

usual 30 inches, each ring of plates is separated from the two on each side by blocks of wood, so that the opening between the plates is wedge shape, the rings touching on the south side, and being a few inches apart on the north side.

The way in which the supplies are brought in and the excavated material taken out will be understood if we follow a load of silt from the heading to the surface. It is loaded upon a small car, which is pushed along a track up to the lock, into which it is rolled over a short section of movable track placed across the sill of the door. Having passed this lock, it is drawn to the second one—first from the shaft—by a mule, which seems to be contented to work continuously under compressed air. This animal has been in the tunnel for three or four weeks, and his physical condition appears to have been most decidedly improved. Passing this lock, the car is drawn by a second mule to the bottom of the shaft, where a small turntable guides it to the elevator, up which it is lifted and then hauled to the dumping ground. Supplies for the heading go over the same route, and are handled in the same way, except that, the grade being down, the cars run by gravity. It is expected to soon replace the arc lights now used at long distances apart by an incandescent system, as the light can be more evenly and generally distributed.

The journey out of the tunnel is quickly made, and it is certainly with a marked sense of relief that the investigator of dark places finds himself in the wash room at the top of the shaft, removing all traces of his travels.

NEW ARMORED CRUISER FOR THE SPANISH NAVY.

On February 24 there was launched from the shipyard of Messrs. J. & G. Thomson, Clydebank, a new Spanish cruiser, named the *Reina Regente*, of which our illustration is a general external view as she is intended to float when finished. This vessel was contracted for after the leading shipbuilders in Britain and other countries had submitted competitive designs to the Spanish government, the designs submitted and since carried out by Messrs. Thomson being adopted. Among the conditions laid down by the Spanish authorities to be fulfilled in this vessel were that she was to be of the protective deck type, the deck having a thickness of $3\frac{1}{4}$ in.; to have four 20 centimeter 12 ton guns, six 12 centimeter guns, and a numerous small armament; to be able to maintain a speed of 19 knots, and to have a radius of action of 5,500 knots. These stipulations have been much more than met in the vessel as constructed, her builders having arranged for a protective deck of $4\frac{1}{4}$ in., four 24 centimeter 21 ton guns, six 12 centimeter guns, a speed of $20\frac{1}{2}$ knots, and a radius of action of as much as 12,000 knots.

The *Reina Regente* is 330 ft. long, and in fully equipped condition she will displace 5,600 tons, although her usual sea-going displacement will not exceed 5,000 tons. She is of steel throughout, and depends for her protection in an engagement partly upon the armored protective deck and partly upon the unusually minute subdivision of the hull between this deck and the one above it; or, in other words, of that part of the ship between wind and water. This part is divided into no fewer than 83 separate watertight compartments, most of which will be used as coal bunkers. The space below the armored deck is divided into 60 watertight compartments, and for the whole length of the vessel a cellular bottom is fitted. The total number of watertight compartments in the ship is 156.

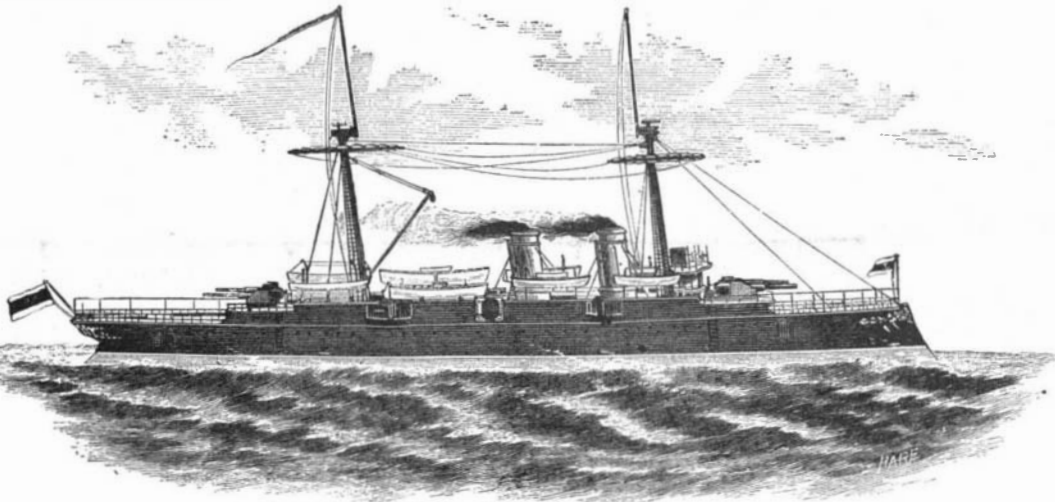
The vessel will be propelled by twin screws, the engines, contained in separate watertight compartments, being of the horizontal type, triple expansion. The boilers, four in number, are also in separate watertight compartments. Well above the water line there are two auxiliary boilers, supplied by Messrs. Merryweather, for raising steam rapidly in cases of emergency. These boilers are connected to all the auxiliary engines on board, which altogether number no fewer than 43. In addition to the two sets of main engines, there are two starting engines, four centrifugal pumps, bilge and fire pumps, feed pumps, ten fan draught engines, steering engine, capstan engine, two electric light engines, two boat hoisting engines, also ash hoisting engines. The four centrifugal pumps are connected to a main pipe which runs right fore and aft, receiving branches from every compartment. The branches are so arranged that the compartments are always in connection with the pumps, and if they become flooded are immediately pumped out; but if water seeks

to enter the compartment from the pipe, it is at once prevented by an automatic valve. Should it be desirable, however, to flood any compartment, the action of this valve can be suspended. The automatic nature of this pumping arrangement should be of the greatest value in an engagement, when men have little time and little power in which to think and act.

The highly important quality of turning power has received special attention in this new cruiser. The patent sternway maneuvering rudder of Messrs. Biles & Thomson, introduced with very marked success in the recently built Spanish torpedo cruiser *El Destructor* and the Russian torpedo boat *Wiborg*, is again a noteworthy feature in the new vessel. This contrivance, it may be mentioned, is a combination of a partially balanced rudder with a rudder formed as a continuation of the after lines of a ship. The partial balance tends to reduce the strains on the steering gear, and thereby enables the rudder area to be increased without unduly straining the gear.

The armament of the *Reina Regente* is, for her size, very formidable. It comprises four 24 centimeter and six 12 centimeter Hontorio guns, six 6 pound Nordenfelt guns, fourteen small guns, and five torpedo tubes. On the main deck, right forward, there are two torpedo tubes, there is one aft, and one in each broadside amidship. There are four gun towers on the level of the main deck, but projecting beyond the side of the ship. Each of the two forward ones fires five degrees across the bow, and to within 30 degrees of right aft. The after guns have a similar range round the stern. The remainder of the armament is placed on the upper deck.

At the fore end there is a platform, about 4 ft. above the deck, upon which two of the 21 ton Hontorio guns are placed. These fire right ahead, and to within 40 degrees of right aft. A similar platform right aft receives the other two 21 ton guns. Between these two platforms, and ranging along both sides, are placed the



THE REINA REGENTE, NEW ARMORED CRUISER FOR THE SPANISH NAVY.

six 12 centimeter guns, two of which fire forward, two aft, and the remaining two have a range of 140 degrees.

Besides the six Nordenfelt guns, there are two 37 millimeter Hotchkiss revolving guns, and of the smaller guns there are five for boat and field service and four for working from the mast heads.

The vessel will be fitted with accommodation on the main deck for 50 officers and about 350 men. The launch took place from Messrs. Thomson's yard, in the presence of a large assembly, the naming ceremony being performed by the Duchess of Wellington.—*Marine Engineer.*

Slag as a Fertilizer.

The slag from the Thomas-Gilchrist process for making steel has long been supposed to have valuable properties as a manure. In the Bessemer converter, there is a lining of lime which, in the process of manufacturing the steel, takes up a large percentage of phosphorus, in the form of phosphoric acid. Phosphate of lime has been used as an artificial manure, in a variety of forms, with very beneficial results on most lands. It was thought that the basic cinder obtained in the Thomas-Gilchrist process might, from its large percentage of lime and phosphoric acid, have a manurial value.

Some two or three years ago, experiments in this direction were undertaken in Germany by M. Fleisher and others, and from the data which they obtained, it appeared that under certain conditions basic slag had a very marked influence upon crops grown on soils which had been top-dressed with it. It was ground into a very fine powder, and then the acids of the soil were able to dissolve the phosphoric acid which it contained; and it was then in a condition to be readily assimilated by plants. Attention is again being called to this point in consequence of a series of similar experiments which have been carried out by Dr. Munro, at Downton, for the North Eastern Steel Company, and which fully confirm the earlier experi-

ments of the German investigators. It was thought that probably the slag would be more efficacious if it were first converted into a "superphosphate," in a similar manner to bones; but Dr. Munro and Mr. Wrightson seem to think that this is unnecessary, if care be taken to have the basic cinder in as pure a state of division as possible.

As basic slag is a waste product, and hitherto has had no industrial application, it ought to be obtainable at a much cheaper rate than the Canadian apatite, coprolites, and bone manures, which have until recently been the chief artificial fertilizers used in agriculture. Dr. Griffiths has recently, in papers read before the Chemical Society of London, advocated the use of iron sulphate as a manure, and as basic slag contains a considerable quantity of iron in the same condition of oxidation as in ferrous sulphate, it may also have some effect upon the manurial value of the Thomas-Gilchrist slag.

The Latest Large Guns.

It may be assumed, says *Iron*, that we are proud of our 110 ton gun; but the satisfaction of being at the head of all other nations in gun making is destined to be but short lived, for already we hear that the formidable Krupp, of Essen, is going to lick all creation, this little island included, in the art. His latest monster, now being manufactured, is to weigh close upon 139 tons, or 143,000 kilogrammes, against our 111,760 kilogramme arm, and to have a caliber of 40 centimeters (15.7 inches). Its length is 16 meters, or 52½ feet. The projectiles to be used with this gun are of two kinds, one a steel shell 1.12 meters (3 feet 9 inches) long, and weighing 740 kilogrammes (1,630 pounds), and the other 1.60 meters (5 feet 2 inches) long, and weighing 1,050 kilogrammes (2,314 pounds), equal to the weight of the barrel of a 12 centimeter gun. The service charge consists of 485 kilogrammes (1,069 pounds) of brown prismatic Dunwalde powder. With

this charge, the lighter shell will have an initial velocity of 735 meters (2,411 feet), the heavier shell one of 640 meters (2,099 feet) per second. Attention might be drawn to the fact that when rifled guns were first introduced, the highest initial velocity attained was only 300 meters (984 feet). The lighter shell will penetrate a wrought iron plate 1.142 meters (45 inches) thick, or two plates of the respective thicknesses of 0.55 meter (21.65 inches) and 0.838 meter (33 inches), placed a short distance from the muzzle of the gun. In the case of the heavier projectile, the figures are 1.207 meters (47.52 inches), 0.60 meter (23.62 inches), and 0.88 meter (34.64

inches) respectively. As far back as 1868, the artillery of the day was unable to penetrate as many millimeters of armor as now centimeters; its penetrative power has consequently increased tenfold, and Krupp is now able to pierce with his new gun an armor plate three times as thick as the bore of the gun. But he is reported to be even now endeavoring to surpass his latest achievement, for a 45 centimeter (17½ inch) gun is in contemplation, weighing 3,000 cwt. The shell to be fired from this piece of ordnance is to weigh 30 cwt., and to be 1.80 meters (nearly 6 feet) long.

A SELF-CLEANING METAL VALVE.

The illustration herewith shows a valve which turns or rotates on its seat before and after the water or steam, or both, are turned on or off, this rotating and grinding action being designed to at once repair any damage caused by the cutting and destructive force of anything in the water, as well as clean off lime scale or rust. The stem of the valve, as will be seen by the engraving, has an enlarged inner end portion, screw-threaded on its exterior, which engages a screw-thread in the barrel. The valve, which is shown closed upon its seat, is connected in a free manner with the inner end portion of the stem by a stud entering loosely within an axial recess, the parts being further united by a screw or pin fitted to pass freely through a longitudinal or oblong slot in the enlarged portion of the stem. In closing the valve, both valve and stem move longitudinally until the valve rests upon its seat, after which, by continuing to work the stem in the same direction, the valve is simply rotated, while the stem is both rotated and moved inward longitudinally. The greater the pressure on the valve, the better it will polish both itself and its seat, and no leather or rubber is used in connection with it.

This invention has been patented by Mr. Samuel W. Smith, of Pinley House, near Coventry, Warwick County, England.