SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico........ $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845)	$3.00	a year
Scientific American Supplement (Established 1876)	5.00	"
Scientific American Building Monthly (Established 1885)	2.50	"
Scientific American Export Edition (Established 1878)	3.00	"

The combined subscription rates and rates to foreign countries will be furnished upon application.

Remit by postal or express money order, or by bank draft or check.

MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, JUNE 21, 1902.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates

ANALYSIS OF THE RECENT AUTOMOBILE ENDURANCE TEST AND SPEED TRIALS.

The second endurance test of automobiles in America this year was held under the management of the Automobile Club of America on Decoration Day, and was in every way a success. The weather was fair, and the competitors were aided in their outward journey by a stiff breeze that blew all day from the southwest.

The first machine was sent over the starting line promptly at 9 A. M., and was followed at one-minute intervals by 54 other vehicles. Seventy-four machines had entered, but 19 failed to start. An examination of the Automobile Club's report of the run, which was compiled from the memoranda of the official observers, one of whom was placed on each vehicle, shows the following interesting facts: Of the 55 vehicles that actually started, 44, or 80 per cent, finished within the maximum time limit, which required them to make an average speed of at least 8 miles per hour. The minimum limit of 6 hours and 40 minutes for the course, which was equivalent to an average speed of 15 miles an hour, was not exceeded by any competitor, and there were consequently no disqualifications for racing, as in the previous Long Island test.

Only a little over one-quarter of the machines that started were of the steam type; all the others being gasoline, with the exception of one electric. Eighty-six and two-thirds per cent of the fifteen steam carriages that started finished, and 72 2-3 per cent finished without a penalized stop, while 3 steam Stanhopes, of a well-known make, equipped with condensers, repeated their performance on Long Island, covering the 100 miles without a single stop. The manufacturers of this vehicle seem to have thoroughly demonstrated that the use of a condenser on a steam carriage is entirely practicable, which results in making it possible for vehicles of the steam type to compete hereafter in the long-distance class.

The percentage of gasoline automobiles that finished was but $79\frac{1}{2}$ per cent, while only 43 per cent of those starting in this class finished without a stop. This low average of non-stop gasoline machines was caused, in some degree, by the presence among the contestants of several old or partly experimental vehicles that either did not get very far, or else succeeded in covering the entire course after many breakdowns and tedious waits for repairs. A German Benz machine built five or six years ago was started on a wager that it could not be made to run the 100 miles in 24 hours. The story of its trip is a most interesting recitation of the overcoming of difficulties and repairing of many breakdowns on the road. The vehicle finally arrived at its destination at 2 A. M. the following morning, thus winning the wager, to the great gratification of its plucky chauffeurs. One of the small American motorettes covered the last 80 miles of the journey on the low gear. The operator was forced to do this or else stop and adjust the high-speed clutch. He chose the former, and succeeded in finishing within the time limit, without making a stop. When it is understood that the small De Dion motor used was obliged to run steadily at a speed of 2,000 revolutions per minute for 8 consecutive hours, some idea can be formed of the strength and fine workmanship contained in this light weight bit of mechanism.

Another cause of the low percentage of gasoline vehicles that finished without stops is that several of the best American machines experienced no little trouble with their water-circulating pumps and oiling apparatus. One carriage with fan-cooled motor was a noteworthy exception, and the perfect performance of three machines of this type over a far more difficult course than that on Long Island would appear to indicate that the problem of the medium-sized, air-cooled gasoline motor has at last been solved in a practical manner.

The endurance test, though a comparatively short one, was yet long enough to develop troubles with many of the cars. The steam carriages made the best showing as to perfect runs under the rules, though it should be remembered that the two stops they were allowed for water, fuel, and lubrication were a relief to the operators and the machines which the gasoline cars did not have. Two of the three steam vehicles, that had condensers and made no stops, lost but 6 gallons of water apiece, and the gasoline consumption was but slightly greater. One of the machines consumed only $5\frac{3}{4}$ gallons, or about half as much as most of the other makes, and less by over a gallon than some of the similar two-passenger gasoline machines. The lowest water consumption of a steam carriage without condensers was 71.35 gallons; the average water consumption was 81.33 gallons. The lowest fuel consumption for gasoline vehicles was three gallons.

The one electric vehicle entered in the test succeeded in turning the halfway point (50 miles) with one change of batteries at the first control, or one-third of the entire distance. Shortly afterward it dropped out, since it was not able to run any further. The performance of this carriage is considerably exceeded by the recent run over muddy roads of two English electric touring cars, which traveled successfully from London to Bexhill, a small town on the south coast some 80 miles away. The American manufacturers evidently have much to learn regarding the production of long-distance electric touring vehicles capable of covering 50 miles of cross-country roads on a single battery charge.

The speed trials held on Staten Island May 31 by the Automobile Club of America were brought to an abrupt close by the fatal accident that occurred to the Baker electric racer. The appearance of this machine before and after the accident was depicted in our last issue. Had it succeeded in finishing without accident, it would undoubtedly have made a world's record. As it was, it made a record for electric machines of 36 1-5 seconds for the kilometer (0.621 mile). Other records made were a mile in 1 minute 12 seconds by a Locomobile racer; one in 1 minute 17 3-5 seconds by a Winton medium-weight gasoline machine; and a third in 1 minute 10 2-5 seconds by an Orient motor bicycle.

The endurance test and speed trials have demonstrated that while contests of the former kind can, when properly organized, be held on the public highway without danger to life and limb, all speed trials should take place on a private course, where the spectators, for their own safety, can view the racers from an elevated point, such as a bank or reviewing stand, where their lives will not be endangered by accidents occurring to the contesting vehicles.

PRACTICAL APPLICATION OF SCIENTIFIC EDUCATION IN GERMANY.

It is the common belief that the commercial rise of Germany has been largely due to the results of the Franco-Prussian war, which put money into its coffers and stimulated the energies of the people. Doubtless much of Germany's phenomenal success of the last quarter of the past century was due to this event; but in order to gage accurately the nation's capacities and aims, it is necessary to look farther back than 1870-71.

It is perhaps unnecessary to say that the whole standard of education in Germany is higher than in either the United States or England, and technical education had its beginning in Germany long before the Franco-Prussian war.

Sixty years ago, Liebig had fifty students working in his factory, and all of the German universities have had their own chemical laboratories since 1827. To-day, there are in German factories 4,500 thoroughly trained chemists, besides more than 5,000 assistants, whose brains are constantly at work upon the problems of improving processes, and lessening the cost of production.

The sugar industry illustrates the practical application which the Germans make of their educational system. In 1840 154,000 tons of beet root were crushed, from which 8,000 tons of raw sugar were produced, showing about $5\frac{1}{2}$ per cent of raw sugar extracted from the root. Twenty years later 1,500,000 tons were treated which produced 128,000 tons of sugar, or about 8 per cent. Last year about 12,000,000 tons were crushed, which produced 1,500,000 tons of raw sugar, raising the percentage to 13. This advance is due entirely to scientific treatment.

The production of dry colors, chemicals and dyes in Germany shows a corresponding increase in product and in dividend-paying capacity. Comparing the statistics of the dyeing industry of the year 1874 with those of 1898, it is found that notwithstanding prices in 1898 were considerably lower than in 1874, the net income in 1874 was 24,000,000 marks (about $6,000,000) and in 1898 was 120,000,000 marks (about $30,000,000). The great increase of earning capacity is due largely to the constant labor of trained men, who by application of their technical knowledge have so cheapened production that they have succeeded in getting this trade away from the English, who formerly controlled it. Another illustration is found in the manufacture of artificial indigo, a chemical process for making which was discovered in Germany about thirty-five years ago. It was started with less than forty workmen, all told. It now employs over six thousand men, and has a staff of one hundred and forty-eight scientific chemists. By placing this substitute upon the market at a very low price the Germans have nearly ruined the natural-indigo industry of India.

The Germans have also discovered a method for obtaining ground slag from steel processes, which is used as a fertilizer; and England, although she produces as much steel as Germany, has become a good customer for this article.

A century ago, the English and French makers of scientific instruments were far in advance of the Germans. During the last twenty years all this has changed. The value of the exports from Germany of scientific instruments for the year 1898 was about $1,250,000—three times what it was in 1888—and the work gave employment to 14,000 people.

The conclusions to be arrived at from the foregoing are not so much academic as economic and practical. In Germany, a young man is called upon to decide, early in his career, whether he will take a classical or a scientific course. If he decides to take the latter he goes into the "Real Schule," or lower scientific school, to be elevated thence to the "Real Gymnasium," or scientific high school, and thence to the "Polytechnicum," or institute of technology, which is separate from the universities. In this course he learns no Greek and only a moderate amount of Latin; but he has the sciences, engineering, mathematics, modern languages, history and a mixture of practical and theoretical training in various technical branches, with frequent excursions for the purpose of inspection of work in factories and public enterprises.

The faculties of these institutions keep in touch with the manufactories, and when capable young men graduate they easily find situations. This is also true of the technical high schools, of which there are twenty-four, which likewise have courses in engineering, architecture, drainage, irrigation, modeling, drawing, chemistry, modern languages, history, etc.

The questions for the people of the United States are: Is our system of education as perfected as it should be? Have we sufficient scientific education of the best grade and are our educational institutions in close enough touch with the manufactories to supply their needs? If not, are we not hampered in competition with our great commercial rival, which enjoys this complete co-operation?

The Imperial Department of Commerce and Industries has been of great assistance to the German manufacturer. It has been an intermediary between the educational and practical work, guiding the one, sustaining the other, and furnishing information to the manufacturer, first in beginning his industry, later in expanding it, and finally in marketing his surplus.

We should not rely too much on our unrivaled natural resources in the struggle for foreign trade. No country can rest in fancied security. What is the cheapest and best to-day may be made cheaper and better by our rival to-morrow, with its human plant of half a hundred thousand trained scientific brains working daily and steadfastly.

RICHARD L. MADDOX, M.D.

It is probable that very few photographers are familiar with the name of Dr. Maddox, who died on May 11 last in Southampton, England, at the age of 85. He was, however, regarded as the inventor of the gelatino-bromide process now so universally used. The process was improved after him by Kennett, Burgess and Bennett. Dr. Maddox prior to the seventies was particularly interested in photo-micrography, and found the work of drawing the enlarged images so vexatious that he looked about to see what could be done in the line of photography. He learned the practice of the collodion wet-plate process, and worked with that for a while. But the small darkroom he used soon became so saturated with ether evaporating from the collodion that it seriously affected his head and health. He then determined to try and ascertain a substitute for the collodion, and made an emulsion of isinglass, gelatine and other materials.

His experiments resulted successfully, for in 1871 he prepared a gelatino-bromide of silver emulsion and coated it upon glass plates, exposed them in a camera, securing very good negatives. These original negatives were placed on exhibition at the Inventions Exhibition in London in 1885, and he was awarded a gold medal therefor.

In 1889 he was awarded the Scott medal of the Franklin Institute at Philadelphia, and in 1901 he was awarded the Progress medal of the Royal Photographic Society of London, in each case in honor of his early work in the production of a practical gelatino-bromide process.

In 1892 a special fund was raised for his benefit of about $2,000 through the efforts of Sir William

Abney and others, "in recognition of his services to photography, and especially of his investigations in connection with gelatine emulsion." Like a true amateur and investigator, he pursued his experiments for the pure love of them, without any desire of pecuniary reward or with a thought of keeping the process secret, and for this his memory will be held in high esteem by succeeding generations of photographers.

THE DEVELOPMENT OF THE SAULT STE. MARIE CANAL.

BY WILLIAM GILBERT IRWIN.

Few save those directly or indirectly interested in the commerce of the Great Lakes fully realize the import upon the various lines of industrial endeavor of the traffic of our great inland seas. In no other way is the magnitude of this internal shipping so fittingly exemplified as in the immense tonnage which annually passes through the Sault Ste. Marie canal, which forms that important artificial waterway which obviates the natural barrier between Lake Huron and Lake Superior, and thus opens up to interlake shipping the greatest link in the world's greatest chain of unsalted seas.

Aside from establishing Duluth as a most important point of shipping, this great canal has been responsible for the marvelous agricultural, commercial, industrial and mineral development of the great Northwest through providing cheap water transportation facilities to the Atlantic. Through the wonderful development of the iron ores the canal has been a factor in establishing the industrial prestige of Pittsburg and other iron and steel manufacturing centers. In fact, no similar expenditure of capital by any state or any nation has conferred such vast benefits to a wide area and to so extensive a population.

The time has come when the accomplishments of the human race in the wide domain of commerce and industry are no longer subordinated to the enactments of war and conquest, and for some time important events in the peaceful fields of industry have been marked by exhibitions of work along these lines. The observance of the beginning of the work which resulted in the construction of this great canal is to be appropriately observed, and although it has not yet been decided just when this event is to be celebrated, there is at this time a bill before Congress for an appropriation for this purpose.

So far as concerns the American canal, the idea was first originated by Gov. Mason, of Michigan, in his message to the Legislature in 1837, the year after Michigan was admitted to the Union. On March 21, 1837, the Legislature of that State passed an act authorizing a survey and appropriating $25,000 for the work. This original survey, made under the direction of John Almy, recommended a canal 75 feet wide and 10 feet deep, with two locks, each 100 feet long, 32 feet wide, and 10 feet deep, the estimated cost of the work being $112,544. On September 7, 1838, the State of Michigan entered into a contract for the construction of the canal with Messrs. Smith & Driggs, of Buffalo. Work was not begun until May, 1839, and was soon suspended owing to a clash between the United States military authorities and the contractors, which resulted in the ejectment of the latter, and thus ended the first attempt at canal-making at this point.

On March 27, 1840, the Michigan Legislature passed a joint resolution protesting against Federal interference with the work, and three days later a memorial on the subject was forwarded to Congress, in which body a bill granting 100,000 acres of land to aid the work of constructing the canal was introduced. The matter rested until 1843, when the Michigan Legislature asked Congress for an appropriation, similar resolutions being passed by that body in 1844 and 1848. In the meantime the copper industry of the Lake Superior region had assumed great importance. In 1849 the State Legislature asked Congress for a cash appropriation of $500,000 for the canal, and finally a bill was passed by Congress and approved by President Pierce on August 26, 1852, by which a grant of 750,000 acres of land was made to assist in constructing the canal. Whether this event or the actual beginning of work on the canal will form the date of the celebration is a matter not yet decided by those in charge of the matter.

Immediately upon the passage of the Act of Congress relative to the land grant for the canal, Gov. McClelland, of Michigan, secured the services of Capt. Canfield, of the United States Topographical Survey, to make a survey for the proposed canal. An Act of the Michigan Legislature, approved by the Governor on February 12, 1853, provided for a canal commission, to which Chauncey Joslin, Henry Ledyard, John P. Barry, Shubael Conant, and Alfred Williamson were appointed. On April 5, 1853, the commissioners entered into a contract with Joseph Fairbanks, J. W. Brooks, Erastus Corning, August Belmont, H. Dwight, Jr., and Thomas Ryer as principals, and Franklin Moore, George F. Potter, John Owen, James F. Joy, and Henry P. Baldwin as sureties, for the construction of the canal, the contractors agreeing to build the canal and defray all expenses for the 750,000 acres of land appropriated by the Federal government.

As the Constitution of the State of Michigan contained a provision which forbade all special charters, the St. Mary's Falls Ship Canal Company, with a capital of $1,000,000, was chartered under the laws of New York, the company organizing with Erastus Corning as president, James W. Brooks vice-president, J. V. L. Prior secretary and treasurer, and Erastus Corning, J. W. Brooks, J. V. L. Prior, Joseph Fairbanks, John F. Seymour, and James F. Joy directors. While the original contract was not assigned to this company until August 25, 1853, ground was broken on the canal on June 4, 1853, by Charles T. Harvey, under whose supervision was constructed the original "Soo" canal, a work which has resulted in opening a vast domain and conferred untold wealth upon a wide section of our country.

Work upon this original canal was conducted with vigor, and on May 21, 1855, a certificate of the completion of the work was signed by Kinsley S. Bingham, then Governor of Michigan, and the members of the canal commission. A certificate to the same effect was made on May 21, 1855, by James T. Clark, engineer, and these two certificates were filed with the Commissioner of the State Land Office on May 24, 1855, and the following day the land appropriated by the general government for the canal work was patented to the St. Mary's Falls Ship Canal Company. This canal was 5,750 feet long, 64 feet wide at the bottom and 100 feet at the water surface, and 13 feet deep. There were two tandem locks of masonry, each 350 feet by 70 feet by 11½ feet on the miter-sills, with a lift of about 9 feet each, and the entire cost was $999,802.46.

Water was first let into the canal on April 19, 1855, and on June 18 following, the first boat passed through the canal, and thus was inaugurated intercommunication between Lake Superior and the others of the Great Lakes. Upon the completion of the canal it passed into control of the State of Michigan, the Governor, Auditor-General and State Treasurer constituting a Board of Control, John Burt being appointed the first superintendent of the canal. The canal remained under State control until 1872; and the old locks, which were built of Ohio limestone, remained in use until 1888, when they were destroyed by the excavations for the Poe lock in 1888.

Upon the transfer of the canal to the Federal government, Gen. O. M. Poe, then in charge of that district, assumed control of the waterway, being relieved by Gen. Godfrey C. Weitzel on May 1, 1873. Under Gen. Weitzel's supervision was built the lock which bears his name. This lock is 515 feet long, 80 feet wide in chamber, narrowing to 60 feet at the gates, with 17 feet of water over the miter-sills, and it was built between the years 1873 and 1881 at a cost of approximately $3,000,000, including the deepening and widening of the canal. Plans now being formulated by the Federal authorities will increase the Weitzel lock so that it will have a length of 1,600 feet, a width of 100 feet and a depth over miter-sills of 30 feet, these improvements to cost nearly $25,000,000.

The Poe lock, which was originally surveyed by Gen. O. M. Poe, is 800 feet long, 100 feet wide, and 22 feet over miter-sills. It was built between 1887 and 1896 at a cost of a little over $4,000,000. The canal has been deepened to 25 feet, and the entrance piers extended so that its total present length is 8,448 feet. The channel through the St. Mary's River is now 20 feet deep at the mean stage of water and 300 feet wide, and the whole improvements on the American side up to date aggregate something over $15,000,000.

While electricity is used for operating the Canadian lock, both the Poe and Weitzel locks use hydraulic power, a pressure of 400 pounds per square inch being used for the former lock and 115 pounds for the latter. The Poe lock can be filled and emptied in about 7 minutes, and an up-lockage of a boat 350 feet long can be made in 11 minutes, the gates being opened or closed in 2¼ minutes.

Canal work on the Canadian side began some time between the years 1796 and 1798, when the Hudson Bay Fur Company built a lock 38 feet long, 8 feet 9 inches wide, with a lift of 9 feet. A towpath was made along the shore for oxen to pull the bateaux and canoes through the upper part of the rapids. This old lock was demolished in 1814 by United States troops from Mackinaw Island under command of Major Holmes. The present Canadian canal is 5,920 feet long, 150 feet wide and 22 feet deep, with a lock 900 feet long, 60 feet wide, and 22 feet of water on the miter-sills. It was built between the years 1888 and 1895, the work being in charge of W. G. McNeil; Thompson, Ryan & Haney being the contractors. The canal cost $4,000,000.

During the first season of the original American canal a registered tonnage of 106,296 tons passed through the canal. Until 1864 no record was kept of the number of vessels passing through the canal, but in that year there were 1,411 lockages, with an aggregate tonnage of 571,438 tons. In 1870, 1,828 vessels passed through the canal, and their aggregate cargo was 690,826 tons, while in 1875, 2,033 vessels passed through the canal, and they carried 1,260,000 tons of cargo. The traffic of the canal in 1880 amounted to 3,503 lockages and 1,735,000 registered tons.

The development of the shipping on the Great Lakes was so rapid during the next few years that in 1884 but 11 per cent of the vessels passing through the Weitzel lock could have used the old canal. In 1885, 5,380 vessels passed through the canal, carrying more than 3,000,000 tons of freight; and in 1890 this had increased to 10,557 vessels, carrying 8,500,000 tons. In 1895, during part of which season the Poe lock was open, 17,956 vessels, carrying 16,806,781 tons of freight, passed through the canal. In 1900, during which year the American canal was open to navigation 231 days, a total of 19,432 vessels, carrying a registered tonnage of 22,315,834 and a net freight tonnage of 25,643,073 tons, passed through the American and Canadian canals, of which traffic fully 90 per cent passed through the American canal. The traffic for both canals for 1901 amounted to 20,041 vessels, with a registered tonnage of 24,626,976 and a net freight tonnage of 28,403,065. The value of this freight was $289,906,865. Navigation for the present year on the American canal opened on April 5, and for April 1,303 vessels carrying a registered tonnage of 2,067,046 tons, passed through the canal, while the Canadian canal, which opened on April 1, shows a traffic for April of 376 vessels, with a registered tonnage of 255,833 tons.

The American "Soo" canal, which is open to navigation only about eight months in the year, has more than four times the annual traffic of the Suez canal. During the past few years the vessels passing through the "Soo" canal have averaged one for every fifteen minutes day and night. Few works of man portray more fittingly the spirit of this age of industrialism, and of great achievements in production and distribution as does this, the world's greatest canal, which has about completed the first fifty years of its existence.

MAKING FIFTY-TON ANCHOR CHAINS.

BY DAY ALLEN WILLEY.

What are claimed to be the largest chains ever made in this country for securing a ship's anchors have been manufactured at the Lebanon Chain Works, of Lebanon, Pa., for the Newhall Chain Forge and Iron Company. They are intended for the steamships being constructed at the plant of the Great Northern Steamship Company, and to bend and join the links special machinery was designed by Eli Atwood, general manager of the works. They were made in four sections or "shots," each comprising 990 feet, so that the total length of the combined chains is nearly 4,000 feet. Two will be supplied each ship, one for the starboard and one for the port anchor, but for convenience in handling and construction each chain is subdivided into shots of 90 or 180 feet joined by swivel shackles.

The material employed was the highest grade of chain iron, drawn out in bars 3 7-16 inches thick for the shackles and 3 3-16 inches for the links. In manufacturing the links the bars were cut or sheared into the requisite lengths, then heated in a special furnace. The bending machine, which is operated by steam power, holds what might be called a model or die of steel of the same shape and size as the opening in the center of the link. The bar, while white hot, was drawn into shape by the jaws of the bender, enough space being left between the ends to insert the two links connecting with it. After the process the ends were "side welded" by hand in the smith shop. As each link ranges between 19 and 20 inches in length, the lengths cut for bars are nearly four feet in dimensions.

To hold the weight of the various sections during the welding and shackling processes, also to stow the complete chain, a series of metal blocks and tackles were employed to which large hooks were bolted. The chains connected with the blocks are operated by trolleys sliding along a track fastened to the frame of the shop roof.

A portion of the completed chain was tested by apparatus installed at the Lebanon Works, which is said to be the largest chain-testing machine in this country, having a capacity of 600,000 pounds. At a strain of 500,000 pounds the jaw of the holding shackle of the machine was broken, but none of the links were affected. At the second test the breaking strain was placed at 549,000 pounds, when the jaw of the machine feeding the oil to the tester was fractured. The chain itself, however, was unaffected. These figures are 55,000 pounds above Lloyd's requirements for such anchor chains.

A further illustration of the great size of the chains can be given when it is stated that each link averages not less than 165 pounds weight, an average of about 100 pounds to the running foot, making the total weight of each anchor section nearly 50 tons. The chains, of course, will be handled in connection with their respective anchors by steam power, either communicated to large winches or to special stationary engines.