grinder for pulverizing furnace linings, in an atmosphere so full of grit and dust that the operator had to keep his mouth and nose masked. The motor under a street car will convince the most superficial observer that there is nothing to be feared on this score.

General Conclusions.

When the shops of a manufacturing establishment are scattered over a considerable extent of territory, the installation of a central power plant having large and economical engines, and the distribution of the power to the different shops by wires, instead of by steam pipes, is a change always to be recommended, and that will soon pay for itself.

When the establishment consists of one large building or compact group of buildings, a change to the electric system is to be recommended where heavy work is to be handled, especially if the machines are somewhat scattered, require considerable power, or are intermittent in their action. In such cases some of the shafting may be left in position, but the writer believes that the more independent motors are used on machines requiring over two horse-power the greater will be the economy.

In shops doing light work and having many small machines compactly arranged and in continuous operation, a change to the electric system would be expensive and of doubtful utility. See, for instance, shops Nos. 10 and 12 in tables.

In building a new shop the chances are better for electric installation; and any manufacturer who does not, under these circumstances, investigate the subject and consider carefully the question of using electricity, is making a great mistake.

The ideal arrangement for a shop handling heavy work is that of a building having one lofty center aisle lighted from above, and the two side aisles of less dimensions lighted from the sides. Every square foot of floor space in the central aisle should be commanded by electric cranes. Here the larger tools will be located, each with special reference to convenience in handling work, and, as far as practicable, fitted with independent motors. The smaller machines are located in the side aisles near the dividing line of columns, and may be driven in groups by short lines of shafting hung on the columns below the tracks of the traveling cranes, each line being driven by a separate motor.

Units of about 5 HP. are large enough for this kind of work. Motors of two or possibly of one HP. are as small as can at present be economically used.

The benches for hand work should be located at the side walls near the windows. Smaller cranes and electric hoists may command all the space in the side aisles. Some of the drills and shapers should be fitted with direct connected motors and have eye-bolts at the top by which they may be moved from place to place. In the power house the use of two generators, one large and one small, will often prove economical, the smaller one being used for night or overtime work.

A POWER SAW FOR HEAVY METAL WORK.

A heavy motor-driven cold saw has recently been put on the market by the Q. & C. Co., Chicago, designed especially for bridge builders, architectural iron works, and other metal workers handling structural steel and other heavy metals. It is substantially and compactly built, occupies the smallest possible space and is easily handled.

The saw blade is 25 ins. in diameter, being amply large for a wide range of work. It is provided with one faced side, making the machine valuable for miter work. Lateral adjustment is provided to the saw blade, requiring but a minute to set the saw to line. This feature dispenses with the necessity of moving heavy work, where in sawing to a scribed line the adjustment required is less than 2 ins.

A cam-lever movement feed allows the operator to change instantly from slow to fast, or vice versa, without stopping or checking the speed of the saw. A stop enables the machine to be thrown out of gear quickly in cases of emergency.

The available surface of the saw blade above the arbor is 10 ins.; available surface of the blade to the right of arbor, horizontal with the lower table, 10 ins.; height of extra table, 12 ins.; the blade extending down 4 ins. below the surface of the lower table.

SECOND TRACK CONSTRUCTION AND IMPROVEMENT OF LINE AND GRADE FROM MADISON TO BARABOO, WIS.; CHI. & N. W. RY.

By H. W. Battin.

(With two-page engraving.)

The eastbound traffic which originates in Minnesota and South Dakota on the Chicago & Northwestern Ry. is joined at Elroy, Wis., by that diverted to it by the Chicago, St. Paul, Minneapolis & Omaha Ry., the whole proceeding on its way to Chicago, Milwaukee and points farther east. From Elroy to Baraboo, a distance of 38 miles, the railway follows the valley of the Baraboo River with no grades to exceed 21 ft. per mile, permitting a rating of 1,600 tons for a 19-in. engine with small wheels. At Baraboo the railway leaves the river valley and crosses the divide between the Baraboo and Wisconsin rivers, passes "Devil's Lake" and Kirkland, and at one place rounds a sharp point of rock known as "Devil's Nose." After passing the Wisconsin River, a second divide is crossed, reaching on the other side the chain of lakes adjacent to Madison. On account of the steep grades over these two summits, and the frequency of meeting points for trains for freight traffic, the latter became very much congested while operating on a single track. To facilitate operation in this congested belt was the urgent demand for double-tracking this particular section of road during a season of severe financial depression.

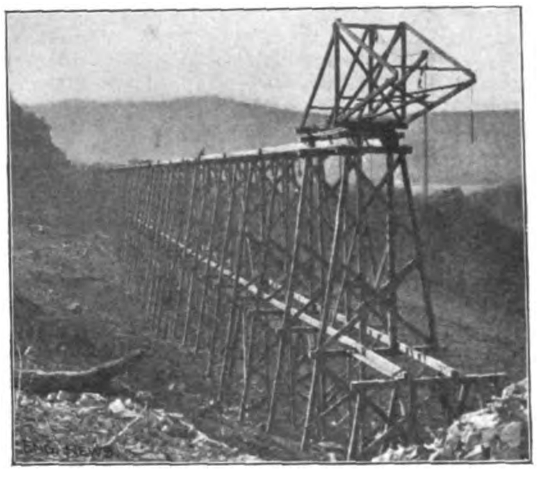


Fig. 4.—Temporary Trestle for Deep Fill Just North of Devil's Nose.

(Length, 1,248 ft.; extreme height, 75 ft.)

Alinement and Grades.—In the 37 miles between Madison and Baraboo, with the exception of about four miles, the curvature was easy, a maximum of 2°. The grades, however, ran as high as 53 ft. per mile. On 47% of the total distance the grades were changed by the reduction of summits and filling up of intervening sags, the changes being frequently as much as 10 ft. in cut and 10 ft. on embankment. The total rise, as shown by the old profile, Fig. 1, was 619 ft., and the total fall was 604 ft. As shown by the new profile the total rise is 508 ft., and the total fall is 493 ft., making a saving of 111 ft. in rise, or, roughly speaking, the saving of a 1% hill for a distance of two miles, the difference in elevation between Madison and Baraboo being 15 ft.

In the above four miles, between Devil's Lake and Devil's Nose, as shown by the general profile, Fig. 1, the maximum curvature was 4° 42', the grade being 69 ft., broken with stretches of 53 ft. per mile. The main problem in the rectification of the line and the improvement of the grade came within these limits and involved the entire elimination of the reversed curvature and the reduction of the grade from 69 ft. to 53 ft. per mile, as well as the reduction of the maximum curvature to 3°. In 3.5 miles, which formerly had grades ranging from 53 to 69 ft. per mile, the maximum grade is now 53 ft. per mile, there being a reduction toward the top of the hill to a 0.9% grade, or 48 ft. per mile. Within the limits of one mile, 87° of curvature were eliminated, throwing out two sets of sharp reversed curves and involving the construction of two heavy fills, one of them 75 ft. and the other 55 ft. in height and ranging in length from 1,500 to 1,800 ft. To accomplish the work of grade reduction and the rectification of alinement from Devil's Lake to Devil's Nose, it was necessary to begin changing the grades at a point one mile south of Devil's Nose at the foot of the 1.3% grade. From this point to the north, the profile was figured for a maximum grade of 1%. This made the new sub-grade at Devil's Nose 13 ft. lower than the original main track. At the same point the curvature was reduced from 4° 42' to 3°. To reduce rock and earth quantities to a minimum in this neighborhood, it was essential that the new alinement should be kept as close as possible to the original main track, and yet leave the latter intact for the conduct of transportation.

Grading.—A contract for the grading was let to Winston Bros., of Minneapolis, Minn., who began rock excavation in the neighborhood of Devil's Nose Feb. 8, 1896, but the earthwork was not generally begun until the middle of April. The rock work was completed in the neighborhood of Devil's Nose, Nov. 26, 1896, and the earthwork in the same neighborhood, Nov. 21. The forces obtained a maximum in October of 504 men and 90 teams on the basis of ten hours' work per day. The whole amount of material moved approximated 1,500,000 cu. yds.

The standard roadbed for earth excavation, Fig. 2, had a base of 37 ft., with side slopes of 1 on 1½. The roadbed for rock excavation had slopes of 4 on 1. The roadbed for embankment had a base of 33 ft., with slopes of 1 on 1½. The greater bulk of the earth work was done with Petelar cars and horses, the loading being chiefly done by hand. The reduction of the summit cut at Kirkland involving about 400,000 cu. yds., required a different method of handling. For this the contractor placed his first steam shovel April 15, which shovel was worked continuously until Oct. 24. A second shovel was started in June and worked until September 12. Both shovels worked day and night for three months. The railway company furnished four engines and 80 flat cars equipped with air brakes and automatic couplers for the prosecution of this piece of work.

Material from the summit cut was used to grade that portion of the new alinement which lay directly opposite the reversed curves; the material being plowed off from top of temporary trestles, the details of which are shown in Figs. 3 and 4. The more northerly, or Trestle No. 1, Fig. 1, 960 ft. in length and 55 ft. in extreme height, was one story, the posts being tamarack piles of length sufficient to answer the height of each bent. The more southerly, Trestle No. 2, 1,248 ft. long and 75 ft. in extreme height, was built in two stories, also using tamarack piles for posts. The sway bracing, as shown in the sketch, was sufficient to hold the trestles in good line during the work, but the longitudinal or spur-bracing as originally planned had to be increased at Trestle No. 2, on account of a tendency of the floor system to push down the hill. This latter movement was caused by the work trains being spotted to position with air brakes set on the whole train. The stringers were of Oregon fir 28 ft. long, lapping 2 ft. past the center of each bent, the span length being 24 ft. This span would seem excessive for a frame-bent trestle, but the structures as built answered the purpose for which they were designed, and offered less obstruction to the filling and were more economical in first cost than the ordinary trestle with spans of 16 ft. or less.

Trestle No. 2 was built parallel to the centre line of the double-tracks and 10 ft. to the east, or on the down-hill side of it, thereby securing a compact embankment when complete. The widening for double track was thus done on the west side entirely. Trestle No. 1 was built with its south end 10 ft. to the east of the center line of double track, its north end being west of the same. This arrangement was necessitated by the fact that the early working of the steam shovel cut was done at a high level, which necessitated building the short piece of heavy grade, shown by Figs. 5 and 6, as close as possible to the original main track. Cross ties 8 ft. long and spaced 2 ft. apart c. to c., permitted the earth to fall from the cars without lodging among the timbers of the floor system. At the trestles, the material was plowed from the cars by a Lidgerwood Rapid Unloader, handling either a center or a side plow, according to the necessities of the work at the time. In order to stretch the cable there were erected at appropriate places a pair of posts, one on each side of the running track, between which a chain was suspended. A large hook on the cable was attached to this chain and the train moved its full length, permitting the cable to unreal from the drum of the unloader and stretch over the full length of the train. The value of the rapid unloader for a work of this magnitude is shown by the fact that at no time through the season, during day or night service, was a plow thrown from a flat car, a fact inevitable and of frequent occurrence when the plowing-off is done by a locomotive. After the trestles were filled, the material to widen the embankment was plowed off the shoulder by a spreader built on a flat car, the latter also being a tool of considerable economy.

The grade line was placed through the summit cut at such a height that the quantities computed from the finished sections would be slightly less than the total quantities in the big fields. By breaking the grade at Station 1,660 from 1% to 0.9%, the effect was to decrease the embankment (Sta. 1,663 to 1,679, Fig. 1), and to increase the excavation quantities through the summit cut compared with the quantities afforded by a 1% grade carried to the top of the hill. The Kirkland passing track, shown from X to Y, in Fig. 5, was abandoned for purposes of operating and was turned over to the contractor for his exclusive use. While taking out material above the old formation level this track remained in its original position, the switch being moved from the main track at Y and the track being extended south to answer as a running track for work trains. It was necessary to keep this southerly extension as close as possible to the main track from Station 1,684 to 1,690 to avoid filling a wide embankment where the steep grade was operating and which would eventually have to be cut down. Beyond the north end of the cut a few sidings were built by the contractor and used for storage of cars and for coaling engines.

Owing to the nature of the material, the steam shovel cut was excavated in four lifts. It was deemed advisable not to exceed 25 ft. in depth for any one lift. By excavating a shelf on the slope of the old cut, a loading track was laid from A to B, Fig. 5, on a grade of about 2.5%. Three cuts in width were taken on this general level, as shown by Fig. 7, extending through the months of May, June and July. The month of June saw an additional cut taken at the old formation level, followed in July by a cut next east of this and 5 ft. lower, and in August by another 5 ft. lower still, which completed the section down to that level. The first system of sidings was taken up and re-laid several times to accommodate the new conditions of working, always keeping a connection at the north end with the track to the fuel and water stations and at the south ends with the running track. By the end of September, most of the excavation had been made, there still remaining to be taken out that fraction of the finished sections which supported the old main track and which could be removed only when traffic was thrown to the lower level. The two large fills required more material than the true sections of the cut afforded, so a borrow pit was made on the extreme east side, Station 1,711 to 1,716.

The rock work at Devil's Nose was begun early in February, 1896, the excavated material being hauled to the north to form the embankment at the south end of Trestle No. 2. The extreme north portion of the excavations was taken out to regular section and formed a through cut. For a distance of 600 ft. the center line of double track was between the running track and the high face of the bluff and the section required to be excavated included the material under the running track to a depth of 12 ft., as shown by Figs. 8 and 9. To accomplish the work the contractor removed all material down to the new formation level and outside of the running track. In order to obtain the material between the face of the bluff and the existing track, two openings 12 ft. in width were made under the latter and the work of blasting and removing of rock proceeded until all that remained to be excavated was a continuous pier of solid natural rock about 600 ft. in length, over which the company's traffic was moved, until thrown to the lower level.

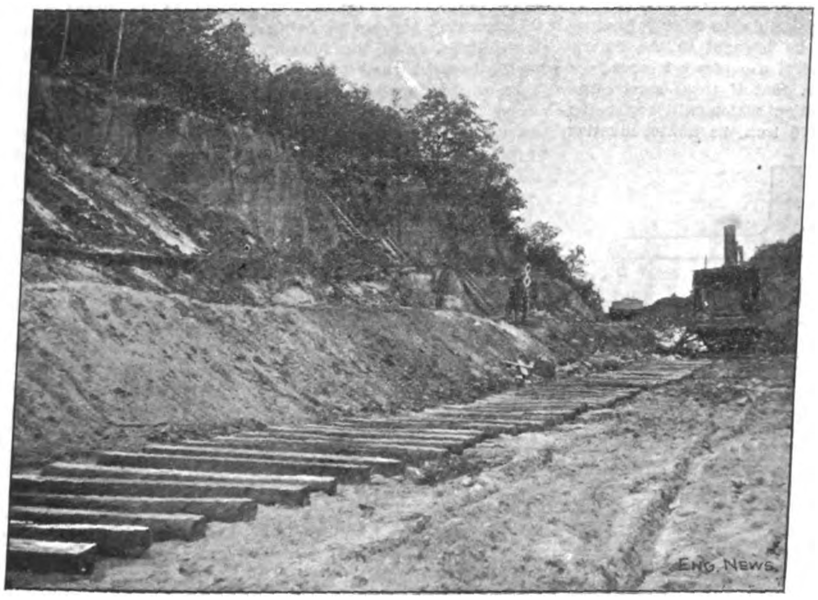


FIG. 6.—SUMMIT CUT, SHOWING THREE LEVELS OF STEAM SHOVEL WORK.
(Shovel working at original track level.)

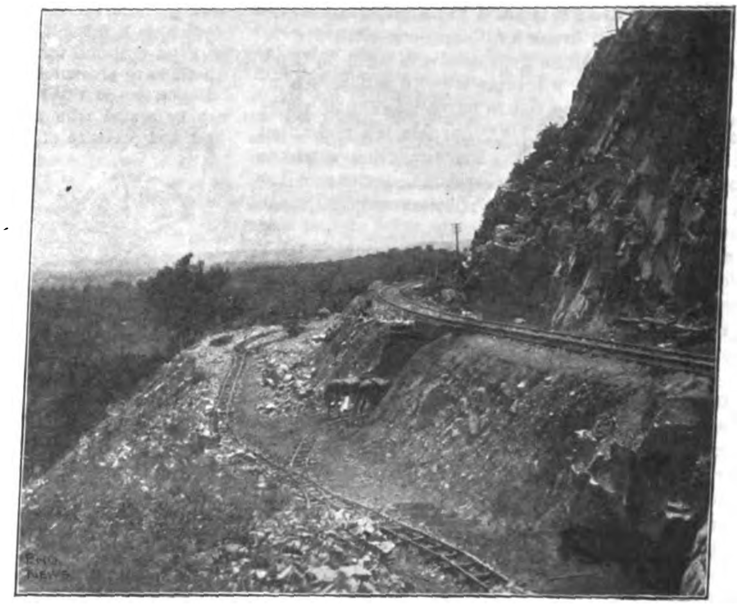


FIG. 9.—ROCK EXCAVATION AND FILL AT DEVIL'S NOSE
View showing temporary openings under the track to reach the excavation on the inside of the curve.

From Devil's Nose toward the south for a distance of one mile, the difference of elevation between grade of the original track and the new formation level caused a state of affairs somewhat similar, as shown by the sketch Fig. 10. The track was lined as far to the west as the original embankment would permit. At the new formation level a shelf was cut, the slope nearest the running track being 1 in 1. In October the easterly or second track was laid on this shelf past Devil's Nose, across the big fills, and through the summit cut from Stations 1,550 to 1,745. Traffic was then turned to the new level and the old track abandoned and taken up. The grading then proceeded, taking out material to complete the sections under the original track, the rock, as shown in Fig. 8, and earth, as shown in Fig. 10. The earth work was completed Nov. 21, and the rock work Nov. 26.

Bridging.—It was desired to push the masonry well in advance of the grading, and in consequence the work was begun early in January, 1896. The bulk of the work, however, was done between March 1 and July 31. In all it amounted to 12,000 cu. yds. of first-class masonry and 3,000 cu. yds. of second-class masonry, distributed in the following 95 structures:

11 new bridges, piers and abutments.
2 new arches.
6 new stone box culverts.
2 new iron pipes.
5 overhead bridges.
16 bridges, in which old piers and abutments were extended.
12 stone arches, extended.
18 box culverts, extended.
23 iron pipes, extended.

The first-class masonry was rock-faced work with dressed bridge seats, back walls and copings. The barrel of each arch was either dressed or rock-faced to make it conform to the work previously done in the same structure. The second-class masonry was built of thoroughly-bonded rubble laid in cement mortar; the bridge seats, copings and steps being of dressed stone. Most of the masonry was laid in Milwaukee cement, but a portion of it was laid in Yankton Portland cement. About 62% of the stone used was a durable sandstone quarried at Ablemans, ten miles north of Baraboo, the remainder coming from Duck Creek quarry, near Green Bay, Wis. All structures were built in stone and iron, the 1,664 ft. of pile and frame bent trestle being filled with earth and not remaining as a permanent structure.

There were no especially noticeable features in the construction of the masonry, excepting those involved in one deep foundation in a marsh six miles north of Madison, the nature of which is shown by Fig. 11. The piles for this foundation, 70 ft. in length, were driven to the level of the water through 40 ft. of soft mud and silt and 20 ft. into hard clay. No vertical settlement ensued after the masonry was built, but the pressure of the new second track embankment moved the south abutment toward the water-way a distance of 2 ins., evidently springing the whole group of piles to that extent. No movement was noticeable adjacent to the old embankment, the latter existing where a pile trestle had been filled fourteen years earlier.

The change of grade just south of Devil's Nose at Bridge No. 344, made it necessary to let down 4 ft. the barrel of a 24-ft. arch. A pair of second-hand plate girders 50 ft. long were spaced 5 ft. c. to c., held together with turnbuckles, and laterally braced with five sets of cross-bracing made of oak bridge ties, as shown by Fig. 12. This deck girder on pile bents driven in the embankment carried the traffic while the work of excavating, tearing down, rebuilding and refilling was accomplished.

The contract for the iron bridge work was let to the Lassig Bridge & Iron Works of Chicago, Ill. It consisted of through and deck plate girders ranging in length from 20 to 75 ft. The bridges came entirely riveted up and ready for placing excepting the 75-ft. deck and through girders and the short through girders with thin floors, Fig. 13. The erection was done by the company's Bridge and Building Department, using a derrick on each of two flat cars. The iron work, which had been unloaded at points convenient for erection, was picked up by the two derricks and swung between the two cars, carried to position directly above the bridge, and with false work taken out, the iron work was dropped into place. This latter method included the spans 55 ft. in length. The 75-ft. bridges were unloaded one girder at a time and erected in places on masonry, the floor system of the through girders being changed not to interfere with traffic.

Track.—The second track was laid with the Chicago & Northwestern Ry. standard 80-lb. steel rails and oak ties, the company's standard truss joint being used, a drawing of which is shown in Fig. 14. The old main track, aggregating eleven miles, was taken up in order to grade to the new profile and in addition two miles were re-graded without interruption to traffic. During the course of the work, 27 temporary switches and five temporary crossovers were put in. The permanent work involved 25 switches and 20 crossovers. In all the latter the company's standard spring rail frogs No. 10 and standard split switches were used, with the exception of two No. 14 leads at the Wisconsin River bridge. All switches have trailing points, the sidings being connected to the main track at one end only. The construction of the second track began May 28 and was finished Oct. 27. The first piece of double track was put in operation June 14 and the last Dec. 3.

Ballasting.—The track was raised on 1 ft. of ballast, the first lift of 8 ins. being made with a coarse ballast from Wales, Wis., and the final lift of 4 ins. and the filling and dressing being done with gravel from Beloit, Wis. The average train haul on 200,000 cu. yds. of this material was 70 miles. About 125,000 cu. yds. were used in ballasting the 35 miles of second track, and 75,000 cu. yds. to re-ballast the 34 miles of old track. In connection with the above it may be said that various sections of the old track were given a light raise only to make them conform to the new profile.

Interlocking and Signaling.—The Wisconsin River bridge at Merrimac (Eng. News, July 9, 1896), is operated as a single track structure with switches at each end worked by mechanical levers and connected electrically, as shown by Fig. 15. Tower Z at the south end contains a four-lever machine with three levers for five signels and one lever for one switch and two derails. This tower is a one-story cabin. Tower BR, two stories high, at the north end of the bridge, contains a twelve-lever machine with five levers for seven signals, one lever for one derail, one lever for two facing point locks, three levers for three switches and three derails, and two spare spaces. The two towers are connected electrically in such a way that the interlocking will prevent giving a clear routing for two trains from opposite directions at the same time. The manual block system is in use, each semaphore having two spectacles, showing red and green disks, with one center lamp. The space interval of blocking averages 3.5 miles.

Conclusion.—It was possible to finish a work of this magnitude in one season, by rushing the masonry in the early part of the year, by putting down track on every half-mile of grade as soon as finished, connecting the track to the old main track with temporary switches, ballasting the new track and connecting it piece by piece as fast as laid and ballasted, putting the second track into operation, abandoning the old track, re-grading, re-ballasting and connecting piece by piece as was done with the second track. On account of this method of conducting the work the latter has, of necessity, not been as satisfactory as it would have been had it been possible to lay and ballast long stretches of track continuously. As soon as a short piece of double track was ready for use it was turned over to the operating department for immediate use. A fortunate and gratifying feature of the whole work has been the absence of serious accidents to trains and comparatively few injuries to persons which were attributed to the construction work. Great credit is due to the officials and employees of the operating department for the care exercised, as traffic was frequently diverted from the old main track to the second track and in reverse order, through temporary switches and crossovers, to permit and facilitate the construction work. Eight passenger trains and an average of 40 other trains daily passed this section of the road while the work was in progress. The cost of the work involving all its features approximated $1,000,000.

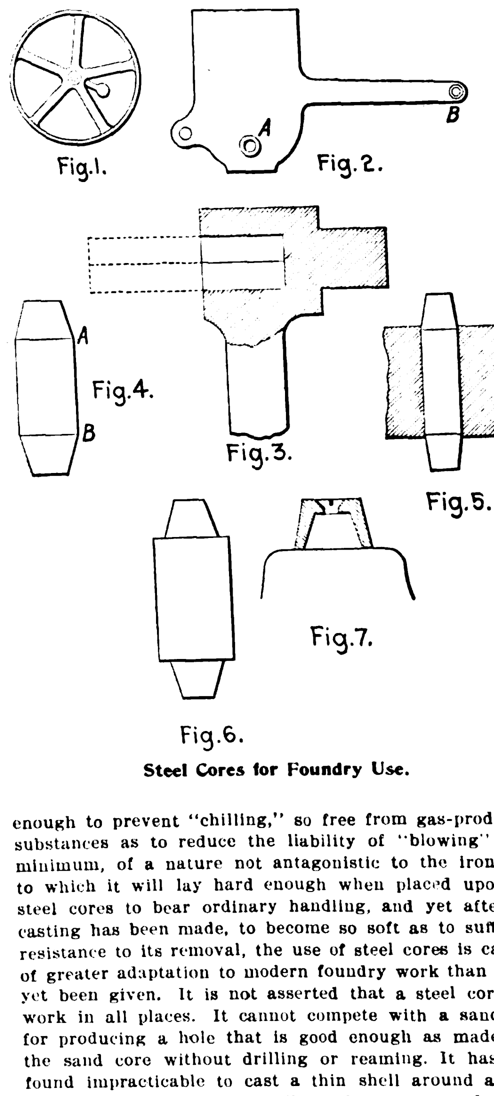
The work was represented in the Chief Engineer's office by Mr. E. C. Carter, M. Am. Soc. C. E., Principal Assistant Engineer. The surveys were made and the construction carried out by Mr. H. W. Battin, Engineer of Second Track. For construction, the work was subdivided into four sections averaging 9 miles each in length, which were placed in charge of Assistant Engineers F. L. Birdsall, L. P. Yale, W. H. Gahagan and J. M. Raymond, the first of whom handled the heavy work from Devil's Lake to Devil's Nose. The contractors were personally represented on the work by Mr. W. O. Winston, and by Mr. E. H. Beckler, M. Am. Soc. C. E., as Engineer for the contractors.

STEEL CORES FOR IRON AND BRASS CASTINGS.

At the meeting of the Philadelphia Foundrymen's Association, on Feb. 3, Mr. George L. Roby, of Albion, Mich., read a paper on "Steel Cores," of which the following is an abstract:

The formation of smooth and approximately accurate holes in iron or brass castings always involves trouble and expense. The improvement suggested is to insert steel cores of the shape and size of the shaft or bar which the hole is to fit in the mold and afterwards remove them from the casting. This has been done in many foundries for years. But, except for special work, the objections of having to make tapering cores so that they may be removable and that the crystallization and chilling of the iron makes it difficult, if not imposible, to do any further work on castings that cannot be brought to the emery wheel, have prevented the general use of steel cores.

It will be admitted, however, that if these steel cores can be coated with a composition which will resist the heat and pressure of the melted iron, be non-conductive



Steel Cores for Foundry Use.

enough to prevent "chilling," so free from gas-producing substances as to reduce the liability of "blowing" to a minimum, of a nature not antagonistic to the iron, and to which it will lay hard enough when placed upon the steel cores to bear ordinary handling, and yet after the casting has been made, to become so soft as to suffer no resistance to its removal, the use of steel cores is capable of greater adaptation to modern foundry work than it has yet been given. It is not asserted that a steel core will work in all places. It cannot compete with a sand core for producing a hole that is good enough as made with the sand core without drilling or reaming. It has been found impracticable to cast a thin shell around a large steel core, but a thinner shell can be cast around a steel core standing on end than lying down in the mold. A thinner shell can be cast around a well-proportioned pattern that can be poured slowly than about one having thin webs.

To be on the safe side, it is best to assume that if the core is standing on end it will not give any trouble if the outside diameter is at least equal to twice the diameter of the core. If lying down, the core ought not to exceed one-third of the total diameter of the adjacent part of the casting. Like all rules, these can be broken with impunity if proper precautions are taken, and we know we are beyond the danger line. If the pattern can be gated so a considerable amount of metal may pass through the part having the steel core set, or if enough of the pattern projects above, so that the pressure of the iron will hold it up, much more difficult results may easily be achieved.

In a case where it was desired to cast a finished hole in a very light wheel, 7 ins. in diameter, that was gated to the rim, a large percentage of the hubs were defective at the upper end. The wheel then gated, as shown in Fig. 1, gave no further trouble, although the hub was less than ⅞ of an in. diameter and had a ½-in. hole 2 ins. long. These wheels went direct from the trimming room to the electing shop, the usual cost in the machine shop being entirely saved and better fitting journals secured than when drilled in jigs. Another case of finished work in this way was in making the castings for the frame of a small machine, shown in Fig. 2. The two sides were joined so that if not set exactly right in the jigs the two sets of holes did not coincide. The shaft working on the bearings A and B were ½-in. and the bosses not ¾-in. at the end, the plates being about ⅛-in. thick. Prints were put in and steel cores used. No trouble was had in casting them, and a more satisfactory job was done than when drilled, but extra care had to be taken to see that the flask pins were a tight fit, and sometimes a long, straight reamer was run through the line up the holes, but the iron not being chilled gave no more trouble than when drilled.

In Fig. 3 is shown a place where a sand core had been used. Great difficulty was found in getting the holes a satisfactory fit for the purpose desired. The steel cores were cut from the stock used. A perfectly finished hole was obtained at a less expense than with sand cores.

One of the greatest chances for money saving is casting gears, or pulleys that are afterwards to be turned up, the chucking and boring being dispensed with. The castings, direct from the foundry, can be driven on their mandrils and turned up. With care used to keep the mixture at a proper consistency, the fit on the shaft will be as perfect as can be obtained. Irregular shaped holes, or cavities with smooth square bottom can be made with steel cores that can hardly be produced in any other way. Then again, on some light work, too small to use sand cores at all, the steel core can be used to great advantage and very small holes can be made.

When lying horizontal in the flask the cores are, of course, only pieces of the stock that is expected to fit the hole, cut in the lathe or shaper with clean square ends; but when standing, the usual taper for cope to close over is essential. It is also suggested that the distance from A to B in Fig. 4 should be a trifle longer than the distance through the casting, so that there will be no danger of "capping over." If steel cores properly coated do not come out easily, it is when there is no chance, as is shown in Fig. 5. On old patterns having small prints it is found convenient to make the core like Fig. 6 and do satisfactory work for small runs, but it will usually be found to pay better to add enough to the print, as in Fig. 7.

In doing jobbing work where but a few pieces are made, it is often much quicker and cheaper to make steel cores than to make a core box and sand cores, even when the latter would answer.

Heavy or larger cores ought to have a hole drilled in the end for handling when dipping. The composition should be kept in tightly closed vessels when not in use, as the liquid is very volatile.

A great deal depends upon the care with which the core is coated. If in proper condition the cores will drain off instantly, leaving a smooth black coat about 1-100-in. thick, without any runs or streaks. This will leave the hole approximately 1-100-in. larger than the steel core, varying somewhat on account of the size and shrinkage.

The composition is supplied by the S. Obermeyer Co., Cincinnati, O., and Chicago, in two grades already prepared, designated as A and B. The composition is a mixture of refractory and non-conducting substances, which are held in suspension by a medium which is evaporated by the heat of the iron before they come into actual contact. Its non-conductive qualities are surprising. It would hardly seem reasonable to suppose that a coating of .01 of an inch thick would prevent the usual "chilling" of the iron. But how effective it is can be proven by placing two chills of equal size against a light bar, one being coated with the composition and the other not.

Like all good things, it is best to use steel cores with moderation. They will not do everything; they must be treated with consideration and coaxed, if need be. The experience every foundryman has had trying to cast around wrought iron will be applicable to their use, with all differences in favor of the coated cores. In the hands of a foundryman willing to put up with a few unexpected results and to cultivate their good side, they become very effective labor and cost reducers.

A POCKET RECORDER FOR TESTS OF MATERIALS.*

By Gus. C. Henning,† M. Am. Soc. M. E.

Many devices have been designed for recording stress-strain diagrams, showing the behavior and general characteristics and quality of materials, ranging in price from $200 to $2,000; each, however, usually designed for special work, or, more generally, for a particular machine. Their number is almost innumerable. I may mention as among the best those of Wicksteed, Gray, Unwin, Barr, Mohr, Federhoff, Olsen, Riehle, and many others. They are, however, rather for checking results than for reliance upon their cards.

Not one of them can be transported and used on machines other than that for which built, and even where

*Abstract of a paper presented at the Hartford meeting of the American Society of Mechanical Engineers.
† St. Paul Building, New York city.

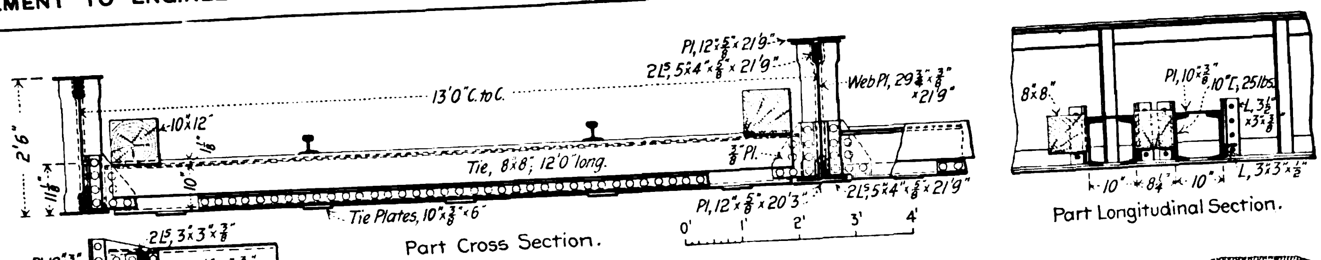


FIG. 13. STANDARD FLOOR FOR SHORT SPAN BRIDGES.

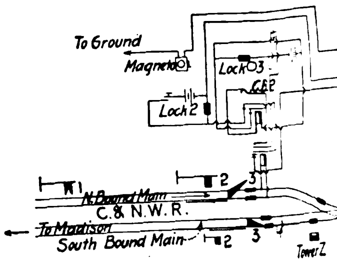


FIG. 15. INTERLOC

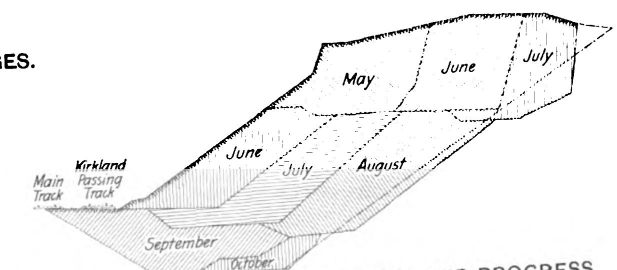


FIG. 7. DIAGRAM SHOWING METHOD AND PROGRESS OF STEAM SHOVEL WORK ON SUMMIT CUT.

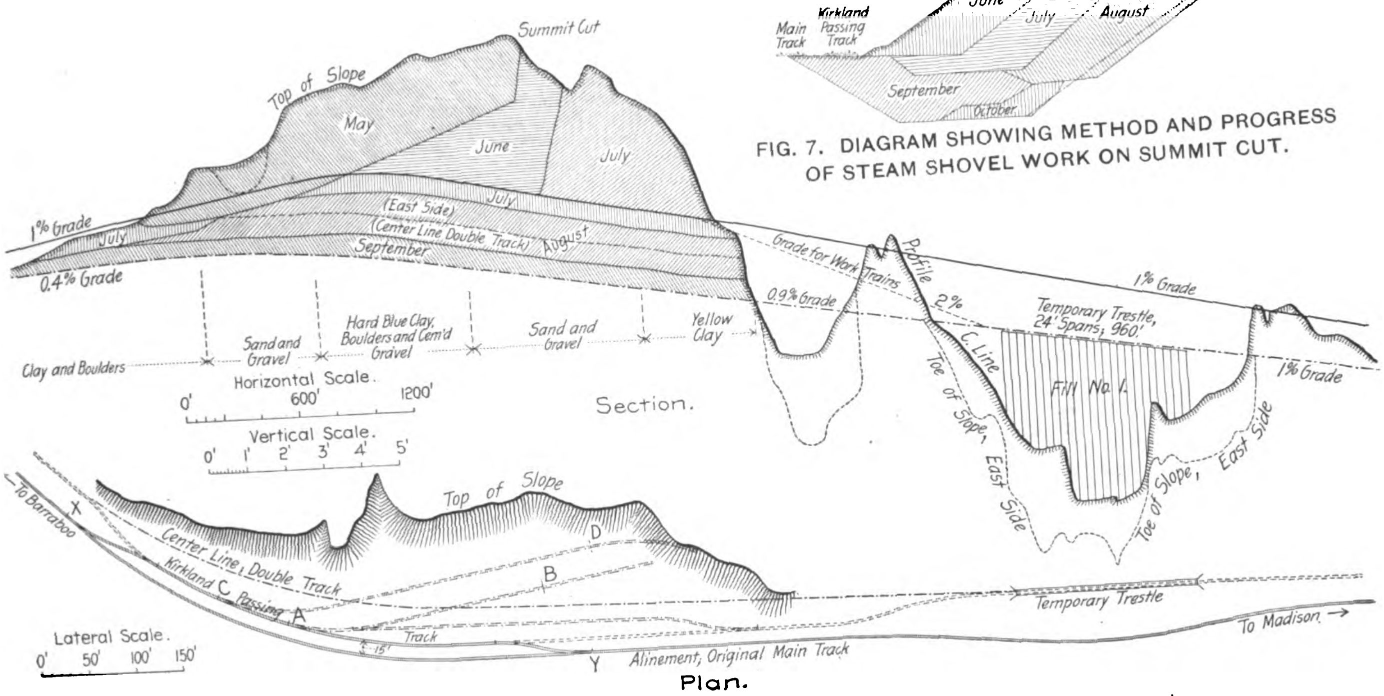


FIG. 5. PLAN AND PROFILE OF SUMMIT CUT AND FILL.

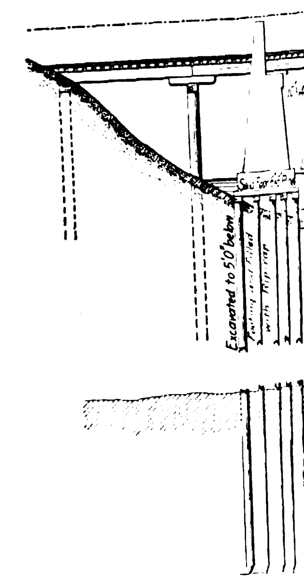


FIG. 1

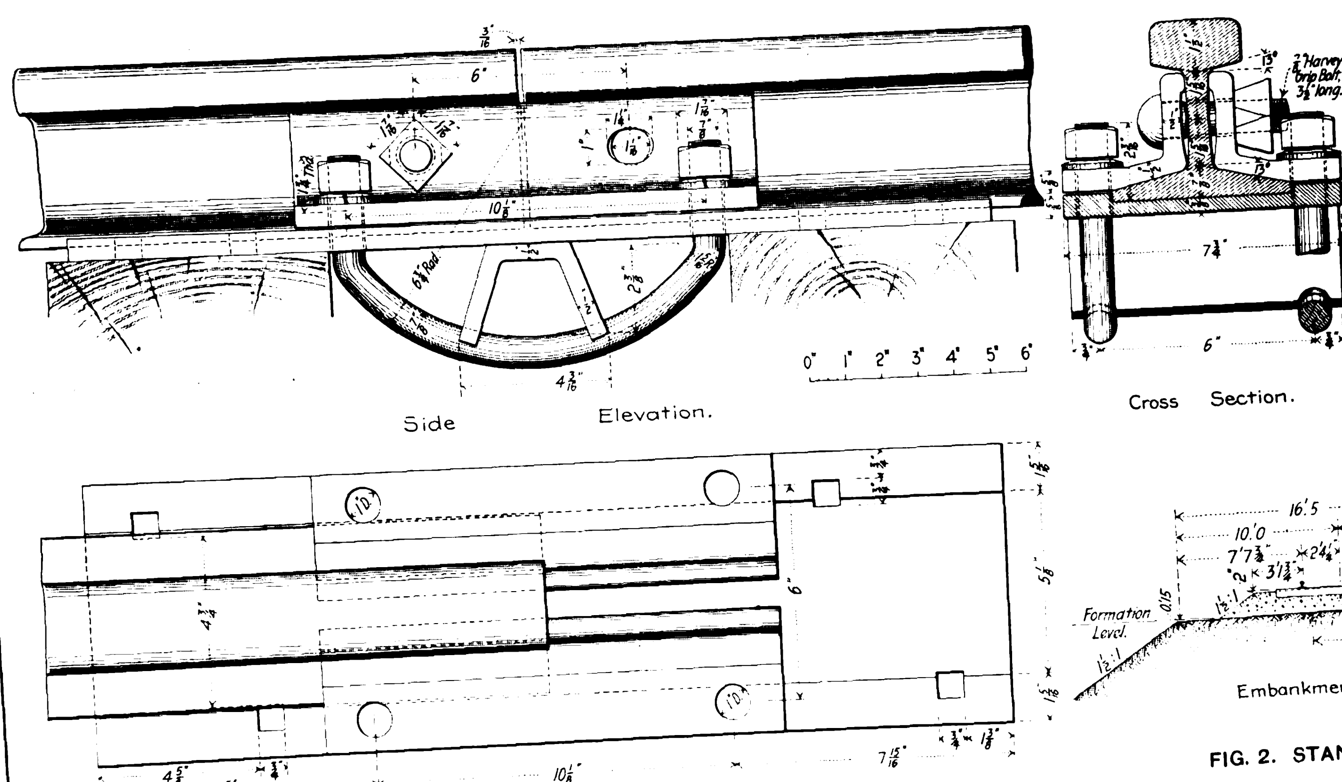


FIG. 14. STANDARD TRUSS RAIL JOINT.

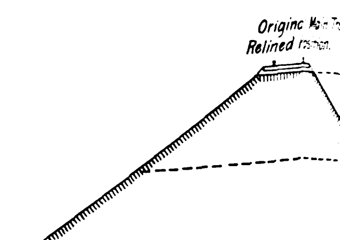


FIG. 10. SECTION SHOWING METHOD OF WORK SOUTH OF DEVIL'S NOSE.

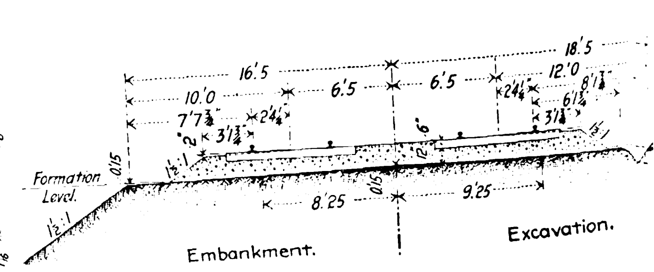
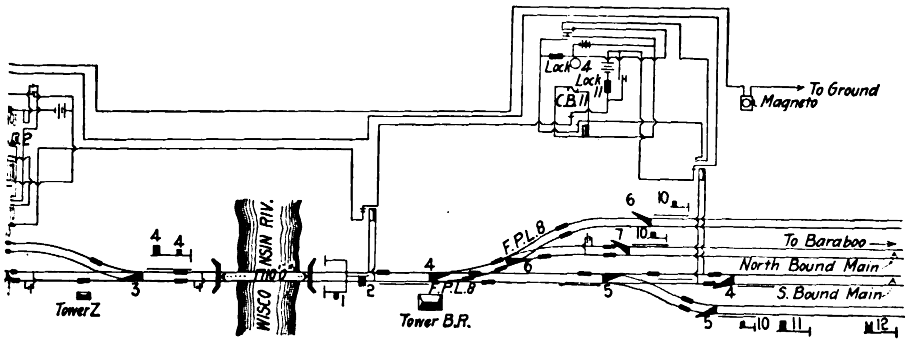


FIG. 2. STANDARD DOUBLE TRACK ROADBED.

SECOND TRACK CONSTRUCTION AND IMPROVEMENT OF GRADE AND LINE

E. C. Carter, Principal Assistant Engineer.
Winston Bros., Minneapolis, Minn., Contractors.



.NTERLOCKING SIGNAL PLANT AT THE WISCONSIN RIVER BRIDGE.

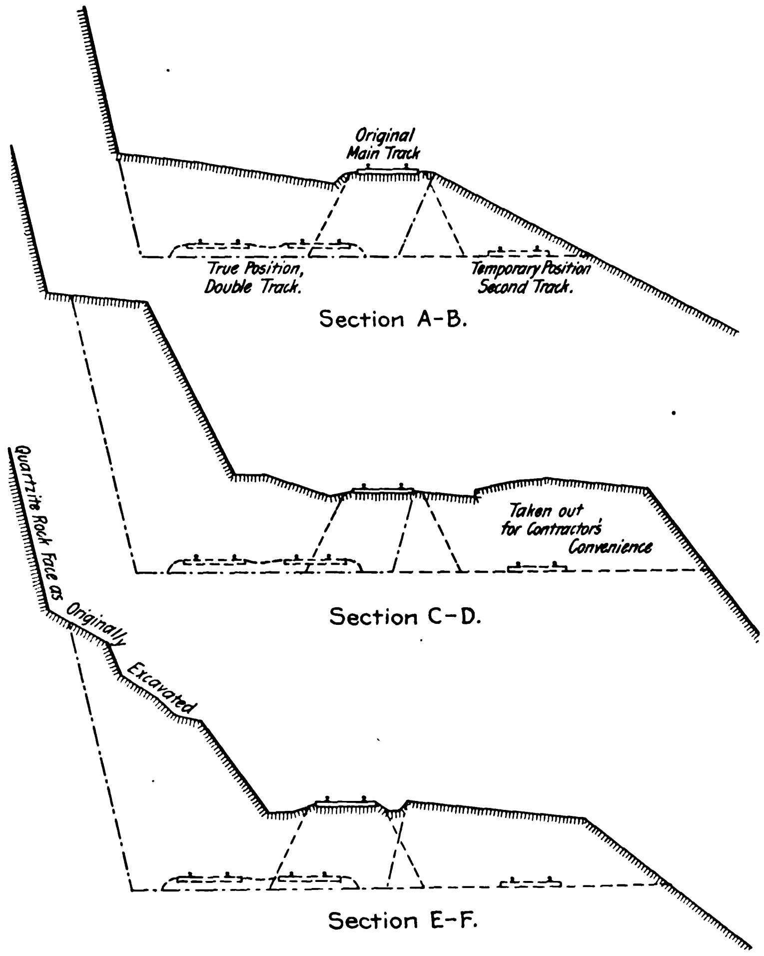


FIG. 8. SECTIONS SHOWING METHODS OF ROCK WORK AT DEVIL'S NOSE.

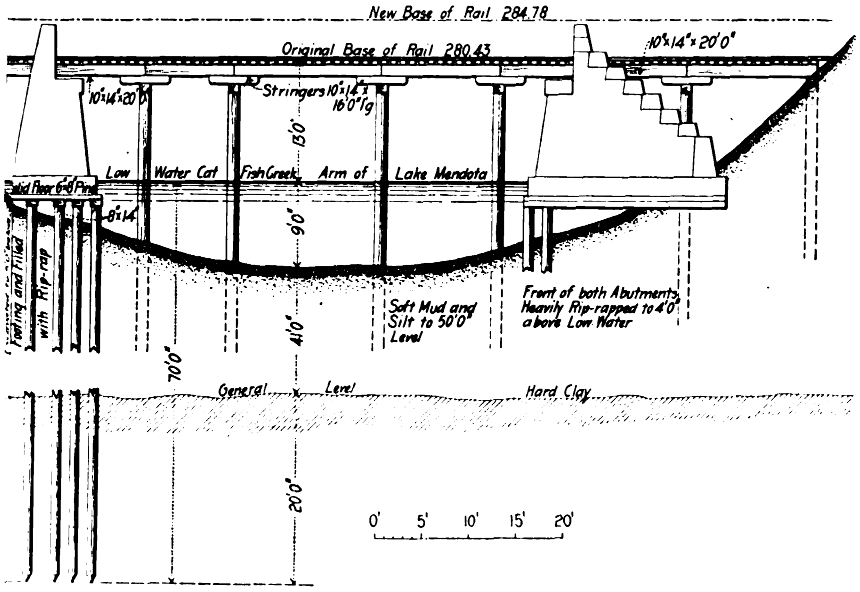


FIG. 11. DEEP BRIDGE FOUNDATION NEAR MADISON.

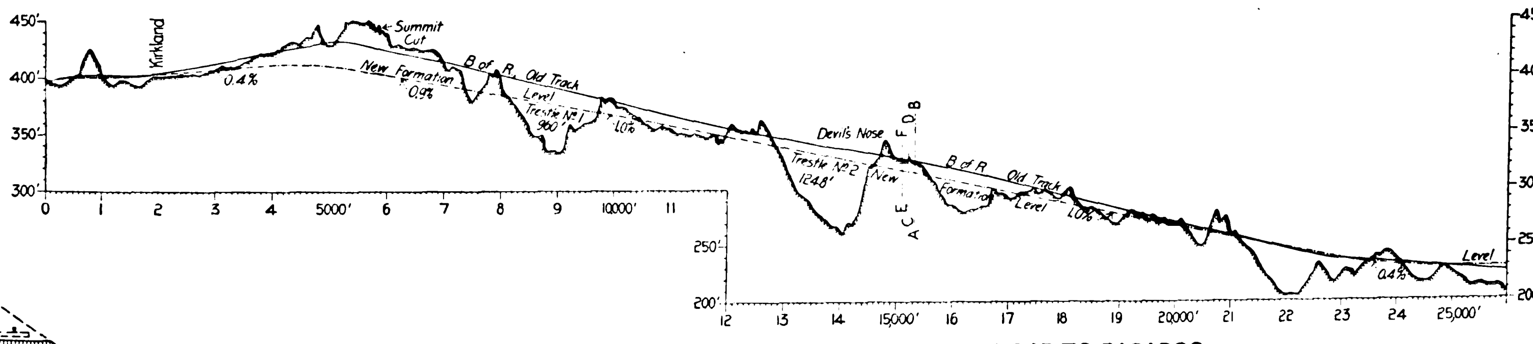


FIG. 1. GENERAL PROFILE FROM DEVIL'S NOSE TO BARABOO.

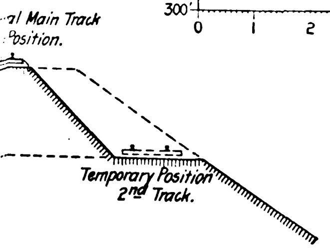


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FIG. 12. VIEW SHOWING MANNER OF CARRYING THE TRAFFIC WHILE REBUILDING A 24-FT. ARCH CULVERT.

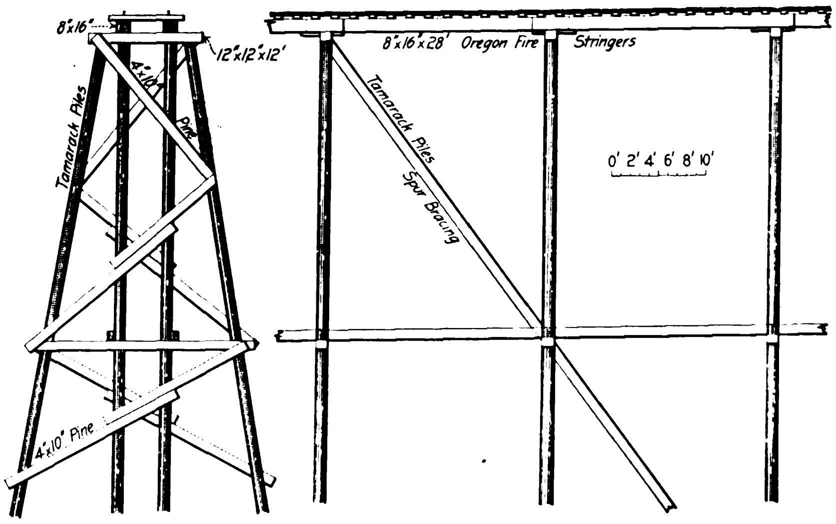

FIG. 3. TEMPORARY TRESTLE FOR CONSTRUCTING HIGH EMBANKMENT.

...NE FROM MADISON TO BARABOO, WIS., CHICAGO & NORTHWESTERN RY.

H. W. Battin, Division Engineer in Charge.
E. H. Beckler, M. Am. Soc. C. E., Engineer for Contractors.