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AND ITS PRACTICAL APPLICATIONS

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ELECTRICAL OPERATION OF EIGHT-TRACK LIFT BRIDGE.

An eight-track motor-operated rolling lift bridge, which is unusual in its arrangement and size, as well as in the completeness of its electrical details, is nearing completion over the Chicago Drainage Canal at Thirty-first Street and Campbell Avenue, Chicago. The structure in reality comprises a group of four double-tracked single-leaf rolling-lift bridges, alternate spans being placed on the same pier. The bridge as first constructed in 1901 consisted of fixed approach spans with an arch channel span of the double-leaf rolling-lift type. Later, when it was determined to open the canal to navigation, the former plan for four double-leaf arch spans was abandoned in favor of four single-leaf bridges lifting in

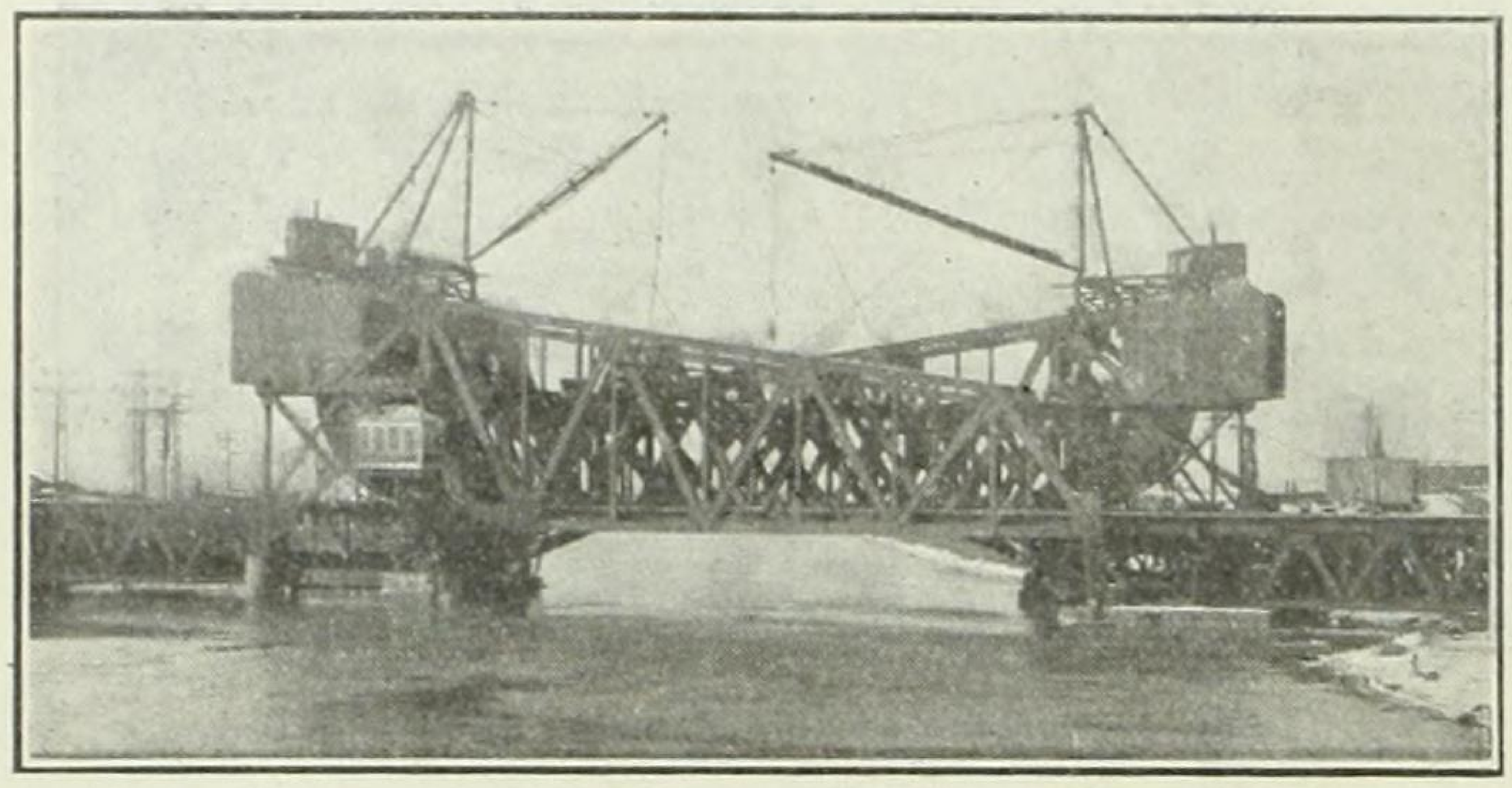

Fig. 1—Side View of Bridge.

alternate directions and bridging from pier to pier. By the use of this alternate interleaving of the spans, a minimum distance is required between pairs of tracks, the outboard rack-and-pinion operating structure for each bridge being so placed at the ends of the adjacent bridges as to require no additional space between the tracks. The bridge spans are accordingly erected with a clearance of about 5 in., in spite of their 150-ft. swings, and as a result of skilful engineering design occupy the piers formerly provided for the first type of bridge.

The longer truss of each span is 154-ft. between bearings, the individual bridges being 29 ft. wide from center to center of trusses, and clearing the water level by 16 ft. The bridges cross the channel on a skew, making an angle of about 68 deg. The clear width of the channel for navigation, provided between piers, is 120 ft. The canal banks have been widened near the bridge by a distance about equal to the width of the concrete and stone piers, giving a clear waterway of nearly 300 ft. beneath the bridge. The total rolling load of the 154-ft. trusses is 852 tons, which is carried on segmental girders of 28-ft. radius, rolling on a toothed track 2 ft. wide. This total rolling load of 1700 tons for the entire bridge, including the 52-ton segmental girders and 363 tons of structural steel in each truss, is counterbalanced by approximately 1000 tons of concrete poured as a monolith filling the riveted plate-metal box and wings, which show prominently in the accompanying illustrations. Niches are left in these counterweights for adding pig iron to make the final adjustment. The highest point of the counterweights and top girders is 79 ft. above the water level. When raised each bridge will extend into the air 197 ft.

The four leaves are controlled from two operators' houses, the south operator manipulating the movement of the two bridges lifted on the south pier, and the other operator controlling the alternate north span. The driving machinery for each bridge, which comprises two 50-hp, 500-volt, direct-current motors connected through reduction gearing to the main pinion shaft, is mounted on the platform level just above the operator's cabin. At the center of the rocker arcs are the main pinions which engage the main racks, one on each side, rolling back over them in a horizontal direction, while the points of bearing contact of the rockers follow beneath, thus raising the bridge. Each motor is provided with a shunt solenoid-released brake which ordinarily is automatically applied when the energy supply to the motors is interrupted. On the main pinion shaft there is also an auxiliary brake which is released by a small motor, operating through gears. By means of this brake, intended for emergency use and as an auxiliary to the solenoid-released brakes on the motor shafts, braking action can instantly be applied at the will of the operator, or automatically when the energy supply to the motor is cut off. At the extremity of each bridge span, a main latch is provided, operated by a 3-hp motor working through gearing and a crank-arm. Supply of energy to the latch motor is automatically interrupted and the series solenoid brake consequently applied, when the latch reaches the end of its travel.

An ingenious and complete system of electric interlocking prevents the operator from raising the bridge without full authority from the signal tower controlling this section of track, besides making it impossible for him to injure the bridge mechanism by any improper sequence of operations, due to oversight or carelessness. Thus, the bridge latch cannot be withdrawn until the corresponding signals have been set by the tower man, auxiliary windings applied to the contractor mechanism rendering it impossible for the bridge operator to get energy for this purpose until authorized. In the same way the bridge itself cannot be raised until the latch has been completely drawn, since otherwise the main contactors cannot be closed until the preceding motions have been performed. The motors are operated from drum-type controllers, through mill-type contactors mounted on the switchboard in the operator's cabin. In front of the operator is an electric-lamp indicator, which shows by lighting successive lamps, the movement of the bridge, reporting when the latter has reached its extreme position. At this juncture the operator is expected to shut off the supply of energy to the main motors, but in case of his failure to do so, auxiliary contacts opened by the bridge's motion interrupt the circuits of the closing coils for the main circuit-breakers, at the same time automatically applying the solenoid brakes. The bridge will be slightly undercounterbalanced, so that in lowering it, after the motors have imparted full speed to the structure, they can be shut off, the shunt solenoid brakes being meanwhile energized and held off by a foot-switch, allowing the bridge to drift freely. It is impossible to throw out

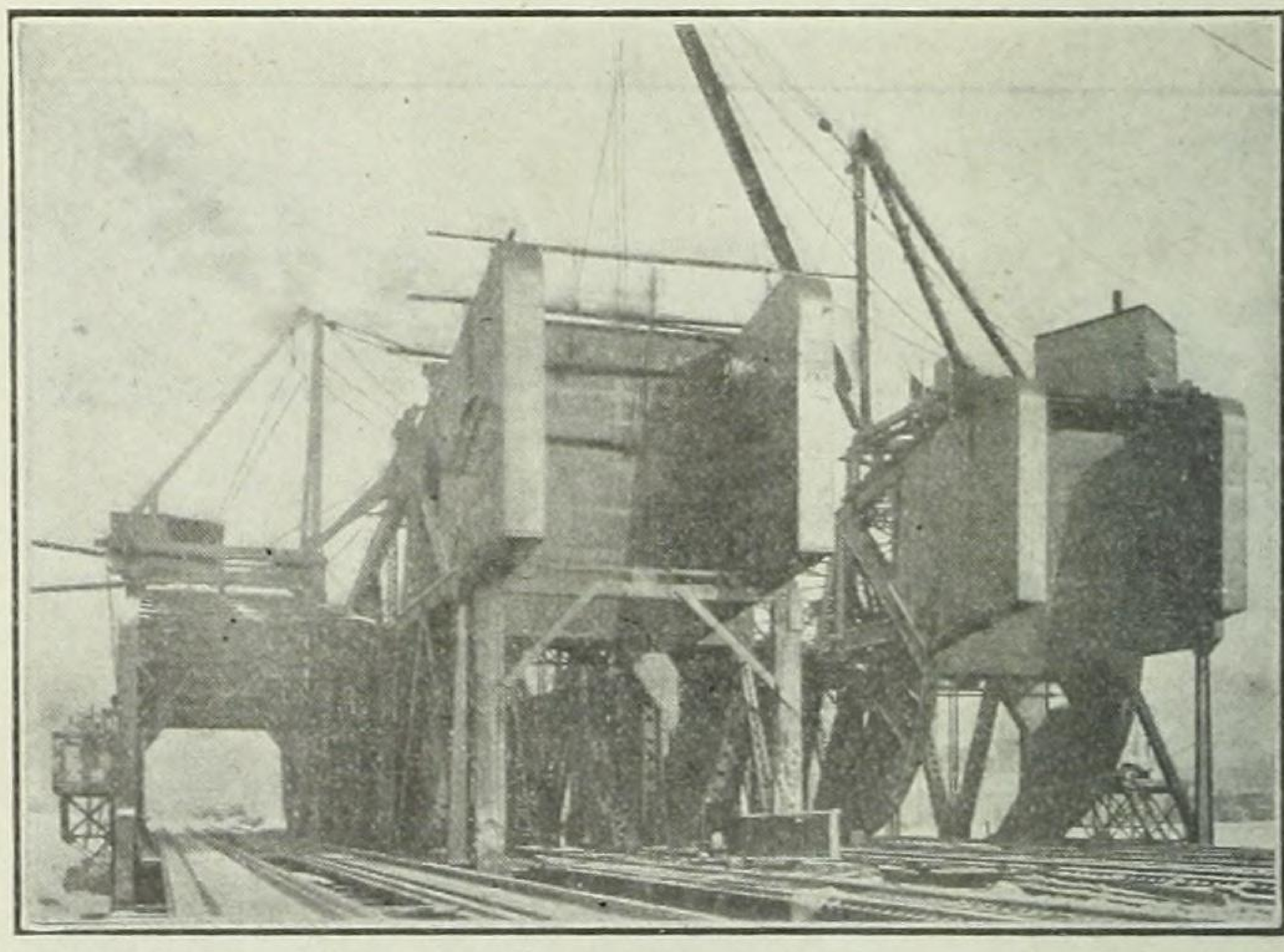

Fig. 2—End View of Bridge.

the bridge latch while the bridge is in the air, or indeed until it has become firmly seated in place on its pier. This act of seating depresses a contact on the distant pier, which secures operating energy for the latch motor. After the latch has been thrown, it is itself locked by a traversing pin which returns the signal to the tower man that the bridge is ready for traffic.

It was before explained that the bridge operator cannot get energy to operate the spans until he has the authority of the tower signalman. However, for use in case of emergency, such as if the bridge were endangered by a large vessel about to ram it—a situation which probably could not be explained to the tower man in time to be of service—the operator's board is provided with a special glass-enclosed switch, by smashing the covering of which, the operator can complete auxiliary circuits which secure him the electrical energy to work the bridge.

Electrical connection between each moving bridge leaf and the stationary members, for the various motor and signaling circuits, is made by cabling all wires inside a 4-in. wire-wound rubber hose, 32-ft. long, looped so as to hang clear of all obstructions in any position of the leaf. Each end of the cable-carrying hose enters a special metal bell, emerging in junction boxes, from which the circuits are carried to their respective destinations. All wiring about the bridge is in conduit. The various electrical circuits of the structure—exclusive, of course, of copper in the appliances, solenoids, motors, etc., themselves—comprise 40,000 ft. of No. 14 wire, 4600 ft. of No. 10, 5000 ft. of No. 2, 140 ft. of No. 20, 600 ft. of 300,000-cir. mil cable, 1125 ft. of 350,000-circ. mil cable and 5000 ft. of No. 14 stranded conductor for use in the flexible connecting cables. There are three submarine cables connecting the opposite piers of the bridge, two of 350,000 circ. mil cross-section conveying the main supply circuits, and a multiple conductor signal cable containing the various auxiliary circuits and providing telephone communication between the operating houses.

The 500-volt direct-current supply for the bridge motors and signal circuits is brought 400 ft. underground from a motor-generator set in the Sanitary District's Western Avenue substation, which is the city terminus and transforming station of the 40,000-volt transmission line from the hydroelectric generating plant at Lockport.

The above-described eight-track rolling-lift bridge, which conveys four tracks of the P. C. C. & St. L. R. R., two tracks of the Chicago Terminal Transfer and two of the Chicago Junction Railway, was designed by the engineers of the bridge department of the Sanitary District of Chicago, Mr. C. R. Dart being bridge engineer and Mr. S. T. Smetters assistant engineer, with Mr. F. R. Williamson in charge of construction. The bridge mechanism was designed by the Scherzer Rolling-Lift Bridge Company, Chicago. Details of the electrical operation and special control appliances were supplied and the equipment installed by Geo. P. Nichols & Brother, Chicago.

A VISUAL ACUITY TEST OBJECT.

Description of a Composite Object Composed of Superposed Gratings.

By HERBERT E. IVES.

VISUAL acuity, as a measure of illumination, has been investigated and employed by Macé and Lepinay, Koenig, Weber, and others. They have shown that the ability to distinguish fine detail is a measure, more or less rough, of brightness. The principle of photometry by visual acuity has been employed to some extent in certain forms of instruments, such as illuminometers for measuring street lighting, and in cases where marked differences of color make the more exact methods of photometry difficult.

Aside from the inherent uncertainties of the method, which it is not the purpose here to discuss, a serious difficulty in the application has always been the lack of satisfactory test objects. As such have been used types of various sizes, converging lines, sets of concentric circles of various diameters, or patterns consisting of combinations or modifications of these. None of these test objects are entirely satisfactory.

In general, visual acuity test objects fall into two classes. In one type details of different size are permanently drawn upon the test plane, and the illumination is varied until a certain fineness of detail is distinguished. In the second type the illumination is taken as it occurs, and the detail of the test object is either varied in size, or is drawn of continuously variable size, and observation is made of the dimensions of the detail which is just distinguishable.

As objects of the first class may be cited type, parallel lines, or patterns of concentric circles, which in their nature cannot be made of continuously variable size within practicable limits of apparatus size. Of these, type of various sizes, such as used by the oculists for eye testing, is probably the least satisfactory as an exact measure of acuity. All letters of the same size are not equally distinct, so that their size is not a good measure of acuity. Further, a psychological element of recognition enters, different for different letters. For instance, if all the letters on a test card were turned through 90 deg., the acuity readings would be considerably changed for all except professional typesetters. Concentric circles are better in this respect; straight lines, whose inclination to the horizontal could be changed between readings, unknown to the observer, would be still better. The inherent defect of this type of test object, however, is that the observer can see the change being made in the illumination, which gives the memory a chance to prejudice the judgment. The only varying quantity should preferably be the size of the detail observed.

Of the second class are such objects as converging straight lines, or figures whose size is continuously varied by changing their distance from the eye. Converging straight lines are imperfect, because the eye is assisted, by observing the lines separated in one part of the field of view, to separate them at another. Only by constructing the test object of quite prohibitive length could the lines be nearly enough parallel in the field of view to obviate this defect. The objection to changing the distance of the object is that visual accommodation is changed, again introducing the element of memory. Further, unless the object occupies only a small part of the field, or the field is uniformly filled at all distances with objects, the total flux of light coming to the eye is changed.

In some work on physiological problems connected with vision and illumination by the writer's colleague, Dr. P. W. Cobb, the need arose for a visual acuity test object as free as possible from the defects of existing forms. The requirements, which will be readily understood after considering the deficiencies of the forms described above, are as follows: The details of the test plate should be continuously variable in size, but the illumination, the flux of light entering the eye, the distance of the object, and the observer's visual accommodation should remain constant. To these should of course be added the requirement that the test object should be of convenient and practical dimensions.

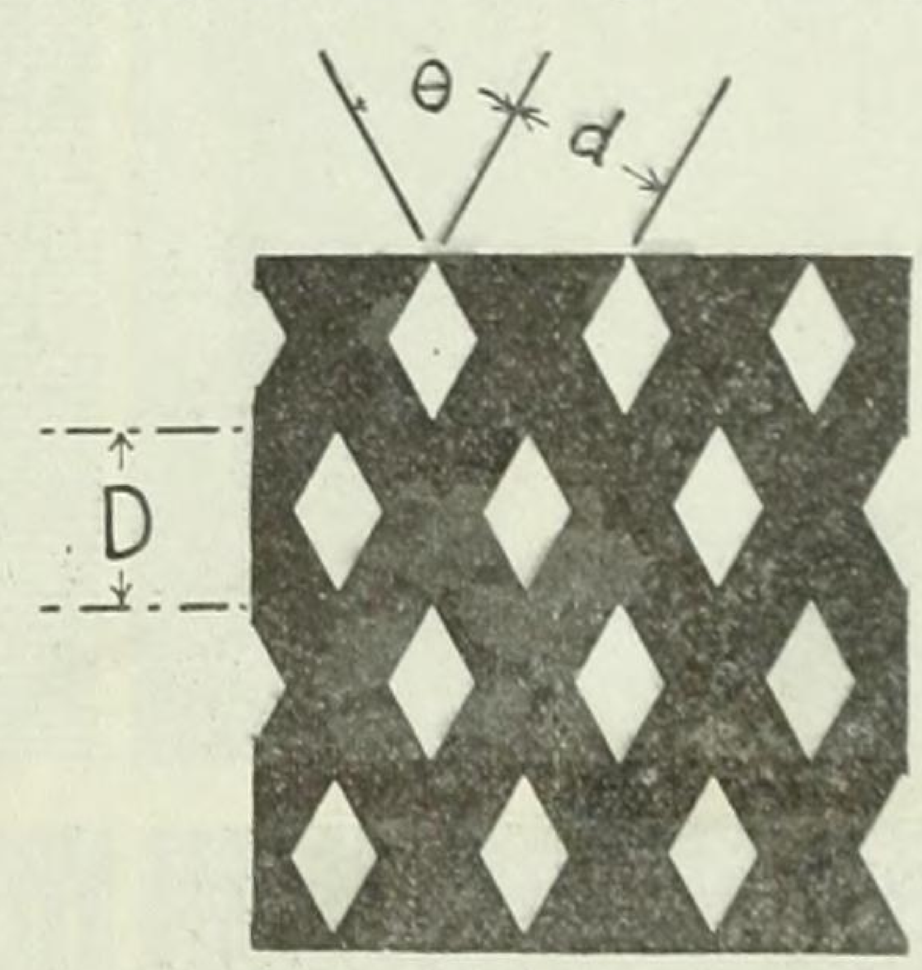

Fig. 1—Test Object.

The first scheme tried to produce this ideal piece of apparatus was to stretch a number of wires between parallel rods whose inclination to the horizontal could be changed by rotation around pivots at their lower ends. This had the effect of continuously varying the distance of the wires from each other. It was, however, not very satisfactory and proved to be only a first step. It occurred to the writer that the same end could be achieved by optical means, making use of a well-known property of fine gratings, which has been used in the testing of diffraction grating ruling engines. If two gratings, consisting of glass plates ruled with fine parallel equidistant opaque lines, too close to be separated by the eye, are laid one over the other and rotated, parallel dark bands are produced whose separation varies with the angle of the grating lines to each other.

The manner in which this comes about is seen in Fig. 1 where the two crossed gratings are shown greatly enlarged. It will be borne in mind that the distance between lines "d" is