upon the class of work involved, and cannot be provided for on the diagram. An allowance of 10 per cent is, in general, enough to care for these details, but in any case the estimator should use his best judgment in this regard.

St. Paul Electrification Progressing Rapidly

First Locomotive Delivered for Main-Line Service Over Rockies—Overhead Construction Completed for 200 Miles

CONSTRUCTION work on the electrification of the Chicago, Milwaukee & St. Paul Railway over the Rocky Mountains has been actively prosecuted since the initial order for equipment was placed with the General Electric Company in September, 1914. The overhead construction, which will embrace 650 miles of single track, has been completed for 200 miles, and the 100,000-volt transmission line parallel to the tracks has been completed for a like distance, together with tie-in lines from the 100,000-volt system of the Montana Power Company. The trackage now ready for train operation includes extensive yards and sidings at Three Forks, Deer Lodge and Piedmont, and passing tracks at other points. The first of the forty-two electric locomotives has been delivered to the railway at Chicago.

One of the illustrations shows the general appearance of the new type of trolley construction and transmission lines. Woodpole construction is used throughout both for cross-span and bracket construction. The twin 4/0 trolley wires are suspended individually and separately from the same steel catenary and the hangers of one trolley wire are located at points mid-span on the other. In the switching yards only one trolley wire is used.

SUBSTATIONS

Seven substations designed to supply power to the first half of the 440 miles of route have been completed and electrical equipment is being rapidly installed. Complete shipments of transformers, motor-generator sets, switchboards and other accessories have been made for the stations first erected, and the equipment of four substations is practically ready for operation. Construction crews are proceeding with the erection of the remaining seven substations between Deer Lodge, Mont., and Avery, Idaho.

Each of the motor-generator sets consists of a 60-cycle, three-phase, 2300-volt synchronous motor direct-connected to two 1500-volt direct-current generators. The generators are connected permanently in series to supply 3000 volts to the trolley. Each set is also provided with an exciter at each end, one providing excitation for the revolving field of the motor and the other supplying the separately excited fields of the direct-current machines.

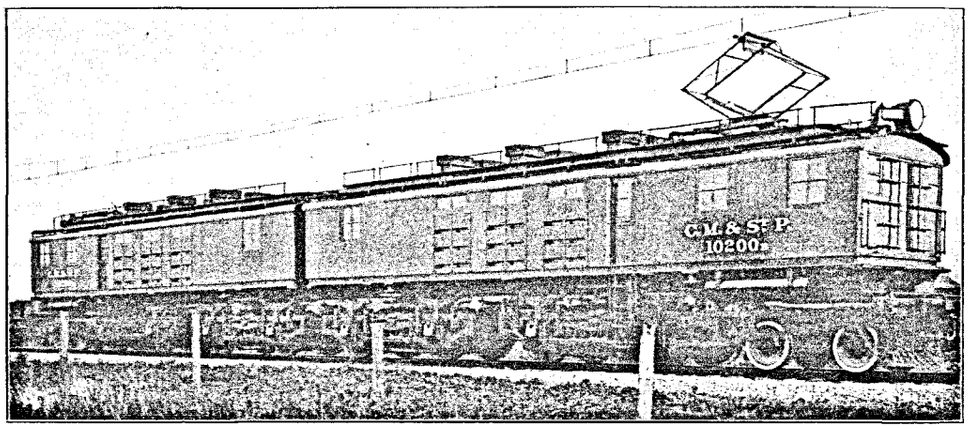
These sets are in general similar to the five 1000-kw., 2400-volt units in operation on the Butte, Anaconda & Pacific Railway except as regards voltage and capacity. One new feature, however, has been added. This consists of a longitudinal ventilation of the core and field coils similar to that employed in the GE ventilated railway motor. The use of this method of cooling has effected a considerable reduction in the floor space required per kilowatt.

The motor-generator sets are designed to operate inverted in case the regenerated power exceeds that required by other trains operating near-by. For this reason there is no necessity for water boxes or other energy-consuming devices, since the excess energy is transmitted to the 100,000-volt system.

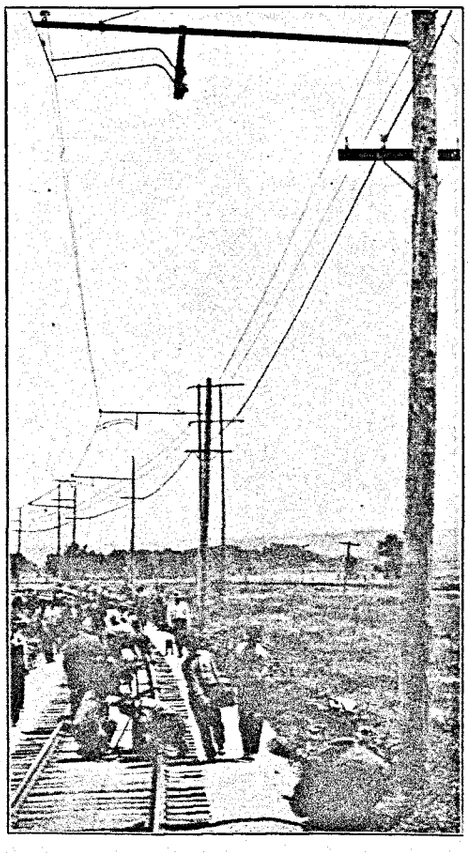
TRANSFORMERS

The transformers are under construction in the Pittsfield works of the General Electric Company. There are a total of thirty-two of these units, which are to be used for stepping down the power supply from the 100,000-volt transmission line to 2300 volts as required for the synchronous motor-generator sets. These transformers will be installed in fourteen substations, which will furnish power for the entire electrification from Harlowton, Mont., to Avery, Idaho. There are twenty-three 2500-kva. and nine 1900-kva. units.

In addition to the main transformer equipment, each substation will be furnished with a standard 10-kw., three-phase transformer stepping down from 2300 to 110 volts for lighting and auxiliary power circuits. For operating the railway signal circuits a standard 25-kw., single-phase transformer is being installed in each substation stepping up from 2300 to 4400 volts.



FREIGHT LOCOMOTIVE FOR ST. PAUL ELECTRIFICATION—WEIGHT 282 TONS



TYPICAL OVERHEAD CONSTRUCTION

LOCOMOTIVES

Work on the construction of the forty-two 282-ton locomotives is progressing rapidly at the Erie Works of the General Electric Company and in the Schenectady plant of the American Locomotive Company. The first complete locomotive was placed on the test tracks early in September and shipment was made Sept. 25 as scheduled. This locomotive has been taken in charge by the railway company at Chicago and is now being exhibited at various points on the Chicago, Milwaukee & St. Paul system under the direction of C. A. Goodnow, assistant to the president. A complete set of tests indicates that the locomotive will easily exceed the expectations of the designers.

The actual weights of the completed freight unit are as follows:

	Lb.
Total weight	564,000
Weight on drivers	448,000
Weight per driving axle	56,000
Weight per guiding axle	29,000

Twelve of the locomotives on order are geared for passenger service and the remaining thirty are geared for freight service. Both freight and passenger types are equipped for regenerative braking, this apparatus being under the control of the engineer. All of the passenger locomotives and several of the freight locomotives will be equipped with oil-fired steam boilers for heating the passenger trains. This equipment will include ample storage tanks for oil and water.

GROSS OPERATING REVENUES FOR JULY on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were $1,130 per mile, showing an increase of $3 or 0.3 per cent as compared with July, 1914. Operating expenses, were $750, a decrease of $36 or 4.6 per cent. Net operating revenue, therefore, was $380—an increase of $39 or 11.5 per cent, and operating income was $330—an increase of $39 or 13.3 per cent. The operating ratio was 66.3 per cent, as compared with 69.7 per cent in July, 1914, and 70.6 in July, 1913. Considering the three main districts, the respective ratios for July, 1915, and July, 1914, were as follows: Eastern, 65.5 and 70.8; Southern, 71.4 and 75.1; Western, 65.5 and 66.7.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Micaceous Rock Requires Careful Watching

SIR: Under the caption, "Rock slide causes second collapse of subway decking," and the subhead, "Concealed cracks cause slide," in your issue of Oct. 2 it appears that the slipping or sliding of the layers of micaceous shift on each other was the primary cause of the recent accident in the New York subway. As some trying experiences have been had recently with rock structure of this kind in preparing the foundations for two large dams for the additional water supply of Hartford, Conn., it may not be out of place at this time to state some of the causes and remedies.

The material accounted for the most part was a thinly foliated mica schist impregnated to a slight extent with quartz and feldspar, and containing veins, dikes and irregularly-disposed masses of quartz and pegmatite. After some exposure to the air many seams showed that had not at first appeared, while others that seemed tight opened up, and the rock layer had to be removed to get a satisfactory foundation. Several well-defined joint planes crossed the formation through which water was given access to the depths of the rock. This water, acting on certain components of the rock, produced layers of hydrated mica having many of the characteristics of graphite. In other cases the joint planes and seams were tightly filled with very finely divided clay. When first uncovered, these materials were firm and the rock had every appearance of solidity, the seams being quite tight. After brief exposure to the air the characteristics were completely changed. Both the hydrated mica and clay became so unguentous that, had opportunity occurred, there would undoubtedly have been considerable rock sliding.

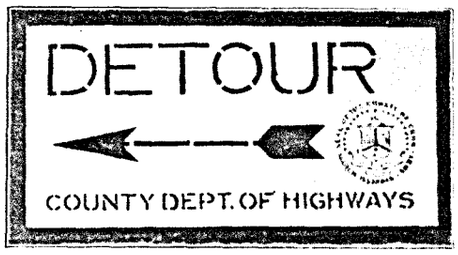
Such conditions are readily detected on the side of a cutting having the ends of the strata exposed, but on the other side the treacherous seams are hidden by apparently firm rock layers. The realization of the conditions and care and patience in searching out and applying remedies at length produced what were considered proper conditions for a foundation. In general, but tempered by experience previously acquired, very extensive use was made of air and water jets to try out the strata. By this same means seams too small to excavate were blown or washed out and the whole mass was tightened up by grouting. Without question the methods here used could also in many cases be applied for the prevention of disastrous rock slides. It is probable that considerable expense could be saved in the rock trenches by a careful study of rock conditions both for preventing unnecessary excavations and for rendering more stable the foundations of heavy buildings in the vicinty of rock cuts.

CALEB MILLS SAVILLE,
Chief Engineer, Board of Water Commissioners.
Hartford, Conn.

[It will be remembered by those who read the description referred to and noted the photographs of this slide reproduced therewith that the break was vertical, and the rock mass had dropped off rather than slid. It should be pointed out that the general practice in New York subway work is to underpin all buildings in advance of any excavation.—EDITOR.]

Signs for Road Detours

SIR: In compliance with a suggestion contained in an editorial in the Engineering Record of July 24 I wish to advise you that this department has ordered detour signs erected, as shown on the accompanying photograph. Whenever a road is to be closed for construction or for bridge repairs by the County Highways Department there has been ordered to be placed such signs,



DETOUR SIGN, COOK COUNTY, ILLINOIS

leading traffic from the point barricaded back to the same road beyond the barricade.

GEORGE A. QUINLAN,
Superintendent of Highways.
Chicago.

Can Sheet-Pile Cut-Off Be Driven in Core of Old Earth Dam?

SIR: Will any of your readers kindly inform me if they know of any case in which interlocking steel piling has been used for repairing a fracture in the puddle core of a high earthwork dam? Such a fracture, due to the erosion of leakage water, has occurred in a dam about 65 ft. high, and it is under consideration to drive a row of piling along the center line of the puddle core for a width of 50 ft., and to a depth of 90 ft. Under such circumstances the questions arise as to whether the piling might be expected to go down vertically, whether it would reach the required depth before becoming earthfast, and whether the shocks of the steam pile hammer would be likely to injure the puddle core.

E. P. HILL.
London.

[Whether the shocks of the pile hammer would be likely to injure the puddle core in question would probably depend on the size of the core and the material of which it is made. It does not seem likely, however, that a puddle core of any size would be injured in any way by driving piling into it. It has been found difficult to keep piling vertical in driving it to penetrations much less than 90 ft. unless a rigid driver and proper guide blocks are used. It is not likely that the cut-off would be a success if any boulders happened to be in the ground below the core. Round piling has been driven to as great or greater depths with the help of jets, and there does not seem to be any reason why sheet piling could not be so driven. If any of our readers have had experience in the use of sheet piling under similar conditions, the Engineering Record will gladly give space to their answers to the questions contained in the above letter. —EDITOR.]

What Is Ultimate Strength of Black Annealed Iron Wire?

SIR: The writer would like to know if you or any of your readers can cite him to references giving up-to-date and reliable data on the ultimate strength of black annealed iron wire, such as is generally used in concrete form work. I am especially interested in the probable ultimate strength of ties formed by twisting two or more strands of wire together as is customary on wall form work.

I have written one large manufacturer of wire, and also to the U. S. Bureau of Standards, but neither is able to give me any information along this line. What data I have been able to find vary considerably, and some of them have proved misleading in my own practice.

ENGINEER.

Inland Water Transportation

SIR: In an editorial in the Engineering Record of Sept. 11, you invite a discussion of an abstract of a paper by Capt. John H. Bernhard on inland water transportation, published on page 332 of that issue. The comments offered by the writer will be confined to the lower Mississippi River problem.

The author of the paper very properly places great emphasis upon the fatal handicap to river traffic imposed by the lack of terminal facilities, with the truly just observation that "with the present river terminals, the height of inefficiency seems to have been reached." He states, also, that "the excessive terminal cost often offsets the advantage of the low river rate."

The first and obvious remedy proposed by the author is to supply these lacking terminals; but that is easier said than done. The author's proposed device of providing floating terminals might in some measure meet the requirements, but can hardly be regarded as other than a makeshift, as permanent elevator structures on the banks of the river are what is needed. But here crops out a fundamental difficulty. You cannot have permanent structures on a river with unstable banks. It is not sufficient that the structure itself be on a permanent site; it is equally important that navigable water be maintained to give access to the structure.

Two notable cases may be cited showing the futility of building costly elevators on permanent sites and not maintaining means of access to them. In the early seventies of last century the Anchor Line Steamboat Company of St. Louis erected a large elevator in Memphis and a similar one in Vicksburg. These elevators very successfully handled a great volume of miscellaneous freight of all kinds. After a few years of such useful service both elevators were rendered wholly inaccessible to steamboats by channel changes created by caving banks several miles distant from their sites, by which the channel in front of the elevators