THE NEW PHILADELPHIA SUBWAY.

BY J. A. STEWART.

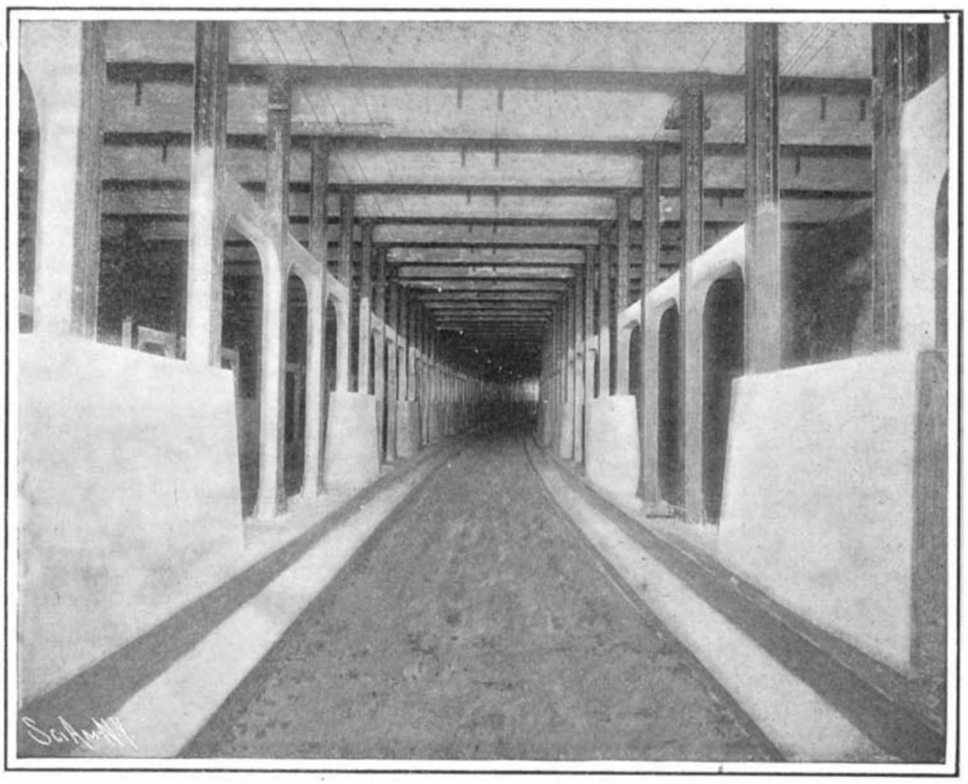
Subway construction has been going on steadily in the large, congested cities of the United States. Its latest enterprise is the new combined underground and elevated street railway opened on December 21, 1905, in Philadelphia, although still incomplete in minor details.

It was the problem of modern urban life—congestion at the central arteries of traffic—which first gave the subway idea its vogue in this country. Boston adopted it with a success that not only gave great prestige to the system of underground transit, but also splendidly exploited the best ideals of municipal administration and ownership of public utilities. New York and Chicago have both demonstrated the value of the subway model in amelioration of the problem of adequate transit facilities. In all cases, it is to be noted, the subway does not claim to be a cure, but it has unquestionably proved to be an effective palliative.

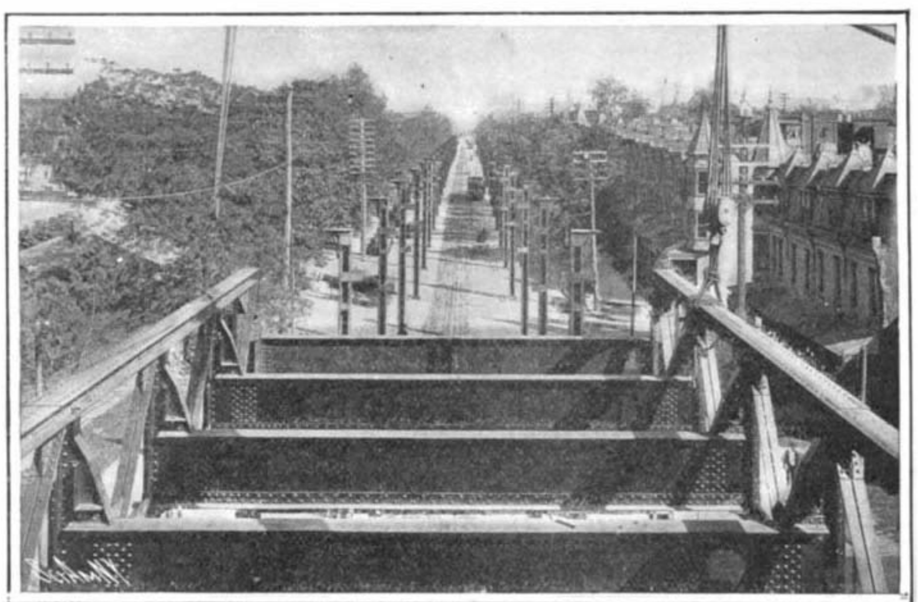
When the far-sighted William Penn laid out the streets of his embryo western metropolis on the banks of the Delaware, he thoughtfully decreed that there should be broad, central thoroughfares at right angles running through and from the center of the city. But even the forethought and wisdom of Penn had not anticipated the needs of the twentieth century Philadelphia. The buildings have stretched toward the sky and far toward the horizon on every side, to accommodate the growth of population. The surface cars, which run on every street in the business part of the city, have long been inadequate for the full tide of traffic. So a subway has been resorted to.

In planning the construction of their extensive operation, the Philadelphia Transit Company's engineers have had the invaluable help of the experience gained from the Boston and New York enterprises. The general approved plans of subway and elevated construction have been taken, with adaptation to local needs and conditions. The work has reached a point where it is appropriate to review and to record its revealed results.

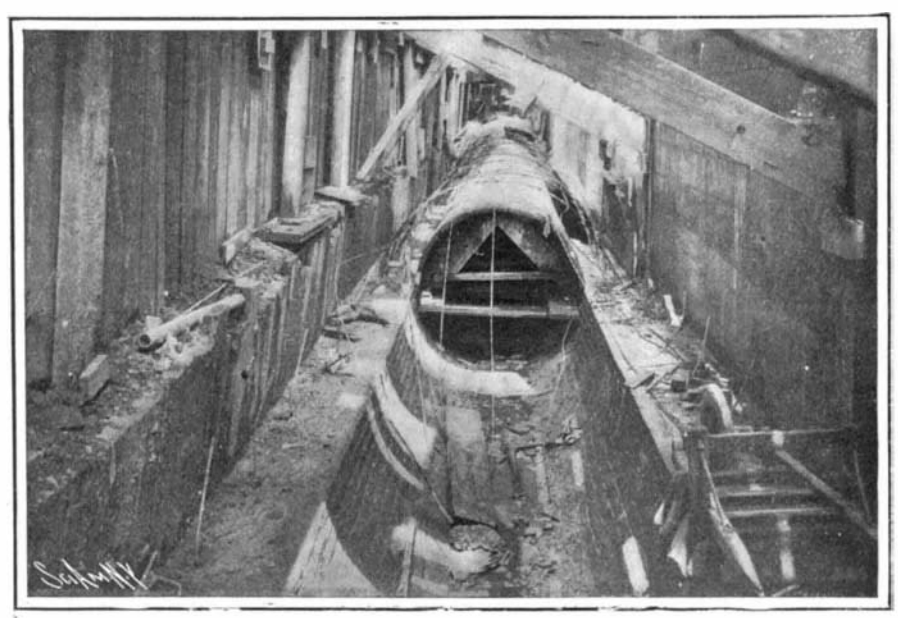
The subway scheme in Philadel-



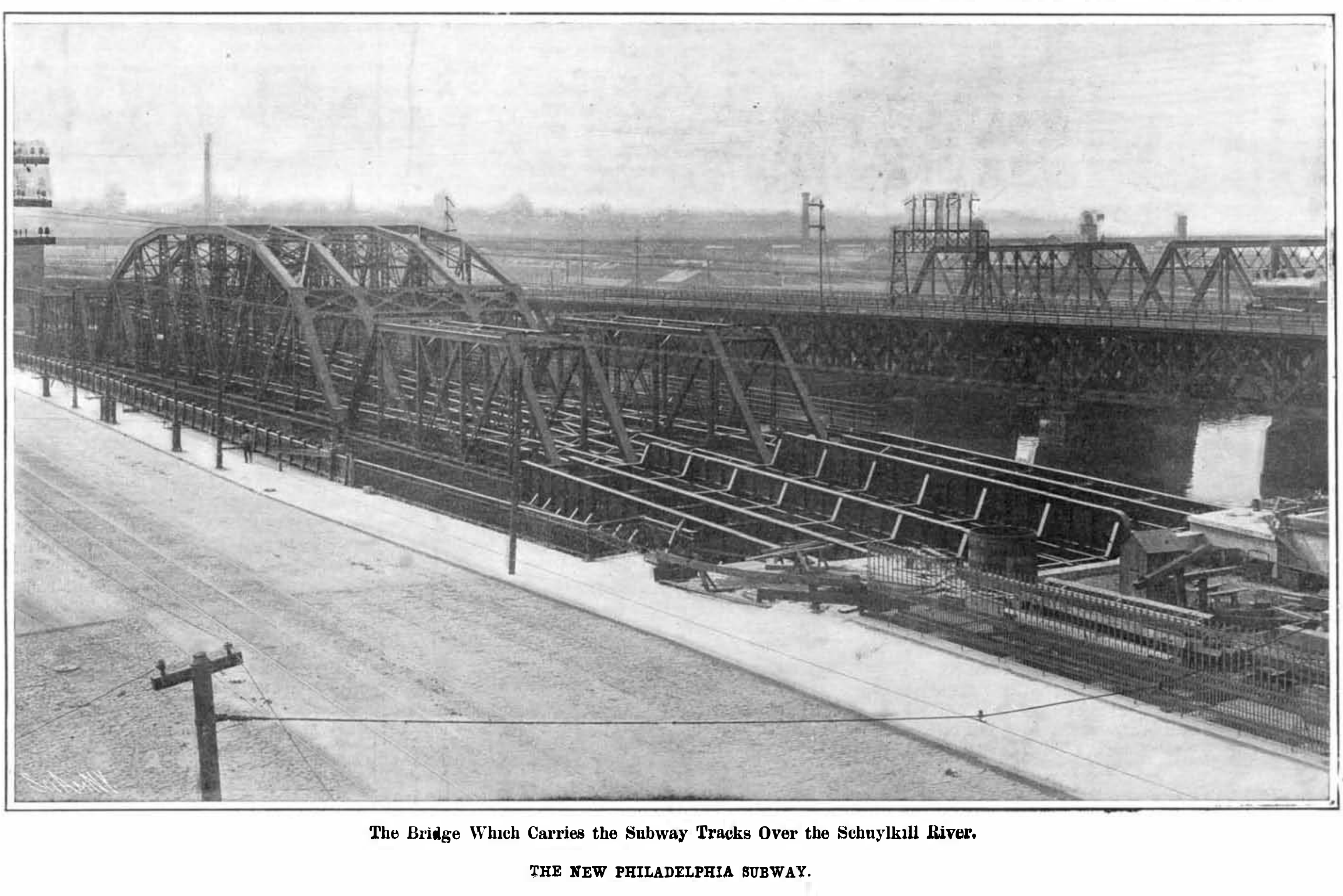
The New Philadelphia Subway Under Market Street Looking Toward the Portal.



The West Philadelphia Elevated Structure in Process of Erection.



Construction Work on the Line of the Philadelphia Subway.



The Bridge Which Carries the Subway Tracks Over the Schuylkill River.

THE NEW PHILADELPHIA SUBWAY.

phia involves, in outline, a tunnel under Market Street from river to river, encircling the city hall; an inclined bridge over the Schuylkill River, and an elevated road to the city line in West Philadelphia. In addition, an elevated road is projected on Delaware Avenue from South to Market Streets; and a subway under Broad Street. All the plans have been made by local engineers, and the work is directed by William S. Twining, as chief engineer; Charles M. Mills, first assistant general engineer of the subway and elevated road construction, and by Frank L. Fisher, engineer of subway construction. The total outlay involved is estimated at twelve million dollars.

Work on the subway was begun April, 1903. For the first twelve months progress was slow, as all the material had to be assembled, and the men instructed in their work. The portion of the operation first instituted—that on Market Street east from the Schuylkill to the city hall—presented no uncommonly difficult engineering problems. There were the usual pipes, sewers, and many other obstructions to contend with. The conditions imposed by the city ordinance that the streets be kept open for traffic were faithfully observed. The earth has been taken out of the north side, without disturbing the street surface. The method employed has been to brace the roof of the excavation, temporarily, with timbers and planking, digging in and upward till the rails on which the surface street car tracks rest were reached. The ironwork and concrete to form the permanent roof of the tunnel at from four to six feet below the surface were put in. Then the dirt was put back, and washed into place with water.

Cast-iron tubes are used in the Glasgow district railway tunnels and in the London underground. The masonry arch was adopted by that model of construction, the Chemin de Fer de Sceaux of Paris. In both Boston and New York, the subway engineers united the best qualities of the foreign construction in the combined masonry and steelwork type. This style of structure has also been adopted by the engineers of the Philadelphia subway.

The general plan of construction in Philadelphia is a four-track, concrete-lined tunnel with the four tracks on one level. It is a roomy structure 14½ feet high, 48½ feet wide, with slightly sloping roof.

In the Philadelphia work, the framework is formed of steel posts set 5 to 5½ feet apart at each side, with steel roof beams across the top. The roof beams extend 16 inches into the sides, being held in place by the concrete of the side walls. The roof and floor are also of concrete, the latter from 1½ to 2 feet in thickness. The side walls, which are 3 feet 5½ inches thick, are reinforced by vertical and horizontal rods and waterproofed by Cerion waterproofing on layers of burlap, finished by 8 inches of concrete. The roof is waterproofed with asphalt mastic covered for protection with 3 inches of concrete. The south wall carries terra-cotta ducts for city pipes.

The roof beams were made in three sections. The sections at either side are the width of one track span, and the center section the width of the two center track spans. When the excavation was completed, the center line of columns was erected, the roof beams were riveted to them and spliced together; then the concrete of the roof was added.

Ventilation chambers have been built in the side walls, in which fans may be installed if necessary. A special ventilating plant has been constructed at Twenty-second Street to relieve the subway of the noxious gases from the large city gas tanks at this point. This chamber has an opening 7 feet by 18½ feet, and is connected by a horizontal duct 8 feet square with a stack 60 feet high.

Drainage facilities are supplied by lines of 12-inch terra-cotta pipe under each track with sumps at regular intervals, the water being carried to a sump at Twenty-second Street, whence it is pumped into city sewers.

The most interesting feature of the new transit enterprise is the plan for crossing the Schuylkill. Instead of tunneling under the river, as has been done at Liverpool, New York, and Boston; or building an elevated superstructure over the present Market Street bridge, which was found unequal to sustain the burden that would have been imposed, the Philadelphia engineers determined to build, at a cost of over one million dollars, a new iron extension spanning the Schuylkill. Incidentally this has left the present bridge free for surface cars, and it has facilitated rapid transit. The center line of the new bridge is just 100 feet north of the central line of the municipal bridge. To reach it, the tunnel deflects to the north on reverse transition curves from a point 47 feet west of Twenty-second Street.

By this arrangement, a large amount of filling was made necessary and undertaken by the city, in the vicinity of Twenty-third and Market Streets, using the subway excavation material. A great change has been effected by the grading thus accomplished on the north side of Market Street, on the east bank of the Schuylkill. A new plaza has been created, with an iron railing, providing a vantage point from which passersby may overlook the traffic at the west portal of the subway.

Emerging from the tunnel at this point, the express trains gain grade with sufficient rapidity on the inclined bridge by which they cross the river to bring them out above the surface at the other side. From that point westward they are elevated. The other two tracks rise to the surface only when they cross the river, and will then follow the surface lines as at present.

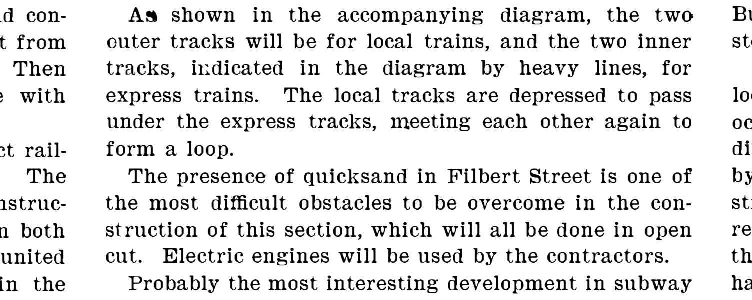
In the construction of the subway, every precaution has been taken to insure the safety of the heavy walls of the Broad Street station train-shed. They have been carefully shored as the work progressed, and despite the wet weather they have remained intact.

The building of the subway about the city hall involved considerable fine engineering and heavy expense. It is expected that three million dollars will be spent. The plans provide for a double-deck two-tracked tunnel that will form a loop about the municipal buildings. The base of the lower tunnel is placed more than 40 feet below the surface of the street. The lower tunnel will be used for the proposed Broad Street subway, and the upper one for Market Street.

As shown in the accompanying diagram, the two outer tracks will be for local trains, and the two inner tracks, indicated in the diagram by heavy lines, for express trains. The local tracks are depressed to pass under the express tracks, meeting each other again to form a loop.

The presence of quicksand in Filbert Street is one of the most difficult obstacles to be overcome in the construction of this section, which will all be done in open cut. Electric engines will be used by the contractors.

Probably the most interesting development in subway construction which the Philadelphia operation will display will be seen in the stations, especially in that at the new Wanamaker store, Market Street and Thirteenth. None like it has hitherto been conceived. Practically the whole Market Street frontage from Juniper to Thirteenth Streets has been given up to it. The station is 350 feet in length. It will be built of reinforced concrete, finished in white tile, with ample heat, light, and ventilating apparatus. There will be cross tunnels beneath, and underground entrances to adjoining mercantile establishments. The plans for the station include show windows 30 feet underground, which will be used by enterprising merchants to display their wares.



SECTION OF PHILADELPHIA SUBWAY AT THE FIFTEENTH STREET STATION.

To supply the requisite power for the operation of the new transit system has made necessary the construction of a great power house, one of the largest ever erected. The building, which is located at Delaware Avenue and Poplar Street, is 200 x 102 feet and three stories high, of stone and brick with steel frame. A battery of thirty-two boilers will be installed, and power will be supplied to the congested district as well as to the subway and elevated line. The cost of the structure and equipment is estimated at $1,500,000.

Taken altogether, when the present comprehensive projects shall have been completed, it is evident that Philadelphia will have made a good beginning in provisions for modern rapid-transit facilities.

Erratum.

In our issue of December 2, 1905, there appeared on page 438 an article by Dr. Myron Metzenbaum, on "Some Effects of Alternating Currents on Dogs," in which it was suggested that workers exposed to the danger of strong currents should wear a corset made of some non-conducting material, such as rubber. This is an error. What Dr. Metzenbaum meant was that they should wear corsets made of some conducting material, such as copper.

A writer in Power states that if there is any place on the ordinary steam engine where the ignorant factor of safety is overdone—surplus iron and strength—it is in the pillow-blocks and never in the flywheel, as it costs much money to get it in the latter place, and little or none to get it in the former. Consequently America is suffering by the continual wreckage of flywheels. Most of the wrecks of the above character are of wheels operated by single or tandem engines.

The Largest Private Electric Plant in the World.

There is at present nearing completion in New York city the largest strictly private electrical plant in the world. This plant, situated in the basement of the Mutual Life Building, and designed to furnish light and power to the entire city square occupied by the company and its tenants, consists of four 600 horse-power Watts-Campbell Corliss engines and four 350-kilowatt 110-volt generators. The engines and generators are joined by marine couplings, the only strain on which is torsional, the shaft being supported on bearings. Each armature and flywheel also rests on its own shaft supported between two bearings. This arrangement allows of disassembling any engines or generators without in any way interfering with the other portions of the unit. The engines are of the Tangye or heavy "rolling-mill frame" type, supplied with Corliss valve-gear. The generators are supplied with a special feature in the form of an automatic brush-shifting device which moves the brushes back and forth across the face of the commutator, thus eliminating the possibility of wearing ridges. This plant is designed to replace the old Mutual Life equipment of four 100 kilowatt Siemens & Halske generators, direct coupled to straight-line engines, which equipment is destined for the company's Broadway building. The work of installation began about a year ago with the removal of the old boilers, originally supplying steam to the Mutual Life Buildings. The present boilers are designed to furnish steam at 300 pounds pressure, if necessary.

The foundations had to be specially constructed, the location of the new units being limited to the space occupied as a court between the various buildings. The difficulty of constructing the foundations was enhanced by the fact that the concrete slabs, supporting the structural steel columns of the buildings' framework, rested on sand which had to be excavated from between the columns with the greatest care. A sufficient space having been cleared out, beams were laid down to form a closely-bolted network, concrete was poured on and about them to fill in the entire excavation, and the various units of the plant were bolted securely to this firmly knit mass. The plant is designed to operate 20,000 incandescent lamps, ten or twelve electric elevators, eight motors of from 2 to 6 horse-power, including an electric pump, and six blowers, with fans ranging from 36 to 60 inches diameter. Two of the units are now successfully operating, and it is planned to have the other two at work in a short time.

That the size of warships is rapidly increasing is common knowledge, but the extent of the average increase is by no means so well known. The number of warships of 12,000 tons displacement or over built and building for the several naval powers July 1, 1899, was 77, of which 46, or 60 per cent, belonged to the English navy. In 1900 the number was 94 (British 48, or 51 per cent); in 1902 there were 101 (British 53, or 52 per cent); in 1903, 139 (British 64, or 46 per cent); in 1904, 155 (British 70, or 45 per cent.); in 1905, 153 (British still 70, or 47 per cent). It will be noted that the falling off this year was due to the loss of a number of Russian ships. The number owned by the United States increased from 9 in 1899 to 14 in 1902, 23 in 1903, 26 in 1904 and 28 in 1905. In the last year France is credited with 15, Italy with 11, Germany and Japan with 10 each and Russia with 9. In this connection it might be remarked that the average displacement of all warships, excluding torpedo craft, has increased successively from 3,883 tons in 1899 to 4,131 in 1900, 4,416 in 1902, 4,725 in 1903, 5,010 in 1904, and 5,739 in 1905. This shows an increase of 48 per cent in six years, which is accounted for partly by an increased size of warships built and partly by the "scrapping" of old style ships, usually of small size. By this latter process England has brought her average displacement in the last year from 6,293 tons to 9,073 tons.—Iron Age.

The Year's Nobel Prizes.

The Nobel prizes were distributed on December 10 by King Oscar of Sweden. The recipients were:

In physics, Prof. Lenard, of Kiel University, for researches into cathode rays; in chemistry, Adolph von Böyer, professor at the University of Munich, for researches relating to the evolution of organic chemistry and the development of the chemical industry; in medicine, Prof. Robert Koch, of Berlin, for researches looking to the prevention of tuberculosis; and in literature, Henryk Sienkiewicz, the Polish novelist. Baroness von Sutter, of Austria, was adjudged the winner of the Nobel Peace Prize. The Baroness for many years has been prominent in international movements looking to the peace of the world. She was one of the Austrian delegates to the International Peace Congress held at Boston last year.

Continued prosperity in the United States is having a marked effect on immigration. For the year ending June 30, 1905, the total was 1,027,421—the first year in which a full million was exceeded.