appreciable diminution of the atmosphere which surrounds the plant. The primary cause of the inspiration of oxygen by the leaves of living plants is, therefore, of a chemical nature. With the facts which have just been announced before us, it seems very probable that, during the nocturnal inspiration, the carbonic acid which appears is formed at the cost of carbon contained in the leaves, and that this acid is retained either wholly or in part, in proportion as the parenchyma of the leaf is more or less plentifully provided with water.

A plant that remains permanently in a dark place, exposed to the open air, loses carbon incessantly; the oxygen of the atmosphere then exerts an action that only terminates with the life of the plant: a result which is apparently in opposition to what takes place in an atmosphere of limited extent. But it is so, because in the free air the green parts of vegetables can never become entirely saturated with carbonic acid, inasmuch as there is a ceaseless interchange going on between this gas, and the mass of the surrounding atmosphere; there is, then, incessant penetration of the gases, as it is called. There is a kind of slow combustion of the carbon of a plant which is abstracted from the reparative influence of the light.

The oxygen of the air also acts, but much less energetically, upon the organs of plants that do not possess a green color.

The roots buried in the ground are still subjected to the action of this gas. It is indeed well known that, to do their office properly, the soil must be soft and permeable, whence the repeated hoeings and turnings of the soil, and the pains that are taken to give access to the air into the ground in so many of the operations of agriculture. The roots that penetrate to a great depth, such as those of many trees, are no less dependent on the same thing; the moisture that reaches them from without brings them the oxygen, in solution, which they require for their development. It is long since Dr. Stephen Hales showed that the interstices of vegetable earth still contained air mingled with a very considerable proportion of oxygen. The roots of vegetables, moreover, appear generally to be stronger and more numerous as they are nearer the surface. In tropical countries, various plants have creeping roots which often acquire dimensions little short of those of the trunk they feed.

If a root detached from the stem be introduced under a bell glass full of oxygen gas, the volume of the gas diminishes, carbonic acid is found, of which a portion only mingles with the gas of the receiver, a certain quantity being retained by the moisture of the root.

The volume of the gas thus retained is always less than that of the root itself, however long the experiment may be continued. In these circumstances, whether in the shade or in the sun, roots act precisely as leaves do when kept in the dark. Roots still connected with their stems give somewhat different results.

When the experiment is made with the stem and the leaves in the free air, while the roots are in a limited atmosphere of oxygen, they then absorb several times their own volume of this gas. This is because the carbonic acid formed and absorbed is carried into the general system of the plant, where it is elaborated by the leaves if exposed to the same light, or simply exhaled if the plant be kept in the dark.

The presence of oxygen in the air which has access to the roots is not merely favorable; it is absolutely indispensable to the exercise of their functions. A plant, the stem and leaves of which are in the air, soon dies if its roots are in contact with pure carbonic acid, with hydrogen gas, or nitrogen. The use of oxygen, in the growth of the subterraneous parts of plants, explains why our annual plants, which have largely developed roots, require a friable and loose soil for their advantageous cultivation. This also enables us to understand why trees die when their roots are submerged in stagnant water, and why the effect of submersion in general is less injurious when the water is running, such water always containing more air in solution than that which is stagnant.

MILK AS A DIET AND ITS EFFECT ON THE SYSTEM.

There is considerable difference of opinion on the subject of a milk diet. It is surrounded with a mass of whims, of prejudices, and of mistaken ideas, which are based more on individual fancies than upon certain fact. To one a glass of milk imbibed is believed to be a sure provocation of a bilious attack, to another, a disordered stomach, to a third, drowsiness, and so on, through such a category of simple though disagreeable ailments that we look aghast at the farmer who drains cup after cup of the fresh pure liquid, time and again during the day, and wonder at the resisting powers which his organization must possess. The truth is, however, that milk is not unwholesome. On the contrary, it contains good substantial bone, muscle, flesh, and brain producing substances, which, assimilating, quickly act rapidly in building up the body. Naturally, we assert, it is nourishing; that it does bring on certain troubles is nevertheless true, but the cause is in the individual stomach, not in the milk, provided, of course, the latter be fresh and sweet. The *Commercial Advertiser* of recent date has some excellent remarks on this subject which are well worthy of repetition. "Milk diluted with one third lime water," it is said, "will not cause any one biliousness or headache, and, if taken regularly, will so strengthen the stomach as to banish these disorders.

"It may be taken with acid of some kind when it does not easily digest. The idea that milk must not be eaten with pickles is not an intelligent one, as milk curdles in the stomach nearly as soon as it is swallowed. When milk is constipating, as it is frequently found to be by persons who drink freely of it in the country in summer time, a little salt sprinkled in each glassful will prevent the difficulty. When it has an opposite effect, a few drops of brandy in each goblet of milk will obviate its purgative effect. As milk is so essential to the health of our bodies, it is well to consider when to take it, and how. It is a mistake to drink milk between meals, or with food at the table. In the former case it will destroy the appetite, and in the latter it is never proper to drink anything. After finishing each meal a goblet of pure milk should be drank; and if any one wishes to grow fleshy, a pint taken before retiring at night will soon cover the scrawniest bones. In cases of fever and summer complaint, milk is now given with excellent results. The idea that milk is "feverish" has exploded, and it is now the physician's great reliance in bringing through typhoid patients, or those in too low a state to be nourished by solid food."

Our contemporary, we notice, says that the persons with whom milk does not agree are the very ones who require it, and whom it would probably regenerate, did they so prepare it as to make it palatable and suitable to their particular constitutions. Not exactly, we think. It should be remembered that "what is one man's meat is another man's poison" is a very frequent case; and while, as we have above pointed out, milk may in perhaps a majority of instances be rendered agreeable to the stomach, still there are certain organizations which persistently refuse it in spite of any assisting admixture. A similar illustration may be found in the case of wine; and we know of instances where persons, of otherwise strong digestion, are utterly unable to drink half a gill of even the purest grape juice without experiencing the same bilious and other derangements which many ascribe to milk. It is a fact, however, that for individuals troubled with dyspepsia, weak stomach, and kindred ills, milk has wrought remarkable and unexpected benefit, and the diet has in cases among our own acquaintances resulted in great relief.

Milk drinking, particularly in this city, has during late years received an unusual impetus through the establishment of dairies, or restaurants where the bill of fare is confined to a few simple articles of farinaceous food and to generous bowls of milk and cream, retailed at very moderate prices. The idea, we believe, originated some five years ago in a small baker's shop, in one of the little down town streets, which had a monopoly of the business for some time, making large receipts. Others, being attracted by the gains, embarked in the business, and now the dairy is as much a fixture in New York city as the more pretentious restaurant. As a matter of curiosity, we recently inquired of the manager of the largest of these establishments as to the people who patronize the diet, and the effect of the increased demand upon the supply. His customers, he told us, comprised every class; the rich banker perches on the high stool beside his errand boy. Clergymen, lawyers, merchants, editors, men whose reputation is worldwide, throng into the doors, proving that, even if this sudden increase in milk drinking be merely a popular mania, it is nevertheless one which has affected all alike.

The milk for the city is brought principally from Westchester and Dutchess counties in this State, and the neighboring counties in Connecticut. In the dairy above referred to, the stocks of several large farms are required to produce the necessary amount. Twelve hundred quarts in cool weather, and upwards of eighteen hundred quarts when the mercury makes excursions into the nineties, are daily consumed by an average of twenty-five hundred persons in the single establishment. This milk is sold at about ten cents a quart, realizing a fair profit.

The greater portion of the milk used in the city does not come direct to the seller, but goes through the same handling, by four or five "middle men," as the often doubtful fluid retailed by the peripatetic milkman. The farmer, for instance, binds himself to supply a certain number of cans to the contractor for a definite period, usually six months, at the price of about 33 to 42 cents per can in summer or 45 cents in winter. The contractor receives the filled vessels from a collector, who gathers them from the different farms and deposits them at the railway stations. Under charge of the latter, they are transported in early trains to the city and sold at the depots to milkmen and dairy keepers at an advance of about five cents per can. The milkmen supply families and grocers with the commodity, *plus* another profit which brings its cost to the consumer, as above stated to about ten cents per quart.

As to the quantity of milk daily consumed in New York, it is difficult to obtain any precise figures; but it is estimated that the supply does not fall short of two million quarts every twenty-four hours. This on a rough calculation is the produce of some thirteen thousand cows and an average of something over two quarts *per diem* to every soul of the population.

THE RESPIRATION OF OXYGEN.

According to the older notions in regard to the provision of Nature for the sustenance of life, the surrounding conditions have been expressly arranged for the benefit of all living creatures, so as to secure not only their existence but their welfare and comfort. According to late ideas, however, as the different living creatures were evolved under previously existing conditions, the mode of their development was such as to accommodate the different organisms to these conditions; and when the conditions changed, a corresponding change occurred in the creatures themselves: those not adapted to the changed conditions perishing, and those most fit for the new era surviving and propagating their species. We will illustrate this by an example: In our atmosphere, the oxygen is diluted with very nearly four times its amount of nitrogen, and all the air-breathing animals, including man, have become adapted to these conditions. If the amount of oxygen became less, a corresponding change would occur in the respiratory system, as is illustrated in the high lands of South America, where, by reason of the rarefied atmosphere, the amount of oxygen inhaled at each respiration is less than near the ocean level; and as a consequence, the human lungs are more developed there, and the inhabitants are remarkable for their largely developed chests, allowing them to make up by quantity for the quality of the inspired air. The reverse is also the case; it has been found that the effect of the compressed air (on those workmen whose constitutions allowed them to withstand the pressure and labor for some length of time in the caissons for the foundations of the Mississippi bridge at St. Louis, Mo., and the East river bridge, New York) was to narrow the volume of the chest, while deep respirations of the highly compressed air were painful.

Now comes an interesting discovery of M. P. Bert, who finds that it is not alone the pressure which is hurtful to the system, which can soon accommodate itself to it, but chiefly the concentration of the oxygen, which even acts like a most violent poison when inhaled pure, under a pressure of three or four atmospheres; consequently when (under a pressure of some 90 or more pounds to the square inch) an amount of oxygen surpassing the normal quantity some six or more times is inhaled at every respiration, its hurtful effects manifest themselves, one of them being a very great increase in animal heat, with a disturbed pulse; this, of course, adds largely to the discomfort. This fact suggests that men who have to submit to conditions of greatly increased atmospheric pressure would be relieved and benefitted by inhaling an artificial atmosphere containing less than the normal amount of oxygen, 10 per cent oxygen to 90 of nitrogen for two atmespheres pressure, 5 per cent oxygen and 95 nitrogen for four atmospheres, and so on. The value of this suggestion is strengthened by the French physicist De Fonvielle, who maintains that the discomfort experienced by travelers on high mountain peaks, or by aeronauts when ascending to high altitudes, is not so much caused by the diminished atmospheric pressure as by the want of oxygen, which, in that rarefied condition, is not given to the lungs in sufficient quantity. He suggested, therefore, the inhalation of pure oxygen at those high altitudes; and two balloonists, Sivel and Croce-Spinelli, have verified this theory during a recent ascent in the balloon *Etoile Polaire.* M. Croce-Spinelli, when he had reached a hight of 16,400 feet, experienced a strong feeling of suffocation; he then resorted to the inhalation of pure oxygen (enclosed in a large rubber bag with which he was provided), and became not only relieved, but recovered his normal condition of perfect comfort. The effect on the pulse was remarkable: while below it was 86 beats per minute, it rose, at a hight of 16,000 feet, to 140; when oxygen was respired, it descended at once to 120.

The published account of this ascent adds the following: "When not using the respirator, the skies appeared to the observers quite dark; but when freely respiring the oxygen, the blue color of the heavens was restored." As the blue color of the sky is due to the refraction of the solar light in the atmosphere, it is an objective phenomenon, and cannot be seen at such high altitudes, where there is little of the atmosphere (and that little very rarefied) left above the observer. The statement that the blue color was restored by the inhalation of the oxygen would infer that the hue is subjective and due to the condition of our eyes, induced by breathing the gas.

In regard to the hight which travelers are able to attain, we may state that Alexander von Humboldt, in his ascent of Chimborazo, was compelled to stop at a hight of 16,000 feet, at which point he had to give up from suffocation; but in late years the brothers Schlagintweit ascended the Himalayas, and slept all night in bivouac at a hight of 19,200 feet, and later ascended the peak Ibi Gamin, 22,200 feet high.

The English astronomer Mr. Glaisher claims that he has ascended to a hight of 26,000 feet without feeling any discomfort, and that only when reaching 32,000 feet he experienced any very serious feeling of suffocation. No doubt, different constitutions are differently affected; some are unable to resist diminished atmospheric pressures, others increased pressure. We met even last summer a consumptive individual on Mount Washington (which is not much over 6,000 feet high), who stated that he felt such a feeling of suffocation that he was obliged to hasten down on the same day.

THE AMERICAN SOCIAL SCIENCE CONGRESS.

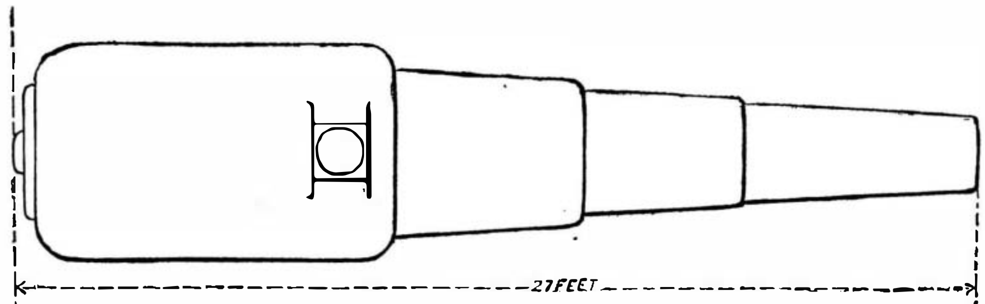
The American Social Science Congress will hold its annual session in New York city, commencing on May 19 and terminating on May 23. The title of this institution is broad enough to cover a vast field of useful knowledge, and the subjects for investigation are very numerous and interesting. Mr. George W. Curtis will preside, and papers by Rev. Dr. Woolsey on exemption of private property from capture at sea, by Mr. W. C. Flagg on the farmers' movement, by President Gilman on California, by Hon. D. A. Wells on taxation, by Professor Peirce on ocean lanes for steamship navigation, by Mr. G. G. Hubbard on railroads, and by Professor Sumner on the Finance Department, will be read. Many other papers relating to public health, penal institutions, charity, and kindred subjects are promised, and the Boards of Health and Public Charities will probably be in session on the same days.

THE bill before Congress for the grant of national aid to the extent of three millions of dollars in behalf of the Centennial Exhibition has been defeated.

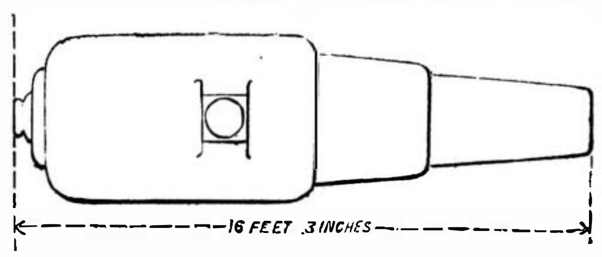
New Eighty-one Tun Gun.

Only two years ago the sobriquet "Woolwich infant" was playfully applied to a gun which had just been constructed in the gun factories of the Royal Arsenal at Woolwich, of the then unprecedented size of thirty-five tuns. Recent events have, however, proved that the name was by no means ill chosen, for a decision has been arrived at which will necessitate our viewing this gun actually in the light of a mere baby, a series of monstrous successors having been designed which will put its nose out of joint altogether. The first four of these, which are intended to form the armament of the future ironclad Inflexible, will be proceeded with so soon as the experimental one, which is the subject of the present paper, has been completed and proved.

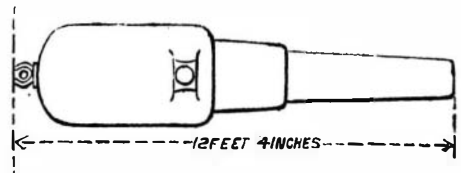
81 TUN GUN. PROJECTILE 1,200 LBS. CARTRIDGE 200 LBS.



35 TUN GUN. PROJECTILE 115 LBS. CARTRIDGE 110 LBS.



7 TUN GUN: PROJECTILE 700 LBS. CARTRIDGE 30 LBS



The new gun will, it is expected, be of a weight slightly over or slightly under eighty-one tuns. Its total length, including the plug screwed in at the breech end, 27 feet; the length of bore, 24 feet; the caliber will, in the first instance, be 14 inches, but ample provision is made in the thickness of the steel tube to increase that figure to 16 inches, if deemed desirable. The rifling has not as yet been decided on, but will be a matter for consideration as the gun approaches completion, by which time the result of the present series of experiments with the $\frac{35}{38}$ tun gun will doubtless have thrown considerable light upon this vexed question. The trunnions are to be 16 inches in diameter. The internal construction is similar to that of the 10 inch gun and upwards, except that the chase is divided into three portions instead of two.

The accompanying engraving will give some idea of the appearance of the proposed gun, and exhibits the grandeur of its proportions as compared even with those of its colossal predecessor. The 7 inch gun is also shown as demonstrating the immense advance that has taken place in modern artillery during the past eight years. When we consider that it was positively stated, when the 7 inch gun was produced, that we had attained the highest point we should ever reach in weight of metal, it seems almost incredible that in less than a decade we should be in possession of artillery twelve times as heavy. One is almost tempted to pervert the Latin proverb, and exclaim: "*Tempora mutantur et arma mutantur in illis.*"

Neither the weight of projectile nor quantity of powder to be contained in the cartridge for the 81 tun gun has been positively fixed, but the first will probably range between 1,000 lbs. and 1,200 lbs., while the second may be estimated at about one sixth of that amount. In the following calculations as to the probable energy of the new gun, or force of impact of its projectile, at the various ranges specified, three weights of shot or shell are respectively dealt with of 1,000 lbs., 1,100 lbs., and 1,200 lbs. An initial velocity has been assumed in all cases at the muzzle of the gun of 1,300 feet per second. It would possibly be considerably greater, but we desire to be within the mark. Working by the well known formula:

The energy in *vis viva* in pounds $= \frac{WV^2}{2g}$

where W = weight of projectile in lbs.,
V = velocity in feet,
g = force of gravity (32·2),

we find at the muzzle for the 1,000 lbs. projectile a blow of 11,715 foot-tuns, for the 1,100 lbs. projectile one of 12,886 foot-tuns, and for the 1,200 lbs. projectile the terrific force of 14,058 foot-tuns! These forces would, of course, be considerably enhanced by the higher velocity which would doubtless be obtained. When we compare such energies with those of the 35 tun and 7 inch guns, namely, 8,404 and 1,855 tuns, respectively, the latter sink into utter insignificance.

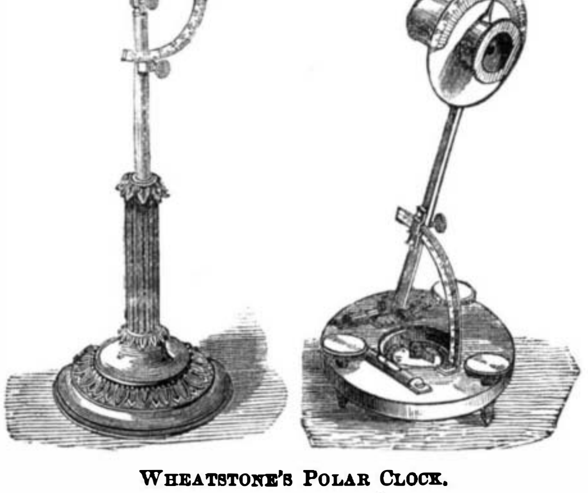
The actual penetrating powers of the 81 tun gun, as distinguished from the striking or racking powers, can only be decided by experiment. With the earlier natures of heavy ordnance, such as the 7 inch and 8 inch, a rough rule gave the penetrative or punching power as 1 inch in excess of the diameter of the projectile. Thus the 8 inch gun would penetrate armor 9 inches thick at a moderate distance. But as we ascend the series, this power developes itself in an increasing ratio, the 10 inch gun piercing armor of 12 inches in thickness, but not going through the backing; while the 12 inch gun of 36 tuns easily pierces 14 inches armor and backing, and only is arrested by the latter after going through 15 inch targets. Hence we may reasonably estimate the power of the gun now under consideration as capable of penetrating at least 19 inches or 20 inches of armor plates and their backing, at a distance of, say, 500 yards. We are aware, of course, that by increasing the diameter of the bore to 16 inches, the charge remaining the same, a loss of penetrative power would result, but we anticipate that (by employment in making up the cartridges of the slow-burning 1¼ inches or 2 inch cubes of pebble powder, some of which have been manufactured at Waltham Abbey, and with which good velocities and low pressures were obtained in recent experiments with the 38 tun gun at the proof butts), as the caliber is increased, so the charge may be increased in proportion. That the 81 tun gun will ultimately have a caliber of certainly 15 inches, we little doubt.—*The Engineer.*

THE POLAR CLOCK—THE TIME OF DAY SHOWN BY COLORS.

One of the most beautiful practical applications of the polarizing instrument is presented in Sir Charles Wheatstone's polar clock, shown in our engravings and described in the following passage by the inventor:

"At the extremity of a vertical pillar is fixed, within a brass ring, a glass disk, so inclined that its plane is perpendicular to the polar axis of the earth. On the lower half of this disk is a graduated semicircle, divided into twelve parts (each of which is again subdivided into five or ten parts), and against the divisions the hours of the day are marked, commencing and terminating with VI. Within the fixed brass ring, containing the glass dial plate, the broad end of a conical tube is so fitted that it freely moves round its own axis; this broad end is closed by another glass disk, in the center of which is a small star or other figure, formed of thin films of selenite, exhibiting when examined with polarized light strongly contrasted colors; and a hand is painted in such a position as to be a prolongation of one of the principal sections of the crystaline films. At the smaller end of the conical tube a Nicol's prism is fixed so that either of its diagonals shall be 45° from the principal section of the selenite films. The instrument being so fixed that the axis of the conical tube shall coincide with the polar axis of the earth, and the eye of the observer being placed to the Nicol's prism, it will be remarked that the selenite star will, in general, be richly colored; but as the tube is turned on its axis the colors will vary in intensity, and in two positions will entirely disappear. In one of these positions a smaller circular disk in the center of the star will be a certain color (red, for instance), while in the other position it will exhibit the complementary color. This effect is obtained by placing the principal section of the small central disk 22½° from that of the other films of selenite which form the star. The rule to ascertain the time by this instrument is as follows: The tube must be turned round by the hand of the observer until the color star entirely disappears while the disk in the center remains red; the hand will then point accurately to the hour. The accuracy with which the solar time may be indicated by this means will depend on the exactness with which the plane of polarization can be determined; one degree of change in the plane corresponds with four minutes of solar time.

Fig. 1. Fig. 2.



Wheatstone's Polar Clock.

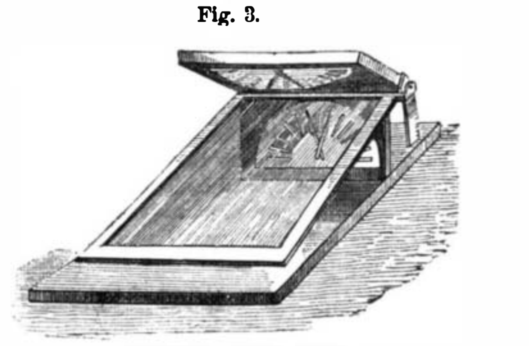
"The instrument may be furnished with a graduated quadrant for the purpose of adapting it to any latitude; but if it be intended to be fixed in any locality, it may be permanently adjusted to the proper polar elevation and the expense of the graduated quadrant be saved; a spirit level will be useful to adjust it accurately. The instrument might be set to its proper azimuth by the sun's shadow at noon, or by means of a declination needle; but an observation with the instrument itself may be more readily employed for this purpose. Ascertain the true solar time by means of a good watch and a time equation table, set the hand of the polar clock to correspond thereto, and turn the vertical pillar on its axis until the colors of the selenite star entirely disappear. The instrument then will be properly adjusted.

"The advantages a polar clock possesses over a sun dial are: 1st. The polar clock being constantly directed to the same point of the sky, there is no locality in which it cannot be employed, whereas, in order that the indications of a sun dial should be observed during the whole day, no obstacle must exist at any time between the dial and the places of the sun, and it therefore cannot be applied in any confined situation. The polar clock is consequently applicable in places where a sun dial would be of no avail: on the north side of a mountain or of a lofty building, for instance. 2d. It will continue to indicate the time after sunset and before sunrise, in fact, so long as any portion of the rays of the sun are reflected from the atmosphere. 3d. It will also indicate the time, but with less accuracy, when the sky is overcast, if the clouds do not exceed a certain density.

"The plane of polarization of the north pole of the sky moves in the opposite direction to that of the hand of a watch; it is more convenient therefore to have the hours graduated on the lower semicircle, for the figures will then be read in their direct order, whereas they would be read backwards on an upper semicircle. In the southern hemisphere the upper semicircle should be employed, for the plane of polarization of the south pole of the sky changes in the same direction as the hand of a watch. If both the upper and lower semicircles be graduated, the same instrument will serve equally for both hemispheres.

"The following is a description of one among several other forms of the polar clock which have been devised. This (Fig. 3), though much less accurate in its indications than the preceding, beautifully illustrates the principle.

Fig. 3.



Selenite Polar Clock.

"On a plate of glass twenty-five films of selenite of equal thickness are arranged at equal distances radially in a semicircle; they are so placed that the line bisecting the principal sections of the films shall correspond with the radii respectively, and figures corresponding to the hours are painted above each film in regular order. This plate of glass is fixed in a frame so that its plane is inclined to the horizon 38° 32′, the complement of the polar elevation; the light, passing perpendicularly through this plate, falls at the polarizing angle, 56° 45′, on a reflector of black glass, which is inclined 18° 13′ to the horizon. This apparatus being properly adjusted, that is, so that the glass dial plate shall be perpendicular to the polar axis of the earth, the following will be the effects when presented towards an unclouded sky: At all times of the day the radii will appear of various shades of two complementary colors, which we will assume to be red and green, and the hour is indicated by the figure placed opposite the radius which contains the most red; the half hour is indicated by the equality of two adjacent tints."

A Correction.—An accidental error exists in the description of the bolt cutter of the Wood and Light Machine Co., which appeared on the first page of our issue of May 9. The beginning of the detailed reference should read: "A is the face plate of the die holder," etc. Instead of the following sentence should appear: B is the head, caused to revolve by proper mechanism, through which passes a mandrel, moving freely back and forth, in the spindle, C.

The green color of the boron flame may be very well shown by boiling a mixture of boracic acid, alcohol, and sulphuric acid, and igniting the vapor.