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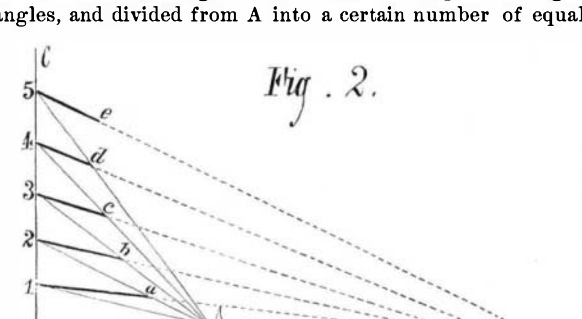
NEW SYSTEM OF ILLUMINATION BY REFLECTION.

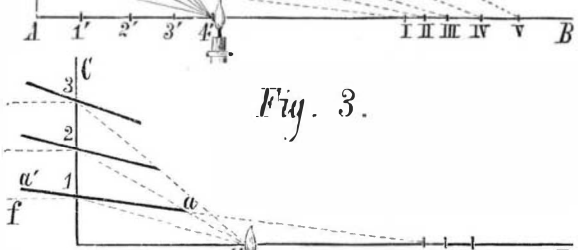
In order to collect rays of radiant light or heat, two means are now used, based, the one on reflection by bright surfaces, the other on the refractive power of suitable lenses. Theoretically, reflection alone has an indefinite application, since recourse may be had to plane mirrors movable in all directions, the rays reflected from which may be converged on a determined point: or to concave mirrors. The practical employment of these last is however impeded by difficulties of fabrication.

In the case of refraction, such as takes place through the lenticular apparatus of lighthouses, for example, a variety of disadvantages exist. There is a large sbsorption of light by the glass, double reflection at the two surfaces of the refracting medium, dispersion due to *striæ* and bubbles, and finally the double aberration of sphericity and refrangibility of the spherical glasses which form the principal part and often the entirety of the apparatus.

It will be seen, therefore, that, in order to obtain best results, a construction is needed which will combine all the advantages of the reflecting system, while eliminating the capital difficulties in fabrication, difficulties which are directly proportional to dimensions, and consequently diminish the use ful effect of the reflector. Such is the problem which, it appears, has been successfully solved by Professor Balestrieri, of Naples, by the invention of the photothermic hollow sphere collector (*collecteur photo-thermique armillaire*), the principle of which we will now explain by the aid of the annexed diagrams.

A C and A B, in Fig. 2, are indefinite lines, placed at right angles, and divided from A into a certain number of equal





parts, 1, 2, 3, 1', 2', 3', etc. Take any point on the line, A B, for example 4', for the focus of the system, and draw therefrom the lines 4' 1, 4' 2, etc. These lines represent rays from focus 4'. From 4' on the line, A B, set off 4' I equal to 4' 1, 4' II equal to 4' 2. etc., and then join, by dotted lines, the points I, II, III, IV, V, with 1, 2, 3, 4, 5, on line, A C. Then these lines, 1 I, 2 II, etc., when the line, A C, is revolved about A B as an axis, will describe surfaces of right cones; and the portions of said dotted lines comprised between the successive rays (made full lines in the engraving) will be superior profiles of segments of these cones on the base.

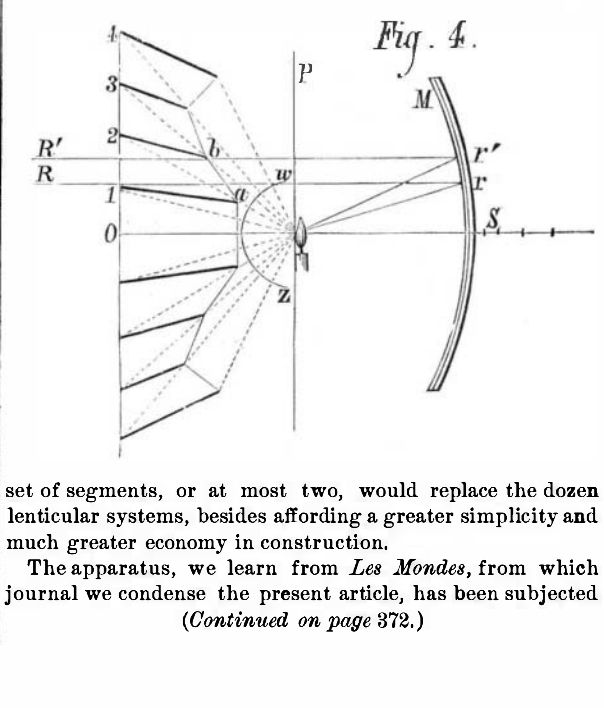
Suppose now that these profiles 1 *a*, 2 *b*, 3 *c*, etc., represent metallic segments with polished surfaces. The ray of light, 4 1, Fig. 3, impinges on the surface or annulet, 1*a*, at the point, 1, and will be reflected to *f*. Now as 4 1 = 4 I in the triangle 4 1 I, the angle 4 I 1 = 4 1 I. Moreover the angle of incidence, 4 1 *a* the angle of reflection, *f* 1 *a'*. Hence the reflected ray, *f* 1, is parallel to A B. Similarly it may be demonstrated that all the other reflected rays will be parallel to the same axis, and consequently the beam of reflected light will be composed of parallel rays,

Fig. 4 represents a section of an assemblage of these reflecting segments of cones, to which the inventor has given the name *armilles* (annulets), and which together compose a collector. The sphere of light emanating from the central source may be supposed to be divided into two hemispheres by the line, P. The rays of the anterior hemisphere are collected and reflected by the segments, 1 *a*, etc., and the quantity of collected rays is indicated by the arc, *w z*. It is equally possible to collect and utilize the rays of the posterior hemisphere, and to this end is arranged the concave mirror, M, the center of curvature of which is at O. The rays from the luminous source, impinging upon the mirror at *r r'*, are projected on the lines, R *r*, R' *r'*, through the spaces between the segments. Each part of said space through which the rays pass equals one half the distanᵔe, 1 2; consequently the reflector adds to the light collected by the segments one half of all that which falls upon its surface. If therefore the segments collect 150° of light, the mirror will collect 75°, and therefore the sum 225° will represent the portion of the luminous sphere utilized.

For lighthouses, at the present time the Fresnel lens is largely employed; but this is subject to the disadvantages already noted as peculiar to refractive apparatus. Moreover, with all lenses, no two rays are truly parallel, and the projection of the light at a distance causes a conjugate focus, which is in relation to the luminous object of which it is an enlarged image. With Professor Balestrieri's device, there is no image, no conjugate focus. In each segment there exists a circular section which reflects the rays from the luminous focus rigorously parallel. The other points of the segment reflect rays slightly divergent or convergent; each of the other points of the flame likewise gives some rays parallel, the rest not so; and the latter, after crossing, diverge in their turn. Thus innumerable parallel and di verging rays are produced, which combine to form a luminous cone, the base of which is projected in space. Thus the size of the flame is a first element of divergence, and the same is true of the segments: the larger they are, the greater is the divergence. Instead of of arranging the segments on a plane, they may be disposed on a curve so as to collect the entire 180° of light of the anterior hemisphere.

No lens can have an opening, A B, Fig. 5 (page 375), greater than its radius of curvature, O C, on account of difficulties in fabrication and of the total angle of reflection of the glass. The angle, A C B, of this opening is but 60°. Now as the principal focus, F, of a plano-convex lens, is very nearly at the extremity of the diameter of the sphere, O F, it follows that the lens cannot collect more than 30° of light. In the construction of lighthouses, this large focal distance is a serious inconvenience, in addition to that due to the small collecting angle. In the case, for example, of a flash light, for lenses of 1 meter, turning around a lamp, C (Fig. 5), O C + C F would be equal to 2 meters, and consequently the circumference about which the lens must travel would be 12·56 meters, or about 40 feet. As the flashes must be rapidly repeated, it follows that, in passing over so long a road, lenses must be multiplied, and therefore it happens that 10 or 12 of the latter are often found in a single lighthouse.

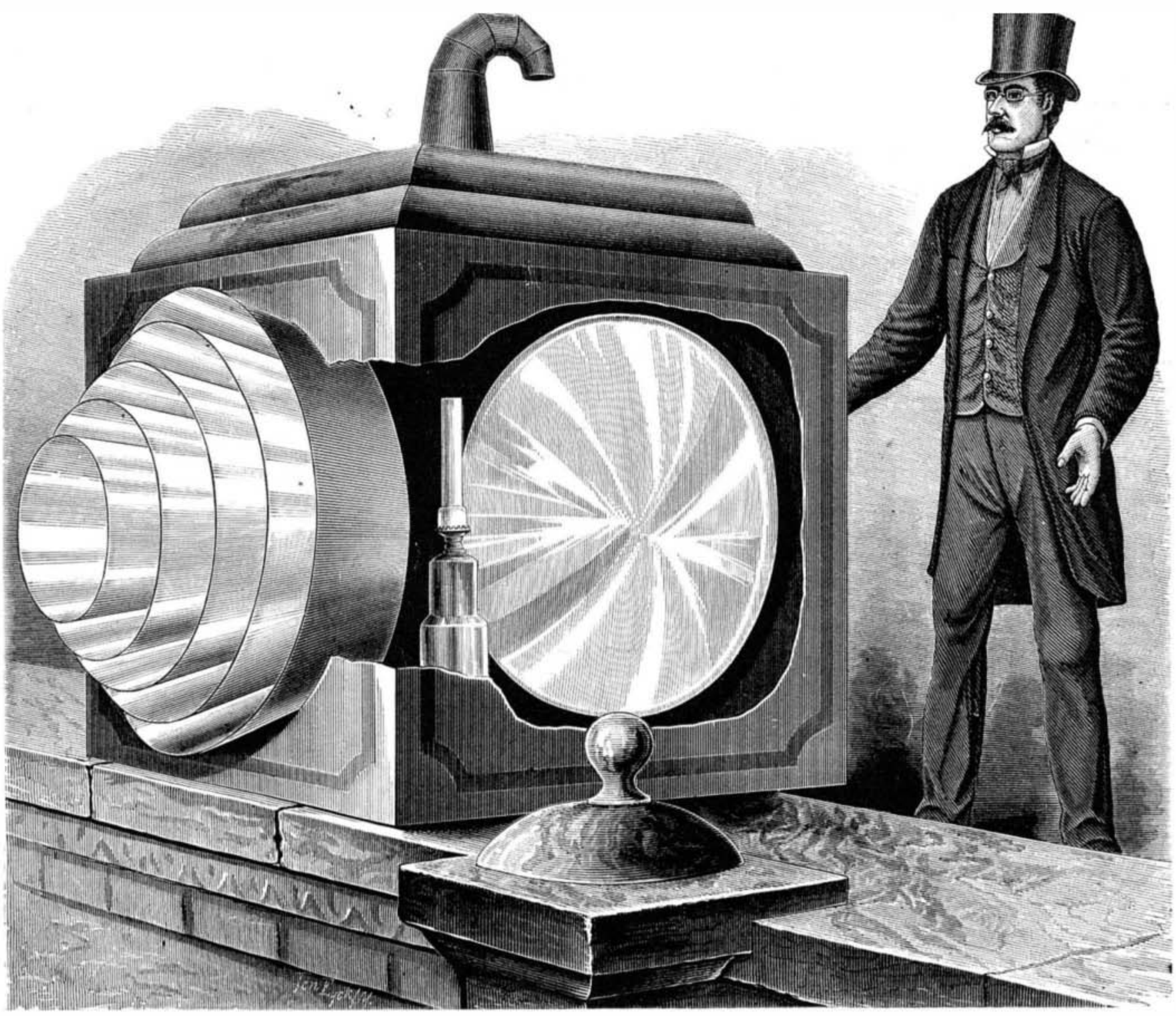
In Professor Balestrieri's apparatus the focal point is arbitrary, and the segments can be adjusted to suit it at any position, to give, say, a focal distance of 19½ inches or even less. The circular travel would be but 5 feet, and a single



set of segments, or at most two, would replace the dozen lenticular systems, besides affording a greater simplicity and much greater economy in construction.

The apparatus, we learn from *Les Mondes*, from which journal we condense the present article, has been subjected

(*Continued on page* 372.)



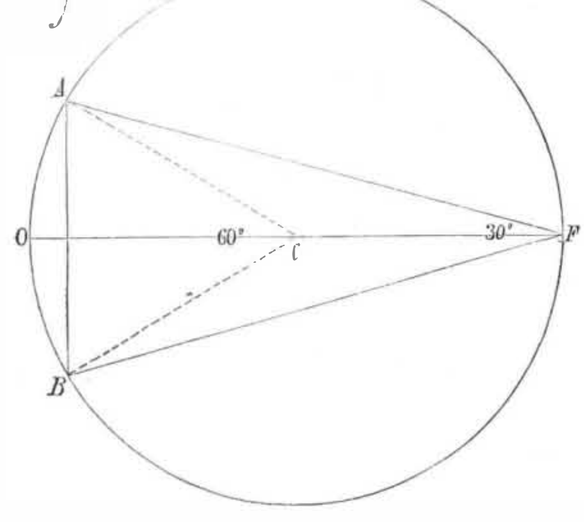
BALESTRIERI'S SYSTEM OF ILLUMINATION.

(*Continued from first page.*)

to minute experiment by Professor Tyndall. That scientist finds the device to be of greater efficiency, while its cost is about one quarter of that of the Fresnel apparatus of similar power, with which it was compared. The Italian government has also conducted comparative experiments between the Balestrieri and lenticular systems, in a lighthouse at Civita Vecchia, and the official commission report the exceeding superiority of the new apparatus.

It being proposed to adapt the invention to the lighting of cities, experiments were lately tried in Rome. The light was placed on the Piazza del Popolo, so as to illuminate the Corso. An oil lamp of considerably inferior power to that used in a lighthouse of the second order was caused to throw a light by which a letter, written in fine characters, could be read at a distance of about 2,000 feet. The inventor has recently devised a smaller apparatus which, at a distance of 224 feet, projects a beam 80 feet in diameter, the source of light being a single butterfly gas burner. This is especially adapted to the lighting of our streets and buildings with great economy of gas.

Fig. 5.



Another important application of this invention is the accumulation not merely of light but of heat rays. A lens 3·2 feet in diameter has an area of 1178·1 inches, and supposing this to reduce the sun's image to 0·15 inch, then the emergent light is condensed 7,854 times. Now, under the most favorable circumstances, a Fresnel lens does not transmit more than one fourth the heat it receives; hence the sun's heat is condensed but 5,236 times. It is possible, says *Les Mondes*, to make a Balestrieri apparatus of two, three, four, or five times the size of the lens; and the calorific effects, increasing directly as the squares of the diameters, will be four, nine, sixteen, or twenty-five times as great as those of a lens of the above-stated size. It seems possible, therefore, to obtain a calorific intensity capable of reducing even the most refractory substances.

[This is a notable example of the way in which American inventions are "re-invented" and the credit monopolized by Europeans. Substantially the same device was patented in this country, as a locomotive headlight, on July 18, 1871, by C. S. Lee and W. M. Baldwin, of Troy, N. Y., and was described in the SCIENTIFIC AMERICAN at that time.—EDS.]

The Newly Discovered Mechanical Action of Violet Light.

M. Paul Bert's recent investigations as to the cause of changes of color in the chameleon have led him to a discovery of considerable importance, since it indicates a mechanical effect of light, and more especially of the violet rays, hitherto entirely unknown. He traces the changes of hue of the reptile to minute corpuscles or chromoblasts, which are located either below the dermis or at the surface of the skin, according as they are affected by certain nerves which are respectively analogous to the vaso constrictors and vaso dilatators. When the chameleon is placed half in red light and half in violet light, obtained by passing sunlight through colored glass, the portion on which the red light falls remains of the normal yellow color, while that affected by the violet light changes to a greenish black hue. This same effect can be produced by suitable nerve excitations and divisions, showing that the accession of color on the skin is absolutely caused by the rising of the colored corpuscles to the surface; while, when the latter remain inert, the natural yellow hue of the creature continues unchanged. Hence it would appear that the colored corpuscles, like certain chemical substances, are not equally affected by all the rays of the spectrum, and that in the violet blue rays alone resides the property of mechanically moving the chromoblasts and drawing them to the surface.

Similar action on contractile substances has already been noted as caused by heat and electricity; but that light should possess an exciting effect of this description is certainly remarkable.

M. Bert proposes to continue his researches to determine the influence of light on contractile matters under other circumstances, and he especially hopes to discover the reason of the favorable influence of light on the skin of children and of lymphatic persons. It seems to us he might go further and observe whether the color in the human skin, either that normally existing, as in the case of negroes, or that obtained by direct exposure to sunlight (tanning or burning), is attributable to any similar cause

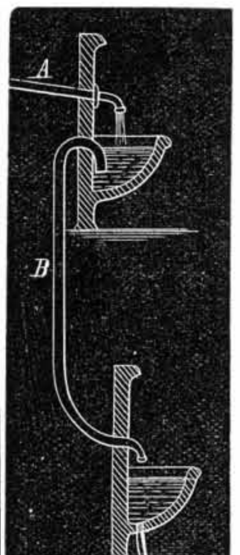
There is one fact worthy of remark here about M. Bert's discovery, and that is that it happens at a singularly opportune time, to be taken advantage of by those who are inclined to consider seriously the supposed influence of sunlight filtered through various colored glasses on phenomena of growth and of disease. Dr. Ponza, an Italian physician, has recently stated that light of certain colors has a beneficial effect on lunatics and other persons suffering under nervous ailments; and since M. Bert has demonstrated in the chameleons the direct influence of light on a nervous system, it appears not improbable that Dr. Ponza's alleged results may have some foundation.

Correspondence.

Intermittent Springs.

To the Editor of the Scientific American:

J. S. O.'s assumption, on page 283, vol. 34, though theoretically plausible, will not upset the accepted theory of intermittent springs, as the following facts will show: Some years ago, while residing in a small village where a club pleasure ground was kept, I was requested to engineer a couple of drinking fountains, one situated on a hillside and the other about 20 feet below, on the main walk. I led the water by a gentle descent from the springs by the pipe, A, to the upper basin, from which the overflow was to be carried through the larger pipe, B, to the lower fountain. Business called me away at the time the pipe connections were being made; the plumber made a change in my plan, producing a comical effect. All were laughing at my fountain when I returned, and one old gentleman described his experience thus: "I was walking on the lower walk, and saw a large stream flow from the fountain; I walked up and took the cup for a drink, when it suddenly stopped. My wife came up, and we were both much surprised. I thought something had got in the pipe, and stooped down to look, when I heard a gurgling sound; and my wife and I were splashed all over with water. You have played us a fine trick." I at once suspected what was the matter, and found in fact that, instead of a perforated plate being placed at the outflow of the upper fountain, the plumber had bent it into a siphon, thinking to prevent the entrance of rubbish. I had a small hole perforated at the top, and the intermittent spring ceased. The theory is that the water, falling from the crown of the siphon, when the pitch is vertical or great, rapidly carries with it the small amount of air in the bend, the place of which is at once occupied by water.



GEORGE H. HENSHAW.

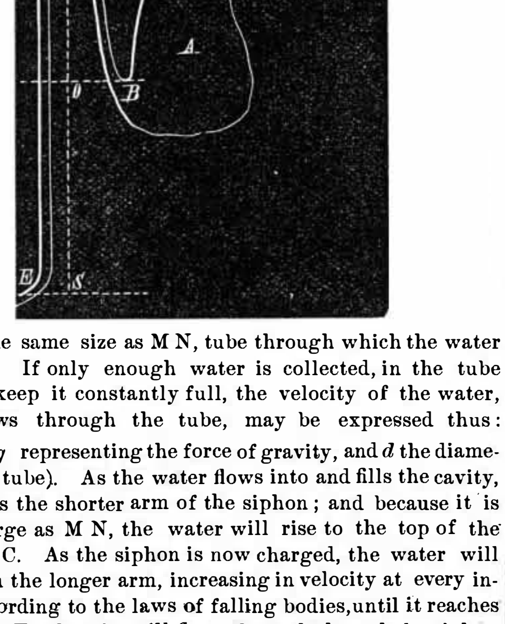
Ste. Anne Bout de l'Isle, Canada.

Intermittent Springs.

To the Editor of the Scientific American:

In your issue of April 29, J. S. O. says: "The generally accepted theory of intermittent springs is that a cavity in the earth has two water channels, one leading into it, the other out, the former being the smaller." Is this the theory? I have examined at different times a number of the standard works on this subject, and I do not think that we must take into consideration so much the size of the tubes as the amount of water which flows through them. More water will flow through a long tube held vertically than through a shorter one of the same bore.

In the engraving, A is the cavity, M N a horizontal tube conducting the water into the cavity, and B C E the siphon



tube of the same size as M N, tube through which the water flows out. If only enough water is collected, in the tube M N, to keep it constantly full, the velocity of the water, as it flows through the tube, may be expressed thus: $v=\sqrt{g\,d}$ (g representing the force of gravity, and d the diameter of the tube). As the water flows into and fills the cavity, it also fills the shorter arm of the siphon; and because it is just as large as M N, the water will rise to the top of the siphon at C. As the siphon is now charged, the water will flow down the longer arm, increasing in velocity at every instant, according to the laws of falling bodies, until it reaches the end at E, when it will flow through the whole siphon with a velocity equal to $\sqrt{2\,g\,h}$ (h being equal to the hight of the water in the cavity above the spring, at E). Now as $2\,h$, in the formula, may be very much greater than d, so may the velocity be much greater in flowing out than in flowing in; hence, the cavity will be emptied and the water will stop flowing out until it is again filled, and so on. When the water first begins to flow out, h is equal to C S, but when it has fallen in A to B, h has decreased to O S; so, as the water falls in the cavity, the velocity of the flow constantly decreases. If the diameters of the tubes be 1 inch, and C S be 20 feet, the velocity of the flow into A will be about 1·6 feet in a second of time; and that of the flow out, at first, about 35·8 feet.

In all intermittent springs, the velocity of the flow, as it continues, must decrease; and as the cavity is shallow or deep, this decrease is small or great.

Canonsburgh, Pa. JAMES F. RAY.

ASTRONOMICAL NOTES.

OBSERVATORY OF VASSAR COLLEGE.

The computations and some of the observations in the following notes are from students in the astronomical department. The times of risings and settings of planets are approximate, but sufficiently accurate to enable an ordinary observer to find the object mentioned. M. M.

Position of Planets for June, 1876.

Mercury.

On June 1, Mercury rises at 5h. 44m. A. M., and sets at 8h 44m. P. M. On the 30th, Mercury rises at 3h. 36m. A. M., and sets at 5h. 58m. P. M.

Mercury was at its greatest elongation on May 21, but can be seen after sunset for some days later, probably through the first week of June, as it sets at a point north of that at which the sun is last seen.

Venus.

Venus must be known to all who at this time observe the western sky. It does not attain the greatest brilliancy until June 7.

Venus rises on the 1st at 7h. 26m. A. M., and sets at 10h. 33m. P. M. On the 30th, Venus rises at 6h. 18m. A. M., and sets at 8h. 36m. P. M.

Mars.

Mars is very small. It can be found by its nearness to Venus, setting an hour later than Venus, on June 1, and at almost the same time on June 30.

Jupiter.

Jupiter is now well above the horizon in the evening, and can be seen as soon as twilight is over. It rises on the 1st at 5h. 56m. P. M., and sets at 3h. 42m. of the next morning. On the 30th, Jupiter rises at 3h. 49m. P. M., and sets at 1h 39m. the next morning.

The satellites of Jupiter revolve around the planet in such short periods that their changes of position can be seen in a watch of a few hours, and on almost any evening one may pass across the disk of Jupiter, making what is called a transit; or it may be hidden by passing into the shadow of Jupiter, in eclipse; or Jupiter may come between us and one of its moons, as in occultations.

These phenomena can be very nicely seen on June 15. According to the *Nautical Almanac*, on this evening the shadow of the first satellite passes across the disk of Jupiter; this cannot be seen without the use of a good telescope. At 9h. 26m. (Washington time) the third satellite, which is the largest, reappears, having been behind the planet for several hours; at 9h. 52m. the first satellite leaves the disk, having been in passage across it for more than two hours, and at 12h. 6m. the third satellite disappears by going into the shadow of Jupiter. On this evening only two of the satellites will be seen from 8 to 9.30 P. M.

Saturn.

Saturn is coming into better position. It rises on the 1st at 0h. 36m. A. M., but on the 30th comes above the horizon at 10h. 39m. P. M., and sets at 9h. 25m. the next morning.

Saturn is among the small stars of *Aquarius*, about 2° south of the star λ.

Uranus.

Uranus is among the stars of *Leo*. It rises, on the 1st, at 9h. 30m. A. M., and sets at 11h. 35m. P. M. On June 30, Uranus rises at 7h. 45m. A. M., and sets at 9h. 45m. P. M.

Neptune.

Neptune cannot be seen without a good glass, and at present is very unfavorably situated, as it comes to the meridian in the daytime.

Sun Spots.

The report is from April 20 to May 21, inclusive. During the past month, the surface of the sun has been remarkably free from spots. The present seems to be the minimum of the sun spot period. On May 6 a small spot appeared coming on. The observation of May 11 showed that this had divided into an elongated pair, which was followed by two very small ones. On May 11 these had disappeared, and the elongated pair had united into one, which was not seen after May 13. From that date till May 21 no spots have been found.

Dyeing Cotton Blue.

For 5 lbs. goods, dissolve 1 oz. copperas in 4 gallons of soft water. Wet the goods in warm suds, put them in the copperas water, let them remain 10 minutes. Dissolve in another vessel 2 ozs. prussiate potash in 4 gallons soft water. Wring your goods, put into this solution, let them remain 5 minutes; wring out again, now add 1 oz. oil of vitriol to the potash water, and stir well; put the goods in again and bring to a boiling point, letting them remain until you obtain the desired shade.