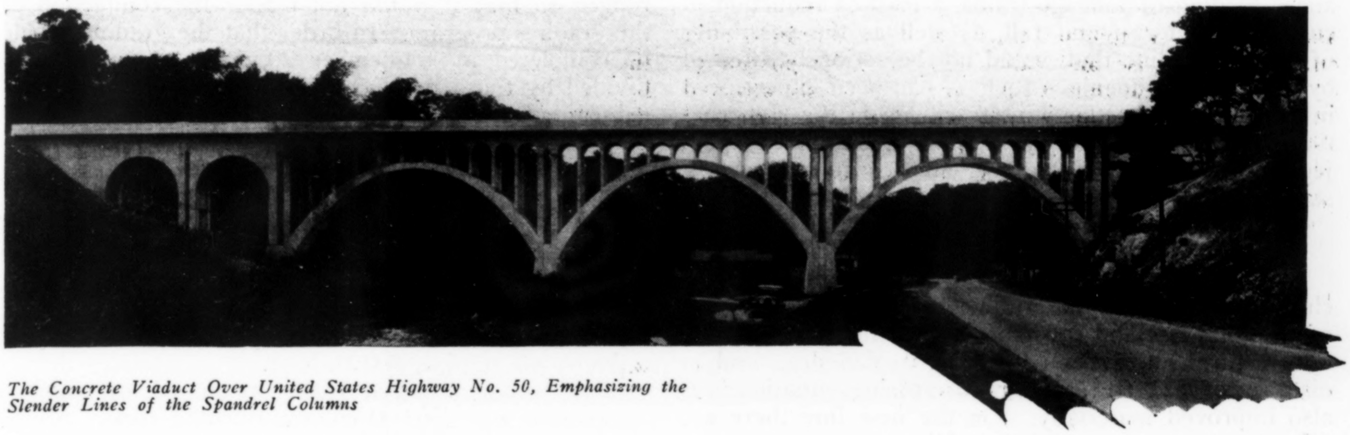


The Concrete Viaduct Over United States Highway No. 50, Emphasizing the Slender Lines of the Spandrel Columns

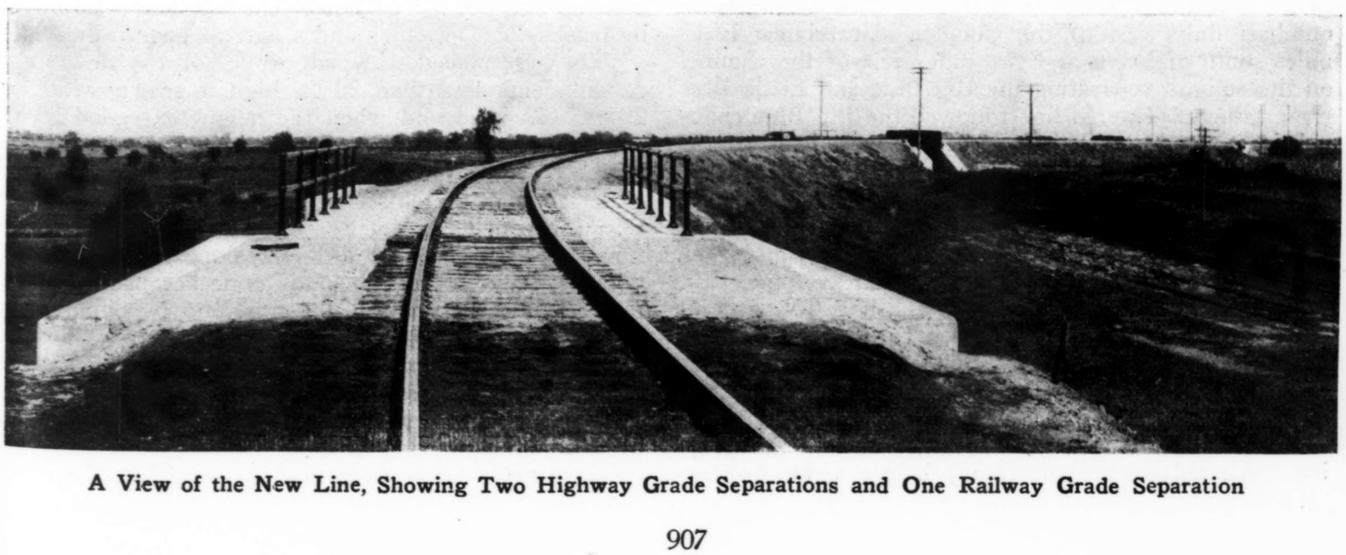
New K. C. S. Line Completes Ownership to Gulf Ports

Heavy grades eliminated by 13.27 miles of new line involving several large structures

ON November 29, 1929, the Kansas City Southern opened a new line 13.27 miles long between Grandview, Mo., and Leeds, near Kansas City, Mo., the completion of which by the Kansas City & Grandview, a subsidiary, gives the Kansas City Southern unbroken ownership of the shortest rail route from Kansas City to the Gulf of Mexico at Port Arthur, Tex., and to Beaumont, and Orange, and Lake Charles, La. At the time of the completion of the Kansas City Southern in 1897, a gap of 11 miles was left between Grandview, which is located in the highland a few miles south of the Missouri river, and the terminal trackage serving Kansas City, which is situated in what is known as the Blue River bottoms. To bridge this gap, trackage rights were secured over a line already in existence.

During the early years of operation, the district between Kansas City and Pittsburg, Kan., had a ruling grade of 1 per cent, with the exception of this joint trackage on which a 1.6 per cent grade 4.5 miles long opposed southbound traffic. By the use of helper engines, traffic was handled satisfactorily until a grade revision program was carried out in 1912, which reduced the maximum grade to 0.5 per cent between Grandview and Pittsburg, Kan., the first freight division point south of Kansas City. As this reduction permitted the heavier loading of all trains and added to the difficulty of operating over the 1.6 per cent grade of the leased line, a study was made which indicated the feasibility of constructing a line that would conform to the ruling grade on the remainder of the district.

It was desirable, also, that ownership of the entire line be acquired, and this was one of the deciding factors in determining upon the construction of the new line. Furthermore, in view of a steadily increasing traffic, the various operating advantages which it afforded, such as the release of helper service, the bal-



A View of the New Line, Showing Two Highway Grade Separations and One Railway Grade Separation

anced loading of tonnage trains, a marked reduction in curvature and rise and fall, as well as the possibility of securing a line that would not be seriously affected by high water difficulties such as had been experienced in recent years on the joint track, made the construction of the new line very attractive. Plans for the project were adopted, therefore, and construction work started in August, 1928.

Characteristics of the New Line

The improvements effected in the completed line include reductions of the ruling grade to 0.5 per cent, of the total rise and fall from 422 ft. to 299 ft., of the total central angle from 993 deg. to 638 deg., and in distance of 321 ft. The grade crossing situation was also improved materially. On the new line there are 17 private crossings and 1 public crossing at grade, 9 overhead and 17 undergrade separations and no railroad crossings, whereas on the old line there were 17 public and 17 private grade crossings, 1 overhead grade separation, 1 undergrade separation and 2 railroad crossings.

The valley of the Big Blue river extends almost directly south from the mouth of the stream at the point where it flows into the Missouri river. The beginning of the new line at Leeds is in the Big Blue valley about one-half mile west of the channel. Grandview is 13 miles south of Leeds and two miles east of the channel on the summit separating the Big Blue and Little Blue river valleys. The old line followed the Big Blue channel from Leeds to Dodson, near the west bank of the river, and then following a small tributary, began the ascent out of the valley to Grandview.

The elevation at Leeds is 775 ft. and at Grandview 1,050 ft., a difference of 275 ft. in 13 miles, giving an average rise of 21.2 ft. per mile, or an average grade of 0.4 per cent. In order to establish a 0.5 per cent ruling grade compensated for curvature, it was then necessary to begin a steady climb at Leeds and carry it up the east side of the valley to the summit at Grandview.

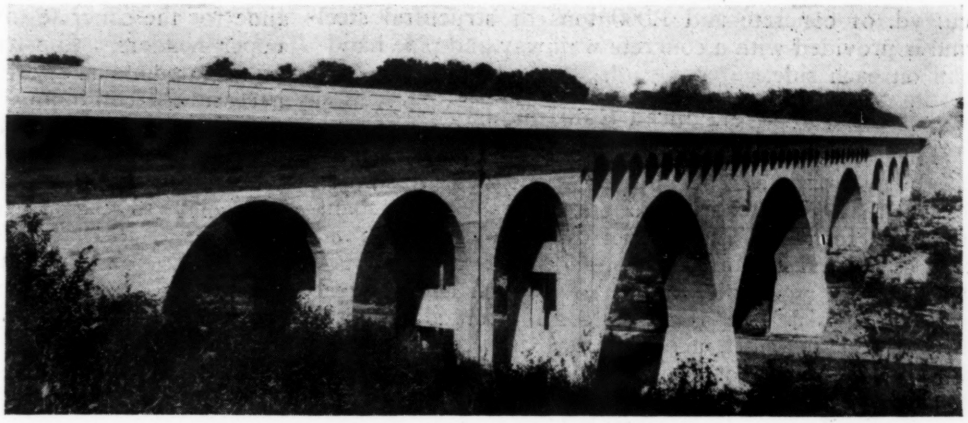
The "backbone" of the construction was the grading. All culvert and necessary bridge work was arranged so that it would not hinder the completion of the grading program. In order that the grading would be completed by September 20, 1929, the work was divided by the general contractor among a number of sub-contractors, and, with the approval of the engineer, every sub-contractor organized his work so that it would be completed by that date. All culvert work was sub-let to one contractor who did the necessary excavating, made the concrete pipe at the culvert location and placed the pipe and the head walls. The openings provided by the pipe vary from that of a single line of 24-in. pipe to the combined openings of two lines of 66-in. pipe. The longest culvert is on Mile 18, consisting of a double 66-in. pipe, 360 ft. long.

The grading required 1,000,000 cu. yd. of common excavation and 450,000 cu. yd. of solid rock. At the north end of the line the general geologic structure consists of a layer of loam covering a stratum of clay, both of varying depths, overlaying a stratified structure of limestone from 5 to 10 ft. thick, which is followed by alternate layers of shale and limestone. At the south end of the line this limestone and shale formation is overlaid directly by the loam. The earth excavation was made with elevating excavators and moved in "cat" wagons, while the rock excavation was made by blasting and the use of power shovels, and was moved by trucks, "cat" wagons and a narrow gage railway.

Fills were placed with side slopes of 1½ to 1. For enbankments less than 20 ft. high a crown width of 20 ft. was used and when the height exceeded 20 ft. a width of 22 ft. was required. All cuts were made with a 26-ft. width at grade. Fills were made with the material from the cuts except those at each end of the line, for which borrow was necessary. Earth excavation was taken out on a 1-to-1 slope from the base, down to solid rock. This was done because the extra material was needed for the fills, and by obtaining it in this manner the cuts were made easier to keep clean at no extra cost. Excavation of the rock was then made on a slope of between ¼ and ½ to 1, as determined by the engineer after an examination of the rock structure by drilling.

The largest fill is on Miles 11 and 12 at the north

A View of the Steel Viaduct on Mile 14 Complete Except for Handrails, Ballast and Track



The Viaduct Over Flying Field Road. The Concrete Handrail Adds Materially to the Appearance of the Structure

end of the line; it contains 405,000 cu. yd. of material and has a maximum height of 65 ft. A 39-ft. concrete arch culvert, 135 ft. long and containing 3,800 cu. yd. of concrete, carries the drainage from Round Grove creek under this fill. The largest cut on the line, which is also on Mile 12, is more than 70 ft. deep and required the excavation of 119,000 cu. yd. of material, of which 71,000 cu. yd. was solid rock.

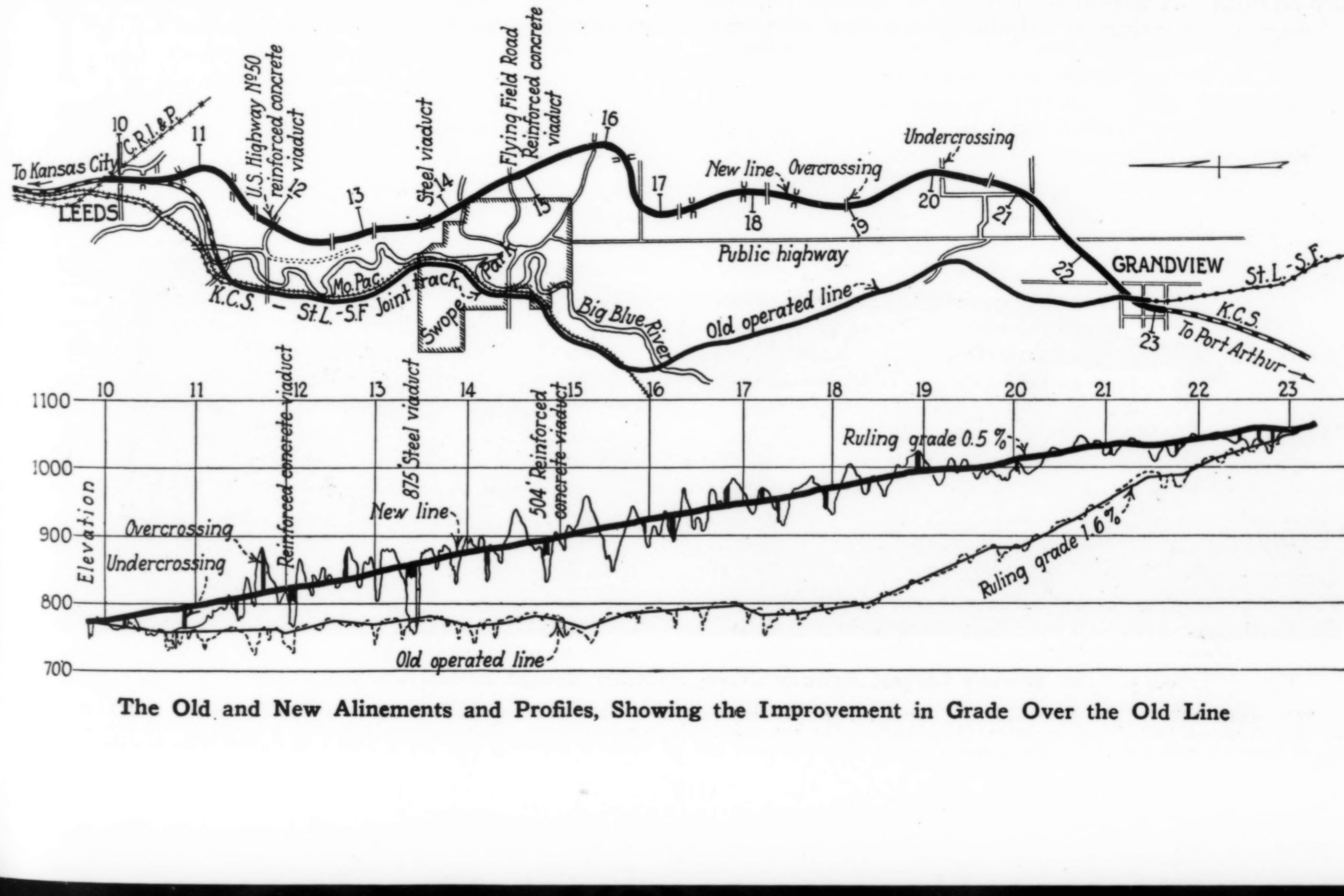
Three Large Structures

The three principal structures on the line are reinforced concrete viaducts over United States Highway No. 50 and Flying Field road, and a steel viaduct on Mile 14. At each of these points it was necessary to provide for both a roadway and a waterway, and there was no excavation available from the cuts for making a fill.

The steel viaduct is the largest of the three structures, having a total length of 875 ft. over the valley of a small tributary of the Big Blue river, and a maximum height of 110 ft. This structure consists of deck plate girder spans carrying a reinforced concrete slab floor for a ballasted roadbed. The girders are supported on steel towers which in turn rest on concrete piers. The clearing was done by the contractor and the excavation for ten of the piers was roughed out with a drag line, the remaining excavation being done by hand. Concrete for the piers and abutments was mixed at each end of the structure and placed by chutes. The abutments and piers rest on solid rock with the exception of those supporting three of the towers near the center of the span, which are on piling.

The steel was brought to the north end of the viaduct over the new line, which had been completed to that point, by company trains and its erection was not a difficult matter. A derrick car of sufficient capacity to place a 65-ft. girder without out-rigging or blocking was used and the viaduct was erected from the north end. The span lengths are one of 65 ft. 8 in., seven of 65 ft., one of 50 ft. and eight tower spans of 38 ft.

The concrete for the ballast deck slab, which was made of quick-hardening cement, was placed from the north end of the viaduct where a mixing plant and unloading hopper were located. A temporary track was constructed across the structure and a railway motor car with a special hopper trailer was used to transport the concrete from the mixer and place it, this work being commenced at the north end and carried across the viaduct. The temporary track was also used to distribute the ties and rails before it was removed. The steel was erected and the slab completed ready for the ballast in six weeks' time. The viaduct contains 2,200



The Old and New Alinements and Profiles, Showing the Improvement in Grade Over the Old Line cu. yd. of concrete and 1,000 tons of structural steel and is provided with a concrete walkway and pipe handrail on each side.

Concrete Poured Continuously

The reinforced concrete viaducts over United States Highway No. 50 and over Flying Field road are similar except that the latter has two more approach arch spans than the former. The viaduct over Flying Field road was completed in March, 1929, and is the largest structure on the new line, with the exception of the steel viaduct on Mile 14. It is built of reinforced concrete throughout, is 65 ft. above the stream and is 504 ft. long, consisting of one 95-ft. and two 78-ft. 9-in. open spandrel type arch spans, with 31-ft. girder approaches, two 31-ft. 3-in. arches and one 34 ft. arch. Excavation for the foundations was started in September, 1928, a power shovel being used to excavate to the rock and and the remainder being taken out by hand. Although the footings were carried down to solid rock, no extraordinary expense was involved at this particular location.

A 120-ft. steel tower and a concrete mixing plant with automatic material-measuring devices were erected by the contractor immediately on moving onto the job. All concrete was elevated by means of the tower and chuted to various parts of the structure through counterbalanced chutes which greatly reduced the conveying time. All pier and abutment forms were built with 1-in. dressed lumber as lagging and 2-in. by 6-in. studding, with walling built up with 2-in. material. On the under side of the arch rings, lagging of 2-in. dressed lumber was used, this being the only place where material of this size was used for lagging. The centering for the three main spans was built up with new 10-in. by 10-in. fir timbers as the main supports.

Before the centering for the main spans was placed, concrete was poured in the piers up to the haunch or springing line of the arch rings. Each arch ring was divided into five sections for pouring; the top section of about 30 ft. of the ring was poured first, the two lower sections adjoining the piers then being placed simultaneously, followed by the concrete for the two key sections. A period of at least 48 hr. was required between the pouring of adjoining sections, to permit time for the concrete to get maximum shrinkage at the upper headers. Construction joints were placed only at such points as were specified by the plans, which necessitated continuous pouring of certain sections for a 48-hr. period. This forced the pouring of some concrete at temperatures near the zero mark, but in such cases all aggregates and water were preheated and the concrete, after being placed, was protected with canvas and salamander heaters.

A Heavy Track

All the track-carrying structures, with the exception of a treated pile trestle over the Municipal Farm spur on Mile 11, are of concrete and steel and have ballast decks. Six of the overhead structures carrying highways are of treated timber and three are of concrete and steel. The track structure consists of 127-lb. rail with 38-in. six-hole angle bars, supported on 7-in. by 12-in. double-shoulder tie plates with a 1 in 20 cant, and 7-in. by 9-in. by 8-ft. treated ties, of which there are 3,000 to the mile. For the time being, the track is surfaced on sand to a depth of 12 in. under the ties, the intention being to place rock ballast when the roadbed has become compacted.

Two one-mile passing tracks, two emergency spurs and one industry siding, all laid with 85-lb. relay rail, have been provided. These tracks have No. 12 turnouts from the main line, consisting of 24-ft. rigid, railbound manganese frogs with raised wing rails, 22-ft. split switches and 8-ft. 6 in. one-piece manganese guard rails. The industry track turnouts have 16-ft. 6 in. No. 10 and one industry siding, all laid with 85-lb. relay rail, and other markers are constructed of concrete.

All grading, culvert, and bridge work was done by the List Construction Company, Kansas City, Mo., while track laying, surfacing and pole-line work was handled by company forces. The project was planned and constructed under the direction of A. N. Reece, chief engineer of the K.C.S., to whom we are indebted for this information. The work was under the direct supervision of E. M. Basye, resident engineer, and P. J. McCarthy and H. E. Durham, assistant engineers. Ash, Howard, Needles and Tammen, Kansas City, and C. S. Heritage, bridge engineer of the Kansas City Southern, were the designing engineers.

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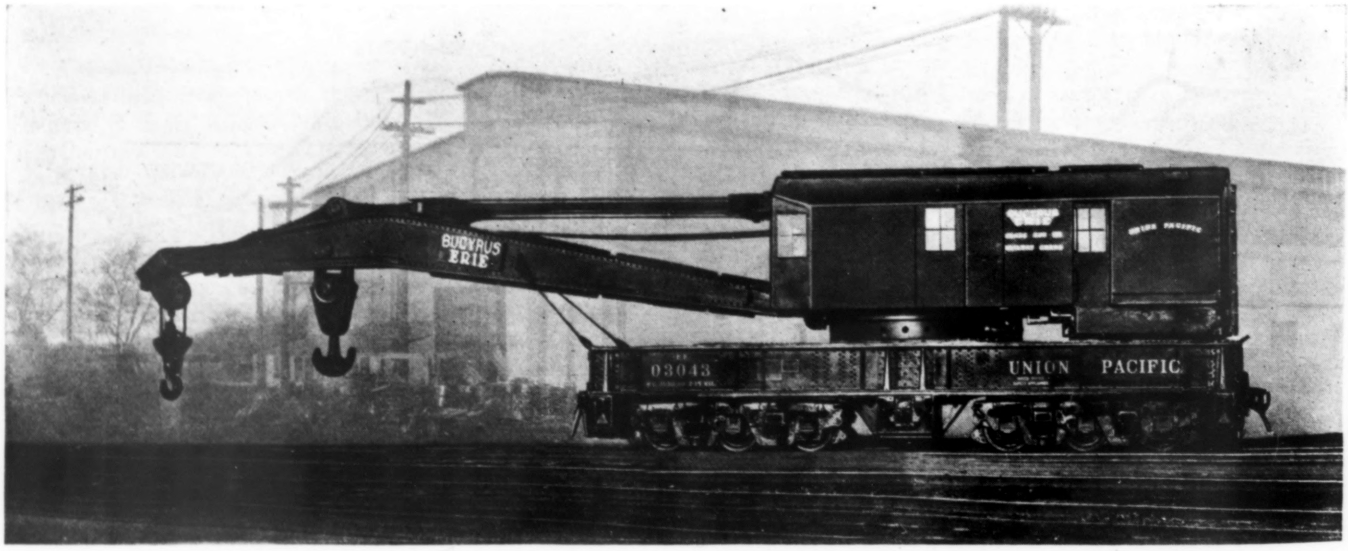

The World's Largest Railway Crane, Recently Bought by the Union Pacific

This crane, built by the Bucyrus-Erie Company, South Milwaukee, Wis., lifts a maximum load of 400,000 pounds at a radius of 17½ ft. For less than maximum loads it has greater working reaches than any such crane previously built. The auxiliary hook, with a capacity of 60 tons at 30 ft., lifts 45 tons at a radius of 48 ft. The machine weighs 375,000 pounds and its center of gravity is very low to permit high speed transportation.

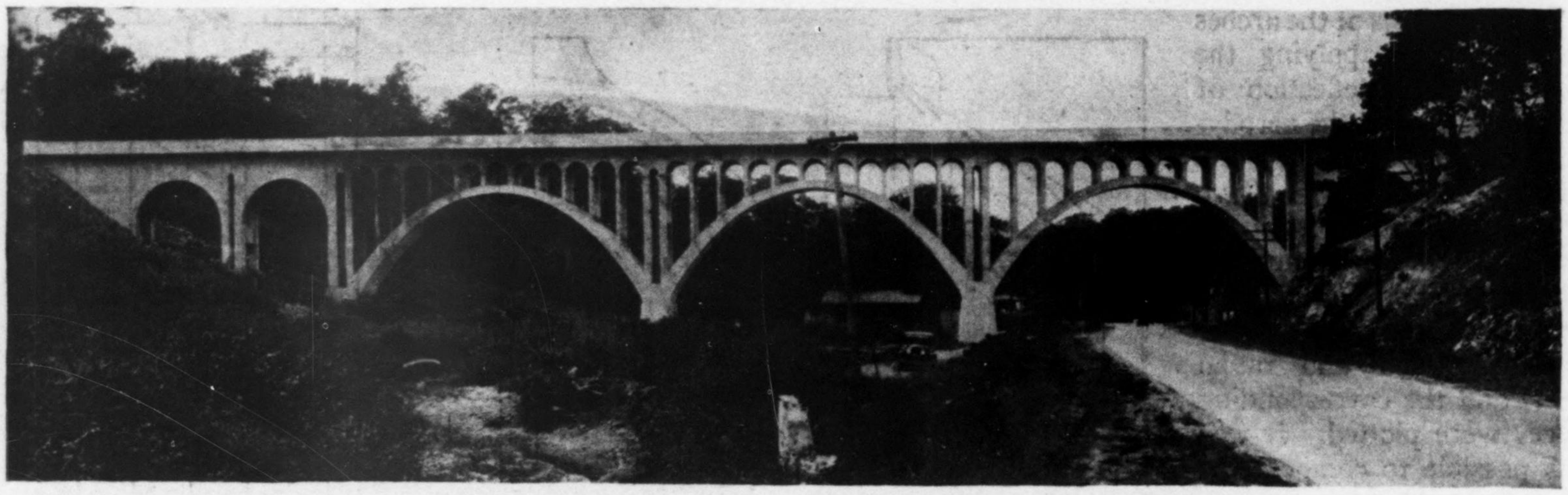

FIG. 1—CONCRETE VIADUCT ON KANSAS CITY SOUTHERN RAILWAY
Viaduct on new line into Kansas City, Mo., crossing a stream and U. S. Highway No. 50. Main arches 95 ft. and 78⅔-ft. span.

New Line for Kansas City Southern Railway

Improved Approach to Kansas City Reduces Grade From 1.6 to 0.5 Per Cent and Eliminates Many Grade Crossings—Concrete Arch Viaducts Are Handsome Structures

WITH the completion of its 13¼-mile line between Grandview and Leeds, Mo., the Kansas City Southern Railway has entire ownership of the shortest route between Kansas City, Mo., and its Gulf ports at Port Arthur, Beaumont and Orange, Tex., and Lake Charles, La. This new line, 13.27 miles long, with single track, built by the Kansas City & Grandview Railway Co., as a subsidiary, forms a new and improved entrance to Kansas City.

When the Kansas City Southern Railway was completed, in 1897, its own line began at Grandview, Mo., 22½ miles from Kansas City. Trackage rights north to Leeds, Mo., 11 miles, for connection with the terminal railway system, were secured over an existing line of the St. Louis-San Francisco Railway, which afforded sufficient and economical operating facilities. At that time the operating district between Kansas City and Pittsburg, Kan., 128 miles, had a ruling grade of 1 per cent, except that the joint-track line had a grade of 1.6 per cent, 4½ miles long, against southbound traffic. With helper engines for this grade, the district was operated satisfactorily until 1912, when the railroad carried out a grade revision program which gave a maximum grade of 0.5 per cent between Grandview and Pittsburg. With the heavier train loading for the reduced grade, there was increased difficulty in operating over the 1.6 per cent grade on the leased line.

Low-Grade Line—Investigation showed that north of Grandview a new line could be built to conform to the ruling grade on the remainder of the district. In determining upon the construction of this line, one of the deciding factors was the desirability of complete ownership in preference to trackage rights. Furthermore, with the steadily increasing business, this new line offered operating advantages in the elimination of helper engines, the balanced loading of tonnage trains, reduction in curvature and in total rise-and-fall, and freedom from the high-water troubles on the joint line. Construction was started in August, 1928.

The striking difference in the profiles of the new and old lines is shown in Fig. 2. At Leeds, about 10 miles from the Kansas City union station, the line is at El. 775 in the valley of the Big Blue River, while Grandview, 13 miles south, is at El. 1050 on the summit of the ridge between the valleys of the Big Blue and Little Blue rivers. With a difference in elevation of 275 ft. in 13 miles, the average grade is 21.2 ft. per mile, or 0.4 per cent. To secure a ruling grade of 0.5 per cent, compensated for curvature, it was necessary to begin the ascent at Leeds and carry the line up the east side of the valley to the summit at Grandview.

Besides the reduction of ruling grade to 0.5 per cent, the total rise-and-fall is reduced from 422 ft. to 299 ft. and the total curvature from 993 deg. to 638 deg., while the sharpest curves are of 4 deg. instead of 6 deg. and there is a reduction of 321 ft. in total length of these curves. On the new line the grade-crossing situation is much improved, for with 44 crossings in 13¼ miles it has only one public highway grade crossing, seventeen private grade crossings, nine overhead and seventeen subway grade separations. The joint line had seventeen public and private grade crossings, one overhead and one subway grade separation and two railroad grade crossings.

Construction Work—As the grading was the main feature, culvert and bridge work was so planned as to avoid interference with it. This grading, which involved 1,000,000 cu.yd. of common excavation and 450,000 cu.yd. of solid rock, was sublet to a number of contractors in order that it might all be completed by Sept. 20, 1929. On the north end of the line a stratum of clay of varying depths covers a stratified limestone 5 to 10 ft. thick, below which are alternating layers of shale and limestone. Farther south the surface loam overlies these alternating layers. Earth excavation was handled by elevating graders, which loaded wagons mounted on crawlers. Rock was blasted and loaded by power shovels into trucks, wagons and narrow-gage dump cars. Fills were given slopes of 1 on 1½, with a top width of 20 ft. for heights up to 20 ft. and a 22-ft. top for higher fills. Material from the cuts was sufficient to make all fills except the two end fills, for which it was necessary to establish borrowpits.

In cuts, the subgrade width is 26 ft. Earth excavation was taken out at a slope of 1 on 1, as material was needed for the fills. These wide cuts are easier to keep clean, thus saving something in maintenance. Below the earth slopes in cuts, the rock was taken out on slopes of 4 on 1 to 2 on 1. The largest fill contains 405,000 cu.yd. and has a maximum height of 65 ft., with a 30-ft. concrete arch culvert 135 ft. long for Round Grove Creek. The largest cut, with a depth of more than 70 ft., contained 119,000 cu.yd., of which 71,000 cu.yd. was solid rock.

Bridges and Culvert—Two reinforced-concrete viaducts and a steel viaduct are the three principal structures. At each of these locations a highway and a waterway had to be crossed, and no excavation from cuts was available for making a fill. Concrete-pipe culvert work was sublet to a contractor who handled the excavation, made the pipe at the site, placed the pipe and built the headwalls. These drainage openings vary from a single 24-in. pipe to a pair of 66-in. pipes, according to the drainage areas and local conditions. The longest culvert, 360 ft., is of the double-pipe type.

All subways have concrete abutments and steel girders carrying a deck slab for ballasted track, except that a creosoted-pile trestle crosses the spur track to the Municipal Farm. Of highway bridges crossing the railroad, six are of treated timber and three are of concrete and steel.

Steel Viaduct—This is the largest of the three main structures, crossing the valley of a tributary of the Big Blue River, with a length of 875 ft. and a maximum height of 110 ft. above the ground. It is a deck plate-girder viaduct with nine spans of 50 to 65 ft. 8 in. and eight tower spans of 38 ft. Concrete is used for the abutments and tower pedestals. A concrete deck slab on the girders carries the ballasted track.

After clearing the ground the foundations were excavated roughly with a dragline machine and finished by handwork. Concrete for the pedestals and abutments was mixed at each end of the structure and chuted into place. All of these are founded on solid rock, except that piling was used at three of the towers. Steel was brought to the north end of the viaduct by company trains, the new line being completed to that point, and was erected by a derrick car capable of handling a 65-ft. girder without outrigging or blocking. Concrete for the deck slab was mixed at the north end of the viaduct and placed in the forms by means of a hopper dump car handled by a motor car on a temporary track.

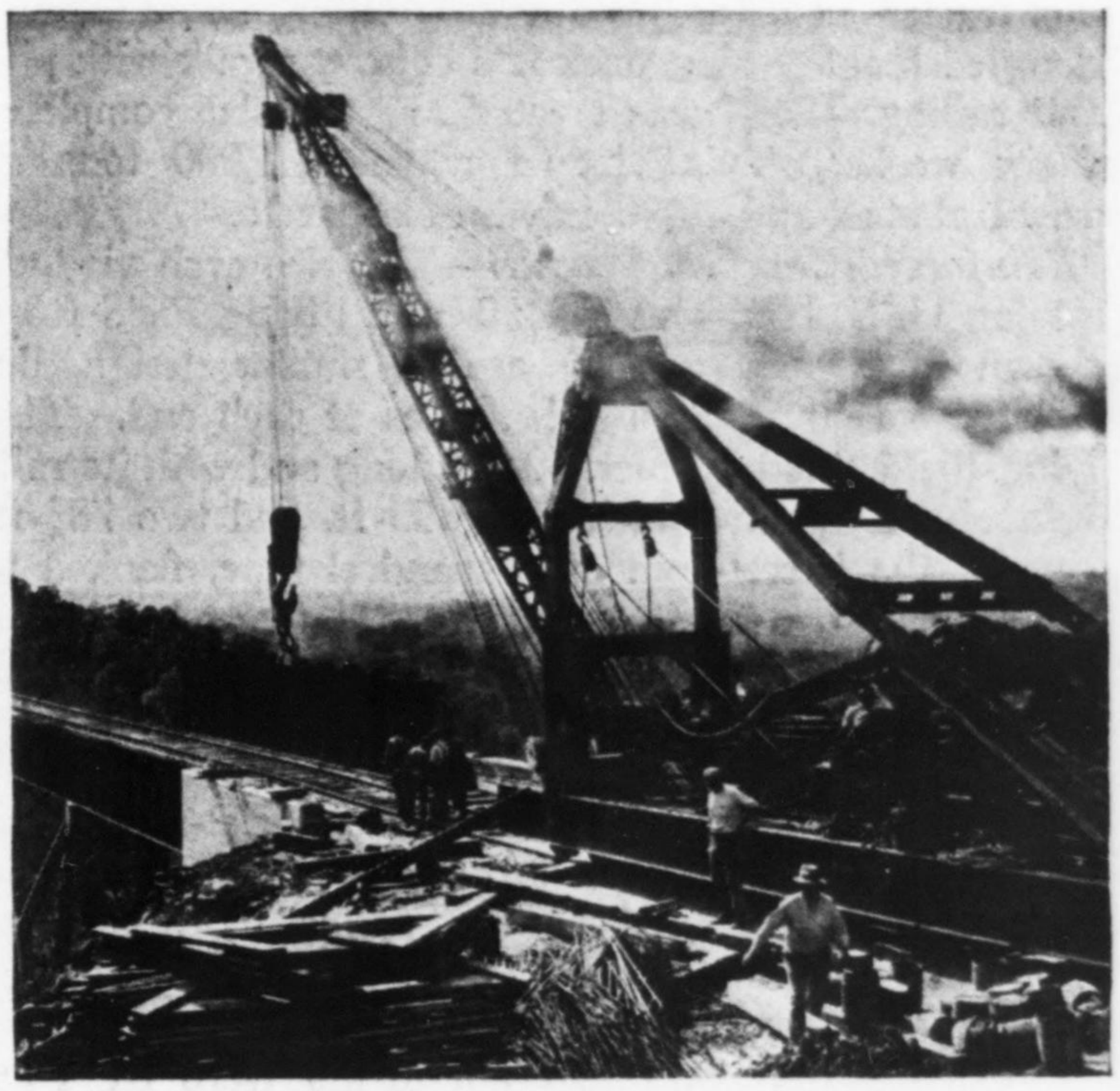

FIG. 3—ERECTING STEEL VIADUCT, KANSAS CITY SOUTHERN RAILWAY

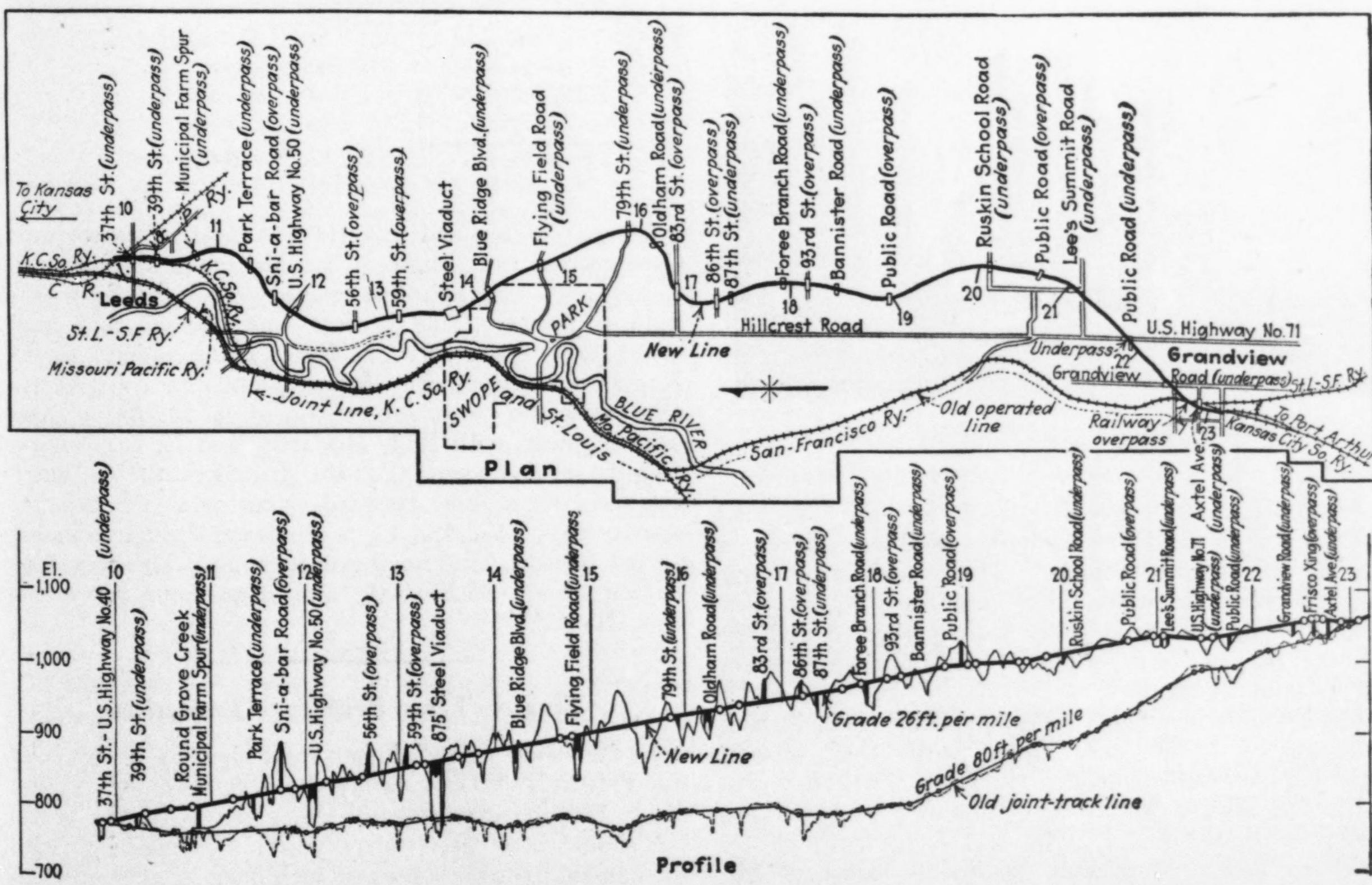

FIG. 2—KANSAS CITY SOUTHERN RAILWAY'S NEW LINE INTO KANSAS CITY

This track was used also for distributing ties and rails. Along each side of the deck is a concrete walk with pipe hand railing. Steel was erected and the slab completed in six weeks. This viaduct contains 1,000 tons of structural steel and 2,200 cu.yd. of concrete.

Reinforced-Concrete Viaduct—The two arch viaducts crossing U. S. Highway No. 50 and Flying-Field Road (shown in Figs. 1 and 4) are of similar design, but the latter has three approach arches at each end. This Flying-Field Road viaduct, 504 ft. long and with its rails 65 ft. above the stream, has one 95-ft. and two 78¾-ft. spans of the barrel-arch open-spandrel type, flanked at both ends by one 34-ft. arch, two 31¼-ft. arches and a 31-ft. girder span. All footings are on solid rock. Earth excavation for the foundations was handled by a power shovel, and rock work was done by hand. A concrete-mixing plant with automatic material-measuring devices and a 120-ft. steel hoisting tower was installed and concrete distributed to the forms by means of counterbalanced chutes (see Fig. 4). About 2,750 cu.yd. of concrete was required.

Forms for the piers and abutments were of 1-in. dressed lagging on 2x6-in. studding, with wales built up of 2-in. material. On the under side of the arch rings, however, the lagging was of 2-in. dressed lumber. The centering for the three main spans was built up with 10x10-in. fir timbers as the main supports. Before this centering was placed concrete was poured in the piers up to the haunch or springing line of the arches. Each arch ring was divided into five sections for pouring. The top section, about 30 ft., was poured first; then the two lower sections adjoining the piers were placed simultaneously, after which the two key sections were poured.

At least 48 hours was required between the pouring of any adjoining sections, to permit the concrete to get its maximum shrinkage at the upper headers.

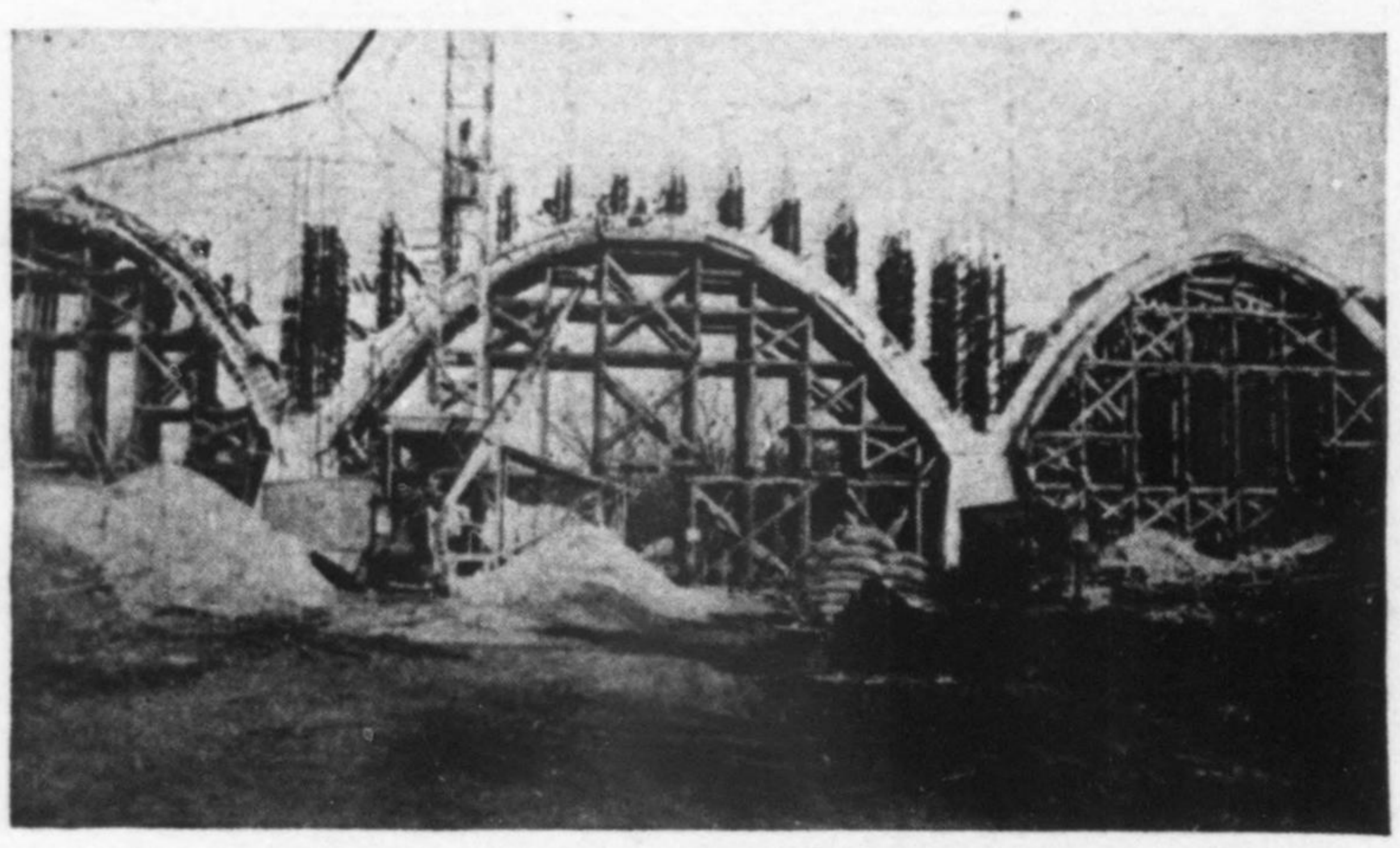

FIG. 4—CONCRETING VIADUCT OVER FLYING-FIELD ROAD

Construction joints were placed only at points specified by the plans, which necessitated 48-hour continuous pouring of certain sections. This involved pouring some concrete at temperatures near zero, but in such cases all aggregates and water were preheated and the concrete in place was protected with canvas covering and salamander heaters.

Track Construction—A heavy type of track is laid, consisting of 127-lb. rails spliced with 38-in. six-bolt angle bars. Double-shoulder tie-plates, 7x12 in., give the rails an inward cant or inclination of 1 on 20 and are spiked to treated ties 7x9 in. and 8 ft. long, spaced 3,000 per mile. At present the line is ballasted with sand 12 in. deep under the ties, but broken stone ballast will be laid when the roadbed has become compacted under traffic. Two passing tracks 1 mile long, two emergency spurs and one industry siding have been built and are laid with 85-lb. relay rails. The passing tracks have No. 12 turnouts laid with 22-ft. switch rails, 24-ft. rigid railbound manganese-steel frogs having raised wing rails, and 8½-ft. one-piece manganese-steel guard rails. Turnouts for the industry track have 19½-ft. switch rails and No. 10 frogs 16½ ft. long. All mile posts, rail rests and other markers are constructed of concrete.

Engineers and Contractors—A general contract for

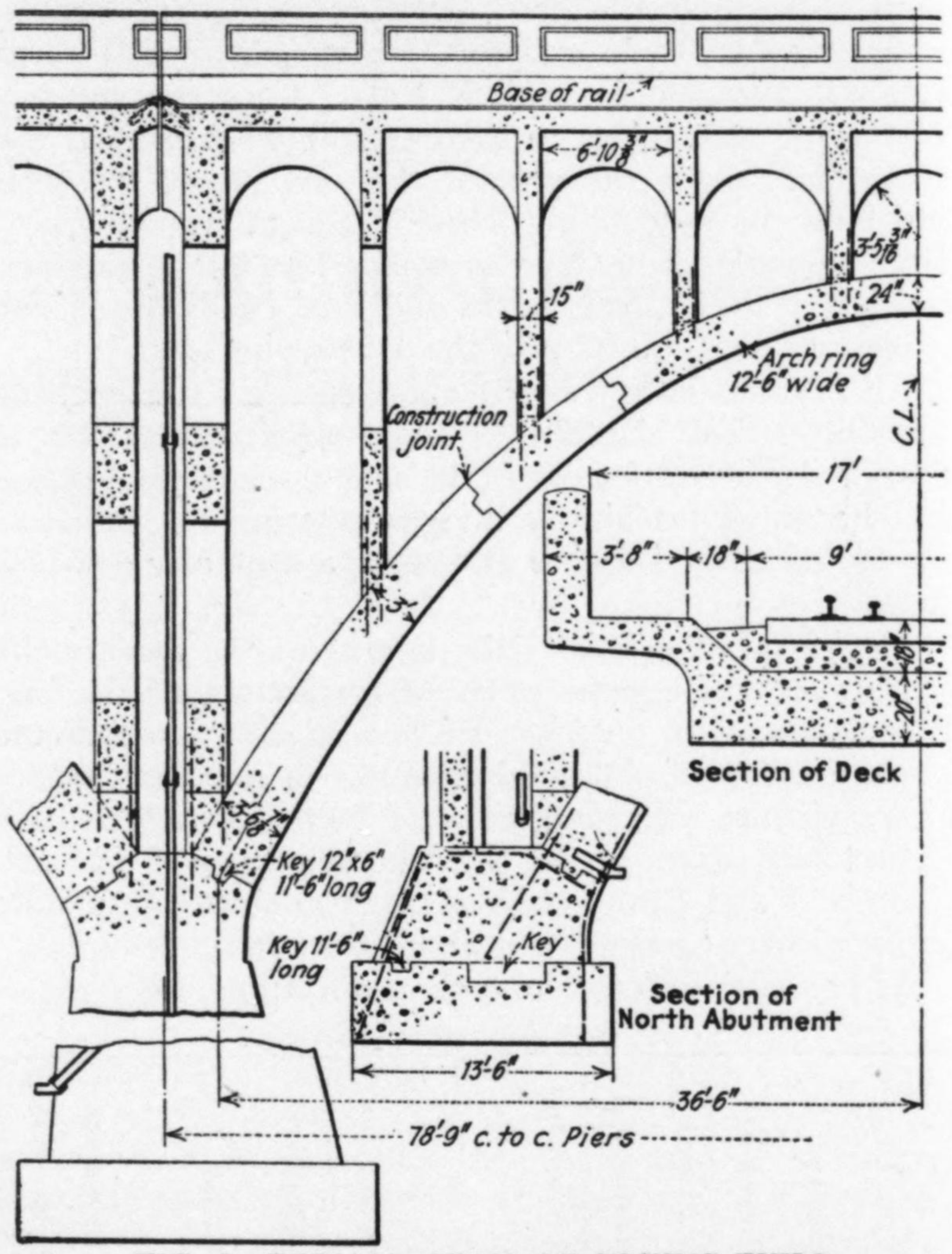

FIG. 5—TYPICAL SPAN OF FLYING-FIELD ROAD VIADUCT

grading, bridging and culverts was awarded to the List Construction Co., Kansas City, Mo. Tracklaying, surfacing and telegraph line work were handled by the railway forces. This project was planned and built under the direction of A. N. Reece, chief engineer of the Kansas City Southern Railway, and its construction was under the direct supervision of E. M. Basye, resident engineer, with P. J. McCarthy and E. N. Durham as assistant engineers. For the structures, the designing engineers were Ash, Howard, Needles & Tammen, of Kansas City Mo., and C. S. Heritage, bridge engineer of the Kansas City Southern Railway. The new line, costing about $3,300,000, was opened to traffic on Nov. 21, 1929.

Timber Truss Bridges—Correction

In the article on the timber truss highway bridge over the Fraser River in *Engineering News-Record* of Jan. 30, p. 186, the expected life was given as twenty years, but should have been thirty years, in accordance with the general life expectancy of such bridges, as mentioned in the same article.