tinuation of Delancey street to Elm street, thus making a connection for transfer to both the East Side elevated lines and the subway, and bringing the terminus of the Brooklyn lines near the center of commercial activity. A very much better temporary relief would be to avail, if possible, of a suggestion made in my report of February 19, wherein two additional tracks were proposed over the Second Avenue Division to City Hall. These tracks could be connected with the Williamsburg Bridge by a line only 1,500 ft. long, and a temporary connection could also be made with such new tracks at the Brooklyn Bridge. A continuous loop would thus be immediately realized.

"Should the above-described plan be carried out, the Borough of Brooklyn will then be connected with the Borough of Manhattan by three bridges carrying six elevated tracks and ten surface tracks, and two tunnels carrying four tracks, every one of which tracks will have a greater carrying capacity than either one of the two elevated or two surface tracks on the existing bridge. These increased facilities of transfluvial transit will in themselves provide the greatest single measure of relief that Brooklyn stands in need of; there remains, therefore, but to propose and to carry into execution as rapidly as possible certain extensions of the rapid transit facilities in Brooklyn, which will be rendered possible by the increase in the terminal facilities in Manhattan. These extensions should obviously be of two characters—one, the extension of the subway system wherever such extensions can be made economically, and become an integral part of the railroad system which the city has already begun; the other, extensions on such terms as the Board may determine of the elevated lines of the Brooklyn Rapid Transit Company, in order that such company may more properly fulfil its obligations. Such extensions as seem to be most important can be described briefly as follows:

FIRST—SUBWAY SYSTEM.

"This system now terminates at the intersection of Flatbush and Atlantic avenues, where a connection can be made providing means of reaching the easterly limits of the Borough of Brooklyn. From the present terminus the subway system should be extended under Flatbush avenue with four tracks to the Prospect Park Plaza. Around the outer limits of the Plaza I propose a loop, and diverging from this loop a three-track line easterly along the Eastern Parkway to, say, East New York avenue. Two of the tracks on Flatbush avenue should be depressed at the Plaza, passing beneath the loop so as to avoid grade crossing, and then be carried southerly along Flatbush avenue to, say, East Broadway. These two lines would reach a portion of the Borough of Brooklyn not now served by any of the elevated lines of the Brooklyn Rapid Transit Company, but a district second to no other in Brooklyn in desirability of improvement, and which in the near future, with proper facilities, will, beyond question, support a large population.

"Another extension of the subway could begin at Flatbush and Atlantic avenues, running south along Fourth avenue to Fort Hamilton, probably becoming elevated at some point where the topography would allow.

"When these lines are carried into execution and the traffic that they would produce has been developed, it is obvious that some further connection will be necessary in addition to the Whitehall-Joralemon street tunnel. It would seem that the best route for such a tunnel would be Atlantic avenue to Whitehall street. The Atlantic avenue line could be connected with the line that I have proposed to the Board running south along Church street, provided such line is constructed.

SECOND—BROOKLYN RAPID TRANSIT ELEVATED SYSTEM.

"Studying the local details of this system one is impressed by the fact that it is without *rapid* transit facilities, as each one of the lines is a two-track structure only, and therefore incapable of furnishing an express service. The following suggestions are made:

"1st. Add a third track on the Fulton street elevated from the end of the line at East New York to the Brooklyn Bridge.

"2d. Add a third and fourth track to the Broadway line, from the loop at East New York to the Williamsburg Bridge, and a third track from the loop to the terminus at Cypress Hills.

"3d. Add a third track to the Myrtle avenue line from Ridgewood to the Brooklyn Bridge.

"4th. Add a third track on the Fifth and Third avenue lines in South Brooklyn, from Myrtle avenue to 65th street.

"5th. Connect the Fulton street elevated, between Williams place and Alabama avenue and the Jamaica plank road. This will permit Jamaica trains to pass down either Fulton street or Broadway and avoid running through the loop.

"6th. Connect the Fulton street line and the Fifth avenue line to provide for the latter a better terminal arrangement and to serve the local shopping district in Brooklyn.

"7th. Construct a new elevated railway from the point where the Brighton Beach Railroad connects with the Fulton street line, to the Blackwell's Island Bridge, with an extension to Flushing Bay, and also a spur from Lorimer street to the Williamsburg Bridge. This line will pass through an extensive portion of the Borough of Queens, and brings it in touch with the wholesale and financial districts in Manhattan, and the retail district in Brooklyn.

"8th. Extend the Fulton street elevated from its terminus at Crescent street to the Jamaica plank road. This extension will give a direct connection to the district lying east of the terminus of the Fulton street elevated and west of Jamaica.

"9th. The Brooklyn Rapid Transit Company is now arranging by means of inclines to make a loop between the Third and Fifth avenue elevated lines to Fort Hamilton, which will very materially increase the facilities at that point. It is obvious that these facilities can be but temporary only, as these lines are on the surface, and the development of that district will, before long, prevent the continuance of running trains in this manner. Elevated structures should therefore be authorized from Third avenue and 67th street, through Third avenue to Clarke street, to Fifth avenue, and thence along Fifth avenue to 38th street, thus completing the loop in question.

"In this report no railroad provisions have been proposed to connect the Borough of Richmond with the Borough of Manhattan. After a very careful study of the problem, I regret to report that the great expense involved is entirely out of proportion to the population to be served.

"The total number of miles of new road proposed by this report is 37, and the total amount of new tracks proposed, whether in new road or as additions to existing roads, is 120 miles. An approximate cost of these improvements, exclusive of abuttal damages, is about $52,000,000, of which about $31,000,000 represents the approximate estimated cost of extending the subway and of constructing the second tunnel with its Centre street connection in Manhattan. If the Board approves the suggestion that is contained in the report that the extensions of the subway and the new tunnel with its connections should be undertaken as municipal construction, the latter figure will represent the cost of so doing."

The St. Louis Terminal Improvements.

(WITH AN INSET.)

The rearrangement of the St. Louis terminals to enlarge the capacity and provide improved and increased facilities for handling the very large business, due to the growing number of trains handled daily, and their greater length, has been mentioned before now in these columns. With the World's Fair approaching, immediate revision became imperative, and work involving a large outlay of money, and some interesting and difficult engineering problems has now begun.

The work at the station proper will include the lengthening of the tracks in the train-shed to give greater standing room for trains; rearrangement of the leads thereto, enabling a larger number of trains to be moved into and out of the shed at one time; revision of the interlocking switches, and signals; the building of a subway under the tracks, and at right angles to them, for moving baggage, mail and express; removal of the buildings of the various express companies, and the mail house, to new places; similar removal of the power station.

To clearly show the proposed changes, both the original arrangement and the plan for rearrangement, are given. Referring to the former, it will be seen that the layout of tracks in the shed and approach is such that only six of the center tracks can hold 12-car trains, now a common length. The tracks at the extreme sides accommodate but very short trains, not more than four cars with an engine.

The maximum capacity of the lead at any one time is four trains—two from the west and two from the east. The standing tracks for the express houses are joined to one branch of this lead, so that all of the express cars have to pass over this branch, causing frequent interference with regular train movements. The schedule shows 232 passenger trains into and out of the station in 24 hours. These are mostly through trains, there being perhaps not more than 10 per cent. suburban trains.

One day last summer the number of movements made at the interlocking plant in 24 hours was 1,835, requiring 24,956 lever movements. Of the 1,835 movements, 162 were freight, 573 were switching, and 736 light-engine movements. The remaining 364 were therefore passenger train movements.

Explanation of the system employed will make this better understood. In the first place it should be known that this is a back-in station. Two movements are therefore required to place a train in the shed, and one to send it out. The road engine of an inward train, after backing the train into the shed, is withdrawn and all further handling is done by the switching engine of the Terminal Association. With the present arrangement, by which the express tracks connect to the lead, sometimes as high as 11 movements are necessary to dispose of a train; this includes the backing-in, the disposal of express and mail cars by the switch engine, and placing the coaches in the storage yard. One of the objects to be accomplished was the reduction of this number of movements as much as possible.

Another matter requiring simplification was the method of handling baggage. The baggage room is now on the west side of the shed, at the north end. The outward baggage is trucked to a runway at the south end of the shed, along this to the desired track, and then along the track to the car. In the case of the tracks on the east side of the shed this requires a trip of something like 1,300 ft.—a quarter of a mile. Trains of nine cars and over have to be cut, as they cannot stand north of the transverse runway. Every train passing in or out interferes with the baggage trucking, and cutting and coupling delays trains.

In planning rearrangement there were a number of limitations encountered, the most serious being that of the confined space north and south. Expansion in either direction is impossible because of the station building on the north, and the Missouri Pacific yards on the south. To move more trains there will be two leads, each having an east and a west branch. The east and west passenger tracks, with which the leads connect, will be increased from four to six. This will make it possible to handle six trains at one time, an increase of 50 per cent. over the present arrangement.

In the train-shed the minimum clear length of track will be 863 ft., and the maximum 1,050 ft. The longest tracks will therefore accommodate 12 cars and an engine, and the shortest 10 cars with engine.

The number of switch and signal movements in the tower per inbound train will be reduced to a minimum of five. This is to be accomplished by making the mail and express tracks independent of the shed leads. The movements for disposing of an inbound train will then be: Two to back into the shed; one for the road engine to withdraw; and two for the terminal engine to take the cars out. This will greatly reduce the switching and light engine movements. The two east and west freight tracks are to be made practically independent of the passenger tracks, so that freight movements will be eliminated entirely.

The baggage subway running from Eighteenth to Twentieth streets at the south end of the shed is to have a double row of hydraulic elevators, one row being for baggage and the other for mail and express; there being one of each kind between each two tracks. The north side of the subway and the north row of elevators will be used exclusively for baggage. Each road using the station will have space allotted to it in the subway under the tracks on which its trains will usually stand. Baggage from the city for outgoing trains will be brought by the wagons into the subway and distributed to the proper railroads. When the trains are backed into the shed the baggage cars will be set opposite the elevators, which latter may be raised to the level of the car floor. Baggage from inbound trains may be unloaded in an equally short time, and if checked beyond St. Louis, is distributed in the subway.

As a part of the improvement in the baggage-handling system, much of the trouble and delay now experienced in checking and re-checking is to be done away with. In the first place, the ticket office has already been enlarged so that a larger number of people may buy tickets at once. Directly opposite the ticket office, across the waiting room, there will be a baggage ticket office. Upon buying his ticket, the passenger goes to this office and presents his ticket and baggage claim check. The destination as indicated by ticket is written on a slip and this, with the claim check, is sent by pneumatic tube to the baggage room at which the baggage has been delivered. The check duplicate is sent in return, the passenger not having left the waiting room at all. Re-checking will be done in a similar manner. Electric annunciators will be put in for notifying the baggage rooms of the approach of a train, indicating the track on which it will come in, so that men can be ready to handle the baggage the moment the train comes to a standstill.

All baggage remaining at the end of the day will be sent to the baggage house at the west end of the subway. At the present time the number of pieces of baggage to be stored daily runs from 7,000 to 12,000.

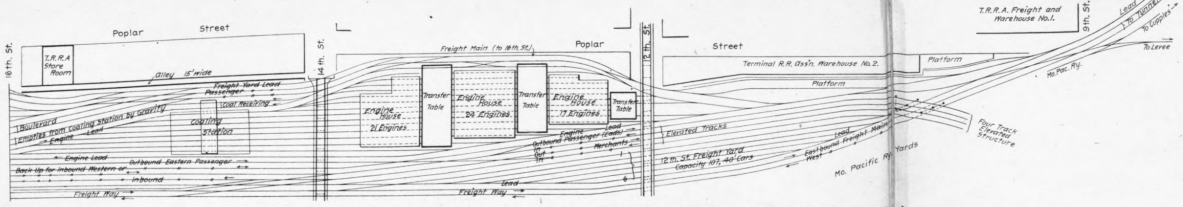
Running lengthwise of the train-shed from the baggage ticket office to the main subway will be a smaller subway 12 ft. wide and 9 ft. high. This will be used principally for carrying to and from the baggage ticket office the valises that have been checked, of which there are daily from 200 to 500. The floor of this subway will be about 6 ft. above the baggage subway; connection with the latter will be by a ramp and also an elevator.

Extending south from the main subway and joining it at grade will be another subway 25 ft. wide and 17 ft. high, which will branch at right angles, one branch running to the power house and the other to the express buildings. Running along the east side of the basements of the latter there will be a subway 12 ft. wide by 18 ft. high which connects with the main subway at the west end.

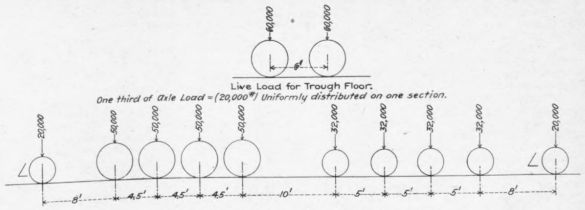
The approaches to the main subway are to be open cuts, that on the east side, in Eighteenth street, having a 4.25 grade, and the one on the west side about the same. The Eighteenth street approach will be longer than the Twentieth street, and will join the subway at right angles. As the latter approach is restricted for room, it would be impossible at the allowable grade to obtain sufficient head-room under the proposed baggage house, should the subway be joined at right angles; for were this to be done it would require supporting girders, for the building, of 60 ft. span and only 18 in. deep. The approach will therefore be carried farther south and swung into the subway on a curve.

The main subway will be divided into three bays, the north one of which will be 40 ft. wide, the middle one 30 ft., and the south one 28½ ft.—a total width of 98½ ft. between walls. As will be seen from the plans, the clear head-room is to be about 12 ft. 3 in. for the north span, 14 ft. 1 in. for the middle, and 14 ft. for the south span. The girder for the widest bay will have an effective depth of 63½ in.; the other two will each be 40 in. These cross girders will be riveted to the longitudinal girders, the north, or heavier, of which will be 62½ in. deep, and the other 61½ in.

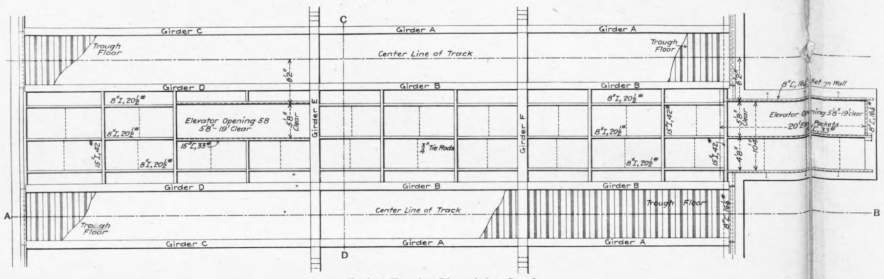
The supporting columns for these girders will be spaced



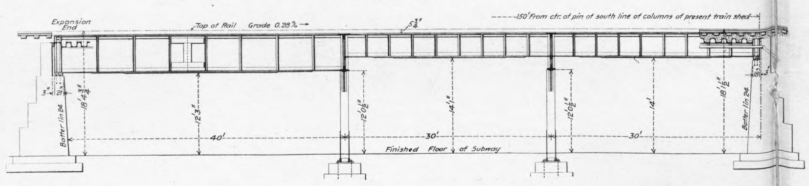
East End of Yard; Tracks Leading to Eads Bridge (Through Tunnel) and to Merchants' Bridge Over Elevated Tracks.



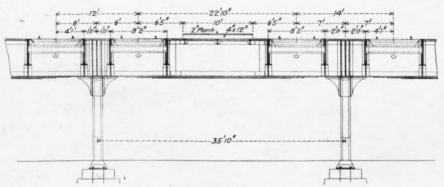
Load Diagram for Tracks Over Baggage Subway.



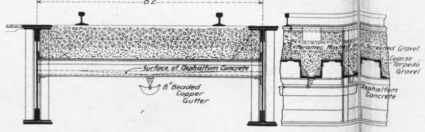
Typical Framing Plan of One Panel.



General Cross Section A-B.

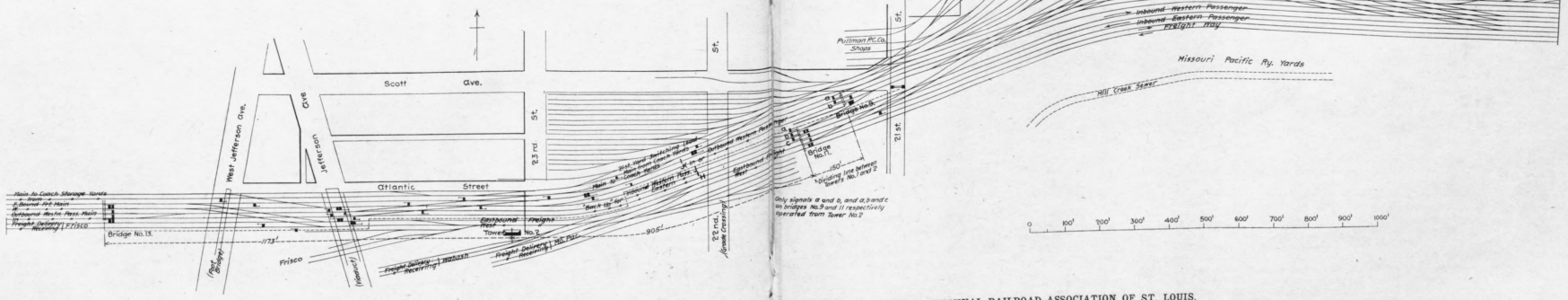


General Longitudinal Section C-D.



Sections Showing Details of Trough Floor.

Plan and Transverse and Longitudinal Sections of Structure to Support Tracks Over Subway.



PLAN OF TRACKS IN THE ENLARGED STATION AND YARD—UNION STATION, ST. LOUIS, MISSOURI—TERMINAL RAILROAD ASSOCIATION OF ST. LOUIS.

35 ft. 10 in. centers, and it will be noted that the north row of these is to be coincident with a row of columns of the proposed train-shed extension of 180 ft. Where these columns occur they will be carried through, making a continuous column from subway grade to roof truss. The total load on these columns will be 1,077,000 lbs.—546,000 lbs. being live load, 278,000 lbs. roof load, and 253,000 lbs. dead load of subway structure. The foundations for these columns will be of concrete, 8 ft. deep, with a bearing of 12 x 15 ft., and with a granite cap 18 in. thick and 5 ft. 8 in. square. They will rest upon 30 piles, spaced 2 ft. 3 in. centers. The intermediate columns on this row will have 12 ft. x 12 ft. foundation, of the same depth as the others, and will rest upon 25 piles. The south row of columns will have 16 piles. From all of the above should be excepted the end columns, which will have but 10 piles, with a 11 ft. x 15 ft. bearing.

The trough floor, supporting the tracks and platforms, will have an effective depth of 7.2 in. The troughs are to be placed parallel to the longitudinal girders or at right angles to the tracks. Each trough will have its bottom guttered with asphaltum concrete, graded to slope from the ends and sides to the center. A 1 in. galvanized pipe nipple, screwed into the trough at this point, will drain the moisture into a copper gutter, swung to the troughs by galvanized iron hangers. Above the asphaltum concrete there will be a filling of coarse torpedo gravel, the whole being overlaid with Meramec washed and screened gravel, in which the ties will be bedded.

The walks between trains will be of 2 in. plank, laid on 4 in. x 12 in. sleepers. The subway floor is to be of concrete finished with asphaltum.

Work on this subway is now under way, excavating being in progress. During this time the tracks will be carried upon timber falsework, of 14-ft. panels, three piles to the panel. Preparatory to driving these piles a diagram was made, carefully locating each pile. Temporary tracks have been laid to the west end of the subway, from which end the work started, and the material is being removed in cars.

For the largest of the lateral subways and its east and west branches it is probable that skylight construction will be used overhead except under the track floors. Where the east and west branches pass under the throats of the leads, a trough floor, 52 ft. wide under the east lead, and 126 ft. wide under the west lead, will be put in. The troughs will carry the entire load. They will be made of 4 in. x 4 in. x ½-in. angles, 20 in. x ½-in. web plates, and 15 in. x ⅝-in. top and bottom plates.

It has been mentioned that the smallest lateral subway would be used for trucking valises from the baggage ticket office to trains. In addition the heating and water pipes, pneumatic tubes and electric wires will be put in it. The pipes will be carried across the main subway and into the large lateral for a distance of 124 ft., through openings in the girder webs, 4 ft. 8 in. x 2 ft. 3 in. At the point above mentioned they will run onto offsets built in each wall of the subway. The largest pipes will be 12 in. in diameter.

It will be observed that one of the south row of elevators is to be placed in this subway some distance from the line of the others. Should it be placed in line it would block the subway, hence the displacement. An umbrella shed will be built out to it from the train-shed.

The well which is seen on the west side of the large lateral subway is to receive the drainage from the elevator pits, which are 6 ft. below the subway floor, and are surrounded by wing walls. Sewer connections from these latter are carried on a .3 grade to the well, the bottom of which is 10 ft. below subway grade. As the sewer at this point is just about at the subway level, two ejectors will be put in the well to raise the contents into the sewer.

The Twentieth street sewer presented one of the numerous difficulties encountered, as the elevation of the subway floor will come about 7½ ft. below the top of the sewer in Eugenia street. It will therefore be necessary to lower the top of that section of the sewer which will pass under the basement of the baggage house and the subway, at the same time preserving the sectional area, and a sufficient grade. The section requiring alteration is approximately 640 ft. long. Under Eugenia street, just north of the baggage house, the sewer is ovate in section, the long diameter being 8 ft. and the short diameter 7 ft. At this point, in order to reach the necessary level to pass under the baggage house, a tumbling basin is to be put in, giving a change of elevation of 4.7 ft. As the sewer passes under the building its section will be changed into that of a very flat ellipse having the ends cut off. The construction is to be of concrete with a 4-in. lining of brick—vitrified at the bottom, and common at the top. The tumbling-basin steps will be of granite.

The sewer passes under the west wall of the Adams express building, making an angle of about 18 deg. with it. The building wall is to be supported at this point by a concrete beam of 70 ft. span. It will be trapezoidal in section, 13 ft. 8 in. deep, 2 ft. 10 in. at the top, and 5 ft. 6 in. at the base, and will be reinforced by 194 steel rails 30 ft. long.

The mail house, which at present is on the west side of the shed, and is small, will be moved to the opposite side and enlarged to approximately three times its present area. It will be fire-proof, and have two stories and a basement; possibly three stories. The proposed site for the new post office is just across the street from the train-shed, and connection between this and the mail house will doubtless be by subway. The mail house basement is at grade with, and adjoins, the entrance to the main subway. As already mentioned the south row of elevators will be used for mail as well as express.

The express buildings will be moved from the east to the west side of the leads and located as shown. These buildings, which will be of mill construction, will each have a basement and two stories, except the Pacific, which will have three stories. The basements will, of course, be at grade with the adjoining subway, and elevators will serve the several floors. On the tracks in front of the buildings there will be room for seven cars for each of the first three buildings (four on one track and three on the other), five for the next, while the tracks serving the last will accommodate nine. Suitable platforms are to be built between these pairs of tracks.

The tracks just west of the express buildings are to be used for cars loaded with theatrical scenery, milk cars, etc.; they are laid out in pairs, with 10 ft. roadways between pairs, making cars on any of the tracks readily accessible by wagons. The storage yards east of the leads are to be greatly enlarged. These are for both freight and passenger cars.

The power house, now under the interlocking tower, will be moved to the east side of the leads. It is to be of fire-proof construction, 99½ ft. x 145 ft., with a pump room 29 ft. x 29 ft. adjoining. There will be a basement and one floor. This house heats the station, the heating being done by exhaust steam. It lights the station, train-shed, outlying buildings, and the yards 1½ miles west and one mile east, alternating current apparatus being used throughout. It will also supply power for a coaling station and transfer tables, and for charging storage batteries on electric lighted trains.

East of Fourteenth street three engine houses of rectangular plan for foreign engines are to be built, with transfer tables between, and another at the east side of the east house. The pits between the houses will each have two tables, a total of five tables to serve the three houses. This will provide ample facilities at all times for quick handling of the engines; the capacity of the three houses will be 65 engines.

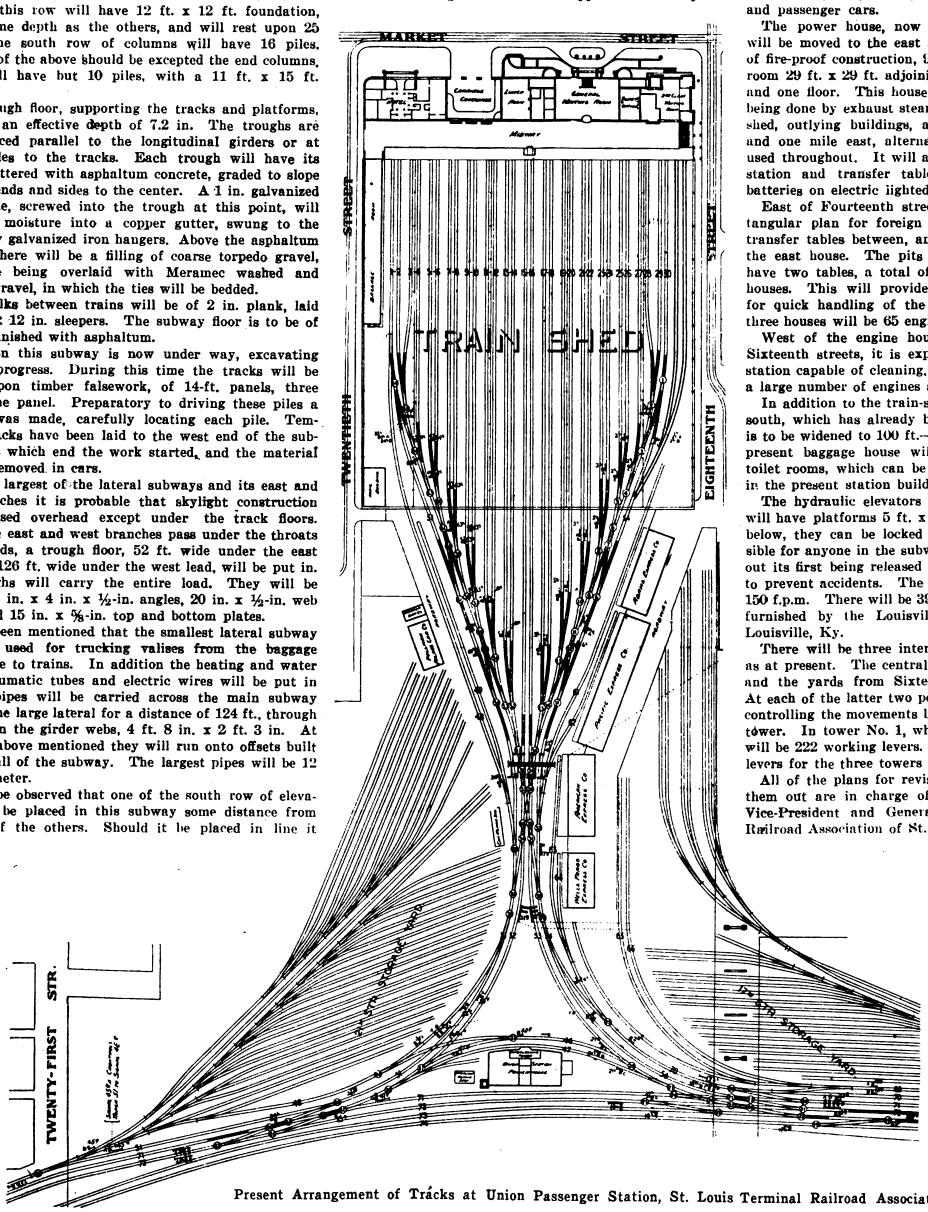
West of the engine houses, between Fourteenth and Sixteenth streets, it is expected to build a large coaling station capable of cleaning, coaling, watering and sanding a large number of engines at one time.

In addition to the train-shed extension of 180 ft. to the south, which has already been mentioned, the "Midway" is to be widened to 100 ft.—double its present width. The present baggage house will probably be converted into toilet rooms, which can be made much larger than those in the present station building.

The hydraulic elevators for baggage, mail and express will have platforms 5 ft. x 19 ft. Though operated from below, they can be locked from above, making it impossible for anyone in the subway to lower the elevator without its first being released from the train-shed floor; this to prevent accidents. The speed of the elevators is to be 150 f.p.m. There will be 39 altogether, and they are to be furnished by the Louisville Foundry & Machine Co., Louisville, Ky.

There will be three interlocking towers instead of one, as at present. The central tower will control the station and the yards from Sixteenth to Twenty-third streets. At each of the latter two points there will be a tower for controlling the movements beyond the limits of the central tower. In tower No. 1, which is the central tower, there will be 222 working levers. The total number of working levers for the three towers will be 349.

All of the plans for revision and the work of carrying them out are in charge of Mr. W. S. McChesney, Jr., Vice-President and General Manager of the Terminal Railroad Association of St. Louis. The details have been worked out under the direction of Mr. Daniel Breck, General Superintendent, assisted by Mr. J. L. Armstrong, Engineer of Maintenance of Way. To these officers we are indebted for the data for this article.



Present Arrangement of Tracks at Union Passenger Station, St. Louis Terminal Railroad Association.

Foreign Railroad Notes.

The new Atlantic-type engine for the Paris-Orleans line in France will weigh about 75 tons and have a total heating surface of 2,600 sq. ft. It is possible that the Sud Express may be increased in weight to 180 tons and the speed increased.

The Midland Railway will put track tanks on the line to the north, which will make it possible to run from London to Leeds, 196 miles, and from London to Manchester, about 185 miles, without stops. The Midland is the last of the important northern lines to introduce this time-saving appliance.