absorbed per tie would be so great that there could be no economy in its use. The attached data and the cross-section samples taken from the ties in the several tests made on these specie of wood with asphaltic residual oil prove that this is not the case. Good penetration has been secured by not over an 8 lb. per cubic foot injection of asphaltic oil, which also proved to be the average amount the various timbers would absorb.

This proves the case with all except the short leaf pine ties, and even with that species the amount of oil necessary to secure a maximum injection was not found to be prohibitive from the standpoint of economy.

The Santa Fe and the National of Mexico have demonstrated by a practical test, under abnormal conditions of about nine years' duration, the value of asphaltic oils when injected into pine ties to refusal. Some of the ties which successfully withstood this test contained a small amount of oil, yet it was in all cases the maximum quantity which the ties would absorb.

The foregoing data is the result of observations and experiments extending over several years with the asphaltic base oil to be found in such immense quantities throughout the central part of the United States.

TRACK ELEVATION AT NINETY-FIFTH STREET AND SOUTH CHICAGO AVENUE, SOUTH CHICAGO

In connection with the elimination of highway grade crossings which has been so vigorously prosecuted by the railways in Chicago for the past 15 years, there has been a very marked tendency for the roads to do away with grade crossings with each other wherever possible. While making the heavy expenditures necessary to get above the streets, the roads have decided in most cases to spend enough more to avoid the steam road crossings, with their expensive delays to traffic, which delays are continually becoming more serious as the business increases. From the very nature of the conditions, such double elimination of crossings is very costly, and introduces many complications, not the least of which is the handling of all construction work without delay to traffic. At no other point has the work assumed such magnitude or become so general as at Chicago.

A very good example of the problems met with is presented at Ninety-fifth street and South Chicago avenue, South Chicago, where work has recently been started. At this point the double-track main line of the Pittsburgh, Fort Wayne & Chicago and the three-track main line of the Lake Shore & Michigan Southern, running northwest and southeast, cross the single-track lines of the South Chicago branch of the Chicago, Rock Island & Pacific and the Chicago & Western Indiana belt railway running east and west. The Baltimore & Ohio double-track main line parallels the Lake Shore from the southeast to the crossing where it connects with the Rock Island, passenger and time freight trains using these tracks west for about 6 miles in entering the city. Freight trains on the Baltimore & Ohio other than time freights turn north at the crossing instead of connecting with the Rock Island and proceed to the Baltiomre & Ohio yard at Ninety-second street, where they are arranged for distribution in the city. After classification, Baltimore & Ohio transfer engines take them to the city by way of Ninety-fifth street and the Rock Island tracks. Just south of the crossing the Cummings branch of the Fort Wayne turns off to the south and extends into the manufacturing district on the north bank of the Calumet River. A similar line owned jointly by the Rock Island and the Belt railways turns off from these roads a short distance west of the crossings and, crossing the Fort Wayne branch about 700 feet south, runs parallel to it for some distance, connecting with the Irondale branch of the Rock Island,

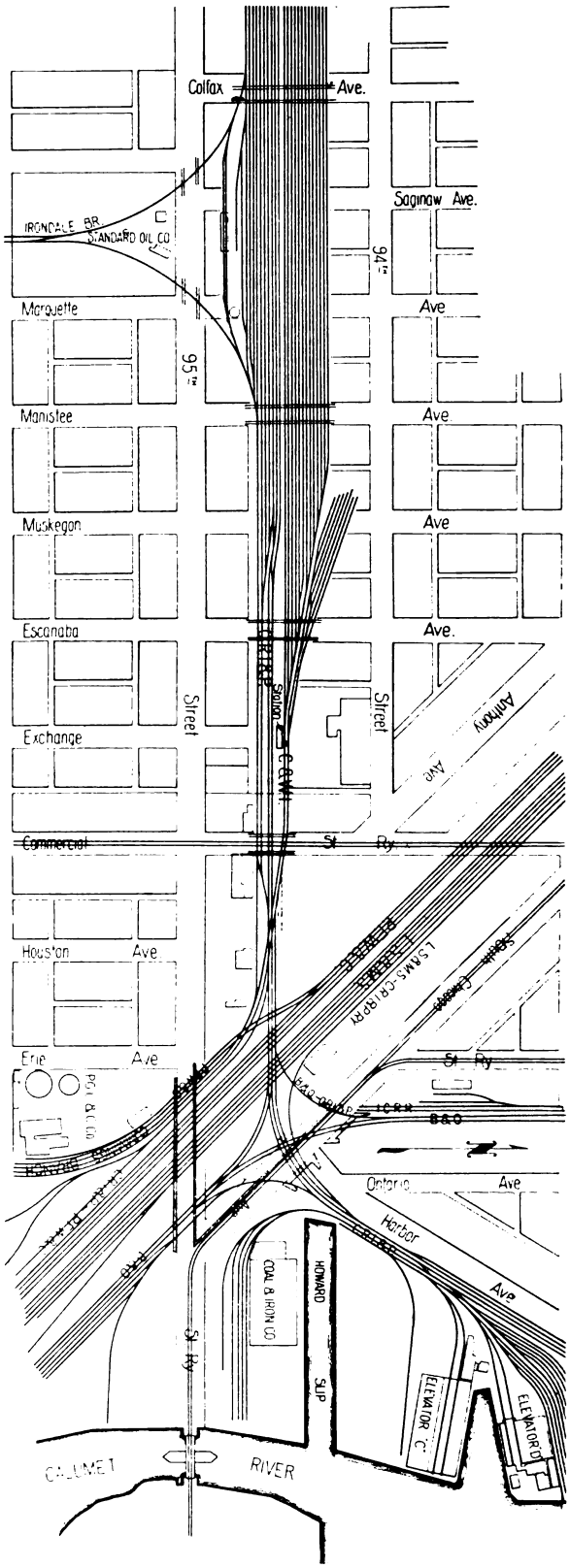


Fig. 1. Final Track Layout for Grade Separation at South Chicago.

which leaves that line about half a mile west of the crossings, and forming a loop. In addition, Y connections are maintained between the Rock Island and Fort Wayne, the Rock Island and Lake Shore and between the Baltimore & Ohio and the Rock Island on three sides.

All passenger and freight trains of the Fort Wayne and Lake Shore entering Chicago cross these crossings, as do all Baltimore & Ohio trains, freight trains passing over them twice, going to the Ninety-second street yard and then into the city. With the exception of the Baltimore & Ohio passenger trains, the Rock Island track is used for freight service only, this branch extending from a connection with the main line to the South Chicago industries, while the Belt railway is used exclusively for freight service. Both the Rock Island and Belt railways have transfer yards a short distance west of the crossing, that of the Belt containing 32 tracks. At these yards deliveries are received from eastern roads and the very heavy tonnage from the steel mills, elevators and other large industries of the Calumet district is classified. All business from this territory routed via the Rock Island is delivered directly to this road, which also receives that destined for the Illinois Central, delivering it to the latter road at Burnside, about three miles west of the crossing. An average of 20,000 cars per month is handled in this yard by the Rock Island. At certain seasons of the year traffic originating in this district equals that handled by the Rock Island in all the rest of Chicago combined. During the latter part of the month the grain business for the elevators is very heavy, often reaching 200 cars daily for its two elevators. The traffic handled by the Belt in its yard averages about 35,000 cars monthly, consisting almost entirely of transfer business.

Considering the amount of traffic handled in this territory, one would expect the number of train movements across this crossing to be very high. A record was kept for several days last Summer, and the total number of train movements of all kinds across these crossings reached over 500 during the daytime and nearly 400 at night, or a total of about 900 during the 24 hours. Of these there are 149 scheduled passenger trains, the maximum interval between the passenger trains during the daytime being 35 minutes, with a general average of about 7 minutes. As many of the freight trains are long and hold the crossings several minutes when passing, they are not permitted to proceed on the time of passenger trains, resulting in constant delays. These delays are especially heavy shortly before midnight, when the various roads are endeavoring to deliver their transfers to save the per diem charges.

The ordinance for this work was passed by the city council of Chicago on June 25, 1906, and required that all work should be completed before December 31, 1911, except that on the Rock Island and Belt railways west of Colfax avenue, which must be completed by December 31, 1916. In compliance with this and other ordinances the Fort Wayne and Lake Shore have already completed their elevation work from the city to the Indiana state line, with the exception of this one piece across the crossings and extending south about 2,000 feet across the Calumet River. The Baltimore & Ohio has also completed its work south of the river. Previous to last Fall neither the Rock Island nor the Belt railways had done anything on elevating their tracks. This ordinance provides for the elevation of their tracks from Jeffrey avenue east to include the crossings, or a distance of about 2 miles.

Preparation of plans for the entire project as far as it has effected the various roads at the crossings has been held up by the recent decision of the United States government to widen the Calumet River, necessitating a change in bridges

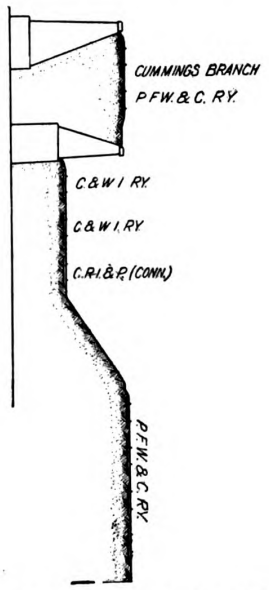


Fig. 3. Cross Section South of Crossing.

from those now in. Last December the government ordered the present bridges removed and submitted two options to the roads, defining the class of structures which would be satisfactory to it, one providing for two 90-foot clear openings with a center pier and the other for one 140-ft. clear opening. The roads have recently accepted the latter option and are now working on designs of these structures, but have not submitted plans to the government for approval.

While many of the detailed designs of walls and subways are not completed, the general plan has been definitely fixed by the ordinance and by agreement between the roads concerned. The Rock Island and Belt railways will start elevat-

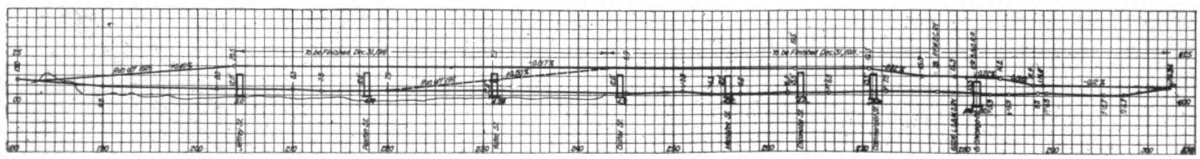


Fig. 2. Profiles of Chicago, Rock Island & Pacific and Chicago & Western Indiana Belt.

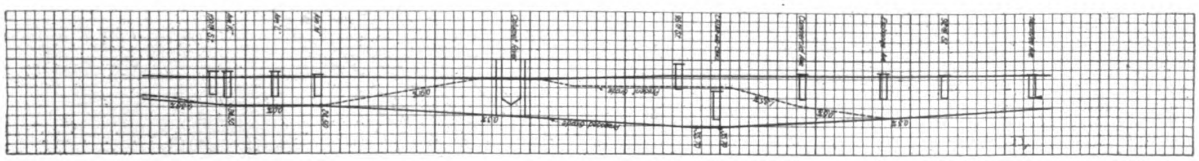


Fig. 2a. Profile of Pittsburg, Fort Wayne & Chicago and Lake Shore & Michigan Southern.

ing their tracks about 800 feet east of the crossing and rise to an elevation of 15.3 feet, Chicago City datum, at the crossings. Beyond this point they will rise to an elevation of 19.5 feet, about 15 feet above the old grade, and continue at this height to the limits of the work. The Baltimore & Ohio will cross the Calumet River at an elevation of 23.0 and Ninety-fifth street at an elevation of 17.8 feet and then descend on a 0.7 per cent. grade to the connection and crossings of the Rock Island. North of the crossing the grade will rise to an elevation of 20.5 feet at Ninety-third street subway. The Fort Wayne and the Lake Shore will cross the Rock Island and the Belt at an elevation of 35.7 feet, which, allowing for 3.4 foot depth of bridge floor, provides 17 feet clearance at the crossings. They will descend on each side on 0.3 per cent. grades, to connect with their previously completed work.

In planning for this work provision has been made for additional tracks. Five tracks in all are planned for the Lake Shore, while the Fort Wayne is providing for four. A double-track is to replace the present single-track of the Rock Island, while the Cummings branches of both the Fort Wayne and the Belt railways will be double-tracked. The Y connections between the various roads will be quite radically changed to fit the new conditions, the final layout being shown in Fig. 1. The present connection between the Lake Shore and the Rock Island (shown on Fig. 5) will be taken up and a new one built on a smaller radius and on a level grade until it crosess the Baltimore & Ohio-Rock Island connection, after which it will run parallel to the Lake Shore on a 1 per cent grade until it reaches the elevation of the main tracks. The three Baltimore & Ohio-Rock Island connections will be on nearly level grades. Due to the burning of a large elevator near the river on the east side of the Baltimore & Ohio tracks recently and the probability that it will not be rebuilt, the connection southeast of the crossing may not be built, as it was used only for this elevator business. Just west of the Fort Wayne tracks the most complications are introduced. The Rock Island-Fort Wayne connection will turn parallel to the Fort Wayne and then rise on an 0.8 per cent grade to the level of the Fort Wayne tracks. The double-track Fort Wayne Cummings branch will leave the main line just north of the crossings, instead of south as formerly, and continue at the main line elevation until it has crossed the Belt line Cummings branch as well as the main lines. In this way another grade crossing is entirely eliminated. Entrance to a boiler works and a gas plant a short distance south of the crossings complicate matters and tracks to these plants will be entirely rearranged. Just south of the crossing on the west side, the low tracks of the Rock Island-Fort Wayne connection and the Belt railway's double-track Cummings branch are between the high Fort Wayne main tracks and their Cummings branch tracks, presenting a cross section as shown in Fig. 3.

The agreement made by the roads provided that each road do the work under its own tracks except at the South Chicago avenue subway, where the Baltimore & Ohio will make the plans and do the work. The roads crossing at the lower level pay a proportion of the increased expenses incurred by the Fort Wayne and Lake Shore in crossing overhead.

Late last Fall the crossings were raised to the final grade of the lower tracks by the Rock Island and the Western Indiana, with temporary run-offs to the old grade. In raising these tracks across South Chicago avenue, the street had to be raised accordingly about 8 feet in order to maintain street

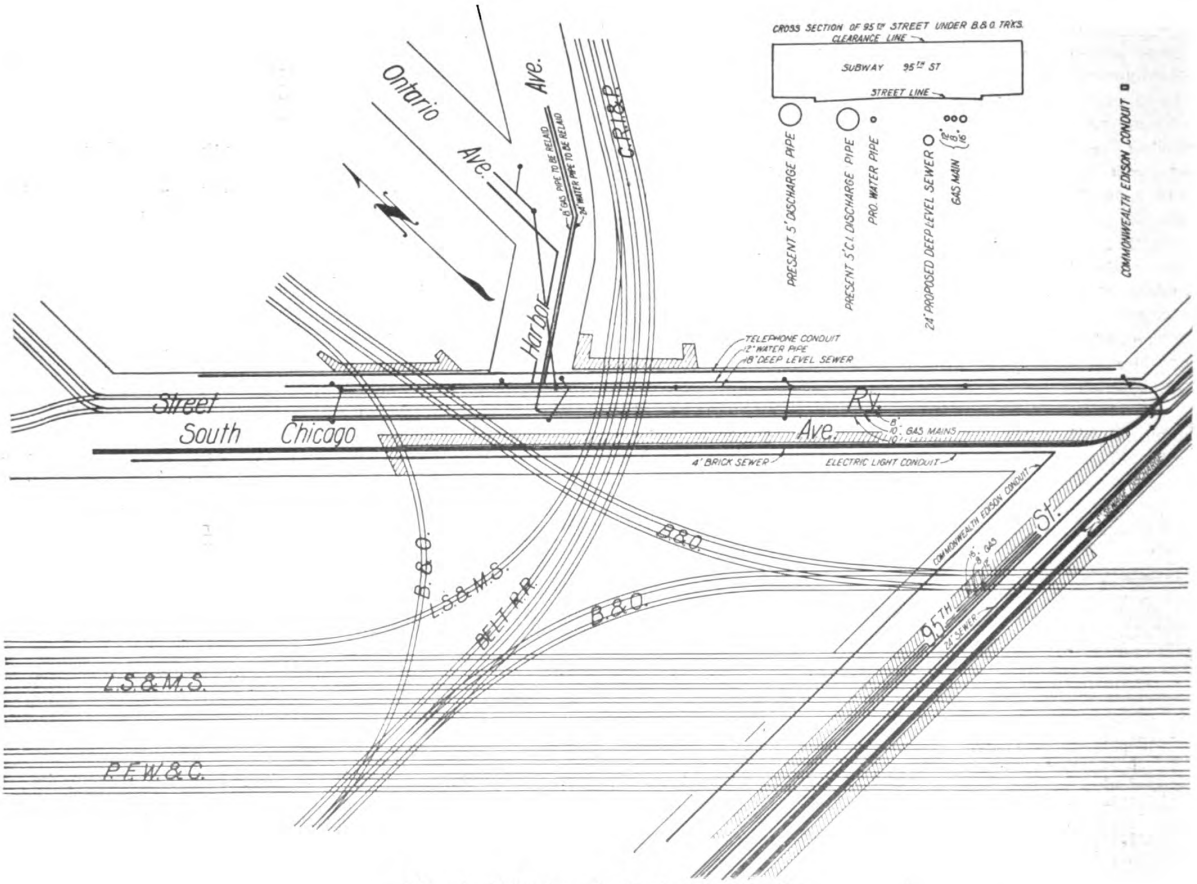


Fig. 4. Subways at Ninety-fifth Street.

car and team traffic. This year a subway will be built here and the street level lowered 7 feet below what it originally was.

The Rock Island has started work within the past month on their elevation west of the crossing. Six subways will be built with the standard clearance of 12 feet required by the city in all cases where there are no street cars, and 13½ feet where there are street cars. On several of these structures the subways will be of steel construction, with all the steel, including pillars, cross girders and I-beam floors, entirely encased in concrete.

The Rock Island will increase its present yard from 8 to 10 tracks this year and plans are made for 7 additional tracks. In elevating the yard the outside new tracks will be raised to grade, after which the other tracks will be raised by spreading from the adjacent high track. Temporary pile structures will be built across the streets, which will be left open and the permanent subways built after all the tracks are up. This year's work will require 350,000 cubic yards of filling, which will be brought in by contract. It is probable that the method followed last year, of bringing in sand over the Lake Shore from Dune park, the loading being done by contract and the unloading by company forces, will be followed. Because of the lightness of this sand, it will be covered with cinders as fast as the tracks are brought up to grade, to hold it down, except under the two main lines, where rock ballast will be used. In all, about 50,000 yards of cinders and 7,000 yards of crushed rock will be required for this work. For hauling

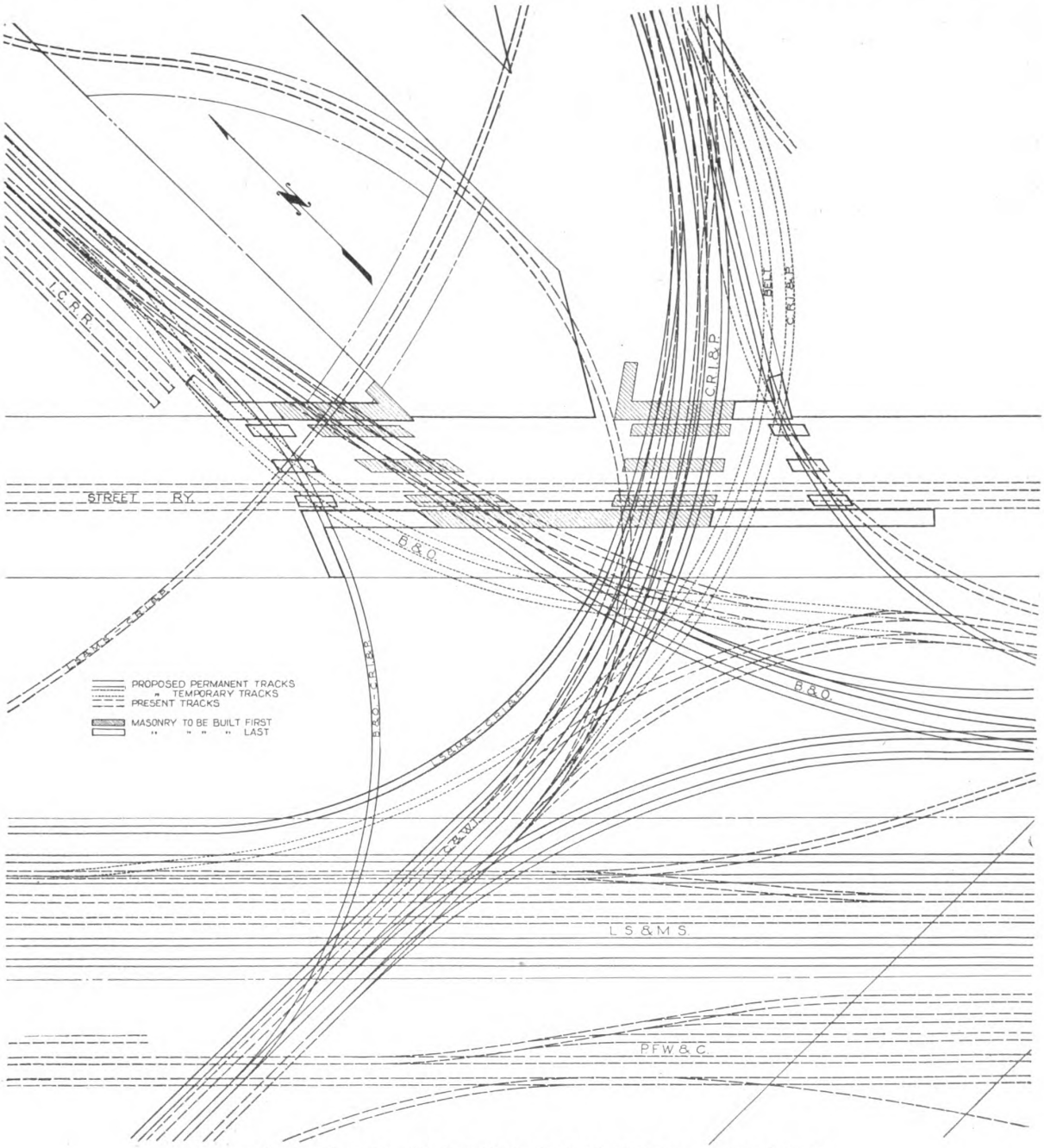


Fig. 5. Construction Track Layout at South Chicago Avenue Subway.

the sand 200 Hart convertible cars will be used. In addition, three freight locomotives, three switch engines, 40 flat cars and one spreader have been allotted to this work. One 10-ton locomotive crane with clam shell will be used to load cinders which have been stored during the winter.

The Rock Island's Irondale branch will be carried across Ninety-fifth street on the elevation, necessitating a subway under each leg of the Y. South of Ninety-fifth street the track will run down to the old level. In the Y and next to the yard tracks a four-stall frame engine house will be built for the use of the switch engines. An air hoist coaling plant, cinder pit, 115,000-gallon steel water tank, and three cranes will be installed. A new yardmasters' office will be built and a new depot is contemplated. East of the crossings the run-off built last year will be extended, requiring the raising of the tracks in the elevator yards to the doors of the elevators. In connection with this work the entire layout will be changed and rebuilt under traffic.

A very complicated problem is met with in the construction of the subways at Ninety-fifth street and South Chicago avenue, shown in Fig. 4. By agreement, the Baltimore & Ohio will construct all of the South Chicago avenue subway, while each road builds that part of the Ninety-fifth street subway under its own tracks. The opening at Ninety-fifth street is a new one, the street not having been used previously. A large part of the piling for the temporary structure at this street has already been driven and the excavation is well under way. The difficulties due to the various water and gas mains are indicated by Fig. 4. In driving piling under its tracks, the Baltimore & Ohio hit a gas main, emptying a large tank a short distance away in a few minutes. One 5-foot sewer had to be moved laterally 3½ feet to provide room for the base of a column and all the gas and water mains had to be lowered. The 48-inch sewer in South Chicago avenue, which turns into Ninety-fifth street, is so high that the oval top will have to be removed and a flat cover inserted to give the necessary clearance for a short distance in Ninety-fifth street.

In planning the construction of the subway on South Chicago avenue, estimates were prepared on two methods of handling the traffic during construction. One way was to follow the customary plan of driving piling and carrying the tracks on timber structures on their present location. The other was to lay temporary tracks on the bank to one side and then complete a part of the structure while the traffic was turned over to these temporary tracks. Estimates of the cost of the pile structures which would be necessary totaled $20,000, and of the temporary tracks, including seven new crossings, amounted to $7,000. In addition to the saving of $13,000 by using the latter plan, the interference with traffic would be very much less, and in driving piling there is the constant danger of hitting pipes and gas mains. The second plan was decided on. The temporary track arrangement, together with the order of building the subway, is shown in Fig. 5.

The ordinance provides that Harbor avenue be raised about 4 feet and paved for about 700 feet, descending into South Chicago avenue subway. As South Chicago avenue was raised about 8 feet last Fall, and now has to be lowered 7 feet the original level or to an elevation of minus 0.5, the excavation quantities will be large. It is planned to move the dirt with a steam shovel and small cars and use the material to fill Harbor avenue. After the first section of the subway is completed, the operation will be repeated on the balance. The floor of the subway being 0.5 feet below lake level, a new sewer must be built to drain it.

After the work is completed, grade crossings will still exist between the Rock Island and Belt and the Baltimore & Ohio freight tracks, and also between the two Y tracks northeast of the crossing. There will also be the junction of the Baltimore & Ohio tracks with the Rock Island. An interlocking plant is proposed for this, but no plans have been drawn.

We are indebted for the above information largely to the following officers, who are in charge of this work for their respective roads: J. B. Berry, chief engineer, and C. W. Petersen, engineer track elevation of the Chicago, Rock Island & Pacific; F. L. Stuart, chief engineer, L. G. Curtis, engineer maintenance of way, and F. G. Toeniges, engineer track elevation, Baltimore & Ohio; Thomas Rodd, chief engineer, R. Trimble, chief engineer maintenance of way, and D. M. Craig, engineer track elevation of the Pennsylvania's Northwest System.

WATER STATIONS FOR TRACK PANS.*

Track pans are primarily used to enable trains to take water while in motion. Their use up to the present time has been almost entirely confined to fast passenger trains making long runs between regular stops, but with increased efficiency from design of pans, methods of feeding and keeping water from freezing and improved scoops, the track pan is being adopted for freight trains, especially where it is desirable to keep trains moving, and in consideration of the excess cost of stopping and starting, the wear and tear of rolling equipment and the danger of breaking draft gear. The relative economy of the delivery of water to locomotives by the track pan and by the tank spout or standpipe is dependent from an operating standpoint upon: First cost, interest, depreciation, maintenance, operation, including cost of water, loss of energy expended in drawbar pull overcoming the dynamic pressure of water from pan or scoop, speed of trains, ruling grade, loss of time and cost of stopping and starting, including wear and tear on rolling equipment, etc. These factors will have a wide variance for different location and designs; hence each particular case should be figured separately.

The track pan should preferably be located on tangent, although it is possible to place same on curves up to three degrees and obtain fair results. The Pennsylvania and the Philadelphia & Reading have pans on two-degree curves which have proven satisfactory. The disadvantage of placing pans on curves, besides some additional first cost and cost of maintenance, are the difficulty of keeping pans in surface and some additional waste of water from spray and water washing over sides.

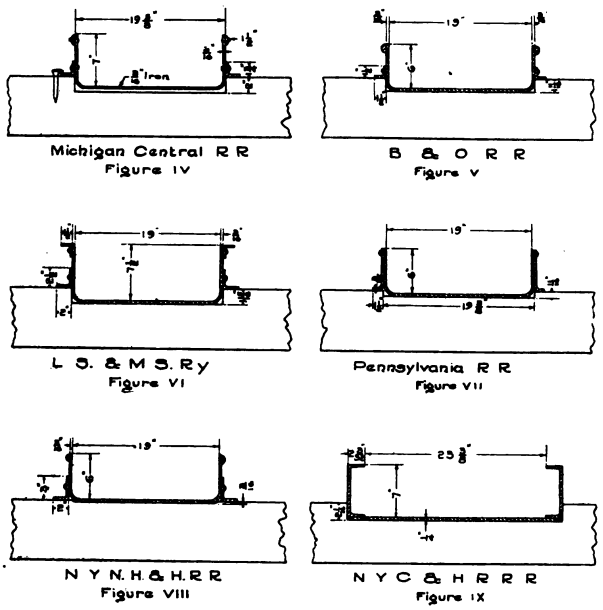
The pan should be laid on a level grade with grade of approaches such as to allow minimum speed required over pan to properly take water, and for this reason track pans should be away from stations, yards, railroad crossings, drawbridges, etc.

Pans are set directly on ties, the ties being dapped out about two inches and width of pan to form seat and allow top of pan to be the same elevation as top of rail. The pan is held in position and anchored by side lugs fastened to ties by ordinary or special form of spike or bolt with proper allowance for expansion and contraction of the material. The section of tie should be larger than ordinary and of white oak or other hard wood. On account of the large amount of waste water thrown over sides of pans, special attention should be given to drainage. The length of pan is one of the factors which determines the capacity. The economical length is dependent on the width of pan, size and adjustment of scoop, quantity of water to be taken into locomotive tanks during a given time and speed and time taken to fill pan. The length of the pan varies from 1,200 ft. on the Baltimore & Ohio to 2,000 ft. on the Lake Shore & Michigan Southern, with a width varying from 19 in. on the Baltimore & Ohio, New York, New Haven & Hartford and Lake Shore & Michigan Southern, to 23⅜ in. on the New York Central and 29 in. on the Pennsylvania. The depth varies from 6 to 7½ in.

*Appendix A, report of Committee on Water Service, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association.

The accompanying table shows the average number of gallons of water taken into locomotive tank with the corresponding number of gallons removed from tank and wasted per foot of length of pan by a scoop of cross-section 6½ in. by 12 in. and pans 19 in. and 29 in. wide for speeds of from 20 to 60 miles per hour.

The different pans in use at the present time are almost exclusively of built-up steel sections, although pans of cast-iron and wood have been used with less success. The type



Sections of Standard Track Pans.

of section is a matter of structural detail. The important considerations are rigidity, life and first cost. The depth should be 7 in. to 7½ in. so as to allow top of pan to be at same elevation as top of rail with a maximum dap in tie of not more than 2 in. to 2½ in. A width of 19 in. has been found to be the most efficient and economical for the operation of fast-speed trains and combined fast and slow-speed trains. The larger width of 29 in. has some advantage in the quantity water

Width of Pan (Inches)	Speed—M. P. H.	Number of Gallons Taken Into Locomotive Tank: Per Ft of Length of Pan	For Length of Pan = 1200 Ft	For Length of Pan = 2000 Ft.	Number of Gallons Taken Out of Track Pan = 100%: Per Ft. of Length of Pan	For Length of Pan = 1200 Ft	For Length of Pan = 2000 Ft.	Per Cent of Waste
19	20	1 70	2040	3400	2 10	2520	4200	.19
19	30	1.90	2280	3800	2 20	2640	4400	.14
19	40	2.00	2400	4000	2.20	2640	4400	.09
19	50	1 85	2220	3700	2.35	2820	4700	.21
19	60	1 70	2040	3400	2 80	3360	5600	39
29	20	2 20	2640	4400	2.90	3480	5800	24
29	30	2.30	2760	4600	2.90	3480	5800	21
29	40	1.90	2280	3800	2.65	3180	5300	.28
29	50	1.70	2040	3400	2.70	3240	5400	.37
29	60	1.60	1800	3000	3.00	3600	6000	50

Performance of Track Pans.

taken into locomotive tank per foot of length of pan for slow speeds, but this is partly offset by the additional waste. Figs. 4, 5, 6, 7, 8 and 9 show different sections of pans that have been found to meet the requirements. The end inclines should be substantially built to resist the larger amount of impact to which they are at times subjected by badly adjusted scoop, hanging under gear, etc. They should be built as a part of the body of pan forming ends. The rate of incline in direction of travel, in and out of pan, should not be more than ¾-in. to 1 ft. 0 in. of length and of perfectly smooth surface.

The size and number of supply pipes should be determined from the pressure, number of openings and minimum time required to fill pan. For expansion and contraction proper provision should be made in the form of corrugated or rubber hose, or by packed or special joints. The placing of pipes in cross tunnels at inlets allows the taking care of water run off from broken pipes, assists in drainage and facilitates repairs. There are two methods of regulating the filling of pans, viz.: (1) by man operation; (2) automatic valve. The latter method is generally the more dependable, and under average conditions should give the more economical and satisfactory result. The inlet should be so designed as to allow the minimum disturbance by flow of water into pan with corresponding minimum loss from friction. The deflector, enlargement of section of pipe at inlet and perforated plates are used at the present time.

To keep the temperature of water in pan below the freezing point or to raise the freezing point to avoid or remove the formation of ice at top of pan so that water can be taken during freezing temperature, the following methods are used:

(1) Blowing steam in water through nozzles in sides of pans spaced at intervals of 20 ft. to 30 ft. along length of pan.

(2) Circulating the water in pan by means of a pump and heater or an injector.

The results obtained by the steam heating method have been mostly satisfactory, but on account of the large amount

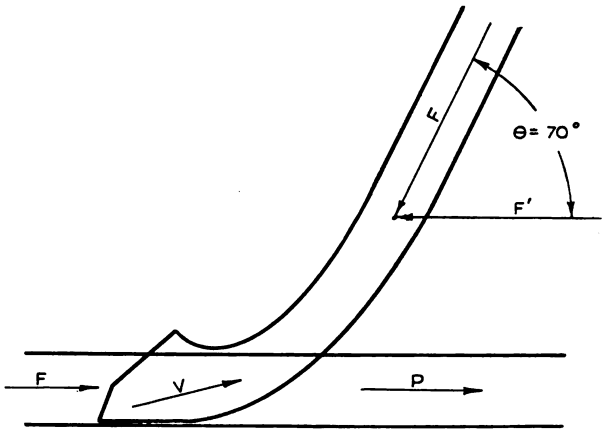


Fig. 1.

of energy expended and the number of connections, etc., to keep up there is a general tendency towards the use of the circulating method, although results obtained up to the present time have not been entirely satisfactory.

The action of the scoop while taking water from the pan is more or less as a blunt plow. At speeds above thirty miles per hour it is very apparent that the velocity of the water entering into the scoop is less than the velocity of the tender; this has the effect of throwing out of the pan, especially at higher speeds, the water on either side of the point of the scoop and between it and the sides of the pan. As the speed diminishes below thirty miles per hour a wave action is set up in front of the dipper, the water being piled up until it falls over the sides. This wave increases in size up to the point where the velocity imparted to it is less than that necessary to overcome the resistance due to gravity and friction, when, of course, no more water is lifted.

The dynamic pressure exerted by a surface moving in still water is equal to that produced by a stream flowing with the same velocity against a surface at rest. By the action of the scoop in the pan a dynamic pressure is produced in the oppo-