

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 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

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

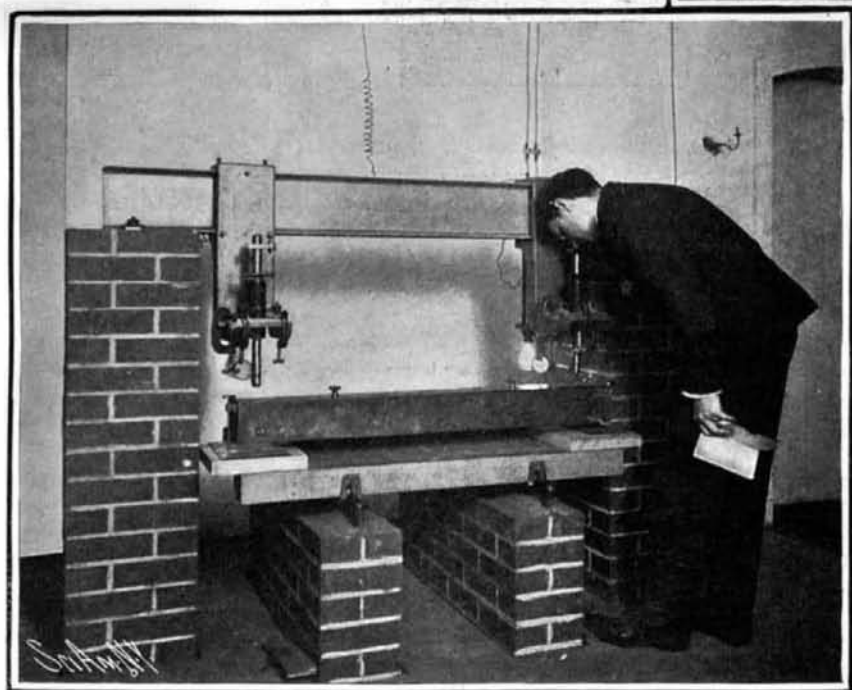


Fig. 1.—COMPARATOR FOR STUDYING STANDARD METER BARS.

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

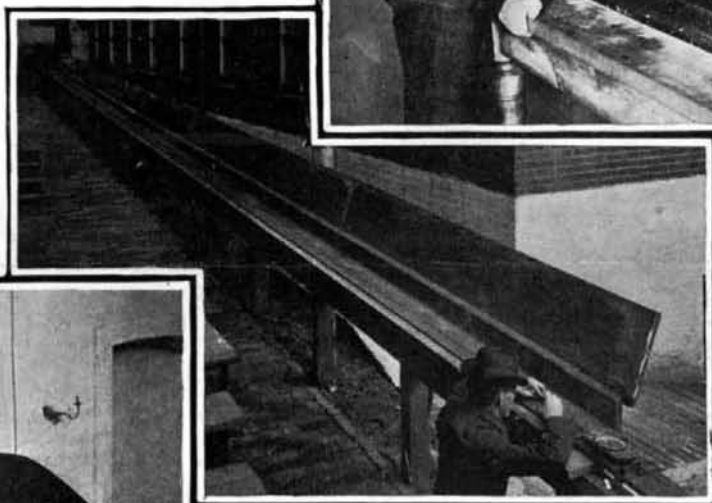


Fig. 3.—TESTING SURVEYORS' STEEL TAPES ON TEMPORARY BENCH.

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.

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—

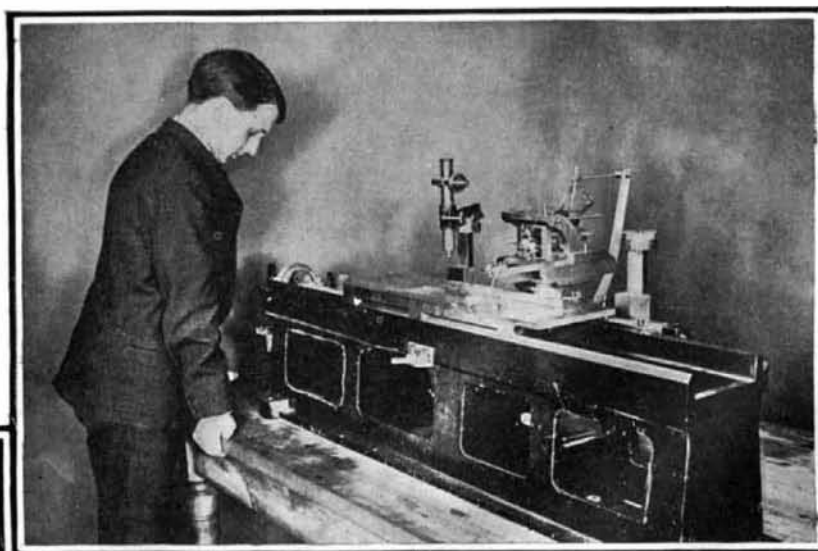


Fig. 2.—DIVIDING ENGINE FOR CONSTRUCTING LINEAR SCALES.

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.

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.

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