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.