ELECTRIC TRACTION

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New Power Station for Columbus System

Interesting Features of Walnut Power Station of Columbus Railway, Power & Light Company Made Necessary By Increase in Railway and Industrial Load

The Columbus Railway, Power & Light Company, as the name might indicate, operates the street cars and supplies light and power for the city of Columbus, Ohio, and its surrounding suburbs and nearby villages This company has quite a number of old power stations, some of which are becoming inoperative due to one reason or another. The company still owns the site and buildings that were used for the first commercial generating station built in Columbus, and the first Edison station started nearly 30 years is still in operating shape and used considerably at times. For a number of years the company has had plans under consideration for new power plant equipment, and in the last two years this problem became extremely active due to the large increase in the industrial load, and also due to the necessity of securing more economical operation.

The growth of the company has been very rapid during the last few years due to the fact that the city has had a very healthy growth along industrial lines. From a small beginning when electric energy was in demand principally for the operation of street cars and for lighting purposes, electric energy is now in demand for the most varied purposes and is necessary for practically all manufacturing plants.

The company furnishes power for the operation of a number of the steam railroad repair shops, for the operation of interurban cars within the city limits and to some extent to the interurbans outside of the city. In addition to this the company also furnishes light and power to all the villages within a radius of approximately 15 miles from the center of the city, and the demand is such that the territory served could be greatly increased if the power was available. The company at the present time is supplying considerable power to Camp Sherman, the National Army Camp at Chillicothe, also to the cities of Chillicothe and Circleville located about 50 miles south of Columbus.

Location of Station

Due to the scarcity and quality of water for condensing purposes, and also to the lack of space for coal storage, it was considered desirable to find a site for a new power station outside of the city. The site chosen is 10 miles southeast of the center of the city at a point where the Hocking Valley Railway crosses Big Walnut Creek. This site consists of 25 acres of rolling ground on the east bank of Walnut Creek, with the railroad running through about the center of the property. The accompanying map of the property shows the location of the plant and the railroad tracks for coal storage purposes and proposed operators' houses. Big Walnut Creek is formed by three small streams—Walnut, Black Lick and Alum Creek, which come together about a mile above the site of this plant. There are approximately 500 sq. mi. in the water shed of Big Walnut above the plant site. There is a natural pool in the creek at the station varying in depth at low water from 15 to 20 ft.

The plant is located on the north half of the property, the low ground of this part being used for coal storage and the other part for houses for the operators and coal storage. It will be the policy of the company to carry sufficient coal in storage, when it can be obtained, to run the plant for three or four months at a time.

The site for Walnut Station was purchased in January, 1917. Active work began in April and the station began regular operation November 18, 1917. This was accomplished in spite of delays in nearly all shipments of equipment and in the midst of a very difficult labor market.

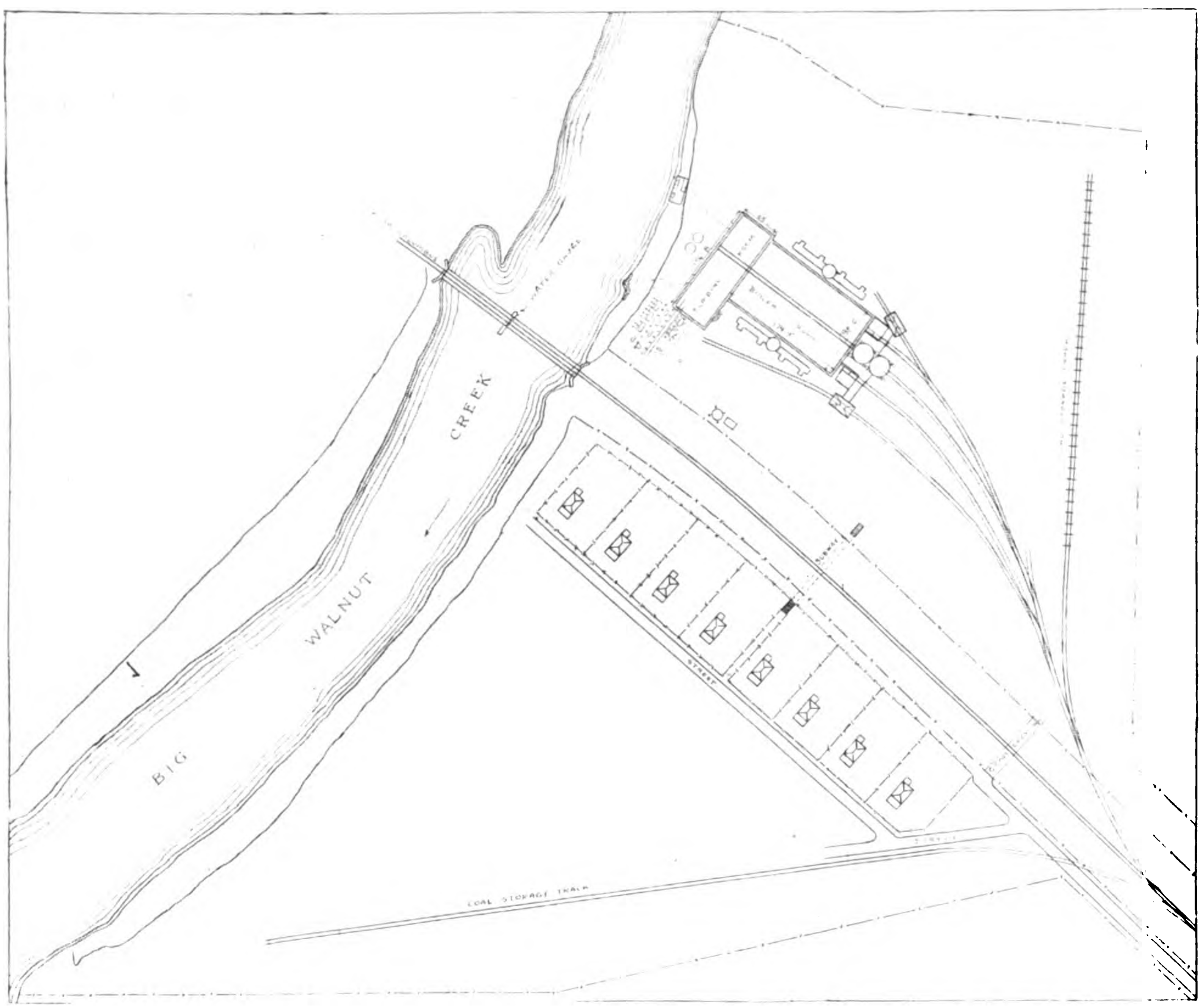
Generating and Distributing Equipment

That part of the station now in operation consists principally of one 18,750-kva. General Electric, 60-cycle turbine and eight Babcock & Wilcox 440-hp. boilers provided with Riley underfeed stokers. The plans include a second turbine, capacity 12,500 kva. and eight additional boilers. This equipment is under order and it is expected that it will be ready for installation in the early part of 1918.

Since the station is located about 10 miles from the center of distribution of the current in Columbus, it was thought desirable to transmit at a higher voltagé than that generated. Therefore, the current will be carried into the city over three transmission line circuits at 39,400 volts, and one 13,200-volt circuit, the latter being the generating voltage, which will feed an industrial section at the extreme south end of the city. The electrical energy will be received at 39,400 volts at one point in the city at the present time and at second and third points later on. Current will be distributed in the city between substations and to large power customers at 13,200 volts, the primary voltage for all other light and power customers is 4,150 volts, four-wire distribution. The tie lines between the principal substations of the city will operate at 13,200 volts and consist of triple conductor lead encased cables laid in vitrified clay duct subways.

The current will be transformed from 13,200 to 39,400 volts at the power station by means of 15,000-kva., 3-phase, 60-cycle, water-cooled, outdoor-type General Electric transformers. Two units will be installed this year and a third transformer at a later date. All switches for the 13,200-volt transformers and main generators will be located within the station, but all of the 39,400-volt switches, lightning arresters and connections will be located outside of the station. Provision is made for taking the transformers in the station on a truck so that they can be placed under the electrical traveling crane for disassembly for any repairs and also for the original erection.

The generators are connected to the 13,200-volt bus through General Electric type H-3 oil switches and a transfer bus is provided with a transfer switch so that any 13,200-volt switch with its instrument transformers may be cut out of service and worked on when necessary without interrupting service. All feeders and other circuits are provided with the same type of oil switch and all of them are remote controlled from the switchboard. All of the turbine controls are also located at the switchboard.

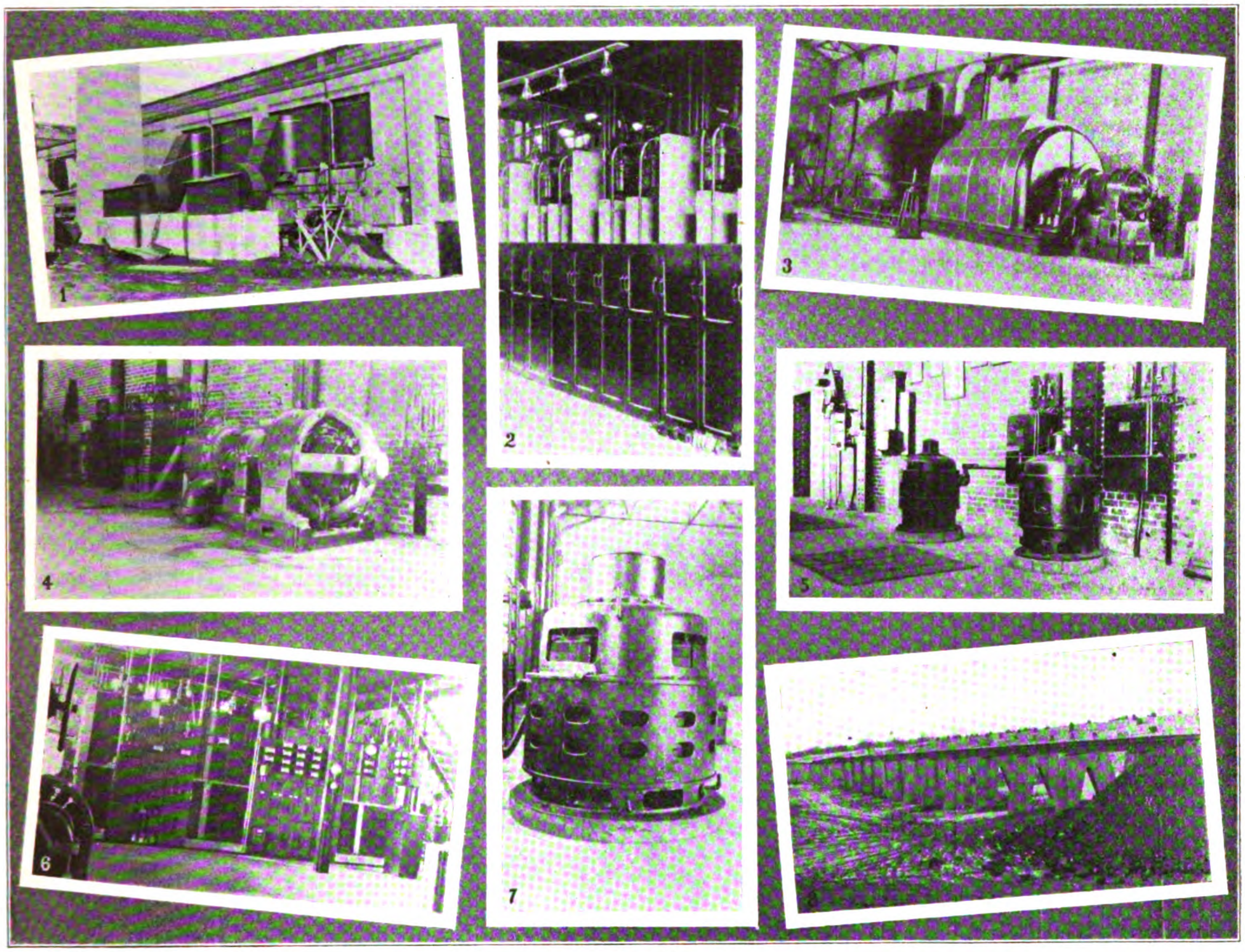


Property Map Showing General Arrangement of Tracks and Location of Plant, Coal Storage qnd Operators' Houses.

All of the auxiliaries in the station will be electrically operated with the exception of one boiler feed pump and two dry vacuum pumps. The current for supplying these motor-driven auxiliaries will be supplied by two duplicate banks of three 300-kva. single-phase, 13,200-volt to 220-volt, outdoor-type, self-cooled transformers. The total connected load of motors for auxiliaries in the station will amount to 2533 hp.

Each turbine is provided with a direct-connected, 100-kw., 250-volt exciter, and a 100-kw., 3600-rpm., geared turbo exciter set is provided for spare service.

The plant is laid out with the idea of having all equipment that requires attention on the main floor level, this applying to the switchboard, turbines, motors for driving circulating water pumps and hotwell pumps, controllers for all forced draft, induced draft and stoker drives, battery charging set, etc. Therefore, there will be as small occasion as possible for the operators leaving the main floor.



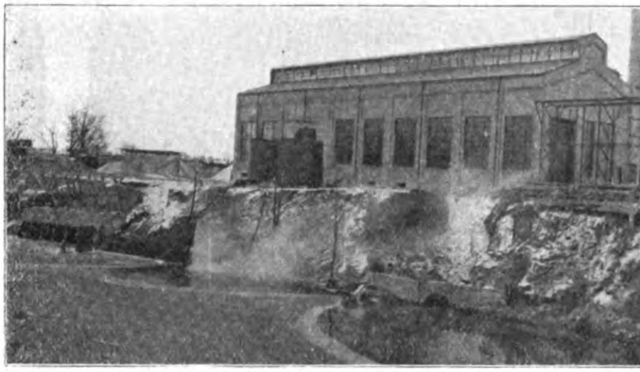
1. Showing Induced Draft Fans for Boilers 1 and 4, and Openings in Walls for Economizers. 2. Showing Detailed View of Portion of 13,200-volt Switch Cells, Showing Location of Potential Transformers, Disconnecting Switches are Located Just Back of Removable Doors. 3. View of Turbine Showing Generator at End with Direct Connected Exciter, Main Steam Pipe for Turbine. The Large Valve in the Foreground is in the Discharge Circulating Water Line from Condenser. 4. Showing 100-kw. Turbo Exciter Set. 5. 120-hp. Vertical, Variable Speed, 220-volt, 3-Phase, a. c. Motor for Driving one of the Circulating Water Pumps. 6. General View of Switch Board Panels and Bus Structure; the Panels at the Left are for Control of the Exciter, Panels in the Center are for Control of Outgoing Lines and Pedestal at the Right Controls Turbine. 7. 35-hp.,220-Volt, 3-Phase, a. c., Vertical, Constant Speed Motors with Controllers for Driving Condensate Pumps. 8. Coal Storage Track. This Track Showing Elevated Steel Support Track Mounted on Concrete Piers. The Coal at the Right is Frozen Slack.

View in Walnut Creek Power Station of Columbus Railway, Power & Light Company.

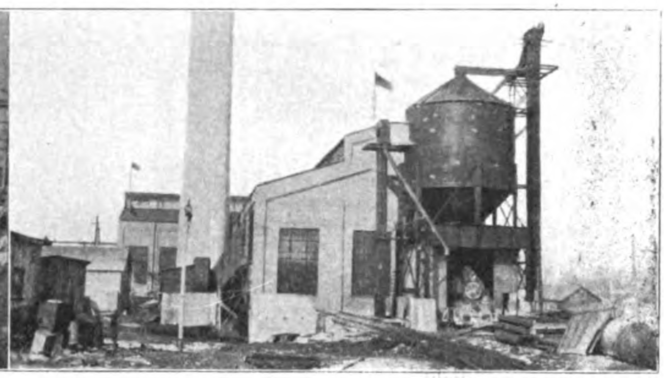
Each turbine is provided with surface condenser and each condenser will be supplied with circulating water by duplicate, vertical, variable speed, motor driven, circulating water pumps. These pumps receive water from a gravity tunnel which runs under the entire length of the turbine room and the water from the condensers discharges into another separate gravity tunnel which also runs the full length of the turbine room and which carries the water out into the river at a point about 160 ft. below the intake. Each condenser is also provided with duplicate vertical motor driven, single stage, centrifugal condensate water pumps. Therefore, by the supplying of these duplicate sets of circulating water and hotwell pumps it is possible to avoid many reasons for shut-down.

The circulating water being carried into the station by a concrete tunnel and in turn being carried out by the same means, eliminates the usual large amount of piping required for circulating water, and also supplies the water at a convenient point with minimum waste of power. The water in the tunnel will have a velocity of about 2 ft. per second with two turbines carrying full load, and about 3.1 ft. per second with 40,000-kw. turbine capacity in operation. The discharge water lines from the condensers are sealed in the discharge tunnel so that advantage is taken of the syphon action obtained thereby.

The intake end of the tunnel is enlarged and provided with a large area of racks (velocity through racks .5 ft. per second first two units, and .8 ft. per second for 40,000-kw. of turbines in operation) for the water to flow through. There are also provided six large removable wire baskets (1-in. mesh), which should catch nearly all leaves, twigs, etc., which may come down stream during high water. Each basket is in a separate compartment provided with a gate for shutting off the flow of water when the basket is raised for cleaning. A traveling hoist is provided for operating gates and baskets. Such particles of leaves, twigs, etc., as pass through these baskets and racks can be removed before reaching the condenser by means of twin strainers (3/8-in. holes), which are located between the circulating water pumps and the condensers. The circulating water pumps are located immediately on top of the intake tunnel so that a minimum suction lift of about 11 ft. is secured.



View of Walnut Creek Power Station from River Side Showing Intake and Discharge Water Funnels, Feed Water Purifying Plant and Portion of Outdoor 39,400-Volt Bus Structure.



General View of Walnut Creek Power Station from Boiler Room Showing Coal and Ash Handling Equipment, Induced Draft Fans and Concrete Stack.

A battery of four 200-gal. per min. motor-driven, centrifugal pumps is located in the basement of the turbine room for furnishing water to the feed water purification plant, for the cooling of bearings and for the 15,000-kva. transformers.

The condenser of the 18,750-kva. unit is bolted direct to the exhaust flange of the turbine without any expansion joint. Car springs are placed below the condenser and so compressed as to balance the weight of the empty condenser. These springs will allow the condenser to expand when heated and the turbine is capable of taking the additional weight of the water which may be in the condenser during regular operation.

The condensate from the condenser is forced by the centrifugal pumps to the top of the boiler room where the water will flow through water meters into an open storage tank. This tank is divided into two compartments, one compartment with a capacity of 6000 gal. for condensate, and one compartment with a capacity of 3000 gal. for make-up water. The water from this storage tank will flow through an open feed water heater having 1300 sq. ft. of heating surface. The feed water heater is divided in two parts; the condensate will pass over one-third of the heating surface and the make-up water over two-thirds of the heating surface. From the heater the water will pass through a battery of four 400-gal. per min. four-stage, centrifugal boiler feed pumps, three of these pumps being driven by 100-hp., 3-phase, 60-cycle, 220-volt, 1740-rpm. motors, and the fourth by a Curtis steam turbine, 1850 rpm. The pumps will discharge direct into headers supplying the economizers, the economizers carrying full boiler pressure, plus the additional pressure required for forcing the water through the economizer to the boilers.

Boiler Room Equipment

The boiler plant will consist of 16 Babcock & Wilcox cross drum water tube boilers, each having a heating surface of 4440 sq. ft. Each boiler has 21 sections of tubes, each section consisting of 10 tubes 18 ft. long and 4 in. in diameter. Single loop superheaters are also provided having 855 sq. ft. heating surface which will give about 150 deg. superheat under average conditions. These boilers are designed for 250-lb. steam pressure and are provided with mechanical soot blowers, feed water regulators, balanced draft regulators for opening the outlet dampers and with furnace meters which record the steam flow, air flow through boilers and the temperature of the exhaust gases, and also indicate the draft under the stokers.

The boilers are set two in a battery and each boiler is provided with one eight-retort Sanford Riley underfeed stoker. The gases from each battery of boilers pass through one fuel economizer having 6300 sq. ft. of heating surface, each economizer having 32 sections, each section consisting of 12 tubes, 12 ft. long, 4 5/8 in. outside diameter. The gases are conveyed from boiler to economizer by means of 5/16-in. steel plate flues covered with 1½ in. of asbestos. The gases from each economizer are in turn conveyed from the economizer by uncovered steel breechings to one 60,000-c. f. m. induced draft fan. These fans are direct connected to 75-hp. variable speed Lincoln motors. The fans discharge downward into a concrete flue located below grade, which connects into the base of a tapered concrete chimney having a height of 150 ft. and inside diameter at top of 14 ft. 6 in. There will be two of these chimneys provided, one chimney accommodating four fans and eight boilers. The economizers are provided with the usual scraper mechanism, and one 5-hp., 720-rpm. motor drives the scrapers on two economizers.

It should be noted that the boilers are arranged in units of two boilers, one economizer, two stokers, one induced draft fan, one forced draft fan, and that no by-passes are provided for the economizer. It is expected to operate this unit continuously and when necessary to make extensive repairs to shut down the entire unit. Of course, either one of the boilers may be shut down for cleaning without disturbing the operation of the other. The stoker, forced draft fan and induced draft fan are all driven by motors, the controllers for which are located conveniently to the boilers and are under the control of the boiler room operators.

The balanced draft equipment will provide the close regulation of the induced draft, and the large steps in the adjustment of this draft are obtained by the variable speed motors which are hand controlled. The forced draft is also hand regulated by varying the speed of the motors and by the movement of the dampers in the air ducts.

The steam from the boilers will be carried through 6-in. steam lines to a main 12-in. steam header. Each row of eight boilers will be provided with a 12-in. steam header, the two headers being connected together at each end so as to form a complete ring. In the same way the feed water will be supplied to the boilers from a 6-in. feed water header for each row of boilers, and the feed water headers will be connected across so as to form a complete loop.

The economizers are operated in parallel and feed direct into the feed water header, and to avoid unequal feeding from economizers there are Monel metal orifices in the feed water header between the connections to the economizers. As for the fine adjustment of the feed to the economizers it is expected to obtain this by regulating the opening of the valves in the connections between the economizers and header, determining the adjustment of these valves by the temperature of the feed water leaving the economizers, as shown by recording thermometers. In addition to the recording furnace meters, there are recording thermometers for the gases leaving the economizers and for the water entering and leaving the economizers and also for the water entering the feed water heater.

The equipment for handling the coal and ash is very complete. The station will be provided, when completed, with two 400-ton coal bunkers located just outside of the boiler room at the end of the station. Coal will be supplied to these bunkers from two track hoppers, the coal passing from the track hoppers by means of a flight conveyor through a coal crusher and thence by bucket elevator to the top of the coal bunkers. The coal from the bunkers will be carried into the boiler room by means of a 4½-ton electric traveling larry, which travels on a standard gage railroad track laid flush with the boiler room floor.

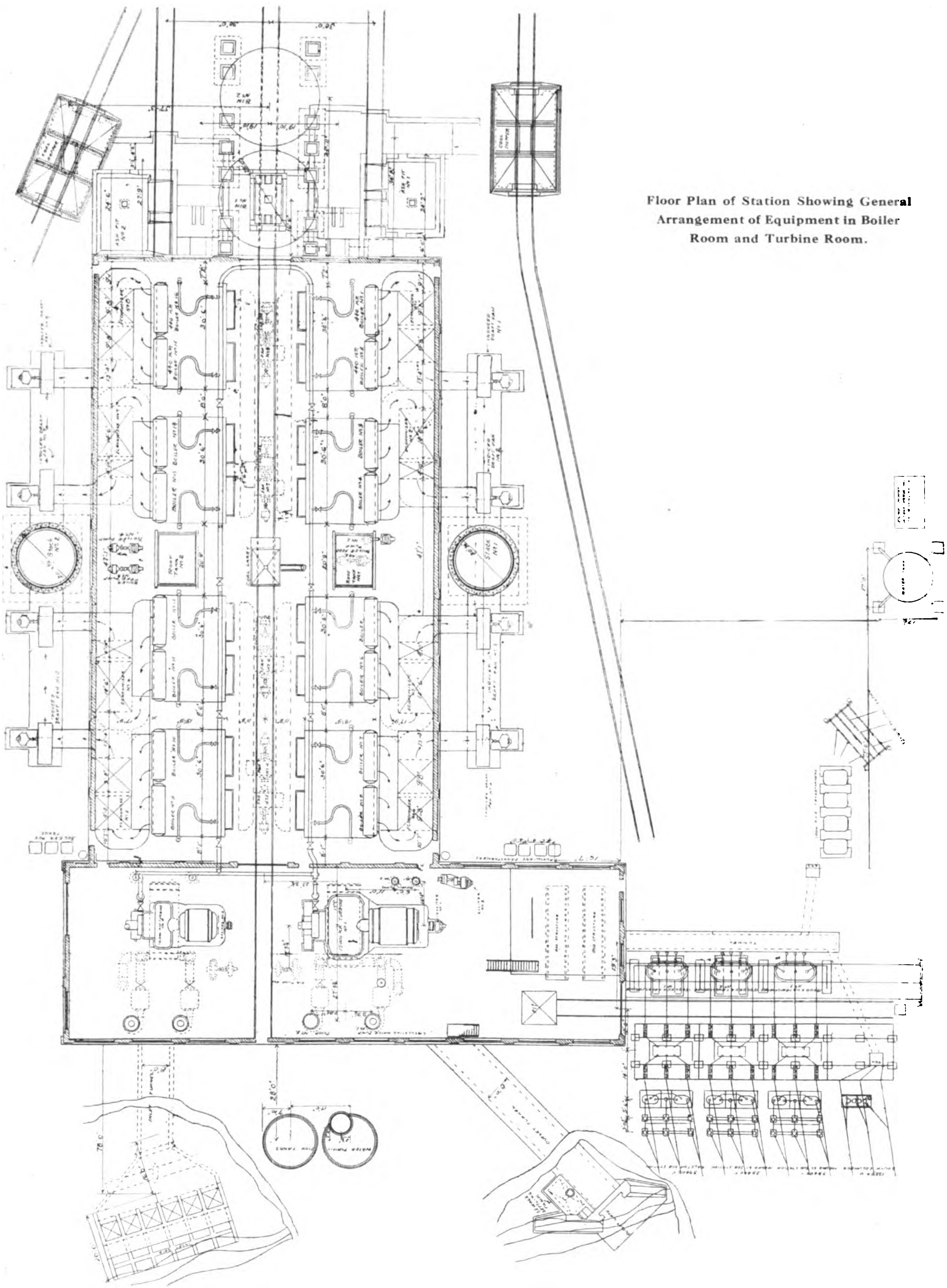
Track scales are provided immediately under one of the coal bunkers so that all coal can be accurately weighed as it is carried into the station. This arrangement will permit the keeping of accurate records of all coal used for the entire station or for any one boiler over any particular period. The larry is electrically operated, has a revolving bin which works like a turret, and is provided with screw conveyor which supplies the boilers on either side of the firing aisle. The larry requires only one man for its operation, is simple in construction and all wearing parts are very accessible for repairs.

The foundations for the boilers are of concrete and form the ash pits. Two drag chain conveyors pass under each row of eight boilers, conveying the ash out to the end of the station and discharging into a clinker crusher which in turn discharges into the boot of a bucket elevator. This elevator may discharge either into a concrete ash pit or railroad car or wagon. The ash can be disposed of for a long time by grading around the property. Each drag chain conveyor has sufficient capacity for carrying out the ash and duplicate conveyors are furnished so as to allow repairs and changes to be made without inconvenience to operation, as arrangements are made so that either one can be isolated for repairs without interfering with the other.

The coal bunkers have a capacity sufficient for one to two days' operation of the station. To provide against car shortage and irregularity of shipments an elevated storage track is provided, a track 480 ft. in length being elevated approximately 15 ft. over low ground. Since practically all the coal received is in hopper bottom cars of one type or another no labor will be required for unloading the cars. This track is supported by reinforced concrete piers, 14-ft. centers, and supported between piers by steel I-beams with steel cross members, on 5-ft. centers, to prevent spreading.

The coal will be distributed over the ground and reloaded into cars for moving into the station by means of a 15-ton steam driven locomotive crane, provided with 2-yd. grab bucket.

For supplying the make-up water for boilers, that is, water over and above that secured from the surface condensers, a lime and soda ash feed water purifying plant is installed.



Floor Plan of Station Showing General Arrangement of Equipment in Boiler Room and Turbine Room.

This plant consists principally of two 20,000-gal. wood stave tanks with stirring mechanism, and an elevated dosing tank. The river water is of fairly good quality except during high water when it may be quite roily.

Station Building

The main building is a steel frame structure supported on a reinforced concrete foundation. The turbine room now completed for two turbines is 156 ft. 6 in. in length and 44 ft. 1 in. in width, is provided with a 35-ton electric traveling crane having a rail height of 25 ft. above the main floor. The turbine room basement is 15 ft. high from floor to floor except under condensers where the height is 20 ft. The boiler room, now completed, is 174 ft. in length and 60 ft. in width, and will be 174 ft. in length and 96 ft. 2 in. wide when completed for 16 boilers. The height under the lower chord of the roof trusses is 30 ft. 6 in. The basement under the boiler room is 10 ft. 6 in. floor to floor.

The outside walls are built of hard burned red brick and the partition and temporary end walls of turbine room are built of interlocking tile. Steel sash, glazed with factory ribbed glass, are used throughout the building. Steel rolling doors are used for large doorways and steel panelled doors are used on all small doorways.

The roofs are supported by Fink trusses, 1/6 pitch, provided with monitors, ventilation being secured by opening sections of the steel sash by means of suitable window operating mechanism. The roof for the boiler room consists of a concrete slab water-proofed with three-ply asbestos felt laid in asphalt. The turbine room roof is similar except that a slab made up of a composition of gypsum and wood fibre is used, this construction being resorted to in order to avoid possibility of condensation forming on the under side of the roof. The concrete slabs for roof and floors are supported by asbestos protected corrugated metal with reinforcing fabric. The slabs are flat in both cases, being 2 1/4 in. thick for the roof and 4 in. thick for the floor.

The foundations for walls and equipment are supported on reinforced mats or footings which rest on hard river gravel or clay hard pan, the character of earth varying according to the elevation of the various foundations. Extensive soundings and test pits were driven to determine the nature of underlying earth previous to starting construction. A test pile was also driven in the deepest portion of the excavation.

By means of the various meters, scales, recording instruments, etc., that are provided, it will be possible to keep an accurate record of the coal used, steam generated and the electrical output of the station both net and gross, for any period of a day, for each day and for the entire month and year. This will allow the station records to be entirely complete with unit costs and with a minimum expenditure for complicated measuring instruments.

The stoker company guaranteed that the furnaces will be amply sufficient to give a maximum rating of 340% of the commercial rating of the boilers, and the turbines are guaranteed for a water rate of 11.35 and 11.50 lb. per kw. hr. for the larger and smaller units respectively, under best conditions.

Summary of Station Features

The notable features of this station are briefly summed up as follows:

This is the first station that has supplied electrical power to Columbus from outside the city, up to this time all electrical power having been generated by plants located within the corporation limits.

The boilers are of the Babcock & Wilcox cross drum type, 10 tubes high and carry 250 lb. pressure and are arranged with economizers, one economizer having approximately 71% as much heating surface as two boilers. Each boiler being provided with one eight-retort Sanford Riley underfeed stoker gives a unit which is capable of turning out a maximum of 340% of its nominal rating, or a battery of boilers has a maximum capacity of 3000 hp., that is, the station may generate roughly 7 kw. per rated boiler horsepower.

Each economizer is arranged for two boilers without by-passes and with the access tubes and blow-off of the economizer on the outside of the building. The brick wall of the building is also omitted opposite the economizer and asbestos sectional covers are used for covering this side of the economizer. The removal of this covering allows the sections to be taken out for replacement. This arrangement is used to economize floor space and make the economizers easily inspected and repaired.

All the steam piping is provided with steel flanges and Vanstone joints, and welded nozzles are used wherever possible to eliminate joints and to make piping compact.

Complete coal and ash handling equipment is provided, the coal being handled with minimum use of conveyors. By means of the electric traveling larry the coal is delivered from the bunkers to the stoker hoppers without the use of conveyors, and this also provides a means of keeping accurate records of the weight of coal used. The coal is discharged from the cars into a track hopper and all passes through a coal crusher making the station independent as to size of coal which may be purchased.

The ash is removed by the use of duplicate drag chain conveyors, there being no labor required to deliver the ash to the drag chains. A clinker crusher is provided so that the ash, whether fine or coarse, is automatically taken care of.

It is worth special mention that there is no reciprocating apparatus in the station, all equipment being rotating. There will be only three steam auxiliaries, these being one steam turbine driven feed pump and two steam driven dry vacuum pumps. All other auxiliary equipment is driven by induction motors, the majority of which are arranged with variable speed control. Also every motor or turbine has a flexible coupling, this including the generating units.

Very little space is required within the station for the electrical equipment. The control part is compact and only the 13,200-volt switches are within the station. All transformers, high voltage bus structure, main line switches and lightning arresters are located outdoors, but any of this equipment can be cut out of service and transported into the station for inspection and repairs, thus securing all the advantages of the outdoor type of electrical equipment with minimum disadvantages.

In providing spare equipment the idea has been to make each spare unit complete so that it can be regularly operated. For example, duplicate circulating pumps are provided, either one available for immediate service, the same being true of condensate pumps.

For the foregoing information and accompanying illustrations we are indebted to the E. W. Clark & Co. Management Corporation, who designed and constructed Walnut Station.

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HOW THE RAILROAD TANGLE MAY BE UNRAVELED

Theodore P. Shonts, President of the Interborough Rapid Transit Company of New York, addressing the Detroit, Michigan, Board of Commerce, said in part:

"As a possible solution of the national problem with which our country is struggling—Shall we return to old railroad conditions after the war?—I suggest a partnership between the government and the railroads, something like the partnership that has been formed in New York City by the City and the rapid transit lines for the construction and operation of the city's new dual rapid transit system.

The interests of the country, with its need for greatly enlarged and extended railroad facilities, and the interests of investors are so interwoven that the financial responsibility should likewise be interwoven. This doctrine underlies the principles embodied in the contract for New York's new dual rapid transit system, probably the first place such a plan has been attempted to any degree of magnitude.

When the Dual System is completed there will have been expended in new development upon rapid transit lines in New York City since 1900 about $441,000,000—an amount almost equal to the capital stock of the Pennsylvania Railroad Company. Of this, $219,000,000 will be private capital. The system will have cost more than the Panama Canal.

* * *

In order that the amount to be provided by the private corporations could be obtained upon fairly easy terms from the money market, it was arranged that the securities representing the interest of the City of New York should be junior to the private investment.

* * *

Let us consider this railroad problem in the same way the Dual System problem was considered, using the same terms for each. Treat this three-year average, which the government grants, as a preferential subject to such readjustment in individual cases as is necessary to be fair; and then let the government supply the money necessary for all the improvements made after June 30, 1917; and, because of its many and different benefits, treat that as a junior lien on the property.

If, when the war is over, it is thought wise to continue this partnership relationship in developing new transportation lines, or adding to facilities on existing lines, both as to construction and equipment, let private capital contribute in the proportion that will insure a fair return out of transportation earnings—to be treated as a preferential payment—the government to furnish the remainder, and the government again, because of its many and indirect benefits, to treat its contribution as a junior lien to be paid out of earnings, and after the government has been made whole then a division of earnings on the basis of the proportion that private capital bears to government capital in each proposition.

* * *

Our steam railroads failed us, not because of inefficiency, but of inadequacy.

Are we to experience the same with our street railways? The public has cause for real concern lest this happens.

Extensions of existing lines and the development of new street railways in this country have practically ceased. And, what is of even more serious consequence, the railways are finding greater and greater difficulty in getting revenues sufficient for improved service and more economic equipment as developed and demanded by the public.

The street railway industry has been peculiar in the extraordinary rapidity with which the mechanical art underlying it has developed. It was only a few years ago that horse cars were very widely used. Then came the cable car, then the overhead trolley, then the underground trolley. All the time each one of these forms of transportation was being subjected to great improvements, the use of which by the companies had been more and more insisted upon by public opinion.

Probably no other factor has contributed more to the comfort and convenience of American life than the street railway. And it is desirable that this development go on.

* * *

It is all the more important now that our utilities be prepared for any load they may be called on to carry to help win the war. Their efficient operation is as necessary for the safe economic condition of the country as any other factor which contributes to the backbone and support of all nations at war. Workmen must be carried to and from work in munition plants and other activities just as necessary to win the war, but less conspicuous. The daily home and business life must go on in a regular, orderly way.