

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 re-

lates 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 $8\frac{3}{4}$ 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 south-east, 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 acid 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 cattle. 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 ochre 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.