THE NEW BRITISH BATTLESHIP "DREADNOUGHT."

The recent launch of the battleship "Dreadnought" at Portsmouth, England, of which we present illustrations, was an event of more than common significance; for the ship is an entirely new type, and, as such, introduces a new era in the art of warship construction. It is true that in the "Lord Nelson" Sir Philip Watts, the designer of the "Dreadnought," had foreshadowed some of the prominent features of the latter ship, particularly as regards the abolition of the secondary armament. But the new ship is not merely superior in gun power; she embodies many other improvements, which render her a far more formidable vessel than the "Lord Nelson."

General Dimensions.—The "Dreadnought" is the fastest and the most powerfully protected and heavily gunned warship yet constructed, and to accommodate her all-round increase in efficiency, it has been necessary to raise the displacement to 18,000 tons. The length has been increased to that of the largest modern cruisers, namely, about 500 feet. She has the enormous beam of 82 feet, and at 18,000 tons displacement will draw the moderate amount of 26 feet of water, which is 4 feet less than that of the "Royal Sovereign" class of battleships, of twelve years ago. Apart from her great length, the most noticeable changes are the practical abolition of the pointed ram, and the addition of a lofty forecastle deck—the latter an entirely new feature in British battleships. In this connection it should be mentioned that a startling innovation is to be made in the location of the officers' quarters, which will be no longer in the after part of the vessel, but forward in the bows, partly within the forecastle deck above mentioned, and also partly on the main deck below. This is the natural location for the executive officers, inasmuch as they will be near the bridge, chart room, etc., therefore more conveniently placed for their official duties. The change was made years ago in the merchant marine, and the continuance of the officers' quarters astern has been due to conservatism, and not to considerations of convenience. A striking novelty in the ship is the provision of two rudders, arranged parallel to the axis of the ship and 20 feet apart. The increased rudder area will give the ship rapid maneuvering ability.

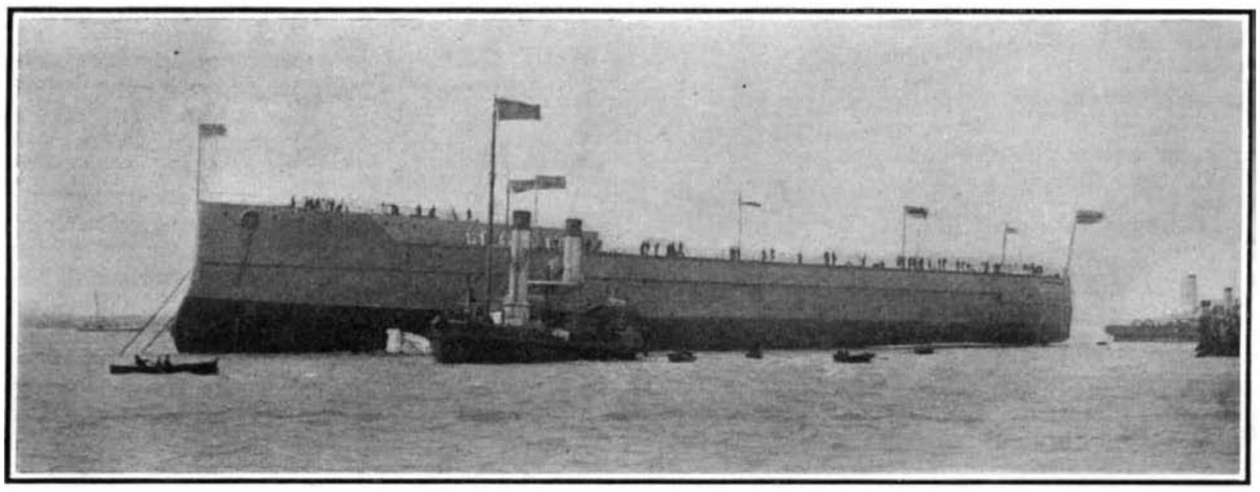
Armor.—The British navy, by arrangement with the Japanese government, was permitted to place several *attachés* on board the ships of the Japanese fleet throughout the operations of the late war, and the new battleship embodies valuable experience gained in this way. The armor distribution on the "Dreadnought" is carefully worked out, and it is not only heavy, but has been widely distributed. It includes the usual complete water-line belt, with the difference that it extends deeper below and higher above the water-line than has been usual, while the side armor above the belt is of extra thickness, and extends along the sides a much greater distance than in any previous ship, reaching from the wake of the aftermost to the wake of the foremost of the 12-inch gun barbettes. Associated with the side armor are armored decks, which serve to limit the destructive effect of high-explosive shell. The abolition of the customary secondary battery of 6-inch guns contributes to the completeness of the protection, inasmuch as the sides of the ship are not pierced by casemates, and a continuous wall of armor extends from below the water-line to the upper deck unbroken by any openings.

Armament.—It is in the armament of the "Dreadnought" that the most striking advance has been made. Hitherto, if we except the "Lord Nelson," the typical battleship has carried four 12-inch guns in two turrets, one forward and one aft, and a numerous battery of secondary guns, generally of 6-inch bore, and in some cases 7, 7½, or 8 inches. It was demonstrated, however, in the battles of the Japanese war, that the vital damage was done by shells of 10- and 12-inch caliber, smaller guns proving ineffective except upon the upper works and other unarmored portions—at least at the great ranges at which the battles were fought. Therefore, the 6-inch gun has been abolished altogether, and the "Dreadnought" carries ten 12-inch rifles, of a new and exceedingly powerful type, with a length of 45 calibers, a muzzle velocity of 2,850 foot-seconds, and an energy of 48,000 foot-tons. This gun is a great advance upon any previously installed in the British navy, the energy of the 40-caliber 12-inch gun mounted on ships as late as two years ago being 30 per cent less than that of the new piece. How greatly the power of a ship is augmented by increasing the number and efficiency of the guns of her main armament is shown by a comparison of the "Dreadnought" with the various classes of battleships built for the British navy since the Defense Act of fifteen years ago. Thus in the "Royal Sovereign" of 1892, the aggregate muzzle energy of all the guns carried by the ship was 160,000 foot-tons. In the "London" class, of a decade later, the total energy had risen to 195,000 foot-tons. With the introduction of 9.4-inch guns in the secondary battery, as in the "King Edward" class of 1903, the total energy rose to 270,000 foot-tons; while in the "Dreadnought" the total muzzle energy of all guns for one discharge is just under half a million foot-tons. These figures are rendered still more impressive when it is remembered that, because of their higher velocity, the 12-inch shells from the "Dreadnought" will be effective up to a range of six miles.

Location of the Guns.—In the location of the guns an effort has been made to give every piece a maximum arc of fire, so that on whatever point the enemy may range, the greatest number of pieces possible may be brought to bear upon him. In the ordinary method of distributing the armament along the broadside, a large number of the guns must, at any given time, be out of action, their fire being masked by the intervening superstructures or decks, as the case may be. In the "Dreadnought" this has been largely overcome by locating all the guns in two-gun turrets, and placing these turrets upon the upper deck, and most of them on the longitudinal axis of the ship, where they may fire on either broadside without interference. The disposition is as follows: Forward on the forecastle deck is a two-gun turret with its 12-inch pieces carried at an elevation of 34 feet above the water-line, and capable of an all-round fire except through a limited arc astern. On either broadside, and somewhat to the rear of this turret, is a two-gun turret firing from well abaft the beam to dead ahead, parallel with the axis of the ship. Astern on the upper deck, and well aft of the engine-room spaces, are two more two-gun turrets, placed one astern of the other on the axis of the ship, the aftermost gun having a wide arc of fire from well forward of the beam on either side to dead astern. The forward of the two turrets can train its guns throughout the same arc of fire except where it is masked by the aftermost turret. The maximum possible concentration of fire is six 12-inch guns ahead, eight on either beam, and two dead astern. To engage a pursuing enemy with both after turrets it would be necessary to swing the "Dreadnought" a little to port or starboard. The comparative weakness of the dead-astern fire is considered to be unimportant in view of the fact that the "Dreadnought," because of her great fighting power, will be pursuing rather than eluding the enemy. The high command of the 12-inch guns, which will vary from 25 to 34 feet, insures that at no time, even in rough weather, will the enemy's ships be shut out from the gunner's sight by intervening waves.

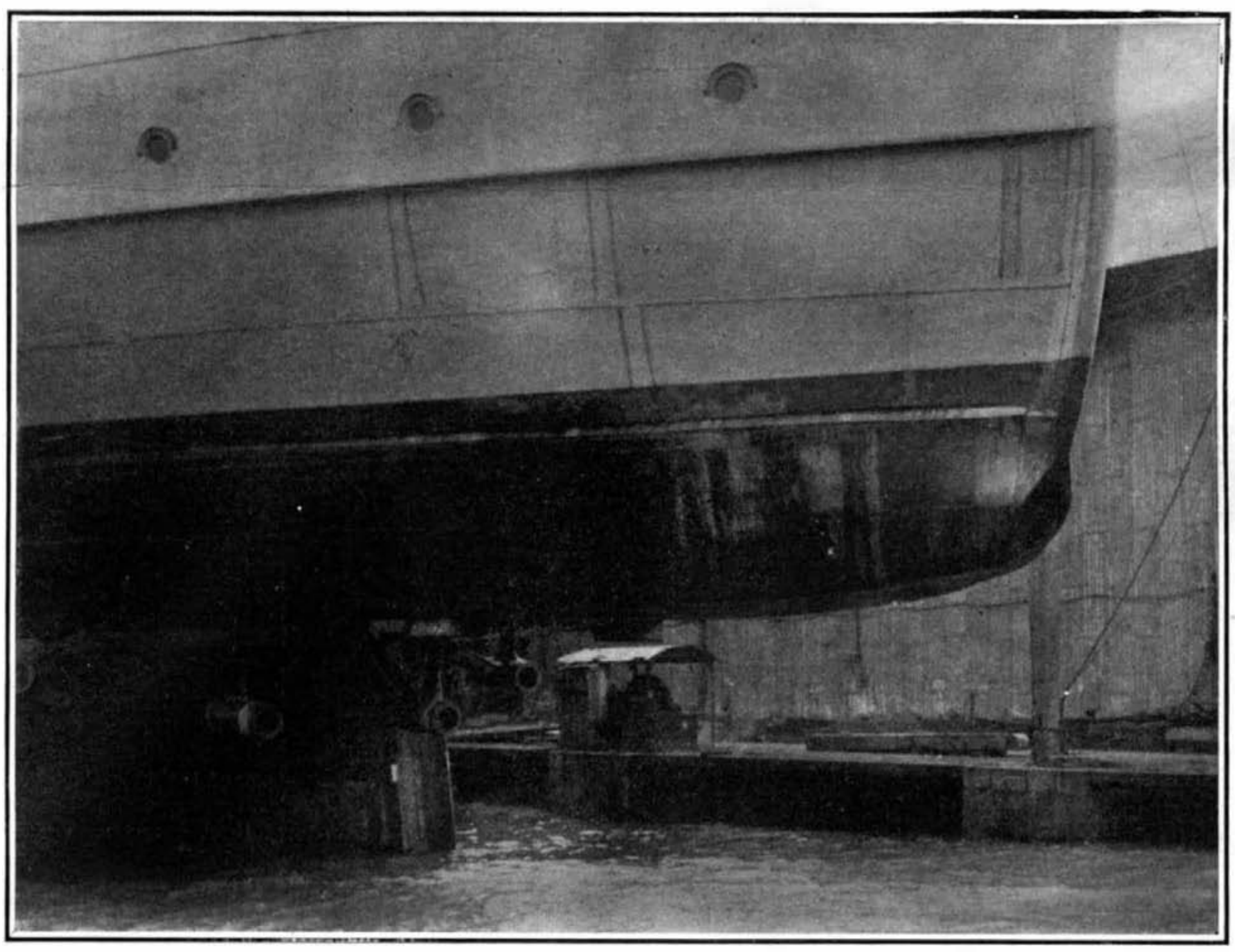
For repelling torpedo attack the "Dreadnought" will carry on her bridge and superstructure a numerous battery of a new type of 18-pounder rapid-fire guns, or better, a smaller number of 4.7-inch guns.

Motive Power and Speed.—The ship will be driven by an eight-cylinder turbine engine, driving four propellers on four shafts. The shafts, as will be seen from our engraving, are located abreast of each other. On each outer shaft will be a high-pressure main turbine and a high-pressure go-astern turbine; while on each inside shaft will be a low-pressure main, a low-pressure go-astern, and a small cruising turbine for



Length, 500 feet. **Beam,** 82 feet. **Draft,** 26 feet. **Displacement,** 18,000 tons. **Speed,** 21 knots. **Armament,** ten 12-inch guns in six turrets on the upper deck. **Motive power,** eight turbines developing 23,000 horse-power on four shafts.

THE LAUNCH OF THE BRITISH BATTLESHIP "DREADNOUGHT."



STERN VIEW OF THE "DREADNOUGHT," SHOWING THE BRACKETS FOR THE FOUR PROPELLER SHAFTS, AND THE STERN TORPEDO TUBE.

steaming ahead at low power. When the vessel is cruising, steam will be led directly to the small low-power cruising turbines on the inside shafts, whence it will pass to the high-pressure wing turbines, and from them to the low-pressure turbine on the inside shafts, whence it will pass to the condenser. With such a wide range of expansion it is anticipated that, even at the slower speeds, an economical coal consumption will be secured, thereby overcoming the one great objection that has hitherto been urged against the turbine as a drive for warships. The keel of the "Dreadnought" was laid in October of last year, and she was launched on February 10, or within a period of four months. It is expected that she will be in commission early in 1907, in which event she will have been constructed within the remarkably short time of eighteen months.

STANDARDS OF LENGTH.

BY HERBERT T. WADE.

The standards of length of the United States are two meter bars, which are kept in the custody of the National Bureau of Standards at Washington, and preserved most carefully in its strong vault. These standards are exact copies of the international prototype meter, and were constructed after years of investigation and labor by the International Bureau of Weights and Measures, being delivered to the United States government in 1890. Three years later the international meter as thus represented was adopted as the fundamental standard of length of the nation by executive order, and to these standard bars now all measures of length in the United States must be ultimately referred. This may seem somewhat strange in view of the fact that the metric measures are but rarely encountered in the United States outside of scientific work, but the yard and its subdivisions are defined in terms of the meter, one yard being equal to 3600/3937 meter. These standard meters are of X-section, a form now employed for all accurate standards, and are made of platinum-iridium alloy. It is of course essential that they should be preserved with the utmost care, and consequently they are only removed from the vault for use in making secondary standards, or for equally important investigations.

To illustrate one of the comparatively rare occasions on which the standard meter bars are employed for purposes of study and comparisons which involve their removal, reference can be made to the examination of the two standards in 1904, previous to sending one to Paris for comparison with the standards of the International Bureau. This study was made with a comparator arranged in the temporary quarters of the Bureau, and as shown in the accompanying illustration (Fig. 1). It was placed in a basement room, there being two masonry piers carrying a heavy steel I-beam, on which were mounted the comparison micrometer microscopes. The two standards to be compared were placed in a box of wood lined with copper and coated with brass, which was carried by rollers on rails laid on the upper surfaces of two smaller brick piers. This temporary instrument differed radically from the comparators of the International Bureau and the British Office of Standards,* where the micrometer microscopes are each mounted on separate piers, yet it proved satisfactory, and the Bureau now proposes to construct a permanent instrument, making the I-beam of invar, a nickel-steel alloy with a remarkably small coefficient of expansion.

With such a comparator it is believed that results almost, if not quite, as accurate as those secured at the laboratories named will be secured, and it possesses the further advantages of permitting the microscopes to be clamped at any point on the bar, thus allowing standards of any length to be studied, instead of those of just a meter, as is the case where the microscopes are mounted on the masonry piers. In such an instrument a secondary standard could be compared directly with the national standard.

It is often desirable to construct secondary standards, and for this purpose what is known as a dividing engine is employed, as is shown in Fig. 2, where a tracing tool can make a series of linear marks as the bar to be graduated is pushed along on its carriage, which is moved by an accurately-cut screw revolving in a nut attached to or pushing against the carriage. Or the standard bar can be placed so that the microscope of the dividing engine is over one of its lines, and a mark is then traced on the new scale. Then both scales are moved along until the microscope is over the desired mark on the standard, when a second line is traced. The instrument can be arranged to work automatically, and a scale with a series of divisions can be engraved speedily. It is able to divide linear scales of different lengths and with different divisions; and when once the characteristics of the screw are determined and various corrections made, considerable accuracy can be attained. Secondary standards prepared in this way are available for many purposes, and with them the standards of instrument makers and mechanical engineers are compared.

In regard to measures of length, one of the most important duties of the Bureau is to standardize and certify surveyors' steel tapes. This is a matter of much practical importance, as the variation of the standards used in laying out the cities of the United States has caused much confusion, and has at times resulted in producing litigation. Thus in Philadelphia, owing to an error in the length of the measure used in early surveys, 100 feet as then measured correspond now to 100 feet 3 inches, and tapes divided on such a basis are actually made and sold for use in this part of the city, while elsewhere a standard foot is employed. In the early surveys of New York and Brooklyn measuring rods, chains, or tapes were used whose errors in some cases amounted to as much as 1½ inches in a hundred feet. Consequently, in laying out a city or large tract, it can be seen how such errors of the standard used to measure distances would soon increase, and occasion discrepancies in surveys and descriptions of property.

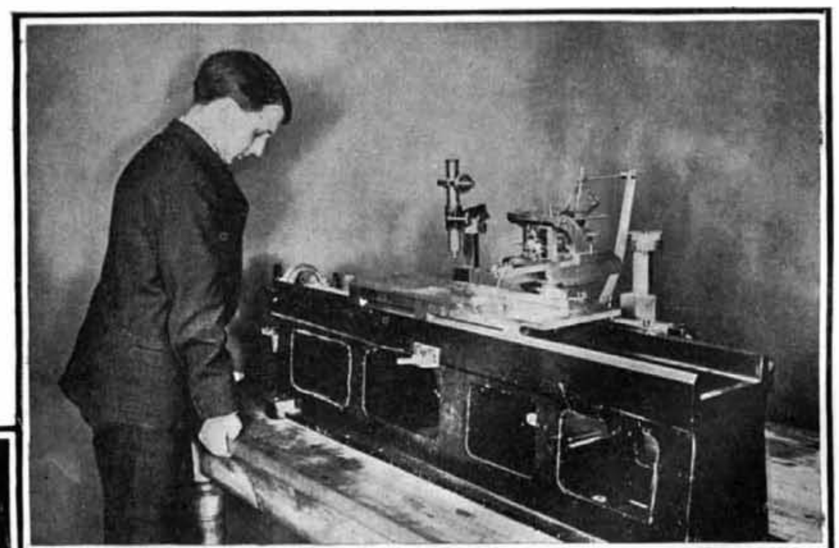


Fig. 2.—DIVIDING ENGINE FOR CONSTRUCTING LINEAR SCALES.

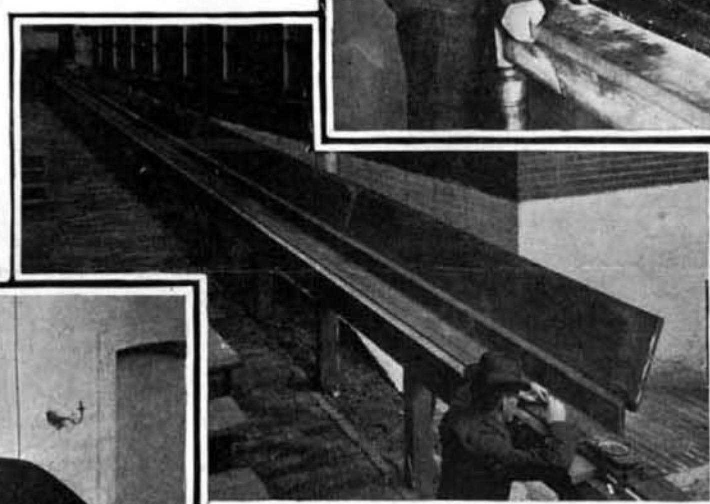


Fig. 3.—TESTING SURVEYORS' STEEL TAPES ON TEMPORARY BENCH.

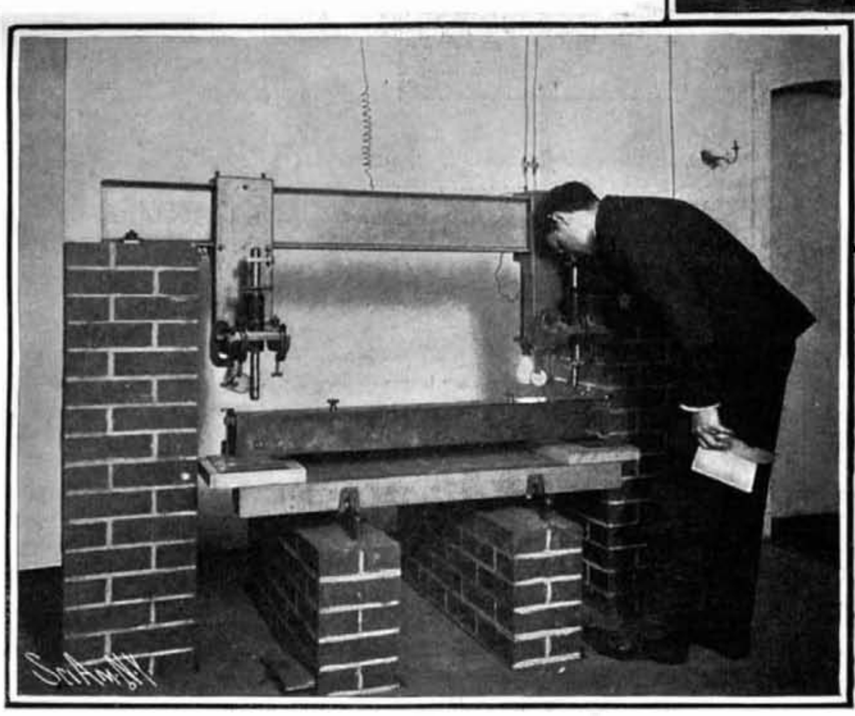


Fig. 1.—COMPARATOR FOR STUDYING STANDARD METER BARS.

While of course there has been a marked improvement from the early days of the nineteenth century referred to, yet to-day it is no less important to have means to accurately standardize tapes, and thus guarantee their true values. At the beginning of the Bureau's work this was done, as is shown in the illustration, Fig. 3, which represents a temporary bench or accurately measured distance, where tapes were tested under a proper and standard strain, due allowance being made for temperature by using carefully tested thermometers. In the new laboratory of the Bureau a special provision has been made for this work, and a standard bench 50 meters—164.04 feet—in length, made of bars of steel welded together by means of thermite, has been constructed, so as to form a continuous strip on which the tapes to be tested can be laid. This is mounted on one of the walls of the tunnel connecting the physical and the mechanical buildings of the Bureau, and on it the standard distances will be laid off most carefully. This tunnel is susceptible of temperature regulation, and here geodetic base bars and other linear standards can be tested and standardized.

The testing of gages and various standards of length, such as test pieces used in mechanical engineering, represents another side of the work of this division of the Bureau. This is of importance, as in manufacturing, especially when carried on on a large scale, it is essential that all standard sizes should not only be interchangeable, but should be defined in terms of a national standard rather than that of a single shop or one arrived at in some arbitrary way. This section of the Bureau is planning to take up quite extensively the testing of watches and chronometers, and for that purpose receives daily from the Naval Observatory noon signals by wireless telegraphy from the standard clock of that institution. The Bureau has a self-regulating clock in its laboratory, which is installed in a vacuum case, and is provided with a pendulum of invar, whose coefficient of expansion at ordinary temperatures is so small as to be practically negligible.

As accuracy in the measurement of linear distances underlies all mechanical as well as scientific work, the importance of preserving and maintaining proper standards and attending to the accuracy of the measures in use can readily be appreciated, and the Bureau is frequently consulted in such matters by various manufacturers. Should at any time within a few years the metric system be adopted, as is being urged by large and influential interests, the work of the Bureau would be to provide for the issue of proper standards and to certify to the correctness of new measures, a task that in Germany was carried on by a similar organization (Normal Aichungs-Kommission) with great success when the metric system was adopted some thirty years ago.

* See SCIENTIFIC AMERICAN, July 22, 1905, p. 65.

One of the latest methods of preserving wood has been patented by Montravel, in France. It has been recognized that one of the best means of preservation is to keep the wood at a high temperature in closed vessels (about 250 deg. C.) and at the same time at a high pressure, some 250 pounds per square inch. This method has been perfected by the inventor. The object of the improvements is to provide means of heating as efficacious as usual, but more practical and economical. Another aim is to utilize a part of the air pressure which has served for one operation, thus saving work in compressing. In the new process the pieces of wood are put in compression cylinders and the air is sent direct from the compressors into the cylinders. To heat the air, each cylinder is surrounded by a masonry envelope not in contact with it, thus leaving a free space. The hot gases from a furnace are circulated in this. Cooling is effected by introducing cold air in the space. To obtain a specially good and cheap heating, a series of gas jets is placed in the lower part of the air-jacket and fed by a gas-tube, and having an air tube to aid in combustion. When the plant uses several cylinders side by side, there is a saving in the work of air compression by utilizing a part of the compressed air in a cylinder at the end of the operation to send it into the next cylinder in commencing the compression here. Piping is arranged between the cylinders for this purpose.