THE HEAVENS IN NOVEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

Though the days are growing colder as the sun gets farther south, and we receive less of his light and heat, we are nevertheless some 600,000 miles nearer the central fire of our system at the end of November than at the beginning.

It may be asked, How do we know this? What evidence have we that the earth's orbit is not a circle, with the sun in the center?

The simplest and most direct proof that the sun is not always at the same distance from us is that its apparent diameter varies. It looks bigger in winter than in summer, to the extent of fully one-thirtieth of its whole diameter. The only reasonable explanation is that it must be nearer us in winter than in summer, by one-thirtieth of its whole distance. If we supposed that its distance did not change, we would have to believe that the sun's actual diameter changed by about 30,000 miles during the year—which is altogether incredible.

These variations in the apparent size of the sun are, however, too small to be discovered without telescopic aid, and hence remained unknown to the ancients. They can, however, be plainly shown by measurement even with a sextant, and with instruments of higher precision they become very conspicuous. A series of solar photographs taken with the same instrument in a fixed adjustment would convince anyone who examined them that the sun seems to grow smaller all through the first half of each year, reaches its smallest in July, and then gradually increases till it exactly regains its original diameter.

This demonstrates that the sun is not in the center of the earth's orbit, but does not prove that the orbit may not after all be a circle with the sun out of the middle. To do this takes more delicate observations. The ellipse in which the earth actually moves is so nearly circular that it would be possible to draw a circle (with its center more than a million miles from the sun) which would never be more than 7,000 miles distant from the real orbit. By assuming that the earth moved in such a circle, we could account fairly well for the observed motions of the sun and planets; but when it comes to modern observations with their high accuracy, the error of 7,000 miles in our assumed position would make our calculations differ from our observations by amounts many times as large as the errors of the latter. In the case of some of the other planets, the errors would be much larger. For example, it is impossible to draw any circle which does not at some point deviate more than 300,000 miles from the orbit of Mars. In fact, it was the failure of all his attempts to represent the motion of Mars by means of a circular orbit that led Kepler to the discovery that its orbit, and those of the other planets, were elliptical.

In addition to all these reasons, we know that the law of gravitation demands that the orbits of the planets shall be conic sections. The proof of this proposition is not regarded as difficult by mathematicians, but as it involves the methods of the calculus it cannot well be presented in a popular article. The law of gravitation, however, is perfectly consistent with the existence of circular orbits of any size, for a circle as well as an ellipse is a conic section. Whether the planets' orbits are elliptical or not, and how their eccentricity, can be determined only by on this point observation speaks de- all elliptical to a greater or less

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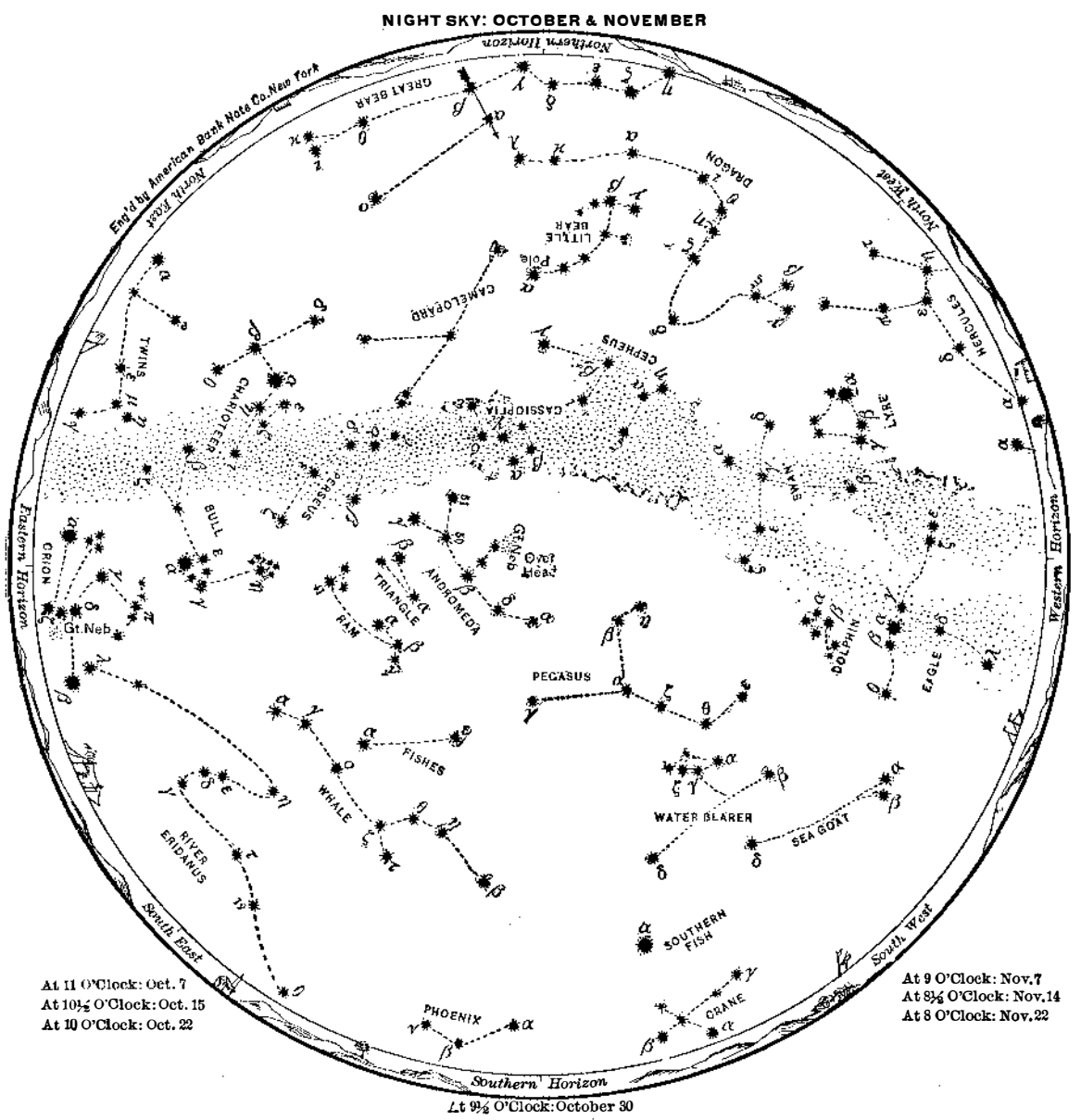
map, we see that the principal western sky are the Eagle and Swan high up above them. The sus is on the meridian close to the zenith. Below it in the southwest are the Goat (Capricornus) and Aquarius the Water-Bearer, and still lower is the bright star Fomalhaut in the Southern Fish.

The Crane and the Phœnix are southern constellations, which we never see to advantage. This remark applies with somewhat less force to Eridanus, a very large constellation whose brightest star, Achernar, never rises above our horizon. Between Eridanus and Pegasus is another very large group—Cetus the Whale. Its principal stars are shown on the map. The star τ is one of our nearest neighbors (its distance being about ten light years) and o Ceti is the famous variable Mira, which is now approaching its maximum, at which it is one of the brightest stars in the constellation, while at minimum it is of the ninth magnitude, invisible without a telescope.

Orion is rising in the east, and Taurus the Bull is above him with its two prominent star-groups—the Hyades, which contain the bright red Aldebaran, and the Pleiades.

Andromeda is right overhead with Aries the Ram to the southeast. In the Milky Way, beginning in the northeast, we have the Twins (Gemini), the charioteer (Auriga), with the great yellow star Capella, then Perseus, Cassiopeia, and Cepheus. Below these are the Little Bear and the Dragon, and still lower down along the northern horizon is the familiar form of the Great Bear.



In the map, stars of the first magnitude are eight-pointed; second magnitude, six-pointed; third magnitude, five-pointed; fourth magnitude (a few), four-pointed; fifth magnitude (very few), three-pointed; counting the points only as shown in the solid outline, without the intermediate lines signifying star rays.

THE PLANETS.

Mercury is evening star in Libra and Scorpio, but is so far south that he will not be well seen in our latitude. Even on the 9th, when he is farthest from the sun, he sets less than an hour after sunset. On the 29th he passes between us and the sun, and becomes a morning star.

Venus behaves in just the same manner as Mercury this month, being evening star till the 29th, and then becoming a morning star. She is extremely far south, and will not be conspicuous, even at the beginning of November.

Toward the end of the month she will be visible only in the daytime in telescopes provided with circles which enable them to be set exactly on the planet. She will be a very interesting object for those who can see her, for she passes almost exactly between us and the sun—apparently about 1½ degrees south of him. Under these circumstances the twilight in Venus's atmosphere produces an elongation of the horns of her crescent, so that it covers three-quarters or more of the circle. Under the most favorable conditions the horns may meet, and the planet appear as a ring of light. This phenomenon will occur on the 29th of November, and may be observable if the weather is clear enough. As it is of rare occurrence, it is mentioned here for the benefit of anyone who may care to look for it. The principal difficulty is to keep the direct rays of the sun out of the telescope, but a little ingenuity will provide a suitable screen. We will return to the subject in December. Mars is morning star in Leo, rising at about 2 A. M. Jupiter is in Gemini, and is fast becoming conspicuous in the evening, as he approaches opposition. He rises at about 8:30 P. M. on the 1st and 6:30 on the 30th. Saturn is in Aquarius, about 25 deg. south of the great square of Pegasus. He crosses the meridian about 7 P. M. in the middle of the month, and is visible all the evening. Uranus is in Sagittarius, and sets at about 7 P. M. on the 15th, so that he is hardly observable. Neptune is in Gemini and rises about 8 P. M.

THE MOON.

Last quarter occurs at 4 A. M. on the 9th, new moon at 3 A. M. on the 16th, first quarter at 7 P. M. on the 22d, and full moon at 6 P. M. on the 30th. The moon is nearest us on the 16th, and farthest away on the 4th. She is in conjunction with Jupiter and Neptune on the 6th, Mars on the 13th, Mercury and Venus on the 17th, Uranus on the 19th, and Saturn on the 23rd. The conjunction with Jupiter is pretty close.

Princeton University Observatory.

RECOVERING METALS MELTED IN THE SAN FRANCISCO FIRE.

BY ARTHUR INKERSLEY.

After the great San Francisco fire, hundreds of tons of lead, zinc, and other metals owned by the Selby Smelting Company were found melted into a solid block at the base of the shot tower that was for many years one of the landmarks of the old city.

The problem of recovering the metals, which were worth many hundreds of thousands of dollars, was a difficult one. The great mass could not be raised or broken up into fragments of a practicable size by any ordinary means. A method has, however, been found by which it is hoped to recover the valuable metals.

After removing several tons of bricks and débris, channels have been cut through the great block of metal by an electrical arc process. The bed of metal is from three to four feet thick, and covers the entire area of the ruins of the tower. The heat and light produced by the process are intense, though only ten volts are used for each implement. The men who are engaged in cutting the channels have their heads and faces covered with canvas to protect them from the blinding light. Large blocks have been cut away from the great pile, and it is expected that the whole work will take up the winter. About two hundred tons of lead, zinc, and tin still remain to be recovered. The work, which is being done by the Dwyer-Frickey Electrical Company, is of so unusual a character, that it is constantly watched by a crowd of interested people. The metal is recovered in blocks weighing nearly a ton each.

SIR RICHARD TANGYE.

Sir Richard Tangye, head of the engineering firm of Tangyes, died on October 14. He was born in 1833. Tangyes have establishments in London, Birmingham, Johannesburg, Sydney, and other cities. Sir Richard, with his brother, George Tangye, founded the Birmingham Art Gallery and Municipal School of Art. His hobby was the collection of manuscripts, books, and other relics of the period of Cromwell and the Commonwealth. He wrote several books, including "Reminiscences of Travel in Australia, America, and Egypt," "The Growth of a Great Industry," and "The Two Protectors." He owned estates in Surrey and Cornwall.