New Refrigerating Machine.

In refrigerating machines, up to the present time, there has been utilized as the sole source of cold the passage of liquid to the gaseous state without the intervention of any chemical phenomenon. The various systems of such machines differ merely in the absolute tension of the vapors on both sides of the compressing piston, and in details of arrangement. Instead of a single liquid, M. Pictet proposes to use a volatile liquid which may be split up into two or more volatile liquids by the mere fact of a fall of temperature. He has oxidized carbonic acid by associating it with sulphur oxide, and has obtained a series of compounds from $C_{40}O_{82}S$, boiling at —71°, to $CO_{16}H_7$, boiling at —7·5°. The more the temperature sinks, the more the original liquid is resolved into elementary volatile liquids, each giving off vapors.

The sum of all these elementary tensions is much more considerable than that which would correspond to a single permanent liquid. At higher temperatures all these liquids recombine into one, and the maximum tension of the vapors is considerably reduced under the influences of the affinities developed. If we introduce into a refrigerating machine the new volatile liquid SCO_4, the vapor tension in the refrigerant will be very much superior to that of pure sulphurous acid, while the tension on compression in the condenser, where the vapors resume the liquid state, will be decidedly less than that of sulphurous acid. The compressing piston will thus receive a stronger pressure in aspiration, but a smaller one in compression, thus effecting a great economy in the force required for working the pump.

COMPOUND OPTOMETER FOR CORRECTING ERRORS OF REFRACTION.

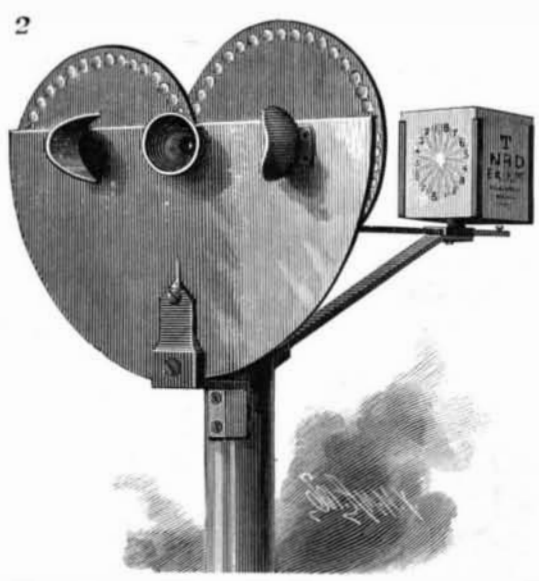
In making examinations of the eye for the purpose of determining its refraction and the adaptation of spectacles to correct defects which may exist, the first part of the process is to determine visual acuteness. Letters are placed before the individual whose eye is being examined, of varying sizes; some to be seen by the normal eye under a visual angle of 5′ at 200 feet, and from that down to the distance at which the letters are from the observer. In order that the refraction of the eye be correctly measured, it must be in a state of rest—adjusted for parallel rays; and this ophthalmologists claim can only be secured by placing objects to be observed at a distance, and 20 feet has been accepted as the distance which practically accomplishes this object. But it is claimed that the optometer herewith illustrated renders rays emanating from objects placed at 13 inches from the eye parallel, and consequently measures the refraction perfectly. Lack of visual acuteness may be due to a defect in the perceptive part of the eye, the retina, or to a refractive anomaly. To determine this a concave and a convex lens, about one-thirtieth, are alternately placed before the eye, and if either improves the vision there is either myopia or hypermetropia. The number of the glass that produces the greatest visual acuteness measures the refractive error. If neither the concave nor convex lens increases the visual acuteness, the test for astigmatism is made, and when none of these tests improves vision the defect is in the retina.

This is the procedure followed by oculists, and while being correct theoretically and in its practical results, it is stated to be awkward and tedious when compared with the optometer.

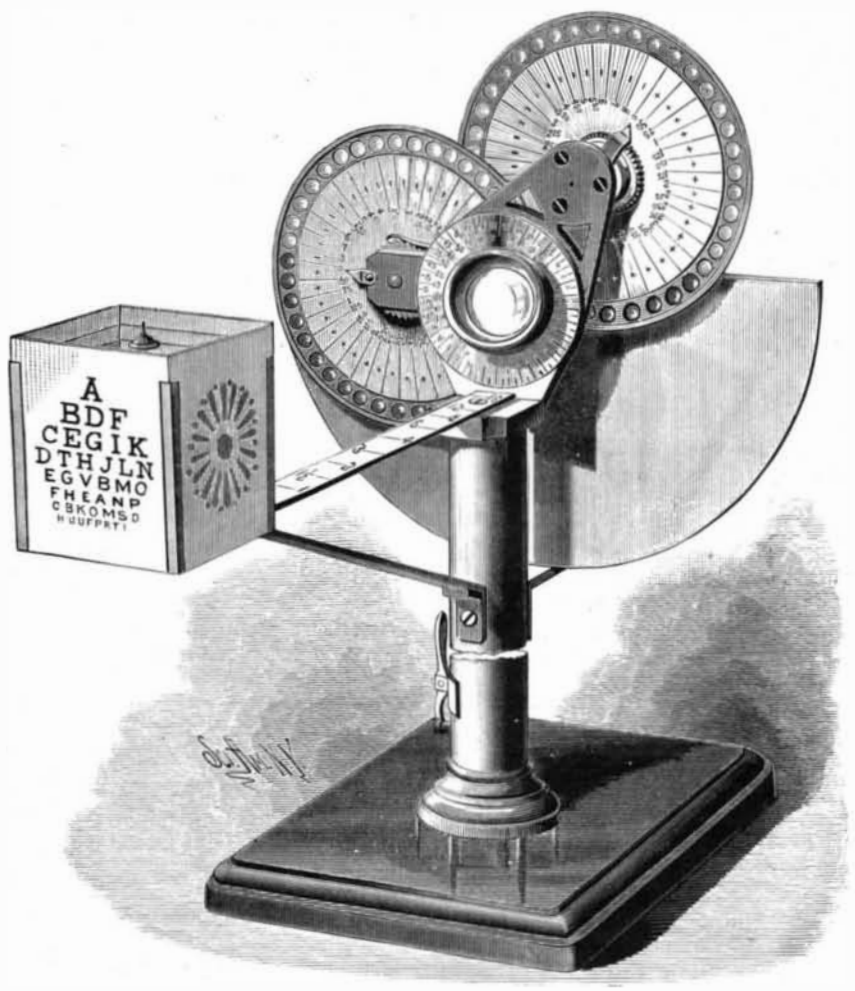
The optometer shown in the accompanying engravings has an upright of about 12 inches, upon which are mounted two circular disks, one for spherical and the other for cylindrical lenses. Each disk can be so revolved that the lenses can be brought in front of a common opening or eye tube, through which the observer sees letters. The disk containing the cylindrical lenses is attached to an arm, by which it has a movement besides the one upon its central axis, and whereby the axes of its cylindrical lenses can be placed in any degree of a circle before the eye tube. The disks are so situated that the lenses of one can be interposed with that of the other, thus combining their effect if necessary. Upon the extremity of a horizontal bar attached to the upright, about 12 inches in length, rests a card rack in which the test letters are placed 13 inches from the observer's eye.

The spherical lenses are 38 in number, 19 concave and 19 convex, embracing a series from $\frac{1}{74}$ to $\frac{1}{4\cdot5}$. Intervening between either extremity of the positive and negative lenses is a plain glass. The disk containing the cylindrical lenses has the same arrangement as the one containing the spherical, as mentioned above. There is an eye piece for the eye being examined, while the other will be deeply shaded, thus practically disposing of the inclination to convergence. The reason for this is that convergence and accommodation are coordinate acts, and in this case by controlling the convergence the tendency to accommodate is also greatly controlled.

At the extremity of the eye tube, and with the center of its system, about 2 inches from the cornea, as it rests in the eye piece, is placed an objective which is a compound achromatic lens, the principal focus of which falls on the test letters on the card. This practically produces a myopia of $\frac{1}{11}$. The rays proceeding from the objective to the eye are of necessity parallel, since the test letters are at the principal focus of the objective. It is claimed that this disposes of the objection to the instrument by those who state that it will not relax accommodation. Placing the objective outside of the anterior focal distance of the dioptric media of the eye magnifies the letters to be observed, but this in no way changes the results of the test for refraction, but the letters used should be proportionately small if a test for visual acuteness be made, else the visual angle of 5′ will be changed; if the letters are magnified one-half, they should be one-half smaller.



BETELING'S COMPOUND OPTOMETER FOR CORRECTING ERRORS OF REFRACTION.



BERTELING'S COMPOUND OPTOMETER FOR CORRECTING ERRORS OF REFRACTION.

In the construction of the system for measuring visual acuteness with this optometer, a letter is used for a basis the measurement of whose diameters forms the base of an angle of 5′, the distance from the center of the system of the objective to the letters forming the sides of the angle. If the eye were placed at 11 inches from the letters, they would be the same size as the objective renders them at 13 inches, so that the visual angle is measured from the center of the system rather than from the position of the cornea. The letter, then, at 11 inches should have a diameter of $\frac{11}{60}$ of a line, or for practical purposes $\frac{1}{5}$ of a line. For the purpose of keeping a record of visual acuteness, as by the method of Snellen, when the smallest letters can be read, which are $\frac{1}{5}$ of a line in diameter, it may be stated that $V=\frac{20}{20}$. When the next letters which are one-half larger are the smallest that can be read, V may be marked $\frac{20}{40}$, and so on up to 200 feet.

This optometer, which is the result of several years of careful study and experiment, has been patented, and is now manufactured, by Mr. L. A. Berteling, of 427 Kearny Street, San Francisco, Cal.

Ornamental Trees.

As soon as the frost has left the ground, loosen the earth around each tree several feet; rake out all the grass and weeds, to prevent turf forming; pulverize the soil thoroughly, to receive and retain moisture; crowd it gently toward the trunk, leaving a small trench around the circumference. This will tend to carry the moisture and nourishment toward the rootlets. Then, if your trees stand in the yard or lawn, you can plant these bare circular spots of ground with any kind of low annuals, such as candy tufts, fumitories, portulaccas, sweet alyssa, pansies, trailing verbenas, etc. Thus you will enlarge your flower space, and the constant cultivation of these flowers will keep the ground about your trees beautiful and in the best growing order. When the season advances, you can mulch with grass or leaves.

Iron Pyrites.

Pyrite, or iron pyrites, is one of the commonest of minerals, occurring in rocks of all geological ages from the oldest granites to the newest slates. It generally occurs in small cubic crystals scattered irregularly through the rocks, but is not uncommon in masses and beds of considerable size. Among the large number of mineral specimens which come to the office of this paper, with the inquiry if they do not contain gold, copper, or some other valuable substance, pyrites comprises the greatest. "Silex," in the *Journal of Commerce* (Boston), gives some interesting facts about pyrites, which is likely to interest considerable of a number of our readers. Pyrites, or sulphide of iron, is composed of about 53 parts sulphur to 47 iron. It is a pale, sometimes bright, yellow mineral, nearly as hard as quartz and about twice as heavy as quartz or granite. It can be but slightly scratched by the knife, is always opaque, somewhat brittle, and strikes fire readily with steel. The latter circumstance gave rise to its name, which is derived from a Greek word for fire.

Pyrite very commonly occurs in quartz veins with various metallic ores, and is almost invariably found in gold bearing quartz intermingled with the precious metal. Gold not uncommonly occurs disseminated through the pyrite, which is then called auriferous or gold-bearing pyrite. A considerable proportion of the yield of gold is obtained from this variety.

Pyrite is one of the most changeable of minerals, and when exposed to the action of the weather for a length of time, as at the outcrop of a vein, it decomposes, loses its yellow color, and becomes of a rusty iron hue, changing into iron oxide. The rusted honeycombed appearance of much gold-bearing quartz is due to the composition of the pyrite. This liability to decomposition renders all rocks containing much of this mineral unfit for building purposes where beauty and durability are desired. The yellow color of pyrite has often led people to mistake it for gold, and a great deal of money has at one time and another been wasted in mining fool's gold, as it is often called, in the belief that it was the precious metal. Gold is very easily distinguished from pyrite, the only resemblance being in the color. Gold is a soft mineral, easily cut by a knife, is of a deep yellow color, and is nearly five times heavier than pyrite. However, as a small proportion of gold is often present in pyrite, it is always well to ascertain by analysis if enough gold is there to pay for working.

Though pyrite contains nearly 50 p. c. of iron, it is never worked for this metal, as it can be obtained much more cheaply and easily from other ores. Sulphur is sometimes obtained from the mineral, but its principal uses are in the manufacture of copperas and sulphuric acid. It has not been mined to any great extent in this country, as yet, for these purposes, though largely used in England. Though pyrite occurs almost everywhere, there are some localities that afford unusually fine specimens, as Waterville, Me., Rowe, Mass., and Roxbury, Conn., in New England. Fine specimens of crystallized pyrite are found in many places in the Middle and Western States, and especially in Colorado.

Amateur Photography.

With the recent improvements in materials and apparatus for photographing, there has come a great accession to the ranks of those who, in all parts of the country, find in this interesting study a pleasurable, inexpensive, and sometimes lucrative employment. As is the case, however, in almost every wide-embracing field of activity, there is no noticeable success attained except by those who make diligent and intelligent application, and this is particularly true with the large number of amateur photographers, who find it so easy to learn the principal elements of what is necessary to make sun pictures before they realize how important it is to have also some artistic taste and education, and learn the nicety of manipulation required in a thousand delicate details which the successful photographer must carefully attend to. This is abundantly indicated in the discussions which take place before the numerous societies of amateur photographers, now springing up in all sections; but the genuine pleasure to be got out of a little patient application in this field, and at very slight expense, appears to be sufficient to insure its steadily growing popularity. One of the leading societies of this kind, that of the Amateur Photographers of New York, is noticed at length in a recent number of *Anthony's Photographic Bulletin*, with a photograph of the President, Mr. F. C. Beach, from a negative made with the electric light. Mr. Beach commenced making pictures as an amateur photographer in 1864, when only sixteen years of age, and has continued to do so ever since, so there seems to be an especial fitness in his occupying the position of first President of the Society of Amateur Photographers of New York. Mr. Beach has himself invented some and improved many of the old processes in photography, and being something of an enthusiast in this line, it is not strange that the society of which he is the head should at once have taken a leading position.

PLANCHETTE.

Planchette is now very seldom met with, and so many questions are constantly sent to the office of this paper concerning it, that we reproduce herewith an illustration of one which appeared in the SCIENTIFIC AMERICAN in 1868.

Many think that there is some hidden secret in the construction of planchette. This, however, is a mistake, as all that is necessary is that the parts should be nicely joined, and that it should stand firmly and move readily on its legs. Any one with ordinary mechanical skill can put one together, and the accompanying cut shows clearly all that is necessary—a heart-shaped cedar board, with two nicely turned metal legs, carrying well lubricated casters, the point of the board having an aperture of suitable size for the insertion of a lead pencil, which serves as the third leg and rests on the paper. It is not to be supposed that planchette will yield at once to the influence, for it is very willful, and often, when it does begin to move, simply speeds across the paper, scribbling incoherences. One of the most extraordinary traits of planchette, however, is the way in which it will persist in writing repeatedly a meaningless reply, until suddenly the humor will seize it, and it will write a coherent word or sentence. Planchette first made its appearance in 1867, and was by no means slow in attracting almost universal attention. The pranks that it was made to play were so many and curious, and its ways so mysterious, that not only did it become the nightmare of the superstitious, but it afforded amusement in many a household. It became also the subject of investigation by some scientists. Marvelous tales were told by the credulous about it, and planchette often told curious tales about itself. Even as distinguished scientists as Prof. Tyndall and Prof. Faraday were drawn into controversies concerning it.

Many believed that humbug was stamped over every movement of planchette, and that one or the other of those whose hands bore upon it always conspired with the little board in the formulation of its replies; but when it became evident that planchette would write coherent answers while under the influence of those who were in ignorance of the replies that were expected, it became necessary to explain the phenomenon on some other basis. Whether this has ever been satisfactorily answered is in the minds of some still a question. Certain it is that planchette has performed some curious feats, and has made for itself a position in the world of mysteries. Probably the most generally accepted explanation is that advanced by Lewes and others, that although there is no intentional movement of the hands of those who are subjecting planchette to the influence, still there is, in spite of this, an unconscious pressure of the finger tips upon the board, which directs the movement of the pencil. Nor does it seem that such can be at all unlikely, for unconscious movement is by no means an unusual phase of our existence. The somnambulist who nightly takes a promenade from cellar to garret, or whose steps by chance have led him to the border of a precipice, has as little knowledge of the peril he has escaped when the morning beams have awaked him as planchette is conscious of its movements. How often also in mercantile pursuits do those who are accustomed to a certain routine perform it unconsciously, and after the work has been finished would be unable to tell you of many of the details of the work which custom has taught them to perform correctly, even while in a state of abstraction. Much has been said at times of planchette's prophetic nature. Under the influence of certain people of a highly nervous temperament, or having to a certain extent the qualities of mediums, future events are said to be foretold. Secrets of which the person touching planchette is in ignorance have been divulged in a remarkable way, and many anecdotes draping planchette in mystery are repeated and believed. Were the testimony, however, more universal, were planchette more consistent, and were it more generally truthful and less given to uttering remarkable sayings only occasionally, there would be more reason for according it a place for thorough and systematic investigation. Perhaps the day will come when mesmerism is understood and mind reading is more satisfactorily explained, that there will be occasion for looking upon planchette more seriously, and of regarding it as a wonderful means of displaying a rational nervous action independent of conscious mental cerebration.

PLANCHETTE.

THE BIRD SPIDER.

Few animals are more repulsive than the gigantic spider which we figure herewith, of natural size. The bird spider (*Mygale avicularia*), for so the creature is called, excites horror in all the countries in which it is found.

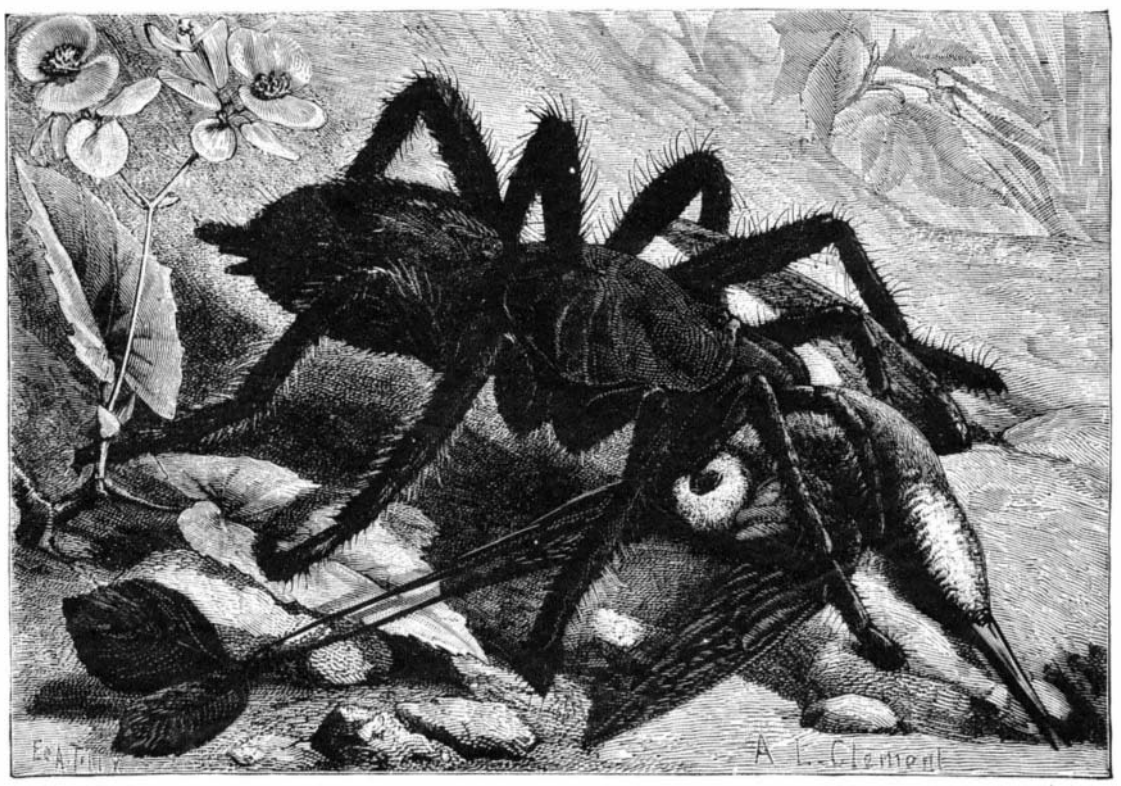
In the Antilles and in the forests of Venezuela, Brazil, Guiana, and Ecuador, its repulsive aspect has, among the residents, as well as among travelers, caused a terror that the imagination of the aborigines has still further exaggerated. How many times, while lying in my hammock during the long equinoctial nights, have I heard the Indians and peons, while squatting around the camp fire in the virgin forest, tell each other stories, or fables rather, whose inexhaustible theme was serpents, bats, and big spiders! In measure as the night advanced, the tales became more and more extraordinary. From hecatombs of birds devoured upon their nests by the *Arana cangrejo* (crab spider), with long velvety legs and poisonous jaws, the orator passed to more dramatic facts, and the last flickerings of the dying embers often lent their fantastic accompaniment to a story about a child whose blood had been sucked while it lay in its cradle!

Freed from these local exaggerations, which are so frequent among these weak minds in a state of nature (and examples of which might be easily found nearer home), the history of the bird spider still remains sufficiently interesting to merit being narrated and be better known.

Linne described this species under the name of *Aranea avicularia*, the specific name recalling the animal's habit of feeding at times upon young birds, and even upon adult humming birds, captured upon the nest. The celebrated entomologist Latreille in 1802 established the genus *Mygale* for Arachnids of the tribe Theraphoses. All the individuals included in this group are hunters, and live either in nests constructed in the earth or in the clefts of stones and under the bark of trees, like the species that forms the subject of this article. Some of them are wonderfully skilled workmen, as the mason spider (*M. cœmentaria*, Latr.), of southern France and the pioneer spider (*M. fodiens*, Walck.) of Corsica.

The habits of the bird spider are not so well known as those of the ones just mentioned, either because from its hunting being done at night it is rarely met with, or because it selects retreats that are not very accessible. There are few authors to be found, however, who have correctly spoken of this curious and dreaded spider; several of them have copied one another, and others have devoted themselves especially to its anatomy. During the course of my travels in equinoctial America I have several times had an opportunity of seeing the bird spider in a state of nature, and it will perhaps be permitted me to add a few personal observations to those of the travelers who have preceded me.

Of the several hundreds of spiders that have been described, this is the largest. The largest specimen that I captured (the one that served for making the annexed portrait) measured exactly, with legs stretched out, 7 inches in diameter. The first one I saw was at Martinique, not far from Saint Pierre, in the trees skirting a road. Its nest was suspended from the branch of a *Palicourea*, an elegant shrub of the Rubiaceæ, and its appearance strikingly recalled those large caterpillar nests that we so frequently find upon the Aleppo pine (*Pinus halepensis*) on the mountains in the vicinity of Cannes and Nice. It consisted of a beautiful white silken tissue, of several thick layers, strengthened by very strong threads capable of arresting a small bird. In the center were placed the eggs, perhaps 1,500 or 2,000 in number. As soon as the young are hatched and escape from the cocoon, large red ants of the genus *Myrmica* wage a bloody war on them, and feast upon their whitish flesh of no consistency and without hairs. Such destruction happily counterbalances the ravages that the spider would make were it to multiply too abundantly. In fact, the adult animal, whose body measures no less than 4¼ inches in length, not including the legs, is as ferocious as its aspect implies. Its entire body bristles with long reddish brown hairs. Its eyes, eight in number, are strangely grouped upon a small elevation (cephalothorax); six of them are arranged in a triangle on each side, and the two others are separate at the apex of the warty prominence. At the extremity of the strong, black, smooth jaws are the palpi,



THE BIRD SPIDER. (Natural Size.)