more incentive for the Western roads to return cars towards home after discharging lading than before the bureau was organized. It was the sense of the convention that a penalty of not less than $1 for each case should be collected from roads diverting foreign cars to transport freight in which the car owner has no interest, and a resolution to this effect was passed to be referred to the General Time Convention for action.

The convention adjourned June 26 to meet in New York either next May or June, as may be decided upon by the Committee of Arrangements.

New Station and Interlocking at the Jersey City Terminus of the Central of New Jersey.

INTERIOR OF TRAIN SHED—CENTRAL RAILROAD OF NEW JERSEY, JERSEY CITY, N. J.

The Central Railroad of New Jersey has just put into operation the extensive interlocking plant erected for it by the Union Switch & Signal Co., at the entrance to its station at Jersey City, N. J. We illustrate herewith the arrangement of tracks, showing the signals and their arrangement, and also give a view of the interior of the train shed, which is notable as having an excellent skylight.

The new station is erected on the site of the old one, and the tracks approaching it have been entirely relaid with 76 lb. rails. The yard has been regraded, the filling being cinders and slag, and has been raised in some places as much as 4 ft. Rock ballast will be put in as soon as the new ground is settled. The train shed is already in use, but the waiting rooms, offices, etc., are not quite finished.

The arrangement of the tracks is very clearly shown in the engraving. The plan is not drawn accurately to scale in all particulars, but the arrangement of the cross-over tracks and switches and the relative position of all important features are correctly shown. The small figures along the upper and lower sides of the drawing give the longitudinal distance in feet between the points of the switches. It will be observed that by the arrangement of the long cross-over track, *S* and the shorter one *N*, every conceivable movement between the station tracks and the main tracks of the main line and the Newark Branch can be made with great facility. Tracks 8 and 10 are used for switching purposes, and signals 11, 12 and 13 are for trains leaving either one of those tracks and moving towards the station. These signals govern switch 29, but not 27. The location of these semaphores is slightly incorrect in the drawing, their position being, like that of the other signals shown on the bridge, at the right of the engineer approaching them. The usual rule of having the upper signal indicate for the right-hand route where two or more arms are placed upon one post, is observed. Signal No. 2 admits to track *S* only. A train proceeding along that track into Nos. 3, 5, 7, etc., has to get another signal (14, 15) before it can proceed beyond switch 39. Signal 3, however, gives a clear road into the train-shed, the track for which it is set being shown by the indicator. Signal 4 gives a clear road on the north cross-over track as far as signal 18, at which point indicators show the route for the remaining distance. Thus the three principal signals just described admit to six, four and five tracks, respectively.

Signals 6, 7 and 8 give similar indications; the other signals, being arranged on the same plan, will be clear to the reader. Although there are 40 switches altogether, there are but 22 levers for them, and these levers also move three movable frogs. There are five movable frogs in the plant, the radius of the slip switches being made quite long (500 ft.) in order to admit of rapid train movements. With a radius of this length ordinary frogs leave a considerable space at the centre unprotected by any guard rail, and they are thus liable to derail trucks which have a short wheel base or are not in the best of order. There are 49 facing-point locks and signals governing 80 routes, making the total number of levers as follows: 22 levers for 40 switches and three movable frogs; one lever for 2 movable frogs; 14 levers for 48 facing-point locks; 29 levers for 40 signals and 40 indicators and one facing-point lock; total, 66 working levers. The heavy coloring at the switches shows their normal position.

There are no distant signals, but the machine has 72 levers, of which two are left spare for the insertion of distant signals for tracks 1 and 4, if it should be desirable. The tower is 15 × 38 ft., and it is manned by three men, two of whom attend to the levers. The lower floor of the tower is sunk about 20 in. below the surface of the ground, and the perpendicular rods and wires from the levers above are joined to the leading-out connections *above* the floor instead of beneath it. In front of the operators in the tower are hung temporary charts, showing in large figures the proper order in which to pull the levers for each movement. The floor on which the operators stand is covered with corrugated rubber, such as is used on car steps, out-door stairs, etc. Inward trains, after discharging their passengers, are "kicked" back by the road engine into track 10, the engine stopping at signal 67. The engine then proceeds on track No. 6 to the engine house. The yard engine distributes the cars from track No. 10 to the sidings leading from track No. 18.

The new station building, or head house, which supersedes some very shabby wooden structures which have been in use ever since the opening of the road to Jersey City in 1864, is of brick, 128 × 215, and three stories high. It has a central tower, with a clock, on the side facing the Hudson River, and there is a magnificent Howard clock, with glass case, facing the train shed. There is a large central hall, or waiting-room, 64 × 96, open to the roof. Surrounding this are the offices, restaurant, etc., on the first floor, and rooms for officers on the second and third. Ornamental iron balconies giving access to the upper stories surround this inner court on three sides. The wainscoting of the interior is of light yellow English glazed brick, with black trimming, and the general appearance is very neat and handsome. The train shed is 215 ft. wide × 512 long, and about 75 ft. high in the centre. The walls are of brick and the roof, as will be seen from the illustration, is of iron and glass. The noticeable characteristic of the train shed is its very light and cheerful appearance, in which respect it is an advance on anything we have seen in this country. The main span of the roof is 144 ft. and the skylight in the centre is 55 by 512. The glass is supported on Helliwell's patent steel bars, with bearings 13 ft. apart. No putty is used. The outer end wall, which does not show to good advantage in the illustration, being so far in the background, is wholly of glass. The Helliwell glass roof, of which Josephus Plenty, of 69 Broadway, New York City, is the agent, has been largely used in England, the Blackburn station of the Lancashire & Yorkshire having 160,000 sq. ft. of it in the roof, and the Brighton station of the London, Brighton & South Coast 107,000. The Hull & Barnsley has a similar roof of 40,000 sq. ft. at Springhead, and a number of other roads have smaller roofs. The Jersey City roof contains 28,000 sq. ft. of glass. Of the 12 tracks in the train shed the six odd numbers are used for inward trains and the six even numbers for outward. The platforms separating each pair of tracks from the neighboring pair are 14 ft. in width and are of the well-known granolithic pavement. They are about 12 in. higher than the rail.

The architects of the station and train house were Peabody & Stearns, of Boston, and the contractors V. J. Hedder & Sons, 18 Cortlandt street, New York. Post & McCord, 102 Broadway, New York, did the iron work, the rolled iron coming from the Phœnix Iron Co. A separate building contains the boilers for heating and the electric light apparatus, which consists of four large Edison dynamos. There are four Babcock & Wilcox boilers. These also furnish steam for heating passenger cars in the yard. The cost of the building, which embraces four new ferry slips, is stated as about $400,000, and the total expenditure $500,000.

American Society of Civil Engineers—Convention of 1889.

The Convention began at Seabright, N. J., Thursday evening, June 20, with a meeting for organization. Mr. J. J. R. Croes was made Chairman of the Convention. Announcement was made of the programme of meetings.

On Friday morning the first paper was that of Mr. Theodore Cooper on

AMERICAN RAILROAD BRIDGES.

The paper is a long and elaborate one, and would fill about six pages of the *Railroad Gazette* without any of the many illustrations which accompany it. It was not read in full.

About one-third of the paper is a brief history of the wooden, iron and combination bridges of the United States, illustrated by examples of several of the early structures.

The first bridge entirely pin connected is thus described:

"In 1858–59, John W. Murphy built for the Lehigh Valley Railroad a Whipple-Murphy bridge of 165 ft. span over the canal at Phillipsburg, N. J. In this bridge he substituted for the cast trunnions on the post feet of the Whipple bridge pins of wrought-iron, unturned. The lower chord was formed of wrought-iron elongated links similar to the Whipple form. The main web bars were wrought-iron bars with looped eyes at each end. The counter bars were also bars with looped eyes, but the lower eye was elongated and fitted with gib castings and keys for tightening the bars. This is the first truss bridge, as far as the author has been able to discover, which was pin connected throughout. In 1869 this bridge was taken down, and put up as the middle span in a long wooden bridge of nine spans, at Towanda, Pa., to reduce the liability of destruction of the whole bridge by a fire. In 1879 it was again removed, and rebuilt by substituting wrought-iron compression members for the cast-iron, turning the pins, reboring the links, etc., and put up at Shepherd's Creek, on the Southern Central Railroad.

"In 1861 Mr. J. H. Linville built a bridge on the Delaware extension of the Pennsylvania Railroad over the Schuylkill River, in which were used for the first time wide forged eye-bars and posts formed of wrought-iron sections.

"The era of long span truss bridges in America may be considered as dating from the building of the first bridge over the Ohio River at Steubenville, between 1863–64, by Mr. J. H. Linville. The channel span was 320 ft. long and 28 ft. deep. The top chord and posts were made of cast-iron. It was proportioned for a rolling load of 3,000 lbs. per foot of track, a notable increase in the load heretofore in use.

"In 1876 the Cincinnati Southern Railroad bridge over the Ohio River was built by the Keystone Bridge Co. under specifications prepared by Mr. G. Bouscaren, the design being made by Mr. J. H. Linville. The channel span was 519 ft., the longest truss span ever built up to that time. The channel spans of the Henderson Bridge, 522 ft., and of the Ohio River Bridge, Kentucky Central Railway, at Cincinnati, 550 ft., are the only independent truss bridges up to the present time with greater spans.

"There are now in existence on American railroads over five miles of bridges with spans from 300 to 400 ft., nearly four miles with spans from 400 to 500 ft., and 2½ miles of bridges with spans exceeding 500 ft., estimated as single track bridges, all exclusive of wire suspension bridges.

"The Erie specifications drawn by the writer in 1878, embodying the results of his experience in the designing of bridges, their shop construction, the testing of material and the study of existing bridges and their defects, was the first general specification covering the designing, proportioning and detail of construction with that completeness necessary to give the railroad company the full advantage of the competitive method, with a certainty that the resulting structure would in all ways be up to the advanced state of the art. It was the first paper on bridge construction in which that relic of ignorance, 'the factor of safety,' was entirely omitted. It definitely specified the working strains to be allowed on the different parts of the structure, according to the service they were to perform.

"A successful bridge engineer, from the American point of view, must be something more than a mere calculator of strains. This is the most elementary part of the duty, and does not come with the province of designing. After the selection of the skeleton form and relative proportions of panels, depths and widths of span, a very moderate knowledge of mechanical mathematics would enable any one to determine the strains in an American bridge. He must, in addition to his knowledge as to the effects of varying forms and proportions, have a full knowledge of the capacity of his forms and their connections, and also of the practical processes of manufacture and erection. He must know how his design can be made and put together, and whether it is so harmonized in all its parts and connections, that each part may do its full duty under all possible conditions of service. In addition to knowing all the elements that make up a perfect design, he must have the instinct of designing or the power of adapting his knowledge to any individual case, in order to obtain the best or the desired result. The experience, observation and a sharp competition with men of like knowledge and instinct will give him his position as a bridge engineer."

Mr. Cooper developed at considerable length the modern American system of computation of strains by the use of a diagram of engine and train load, obtaining the maximum shear and maximum moment at any given point in the truss. This method was worked out simultaneously, but independently, by Mr. Cooper and by Mr. Robert Escobar in 1880, and has since been adopted by the various bridge companies and published in the text books of Prof. Merriman and Prof. Burr.

The development of the methods of obtaining knowledge of the strength of materials was then taken up and Mr. Cooper says: "To-day every first-class bridge manufactory has its complements of testing machines, to test with all the refinements either samples of the material or full-sized members in compression, tension or traverse strain. Our knowledge of the strength and capabilities of our material and of the usual forms employed in the American style of bridge is such that no first-class bridge company in America hesitates to accept the clause now general in all specifications, that 'full-sized members may be tested to destruction,' with the sole proviso that the expense of testing and cost of the piece shall be paid for by the purchaser if it satisfies the requirements of the usual specifications. This positive knowledge of the capacity of our full-sized members marks one of the great advantages of our system of bridges over all others. We, therefore, have a right to claim, that as our working strains are as low and in many cases lower than those used in Europe, with our more perfect knowledge of the strength of our members, we have in our first-class structures a greater factor of security than prevails in European bridges.

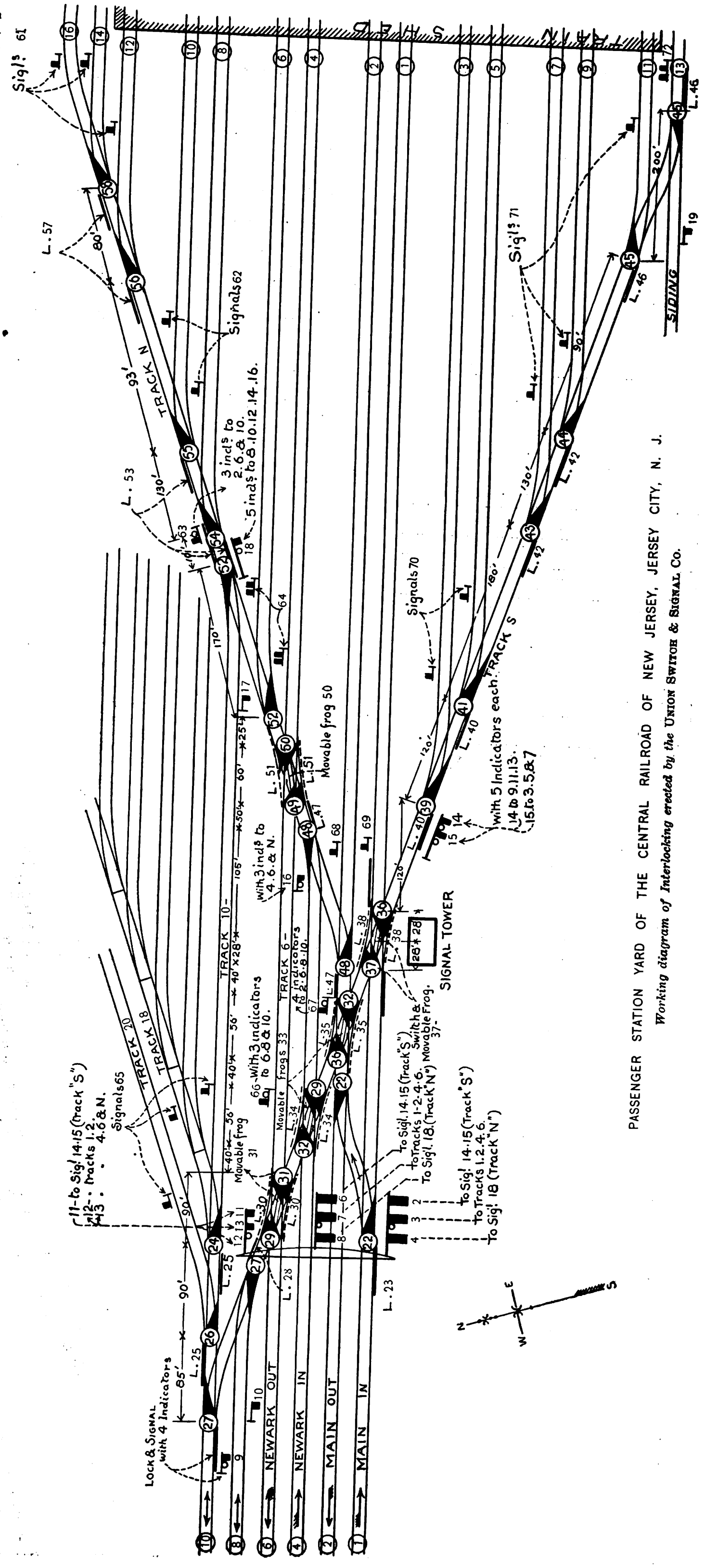
"There are to-day in America more than forty bridge building companies manufacturing railroad and highway bridges. Of these, at least a dozen are capable of constructing bridges of every size in a first-class manner. The shops, which can be called especially shops capable of constructing the largest class of railroad or highway bridges, are capable of turning out by the year 125,000 tons of bridge work. It would be safe to estimate that all the shops could turn out 200,000 tons, or approximately 80 miles of 100-ft. spans of single track railroad bridges, per year, if their plant were devoted exclusively to this work. Other iron work, as roofs, iron buildings, piers, elevated railroads, etc., however, make a considerable figure in their yearly output. Some few of the bridge shops have been constructed to do riveted work almost exclusively.

"The surety of the fitting of the members of even the largest structures after they have passed through a properly organized bridge shop is such that no assembling of the finished members of a structure is ever made at the shops, except in extremely crooked and complicated structures, and even then not as a whole, but only sufficient to test the fitting of specially intricate connections."

A general description of the parts of a typical American bridge was given, and a statement of the great advantages offered by the pin-connected structure for rapid erection. The case of joist erecting on the Cairo Bridge, which was described in the *Railroad Gazette* some months ago, was cited, and photographs of the span in various stages were given.

The statement was made that "with the exception of not over a few score spans, the longest of which are 180 ft., lattice bridges, the iron bridges of the United States, for spans of over 100 ft., amounting to about 7,000 spans, aggregating 210 miles in length, are of the pin-connected type. * * * The longest pin-connected truss span in existence is the recently completed channel span of the Ohio River Bridge at Cincinnati, 545 ft. from centre to centre of end pins, 84 ft. deep at the centre and 60 ft. at the end posts; panels, 27 ft. 1½ in.; trusses, 30 ft. apart, centre to centre. It carries a double-track railroad between the trusses, and has on each side a wagonway and foot walk 16 ft. wide. The persistence of the pin-connected type of structure, now that the bridge engineer acting for the railroad companies has become an important factor in the problem of bridge construction, shows that it is not solely due to the preferences of the manufacturers; but that the operation and maintenance of such structures are also in favor of this type."

"Taking from the Railroad Commissioners' report such data as appeared correct and complete, and adding thereto this additional information [from the railroads direct], avoiding as far as possible any duplication of the same roads, data covering nearly 60,000 miles of railroad, fairly distributed over the whole of the country, were obtained. In order to make these data as nearly comparable as possible, the length of all double-track bridges was reduced to the corresponding length in single-track bridges. In like manner, the length of all main tracks, omitting sidings and turnouts, was put into terms of single track. Elevated railroads, which are composed mostly of bridges or trestles, have been omitted entirely. Table No. 1 gives the general data as to quantity of bridges and trestles and the average rate per mile of track. It shows that the relative amount of bridges and trestles varies in different districts from 58 ft. per mile to 231 ft. per mile. This last, however, is excessive, from including the crossing of Lake Pontchartrain, near New Orleans, on a trestle 22 miles long. Omitting this, we would get only 162 ft. per mile as the maximum. These variations are not entirely due to geographical location, as might appear at first thought. They are also affected by principles governing the original location of each road or division of a system. The alignment and grade may have been sacrificed to the avoidance of bridges or trestles, or the contrary. From the large



PASSENGER STATION YARD OF THE CENTRAL RAILROAD OF NEW JERSEY, JERSEY CITY, N. J.

Working diagram of Interlocking erected by the UNION SWITCH & SIGNAL CO.