New Power Source for Columbus (Ohio) Railways

Station Has Large Units for Size of Community Served and Is Located Without Regard for Load Center—Most of Electrical Equipment Out of Doors—No Reciprocating Units Installed

THE Columbus Railway, Power & Light Company, Columbus, Ohio, has completed for operation the first part of its new Walnut power station, located on the east bank of Walnut Creek, about 10 miles southeast of the center of the city. This company operates the city railway system in Columbus, supplies light and power to the city and surrounding villages within a radius of 15 miles, and supplies power to some extent to the interurbans entering the city. It also furnishes considerable energy at the present time to Camp Sherman and the national army camp at Chillicothe, and also to the cities of Chillicothe and Circleville, about 50 miles south of Columbus.

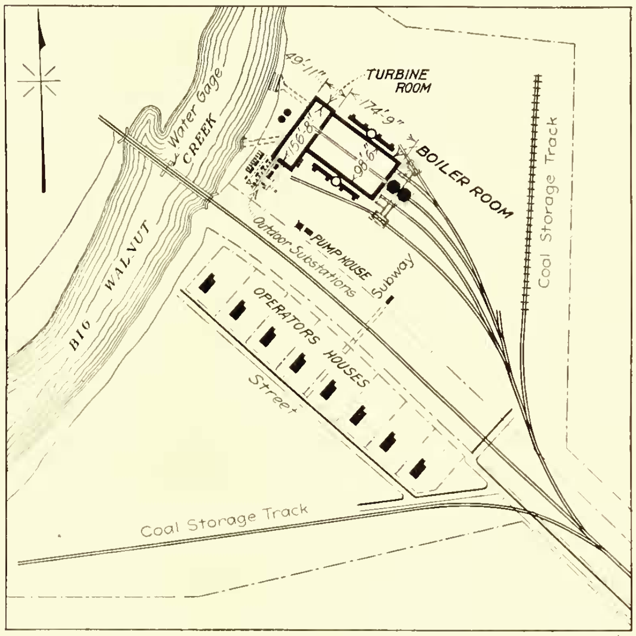


FIG. 1—PROPERTY MAP OF COLUMBUS RAILWAY, POWER & LIGHT COMPANY'S WALNUT STEAM STATION

The company has several old power stations, some of which are becoming inoperative, and all of which are located within the city limits. The new steam station became necessary owing to the large increase in the industrial load, and to the necessity of securing more economical operation. Due to the lack of suitable water for condenser purposes and of space for coal storage, a site outside of the city was selected, determined by the natural resources rather than the density of population.

Walnut Creek has a water shed above the plant site of approximately 500 square miles, and a natural pool at the station varying in depth at low water from 15 to 20 ft. The Hocking Valley Railroad runs approximately through the middle of the 25-acre property on which, in addition to the plant, will be built operators' houses and a large coal storage system. When coal is obtainable three or four months' supply will be carried in storage.

The generating equipment now in operation consists of one 18,750-kva., General Electric, 60-cycle turbo-alternator. The plans include a second turbine unit of 12,500-kva. capacity. Eight Babcock & Wilcox 440-hp. boilers are now installed, and eight more will be added later. The future equipment is under order and is expected to be ready for installation the early part of this year. Energy is generated at 13,200 volts and is transmitted over three 39,400-volt transmission lines, and one 13,200-volt circuit, which feeds an industrial section at the extreme south end of the city.

The plant is laid out with the intention of having all equipment that requires attention on the main floor level. This applies to the switchboard, turbines, motors for driving circulating water pumps and hot-well pumps, controllers for all forced-draft, induced-draft and stoker drives, battery-charging sets, etc., giving little occasion for operators to leave the main floor for any length of time.

A noteworthy feature of the plant is that no reciprocating apparatus is used. The only steam auxiliaries are one steam turbine-driven feed pump and two steam-driven dry vacuum pumps. All other auxiliary equip-

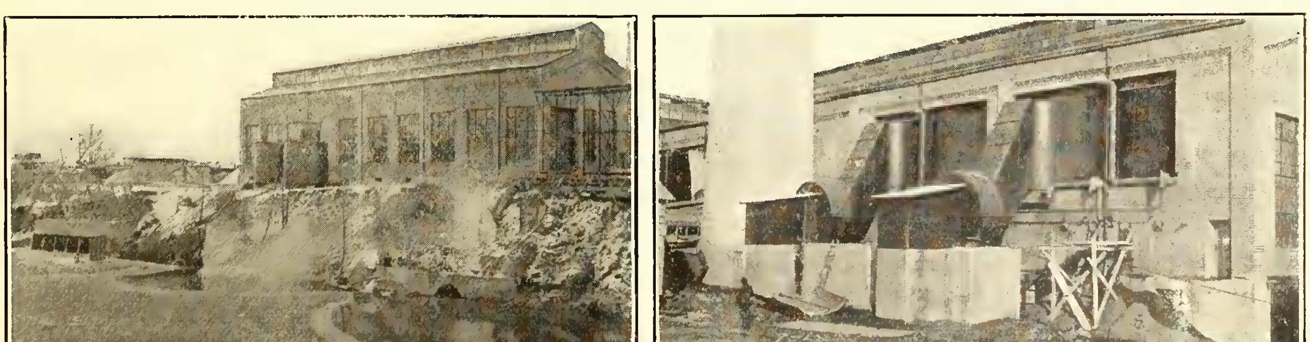


FIG. 2—GENERATING END OF PLANT SHOWING INTAKE AND DISCHARGE TUNNELS AND FEED-WATER PURIFYING PLANT —INDUCED-DRAFT FANS AND WALL OPENINGS FOR ECONOMIZERS

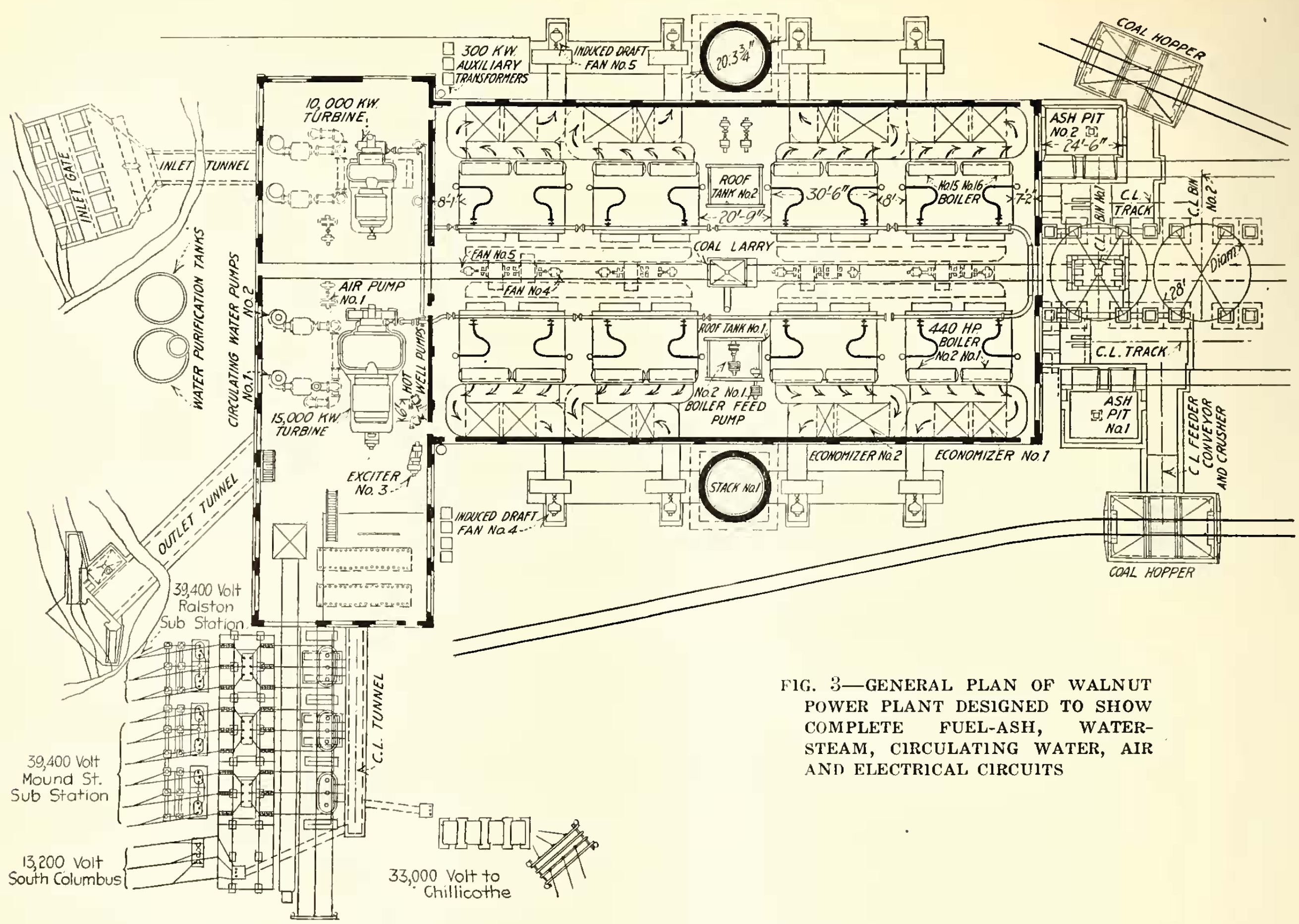


FIG. 3—GENERAL PLAN OF WALNUT POWER PLANT DESIGNED TO SHOW COMPLETE FUEL-ASH, WATER-STEAM, CIRCULATING WATER, AIR AND ELECTRICAL CIRCUITS

ment is driven by induction motors, most of which are provided with variable-speed control. Every motor or turbine, including the generating unit, has a flexible coupling.

Very little space within the station is used for electrical equipment, all transformers, high-voltage bus structures, main-line switches and lightning arresters being located out of doors. Any of this equipment, however, can be cut out of service for inspection and repairs, thus securing all the advantages of the outdoor type of electrical equipment with minimum disadvantage. The control is compact, and only the 13,200-volt switches are within the station.

In providing spare equipment the effort has been to make each unit complete so that it can be regularly operated. For instance, duplicate circulating-water pumps and condensate pumps are provided, the spare unit in either case being available for immediate service. The large alternator is provided with a direct-connected exciter, and a geared turbo-exciter set is installed for spare service.

The boiler plant, as previously stated, will ultimately contain sixteen boilers, each having a heating surface of 4440 sq. ft. These are designed for 250 lb. pressure, and are provided with Diamond mechanical soot blowers, Copes feed-water regulators and balanced-draft regulators. Bailey furnace meters are also used to record steam flow, air flow through boilers, temperature of exhaust gases and draft under stokers. The single-loop superheaters will produce about 150 deg. of superheat under average conditions.

The boilers are set two in a battery and the gases from each battery pass through 5/16-in. steel-plate flues, covered with ½ in. of asbestos, to one Green fuel economizer of 6300 sq. ft. heating surface. The gases from each economizer are in turn conveyed from the economizer through uncovered steel breechings to one 60,000-cu.-ft.-per-minute Green induced-daft fan. The fans discharge downward into a concrete flue, located below grade, which connects with the base of a tapered concrete chimney of 150 ft. height and 14.5 ft. inside diameter at the top. Two such chimneys will be provided, each to accommodate four fans and eight boilers.

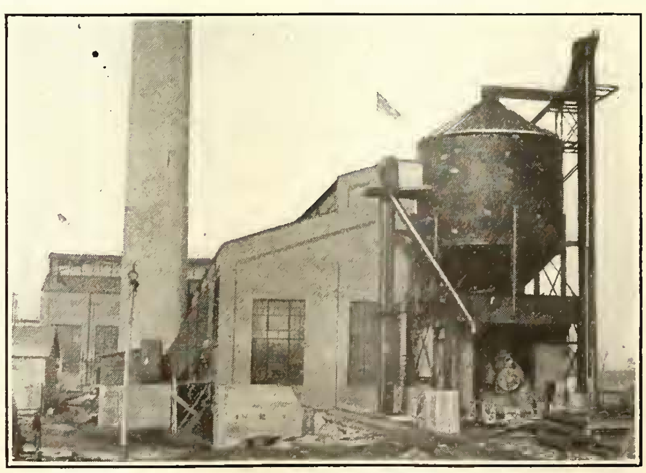


FIG. 4—STEAM END OF PLANT SHOWING COAL AND ASH-HANDLING EQUIPMENT

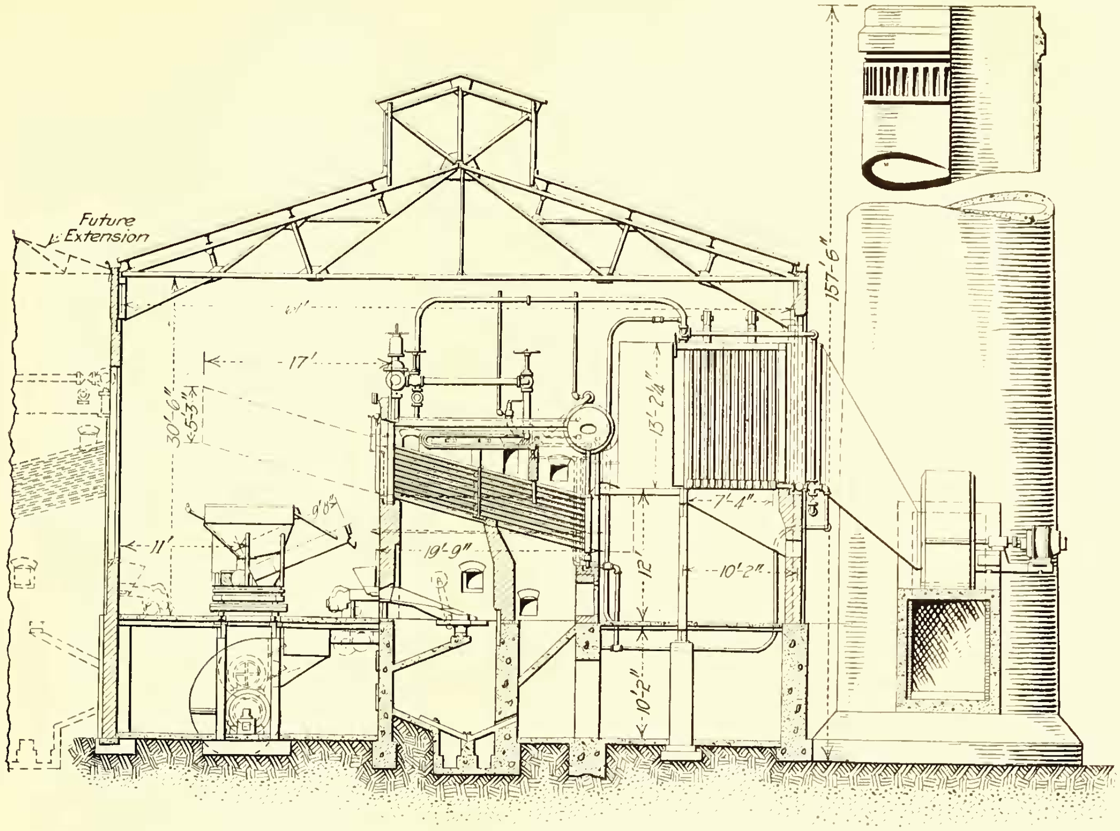


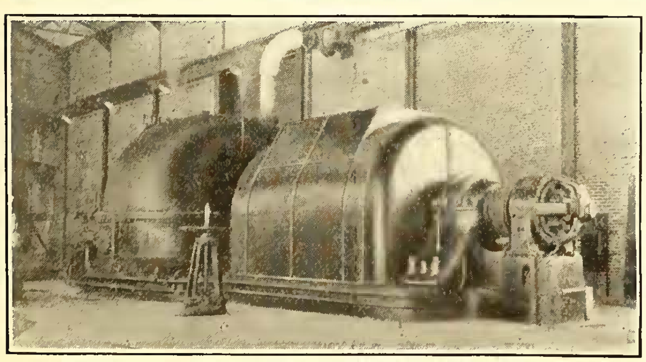
FIG. 5—CROSS-SECTION OF BOILER ROOM SHOWING ARRANGEMENT OF EQUIPMENT AND SCHEME FOR EXTENSION

The turbines are guaranteed for a water rate, under best conditions, of 11.35 lb. per kilowatt-hour on the 18,750-kva. unit, and 11½ lb. on the future 12,500-kva. unit. The steam equipment is arranged in units of two boilers and one economizer, the economizer having approximately 71 per cent as much heating surface as the two boilers. Each boiler is provided with one eight-retort Sanford Riley underfeed stoker. This gives a unit which is capable of turning out a maximum of 340 per cent of its nominal rating, according to guarantees by the stoker company. The battery of boilers therefore has a maximum capacity of 3000 hp., so that the station can generate approximately 7 kw. per rated boiler horsepower.

It should be noted that no by-passes are provided for the economizer, as it is expected to operate each unit of boilers with draft fans continuously. When it is necessary to make extensive repairs an entire unit will be shut down. Either one of the boilers may be shut down for cleaning without disturbing the operation of the other. The economizers are provided with the usual scraper mechanism, one 5-hp. motor driving the scrapers on two economizers. The controllers for the motors driving the draft fans are located near the boilers and are under the control of the boiler-room operators. The balanced-draft equipment provides for 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 is carried through 6-in. steam lines to a main 12-in. steam header for each row of eight boilers. The two headers are connected 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 to form a complete loop.

The economizers are operated in parallel, feeding di-



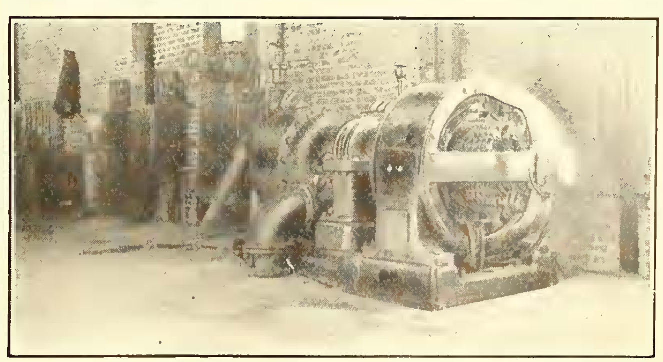


FIG. 6—18,750-KVA. TURBINE SET WITH DIRECT CONNECTED EXCITER—100-KW. TURBO EXCITER SET

rectly into the feed-water header, and to avoid unequal feeding Monel metal orifices are provided in the header between the connections to the economizers. It is expected to obtain fine adjustment of the feed to the economizers by regulating the opening of the valves in the connections between the economizers and the header, determining the adjustment of these valves by the temperature of the feed water leaving the economizers as shown by Bristol recording thermometers. These are supplied for the gases leaving the economizers, for the water entering and leaving the economizers, and for that entering the feed-water heater.

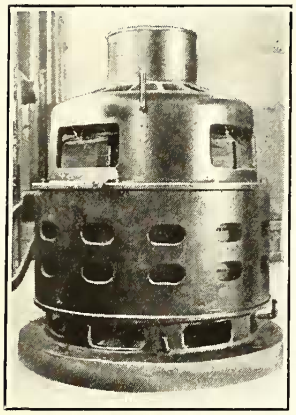


FIG. 7 — 120-HP. VERTICAL VARIABLE-SPEED MOTOR FOR DRIVING CIRCULATING WATER PUMP

The economizer arrangement is such that the access tubes and blow-off are on the outside of the building. Asbestos sectional covers are used over the outside of the economizers, and the opposite brick wall of the building is omitted. This arrangement provides for easy inspection and repairs and saves floor space. All steam piping is provided with steel flanges and Vanstone joints, and welded nozzles are used wherever possible to eliminate joints and to make piping contact.

Coal passes from two track hoppers by means of a flight conveyor through a crusher and thence by bucket elevators to the top of two 400-ton coal bunkers located just outside the boiler room at the end of the station. The coal from the bunkers is carried into the boiler room by means of a 4½-ton traveling larry on a standard-gage track laid flush with the boiler-room floor. The larry is electrically operated, has a revolving bin which works like a turret, and is provided with a screw conveyor which supplies the boilers on either side of the firing aisle. It is operated by one man, is simple in construction and all wearing parts are easily accessible for repairs. Track scales are provided under one of the coal bunkers so that all coal can be weighed as it is taken into the station. This will permit the keeping of an accurate record of coal used by any boiler or for the entire station during any desired period.

To provide against shortage of coal, through lack of cars or irregularity of shipments, an elevated storage track is provided, which is 480 ft. long and elevated approximately 15 ft. above the ground level. The track is carried on reinforced concrete piers, 14 ft. between centers, and is supported between piers by 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 as needed by means of a 15-ton Brownhoist steam-driven locomotive crane equipped with a 2-yd. grab bucket.

The ash pits are formed by the concrete foundations of the boilers. Two drag-chain conveyors pass under each row of eight boilers conveying the ashes out to the end of the station and discharging them into a clinker crusher, which in turn discharges into the boot of a bucket elevator. This elevator can discharge into a concrete ash pit, a railroad car or a wagon. The ashes can be disposed of for a long time in grading around the property. Although each conveyor has sufficient capacity for carrying out the ash, duplicate conveyors are furnished so as to permit repairs or changes without inconvenience to operation.

The circulating water for the Alberger surface condenser under the turbine is supplied by duplicate vertical variable-speed motor-driven pumps. These pumps receive water from a gravity tunnel, which extends under the entire length of the turbine room. The water from the condenser discharges into another gravity tunnel, which also extends under the turbine room and carries the water out into the river at a point about 160 ft. below the intake. Each condenser is provided with duplicate motor-driven single-stage centrifugal condensate pumps. The concrete tunnels under the turbine room eliminate the usual large amount of piping required for circulating water and also conveniently supply the water with a minimum waste of power. The water in the tunnel will have a velocity of 2 ft. per second with the two turbines carrying full load and about 3.1 ft. per second with 40,000 kw. of 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.

The intake end of the tunnel is enlarged and provided with a large area of racks for the water to flow through

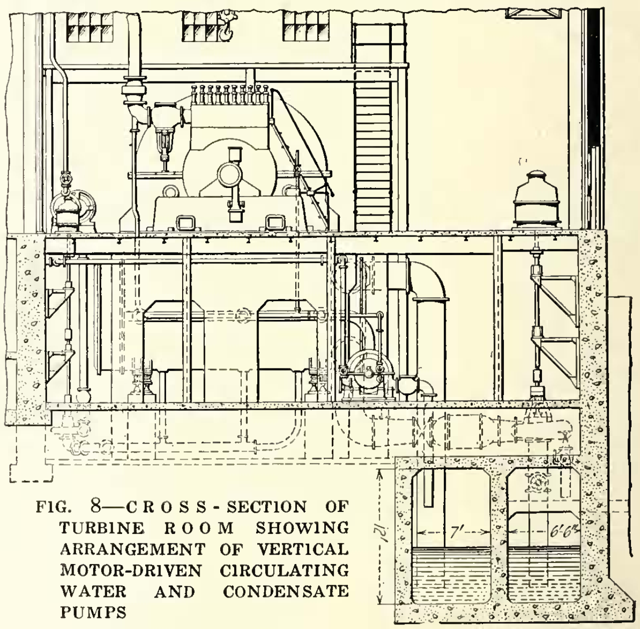


FIG. 8—CROSS-SECTION OF TURBINE ROOM SHOWING ARRANGEMENT OF VERTICAL MOTOR-DRIVEN CIRCULATING WATER AND CONDENSATE PUMPS

The velocity through these racks will be ½ ft. per second for the first two units and 0.8 ft. per second for 40,000-kw. of turbines in operation. There are also provided six large removable wire baskets of 1-in. mesh, designed to catch leaves, twigs, etc., that may come downstream 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 the gates and baskets. Any material that passes through the baskets and racks can be removed before reaching the condenser by means of Elliott twin strainers having ⅜-in. holes and located between the circulating water pumps and the condensers. The circulating water pumps are placed on top of the intake tunnel so that a minimum suction lift of 11 ft. is secured.

The condenser of the unit now installed 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

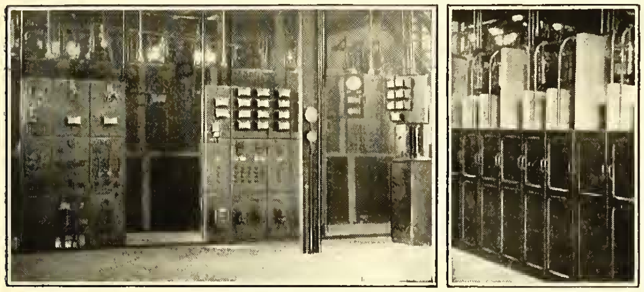


FIG. 9—SWITCHBOARD PANELS AND BUS STRUCTURE—DETAIL VIEW OF 13,200-VOLT SWITCH CELL

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 it flows through water meters into an open storage tank. This tank is divided into two compartments, one with a capacity of 6000 gal. for condensate and the other with a capacity of 3000 gal. for make-up water. The water from the tank flows through a Hoppes open feed-water heater having 1300 sq. ft. of heating surface. The feed-water heater is divided into two parts; the condensate passing over one-third of the heating surface and the make-up water over the remaining two-thirds.

From the heater the water passes through a battery of four 400-gal. per minute four-stage Cameron centrifugal boiler feed pumps. Three of these pumps are motor driven and one is steam driven. The pumps discharge into headers supplying the economizers, which carry full boiler pressure plus the additional pressure required for forcing the water through the economizer to the boilers.

To supply the make-up water for the boilers, that is, water in addition to that secured from the surface condensers, a lime and soda ash feed-water purifying plant is installed. This plant consists essentially 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 riley. A battery of four 200-gal. per minute motor-driven centrifugal pumps is located in the basement of the turbine room for furnishing water to the feed-water purification plant and for cooling bearings and transformers.

MUCH OF THE ELECTRICAL EQUIPMENT PLACED OUT OF DOORS

In general the electrical system is that which is considered modern practice for the potentials at which it operates. The alternator is connected to a 13,200-volt bus through a General Electric, type H3 oil switch. A transfer bus is provided so that any 13,200-volt switch with its instrument transformers can be cut out when necessary without interrupting service. All feeders and other circuits have oil switches of the same type and all of them are remote-controlled from the switchboard. The turbine controls are also located on the switchboard.

Energy is transformed from the generated voltage of 13,200 to 39,400 volts by means of 15,000-kva., three-phase, 60-cycle, water-cooled, outdoor type transformers, two units of which will be installed this year and a third at a later date. All of the 39,400-volt switches, lightning arresters and connections are located outside of the station. Electrical energy for Columbus will be received at 39,400 volts at one point for the present, and at a second and a third point later on, and will be distributed in the city between substations at 13,200 volts. The primary voltage for all other light and power customers is 4150 on a four-wire distribution system. The tie lines between the principal substations of the city operate at 13,200 volts and consist of triple-conductor lead-incased cables laid in vitrified clay duct subways.

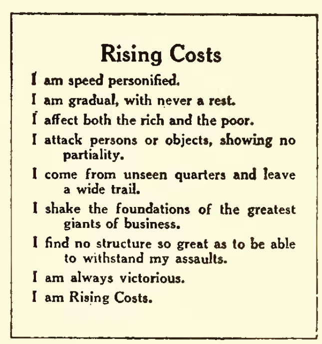
The Walnut station was designed and constructed by the E. W. Clark Management Corporation, through whose courtesy the foregoing illustrations and data were obtained.

Who Put the Nick in the Nickel?

A CURRENT bulletin issued by E. J. Cooney, executive assistant Rhode Island Company, Providence, R. I., in the interest of a 6-cent fare contains a presentation of the "rising costs" question that will undoubtedly be of interest to other railway men. The material is shown by the accompanying illustrations and the following paragraphs:

"For some years past electric railways have been suffering under burdens placed upon them by various municipalities in the form of taxes, etc., until investors have looked upon them as questionable security.

"But the situation became really serious in 1914 when war broke out in Europe, shocking the whole world. As the months passed all lines of business



Rising Costs

I am speed personified.
I am gradual, with never a rest.
I affect both the rich and the poor.
I attack persons or objects, showing no partiality.
I come from unseen quarters and leave a wide trail.
I shake the foundations of the greatest giants of business.
I find no structure so great as to be able to withstand my assaults.
I am always victorious.
I am Rising Costs.

TWO PAGES OF "RISING COST" BULLETIN ISSUED BY RHODE ISLAND COMPANY

became affected by a sturdy youth named 'Rising Costs.' As he grew he stretched out his tentacles and pulled in one commodity after another, until he reached the public service utilities.

"Nothing was too big for him to tackle as he went onward, and the electric railways began to feel the effects of his attacks. The nickel that for so many years gave them profits on their huge investment began to weaken, until 'Rising Costs' cut a nick in the nickel that greatly reduced its value."