ELONGATION AND DUCTILITY TESTS OF RAILS FOR NEW YORK CENTRAL LINES.

By P. H. Dudley.

The acceptance of rails under a single drop test of 2,000 lbs., falling a given height, rejects only those of less ductility than is required to take up the energy of the drop before rupture. This range of rejections varies from a small percentage of 1 per cent to 3 per cent of the output, and all in manufacture should be avoided.

Experience has shown that there are likely to be a number of heats of Bessemer and occasionally a melt of open hearth rails in which the ductility is just sufficient to absorb the energy of a single blow of the drop and pass the rails. The butts, however, will break from a second blow without giving any increased elongation, while a number of the rails are so severely strained by gagging in the straightening presses that the strains develop into checks and detailed fractures from service in the tracks.

The percentage in plain Bessemer ranges from 2 to as high as 15 per cent in some rollings, and is yearly increasing in this class of rails. Eighty to 90 per cent of the heats of Bessemer or of the melts of open hearth require two or more blows under the drop to break them, giving a desired range of 12 to 18 per cent of ductility in the rails for service as girders, which experience shows has rendered excellent service in New York Central Lines, where the temperatures often fall to 30 and 40 deg. Fahr. below zero. It is only natural that railway officers should try to secure as good or better material as was possible from 1890 to 1900, in rails for their constantly increasing wheel loads and speeds.

The 1890 specifications of the Boston and Albany and New York Central & Hudson River for the low 0.06 phosphorus and 0.60 to 0.65 carbon Bessemer rails, required a drop test from each heat and that 90 per cent should stand a test of 2,000 lbs. falling 20 ft. without breaking for either the 80, 95 and 100 lb. sections. To this requirement, then, was soon added, "That a butt which broke, yet gave 4 per cent maximum elongation per inch, the rails of the heat would be accepted." It is but proper to say that while a few of the rails had a minimum range of 4 per cent ductility, the majority had from 8 to 16 per cent, and comparatively few breakages occurred. The surface wear and flange abrasion were of slow rates, the rails lasting two and three times as long as more recent Bessemer rails.

To carry the present high speed wheel loads, the former minimum elongation of 4 per cent per inch has been raised to 6 per cent for the maximum inch or two consecutive inches must each give 5 per cent. The ductility of the metal must be exhausted in the test butt from Bessemer heats in which the equivalent of one-tenth of 1 per cent of metallic titanium has been used in the bath of steel. The range of ductility secured in this steel is the minimum specified to 18 per cent per in., though the range of the majority of the heats is from 11 to 16 per cent. The Bessemer heats each, according to weight of section, makes from 18 to 30 rails accepted or rejected by one ductility test.

The basic open hearth melts of 60 to 80 tons each making from 100 to 150 rails, according to section, are accepted or rejected upon the results of three ductility tests, one from the second ingot, one from the middle ingot of the melt, and a third from the next to the last ingot teemed. To accept the rails of the melt each test must show 6 per cent maximum elongation for 1 in., or 5 per cent each for two consecutive in. The ductility of the metal is exhausted in rotation from each of the different tests of the melt and we thus ascertain the general uniformity of the steel of the first to the last teemed. This has tested, but not confirmed, a published statement that the first steel teemed is liable to have so high a temperature that it will be brittle; while the middle ingot will have a proper temperature and be tough, the last ingot will be teemed of steel so cold that it will be brittle. This does not seem to apply to these large melts of rail steel, as shown by the ductility tests. Basic open hearth rails have been rolled under these specifications at Bethlehem, Buffalo and Gary.

The three tests per melt on the open hearth rails call attention definitely to several conditions of mill practice which in hot metal must proceed at the right temperature in a logical and orderly manner. A melt or two at first did not pass, but the causes for failure could be quickly ascertained and remedied in the following melts, the making and rolling of the steel proceeding in a more satisfactory manner to both the manufacturer and customer. The specifications provide that a distinction must be made between a chilled butt and one that is brittle, before acceptance or rejections of rails are made, while the full ductility tests give the low as well as the high range, facts not before available for the manufacturers to study, and guide their efforts to secure the desired range.

The specifications are intended as an aid to good commercial work in manufacture for the necessary quality for present service as well as output. Attention is called to good mill practice after the ingots are teemed and set on top; they should be promptly stripped, weighed and charged into reheating furnaces. This is to avoid unnecessary cooling of the metal developing large shrinkage cavities in the ingots from the inexorable law that molten or hot steel has a greater volume than when cold.

The management of one rail mill has organized a railway service for uniform prompt delivering and charging into the reheating furnaces of its large ingots, with the result of nearly entire elimination of piped rails, under the commercial discard.

CHICAGO PASSENGER SUBWAYS.

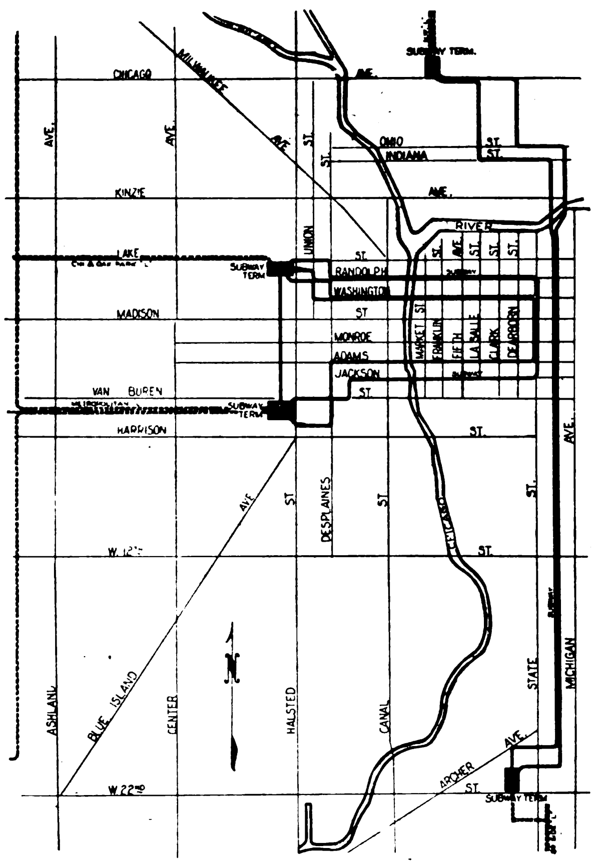
Bion J. Arnold, chief subway engineer of the city of Chicago, has prepared general plans for a complete subway system for the city, in a report transmitted to the mayor and the committee on local transportation of the city council under date of January 31, 1911. Detailed construction plans for the complete work are not yet finished, pending the decision of the city council on the financial policy to be adopted. The information compiled by Mr. Arnold in preparing his report is very complete, covering foundations, underground utilities, occupancy of sub-sidewalk space, the character of soils and other difficulties that would be met in this construction.

The building of a passenger subway for the city of Chicago has long been considered and many plans have been proposed. In 1900 a plan prepared by John M. Roach, president of the Union Traction Company, was presented to the council's committee on local transportation by all the street railway companies operating in the city at that time, the intention being to build a system of terminal loops to accommodate surface cars without providing for any through routes. These plans were not acceptable to the city council, and in pointing out some of the defects in them, John Ericson, city engineer, drew up a tentative plan, embodying the features that were thought essential, but no definite action was taken on his proposal.

The building of the conduit or tunnel which was begun by the Illinois Telephone & Telegraph Company, and which, after changing ownership several times, is now operated as a freight tunnel by the Illinois Tunnel Company, complicated the design of plans for a passenger subway, since its depth below street level made it extremely difficult to provide for a two-level passenger subway above it.

In 1904 the government ordered the dredging of the channel of the Chicago River, to allow navigation of the river by large lake steamers. This necessitated the lowering of the three river tunnels that had been built to remove street car traffic from the bridges. In planning for the rebuilding of these tunnels the question of a subway was again revived and the council committee on transportation had one of the assistant city engineers prepare plans for two subway loops connecting the Washington street and La Salle street tunnels and the Washington street and Van Buren street tunnels. It was the intention to run all surface cars using the tunnels through these subways in the loop district.

George W. Jackson, who was the builder of the freight tunnels, proposed a plan for passenger subways as early as 1902, and in 1904, in accordance with a commission by the city council, he presented a report covering the complete local transportation situation, in which he advocated



Subway Proposed by John Ericson, City Engineer.

building of passenger subways, with two routes to the south side, two to the west side, and one to the north side.

In 1908 the mayor sent a communication to the city council, asking for an investigation of the passenger subway problem, in order that the municipal government could seriously consider the question of providing such transportation. In accordance with this request, Mr. Ericson, the city engineer, prepared a very complete report on the subject, which was transmitted to the city council under date of January 2, 1909. Plans submitted with this report provided for the traffic on the elevated roads, as well as those of the surface lines, which further complicated the problem, since no previous plan had been drawn which had in mind the provision of facilities for handling the trains of the elevated roads in the subway. A great amount of local transportation data was collected upon which to base conclusions in the design of the subway. These statistics showed that the population of the Chicago center was 2,172,000 in 1906, and according to the best estimates would be 6,000,000 in 1950. Since it is known that the ratio of increase in the number of passengers in a local transportation system is greater than the city's population, it was estimated from the statistics of past traffic that the number of rides annually per capita in 1940 would have reached 404. The figures for past years were as follows: In 1885, 100 rides per capita, population 850,000; 1908, 230 rides per capita, population 2,300,000.

The routes for subways proposed by Mr. Ericson are shown in the accompanying map and were intended simply as the first steps in the building of a complete system of rapid transit for the city. The plan as outlined includes three main subways, a north and south line extending through the business district on Wabash avenue, and two east and west subways forming loops on Jackson boulevard and Randolph street and Adams street and Washington street. The terminals of these subways are arranged so that elevated trains can be diverted to them, as well as surface lines, from a large district radiating from the termini. Since the north and south lines of the loop subways are on State street, there are no crossings involved in this system, and the entire length could be built at the high level.

Various other systems for providing for rapid transit have been proposed by engineers interested in the city's development. One of the most recent of these is the shuttle system, outlined in a paper presented before the Western Society of Engineers on February 8, 1911, by A. S. Robinson. This plan proposed building a through north and south subway on La Salle or Clark streets and a loop from the west side on Washington, Clark and Van Buren streets, with the addition later of four or five parallel north and south lines, and as many more additional loops from the west side radiating to the northwest and southwest, so as to eventually serve the entire residence district of the city. This plan was not strictly a two-level design, although within the loop district, where crossings were numerous, Mr. Robinson planned to avoid grade crossings by depressing one of the lines under the other. No stations were planned for the low level, however, to avoid requiring passengers from any section of the city to use the lower stations.

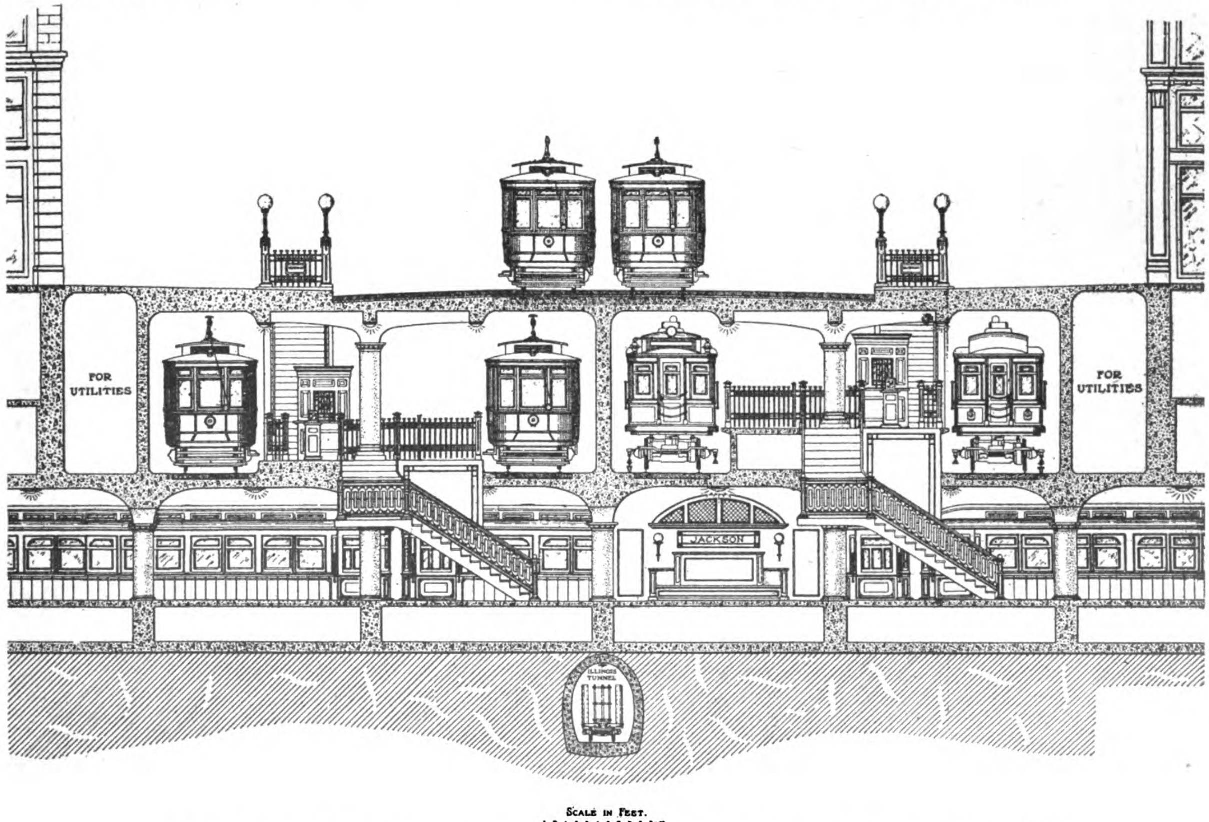
Bion J. Arnold was appointed chief subway engineer of the city in 1910, and proceeded at once to submit a report. In preparing his plans, Mr. Arnold seems to have eliminated most of the undesirable or impracticable features of the numerous plans that have been advanced, and it now seems probable that some definite action upon his report will be taken at an early date. This report includes two alternative plans, one for a comprehensive subway system to care for surface, elevated and high-speed subway cars, and the other for a system providing exclusively for surface cars, with the object of relieving the present congestion in the business district.

Mr. Arnold says in his letter of transmittal that no subway plans should be adopted involving any system of loops which would prevent the building of a high-speed subway system which will ultimately cover the entire city, for no extensive subway building can be justified as an investment unless the operation of such high-speed trains resulting in low operating costs is provided for. The report does not attempt to deal with the financial aspects of the situation, as it is held that regardless of the possibility of justifying the investment from a financial standpoint, the building of the subways is desired by the city to relieve the present congested condition. The complete system should provide for through operation from southern to northern termini, for similar operation on east and west lines, with loop terminals in the business district, and eventually diagonal subways on diagonal streets to connect these north and south and east and west lines. The complete system has been divided in the report into a number of parts, with the idea that the parts can be built consecutively as the available capital and other conditions warrant. The portions included in each step are arranged to afford their proportionate share of relief for present conditions, the relief being commensurate with the investment necessary for building each part. The first step would provided a through north and south subway and a double loop from the west side, to relieve much of the surface line congestion in the loop district. The second step would furnish a north and south line to care for the trains of the Northwestern Elevated and the South Side Elevated, and two loops from the west side, one for the Chicago & Oak Park, and one for the Metropolitan Elevated trains. The building of this second section would make possible the removal of the present elevated loop. Step No. 3 would connect the two west side loops for elevated trains, allowing through routing and a more universal service. The fourth step would provide a loop on Chicago avenue, Michigan avenue and Twelfth street, which, in addition to the sections previously built, would furnish a connection between all steam railway passenger terminals in the city. The accompanying map shows the combination of these four steps, with all the stations recommended by Mr. Arnold. Further steps are provided in the report, to care for future needs as the city expands, but these cannot be accurately forecasted and must be largely conjectural at present.

The bore of the subway, according to the plans submitted, would be of reinforced concrete steel construction, with combination eye-beam and concrete construction in some instances. The size of the bore would be such as to allow the cars now used on the elevated railways to pass through with ample clearance, although the provision for this size involves some additional expense over a subway intended only for surface cars.

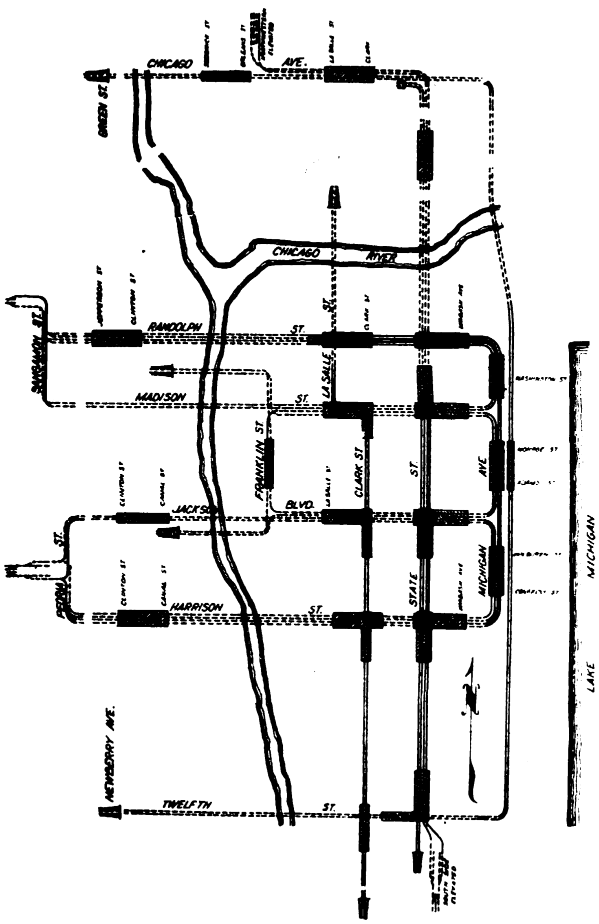
The plans proper do not seriously interfere with the structure of the Illinois Tunnel Company, although at some points this tunnel will have to be slightly changed. The design permits a shallow construction on the high level subways, allows sufficient room for the low level subway to pass under the high level and over the Illinois tunnel, and also allows the low level passenger subway to be placed almost as close to the surface of the streets as the single-decked subways of other cities where mezzanine floors are used. On account of the fact that the freight tunnel is so near the surface that the general use of stations with mezzanine floors is impossible, it will be necessary to increase the width of sidewalks on some of the streets to provide direct stairways from sidewalk to the platform of the high-level subway. The accompanying cut shows one of the recommended stations, the tracks being so located that the entrances to the station can be made directly from the sidewalks without the use of a mezzanine floor. In the stations as designed the cars of the high-level subway will be easy of access from the streets, and passengers will be able to reach the low-level subway without excessive exertion by using the escalators.

The general arrangement of the stations provides straight train or car platforms of sufficient width for all traffic, to or from which passengers may pass expeditiously. Congestion will be avoided by providing that traffic in one direction will not be crossed by traffic in another direction, and at stairways to be used jointly by passengers entering and leaving, railings will be provided where practicable, to separate the traffic going in opposite directions. In general, the island platform type of stations will be used, which is one with its train or car platform between two tracks, so that passengers may be discharged from or loaded upon trains on either side of the platform. If the traffic is to be handled by trains, the platforms will be long enough for trains of ten cars, or 500 feet in the clear, which will permit passengers



Cross Section of Subway Station Looking North in State Street at Jackson Boulevard.

to enter or leave through the vestibules at the end of each car in the train, or through side or middle car entrances. The width of the island station platform is limited by the amount of space available for tracks and stations between the building lines of streets in which the subways will be located, thus limiting the width to 16 feet in most cases, yet giving sufficient capacity for the passenger traffic of trains on the two station tracks at the same time. The stations for passengers using cars of the surface lines not running in trains will have platforms not less than 250 feet long, to permit the operation of cars in strings of at least four cars, not coupled together, but with sufficient space between for safe operation. In addition to the length of train or car platforms required for passengers to enter and leave trains or cars, additional space will be required at each end to



Combination of First Four Steps Recommended by Bion J. Arnold.

provide room for stairways from the street surface, ticket booths, news-stands, telephone booths and public comfort rooms.

The types of high-level subways suggested have sufficient space on each side of the subway structure for utilities. The low-level subways in general permit the location of utilities overhead in galleries, either outside or inside the curb line, and except when the open-cut method is under way at stations, existing utilities need not be distributed.

Mr. Arnold's report includes a detailed estimate of costs of the various steps recommended, which are briefly extracted below: Step 1 will include a two-track subway having 4.128 miles of single track and four stations, at $726,710 per mile, a total of $3,000,000, and 3.663 miles of single track subway and six stations, at $1,364,950 per mile, a total of $5,000,000. Step 2 includes a four-track subway with 10.184 miles of single track and five stations, at $768,550 per mile, a total of $7,750,000, and a two-track subway with 9.5 miles of single track and 14 stations, at $1,421,100 per mile, a total of $13,500,000. Step 3 provides for a two-track subway with 5.954 miles of single track and nine stations, at $1,049,710 per mile, a total of $6,250,000; and step 4 is a two-track subway with 8.78 miles of single track and four stations, at $1,104,780 a mile, a total of $9,700,000. This makes a total estimated cost of $45,200,000 for the first four steps suggested.

NEW CHICAGO PASSENGER TERMINAL OF THE CHICAGO & NORTH WESTERN.

The new passenger terminal of the Chicago & North Western at Chicago, the general design and construction of which have been described in the Railway Age Gazette from time to time, is now nearing completion. The building of this terminal includes not only the constructoin of the terminal building and train shed but elevated approaches connecting with the main lines west about two miles out from the station and north about a mile and a quarter.

The terminal station building has an east and west frontage of 320 ft. on the north side of Madison street, and a north and south frontage of 218 ft. cn Canal and Clinton streets. It is a four-story structure of the early Italian Renaissance style of architecture, with a lofty Doric portico at the Madison street entrance, supported on a colonnade of six granite columns. Immediately back of this colonnade and entered by three great arches is a vaulted vestibule, 132 ft. wide, 22 ft. deep and 40 ft. high. At the end of this vestibule are broad granite staircases leading to the main waitingroom. The interior arrangement of the building was fully described in the Railway Age Gazette of August 14, 1908.

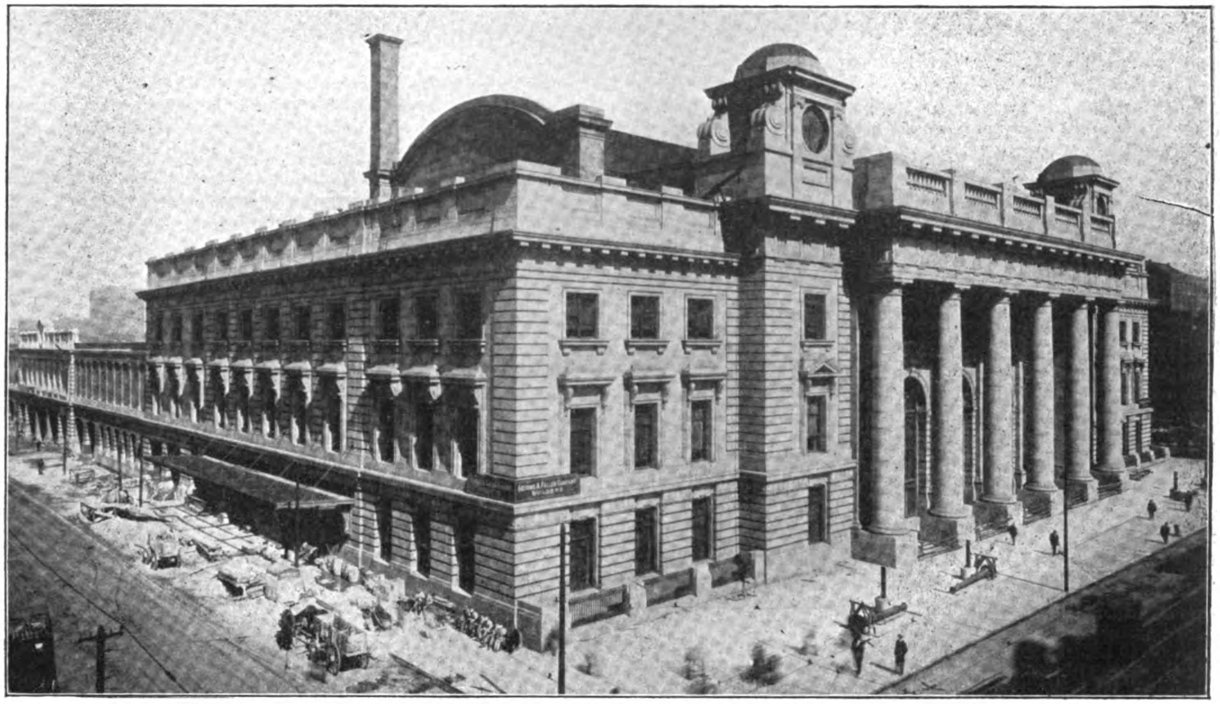
The train shed is of the Bush type, consisting of a connected series of arched girder spans, spanning two tracks and brought down close to the smoke stacks of the locomotives, with a smoke duct running the full length of the shed over each track. (Railway Age Gazette, July 16, 1909, and March 17, 1910).

The power station for light, heat and power is on a triangular piece of ground bounded by Lake street, Clinton street and Milwaukee avenue. It is of mottled gray brick, matching the train shed enclosing walls, with a granite base 6 feet high. The equipment in the power plant was described in the Railway Age Gazette of July 15, 1910.

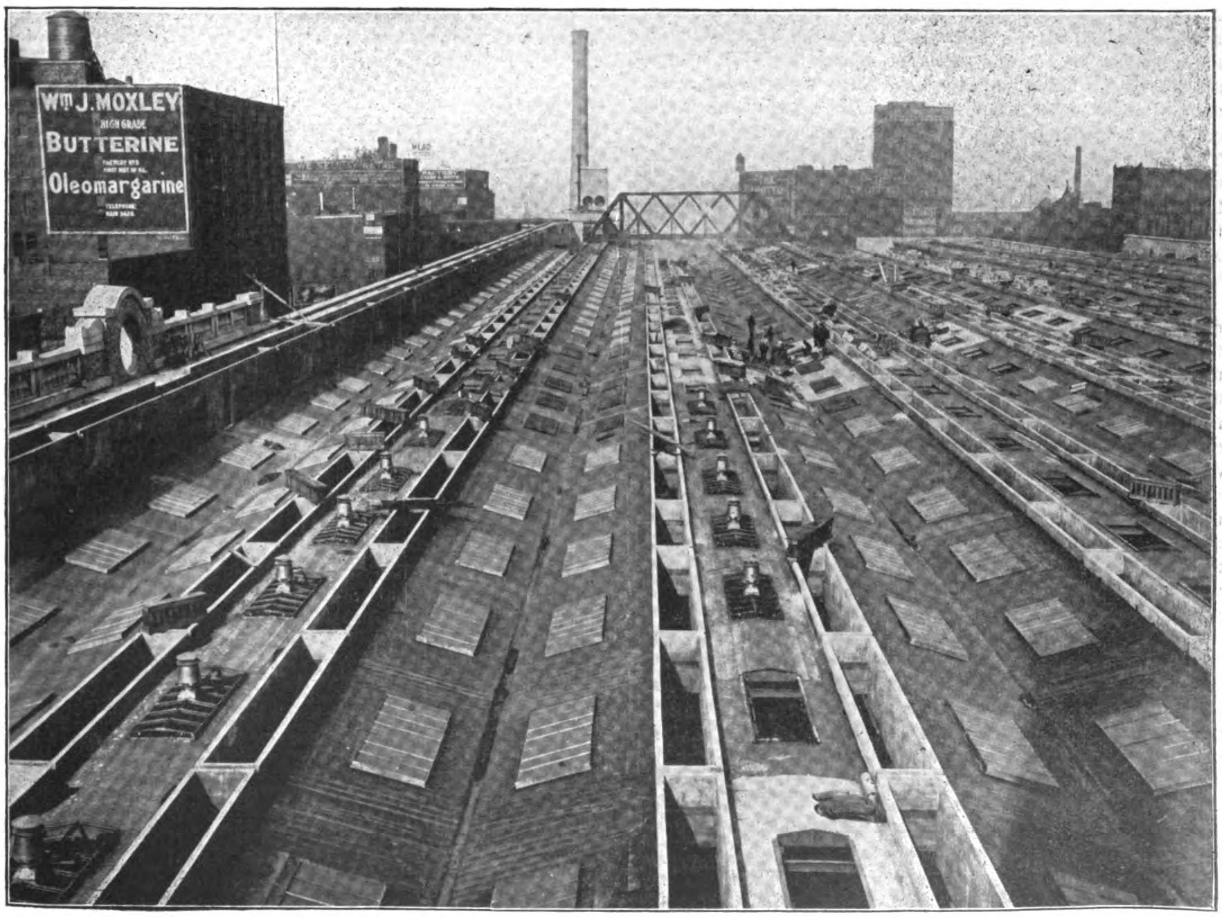
A comprehensive system of electric lighting has been provided for the terminal, one feature of which includes a projector over the entrance to the Washington boulevard subway on the Canal street side, from which a vertical beam of light will be thrown into the air, making the terminal location conspicuous at night. Complete elevator, telephone and fire alarm systems have been provided and a special system for snow melting has been installed. A pneumatic tube system connecting the incoming and outgoing baggage rooms has been installed. The tubes are oval or elliptical in shape, 3 in. by 6 in., and the cartridges are 9 in. in length. in length.

The approaches to the terminal station and the terminal station tracks north of Lake street are laid on sand filling between concrete retaining walls, being carried across the street on concrete trough floor steel viaducts resting on concrete abutments and center piers.

Preliminary studies on the general plan were begun in December, 1905. Work was started on the detail plans in the following November and the wrecking of the buildings on the site was begun at the same time. The first construction work was started on October 27, 1908. Some difficulties were



New Chicago & North Western Station Building at Chicago.



Looking North Over Train Shed from Station Building.

met in sinking wells, when fine running sand and water were encountered, making it necessary to use compressed air and requiring the sinking of the wells to rock. These wells were filled with concrete, the last one being completed June 1, 1909. Cast base setting for the steel work was started in the latter part of March, 1909, and th work of setting the foundation girders commenced the first week of April, 1909. The last steel was placed in position on March 22, 1910. Granite setting commenced the second week in May, 1909, and was completed on April 16, 1910.

In the train shed, pile driving for the foundation was commenced on October 1, 1908. Thirty-six caissons, each 6 ft. in diameter, were sunk under the approach to the Washington boulevard subway and were completed June 18, 1909. Pile driving for the foundation of the powerhouse was started August 6, 1909, being completed October 4, 1909, and was followed immediately by the concrete capping and the construction of the retaining walls. Brick-laying commenced February 1, 1910.

At the present time almost all the work has been completed except the installation of signals and some finishing on the interior of the building. This work is being rushed as much as possible, and it is expected that the station will be open for service within a few months, although no definite date has as yet been set.

COMMITTEE ON SIGNALING OF THE AMERICAN ELECTRIC RAILWAY ASSOCIATION.

The committee appointed by the American Electric Railway Association to investigate and make a report on signaling systems for interurban railways met at the Congress Hotel at 9 o'clock Wednesday morning, March 22, 1911. Representatives of seven signal companies were present, and arrangements were made for them to present the claims of their various systems at stated times during the day. The committee asked for suggestions as to the best method of procedure in its study of the principles involved, and Frank Rhea, of the General Electric Co.; L. F. Howard, of the Union Switch and Signal Co., and W. K. Howe and M. R. Briney, of the General Railway Signal Co., offered some excellent ideas.

It was the consensus of opinion in the meeting, as it is elsewhere among engineers and railway officers who are interested in the subject, that the proper course for electric railways to pursue in signaling their lines is to cover the dangerous points first with apparatus so designed that it will form a basis for future extension and an ultimate complete and comprehensive system of protection. The committee occupies a peculiar position, and its work is going to be very important in the development of protective measures. The problems to be solved are in the main the same that have been so well handled by steam road signal engineers, but they differ in many minor particulars which only a thorough knowledge of operating requirements can reconcile with the technical necessities involved.

As was said in the meeting, the first thing to do is to prepare a plan of the situation to be signaled, and then the proper protection can be applied. The committee's "data sheets," which are being sent to all electric railways, are doing this in a general way, and will give the association information regarding practically all of the important conditions which will be dealt with in its work.

TWO-DAY MEETING OF SIGNAL ASSOCIATION.

The Railway Signal Association is planning to make the meeting which will be held in New York City during June this year a two-day meeting.

IMPACT TESTS ON REINFORCED CONCRETE TRESTLE.

By J. H. Prior, Assistant Engineer, C. M. & St. P.

Some tests to determine the amount of impact on a trestle of reinforced concrete under train loads have recently been completed by the Chicago, Milwaukee & St. Paul, under the direction of C. F. Loweth, chief engineer. The tests were made on the reinforced concrete trestle, shown in Fig. 2 and Fig. 4, by R. L. Stevens, assisted by an instructor from the University of Wisconsin, experienced in such work.

An examination of Fig. 4 shows the trestle to consist of two beams supporting the slab, forming a double T-beam. The total depth of this beam is 3 ft. 6 in., but if the parapets are considered as part of the beam this depth is increased to 5 ft. 4 in. As the span is only 16 ft. center to center of piers, the concrete beam has a large ratio of depth to span. Some unexpected difficulties were encountered in this work, due to this ratio of depth to span, and also to the fact that the girders are practically continuous over the supports.

The information mostly sought in these tests was the unit stress in the steel, due to the total loads on the structure, including impact, as this information is of fundamental importance in the design of similar structures. On account of the great depth of span compared with its length, and the partial continuity of the beam over the supports, which had been only partly relied on in the design, the unit stresses in the steel were low and the consequent distortions were so small that errors of the smallest magnitude affected the results by large percentages. On account of this, the results as a whole are somewhat unsatisfactory, but are thought worthy of publication in order to mark out a little progress in the subject and save others from traversing the same ground.

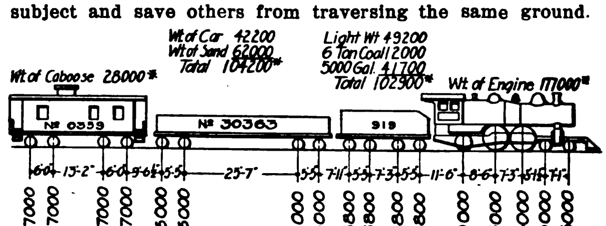


Fig. 1. Test Train.

Table 1 gives most of the important results of the tests. The following is a description of the manner in which these results were obtained: The test train, shown in Fig. 1, consisting of the railway company's class A-2 engine, one gondola car, loaded with sand, and a caboose, was used for making the test. The trestle spans were designed for an E-50 loading, but the above train was equivalent only to about E-35 loading. An engine class A-2 was selected because in this type, which is a four-cylinder compound, the unbalanced weights on the drivers are rather excessive and were expected to produce greater impact than other classes of locomotives. A marker was placed on one driver so that the location of the counter-weight might be determined for the various runs.

Table I. Summary of Results, Showing Percentage of Impact.

(1) Speed m. p. h.	(2) Extensometer No. 9. Engine. Per Cent.	(3) Extensometer No. 9. Car. Per Cent.	(4) Extensometer No. 10. Engine. Per Cent.	(5) Extensometer No. 10. Car. Per Cent.	(6) Extensometer No. 11. Engine. Per Cent.	(7) Extensometer No. 11. Car. Per Cent.	(8) Extensometer No. 12. Engine. Per Cent.	(9) Extensometer No. 12. Car. Per Cent.
8								
20	16	41	14	25	15	54	18	32
45	16	32	14	31	18	24	20	21
50	33	32	36	40	33	24	45	27
60	41	38	46	31	42	39	54	27
21	14	29	19		15	42	12	18
63.5	38	46	27	87	18	30	33	18

The four extensometers and the deflectometer used in the tests were loaned by the University of Wisconsin. The tests were conducted in a manner similar to those made by the American Railway Engineering and Maintenance of Way As-