type, and in every instance they are directly coupled to the prime movers and deliver current at 550 volts at the switchboard.

As a further instance of work devolving upon the power plant, take the water-pumping requirements. At the Paris Exposition the pumping service called for 45,000 gallons of water per minute; at St. Louis, the requirements are 90,000 gallons of water per minute. This water is to be lifted by three centrifugal pumps of the Worthington type, which pumps are entered as exhibits. Each is planned to deliver 30,000 gallons of water per minute against a total head and suck of 158 feet. Three induction type motors, each of 2,000-horsepower rating, are to operate the pumps. The energy required for the operation of this feature alone equals the total energy had from the Niagara power plant by the Pan-American Exposition, and the total energy availed of for illuminating the Buffalo Exposition.

It may be interesting to note, with reference to the waterways, that the main one consists of a grand basin with lateral lagoons. The water is delivered into this basin from a niche in front of Festival Hall and from fountains in front of two ornate restaurant buildings which flank the Terrace of States. From these three points it flows over cascades, and it is to be illuminated by electric lights placed under the lip of each step which breaks the spill.

Speaking generally, about 80 per cent of the energy developed by the power plant will be in 6,600-volt alternating current, three-phase, 25 cycles, this for the general lighting and hydraulic work of the Exposition; but there will be a material amount of 2,300-volt, 50 cycles, three-phase alternating current, generated by foreign exhibits and used for arc lighting, and there will be the 550-volt direct current, for the operation of the Intramural Railroad. In addition to the foregoing, there will be minor installations for the generation of both alternating current and direct current of standard voltages and characteristics, for the motor service of exhibitors in Machinery Hall.

More than a year ago the claim was made that the steam boiler, boiler appliances, gas producer, and fuel handling propositions would be adequately and creditably housed in a spacious building and that this building would be found in the center of the ground. This claim has been made good, and at this writing a steel structure in close juxtaposition to Machinery Hall proper is rapidly nearing completion, and in outward appearance this latter building, known as the Steam, Gas, and Fuel Building, will be architecturally in full keeping with the main Machinery Hall.

In this annex it is proposed to illustrate the most modern methods and economy in steam and gas generation and the handling and treatment of fuels; and, parenthetically, it may be remarked that the most exhaustive methods will be followed to secure absolute and reliable data as to the performance of every plant under the control of the Machinery Department. The reports will be embodied in the final Exposition reports to the United States government, and will doubtless be availed of by the foreign commissioners in reporting to their respective governments. In this connection, take the announcement of one of the fuel-gas producing companies that they will require, when developing 1,750 horse power in one of the gas engines of the power plant, 1,575 pounds of anthracite coal per hour, and when not operating, 50 pounds of anthracite coal per hour. This means less than 1 pound of coal per horse power per hour, and if the claim is made good as a result of six months of Exposition service, there will be some valuable data at hand from wholly disinterested and capable observers.

Economical illustrations in the Steam, Gas, and Fuel Building will commence with the coal in 50-ton, hopper-bottom, self-cleaning, steel cars controlled and operated by the Exposition. These cars bring the coal from the mine to the Fuel Building, where it is dumped and automatically conveyed to and from bunker and crusher, or either, and thence to the mechanical stokers, gas producers, and briquetting machines. Over 2,200 lineal feet of conveyor lines are required in this automatic coal-handling system. Bituminous coal, anthracite coal, briquettes, and crude oil will all be used for the purpose of providing lines for comparison and to illustrate as fully as practicable the broad subject of the use of fuels for power purposes. Every attention will be paid to the avoidance of smoke, and special facilities will be accorded stoker builders to substantiate their claims in this direction. In this building will be found a line of marine water-tube boilers representing nearly all the more distinguished types in service in the world to-day, and a separate stack will be available if called for by any one exhibit, provided at least 1,500 horse power is involved.

A permit has been granted to the Philadelphia, Washington and Baltimore Division of the Pennsylvania Railroad to build twin tunnels under the United States capitol. Electricity is to be the motive power.

THE HEAVENS IN OCTOBER.

BY HENRY NORRIS RUSSELL, PH.D.

Though the part of the sky which can now be well seen in the evening is not a very brilliant one, we may yet find much to interest us in identifying the various constellations which are now visible and the planets which happen to be in sight.

We may well begin with the brightest object of all —the planet Jupiter. At our usual hour (10 P. M. at the beginning of the month, 9 P. M. in the middle, or 8 at the end) he is a little to the east of south about half way up the sky, and cannot possibly be mistaken for anything else.

Above Jupiter is the great square of Pegasus, which is very easy to recognize. Its right-hand side points downward toward the planet. Farther down on the same line is an isolated bright star. This is Fomalhaut, which, with the small stars, nearly forms the constellation of the Southern Fish.

The lower side of the great square of Pegasus, prolonged to the right for about three times its own length, brings us near a bright star in the Milky Way with a fainter one on each side of it. This is Altair, which, like Fomalhaut, is quite near us, speaking from the astronomical standpoint—a mere matter of eighty or a hundred millions of millions of miles. The little diamond-shaped group between Altair and Pegasus is Delphinus, sometimes known to sailors as Job's Coffin.

The bright object below and to the left of Altair is the planet Saturn. The two small stars in between are in Capricornus, and are the brightest in that constellation. Both are worth looking at with a field-glass.

Aquarius, in which Jupiter is now situated, is also lacking in conspicuous stars. Its most characteristic group, resembling the letter Y lying on its side, may be found by prolonging the diagonal of the great square of Pegasus downward and to the right for about its own length.

The opposite diagonal, carried up into the Milky Way, lands us in Cygnus—a very fine constellation, with the familiar "cross" of bright stars—and, extended farther, comes near Vega, the very bright bluish star which marks the constellation Lyra. Below Vega, and more to the right, is Hercules, now well down in the west.

Returning once more to Pegasus, we notice that from the upper left-hand corner of the square there extends a line of fairly bright stars. The first two of these are in Andromeda. The third, at a little greater interval, is Alpha Persei, while the one below, and rather out of line, is the famous variable Algol.

Still farther on is Auriga, with the brilliant Capella. Farther south is Taurus, with the ruddy Aldebaran just rising, and the silvery Pleiades higher up.

Below Andromeda a little triangle marks the head of Aries. The large constellation, Cetus, fills most of the sky lower down, extending from the edge of Taurus nearly as far as Fomalhaut.

Of the circumpolar constellations, Ursa Major is directly below the pole. Draco and Ursa Minor are on the left, and Cepheus and Cassiopeia are above it.

Beta Andromedæ, the first star of the line that runs northeastward from the great square of Pegasus, may be used to help us find a very interesting object. A short distance northward of it, in a direction at right angles to the main line of stars, we come upon a small star of about the fourth magnitude, and then on a second, a little out of line. Just beyond this, and exactly in line with Beta and the first star, is a hazy patch of light, visible to the naked eye, but much more conspicuous with a field-glass. This is the great nebula of Andromeda—the brightest of all such objects and the type of a large class of nebulæ.

Viewed with a small telescope, it appears only as a dull mass of light, with no well-defined boundaries, but concentrated rather sharply to a central nucleus. With large visual telescopes two parallel dark lanes or streaks can be detected near one side of the nebulosity, but this is about all. But long-exposure photographs tell a very different story, and show that this nebula, so insignificant to the naked eye, is really one of the most magnificent objects in the heavens.

So many of these photographs have been reproduced that the majority of our readers are probably familiar with their appearance. They show that the dark lanes visible to the eye are only parts of a much more extensive system, which divides the nebula into a series of concentric elliptical rings. The impression given by the photographs is of a vast, thin, flat sheet of luminous matter, nearly circular in actual form, but much foreshortened by being seen at a high angle. The outer parts of this sheet show a cloud-like structure, and are arranged in spiral streams, which can be followed as they wind gradually in toward the center until they are lost in the glare produced by the over-exposure of the bright inner part of the nebula. The dark lanes seem to be simply the places where we look through between these luminous clouds to the dark sky beyond.

The whole appearance of the photographs suggests strongly the idea of the old nebular hypothesis—a shrinking mass which, as it contracts, throws off rings ready to condense into planets. But we must be cautious in adopting any such view, especially as the theory on which it is based is now being severely criticised upon mathematical and physical grounds.

The real constitution of this nebula, and of the many others which resemble it in general characteristics, is still uncertain. Its spectrum appeared to its first investigators to be quite continuous. This is very puzzling, as it would seem to follow that the light of the nebula comes from glowing solid or liquid matter, or from gas under a high pressure.

More recent photographs of its spectrum have brought out the still more important fact that it contains faint dark lines, and resembles the solar spectrum in general character, though the lines are faint and diffuse.

The existence of these dark lines is not universally admitted, and further observations are desirable, but the writer is disposed to believe in their reality.

Now the only way that we know of by which such dark lines in the spectrum can be produced is by the selective absorption of a highly heated atmosphere like the sun's. It is inconceivable that the nebula as a whole can have such an atmosphere, and so we are led to the conclusion that it must consist of a mass of stars.

Many attempts have been made, from the time of Herschel downward, to resolve this nebula into stars, but even the most powerful telescopes fail utterly to do so. If it really consists of stars, they must be so small, or so enormously far away, that they cannot be seen individually even with the largest instruments, but form a mass of diffused light, just as the stars of the Milky Way do to the naked eye.

This theory appeals keenly to the imagination, for if it is true this nebula may be an assemblage of stars even greater in extent than the whole of the Milky Way, and at a correspondingly enormous distance from us—one which it might take light a million years to travel.

It seems pretty sure that, viewed from such a distance, our own Galaxy would appear as a spiral or a ring nebula, something like the Great Nebula, though without its central condensation, and it is certainly possible that the Andromeda nebula may be of this character—another "universe" perhaps more extensive than our own. But it must be clearly borne in mind that the evidence available at present is too scanty to justify us in making any definite statement to that effect.

THE PLANETS.

Mercury is evening star until the 3d, when he passes through inferior conjunction and becomes morning star. He will not be visible till the latter part of the month. On the 18th he reaches his greatest elongation west of the sun, and rises about an hour and twenty minutes before him, so that he should be seen without much trouble near the horizon, a little south of east, at about an hour before sunrise.

Venus is also morning star, and is very conspicuous, rising an hour and a half before the sun on the 1st, and more than three hours before him on the 31st. During the first part of the month she rapidly grows brighter as her narrow crescent widens, and at the time of her greatest brilliancy, on the 24th, she is twice as bright as she was on the 1st. Later on she slowly decreases in brightness.

Mars is evening star in Scorpio, but is inconspicuous, being faint and far south. On the 3d he is quite near Arcturus—about 3 deg. north of the star. In the middle of the month he sets at about 8 P. M.

Jupiter and Saturn are in Aquarius and Capricornus respectively, as already described, and are both well placed for evening observation. Saturn is in quadrature on the 27th.

Uranus is in Ophiuchus, and has practically disappeared for the year, as he sets at about 8 o'clock. On the 24th he is in conjunction with Mars, being about 1¼ deg. north of the latter. Neptune is in Gemini, and rises at about 9 P. M. on the 15th. It will be a couple of months yet before he can be conveniently observed in the evening.

THE MOON.

Full moon occurs at 10 A. M. on the 6th, last quarter at 3 P. M. on the 13th, new moon at 10 A. M. on the 20th, and first quarter at 3 A. M. on the 28th. The moon is nearest us on the 16th, and farthest away on the 28th. She is in conjunction with Jupiter on the 4th, Neptune on the 12th, Venus on the 17th, Mercury on the 19th, Mars and Uranus on the 24th, Saturn on the 28th, and Jupiter again on the 31st.

On the 6th there occurs a large partial eclipse of the moon, seven-eighths of which is obscured. It is invisible in America, but can be seen throughout Asia and in part of eastern Europe and Africa.

Florence, Italy, September 3, 1903.