such plates, and makes no change in the recommendations then presented. C. H. Bryant, J. W. Drew, W. E. Tuttle.

4. Tie-Plates: Under What Conditions are the Best Results Obtained from Their Use? Their Value in Keeping the Track to Gage and in Preserving the Tie. —In the report of the Committee on Tie-Plates accepted last year by this Association, their use was advocated under certain conditions, to which report the members are now referred. In that discussion it was shown that the use of tie-plates not only adds life to the tie, but is a saving of labor to the trackman. The best results obtained from their use should be ranked in the following order:

At terminal yards, where, on account of frequent switching and the use of sand, the rail base cuts into the ties quickest and their renewal interferes most with the traffic, and where the least labor can be performed by trackmen.

At bridges, where the first cost of the ties and the expense of fitting them warrant the use of tie-plates.

On sharp curves, to save the uneven wear of the rail heads; to save the frequent adzing of ties, with loss of their thickness; to save the frequent respiking; to give correct gage and to keep the alinement of the curve, so as to prevent the oscillation that wears the rolling stock.

At switch runs on main line, under those rails that cut into the long ties, requiring expensive renewal, while the tie is good under the other rails.

At joints, on tangents, to save the rail ends from crippling, especially in double track, where the blow of the wheel is in one direction.

On tangents, where the ties are cut out before they decay.

As regards the second clause of the question, refer to the five benefits derived from the use of tie-plates as reported in last year's report—namely:

The decreased annual outlay for ties through their greater longevity, and the correspondingly lessened cost of labor in replacements.

The lessened amount of labor necessary in maintenance, such as tamping, shimming, gaging and lining.

The preservation of angle bars and bolts, and the true surface of the rail.

The double resistance of lateral pressure.

The saving in power and wear to rolling stock through the above results. E. H. Bryant.

5. Experience in Regard to the Beveling of Iron and Steel Rails. Is One Side of the Rail Higher than the Other, Requiring that the Lower Side be Turned in, in Order to Better Fit the Tread of the Wheel.—In a rail properly made there is no need of turning rails to have the brand either outside or inside when laid. Lay them as they come from the mill, having ties level, to give an even bearing for wheel tread on top of the rail. We do not know of any rails rolled today but those designed to be alike on both sides of the head and base. Wm. E. Clark, M. E. Drew.

6. How Can We Reduce the Number of Frogs Carried in Stock?—As each particular section of rail calls for frogs to match, it is advisable to have as few patterns of rail as possible on any one division.

Do away with half sizes and fractional numbers of frogs; for example, instead of having No. 8, 8½, 9, 9½, etc., have only No. 8, No. 9, etc.

Adopt a standard main line frog, and in all new construction and renewals use this standard, and thereby in time get rid of all odd sizes of main line frogs. Your committee recommends a No. 10 for main line standard.

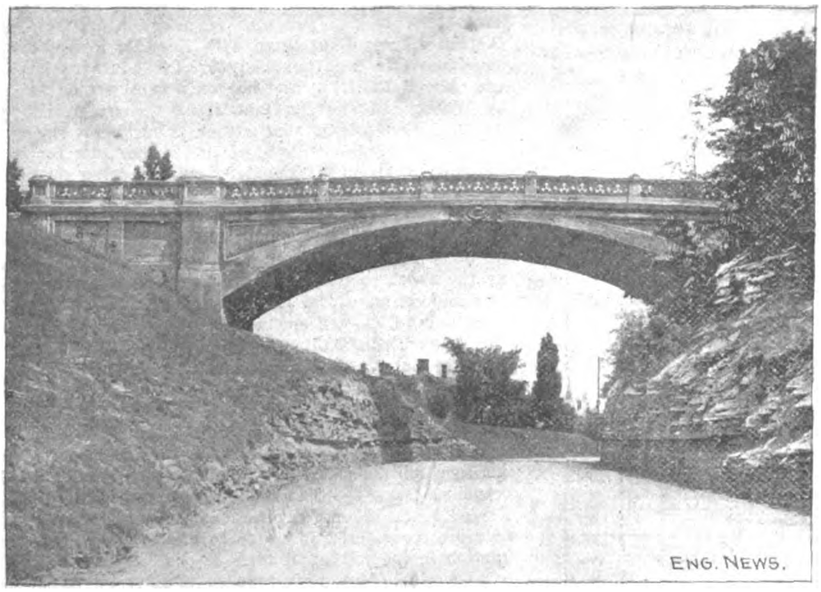
Also adopt a standard yard frog, and in all new work and renewals use this standard. Your committee recommends a No. 8 for yard standard.

Special frogs should be used only where standard frogs cannot be used, and your committee fully recognizes the fact that many times only special frogs can be used. G. L. R. French, P. A. Eaton, J. W. McManama.

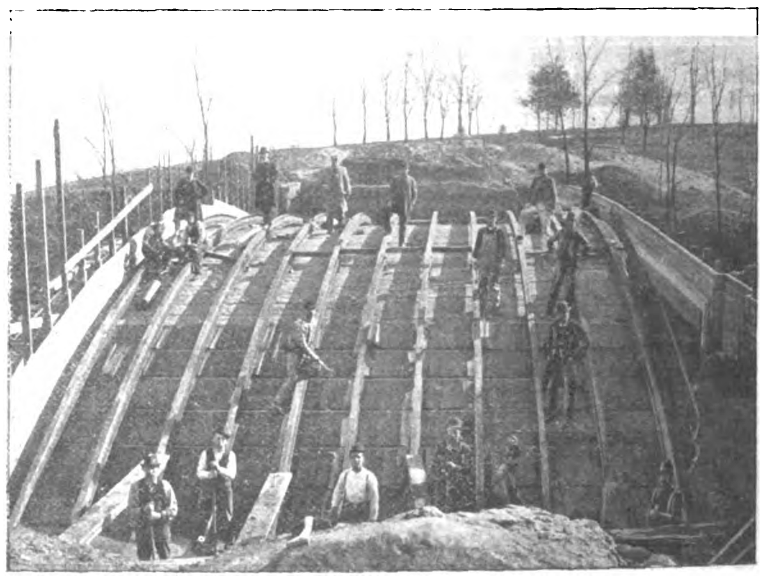
A MELAN CONCRETE ARCH IN EDEN PARK, CINCINNATI, O.

By Fr. Von Emperger, C. E.

The concrete arch illustrated in the accompanying engravings is located in picturesque Eden Park, and pride of Cincinnati, and crosses Park Ave., the main thoroughfare of the Park. It connects two hills, on one of which the city water tower is situated, while the other promontory skirts the Ohio valley and commands a splendid view of the suburbs of Cincinnati and the Kentucky border up to Fort Thomas. The beauty of this landscape was lost on me when I commenced concrete work on this bridge in the middle of November, 1894, with the intention of finishing it before the ensuing winter. It is not only far colder on these hilltops than in the city below, but there is always at this season of the year a fierce wind blowing through Park Ave., and the idea of working concrete at temperatures below 26° F. (up to which limit it can be done with no great precautions) had better be abandoned.



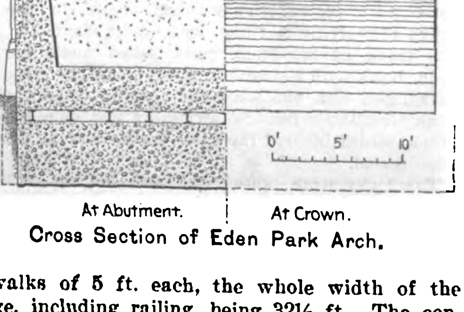
MELAN CONCRETE ARCH IN EDEN PARK, CINCINNATI, O.



IRON RIBS OF EDEN PARK CONCRETE ARCH.

Designed and Built by F. von Emperger, C. E.

The arch has a span of 70 ft., a rise of 10 ft. and carries an 18-ft. roadway and two concrete



Cross Section of Eden Park Arch.

sidewalks of 5 ft. each, the whole width of the bridge, including railing, being 32½ ft. The concrete is 15 ins. thick at the crown and 48 ins. at the haunches. It is built according to the Melan system, being reinforced with 9-in. I-beams weighing 21 lbs. per ft., spaced 36 ins. apart, and supported by a cross channel at each end. The foundations are bedrock limestone, with a few layers of decayed, clay-like material, but altogether solid enough to justify very small abutments.

The spandrel walls on top of the arch were continued as wing walls, according to the profile of each hill, and were reinforced by pilasters, as shown. This, as well as all the other detail upon the facade, was attained by constructing a corresponding wooden molding, behind which concrete of 1 cement, 3 sand and 6 stone was rammed in 6-in. layers, with colored face mortar at least 2 ins. thick on the outside. When these moldings are removed early, it is comparatively easy to make a smooth finish; but in some instances, as, for example, in the sudden snowstorm of Dec. 4, 1894, we were compelled to leave part of the molding on the work to protect the newly-set concrete. As some parts could not be finished for some five months afterwards, it then required considerable work to do the finishing on account of all the hardened irregularities which must always be expected from board lines and the like; but the snow and frost themselves did no damage, except to the ornamental key piece, a few of the projecting leaves of which required some repair. For forming this piece a casting of plaster of paris was used, made from a wooden model, and this, on account of its hygroscopic qualities, required to be removed as soon as the concrete had set. The concrete casting should have had very careful and continuous wetting for a couple of days afterwards, but this naturally had to be neglected on account of the frost and storm.

To avoid a misconstruction of this statement, I want to say that in my opinion, under the average circumstances, concrete work is more easily performed during the cold than in the hot months, but the site of this bridge is such that even the workmen refused to work if the weather grew colder. I succeeding in completing the main part of the work before the winter (only one face wall had to be built during some warm days in January under the supervision of Mr. Ludwig Eid, of Cincinnati, who also had charge of the rest of the work).

There are many engineers who do not admit that well-made concrete work is weather-proof,* notwithstanding the fact that most American cities have plenty of concrete sidewalks to prove it.

For this reason the position taken by Mr.

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* The following is a testimonial bearing on the weatherproofness of the first Melan bridge built in this country in the summer of 1894:

Office of the City Recorder,
Rock Rapids, Ia., July 5, 1895.

Mr. I. F. Ackermann,
City Clerk, Plymouth, Wis.

Dear Sir: The Melan cement bridge, of which you desire information, is five miles from here, and was built by the county, and not by the city.

I visited the bridge recently, and find that the cold weather had no more effect on the work than on so much solid stone. In fact, the bridge is solid stone now, being made of crushed Jasper stone and imported Portland cement. The bridge is all O. K., and will last forever.

Yours truly, (Signed) J. K. Medberry,
Recorder.

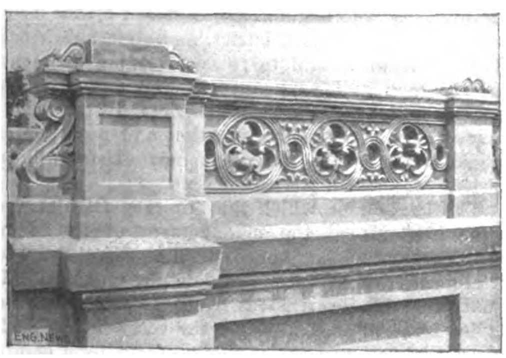
This bridge is a span of 36 ft., and was built by Messrs. S. M. Hewett & Co., of Minneapolis, Minn.

Warder, the Superintendent of Parks, who supported and favored this style of bridge, deserves full credit, especially as he is not an engineer by profession.

Plans for both stone and concrete arches were admitted to competition in the letting, and it was required of the latter that everything should be of concrete. It was not even permitted to make the arch imitate stone by making fancy joints, such a design being branded as an architectural lie. This explanation is made to show how the present design originated. The bids for a stone arch ranged in the neighborhood of $12,000, while the bridge as it now stands was contracted for by the writer at $7,130.

To remove the grayish and lusterless cement color, the specifications prescribed that colored mortar should be used in making the face. The colors at our disposal were yellow, black and red. The latter and dark green are advantageously used where the concrete has to imitate stone. In the concrete arch at Munderkingen (Germany), for instance, the arch stones were colored red, while the spandrels were colored dark green. For this reason the black and the red were declared out of the question, and there remained only yellow, which was added at the rate of 10%, the limit to which color should be used. The coping, railing and the arch proper are not colored.

After the excavation was done and the falsework erected, the bent ribs were laid, splices and cross angles fastened and the concrete in the abutments started, so as to enclose the ends of the iron ribs. Then some of the wingwalls and pillars



Concrete Railing, Eden Park Arch

were built, just to train the workmen, which were common laborers paid at the rate of 13½ cts. an hour. The arch was built in two longitudinal halves, each of them started on both sides, and closed up to the center in one day of 12 working hours with a force of 40 men mixing, wheeling and ramming 80 cu. yds. of concrete. The concrete in the arch was in the proportion of 1 : 2 : 4 (which had to be increased to 1 : 4, as the broken stone furnished was too small, and there was no time to substitute larger).

After this the above-mentioned molding of the center ornament was set in place and the facewalls completed, as already described. Immediately after the removal of the boards placed on the inside of the facewalls, the filling of the bridge was put in and completed to the level of the copingstone, where the work was stopped during the winter. The artificial stone for the railing and coping were cast during that time and were stored near the bridge. In the spring the falsework was struck and the work completed.

After the removal of the falsework the filling was compressed with a 15-ton steam roller, which was a very trying test, as the filling at the crown is not more than 6 ins. thick over the concrete, and the specifications only require the finished bridge to carry this load. There is no necessity to explain what the difference is in the distribution of the load if such a steam roller is used on an asphalt pavement with a solid foundation or on the bare concrete arch. Although they were not entitled to such a test, I was glad to comply with the desire of the city authorities, feeling confident that such a load could do no harm to the bridge.

Very careful measurements were taken after the removal of the falsework and on other occasions, and did not show any measurable settlement or deflection, which was partly due to the heavy dimensions, but also to the very long settling time given to the bridge before striking centers.

The cement used was "Porta" cement, from Bremen, Germany, and tests of same made by the writer and the city gave satisfactory results. The stone used was crushed limestone, as hard as it was possible to get in the neighborhood. For the exterior of the bridge and the artificial stonework mortar made a fine, sharp sand, carefully sifted, was used in the proportion of 2 cement to 3 sand.

CAR HEATING BY ELECTRICITY.*

By J. F. M'Elroy.

The general principle employed in the construction of electric heaters is that of placing in these heaters suitable resistances, which become heated by the passage of the electric current. In the Burton heater, one of the earliest electric heaters tested on the electric railways in this country, a resistance wire made of German silver was bent in a zigzag form and placed within the hollow space between two iron castings. The wire was embedded in powdered fireclay and the castings bolted together. These two castings, which together formed the casing or outside of the heater, had a roughened surface for the purpose of enlarging the radiating surface. It was claimed that the embedding of the resisting conductor within a powdered mass of fireclay prevented the air from reaching the conductor, and hence prevented its destruction by oxidation when exposed at high temperatures of air.

Oxidation in a resisting conductor may be retarded if it is possible to keep the oxygen of the air from reaching the surface of the conductor, but by such a construction results may be reached which are just as objectionable as the oxidizing of a conductor by contact with air. The embedding of a resisting conductor in powdered fireclay, or other material which, from its very nature, would be classed as a non-conductor, would retard the escape of heat. The objectionable result is then reached that the temperature of a conductor rises to such a degree that the life of the conducting material is soon destroyed. Other electric heaters were put upon the market, but much difficulty was experienced, either from the oxidation of the resisting conductor, or from its destruction by fusion when enclosed in a mass of material, such as is shown in the Burton heaters.

High temperature is one of the conditions leading to the destruction of the resisting conductors, and while this difficulty is not experienced at 300 or 400°, it is always experienced when the metals are heated to a temperature of 900 to 1,200° F. Another condition is the crystallization of the conductors at high temperatures, and this is specially the case with German silver or any alloy. It is not necessary to run near to either of these danger points. The temperature of the resisting conductor depends upon the amount of heat which that conductor gives out per square foot of its surface, and the total amount of heat would, therefore, depend upon the number of such units of surface which there may be in the conductor. The reduction of temperature in the resisting conductor may be carried to any extent desired by simply increasing the amount of actual surface in the resisting conductor, its temperature thus being reduced to a point where the conductor is absolutely safe and its life is permanent.

In the construction of the heaters made by the Consolidated Car Heating Co., of Albany, cylindrical porcelain tubes are threaded upon a ⅝-in. square iron rod, the tubes having on the surface a spiral groove which runs from end to end. A porcelain disk is placed at each end of the heater, and when desired one is placed at the center to furnish a support for the binding screws, to which the ends of the resisting conductors are attached. No. 20 B. & S. galvanized iron wire is coiled in the form of a close and continuous helix. As this wire is wound by a machine in the form of a continuous coil, just so much of the wire is separated in forming a coil as gives just the proper resistance. These coils are then placed in the groove which runs spirally around the porcelain insulators. Care is taken to stretch out the coil sufficiently to prevent adjacent spirals of the coil from coming in contact with each other, and contact with that part of the coil in neighboring grooves is prevented by ridges separating the grooves on the porcelain. The result is that the wire is thoroughly insulated, and short-circuiting within the heater itself is prevented, and still it is wound open so as to present its whole surface to the air. It is so arranged, too, by its even pressure upon the porcelain insulator, that no part of this coil can vibrate, and hence there is no danger from the crystallization of the iron wire while hot from tremor or vibration of the heated wire. This feature of this heater is a very important one, as it absolutely prevents the crystallization, and hence breaking of the resisting conductor. These coils have now been operated for over three years, and not one coil has given out or has shown any oxidizing effect in the substance of the wire. The use of iron as a resisting conductor obviates the difficulties of crystallization to which German silver is especially liable. The melting point of iron is at a temperature of nearly 3,000° F., so that the temperature of fusion is so far above the normal temperature of the resisting conductor, and as vibration of conductor is prevented by the method of winding it on the insulator, no danger occurs from oxidation, fusion or crystallization.

It is important in the construction of electric heating devices that the expansion of the metallic wire due to change of temperature be fully provided for, and that the heater be so arranged that under no circumstances can the force of expansion and contraction create a strain upon the resisting conductor or upon the insulating parts which would be liable to injure or to break them. This is especially important in conductors designed to be run at a high temperature, as the difference in length of the conductors at the extremes of temperature to which it is subjected is quite a considerable part of its length.

It is a well-known principle that a wire of a given length, if heated and then cooled, and again heated and cooled, is not the same length at the same temperature that it was in the first test. Changes will go on for some time in lengths of wires so subjected to heating and to cooling. On the other hand, care must be taken that under no conditions can the expansion of the wire make it loose on the insulator, and so cause a short circuit between neighboring wires. In a car equipment of the heaters just described, the length of wire, when heated to the highest temperature to which it is subjected in the regular operation of the heater, is 7 ft. 5 ins. longer than it is when cold. By the construction adopted, this expansion is taken up between consecutive layers of the wire itself, so that expansion and contraction of the wires do not operate to vary the tension of the coil of wire, nor even to vary the pressure with which it binds the insulator itself.

The change of temperature in resisting conductors is attended with other phenomena, which should be considered in the construction of electric heaters. For example, it is well known that the resistance of a wire of a given material of given length and cross-section depends upon the temperature at which the resistance is measured. Iron wire possesses certain qualities in its variation of resistance with temperature which admirably fits it for use in electric heaters. An iron wire having a resistance at 0° C. of 100 ohms has its resistance doubled when the temperature is increased to 180° C., and its resistance is increased to 500 ohms when its temperature is 525° C. The change of resistance in German silver is but a fraction of the change of resistance of iron wire.

The application of this favorable resistance in the construction of an electric heater is the automatic control which this property of iron wire gives over the temperature of the electric heater itself. If a non-conducting hood is placed over an electric heater which prevents the circulation of air, the escape of heat will be prevented, and the temperature raised to a dangerous extent.

The use of the variable resistance, so marked in iron wire, is apparent, as its effect is to reduce the amount of current flowing through the heater, and hence to reduce the amount of heat generated. Two electric heaters, one of iron wire and the other of German silver, both having the same resistance at 0° C., and both being covered with a non-conducting hood, which prevents the escape of heat, would, as the temperature rises, act very differently. If the temperature rises to 300° C., only two-fifths as much current would pass through the iron resisting wire as passes through the German silver. This throttling action of the iron wire increases more rapidly even than the increase of temperature, so that at 600° about one-fifth as much current passes through the iron wire as passes through the German silver, and in each case the reduction in current means also a reduction in the amount of heat generated. A heater, therefore, provided with an iron-resisting conductor has this advantage over that fitted with German silver, that if for any reason the escape of heat from an electric heater is prevented, either purposely or accidentally, the action of the rise of temperature upon the heater itself is to so throttle down the amount of current passing through it (and hence the amount of heat generated) as to prevent such a high temperature of heat as might prove dangerous.

Careful tests made with thermometers placed against the grated openings, which the clothing of passengers might possibly touch, show that the highest temperature of the air is about 180° F., owing to the free discharge of air up through the heater.

The proportion of electric energy transformed into heat in a conductor depends upon the resistance of the conductor. The electric heater is the only case that comes within our knowledge where 100 units of electric energy may be transformed into 100 units of any

*Abstract of a paper read at the annual meeting of the New York State Street Railway Association, held at Albany, N. Y., Sept. 17.