THE HEAVENS IN APRIL, 1902.

BY HENRY NORRIS RUSSELL, PH D.

The evening skies still remain unadorned by any of the planets, and even the bright winter constellations are now disappearing in the west. Though the present is therefore a dull season for the amateur astronomer, it affords an excellent opportunity to see certain objects—we can hardly call them bodies—which, though belonging to our solar system, bear the same relation to the planets that the Milky Way does to the stars.

The most conspicuous of these objects is known as the zodiacal light. It can easily be seen on any clear evening when the moon is out of the way. As soon as the twilight has faded from the western sky, so that the Milky Way becomes visible, there appears a band of light, rising from the horizon near the point where the sun has set, and extending upward, with a considerable inclination toward the left. Its lower portions are fully as bright as the Milky Way, and of considerable breadth, but it grows narrower and fainter as it ascends, so that its general form is wedge-shaped. At the present season its top is lost in the Milky Way.

A similar phenomenon can be seen in the eastern sky before dawn.

Upon investigating the position of this light among the stars, it is found that its central line lies along the ecliptic, among the constellations of the Zodiac. It is for this reason that it is called the zodiacal light. Unlike the Milky Way, the zodiacal light does not remain in the same position among the stars. It moves around the ecliptic once a year, with the sun, so that it is always seen in the west after sunset, or in the east before sunrise. It is not, however, always equally conspicuous, at least in our northern latitudes. In spring the ecliptic rises steeply above the western horizon, and the evening zodiacal light is prominent. In the autumn, when the ecliptic makes but a small angle with the horizon, it is, for the most part, lost in the haze.

The zodiacal light is best visible in the morning just when it is least conspicuous in the evening, that is, in the late autumn.

Since it thus keeps pace with the sun, the zodiacal light is evidently connected in some way with the solar system. The generally accepted explanation of it is parallel with that which the telescope gives us for the Milky Way. Just as the latter is composed of multitudes of stars, too small to be separately seen, so the zodiacal light is supposed to be due to sunlight reflected from a multitude of small planets.

The separate stars which compose the Milky Way can be seen with the telescope; but this is not the case with the zodiacal light. The points of light whose aggregate produces the effect we see must in this case be much fainter, and much more numerous; such small bodies, in fact, that they are more akin to the meteoric stones which sometimes fall upon the earth than to the planets, or even the asteroids.

We may then say that the zodiacal light is sunlight reflected by a vast swarm of meteorites revolving about the sun. From the observed form of the light, it appears that this swarm has the form of a lens, with the sun at the center. Its denser parts do not extend outside the orbit of Venus, but the outer portions pass somewhat beyond the earth's orbit.

This is shown by the fact that, in clear air, the zodiacal light has been seen to extend clear across the sky, as a faint band. On this band, directly opposite the sun, appears a brighter spot, known as the Gegenschein, or counterglow, which has of late years been of considerable interest to astronomers. We hope to speak of it more fully next month.

THE HEAVENS.

At 9 P. M., on the 15th, Perseus, Taurus, Orion and Canis Major are near the western horizon, and will soon set. Auriga, Gemini and Canis Minor are above them. Ursa Major is in the zenith, and Leo on the meridian south of it, with Hydra below, and Virgo on the left. Bootes is well up in the east, with Corona Borealis and Hercules below and to the left. Vega has just risen in the northeast. Cepheus and Cassiopeia are below the pole, and Draco to the right of it.

THE PLANETS.

Mercury is morning star till the 28th, when he passes behind the sun and becomes an evening star. He cannot be seen except perhaps during the first few days of the month, when he rises about 40 minutes before the sun.

Venus is also morning star, rising about two hours before sunrise. Her elongation, or apparent distance from the sun, increases until the 25th, after which it slowly diminishes. On the 1st she appears telescopically as a broad crescent, and on the 25th as an exact half-moon. Her distance from us is rapidly increasing, and her light is in consequence diminishing.

Mars is morning star, but is too near the sun to be seen.

Jupiter is morning star in Capricornus, rising about 2:30 A. M. on the 15th.

Saturn is also morning star and rises about three-quarters of an hour earlier than Jupiter.

Uranus is morning star in Ophiuchus, and Neptune evening star in Gemini.

THE MOON.

New Moon occurs on the morning of the 8th, first quarter on the evening of the 14th, full moon on the afternoon of the 22d, and last quarter on that of the 30th. The moon is nearest us on the 10th, and farthest off on the 26th. She passes near Saturn on the 2d, Jupiter on the 3d, Venus on the 5th, Mercury on the 7th, Mars on the 8th, Neptune on the 13th, Uranus on the 26th, and Saturn again on the 29th.

Two eclipses occur during the month, but neither can be seen in this country. The first—a very small partial eclipse of the sun on the 8th—is only visible in the Arctic Ocean north of Alaska. The second—a total eclipse of the moon, on the 17th—is visible generally throughout Asia, and, all but the beginning, in Europe and Africa.

Princeton, N. J.

ELECTRICITY AND POWER DIRECT FROM HEAT.

BY JAMES ASHER.

There are several methods of obtaining electricity from heat without the use of any working fluid, such as steam or gas used in engines to drive dynamos.

The thermo-electric battery consists in a set of strips of either unlike metals, or of alloys whose alternate junctions are heated while their opposite junctions are cooled. Mr. Nicola Tesla once told the writer that it is utterly impossible to obtain an efficiency of more than 2 per cent from any thermo-electric battery. On another occasion he said that the low output of the thermo-electric battery is not its greatest defect, but the fact that the junctions of the metal become greatly impaired while in use. Mr. Henry Barringer Cox invented a battery in which he claims that the latter objection has been overcome. The elements during construction are melted together so that the alloys enter into intimate contact with each other.

Thermo-electric batteries might be directly heated by the rays of the sun. The battery might be supported on a frame inclined to face the solar rays and provided with an axle in order that it might always face the sun during the day. An automatic device might impart a slow rotation to the battery in a manner similar to that in large equatorial telescopes. The battery should have a glass roof similar to that of a hothouse. The roof should be quite close to the battery. The ends of the elements facing the sun should be coated with lampblack in order to secure great absorption of heat. The short, or light rays which enter the glass on reaching the elements of the battery would be transformed into long or heat rays. Such rays cannot escape through glass. The glass roof would act as a trap to the solar rays. Besides it would prevent the heat from being carried away from the battery by the wind. The running expense of such a thermo-electric battery would be nothing because the heat of the sun is free. About one horse power from the sun falls on every square yard of the earth. If a thermo-electric battery can transform even 2 per cent of the total energy into electricity it might be advisable in many cases to erect large solar thermo-electric batteries. It might be thought that there would be an advantage in using a smaller battery and many mirrors. But there is no advantage in maintaining one end of a thermo-electric battery at a temperature of more than 100 degrees higher than the other end. The lower ends of a solar thermo-electric battery would be cooled by the atmosphere and by radiation to the shaded earth below. The current of electricity could be conducted along a wire to a distance, and used to drive motors, and to charge storage batteries, in order to yield electric light. No attendant would be required.

A battery consisting of a set of iron cups containing carbons and caustic potash set over a furnace was invented by Mr. W. W. Jacques, of Massachusetts. The experiments caused many to believe that the time was near when electricity could be economically generated direct from the heat of burning fuel such as coal. Mr. C. J. Reed made a number of experiments with this invention which satisfied him that it is really a thermo-electric battery.

A pyromagnetic generator was invented in 1887 by Mr. Edison. It consists in a number of horizontal electromagnets whose poles point toward a vertical shaft. Facing the poles of the electromagnets are several compound vertical armature tubes of sheet iron only 1-200th of an inch in thickness. The upper ends of the tubes are fastened in a thick iron disk, while their lower ends are fastened in a similar disk. The iron disks serve as pole pieces for the electromagnets. The tubular armatures are wound with insulated copper wire which is led to a number of brushes which press against a commutator. Instead of having two brushes and many commutator bars this machine has many brushes and two commutator bars. The shaft bears a semicircular disk of fireclay at its lower end. During rotation, which is produced in any suitable manner, the fireclay disk successively screens the lower ends of the armature tubes from the upward passage of the hot furnace gases. During the passage of the hot furnace gases throughout the tubes these armature tubes lose magnetism, but while their lower ends are screened they become cool and gain magnetism from the electromagnets. The successive magnetizations and demagnetizations of the armature tubes cause currents of electricity to be generated in the wires which are wound on the tubes. The commutator aranges the currents so that a direct or continuous current flows in the external circuit. The machine is mounted on a furnace which resembles a coal heating stove. Mr. Edison stated that a pyromagnetic generator weighing two or three tons would maintain thirty incandescent electric lamps each of 16 candle power.

A pyromagnetic motor was also invented by Mr. Edison. His largest machine weighs 1,500 pounds and yields about 3 horse power. Experiments showed that it is more economical of fuel than most other heat engines. This motor has a bipolar field magnet between whose pole pieces is an armature composed of a great many iron tubes each only about 1-200th of an inch in thickness. The armature has a vertical shaft. Two earthenware guides, one above the upper end and the other below the lower end of the armature, guide cold air into and out of about one-half of the armature tubes. A broad segment of the armature is being always cooled, while the two outer segments are always heated by the hot furnace gases which are blown through them. The cold air during its passage through the hot tubes while cooling them becomes elevated in temperature. This air is led below the burning coal. As a regenerative device this bears some resemblance to that used by Captain John Ericsson in his early hot-air engines. The two earthenware guides are stationary and they are set dissymmetrically in regard to the pole-pieces of the field magnets. The parts of the armature which are red-hot refuse to carry magnetic lines while the cooler parts carry them with great ease. Because of the dissymmetrical setting of the earthenware guide plates a distorted magnetic field is set up, which causes the armature to rotate with a speed of about one hundred and twenty revolutions a minute. This machine has serious faults. The excessively thin iron tubes soon become ruined by oxidation. Heat cannot be practically imparted to, and withdrawn from the tubes so as to permit a greater speed than two revolutions a second. The vast number of tubes having small bore would soon become clogged with soot and ashes.

A pyromagnetic motor generator was invented and constructed by M. Menges, of The Hague, in Holland. It has a vertical shaft which bears a Gramme ring and a commutator. Fastened near the armature so as to rotate along with it is a corrugated sheet iron ring. A group of gas jets is set at about 45 degrees from the middle of one pole piece of the field magnet. Diametrically across the armature is a similar group of gas jets. These heat successive parts of the thin annular iron screen, while it and the armature rotate. The screen is cooled by two blasts of air diametrically across the armature from each other. The red-hot parts of the screen permit the passage of very few lines of force from the pole pieces of the field magnet. A distorted magnetic field is consequently set up which causes the rotation of the armature and the sheet iron screen which it carries. The iron ring of the armature, being wound with insulated copper wire, not only rotates and can give motive power direct, but electricity is generated in the wire of the armature. The current is led off by means of the commutator. Part of the current may excite the field magnet and part may supply electric lights. When motive power alone is required a permanent field magnet may be used. In this case neither wire on the ring, commutator nor brushes are required. This machine is a pyromagnetic motor. Menges' machines have two faults in common with those of Edison. The armature cannot revolve at a greater speed than 120 revolutions a minute and the rapid alternations of heating and cooling soon cause a failure of the thin annular screen. Pyromagnetic machines similar to those of Menges might be heated by the sun's rays reflected from a great many plane mirrors. This method would have an advantage over the solar steam engine such as the 10 horse power engine in use at Pasadena, Cal., because neither boiler, water nor engine would be required in order to generate currents of electricity.

The motive power in pyromagnetic machines is due to heat energy. Magnetism is introduced as a convenient means of transmitting energy from burning fuel to the armature of the machine.

It is said that Prof. Haeckel has consented to sit for a statue to Prof. Harrow Magnussen. The statue will probably be placed in the Zoological Gardens at Jena. One of Prof. Haeckel's friends some years ago gave 15,000 marks for this purpose.