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NEW YORK, SATURDAY, NOVEMBER 30, 1901.

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 RECENT HIGH-EXPLOSIVE SHELL TESTS AT SANDY HOOK.

In the presence of such a brilliant success as has just been achieved by the new army high-explosive armor-piercing shell against heavy Kruppized armor plate, there is, of course, always a danger of overestimating its value; but we shall be within conservative limits when we state that this is one of the most phenomenal and epoch-marking achievements recorded in the history of the long contest between guns and armor, the credit in this case, however, being due to the projectile rather than to the gun. From their very first appearance high explosives have appealed strongly to the artillerist; for it has been realized that if they could be detonated either against or within the structure of a warship, they would produce enormously destructive effects. Experimentalists in the matter of throwing high explosives have been divided into two schools. One of these, represented by Zalinsky with his pneumatic dynamite gun and Gathmann with his torpedo shell, have claimed that it was only necessary to explode a large amount of guncotton against the side or deck of a battleship to blow in the structure and sink the vessel. The other school has claimed that high explosives would be comparatively ineffective if detonated on the outside of the armored portions of a ship, and that the only way to secure their full effect would be to carry them in armor-piercing shot and shell through the armored sides of a vessel and burst them in her interior.

The significance of the recent tests at Sandy Hook lies largely in the fact that the two systems were tried out under exactly equal conditions, and that in one of them at least it was proved that we have a combination of an explosive, a fuse and a shell, which has given the highest possible results that could be demanded, and has placed the very best modern armor plate completely at the mercy of the gun. We refer, of course, to the high-explosive, armor-piercing shell, loaded with either dunnite or maximite, and provided with the Dunn delay-action fuse, which latter is absolutely necessary to the detonation of the high-explosive filler. The results of the test, as shown on our front page, make it certain that the best-protected armorclad afloat, if attacked at pointblank range, would be speedily put out of action, either by the disablement of her guns, the destruction of her personnel, or the ultimate sinking of the ship itself.

With regard to the Gathmann test, it is our opinion that while the results are not comparable, in their effect upon the plate itself, to those achieved by the army shell, the effects produced upon the target as a whole were so tremendous as to render the Gathmann shell anything but the absolute failure which it has generally been pronounced to be. A shell that is capable of crumpling in, concertina fashion, the plate-steel framing of an "Iowa" and swinging the 12-inch Krupp plate with its steel and timber backing and several hundred tons of sand around, 8 feet to the rear and 8 feet to the left of its original position, is certainly entitled to be called something more than an absolute failure. At the same time it must be remembered that the target did not represent actual conditions; for had the plate been standing in its proper place on the side of a battleship, the lateral and vertical displacement which took place would have been impossible, since the plate would have been held in position by the strong armor shelf below, the 12-inch adjacent armor plates on either side of it, and by the mass of 6-inch side armor above it. Under such conditions it is quite a question whether the blast of the guncotton and the 52,000 foot-tons striking energy of the shell would have proved sufficient to crush in the plate-steel backing, representing the framing of the ship, in the way that it did in this test. The problem could only be settled by a trial under actual conditions. At the same time it is argued that it was the cushioning effect of the yielding plate frames that prevented the detonation from exerting its full effect upon the plate itself; and it is urged that had the plate been laterally and vertically supported, the energy of the detonation, which here showed itself in swinging the whole 700-ton mass of the target around to the left, would, had the plate been rigidly supported in the side of a ship, have expended its energy in smashing up the plate. It is possible, of course, that the tamping effect due to a more rigid backing would have concentrated the force of the detonation on the plate itself, and this contention is borne out by the fact that at Indian Head the detonation of 500 pounds of guncotton merely suspended against a 17-inch armor plate that was backed solidly against a cliff of wet clay, resulted in the complete demolition of the plate.

Justice to the Gathmann shell compels us to draw attention to these facts; but at the same time it must be remembered that a shell of the same size as the Gathmann filled with either maximite or dunnite, which have a greater density and far larger explosive energy, would have done more than the Gathmann shell, and would probably have smashed the plate into fragments. Moreover, the new army explosives are absolutely insensitive to shock; are perfectly safe to handle, and both the chemical composition and the delay-action fuse which is essential to their detonation are secrets which are in the safe-keeping of the United States army.

A NEW THERMO-ELECTRIC COUPLE.

In 1827 the elder Becquerel showed that copper sulphide is strongly positive to ordinary copper. He pointed out that thermo-electric couples of copper sulphide and copper yield electromotive forces greater than those obtained from any other bodies which he had tried, such as iron sulphide and manganese peroxide. These researches were continued by Edmond Becquerel in 1865 and 1866. He showed that copper sulphide can be used for the construction of thermo-electric couples in contact with copper or German silver, and remarked that in order to obtain powerful effects the copper sulphide should be in a peculiar condition. He claimed that the best means of obtaining this peculiar condition was to heat the sheets of copper in sulphur vapor, and then to melt the copper sulphide thus obtained, and to cast it in molds at a temperature as nearly as possible equal to its melting-point. Eugene Hermite and Charles F. Cooper, of Paris, France, in a patent which they have received in the United States declare that they have proved that in this last point the younger Becquerel was in error. Becquerel obtained bars of sulphide having a fibrous fracture with bubbles disseminated through the mass. If the melting is repeated several times at a high temperature and if the homogeneous mass is cast, MM. Hermite and Cooper state that its thermo-electric power is merely destroyed. In spite of all his precautions Becquerel did not always obtain bars giving the same electromotive force.

Ruhmkorff stated that by adding to the copper sulphide a little antimony sulphide he obtained bars of a more uniform thermo-electric power. Finally Becquerel, continuing his researches, found that by reheating his bars of melted copper sulphide for several hours, the thermo-electric power became more regular. Becquerel constructed a thermo-electric battery in the laboratory with bars of fused copper sulphide thus obtained, covered at their ends with coils of German silver wire or copper. This battery gave an electromotive force relatively much higher than that obtained from any other thermo-electric couple studied; but the internal resistance of the battery was so great that it was of no practical use. Such was the state of affairs when Hermite and Cooper began their researches. As a result of their investigations they have reached the conclusion that copper sulphide properly prepared and coupled with certain metals is eminently fitted for the construction of industrial thermo-electric batteries.

The difficulties to be overcome are, first, to obtain copper sulphide in a form virtually quite homogeneous and offering the least possible electric resistance and at the same time yielding a constant electromotive force variable for given temperatures, and second, to make contacts between the copper sulphide and the metal employed which will be indestructible by heat, and which will at the same time suppress all accidental and useless resistance to the passage of the current. The inventors are probably the first to show an industrial method of using copper sulphide. Becquerel's battery was merely a laboratory curiosity.

The copper sulphide is melted and then cast in molds of sand to give it the form desired in the construction of the couples. The pieces obtained are placed in a crucible or furnace and heated to redness, whereupon they are subjected to the action of sulphur vapor for about half an hour. The piece absorbs the sulphur and increases in volume. If the crucible or furnace be opened, the piece will be seen surrounded by the blue flame of burning sulphur. Before the complete disappearance of this flame, the piece is withdrawn from the furnace and allowed to cool. In this condition the copper sulphide gives only a very weak electromotive force, and offers most resistance to the electric current. It is therefore replaced in a well-closed furnace and heated to bright redness for several hours under the exclusion of air, copper sheets or ingots being placed in the furnace to absorb the sulphur vapor involved.

This operation reduces the resistance considerably, and every piece gives a perfectly regular electromotive force of from two-tenths to three-tenths of a volt, depending upon the temperature to which it is heated. By adding a small amount of sulphide of iron it is found that the action of the final roasting is strongly resisted. Hermite and Cooper have found that the best metals for the contacts in the construction of thermo-electric couples are copper, German silver, silicon iron or steel, chrome iron or steel, platinum or platinum iridium, and chiefly commercial brass. Brass oxidizes much less than copper when hot; and strange to say, does not combine in a red heat with sulphur as copper does. The discovery that copper can be transformed into sulphide on the surface of brass is the key to the new method of preparing contacts on the bars or tubes of copper.

THE GROWTH AND STATUS OF NATURAL GAS.

Aside from coal, gas now forms the most important fuel, and while much has been written concerning the decadence of the natural gas supply and the substitution of artificial gas produced from coal for the natural product, the fact remains that the natural gas production is still considerable, and this form of fuel has still a wide importance in industrial operations, although the supply at this day is not up to that of a few years ago, when the natural gas production was in the heyday of its existence. For ages natural gas escaping from the ground has been known to mankind. In primeval days it was venerated by the fire worshipers, and down through the ages we have faint records of its presence at various places, but it remained for modern days to effect the utilization of the product so as to bear upon the course of human progress.

Geology gives the gaseous, liquid and solid carbon compounds and bitumens a close relationship, and tells us that rock gas, now generally recognized as natural gas, is technically known as carbureted hydrogen and that marsh gas is one of its important constituents. Concerning the genesis of natural gas various hypotheses have been put forth. Some contend that its origin is organic, while others cling to the inorganic theory. Modern science is able to transform wood into lignite, and from that substance into bituminous coal, and it is now pretty well accepted that natural gas is the product of the slow decomposition of organic matter at a low temperature. In New York, Pennsylvania and other sections of the Appalachian field the gas pockets are mostly confined to the oil sands of the Devonian period, while in other sections they occur in the carbonaceous, the cretaceous, and the tertiary geological formations. Like petroleum, the natural gas belt seems to run around the world from Canada to California and northward from Hindostan to Wallachia, but it exhibits a less continuous sign than does petroleum. For twenty or thirty years the history of natural gas was coincident with that of petroleum, with the exception that the oil was utilized and gas despised. Nearly all the oil wells produced some gas, but its value was not early recognized, and for a long time wood was used to fire the boilers in oil-well drilling, while the gas was allowed to go to waste.

Probably the first attempts toward the utilization of natural gas were made in western Pennsylvania, where the oil industry was an important one as early as the middle of the last century, and it is certain that the first discovery of natural gas in this country was made in this section. The earliest record of the product dates back to 1823, when John Klingsworth, Philip Klingsworth and Nicholas Long struck a gas pocket at a depth of 300 feet while drilling a salt well near Grapeville, thirty miles east of Pittsburg. The gas rushed to the surface with great force, and, igniting, burned fiercely for months, but it was not until about fifteen years ago that the real value of the gas deposits at Grapeville were developed, and this field proved one of the most prolific in the country. For many years the existence of gas in Washington County, Pennsylvania, was known and throughout the oil regions of western Pennsylvania the product was invariably found.

One of the first natural gas companies organized in this country was the Fuel Gas Company, organized in Pittsburg in 1874. The organization of the Philadelphia Company in July, 1884, marked the real beginning of the natural gas industry, and the capital of the natural gas companies operating in Pittsburg in 1886 aggregated $20,000,000. That year saw a decided increase in the production and consumption of the product, and it was in that year that natural gas was first applied to the manufacture of glass. As early as 1885 the new fuel was responsible for the employment of 10,000 additional men in the industrial establishments of Pittsburg, and during that year the new fuel displaced 2,500,000 tons of coal in the Pittsburg district.

In western Pennsylvania the natural gas industry reached its zenith in 1888, and the value of the product consumed in Pennsylvania in that year aggregated $20,000,000. The production of natural gas in the Pittsburg field in that year was something like 300,000,000,000 cubic feet. The success of natural gas in industrial operations was instantaneous, and through the introduction of this new fuel to Pittsburg in 1885 her manufacturing industries entered upon the most marvelous development witnessed in modern times. What bituminous coal in three-quarters of a century laid the foundation for, natural gas in one-tenth of the time built to quadrupled dimensions. The natural gas excitement increased the assessed valuation of real estate in Allegheny County, Pennsylvania, nearly $200,000,000 between the years 1885 and 1893. In 1884, before the introduction of natural gas to furnace operations, seventeen furnaces in Pittsburg produced 487,000 tons of pig iron. In 1890 there were twenty-five furnaces with a combined annual output of 1,489,000 tons. During the past decade there has been a gradual decline of the natural gas output in western Pennsylvania, and while the product still holds a prominent place in industrial operations, as well as for domestic heating and lighting, the effect of the application of this form of fuel to iron and steel and glass making has been far-reaching. The success of the new fuel paved the way for the introduction of artificial heating and illuminating gas, which industry is to-day a most important one in all parts of the country.

During the past decade many new gas fields have been exploited, and in this way the production has been kept to a fair average during the past ten or twelve years. In 1888 the value of the natural gas produced was about $22,000,000, while the value of the annual production at present exceeds $15,000,000. The value of the natural gas utilized in Pennsylvania in 1888 was $19,000,000, while the annual value of this product in that State to-day is about $7,000,000. The fields of Ohio and Indiana are about holding their own, while West Virginia has been a heavy gainer in the output of this product during the past year. There are at present over one thousand companies or individual concerns engaged in the production and marketing of natural gas. About 8,000 wells are now producing, and the 90,000,000 cubic feet of gas annually produced is carried to the points of consumption by nearly 18,000 miles of pipe, the product being used by more than half a million domestic fires, half a hundred iron mills and steel works, 200 glass houses and 3,000 other industrial establishments.

The general use of natural gas for industrial operations has done much to abate the smoke nuisance in cities, and with the economic use of this fuel its exhaustion will not be accomplished for years to come. Geologists have not yet settled conclusively whether or not gas is still forming, but the fact remains that many new wells are being brought in each year. A fact in connection with the introduction of natural gas into the iron and steel and allied manufacturing industries is that this fuel had the effect of greatly raising the standard of these products, and in many instances artificial gas is used to-day where natural gas is not obtainable, in order to produce the same results as are possible with natural gas. Pittsburg has always been foremost in the introduction of new fuels in industrial operations. It was in the iron and steel plants of that city that fuel coke was first used and there, too, natural gas was first adapted to the uses of modern industry. To-day Pittsburg stands pre-eminent among the industrial centers of the world so far as regards her fuel supply, and the part played and importance which the natural gas supply still holds with relation to the great iron and steel and varied manufacturing industries of the city are not to be overlooked in summing up the stupendous industrial development which has taken place about the headwaters of the Ohio. W. G. I.

THE HEAVENS IN DECEMBER AND THE NEW STAR IN PERSEUS.

BY HENRY NORRIS RUSSELL, PH.D.

A triple planetary conjunction, no less remarkable than that of last month, takes place about the 15th of December. Jupiter and Saturn participate in it, as they did in the last one, but the third body is Mars. Moving slowly eastward, he passes Saturn in the morning of the 14th, and Jupiter on that of the 17th. While the two larger planets appear farther apart than a month ago, Mars passes much nearer them than Venus did. Unfortunately, all three are so near the sun, and in consequence so deep in the evening twilight, that Mars can hardly be seen, though Jupiter should be easily visible, and Saturn without much difficulty. The best time to look for them will be about half an hour after sunset.

THE NEW STAR IN PERSEUS.

The most noteworthy current astronomical news relates to the new star in Perseus, or, rather, to its surroundings. A couple of months ago it was found that the new star is surrounded by a very faint nebula, so faint, in fact, that its brightest parts alone can be seen with the telescope, the rest being revealed only by photography. The photographs show that the form of the nebula is roughly circular, and that the luminous matter is gathered into nearly concentric circular streaks, so arranged about the new star as a center that there can be little doubt of the physical connection of the two.

Now comes a telegram from the Lick Observatory, stating that the brighter spots on the edge of the nebula are *moving*, supplemented by one from the Yerkes Observatory, a day later, saying that the nebula is probably expanding in all directions, and that this is certainly true of its southern (and brighter) half.

As no such motion relative to the stars has ever before been detected in a nebula, this discovery would in any event be considered important, but its most sensational feature remains to be mentioned—the enormous rate of motion—one minute of arc in six weeks. This speed, at which it would take a body about three and a half years to traverse a distance equal to the moon's apparent diameter, may not seem at first to warrant the adjective that has just been applied to it. But when it is compared with the motions which have previously been observed among the stars, its true character at once appears.

The greatest proper motion—that is, velocity of a star among its neighbors—which has previously been known to science belongs to a small star in the southern hemisphere, which traverses 8¾ seconds of arc in a year. But the edge of this nebula is moving at the rate of over 500 seconds of arc a year, which is nearly sixty times as fast. When we come to translate this angular velocity into actual miles per second, we reach results that are yet more remarkable. If we assume that the nebula is as near as the nearest known star, the velocity of its edge comes out more than 2,000 miles a second—enough to carry it from the earth to the sun in twelve hours.

If the nebula is farther from us, the velocity is greater in proportion to its distance. Now the greatest velocity which any heavenly body (not moving in an orbit close to another) has previously been proved, or even supposed, to possess is about 200 miles per second. So we find ourselves faced with the following alternatives:

Either the new star in Perseus, and its surrounding nebula, are much nearer than any known star, or the velocity of expansion of the nebula is much greater than any which has previously been observed, or even suspected.

The first of the above alternatives seems on the face of it the more probable. It will soon be tested by observations for the parallax of the star. But, in any case, the velocity with which the luminous part of the nebula appears to move must be very great. One escape from the difficulty presents itself. It is possible that the gas of which the nebula is composed is normally dark, and that its shining is caused by some sort of impulse radiated out from the central star. Such a "wave" might travel very rapidly, although the gas as a whole was at rest, just as sound, in perfectly calm air, moves at the rate of eleven miles a minute.

In any case, however, it seems probable that Nova Persei and its nebula are much nearer than the average of the stars.

THE HEAVENS.

The familiar winter constellations may be dismissed briefly. At 9 P. M., on December 15, Vega is just setting in the northwest, below Cygnus. Pegasus is low in the west, Andromeda above him, and Perseus in the zenith. Pisces, Cetus, and Eridanus fill the southern sky.

Gemini and Orion are well up in the east and southeast, with Auriga and Taurus above. The two dog-stars, Procyon and Sirius, lie below them. Cassiopeia is above the pole, Ursa Minor and Draco below, and Ursa Major on the right of the last.

THE PLANETS.

Mercury is morning star throughout the month, but can only be seen during its first few days, as he is afterward too near the sun.

Venus is evening star in Capricornus. On the 4th she reaches her greatest elongation, being 47 deg. east of the sun. She approaches the earth and increases in brightness all through the month, and, as she is also moving northward, she becomes much more conspicuous, being visible for more than three hours after sunset. At the beginning of the month she appears telescopically as an exact half-moon, but by the end she has become a pronounced crescent.

Mars is evening star in Sagittarius, too near the sun to be well seen.

Jupiter and Saturn are also evening stars in Sagittarius, close together, but gradually drawing apart. By the end of the month they are too near the sun to be conspicuous.

Uranus is in conjunction with the sun on the 9th, and is quite invisible.

Neptune is in Gemini. He comes to opposition on the 22d, but can only be well seen with a large telescope.

THE MOON.

Last quarter occurs on the afternoon of the 2d, new moon on the evening of the 10th, first quarter on the afternoon of the 18th, full moon on the morning of the 25th, and last quarter again on the morning of January 1.

The moon is nearest us on the 23d, and farthest away on the 8th. She is in conjunction with Mercury on the afternoon of the 9th, Uranus on that of the 10th, Mars, Jupiter and Saturn on the night of the 12th, Venus on the morning of the 15th, and Neptune on the night of the 25th.

At 7 o'clock on the morning of the 22d, the sun enters the sign of Capricornus, and, according to the almanacs, winter begins.

Princeton, N. J., November 19, 1901.

SCIENCE NOTES.

The Jesup expedition (sent out by the American Museum of Natural History, New York city, to explore the unknown portions of Northeastern Siberia) has finished its work. The leaders, Norman C. Buxton, an American, and Aigenson (Jackelson?) have arrived at Moscow, after having traveled 5,000 versts (about 3,300 miles) in Kamchatka and other semi-polar districts. They have brought with them 100 boxes of collections for the American Museum of Natural History. Duplicates will be given to the St. Petersburg Academy of Sciences. The explorers have thoroughly investigated many tribes during the past fourteen months.

The scientific expert of the Indian Tea Association has issued a report on tea-seed oil and cake. Investigations show that tea-seed oil is clear, light, and yellow, but always has a more or less acrid taste. It cannot safely be used as an edible oil, owing to the presence of saponin, which is a constituent of the seed. For the same reason the tea-seed oil-cake is decidedly dangerous as a food for catle. As a manure it is far behind the other oil-seed cakes of commerce. The oil could be used as a lamp oil, and the cake might be useful as an insecticide. It was attempted, in 1885, to put tea-seed, as such, on the London market, under the name "tanne," but the seeds found no buyer, and the price asked sank quickly to a level far below the cost of importation.

The Century Magazine for October contains a short article on "How to Cross the Atlantic in a Balloon," by Prof. Samuel A. King, with an introduction by Prof. Cleveland Abbe. Prof. King deprecates the attempt to solve a problem of this character by means of flying machines or mechanically-propelled balloons, and thinks that the secret of success lies in mastering the problem of maintaining the ordinary spherical balloon at any required height by the aid of the drag rope or similar appliances. The author also points out the necessity of overcoming the propensity of the balloon to rise and fall with varying temperature, and suggests the use of a hood as a protection from solar radiation. With proper precautions, Prof. King considers a Transatlantic balloon voyage now quite within the range of feasibility.

Two remarkable caves have been discovered in France by Messrs. Capitan and Breuil, in which the walls are covered with drawn and painted figures of the paleolithic epoch. These are mostly figures of animals, and some of them have been drawn with striking correctness. In the first cave, at Combarelles (Dordogne), the figures are drawn with a deeply engraved line and are vigorous in execution. They include the mammoth, reindeer and other animals extinct in France. In the second cave, at Font-de-Gaume, not far from the former, black lines are used, and sometimes the whole animal is painted black, forming a silhouette. Red ocher is also used in the figures, which are sometimes four feet long. Many of the figures are covered with a stalagmite deposit which often reaches an inch in thickness.

An ingenious labor-saving machine, which will completely revolutionize the finger-ring manufacturing industry of England, has been devised by Mr. C. P. Denkin, a Birmingham jeweler. This machine effects in one almost instantaneous operation the work of several men. A signet ring fresh from the mold is placed in one tool of the Denkin invention, and within the space of a few seconds the inside is fixed, polished and lapped. The treatment of the face of the signet is equally simple and rapid. By means of an ingenious device it is clamped, and trained to a revolving surface of special design. In a short space of time the face is finished to perfection, whereas at present the ring has to pass through the hands of four skilled workmen. The process is so simple that it can be worked by a boy or girl, which means a considerable economy in the cost of production.