X.
APPRAISEMENT.

The data brought together in the appraisement of the station was obtained and checked in three different ways. That portion of the equipment which was installed under contracts by the C. C. Moore Co. was first itemized, and then a segregated statement was obtained from the contractors. These prices were then compared with current prices of similar machinery and the costs of erection were checked on a basis of ten dollars per ton.

The construction work carried on at the same time by the City is recorded in the demand books kept in the office of the City Auditor. These records are not separated however, and it was consequently necessary to extract them from the records of all other payments made from the office of the City Auditor.

The costs of the distribution system were obtained from the same records. They were checked from the data obtained in making the map of the 2200 volt distribution which also included the location and capacity of each transformer on the system.

The line material in stock at the time of the appraisement was deducted from thetotals as it was considered to constitute an asset but nor an earning investment.

From the line construction account and from data furnished thru the courtesy of Manager Koiner, an approximate idea of the cost per connection, cost per mile of pole line, etc. were obtained . These items along with other data will be found in the summary.

STATION ITEMS.

Installation under C. C. Moore contracts, etc.

1. Building.
2. Foundations and materials.
3. Labor.
4. Constant current transformers.
5. Arc and generator switchboard.
6. Wiring supplies.
7. Oil tank.
8. Cooling tower.
9. Pipe and fittings.
10. Sundries.
11. 4-170 H. P. Boilers.
12. 2 Economizers.
13. 1-300 H. P., 1-450 H. P. engines.
14. Condensers and pumps.
15. Feed pumps, oil pumps, tanks, etc.
16. Piping and gauges.
17. 2 Steel stacks, railings, etc.
18. Engineering and sundries.
19. 1-250 K. W., 1-300 K. W. alternators, exciters, panels, motors, auxiliary transformers and wiring.

Extensions from Jan. 1909 to Jan. 1911.

20. No. 3 Engine foundation.
21. " " "
22. " " Condenser.
23. " " Alternator and Exciter.
24. Erection.
25. Pipe and fittings.
26. Sterling Boiler 1 - 300 H. P.
27. Switchboard.
28. Tirril Regulator.
29. Auxiliary transformers.
30. Additional labor.
31. Freight, teaming, etc.
32. Miscellaneous switchboard and wiring material, lumber, etc.

DISTRIBUTION ITEMS.

33. Labor.
34. Poles.
35. Cross Arms.
36. Construction material, pole hardware, insulators, etc.
37. Transformers.
38. Wire.
39. Meters.
40. Sundries used in construction.
41. Freight on above material.
42. Street light material.

DEPRECIATED VALUES - STATION.

Item No.	First cost.	% Dep.	Age.	Present value.
1.	$7900.	6	3	$ 5700.
2.	3600			3600
3.	900	3	3	800
4.	8200	3	3½	7300
5.	1400	2	3½	1300
6.	1000	5	3	800
7.	2100	2	3½	2000
8.	1000	25	3	200
9.	1000	10	3	700
10.	900	5	3	800
11 .	20700	3½	3	18500
12.	3800	8	3	2900
13.	24000	7	3	19000
14.	7700	5	3	6500
15.	5700	5	3	4800
16.	10900	10	3	7600
17.	3600	10	3	2500
18.	4000	5	3	3400
19.	17300	3	3	15700
20.	1800			1800
21.	19500	5	1	18500
22.	4550	5	1	4300
23.	9800	3	1	9500
24.	1600	5	1	1500
25.	6000	10	1	5400
26.	7200	3½	1	6900
27.	1800	2	1	1800
28.	700	3	1	700
29.	600	3	1	600
30.	3800	5	1	3600
31.	1000	5	1	900
32.	1500	5	1	1400
Totals	$ 176,550.			$ 149000.

DEPRECIATED VALUES- DISTRIBUTION.

Item No.	First Cost.	% Dep.	Age.	Present value.
33.	$61394	8	2½	$49120
34.	29840	8	2½	23870
35.	5740	8	2½	4590
36.	29340	8	2½	23470
37.	19240	4	2½	17320
38.	72760	3	2½	67300
39.	43240	3	2½	40000
40.	8540	8	2½	6830
41.	1680	8	2½	1340
42.	8890	8	2½	7110
Totals	$ 285170.			$ 240950.

XI.

SUMMARY OF UNIT COSTS, CAPACITIES, ETC.

- STATION -

Labor Installation Costs.

Engines and generators (including engine auxiliaries)	$6.40	per	ton
	$1.50	"	K. W.

Weight of above apparatus .23 ton per K.W.

Engines, Generators, Switchboard, wiring and foundations	$17.90	"	ton
	$ 5.10	"	K. W.

(Weight does not include foundations)

Boilers	$ 7.50	"	H. P.
(Weight does not include brick work and foundations)	$65.00	"	ton.

Weight per boiler H. P. .23 ton per H. P.

Segregated costs per K.W. capacity.
as at present installed.

(Costs of various apparatus include labor of installation and foundations)

Engines, Auxiliaries, Auxiliary piping and foundations.	$46.00	
Boilers and Economizers with foundations	$24.00	
Pumps, Headers and other piping (Not included in Engine auxiliaries).	$16.00	
Generators, switchboard and arc regulators.	$28.00	
Building, land, tanks, etc.	$12.00	
Total	$ 126.00	per K. W.
K. W. capacity per boiler H. P.	1.45	K. W.

Foundation Costs.

Cement	$2.15 per brl.	
Gravel and Sand	$1.45 " Cu. Yd.	
Foundation material (sand, gravel, cement)		$3.15 per cu.yd.
Excavation		.74 " " "
Forms		1.34 " " "
Machine mixing		.80 " " "
Total cost per cu. yd.		$6.03 " " "

Approximate Mixture 1-3-6

K. W. Generator capacity per cu. yd. of foundation.	3.5 K. W.
Bearing surface per ton of apparatus	3 sq. ft.

- DISTRIBUTION-

Transformer Capacity per phase

A B	A C	B C
511	644	687

Station capacity per customer	.36 K.W.
No. of inhabitants per customer of City plant.	7.6
Transformer Capacity per K. W. of Station capacity.	1.3

Prices paid for poles (untrimmed cedar).

60 ft.	$12.25
55 "	10.85
50 "	9.40
45 "	7.95
40 "	6.90
35 "	5.70
30 "	4.70
25 "	3.70

D. G. D. P. Glass Insulators	4½ - 5½	cents	each
Strain Insulators	6	"	"
W. P. Wire per pound	14½ - 18½	"	
Lag screws	1 3/4	"	"
Cross arm braces	8½	"	"
Cross arms	27 - 36	"	"
Locust pins	1½	"	"
Wood-top steel pins	9 - 12	"	"
60 ft. Tripartite poles	$65.00		"
Cross arm bolts	9	"	"
12 ft. anchor rods	$ 2.00		"
Brackets	2	"	"
Digging holes	32	"	"

Cost of transformers per K.W.

3 K.W.	15 K. W.	50 K. W.
$12.30	$8.00	$5.40

Cost of meters

Single phase 5 amp. watthour meters	$11.60
Three " 10 " " "	32.45
Cost per house connection	6.50
Cost of overhead lines per K. W. of transformer capacity.	60.00

Pole spacing approximately 40 poles per mile

Per cent. of total distribution costs including street lighting.

Transformers	7%
Meters	15 "
wire	25 "
Poles and cross arms	12 "
Labor	21 "
Hardware, insulators, street lights, and fixtures	20 "
	100 "

Per cent.of total cost of system.

Distribution (Commercial)	33 %
Street Lighting	28 %
Station	39 "
	100 "

STATEMENT OF STREET LIGHTING.

ARC CIRCUIT NO. 1.

Arcs	43	750 c. p.
40 c. p.	27	Load 24.2 K. W.
80 C. p.	3	7.7 mi. No. 8.

ARC CIRCUIT NO. 2.

Arcs	55	Load 29.1 K. W.
40 c. p.	32	9.3 mi. No. 8

ARC CIRCUIT NO. 3

Arcs	57	Load 31.95 K. W.
40 c. p.	42	10.7 mi. No. 8.
80 "	1	
200 "	5	

ARC CIRCUIT NO. 4.

Arcs	46	Load 30.05 K. W.
40 c. p.	82	5 mi. No. 6.
80 "	7	12.4 mi. No. 8.
200 "	9	

ARC CIRCUIT NO. 5.

Arcs.	51	Load 41.2 K. W.
40 c. p.	204	13 mi. No. 6.
80 "	24	10.4 mi No. 8.
200 "	10	

ARC CIRCUIT No. 6.

Arcs.	55	Load 31.65 K. W.
40 c. p.	35	5 mi. No .6.
80 "	14	8.7 Mi. No. 8
200 "	4	

TUNGSTEN CIRCUIT No. 7.

40 c. p.	304	Load 17.25 K. W.
60 "	6	11.8 Mi. No. 6
80 "	6	
200 "	2	
Arcs	1	

TUNGSTEN CIRCUIT No. 8.

40 c. p.	326	Load 17.22 K. W.
60 "	11	13.7 Mi. No. 6.
80 "	1.	

130 Clusters 13 lights each.

SUMMARY OF ARC. CIRCUITS.

Total load	220.62	K. W.
Total loss	13	K. W.
Over all efficiency	94.8 %	
Total c. p.	290,000	
Total Miles No. 6	48.5	
" " " 8	58.9	

Total No. arcs	308
" " 40 c. p. incandescents	1052
" " 60 " "	17
" " 80 " "	59
" " 200 " "	33

Approximate cost per K. W. lighting capacity of public lighting installation which includes proportionate share of pole lines, insulators, cross arms, lights and fixtures. $400.00

Commendations.

Many of the features embodied in the fuel oil and feed water systems are good, while there are some improvements that should be made.

Covering the fuel oil pipes, heating the feed water, and taking make-up water from the warm circulating water are all good practices. The relative sizes ofthe prime movers are according to good engineering practice. The operating efficiency of the generators is very satisfactory. The construction employed in the distribution system is first class.

Suggestions.

The fuel oil tank is too high to be completely filled by gravity from the tank cars. Duplicate piping for the oil burners would be a safeguard as would also the interconnection of all of the condenser systems. A feed-water meter would give an opportunity for checking the economy of the boilers from time to time. Proper floor drainage and general cleanliness are difficult to maintain under the present conditions. The engine and boiler layout is not the best and the various departments have not been separated by walls.

The arc regulators were designed for 60 cycle current, hence on the 50 cycle current now in use the exciting current is somewhat greater, which consequently increases the copper loss. The candlepower of the arc lamps is probably not more than 75% of that which would be obtained on 60 cycle current.

The station wiring has been somewhat disarranged due to certain alterations which have been made. In general there has been a tendency to sacrifice safe construction for low first costs at the station.

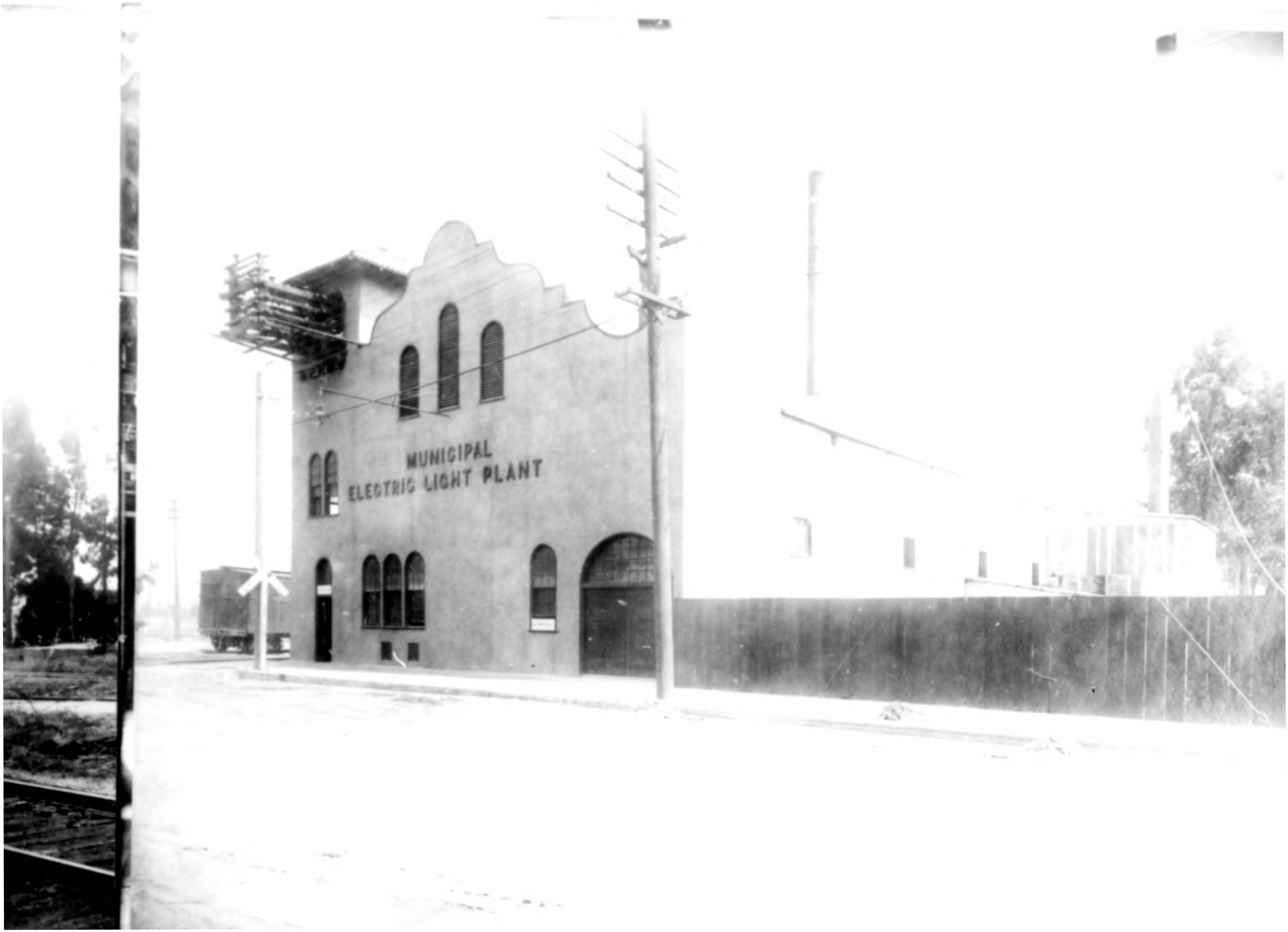
The conductors used in the distribution are of small carrying capacity as are also the transformers.

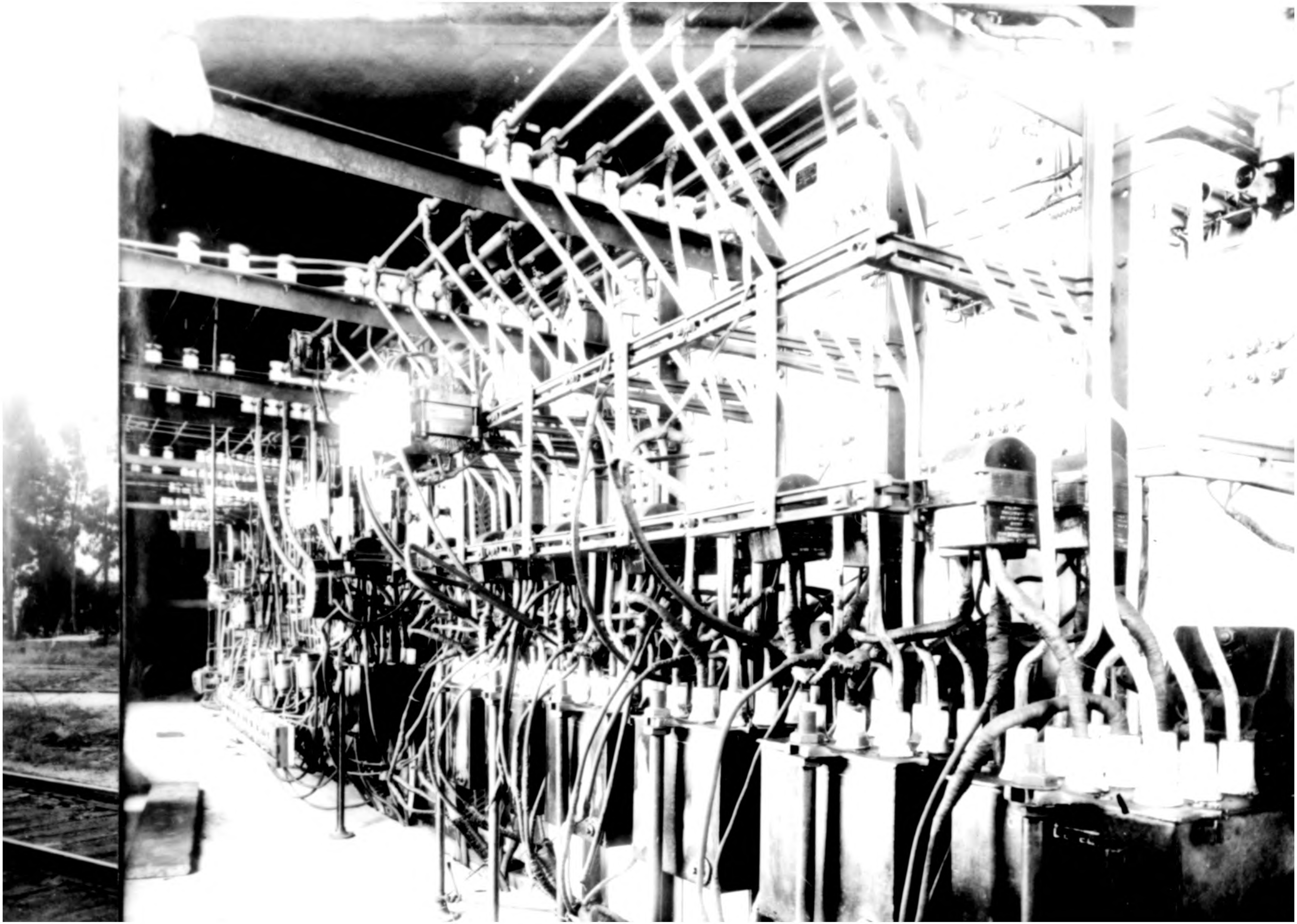
XII.
PHOTOS.

Three views of the station, switchboard, oil tank and cooling tower respectively were taken for the purpose of presenting to the reader a ready means of noting the various points referred to in the station description.

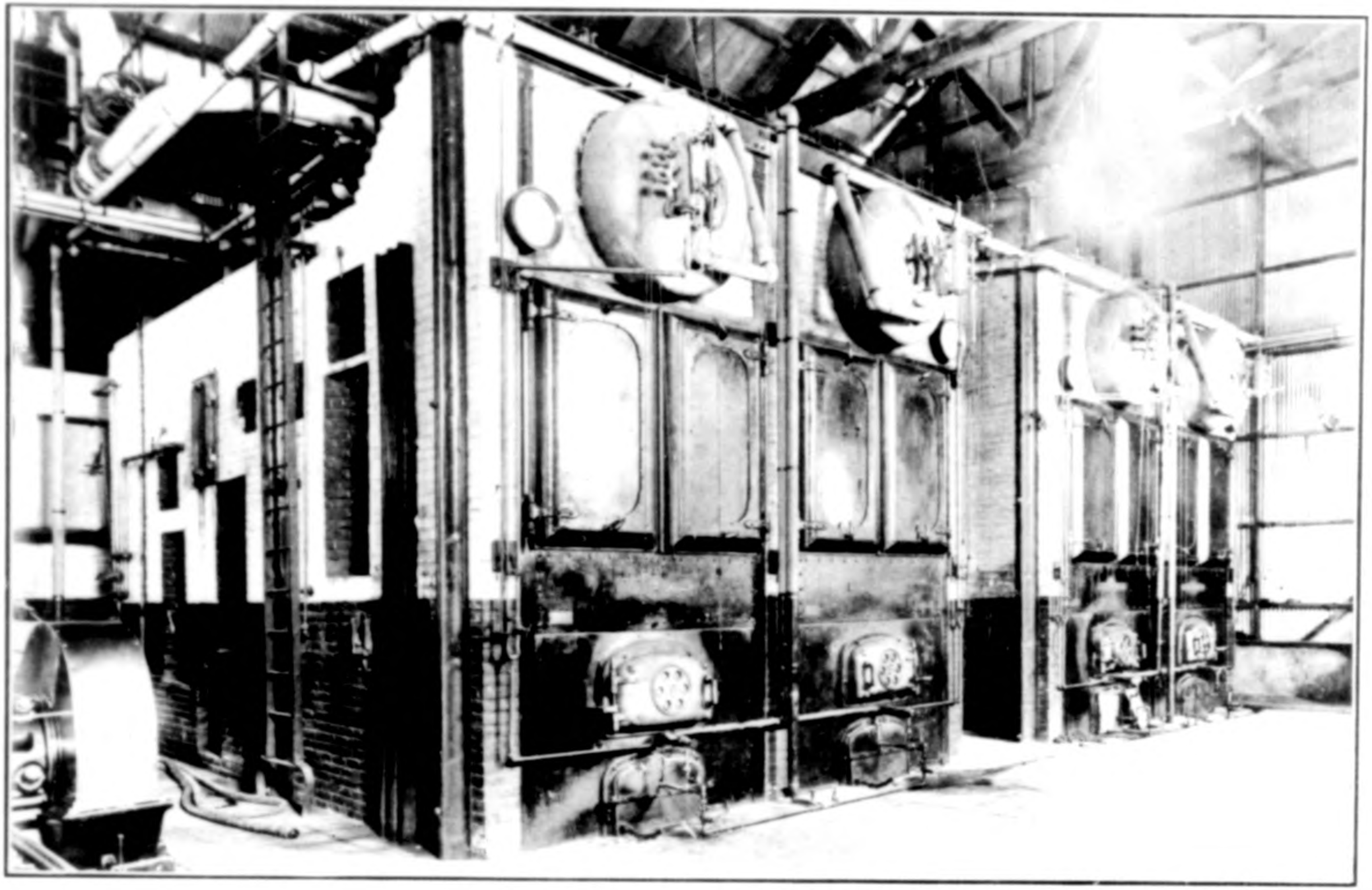
The outside view of the plant was taken from a position about 200 feet to the Northwest. The general design of the building, location of distribution tower, etc. may be seen from the illustration. The view of the rear of the switchboard shows very clearly the congested condition of the wiring, exposed fuse blocks and other points before mentioned. From the third view an idea may be obtained of the relative positions of the fuel oil reservoir (to the left) and discharge box for the tank cars which is located between the rails immediately at the rear of the flat car standing on the siding.

The two views of the interior of the station were taken from a point midway between the boilers and engines. They were obtained from copies of the annual report of the City Auditor of Pasadena .

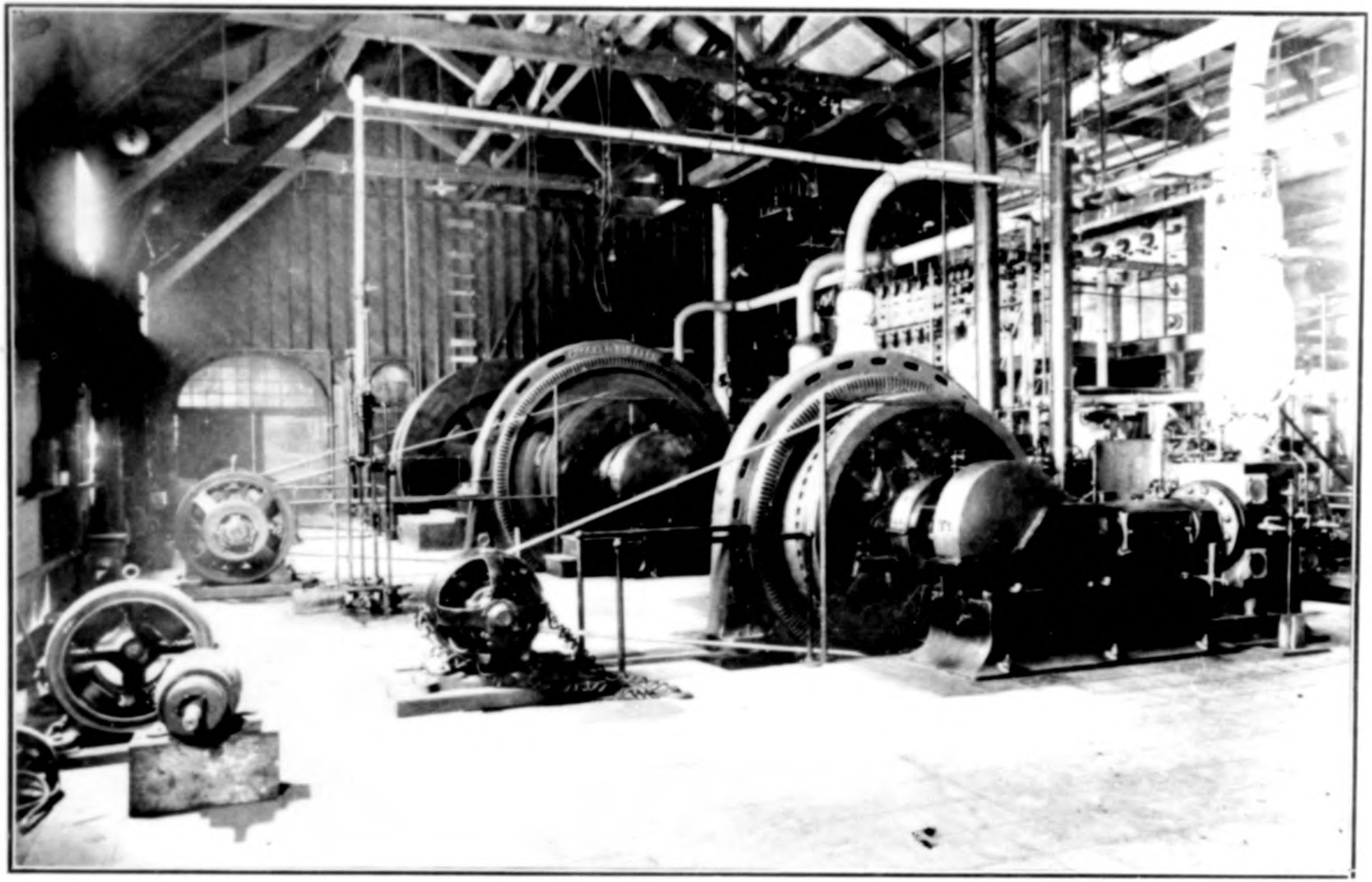

MUNICIPAL
ELECTRIC LIGHT PLANT




S.P.L.A.&S.L.



Interior View Municipal Lighting Plant



Interior View of Machinery in Municipal Lighting Plant

XIII.
OFFICE ACCOUNTING.

The methods of accounting used by the Municipal Lighting Works may most easily be followed by tracing the course of the process from the time of enrollment of the City customer on the City files to the time of discontinued service.

A prospective customer is presented with a meter set-order made out in duplicate form . This order is then presented to the distribution foreman who sets the meter and makes an entry on the meter set-order of all the details of the new service connection. From this set-order entries are made in a card index used as a reference at the desk, the double entry ledger, the meter card index, the meter route books, and the stencils used in addressing the monthly bills.

The card index of names is arranged alphabetically and contains also the address and ledger number. The double entry ledger contains the name, address, date of connection, description of meter and load, dates and meter readings for each month , notes of disconnection or reconnection, statement of monthly bills and dates of payment. The accounts are arranged in the numerical order in which the customers were given service .

The meter card index contains the meter number , the exact location, a description of the meter and any other information as to date and character of tests made. The cards are arranged according to the City numbers which are placed on the meters as they are purchased from the factory.

The list of customers in the route books is arranged according to the order in which the meters are read each month. These lists contain the name, address, meter number and monthly meter reading of each customer, and from these books the monthly statements of energy consumption are made out and entered on the bills and ledger.

The stencils are used in a triplicate addressing machine which places the customer's name, address and ledger number on each one of the three sections of the bill. The stencils are filed in the same order as that used in the meter route book. The bills are first addressed by the stencil machine and then statements of energy consumption and charges are placed on them. The bills are thus kept in a convenient order. The bills are afterwards cross checked with the ledger before being sent out. The three sections of the bill consist of the office stub on which energy consumption and charge are indicated, the receipt slip which contains also a statement of the meter reading, and the mailing bill on which a statement is made similar to that or the office stub. The receipt slip is given to the customer on payment of the bill and the mailing slip is destroyed at that time.

In case of trouble or complaint where only the address is given, reference is made to the meter set-order file which is arranged alphabetically according to the streets.

We, the undersigned students of the Senior Class of Throop Polytechnic Institute hereby submit the foregoing report as a Thesis preparatory to the degrees indicated below.

(Signed) Stanley M. Lewis
Candidate for degree B.S. E.E. & (M.E.)

DATED May 31, 1911.

Harold C. Hill
Candidate for degree B.S. (M.E.)

Royal U. Ward
Candidate for degree B.S. (E.E.)

OFFICE OF THE MUNICIPAL LIGHTING WORKS DEPARTMENT.

Pasadena, Cal. August 9, 1911.

To The Honorable Mayor, William Thum,

of the City of Pasadena.

Dear Sir:

I have checked over the thesis of the class of 1911 which made a preliminary report of Pasadena's Municipal Lighting Works.

On Page 1, Part 3, Subject "Boilers" - they have given the capacity of the four B & W Boilers as 150 H. P. This is a slight error inasmuch as the boilers are equipped with superheaters and economisers and contain 1750 sq. ft. of heating surface and should be rated at not less than 175 H. P. and will stand a rating of 200 H. P. each.

On Page 3, Part 5, Subject "Prime Movers" - The comment concerning the general arrangement of the powerhouse is well taken as the fundamental principal of powerhouse construction is to always separate the boilers and engines by means of a wall, planning the powerhouse, where there is room, so that the boilers will occupy the portion on one side of the division wall and the engines on the other, giving short steam connections between the boilers and header and between the engines and header. When the Municipal Lighting Plant was started, of course, it was inaugurated under adverse circumstances and conditions were such that those who started the works only had a very small piece of ground to begin with and I presume they did the best they could.

On Page 2, Part 6, Subject "Machine Leads, etc." - the condition of wiring referred to was the best that could be done under the circumstances and was semi-temporary. With the extensions under way, it is planned to re-arrange the wiring and run it all in a conduit system, reaching the switchboard through a route that will be taken outside the building.

The preceeding points, referred to and covered by the boys, are well taken and show that they are aiming at good design and good construction.

Page 1, Part 7, Subject "Distribution and Mapping" - it seems in giving their attention to the transformers, their capacity, etc., they did not understand the fundamental principles nor did they take into consideration the conditions under which the distributing system and transformers were erected. On a great many of the streets we expected to get the full amount of business and when we did not get the business this left a larger transformer in certain sections than was necessary for the amount of load we secured. Their reference to transformers carrying abnormal load is not correct . It is true that sometimes a transformer will become overloaded and a larger one is substituted, but from their comment, it would appear that this was general rather than exceptional.

They speak of certain transformers having been installed because there were not transformers of sufficient size in stock . This was an error. It is true that in some sections where we found that we were not securing the amount of business that we expected, we installed smaller transformers until our business grew to a point where it was necessary to re-substitute larger transformers.

On Page 2, under the same subject,- they do not understand our system of distributing nor its principle as contrasted with the old system of extending extremely long heavy copper leads from one transformer. In figuring out the distribution in certain sections of Pasadena, it is more economical in view of the fact that we can secure transformers of extremely low core loss, to use two transformers in exceedingly long blocks, banked with smaller secondary wires connecting the two. The cost of this class of construction is less than thatreferred to above, under our system of construction and further, the regulation of the two transformers in distribution, maintaining an even voltage along the entire line, is much better than when one transformer feeds such exceedingly long sections as referred to here.

I do not consider that we have in use anywehere what would be considered a small size transformer. The smallest size that we have purchased is 2 kilowatt and only 2½% of our transformers are this size . These are used in outlying sections where we only get a few customers for each transformer. In fact, we have left a margin in these for future growth in such sections. Only 18% of our transformers are 3 kilowatt size. I do not consider a 3 kilowatt transformer a small one for residence lighting. 23% of our transformers are 5 kilowatt. This size is standard with us. 56% of our transformer capacity is above 5 kilowatt , hence from these figures, you will readily understand that we do not have as many small transformers as is the impression conveyed by the report under discussion.

Page 1, Part 9, Subject "Discussion of General Conditions." - In referring to the injury received to the frame of No. 3 Generator, the comment is made that its value was not "seriously" imparied. The fact of the matter is that the value is not in any way impaired, as it does not effect the efficiency or operation of the machine one iota. It only cracked the lower half of the frame which was repaired by a large forging which made it as strong or stronger than the balance of the frame.

Page 2 of the same subject, - Reference is made to the cramped condition owing to the lack of room, however, this is not serious.

Page 5, Subject "General" - There has been an error made in the rate; the statement being made that a 6-cent rate was made, whereas 5-cents was the real rate.

Page 6 of the same subject- an error has been made in the amount that the plant is indebted to the City for interest and sinking fund. They put it at $80,000.00 whereas it is $48,012.50 plus a $23,000.00 loan with the exception of the direct tax of $52,332.35.

Page 7 of the same subject - I do not quite understand their criticism concerning bond elections for financing municipal enterprises. This page looks to me as though they had been influenced from outside sources. They do not comprehend the advantage of municipally owned utilities. This also applies to Page 8.

Page 1, Subject "Commendations" - Under the head of "Suggestions" there is an error in the statement that the candle power of the arc lamps is not more than 75% of that which would be obtained on 60 cycle current. The arc lamp regulators were formerly made for 60 cycle operation and we are now operating them at 50 cycle. However, they have been adjusted for 50 cycle work and as long as the volume of current, namely, 6.6 ampere, is maintained with 72 to 73 volts across the arcs of the lamps, they give just the same light as if operated at 60 cycle frequency. Their statement is a serious error.

Page 2, of the same subject - The statement made in the last paragraph is not strictly true as referred to above under the subject of transformers. The young men do not seem to grasp the situation on this point as they should. The conductors are sufficient for the work for which they were planned and as a feeder becomes overloaded, of course, it is reinforced. The distributing system is now taking care of double the number of consumers that it was planned to take care of at the time it was started. Our transformer capacity and distributing system are ample to take care of the present business and would be ample to take care of the entire City with some re-arrangement of transformers and of course, some additional transformer capacity and the re-inforcing of certain feeders. That is to say, the expense of taking care of the entire City would not be anywhere near, in proportion, to the expense of taking on our present load.

Under the head of depreciation, they get some of their charges and percentages too high and I believe some too low. For instance, Item 8 Cooling Tower, depreciation 25% This has been in service four years and according to their percentage there would be nothing left of it, however, I consider that it is good for at least 8 or 10 years total life, unless it becomes inadequate. 10% would have been a fair allowance for this item. #9 Pipe and Fittings, I consider this too high, also #16 and #25. A number of the items of depreciation, I consider correct. The average depreciation on our entire system should not exceed 5% and if the entire equipment was carefully listed, it should not overrun the above amount.

In all seriousness, I would suggest that you should not give this to the papers for publication for the following reason: While the young men who made the report were in search of information and took matters as they viewed them and no doubt they received some coaching from outside, as in their search for information they would naturally ask questions of other companies in this vacinity and those who would not be in sympathy with municipal ownership of public utilities and while their criticisms were made in good faith, if published they would be snapped up by the Southern California Edison Company and used against the plant. They would publish these criticisms in magazines as they did a remark which Mr. Early made sometime ago in Los Angeles and as they do with any remark that is made which will give them a leverage or a missile which they can throw at Pasadena's Municipal Lighting Works Department.

Yours respectfully,

C. W. Koiner,

General Manager Municipal Lighting Works Department.

K/C.

OVERSIZE DRAWING

SEE SUPP. FICHE

FLASH CARD