THE APPLEYARD SYNDICATE'S INTERURBAN SYSTEM—II

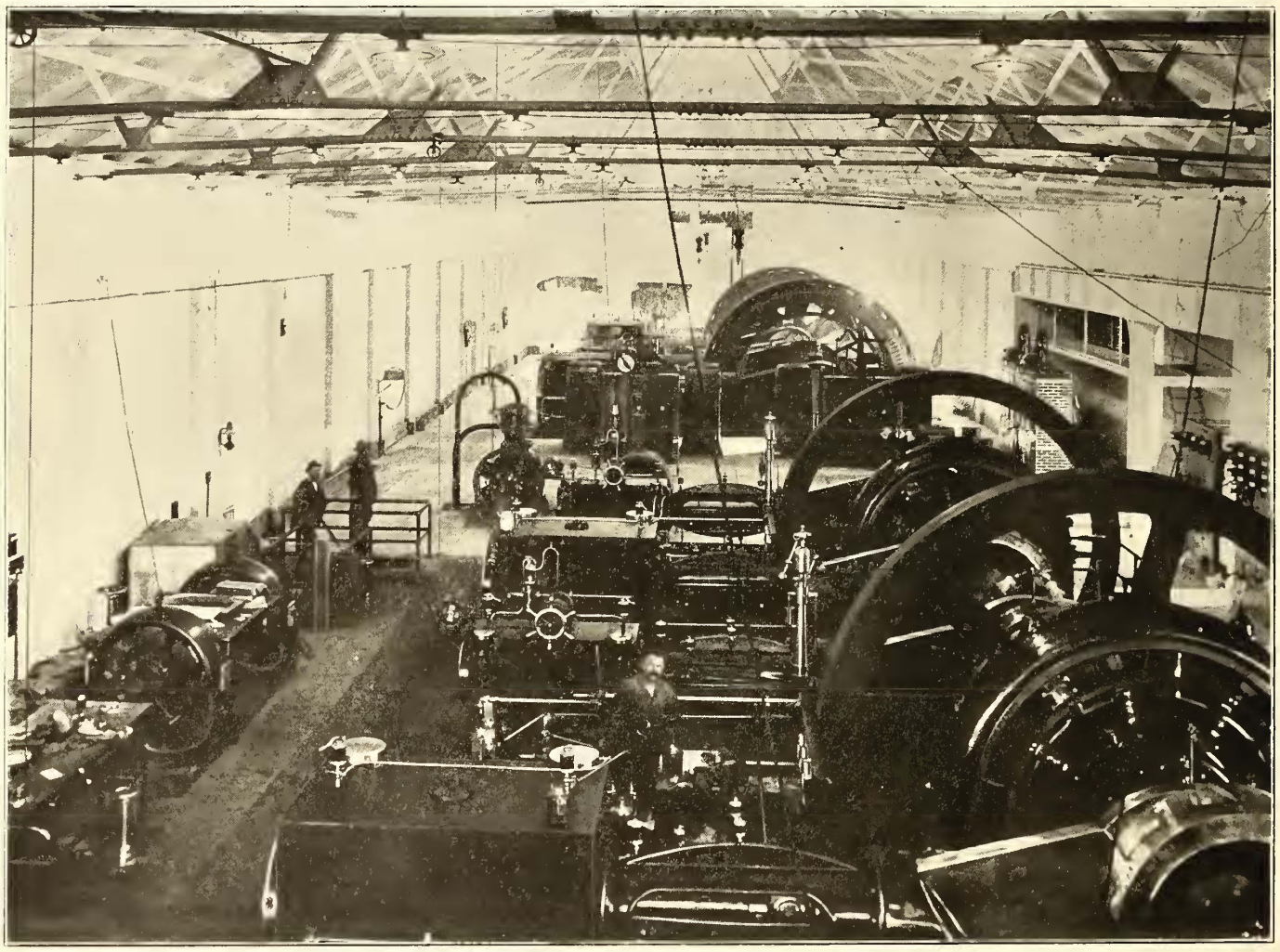
The power equipment for the Appleyard system between Columbus and Cincinnati, with the extensions north, will be centralized at Medway power house on the Dayton, Springfield & Urbana line. The character and extent of the group of electric lines to be supplied and the equipment of the system were thoroughly described in the last issue. At present there are small direct-current stations at Summerfield, on the Columbus, London & Springfield; at Glen Echo, on the Dayton, Springfield & Urbana, and near Columbus on the Columbus, Grove City & Southwestern. The two first mentioned are at present closed down, but the small station near Columbus will probably be retained for some time, to take care of the heavy loads near the city. This station is provided with a storage battery which will take care of the peak on the Central Market system in Columbus.

The Medway house has been for the last two years the chief station of the Dayton, Springfield & Urbana line. On account of its advantageous location and in order to secure economies from centralization, the syndicate decided to double the size of this station and install alternating-current equipment to take care of the greater portion of the system. The new equipment has recently been placed in operation, but at the present time the two sections of the station are operated entirely independent of each other, the old portion supplying the Dayton, Springfield & Urbana as heretofore, and the new portion taking care of the Columbus, London & Springfield, and feeding into the Columbus city system.

MAIN POWER HOUSE

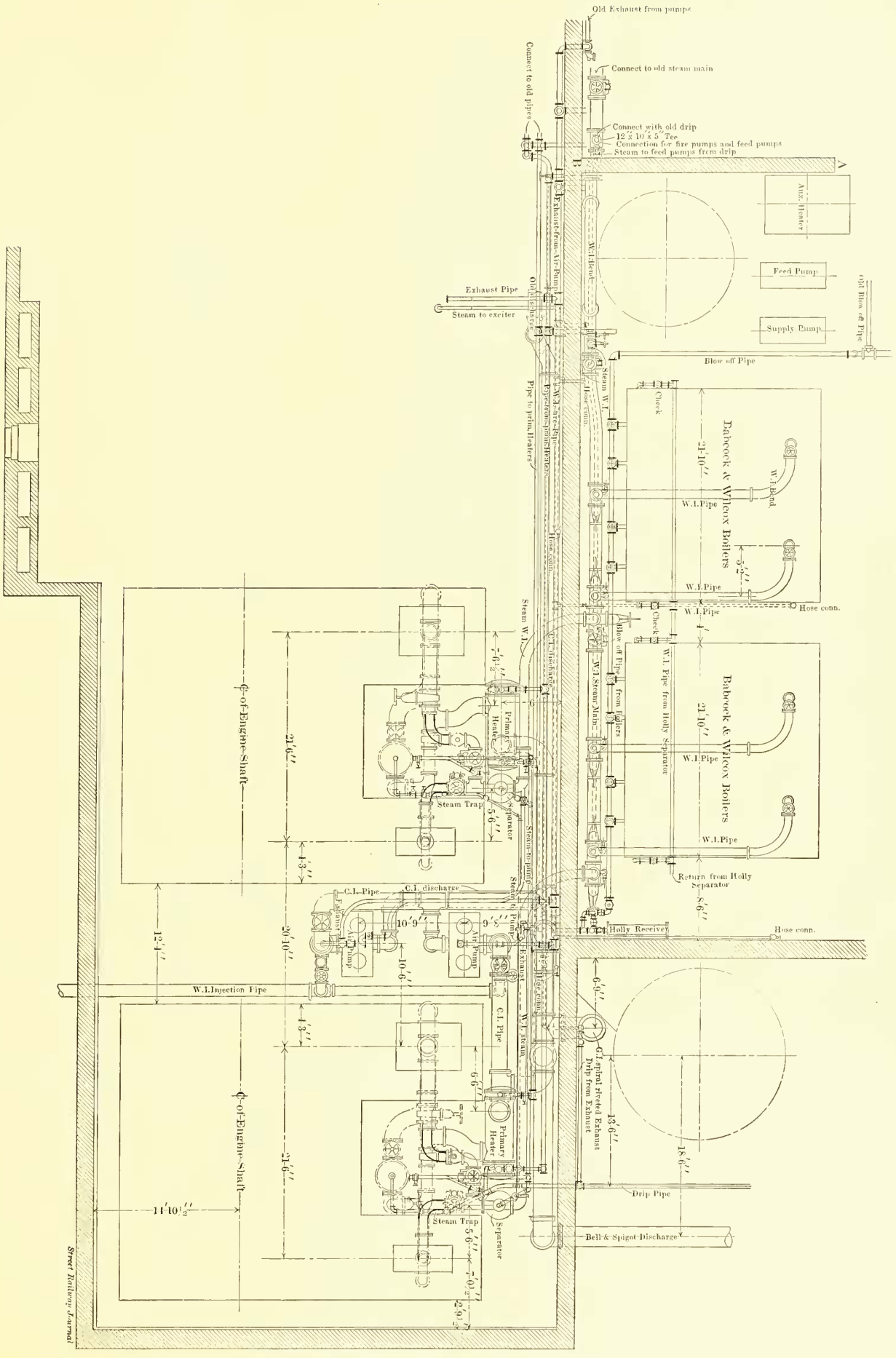
The house, as it stands, is 194 ft. long by 48 ft. 6 ins. wide, being double the length of the old building. It is a substantial brick structure, having a truss steel roof with slate laid on tongued and grooved sheathing. Separated from it by a brick wall is the boiler room, which is 112 ft. x 56 ft.

The equipment of the Dayton, Springfield & Urbana side of the station was described in an article on this system published in the Street Railway Journal of April 7, 1900. There are three 450-hp cross-compound condensing engines, built by the Slater Engine Company; the high-pressure cylinder is 16 ins., and the low-pressure cylinder 32 ins., with a 42-in. stroke. Engines are fitted with the Monarch safety engine stop, which closes down automatically at 108 r. p. m. Directly connected by shaft are three 325-kw Westinghouse direct-current generators of the compound-wound type, operating at 100 r. p. m., and supplying 600 volts. There is also a 150-kw booster set. The electrical equipment is controlled through an eight-panel switchboard, supplied with Westinghouse and Weston instruments. The first two panels are intended to control the booster set, but this at present is not used. The next two panels control the outgoing feeders, and they have a meter, a circuit breaker and switch on each outgoing feeder line. The fifth panel contains a total ammeter, total wattmeter and the station voltmeter. The remaining three panels are for the generators, and they have Westinghouse automatic circuit breakers and Monarch automatic circuit breakers for the engine stops, also equalizers for the positive side, the machines operating in parallel.



ENGINE ROOM, MEDWAY POWER STATION

In the boiler room are three 250-hp Babcock & Wilcox boilers, a Cochrane heater and purifier and two Blake duplex boiler feed pumps, each 4½ ins. x 7½ ins. x 10 ins. In the auxiliary room below the engine room are two Blake vertical-type condensers and air pumps.

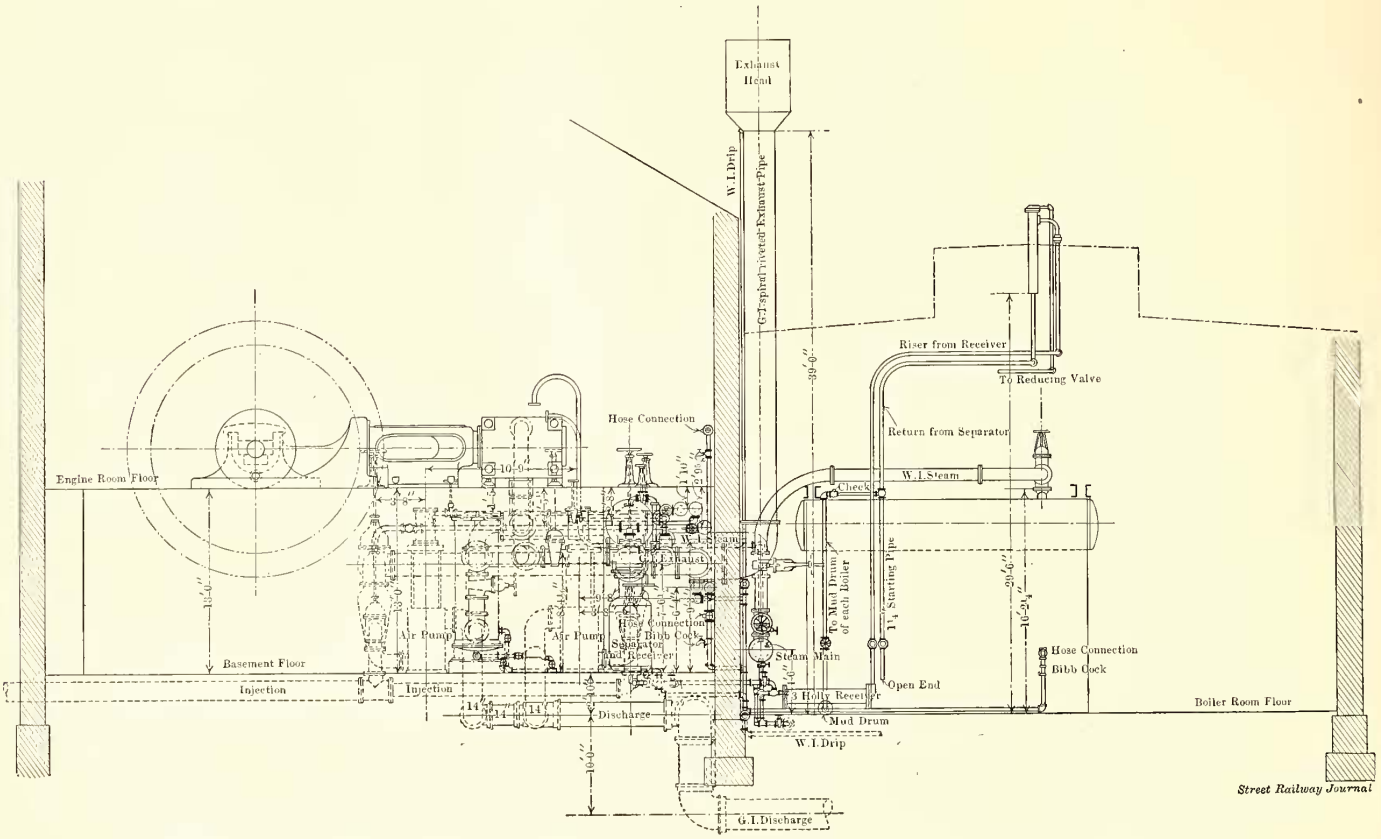


PIPING PLAN OF MAIN POWER HOUSE AT MEDWAY, FOR COLUMBUS, LONDON & SPRINGFIELD RAILWAY

STEAM PLANT

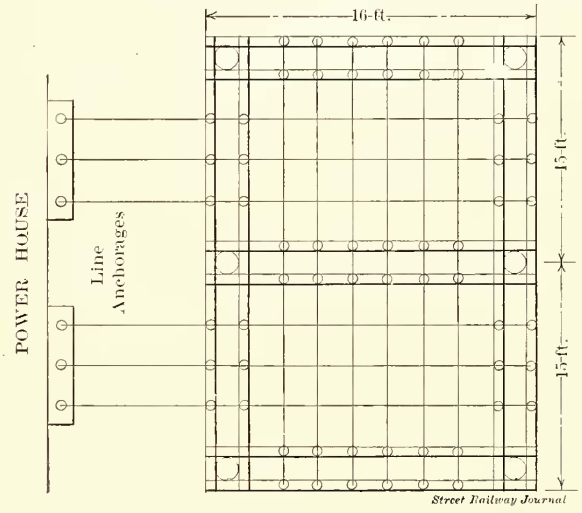
In the boiler room of the new section of the house are four 250-hp boilers of the Babcock & Wilcox type, similar to those on the Dayton, Springfield & Urbana side. They have 126 4-in. tubes, 18 ft. long. Plane grates are used, giving 66 sq. ft. of heating surface. Boilers operate at 160 lbs. steam pressure, and they are fitted with the Holly steam loop and gravity return system for condensed water, the condenser for the

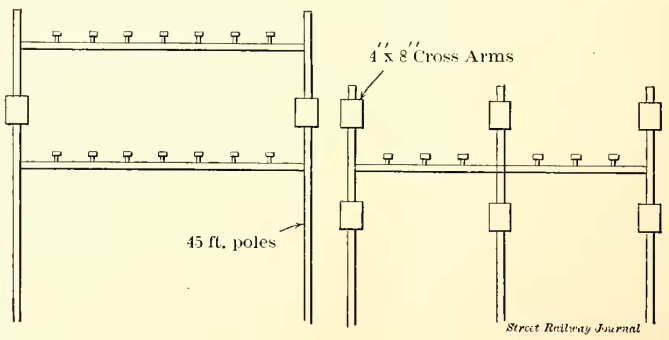
system being located on the roof, away from the heat of the boilers. Boiler tubes are cleaned by a Weinland hydraulic outfit, using water at 125 lbs. pressure. Coal bunkers are



CROSS-SECTION OF COLUMBUS, LONDON & SPRINGFIELD STEAM PLANT AT MEDWAY POWER HOUSE

located at the side of the boiler room, and they have a capacity of 900 tons. Dump-bottom cars are hauled over the line by an electric locomotive from the Big Four Railway at Donaldsville, and are dumped into the bunkers from an overhead steel bridge. Jackson Hill run of mine coal is used, and plans have been completed for installing an industrial track system through the boiler room and bunkers, with connecting switches in both sections of the house. Side dump-cars, holding 2 tons and furnished by the C. W. Hunt Company, will be installed, and each car will be weighed as it crosses a Fairbanks scales, located between the two boiler rooms. On the Columbus,





PLAN, END AND SIDE VIEW OF ARBOR

London & Springfield side there is a 1200-hp Cochrane heater and purifyer and two Blake duplex feed-water pumps of the outside packed-valve type. Cylinders are 10 ins. x 6½ ins. x 12 ins. One pumps the feed water and the other pumps from the heater to the boilers, and they are arranged to work either way. Water is supplied to the boilers at 210 degs. Ordinarily water is pumped from a mill race at the side of the house. The race is 1½ miles long, and is provided with a bulkhead, so that it may be drained and cleaned. There is also a line to an adjoining creek and a third line to a deep well, which is supplied by a never-failing spring. The three lines are connected in the house, and water may be pumped from any of the three. The first stack is 125 ft. high with 6-ft. flue, while the stack recently erected is 150 ft. tall with 7-ft. flue. They are both built of perforated brick. The new stack rests on a square base, 14 ft. x 14 ft. outside of the building, and the breeching is connected to that of the other stack, and they may be operated singly or together. The steam loss and feed-water mains in both sections of the house are also connected to provide for possible parallel operation of all boilers and pumps.

ENGINES

The recently installed units, two in number, have horizontal cross-compound condensing engines of the Hamilton-Corliss type. They have Corliss rotary valves, and have cylinders 26-in. and 50-in. with 48-in. stroke. Total weight is 290,000 lbs. The fly-wheel alone weighs 100,000 lbs., being 18 ft. in diameter,

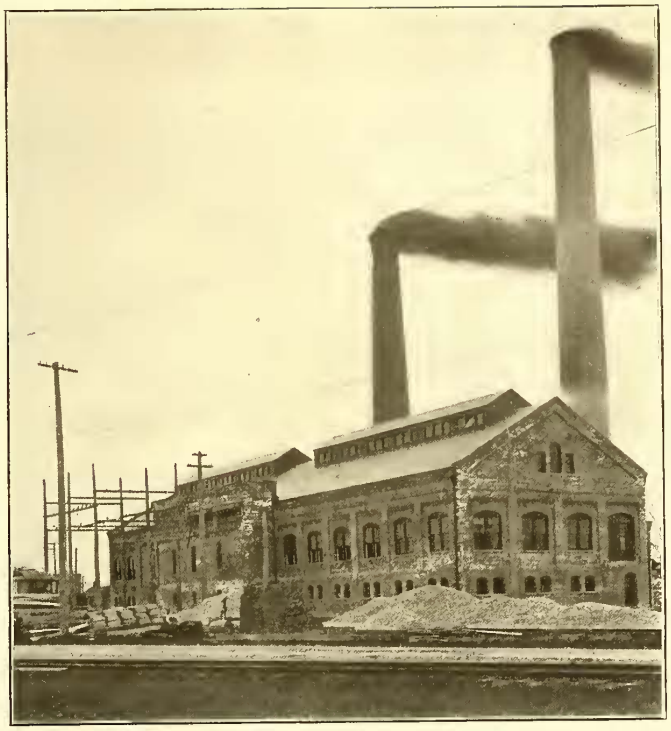
with web 18 ins. x 20 ins. The engines may be run either condensing or non-condensing, or it is possible to use either cylinder independent of the other. Steam from the high-pressure cylinder is exhausted into a receiver below, and then passes into the low-pressure cylinder and is exhausted through a primary heater into the condenser. From the condenser the steam goes through the exhaust line to the Cochrane heater, where it heats the feed water, and then passes through a vent into the atmosphere. The condensers are located in the auxiliary room below the engine room, and are of the Blake vertical type. They are fitted with the simplex valve gear and take water from the mill race. All piping is of wrought-iron, extra heavy, and bends are used instead of elbows. The steam header is 12 ins. in diameter, the mains from the boilers 8 ins., inlet to high-pressure cylinder 8 ins., to low-pressure cylinder 16 ins., and low-pressure exhaust 18 ins. There is a Stratton separator and a Nason trap connected to the receiver between the high and low-pressure cylinders.

GENERATORS

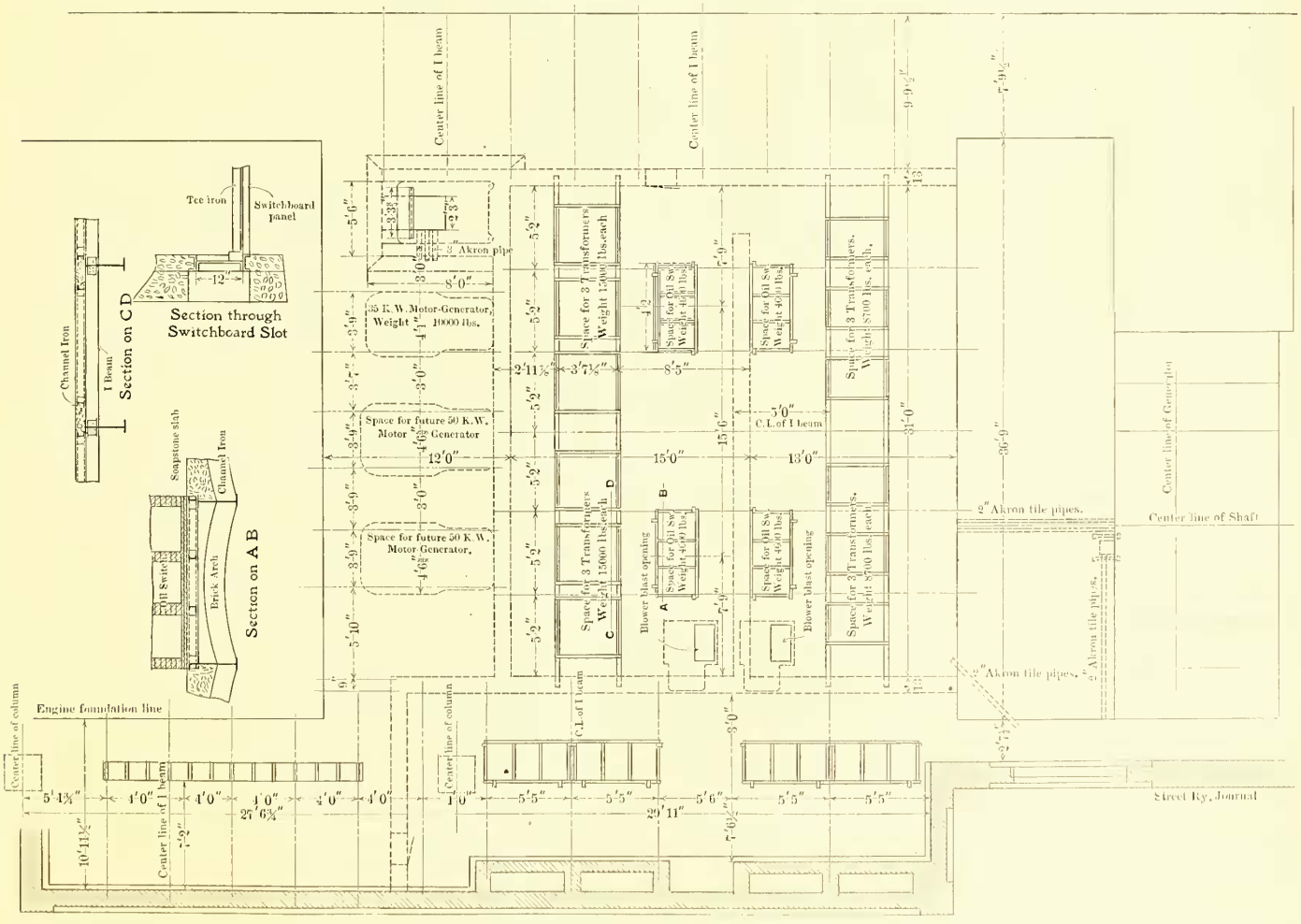
The generators are of the revolving field type, rated at 800 kw, 2300 volts, 201 amps. and 25 cycles, and they are designed for 94 r. p. m. Edgewise field winding is used, and the armature coils are conected with clips, so that in case one or more should burn out they may be unsoldered and replaced in a very short time. Current for exciting the fields is supplied by a 25-kw, 125-volt direct-current generator, connected to a small marine engine, and by a similar generator driven by a 2300-volt, three-phase 25-cycle induction motor. The first set is used in starting, and it is closed down and the motor-driven set switched on when the machines are up to normal voltage.

TRANSFORMERS AND AUXILIARIES

The current is stepped up by means of two banks of three single-phase air-cooled transformers, each rated at 275 kw, giving 26,400 volts on the secondary side. Each bank is connected without switches to the corresponding generator, thereby always giving a transformer capacity in service equal to the generating capacity. The transformers are cooled by two Buffalo Forge Company's blowers, each driven by a 3½-hp, 125-volt direct-current motor. These motors are supplied by

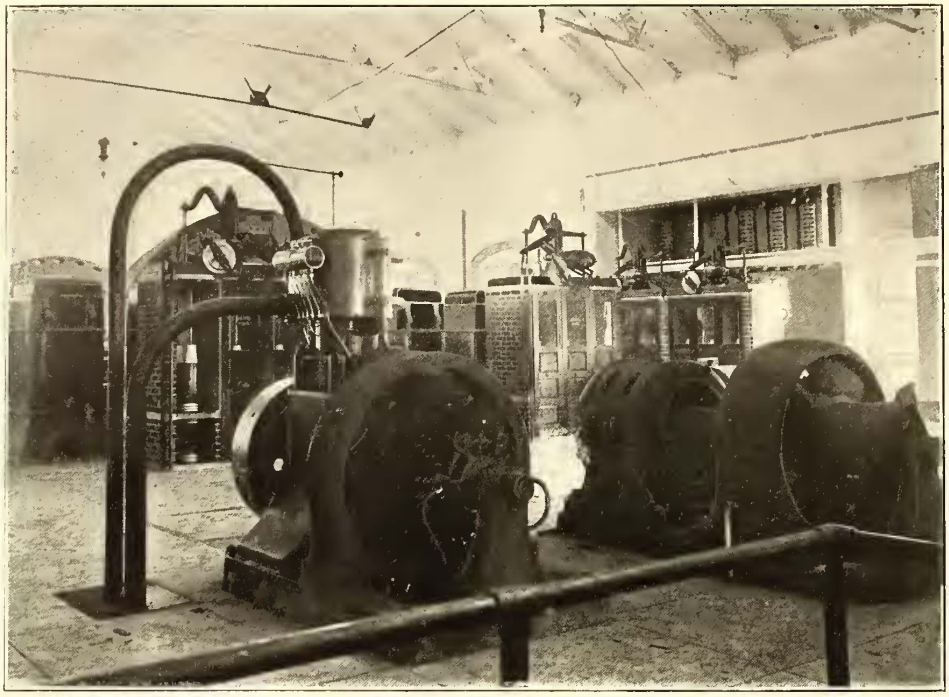


MAIN POWER HOUSE AT MEDWAY, SHOWING ARBOR FOR DISTRIBUTION SYSTEM



PLAN FOR ENGINE AND GENERATOR ROOM, COLUMBUS, LONDON & SPRINGFIELD SIDE OF MEDWAY POWER HOUSE

the exciters and controlled by circuit breakers, and starting boxes on small panels in front of the blower sets. The blowers



EXCITER SET, TRANSFORMERS AND OIL SWITCHES ON COLUMBUS, LONDON & SPRINGFIELD SIDE OF MEDWAY POWER HOUSE

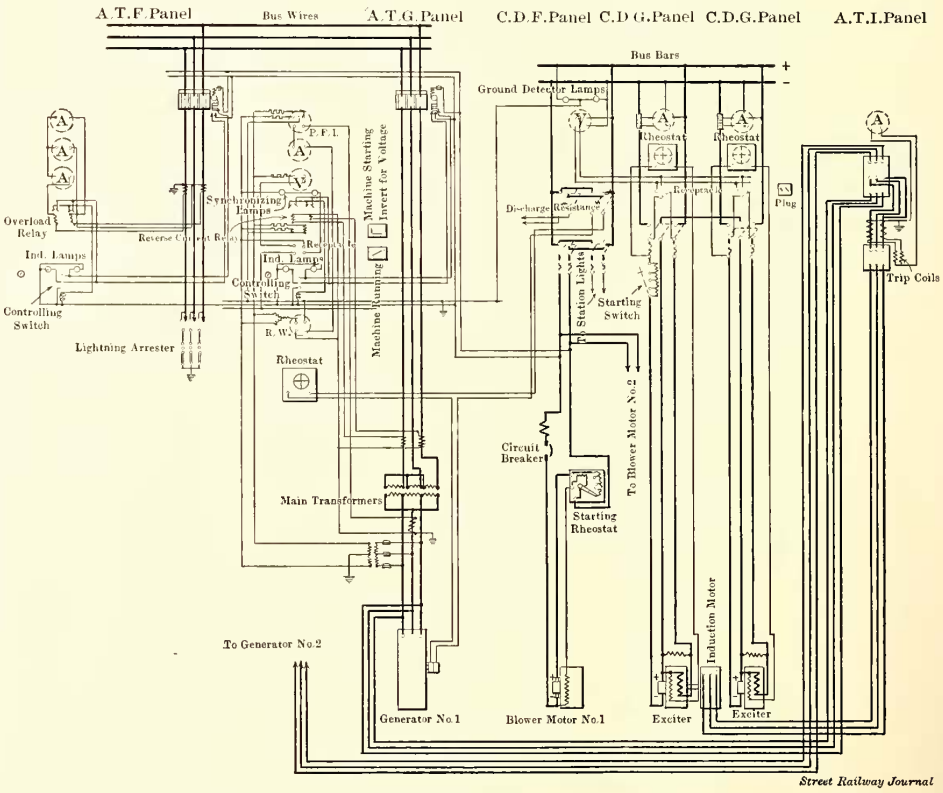
stand on the main floor, and discharge downwardly into the air-blast compartment, which is made up of the basement below the transformers and blowers. This is kept under a pressure of 5/8 of an ounce per square foot, and the air current passes up from this compartment through the transformers. Each transformer is provided with a damper so that only those in use are ventilated.

After being raised to 26,400 volts the current passes through the generator oil switches, two in number, located in front of the transformers. These are of the General Electric form H type, the same as are used in the Aurora, Elgin & Chicago plant. The oil switches are in brick compartments with barriers between the different phases. Each switch is operated by a 1-hp direct-current motor, which is controlled by a small switch on the corresponding panel. Red and green lamps on the generator panels indicate whether the switches are opened or closed.

From the generator oil switches the current passes to the station bus-bars, which are located for the most part in the air blast compartment mentioned. The high-tension wires in the bus-bar room are in separate compartments, having concrete partitions. They are secured on Locke No. 298 brown porcelain insulators, mounted on malleable iron pins screwed to bolts set in the concrete. From the bus-bars the current passes through a similar oil switch for each line. Each line is also equipped with a set of lighning arresters in a gallery of a bay to the main buildings; the bay is 6 ft. wide, 56 ft. long and 30 ft. high. The lightning arresters are the standard General Electric 2000-volt type, connected in series and mounted on insulated frames. In leaving the station the lines pass through a fireproof anchorage, to which they are secured by means of strain insulators. To carry out the lines and make a substantial right-angle turn in front of the building, the engineers were obliged to design a unique arbor for distributing the lines from the anchorage. The details of the arbor are shown on page 760. It is composed of 45-ft. poles with 4-in. x 8-in. arms. The lines from the anchorage pass directly across the arbor and are secured with dead ends to insulators on the opposite side. Other lines cross the arbor on other cross-arms, the six eastbound wires going above and the six westbound going below the station wires, and they are secured on the opposite sides with dead ends. The circuits are completed by means of short connecting wires attached with soldered points, the eastbound connections going up and the westbound connections down.

SWITCHBOARD EQUIPMENT

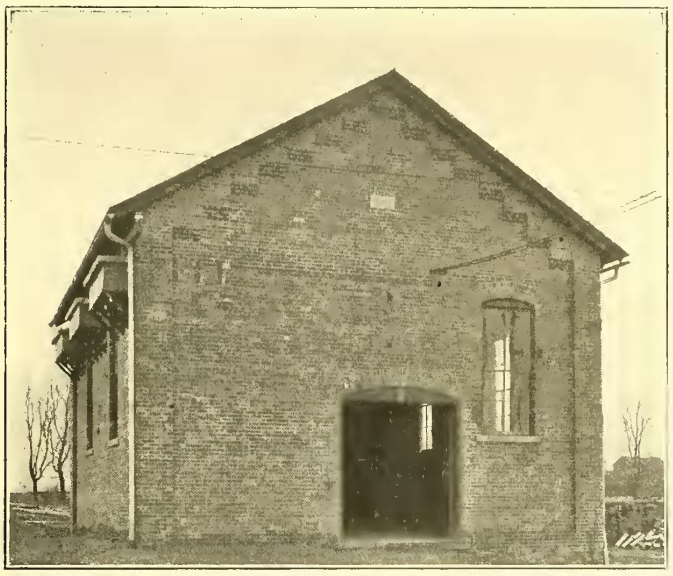
Following the usual General Electric practice no high-potential currents are carried to the switchboard. The latter is located on the line between the bay and the main room, and a wiring diagram is presented herewith. The board is of blue Vermont marble, and at present there are eight panels, each 16 ins. wide. The first is the 2300-volt panel for the motor-driven exciter. It con-



WIRING DIAGRAM FOR SWITCHBOARD OF COLUMBUS, LONDON & SPRINGFIELD RAILWAY, AT MEDWAY POWER HOUSE

tains an ammeter, a double-throw switch and an automatic oil switch. Current transformers on the back deliver secondary currents to the instruments on the panel. The second panel controls the direct-current end of the motor-driven exciter. There is a Thomson astatic 500-amp. meter, a rheostat, a 3-pole switch and a starting switch, so that the

motor-driven exciter may be started by direct-current. The third panel is the engine-driven exciter panel. It has an ammeter, a rheostat and a 3-pole switch. The rheostat hand wheels on these panels are connected by means of sprocket chains to the field rheostats located in the basement below. Current from the exciter sets is carried over bus-bars on the back of the exciter panels to the field panel. The fourth panel contains the generator field switches, the controlling switches for the blower motor circuits and oil switches, and space is also reserved for two generator field switches, which are to be installed later. The fifth and sixth panels control the two generators. They have power factor meters, ammeters, voltmeters, recording wattmeters, rheostat hand wheels and automatic controlling switches for generator oil-break switches. The seventh and eighth panels are for the line switches. Each contains three ammeters and an automatic controlling switch for the corresponding line oil-break switch. On the backs of the generator panels are overhead relays, which, in event of short circuit on the high-tension lines, automatically open the generator switches. The feeder switches are protected in a similar manner. The line switches are set to open at a lower current than the machine switches, so that in case of trouble on one line the line switch will open instead of the generator switches. Under the present arrangement of the board space is left for two generator panels, two outgoing line panels and two exciter panels. There are also spaces left in the house for oil switches, transformers, lightning arresters and exciter sets for 4000 kw additional equipment. Conduits are imbedded in the concrete flooring for the additional small wiring.



STANDARD SUB-STATION FOR SMALL TOWNS ON COLUMBUS, LONDON & SPRINGFIELD RAILWAY

ADDITIONAL EQUIPMENT

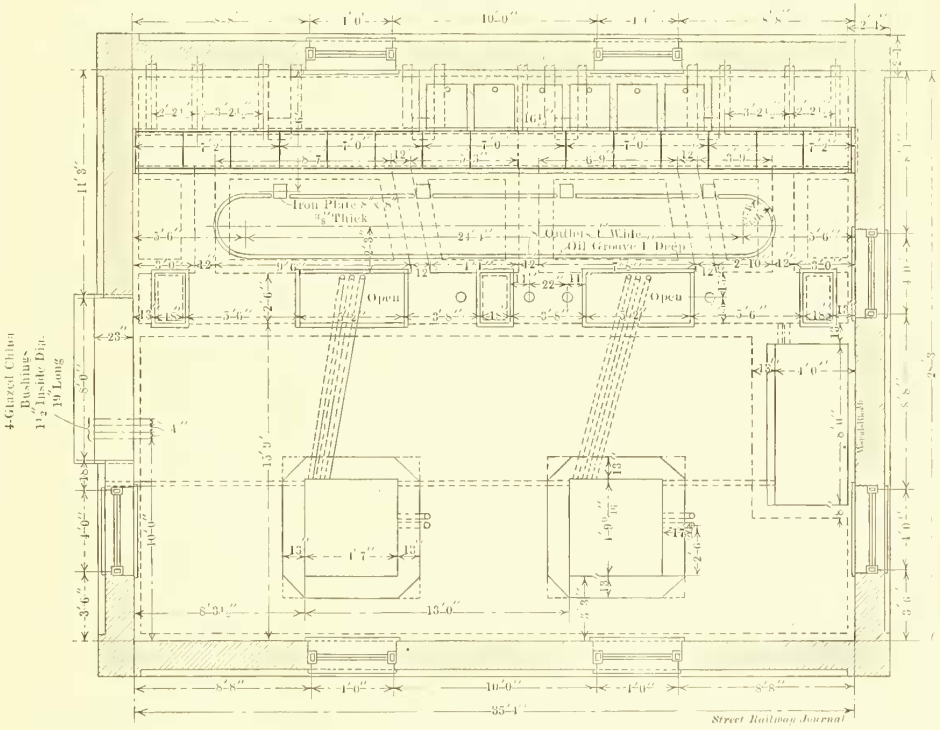
A contract has already been placed for one 2000-kw Curtis turbine generator set, and to accommodate this the west end of the building will be extended. The ultimate plans for the house provide for a westward extension of 200 per cent.

The station lighting is done by arc lights in multiple, current for which is supplied from the 600-volt line, but there is a double system of wiring with cut-out switches, which permits the use of the engine-driven exciter set when the station is shut down. In conection with the turbine unit there will be three 675-kw air-blast transformers and other necessary station equipment. The turbine will be run in multiple with the two present units.

SUB-STATIONS

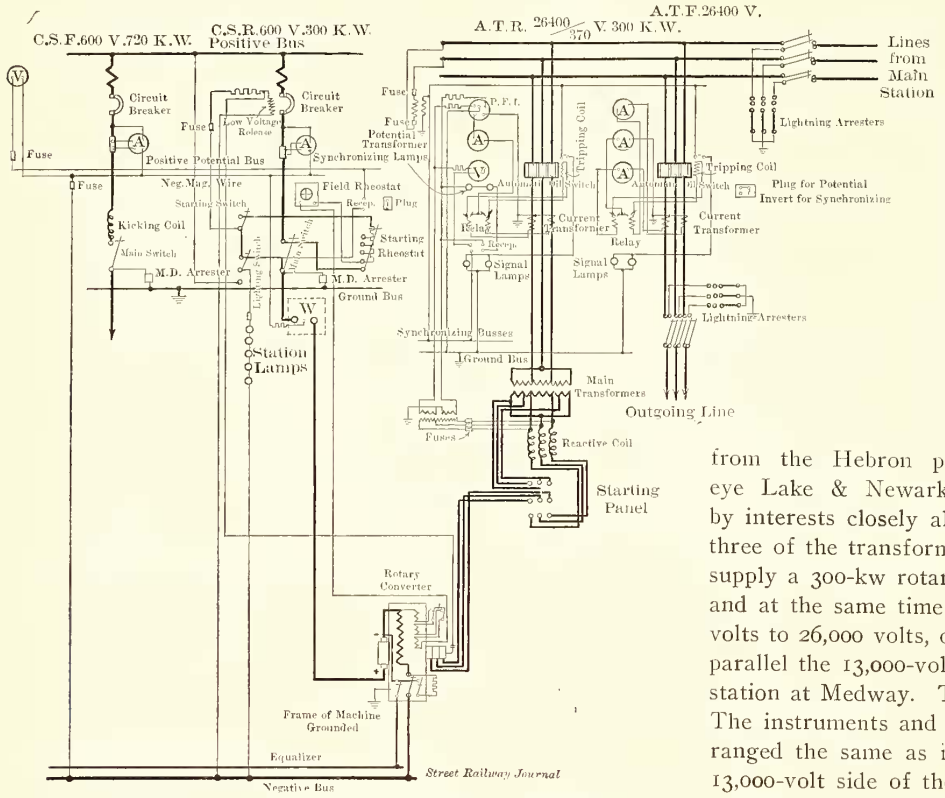
Ultimately sub-stations will be located on an average of about 15 miles apart between Columbus and Cincinnati. Stations are now in operation at West Jefferson, Brighton and Springfield, and others are being erected at Columbus, Urbana, Bellefontaine, Dayton, Kenton and Lebanon. The stations at Springfield, Dayton and Columbus will each have two rotaries installed, with space for three, while the other stations will have one rotary each with space for a second. The smaller stations are of the type illustrated herewith. The stations at Urbana, Bellefontaine and Kenton will be combination sub-stations, freight and passenger station and residence for the attendant. The plans of this type are presented herewith. They were developed from similar plans adopted by the Toledo & Western system, which was described and illustrated in a recent issue of the STREET RAILWAY JOURNAL. The buildings will be of pressed brick and will have dining and living rooms below, in order that the attendant may be as close to his machines as possible. The stations will cost nearly $6,000 each exclusive of equipment.

Each sub-station will have three 110-kw type-H oil-cooled transformers, together with one oil-cooled reactive coil for each rotary. The rotaries are of 300-kw capacity, of the 6-pole type, and operate at 500 r. p. m. The switchboard in the single stations will consist of a 16-in. panel for the direct-current side of each rotary, and two 1200-amp. direct-current feeder panels. Space is left to take in two more feeder boards and the direct-current panel for the second rotary. The alternating-current instruments and switches are not located on the switchboard, but are mounted on pedestals, which are placed on the floor directly in front of the transformers. The rotary pedestal contains a power factor meter, ammeter, voltmeter and synchronizing plug. The high-tension line enters the station through a fireproof anchorage and is connected directly to high-



PLAN OF SUB-STATION FOR COLUMBUS, LONDON & SPRINGFIELD RAILWAY

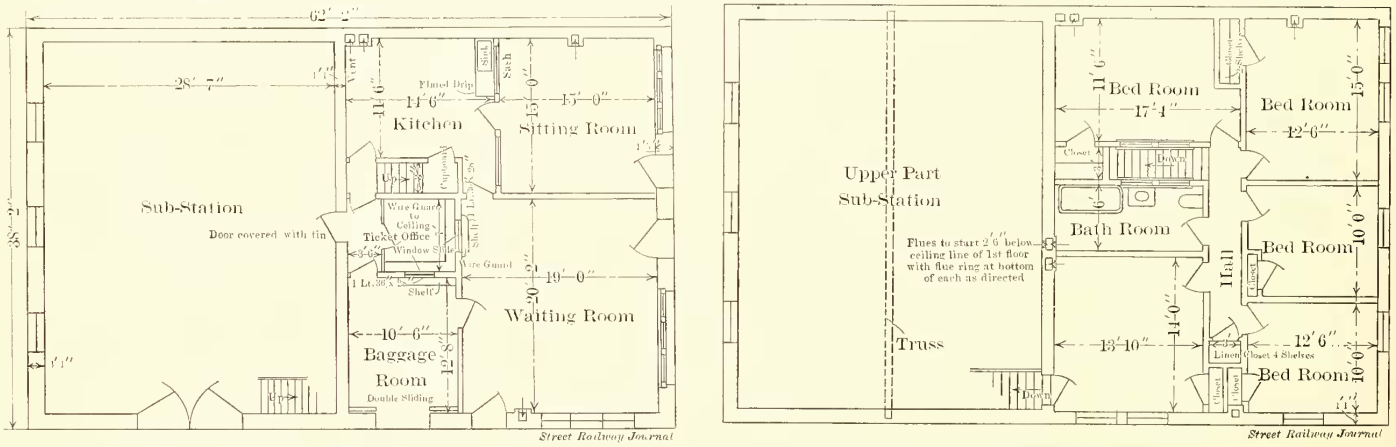
tension bus-bars and lightning arresters. The outgoing line to the next station is connected from bus-bars to the line through a hand-operated form-K switch, designed to break 50 amps. Outgoing lines are provided with an instrument pedestal having three ammeters. Switches are automatic and will open in case of short circuit on the line. All the stations are practically alike except for the differences enumerated and for the additional fact that terminal station, of course, have no outgoing line switches. The high-tension wiring in stations is all bare No. 2 Brown & Sharpe wire, mounted on Loche 298 brown porcelain insulators and iron pins. The wiring is arranged so that it is impossible for a man to fall against the high-tension lines. The bus-bars are 17 ft. above ground. Oil switches are mounted in fireproof compartments, the phases separated by 4-in. brick walls. The low-tension wiring is carried from the transformers to the rotaries and from the direct-current side of the rotaries to the switchboard in vitrified tile pipe under the floor. The cables for the low-tension circuits are 750,000 cm, insulated with asbestos and cotton braid. The high-tension lightning arresters are hung on an iron frame 3 ft. from the wall. This frame also supports the gallery, which is built just below the arresters. The connections from the oil switches to the bus-bars and transmission lines are carried on the iron frame work back of the lightning arresters.



WIRING DIAGRAM OF SWITCHBOARD AT COLUMBUS, LONDON & SPRINGFIELD RAILWAY INTERMEDIATE SUB-STATION

The Springfield sub-station will be the general distributing point for the Urbana, Bellefontaine and Kenton sub-stations to the north, and the Brighton, West Jefferson and Columbus sub-stations to the east. Two outgoing high-tension lines leave the station, one going north and the other east, and there are duplicate incoming lines from Medway. Both incoming and outgoing lines will have oil switches and instrument pedestals provided with ammeters.

The Columbus sub-station will be a unique outfit in that it will have three 300-kw rotaries and nine 110-kw air-blast compensating transformers, wound for 26,400 volts and having taps brought out for 13,000 volts, making it possible to operate the station from the Hebron power house of the Columbus, Buckeye Lake & Newark Traction Company, which is owned by interests closely allied to the Appleyard syndicate. With three of the transformers in this station it will be possible to supply a 300-kw rotary at either 26,000 volts or 13,000 volts, and at the same time 300 kw can be stepped up from 13,000 volts to 26,000 volts, or vice versa. It will also be possible to parallel the 13,000-volt station at Hebron with the 26,000-volt station at Medway. The two plants are about 95 miles apart. The instruments and switches on the 26,000-volt side are arranged the same as in other stations. The switches on the 13,000-volt side of the system are operated from the switchboard, and the instruments from the 13,000-volt circuits are also mounted on the switchboard. There will be lightning arresters for the 13,000-volt incoming lines as well as for the 26,000-volt lines. The two systems will be entirely independent of each other, yet both switches will be automatic. The 13,000-volt wiring from the switches to the transformers are lead-covered, triple conductor, paper insulated cable, while the 26,000-volt wiring is the same as in the other stations.



First Floor. Second Floor.

PLANS FOR THE COMBINATION RESIDENCE, SUB-STATION, PASSENGER AND FREIGHT DEPOT

PORTABLE SUB-STATION

Another interesting feature of the equipment will be a portable sub-station, which will also be equipped to operate either from the Medway or the Hebron station. It will be equipped with one rotary and one three-phase air-blast transformer, with 26,000-volt windings and taps brought out to be run on 13,000 volts. The electrical equipment of the power house addition and of the sub-stations was installed by the General Electric Company, under the supervision of Egbert Douglas.