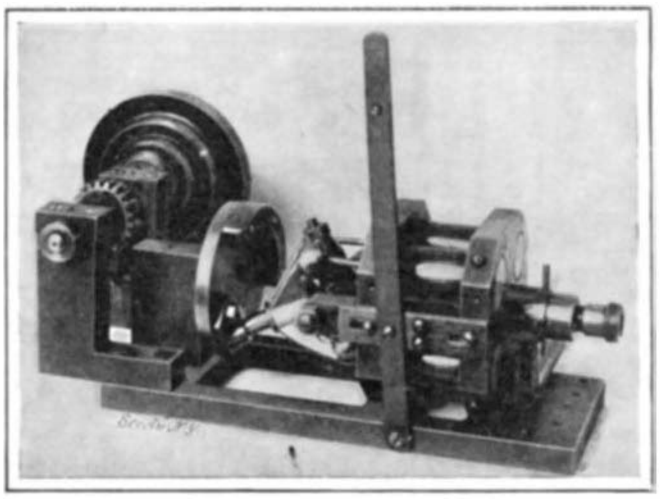
A NOVEL GYRATING STEAM ENGINE.

A new form of steam engine, with which a constant thrust is obtained on the driven shaft, is shown in the accompanying illustration. The engine is the invention of Mr. Frederick Egge, of Bridgeport, Conn., and it will be found particularly useful for any service where a powerful, compact, and light-weight engine that can be instantly reversed is desired, such as for hoisting work and for automobiles. As can be seen in the illustration, the engine consists of four horizontal cylinders placed symmetrically around a central tube containing, near its right-hand end, ports opening into the cylinders (one port for each). The piston-rods are fitted with ball and socket joints at both ends. Their outer ends are connected to a sort of spider set at an angle with the transversely-placed disk on which it is mounted. The thrust of the piston rods on the arms of this spider tends to push it off the periphery of the disk, but as the spider is firmly secured to the disk, this is revolved instead, and the spider goes through a gyrating motion as it is successively driven by each of the four pistons. The spider is mounted on and pinned to a short rod having a bearing at its upper end near the periphery of the disk and at its lower end in a block on the extremity of a small central shaft that actuates the rotary valve for supplying live steam to and carrying off the exhaust steam from all four cylinders. The gyrating movement of the spider causes this rod (which has a universal joint near its lower end) to make one turn to every revolution of the disk, and thus the valve also is driven at the same speed as the disk. The valve consists of a sleeve having two sets of ports—one set for running in either direction—as well as a suitable exhaust port. The lever on the side of the engine slides the valve laterally, and instantly reverses the engine. This feature is the result of the constant thrust at an angle of 30 deg. obtained from one or another of the four pistons.

The photograph which we reproduce is that of a working model designed to show the use of the motor as a hoisting engine. It could also be applied to an automobile by direct attachment to the rear axle with a bevel or spur gear drive. An engine of this type can be built of very light weight, and so should be useful in all cases where a portable motor is needed.



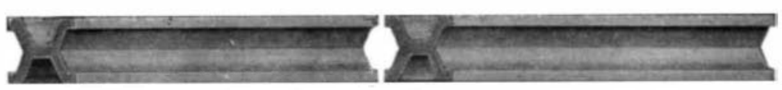
A NOVEL GYRATING STEAM ENGINE.

THE NEW BRITISH YARD STANDARD.

BY HERBERT T. WADE.

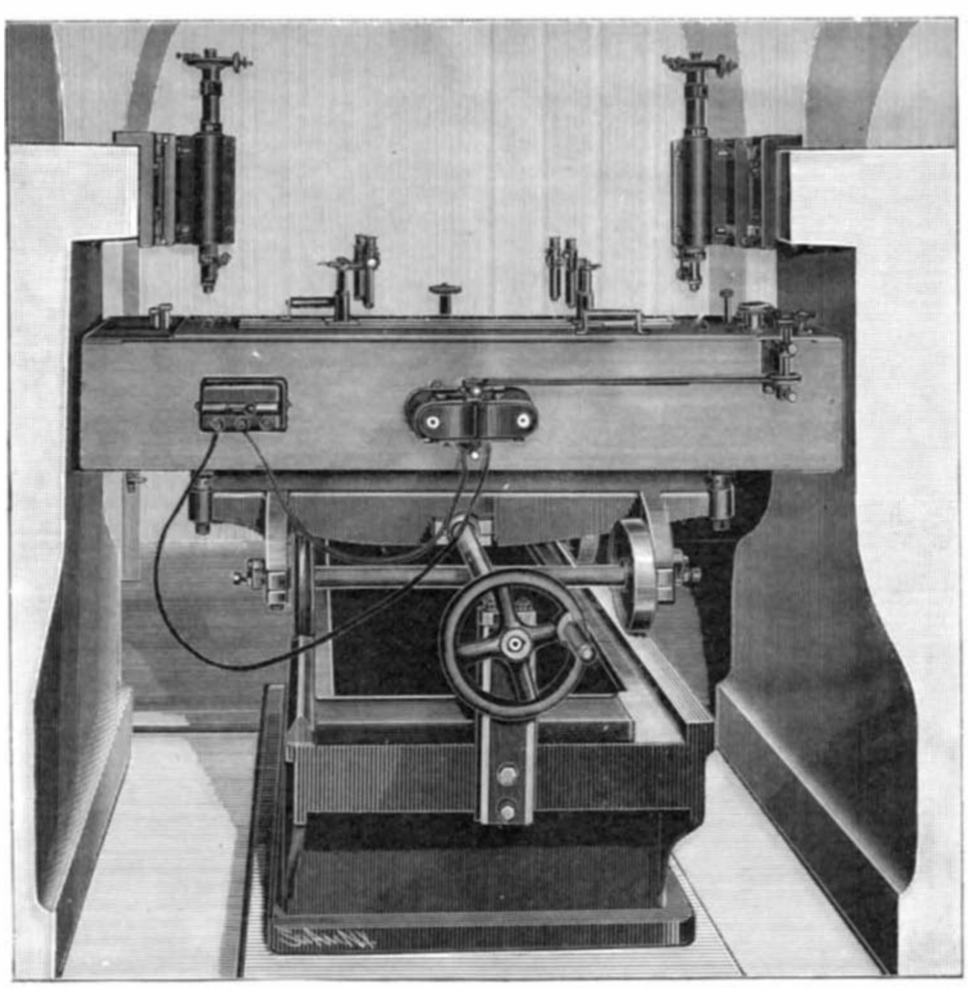
During the past year the Standards Department of the British Board of Trade has been engaged in studying and verifying a new yard standard, in which have been incorporated all the refinements made possible by the modern science of metrology. The present imperial standard or legal yard of Great Britain is a bronze or gun-metal bar of rectangular section legalized by Act of Parliament in 1855. The true or legal yard is taken as the distance at 62 deg. F. between two fine lines on the surfaces of two gold plugs that are sunk in wells or holes near the ends so that their surfaces lie in the median or neutral plane of the bar where any effects of flexure are reduced to a minimum. A number of copies of this standard bar were made when it was constructed and one of them, No. 11, was given to the United States government, and is now in the fire-proof vault of the National Bureau of Standards at Washington. It has twice been taken to England for comparison with the British standards, and for many years served as a standard of length for the United States. A study of the various bronze standards, however, showed that they were not absolutely invariable and that their length was likely to be altered some minute but appreciable amount by molecular and other changes taking place in the alloy of which they were formed. In fact, the unsuitableness of bronze for a prototype standard was recognized at the time when the construction of an international standard meter was proposed in 1872, and the commission determined on an alloy of platinum and iridium, not only for the international prototype, but also for the various national standards which were to be similar in size, form and composition. In making these standards, it was necessary to use a material that resembled as closely as possible the original platinum meter of the Archives, but also its composition should be such that it would be free from oxidation and possess as well the requisite strength, elasticity, and other mechanical characteristics. These meter bars when completed represented the most careful and accurate workmanship, so that when the two standards allotted to the United States were received by the government, it was only a brief space of time before they were adopted by executive order as the national fundamental standards of length, from which the yard or common unit was to be derived by using the ratio 3600/3937 specified in the Act of July 28, 1866. Thus the British bronze standard yard was displaced as a standard of length in the United States by the platinum-iridium meter of the International Commission, despite the fact that Anglo-Saxon weights and measures were and are universally employed.

Convinced a few years ago of the necessity of constructing a new copy of the imperial standard yard, the Standards Department of the Board of Trade, under the direction of Mr. H. J. Chaney, superintendent, decided to employ such a material as would best answer the requirement of resistance to oxidation, hardness, density, permanence, elasticity, etc., and select such a form as should be considered best in the light of actual experience with standards of length and the developments of metrological science. These matters had been most thoroughly discussed and investigated at the time of the construction of the international metric standards, when it was realized that such materials as gold, platinum, iron, or even rock-crystal, for various reasons, were quite unsuitable. Accordingly, it was determined to employ an alloy of 90 per cent platinum with 10 per cent iridium. This was possible by the adoption of a peculiar cross section of X shape devised by M. Tresca, of the French committee, whereby sufficient strength and rigidity were obtained without the employment of an undue amount of metal such as would render the cost prohibitive or the bar of unwieldy mass. Furthermore, the platinum-iridium alloy expands but little with an increase in temperature, while its surface can be given a high polish so that the lines marking the standard distance could be engraved directly on its surface. These international standards had not only proved eminently satisfactory in their use at the Bureau of Weights and Measures and in the various national laboratories, but no essential improvements could be suggested, so that the British metrologists concluded that they could do no better than to copy the composition and their form in constructing their new standard yard. Thus they would have a standard whose constants would be known not only independently, but also in terms of the International Prototype Meter. Fortunately, they were able to obtain one of a series of bars made from an ingot of the specified alloy which was cast at the Conservatoire des Arts et Métiers at Paris for the use of the Bureau International des Poids et Mesures. In 1902 this bar was polished and adjusted at the laboratory of the Société Genevoise pour la Construction d'Instruments de Physique at Geneva, and was then sent to the International Bureau of Weights and Measures at Sevres, near Paris, where a meter and a yard were traced on the bar by M. J. Rene Benoit, the director. This was accomplished with the dividing engine of the bureau, and the same general means and methods were employed as were used when the standard meter bars were constructed and graduated. The construction and form of the new standard will be apparent on reference to the accompanying illustration, which shows clearly the X or Tresca section. The rigidity of the bar is manifest from its design, while provision is made whereby the neutral or median plane coincides with the upper surface of central portion or cross bar on which the lines are traced, reducing to a minimum any effects of flexure caused by inequalities of the supports. On this surface parallel with the axis of the bar are traced two fine lines, 0.2 millimeter distant from each other, and across these is another fine line which marks one extremity of the standard length, the latter being measured between two such lines, points being taken which are included between the longitudinal lines, the general appearance when seen under the microscope being as shown in the accompanying engraving. In the new British standard one such transverse line marks the beginning for both the meter and the yard, while at the opposite end of the bar there are similar sets of lines to indicate the limits of each. In short, the new standard is practically a standard meter with a yard marked on it, and thus the British Standards Office now has on a single bar a determination of the value of both of these fundamental units of length as given by the officials of the International Bureau in terms of the international standards, and also, after the conclusion of the present investigation of the bar, its value in terms of the Imperial Standard, which doubtless will be legalized in some form or other. According to the officials of the bureau the new British standard when referred to the International Prototype Meter at 0 degree Centigrade is too long by 2.9 microns or 29 parts in ten million, while the yard marked when referred to the yard standards and equivalents of the Bureau was too long by 0.000226 inch when reduced to 62 deg. F., the British standard temperature. After its determination and study at the Bureau, the new bar was then carried to London, where it has been the subject of a most careful investigation by the officials of the Standards De-



British Iridio-Platinum Yard Standard Showing Cross-Section. The Bar is in the Position it Occupies in the Comparator.

The Standard Turned on Its Side and Showing the Two Defining Lines (Magnified) on the Neutral Surface of the Bar.



THE NEW MICROSCOPIC COMPARATOR OF THE BRITISH STANDARDS OFFICE.

partment, having been compared directly with the national or Imperial Standard in an elaborate series of experiments. The result of the preliminary observations when computed and reduced was that the platinum-iridium standard was too long by 0.000227 inch, but the investigation has not as yet been concluded and this value may be changed. The research, however, brought out many interesting points about the British standards of length and their degree of accuracy. The Imperial Standard yard is legally defined to have its true length when measured at the temperature of Fahrenheit's thermometer, but there was and is no legal standard of the Fahrenheit thermometer, and the original temperature measurements employed in determining the bar were made with mercurial thermometers which vary 0.3 deg. Fahrenheit plus and minus. As the length of any solid such as a bar is continually varying with changes in temperature, it is of course impossible to determine linear values with precision unless the temperature is known with a degree of accuracy corresponding to the other measurements. Consequently, the British observers were forced to follow the example of the International Bureau and modern physicists generally reduce all their readings to the scale of the gas thermometer containing hydrogen. This also involved a careful study of the thermometers, new and old, so that in the present determinations the temperature effects could be considered and corrected for with the greatest possible precision. The comparisons were made at the Standards Office, Old Palace Yard, Westminster, and the old Sheepshanks comparator used when the Imperial Standard was constructed was employed in some of the comparisons, as well as a Troughton and Simms comparator which was built in 1870. But these instruments were considered to be somewhat below the standard demanded by modern metrological science, so accordingly a new comparator was built capable of the greatest accuracy and embodying all refinements that scientific thought could suggest and precise workmanship execute. As the object of a comparator is to determine as accurately as possible the difference in the length of two or more standards, its essential characteristics are two micrometer microscopes mounted on heavy masonry pillars, so as to be free from all vibration, and some suitable mechanical device to permit the scales to be placed successively below the microscopes in the same position. The distance between the two microscopes remains constant during the comparison, and the bars to be compared are placed below them, so that the cross-wires of the microscopes can bisect the fine lines of one of the standards. Then when this standard is replaced by the other under exactly similar conditions, by means of the micrometers the cross-wires can be brought to bisect its lines, and the difference in length be determined. Of course, means must be provided for carrying and moving the standards, for regulating the temperature and keeping it uniform, illuminating the surfaces of the bars, avoiding vibration and other disturbances, and providing for many other conditions demanded in exact measurement. The construction and action of a modern comparator can best be appreciated by reference to the illustration, which shows the new instrument of the British Standards Office, which is essentially the same as the comparator of the Bureau International, and involves the most improved devices. It is mounted on a deep foundation of concrete, which rests on rubble over sand. On the concrete are placed three slate slabs, two of which carry massive blocks of Yorkshire stone, forming the two pedestals for the microscopes, while the third or center slab carries the heavy cast-iron frame on which are the rails for the carriage carrying the scales. To prevent any movements of the observers being communicated to the apparatus, there is an air space surrounding the foundation to a depth of five feet. On the tops of the stone pedestals are bolted heavy cast-iron supports or brackets for the microscopes, whose objectives are about 95 millimeters above the bars. The latter are carried in a trough on a carriage capable of a transverse movement beneath the microscopes, and also so arranged that the height of the bars can be adjusted by micrometer screws which raise or lower the trough. The latter is double-walled, and water kept in circulation by an electrically-driven agitator flows in the intervening space, and causes a constant temperature to be maintained. The bars themselves rest on rollers in the trough, so that they are free to expand or contract with any change in temperature. The micrometers are of the ordinary type, where a system of cross-wires arranged in the focal plane of the objective can be moved by means of an accurately cut screw with a divided head moving in a nut. By means of a linear scale placed in the field of the microscope, the value of the space traversed by the cross-wires during one revolution of the screw is ascertained, and fractions of a revolution can be determined from the graduated head and its vernier. The illumination of the surface of the bars is also important, and the method adopted is to send light from a small incandescent lamp into the microscope tube, and by means of a thin polished plate of glass inclined at an angle of 45 degrees reflect it onto the lines of the bar. With this new instrument it is believed that the highest accuracy can be secured, and that the British Imperial yard can be defined in a more satisfactory manner, as well as be represented by a more permanent and accurate standard.

THE MAMMOTH CUNARD LINERS.

It is many years since there was the same amount of interest attached to the building of a new liner for transatlantic service as is shown in the two turbine-driven Cunarders which are now under construction, one at Swan & Hunter's yard on the Tyne, and the other at the John Brown Company's works, Clydesdale.

This interest is due to the extreme size, the high speed aimed at, and the novel character of the motive power. To find a parallel to the interest in these vessels we have to go back to the year 1889, when the Inman and International Company brought out the first twin-screw ships to be seen in the Atlantic service, the "City of New York" and "City of Paris." Furthermore, it is realized by the general public that these new Cunarders represent the determination of Great Britain to win back the Atlantic record, which was lost several years ago to the "Kaiser Wilhelm der Grosse," and which has subsequently been casily retained by those other fine German ships, the "Deutschland" and the "Kaiser Wilhelm II."

It is known that the new Cunarders are to be the largest ships ever built; but it is not generally realized how very much larger these ships are to be than any of the huge liners which now excite our wonder by their great proportions. The increased dimensions are shown in the accompanying table, which includes the largest of the ocean liners that have been built of late years; and on comparing the Cunarders with the largest of the existing fast passenger ships, the "Kaiser Wilhelm II.," we find that she is longer by 94 feet than that vessel; that she has 7½ feet more molded depth; that she has 16 feet more beam; that her designed horse-power is nearly twice as great; that her displacement is 13,000 tons more; and her sea speed will be 1½ knots greater. Furthermore, in view of the fact that turbine engines invariably develop a horse-power greatly in excess of the contract, it is possible that on her trial she may make 26 knots an hour, or 2½ knots more than the record speed of the "Kaiser Wilhelm II."

THE BIG STEAMSHIPS OF THE WORLD.

	Length over all in feet	Beam, feet.	Depth, feet.	Displacement.	Horse-Power.	Speed.
Great Eastern	692	83	57½	27,000	8,000	14.25
Lucania	625	65	42	19,000	30,000	22.01
Oceanic	704	68	49	28,500	28,000	19.50
Deutschland	686	67	42	23,000	37,500	23.5
Baltic	725	75	49	40,000	18,000	16.25
Kaiser Wilhelm II	706	72	52½	30,000	40,000	23.5
Turbine Cunarders	800	88	60	43,000	75,000	25

It was not the original intention to make these vessels of such extreme proportions. They grew to the dimensions ultimately adopted, as the result of the elaborate studies that were made, both at the towing tank and at the designing board. The first tentative plan called for a vessel 700 feet in length. This grew to 720 feet, and finally to the present overall length of 800 feet. The beam is 88 feet measured over the skin plating, or 87 feet 6 inches to the outside of the frames; the plating, by the way, being 1½ inches in thickness, which, on the lap, will bring it to a total thickness of 3 inches on each side. The plated depth is 60 feet, which may be compared with the 42 and 49 feet molded depth of such ships as the "Deutschland" and "Oceanic," the plating being, in this vessel, carried up one deck higher. This increase is rendered necessary by considerations of the longitudinal girder strength of the ship as a whole, and is one of the means by which the necessary shearing strength is obtained. The extreme draft is 36 feet; but this, of course, can only be availed of when the new Ambrose Channel into New York harbor shall have been fully dredged out. The government has promised sufficient depth in this channel, by the time the Cunarders are ready, to enable them to come and go, drawing 33½ feet of water. On the latter draft they will displace a little over 40,000 tons, and on the full draft of 36 feet they will displace about 43,000 tons. Of the dimensions given above, the beam is the most striking, and these ships are the first to exceed in beam that accepted standard of measurement for modern steamships, the "Great Eastern."

The drawing on our front page contains the first authentic information regarding their interior structure. The double bottom, which is the most important structural element in the hull, will be 5 feet 6 inches in depth between the outer and inner shells. There will be a dead rise of 18 inches from the keel to the bilge, and the frames will decrease from 5 feet 6 inches at the keel to about 4 feet in depth where the curve of the bilge straightens into the sides. There will be about twenty longitudinal frames consisting of heavy built-up I-beam sections, extending, some of them, the full length of the ship. Our sectional view is taken at about the midship section, and it passes through one of the boiler compartments. The great width of the ship enables the Scotch boilers, which will be of the largest size, to be placed four abreast, and still leave room for large coal bunkers in the wings. There are eight decks in all. First, the Orlop deck, just above the boiler rooms, on which, in this particular part of the ship, there will be space for carrying the regular ship's stores; the deck above, known as the Lower deck, will be devoted largely to third-class passengers. A feature that will add considerably to the comfort of these passengers will be the subdivision of the space into separate staterooms. The waterline will be at the level of this deck, which will be lighted with portholes, and thus provide a large number of outside staterooms for the third-class passengers. The Main deck will be given up to first-class staterooms. The Upper deck, also, will be devoted to first-class accommodation, and on this deck will be the great dining saloon, which will extend the full width of the ship, providing a single room over 80 feet in width by 125 or more feet in length, and capable of seating over 500 people. In the center will be a large overhead well, which will extend through two decks and be crowned with a dome of cathedral glass. The fifth, or Shelter deck, completes the molded portion of the vessel, and is 60 feet above the keel. The three decks above this, known as the Bridge deck, Promenade deck, and Boat deck, are devoted to first-class passenger accommodation, and they have, on each side of the central tiers of staterooms, a broad promenade open to the weather.

How greatly these ships will exceed all others in the nature of the passenger accommodations is shown by the fact that the first-class staterooms are to be 50 per cent larger than the customary size. The total height of the ship, from the keel to the boat deck, is about 90 feet, or the height of say an eight-story building. In the presence of such dimensions, the problem of what might be called "vertical travel" becomes a serious one. On shore we have overcome it by the adoption of the elevator; and with the growth in size and steadiness of the giant passenger ships, the time has now come when the passenger elevator can be applied with perfect safety to these floating hotels. The Cunard Company was the first to incorporate the elevator in the plans for its new ships; and it may interest the readers of the Scientific American to know that the first practical suggestion of the use of the marine elevator was made in 1902 by a member of the staff of our paper to Mr. Vernon H. Brown, the general manager of the company in America, who thought so well of it, that he forwarded the suggestion to the Liverpool office with his approval of it as a practical improvement. The suggestion was adopted, and at once incorporated in the plans of the ship. There can be no question of the great convenience that will be afforded by a passenger elevator on board large steamships, and it is pretty certain to be generally adopted.

The motive power will consist of four turbines, each of a designed indicated horse-power of 18,000, which latter, by the way, is about the total horse-power of the "City of Paris" and the "City of New York," above referred to. All four turbines will be placed upon the same platform; but while the propellers of the inside pair will be located just forward of the rudder in the usual position, the propellers of the outside pair of turbines will be located forward of the inner pair, the great beam of the ship admitting of this arrangement. Although the contract horse-power is about 71,000, the boiler power is sufficient for 75,000 horse-power, and 75,000 horse-power with reciprocating engines would, according to the tank test, give a speed of 25 knots an hour. Mr. Hunter, of the firm of Swan & Hunter, where one of these ships is being built, has supplemented the tests of the tank models, constructed on a quarter-inch scale, by building a working model on a ¾-inch scale, which is 50 feet in length. He has equipped this model with turbines and four propellers, and has been making a large number of tests with propellers of every conceivable practicable type. The results of these experiments, of course, are not available outside the company, but it is sufficient to say that they are very promising for the complete success of the great ships themselves. As regards the speed of the vessels, they must show an average of 24½ knots an hour on actual voyages. Judging from the way in which the steam turbines in the British cruiser "Amethyst" ran ahead of the anticipated results, we shall not be surprised to see these vessels exceed an average speed of 25 miles an hour from port to port under favorable conditions.