RAILWAY ELECTRIFICATION IN WASHINGTON

(Little has been heard in recent months of the railway electrification in the Northwest, but the work is progressing and it is expected that trains will operate through the Cascade Mountains by September first. Here is a review of the present status with a brief description of equipment and construction work.—The Editor.)

The Puget Sound section of the State of Washington, the scene of the state's greatest commercial and industrial activity, is soon to have its prestige greatly enhanced. About July 1 of this year, the Chicago, Milwaukee & St. Paul Railway will begin operating its trains electrically through the Cascade mountains. By this electrification much of the handicap occasioned by the existence of a high range of mountains between Puget Sound and the east will be removed.

The electrification covers 218 miles between Othello in eastern Washington and Seattle and Tacoma, and such was the consequence of the work that it has not been interrupted by the fact of war. The poles and fixtures necessary to the support of the power-transmission wires, as well as those for the trolley, feeder and other wires, are practically in place. Between Othello and Tacoma the substation buildings have been finished and much of the substation equipment installed.

Progress on Substations

There are eight substations situated approximately 28 miles apart, of brick construction with tar and gravel roofs. The roofs are flat with two exceptions, these being in the region where the snow fall is heavy. The substations are at Tacoma, Renton, Cedar Falls, Hyak, Cle Elum, Kittitas, Doris and Taunton.

Taunton substation is 9.2 miles west of Othello, where a connection is made with the Long Lake hydroelectric station of the Washington Water Power Company, by a 110,000 volt transmission line 170 miles in length and a connection is made at Cedar Falls substation with the Snoqualmie plant of the Puget Sound Traction Light & Power Company, where a substation is being erected by the last named company in which the generator voltage is to be stepped up to 110,000 for transmission to the railway company. The new substation of the traction company will contain three 4500 kva. transformers, General Electric type, and one held in reserve, all outdoor installations. Special type of large disconnecting switches is also included, being supplied by the Electrical Engineers' Equipment Company, Chicago. The Milwaukee constructs its own transmission tie lines.

Power Line Construction

For the power-line construction between Taunton and Cedar Falls the Milwaukee company is to make use of 6-strand No. 00 copper cable with hemp center which makes a 133,000-circular mil cable with a diameter of 0.446 inches. From Cedar Falls to Renton and Tacoma by way of Snoqualmie Falls, the line has six strands with hemp center and cable diameter of 0.938 inches. For the Long Lake-Taunton line seven No. 8 wire are used, which gives a cable of 0.3855 inches and 115,000-circular mil area.

Details of Equipment

The substations were built by the Milwaukee Company. They are T-shaped with a 50 by 84 foot high-tension room in the rear, and a 40 by 60 foot room in front for the motor generator set. The Westinghouse Electric & Manufacturing Company is equipping the substations at Taunton, Dorris and Kittitas and the General Electric Company those at Cle Elum, Hyak, Cedar Falls, Renton and Tacoma. At Taunton and Tacoma the stations are two-unit with two units to be installed. Cedar Falls, Doris and Hyak are three-unit stations, with two units installed at each point. At Cle Elum and Renton the stations are two-unit with one unit installed in each case. These units are all 2000 kw.

The type of equipment installed by the respective companies in these substations will be understood from the following descriptions: Westinghouse Electric & Manufacturing Company installed the equipment in the Taunton substation. This substation contains two oil insulated, self-cooling tubular type transformers for indoor service. They are of the shell type, 2500 kva., three-phase, 60 cycles, with high-voltage winding for 102,000 volts, and low voltage winding for 2300 volts. There are additional taps on the high-tension winding to give 97,200 and 92,400 volts at full capacity. Taps for 1150 volts are provided on the low tension winding to supply the starting voltage for synchronous motors of the motor generator sets. The transformers are connected in star on the high-voltage side and in delta on the low-voltage side. Each transformer is connected and has the corresponding capacity for supplying one motor generator set.

Flat coils make up the high-tension windings to make sure that the low-voltage stresses between coils is kept low. Each of these coils is wound with layers of thin copper ribbon, which is bare, but as the coil is wound the conductor is automatically insulated with layers of paper and cloth applied through a folding tool.

Taps are placed in the body of the high-tension windings rather than at the ends to avoid exposure to the effects of line surges. Low-tension coils are made up of rectangular copper conductors in multiple, each covered with two layers of cotton insulation. Transformer tanks are made of boiler plate, with cover bolted to the top, a gasket between tank and cover to make them air tight.

Leads and taps from high-tension coils are connected to the terminals, which are carried by insulating supports mounted upon the barriers between the coils. This makes a terminal arrangement free from grounded supports. The three high-tension leads are carried through the cover by bushings of the condenser type. The five low-tension terminals are brought through bushings in the cover, terminal boards being mounted inside the transformer case.

There are two motor generator sets in the substation, each consisting of 1000 kw., 6-pole, 1500 volt direct-current generators connected in series and driven by a three-phase, 60 cycle synchronous motor, the motor and two generators being on the same shaft and bedplate. The shaft has an exciter at each end, one for the generators and one for the synchronous motor. The normal full-load output of each set is 2000 kw. at 514 r.p.m., 3000 volts, 667 amp. Exciter for generators is rated at 10 kw., 125 volts; exciter for the synchronous motor is rated at 30 kw., 125 volts. By a special winding the power-factor on the motor is automatically held at 95% leading when delivering maximum load, with provisions for adjusting the power-factor setting to give unity or leading power-factor between one-half and full load.

Feeders of the power company are controlled by 110,000-volt, 200 ampere, remote controlled, hand operated oil circuit-breakers which have a very high ultimate rupturing capacity at the arc. Bushing-type current transformers operating the protective relays are provided for these. From a panel located in the middle wall each coil circuit-breaker is controlled and upon which is mounted the controlling, operating and indicating mechanism and disconnecting switch. The incoming power line and railroad 3000 volt feeder lines are equipped with static voltage detectors. Nine panels are contained in the chief switchboard. There is one resonant shunt to be connected across the 3000-volt direct-current busbars, to be so proportioned that it will shunt out the harmonics caused by slot action in the machines.

The Westinghouse flash suppressor is a feature of the equipment. This is a combination of electrically operated switches that work to create a short-circuit across the collector rings on the armatures of the direct-current generators, acting at once upon any sudden rush of current greater than that for which the combination is adjusted. The result is to kill instantly the direct-current voltage and suppress any tendency to flash over at the generator commutators.

Cedar Falls Substation

The Cedar Falls substation was equipped by the General Electric Company and has two 2000 kw. motor generator sets, two 2500 kva. step-down transformers, and switchboard equipment. The oil-cooled transformers have steel plate tubular tanks and the high-voltage winding has approximately 5 per cent taps. The low voltage is provided with approximately 50 per cent starting taps in the same manner as those contained in the Westinghouse equipment. If the total rated capacity available on busbars or circuits to which switches are connected does not exceed specified limits, the oil switches can safely protect the machines and feeders under short-circuit conditions. The 110,000-volt circuits of the power company and the railroad transmission lines are controlled by large circuit-breakers, while the transformers are controlled by 100-amp. circuit breakers. As is the case with the Westinghouse substations, these oil breakers are operated from panels located in the middle wall.

The two motor generator sets each consist of one 2300-volt, 2500 kva., three-phase, 60 cycle synchronous motor, started from transformer taps, direct-connected to two 1500-volt, 1000-kw. generators, connected in series for 2300 volts direct current, and two 125-volt exciters rated at 30 and 10 kw. The switchboard consists of a panel for each of the motor generator sets, panels for two 2300-volt direct-current feeder circuits, storage battery panel, auxiliary light and power panel for station use, a panel for the power company meters and one for power limiting equipment.

The 3000-volt direct-current feeder lines are continuous between substations with taps to the trolley line every 1000 feet. Return circuits are made up of a No. 4/0 copper cable strung on the feeder-line poles connected at intervals of 8000 feet, to the running rails. This cable is to prevent the interruption of circuit and dangerous voltage at the rail joints if bonds are broken. Necessary current for automatic signaling is also transmitted by the running rails so that the only cross connections between main-line tracks will be the reactance bonds when connecting with signals.

The catenary type of trolley construction is used and consists of two standard No. 4/0 grooved wires for which hangers are alternately spaced and separated for each wire by an average distance of 15 feet. There is no rigidity of connection between the two wires. Thus flexibility of support is provided, giving the increased trolley contact surface and current carrying capacity necessary in high speed conditions. One trolley wire is all that is provided on passing tracks and yard tracks. The normal height of the trolley wires above the top of the rail is 24 feet 2 inches, while the minimum height, having relation to bridges and tunnels, is 19 feet.

Westinghouse Electric & Manufacturing Company is also furnishing a power indicating and limiting system apparatus. Similar apparatus has been in operation for some time on the Milwaukee Company's Rocky Mountain Division in Montana and consists of providing a convenient means of measuring and recording at some designated point, the entire power necessary to operate the newly electrified territory, and providing the means by automatic lowering of the direct-current substation voltage of limiting the maximum demand or the output of a particular substation to a certain predetermined amount. The indicating and limiting apparatus in the substations and dispatcher's office is connected by a circuit consisting of two No. 8 B. & S. copper wires on the trolley poles. This circuit extends from Taunton, the most easterly substation, passing through each substation to the dispatcher's office, its frequency in any section being dependent on the load in the substations east of that point.

Locomotive Design

Locomotives for this line are being built by the Westinghouse Electric & Manufacturing Company and the General Electric Company, ten by the former and five by the latter.

The Westinghouse locomotives will have two main running gears, each having a four-wheel guiding truck, three driving axles in a rigid wheel base, and a two-wheel trailing truck. The whole running gear will be composed of two Pacific type running gears coupled together with the two-wheel trucks on the adjacent ends. On the running gears a single cab will be mounted. Motors will be of twin armature four-pole type, having two armatures connected permanently in series and carried in a common frame. These two armatures are to be geared through a single gear to a quill surrounding the driving axle and carried in bearings in the motor frame.

The General Electric Company locomotives will be of the through passenger type and will be equipped with steam heater, train lighting apparatus, and 12 gearless motors; two four-axle rigid trucks, and three axle guiding trucks. A separate cab in the center will contain the heating equipment. That portion of the cab extending toward the end of the locomotive from the operating cab will have a rounded form resembling to an extent the shape of the present steam locomotive ahead of the engineer's cab.

It will not be necessary to purchase freight locomotives as the present locomotives used for passenger service will be changed in their gears so as to adapt them for freight service. The passenger service will be handled by the new locomotives above described. Each of these locomotives will have a capacity corresponding to that required to haul a load of 960 tons or about 12 cars, in a continuous run over any part of the profile between Harlowton, Montana, the eastern terminus of the present electrification, and Tacoma and Seattle. The speed varies from 60 miles an hour on the level to 25 miles when ascending the heaviest grades. Under the plan of control regeneration will be permitted on down grades.

This is the most extensive electrification of its nature now being carried through. Taking into consideration the 440 miles of line which the Milwaukee company previously electrified between Harlowton, Montana, and Avery, Idaho, the company will have on July 1st of the present year 660 miles of trunk line electrified.

Engineering and construction work are being handled by the electrification department of the company. R. Beeuwkes is electrical engineer in charge, and F. B. Walker superintendent of construction.

SELLING ELECTRICAL GOODS IN CHINA

(West Coast trade with the Orient is again taking shape—and awaking to the vast possibilities in the practically undeveloped field of China. The United States as a nation stands well with the Chinese and American goods have a good name,—it remains only to take advantage of that country's needs and tendencies of growth as they are pointed out in these interesting extracts from the report of a special investigator in the Orient.—The Editor.)

Growth of Electrical Imports —

Those who have never been to China are likely to think of this nation of ancient civilization as it was presented to them in their school geography. They have not comprehended a change in other parts of the world similar to that in our own. As a matter of fact, however, there has been a gradual development in that country due to more intimate contact with foreign civilization, to better transportation facilities, and to a slowly increasing earning power.

In the sale of electrical goods, prime movers, machinery, propellers (as boilers, turbines, etc.), the pre-war years showed the imports from the United Kingdom to represent 65 per cent of the total, while the direct imports classified under "electrical material and fittings" showed that less than 8 per cent came from the United States.

The people of China have shown a progressive tendency and with its great population and increasing purchasing power, an increase of a very small percentage of the people will make a large aggregate. As an instance, it is shown that one per cent of the population aggregates three times the population of New Zealand alone. Not only do the numerous wealthy merchants and officials appreciate modern conveniences and comforts, but as one passes along the streets where electricity is available he is struck by the number of small shops that have electric lighting. Not only this, but they appear over rather than under lighted, showing they are liberal consumers.

The strong present market lies in the furnishing of apparatus and materials for new stations. This market is being developed faster than one would expect.

Future Possibilities —

While a fair volume of electrical trade is possible now, the great volume of trade with China will come with the greater development of the country; this will increase purchasing power, which will result in a more extended use of electrical service. Combined with earning power, education will also result in better living and everything that goes to make up a higher standard of living.

Conditions of Trade —

Those who wish to meet success in entering this market must bear in mind that first of all they must arrange for proper representation; that, secondly, they must have goods adapted to the needs of the Chinese under existing standards; and that they will find it a great advantage if their representatives in China are able to extend moderate terms of credit to native companies that may buy central station apparatus and materials. American goods have a good name and the United States as a nation stands well with the Chinese. If American electrical manufacturers are willing to cultivate the market in a broad-minded, thorough manner, China affords an export market almost as rich in its potentialities as all of South America. It is relatively a small market