

the structure is completed, the eye will turn with a sense of relief from the exaggerated perpendicular lines of the modern office building to the long, low perspective of this station, relieved at its mid-length by the lofty walls and roof of the waiting room. The exterior construction is of pink Milford granite, similar to the building stone of the Boston Public Library and the University Club in New York. This is a particularly effective structural stone, and its soft shades of color are decidedly pleasing to the eye.

The main entrance to the station for foot passengers will be at the center of the Seventh Avenue façade and opposite the intersected end of Thirty-second Street. Once inside the building the passenger will find himself in a noble arcade,

45 feet in width and 225 feet in length. On either side will be shops where will be displayed wares suitable to the needs of the traveler. At the further end of the arcade the intending traveler will pass the entrance to two large restaurants, one to the left, the other to the right, and will then find himself at the head of a broad flight of stairs leading down to the floor of the general waiting room. This vast hall will be 103 feet in width, 277 feet in length, and will have a clear height from floor to ceiling of 150 feet. Within its spacious walls will be located ticket offices, parcel rooms, telegraph and telephone offices, and baggage checking windows, all so disposed that a passenger may proceed from one to the other in their logical order. Adjoining the general waiting room on the west will be two subsidiary waiting rooms, corresponding in their relation to the main hall to the two restaurants. Each waiting room will measure 58 x 100 feet. One of these is reserved for men, the other for women, and each will be provided with every convenience for comfort. The entrances for carriages will be by way of pavilions located at the corners of Thirty-first and Thirty-third Streets and Seventh Avenue. The carriages will descend on a slight gradient until they reach the level of the station proper. Entrance will be had by the Thirty-first Street incline,

and the carriages will leave by the Thirty-third Street ascent as an exit.

To the east of the general waiting room is the main baggage room with its 450 feet of frontage. The baggage will be delivered and taken away by a special subway, 30 feet wide, which will extend under and along the entire length of Thirty-first Street and Sev-

enth and Eighth avenues. From the baggage room trunks will be taken to the tracks below by motor trucks and elevators. Cab-stands will also occupy this level.

The passenger, after securing his ticket, checking his baggage, etc., passes through between the smaller waiting room entrances onto the great station con-

also be made, in due time, with the proposed subway station of the Hudson Companies' subway running up Sixth Avenue from the North River tunnels of that company. The northern side of the station, paralleling Thirty-third Street, will be assigned to the suburban service of the Long Island Railroad. The third level, which will be at a depth below the surface of

the street corresponding to the height of an ordinary four-story building, will be entirely covered below the station building with twenty-one parallel tracks and their respective platforms. Within the station area, covering 28 acres of ground space, there will be 16 miles of tracks. A trackage area of this amount will afford ample facilities for the easy movement by electric power

of the many hundreds of trains per day that will use this station. Through trains from the West, after discharging passengers, will proceed at once to Long Island City, where the main train yard and terminals will be located, thus leaving the station tracks clear of any idle equipment. In like manner, the westbound through trains, which will be made up at the Long Island City terminal, will pass through the station, stopping only to take up their quota of passengers. The suburban service of the Long Island Railroad will be operated on the "shuttle" plan. The planning of the station, with its numerous entrances and exits independent of each other, and separating the incoming from the outgoing throng, was worked

out to facilitate, in greatest measure, the prompt and uninterrupted movement of the traffic. The exposure of the building on all four of its sides to main arteries of street traffic gives the plan a flexibility which is rarely obtainable and also insures easy connections by underground subways with the future extensions of the city's rapid transit system. The station will probably be opened for service early in 1910.

NEW GRAND CENTRAL TERMINAL STATION.

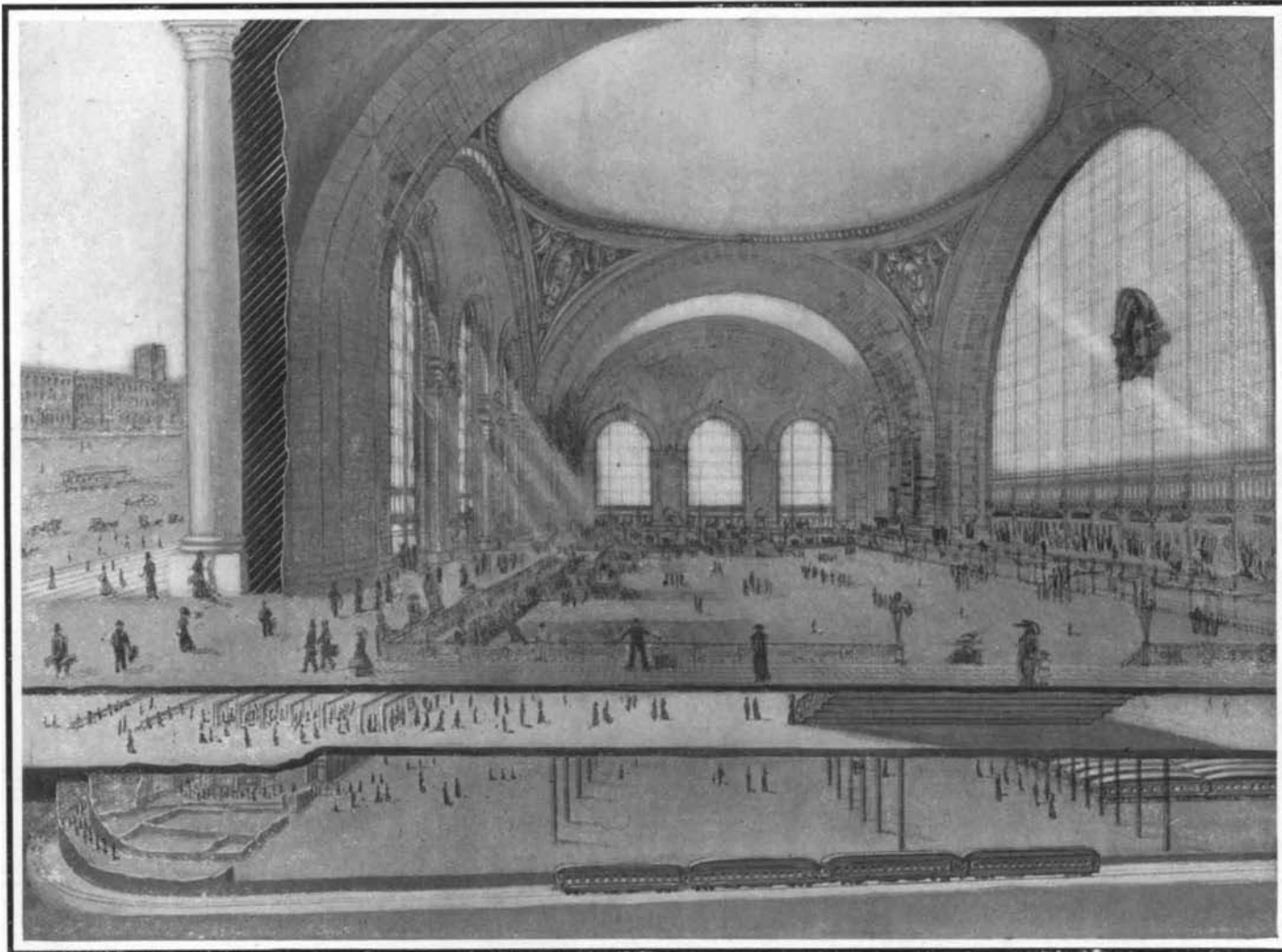
Of equal importance to the Pennsylvania terminal above described is the reconstruction of the terminal station of the New York Central

& Hudson River Railroad Company at Forty-second Street, familiarly known as the Grand Central. Briefly summarized, this work includes the removal of the old train shed (which was done a few months ago); the pulling down of the present terminal and office building; a great enlargement of the present station yard, and its excavation to an average depth of about



VIEW OF THE NEW GRAND CENTRAL STATION FROM FORTY-SECOND STREET.

course, an iron-and-steel-covered area over 100 feet wide, which extends across the entire width of the building. Crossing the concourse he will be confronted by a series of gates, bearing signs announcing the destination and time of departure of the trains on the various platforms below at the track level. The concourse and the adjacent areas are open to the tracks, and together they form a great courtyard 340 feet in width by 210 feet broad, roofed in by a lofty trainshed of iron and glass similar in design to the famous trainsheds of the new stations in Frankfort and Dresden, Germany. In addition to the entrances to the concourse from the waiting room, there are also direct approaches from Thirty-first Street, Thirty-third



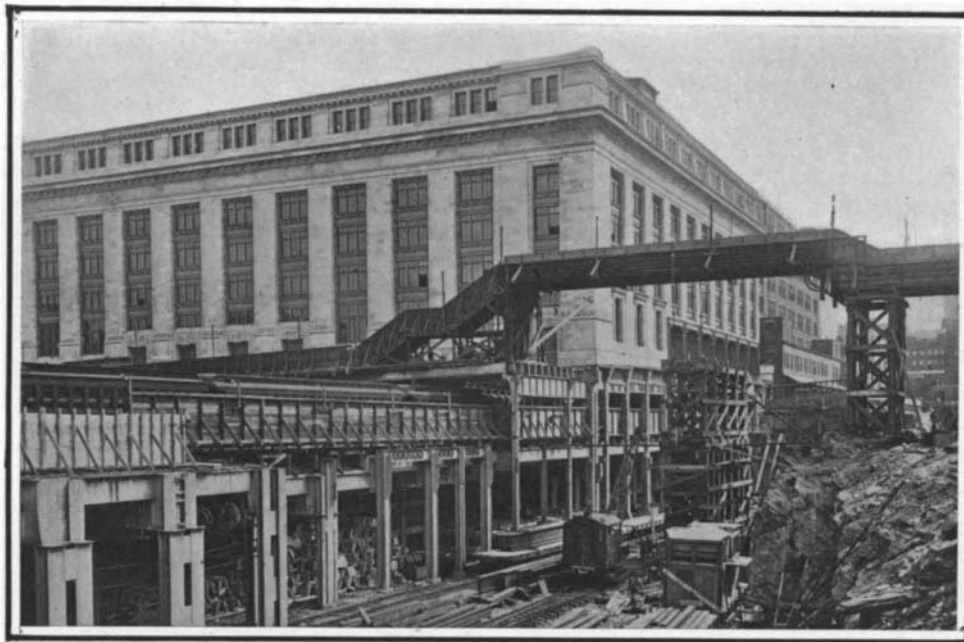
The grand concourse on the upper floor will be 160 feet wide, 470 feet long, and 150 feet from floor to roof. To the right will be the entrance gates to the express tracks. On the lower floors will be waiting rooms, ticket booths, etc., and the loop and stub tracks for the local trains.

SECTIONAL VIEW OF THE NEW GRAND CENTRAL TERMINAL STATION.

Street, and Eighth Avenue. Below the main concourse, and located between it and the tracks below, is a sub-concourse, 60 feet in width, which will be used for exit purposes only. From the sub-concourse staircases and inclines will lead to the streets and avenues and to future rapid transit stations under Seventh or Eighth Avenue. Direct connection may

40 feet below the old level, the work involving the removal of over 2,000,000 yards of material; the erection of new terminal buildings and offices on a greatly enlarged scale; and the electrification of this terminal and the main line of the road for thirty-five miles out from the city. Incidentally, this work has also involved the electrification of the main line of the New York, New Haven & Hartford Company, whose trains enter the Grand Central station, from Stamford, thirty-five miles distant, to the junction of that company's lines with the New York Central system, at Woodlawn.

The station building proper, together with the general offices of the company and the post office and express buildings, will cover the blocks lying between Vanderbilt and Lexington avenues from Forty-fifth to Forty-third Street, inclusive, and the block fronting on Forty-second Street between Van-



This view shows on the right the present level of the old station yard; on the left the lower and upper levels of the new yard, and the new Post Office building, whose architecture conforms to that of the new station building.

arched and domed roof of the concourse will extend entirely across the full width of the station building, a distance of 300 feet, or from Vanderbilt Avenue to Depew Place; but the concourse floor will be carried westerly under Vanderbilt Avenue for a distance of 170 feet. Back of the concourse, and located under the broad approach on Forty-second Street, will be the ticket booths and main waiting room, which will have twice the area of the present one. Surrounding it will be several retiring rooms, telephone and telegraph booths, and the various other conveniences of a modern station. Back of the waiting room will be a large restaurant. Across the northerly end of the concourse will extend the customary line of gates admitting to the express platforms. Beyond the gates will be located no less than thirty-four stub tracks, with broad platforms between them, the average width being about 16 feet,



The completed portion of new yard.

The new Post Office.

Site of the train shed.

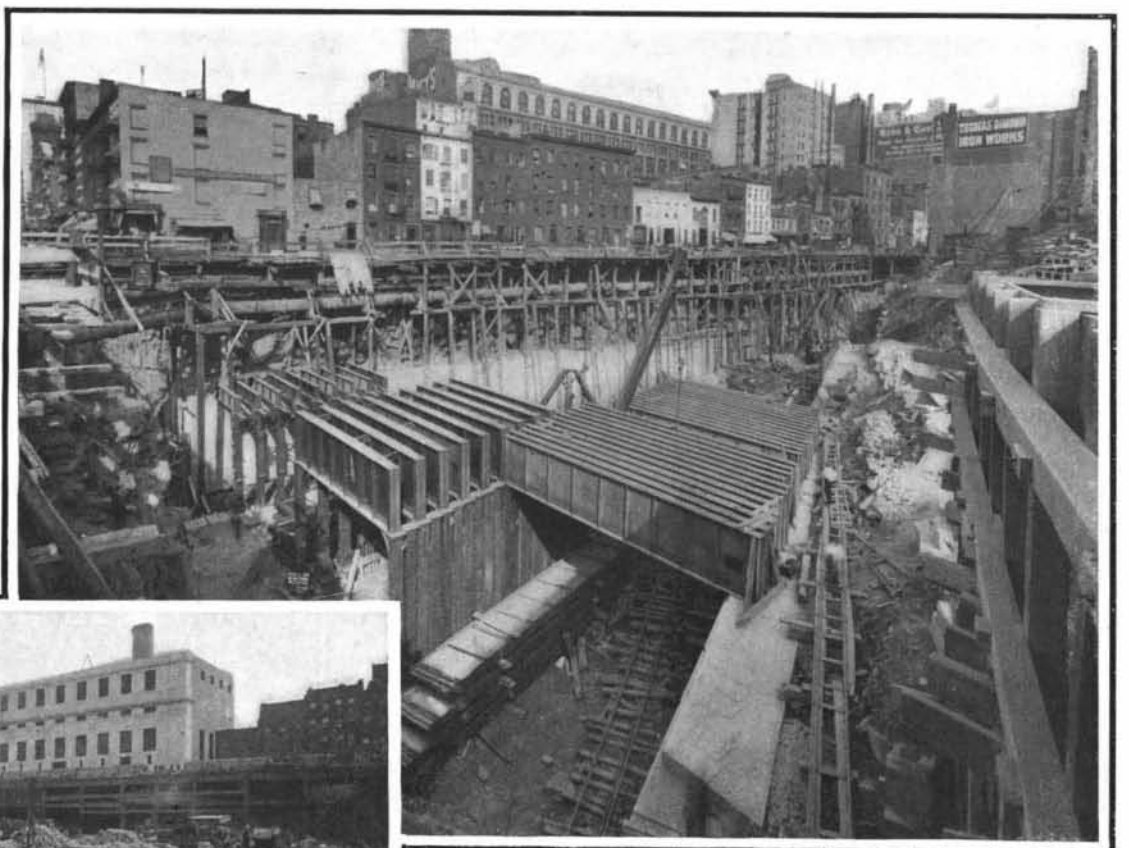
GENERAL VIEW OF THE NEW YORK CENTRAL YARD, SHOWING PRESENT CONDITION OF WORK.

derbilt Avenue and Depew Place. The main architectural features are governed strictly by the ground plan, the dominant architectural elements being determined in every case by the structural engineering necessities of the station. The southerly façade will stretch for 300 feet on Forty-second Street, and the westerly façade, including the broad approach on Forty-second Street, will reach for 680 feet on Vanderbilt Avenue. The building will extend 625 feet on Forty-fifth Street, 400 feet on Lexington Avenue, 275 feet on Forty-fourth Street, and 260 feet on Depew Place. The southerly half of the building incloses the station proper, this portion extending as far north as the northerly side of the great arched roof, seen in our sectional view. The northerly part of the building is given up to the offices of the company.

The imposing main entrance to the station on Forty-second Street is composed architecturally of three massive arches, each 33 feet wide and 60 feet in height. On entering, the passenger will find himself on a broad gallery, which runs around three sides of the grand concourse. From the gallery, passengers will descend by broad staircases to the floor of the grand concourse, which, by the way, is considerably

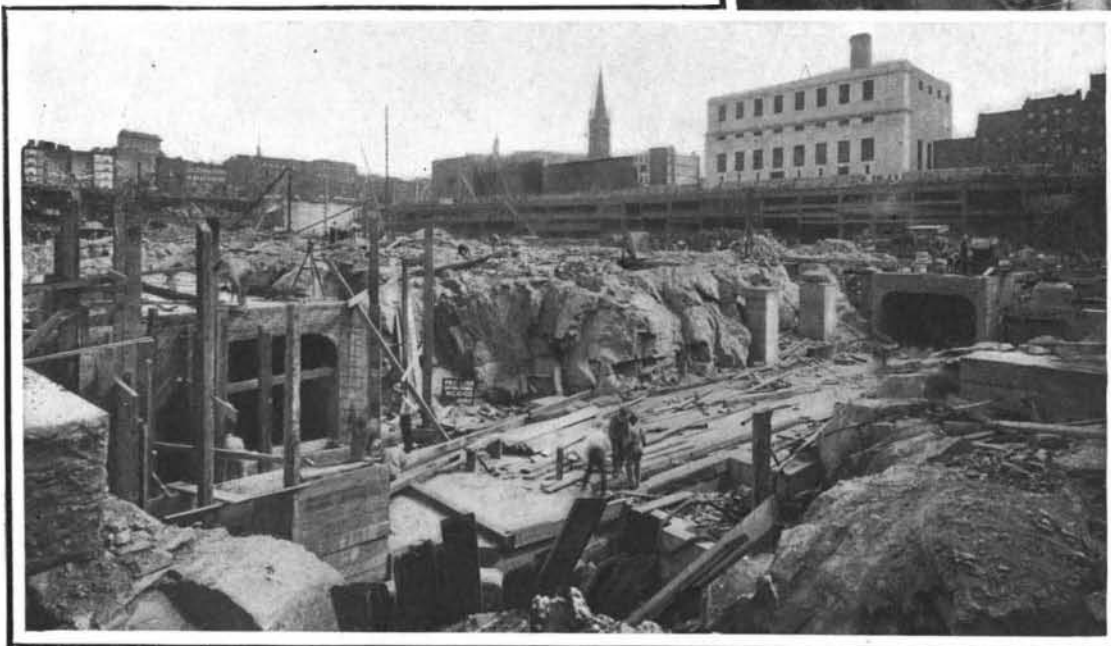
the largest of its kind in the world. Its width is 160 feet, its length 470 feet, and the height from the floor to the top of the domed roof is 150 feet. The noble

extra space being provided, in order to avoid the excessive crowding which is such a troublesome feature under existing conditions. Of these thirty-



VIEW OF THE SUBSTRUCTURE OF NEW PENNSYLVANIA TERMINAL STATION, SHOWING THE CONVERGENCE OF THE YARD TO THE TUNNELS LEADING TO LONG ISLAND.

four tracks, the westerly eight or ten will be reserved preferably for incoming trains, and the arriving passenger, on passing through the gates onto the concourse, will find himself opposite a large cab stand, and with conveniences right at hand for securing his trunk and driving away with it with as little delay as possible. In addition to leaving directly by cab, he has the choice of four other means of exit from the station; for he may pass by a covered walk directly to the Subway, or by a 25-foot stairway to the concourse gallery and so to the street, or he can pass out



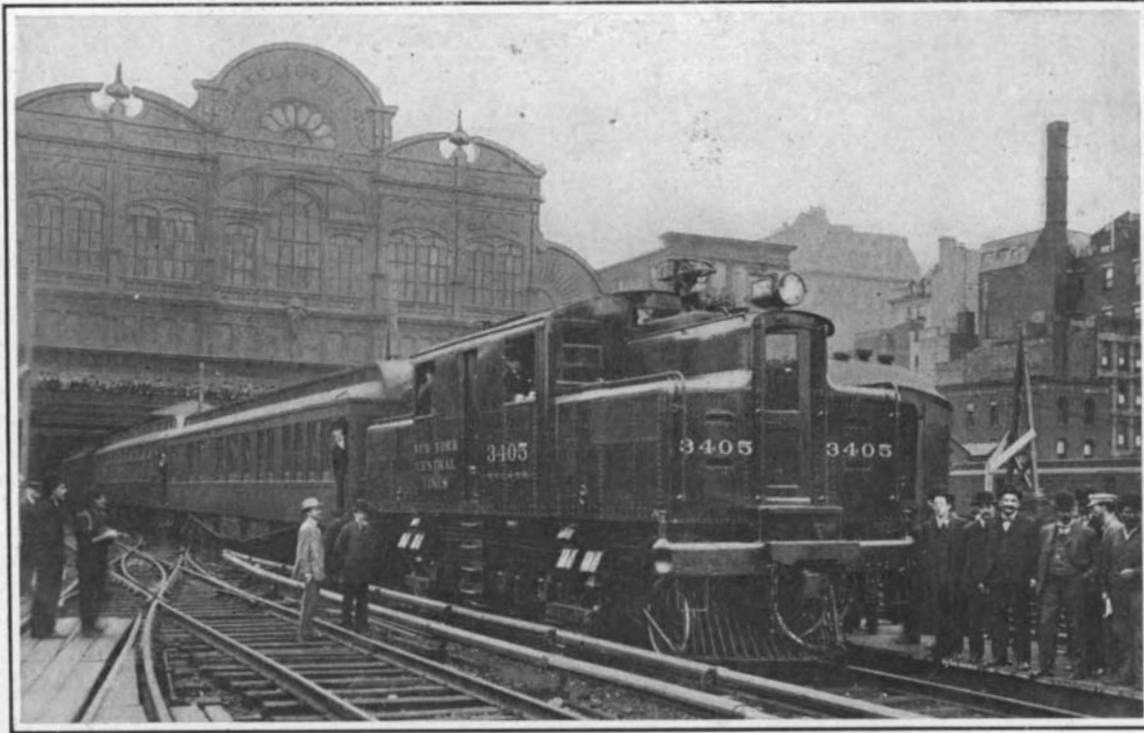
VIEW OF PORTION OF THE HUGE EXCAVATION FOR THE PENNSYLVANIA TERMINAL, SHOWING BAGGAGE SUBWAYS.

to Madison Avenue and Forty-third Street by a covered subway, or crossing the concourse, he may leave by another covered subway to Lexington Avenue. It will be understood, of course, that the thirty-four tracks extend the full width of the concourse, the most easterly track abutting on Depew Place and the most westerly on Vanderbilt Avenue, and this, of course, necessitated some careful engineering work in supporting above these tracks the immense weight of the northerly half of the station building, containing the company's offices. Care has been taken to so arrange the supporting columns that none of them shall interfere with the passenger platforms.

The plans for the new station involved, as an absolute prerequisite to success, that the suburban travel should be entirely separated from the express; and it was considered that the best way to insure this was to place the suburban tracks below the express tracks and provide a suburban concourse, waiting rooms, and other conveniences on this lower level. Moreover, it was decided that, with a view to further separating the two classes of travel, separate entrances and exits should be provided, so that the suburban passengers could enter or leave the lower level from the street or the Subway without meeting the long-distance travel. Access to the suburban tracks and station is obtained by gradually depressing the two outside tracks in the entrance tunnel below Park Avenue until they reach the lower level. In the rush hours the suburban trains will pass into the station and around a loop which will extend beneath the restaurant on the express level, the trains passing out again without breaking bulk. Toward the close of the rush hours, alternate trains will discharge their passengers from the series of seven stub tracks, which occupy the train space within the loop and in front of the suburban concourse. Trains will be stored here and in the station yard until the evening rush hour,

at least one hundred per cent by the great enlargement of the station yard. One of the most serious obstacles to a further increase in the number of passenger trains under existing conditions, is the fact that the storage yard for express trains is at present located at Mott Haven, and every express train that enters New York has to make the trip through the tunnel

third-rail direct-current system. The third rail is carried on brackets supported on extensions of the ties, the contact rail being under-hung, and the shoes on the electric locomotive bearing against the under side of the rail, which is protected by wooden sheathing on the top and sides of the rail. This sheathing has been found to afford not only a most excellent safeguard to employees and foot passengers, but has proved to be an excellent construction for preventing clogging of the rail by snow and ice in the winter time. The long distance trains are operated by electric locomotives of about 2,300 rated horsepower which weigh 100 tons. They have proved to be capable of handling the heaviest express trains of the system with a considerable margin of power to spare. The local trains, operated by the multiple-unit system, have shown in actual service a great advance on the old steam-operated trains on every point of comparison. Current is generated in two identical power stations, one at Yonkers, and the other at Port Morris. When the complete plant has been installed each station will have a capacity of 40,000 horsepower, and each has sufficient capacity to operate



The locomotive, which weighs 100 tons, can develop a maximum of over 3,000 horse-power.

START OF THE FIRST ELECTRIC TRAIN FROM THE NEW YORK CENTRAL STATION.

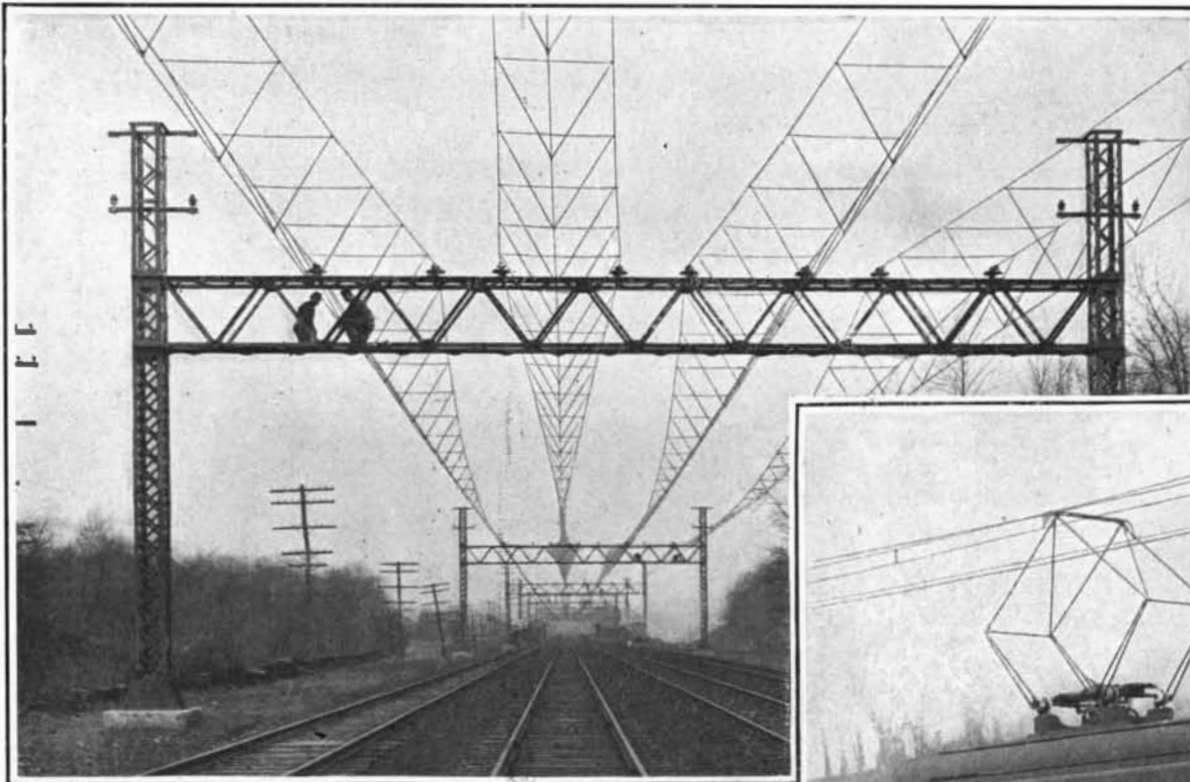
four times, twice in entering and leaving the station with passengers, and twice in making the round trip to the yard for cleaning purposes. With the enlarged area of yard provided in the new arrangement, the storage of express trains will take place at Forty-second Street, and the tunnel will be relieved proportionately. The excavation of the yard involves, as we have noted above, the removal of over 2,000,000 cubic yards of material. The express and local service will be separated, the former using the upper and the local the lower deck of the station. The upper level will be depressed some 15 feet below the present yard level, and Park Avenue and the various cross streets will be carried over the yard on steel viaducts.

The New York Central lines are operated on the

whole system. The plant was built in duplicate, with a view to having a complete reserve plant at command in case of breakdowns. The whole of the equipment of New York Central lines was built by the General Electric Company; and they are to be congratulated on the fact that from the very inception of the service it has been operated with a remarkable freedom from breakdowns or interruptions of any kind.

The equipment of the four-track road of the New York, New Haven & Hartford Railroad Company from Stamford to Woodlawn possesses unusual interest from the fact that this represents the first attempt to operate a heavy trunk railroad by the alternating current. Among the theoretical advantages of this system over the direct-current system, is the fact that sub-stations are done away with, and their heavy expenses due to initial cost and the maintenance of skilled staffs of operators are saved. The current is generated at a power station located at Cos Cob, and is delivered to the overhead line at 11,000 volts. Each locomotive carries its own transformers, of which there are two to each locomotive. This adds greatly to the weight, which reaches the high figure of 95 tons for a rated horse-power of about 1,000. An interesting feature of these machines is that they are arranged to take either single-phase current from the overhead lines or direct current from the third rail. The overhead

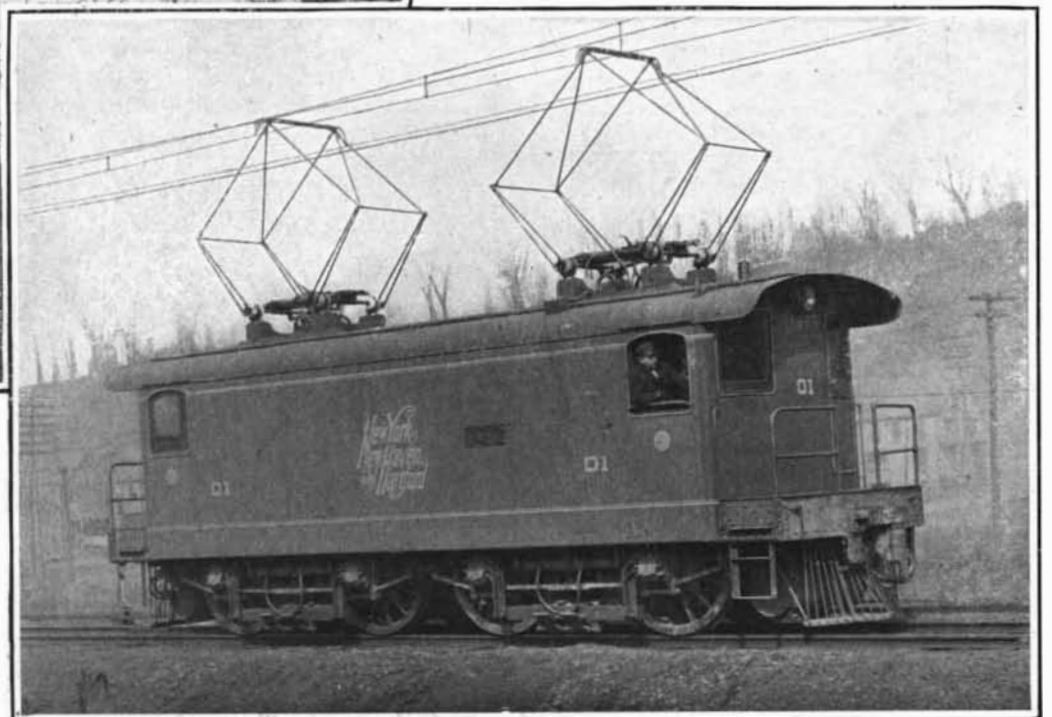
(Continued on page 417.)



THE OVERHEAD LINE OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD, WHICH CARRIES CURRENT AT 11,000 VOLTS.


when they will be switched out into service again. Provision is made at the inner end of the loop for connection direct to the tracks of the Rapid Transit Subway below Fourth Avenue; and it is a fortunate circumstance that the Chief Engineer of the Subway, by moving the two tunnels below Park Avenue over toward the curb line, made provision for this connection with the New York Central system, although, at that time, the New York Central Company was not disposed to consider any such connection.

In conclusion, it should be mentioned that the capacity of the Park Avenue tunnel has been increased



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been driven; and, as a provision against this, the original plans provided for sinking hollow cast-iron piles through the floor of the tunnel to bedrock, and laying the tracks upon a system of longitudinal girders within the tunnel, which would serve to transfer the trainloads directly to the piles, and so relieve the tubes themselves from all stresses due to live loads. These piles were to be 27 inches in outside diameter, with a shell 1½ inches in thickness. After the tubes had been driven, the satisfactory behavior of the Hudson Companies' tubes, which were built without any pile supports and have failed to show any settlement after many months of operation, convinced the engineers that the Pennsylvania tubes would be sufficiently stable without the supporting piles; and, consequently, this feature has been omitted. The tubes were driven by the shield method, and the work was pushed through without developing any problems of a serious or unusual character. The same may be said of the building of the tunnels across Manhattan Island, where the work consisted for the most part of straight rock excavation. With a view to accommodating the heavy future increase in suburban traffic to Long Island, the company determined to build four separate tubes beneath the East River. Because of the difficult character of the material encountered, the work on these tunnels has been somewhat protracted, many blowouts having developed, necessitating the construction of a false bottom to the river above the heading of the tubes by dumping in many thousand cubic yards of material from scows. All obstacles, however, have been overcome, and the whole of this vast tunnel system will have been completed before another twelvemonth has gone by. The total length of the run in tunnel from the portal in Jersey City to the portal on Long Island is 5.3 miles. The total length of single-track tube tunnels under the two rivers is 6.8 miles, and the total length of single-track tunnel under the land is also 6.8 miles. The total length of track in tunnels exclusive of the yard tracks and the station will be 16½ miles.

Contemporaneously with the execution of the above work, the financial interests which are responsible for the operation of New York city's subways were engaged in constructing a twin-tube tunnel below Forty-second Street and the East River from the Grand Central Station, Manhattan, to Long Island City. The tubes are similar in dimensions and general construction to those which form the connecting link at the Battery between the Manhattan and Brooklyn Subway systems: The tunnel was built under an old franchise granted many years ago, and it has been offered for purchase by the city at a price of \$7,000,000.

NEW GRAND CENTRAL TERMINAL STATION.
 (Continued from page 412.)
 trolley system consists, for each track, of two steel messenger wires below which is carried, by means of triangles of steel tubing, the ¾-inch copper trolley wire. In the early days of the operation of the system, difficulties developed, due to the hammering of the collector shoes as they passed the points of suspension of the wire at the apex of the triangles. This was cleverly overcome by suspending a second wire below the first by means of clips attached to the upper wire midway between its points of suspension from the triangle. The arrangement has provided a system which combines great stiffness with uniform flexibility of the trolley wires; and the troubles of sparking, wear, and breakage have been practically eliminated. The electric locomotives, which because of their short wheel base were found to sway heavily at high speed, have later been provided with end trucks of ingenious design, which have completely eliminated the trouble, and rendered these locomotives as steady in their running as a Pullman car. The whole of this work was done by the



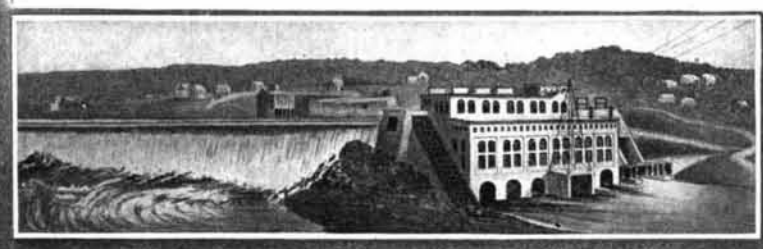
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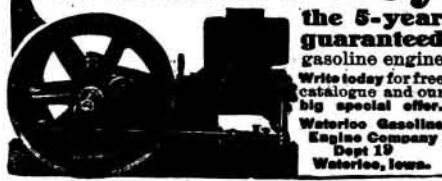
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Westinghouse Company; and both they and the New Haven Railroad Company are to be congratulated on having overcome, in spite of many initial discouragements, the inevitable difficulties attending the execution of pioneer work, on such a vast scale and under the stress of traffic of one of the busiest four-track systems in the world.

In closing it should be mentioned that the results of operation of these two systems are claimed by the companies to have been highly satisfactory. The number of train movements in the yard has been greatly reduced, the Park Avenue tunnel has been robbed of its terrors, and even to-day, while the work of excavating the yard is in progress, the trains are being operated at this terminal with a regularity and dispatch which has never been surpassed in the early history of the road.

PATENT CAUSES

INVENTORS are invited to communicate with Mann & Co., 361 Broadway, New York, or 825 F Street, Washington, D. C., in regard to securing valid patent protection for their inventions. Trade-Marks and Copyrights registered. Design Patents and Foreign Patents secured. We undertake all Patent, Trade-Mark and Copyright Practice, both before the Patent Office and the Courts, and we have special facilities for handling infringement and other suits in Federal and State jurisdictions. A Free Opinion as to the probable patentability of an invention will be readily given to any inventor furnishing us with a model or sketch, and a brief description of the device in question. All communications are strictly confidential. Our Hand-Book on Patents will be sent free on request. Our is the Oldest agency for securing patents; it was established over sixty years ago. MUNN & CO. 361 Broadway, New York City

INDEX OF INVENTIONS

For which Letters Patent of the United States were issued for the Week Ending November 24, 1908. AND EACH BEARING THAT DATE [See note at end of list about copies of these patents.]

- Agitating and aerating apparatus, L. C. Trent. 905,025
Air brake system, H. J. Ulrich, W. Bernard. 904,502
Amusement device, Hamilton & Melre. 904,953
Animal trap, W. Sebellin. 905,006
Armor exploding projectile, A. Wratske. 905,042
Ash handling apparatus, C. G. Armstrong. 904,916
Atomizer, H. H. Mallory. 905,087
Atomizer, invertible, T. A. De Vilbiss. 904,515
Auger, J. Moo e. 904,796
Automobile canopy, E. T. Robinson. 905,001
Automobile transmission gear and casing, E. J. Gulley. 904,774
Automobile transmission mechanism, M. O. Reeves. 904,723
Automobiles and like vehicles, generation, control, and transmission of electric energy, particularly for use on, A. H. Midgley. 904,794
Autosleigh, C. W. Dennis. 905,058
Axle, B. W. Berry. 904,672
Bag holder, W. L. Herrick. 904,995
Band adjuster, H. J. Ulrich. 904,709
Bandages fitting up antiseptic, J. E. Lee. 905,088
Barrel packing machine, Vogt & Storck. 905,017
Batter grid, Post & Morley. 904,645
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Belt fastener, J. H. Wooliscroft. 904,910
Belt thrower, D. A. Roderick. 904,648
Beverages, making fermented, M. Wallerstein. 905,029
Binder, loose leaf, O. Kellner, Jr. 904,618
Bit brace, J. B. Bartholomew. 904,702
Blower, H. E. Parson. 904,804
Blowing engine and the like, C. N. Scott. 905,108
Book, loose leaf, H. E. Hawkins. 904,777
Bottle case or crate, S. Becker. 904,829
Bottle corking machine, Schlosser & Fisher. 905,005
Bottle or other receptacle and stopper or cover for such receptacles, H. Marles. 904,705
Bottle stoppering machine, W. S. Dorman. 904,768
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