followed by a train weighing 2,240 pounds per running foot. In order to provide for vibrations and wind pressure, the bottom lateral bracing in through bridges is proportioned to resist a lateral strain of 450 pounds for each foot of span.

The viaduct is composed of lattice girders supported upon six iron piers, the distance between facing columns of the piers being 50 feet in all except that next the bridge, which is 60 feet. Much trouble was experienced in obtaining a suitable material upon which to build the piers, and in some instances excavations to the depth of 60 and 80 feet had to be made before finding a good foundation. The bridge piers rest on masonry, built on piles driven to refusal.

The placing in position of a structure of this magnitude at so great a height involves great care and much labor, and its rapid and successful completion makes it a subject well worth studying. No false work was used in erecting the viaduct. The piers consist, practically, of four iron columns resting on beds of masonry, and firmly held in position by struts and ties. After the foundations had been completed the columns were raised in place, when a gin pole (a wooden mast having a pulley at its upper end, through which a hoisting rope passes) is fastened to them by iron bands. A rope passes from a hoisting engine through a block at the base, thence through the pulley in the gin pole. By this means the several parts were raised into position and secured. The work was completed, section by section, to the full height and the track laid. As soon as the first section had been finished a traveler, operating on top, assisted in the work of raising the balance.

Very different and much more difficult was the task of erecting the spans. In this case it was necessary, in order to support the great weight of iron, to build a framework of heavy timber of strength sufficient to bear the load and resist the wind which sometimes sweeps through the gorge with great violence. Our drawings show a side and transverse elevation with details of the top, bottom, and splice. All bolts were three-quarter inch, all diagonal transverse braces were 3 inches by 8 inches, all horizontal transverse braces were 4 by 8 inches, all longitudinal braces 3 by 8 inches, with X bracing between outside and center legs. This framework was supported on piles; the distance from the top of the piles to the caps was 142 feet. Three hundred thousand feet of timber was used and 416 piles. Putting the span together after this had been finished was comparatively easy. About two-thirds of the total cost of erection was for the false work, engines, blocks, tackle, and other appliances. The total cost of erection was about 1½ cents per pound. The cost was from one-third to one-half a cent per pound greater than it would have been in summer, owing to last winter being an unusually inclement one. Much of the time the ropes, stagings, etc., were covered with ice.

Consideration for Employes.

Referring to an article published in the SCIENTIFIC AMERICAN in its issue of June 2d, on "Consideration for old Employes," the proprietors of the Morgan Crucible Company, London, England, send a plan of a scheme for the encouragement and relief of faithful, disabled, and aged employes, which is in practical operation with them with good results. In brief, the plan gives to each employe at weekly wages: to all who have been employed six months, a bonus of six pence on the pound, or 2½ per cent; to a one year's worker, 3¾ per cent; to a five years' employe, 5 per cent.

These bonuses must be placed in the Post Office Savings Bank, and every twenty pounds thus deposited will draw yearly 2½ per cent given by the company. The company give pensions also to incapacitated workmen at a rate of six shillings per week for a workman of ten years' continuous service, eight shillings per week for one of fifteen years' service, ten shillings per week for twenty years, and when a workman has performed twenty years of continuous service and has been retired, he receives 30 per cent of his salary thereafter.

Tar and Ammonia from Coke Ovens.

In the course of his inaugural address as President of the Iron and Steel Institute, Mr. B. Samuelson, M.P., F.R.S., said, with reference to the recent improvements in the manufacture of coke, that the yield of this product per ton of coal had been increased from about sixty per cent—the average of the ordinary beehive oven—to seventy-five and seventy-seven per cent. These were the figures realized by certain oblong ovens erected at the president's own collieries in Durham, and by the new ovens on the Corves system erected by Messrs. Pease. At the same time that the yield of coke had been increased, the by products were utilized to the extent of seven gallons of tar and thirty gallons of ammoniacal liquor per ton of coal. The value of these by-products at present is 4s. 3d. per ton; but against this must be set the charge of 1s. 4d. per ton for additional labor, and the interest on the capital cost of the plant, which is considerable. Viewed from the standpoint of the iron manufacturer, this advance in the utilization of by-products simply means a reduction in the cost of the production of iron. It does not appear, however, that Mr. Samuelson gave any further details of the profit and loss of the process referred to in his own case; and therefore his hearers were left unenlightened as to the extent to which the development of the system may be looked for.

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(Illustrated articles are marked with an asterisk.)

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THE SCIENTIFIC AMERICAN SUPPLEMENT

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THE TOTAL SOLAR ECLIPSE OF THE 6TH OF MAY.

Not a word was heard from the astronomers who traveled many thousand miles to observe the solar eclipse, until the 12th of June. The glad news then flashed over the wires from San Francisco that the weather on the momentous day was excellent, and that the results attained were a great success. Somewhat fuller accounts of the expedition have since found their way eastward, but the full results of the observations can only be obtained from the official reports of the observers, which will be forthcoming as speedily as possible.

It will be remembered that the American expedition was sent out by the National Academy of Sciences to observe the total eclipse of the sun on the 6th of May at Caroline Island, in the South Pacific Ocean. It consisted of six members, and was in charge of Professor Holden, of the Washington Observatory, of Madison, Wis. The observers started for their destination on the 1st of March. From Callao, Peru, they were conveyed by the United States steamer Hartford to Caroline Island, which they reached on the 20th of April. Two observers joined them at Callao, sent out by the Royal Astronomical Society of Great Britain, and four officers from the Hartford increased the number of observers to twelve. On the 22d of April, a party of French astronomers arrived in the L'Eclaireur, and took up their quarters on the island. Among the members of the French expedition were several astronomers of world-wide fame, including M. Janssen, to whom total eclipses and their awe-inspiring phenomena are as familiar as the letters of the alphabet to ordinary men; M. Tacchini, of the Roman Observatory, famous for his power of handling the spectroscope; M. Trouvelot, whose wondrous drawings of the sun and the planets gained for him great fame during his residence in Cambridge, Mass.; M. Palisa, distinguished for his skill in picking up asteroids; and M. Pasteur, of the Meudon Observatory, well known as an accomplished photographer.

Caroline Island was found to consist of a chain of small coral islands encircling a lagoon. The vegetation is good, and cocoanuts and a small quantity of guano form articles of export for a London firm which has leased the island from the British government. At the time of the astronomical invasion the seven inhabitants consisted of four men, one of whom was accompanied by a wife and two children. Caroline Island was not their permanent abode, but they had been brought from Tahiti to take care of the young cocoanut trees and the property left on the island.

The men of science landed on the coral rocks, not without difficulty, and encountered still greater difficulty in getting their precious instruments on shore. But the unloading was finished at last, and the Hartford, leaving ten men behind to give needed assistance, steamed away to Tahiti, to find a harbor where she might safely lie till the eclipse was over.

The intervening time was spent in mounting the instruments and making every possible preparation for the coming of the great event. At length, the day of the eclipse dawned, and American, English, and French astronomers were at their posts, determined to do what men can do to wrest important secrets from the grasp of the sun, while his face was veiled by the dark shadow of the moon. Serious doubts as to the weather disheartened the observers on the morning of the eclipse. But the clouds scattered, and the sky cleared before the grand event, and remained nearly clear till after the eclipse was over. A slight haze and a few passing clouds alone interfered with the perfection of the conditions under which the phenomenon was observed. The period of totality was five minutes and twenty-five seconds, and the practiced observers made the most of the precious minutes as they passed, each observer devoting himself to the part assigned to him.

The most glorious sight ever witnessed by human eyes was displayed in all its grandeur and sublimity to the band of observers on this lone island of the ocean. The four contacts were noted, and, as the moon covered the sun's face, the corona beamed brightly forth, with five well defined streamers. The rosy protuberances were, however, very few, and the chromosphere was in a state of unusual quiescence. Photographs were secured of the corona and its spectrum, and of the sky in the vicinity of the eclipsed sun. Some very interesting spectroscopic observations of the corona were made, whose result seems to upset prevailing theories; for Professor Hastings, of Baltimore, one of the observers, asserts that the corona is not an appendage of the sun, but an optical phenomenon. There was a time when this was the general view, but astronomers of late years have not only considered the corona as belonging to the sun, but photographs of the solar disk have been recently made showing the silvery streamers when there was no eclipse. Professor Hastings will have to support his observations by proofs strong as Holy Writ before his theory will be accepted, now that a different one has been long considered valid by the astronomical mind.

Not a trace of that mythical member of the solar brotherhood, the planet Vulcan, was obtained, though careful search was made. Perhaps there is no such planet, and perhaps he was safely hidden behind the sun's vast mass, and may beam forth at some future total eclipse to prove conclusively that Mercury's unexplained perturbations have a tangible cause. Much more valuable work was done. Trouvelot made a sketch of the corona; Dr. Dixon sketched its five well defined streamers; Tachini observed a spectrum resembling that of comets in one of the coronal streamers; Janssen noted dark lines in the spectrum of the corona.

The English and French astronomers obtained a series of coronal negatives. Some of these extended to its outer limits, and some of those of the coronal spectrum contained several bright lines. The meteorological observations showed a rise in barometric pressure of 0·02 inch, the rise in humidity was five per cent., the temperature fell to that of night, the direction and velocity of the wind were uniform, and the observations on radiation showed that the reception of heat by the earth was almost entirely checked.

Even these barren items of information are of exceeding interest, and will furnish admirable material for thoughtful study until the official accounts are made public, and a wonderful story of personal experience, observation, and devotion to science will be related that will find admiring listeners all over the civilized world.

The astronomers enjoyed excellent health during their long trip. After the eclipse, the Hartford returned to Caroline Island and carried the American party to Honolulu, from whence they took passage to San Francisco and home.

HOW SCREWS ARE THREADED.

Screw threads are "originated" in the lathe usually. All lathe turning, with regular—constant—feed of the turning tool, is screw cutting, or threading; the tool cuts a spiral around a revolving cylinder.

It is evident, therefore, that by increasing the speed of the feed relative to that of the revolving cylinder, and having the point of the cutter properly shaped, a screw thread would result, instead of a paring off of the entire surface of the cylinder. All important actuating or working screws, as those for feeding on machine tools, are formed in this way, and large numbers, also, of ordinary machine screws, which when once seated are expected to remain *in situ* until the machine or implement of which they form a part is worn out.

Wood screws, as screws for fastening wood to wood, metal to wood, etc., are threaded in a similar manner, the thread being cut from the solid by a single cutter removing the material between the threads.

Large numbers of screws are threaded by dies, which may be called hollow screws, or nuts with cutting edges. These, by rotating, form the feed as well as the cutting device for threading the smooth cylindrical rod or bar. Some of these dies are worked by hand, others by power, but in either case the cut, by the modern and improved dies, is clean, and the thread is formed from the solid. The old fashioned dies were adjustable so as to be "set up," and could be made to cut several sizes of diameters. Much of their work was done by pressure, or squeezing, and a part of the thread was "raised" instead of being cut from the solid material. There are adjustable dies made now, but they are so formed as to do solid cutting.

There is another method of cutting threads direct from the solid, and that is by milling. It is the invention of the late Eli Horton, the chuck man of Windsor Locks, Conn. The machine is entirely automatic, the blank to be cut being rotated as in a lathe, and a rotary milling tool rotating against it at an angle adapted to the pitch of the thread desired. As the blank revolves slowly toward the cutter, the cutter revolving more rapidly forms the thread by being fed along over the blank as is the cutting tool in a lathe. The milling tool is so formed in cross section as to produce any shape of thread desired. This method is still in use by the successors of Mr. Horton to thread the steel screws of their chucks.

Threads on large cast iron screws are sometimes formed simply by being cast, and formerly there was much cheap small work of that sort in the market.

Threads may be raised by forging in dies, and some good work by this is produced. In both these cases, however, an after finish in the lathe is desirable.

For some peculiar purposes threads are formed by twisting a square or a flat bar; a common form of hand drill that has superseded the bow drill being a case in point. The stock of this drill is a bar, square in cross section, twisted, and which is rotated by sliding a loosely fitting nut rapidly back and forth over its length. A familiar instance of a screw thread of this description is the ordinary auger or bit, the cross section of which is a flattened parallelogram like a flat bar.

One peculiar method of forming screw threads remains to be mentioned. It is that of raising a thread by rolling between dies under pressure. There is a great deal of what is known as "bright wire goods" in the market, which are threaded. In many cases these threads are formed by simply rolling—one revolution, or a little more—the wire between two hardened steel plates that are corrugated spirally to form, when combined, a continuous thread. Sufficient pressure is applied during the rolling—which, however, is very rapid—to raise the metal from the annealed wire enough to make a thread. In this case the threaded portion is considerably larger than the stock or wire, at least half the depth of the thread on each side.

The threads in nuts are produced either by the "originating" method, cutting them in a lathe, by being tapped, or sometimes by being cast of soft metal, as brass, on a threaded core of hard metal, as iron or steel. But nuts are mostly threaded by tapping, running one, two, or three successive taps through them either by hand or in a power machine. Nuts of very thin material, as sheet brass for lamp tops, jar covers, etc., are formed simply by rolling between spirally corrugated rolls, a work analogous to "beading" on tin ware.

D'ARREST'S COMET.

[Translated for the SCIENTIFIC AMERICAN from *Ciel et Terre* of the 15th of April.]

On the 27th of June, 1851, D'Arrest discovered at Leipzig a very faint comet. After following its course for a fortnight, D'Arrest and Yvon Villarceau announced, almost simultaneously, that the orbit of the new comet was elliptical, and that it must be ranked among periodical comets that return at regular intervals to perihelion, the only time when they are visible. The comet was observed for three months. Yvon Villarceau, from the computation of its positions, assigned to it a period of about six years and a half, and an orbit that at aphelion approached very near the orbit of the giant planet of our system, the mighty Jupiter, whose mass is nearly 340 times greater than that of the earth, and whose attraction must consequently exert a powerful influence upon the path traversed by the comet, and complicate the determination of the successive epochs of its return.

It is difficult to form an idea of the length and tediousness of the process required by these mathematical calculations. The task was, however, undertaken, and, on the 1st of June, 1857, Yvon Villarceau announced the return of the comet during the winter of 1857-58.

According to the ephemeris issued at the same time with the article in question, he also announced that the comet would not be visible in the northern hemisphere, and notified observers in the southern hemisphere of the results of his work, that they might be on the watch for the erratic visitor. On the 4th of December, 1857, Sir Thomas Maclear, of the Cape of Good Hope Observatory, detected a faint comet in the neighborhood of the position assigned to it.

In July, 1861, Yvon Villarceau published a new paper concerning the comet's orbit. He predicted its return to perihelion on the 26th of February, 1864, but declared that its faint luster and small angular distance from the sun would probably render it invisible. This prediction was fulfilled, and the return of 1864 was not observed.

The next appearance of the comet was announced for 1870. M. Leveau calculated the probable orbit for this epoch; following the plan of M. Yvon Villarceau, he introduced into his calculations an indeterminate quantity from which he selected three probable values that gave him three different ephemerides. In spite of the great perturbations caused by the attraction of Jupiter between the returns of 1858 and 1864, and the absence of observations in 1864, D'Arrest's comet was detected by Winnecke at Carlsruhe on the 31st of August, 1870.

Its position was in right ascension 16 h. 38 m. 3 s.; its declination was 10° 39·8′ south. One of the ephemerides of M. Leveau had assigned to it for this epoch a probable position in right ascension of 16 h. 38 m. 18 s., and in declination of 10° 41·1′ south. The agreement between calculation and observation is remarkable.

Finally, the return of 1877 was observed at Marseilles on the 8th and 9th of July. The return of the visitor is expected during the present year. It has even been already announced, but the news proved to be without foundation, and the celestial object mistaken for D'Arrest's comet is a faint new nebula.

The reader will, perhaps, ask what scientific interest there can be in announcing the return of periodic comets. After the brilliant confirmations of the law of universal attraction that have been furnished by phenomena of various kinds, of what use is it to build monuments of figures in order to predict the return of a comet? At first sight it would seem that such labor is unwarrantable, and without direct utility.

We must, however, discard such conclusions, for they are in contradiction to the essentially perfectible character of science. Certainly it is no longer necessary to seek in the movements of the planets of our solar system confirmation of the law of universal gravitation; but the utility of the labor in question is not bounded by this law!

A multitude of secondary causes play a part in the economy of the material universe, and the effect of these multiple causes can only be revealed by the constant observation of all the phenomena offered for examination. Each observation constitutes, in some measure, a function of the constant quantities that enter into the great law of universal attraction, combined with the effects of these causes in detail. The accumulation of a great number of these functions will alone allow us in the future to suspect the existence of these causes and to discern the part that belongs to each one of them in the production of phenomena as we observe them. The constant study of facts constitutes the experience of science; this is not lost, like personal experience, but it can be transmitted to our successors to throw light upon their researches in ages to come.

Each comet therefore presents, as it were, a special interest in our studies of the universe. Encke's comet seems to feel the effect of the resisting medium through which it passes. The great comet of 1882 grazed the sun's atmosphere and furnished appreciable elements of the small resistant power of this atmosphere. D'Arrest's comet offers in the same way at every reappearance the possibility of measuring the extent of the perturbations to which it has been subjected, and as it passes exceptionally near to Jupiter it is eminently adapted for furnishing the data of observation relative to the mass—not yet absolutely determined—of this immense planet, which exerts so powerful an influence upon the solar system.

Snakes in Australia.

"Although the bushman has nothing to fear out here from the attacks of any wild animals," says a writer whose knowledge of Australian country life is not to be excelled, "he has still his secret enemies, which in many cases are as dangerous as the open foe; and what he has most to dread in the Australian bush are the snakes." Such is certainly the case. "I do not believe," he continues, "any part of the world can be more infested with these reptiles in the summer season. Let him walk where he will—in the depths of the forest, in the thick heather, on the open swamps and plains, by the creek or water holes—the shooter is sure to meet with his enemy, the black snake. It enters his very tent or hut, and coils itself in his blankets. In fact, nowhere is he safe; and if he did not banish the thought of them altogether from his mind, he would not have a moment's peace.

"It does, indeed, appear as if the eye of a watchful Providence peculiarly guarded the traveler in these wilds; for at any moment he is liable to tread upon a deadly snake, coiled up in his very path, which does not always get out of the way, but lies watching him with his basilisk eye, ready in a moment to make the fatal spring if touched, and very often the snake is not seen until the danger is past." Bushmen soon become accustomed, like the black fellows, to the indications of the presence of a snake, and can see it before reaching it, unless coiled up very snugly. The bush fires destroy thousands of snakes, but seem to make no impression on their numbers. Curiously enough, snakes are not found in New Zealand, although there is no record of St. Patrick having ever visited that part of the world.

A Bolivian Saurian.

"The Brazilian Minister at La Paz, Bolivia, has remitted to the Minister of Foreign Affairs in Rio photographs of drawings of an extraordinary saurian killed on the Beni after receiving thirty-six balls. By order of the President of Bolivia the dried body, which had been preserved in Asuncion, was sent to La Paz. It is twelve meters long from snout to point of the tail, which latter is flattened. Besides the anterior head, it has, four meters behind, two small but completely formed heads(?) rising from the back. All three have much resemblance to the head of a dog. The legs are short, and end in formidable claws. The legs, belly, and lower part of the throat appear defended by a kind of scale armor, and all the back is protected by a still thicker and double cuirass, starting from behind the ears of the anterior head, and continuing to the tail. The neck is long, and the belly large and almost dragging on the ground. Professor Gilveti, who examined the beast, thinks it is not a monster, but a member of a rare or almost lost species, as the Indians in some parts of Bolivia use small earthen vases of identical shape, and probably copied from nature."

Mr. William E. A. Axon, in a note giving the above to the *Journal of Science*, says: "If this account should prove to be accurate, it would form a counterpart to the etching of the mammoth, which forms so interesting a memorial of prehistoric art."

New Explosive.

Herr Koppel has devised a new explosive substance, which he expects to be less costly than any other, to give out no injurious fumes, and not to be liable to explosion by shock or friction. The following is the composition of two kinds, No. 1 being suitable for hard rocks, such as basalt, and No. 2 for softer, such as sandstone:

	No. 1.	No. 2.
Saltpeter	35	42
Soda	19	22
Sulphur	11	12 50
Sawdust	9·50	10
Chlorate of potash	9·50	—
Charcoal	6	7
Sulphate of soda	4·25	5
Prussiate of potash	2·25	—
Refined sugar	2·25	—
Picric acid	1·25	1·50
	100	100

The New Nickels not a Standard Weight for Measure.

The new V nickels are now coming into general use, the word "cents" having been added to prevent their being mistaken, when gilded, for half-eagles. The following, which was true of the old nickel, although it does not apply to the new, is now going the rounds of our exchanges:

"*Five Cent Nickels as Measures.*—A fact probably but little known is that the United States nickel five cent pieces furnish a key to metric measures and weights. This coin is two centimeters in diameter, and its weight is five grammes. Five of them placed in a row will give the length of a decimeter, and two of them will weigh a decagramme. As a kiloliter is a cubic meter, the key of the measure is also a key to a measure of capacity."

Although the new nickel pieces are larger in diameter than the old, they weigh less.

The average weight of those which we have tested is 4·9 grammes, or 75½ grains, while the diameter is 21 millimeters. Both old and new are so nearly two millimeters in thickness that the eye cannot distinguish the difference, hence a very correct idea of a millimeter can be had by taking half the thickness of a five cent nickel.

To give an idea of larger metric measures we may add that the column rules of the SCIENTIFIC AMERICAN are 0·36 meter, or 36 cm., in length, while the editorial columns are 8 cm. wide. The columns of the New York *Sun* and *Times* are nearly 54 cm. long and 6 cm. wide.