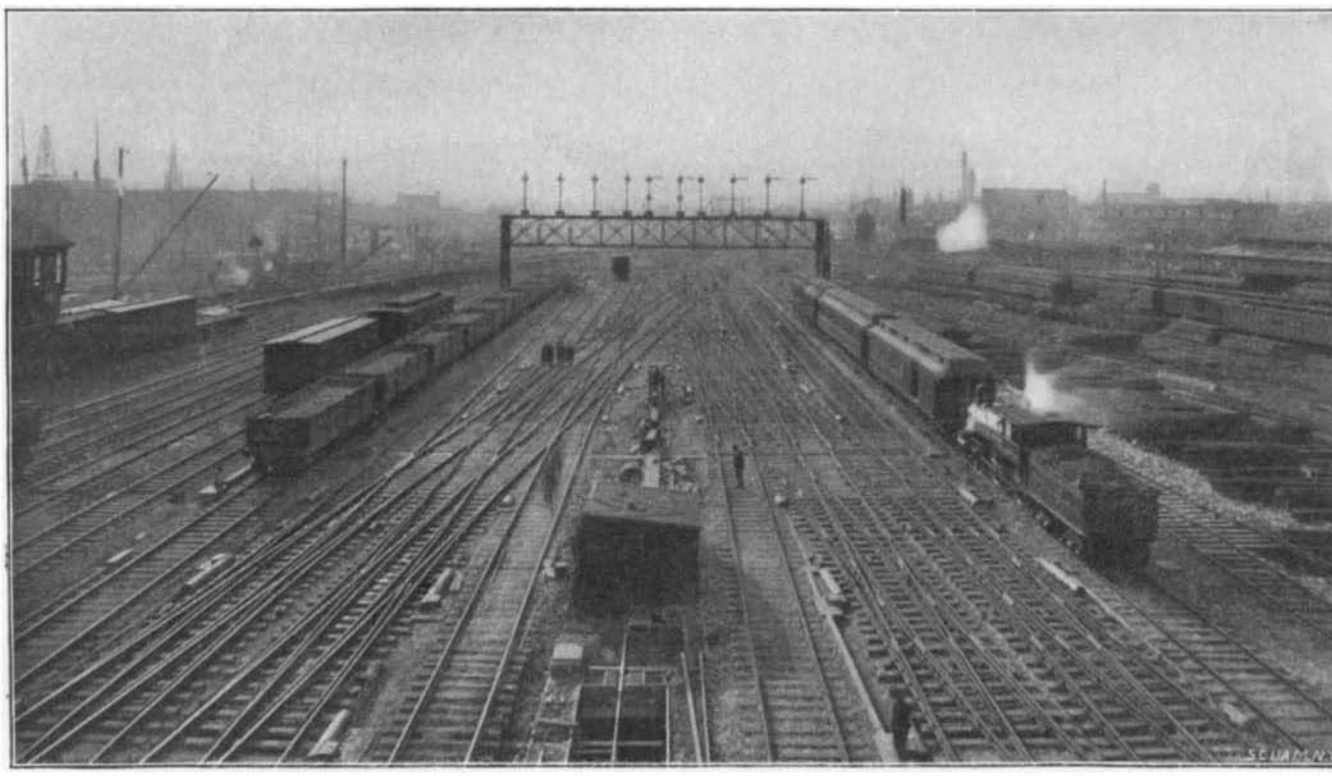
ELECTRO-PNEUMATIC SWITCHING AND SIGNALING SYSTEM AT THE SOUTH BOSTON TERMINAL STATION.

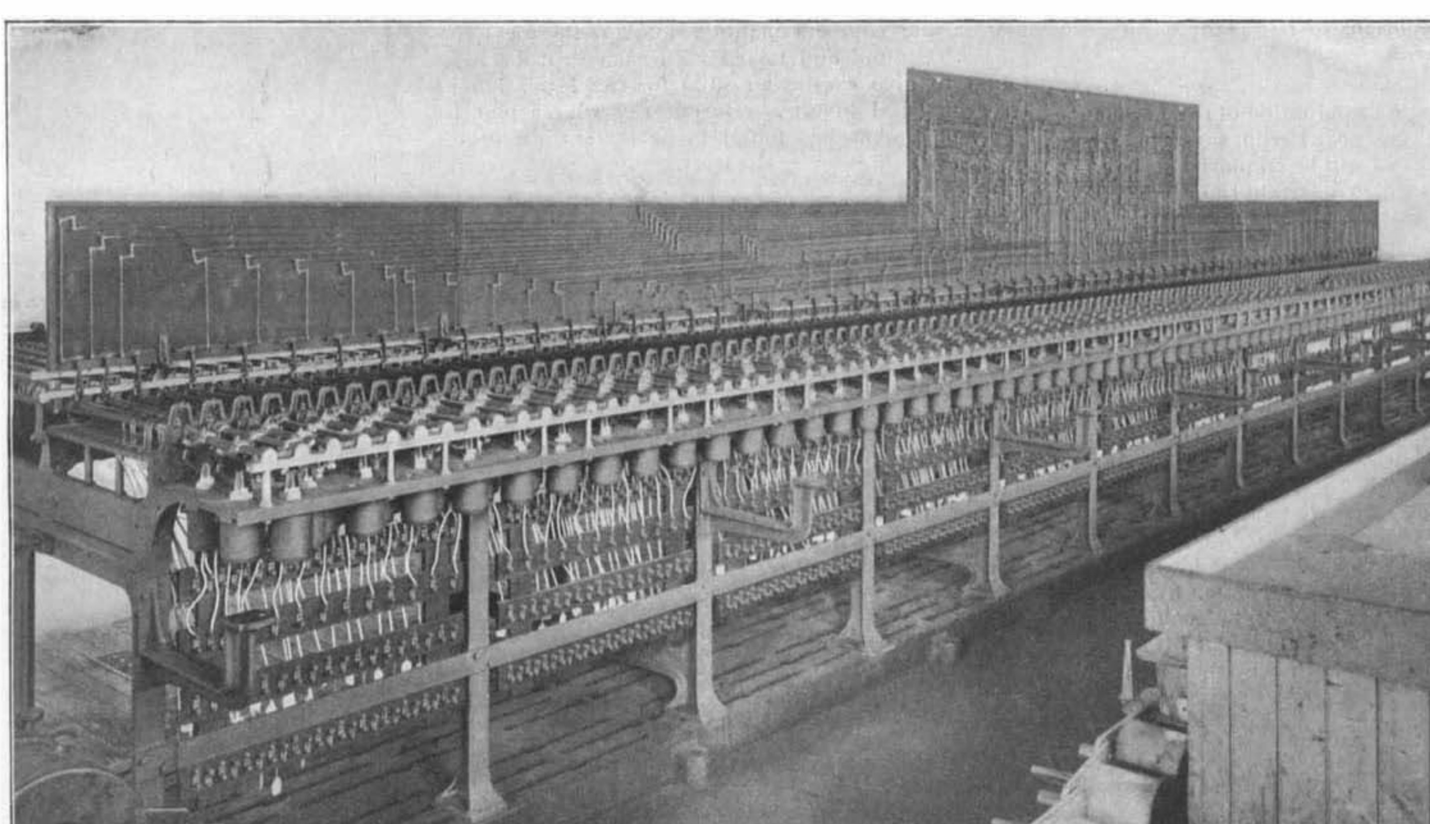
The vast size of the new South Boston Terminal Station necessitated the planning and construction of special work in more than one department of mechanical and civil engineering. Not the least complex and difficult problem was the arrangement of a satisfactory system of signals and switches, for expeditiously and safely controlling the great volume of traffic which day by day rolls into or out of the station. We have already, in our issue of January 14, 1899, given an illustrated description of this remarkable station, which was opened for traffic at the commencement of last year.

It will not be amiss in connection with the present article to recapitulate some of the leading features of this great work. The station was built to provide terminal facilities for the express and suburban traffic that enters Boston by four different railroad systems, namely, the Providence division of the New York, New Haven and Hartford Railroad, the Old Colony, the New England, and the Boston and Albany railroads. This traffic is estimated to amount annually to about 25,000,000 passengers. Whereas it was formerly handled in four separate and scattered stations it now enters and leaves from one common center. The total area of the terminal site, including the great yard, of which we present an illustration, is thirty-five acres, and thirteen acres of this is covered by the building itself. The maximum length of the main station is 850 feet, its maximum width 725 feet. The trainshed itself, which is 602 feet long by 570 feet wide, is covered by one vast curved roof, which is supported on a series of huge cantilever trusses, the middle span of which is 228 feet, and the two side spans 171 feet in width. The mere statement of the area of the trainshed does not represent the extent of the accommodations for tracks, as the station is of the double-deck type, the long distance express traffic being handled upon twenty-eight parallel "stub" tracks on the main floor of the building, and the suburban traffic being accommodated on a two-track loop, located on the lower level below the main floor, an arrangement which enables the suburban trains to unload their passengers, load up, and depart, without any of the delay due to making up trains.

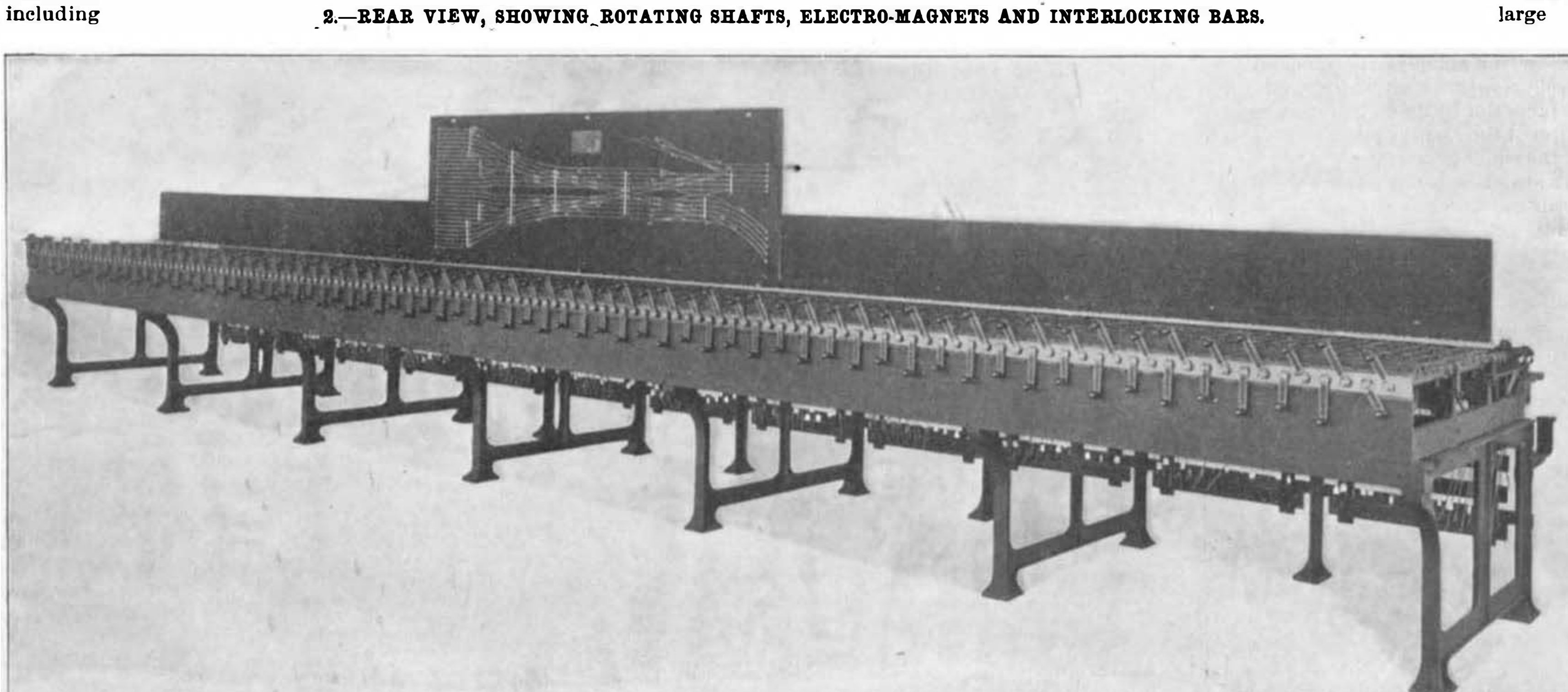
The present schedule calls for a daily service of 737 trains. When we remember that the making up of these trains will involve an even larger number of train movements, it can be seen that the track layout must necessarily be very extensive and elaborate. In determining what system of switching and signaling to adopt, it became a question of choice between a mechanical plant, in which the connections from the signalmen at the tower to the signals and switches are made by means of an elaborate system of bell-crank levers and pipe connections, and an electro-pneumatic system, in which the pipe connections are displaced by electric wiring and hand power by pneumatic power. A mechanical plant was out of the question because of the large tower



1.—SOUTH BOSTON TERMINAL YARD, SHOWING DIAMOND CROSSINGS AND SWITCHES, AND ONE OF THE SIGNAL BRIDGES.



2.—REAR VIEW, SHOWING ROTATING SHAFTS, ELECTRO-MAGNETS AND INTERLOCKING BARS.



3.—FRONT VIEW OF ELECTRIC INTERLOCKING MACHINE, SHOWING OPERATING LEVERS AND WORKING MODEL OF YARD.

building which would be required, and the large amount of valuable land that would be occupied by the lead-out piping, the width required near the tower in each direction being about 45 feet. Moreover, the electro-pneumatic system is more economical in labor, and it is estimated that on account of the magnitude of the plant, the cost would be as great, or even greater, for a mechanical than for a pneumatic installation.

The yard is controlled from three towers. Tower number 1, which is the nearest of the three to the station, controls an area of tracks in which there are switch and frog points equivalent to 238 ordinary switches. It is possible for eleven trains to move to or from the trainshed at any one time; and for the control of these there are 148 semaphore signals. Tower number 2 controls the switches and signals of the suburban tracks; and tower number 3 has charge of the train movements at the yard limits, which are too remote to be controlled by tower number 1. There are nine steel-truss signaling bridges in the yard, which serve to carry the greater part of the signals. One of these bridges, carrying ten semaphore posts, is shown in our engraving of the yard. The posts are hollow iron columns with the operating connections inside, and as far as possible they are placed vertically over the center of the track which they control. Forked blades are used to indicate that a route clear through the system has been arranged, and they are also used at the last signal before entering the trainshed, to indicate that cars are standing on the track in question, within the shed. Red indicates "stop;" green "all right" and yellow "caution."

The switches and signals are operated by compressed air, which is piped to the desired points throughout the yard. Single-acting air-cylinders controlled by magnets are used to raise the signal arms, which are brought back to a stop position and held there by counter-weights. The switches are moved by double-acting air-cylinders, which are provided with two pin valves, magnetically controlled, one for each end of the cylinder, which serve to control the auxiliary cylinders that shift the D-valve. The D-valve cannot act until a plunger which prevents its movement is withdrawn, the withdrawal is effected by a third magnetic valve and auxiliary cylinder. The three magnetic valves are controlled by three separate wires, which lead from them to the contacts of the interlocking machine at the signal tower. The first part of the stroke of the main piston moves the detector bar, the middle part moves the switch, and the latter part locks it in position. Hence, if the detector cannot rise, being held down by the wheels of a passing train, the switch cannot be thrown. The pneumatic cylinders which operate the semaphores are controlled by similar magnetic devices.

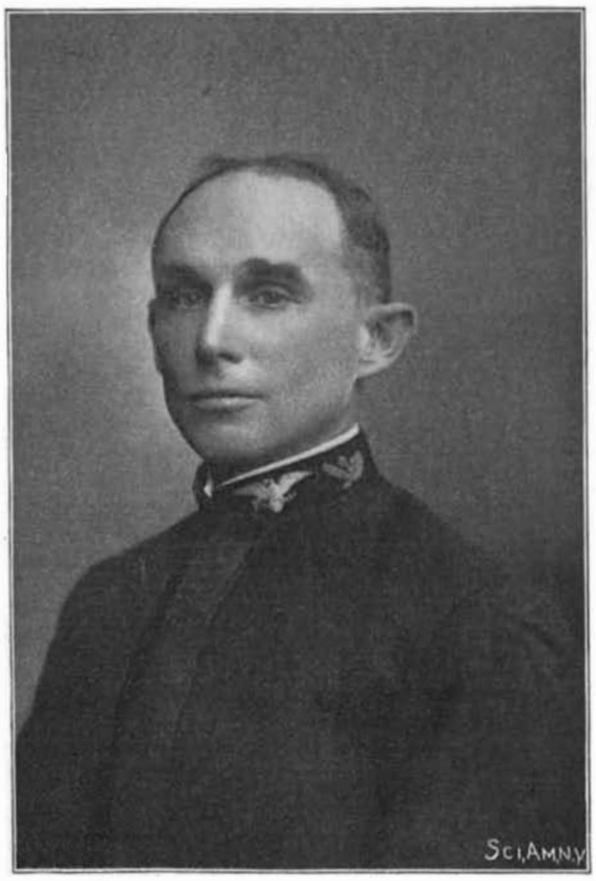
We present two illustrations of the interlocking machine as installed at the principal signal tower, No. 1. Each pair of switch points and each semaphore, in that portion of the yard controlled by this tower, is connected by wiring to this inter-locking machine, which has complete control of the action of the electro-magnets throughout the yard. Running transversely across the interlocking table, and operated by the small hand-cranks shown in the front view of the same, are a series of horizontal rotating shafts which are capable of being moved through an arc of sixty degrees. At their rear end the horizontal shafts are provided with electric contacts, and below them are arranged the armatures of the series of magnets which will be seen in Fig. 2, supported below the rear edge of the table. The manipulation of the horizontal shaft by the signalman serves to give the required condition to the magnets at the switches and signals throughout the yard for their operation.

Arranged above the interlocking table at right angles to the rotating shafts, and extending its full length, is a vertical board, upon the back of which are carried a series of transverse and vertical bars, to which horrizontal and vertical movements are given by means of bell-crank levers. Each horizontal rotating shaft is connected to its own system of transverse horizontal bars. The bars are arranged to interlock with one another by a system of cross-locks. The ends of the rotating shafts are engaged by the armatures of electro-magnets, which are so governed, by the switches and signals operated, that the levers and apparatus operated by them must agree in position before a prescribed route through the yard may be given.

A working model of the yard is attached to the interlocking machine and faces the signalman as he stands at the front of the table, see Fig. 3. The working model shows all of the switches moved by the interlocking machine, and every movement of the switches or signals throughout the yard is faithfully represented on the model as it takes place. We are indebted for our description to the courtesy of George B. Francis, M.Am. Soc. C. E., resident engineer of the Boston Terminal Company.

NAVAL CONSTRUCTOR FRANCIS T. BOWLES.

Francis Tiffany Bowles, son of Benjamin F. Bowles and Mary Elizabeth Bailey, was born in Springfield, Mass., October 7, 1858. His grandfather, Samuel Bowles, was the founder, and his uncle the great editor, Samuel Bowles, of the Springfield Republican. The family is of clear New England Puritan stock and allied on every side with well-known Puritan names.



FRANCIS T. BOWLES, U. S. N., CHIEF NAVAL CONSTRUCTOR OF THE NEW YORK NAVY YARD.

In 1875, Mr. Bowles entered the Naval Academy as a cadet engineer. Early in the course, he determined to become an Assistant Naval Constructor. Although provided for by law, no appointments had ever been made from graduates of the Naval Academy, owing to the opposition of the old school of constructors.

In order to thoroughly equip himself as a naval architect, Mr. Bowles applied, during his last year at Annapolis, for permission to attend the School of Naval Architecture at the Royal Naval College, Greenwich, England. His request being seconded by Senators Edmunds and Dawes, the Secretary of the Navy made application to the English Government for Mr. Bowles and his classmate, Richard Gatewood, to take the three years' course. These young men began in 1879 a course of study which has since been the highest prize attainable by distinguished graduates of the Naval Academy, and has proved a most efficient method of recruiting an efficient corps of Naval Constructors. Mr. Bowles' instructor in naval architecture was Sir William White, now Director of Naval Construction of the British Admiralty.

Mr. Bowles, coming fresh from the English and Scotch shipyards in October, 1882, and charged with the latest information as to design and construction, was soon detailed as Secretary of the Naval Advisory Board, then charged with the control of the design and construction of the first ships of the new navy. It is difficult to realize now the then existing conditions of dense ignorance as to the real state of the art of ship and engine building, and Mr. Bowles was met with the most absolute incredulity as to the results obtained abroad. It is interesting to recall that the ships recommended for the navy by the first advisory board were all single-screw vessels, even up to a first-class cruiser of 6,000 tons. They were all unprotected, sheathed with wood, of full sail power, with gun deck batteries, and a speed of 10 to 15 knots for the various classes. Twenty of the small vessels were to be built of wood, and on the material for constructing the others the board divided, part advocating steel and part iron.

Mr. Bowles struggled to infuse the new ideas and succeeded in many important features of the designs. He advocated twin-screws for all the ships, a system which was adopted for the "Chicago." He made and secured the adoption of the battery plans of the "Boston" and "Atlanta." He fought against sheathing with wood and won his case so thoroughly that the question has laid at rest until recently. His services on this board, which extended over its active service of four years, are described in a letter of the late Rear Admiral Simpson, at one time president of the board:

"Mr. Bowles has been attached to the board since its inception, and as the center figure about which the business of the board has circulated, he has shown an amount of method and system, which combined with a very retentive memory, has made him a valuable, and, I may say, an unfailing reference at all times. This, however, would indicate but faintly the value of his services, which could not have redounded to the credit of the service and his own reputation without the knowledge he possesses of marine architecture and engineering, both of which have been frequently utilized by the board."

Secretary Whitney made Mr. Bowles a member of the Walker Board, which prepared the designs of the "Newark," "Charleston," "Yorktown," etc.

In 1886, Mr. Bowles was detailed to the Norfolk Navy Yard, and was soon placed in charge. He there organized a modern shipbuilding plant, producing with the very small means available the Navy's most efficient yard. He built the battleship "Texas," the cruiser "Raleigh," and completed the monitor "Amphitrite." During this tour of duty, extending over nine years, he served as a member of all important boards at Washington having to deal with matters of ship design.

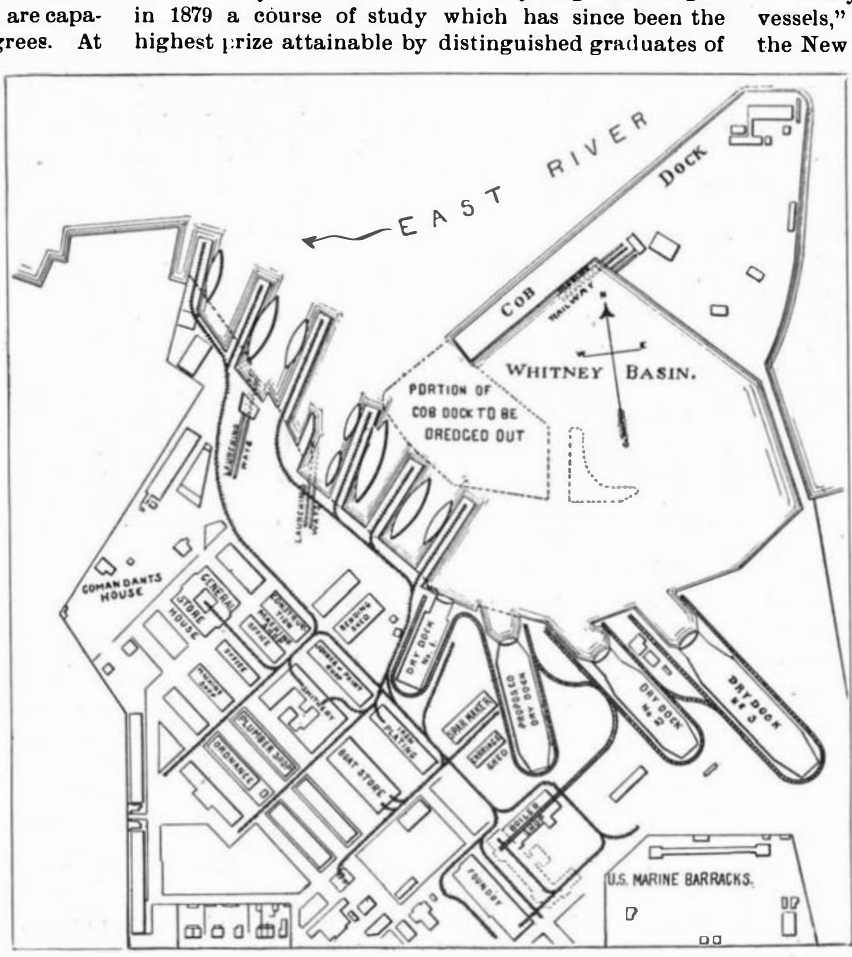
On his departure from Norfolk the employes adopted resolutions, testifying to his "executive ability and skill," thanking him for "his untiring energy as manifested for the advancement of this yard, in securing the necessary tools and appliances for the construction of vessels," and congratulating him on his promotion to the New York yard, "the best appointment in the gift of the department."

Mr. Bowles' administrative and business capacity has always been recognized in the navy, as well as his unflinching demand for efficient personnel in the navy yards. This has frequently brought him into conflict with politicians, and led to investigations of his conduct of affairs, which have always resulted in credit to himself and confusion to his enemies.

Secretary Tracy consulted him in regard to the introduction of Civil Service into the navy yards and made large use of his knowledge and experience in framing the first rules put in force.

Mr. Bowles came to the New York Navy Yard in 1895, being detailed by Secretary Herbert at a time when certain irregularities were found in the employment of men in violation of the rules. He proceeded quietly and effectively to rid the place of incapable, idle and worthless employes who had infested it for years, and has produced an organization whose efficiency was demonstrated clearly in the Spanish war, when the work turned out at the yard won the admiration both of the navy and the business community.

In September, 1897, desiring the earliest possible completion of the repairs to the large dry dock at the New York Navy Yard, the Secretary of the Navy placed the work under the immediate charge of Mr. Bowles, by whom it was brought to a successful conclusion and the dock put in excellent condition. Since its completion,



PLAN OF THE NEW YORK NAVY YARD, BROOKLYN, SHOWING PROPOSED IMPROVEMENTS.