to Tasmania to select piles, and while there, at the request of the Tasmanian Ministry, read a paper before the Royal Society of Tasmania on the timber in that colony. Being acknowledged as an expert on the subject, and having had a long experience in Baltic and American timber, his remarks were naturally listened to with considerable attention, and printed for circulation in the state by the government. In an interview with the writer, he was enthusiastic about the wonderful properties of the Tasmanian timber, but spoke sadly of the waste he witnessed in the great forests of that state, caused through bushfires and useless ring-barking, etc. At the same time he had a good word to say for the Tasmanian axmen, declaring them to be among the finest in the world, as the splendid workmanship shown in the squaring of the Dover piles proves. Indeed, at a short distance, it is difficult to distinguish whether they are sawn or hewn. It is a curious fact, and complimentary to American industry, that they infinitely prefer the American ax to that made in any other country.

Before leaving Tasmania Mr. Heyn read a second paper before the Society, in which he declared that the government of that State could take a leaf from the method of the Agricultural Department at Washington by establishing a school or schools of forestry such as are to be found in the United States and other great countries. The work of such an institution should include, in his opinion, the importation of desirable seeds from different parts of the world, as well as collection of native seeds for afforesting the waste lands on the island; growth and distribution of nursery stock, particularly of trees likely to benefit, materially and physically, Tasmania; and practical teaching, with ocular demonstration, of the art of forestry to those desiring it. The institution would also see that the laws for the protection of forests were rigidly enforced.

TASMANIAN AXMEN SQUARING BLUE-GUM PILES IN THE BUSH.

SPAN OF OXEN AT WORK IN A TASMANIAN BLUE-GUM FOREST.

"BIG BEN" GUM TREE.

Its height is nearly 250 feet; its circumference, five feet from the ground, is 95 feet; its interior measures 20x25 feet.

A New Variety of Potato.

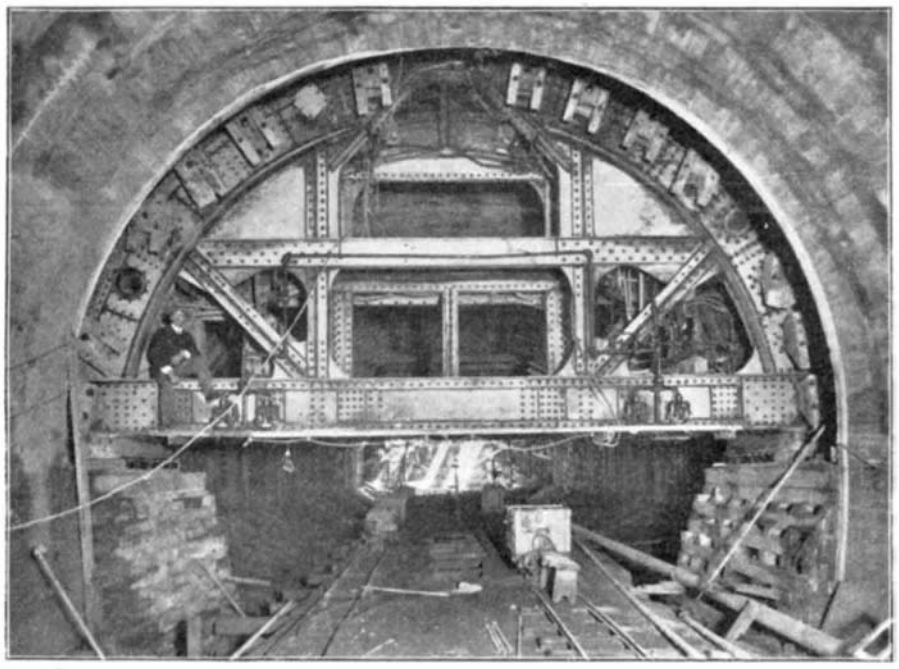
M. Labergerie has been making some experiments in France upon a new variety of potato which not only has the advantage of growing in damp earth, but gives an extraordinary yield. This variety is known as *Solanum commersoni*, and comes from Uruguay. He obtained some specimens from Prof. Davin, of the Marseilles Botanical Garden, who had recently secured some of the plants. M. Labergerie commenced planting the potatoes in a fertile and wet soil on the banks of a stream. They began to grow regularly, and in 1904 he already had 11,500 plants. He finds that the yield is no less than 100 tons per hectare (which figures about 30 tons per acre) in wet soil, and but 3 tons per acre in dry soil. The potatoes are exceptionally large and weigh 2½ pounds, and at the same time are of good quality. The branches of the plant are as long as 12 feet. The potatoes contain a large proportion of starch, and he finds 17 per cent in the present specimens. The taste is good, and in this regard will compare very well with the ordinary varieties. The plant is considerably influenced by water and light. It appears that the Solanum was considered formerly as only good for cattle, but we now find that it can be developed so as to be nutritious and good-tasting. At the same time it prefers wet soil where ordinary potatoes will not flourish.

COMPLETION OF THE EAST BOSTON TUNNEL.

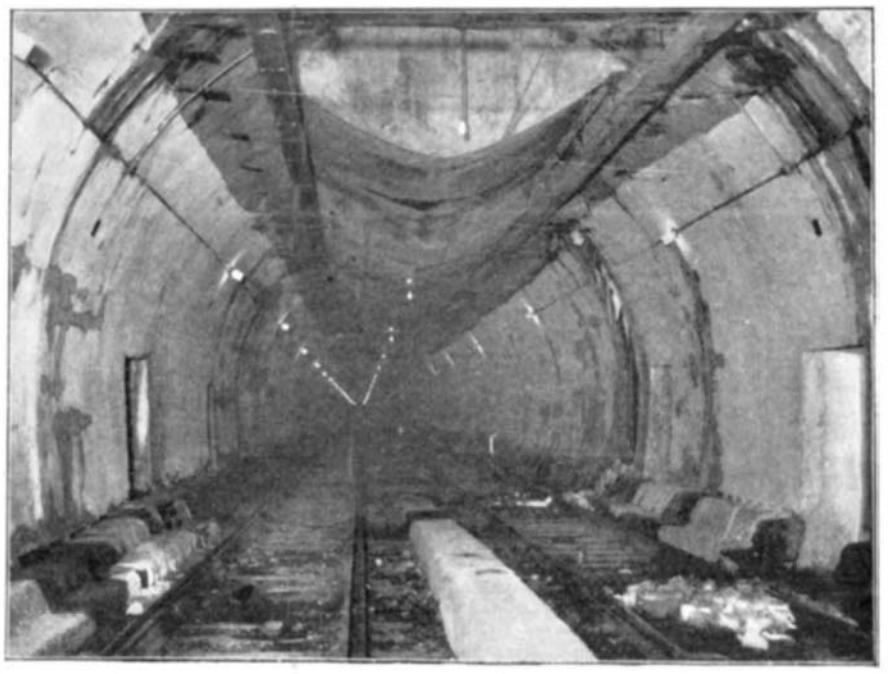
The completion of the East Boston tunnel marks the inauguration of one of the many rapid-transit subway systems which are being constructed in the leading cities of the world. The tunnel was built by the Boston Transit Commission, under Mr. Howard A. Carson as Chief Engineer; and it forms a most important extension of the system of trolley subways which that city constructed several years ago. We take this opportunity to refer to the indebtedness of New York city and all municipalities that either already have, or will shortly inaugurate, subway systems to the city of Boston, which, in successfully putting through her subways, proved the practicability and great convenience of such a system where the traffic conditions on the surface are badly congested.

The new tunnel extends from Scollay Square, an important station on the Boston Subway, beneath a wide arm of Boston Harbor, to Maverick Square in East Boston, the total distance between these two points being 7,480 feet, or 1.4 miles. From Maverick Square the tunnel falls on a grade that varies from 4.7 to 5 per cent for a distance of 2,000 feet. Here the lowest point of the tunnel below low water is reached, the bottom of the masonry being 82.3 feet and the top of the rail 73.3 feet below mean low water. At this point is located a pump well, where all water that enters by seepage is collected and pumped out. The location of the well is about 550 feet out from the East Boston shore line. From this point the tunnel rises for about 2,000 feet on a grade of 0.5 per cent, until it reaches a point approximately below the Boston harbor line. The grade then steepens to 2.5 per cent until the first station on the Boston side is reached, at a point just beyond Atlantic Avenue. Another 1,500 feet on an upgrade of 4 per cent, reducing in the last 300 feet to 2.5 per cent, brings the tunnel to near Devonshire Street station, and then 500 feet of 3.5 per cent ascent brings the new tunnel to a junction with the existing Subway at Court Street adjoining Scollay Square.

Apart from its great importance as affording a direct double-track trolley road from Boston to East Boston, the tunnel possesses particular interest because of the

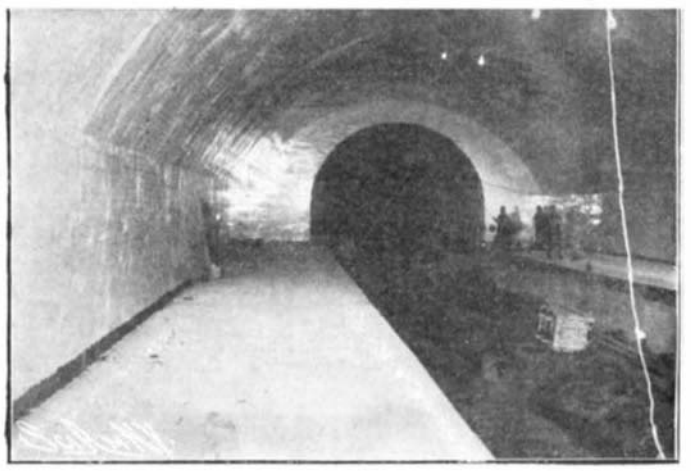


Rear View of Shield With Which the Upper Half of Tunnel Was Excavated.

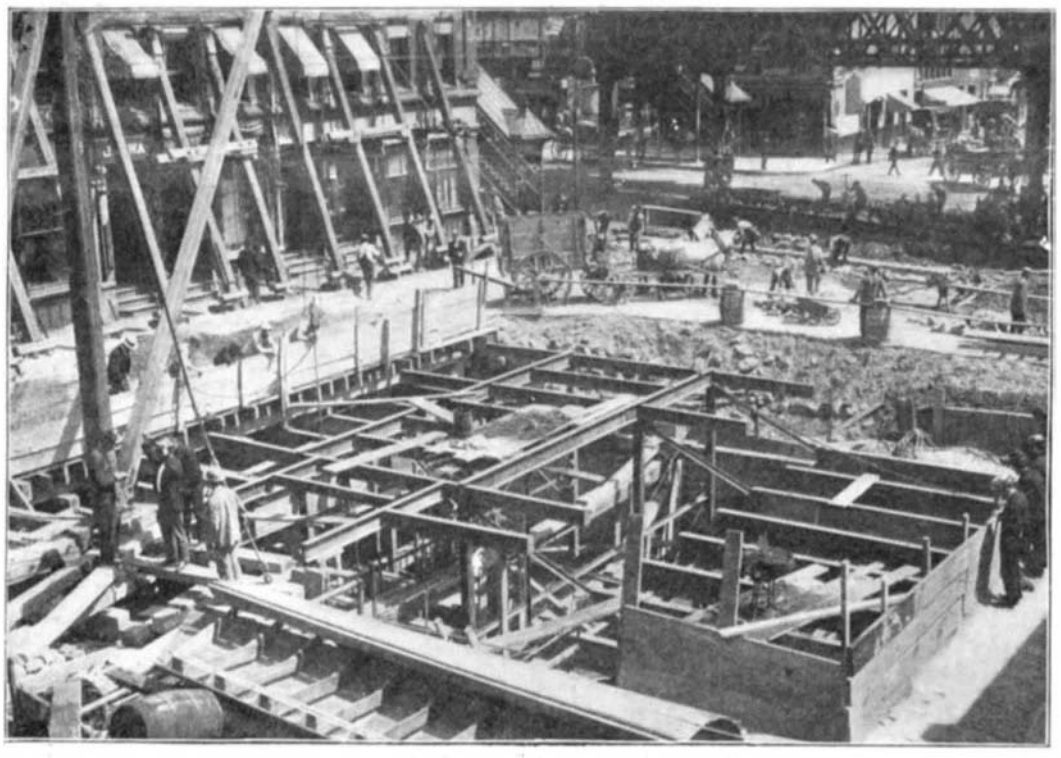


View in Completed Tunnel, Showing the Ventilating Duct in the Roof.

Devonshire Street Station, Showing Method of Interior Finish.

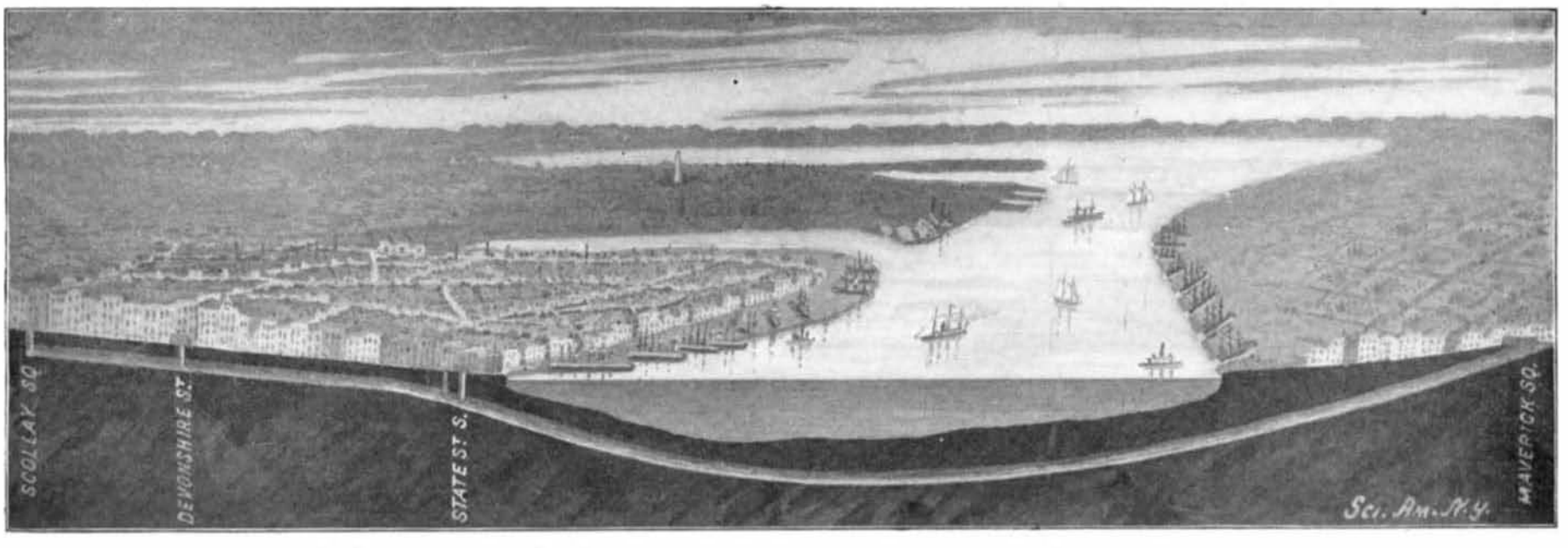


View in Completed State Street Station.



State Street Station Under Construction.

Exit, Maverick Square, East Boston.



Sectional View of the New Tunnel from Scollay Square, Boston, to Maverick Square, East Boston.

COMPLETION OF THE EAST BOSTON TUNNEL.

boldness of the plan upon which it was so successfully carried through. In the first place, it is notable as being the only double-track tunnel thus far built in America. The tunnels under the Hudson River and under the St. Clair River, and those now under construction beneath the East River, in connection with the Brooklyn Rapid Transit lines, being single-track tunnels and of considerably less sectional area. The width of the tunnel under the harbor where it is lined with ribbed tile is 23 feet, and in the upper part of State Street and Court Street it is 23.67 feet wide. The height of the tunnel from the top of the rail to the roof in the upper part of State Street and Court Street is 14.17 feet, and in the lower part of State Street, and under the harbor, the height is 17.3 feet. The excavation was done partly in open cut, this method being used where the tunnel lay near the surface, and there were no physical or other difficulties to prevent its use, and partly by means of shields and compressed air, the latter system being used in the construction of about 4,900 feet of the tunnel. It is the latter part of the construction that is most interesting, because it was carried through by an entirely new and exceedingly bold method which, as far as we know, has never been attempted under similar conditions.

When the borings for the proposed tunnel were made, it was found that it would pass through a stratum of exceedingly fine bowlder clay, of a consistency much firmer and more reliable than is usually found in subaqueous tunneling of this kind. Hitherto in such tunnels, where the shield has been used, among which might be mentioned the Blackwall tunnel under the Thames, London, and the tunnels under the St. Clair and Hudson rivers in this country, it has been customary to use a completely circular shield, which is pushed forward by hydraulic pressure, the tunnel as it is excavated being lined with a heavy segmental cast-iron lining, which is bolted together and grouted to render it perfectly water-tight. For a double-track road like this, however, the use of a circular tunnel would have involved much more excavation than was really necessary to accommodate two lines of trolley cars, there being a considerable amount of waste space in such a tunnel both above and below the cars. The engineer, therefore, determined to take advantage of the firm nature of the material, and build the tunnel with a semicircular roof, perpendicular side walls, and a flat invert. The irregular section that this method necessitated, made it impossible to use a shield in the ordinary way. Consequently, a semicircular half-shield was used for the construction of the upper half of the tunnel, and the lower half was built by means of drifting, in the manner now to be described.

Two bulkheads were constructed, one at each end of the central portion of the tunnel extending below the river, and these were provided with the usual air locks. The next step was to drift out two small tunnels, one in the line of each side wall, and large enough to permit these walls to be built therein. The walls were built of concrete and carried up to the springing of the semicircular arch. On the top of the walls was laid a heavy trackway, upon which rested the ends of the semicircular shield. The shield was then advanced by hydraulic pressure in the customary way, the clay being dug out, passed back through the central openings, and removed through the air locks. The concrete roof, three feet in thickness, was then rammed in place, being temporarily supported on falsework, in the customary manner. The material lying between the side walls was then excavated down to grade and the concrete invert was built in place. Except for a blowout, and one or two minor accidents, this very bold and original method of excavation was carried through successfully. The pneumatic pressure served to hold the clay in place until the concrete side walls, arch, and invert had been built in place and given sufficient time to harden. The boldness of this scheme will be appreciated when we remember that at extreme high water, the bottom of the excavation was exposed to a head of about 100 feet of water, and that until the concrete shell had been built in and had set there was nothing to prevent inward collapse, except the natural tenacity of the clay, assisted by the pneumatic pressure.

The work presented many features of engineering interest, arising in some cases from the cramped location, and in others from the fact that lofty buildings abutted on the tunnel and care had to be taken to provide against lateral displacement. To relieve the lateral thrust due to the weight of the concrete arch, and its superimposed load, a series of cross-tie rods with turnbuckles was let into the arch near the crown. These were so arranged that when the concrete had set, the rods could be removed. In some portions of the tunnel near the high levels, the structure was built with a flat roof, the necessary bending strength being secured by embedding twisted steel rods in the concrete—a method of construction known as reinforced concrete.

In order to secure proper ventilation, an air duct was formed at the crown of the arch, extending from Webster Street, East Boston, to and under the harbor to the Atlantic Avenue station. It has a cross section of about 48 square feet, and is formed of a diaphragm one inch in thickness, made of metal and inclosed in cement mortar. This diaphragm is attached to the tunnel walls by steel rods and plates which are then incased in concrete. At the center of the duct, midway between the two ends, is a partition which divides it into two approximately equal portions. On each side of the partition there are fourteen openings, each 4 feet long and 1 foot 5 inches wide, formed in the flat portion of the ducts; and at intervals of about 550 feet there are other groups of openings diminishing in number as they approach the chambers above the surface in which the fans are located. These openings are fitted with doors which can be opened or closed from the tunnel below. Fresh air enters the tunnel from the portal at East Boston and through the station near Atlantic Avenue. This air moves to near the middle of the tunnel and then passes up through the openings into the duct, through which it is drawn back to the east and to the west, and leaves the tunnel through the ventilating fans located near each end of the tunnel.

Work on the tunnel was commenced May 5, 1900, so that the work has taken about four and a half years to complete. Its approximate cost is $3,300,000.

THE NEW GRAND CENTRAL STATION, NEW YORK.

(*Continued from page* 40.)

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 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 ticket lobby, will be the main waiting room, which will have twice the area of the waiting room of the present station. 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, located beneath the broad approach to the station. 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, extra space being provided, in order to avoid the crowding which is such a troublesome feature under existing conditions. Of these thirty-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 into the main ticket lobby, or he can pass out 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. To recapitulate, it should be explained that the ticket lobby and the gallery are at street level, and the express tracks, the main concourse, the express waiting rooms, and the restaurant are at a level 15 feet lower than that of the street.

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, 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 Mr. Parsons, 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.

The suburban station is provided with a broad concourse and with the necessary waiting room and other conveniences, all arranged on the lower level, and with separate exits both to the Subway and to the street. This station is, to all intents and purposes, absolutely independent of the express station above; although provision is made by means of staircases for communication direct from the ticket lobby and the main concourse to the suburban station.

In conclusion, it should be mentioned that the capacity of the Park Avenue tunnel has been increased 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 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 whole of the station yard will be operated electrically, as will also the suburban trains on the New York Central, the Harlem, and the New Haven Railroads. Suburban trains will be operated on the multiple-unit control system with motors on the car axles, and shorter trains will be run at more frequent intervals. The long-distance expresses will be hauled as far as Croton on the main line, White Plains on the Harlem Division, and Portchester on the New Haven Road, by electric locomotives. It is expected that the local service will be in operation in from two to three years' time, and that the whole scheme will be completed about a year later.

The Current Supplement.

The current Supplement, No. 1516, opens with a continuation of our correspondent's review of the Paris Automobile Show. His two articles, taken in connection with the Automobile Number of the Scientific American, which is to bear date January 28, will give the reader a most excellent review of automobile progress in Europe and America. Mr. Ambrose Swasey writes on "Some Refinements of Mechanical Science." Dr. O. F. Herz discusses at length the great frozen Siberian mammoth which he unearthed in 1901, in an almost perfect state of preservation. Splendid pictures accompany the text. Prof. William Bateson's article on breeding and heredity is continued. Prof. G. W. Ritchey presents another chapter on the "Modern Reflecting Telescope, and the Making and Testing of Optical Mirrors." In this installment he discusses silvering. Arthur Gulston's splendid discussion of ice-breakers and their services is concluded.

Next Week's Special Automobile Issue.

This is the season of the year when the prospective automobile buyer casts about him for a machine that suits his taste and purse. For several years the Scientific American has come to his assistance by publishing special automobile issues, in which the very latest types of cars, big and little, costly and cheap, have been described with a fullness of detail and a wealth of illustration that have been of immense assistance in such a selection. This year the Scientific American will outdo anything it ever before attempted in this direction. Next week's Special Automobile issue will contain forty-four pages, and will be larger than any of its predecessors. The subject of the colored cover is a wild automobile ride through a blinding snowstorm.

Naturally, the issue will be devoted largely to the products of American manufacturers; but the foreign maker has by no means been forgotten. Commercial vehicles, novelties of the Automobile Show, motor bicycles, racing cars, automobile accessories, are also discussed. For the general reader extra pages have been incorporated in the issue, which pages are devoted, not to automobiles, but to the usual subjects described and illustrated in these columns.