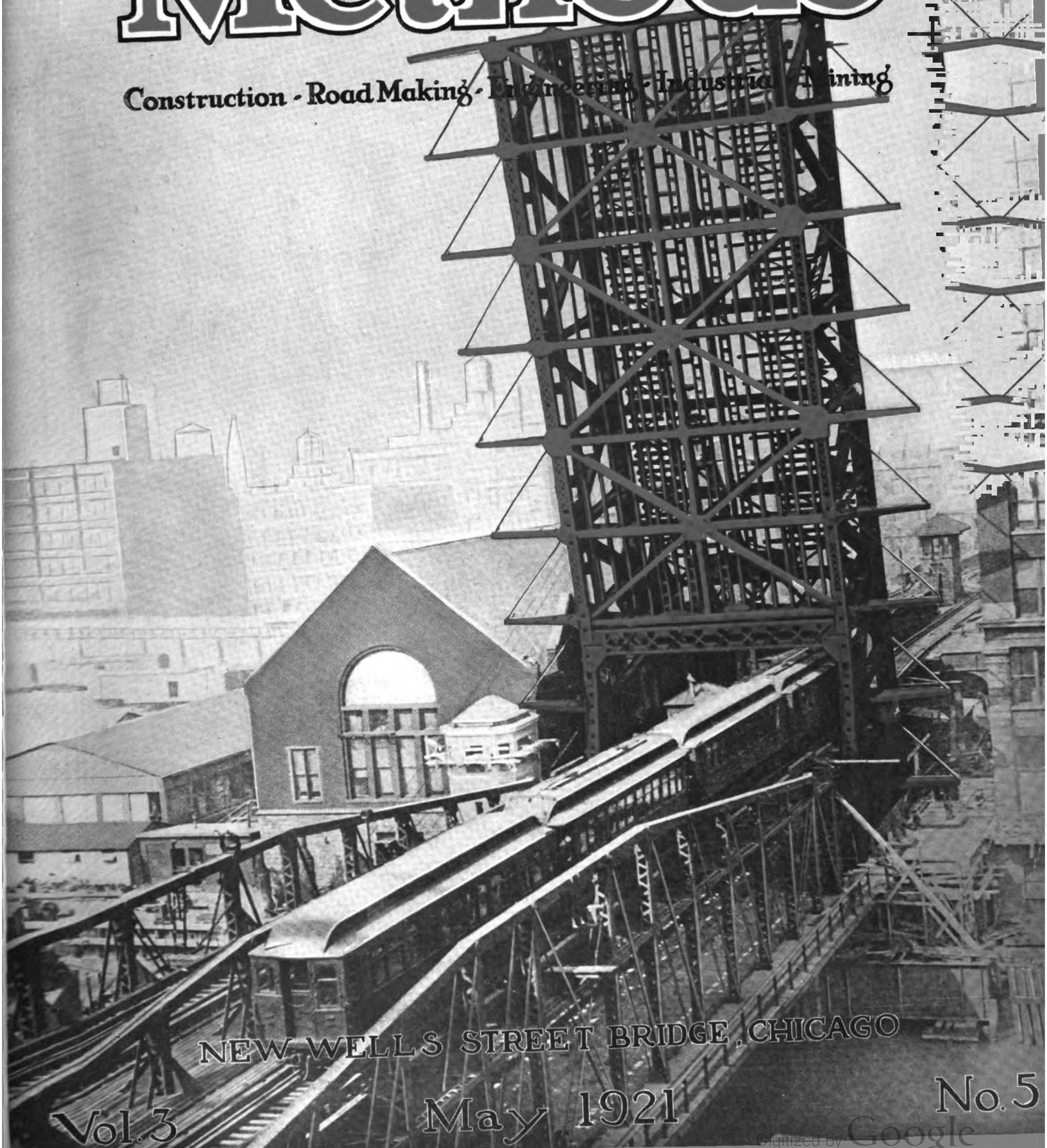
Successful Methods

Construction - Road Making - Engineering - Industrial - Mining



NEW WELLS STREET BRIDGE, CHICAGO

Vol. 3 May 1921 No. 5

BASCULE REPLACES SWING BRIDGE

New Double Deck Structure in Chicago Is Being Built with Minimum Interruption of Traffic

By ARTHUR W. CONSOER

THE new Wells Street bridge across the Chicago River in Chicago is rapidly nearing completion, as shown on the cover of this issue of SUCCESSFUL METHODS. The substructure has been completed and practically all of the structural steel has been erected. Work is progressing at a favorable rate on the ornamental concrete bridge towers, on the approaches and on the bridge floors.

The concrete bridge towers are pleasing architecturally and the bridge and towers have been designed to harmonize with the water front development along the Chicago River, between the new Franklin Street bridge, which is a good example of how much of the ugliness of a steel bridge can be eliminated by suitable architectural treatment, to the new Michigan Avenue "Boulevard Link" Bridge, which has received much favorable comment since it was opened to traffic last summer. All of these bridge improvements are part of the scheme for the improvement of the Chicago River proposed by the Chicago Plan Commission.

The Wells Street bridge is the most important avenue for traffic between the north side of Chicago and the loop district. It is a double-deck structure, the upper deck carrying the trains of the Northwestern Elevated Railroad and also the trains of the Chicago and North Shore Electric Railroad, and the lower deck carrying the street car traffic, vehicles, and pedestrians. It was deemed necessary by the city officials to erect the new bridge without seriously interrupting the traffic on either the upper or lower levels of the old swing span. The construction operations were planned so as to involve the least possible interruption to traffic. Naturally this procedure increased the cost of construction and has resulted in considerable delay in completing the bridge.

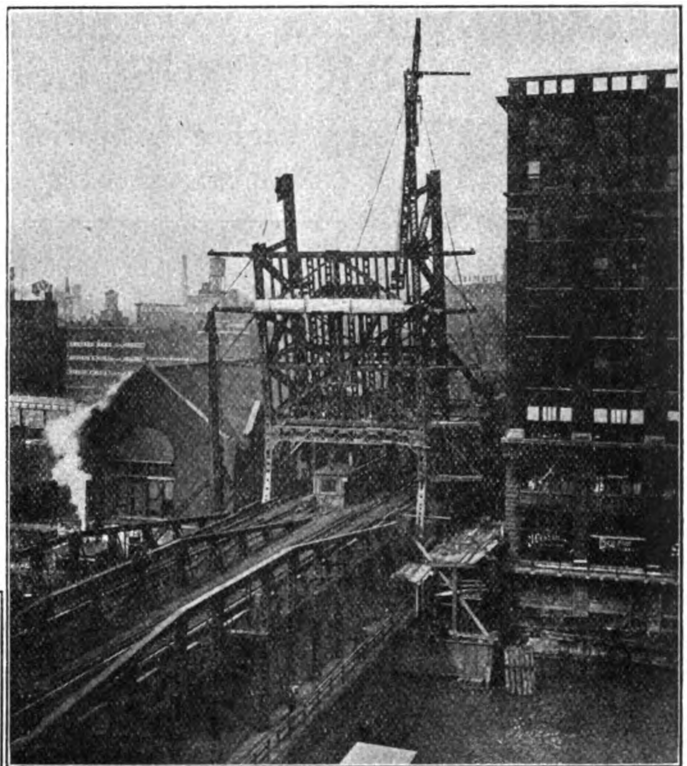
When the time comes to place the bridge in service it will be necessary to interrupt traffic for only a short time. It is estimated by the contractors for the superstructure that at that time traffic will be suspended for not more than 2 days. As shown in the construction views in this issue the spans of the new bridge are being erected in the upright position, so that the old swing bridge can remain in service at all times. When the erection of the new bridge has been completed, the swing bridge will be swung out and supported at the various panel points on pile bents. The center portion

LINING UP ONE OF THE BIG TRUNNIONS. THIS OPERATION HAD TO BE CONDUCTED WITH GREAT CARE AND ACCURACY.

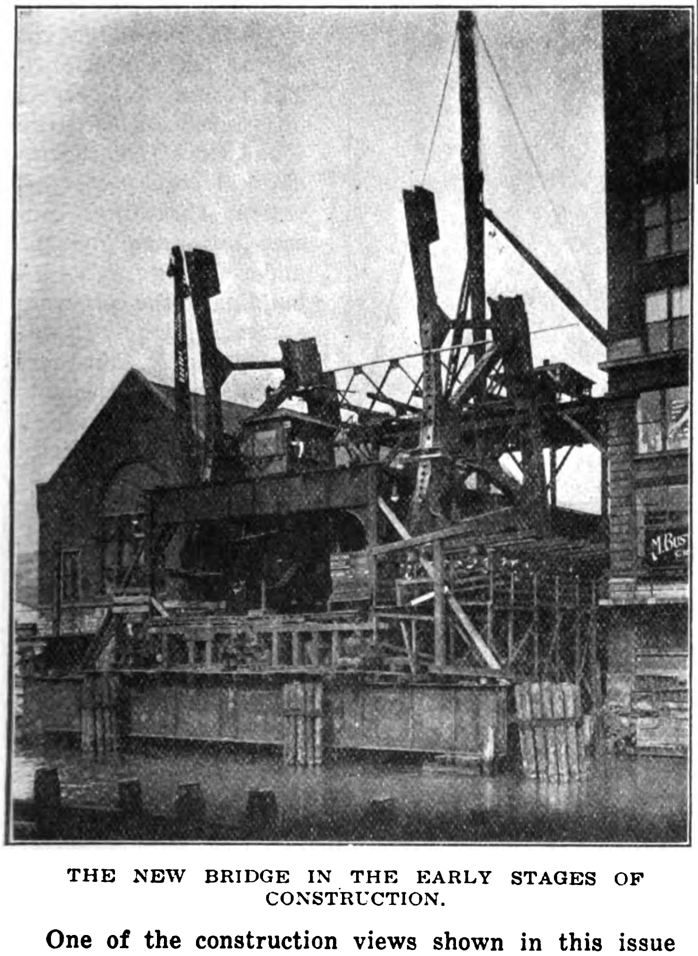
of the old bridge will be rapidly cut out with oxy-acetylene apparatus, and the two spans of the new bridge will be lowered into place.

One other double-deck bridge of similar design has been built in Chicago over the river at Lake Street. In that case, however, no attempt was made to maintain traffic on the street level during the construction period, although provision was made for keeping the upper deck in service.

The new Wells Street bridge is of the trunnion bascule type as developed and designed by the Bridge Department of the City of Chicago. The new bridge has a span of 268 ft. between centers of trunnions, which will provide a clear channel of 200 ft. between the protection piers which will be built in front of each abutment. The upper deck carries two tracks of the elevated railroad and the lower deck has a 38-ft. roadway with two street car tracks, and also provides for two 13-ft. sidewalks.



STILL RISING WITHOUT INTERFERING WITH TRAFFIC.



THE NEW BRIDGE IN THE EARLY STAGES OF CONSTRUCTION.

One of the construction views shown in this issue illustrates the type of trunnion bearing used on this bridge. These trunnions are 27½ in. in diameter. Great care was used by the engineers in charge of the work to insure the accurate placing of these trunnion bearings. The photograph illustrates the device which was used to line up the trunnions. Points were set on either side of each trunnion, and then a wire was stretched between these points and kept taut by hanging weights. The head of a pick which can be seen in the photograph is doing duty as a weight. The face of the trunnion was then brought to a correct position by measuring the correct offset from the wire, and adjusting the position of the trunnion base by means of jacks.

Timber platforms were placed as shown in one of the construction views to protect the traffic below from possible injury by falling rivets or tools.

In order to erect the spans in the upright position without interruption to traffic derricks for the erection were placed on top of the abutment walls and later other derricks were placed on top of platforms built over the elevated railroad. In this way the bridge members could be picked up from the barges in the river and hoisted into position without interruption to traffic on either deck of the old swing bridge.

The contractors for the substructure were the Fitzsimmons-Connell Dredge and Dock Company of Chicago, and the superstructure is being erected by the Ketler-Elliott Erection Company.

STATE AND BOROUGHS COOPERATE

ON a number of highways being constructed by the Pennsylvania State Highway Department the routes pass through boroughs in which the streets are wider than the highways outside of the borough limits. The problem presented by this condition has been solved by the state paying for 18 ft. of the total cost of the road within the boroughs and the borough paying for the extra width necessary to complete the paving from curb to curb. This method of adjustment is working out satisfactorily to both the state and the boroughs, and is a great improvement over the practice in some parts of the country where the cities and towns have absolute jurisdiction over the construction of roads within their limits.

Vol. XXVII JANUARY TO DECEMBER, 1922

JOURNAL

OF THE

WESTERN SOCIETY

OF

ENGINEERS

PAPERS, DISCUSSIONS, ABSTRACTS
PROCEEDINGS

CHICAGO
PUBLISHED BY THE SOCIETY
1736 Monadnock Block

The Wells Street Bridge

BY THOMAS PIHLFELDT,* M. W. S. E.
Presented October 10, 1921

I believe it would not be out of the way to go back a little into history to show the conditions that led up to this somewhat unusual method of constructing a bascule bridge. The activity of the Department of Public Works in replacing center pier bridges by bascule, had its beginning in 1901. The problems confronting the City Bridge Division then, and for several years later, were comparatively easy. Wherever a bascule bridge was to take the place of a center pier bridge the traffic was diverted and distributed over adjacent bridges in the territory. Or, if the thoroughfare happened to be a very busy one, a temporary bridge on pile bents, with a movable portion that would give an opening sufficient for the movement of vessels was constructed far enough away from the permanent bridge site to give ample room for free and efficient construction operations.

In the early part of 1909 the Federal Government having control of our navigable waters, through the Secretary of War, ordered the removal of the double-deck swing bridge at Lake street. This Lake street bridge then was considered an obstruction to navigation. The order also stipulated the replacement of the center pier bridge, with a bridge having a clear opening for navigation, not less than the distance face to face of abutments at datum of the center pier bridge. This distance was approximately 210 feet. The draw openings were approximately 66 feet wide.

The question then arose as to how to take care of the Oak Park Elevated Railroad, using the other deck without an encroachment on the then existing facilities for vessel movements, during construction of the new bridge. A temporary bridge was considered impractical both as to efficiency and cost. It would have been possible to reinforce and double-deck Madison Street Bridge, with a temporary elevated structure east of the river, connect to the Market street spur, and west of the river in Madison and Canal streets connect to the main line in Lake street. While this proposition was discussed in the official family of the Bureau of Engineering only and never emerged from its embryonic state, nevertheless its existence became known to outsiders and this resulted in a vigorous protest from property owners along Madison street whose frontage consent was necessary for its consummation, and the proposition was consequently dropped. With the suggestion of a temporary bridge, also the utilization of the Madison Street Bridge during the construction period of the new Lake Street Bridge, both abandoned, we were back to our starting point, the government's removal order and with a somewhat gloomy outlook as to the practical solution of this, to all appearances, knotty problem.

Let us for a moment consider the immense volume of traffic over our bridges, particularly the double-deckers. I shall give you some figures based on our traffic counts, which are taken twice a year. The figures are, of course, averages, and cover the period from 7 in the morning until 7 at night, or 12 hours. We find as follows: Eight hundred and fifty teams, 1,130 autos, 1,000 trucks, 1,050 street cars, 7,000 pedestrians, 1,000 Elevated trains; and let us not forget that these bridges are open for vessels on an average of 300 times a month. Reflecting on these figures I think you will agree with me that the task of maintaining this enormous volume of traffic over a bridge, when a new bridge is constructed under and over it, is not so very easy after all, and I do

*Engineer of Bridges City of Chicago.

not think you will be surprised when I confess that there were times when I thought myself stumped. In analyzing the situation at Lake street it occurred to me that by abandoning all the traffic on the lower deck and only maintaining the elevated trains, which could not be diverted, or maintain about one-sixth of the total volume of traffic, our problem would be materially simplified, and that actually proved to be so. Shutting off the traffic on the lower deck enabled us to remove the sidewalks and their brackets, pull the piles in the pier protection, redrive them closer to the center pier, which again allowed us to construct cofferdams and still maintain the same width of the two draws as before. With proper temporary supports for the end of the swing bridge and the elevated structure we had fairly good room for the construction of the foundations, and with that completed we felt that we were out of the woods.

The City Bridge Division took hold of the Wells Street proposition in a hopeful and cheerful mood, enriched by our wonderful experience gained through the design and construction of the Lake Street Bridge, notwithstanding the demand to so design and construct the new bascule bridge that the full volume of the traffic could be maintained over the present swing bridge with a minimum of interruption and inconvenience to the public. In the case of the Wells Street Bridge the sidewalks on the old swing span were not removed, only made narrower, because the draws of this bridge were somewhat wider than the draws at Lake street.

The present Wells Street bridge was built in 1888 as a highway bridge for ordinary street traffic, including street cars, and remodelled in 1896 to carry in addition the double track load of the Northwestern Elevated Railroad. This old bridge is now about to give way to its modern successor, a double leaf, double-deck trunnion bascule bridge, which, on account of the long span, and the heavy loading, exceeds in weight any of the city's two-truss bridges thus far built. I shall not attempt to give in detail an explanation of the design and description of this bridge, but will confine myself to a brief explanation of the converting of the bridge from swing to bascule.

In order to make possible the maintenance of traffic on the lower deck, it was necessary to provide temporary supports for the roadway and sidewalks on the fixed approaches to the old bridge, so that the new substructure could be placed thereunder. For this purpose, steel girders and trusses were provided, and the floor loads were carried by them to pile clusters outside of the limits of the new work. The construction of the greater part of the cofferdam could then be accomplished without disturbing the old bridge. During the remodelling of the lower deck on the fixed part the street was closed to vehicular traffic only one roadway at a time, and very slight inconvenience was caused thereby.

Provision for driving those portions of the cofferdam directly under the swing bridge was made by stopping traffic between the hours of 1 A. M. to 4:45 A. M. for a period of about two weeks for each dam, and swinging the span to the open position during that time. After the completion of the cofferdam, the excavation for the counterweight pits and sub-piers was in order and this was followed by the placing of the concrete and steel for these parts of the structure.

To effect the erection of the bridge superstructure, without interfering with traffic, it was necessary to omit floor beams, stringers and bracing in two panels, so that with the bridge leaves in the open position, vehicles and elevated railway trains could pass through the structure with a clear space from truss to truss.

On the 2nd of December we expect the work on the superstructure to have progressed so far as to bring it to the last leg of construction, that of changing from the old swing bridge to the new bascule. For that purpose the elevated road traffic will be completely shut off, the old swing bridge will be opened and blocked up on the pier protection. A portion of the bridge will then be cut out, either by burning or cutting the members enough to give clearance for the leaf of the new bascule bridge. While this is being done, the steel floor system and bracing of the new bridge leaves can be completed and a track on the upper deck installed. It is expected that the interruption of elevated railroad traffic will not exceed 48 hours. In other words, if nothing unforeseen happens, traffic on the old swing bridge will be shut off at 8 P. M. Friday, Dec. 2, and traffic resumed on the new bridge Sunday evening, Dec. 4. At the south end of the bridge the construction of a temporary approach is necessary until the improvement of South Water Street has advanced far enough to permit the building of a permanent approach as a part of that project.

It is expected that the entire improvement will be completed in January, 1922. The total interruption to street traffic during this entire construction will be approximately 90 days.

DISCUSSION

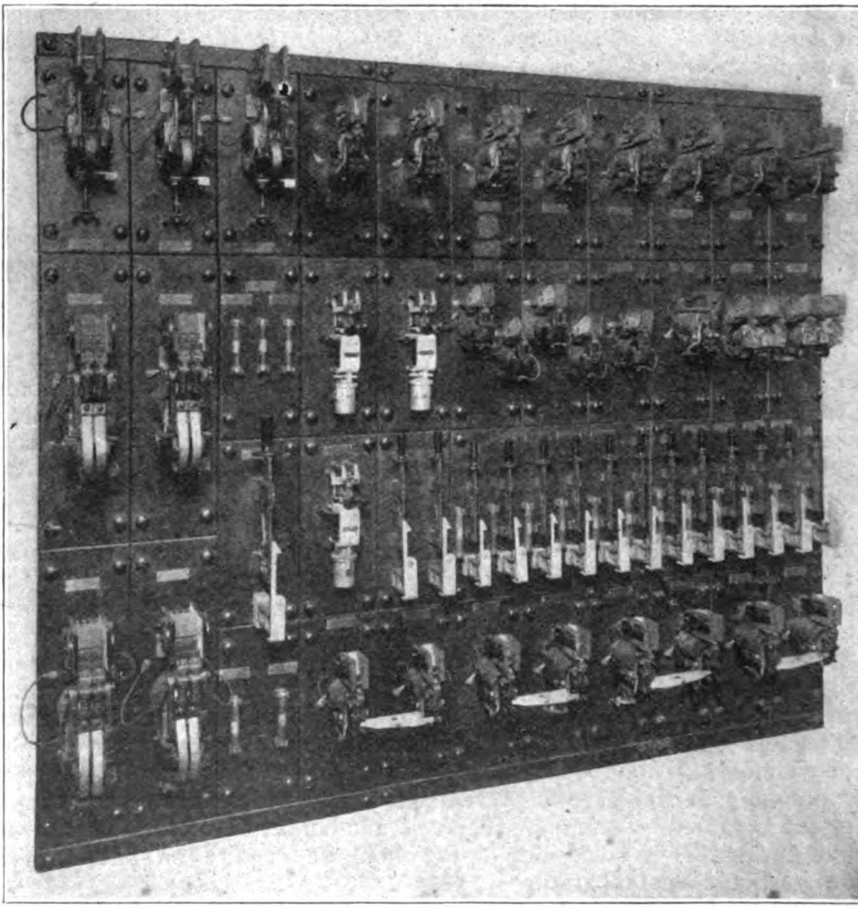
C. H. Norwood, M. W. S. E.: We have here a photograph of the control apparatus on one side of the Wells Street bridge, which was taken in the factory. We cannot photograph these when installed because the room they occupy is so small that we cannot focus the camera to get the whole board. Quite a difference between a control panel of today as compared with the street car type of controller of the older bridges, such as Dearborn Street.

To give you some idea of the mechanism or the power required on the Wells Street bridge, I will say that the main motors are two 100-h. p. mill type, direct current, 600 volts. There are two heel lock motors which operate a latch which is supposed to lock the bridge from behind—one in each pit. In the center of the bridge, at the elevated level, is a lock motor about 3 horse power. Besides this, there are two pit pump motors, 15 h. p. each, eight motors operating roadway gates and four motors, I think, 5 h. p. each, operating barrier gates. These are on the street level. You know the bascule bridges of this double-deck type, when they open up, leave a big gap in the street. They put up a barrier gate to prevent teams and pedestrians from going in. These are operated by motors. There is another small motor that operates the gates. This gives some idea of the room we require on one of these bridges to house this apparatus.

One point I might speak of, the City of Chicago has always insisted on two sources of electrical supply for operating their bridges. On the Wells Street bridge we have one source of supply from the elevated railroad, connections being made on each side of the river, and the other connection is made with the surface lines, one at South Water street and one at Kinzie street. The reasons for that are to assure current for the operation of the bridge at all times. If by any means the current should fail, as it has failed on the elevated, they can be assured of current from the surface lines. This, I think, is a very excellent idea and has been carried out on practically all of the bridges that I have had anything to do with. In some cities where they haven't the power, cannot secure the double service as we do here, they install auxiliary gas engines.

I understand a test was made recently on some gates at Michigan avenue. A barrier gate in order to be successful has got to stand a pretty good impact, and I do not know whether these tests that have been made are going to be the real answer or not. I think the real answer will come after those gates have been in service for a few months.

One other point that might be mentioned, they started out to put on some rack brakes on Wells Street bridge. I've been fooling with rack brakes for



Control panel for one leaf of the Wells Street Bridge.

six or seven years, and I have not yet found one that will work very satisfactorily. I have had several conferences on this matter and the city had several conferences and finally the rack brakes on Wells Street were abandoned. I was glad to see them taken off. The first rack brake that we ever had any experience with was, I think, on the Great Northern, at Seattle. They tried to operate that with an air cylinder with air on one side of the piston only. The brake would get set and for some reason or other could not be released. Finally they decided to put air on both sides. Some of the rack brakes today are designed so you can only put air on one side and release with a spring.

That, I think, is very bad, because the release is obtained by steel springs which I don't think is reliable.

There is another point that I want to speak of that is rarely mentioned in papers, and that is the maintenance of an electric installation after we leave the job. The matter of inspection and maintenance on the job is absolutely vital. We can put in the most expensive machinery. There are just a few little things that can happen on a control panel, such as dirt getting on contacts, bolts coming loose, etc., that will put the whole control system out of commission. In installations like that is, it is absolutely necessary to have an auxiliary source of power. The other points on maintenance are almost too many to mention.

It is absolutely essential in bridge designs, especially in machinery, to place runways or I beams, or something by which the heavy apparatus can be easily removed.

Lubrication—Various types of bascule bridges require different kinds of lubrication. We try to get the oil waste bearing wherever we can, we get them on direct current motors, but we cannot get them on alternating currents unless we have a special head design, and frequently that costs more money than we can afford to spend. The oil waste bearing will permit the motors to be turned over (there are certain types of bridges that the motor goes up with the bridge). In that case you cannot use the oil ring bearing, you have to use the waste packed bearing. The motors out on the end of the bridge, for instance the lock motors, always go up with the bridge. From a maintenance standpoint, I think the oil waste bearing is very much preferable to the oil ring type. With that type, frequently the ring gets stuck and you do not know you have trouble until the motor is burned out. An oil waste bearing will keep on doing as well as it can, until the oil is gone, and then you will smell some burning waste.

Now that electric equipment has become quite complicated on bascule bridges it is very necessary that spare parts be carried. The Baltimore & Ohio Railroad has found this greatly to their advantage. The City of Chicago carries a spare armature for each leaf and now orders on their contracts spare parts for each one of the contactors. A maintainer should go over his plant at least once a day. On railroads they get that attention because electrical maintenance is generally under the supervision of the Signal Department and these maintainers are trained in the maintenance of delicate apparatus.

The electrical interlocking on these bridges is such that the first thing the operator does on opening the bridge is to close his roadway gates. Closing the roadway gate gives current to the motors operating the barrier gates, which in turn give current to the heel lock motors, after these have completed their cycle, the current is given to the contactor, releasing the center lock motor which completes its cycle, and in turn gives current to the main operating motors. Of course when I say completes its cycle it energizes the contactor next in sequence at the end of that cycle which gives current to its particular motor. There are indicator lights which show the completion of the cycle on the heel lock motor, center lock motor, and main operating motors, and the operator knows when the main contactor closes. The lamp indication shows that the cycle has been completed and he can then throw the master controller which operates the main motors. One point about the master controller, it does not give automatic control. In some classes of work it is desirable to have automatic control, in other words the operator could take this master controller and slam it right over and the motor accelleration takes care of

itself. That is not so ón a bridge. We do not think it desirable. We have taken the stand ever since the remote control has been used on moving bridges that the accelleration of the main motors should always be under the control of the operator. In other words, he might want to notch it up, one, two, three, four, five, up to six notches (six notches is the most on this type of control), but it always ought to be under his control. The objection to the automatic control is the variations in the load. All bridge engineers know that in the bascule type of bridge, the load varies with the weather, and in order to obviate that adjustment on the current relays due to variations in the load, and the continual manipulation of the adjustment of the contractors, straight shunt control is desirable with the accelleration under the control of the operator at all times.

When the operator closes the bridge the cycle is reversed, first the main motor gives current to the center lock motor, then the heel lock motor, then to the barrier gates and then to the roadway gates. They have all got to complete their respective cycles or nothing that follows functions—if it doesn't function the bridge tender has to go out and find out what the trouble is—generally they find the trouble is a little dirt under the contacts, things are not kept clean. It is not the serious things that generally put these electrical devices out of commission. Of course they do occasionally, but frequently it is dirt or lack of lubrication that will put a fine piece of apparatus out of service.

The electrical apparatus costs more on the new bridges because we are putting this remote control apparatus in nowadays as a "safety first" precaution. I forgot to mention that Franklin-Orleans and possibly Monroe Street are the first bridges that I know of in the United States to use safety first control devices, that is, they are safety first in that there is no exposed copper in the operator's house. All this complicated mechanism that I have shown is locked up in a room below, where the general public cannot get at it. That is one of the reasons of the increased cost. Another thing, engineers are motoring their bridges heavier, larger spans requiring larger motors, and when we get into the larger unit it is quite necessary to put in the remote control. Any job over 50 horsepower we find, that it is, generally speaking, cheaper to put in the remote control. With remote control we require solenoid brakes.

Question: Do the motors operate in parallel?

Mr. Norwood: Only when the bridge motors are operated from a storage battery. I think there has been no series-parallel operation of motors since 1912. We do not advocate the use of series-parallel control on any type of bridge where the current is secured from power stations (direct current). For ordinary purposes it is desirable for mechanical reasons to use the parallel control. Parallel control is used in both the direct current and alternating current. I say parallel; in alternating current each motor is handled with a separate controller and in the direct current it may be handled from one control but each motor should have separate resistance. It gives a better load balance for the motors. On some of the vertical lift bridges, there are some in Portland and in several in Chicago of the Waddell type, I understand they do have the series operation of the motors. Now I do not know why, of course it gives wonderful torque in starting and all that, but I have found that one of the lifting motors will generally do the work.