possible with the latter. The average speed of the suburban train is very largely a question of rapidity of starting and stopping. In regard to quick stops, of course, the steam and electric service are on the same basis, although the introduction of the magnetic brake, which is being applied so successfully in the street car service, would place an electrically-operated system at a great advantage, even in respect of rapidity of stopping. It is in the relatively slow acceleration that a steam suburban service is handicapped as compared with one operated electrically.

With a view to handling its suburban trains with greater despatch, the New York Central Railroad Company has brought out a suburban locomotive of great size and power, of which we herewith present an illustration. The first of this class was built by the American Locomotive Company several months ago, and the service which it gave was so satisfactory that a later order was given for fifteen additional locomotives of the same type. As will be seen from the illustration, the locomotive is carried on no less than fourteen wheels, consisting of a pony truck, six coupled drivers and a six-wheeled truck beneath the tender, the latter being carried on the same frame with the boiler and engines. The barrel of the boiler, which is of the straight, wide firebox type, is 70 inches in diameter. The firebox is 93 inches in length, 97⅞ inches in width, and 67 inches in depth at the front end and 53½ inches at the back. There are 365 2-inch tubes which have a total length over tube sheets of 12 feet. There are 2,275 square feet of heating surface in the tubes, and 162 square feet in the firebox, making a total heating surface of 2,437 square feet, while there are 62 square feet of grate surface. The steam pressure is 200 pounds to the square inch.

The cylinders are 20 inches in diameter by 24 inches stroke, and the driving wheels are 63 inches in diameter. The slide valves are of the piston type, with inside admission and 5½ inches travel when in full gear. The engine frames are narrowed down to plate form where they extend under and support the tank.

The weight of this fine engine in working order is 216,000 pounds, of which 128,000 pounds is on the driving wheels. The tender has a capacity of 3,700 gallons of water and 5 tons of coal. These are considerably the heaviest and most powerful engines ever made for suburban service for this or any other country.

The fifty-first meeting of the American Association for the Advancement of Science will this year be held at Pittsburg, Pa., from June 8 to July 3. Mr. Stewart Culin, of the University of Pennsylvania, will preside over the section of Anthropology

THE GROWTH OF THE TRANSATLANTIC STEAMSHIP.

On July 4, in the year 1840, a little wooden sidewheel steamer cast loose from her dock at Liverpool and fourteen days and eight hours later steamed into Boston Harbor, amid the acclamations of the assembled citizens and every manifestation of civic pride and rejoicing. The little craft was the "Britannia," the first of the since-famous Cunard line, and the first steamer to sail under regular government contract for the conveyance of the transatlantic mails. In the accompanying very interesting diagram, showing the growth in size of the transatlantic mail steamship, we have commenced with the "Britannia" for the reason that although she was not, by any means, the first steamship to cross the Atlantic, she was the first to do so on a regular schedule. The Cunard Company continued for many decades to be the most prominent of the transatlantic steamship companies, and the successive vessels put afloat by this company are representative of the development of the steamship. The first seven of the vessels shown in our diagrams, therefore, are chosen from the records of the Cunard Company.

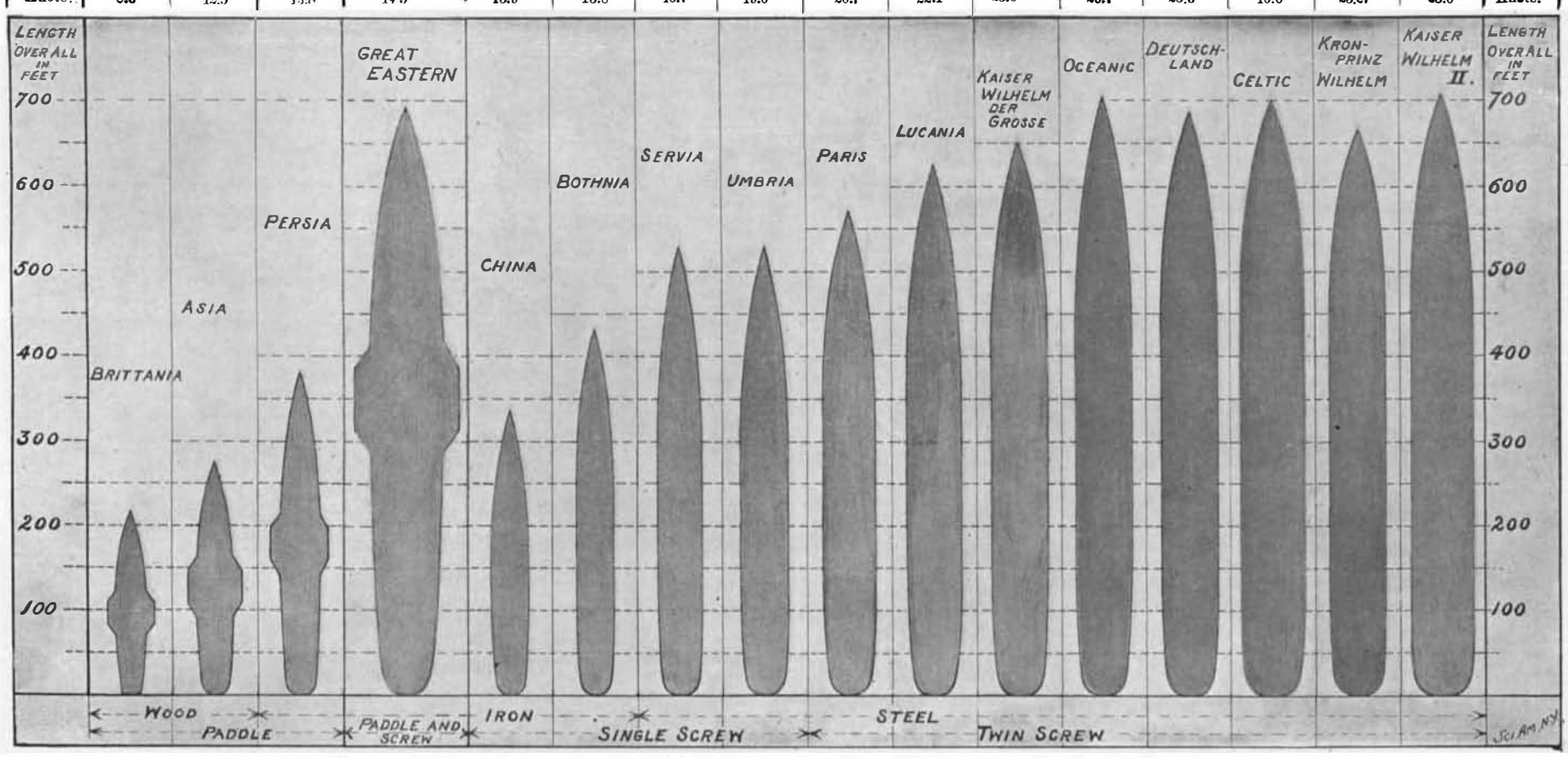
The "Umbria" was the last, largest and fastest of the single-screw vessels, and it was not until the "New York" and the "Paris" of the Inman and International Company were built, that the twin-screw steamer made its appearance on the transatlantic route. After this time the credit of producing the notable steamships of the world is jointly due to the Cunard Company, the White Star, and the two great German companies, the Hamburg-American and North German Lloyd.

The "Britannia," as we have said, was a wooden sidewheel steamer. Her length over all was 215 feet; her beam 34 feet 4 inches; her molded depth 24 feet 4 inches, and her displacement 1731 tons. Her engines of 740-horse power gave her an average sea speed of 8.5 knots an hour. She was one of four sister ships which were built under a seven years' contract with the government, by which the company was to provide four steamers and despatch one of them from Liverpool for Halifax and Boston on the 4th and 19th of every month from March to October, and on the 4th of each of the four winter months. For this they were to receive a subsidy of $400,000 per year. During the ten years from 1840 to 1850 the company added six additional wooden paddle-steamers to their fleet on the Atlantic and had a practical monopoly of the trade; but the formation of the United States Collins line introduced an element of fierce competition, to meet which two larger and faster boats, the "Asia" and the "Africa," were built. They were 275 feet long over all, 40 feet beam, 27 feet 2 inches molded depth and displaced 3,340 tons With 2,400 horse power they maintained an average speed of 12.5 knots an hour across the Atlantic. Seven years previous to this the great Brunel had built the first iron steamship, "Britannia," and the success of this vessel induced the company to build their next mail ship, "Persia," of the same material. Launched in 1855, the "Persia" was a great advance in size and power on all previous vessels. She was 385 feet on deck, 45 feet 3 inches in beam, 31 feet 6 inches in molded depth, and her displacement was just under 5,000 tons. With 4,000 horse power she maintained an average speed for the whole passage of 13.8 knots an hour. The "Persia" and her sister ship, the "Scotia," were the last of the big sidewheelers.

We have introduced into our diagram a phenomenal vessel which, strictly speaking, should not have any place in the history of the development of the transatlantic mail steamer, for the reason that she was never run on any regular schedule under a government contract. We refer to the "Great Eastern," and she is shown in our diagram to emphasize the fact that she was fifty years ahead of her time and, in fact, anticipated in point of size such vessels as the modern "Oceanic" and "Celtic." The "Great Eastern" was a splendidly-built ship, and cost no less than $3,650,000. She was 692 feet long on deck; 118 feet broad over the paddle-boxes; her beam was 83 feet; her depth 58 feet, and her displacement about 28,000 tons on the draft on which she was ordinarily run, although on a draft of 30 feet she would have displaced 32,160 tons. She was driven both by paddle wheels and by screw propellers. Her paddle wheels were enormous affairs, 56 feet in diameter; they were driven by a pair of two-cylinder, oscillating engines of 14 feet stroke. The screw propeller was driven by horizontal engines, and the combined indicated horse power of all engines was 8,000. Her maiden trip was made from Southampton to New York, in 1860. The highest speed during the trip was 14½ knots an hour, and the longest day's run 333 miles. Although she was a failure commercially, she proved invaluable by successfully laying the first Atlantic cable in the year 1866. She laid two more Atlantic cables in 1873 and 1874, and finally, in 1888, she was sold and broken up at Liverpool.

For several years the Inman line, now the American line, had been using the screw in place of the paddle-wheel, with very satisfactory results, and consequently the next vessel built by the Cunard Company, the "China," was of the screw-propeller type. She was considerably smaller than the "Persia," as the dimensions show, and her speed was about the same. It was about this time that the compound engine with its higher steam pressure and superior economy began to make its appearance. Simultaneously came in that era of long and narrow ships which was destined to

Date.....	1840	1850	1855	1858	1862	1874	1881	1884	1889	1893	1897	1899	1900	1901	1901	1903	Date
Length on Deck...	215′	275	385′	692′	337′	435′	530′	525′	560′	620′	649′	705′	686′	700′	663′	707′	Length on Deck.
Beam ..	34′ 4″	40′	45′ 3″	83′	40′ 5½″	42′ 3″	52′ 3″	57′ 3″	63′	65′ 3′	66′	68′	67′	75′	66′	72′	Beam.
Moulded Depth .	24′ 4″	27′ 2″	31′ 6″	58′	29′	36′	40′ 9″	40′	42′	41′ 6″	43′	49′	44′	49′	43′	43′	Moulded Depth.
Displacement in Tons.	1,731	3,340	4,950	28,000	3,808	6,834	11.088	12,190	15,000	19,425	21,000	32,500	23,500	37,700	21,300	27.000	Displacement in Tons.
Indicated H. P...	740	2,400	4,000	8,000	2,250	3,250	9,900	14,500	20,000	30,000	31,000	28.000	37,500	14,000	37,000	38,000*	Indicated H. P.
Speed in Knots.	8.5	12.5	13.8	14 5	13.9	13.8	16.7	19.6	20.7	22.1	23.0	20.7	23.5	16.0	23.27	23.0*	Speed in Knots.



* This is the contract horse power and speed; likely, as in the "Kronprinz Wilhelm," to be greatly exceeded when the ship is in service.

GROWTH OF THE TRANSATLANTIC STEAMSHIP FROM 1840 TO 1903.

play such an important part in the history of the steamship. The "Bothnia," built in 1874, was a compound, single-screw vessel which may be taken as thoroughly typical of the fashion of the day; with a length of 435 feet, her beam was only 42 feet 2 inches, giving a ratio of length to beam of nearly 1 to 10. She was 36 feet in molded depth and of 6,834 tons displacement. Her speed, however, was only 13.8 knots an hour, or the same as that of the old paddle-steamer "Asia" of nearly twenty years earlier date.

Between the "Bothnia" and the "Servia" the development of the steamship passed through perhaps its most important stage; for, with the introduction of the Bessemer process of steel manufacture, it became possible to turn out steel which possessed the necessary qualities for shipbuilding and was at the same time moderate in price. The first steel steamer built for the Cunard Company and the largest and most powerful ship (except the "Great Eastern") ever constructed up to this time, was the "Servia," which took her place on the Atlantic in 1881. This vessel was the wonder of her day. She was 530 feet long on deck; 52 feet 3 inches in beam; 40 feet 9 inches in depth, and she had the great displacement of 11,088 tons. With her three-cylinder, compound engines of 9,900 horse power, she maintained an average speed of 16.7 knots an hour across the Atlantic. The last and most famous of the single-screw steamships were the "Umbria" and "Etruria" of the same company. In these vessels we see a return to a more moderate proportion of beam to length. With 5 feet more beam the "Umbria" was 5 feet shorter over all than the "Servia" and her molded depth was about 9 inches less. Her displacement was 12,190 tons. Her engines, the largest single-screw engines ever put into a steamship, indicated 14,500 horse power. She maintained a speed of 19.6 knots an hour for the whole trip across the Atlantic. The "Umbria" was the first transatlantic steamship to make the trip in less than six days. In July, 1892, she covered the distance in five days, twenty-two hours and seven minutes, at an average speed of 19.6 knots an hour.

To the Inman and International line belongs the credit of producing the first twin-screw transatlantic steamers, the "City of Paris" and the "City of New York." These ships are 560 feet in length over all, 63 feet in beam, 42 feet in depth and the displacement is 15,000 tons. The twin-screw, triple-expansion engines have each indicated as high as 10,000 horse power, making a total of 20,000, and the "City of Paris" has the credit of making the trip across at an average speed of 20.7 knots an hour. These magnificent ships introduced many new features, one being their great breadth in proportion to their length and another the remarkably handsome dining saloon placed forward of the engines. They now belong to the American line, and have been changed by the substitution of quadruple-expansion for triple-expansion engines, with the result that the coal consumption has been reduced from 320 to 270 tons per day, the speed remaining about the same. In 1893 the Cunard Company again took the leading position with a pair of steamships which were the first to exceed 600 feet in length. The "Lucania" and "Campania" were designed to be considerably the fastest vessels afloat and to this end engines of 30,000 horse power were provided. From the very first they were a great success, and the "Lucania" was the first steamship to cross the Atlantic at a speed of over 22 knots an hour, her speed for the whole trip being 22.1 knots.

Five years later the North German Lloyd Company put in service a type of vessel which has been very closely followed by the German companies in the later ships which they have built. The "Kaiser Wilhelm der Grosse" was 649 feet long, 66 feet in beam, and 43 feet in depth. She was the first vessel to exceed 20,000 tons in displacement. Her horse power is greater than that of the "Lucania" and she has steadily added to her speed during the time she has been in service. Her fastest passage was made at an average speed of 23 knots an hour. She carries four smokestacks and presents an extremely handsome and rakish appearance. The four funnels are a feature which distinguishes the later German liners from those of other fleets. In 1899 the White Star line, whose vessels have always been justly famous for comfort and regularity, determined to build a first-class liner which should greatly exceed in size anything that had yet been constructed. On every point of comparison, except that of horse power and beam, the "Oceanic," as she is called, surpasses every previous vessel, not even excepting the "Great Eastern." She is 705 feet in length (the "Great Eastern" was several feet shorter than 700), 68 feet in beam; 49 feet in depth, and on her maximum designed draft of 35 feet she will displace 32,500 tons. She is thus, it will be seen, vastly greater than any previous vessel. With 28,000 horse power she has made an average speed for the whole trip of 20.7 knots an hour.

The next famous vessel, the "Deutschland," of the Hamburg-American line, was built at the Vulcan yard, Stettin, by the same firm that turned out the "Kaiser Wilhelm der Grosse." She is an enlarged and more powerful edition of that vessel. Her engines, designed to give 33,000 horse power, actually developed last year 37,500 horse power for a whole trip across the Atlantic, and on that occasion she maintained an average sea speed of 23.5 knots an hour. The next notable ship, the "Celtic," of the White Star line, is remarkable for her great bulk. She is of the combined passenger and freight type that is so popular and profitable in these days. Of about the same length and depth as the "Oceanic" she has the great beam of 75 feet, and with her fuller lines it is not surprising to learn that her displacement on her maximum draft of 36½ feet is 37,700 tons. She made her appearance early in 1901. In the fall of the same year the North German Lloyd Company dispatched on her maiden voyage the "Kronprinz Wilhelm," another product of the Stettin yard. She is intermediate in size between the "Kaiser Wilhelm der Grosse" and the "Deutschland," but resembles them greatly in other respects. Her contract horse power was 33,000, but she has actually developed 37,000 under favorable conditions. Her best average speed at the present writing is 23.27 knots an hour, but in view of her performance on several occasions, when the weather has been favorable, it is expected that she will about equal the speed of the "Deutschland" before the season of 1902 is over. There is now nearing completion at the Stettin yard, for the same company, a vessel which is to be the longest and fastest, though not the largest, in the world. She is known as the "Kaiser Wilhelm II.," and her dimensions are as follows: Length over all 707 feet, beam 72 feet, depth 43 feet, displacement 27,000 tons, and contract horse power 38,000. Judging from the excellent performance of the engines of the previous boats turned out by these builders, it is likely that the engines of the new "flier" will develop between 42,000 and 43,000 horse power and that her speed will reach the 24-knot mark.

An announcement has recently been made of the purpose of the Cunard Company to place two more liners on the Atlantic route which shall exceed, in speed at least, any previous vessels. The ships do not appear in our diagram for the reason that the details of length and size have not yet been determined upon. An interesting feature of these ships is that they will probably be equipped with turbine engines of from 47,000 to 50,000 horse power, and that the contract speed will be 24 knots an hour.

Summing up this brief review of the growth of the transatlantic ship during the past sixty-two years, we note that the length has gone up from 215 to 706 feet, the beam from 34 feet 4 inches to 75 feet, the depth from 24 feet 4 inches to 49 feet, and the displacement from 1,731 tons to 37,700 tons; while the horse power has increased from 740 to 37,000, or about fifty times, and the speed has been trebled. As to passenger accommodation the growth has been marvelous, for whereas the "Britannic" of 1840 could give indifferent accommodation to only 90 passengers, the "Celtic" can carry 3,194 souls, of whom 2,859 would be passengers.

America's Greeting to Lord Kelvin, the British Scientist.

Lord Kelvin and Lady Kelvin, who arrived in New York on the 19th ultimo, were tendered a reception at Columbia University on the evening of April 21 by Columbia University, the American Institute of Electrical Engineers, the American Association for the Advancement of Science, the American Physical Society, the American Mathematical Society, the Astronomical and Astrophysical Society of America and the New York Academy of Sciences, which was very largely attended. A most cordial feeling prevailed for Lord and Lady Kelvin who were the central figures of the evening, surrounded on the large platform by many prominent scientific men. Dr. Francis B. Crocker presided and introduced President Nicholas Murray Butler, the new president of Columbia University, who extended to Lord Kelvin an entertaining address of welcome. Prof. Elihu Thomson spoke of the remarkable clearness of Lord Kelvin's expositions of difficult electrical problems. He was easily understood because he fully understood the subjects he explained. He was the father of electrical engineers. He not only explained theories, but also designed apparatus to carry them into effect. His calculations were so accurate that he was able to predict in advance the kind of submarine cable that would be operative. His reflecting galvanometer, and later his simple but effective siphon-recorder for the recording of cable messages in ink were prominent examples of his inventive genius, which were now in use all over the globe. Having done so much in the promotion of cable telegraphy, it was fitting the invitation to attend the reception should have been sent to him one hundred miles out to sea by wireless telegraphy, the most modern form of communication, and that his acceptance should be returned in the same way.

Dr. Arthur Gordon Webster, for the American Physical Society, welcomed Lord Kelvin as one of the most advanced scientific thinkers. He possessed a trained imagination, which was of great assistance in evolving explanations of the problems he had to contend with. It was the moral and financial support of Cyrus W. Field, in the early days of the cable and cable construction, that became an incentive to Lord Kelvin to master the difficulties that were then presented.

It was Kelvin who predicted the possible conversion of the great power of Niagara into electrical energy. He was a man of singular activity in scientific investigation and was still busy in his laboratory when at home. He was most cordially welcomed, and the best wishes of all were extended to him.

Dr. Robert Simpson Woodward, in behalf of the American Association for the Advancement of Science and other scientific bodies, gave a brief address of welcome strongly eulogistic of Lord Kelvin's scientific attainments. Upon its conclusion, Lord Kelvin arose to respond and was given a rousing welcome by the whole great company of some two thousand rising and enthusiastically applauding for a few minutes. He said in part:

"I am not much of a speaker, but he would be poor in speech, indeed, who could not find words to thank you heartily for this splendid reception. This meeting is not only a meeting of welcome to a citizen of another country, but I may see it is a union of the sciences, and to scientific men such an occasion is always memorable.

"Some kindly references have been made by some of the speakers to the little I was permitted to do in connection with the laying of the Atlantic cable. That was a great work and a great monument to a great American. Others helped in the work, but Americans must never forget, as the world will never forget, the name of Cyrus W. Field." (The mention of his name caused great applause.)

Lord Kelvin then described the cable of 1858, which operated only for three weeks, the various disappointments that followed the final completion of the successful cable in 1865, of its breaking in two, and the difficulties encountered in grappling for it and its final repair, and how he acted as assistant electrician to Mr. Varley on board the "Great Eastern" in its completion. He then continued: "Science has advanced greatly during the years along all lines, and one of the greatest achievements is that of Marconi and wireless telegraphy. It is a great achievement to send a message inland from 100 miles out at sea, or for several hundred miles. The work that he has done indicates that the time will come when messages will be sped over the ocean without an intervening wire. But, my friends, we must not forget the great achievement which gave us sub-marine telegraphy, which will continue to serve us well even with wireless telegraphy as a commercial success.

"As I said before, Americans of all others, must not forget the work of Cyrus W. Field. I always got inspiration from the time I first came to America. The first time I landed on this continent was in 1866, and my landing was in Newfoundland. One might not believe it, but I got wonderful inspiration from Newfoundland. Ten years later, I came over to your Centennial Exposition and America had given to the world then a triumph of science in the telephone. I got inspiration on that visit from meeting and talking with Alexander Graham Bell.

"The next time I came was in 1884 and then I found the great achievement of Edison perfected, and New York as bright by night as by day through his invention." Great applause here interrupted the speaker, which did not subside until Mr. Edison rose and bowed his acknowledgments.

Lord Kelvin spoke finally of the inventions which made possible the transmission of power at high voltage and the harnessing of Niagara. Of this he said:

"Beautiful as that wonderful work of nature is, it would be more beautiful still if those waters fell upon turbine wheels every one of which was turning the wheels of industry."

After the address the audience walked across the stage and shook hands with Lord and Lady Kelvin.

An unusually interesting discovery has been made at Stanford Bishop, England. Dr. James Johnson, the eminent antiquarian, has found an old oak chair in the village church, which is said to be the most perfect example of ancient British carpentry extant. It is believed to have been used by St. Augustine at the synods held between A. D. 590 and 603. The chair is made entirely of oak, without any form of iron work. It is oblong in shape, the outside measurement being 32 inches in length and 22 inches in width. Four massive posts, with two boards on each side mortised into them, form the supports. The seat is 26 inches in length and 18 inches in width, and appears to have originally been 2 inches in thickness. It is movable like the lid of a box; the hinges being two round tenons inserted into mortise holes in the rear posts. The construction of the chair is similar in many respects to a Roman solium, or chair of authority.