jelly. This point is found to vary one or two degrees, according to the fermentation consequent upon bruises in handling the fruit, decay of the same, or any little delay in expressing the juice from the cheese. The least fermentation occasions the necessity for a lower reduction. To guard against this, no cheese is allowed to stand over night, no pomace left in the grater or vat, no cider in the tank; and further to provide against fermentation, a large water tank is located upon the roof and filled by a force pump, and by means of hose connected with this, each grater, press, vat, tank, pipe, trough, or other article of machinery used, can be thoroughly washed and cleansed. Hot water, instead of cider, is sometimes sent through the defecator, evaporator, etc., until all are thoroughly scalded and purified. If the saccharometer shows too great or too little reduction, the matter is easily regulated by varying the steam pressure in the evaporator by means of a valve in the supply pipe. If boiled cider instead of jelly is wanted for making pies, sauces, etc., it is drawn off from one of the upper evaporator tubes according to the consistency desired; or can be produced at the end of the process by simply reducing the steam pressure.

As the jelly emerges from the evaporator it is transferred to a tub holding some fifty gallons, and by mixing a little therein, any little variations in reduction or in the sweetness or sourness of the fruit used are equalized. From this it is drawn through faucets, while hot, into the various packages in which it is shipped to market. A favorite form of package for family use is a nicely turned little wooden bucket with cover and bail, two sizes, holding five and ten pounds respectively. The smaller packages are shipped in cases for convenience in handling. The present product of this manufactory is from 1,500 to 1,800 pounds of jelly each day of ten hours. It is calculated that improvements now in progress will increase this to something more than a ton per day. Each bushel of fruit will produce from four to five pounds of jelly, fruit ripening late in the season being more productive than earlier varieties. Crab apples produce the finest jelly; sour, crabbed, natural fruit makes the best looking article, and a mixture of all varieties gives most satisfactory results as to flavor and general quality.

As the pomace is shoveled from the finished cheese, it is again ground under a toothed cylinder, and thence drops into large troughs, through a succession of which a considerable stream of water is flowing. Here it is occasionally agitated by raking from the lower to the upper end of the trough as the current carries it downward, and the apple seeds becoming disengaged drop to the bottom into still water, while the pulp floats away upon the stream. A succession of troughs serves to remove nearly all the seeds. The value of the apple seeds thus saved is sufficient to pay the daily wages of all the hands employed in the whole establishment. The apples are measured in the wagon box, one and a half cubic feet being accounted a bushel.

This mill ordinarily employs about six men: One general superintendent, who buys and measures the apples, keeps time books, attends to all the accounts and the working details of the mill, and acts as cashier; one sawyer, who manufactures lumber for the local market and saws the slabs into short lengths suitable for the furnace; one cider maker, who grinds the apples and attends the presses; one jelly maker, who attends the defecator, evaporator, and mixing tub, besides acting as his own fireman and engineer; one who attends the apple seed troughs and acts as general helper, and one man-of-all-work to pack, ship, and assist whenever needed. The establishment was erected late in the season of 1880, and manufactured that year about forty-five tons of jelly, besides considerable cider exchanged to the farmers for apples, and some boiled cider.

The price paid for apples in 1880, when the crop was superabundant, was six to eight cents per bushel; in 1881, fifteen cents. The proprietor hopes next year to consume 100,000 bushels. These institutions are important to the farmer in that they use much fruit not otherwise valuable and very perishable. Fruit so crabbed and gnarled as to have no market value, and even frozen apples, if delivered while yet solid, can be used. (Such apples are placed in the water while frozen, the water draws the frost sufficiently to be grated, and passing through the press and evaporator before there is time for chemical change, they are found to make very good jelly. They are valuable to the consumer by converting the perishable, cheap, almost worthless crop of the bearing and abundant years into such enduring form that its consumption may be carried over to years of scarcity and furnish healthful food in cheap and pleasant form to many who would otherwise be deprived; and lastly, they are of great interest to society, in that they give to cider twice the value for purposes of food that it has or can have, even to the manufacturer, for use as a beverage and intoxicant.

IMPROVED GRAPE BAGS.

It stands to reason that were our summers warmer we should be able to grow grapes successfully on open walls; it is therefore probable that a new grape bag, the invention of M. Pelletier, 20 Rue de la Banque, Paris, intended to serve a double purpose, viz., protecting the fruit and hastening its maturity, will, when it becomes known, be welcomed in this country. It consists of a square of curved glass so fixed to the bag that the sun's rays are concentrated upon the fruit, thereby rendering its ripening more certain in addition to improving its quality generally. The glass is affixed to the bag by means of a light iron wire support. It covers that portion of it next the sun, so that it increases the amount of light and warms the grapes without scorching them, a result due to the convexity of the glass and the layer of air between it and the bag. M. Pelletier had the idea of rendering these bags cheaper by employing plain squares instead of curved ones, but the advantage thus obtained was more than counterbalanced by their comparative inefficacy. In practice it was found that the curved squares gave an average of 7° more than the straight ones, while there was a difference of 10° when the bags alone were used, thus plainly demonstrating the practical value of the invention.

Whether these glass-fronted bags would have much value in the case of grapes grown under glass in the ordinary way is a question that can only be determined by actual experiment; but where the vines are on walls, either under glass screens or in the open air, so that the bunches feel the full force of the sun's rays, there can be no doubt as to their utility, and it is probable that by their aid many of the continental varieties which we do not now attempt to grow in the open, and which are scarcely worthy of a place under glass, might be well ripened. At any rate we ought to give anything a fair trial which may serve to neutralize, if only in a slight degree, the uncertainty of our summers. As it is, we have only about two varieties of grapes, and these

not the best of the hardy kinds, as regards flavor and appearance, that ripen out of doors, and even these do not always succeed. We know next to nothing of the many really well-flavored kinds which are so much appreciated in many parts of the Continent. The fact is, our outdoor culture of grapes offers a striking contrast to that practiced under glass, and although our comparatively sunless and moist climate affords some excuse for our shortcomings in this respect, there is no valid reason for the utter want of

GRAPE BAG.—OPEN.

good culture which is to be observed in a general way. Given intelligent training, constant care in stopping the laterals, and checking mildew as well as thinning the berries, allowing each bunch to get the full benefit of sun and air, and I believe good eatable grapes would often be obtained even in summers marked by a low average temperature. If, moreover, to a good system of culture we add

GRAPE BAG.—CLOSED.

some such mechanical contrivance as that under notice whereby the bunches enjoy an average warmth some 10° higher than they otherwise would do, we not only insure the grapes coming to perfection in favored districts, but outdoor culture might probably be practiced in higher latitudes than is now practicable. The improved grape bag would also offer great facilities for destroying mildew or

CURVED GLASS FOR FRONT OF BAG.

guarantee the grapes against its attacks, as a light dusting administered as soon as the berries were fairly formed would suffice for the season, as owing to the glass protecting the berries from driving rains, which often accompany south or south-west winds in summer and autumn, the sulphur would not be washed off.

The inventor claims, and we should say with just reason,

CURVED GLASS FIXED ON BAG.

that these glass-fronted bags would be found equally serviceable for the ripening of pears and other choice fruits, and with a view to their being employed for such a purpose, he has had them made of varying sizes and shapes. In conclusion, it may be observed that, in addition to advancing the maturity of the fruits to which they are applied, they also serve to preserve them from falling to the ground when ripe.—J. CORNILL, in the Garden.

UTILIZATION OF SOLAR HEAT.

At a popular fête in the Tuileries Gardens I was struck with an experiment which seems deserving of the immediate attention of the English public and military authorities.

Among the attractions of the fête was an apparatus for the concentration and utilization of solar heat, and, though the sun was not very brilliant, I saw this apparatus set in motion a printing machine which printed several thousand copies of a specimen newspaper entitled the *Soleil Journal*.

The sun's rays are concentrated in a reflector, which moves at the same rate as the sun and heats a vertical boiler, setting the motive steam-engine at work. As may be supposed, the only object was to demonstrate the possibility of utilizing the concentrated heat of the solar rays; but I closely examined it, because the apparatus seems capable of great utility in existing circumstances. Here in France, indeed, there is a radical drawback—the sun is often overclouded.

Thousands of years ago the idea of utilizing the solar rays must have suggested itself, and there are still savage tribes who know no other mode of combustion; but the scientific application has hitherto been lacking. This void this apparatus will fill up. About fifteen years ago Professor Mouchon, of Tours, began constructing such an apparatus, and his experiments have been continued by M. Pifre, who has devoted much labor and expense to realizing M. Mouchon's idea. A company has now come to his aid, and has constructed a number of apparatus of different sizes at a factory which might speedily turn out a large number of them.

It is evident that in a country of uninterrupted sunshine the boiler might be heated in thirty or forty minutes. A portable apparatus could boil two and one-half quarts an hour, or, say, four gallons a day, thus supplying by distillation or ebullition six or eight men. The apparatus can be easily carried on a man's back, and on condition of water, even of the worst quality, being obtainable, good drinking and cooking water is insured. M. De Rougaumont, a young scientific writer, has just published an interesting volume on the invention. I was able yesterday to verify his statements, for I saw cider made, a pump set in motion, and coffee made—in short, the calorific action of the sun superseding that of fuel. The apparatus, no doubt, has not yet reached perfection, but as it is it would enable the soldier in India or Egypt to procure in the field good water and to cook his food rapidly. The invention is of especial importance to England just now, but even when the Egyptian question is settled the Indian troops might find it of inestimable value.

Red tape should for once be disregarded, and a competent commission forthwith sent to 30 Rue d'Assas, with instructions to report immediately, for every minute saved may avoid suffering for Englishmen fighting abroad for their country. I may, of course, be mistaken, but a commission would decide, and if the apparatus is good the slightest delay in its adoption would be deplorable.—*Paris Correspondence London Times*.

HOW TO ESTABLISH A TRUE MERIDIAN.*

By PROFESSOR L. M. HAUPT.

INTRODUCTORY.

THE discovery of the magnetic needle was a boon to mankind, and has been of inestimable service in guiding the mariner through trackless waters, and the explorer over desert wastes. In these, its legitimate uses, the needle has not a rival, but all efforts to apply it to the accurate determination of permanent boundary lines have proven very unsatisfactory, and have given rise to much litigation, acerbity, and even death.

For these and other cogent reasons, strenuous efforts are being made to dispense, so far as practicable, with the use of the magnetic needle in surveying, and to substitute therefor the more accurate method of traversing from a true meridian. This method, however, involves a greater degree of preparation and higher qualifications than are generally possessed, and unless the matter can be so simplified as to be readily understood, it is unreasonable to expect its general application in practice.

Much has been written upon the various methods of determining the true meridian, but it is so intimately related to the determination of latitude and time, and these latter in turn upon the fixing of a true meridian, that the novice can find neither beginning nor end. When to these difficulties are added the corrections for parallax, refraction, instrumental errors, personal equation, and the determination of the probable error, he is hopelessly confused, and when he learns that time may be sidereal, mean solar, local, Greenwich, or Washington, and he is referred to an ephemeris and table of logarithms for data, he becomes lost in "confusion worse confounded," and gives up in despair, settling down to the conviction that the simple method of compass surveying is the best after all, even if not the most accurate.

Having received numerous requests for information upon the subject, I have thought it expedient to endeavor to prepare a description of the method of determining the true meridian which should be sufficiently clear and practical to be generally understood by those desiring to make use of such information.

This will involve an elementary treatment of the subject, beginning with the

DEFINITIONS.

The *celestial sphere* is that imaginary surface upon which all celestial objects are projected. Its radius is infinite.

The *earth's axis* is the imaginary line about which it revolves.

The *poles* are the points in which the axis pierces the surface of the earth, or of the celestial sphere.

A *meridian* is a great circle of the earth cut out by a plane passing through the axis. All meridians are therefore north and south lines passing through the poles.

From these definitions it follows that if there were a star exactly at the pole it would only be necessary to set up an instrument and take a bearing to it for the meridian. Such not being the case, however, we are obliged to take some one of the near circumpolar stars as our object, and correct the observation according to its angular distance from the meridian at the time of observation.

For convenience, the bright star known as *Ursæ Minoris* or *Polaris*, is generally selected. This star apparently revolves about the north pole, in an orbit whose mean radius is 1° 19' 13", making the revolution in 23 hours 56 minutes.

During this time it must therefore cross the meridian twice, once above the pole and once below; the former is called the *upper*, and the latter the *lower meridian transit or culmination*. It must also pass through the points farthest east and

* A paper read before the Engineers' Club of Philadelphia.

† This is the declination as given in the Nautical Almanac. The mean value decreases by about 20 seconds each year.

west from the meridian. The former is called the *eastern elongation*, the latter the *western*.

An observation may be made upon Polaris at any of these four points, or at any other point of its orbit, but this latter case becomes too complicated for ordinary practice, and is therefore not considered.

If the observation were made upon the star at the time of its upper or lower culmination, it would give the true meridian at once, but this involves a knowledge of the true local time of transit, or the longitude of the place of observation, which is generally an unknown quantity; and moreover, as the star is then moving east or west, or at right angles to the place of the meridian, at the rate of 15° of arc in about one hour, an error of so slight a quantity as only four seconds of time would introduce an error of one minute of arc. If the observation be made, however, upon either elongation, when the star is moving up or down, that is, in the direction of the vertical wire of the instrument, the error of observation in the angle between it and the pole will be inappreciable. This is, therefore, the best position upon which to make the observation, as the precise time of the elongation need not be given. It can be determined with sufficient accuracy by a glance at the relative positions of the star Alioth, in the handle of the Dipper, and Polaris (see Fig. 1). When the line joining these two stars is horizontal or nearly so, and Alioth is to the west of Polaris, the latter is at its eastern elongation, and *vice versa*, thus:

But since the star at either elongation is off the meridian, it will be necessary to determine the angle at the place of observation to be turned off on the instrument to bring it into the meridian. This angle, called the azimuth of the pole star, varies with the latitude of the observer, as will appear from Fig. 2, and hence its value must be computed for different latitudes, and the surveyor must know his latitude before he can apply it. Let N be the north pole of the celestial sphere; S, the position of Polaris at its eastern elongation; then $\angle NS = 1^\circ 19' 13''$, a constant quantity. The azimuth of Polaris at the latitude 40° north is represented by the angle $\angle NOS$, and that at 60° north, by the angle $\angle NOS'$, which is greater, being an exterior angle of the triangle, $\angle OSO'$. From this we see that the azimuth varies at the latitude.

We have first, then, to find the latitude of the place of observation.

Of the several methods for doing this, we shall select the simplest, preceding it by a few definitions.

A *normal* line is the one joining the point directly overhead, called the *zenith*, with the one under foot called the *nadir*.

The *celestial horizon* is the intersection of the celestial sphere by a plane passing through the center of the earth and perpendicular to the normal.

A *vertical circle* is one whose plane is perpendicular to the horizon, hence all such circles must pass through the normal and have the zenith and nadir points for their poles. The *altitude* of a celestial object is its distance above the horizon measured on the arc of a vertical circle. As the distance from the horizon to the zenith is 90° , the difference, or *complement* of the altitude, is called the *zenith distance*, or *co-altitude*.

The *azimuth* of an object is the angle between the vertical plane through the object and the plane of the meridian, measured on the horizon, and usually read from the south point, as 0° , through west, at 90° , north 180° , etc., closing on south at 0° or 360° .

These two co-ordinates, the altitude and azimuth, will determine the position of any object with reference to the observer's place. The latter's position is usually given by his latitude and longitude referred to the equator and some standard meridian as co-ordinates.

The *latitude* being the angular distance north or south of the equator, and the *longitude* east or west of the assumed meridian.

We are now prepared to prove that the altitude of the pole is equal to the latitude of the place of observation.

Let $HPZQ$, etc., Fig. 2, represent a meridian section of the sphere, in which P is the north pole and Z the place of observation, then HH' will be the horizon, QQ' the equator, HP will be the altitude of P, and $Q'Z$ the latitude of Z. These two arcs are equal, for $\angle H'ZQ' = \angle PCQ' = 90^\circ$, and if from these equal quadrants the common angle $\angle PCZ$ be subtracted, the remainders $\angle HCP$ and $\angle ZCQ'$, will be equal.

To determine the altitude of the pole, or, in other words, the latitude of the place.

Observe the altitude of the pole star when on the meridian, either above or below the pole, and from this observed altitude corrected for refraction, subtract the distance of the star from the pole, or its *polar distance*, if it was an upper transit, or add it if a lower. The result will be the required latitude with sufficient accuracy for ordinary purposes.

The time of the star's being on the meridian can be determined with sufficient accuracy by a mere inspection of the heavens. The refraction is *always negative*, and may be taken from the table appended by looking up the amount set opposite the observed altitude. Thus, if the observer's altitude should be $40^\circ 39' 00''$, the nearest refraction $01' 07''$, should be subtracted from $40^\circ 39' 00''$, leaving $40^\circ 37' 53''$ for the latitude.

TO FIND THE AZIMUTH OF POLARIS.

As we have shown the azimuth of Polaris to be a function of the latitude, and as the latitude is now known, we may proceed to find the required azimuth. For this purpose we have a right-angled spherical triangle, ZSP , Fig. 4, in which Z is the place of observation, P the north pole, and S is Polaris. In this triangle we have given the polar distance, $PS = 1^\circ 19' 13''$; the angle at $S = 90^\circ$; and the distance ZP , being the complement of the latitude as found above, or $90^\circ - L$. Substituting these in the formula for the azimuth, we will have $\sin Z = \frac{\sin PS}{\sin PZ}$ or $\frac{\sin \text{of polar distance}}{\sin \text{of co-latitude}}$, from which, by assuming different values for the co-latitude, we compute the following table:

AZIMUTH TABLE FOR POINTS BETWEEN 26° AND 50° N. LAT.

LATITUDES	50°	
	°	'
50°	2	03 11
48°	1	53 20
46°	1	53 34
44°	1	50 05
42°	1	46 33
40°	1	43 21
38°	1	40 29
36°	1	37 52
34°	1	35 30
32°	1	33 22
30°	1	31 25
28°	1	29 40
26°	1	28 05
Year		
1882	1	28 05
1883	1	27 45
1884	1	27 23
1885	1	27 01
1886	1	26 39

An analysis of this table shows that the azimuth this year (1882) increases with the latitude from $1^\circ 28' 05''$ at 26° north, to $2^\circ 3' 11''$ at 50° north, or $35' 06''$. It also shows that the azimuth of Polaris at any one point of observation decreases slightly from year to year. This is due to the increase in declination, or decrease in the star's polar distance. At 26° north latitude, this annual decrease in the azimuth is about $22''$, while at 50° north, it is about $30''$. As the variation in azimuth for each degree of latitude is small, the table is only computed for the even numbered degrees; the intermediate values being readily obtained by interpolation. We see also that an error of a few minutes of latitude will not affect the result in finding the meridian, e. g., the azimuth at 40° north latitude is $1^\circ 43' 21''$, that at 41° would be $1^\circ 44' 58''$, the difference ($01' 35''$) being the correction for one degree of latitude between 40° and 41° . Or, in other words, an error of one degree in finding one's latitude would only introduce an error in the azimuth of one and a half minutes. With ordinary care the probable error of the latitude as determined from the method already described need not exceed a few minutes, making the error in azimuth as laid off on the arc of an ordinary transit graduated to single minutes, practically zero.

REFRACTION TABLE FOR ANY ALTITUDE WITHIN THE LATITUDE OF THE UNITED STATES.

Apparent Altitude.	Refraction minus.	Apparent Altitude.	Refraction minus.
25°	0° 2' 4.2"	38°	0° 1' 14.4"
26	1 58.8	39	1 11.8
27	1 53.8	40	1 9.3
28	1 49.1	41	1 6.9
29	1 44.7	42	1 4.6
30	1 40.5	43	1 2.4
31	1 36.6	44	1 0.3
32	1 33.0	45	0 58.1
33	1 29.5	46	0 56.1
34	1 26.1	47	0 54.2
35	1 23.0	48	0 52.3
36	1 20.0	49	0 50.5
37	1 17.1	50	0 48.8

APPLICATIONS.

In practice to find the true meridian, two observations must be made at intervals of six hours, or they may be made upon different nights. The first is for latitude, the second for azimuth at elongation.

To make either, the surveyor should provide himself with a good transit with vertical arc, a bull's eye, or hand lantern, plumb bobs, stakes, etc.* Having "set up" over the point through which it is proposed to establish the meridian, at a time when the line joining Polaris and Alioth is nearly vertical, level the telescope by means of the attached level, which should be in adjustment, set the vernier of the vertical arc at zero, and take the reading. If the pole star is about making its upper transit, it will rise gradually until reaching the meridian as it moves westward, and then as gradually descend. When near the highest part of its orbit point the telescope at the star, having an assistant to hold the "bull's eye" so as to reflect enough light down the tube from the object end to illumine the cross wires but not to obscure the star, or better, use a perforated silvered reflector, clamp the tube in this position, and as the star continues to rise keep the horizontal wire upon it by means of the tangent screw until it "rides" along this wire and finally begins to fall below it. Take the reading of the vertical arc and the result will be the observed altitude.

ANOTHER METHOD.

It is a little more accurate to find the altitude by taking the complement of the observed zenith distance, if the vertical arc has sufficient range. This is done by pointing first to Polaris when at its highest (or lowest) point, reading the vertical arc, turning the horizontal limb half way around, and the telescope over to get another reading on the star, when the difference of the two readings will be the *double* zenith distance, and *half* of this subtracted from 90° will be the required altitude. The less the time intervening between these two pointings, the more accurate the result will be.

Having now found the altitude, correct it for refraction by subtracting from it the amount opposite the observed altitude, as given in the refraction table, and the result will be the latitude. The observer must now wait about six hours until the star is at its western elongation, or may postpone further operations for some subsequent night. In the meantime he will take from the azimuth table the amount given for his date and latitude, now determined, and if his observation is to be made on the western elongation, he may turn it off on his instrument, so that when moved to zero, after the observation, the telescope will be brought into the meridian or turned to the right, and a stake set by means of a lantern or plummet lamp.

It is, of course, unnecessary to make this correction at the time of observation, for the angle between any terrestrial object and the star may be read and the correction for the azimuth of the star applied at the surveyor's convenience. It is always well to check the accuracy of the work by an observation upon the other elongation before putting in permanent meridian marks, and care should be taken that they are not placed near any local attractions. The meridian having been established, the magnetic variation or declina-

APPROXIMATE EQUATION OF TIME.							
Date.	Minutes.	Date.	Minutes.	Date.	Minutes.	Date.	Minutes.
Jan. 1	4	April 1	4	Aug. 9	5	Oct. 27	16
8	5	2	3	15	4	Nov. 15	14
5	6	7	2	20	3	20	15
7	7	11	1	24	2	24	13
9	8	15	0	28	1	27	12
12	9			31	0	30	11
15	10	19	1			Dec. 2	10
18	11	24	2	Sept. 3	1	5	9
21	12	30	3	6	2	7	8
23	13	3	3	9	3	9	7
25	14	May 29	4	12	4	11	6
31	14	June 5	5	15	5	13	5
Feb. 21	15	10	2	18	6	16	4
27	14	15	1	21	7	18	3
4	13		0	24	8	20	2
M'ch 8	12	20	1	27	9	22	1
12	11	25	2	30	10	24	0
15	10	29	3	Oct. 3	11		
18	9	31	3	6	12	26	1
22	8	July 11	4	10	13	28	2
23	7	15	5	14	14	30	3
25	6	28	6	19	15		
28	5						