

MOTORS FOR THE NEW YORK CITY SUBWAY.

The Interborough Rapid Transit Company, more popularly known as the New York Subway, will operate two classes of train service. The first will consist of five-car local trains, composed of three motor cars and two trailers, making an average speed of approximately 16 miles per hour. The second will be eight-car express trains, comprising five motor cars and three trailers, making an average speed of 25 miles or more per hour. The same motors and gearing will be used for both classes of service. The motors, which are to be supplied by the Westinghouse Electric and Manufacturing Company, were designed especially for this purpose, and were made to fit the particular conditions and requirements involved. One of these requirements, and perhaps the most difficult, made necessary the designing of a motor of large capacity to fit into a limited space. As a result, the present motors are probably of smaller size for their output than any built heretofore.

The nominal capacity of the motor is 300 amperes at 570 volts, or 200 horse-power, for one hour. With this current and voltage, a tractive effort of 4,150 pounds is developed at the periphery of a 33-inch wheel, at a speed of 19 miles per hour. Although designed for an average voltage of 570, the motor will operate satisfactorily with voltages up to 625. It will carry loads up to 500 amperes without injurious sparking.

The motor has a field frame of cast steel, divided into halves on the line of the centers of armature and axle, and completely surrounding the axle. There are thus no separate axle bearing caps, and the number of pieces is consequently reduced to the least number possible for an easily accessible motor. The top half of the field can be readily lifted off, and access gained to the interior for inspection and repairs.

The four pole-pieces are made of laminated steel punchings held between heavy end plates and secured by rivets. The field coils are made of copper strap wound on edge. The insulation between turns consists of asbestos and mica, held in place by shellac and baked at a high temperature under heavy pressure, so that the coil and insulation make a solid mass. The completed coil is sealed in a curved metal case, from which it is insulated by molded mica made like the V-rings of a commutator. This construction gives a coil which is absolutely fireproof, moisture-proof, and practically indestructible.

The armature is 20 inches in diameter and weighs 1,930 pounds. It is of the slotted drum type, and is composed of sheet-steel punchings assembled on a cast-iron spider. The commutator is also carried on the same spider, and the shaft may thus be removed and replaced, should this ever become necessary, without disturbing the armature winding or its connection to the commutator. The winding itself is of the two-circuit type, and is of ventilated construction. There are 53 slots and 159 coils, i. e., three coils per slot. Each coil consists of a single turn of copper strap. The coils are held in the slots by wedges of special unshrinkable material, which will withstand a high degree of heat without injury. This is a valuable feature, and gives a construction which is stronger and safer than the use of bands. It also greatly facilitates the removal and replacing of the armature coils. The armature insulation consists essentially of mica, which extends between turns at all points. The mica is protected by a sufficient amount of fibrous material to insure against deterioration due to mechanical vibration. This fibrous material is treated with a moisture and oil proof compound, forming an insulation capable of withstanding very high temperature without injury. The commutator is composed of 159 rolled and hard-drawn copper bars, held in place by two steel V-shape rings, one of which serves as an oil guard to thoroughly protect the mica from oil or grease. A low voltage between the commutator bars is secured, decreasing the liability of flashing from any cause. The bars are insulated from each other by sheets of mica of a hardness that insures its wearing at the same rate as copper. The mica separating the bars from the rings is 1-16 inch thick, and the mica ring also separates the bars from the commutator spider. The wearing surface of the commutator is 16 3/4 inches in diameter and 9 3/8 inches long. The bars are of a depth which allows a reduction in diameter of 2 inches.

The brush holders consist of two cast-brass arms, each carrying three carbon brushes 3/8-inch by 3 inches in section. The brushes slide over finished surfaces, and each is pressed on the commutator by a spring

finger. The tension of these fingers is readily adjustable, and the brush holder arm is arranged for radial adjustment to allow for wear of the commutator. Copper clips are bolted to the carbon, and these clips are connected by flexible shunts, of ample capacity, to the body of the brush holder, thus relieving the springs from carrying the current.

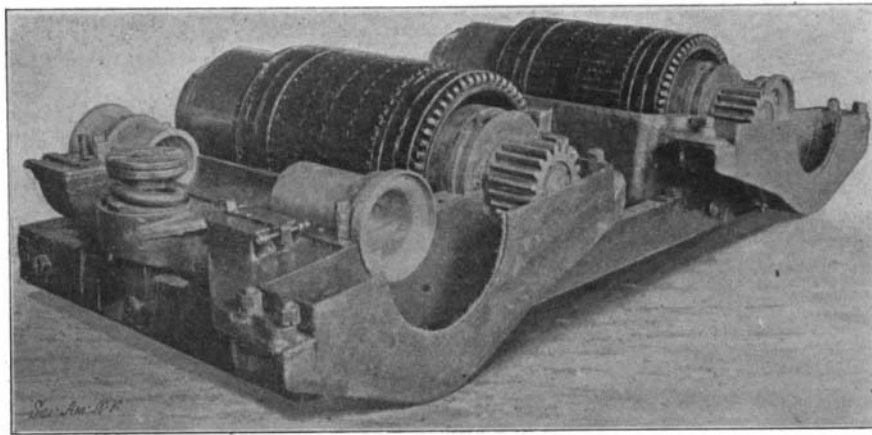
The completed motor will stand an insulation test between winding and motor frame of 4,500 volts alternating momentarily, or a test of 3,000 volts for one minute.

The armature bearings are contained in housings which are securely held between the halves of the field frame. These and the axle bearings are lubricated by oil fed to the journals by waste, in accordance with standard railway practice. The oil boxes are formed so that the waste will pack itself against the journals.

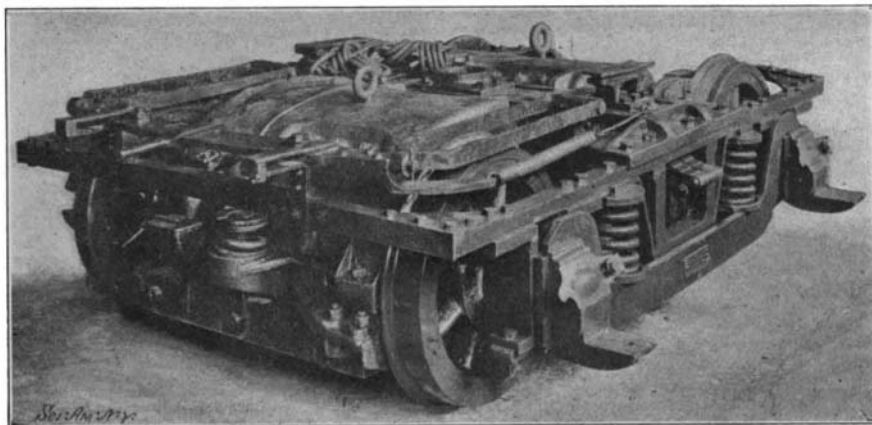
The gears are solid, of cast steel, with cut teeth. The pinions are forged steel with cut teeth. The gear case is made of malleable iron planed to a tight joint, with a suitable opening at top having a hinged cover. It is supported at the ends by horns cast on the motor frame and so shaped that they support the gear case without side strain, the weight being carried in its own place. The whole motor can be dismantled with great ease and dispatch without the use of any special tools. Its total weight including gear, gear case, etc., is about 6,600 pounds.

The Current Supplement.

The current SUPPLEMENT, No. 1426, opens with an



MOTORS FOR NEW YORK SUBWAY. UPPER HALF FIELDS REMOVED.



NEW YORK SUBWAY MOTORS MOUNTED ON TRUCK.

instructive article on the great viaduct at Fort Dodge, Iowa. Several excellent illustrations accompany the article. Our Consul-General at Berlin gives a very valuable account of lignite, peat, and coal-dust fuel in Germany. Another technological article on a somewhat allied subject treats of the value of rational methods in coke production. Emile Guarini continues his lucid exposition of the development of the Marconi system of wireless telegraphy. Prof. W. Smart discusses industrial trusts. A readable description of Japanese lacquer and of its preparation and application is presented by Randolph I. Geare. Among the many things taught by the Correspondence Schools at Scranton is the method of instructing railroad men in the use of the air-brake. An article on the instruction given is published, together with some helpful pictures. Prof. A. W. Bickerton, whose letters on Star Explosions published in the SCIENTIFIC AMERICAN are doubtless remembered by our readers, outlines an original theory of cosmic evolution. Prof. John H. Poynting, well known to physicists the world over, tells of some recent studies in gravitation.

A Proposed Alliance of Astronomers.

In a pamphlet entitled "The Endowment of Astronomical Research," Prof. Pickering, of the Harvard Astronomical Observatory, proposes a combination of the world's observatories on a trust basis. He believes that by such a combination it will be possible to utilize existing astronomical stations to the utmost capacity.

Prof. Pickering shows that the astronomical industry is by no means as unimportant as one might sup-

pose. The observatories of the world represent an investment of more than ten million dollars. Their expenditures, moreover, are large. The money spent varies from a few thousands to \$85,000 per year.

The great observatories have so far shown a singular incapacity for concentrated effort. In 1891 fifty observatories agreed to watch the opposition of the planet Eros. But so far as is known, only two or three of them have made the reductions needful to give value to their observations. Sometimes it has happened that a great observatory has not been adequately equipped with a telescope; sometimes a great telescope stood ready for use, but no astronomer was at hand to use it; sometimes the collected observations of a famous astronomer have lain unpublished for years for want of a few hundred dollars.

Prof. Pickering has suggested the appointment of an advisory board of leading astronomers of the United States, who would meet at regular intervals for the purpose of considering how resources may be expended in order to receive the maximum scientific return. Details of organization are also outlined.

THE LATEST ATLANTIC LINER, "KAISER WILHELM II."

If we consider her great size, unprecedented power, and the exceptional beauty of the boat, both within and without, it must be admitted that there was never a great transatlantic liner slipped into the port of New York at the close of her maiden voyage so modestly, or made fast at her dock so quietly as the new "Kaiser Wilhelm II." Ships that are notable are put afloat in these days in such rapid succession, that it takes a very big or a very fast boat to be entitled to special notice. Of the recent great liners there have been the "Oceanic," 705 feet over all, the longest ship afloat since the "Great Eastern;" the "Deutschland," with her average Sandy Hook-Plymouth speed of 23.5 knots an hour, the fastest of the great liners; the "Celtic" and "Cedric," each 700 feet long and 75 feet beam, and over 37,000 tons maximum displacement, dimensions which entitle them to be called the widest and largest ships afloat. Then a couple of weeks ago we chronicled the launch of the "Minnesota," which, with her molded depth of 56 feet, is the deepest ship in the world, her displacement being somewhat less than that of the "Cedric" and "Celtic."

The "Kaiser Wilhelm II.," the latest of these big liners, 706.5 feet in length over all, is remarkable as being the longest ship in the world, and also the ship having the greatest horse power, the contract requirement being that she should indicate 40,000 horse power, which is 7,000 more than the stipulated horse power of the "Deutschland." The complete dimensions of the new boat are, length 706 feet, 6 inches; beam, 72 feet; molded depth, 52 feet, 6 inches; load draft, 29 feet; and displacement, about 26,000 tons. The double bottom, which extends the full length of the ship, is divided into twenty-six compartments, while the hull itself is divided into nineteen watertight compartments. There are seven decks, known respectively as the orlop, lower, main, upper, lower promenade deck, upper promenade deck, and awning or boat deck. The vessel thus carries one more deck than is common in large passenger ships of her type, her predecessors having only one instead of two promenade decks; and by the way, these two decks are truly magnificent in their clear, unobstructed sweep from the bridge to within a short distance of the taffrail. To those passengers who spend most of their time on deck, and much of it in a steamer chair, the doubling of the promenade deck accommodation will be a positive boon. In her general appearance the new ship shows the characteristic features of the German boats that have come from the Stettin yard. She has the same pronounced sheer and perceptible lift of the sheer line toward the stern, and she carries the usual four funnels, although there is an innovation in the fact that she has three masts, placed somewhat the same as in the "Oceanic." As a result of the great height of the upper works of the "Kaiser Wilhelm," she does not look to be as long as she actually is. The best impression of her size is gained when standing on the captain's bridge or on the second bridge astern at a height of between 60 and 70 feet above the water, and letting the eye range up and down the full 706 feet length of the vessel.

The passenger accommodation includes 290 first-class cabins and 107 second-class, and one of the "show" features of the ship is her two imperial suites, each of which includes a dining-room, drawing-room, bedroom, and bathroom, all most daintily and tastefully