stem to stern; it is strongly arched in the athwartship direction, having a curve of about 4 feet. At the middle line this deck is about 1 foot below water, at the sides it is about 5 feet below. It forms a roof or shelter to the bold space situated below it, and in the space thus protected are placed the vitals of the ship—magazines, shell rooms, engines, boilers, etc.

Minute water tight subdivision of the bold space below the protective deck, and of the space between it and the main deck, is effected by means of transverse and longitudinal bulkheads and of horizontal flats or platforms. Magazines, shellrooms, etc., are also converted into separate water-tight compartments. All openings in the protective deck are trunked up by water tight steel casings to the height of the main deck, and surrounded by cellular coffer-dams, which can be packed with canvas, oakum, or other material which would readily check the inflow of water if, in action, the trunk casings were shot through. This coffer-dam protection resembles that long used by the Admiralty constructors in vessels of the central citadel type; and another feature in the Esmeralda in which Admiralty practice has been imitated is in the use of cork, packed in cellular spaces, as a safeguard to her buoyancy, stability, and trim in case the sides in the water line region should be riddled in action. The steel deck is intended to be chiefly useful in protecting from shell fire the vital parts situated below it, and this protection is greatly increased by the conversion of the spaces between the main and lower decks into coal bunkers.

She has twin screw propellers driven by two independent sets of machinery. The engines are horizontal, and on the two-cylinder compound principle. The cylinders are 41 inches and 82 inches in diameter, and the stroke is 36 inches.

The armament is exceptionally heavy and powerful for a ship of such moderate size; and the mountings are of a very novel character, representing some of the latest products of the famous Elswick factory. It includes two 25 ton 10 inch breech-loading guns, six 4 ton 6 inch breech-loading guns; two rapid fire 6 pounders, of Captain Noble's design, and a number of machine guns. The 25 ton guns are mounted as bow and stern chasers, and have an arc of training of about 240 degrees—120 degrees on each side of the keel line. They are carried on central pivot mountings, and fire over a "glacis" formed by the ends of the upper deck. The engraving illustrates the nature of the mountings. On the rear of each slide is a strong steel screen, protecting the captain of the gun; and within the shelter of this screen are placed the hydraulic and other gear by which the gun is trained, moved in or out, elevated, and depressed. Hydraulic mechanism, of Elswick design and manufacture, is employed for these heavy guns, and used for loading as well as working them. A very few men thus suffice, and these are well protected from rifle and machine gun fire.

One important feature in the arrangement is the strong steel loading station built in the rear of each gun. This is really a large steel house, within which are the upper ends of steel tubes, extending down to the magazines and shell rooms. By means of hydraulic hoists the projectiles and cartridges are lifted through the tubes into the loading stations, being sheltered in their transit.

Having reached the loading station, the gun is laid fore and aft, and run in on the slide, being elevated for the purpose of loading. After the breech piece has been withdrawn, the projectile and powder charge are rammed home; and throughout the operations the powder is protected from rifles and machine guns. With large charges exceeding 2 cwt. of powder for the 10 inch guns, this is a matter of great importance. The penetrative power of these 10 inch guns is represented by 21 inches of iron armor; and both of them can be fought on either broadside, as well as being used for chasers.

On each broadside there are also three 6 inch 80 pounders, carried on central pivot automatic carriages, and having a horizontal range of training of about 130 degrees.

The Esmeralda has also a very good auxiliary armament with which to deal blows upon an enemy similar to those against which her men are exceptionally well protected.

We are indebted to the *Engineer* and the *Graphic* for these particulars and for our illustrations.

White Bricks.

M. Hignette, in the *Bulletin technologique des Ecoles nationales d'Arts et Metiers*, describes a new ceramic product from the waste sands of glass factories, which often accumulate in immense quantities so as to occasion great embarrassment. The sand is subjected to an immense hydraulic pressure, and then baked in furnaces at a high temperature, so as to produce blocks of various forms and dimensions, of a uniform white color, which are composed of almost pure silex. The crushing load is from 370 to 450 kilometers per square centimeter. The bricks, when plunged in chlorhydric and sulphuric acids, show no trace of alteration. The product has remarkable solidity and tenacity; it is not affected by the heaviest frosts or by the action of sun or rain; it resists very high temperatures, provided no flux is present; it is very light, its specific gravity being only 1·5; it is of a fine white color, which will make it sought for many architectural effects in combination with bricks or stones of other colors.

WORKERS in bleacheries where chlorine is largely used are singularly exempt from all germ diseases, hut suffer from special ailments induced by inhaling that gas.

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Contents.

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TABLE OF CONTENTS OF THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 464,

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GRINDING REAMERS.

Every machinist knows the tendency of reamers to chatter and leave flutings. The most careful handling could not always prevent it. For a remedy the scores or flutings of the reamers have been made of uneven numbers, so that a space should oppose a tooth; and sometimes a "slashed" or spiral tooth has been cut instead of a straight one. But no remedy has heretofore been found that is so effectual as careful using and a very light scraping chip.

In a large establishment for the manufacture of hand and machine tools, some experiments have been made with reamers with a result of nearly, if not entirely, removing this tendency to chatter. The remedy is in grinding the flutes or teeth on their face or cutting side, so that they present a sharper angle to the work, and cut rather than scrape.

After the reamer has been fluted in the milling machine or the crank planer, and hardened and tempered, it is submitted to the action of a narrow, round-faced emery or corundum wheel, that cuts under the straight face of the flute and projects its head forward, making a more cutting angle. Trials on very hard charcoal iron castings seem to prove the advantage of this after-grinding. This test was proved on a hole for a taper fit. The finished steel pin was placed in the reamed hole, and driven to seat by a Babbitt metal hammer. When driven back there was not a mark of the reamer's work, although the pin had been oiled to show the marks if any there were. Lampblacking the reamed hole and then driving or pushing in a plug of wood turned and covered with white paper gave a clear smut without any corrugations. In use the reamer cut so freely that no forcing was necessary.

WHAT THE DOCTORS SAY ABOUT BICYCLE RIDING.

Those who work the pedals of the graceful bicycle will, unhappily, find little to commend their favorite exercise in the columns of the medical journals. From time to time there have appeared the results of inquiries of the medical faculty into the effect produced upon the body by continued bicycling; and though a verdict may scarcely be said to have been rendered, the evidence presented proved, in some cases, sufficiently convincing to condemn the practice. The latest opinion on the subject is contained in a paper contributed to the London *Lancet* by Dr. S. A. Strahan, of Northampton. Neither Dr. Strahan nor those who preceded him on the subject condemn bicycling altogether; but when indulged in constantly and especially when the course traversed is rough or hilly, they agree that it leads to serious disorders. In the case of growing boys, Dr. Strahan declares that the amount of pressure upon the perineum directly affects the prostate, the muscles of the bulb, and indeed the whole generative system. "The pelvis," he says, "is flexed upon the thighs or rolled forward. This rolling forward of the pelvis is slight in easy riding, and very marked in fast riding and hill climbing. Now, when the body and pelvis are bent forward, the ischial tuberosities are raised from the saddle, and the whole weight of the body, save what is transmitted to the pedal by the extended leg, is thrown upon the perineum."

This results, he says, in irritation and congestion of the prostate and surrounding parts, tends to exhaust and atrophy the delicate muscles of the perineum, and leads to early impotence. Many cases could be cited where races have become almost totally impotent from immoderate equitation, as the Tartars, and partially so from the same cause, as the Indians. Like others who have written on the subject, Dr. Strahan speaks of the "disease of the Scythians," but doesn't tell us just what it was. We know that they were a warlike race and continually in the saddle, and can only conclude that he means this constant perineal pressure reduced them to the wretched condition in which Hippocrates tells us he found them. Hippocrates says: "Their bodies are gross and fleshy; the joints are loose and yielding; the belly flabby; they have but little hair, and all closely resemble one another." Yet bicycling is said to be ten times as severe on the perineum as riding.

THE EADS SHIP RAILWAY.

The working model of Captain James B. Eads' plan for the Atlantic and Pacific ship railway, now in process of construction across the Isthmus of Tehuantepec, has been brought from London, and is now on exhibition in this city, in the basement of the Mutual Life Insurance building, Nassau and Liberty Streets. As a specimen of fine mechanical work this model is quite remarkable, and probably surpasses anything of the kind heretofore constructed.

It represents the hydraulic lifting dock by which the largest ships are quickly lifted out of water; the railway cradle and truck, by which the great vessels are transported across the country; and the hydraulic turn table, by which truck and ship are rapidly revolved to meet any required changes of direction in the line of travel of the railway.

The gigantic size of the cradle truck that bears the ship overland forbids the employment of curves of a less radius than twenty miles; but by means of the hydraulic turn table, which is simply a great float, the largest vessel may be turned, switched off to pass other vessels, and run upon any desired diverging track, thus obviating the necessity of curves in the railway track itself.

The Tehuantepec Ship Railway will be 134 miles in length. It commences on the Atlantic side at Minatitlan, and will terminate on the Pacific side probably at Salina Cruz.

The working model now shown is made to a scale of three-quarters of an inch to a foot, and occupies a length of about thirty feet. The model ship floats in water over a hydraulic pontoon, on which the railway cradle truck is placed. The working of the pumps soon raises the ship, and she rises out of water supported on self-equalizing hydraulic jacks, arranged in such manner that the lifted vessel, although above the water, may still be said to float thereon. Screw blocks attached to the truck cradle are now run up and secured against the ship's keel and bottom at many points. The hydraulic jacks are then released, which leaves the ship secured within the truck cradle, ready for the overland trip. Wherever a turn in the road is to be made, or vessels coming the other way are to be passed, the ship and truck are run upon a floating pontoon, the height of which is quickly adjusted, and the ship is revolved to the degree desired, to reach the diverging track, and the journey is then continued.

The various parts of this wonderful model are made to work with surprising ease and accuracy. Captain Eads' plans for the practical realization of this great ship railway, including the working model, were examined and indorsed by hundreds of the leading engineers in Europe, and there appears to be no doubt in their minds of its complete success. The estimated cost of the railway is only forty-five millions of dollars, and it will have a greater capacity for the transfer of ships than the proposed Panama Canal, on which, it is said about one hundred millions of dollars have already been spent, although the work may be said to have only just really begun.

Photo Enlargements on Canvas.

What is the best and cheapest method of producing an enlarged photograph from a small negative on canvas for the use of the colorist in oils? This is a query, says the *British Journal of Photography*, that comes to us with a certain degree of frequency. The question is one which admits of some latitude. It presupposes the existence of several methods, some of which are cheap; others—irrespective of cost—good. Having a small negative of a portrait, how are we to enlarge it in a cheap yet good style?

One of several methods which forces its attention upon us at the present time is that by the transfer of a collodion film from the glass plate, upon which it has been taken, to the canvas upon which it finds a final resting place.

Let us suppose that an artist is desirous of having a certain face and bust transferred to canvas. It is first of all necessary that the apparatus for producing a large image of the original be at hand. If daylight be the luminant employed, then the question is reduced to one of extreme simplicity. The negative is erected in such a manner as to have the sky as its background, and at a right angle to it is placed the lens by which an image is to be formed. A screen for receiving this image is erected at the other side of the lens, and the optical conditions are thus rendered complete.

We will now presume that the enlarged image has been obtained in a collodionized glass plate of any reasonable dimension—such as twenty or thirty inches in length by a proportionate breadth—and that it has been treated in such a manner as to insure permanence as well as the requisite amount of detail. What then? While the collodion image is being washed, let us turn our attention to the canvas upon which it is to be placed as a final support.

Canvas prepared for painters is readily procurable from those artists' colormen who make a specialty of this department of artistic requirements; and we now take it for granted that a sheet of such canvas has been obtained. The first thing to do with it is to sponge it all over with soda (monocarbonate) and water until every trace of greasiness has quite disappeared, allowing the water to flow freely over the surface. When this is the case a moderately strong solution of gelatine, containing a feeble admixture of chrome alum, is sponged over or otherwise applied to the surface of the canvas, and allowed to become quite dry. It is, indeed, better that such canvases should be kept in stock ready for use.

Let us now revert to the collodion image upon the glass plate. When it is found to be well developed and still clear in the shadows, the plate is laid, glass side down, upon a block or tablet which has been erected at one side of the sink at which the development and washing have been effected. The canvas, previously sponged over with water until plastic, is laid face down upon the collodion film, and pressed into close contact by means of the squeegee.

It is, of course, understood that the glass plate, previous to receiving its coating of collodion, shall have been thoroughly wiped over with a rubber charged with finely powdered French chalk or with a solution of beeswax in turpentine or other solvent. We find in our own practice that French chalk answers the purpose admirably, and, as it is cleanly and easily applied, we commend its use to all who try this process.

The plastic canvas, now quite wet, must be pressed into intimate contact with the equally wet collodion film containing the image, and the plate is then laid down upon a flat table, a few folds of blotting paper, backed by a thick pad, being superposed. This must remain undisturbed for a short time, after which a trial may be made at one corner to see if the canvas when raised carries with it the collodion film, which becomes detached from the glass in favor of the textile fabric. If the film be found to attach itself to the canvas, the latter should be carefully raised from the glass.

The great advantage of effecting the transfer previous to the canvas and film becoming dry is that the film adheres in a most perfect manner to the canvas—certainly adapts itself more perfectly to the textile character of the fabric—and dries *flat;* whereas, if the transfer be not made until the film has become quite dry, the surface is of a shining and glossy character, being, indeed, then a transcript in regard to mechanical smoothness of the surface of the glass, which from an artistic point of view is somewhat offensive.

When the canvas is stretched out so as to become quite dry, the collodion film will, upon being dried, be found to have become "part and parcel" of its surface. There will be no gloss, but the interstices of the textile fabric will be as plainly shown through the thin collodion image-bearing film as if no such pellicle were superposed upon its surface.

Swift War Ships.

An opinion was at one time prevalent to the effect that a high rate of speed could only be attained by vessels of very large dimensions, until Sir E. J. Reed demonstrated the fallacy of this assumption by designing the Pallas. The Iris and Mercury, designed by Mr. N. Barnaby, and the Sfax, of the French Navy, designed by M. Bertin, which are the swiftest cruisers of the respective navies, are vessels of considerable size; but Herr Dietrich, chief constructor of the German Navy, has shown that a high rate of speed can be got out of a cruiser of, comparatively speaking, insignificant dimensions. We refer to the Blitz, launched in 1882, which is a vessel of only 1,380 tons. She carries an armament of one 4¾ inch and four 3⅜ inch Krupp guns, as well as torpedo discharging apparatus, and is propelled at a speed of 16·2 knots by engines of 2,816 indicated horse power. The successful performances of this craft have, no doubt, induced our own and the French naval authorities to follow suit, the former with the Alacrity and Surprise, and the latter with the vessels of the Condor type.

We have already observed that speed is, in our opinion, the most important requisite of a modern cruiser, even if it is purchased to some extent at the cost of her fighting power. Messrs. Sir W. G. Armstrong, Mitchell & Co. have, however, proved that an enormously powerful armament can be combined with a high rate of speed in vessels of moderate or even small dimensions. The Protector, for instance, is a vessel of only 900 tons; yet she steams 14·2 knots, and carries one 8 inch and five 6 inch breech loading guns. The Japanese cruiser Tsukushi is another vessel of the Elswick type. She has a displacement of 1,500 tons, steams 17 knots, and mounts two 10 inch and two 4¾ inch breech loading guns. The largest vessels of this class at present afloat are the Italian Giovanni Bausan and the Chilian Esmeralda, sister ships. The Esmeralda has a displacement of 3,000 tons, a mean speed of 18·3 knots per hour, and carries two 10 inch and six 6 inch breech loading guns. It is not probable that her designer, Mr. W. H. White, will rest satisfied with these results, and we may therefore expect to hear of even still greater achievements ere long. Unfortunately, the British Navy has not as yet derived any benefit from the experience and enterprise of the Elswick firm; and while Italy, Austria, Japan, China, Chili, and other possible enemies are availing themselves of our national resources, we are "fascinated" by the activity prevailing around us, and are seemingly incapable of energetic exertions. The smaller foreign naval powers, notably Germany, are watching the gradual decline of our naval supremacy with evident satisfaction, as their second rate fleets are thus brought into greater prominence. The German Navy is composed of seventy-four steamships, including twenty-seven iron clads, which force is sufficient to secure an overwhelming majority to the navy of either France or England, should the interests of the empire necessitate its active participation on one side or the other in the event of war between England and France.—*The Engineer.*

Armor Experiments at Spezia.

The following statement of the results obtained during the recent armor plate trials at Spezia is from an Italian source, and has not been verified by us. We have no reason, however, to question its substantial accuracy in all respects. It will be seen that the gun has again scored a victory, and in so far the armor controversy assumes another phase. In a letter to the *Times* marked by all his great ability, Sir E. J. Reed criticises unarmored cruisers, and endeavors to show that their destruction must be certain should they encounter an ironclad. The Spezia experiments, however, seem to indicate that the only armor which can be of any real use must be so thick and of such enormous weight that the construction of a small high-speed armored cruiser is out of the question. In other words, the fact seems to be that against such guns as those carried, let us say, by the Esmeralda, vessels of the Penelope or Bellerophon type, carrying moderately thick armor, would be as badly off as the Esmeralda herself, while the greater speed of the latter ship would place her in a position to fight or not just as she pleased, and to fight when and how she liked.

The experiments against armor, which took place on the 1st October at the polygon of Muggiano by the Royal Italian Marine, have excited a lively interest in the marine and in military circles. These experiments had been ordered by the Minister of Marine to find out exactly the resistance of the armored redoubts of the Italia and Lepanto, clad with Schneider steel or compound plates, and above all to ascertain the effective power of the new Armstrong 43 centimeter breech-loading gun, with forged and tempered steel projectiles of best quality. For this purpose there had been erected three targets representing the redoubt of the Italia. The plates were placed against a backing of teak wood 520 millimeters thick. The plates measured all three 3,050 millimeters long by 2,600 millimeters wide, by 480 millimeters thick, and were all fixed to the backing by eighteen bolts. One of the plates was forged Schneider steel from the works at Creusot, and two of the compound type from Cammell's and Brown's works. In all experiments hitherto made, chilled cast iron or steel cast projectiles had been used with a velocity not exceeding 470 meters at impact. In the experiment of the 1st October, not only were forged steel Krupp projectiles used—which are supposed to be the best at present—but they were also fired with a velocity of 580 meters, *i. e.*, with 100 meters more velocity at the point of impact than in the previous tests.

The introduction of these two new factors in the firing were, as had been perfectly foreseen, of such a nature as to modify the results obtained. In effect, the Schneider and the compound plates had until now broken the projectiles of medium quality, such as cast iron and cast steel, at the first shock. Such shot produced in the plates damage varying according to their degree of fragility, without piercing them.

The new forged steel projectiles, such as those of Krupp's make, possessing tenacity and great cohesion, require, in order to break them, an effort and space of time infinitely greater than those of cast iron or brittle metal, so that their effort of penetration or punching the material of the plates has time to develop itself before the pieces of the projectile become separated.

In the test of the 1st of October, the circumstances foreseen by the competent authorities were completely verified. The 43 centimeter Armstrong gun was charged with four bags of 87½ kilogrammes each, being altogether 350 kilogrammes of progressive Fossano powder, and a perforating hollow projectile of forged and tempered steel from Krupp's works at Essen, weighing 835 kilogrammes weighted. Under these conditions the initial velocity measured at each discharge was an average of 572 meters, and the target being at a distance of 99 meters from the mouth of the gun, an average velocity at impact of 568 meters was the result. The projectile had therefore a total energy of 13,700 meter tons at impact, that is to say, the energy required for piercing an iron plate 99 centimeters thick, according to the formulæ of the French Navy.

Under such conditions of firing, which have never hitherto been produced with any gun, the following results were obtained: The first shot fired against the Cammell plate pierced it and the backing, dividing the plate into six large pieces by radial cracks. The shot was broken up, the point being carried to the sandhill, distant 15 meters, which it entered to a depth of 400 millimeters. The second shot was fired against the Brown plate. The results were similar. The plate was divided into four pieces only by radial cracks, but the steel face was torn off round the point of impact. The projectile was more broken up than in the first shot, and the point was found lying at a distance of 7 meters in the rear of target, *i. e.*, in the front of the sandhill. The third shot was fired against the Schneider plate. The projectile pierced the plate neatly, like a punch, forming a circular hole 580 millimeters diameter. The plate was divided into three large pieces by radial cracks. The projectile was found to be least broken up of the three, and the point to have entered the sandhill to a depth of 1,400 millimeters.

The compound plates have therefore, it appears, shown more resistance to penetration than the steel plate, although they were more broken, as anticipated, but no portions were stripped from the target, and the lateral support which the compound plates have from the adjoining plates when fixed on the ship's sides would place them there under much more favorable conditions than in the Spezia experiments; while the same conditions would not increase the resistance of a softer material, such as the Creusot steel plate or an iron plate. As compound plates 48 centimeters thick under favorable circumstances have shown such resistance to penetration at close range and normal fire of the present most powerful gun, it is evident that, when placed on a ship—especially at an angle, as in the Lepanto and Italia—they will afford perfect security against the attack of the same gun when fired at any probable distance and under the most favorable circumstance which are likely to exist in actual warfare. They have also the well known advantage of resisting the projectiles from small guns better than steel plates. These can be destroyed by projectiles which would have very little effect on compound armor.—*The Engineer.*

Treating Tellurium with Nitric Acid.

It is generally admitted that in the reaction of tellurium and nitric acid the only product is tellurous anhydride. M. Klein in a former communication described a basic telluric nitrate obtained on attacking tellurium with a large excess of hot dilute nitric acid. The authors having re-examined the matter, find that on treating tellurium with nitric acid there is formed—(1) a solution of tellurous hydrate soluble in nitric acid (at about 0°); (2) a tellurous nitrate, which is decomposed at 70° to 80°, forming tellurous anhydride and a basic nitrate. This tellurous nitrate is formed at about 20°, and is decomposed spontaneously on standing; even in the cold, into basic nitrate and anhydride. The basic telluric nitrate is also decomposed by water. The properties of tellurous anhydride have been very incorrectly described. It is spoken of in the text-books as slightly soluble in water. But it is almost as insoluble as barium sulphate, 1 part requiring for solution 150,000 parts of water.—*D. Klein and J. Morel.*