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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.


## THE BLINDNESS OF THE SUBMARINE.

The loss of the British submarine, that was recently struck by a merchant steamer, and sent to the bottom with its hapless crew of eleven officers and men, proves once more, in a very dramatic way, that the most serious fault of the submarine in its present stage of development is that it is blind. In saying this we refer to submarines as a whole, and do not wish to be understood as saying that in the great activity which is now being shown in the development of this most interesting craft, there may not be some one type that is able to maneuver under water with its eyes open most of the time; indeed, there is reason to believe that in this country the "Lake" submarine, which was recently indorsed so strongly by a United States army board, is provided with an improved form of "periscope" that is greatly superior to anything of the kind that has been used up to the present at least in these waters.

The British submarine disaster happened to one of the new and larger vessels of the Holland type, which have recently been constructed by the Admiralty. It was lying submerged off the Nab lightship, awaiting the approach of a battleship, when it was run down by a South African liner. Inasmuch as the accident happened at a time when a special lookout was being kept, it is natural to conclude that the failure of the submarine to detect the approach of the liner was due to the limited range of her periscope. We are not aware what means of vision is being used by the British submarines; but if it is the same as that with which we are familiar in this country, the field included by the glass is limited to a narrow angle of vision ahead. It can readily be understood that if the instrument was of this type, and was being directed steadily toward the approaching battleship, the merchant steamer might have run down the submarine from astern, the crew of the submerged boat having no warning of the impending disaster until they were struck and rolled over by the big ship.

An improved type of periscope, recently described in the SCIENTIFIC AMERICAN SUPPLEMENT, contains five separate lenses, four of which look to the four quarters of the compass, and convey a reduced image, sufficient for observation all around the horizon, to the navigator in the submarine, while the fifth lens looks ahead and presents the image in its true size, without distortion. So far, so good—provided the weather be clear and the water calm; but the troubles of blindness begin to overtake all submarines when the winds freshen and the sea rises. Then, with the pitching of the boat, which, even when submerged, must be more or less affected by the waves, the periscope tube begins to rock with a reversed pendulum motion, and the field of vision caught by the lenses varies from sky to water and from water to sky, while the salt spray blown against the glass begins further to destroy the sight of the little submerged fighting ship. It will be a brave step in the right direction when someone discovers a means of automatically maintaining the line of sight of the periscope lens in the level position.

The recent disaster will necessarily, for a time at least, shake the public faith in the submarine; but that it will seriously hinder its development, we do not believe. It was only a few days before this accident, during another series of submarine maneuvers in which a fleet of British battleships was attacked, that a decision was given in favor of the submarine; some of the battleships being ruled as torpedoed and put out of action. Moreover, the crowded condition of the field of operations when the boat was lost, the maneuvers being carried out in one of the most busy maritime thoroughfares, would never occur in war time, except on the rare occasion of a general *melée* at the close of a hard-fought naval engagement.

## HIGH-EXPLOSIVE PROJECTILES.

The frequent reports from the Far East to the effect that many of the shells thrown into Port Arthur fail to burst, naturally renders the question of our own projectiles one of great interest.

At the time when maximite was undergoing tests by the Ordnance Board of the United States Army, just prior to the purchase of the secret of its manufacture and its adoption by the government as a bursting charge for projectiles, as full particulars as were permitted to be published concerning this explosive appeared in the SCIENTIFIC AMERICAN. Since that time its extensive employment has afforded ample opportunities for further studying and verifying its valuable qualities.

The explosive is melted in steam-jacketed kettles, and shells are filled with it by the simple process of pouring. On cooling, it forms a very hard and dense mass, firmly adhering to the walls of the projectile, which renders it incapable of shifting when the projectile is discharged from the gun, or by the impact when the projectile strikes armor-plate.

It is about fifty per cent stronger than is ordinary dynamite, and its density is about 1.66, being a little more than once and a half as heavy as water. It is practically incapable of being exploded by any form of shock, and upon ignition it will simply burn like pitch. Experiments have demonstrated that projectiles filled with it can be fired through armor-plate as thick as the projectile itself will stand to pass through, without danger of exploding the maximite from shock, thus allowing the fuze to detonate the high explosive within the vessel itself.

A fuze for high explosives requires a detonator or exploder, usually consisting of fulminate of mercury, or some other fulminating compound. Ordinary dynamite requires only several grains to effect its complete detonation, but the new explosive is so insensitive that from 300 to 350 grains of the most powerful fulminate are required. When thus detonated, the projectile is broken into a very large number of fragments. A twelve-inch projectile weighing half a ton was broken into probably ten thousand fragments in one of the experiments at Sandy Hook. Seven thousand of these fragments were actually recovered and counted.

It has been a difficult task to provide a fuze which will carry a sufficiently large detonator and still be safely discharged from the gun, without danger of going off prematurely and setting off the high explosive, wrecking the gun and killing the gunners.

Lyddite, the high explosive used by the British government during the Boer war, was simply picric acid melted and cast into the projectiles. While cast picric acid is sufficiently insensitive to enable shells filled with it to be fired from guns with safety, it can only be fired through moderately thin plate without exploding from the shock. Nevertheless, in the Boer war a very large percentage of the Lyddite shells did not explode at all, while many more only partially exploded, as evidenced by the green character of the smoke, and the fact that the captured Boers were frequently found to be stained a brilliant canary color. This was owing to the fact that the British government had no fuze by which picric acid could be exploded with any degree of certainty. Many of the shells thrown by the Japanese in the recent bombardment of Port Arthur failed to explode from the same cause.

The difficulty in exploding fused picric acid has led many of the Continental powers to use picric acid in granular form compressed into the projectile, although its density is much less. Still, much less fulminate is required to explode picric acid in powder or granular form than when it is cast solid, and an efficient fuze is not so difficult to provide. But while it is impossible to penetrate armor-plate of any considerable thickness, even with cast picric acid, picric acid in granular form will stand even less shock, and cannot be considered an efficient explosive for armor-piercing projectiles.

Furthermore, it is obvious that when a high-explosive projectile penetrates a warship and explodes inside, if the projectile contains a larger quantity of the same explosive, a higher shattering and wrecking effect will be produced upon the surrounding structure of the vessel, owing to the larger volume of gases produced. Consequently, it is even for this reason alone desirable to penetrate a war vessel with the maximum weight of explosive in the projectile, other things being equal.

The Austrian government has recently adopted a mixture of powdered aluminium and nitrate of ammonia as a bursting charge for projectiles. This explosive is termed ammonal. It is said to be exceedingly powerful, and to have produced most satisfactory results, as far as explosive energy is concerned. It is also claimed that it is quite insensitive to shock, and can be safely fired from guns. But it is not clear that it can be fired through armor-plate with much success.

To explode ammonal, it seems to be only necessary to ignite it, as in the case of black powder. The very fact that ammonal can be exploded by mere ignition renders it dangerous as a bursting charge for projectiles, for the reason that the least flaw in the projectile or fuze would allow the chamber gases of the gun to enter the chamber of the projectile and cause an explosion, blowing up the gun and killing the gunners. The same is true with powdered picric acid, only to a slightly less extent than with ammonal. It is furthermore obvious that the detonator or igniting means of a high explosive should not be located within the high explosive while in the gun. In other words, the fuze should be so constructed that the detonator should not be within a detonative distance or firing distance of the high explosive until after the projectile has left the gun and has struck the target.

For the detonation of our own and other insensitive high explosives used in projectiles, Mr. Maxim has recently developed a fuze which experiments have shown to be capable of carrying any desired quantity of fulminate compound, in such a way that it is impossible for the high explosive to be either ignited or set off, even should the detonator be exploded prematurely.

The explosive used by our own army is indeed so insensitive, that should a shell from the guns of an enemy enter and explode in a ship's magazine filled with projectiles fully charged with it, all armed with the fuze and ready to fire, no explosion of the shells would be produced. Furthermore, should a projectile contain a flaw, and the fire from the gunpowder charge enter the shell space, no explosion would be produced in the gun, nor would there be any if the projectile should break up in the gun. A small portion of it would be burned by the powder gases, but with no disastrous results.

The fuze above mentioned is also so constructed that when an armor-piercing projectile strikes the plate, there is just delay action enough to allow the shell to pass clear through the plate, when the fuze acts to explode it immediately behind the plate. If, however, a projectile be fired through very thin plate, or even the hull of a torpedo boat, or should the projectile strike a glancing blow, it will always explode within ten feet.

The position which the United States occupies to-day with respect to foreign powers in the art of throwing high-explosive projectiles from guns and in the penetration of heavy armor-plate with the same, is about as follows: This government can penetrate with its high-explosive projectiles any plate as thick as the projectile itself will stand to go through, and it is provided with a fuze to explode the shell exactly where desired. In the bombardment of towns and fortifications, our shells would never fail to explode with the very highest results.

As near as can be learned, the best that has been attained abroad is to fire high explosives through plates about half as thick as are successfully penetrated by us, while no foreign government is provided with a fuze that can be depended upon to detonate a high explosive which can be successfully used in armor-piercing projectiles.

## DISPERSION AND WAVE LENGTH OF N-RAYS.

In a paper recently read before the French Academy of Sciences, Prof. Blondlot records his experiments on the dispersion of N-rays, in connection with which the wave lengths of these rays were measured. The method used is quite similar to the one employed in connection with light rays, aluminium prisms being used, as these do not exhibit the property of storing up the rays. The radiations produced by a Nernst lamp, after traversing a window closed with an aluminium foil, would strike on their way a board of pine wood 2 centimeters in thickness, another aluminium foil, and two sheets of black paper, so that any other radiation could be expected to be eliminated. By means of a slit made in moist pasteboard, a well defined bundle of N-rays was eventually separated, striking an aluminium prism, the one face of which was perpendicular to the direction of the rays. Now the author states that from the opposite face of the prism different bundles of N-rays will issue, having undergone a horizontal dispersion; and the presence and deviation of these rays are ascertained by shifting a slit filled with phosphorescent calcium sulphide, according to the well-known Descartes method. The indices of refraction of the rays thus separated are 1.04, 1.19, 1.29, 1.36, 1.40, 1.48, 1.68, 1.85 respectively. These results were checked by measurements made with an aluminium lens.

In order next to determine the wave lengths concerned, the author caused the bundle of rays to strike another screen of moist pasteboard, containing a narrow slit so as to isolate a very narrow portion of the bundle. To the movable alidade of a goniometer, an aluminium sheet was attached so that its plane was perpendicular to the alidade. This metal sheet contained a slit only 1.15 millimeters in width, provided with phosphorescent calcium sulphide. By turning the alidade, the direction of the bundle of rays may be accurately marked. Now, when placing a grating in front of the slit of the second moist pasteboard, and exploring the issuing bundle by turning the alidade to which the phosphorescent sulphide is fixed, the presence of a system of diffraction bands quite similar to those observed with light rays is stated, but these bands are much closer together and have approximately the same reciprocal distance. Hence it may be inferred already that N-rays have much shorter wave lengths than light rays. As the angular distance of the single bands is rather small, the wave length may be determined after the reflection method with a scale and a telescope, a mirror being stuck to the alidade. Furthermore, the author ascertains the distance of two symmetrical bands of a higher order, so as to determine from these elements, according to a well-known formula, the wave length of the ray in issue. The values thus found by Blondlot are:

| | |
|---|---|
| 0.00815 $\mu$ for refraction index........... | 1.04 |
| 0.0099 " " " ........... | 1.19 |
| 0.0117 " " " ........... | 1.4 |
| 0.0146 " " " ........... | 1.68 |
| 0.0176 " " " ........... | 1.85 |

From the above results, which, moreover, were checked by further experiments according to the method of the Newton rings, it is seen that the wave lengths of N-rays are much smaller than those of light rays, in opposition to the original opinion of the author and of other experimenters.

## THE HEAVENS IN APRIL.

BY HENRY NORRIS RUSSELL, PH.D.

It is a dull part of the heavens that is presented to our view in the evenings of this month. The Milky Way, near which so many of the brightest stars lie, is in its least conspicuous position, close to the horizon, while the relatively barren regions near the galactic pole are high up near the zenith.

If we turn our faces westward at about 9 o'clock in the evenings of the middle of the month, we shall see Taurus, Orion, and Canis Major just setting. Above them, and in the Milky Way, lie Canis Minor, Gemini, and Auriga, with Perseus to the right, and Cassiopeia farther still, close to the northern horizon, and almost under the pole. Along the meridian the only prominent constellations are Ursa Major, which is right overhead, and Leo, south of the zenith. Both these constellations bear some resemblance to the objects for which they are named—which is more than most of the others do.

It is not hard to make out the Great Bear. The handle of the Dipper forms her tail, its bowl is in her body, and some fainter stars to the westward mark her head, while her paws are represented by three pairs of stars which lie about 15 deg. apart in a straight line midway between the dipper bowl and the "sickle" in Leo. With the aid of some smaller stars, it is easy to make out a very fine likeness.

As for Leo, the curve of the sickle marks the head and mane of a couchant lion, while the three conspicuous stars some distance to the left are in his hindquarters, and the bright Regulus is in its traditional position at the lion's heart.

Below Leo is a very dull region, occupied by the long line of Hydra. On the left is Virgo, with the first-magnitude star Spica, and a curving line of five third-magnitude stars between this and Leo. Below it is the little quadrilateral of Corvus.

In the northeastern sky we come again to a brighter region. Arcturus, which lies northeast of Spica, is much the brightest star in this part of the sky. The fairly bright stars north of him also belong to Boötes. Below them is the small semicircle of Corona Borealis, whose regularity, rather than its brightness, makes it a fairly conspicuous constellation. Below this again, and to the left, is Hercules, beyond which we finally come to Lyra, just rising in the northeast. Draco and Ursa Minor, on the right of the pole, and Cepheus below them, complete the list of the prominent constellations.

### THE PLANETS.

Mercury is evening star throughout April, and is very favorably placed during the last half of the month. He reaches his greatest elongation on the 21st, at which time he is in Taurus, a few degrees west of the Pleiades, 20 deg. distant from the sun, and 10 deg. north of him. He does not set till after 8 o'clock, and, as he is very bright, he should be seen without difficulty. He should surpass in brightness all the fixed stars, except perhaps Sirius.

Venus is morning star in Pisces, but is not very conspicuous, since she is south of the sun, and rises not more than an hour before him.

She is 150 million miles from the earth, and only about one-quarter as bright as she is at her best.

Mars is evening star, but is now so near the sun that he is practically invisible. On the 1st he sets about an hour after the sun, but only half an hour after him on the 30th. He is in conjunction with Mercury on the 8th, but both planets are too deeply involved in the twilight to be well seen.

Jupiter is morning star, but is not visible till the latter part of the month, when he gets far enough away from the sun. On the 22d he is in conjunction with Venus. The two planets are only half a degree apart, and they will be well worth looking at.

Saturn is morning star in Capricornus, rising about 4 A. M. Uranus is in Sagittarius, and comes to the meridian at 4 A. M. on the 20th. Neptune is in Gemini, and is visible only in the early evening.

### THE MOON.

Last quarter occurs at 1 P. M. on the 7th, new moon at 5 P. M. on the 15th, first quarter at midnight on the 22d, and full moon at 5 P. M. on the 29th. The moon is nearest us on the 26th, and farthest away on the 10th.

She is in conjunction with Uranus on the 6th, Saturn on the 10th, Venus on the 13th, Jupiter on the 14th, Mars on the 16th, Mercury on the 17th, and Neptune on the 20th. None of these conjunctions is close.

It is not often that results of astronomical value can be obtained from the work of a schoolboys' drawing class; but this is a fair description of the outcome of certain "experiments as to the actuality of the 'canals' of Mars," that have recently been made by Messrs. Evans and Maunder at Greenwich.

It is well known that there has long been a controversy on this subject. Some observers see the surface of Mars covered with a network of fine straight dark lines, while others, equally keen-sighted in other cases, can see only diffuse shadings. There is no doubt whatever that the observers of the "canals" have drawn the planet just as they saw it, but there is a good deal of doubt whether, if we could see Mars at, say, the moon's distance, we would find that the actual markings were linear and straight.

It is in the solution of this problem that the Greenwich schoolboys have furnished valuable material. These boys (averaging about thirteen years old), who knew nothing of the telescopic appearance of Mars, were told to draw all that they saw on a circular disk that was placed before them.

These disks (different upon different days) were placed at such a distance from the boys that their apparent size was like that of Mars as seen with an ordinary telescope. The principal markings on them were copied from actual drawings of Mars, and represented the prominent dark areas of its surface. In addition to these, some disks had "canals" drawn on them, while others had black dots inserted in the light areas, and in others still irregular river-like lines and lines of faint dots took the place of the rectilinear markings.

In the majority of cases, the boys drew straight lines in place of the irregular lines and lines of dots, producing drawings which exactly resemble those of the canals of Mars made by telescopic observers. A number of them also had a tendency to draw "canals" connecting two black dots, or one dot and an indentation on the edge of the light region, when no line at all really existed on the drawing.

On the other hand, when the boys had to copy a drawing showing straight "canals," they almost all drew them very much as they existed.

The conclusion to which Messrs. Evans and Maunder have come may be stated as follows:

If we have an irregular or broken line, and look at it from such a distance that we can hardly see it at all, it is much easier to be sure that there is a line there than that the line is crooked or broken. Consequently, a perfectly unprejudiced observer may see and draw such an object as a straight line.

This is just what the schoolboys did, as they were seated at such a distance from their copy that the fainter markings were barely visible. On the other hand, since real straight lines are much easier to see under the same conditions than irregular ones, a figure really consisting of straight lines is likely to be seen and drawn so by all observers.

But this is not the case with the faint markings on Mars. It is therefore probable that they are not really straight lines, but are irregular, consisting of a multitude of fine details much too small to be seen separately, and that they appear straight and continuous only because they are so hard to see at all.

Cambridge Observatory, England.

## HIGH-SPEED STEAM RAILWAY SERVICE.

As an indirect consequence of the Marienfelde-Zossen high-speed electrical railway trials, experiments are being made on a number of German railway lines with a view to investigating the working conditions of a steam railway service with increased speeds. On the Cassel-Hanover line, for instance, the trains tested are made up of gigantic high-speed locomotives and solidly connected six-axle cars, warranting a mean speed as high as 130 kilometers (81 miles) per hour. This speed would enable the journey between Berlin and Hamburg to be completed in about two hours, and it is safe to state that one such train in either direction would be quite sufficient for the present traffic. In the case of these experiments giving satisfactory results, it is thought probable that next summer some specially suitable lines will be arranged for a similar increased speed service, the more so as the Berlin-Zossen trials have shown existing permanent ways (provided they be fitted with heavy rails) to be fully suitable for a similar service. Even in the case of the introduction of electric high-speed railways being postponed for economical reasons, a material improvement in the German high-speed railway service may therefore be anticipated, as far as lines with specially dense traffic are concerned.

## SCIENCE NOTES.

J. D. Kobus has made some experiments for the purpose of determining whether it is possible to improve sugar-canes by vegetative propagation of selected plants, and whether there is any correlation between the amount of sugar present and the power of resisting the *sereh* disease. The results obtained from experiments extending over a period of several years, and involving very numerous analyses, promise to be very valuable to sugar planters. It is shown that for any given variety of the sugar-cane, when grown under uniform conditions, the heavier the plant the greater is the proportion of sugar formed. Also that by taking cuttings from canes which contain a large amount of sugar, the plants so obtained continue to show this increase. Further, it was found that as the proportion of sugar was increased by selection according to the total weight of the plants, so does the power of resistance to the *sereh* disease also become greater.

Edouard Meyer finds that the vegetable organism, as well as the animal, gives off N-rays in varying quantities, as may be made evident by the feebly fluorescent screen. The most marked indications are given by the green parts, such as stems and especially leaves, but the emanations are feebly detectable from the flower. Roots, bulbs, and etiolated parts also give off the rays; but the greatest radiant activity appears at the point where the vegetable protoplasm is in its most active state, or is in process of evolution. Thus with two tubes of cress sown on moist wool, one in active germination, the other only recently sown, the evidence of radiant energy was much more marked in the former, and was even obtained from the bottom of the tube, where the radicles had penetrated the wool in the course of their growth. On treating tissues in active growth with the vapor of chloroform so as to slacken their vital functions, the N-ray indications were correspondingly lessened.—Comp. Rend.

Prof. H. du Bois and H. Rubens eleven years ago investigated the polarization of non-diffracted infra-red rays through narrow wire gratings, with a view to obtaining simpler conditions than in the case of visible short-wave rays. In fact, in the infra-red region of the spectrum, there is much less dependency on the molecular own vibrations of the substance, which so influences the behavior of the visible spectrum that a confirmation of the electro-magnetical theory meets with the highest difficulties. Now, in a recent paper read before the German Physical Society, Berlin, the experimenters extend their researches to much higher wave lengths, using the so-called residual rays (Reststrahlen) from fluorspar (mean wave length 25.5 $\mu$) and from rock salt (mean wave length 51.2 $\mu$), the mantle of an Auer burner serving as the illuminant. After being polarized through a reflection on glass or quartz plates under the angle of polarization, the rays were reflected from four fluoride or five rock-salt surfaces, whence a concave mirror concentrated them on a thermic battery. From the results of these experiments, it is inferred that the transmissibility of rays will augment for increasing wave lengths. The increase of the unpolarized rays is particularly remarkable, being fairly well in accord with the theoretical value.

It will be remembered that some little time ago, Messrs. Siedentopf and Zsigmondy showed that by using a very intense source of light it was possible under suitable conditions to recognize in the microscope bodies much below the real limit of visibility. The bodies appear merely as diffraction disks, and it is impossible to examine their actual structure. In a communication to the Société Française de Physique, MM. Cotton and Mouton describe an application of the same principle to the study of liquids. The liquid to be examined rests on a sheet of glass, and is covered by a very thin cover strip of mica. The whole rests on a block of glass, up through which sunlight is directed, the angle of incidence being such that the light undergoes total reflection from the underside of the cover strip. When examined in this way, even the emulsion used by Mr. Lippmann in his system of color photography shows a multitude of shining points. Similarly an emulsion of Chinese ink examined in the same way shows, in addition to the larger particles, a number of similar points, and the same points also appear in colloidal solutions. Further, a culture of the pleuro-pneumonia microbe, which examined in the ordinary way showed only a sort of indistinct granulation, exhibited, when observed as described above, a large number of these shining corpuscles.