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.

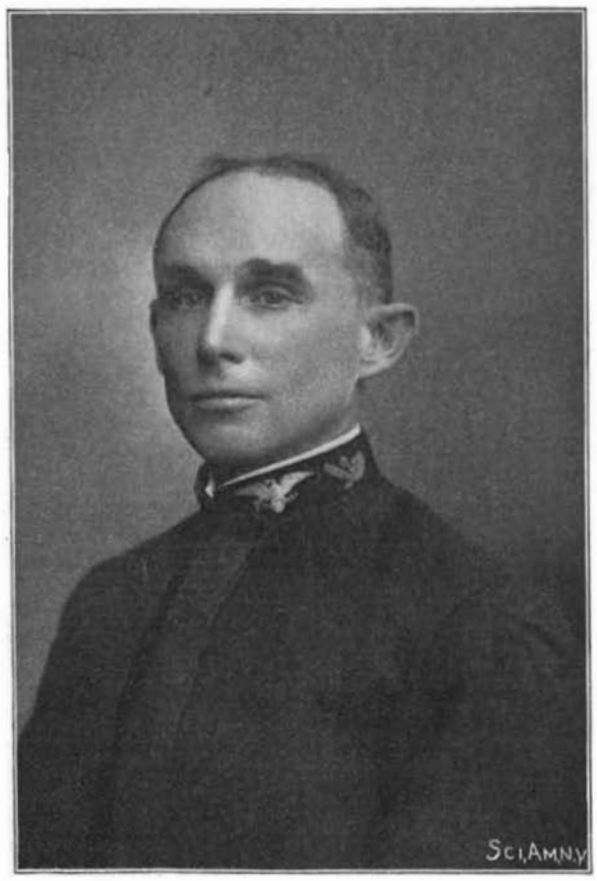
The yard is controlled from three towers. Tower number 1, which is the nearest of the three to the station, controls an area of tracks in which there are switch and frog points equivalent to 238 ordinary switches. It is possible for eleven trains to move to or from the trainshed at any one time; and 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 The D-valve cannot act until a plunger which prevents its movement is withdrawn, the withdrawal is effected by a third magnetic valve and auxiliary cylinder.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.




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

## 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.

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.

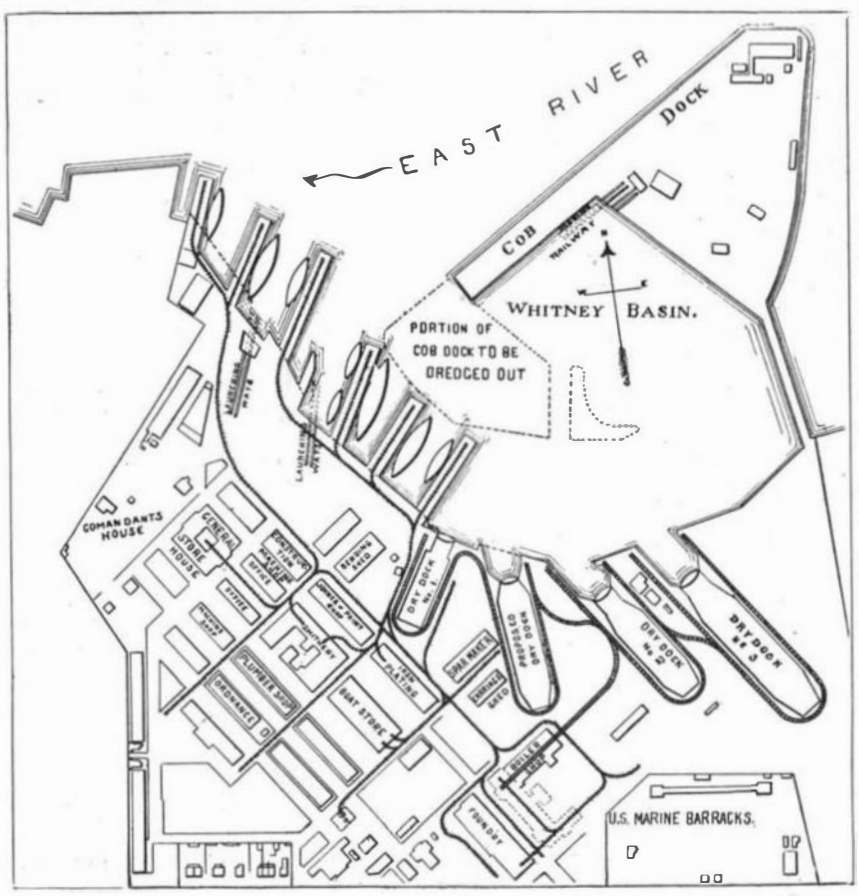
On his departure from Norfolk the employes adopted resolutions, testifying to his "executive ability and skill," thanking him for "his untiring energy as manifested for the advancement of this yard, in securing the necessary tools and appliances for the construction of vessels," and congratulating him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

all of the largest and heaviest ships in the navy have been successfully docked therein.

During the Spanish-American war there were 2,200 construction employes, averaging 14 hours per day, under Mr. Bowles' orders. Due largely to his remarkable executive ability and quick and correct decision, there were fitted out at the New York Navy Yard, for auxiliary service, forty-seven vessels—as many as were turned out in all other yards together. Mr. Bowles was further in complete charge of fitting out the army hospital ship "Relief," which for completeness of hospital arrangements is to-day unsurpassed. Secondary batteries were fitted on the "St. Louis," the "Harvard" and "Yale," without interfering with their movements. In many instances, the alterations were outlined, plans made and issued, and work begun within twenty-four hours after a vessel's delivery at the yard.

Mr. Bowles was the prime mover in the organization of the Society of Naval Architects and Marine Engineers. From its incorporation he has been Chairman of the Executive Committee of the Council, and since 1895 has also served as Secretary-Treasurer of the society. In moving him a vote of thanks, Vice-President Loring, of the society, stated "In the work of inception and execution, the master mind and guiding hand have been those of Naval Constructor Francis T. Bowles." Col. Edwin A. Stevens, member of the Council, said: "I take it that we can regard Mr. Bowles' work in fostering this society. . . . as an example of the spirit of the service, taking Mr. Bowles as the type of the re-constructed navy of the United States, of the men that have made that re construction possible." Sir Nathaniel Barnaby calls the corresponding English organization "The home for research in naval construction;" and due to the efforts of Mr. Bowles, the American society has come to occupy a similar place and is meeting with great success in its object, "the promotion of practical and scientific knowledge in the arts of shipbuilding and marine engineering and the allied professions."

## NEW YORK NAVY YARD, BROOKLYN.

One of the most evident facts demonstrated by our late conflict with Spain was the important part which must always be played by the navy yards of the country in the successful prosecution of a war—a fact too little understood or too long overlooked by Congress. Only those who were *au courant* with our deficiency in dry docks and other essential facilities knew to what straits we might have been brought by the sudden crippling of half a dozen of our deep-draught ships, and the consequent demand for instant docking. Happily, however, Congress seems now to have awakened to the importance of this question, and our various yards will soon be suitably equipped to meet the needs of an ever-growing navy.

By far the most important of the navy yards of the United States is that known officially as the Navy Yard, New York, and popularly as the Brooklyn Navy Yard. It bears the same relation to our navy as Portsmouth and Chatham to the British navy, and Brest and Toulon to the navy of France, and some idea of its capacity may be gathered from the fact that in the course of a single year as many as 120 vessels have visited the yard for repairs or alterations, 50 of these being vessels of the regular service and 70 of them being vessels on which considerable structural changes were necessary in transforming them to suit the needs of naval service. In the same period 66 vessels were docked and painted.

Location and History of the Yard.—If the reader will take up a map of New York he will notice that the East River for the first mile and a half of its course from the southern end of Manhattan Island, runs in an easterly direction and then turns sharply to the north, making a bend of about 90 degrees. The outer angle of the bend forms what is known as Wallabout Bay in which is situated an island, separated (save for a narrow causeway) from the main land by the Wallabout Channel. The island, the channel and most of the adjoining land encompassing the channel, go to form the 213 acres inclosed within the boundaries of the New York Navy Yard. Historically the site will always possess a mournful interest owing to the fact that during the Revolutionary War the British prison ships were moored in the Wallabout Channel, and that on board of these vessels thousands of American patriots perished. They were buried right in the mud flats of the bay upon which stands the present dry docks and buildings of the Navy Yard, and during the excavations for various new structures, portions of skeletons have frequently been exhumed. This has occurred as recently as February of this year, when in excavating near the clothing factory, fragments of several skeletons were brought to light.

For the origin of the New York Navy Yard we must go back to the year 1801, when the Chief Executive of the United States, John Adams, having exhausted every argument to induce Congress to appropriate the necessary money, purchased on his own responsibility the sites for six navy yards. Among the yards thus secured was the "Waallbought," Brooklyn, now corrupted into "Wallabout." Subsequent additions were made in 1824, 1848, and 1867, and at a later date two sections were sold to city of Brooklyn, one of which is occupied by the well-known Wallabout Market. The present value of the yard, with its docks, buildings and plant, is estimated at about $19,000,000.

The extent of quay wall available for the berthing of vessels is approximately one and a quarter miles. The boundary limits are on an average about one-quarter of a mile from the water front and the yard including the island known as Cob Dock, contains as we have said, some 213 acres. The greater part of the buildings were erected prior to the reconstruction period of the navy, which dates from about the year 1883, at which time the buildings and machinery were entirely inadequate to the requirements of a modern navy yard. Subsequently to the date mentioned, and particularly during the last decade, the more generous appropriations and the advent of vigorous and competent officials to the yard, have resulted in a great improvement of its capacity for every kind of naval work. Many old and unsuitable buildings have been torn down, and replaced by modern structures, fully equipped for the necessities of the new navy. Complete arrangements have been made for receiving and disposing the vast quantities of naval stores of all descriptions which pass through this principal supply depot of the navy. Complete electrical plants, both for lighting and power, have been installed, and elaborate hydraulic and pneumatic plants have been laid down. The quay walls have been extended, and, by dredging, have been made available for vessels of great draught of water. At the commencement of the era referred to the yard possessed but one dry dock, the old stone dock, with a length of only 370 feet. Since this two large docks, one 500 feet in length, and the other 670 feet have been constructed, and the 500-foot dock is now being largely rebuilt in concrete.

An important feature in connection with the arrangement of the docks is the system of double-track railways which encircles each dry dock and by means of connecting branches unites them with the boiler shop. On this system there are two large 40-ton locomotive cranes which have a reach of about 60 feet. The arrangement of the tracks is such that it is possible for the crane to pick up a boiler in the boiler shop, carry it to any one of the dry docks, and lower it directly into the hold of the vessel. These cranes are also of the greatest service in handling guns, gun carriages, and the heavier pieces of machinery and ship's framing and fittings. One of our illustrations on the front pages shows the yard floating derrick which has a capacity of 75 tons at the end of a 65-foot boom. One advantageous feature of this derrick is that the boom is capable of rotation about the mast. The floating derrick and the large locomotive cranes just referred to make it possible to handle the heaviest weights with ease and dispatch. There is also an elaborate system of single-track railway, as indicated by the single line on the accompanying plan of the yard. It will be seen that the tracks extend down the whole water front and through the main streets of the yard, short branches being run from the streets into the various shops.

Buildings.—The buildings of the yard are commodious and of a very substantial character. The older structures have been largely rebuilt and refitted and there are several entirely new structures that have either just been completed or are in process of erection. The largest building is the smithery, which measures 300 × 200 feet. The foundry is 350 × 110 feet, and the main machine shop of the Steam Engineering Department measures 350 × 100 feet with a wing 210 × 95 feet. The general storehouse measures 200 × 200 feet, and the joiner and paint shop is contained in a fine granite building which is over half a century old, in which is also the Construction and Repair Electrical Plant. On the summit of the hill, in the northwestern corner of the yard, is situated the commandant's house, now occupied by Rear Admiral J. W. Philip, well known as the commanding officer of the "Texas" during the Spanish-American war. It will interest our readers to know that the first commandant of the yard was Lieutenant Jonathan Thorne, the hero of Washington Irving's "Astoria."

The Department of Construction and Repair.—The work undertaken at the Government Navy Yard is so complex as to necessitate its division under various departments. The most important of these is the Department of Construction and Repair, which has charge of all work connected with the hull proper of the vessels. It has charge of the important work of docking, painting and undocking; it installs and supervises all piping in connection with the drainage, water, and ventilation systems; it looks after the necessary work in fitting up the quarters and receiving spaces of ships, and provides the necessary furniture and various details essential to life aboard ship; it has under its supervision the steering machinery and that for the hoisting of anchors and handling of the many boats with which all naval vessels are supplied. It also has charge of building the boats themselves, and in this connection it should be mentioned that a large three-story boat storehouse has been planned which will be erected on the spot indicated in the accompanying map of the yard. Electric traveling cranes, running from one end to the other on each floor, will enable the boats to be picked up and carried to a well at one end of the building, where they will be lowered on to suitable trucks on the yard railway and carried to the water.

There are thirteen buildings connected with this department, and in addition to these a large steel storehouse is in process of erection. Several of the illustrations on the first page of this issue show the interior of these buildings and the various improved tools and appliances in the shops. Limitations of space prevent any very detailed description, but we draw particular attention to the gas plant which furnishes the necessary fuel for the various forges for the plate-bending sheds and smitheries. It consists of a Root blower which delivers air at a pressure of 2 pounds to the square inch. A part of this air passes through the large tanks of gasoline shown in the illustration, and the gas thus formed is piped to the different forges and bending furnaces. The other part of the air is carried through an air main to the various shops, and by means of an air pipe and a gas pipe at each forge the mixture is regulated according to the work to be done.

A comparatively new feature of this department is the compressed air plant, whose mains are carried to the different shops and are also extended to and around each of the dry docks. The mains at the docks are located a few feet back from the curb, and are provided at intervals with connections from which the air is piped through flexible hose to the various portable machines used for drilling, chipping and caulking both on the inside and outside of the vessel. Among the uses of air in the shops is that of wood boring in the boat shop, brass polishing, hoisting in the blacksmith and machine shops, machine molding in the foundry, and for tests of all auxiliary machinery where steam may not happen to be available.

The Department of Steam Engineering, as the name indicates, has charge of all work connected with the engines and boilers of the ships, and such auxiliary machinery as is not under the direction of the Construction Department. The Department of Yards and Docks has charge of the erection and maintenance of all the yard buildings; attends to the lighting, heating, and furnishing of these buildings, and keeps in repair the dry docks, quay walls and slips, streets and tracks. The Equipment Department has charge of all matters relating to the rigging of the ships; furnishes all electrical appliances and the instruments connected with the navigation of the ships, and installs the complicated system of electric wiring which is now such an important item in the vessels of our navy. The Department of Supplies and Accounts has charge of the accounts of the officers and employes of the yard and the purchase of all material for the use of the various departments. It keeps a general storehouse supplied with naval stores for the use of all the vessels in the navy and in many cases it supplies the other navy yards as well. The Ordnance Department has charge of all matters relating to the ordnance of vessels, their guns, torpedoes, and ammunition. It has to see that the vessels are fully supplied with the ammunition and various stores connected with ordnance. The efficiency of this department was displayed conspicuously during the recent war when our vessels, not merely in Cuban waters, but in the Far East, were never in danger at any time of running short of ammunition.

Proposed Improvements.—Although the New York Navy Yard has made such a good record in respect of its ability to turn out a large amount of work, it is a fact that much of the repairs, etc., undertaken at this yard, is done at a great disadvantage, owing to the lack of proper berthing space and the impossibility of placing the ships at wharves reasonably accessible to the shops. The trouble is due to the existence of the Wallabout channel and the fact that on the navy yard side of the channel there are, at present, berths available for not more than five ships, and that of these only two are suitable for large or long vessels. This necessitates the berthing of some of the ships that come to the yard at the Cob Dock, communication with which is only possible by a slow and inadequate rope ferry, which is subject to constant interruption from passing tugs and barges. Moreover, all materials and stores for ships on the Cob Dock have to be hauled fully a mile by teams over poor roads extending around the dry docks and over the causeway.

The accompanying plan shows the scheme of alterations, drawn up by Naval Constructor Bowles, with a view to remedying this serious defect by providing ample berthing space in close proximity to the shops. The plan, which has every probability of being carried out, contemplates the removal of the southern end of the Cob Dock and the building out into the enlarged channel thus formed of six long piers and one shorter one, all projecting from the Brooklyn shore as shown. By abolishing the Cob Dock for berthing purposes, the enlarged berthing space thus afforded on the Brooklyn shore would be sufficient to accommodate at any one time eleven of the largest