SCIENTIFIC AMERICAN SUPPLEMENT

VOLUME LXXXI
NUMBER 2111

★NEW YORK, JUNE 17, 1916★

10 CENTS A COPY
$5.00 A YEAR

German soldiers baling water out of a flooded trench.

WINTER IN THE TRENCHES.—[See page 392.]

The Sidereal Center*

Considerations Tending to Indicate That Canopus Occupies This Position

By O. R. Walkey, F. R. A. S.

THE Helium or B type, the so-called "Orion," stars are those which recent studies concur in placing at great distances from our system, while their brighter members, too, appear, according to Prof. Campbell (*Lick Obs. Bul.*, 195) to lie as fully remote as do their fainter. This peculiarity, together with the rapid decrease, with diminishing magnitude, in the numbers of this class, argues a great average luminosity, coupled with great distance. Further, these stars are found by Profs. Campbell and Boss (*Lick Obs. Bul.*, 195; *Astron. Journ.*, 620, 635-6) to be virtually free from that preferential motion, or star-streaming, which seems to be characteristic of the other spectral classes. These stars thus peculiarly invite treatment as of those most truly representing the visible universe, of which they may not unfairly be regarded as the framework.

In a recent study by the writer (*Mon. Not. R.A.S.*, May, 1914) of the distribution of the several spectral classes—particularly of type B—with reference to the galaxy, the relative preponderances of these stars (Oe5 to B5) in galactic latitude and longitude respectively places the apparent center of their system on the 230 degree galactic meridian—or of "galongitude," reckoned from the intersection of the galactic and celestial equators in Aquila—and between 20 degrees and 30 degrees south in galactic latitude, or of "galatitude." This, in other words, is the direction from which our solar system appears to lie eccentric within the universe defined by the helium stars. The relatively small number (706) of these stars involved (as given in *Harvard Annals*, Vol. 56, pt. 2) is largely compensated by the generally remote and therefore comprehensive distribution just referred to of this type's brighter members, of which this number is largely composed, and includes them all. The sidereal center probably lies, therefore, on the line just named, or between α 6 hours 0 minutes, δ −55 degrees, and α 6 hours 55 minutes, δ −52 degrees. The same studies with the work of Kapteyn, Boss, and Campbell further indicate the distance of this center as being in the neighborhood of 400 light-years, or 140 "secpars," to adopt under this name the more useful unit of stellar distance corresponding to 1.0 second parallax.[1]

The association of a particular star with the sidereal center would, if established, give coherence to the several lines of study now proceeding in stellar motion and distribution, and enable us to realize more clearly their true significance. Accepting the position line defined, it will be found to lie nearly symmetrically across the splendid star Canopus, and the only star within the prescribed limits of which we have any definite knowledge. This star appears to be the greatest sun of which we know anything, and is referred to by Prof. See as an example of his hypothesis of condensed star-clusters. In view of this remarkable coincidence the further study of this star assumes a peculiar interest as pertinent to the question of a sideral center.

First, as to the distance of Canopus: the late Sir David Gill found its parallax and proper motion to be insensible with regard to four 8th-magnitude comparison stars, of which the average absolute parallax, according to Prof. Kapteyn's table -*Gron. Pub.*, No. 24) is 0.0065 seconds. Considering, however, the uncertain application of averages to individuals, further evidence is desirable in support or otherwise of this value, and is best afforded by a study of the cross and radial motions in relation to the solar motion in space. The speed of solar motion and its apex appears to vary slightly, according to the spectral class of the stars to which they are referred. Here, as for their general fixity, the helium stars are the chosen reference for the solar position, so in consistence to them also should the direction and speed of solar motion be referred. Prof. Boss (*Astron. Journ.*, 623-4) has derived the solar apex relative to 490 of these stars alone, the mean of his two solutions placing the apex in α 18 hours 17 minutes, δ + 35 degrees 0.4 (assuming a solar velocity of 20 kilometers a second); while Kapteyn, Campbell, and Stroobant (assuming apices derived from all spectral types, and but little removed from Boss) derive from the B stars solar velocities ranging from 20.7 to 23.3 kilometers per second; the mean of these (weighted according to the number of stars used) is 21.5 kilometers per second, and is here adopted with Boss Apex, of which the antapex lies therefore in α 6 hours 17 minutes, δ −35 degrees 0.4, a point found to lie 21 degrees 9 minutes south in galatitude (referred to Newcomb's mean north galactic pole in α 12 hours 48 minutes, δ + 27 degrees). The antapex further lies 17 degrees 15 minutes northward from Canopus, the speed of apparent or parallactic drift of which (due to the solar motion) becomes 6.37 kilometers per second towards this antapex. The corresponding radial component (recessional) set up in Canopus is 20.53 kilometers per second, a figure which almost exactly coincides with the observed velocity of Canopus, 20.6 kilometers per second in recession. This indicates Canopus to be stationary with regard to the universe defined by the B type stars.

The annual proper (cross-) motion of Canopus, according to Bos ("Prelim. Gen. Cat.") is 0.0184 seconds in the direction 57 degrees 0.2, or at 60 degrees 0.4, with the direction of the solar antapex, whither the parallactic component is therefore 0.0091 seconds, while the normal to this line is 0.0160 seconds. Taking the parallactic component to represent the parallactic speed previously derived, the absolute parallax of Canopus becomes 0.0067 seconds. Apart from the inherent uncertainties of these small quantities (considering, too, Gill's failure to detect proper motion), this figure may be affected in either direction by the component of any real motion which Canopus may have crosswise towards or away from the antapex. The absence, however, of peculiar radial velocity argues the probability that any peculiar motion may be entirely absent, and in any case its crosswise component should not be large enough to affect materially the derived parallax. If, on the other hand, we accept the reality of peculiar motion, there is an hypothesis which is strongly supported by the A type stars, and which may be mentioned, of motion parallel to the galactic plane as brought out by Prof. Campbell and applied by Prof. Plummer. This hypothesis usually supplies a good criterion of the distance of an A type star. Since Canopus, however, belongs to type F, a class which affords no definite evidence of galactic planar motion, the application of this method fails, as is evidenced, too, by the parallax (0.077 seconds)[2] so derived being inadmissibly large in the face of Gill's careful measures.

The peculiar motion (if any) of Canopus would therefore be at random, in which case it may be used in two ways, according to the assumption involved, to derive the parallax. Assuming (i) Boss' average ratio (*Astron. Journal*, 614)

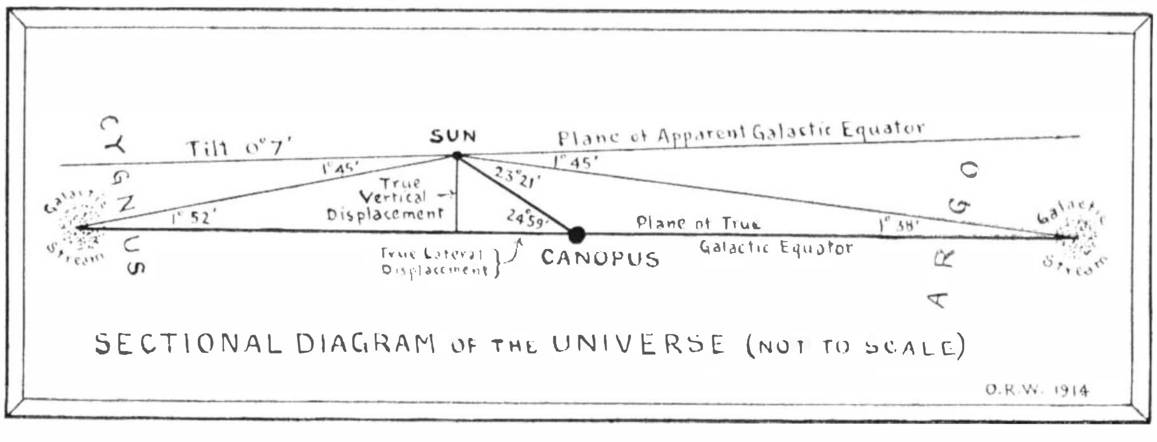
$$\frac{\text{parallactic motion}}{\text{whole motion}} = 0.7$$

to apply in this case, the resulting parallactic motion (0.0129 seconds) yields, with the parallactic speed, an absolute parallax of 0.0096 seconds, or a distance of 104 secpars; (ii) that the speed of motion peculiar to this star be 15.3 kilometers per second, the mean of Campbell's (14.4) and Boss' (16.2) values derived for the F stars, in which case the parallax becomes 0.0050 seconds, giving a distance of 200 secpars. The mean parallax on these two assumptions becomes 0.0073 seconds, while the mean by distances is 152 secpars. Though probably neither of these assumptions is true, yet, being independent and complementary, the truth, in the event of peculiar motion, should fairly lie between them, so that their mean result may be taken as a further index of the distance, and is in striking agreement too with two previous estimates.

In view of the excellent agreement of these entirely independent estimates, the distance of Canopus may fairly be assumed to be 150 secpars, a figure which agrees well too with the order of distance derived for the sidereal center.

As to the luminosity of Canopus, the R. H. P. magnitude is −0.86, while that of our Sun, if removed to a distance of one secpar, may be taken as 0.0 (implying an actual stellar magnitude −26.57); thus Canopus is actually 49,700 times as luminous as the Sun, while its spectrum is class F. Prof. Russell and Dr. Shapley have derived from the known binary systems the surface brightness of the several spectral types, and which should (they state) be fairly constant for each type. They find the surface brightness of the F stars to be 1.1 magnitude, or 2.75 times brighter than the solar (and with a temperature of 7,500 degrees against the solar 5,000 deg. Cent.). The area of Canopus thus becomes 18,000, the diameter 134, and the volume 2,420,000 times those respectively of the Sun. Russell and Shapley further find that, on a diagram of surface areas (derived from absolute magnitude with unit surface brightness) for different type stars of unit (solar) mass, the F stars segregate compactly just one magnitude larger than our unit Sun, whence follows a relative density of 0.25 the solar. Applying this to the bulk of Canopus, its mass becomes 609,000 times the Sun's. The chief uncertainty in these values lies in the actual density of such a great sun as Canopus manifestly is. The mutual attraction of so large a volume of gas thus presented would give rise to a set of condition surpassing anything with which we are acquainted; the tendency, however, should be to increase the density and consequently the mass, of which therefore 600,000 times the Sun may be fairly set down as the lower limit.[3] A previous estimate, by the late Mr. Gore, of the Canopus mass, based on a parallax of 0.01 seconds, from comparison with Procyon (F5 spectrum), made it a million times the Sun. This estimate, though agreeing well with the present one, rests on one star alone, and that of a spectrum not exactly similar.

Given such a mass, its effect should be evident in the relative motions of the faint stars among which it is situate. In order to apply some such corroborative test, a region was chosen extending from 6 hours 4 minutes to 40 minutes in R.A., and from 50 degrees to 55 degrees in south declination, representing an area some 5 degrees square around Canopus, and all the stars of the Cape and Sydney astrographic catalogues within these limits were plotted. The proper motions of those in the southern belts (below −52 degrees and allotted to Sydney) are, unfortunately, not reduced, so that only those (Cape) stars between −50 degrees and −52 degrees having assigned motions[4] appear in Fig. 289, supplemented for brighter stars from Boss' "Preliminary General Catalogue." Fig. 289 consequently shows 23 stars (numbered in order of R.A.) in the northern vicinity of Canopus, to which their cross-motions have been reduced relative. Resolving these tangentially and radially, and reckoning their components positive according as they are respectively clockwise around and away from their primary, the mean tangential component



* From *Knowledge*.

[1] The name here adopted is the proposed "parsec," with the syllables reversed to meet the objection lately raised to its implication (by English usage of final syllables) of time or pure arc rather than distance.

[2] Using the general values of solar motion and its apex, as used by Plummer, the parallax reduces to 0.032", a value still too large, however.

[3] One source of uncertainty, that affects some of the quantities derived, is the adopted stellar magnitude of the Sun. Russell adopts one 0.3 magnitude brighter, evidently following the Harvard reduction −26.83. Substituting this for the (unital) −26.57 figure, the luminosity of Canopus reduces to the actual value 39,100, the area to 14,200, diameter to 119, and bulk to 1,691,000 times these solar quantities; the density, on the other hand, increasing to 0.36 the solar, leaves the mass unchanged, and independent therefore of the adopted stellar magnitude of the Sun.

[4] The four comparison stars used for determining the parallax of Canopus are excluded as being assigned no motion, their mean motion being indistinguishable from that of their primary; a result to be expected in the case of more or less symmetrically placed "satellites," if such at all.

is found to be 0.0505 seconds (clockwise) as against 0.0344 seconds (outward) mean radial motion. Of the tangential components only two are negative and one zero, while their stated mean represents 83 per cent of the mean whole motion. This, coupled with the fact that the negative radial components confine themselves to one side (west) of their primary, appears to afford evidence of orbital motion enough to justify a closer study in weeding out any stars plainly extraneous to any presumable sub-Canopic system. An inspection of Fig. 289 will eliminate Nos. 10, 13, 17, and 22, as having large proper motion, and apparently sharing the drift of the more rapid of Kapteyn's two-star streams (that towards α 90 degree, δ −12 degrees), their large P.M. arguing a common greater proximity to our system. On this score No. 21, with 0.15 seconds in the opposite direction, should also be excluded.[5]

The relative motions of the remaining 18 stars, as of those at presumably the same order of distance, will remain unaffected by the component of solar motion, and, as possible satellites to Canopus, present the following quantities, which have been derived as simple means as sufficiently approximate, considering the inherent uncertainties of our data:

CANOPIC SYSTEM.

Mean distance from Canopus........ D 133 minutes 0.1 sec.
Mean tangential component (clockwise)............................ T 0.0341 seconds
Mean radial component (outward).... R 0.0042 seconds
Mean inclination to radius-vector $\tan^{-1}\frac{T}{R} = \theta$ 83 deg. 0.0
Minimum mass (times the Sun)........ 794,000

The angle θ expresses in its approach to 90 degrees that towards the condition of satellites symmetrically placed in a common orbital plane, or of circular motion in a plane normal to the right line. This latter case, if true, would represent the minimum mass $M = DT^2$ when at a distance of 150 secpars, D represents 1,200,000 astronomical units, and T 15 miles a second, or 0.81 of the earth's mean orbital speed. This mass and that previously derived adepend alike on the adopted distance of Canopus, of which their mutual relation is consequently independent. Though necesarily provisional, the strikingt agreement—after due allowance for coincidences—of the two entirely independent estimates of the minimum mass constitutes a somewhat forceful case for the reality of orbital motion for the faint star in the vicinity of Canopus. This of course, cannot be accepted as fact until we have the evidencŏe of such stars of the −52 degree to −55 degree belt in the southern vicinity of Canopus, as may reasonably lie at the same distance. The reduction of these motions is therefore highly desirable, as invested with a peculiar interest.[6]

There is in this connection one point to be observed, namely, that "forward" orbital motions distributed in all planes around their primary will appear "forward" or "retrograde" according as their stars lie on the near or far side of their primary. The settlement of the question thus awaits the development of appliances able to measure the radial velocities of these faint stars.

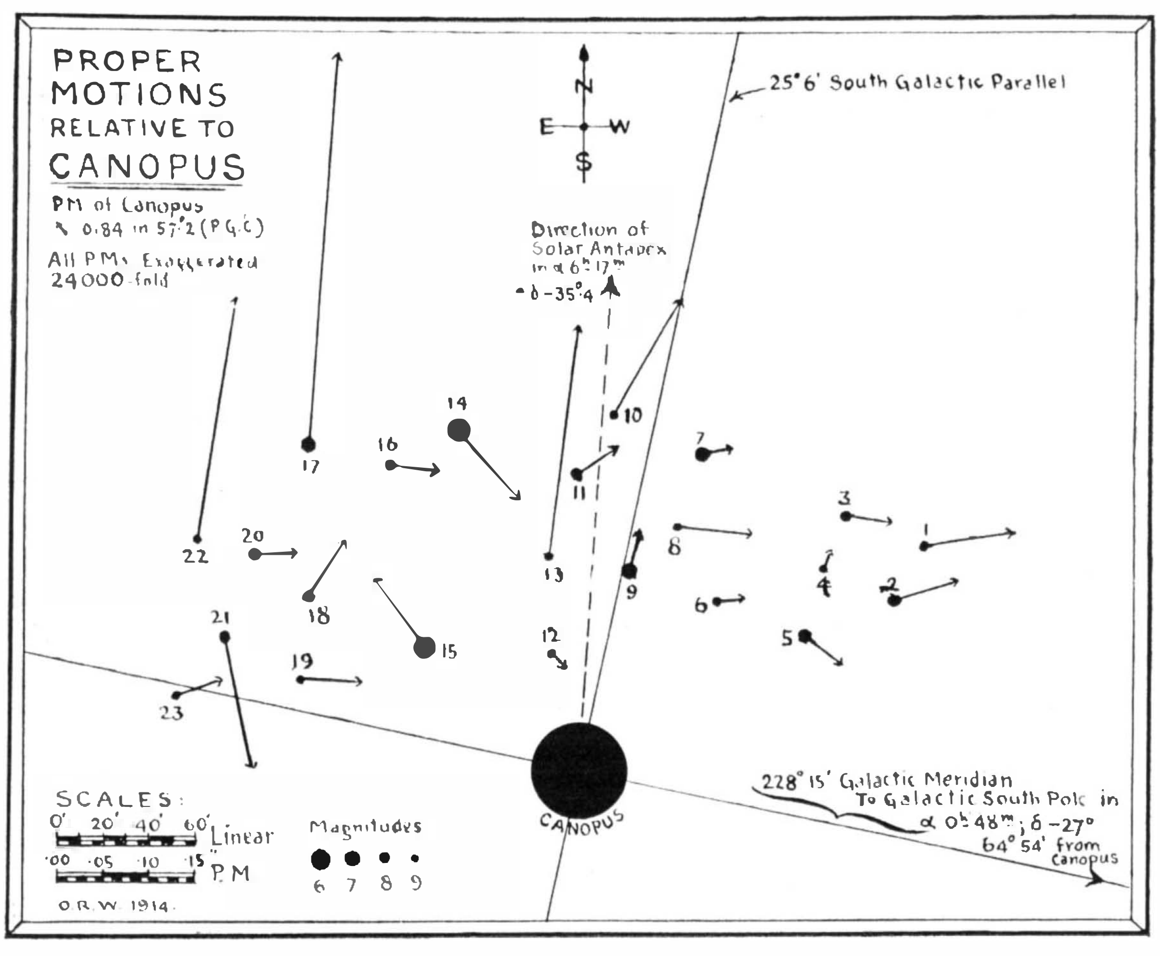
The actual mass of Canopus will be anything greater than the figure derived, according to the mean orbital inclination (i) to the line of sight. The most reasonable index as to this will follow from the assumption of random orbital inclination, whence integrating $\sin^3 i$ (by the inverse of which the mass varies) gives a mean value 0.589: this, divided into the minimum mass, gives 1,350,000 times the Sun as the probable actual mass of Canopus.

A curious result which follows from this is that such a mass, acting at 150 secpars, would of itself produce in our Sun's motion a tangential component of 3.86 miles or 6.21 kilometers a second. When we consider that the actual crosswise component of solar motion is 6.37 kilometers per second, the striking agreement, which it seems hard to believe entirely coincident, impresses itself in confirmation of the foregoing hypothesis. Again, this agreement of the estimate with the fact supplies an indirect confirmation of the distance of Canopus, since this is ultimately a direct function of the velocity.

The mass necessary at 150 secpars to produce the actual crosswise solar component would be 1,420,000 Suns. The close agreement of these estimates implies that the combined attraction of the lesser suns around us is balanced in this respect—a state of affairs which, if continuous, would indicate for our Sun a highly eccentric hyperbolic orbit in a plane nearly perpendicular to the celestial, and having its "outer" focus distant 160 secpars in the direction α 6 hours 14 minutes, δ −18 degrees, 10 minutes (a degree west of β Canis Majoris), towards which point, therefore, the solar antapex would imperceptibly shift with the lapse of time. As a matter of curiosity—for it assumes continued absence of disturbing forces—the elements of the hyperbola derived are given as follows:

Eccentricity............. 8.52
Angle between asymptotes. 166½ degrees
Direct axis.............. 10.9 secpars; inclined 13 degrees to galactic plane
Conjugate axis........... 92.3 secpars; inclined 23 degrees to galactic plane
Parameter............... 780 secpars; inclined 23 degrees to galactic plane
"Perihelial" distance...... 41.0 secpars
Epoch since "periastral" passage..219×10^{12} years

Needless to say, the final item is imaginary of the present creation being then existent! The angular divergence of the asymptotes indicates (in its supplement) that the ultimate deviation of the solar path due to Canopus is 13½ degrees from the straight line.



The several indications in favor of the present hypothesis may now be summarized as follows:

(i) Canopus occupies the approximate position derived for the center of the stellar system, as defined by the remote helium stars.

(ii) Its distance is of the same order as that indicated for this helium star center.

(iii) Canopus appears to be stationary with reference to these virtually "fixed" helium stars.

(iv) Its predominant luminosity and mass are in character with their suggested significance.

(v) The relative motions of the faint stars, so far examined, in the vicinity of Canopus indicate an orbital motion confirming the independently derived mass.

(vi) The component of solar motion tangential to Canopus indicates the existence of such a mass at the given distance.

Two other features, which may prove relevant, are:

(a) The objectives (α 90 degrees, δ −12 degrees and α 263 degrees, δ −60 degrees) of Kapteyn's two star-streams (assuming their reality) lie on either side of Canopus at angular distances inversely proportional to their respective speeds, and in nearly the same apparent south galatitude as Canopus.[7]

(b) The solar antapex lies in nearly the same apparent south galatitude.

It will, of course, be clearly understood that none of the foregoing indications are set forth as in any way *proving* the central position of Canopus, the indication in some cases being within its own limit of error. They nevertheless point consistently in the same direction, though mutually independent, so that, however slender may be each cord in itself, yet, collectively, they assume that comparative strength which the cable bears to its component strands. As a chain of mere coincidences in a common direction, the foregoing indications would be less remarkable than the fact they demonstrate.

Finally, the central position of Canopus may, if established, be used to determine the galactic distances in terms of the Sun-Canopus line, which would thus serve for the sidereal system the purpose served by our astronomical unit (Earth-Sun line) for the solar system. The table summarizes the resultant distances relative to the unit line, and absolutely in secpars and light-years.

GALACTIC DISTANCES.

Quantity.	Unital.	Secpars.	Light-years.
Sun to Canopus.............	1.00	150	489
To Galaxy in Cygnus........	12.98	1,950	6,330
To Galaxy in Argo..........	14.80	2,220	7,220
True Galactic Radius........	13.88	2,080	6,780
Vertical Displacement of Sun.	0.422	63.3	206
Lateral Displacement of Sun.	0.906	136	442

The quantities follow from the apparent southward deviation 1.75 degrees, derived by the late Prof. Newcomb for the main galactic stream in connection with the apparent south galatitude 25.1 degrees of Canopus, relative to the plane having its N. pole in α 192 degrees, δ + 27 degrees.[8]

Our eccentricity within the galaxy is therefore vertically 1/33 and horizontally 1/15 of the galactic radius, while the figure derived for this radius, corresponding to a parallax of 0.0005 seconds, follows the trend of recent indications by other methods.

While considering the distance of the galaxy, an independent and rough index of this is supplied from the average actual luminosity in terms of our Sun of the Type II (F, G, K) stars, of which the class Faith's integrated spectrum (*Ap. Journ.*, volume 36, page 362) indicates the galaxy mainly to consist.[9] According to all the recent studies embodied in Prof. Russell's "absolute magnitude" diagram, these stars average at 0.8 "sunpower," and, taking these to be represented by the average galactic star of apparent magnitude 17, their mean parallax becomes 0.00045 seconds, giving a distance of 2,230 secpars, or 7,250 light-years, which strikingly confirms the present estimate, and consequently the suggested Canopic hypothesis on which it rests.

There is, to conclude, one factor not to be ignored, and which, though at first sight irrelevant, yet, if established, should be decisive on the question of visible galactic distances, and that is the date of Creation. If the true interpretation of the period named in the inspired account (Genesis i) be six literal days—for which the Hebrew evidence seems strong—and if, again (though the evidence is not so definite), these days apply to the

(*Concluded on page 394.*)

[5]Other stars, such as Nos. 1, 14, and 15, might further be omitted: such exclusion, however, is scarcely warranted in view of the uncertainties of small P.M.'s, while their exclusion effects no appreciable change in the resultant quantities.

[6] The two stars of known P.M. in this region, δ Pictoris (4.8 magnitude) and G Carinae (4.4 magnitude), have nearly equal and parallel motions (counter-clockwise), which implies a common drift and considering too their brightness, and being only two in number, they supply no real criterion.

[7] The galactic meridian of Canopus bisects the remarkable assemblage of helium stars in a belt 10 degrees wide between 200 degrees and 260 degrees in galongitude, and comprising about a quarter of the present count for the whole sky.

[8] This pole seems to give the simplest representation of the truth, being the mean of Newcomb's reductions: Newcomb's pole for the main stream alone lies in α192 degrees 0.8 minutes, δ+27 degrees 0.2, the deviation of which, however, from that adopted here leaves the mean southward dip unaffected.

[9] This would seem to dispose of Prof. See's exceptional estimate of a million light-years galactic distance, based on the assumption that the galactic stars are type *B* of nearly one thousand "sun-power."

Chemical Gardens

Some Pleasing Experiments That Are Easily Performed

By S. Leonard Bastin

It is very easy to secure some attractive growths of the silicates of certain minerals. In this way pretty chemical gardens may be formed, and these are always very interesting. For the purpose it will be needful to get a glass vessel which is not less than three inches deep. Actually a globe similar to those which are employed for the keeping of goldfish would be suitable, or even a glass jam jar might be used. We shall need as well a few lumps of sulphate of copper and some pieces of aluminium and iron. It is also needful to get some sodium silicate. This is widely sold under the name of water glass, in which form it is used for preserving eggs. A solution of the sodium silicate must be formed by adding one part of the substance to three parts of water. The actual amount of the mixture will naturally depend upon the capacity of the vessel in which the garden is formed; find out how much this holds, and then allow sufficient of the solution to fill the receptacle to about three quarters of its extent.

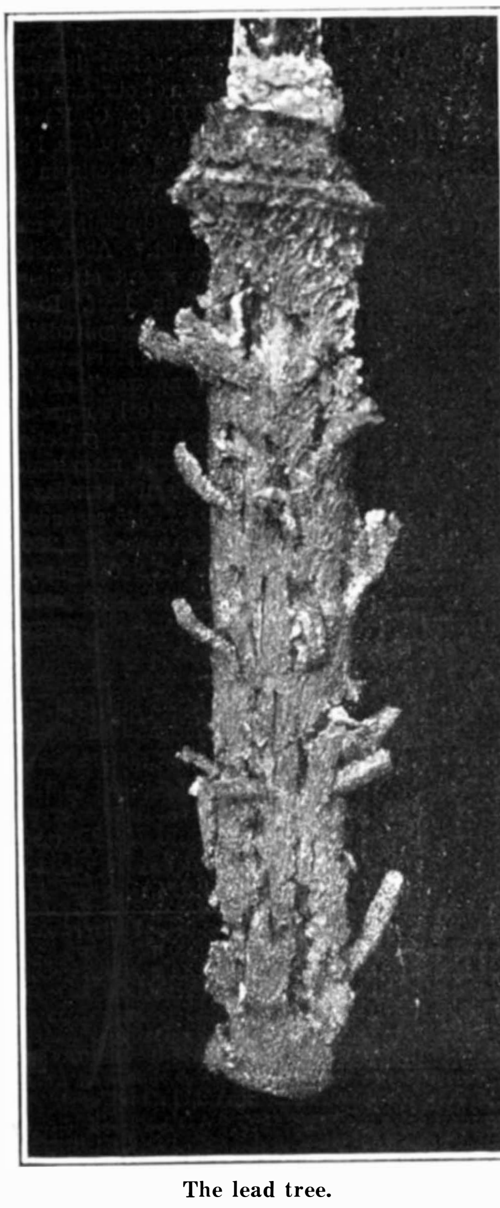
Place the water glass solution on one side and start to prepare the chemical garden. See that the glass vessel is quite clean, and then in the bottom arrange sand to the depth of about an inch. Now take pieces of the sulphate of copper and other minerals and spread these well mixed over the surface of the sand. When a sufficient quantity of the substances are in position the water glass solution may be poured over the whole. The glass vessel with its contents should now be removed to some position where it will not be disturbed.

After three or four days the chemical garden will be seen to have started its growth. Much will depend upon temperature, for all kinds of chemical action proceed more rapidly under warm conditions. Probably in about a week the growth of the silicates will be complete. These will take the form of attractive and often fantastic developments, colored brightly in shades of red, blue, green, yellow and brown. No two of the formations are alike, and as a whole they go to form a garden of singular beauty. The chemical garden can be rendered permanent by washing away the glass solution. But this process must be carried out with great care, seeing that the growths are in many cases very fragile. The best plan is to stand the glass vessel in some position where the overflow can escape and then start to pour in water very gently. It is a good idea to let the stream flow down a strip of wood. When the liquid in the globe appears to be quite clear, the water glass may be considered to have been washed away. Then the colors of the silicates will stand up with startling vividness. The chemical garden will last for an indefinite period if it is not shaken about.

The materials required for producing chemical gardens.

A pretty chemical garden, which when prepared may be suspended with a light behind, i. e., in front of a window or some artificial illuminant, can be prepared on the following lines. Fill a jar with a cold saturated solution of Glauber's salt. By means of a piece of thread suspend a haricot bean in the solution. In a short while it will be seen that the most beautiful crystals start to radiate from the bean until finally the effect is that of a sea urchin. A stone, or any nonporous substance, does not attract the crystals. The explanation of this is probably due to the fact that the bean absorbs the moisture but not the salts. In this way a saturated solution of the salts gathers round the bean and the crystals as they form attach themselves to the object. Very pretty growths will also result if portions of coke are suspended in a hot alum solution. The mixture should be nearly saturated, and the coke should be suspended for about twenty-four hours. It is understood that the solution need only be hot at the start. If colored growths are desired, boil with the alum and water a penny dye of the desired shade.

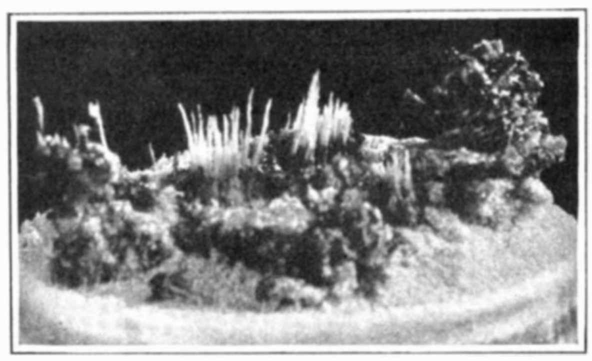
An interesting form of the chemical garden is the making of a lead tree. The preparation of this calls for the use of highly poisonous substances, and care must be exercised. In the first place, dissolve lead acetate in water, adding a few drops of nitric acid, and then suspend a zinc rod in the solution. The precipitation of the lead takes the form of large and pretty sheets. The process goes forward until the solution is exhausted. It is interesting to remember that the action is electro-chemical. Actually the first pieces of lead precipitated are combined with the zinc, forming a voltaic arrangement powerful enough to decompose the salts.



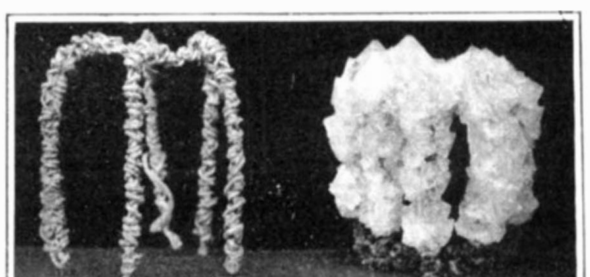
The lead tree.

Danger in Shaking Hands

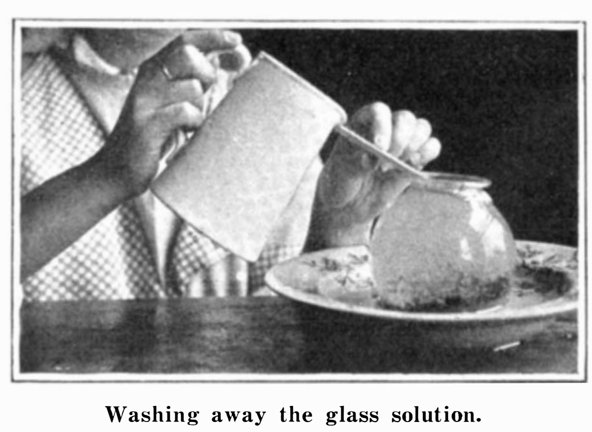
That there is danger of infection from shaking hands is recognized by the medical profession, and to some extent by the public. In China people do not shake hands with each other, but perform the ceremony by shaking hands with themselves, and undoubtedly this custom arose from hygienic reasons. What is not realized, however, is that it is not the mere contact of the hand that is dangerous, but the finger nail deposits. The finger nail offers a place where all sorts of mater collect, and a slight scratch by the nail transfers any infectious matter most effectually. Moreover, this is not confined to people of careless personal habits, for it has been found that the usual toilet operations with soap, hot water and clean towels do not remove the dangerous matter, according to a writer in *The Journal of the American Medical Association*, even when accompanied by a vigorous application of a nail brush. The only safeguard seems the trimming of the nails to the quick, which most people object to.



Elaborate formation of colored crystals.



One style of wire frame for the deposition of crystals, and a specimen of alum crystals formed on it.



Washing away the glass solution.

Synchronous Gearing

Mechanisms of Essential Importance in the Printing Telegraph

Mechanical synchronism is a never failing subject of interest. It is so desirable in many instances, and seems theoretically easy, yet in practice is difficult of attainment. The solution of the problem is of especial importance for some forms of telegraphy, as for printing telegraphs, some systems of multiplex telegraphy with one wire, and for the telegraphic transmission of photographs.

An interesting article on the question of synchronous gearing by a writer named Hans Bourquin appeared in a late number of the German journal *Prometheus*. In discussing the subject, the author says:

"The current impulses sent by the keys of the Hughes printing-telegraph are qualitatively and quantitatively alike, so that there would seem to be no reason why one time an *A* and at another a *B* should be printed on the receiving strip of paper. It is evident that to attain this result the current impulse of the receiver must be so controlled that it can only impress on the paper the type intended by the sender. In the same way, when an element of a picture is to be transmitted the essential matter is that this element be directed to the proper spot. Consequently, synchronism is as important for apparatus with rotating cylinders as for the type-wheels of the sender and receiver of a Hughes telegraph. In a more popular sense anyone who wishes his watch to keep standard time demands synchronism with the standard clock.

"Synchronism may be attained in a relatively simple way if the two gears run together by controlled motion, as for instance, in electrically controlled clocks. There are three main types of such clocks. In one the

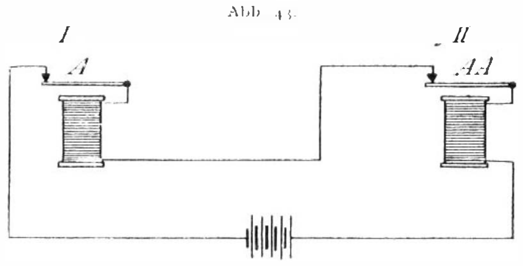


Fig. 1.—Siemens system circuit breakers.

controlling clock sends to the other a current impulse every minute or so; the current causes the attraction of an armature, and this movement advances the hands. When the current is interrupted the armature is returned to the position of rest by a spring. Should currents of alternating direction be employed the armature can be made to oscillate without the aid of a spring, if a polarized plant is used. Or a rotary armature can be employed which transmits its movement to the hands by means of a driving gear. Such synchronistic apparatus, however, are not satisfactory beyond a certain point, for they are suitable only for wheelworks with a relatively slow movement."

Anyone who has experimented with Wheatstone's dial telegraph will have noticed how quickly the two pointers are out of accord should one begin to rotate suddenly.

Siemens, in his old dial telegraph, used a method with two automatic circuit-breakers. It is seen from Fig. 1 that the two armatures *A* and *A A* must oscillate simultaneously, and can therefore be used to drive two pointers, the movement of which is an aid to synchronism. To attain this both armatures must be attracted simultaneously, whereby the current is broken at two points. If one of the armatures were to return to the starting position before the other the renewed attraction of both could only occur when the second reached the contact. A close agreement in the inertia of both armatures must naturally be presupposed for the carrying out of a movement which only runs smoothly when the velocity of rotation is slight.

The later form of the synchronous apparatus is much more efficient, but also far more complicated. In this both stations have their own driving mechanism, which can be regulated as desired, and there are special testing devices to determine the degree of synchronism attained, and methods of regulation and correction, although all synchronous apparatus does not contain every one of these devices.

Bakewell used an interesting method in his copying-telegraph to determine whether the receiver was running at the right speed. A straight line was transmitted by the copying-telegraph, and the form given this guide-line by transmission showed whether the apparatus was working too rapidly or too slowly. In the Hughes apparatus any desired key is held down for a time. If letters appear at the other station, which advance in alphabetic succession, it is then evident that the receiver is working too rapidly—and the reverse.

Prof. Korn has equipped the driving motors of his telegraph for transmitting photographs with two collector-rings from which an alternating current is taken and led to a Hartman and Braun's frequency-meter, which will show deficits of agreement of 0.25 per cent.

In Rowland's telegraph station *I* sends current impulses to station *II* that generate a tone in a telephone, the pitch of which is proportional to the velocity of the wheelwork at *I*. The wheelwork of *II* also acts upon the telephone in the same way. The ear can thus measure by the oscillations how far the two machines are out of tune. Synchronism can be regulated and maintained either mechanically or electrically. A well-known example of the first kind is Siemens and Halske's brake and governing device for the Hughes apparatus, shown

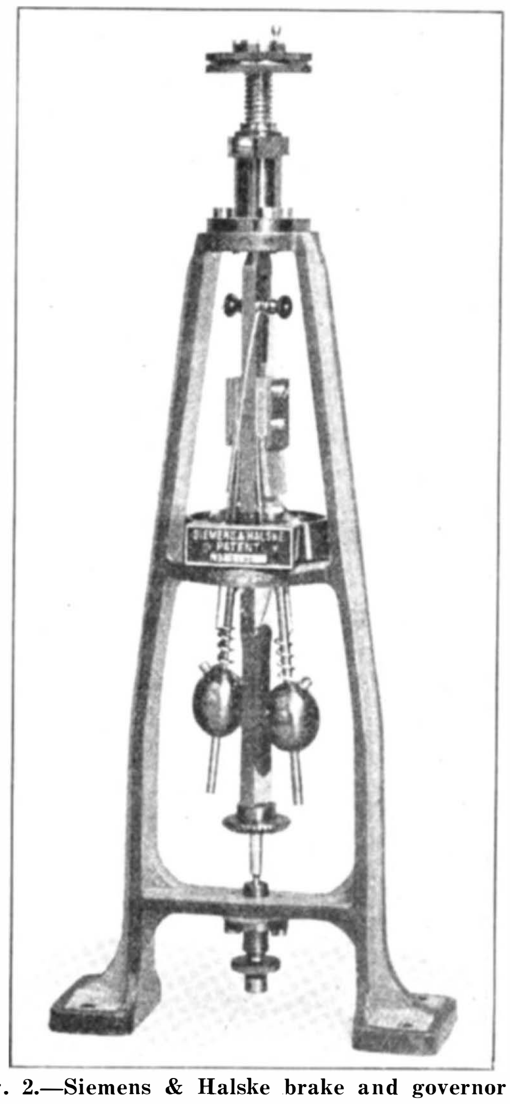


Fig. 2.—Siemens & Halske brake and governor for the Hughes apparatus.

in Fig. 2. The balls of the governor rotating in known manner press brake-blocks more or less firmly against the inner wall of the brake-ring shown half way up the device. In this way a check is put on the movement of the vertical axle that has a connection by means of a driving gear (below) with the axle of the flywheel. The balls are raised or lowered by means of an adjusting-screw seen above. In the first case, the uniform running of the wheelwork has a reduced velocity of rotation, in the latter, a greater velocity of rotation.

In his multiplex telegraph Meyer has arranged a rod hanging above in a universal joint; a heavy weight slides up and down on it, and the lower end is carried around in a circle by gears. Increasing velocity of rotation causes the diameter of the circle to become greater, whereby the gear of the wheels is increased, and this leads to stoppage.

When the gears are driven electrically they can be regulated by changing a resistance in the circuit, as is the case in the apparatus of Korn and Rowland. In Rowland's apparatus synchronism, when once gained, is maintained in an original manner. The current from *I* that causes the telephone in *II* to sound flows through a small motor in *II*, which it should rotate with a velocity proportional to that of the gears of *I*. This motor, though, is also rotated by the gears of station *II* and at a rate corresponding to that of this gearing. If, therefore, the gears of *II* are running too slowly its movement will lag behind that which the current from *I* endeavors to give it. The motor upon this increases speed, and thus increases the movement of wheelwork *II*. If, on the other hand, the velocity is too great the motor runs as a dynamo, thus consuming force.

The more exact regulation and maintenance of synchronism in the Siemens rapid telegraph just mentioned is effected by the auxiliary motor *h* and the resistance regulator *p* under the influence of the regulating relay *R R I I*.

"If a Neef hammer-interrupter," continues the author in discussing the subject further, "is arranged in which the prong of a tuning-fork oscillates as armature, there will be obtained only intervals or current impulses, absolutely regularly spaced, corresponding in number to the pitch of tone of the tuning-fork. If these currents are passed through the coil of an electro-magnet, before the one pole of which a toothed wheel can rotate in such manner that the teeth in rotation become armatures for the magnet, then this wheel acquires an absolutely uniform movement. This is the principle of La Cour's 'phonic wheel.' If two stations are equipped with such wheelworks, these would run synchronously were it possible to bring the two tuning-forks to exactly the same tone. Belany has provided his multiplex-telegraph with special correcting devices, because he does not consider that tuning-forks are a guarantee for absolute synchronism.

"Not all systems that make use of such an auxiliary maintain a special current for correcting devices. The

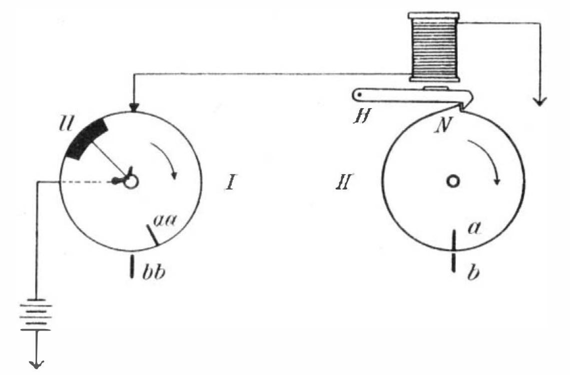


Fig. 3.—Arlincourt's system.

Hughes apparatus, for instance, does not make use of a special current. In this apparatus as each character is formed a 'correcting cam' engages in a corresponding cavity of a 'correcting-wheel.' If the type-wheel stands exactly true the cam moves freely. If, however, the type-wheel in its course toward the sliding-contact lags somewhat, the cam strikes against the downward hanging flank of the tooth grazing the space above and pushes the correcting-wheel, and also the type-wheel, somewhat forward—and the reverse."

Arlincourt's is an example of the systems maintaining a special correcting current. Arlincourt's system, which has also been used by Prof. Korn, is distinguished by the simplicity of genius. In this the movement of the controlled wheel *II* is so adjusted that it runs somewhat faster than *I*. in the position shown in Fig. 3 *II* has just completed a rotation, as shown at *a* and *b*. At this moment it is arrested by the lever *H* by means of the hook *N*. In the meantime *I* has not yet finished its rotations as shown at *aa* and *bb*. As soon, however, as this takes place, a contact is formed at the segment *U* that causes the flowing of a current which raises the lever *H*, in order to release *II*. Presupposing that the movements of the gears are uniform, there is more certainty of attaining actual synchronism, the smaller the angle between *aa* and *bb*.

The arrangement would be much more difficult if *II* were to run more slowly than *I* and if *I* ought to retain the lead. In this case strengthening impulses must be conveyed to *II*. Meyer's multiplex telegraph was based on this principle, but its complicated correcting device never worked satisfactorily.

Cement Trade in Ecuador

The statement has been published that before the war three fifths of the cement imported into Ecuador came from Germany. On account of large public works since undertaken the demand has largely increased, and the greater portion of the business now goes to England on account of the superior quality of the barrels used for packing, which greatly decreases the losses in transit.

The Mechanism of a Dream*

Operations of the Mind When Volition Is In a State of Suspense

By John Bassett Chapin, M.D., LL. D.

A DREAM is defined as "a train of thought or an image passing through the mind in sleep." The limitations and acceptance of this definition will exclude those mental states classed as fantasies, phantoms, reveries, ecstatic conditions, which occur during waking hours; also the trance state, illusions of the senses induced by drugs or intoxicants, and the disordered delusional mental states of the insane. Dreams may be said to be a common and universal experience, although there is a record by name of two persons who are said to have been exempt, yet it is probable or even possible *they* were such sound sleepers the dreams, if any were framed, were not remembered or recalled.

The Old Testament scriptures make 120 allusions to dreams and dreamers. Dreams at an early period were often regarded as the harbingers of coming events. They were accepted as a direct message from God. The soothsayer was sought to interpret their true meaning. The interpretation was sometimes the cause of wars and affected and changed the course of nations and individuals.

In the New Testament scriptures there are few references to dreams, if we except the revelations of holy and inspired men.

Whether the translators of the sacred scriptures used the words "dreams and dreamers" in the sense and with the limitations of modern usage does not appear, but they often assigned to them a higher than human significance and may have ascribed to God the power of causing "His ministering spirits to communicate to man His purposes through these means."

The dreams of scripture, those thoughts from the visions of the night, when deep sleep came upon men, were associated with the mission of an angel, or immediate communion with the Deity, for He has said that He would "speak to His prophets in a dream," an instance of which is the fulfillment of the Annunciation. Again, it is said: "The voice of God came in a dream;" "The angel of God came in a dream." These are recorded as instances of the direct transmission of the Divine Will.

Shakespeare makes 249 references to dreams and dreamers, and from his resourceful insight of human feelings and actions, tells us of the stuff that dreams are made of, as well as other things.

The state of sleep or repose—the opposite of the wakeful state—seems to be a provision for the restoration or recuperation of exhausted energy in the animal and vegetable kngdoms. In the human species during sleep there is a suspension of the faculty of volition while other functions not under control of the will are performed, as respiration, the heart, and other vital functions. During waking hours our thoughts and actions move along in channels controlled by the will, and their frequent repetition form what we call "habit." The will dominates the course and current of our ideas. By its supreme power the will—the faculty of attention—is applied to any subject that may present and enables us to form conclusions or judgments which the will may put in execution.

It has been said: "All men while awake are in one common world, but that each when asleep is in a world of his own."

On the other hand, who has not experienced or witnessed the weariness and exhaustion from sleeplessness in sickness or misfortune, when the hours pass slowly and the sad experiences of life pass in review and wretched thoughts have control. History informs us that Caligula, a Roman emperor, suffered and died from sleeplessness and remorse at the recollection of his cruelties. When a school class was asked by the teacher to write upon a slate what they could say of Caligula, one member wrote: "The less said of Caligula the better."

There is a certain mental preparation for sleep by an attempt to dispel all worry about the thoughts of the day that have seriously engaged the mind. The eyes are closed lest surrounding objects should by association excite new trains of thought. Those recognized principles that have been styled "laws of association" in accordance with which certain ideas or thoughts are connected together, or as a result of habit, are recalled for review. Monotonous sounds and motions—the croning of a nursery song, the breaking of waves and surf upon the shore—still and soothe the troubled mind and conduce to quiet and sleep. In the dream state the laws of association are still operative, in accordance with which one thought is followed and suggested by another, and as the sight of former places and occurrences bring back to us former reminiscences, or as visits to places familiar to early years restore to our memory the well-known persons and incidents of early years, are not wholly in abeyance, but in their temporary suspension, the most incongruous conclusions are sometimes formed, even from the dissociate thoughts that ramble through the mind. In the absence or suspension of the will or volition it is not probable that any continuous process of reasoning can be carried on. The rapid operation of the mind is illustrated in a measure by dreams. "A gentleman dreamed that he had enlisted as a soldier and that he deserted, was tried by a court martial, and condemned to be shot, and was led out for execution. The guns of the platoon were fired, at which he awoke. A heavy fall in an adjoining room making a loud noise had both produced the entire dream and awakened the dreamer in such a brief period of time as could hardly be estimated."

While it is possible to conceive that God might communicate through His ministering spirits messages to man, yet at one period a prevalent conviction existed that it did occur and that dreams had an important significance in the nature of prophecy. The Romans worshiped Brizo, the goddess of dreams. On any important expedition the Greeks and Romans placed great confidence in the manifestation of dreams, and the Jews went through certain ceremonies which they called the "benefaction of a dream." The dream often foreboded some calamity about to happen. Probably, this was mainly due to a suspension of judgment, or fears overshadowed deliberation and knowledge.

Important and critical battles were fought in locations which dreams are said to have indicated where victory would be won. Two impostors, Mohammed and his imitator, Brigham Young, ascribed their revelations to dreams, and thousands of their deluded followers are living at the present day.

Prophecies have come to persons in dreams of sudden death by violence and other means, which have been realized. The stopping of a clock has to some marked the hour that a death of some near friend had occurred, and the news is awaited with anxiety. Many of such events are susceptible of psychological analysis and explanation. On the other hand, there are many more prophetic dreams that are never fulfilled and treated as of no consequence except by the superstitious. When they do occur, they are instances of remarkable coincidence rather than the fulfillment of prophecies.

In my professional experience and relations, a request was made to examine an employe of the United States mint, who was indicted, charged with a dishonest act in appropriating bullion to his personal use. The United States attorney had reason to expect that an insanity defense would be offered, and desired that he should be examined as to his mental condition. The prisoner willingly submitted and stated in explanation of his crime that an officer of the New York office, performing duties similar to the duty he performed in the Philadelphia office, received a larger compensation than he was paid. He had endeavored to ascertain by prayer what he might do to equalize his salary. He declared it was revealed to him, in answer to prayer, to appropriate any public money within his control or reach, which he had done. He said the voice was not human, but from a higher than human source. The voice was similar in tone and expression to the human voice: It was audible and clear. When I asked him whether he had not mistaken what he called the voice of God, and that it might have come from the devil, he replied that "he had not thought of that." He was duly convicted. It is doubtless true that intense and prolonged thought upon a given subject is carried into the realms of dreams and brings about some foundation for acts during the waking state that ensues.

The so-called realm of dreams is too vast to explore during a session of this association. Much, indeed, that may be stated is wholly speculative and may not be susceptible of demonstration. The phenomena of somnambulism—sometimes called "sleep walking"—may be described, but the condition may be understood as one of unconsciousness with the power of moving. Ordinarily, the power of walking in obedience to dreams does not exist, but in "sleep walking," or somnambulism, it does still exist. "Sleep walking" in a semi-conscious state may extend over a considerable period of time. A clergyman of Massachusetts disappeared and all efforts to trace him failed. Several weeks after his mysterious disappearance he was recognized by a friend who found him selling penny newspapers in Norristown, near Philadelphia. He was unable to furnish an account of his wanderings and his new vocation.

A medical student disappeared from Philadelphia and several weeks afterward was found in New York in a semi-conscious condition with dirty clothes in rags, unable to account for his movements or furnish any motive for his wandering. Both of these seemed to be in a dream state with the power of moving in accordance with the ideas or suggestions of the dream. Both were typical cases of somnambulism or sleep walking. So in the cases of talking aloud in sleep the ideas of the person are passing through the mind and the power of expressing them aloud from habit is not suspended.

In the further analysis of the subject of dream making, we must bear in mind the functions of our several senses, by means of which the mind has received sensations. The sensations have been received during life and remain stored in the brain. By analogy they are like the stored films of the photographer until recalled in some orderly association of ideas. They must prove to be intensely interesting, for in many dreams there are vivid pictures of the past and we seem to hear even the voices of dear friends who have passed beyond. These images or impressions often linger until far into the waking state. On the other hand, dissociated ideas of a dreadful character having no relation to each other by association pass through the mind in succession in the dream state. They are incongruous. Volition is suspended or does not act. Whoever has observed the insane in acute forms of insanity or in states of delirium can have some comprehension of the dream state. In some forms of mental disorder the will retains control over bodily movements, but its control over currents of thought is in a state of suspense. Ideas flow with such rapidity they cannot be or are not directed or controlled. They are accentuated in loud tones as if propelled by some physical force, while the power of the will is undiminished. Delusive ideas are also suggested in the dream state, as in the case of an invalid, who was prescribed a mustard poultice to be applied to the feet and as it warmed the extremities he had the hallucination he was walking upon the hot lava of Vesuvius. Another person who had a blister applied to the head had a dream that he was being scalped by Indians.

There is a case recorded of a young lady who was sleeping in a bed by the side of her mother, showing exceptionally that volition is not always suspended during the dream state. The mother noticed her daughter's fingers were playing over her head. In a few moments the daughter arose and went to a piano and executed a difficult piece of music, which she had been unable to execute during the waking moments. The case illustrates an exception to the general rule that volition is in a state of suspense during sleep.

The origin of dreams can often be traced in a psychoanalysis to association of ideas. The impressions of earlier years remain with us longer and account for the frequency of dreams connected with that period of life, many of which are not remembered or recalled in waking moments. Dreams are influenced by temperaments. The child is ushered into the world with a brain which has not possessed conscious intelligence, but is capable of receiving impressions through the senses. These impressions are "stored up" in the brain as "memories," and probably remain throughout life. There is a certain individuality in the way the impressions are received, so that the influence they produce differs in different persons and thus different characters and temperaments respond in different ways, else all people would be alike. The environment of different races may be understood to produce different effects, and the reaction of the savage to the customs and habits of his race would differ from that of a civilized being; and the traditions of centuries would affect the manner of receiving impressions; and the state of cultivation or brain capacity would thus show the effect of heredity. The first knowledge gained is of the simplest and leads to the exercise of those functions which tend to the preservation of life. Later, it becomes more complicated and volitional activities are developed. The primitive impressions are thus crowded into the background and from frequent

*Read before the Scientific Association of Canandaigua.

use become automatic, and are performed without arousing the conscious attention of the individual. There thus develops what has been termed a "subconscious existence," which is constantly active though without arousing the attention. It has been described by William James as a constantly flowing "current" or "stream." At times, especially during fatigue or when conscious attention is in abeyance, this subconscious stream rises to the surface. It is in large measure associated with the primal instinct of self-preservation, and is thus closely allied to the feeling of fear. In sleep the attention may be momentarily attracted by this current of thought, which enters the realm of consciousness, and so has the effect of a dream.

To summarize briefly, it may be stated that from an early period of life the mind has been a receptacle and storehouse of innumerable sensations and impressions, upon which, during our waking hours, we are constantly making drafts, forming new combinations, and judgments. Inventions do not come in dreams. They are the result of newly formed combinations of principles. No one has ever invented anything in a dream, though in the early waking moments following the refreshment that comes from sleep some problems that have absorbed our attention are attacked with a clearer mental vision. During waking hours the current of our thoughts is directed by the will, but in sleep volition is in a state of suspense, the currents of thought being mainly controlled by the laws of association, which remain in a measure active, and are recognized or remembered as dreams

I invoke the god of Morpheus to give you pleasant dreams.

Medicines Used by the Ancient Romans*

PLINY is the chief source of information regarding Roman folk medicine, but some can be picked from Cato, Livy, Tacitus and Lucian. Pliny has an occasional reference to the cure of wounds, but none to army surgery. Tacitus says the wounded warrior brought his injuries to his mother or wife to be attended to. Cato had a book of simples from which he treated his family and slaves. The foundation of simples, the principle that like cures like, was imbedded in their practice, even as it is found in Cherokee medicine.

There was a touch of magic in their mode of treatment which had drifted down from Chaldean days, and is still to be found among ourselves. George Eliot neatly terms it "the medicine given with a blessing."

Folk medicine of the Romans was a proposition as separate and distinct from the practice of the Greek physicians in Rome as the negro remedies in the South are different from the usages of regular medical practice of to-day. Among some of the quaint ideas of folk medicine we find the following:

The dung of goats was supposed to expel the stone, as was also the ashes of the hair; the roasted flesh was used for falling sickness, the roasted liver for dimness of sight, the eyes being held over the steam. Mixed with honey the liver was given for dropsy, and with bran was used for dysentery.

For gout in the left hand the tooth of a field mouse killed in a manner prescribed was taken and was stitched to the skin of a freshly slain lion; the skin was then bound around the left leg, when the pain was supposed to cease. A bronze statue in the garden was extolled for tertian ague, and a bronze statue of Hippocrates would cure as Hippocrates did in life. A charm with the mighty name of Solomon would drive off tertian fever. The liver of a hedge hog roasted and eaten, the grease rubbed on the eyes, followed by an application of asses' dung, was claimed to cure the night blindness. An application of crabs' eyes was used for swollen eyes.

Augustus was said to have been cured of sciatica by a sound thrashing with a stick. A ring of myrtle wood that had never been touched by iron was said to be a specific for swelling of the groin. Onions and goose grease were recommended for deafness. Four seeds of heliotrophum were said to cure quartian fever, three to cure tertian. Dittander attached to the arm on the suffering side was used for toothache. Root of parsley was worn around the neck for affections of the uvula.

Another "cure" for tertian fever was as follows: "Take three grains of coriander or parthenium, hold in the left hand, mention who it is for, and look not back."

Hoarhound and stale axle grease was claimed to cure the bite of a dog, and the juice of mallow taken daily was said to prevent all diseases. Erynga boiled with a frog was used as an antidote for aconite and other poisons. Nettle leaves beaten with bear's grease were used as a cure for gout and nine grains of barley held in the left hand and traced three times around a boil and then thrown in the fire was said to give immediate relief. To "cure" scrofula, the following procedure was recommended: "Trace a circle around a quince root, pull it with the left hand, state for what and for whom, pull and wear as a charm." The calyx of blossom of pomegranate plucked with thumb and fourth finger, rubbed on the eyes and swallowed without touching the teeth was supposed to prevent maladies of the eyes for a year.

Scrofulous sores were treated as follows: "Bite off a knot from a fig tree without being seen by any one, then wear it in a leather bag suspended by a string around the neck." A sprig of myrtle that had touched neither the ground nor iron, worn on the person, was said to prevent ulceration of the glands, while a sprig of poplar held in the hand was used to prevent chafing.

Red pimples were treated by scourging with a branch of elder. Tamarisk sprigs if not allowed to touch earth or iron were supposed to allay pain in the bowels.

A smilax sprig of an even number of leaves was used for headache. Jaundice was treated with madder worn as an amulet and looked at now and then. Wild madder was supposed to prevent hydrophobia, and the person bitten needed only to look at the plant and the flow of corruption from the wound will be staunched at once.

Tongue grass was supposedly efficacious for tumors if beaten with stale axle grease and if the patient spit three times on the right side. It acted better if rubbed on by three persons of three nations.

Nine joints of *Triticum repens* gathered fasting wrapped in greasy black wool and taken to the patient when he was absent was recommended for tumors. Epilepsy was "cured" by eating part of a wild beast killed with a weapon that had slain a man.

Human ear wax was used to cure human bite, and powdered human tooth for snake bite. The first hair cut from an infant's head attached to the limbs was supposed to relieve gout. A circle was traced around an ulcer with a human bone to prevent spreading. Elephant's blood was used for consumption; the liver for epilepsy. Crocodile hearts wrapped in black wool were worn for quartian fever. Two bugs wrapped in stolen wool was extolled as a cure for nocturnal fever, while when wrapped in russet colored cloth was used for day fever.

Pliny had much to say about drugs, things wise and otherwise. He tells us verdigris can be obtained by sprinkling vinegar on copper filings and stirring until dissolved; also that it is used as an ingredient in plasters for wounds and in cerate as a detergent upon ulcers. Sulphur was used as a fumigator to purify houses.

Elaterium or wild cucumber was used as a purgative; colocynth as a violent purgative; elecampane was recommended for cough.

Squills, he found, was a remedy for twenty-three maladies, especially used as a diuretic, and for dropsy. Vinegar of squills was made by maceration in a stone jar, kept many days next to a tile roof. A large dose of it would make one appear as though dead.

Milk curdled with sour milk was deemed wholesome for the stomach, thus anticipating Metchnikoff. Madder was found insoluble in water, but soluble in oil.

Strychnos was considered more poisonous than opium. Glycyrrhiza juice was said to be good for the voice, and for the chest and liver. Anthemus was recommended for flatulency. Castor oil was extolled as a purgative.

Expressed oil of almond was said to efface wrinkles from the skin and to improve the complexion. Gall nuts were serviceable for affections of the gums and uvula; storax for cough; juniper as a diuretic; groom seed for strangury.

Of hyoscyamus, it was said that more than four leaves were deleterious to the mind and that its use as a medicine was highly dangerous. The seed of conium was known to be poisonous, the seed resembled anise, but was more substantial; the leaves were said to have soothing effect on all kinds of pains and tumors.

Pliny reported twenty-nine preparations from marrubium for cough; thirty from wool grease. Nero boiled water, enclosed it in glass vessels and cooled it with snow. Danger was avoided in deep wells by letting down a lamp, and observing if the lamp be extinguished. Mud of mineral springs was used externally.

Hollow balls of wax or sealed jars let down in nets into the sea, were found filled with fresh water when drawn up; sea water was made fresh by filtering through argillaceous earth.

Fish oil was used to keep off flies; gourds were used for cupping; mercury was obtained by distillation. The druggists were charged with buying their plasters and eye salves ready made, and that to the detriment of the public.

Pliny discoursed on pennyroyal, anise, saffron, dog's tongue, wormwood, dill, fennel, cumin, rue, parsley, savin, myrrh, acacia, elecampane, melissa, catnip, lovage, althæa, symphetum, betony, chelidonium, asarum and galbanum.

Mustard was recommended as a rubefacient, and as a blister; linseed meal with figs was used to ripen abscesses; forests of pine and hemlock were known to be beneficial to patients suffering from phthisis; to breathe such air was more beneficial than a voyage to Egypt. Tar ointment cured itch, as did crude petroleum.

*By J. T. Llewellyn in *Druggists Circular*.

Baking Paint on Steel Cars

AFTER making a large number of tests on small steel panels, it was decided by the Pennsylvania Railroad in 1912 to build an oven sufficiently large to bake the paint on an entire car, and this first oven was completed in January, 1913.

The oven has been in continuous service since it was built, the only changes made being the introduction of additional radiators and a heat control device. This can be set to automatically control the flow of steam to the radiating coils and thus give any desired temperature which the painter may wish to obtain. The oven is 15 feet high, 13 feet wide, both clearance measurements, and 93 feet 3 inches long. It is lined with a ⅛-inch steel shell. This is insulated with magnesia lagging 3 inches thick, the insulation being held in place by an outer jacket of galvanized iron. The doors are insulated with the same kind of lagging which is held in position by steel plates on the outer and inner sides. The arrangement of the steam coils makes it possible to obtain any desired temperature up to 275 deg. The oven is equipped with ventilators on the sides at the bottom for the admission of air, and also with four ventilators in the roof, which may be opened or closed, as desired. The ventilators provide for the introduction of the fresh air required in drying the various paint coats, and also allow the volatile portion of the coats used, the turpentine for example, to escape through the roof.

The process of painting a car is as follows: The car is first painted inside and out with a priming coat. This is baked for about three hours at 250 deg. Fahr. The primer is designed to obtain a product which will adhere firmly to the metal and serve as a protective coating, which will prevent the steel from rusting, and will also serve as a foundation on which to build the remainder of the constituents entering into the surface coating. This is followed by necessary glazing and putty to fill all deep depressions and indentations in the steel used. A number of surface coatings are then applied, the number varying from one to perhaps four, depending on whether the steel used is rough or relatively smooth. Each coat of material applied is baked. The car is then rubbed with emery cloth and oil for the purpose of securing a smooth, flat surface. The various colors desired on the car are then applied. Two coats of these are required and each coating of color is also baked. The car then receives the necessary striping, etc., after which it receives two or three coats of high grade baking finishing varnish. After the varnish on the inside of the car has been rubbed, the car is ready for service.

When the first oven was built, it was hoped that the following advantages would be realized: A durability at least double that obtained by the air dry process; longer retaining of newly painted appearance; obviation of cracks in the varnish; easier keeping clean of the outside of the car; reduction in the time of keeping a car in the shop for painting from about 16 days to from 5 to 7 days; and the reduction of the number of cars in the shop at any one time to about one-half the previous number. The baking system has now been in use almost three years, insofar as one oven could do the work, and the objects hoped for have been attained. Two additional ovens are now being provided for, and it is probable that as soon as they have been put in service a still further extension of the system will be made.—*Railway Age Gazette.*

Power From Tidal Currents in the Bay of Fundy

PLANS for the utilization of the tidal currents in the Bay of Fundy are now being studied. This bay is about 150 miles long, and for a large portion of this length it is about 40 miles wide. The tide rises 50 feet at the head of the bay, and in the main body from 28 to 30 feet. In the middle of the bay the current flow is from one to two knots, and in the Digby Gut, on the Nova Scotia coast, it rises to four knots; but in the Minas Channel a rate of from eight to ten knots exists, and it is here that it is proposed to establish a power station. This location is also desirable, as the possibilities of disposing of power in this neighborhood are especially good. Special motors will have to be devised for this use of the tidal current; and probably some system of storage reservoirs will also have to be provided to cover periods of the day when there is no tidal flow.

A trench in France with several inches of water and mud, showing neat wooden foot paths laid along the bottom.

Winter in the Trenches

Disheartening Conditions for the Fighting Men in France

The first winter of the war in France and Belgium was particularly cold, and the troops on both sides suffered severely from frost, ice and snow; but while the second winter has not been so rigorous in temperature, the conditions were more discouraging, as a cold, penetrating rain fell almost continuously, and this in itself not only chilled the men almost as much as the snows of the previous year, but filled the trenches with water and mud that proved a sore trial to every one.

The entire army does not remain permanently in the trenches, but serves in turn in sections to hold the advance lines; but as there are frequently over sixty miles of trenches of the various kinds to a single division, including several lines of fighting trenches, together with communicating trenches, it is evident that a large number of men are constantly required to live in these water-soaked, miry burrows, where anything like adequate drainage is frequently impossible. The difficulties of draining can be appreciated when it is realized that some of the trenches are thirty feet deep, and, where such is the case, the only resource is to either pump or bail the water out with buckets. One of the accompanying illustrations shows this latter process, and one of the methods adopted in a German trench. The bucket is suspended from a little trolley that rides on a wire stretched from the bottom of the trench to a rude mast, and when it has been pulled up to a sufficient height by the man below, a second operator on a platform above the trench transfers the full bucket to another trolley running on a wire that will convey the bucket away to some drainage point where the water cannot find its way back into the trench. It is slow and tedious work where thousands of gallons must be disposed of, and at times must be kept up continuously for long periods.

Even under the most favorable conditions the trenches could not be made perfectly dry, and several inches of slimy mud and water was always present. To ameliorate conditions as much as possible in such cases, wooden gratings of various kinds are laid in the trenches to form foot paths and dry standing places for the defenders. In one of the illustrations will be seen the neat paths built up with timbers and battens, while in another view, supposed to show some of the flooded defenses along the River Meuse, hurdles made of interwoven branches serve the same purpose. In the latter picture one of the means for retaining the banks of earth and soft sand is shown, and the same methods are resorted to where the entrenchments are dug below the surface.

So extensive and complicated is the system of trenches in some regions that the men have named them, like the streets in a city, to enable one to find his way about; and in a sketch made at the front, which recently appeared, is seen a sign "Boyan Du Nord," that fitly describes the condition of the passage, and illustrates the humor of its defenders.

The Proposed German Nitrogen Monopoly

The German proposal for a State nitrogen monopoly, which has attracted so much attention both in Germany and in the nitrogen-producing countries, is being opposed by a number of German industrial concerns and institutions. The Union of German Manure Manufacturers have forwarded a communication to the authorities, in the interests of the German super-phosphate industry, in which they give expression to the opinion that the new German nitrogen works, which are designed for the use of coal, must entail a greater cost than the Norwegian factories where water power is used. This will mean a higher price of the product to the German consumer. On principle they also object to a monopoly arrangement. So does the Chamber of Commerce of Frankfort-on-the-Main, which also points out that higher nitrogen prices will weaken the competitive power of the German chemical industry, which, at the conclusion of the war, will have to exert itself to regain its markets abroad. The problem is altogether a difficult and complicated one, the solution of which it might be better to leave for quieter times. The matter is being brought forward as an emergency measure, but the Frankfort Chamber of Commerce cannot find that this emergency exists. During the war the monopoly would be of no effect. The installations are either ready or are approaching completion, and it is impossible to gather what effect the monopoly will have upon the German nitrogen supply. The large Baden Anilin and Soda concern recently made a comprehensive statement, in which it opposed the nitrogen trading monopoly, at the same time giving some interesting information about its own nitrogen industry, which, it would seem, has not before been disclosed. The company, in the year 1913, commenced working a large factory in Oppan by Ludwigshafen for the synthetic production of ammonia from its elements. The results of this first installation, calculated to produce some 35,000 tons of sulphate of ammonia per annum, were so favorable that in the same year it was decided to increase the capacity to fourfold. The production will shortly reach 150,000 tons of sulphate of ammonia per annum. In the meantime the war has given rise to further extensions, after the completion of which, next year, the production should amount to 300,000 tons of sulphate of ammonia per annum. Although this quantity represents more than half the total of Germany's imports from abroad, this does not, of course, represent the limit of what the company could produce. The home supply of raw material is unlimited, and the company's power of extending its production is, consequently, also unlimited and entirely independent of foreign countries. The only limit is the capacity for consumption of the world's markets. The company is a decided opponent of any kind of monopoly because it is not in need of the protection it might offer, and feels sure of being able to meet any rival in free and open competition. Gas works are also naturally opposed to a monopoly. They must extract the ammonia from their gas, because otherwise it would be very impure, and for this and other reasons they are interested in the production of ammonia. The ammonia from coke-ovens and gas works, as well as the production of the Baden Company, will therefore be available for the country, whether there is a monopoly or not. The monopoly can but serve one purpose, viz., the wholesale production of that kind of manure for which the agriculturists have the smallest liking, viz., lime and nitrogen compounds. The Baden Company sums up its opinion of the monopoly as follows: Either the monopoly will guarantee the lime-nitrogen industry paying its way or the monopoly will fix its price according to those ruling on the international market, in which case the object of the monopoly, to afford a guarantee for the lime-nitrogen industry paying its way, will become entirely illusionary.—*Engineering.*

Phosphorescent Calcium Sulphide

The property possessed by impure calcium sulphide of emitting light in the dark after having been exposed to a bright light was discovered by Canton in 1761. His preparation of "phosphorus" was obtained by heating crushed oyster shells and sulphur together and exposing the fused mass to sunlight. The phosphorescence is not the result of a slow process of oxidation, for it has been shown to be produced by a specimen of the material which had been sealed up in a glass tube for over a century. Later investigation showed that perfectly pure calcium sulphide does not phosphoresce, but that the presence of traces of salts is necessary to produce the phenomenon.—*Knowledge.*

Flooded trenches near the Meuse. Along the outer embankments hurdle platforms have been built of small branches.

Electric Truck Troubles*

Early Experiences of Manufacturers, and How They Have Been Overcome

By F. E. Whitney

In considering the subject assigned to me, the question has arisen in my mind as to whether the thought in the minds of the Papers Committee was to bring out the troubles encountered by numerous designers and manufacturers in arriving at the present state of development of the industry, or whether this topic should be considered solely from the point of view of a purchaser of electric vehicles to-day and attempt to cover the means used by the men having in charge the operation of these vehicles in keeping them in daily service.

The development of the electric vehicle from crude, clumsy, expensive machines to the present efficient, durable and economical production has been marked by continued, steady and rational progress with little of the spectacular, but the continued indication that this type of power-driven vehicle is ultimately destined to replace horses for city transportation.

As in every line of mechanical development, troubles have been encountered, and while some have given designers and engineers considerable concern for the time being, they have, nevertheless, been met and overcome, with the result that the electric vehicle as produced to-day by a number of well-known manufacturers, is a highly developed mechanism, capable of doing hard work under severe conditions and, if properly applied, effecting for the user considerable economy in the transportation of his merchandise as compared with any other type of vehicle, either horse-drawn or power-driven.

In view of my association with the fraternity of manufacturers, it would hardly seem appropriate to bring to light too many of our family skeletons, and in view of the honest differences of opinion held by designers as to the merits or demerits of various types of construction, I feel that an attempt to draw too close a comparison would be getting me on to rather dangerous ground

There are, however, a number of the items in the general development of electric vehicles which have enabled all of the manufacturers to benefit and produce a better article, which will be of interest, and in order to do this, I will attempt to bring out points in connection with the elements that go to make up the complete vehicle—namely—batteries, tires, motors, controllers, wiring, wheels, springs, bearings, etc., where troubles have been met and improvements made, enabling the manufacturer to reduce the weight, increase mileage range, reduce power consumption and reduce maintenance cost.

Batteries.—The one item in the makeup of an electric vehicle which raises a question in the minds of the uninitiated is the question of the care and upkeep cost of the battery, as well as the question of whether or not the truck will be stranded, out of power while on an important mission. This question in the minds of the public is the result of difficulties experienced by the small user principally, in the care of his vehicle, due to lack of expert knowledge and to frailty on the part of the battery,

There has also been difficulty due to lack of standardization, in that an owner having batteries of different makes has found it necessary to use different sizes and shapes of battery jars for batteries having the same number of plates and rated capacity. These difficulties have largely been overcome by radical improvements in the general make-up of the battery, and I understand that real progress has been made towards standardization of battery jars that will greatly reduce the number of sizes and simplify the problem for the repair man. At the present time a number of manufacturers of lead acid batteries will guarantee to the user that it will not be necessary to dismantle his battery until the plates are exhausted, and assuring a sufficient life of the plates to make the battery cost well within reasonable limits.

Improvements have also been made in the nickel-alkali battery, so that to-day a user can easily select a battery suited to his needs and be able to secure reasonable service.

It should also be noted that batteries are now generally connected permanently in series instead of being split up in series parallel combinations, thus eliminating troubles arising from this practice brought about by an occasional cell being missing or an open circuit in one section of the battery causing unequal discharge and other difficulties resulting from different parts of the battery not being in a uniform state of charge.

The greatest benefit in battery development has been the reduction in weight, which has been accomplished by practically all of the battery manufacturers.

There has also been considerable development in the means to prevent sloppage of electrolyte and to enable the garage man to more easily flush the battery.

In referring to the battery, I feel that reference should be made to a plan that is meeting with popular favor, and in the opinion of the writer, will overcome the largest handicap to the satisfactory adoption of electric vehicles, namely, a form of service system whereby the user can secure from either a garage, central station, or representative of the vehicle company or battery company, an agreement to maintain his battery on a definite upkeep basis. From all reports this is meeting with favor wherever it has been adopted.

Ampere Hour Meters.—One of the principal difficulties a few years ago was the fact that the driver had no information as to the state of charge or discharge of his battery. Some trucks were equipped with volt and ammeters, but such delicate instruments were not dependable for truck work and practically useless.

The development of the ampere hour meter has been one of the biggest single items of benefit to the electric vehicle user, as it is reasonably dependable and furnishes the driver with sufficient information to enable him to get maximum work out of his vehicle. It is also of great assistance to the garage man in charging the battery.

Tires.—A few years since whenever an owner wished to change from one make of tire to another it was necessary to have his wheels changed over to conform to the dimensions required for the particular type of tire to be used. The standard wheel dimensions, which have been adopted by the Society of Automobile Engineers, has solved this difficulty, and now any make of tire can be applied to the wheels now being furnished, resulting not only in a distinct advantage to the owner but also enabling the manufacturer to carry in stock a reasonable quantity of wheels which can be used for any make of tire.

Less than ten years ago the best guarantee on truck tires that could be secured from any tire manufacturer was a life of ninety days, whereas to-day practically all of the standard makers will guarantee tires for electric trucks for 8,000 to 10,000 miles over a period of eighteen months.

There has also been a distinct improvement in compounding the rubber used for electric vehicles, enabling us to get from 15 per cent to 25 per cent more mileage on one charge of the battery than was possible with some of the earlier makes of tires.

An instrument for checking tire efficiency is now in general use, enabling the purchaser to know approximately what he is getting before putting the tire in service and thus avoiding the difficulty of reduced mileage and increased current consumption brought about by inefficient tires.

*A paper read before the convention of the National Electric Light Association.

Motors.—The earlier motors were patterned directly from the street railway motors in use at that time, but due to the more exacting requirements on account of small gearing and closer limits required, considerable difficulty was experienced with the motors with plain bearings lubricated with grease boxes. The trouble was principally felt on gear drive trucks which were in vogue at that time. The wear of the bearings would allow the gears to separate far enough to cause rapid wear and frequent breakage, with the consequent trouble of teeth breaking off and lodging between the gears, bending shafts and doing other damage. With the adoption of ball bearings these troubles were eliminated.

I would also call attention in passing to the greatly reduced motor trouble brought about by undercutting the mica in the commutators. In some of the earlier types it was as necessary to sandpaper the commutators daily, as it was to charge the battery; the result being very short life to the commutators and brushes—to say nothing of low efficiency and high cost of upkeep. The commutators in the motors that are being produced to-day will probably outlast the truck, and the brushes usually give from two to three years' life.

Controllers.—In the earlier type of controllers in which the circuit was broken at each step, it is not surprising that all kinds of mechanical troubles were present. The advent of the continuous torque design, resulting in smooth acceleration, was a big step in advance. This has been further augmented by renewable parts, making repairs to controllers a simple job easily done by the driver and overcoming a frequent cause of tie-up and delay.

The old type step by step controller required as constant attention as the commutators, due to arcing and burning at practically every point. As referred to under the heading of "Batteries," controllers are now generally arranged to run the batteries permanently in series instead of making series parallel combinations.

Wiring.—Along with the improvement in controller design, came an improvement in the work of installing the wiring. Practically all manufacturers to-day use conduit throughout, and wiring installed in this way is practically as permanent as any other part of the vehicle, and in the rare event of wiring trouble developing, it can be easily located and readily remedied.

Wheels.—In the early days the old Sarven wheel was used, but these have been replaced by the artillery type, which is lighter, and allows the maintenance man some opportunity of tightening the hubs, which was impossible with the older type.

Bearings.—The use of ball and roller bearings has been universally adopted, making it unnecessary to remove the wheels for frequent greasing, as was the case previously, and at the same time, reducing the power required to drive the vehicle.

Springs.—Spring trouble has been practically eliminated by the adoption of alloy steel in place of the old carbon steel wagon springs, and at the same time, greatly improved by advanced methods in the art of heat-treatment which has developed rapidly within the last few years. Trouble has been further reduced by the use of eyes formed at ends of one or two top plates attached by links instead of the old flat form of construction.

Several schemes are in use to prevent shifting of plates such as ribbed ends of plates and frequent breakage of plate—centers is largely overcome by use of teats or ribs in center instead of hole and center bolt. Rebound clips are also in general use, greatly reducing breakage of top plates.

Frequent breakage of spring bolts has been eliminated by the use of hardened bolts, and a number of users are bushing the eyes of the springs, still further reducing the wear and consequent trouble.

Lights.—A small item and still one that has caused the user considerable annoyance has been the question of keeping the lights always in proper condition. This item is frequently neglected, due to the fact that the lights are used such a small percentage of the time. The old Edison base, or more properly speaking the "Medium Screw" base, has been almost universally used, but has caused trouble on account of the bulbs easily shaking out of the sockets and then rattling around and becoming broken. The usual type of socket has not been generally satisfactory for vehicle work, due to the number of parts which shake loose in service. The small bayonet base lamp, as is being generally used on gasoline pleasure cars, is coming into more general use for electrics, but in the opinion of the writer, is not the proper lamp for truck work where voltages are so much higher than is current practice on pleasure vehicles and the vibration resulting from operation on solid tires is very much more severe.

I am of opinion that a lamp using the Ediswan form of bayonet base but of a different size in general use in Europe, would be more suitable. At the present time the difficulty is that, although the lamps could readily be procured, there are no sockets of this type on the market.

Warning Signals.—Bells have been most generally used on electric trucks, but are also a small item which has been of considerable cost in keeping in proper repair.

A number of users are beginning to abandon the bell and use instead mechanical signals, which are lower in first cost and are more dependable. This has not met with general favor as there seems to be a feeling on the part of some manufacturers as well as users that the bell is a distinctive mark, so to speak, of the electric vehicle, and they apparently cling to it as a matter of tradition.

Miscellaneous Parts.—In practically all parts of the vehicle that are subjected to wear, manufacturers are now making these renewable, so that instead of the repair man being required to drill and ream worn holes and bush them, the renewable parts are driven out and readily replaced with new ones. Numerous pins, bolts, screws, etc., are being hardened and ground; alloy steel being largely used in gearing and other parts. More attention is being given to parts exposed to grit and dust to prevent its getting in and causing damage.

The general result of the various improvements has been that electric trucks as they are now on the market, with anything like reasonable attention, can be depended upon for long life at low maintenance cost.

In the early part of my paper I touched on the advantages derived from a battery service system. I feel, however, that if such a system is confined to the battery alone, the work is only partly done. The user of one or two trucks does not usually have a competent mechanic, and where electric trucks are sold to replace horses, they are usually put in the hands of teamsters or others equally lacking in technical knowledge to give the vehicle proper care.

A number of companies have been experimenting with various forms of service systems, some confining their efforts to battery maintenance or rental, while others are endeavoring to cover not only the battery maintenance but also chassis, body, tires, including painting and current as well as storage and washing, and I firmly believe that the adoption of electric trucks for general use will be brought about by the development of something of this kind.

The company with which I am connected has experimented to some extent in connection with their Maintenance Department in Philadelphia by using various helps to insure to the customer continued use of his vehicle, with results exceedingly satisfactory to the user as well as to the company.

The experiment was first tried out by furnishing to the user spare wheels and batteries on a rental basis for such a time as necessary for the user to have his parts repaired. The charge for the use of these parts has been approximately the same as the cost to the user for running his own equipment and has resulted in his getting continued service from the complete vehicle.

During the past year we have experimented still further, entering into contracts with a number of users, first to overhaul their trucks and then to maintain the truck, including furnishing current and garage service for a fixed amount per month; the charge including not only current and garaging but all work and material necessary to keep the battery up to the proper standard of capacity, making all repairs and replacements to chassis, repairs to body (including an occasional repainting of the vehicle) renewal of tires and, in fact, every item of expense with the exception of licenses, and accident and liability insurance.

In every case where this has been tried, and I might add that in several cases the user was on the fence as to whether or not to discard electric vehicles, they have become not only satisfied, but enthusiastic, and our feeling is that the experiment so far conducted will lead to the adoption of some system of this kind that will be the greatest help towards selling electric vehicles that so far has been developed.

In a great many cases there are good reasons why it is not satisfactory or feasible for the user to send his truck to a garage every night, and in order to meet this difficulty we have made some experiments with the idea of maintaining the vehicle while stored, and the battery charged on the customer's premises, and it is entirely possible that something along this line will be worked out that will entirely relieve the purchaser of any care of the vehicle other than washing the vehicle and having the driver or night-watchman posted sufficiently to insert the charging plug in the vehicle after it has completed its day's work. This, to my mind, will eliminate practically all of the objections which are offered at the present time against the operation of electric vehicles, as by this method care of the battery and parts of the vehicle will be in hands of experts.

In order to handle a plan of this kind satisfactorily, it will be necessary for either the central station, the manufacturer, the battery company or some combination of the three, or better still an entirely disinterested party, to enter into a contract with the central station to purchase current at proper prices. He will, on account of the quantity of work done, be able to secure his battery renewals and other parts reasonably low, and by concentrating his mechanical repairs as well as the battery and other work at a central point where it can be handled economically, be able to furnish this service to the user at attractive prices, and there will still be sufficient margin of profit to make the venture attractive.

A maintenance system of this type will, of course, be of advantage principally to the user of one or two trucks. Owners who operate fleets of trucks are usually sufficiently well equipped to take advantage of numerous economies under the direction of capable men, thus avoiding the troubles which at the present time stand in the way of the small user of electric trucks.

The Sidereal Center

(*Concluded from page 387.*)

original creation named in the first verse (and not to any subsequent six-day "reconstruction," allowing an indefinitely long interval between this verse and the next), then it should follow that we cannot yet have received the light of stars lying beyond some 6,000 light-years, or 1,800 secpars. One test, however, which will occur to those who have not committed themselves irretrievably to any one of the modern evolutionary doctrines (involving all ranges in millions of years) is whether, after an appreciable lapse of time, the number of stars down to a limiting magnitude (necessarily faint) tends to show any increase. The time required, however, is likely to be long, seeing that any appreciable increase in the number of suns able to impress themselves at such outlying distances necessitates a considerable proportionate extension in the star-depth, with its corresponding wait in light-years.

The possibilities of the Canopic hypothesis, as they now stand, may be summed up in the suggestion that:

"The visible Universe probably of oblate spheroidal form, with an equatorial radius of some 2,000 secpars, has its center marked by the bright star Canopus, probably the greatest seen in the Universe, stationary therein, forty or more thousand times as luminous as our Sun, and nearly a million and a half times as massive.

"Meanwhile, our Sun, now distant 150 secpars from Canopus, is traveling (from the influence, apparently, of some original impulse) at, for the present, just over 13 miles a second in a course inclined rather more than 20 degrees (upwards) from the galactic plane, and rendered hyperbolic by the influence of Canopus, which would ultimately deflect it over 13 degrees out of the straight. The attractive effect, meanwhile, of the other stars around may prove to be generally neutral."

As to what may lie beyond the galaxy, whether or not it be "the waters above the firmament," our boasted knoweldge fails as yet to interpret aright the Creator's meaning therein expressed, while speculation becomes a useless search to be "wise above what is written."

Zinc Wire

It is stated that German manufacturers are producing zinc wire which is but slightly inferior to copper wire from a mechanical standpoint. The new zinc wire is now authorized by the Electro-technical Union for electric wiring purposes, such as for insulated wires or cables employed in steel conduits for house wiring, or for larger conduits. Lead-covered cables are now made with the conductors in zinc. The main advantage of zinc over iron lies in the fact that zinc has double the electric conductivity of iron, and, besides, it is non-magnetic. Again, zinc wire is more flexible than iron, hence it works better upon insulators; and another point is that it does not need to be protected from rust. It took some time, however, for the new wire or cables to enter into practice, especially as during the first stages the manufacture of it was far from perfect, and on this account there were considerable difficulties in handling the wire and installing wires or cables, but it is claimed that all the drawbacks are overcome at the present time. The wire and cable commission has now prepared the needed data on the subject, including the physical properties of zinc and the difference it presents from copper, also the advantage which it has over iron. The directions also include the proper methods for laying zinc or wires or cables as well as mounting bars of thin metal for switchboards. However, iron wire is still preferred to zinc for overworked electric lines in default of copper, on account of its greater strength.

Artificial Seasoning of Timber*

Methods and Principles Adopted for Various Materials

By Ollison Craig, Associate Professer Mechanical Engineering, Iowa State College

The artificial seasoning of timber is usually carried on in what are known as dry kilns. These kilns may be variously classified, depending on construction, method of operation, etc. Old kilns were constructed with a chamber in which fuel was burned, and a second chamber in which the timber to be dried was placed, the burnt gases flowing from the combustion chamber to the drying room and over the piled lumber. With the present use of steam for drying, almost all modern kilns can be divided into two classes as to construction—radiator kilns and hot-blast kilns.

Radiator kilns are built with steam pipes under the floor of the drying chamber. Air passes through these coils, up through the floor, and on to the lumber.

Hot-blast kilns have a bank of heating coils placed in a separate housing, through which air is blown by a fan and forced on to the drying room.

Radiator kilns are thought of as those having the heating elements in the same room as the lumber to be dried, and circulation produced by difference in temperature; while hot-blast kilns are thought of as those having the heating element separate from the drying room, and circulation produced by a blower.

Kilns are also classified as to operation into hot-blast kilns and moist-air kilns, although this is a very unsatisfactory classification. This is based on former practice, in which the relative humidity in blower kilns was low, and so the type was called "hot-blast"; while in radiator kilns and box kilns the relative humidity could be raised by decreasing circulation or by closing the dampers, and these became known as "moist-air" kilns. A better classification as to operation would be moist-air kilns and dry-air kilns, as either blower or radiator kilns could be so regulated as to obtain a high or low relative humidity in the drying chamber.

A third classification, which is based on a combination of operation and construction, divides kilns into either compartment kilns or progressive kilns. In the former the lumber is piled in a chamber and allowed to stay in one position until dry, while in the latter the lumber is moved along the length of the kiln at intervals; dry lumber being taken out at one end when a fresh truck load was run in at the other.

A kiln is being developed on the Pacific Coast at the present time in which superheated steam is used, the steam coming in direct contact with the lumber. Some difficulty, however, has been experienced, as the temperature of the steam used was above the ignition point of the lumber; and if care was not used to exclude air, charring would occur, and in some cases, where the doors were opened prematurely, combustion has taken place.

In all kiln-drying operations, the primary object is to release the contained moisture from the wood and to leave the wood in the best condition possible. The moisture is taken from the wood by evaporation; and to cause evaporation, heat is necessary, and in sufficient quantity to evaporate all the moisture to be released. Approximately 1,000 heat units are required for the evaporation of each pound of water contained in the lumber, and a second quantity (at present unknown) is required to overcome the attraction between the wood and water. This attraction is known as "hygroscopicity."

The first object, then, is to supply the required amount of heat necessary to evaporate the moisture. The second object is to supply the heat and to produce evaporation under such conditions as will leave the lumber in the best possible condition when dry. To do this, several factors—namely, temperature, relative humidity, circulation and rate of drying—must be controlled and correlated.

The various combinations of these factors depend upon the species of lumber to be dried, its size, and initial moisture content.

The rate of drying is dependent upon the other three factors. It is determined in any particular case by weighing samples at intervals of time and making moisture determinations. Moisture determinations are made by weighing a sample piece before and also after oven dryng, and calculating the per cent loss based on the dry weight, or the ratio of the weight lost to the dry weight. This is called the "per cent moisture," and the rate of change of the per cent moisture is proportional to the rate of drying.

Relative humidity is usually determined by the use of wet and dry bulb thermometers, although some form of hygrometer, such as a hair hygrometer, is sometimes used. Methods of hygrometric determinations in dry kilns are not at present entirely satisfactory. Temperatures are measured by a mercury thermometer, and circulation by an aneometer, although the latter determination is rarely made.

In most kilns it is impossible to control these factors independently. For example, if the temperature in a radiator kiln is increased by increasing the supply of steam to the radiator, circulation will be increased and the relative humidity decreased.

The ideal method of drying would be one in which all factors could be varied independently, and the right combinations obtained in any particular case to give the best results in time and quality of product.

In some cases lumber is subjected to a treatment of steam or a mixture of steam and air before being dried in the kiln. In the first case a steel cylinder is provided, in which the lumber is submitted to steam under pressure for a short time, usually from 5 minutes to 30 minutes, and then transferred to the kiln. In the second case, a portion of the kiln is divided off into a steaming chamber of a size to contain one truck load, and there the lumber is heated by steam sprayed in from the steam pipes. The effect of this treatment is to heat the wood thoroughly in a saturated atmosphere and prevent surface evaporation during initial heating. However, care must be used; for if the lumber is changed suddenly to an atmosphere of much lower humidity, surface evaporation will result, and the lumber will be checked. This is due to the fact that evaporation will increase with a decrease in relative humidity, the heat being supplied from within the wood; and rapid evaporation at the surface will cause unequalized shrinkage, and consequently considerable checking.

The rate of drying may be increased by a rise in temperature, a decrease in relative humidity, or an increase in circulation. The rate of drying is a very important factor in producing proper results. With high moisture contents the rate of evaporation or drying tends to be greater than with lower moisture content. The tendency is, then, for the drying to so progress that if a moisture time curve should be plotted it would have a much greater tangent slope at the beginning than at the end of the process. If the slope of the curve is too great at the beginning, the result will be "casehardening" and probably "honeycombing."

Just why this produces "casehardening" is a matter of speculation, although the effects are very evident. If the rate of evaporaion is too great, the distribution of moisture through any section of a piece of lumber will not be uniform. It is impossible, of course, to obtain absolute uniformity in the moisture distribution within a finite time. However, as it is a matter of degree only, for practical results a certain minimum limit would be set for variation in a section without injury. As a result of too rapid drying, the center of a piece may be above the fiber saturation point, while the surface is as dry as can be obtained in the kiln. This will cause, first, "casehardening," as mentioned before; then either deep checks from the surface or "honeycombing." Woods having pronounced medullary rays would in this case "honeycomb."

Again, if this material is resawed, warping will undoubtedly take place. If timber, however, is properly dried, the product is something which is not only free from moisture and liability of checking and warping, but it is much stronger than in the green state.

The effect of moisture on wood, as explained in United States Forestry Service Circular 108, is to weaken it up to the fiber saturation point, but beyond this point an increase of moisture has no effect on the strength. Shrinkage is also connected with the fiber saturation in that no shrinkage occurs until the moisture content has been reduced to the fiber saturation point; but if from that point the moisture is still further reduced, the shrinkage is proportional to the loss of moisture. The shrinkage affects the strength, as the cross section of a dry piece is less than the same piece green. However, the gain in strength due to drying of the fibers overbalances the loss due to shrinkage.

Various species of wood have characteristics which must be taken into account if successful drying is to be expected.

Most conifiers dry easily, and can be submitted to relatively high temperature and rate of evaporation and low relative humidity without injury.

The oaks, however, on account of more complicated structure, soft medullary rays and greater shrinkage, must be handled with much more care; and if a high temperature is used in drying, a high relative humidity must also be used, particularly at the start; also the rate of evaporation must be limited, depending upon the condition of the wood. In some cases it is not advisable to evaporate more than one per cent, or even one half per cent, moisture content per day.

Other woods, such as red gum, are subject to warping and twisting when dried. Care must be taken in that case to dry slow, keep up the humidity and to have the material carefully piled in the kilns.

With hardly an exception, all users of dry kilns expect to have hard wood lumber air dried or partially air dried before placing it in the kiln. Usually, however, the lumber goes into the kiln without the manufacturer knowing very much as to just what the condition is. Properly, moisture determinations should be made.

If the lumber manufacturer wishes to air dry his material before placing it in the kiln, he would gain nothing, as some expect, by allowing it to lie in the yards after the air-dry condition has been reached. Timber will probably be no drier after lying 5 years than after lying 1 year, unless of unusual size. The air-dry condition is a moisture content which is a balance between the relative humidity of the atmosphere and the hygroscopicity of the wood. For a given locality this content will be fairly defined within certain limits. In this locality the air-dry condition is a moisture content of from 12 to 15 per cent; and when lumber has once reached that condition, no length of air seasoning will make it any drier.

Lumber should be dried in the kiln, not until the workmen say that it works right under the tool or until the superintendent says that by the sound and smell it is dry, but until it has reached the per cent of moisture content most desired for the purpose for which it is to be used. There is no necessity for kiln drying lumber which is to be exposed to the atmosphere without paint. Material to be used in vehicles should be, and is in well-regulated kilns, dried to about 8 per cent, when the vehicles are to be used in the North and East. If the vehicles are to be used in the hot, dry climates of the Southwest, the material should be dried to about 4 per cent. Furniture and wood for interior finishing should be dried to about 6 per cent and used before having an opportunity to reabsorb moisture.

It is good practice to allow lumber to stand for a time—say, 1 or 2 days, depending upon the conditions—before being worked. On coming out of the kiln, it is probable that the surface will be drier than required, while the center may not be dry enough. If allowed to stand in a dry, warm place, a distribution will take place which will produce more uniformity of moisture, with less liability to warping or cupping when worked.

As stated before, the theoretical kiln should be subject to independent control of all factors involved—temperature, relative humidity, circulation and rate of drying. Also, it should be known for any given lot of lumber just how these factors should be varied to produce ideal results. The evaporation time curve should probably be a straight line parallel to the time axis. The moisture content time curve should be a straight line, with a negative slope, although the tendency is toward a curve of increasing radius of curvature, as previously explained. The relative humidity time curve should be one having an increased slope, with an increase of time.

When the exact form of all these curves and the method for obtaining in the kiln what they represent is known for any given set of initial conditions, then the particular lumber can be dried perfectly and the performance duplicated, with assurance of success.

This would also bring the practice of kiln drying to the point where previous air drying would be useless, and green material could be placed immediately in the kiln.

* Reprinted from Proceedings of the Engineering Association of the South, Vol. XXIV., No. 1.

Production of Iron Ore

According to figures given out by the United States Geological Survey, 55,526,490 gross tons of iron ore were mined in this country in 1915. This output is exceeded only by that of 1910 and 1913.

A New System of Navigation and Nautical Astronomy

By Capt. Fritz E. Uttmark

INTRODUCTION.

"Efficiency and simplicity in Navigation and safety at sea" will be our motto.

In our time of hurry and speed anything that will have a tendency to make Navigation more efficient, calculations quicker, with less possibility of mistakes, should be welcome. I, therefore, venture to place before the public the suggestion of a new system of Navigation, a system which has been carefully thought out, and which the author trusts will fulfill many of the requirements lacking in the old complicated system.

On the new charts issued by United States Hydrographical Office the old method of naming the compass points is discontinued and the compass diagrams divided into degrees extending from North which is considered as zero (0°), increasing right-handed (over East, South and West) up to 360°. This is a step in the right direction and has a tendency to minimize the chances of errors in applying variation and deviation of the compass. This method is already in use by the U. S. Navy.

This gradation of the compass, which I think cannot be further improved, will be adopted throughout this work. Let us now consider Navigation and Nautical Astronomy according to the author's new system.

LATITUDE AND LONGITUDE BY DEAD RECKONING.

Definitions.

Latitude.—The North Pole being considered as zero (0°), the Equator as ninety degrees (Lat. 90°) and the South Pole as one hundred and eighty degrees (Lat. 180°), the Latitude of any place or position is therefore its distance from the North Pole measured on a meridian and expressed in degrees, minutes and seconds of arc.

Longitude.—The meridian passing through the Capitol at Washington, D. C., being considered as the Prime Meridian (Long. 0°) and the Longitude reckoned right-handed (Eastward) continuously increasing up to 360°, the *Longitude* of any place or position is therefore the angle at the Pole between the Prime Meridian (Meridian of Washington) and the meridian passing through the given place or position, reckoned right-handed (Eastward) and expressed in degrees, minutes or seconds of arc. (See Fig. 1.)

VARIATION AND DEVIATION.

Variation.—Assuming we are looking from the center of the diagram toward the circumference.

In Figs. 2 and 3 let the lines N. S. represent the true meridian and the lines N′. S′. represent the magnetic meridian. Then, when as in Fig. 2 the *Magnetic* Meridian falls to the *left-hand* side of the True Meridian, the variation is *subtractive* (–).

When, as in Fig. 3, the *Magnetic* Meridian falls to the *right-hand* side of the True Meridian, the variation is *additive* (+).

Deviation.—In Figs. 4 and 5 let the lines N′ S′ represent the magnetic meridian and the lines N″ S″ represent the compass meridian. When, as in Fig. 4, the compass meridian falls to the *left-hand* side of the magnetic meridian, the deviation is *subtractive* (–). When, as in Fig. 5, the compass meridian falls to the *right-hand* side of the magnetic meridian, the deviation is *additive* (+).

Converting a Compass Course (C. C.) into True Course (T. C.).—When converting a compass course into a true course, allow variation and deviation according to their proper signs. For example: C. C. equals 232° Var. 10°(–). Dev. 4°(+). Then T. C. equals C. C. – Var. + Dev. or 232 – 10 + 4 equals 226°.

Let us now put this system to a practical test and consider first the Traverse Sailing problem and how to construct the Traverse Table and place Difference in Latitude (D. L.) and Departure (Dep.) in their proper columns.

Difference in Latitude and Departure.

When the True Course is

between 0° and 90° the D. L. have – sign and the Dep. + sign.
" 90° " 180° " " " + " " " " + "
" 180° " 270° " " " + " " " " – "
" 270° " 360° " " " – " " " " – "

From a position in Latitude 50° 10′ 00″ and Longitude 20° 40′ 00″ a ship sails the following courses and distances:

C. C. 42° Var. 10°(–). Dev. 6°(+). Dist. 120 miles.
C. C. 140° " 10°(–). " 4°(–). " 86 "
C. C. 196° " 11°(–). " 5°(+). " 43 "
C. C. 305° " 11°(–). " 8°(–). " 162 "

Require the Latitude and Longitude by Dead Reckoning, also the course and distance made good. To be worked by inspection from Nautical Tables.

c. c. 42
v. – 10
32
d. + 6
T.C. 38

c. c. 140
v. – 10
130
d. – 4
T.C. 126

c. c. 196
v. – 11
185
d. + 5
T.C. 190

c. c. 305
v. – 11
294
d. – 8
T.C. 286

True Course.	Distance.	Diff. Latitude. –	Diff. Latitude. +	Departure. –	Departure. +
38°	120	94.6	....	....	73.9
126°	86	....	50.5	....	69.6
190°	43	....	42.3	7.5	....
286°	162	44.7	....	155.7	....
		–139.3	92.8	–163.2	143.5
		– 92.8		–143.5	
		– 46.5		– 19.7	

From Lat. 50° 10′ 00″
D. Lat. – 46′ 30″
Lat. in 49° 23′ 30″

From Long. 20° 40′ 00″
D. Long. – 26′ 00″
Long. in 20° 14′ 00″

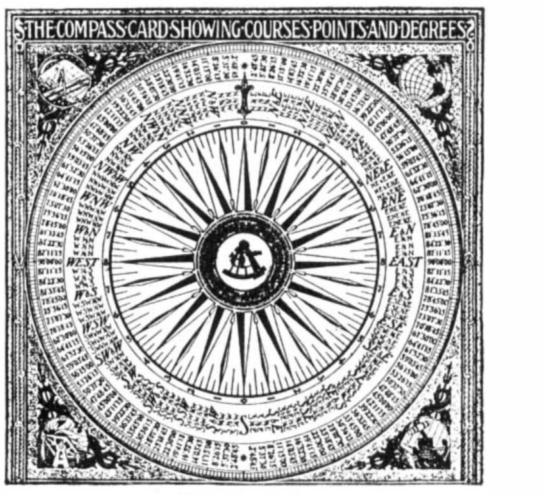
Middle Latitude taken to the nearest degree (remembering North is 0) equals 50°.

With the Middle Lat. (50°) considered as a Course and with the Departure in a Lat. column we find Diff. Long. in a Distance column. Dep. 19.7 = D. Long. 26′.

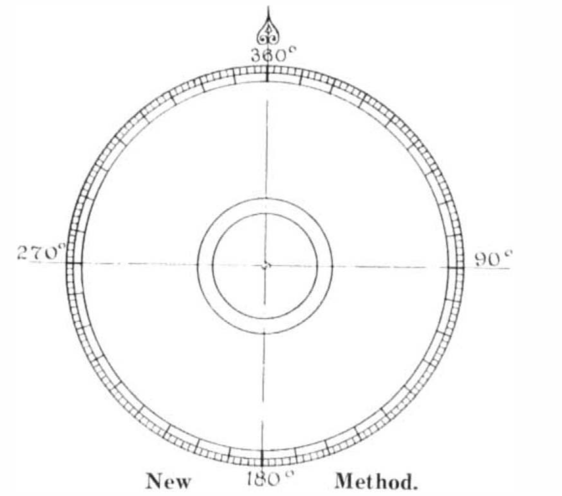
The course and distance made good is found in the usual way.

Course made good = 337°
Distance made good = 51 miles.

This can also be worked by logarithms according to well-known formulas which can be adapted to this system.



Old Method.



New 180° Method.

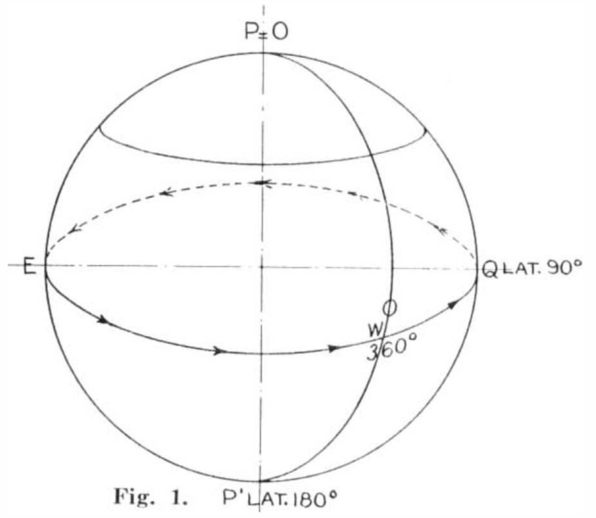


Fig. 1.

North Pole P equals Zero (Lat. 0°). The equqator W. Q. E. W. equals 90° (Lat. 90°). South Pole P′ equals 180° (Lat. 180°). O is the center of the Capitol at Washington. D. C. The semi-circle P. O. W. P.′ is the Prime Meridian.

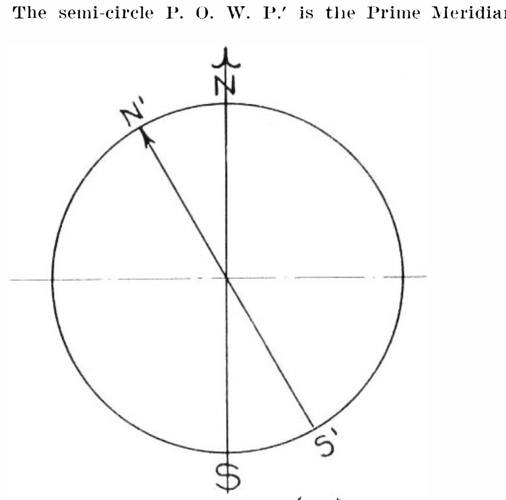


Fig. 2. VARIATION (–)

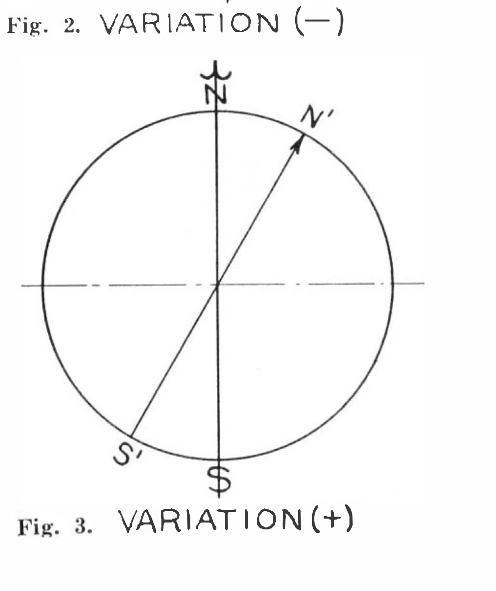
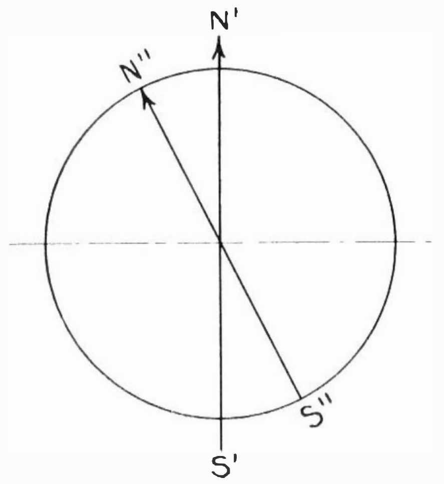
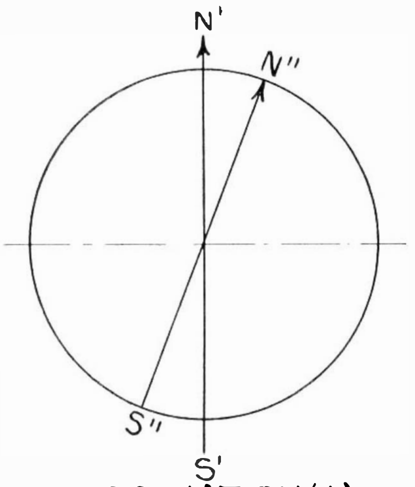


Fig. 3. VARIATION (+)



DEVIATION (—)
Fig. 4.



DEVIATION (+)
Fig. 5.

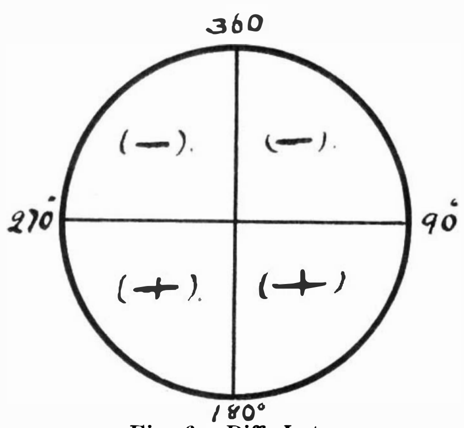


Fig. 6.—Diff. Lat.

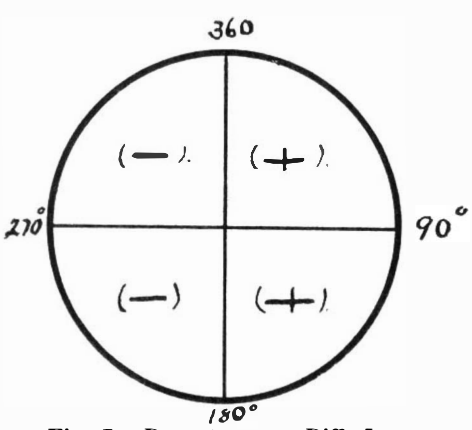
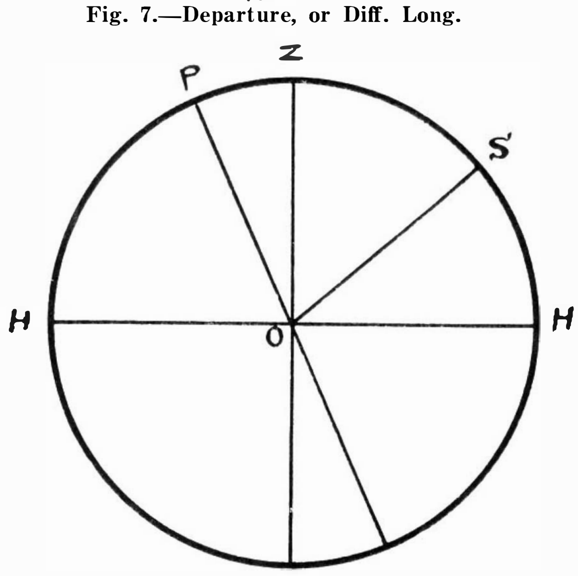


Fig. 7.—Departure, or Diff. Long.



H. H.' is the True Horizon. S. H.' is the Altitude of S. Z. S. is the Zenith Distance of S. P. S. is the Polar Distance of S. P. O. Z. is the Latitude at the Point of Observation.

Middle Latitude Sailing.—The working out of this, as well as the Mercator's Sailing problem, would differ very little from the Old Method. We need only to bear in mind our new starting points of Latitude and Longitude and follow the simple rules. Let us illustrate by the following example:

Find the True Direction and Distance from the Capitol at Washington, D. C., in Latitude 51° 06′ 40″ and Longitude 0° 0′ 0″ to Gibb's Hill Lighthouse (Hamilton, Bermuda) in Latitude 57° 44′ 55″ and Longitude 12° 10′ 56″.

From Lat.	51° 06′ 40″	Long.	0° 00′ 00″
To Lat.	57° 44′ 55″	Long.	12° 10′ 56″
Diff. Lat.	+6° 38′ 15″	Diff. Long.	+12° 10′ 56″
	60		60
	360		720
	+38′ 15″		+10′ 56″
Reduced to	+398.2 minutes of Latitude or miles.		+730.9 min. Long.

The Middle Latitude computed to the nearest degree equals 54°. With this and the above Difference in Longitude 730′.9, we obtain Departure 590.6 miles.

From this we find the

True Course or Direction to be 124° and

The Distance 712 miles.

Mercator's Sailing.—Find the True Direction and Distance from a place A in Latitude 60° 30′ 00″ and Longitude 20° 40′ 00″ to a place B in Latitude 64° 20′ 00″ and Longitude 18° 10′ 00″.

Lat. A	60° 30′	M. P. 1842	Long. A	20° 40′
Lat. B	64° 20′	M. P. 1584	Long. B	18° 10′
Diff. Lat.	+3° 50′	M. D. L. 258	Diff. Long.	−2° 30′
	60			60
	180			120
	50			30
Reduced to 230 miles.			Reduced to 150 minutes of Longitude.	

Entering the Nautical Tables with M. D. L. in a Latitude column and Diff. Long. in a Departure column we find the corresponding Direction to be 210°. With this Direction or Course and the Diff. Lat. in a Latitude column, we find the corresponding Distance in a Distance column to be 266 miles.

True direction 210°.

Distance 266 miles.

The following diagrams, Figs. 6 and 7, indicate at a glance how to determine the Course or Direction.

Diff. Lat. (−).	Long. or Dep. (+).	Then the Course is between	0° and 90°.
" " (+).	" " " (+).	" " " " "	90° " 180°.
" " (+).	" " " (−).	" " " " "	180° " 270°.
" " (−).	" " " (−).	" " " " "	270° " 360°.

LATITUDE BY ALTITUDES OF A HEAVENLY BODY.

Definitions.

Declination.—This term will not be required in the new system. Polar Distance will in all cases take its place.

Polar Distance.—The Polar Distance of any point, or the center of a heavenly body, is its angular distance from the North or Zero Pole measured on its hour circle.

RULES FOR FINDING THE LATITUDE BY MERIDIAN ALTITUDES OF A HEAVENLY BODY.

Rule 1.—Correct the Observed Altitude in the ordinary way for Dip, Refraction, and in the case of the Sun, for Parallax and Semi-Diameter in order to obtain the True Altitude A.

Rule 2.—Obtain the Zenith Distance by subtracting True Altitude from 90° (Z = 90° − A).

Rule 3.—Take out from the revised Nautical Almanac the Polar Distance at the nearest noon preceding the Observation and turning the Longitude into Time, correct the Polar Distance up to the time of observation.

Rule 4.—If the bearing of the body is 180° when on the meridian, *subtract* the Zenith Distance from the Polar Distance. If the bearing is 0° *add* the Zenith Distance to the Polar Distance; the result will be the Latitude.

Bearing 180°, Lat. = P − Z.
Bearing 0°, Lat. = P + Z.

Example 1.—On June 12th, 1915, in Longitude 0°, the Observed Altitude of the Sun's lower limb was 73° 54′ 30″, Sun's bearing 180°, Height of Eye 20 feet. Required the Latitude.

Obs. Alt.	73° 54′ 30″	
Correction	+ 10′ 35″	
True Alt.	74° 05′ 05″	
Subtract from	90° 00′ 00″	
Zenith Dist.	15° 54′ 55″	Sun's bearing 180°
Polar Dist.	67° 01′ 35″	*subtract.*
Lat. by Obs.	51° 06′ 40″	

This is the Latitude of the Capitol of Washington, D. C., according to the new system.

Example 2.—On July 4th, 1915, in Longitude 0°, the Observed Altitude of the Star Vega (α Lyræ) was measured to be 25° 40′, the Star's bearing 0°, Height of Eye 25 feet. Required the Latitude.

Obs. Alt.	25° 40′ 00″	
Correction	− 7′ 10″	
True Alt.	25° 32′ 40″	
Subtract from	90° 00′ 00″	
Zenith Dist.	64° 27′ 20″	Star's bearing 0°
Polar Dist.	51° 17′ 46″	*add.*
Lat. by Obs.	115° 45′ 06″	

These two examples will be sufficient to illustrate the practical and simple working of the system in finding Latitude by Meridian Observation. Space will not allow for the demonstration of the ex-Meridian and other Latitude problems.

LONGITUDE BY OBSERVATION OF A HEAVENLY BODY.

Definitions.

Hour Angle.—The Hour Angle of any point or center of a Heavenly Body is the angle at the pole, intercepted

between the meridian of the observer and the hour circle passing through the point or center of the Heavenly Body toward West up to 24 hours or 360°.

In Fig. 9. O is the place of Observation
P Z Q H′ P′ is the meridian of the observer
E Q is the celestial Equatorial line
P is the North or Zero Pole.
S is the position of a heavenly body or point
P S or p is the Polar Dist. of S
Z is the Zenith of the observer
P Z or l is the Latitude of the observer
H H′ H″ is the Horizon
S H′ or h is the Altitude of S
The angle Z P S or t is the Hour Angle

$$\text{Sine}^2 \frac{1^t}{2} = \frac{\text{Cos S sine } (s\text{-}h)}{\text{Sine L sine P}}$$

or

$$\text{Sine}^2 \frac{1^t}{2} = \text{Cos S} \times \text{Sine } (s\text{-}h) \times \text{Cosec. L} \times \text{Cosec. P}$$

$$S = \frac{h + L + P}{2}$$ when h is the Altitude, L the Latitude and P the Polar distance.

Rule 1.—Add together Altitude, Latitude and Polar Distance, call this sum 2 S, then dividing this by 2 we have the value of S. Then subtract the true Altitude from S for the value of $(s\text{-}h)$. Against these values take out the corresponding logarithms as indicated by the formula. Add these together and obtain the hour angle from table 45 Bowditch.

Note.—If the Latitude exceeds 90° *subtract* 90° from *2 S before* proceeding to find the value of S and $(s\text{-}h)$.

Rule 2.—To find the Longitude in time *always subtract* Washington time from Ship's time, adding 24 hours to the Ship's time if necessary, and converting this into degrees, minutes and seconds of arc the Longitude is obtained.

Rule 3.—For Stellar Observations.—Find the hour angle (H.A.) as before (Rule 1). To this hour angle *add* the Star's right ascension, the result will be the right ascension of the meridian (R.A.M.), from which *subtract* the corrected Mean Sun's right ascension (M.S.R.A.), the result will be the mean time at Ship or place (M.T.S.). The Longitude is then obtained according to Rule 2.

Example 1.—July 4th, 1915, before the Sun passed the meridian, the observed Altitude of the Sun's lower limb was taken as 20° 00′. Latitude by Dead Reckoning 60° 30′. Height of Eye, 20 feet. Index correction 0. Washington time by chronometer (corrected) 16 h. 05 m. 10 s. at time of observation. Required the Longitude.

Obs. Alt. Sun's L.L.......	20° 00′		
Corr. Tab. 46............	+ 9		
True Alt. of Sun's center..	20° 09′		
Latitude by D. R.........	60° 30′	log. cosec	= 0.06030
Corr. Polar Dist..........	67° 03′	log. cosec	= 0.03581
2 S =	147° 42′		
S =	73° 51′	log. cosine	= 9.44428
$(s\text{-}h)$ =	53° 42′	log. sine	= 9.90630
Apparent H.A. 19h 44m 34s....		log. haversine	= 9.44669
Equation of time + 3 26			
M. T. Ship.... 19h 48m 00s			
M. T. Wash... 16 05 10			
Long. in time.. 3h 43m 50s			

Long. = 55° 57′ 30″.

Example 2.—July 4th, 1915, after the Star A Virginis (Spica) had passed the meridian, its altitude was observed to be 18° 23′; Washington time by Chronometer 15h. 10m. 20s. at time of observation. Height of Eye, 25 feet. Latitude by D. R. 105° 24′. Required the Longitude.

*Obs. Alt................	18° 23′		
Corr. Tab. 46...........	− 8		
*True Alt...............	18° 15′		
Lat. by D.R............	105 24′	log. cosec	0.01588
Polar Dist..............	100 43′	log. cosec	0.00764
2 S	224° 22′		
	90 00		
2 S − 90	134 22		
S	67 11	log. cosine	9.58859
$(s\text{-}h)$	48 56	log. sine	9.87734
*H.A. 4h 29m 59s......		log. haversine	9.48945
*R.A. 13 20 43			
R.A.M. 17 50 42			
M.S.R.A. 6 48 07			
M.T.S. 11 02 35			
M.T.W. 15 10 20			
Long. time 19h. 52m. 15s.			

Longitude 298° 03′ 45″

AMPLITUDE AND AZIMUTH.

Definition.—Both Amplitude and Azimuth of a point or of the center of a heavenly body is the angle at Zenith, between the Meridian and the Vertical circle passing through the point or center. It is reckoned from North, right handed up to 360 degrees. The Amplitude is used for points *at the Horizon.*

The Azimuth is used for points *above* the Horizon. The formulas and examples for Amplitude and Azimuth have been omitted in this short treatise, but several formulas may be adapted with advantage to suit this system.

The new system as presented by the author would amount to a revolution in the science of Navigation, simplifying the work and increasing its efficiency. The existing Nautical Tables, Almanacs, and Charts will require revising, although the greatest part of the Nautical tables may easily be converted to suit the new system. The gradation of the Latitude, as well as the Longitude scale on the charts, is the only part that needs alteration.

The Latitude in this system is really the terrestrial polar distance, but the author has preferred to retain the name "Latitude," so as not to confuse it with the polar distance of a heavenly body.

The formulas given in this work may be modified in many ways; the author's intention at present, however, is only to give an outline of the system and show that even in Navigation we are laboring with formulas and arrangements invented centuries ago, when time was of no particular value.

Oceanic Tides With Special Reference to the Work of the United States Coast and Geodetic Survey*

The mathematical theory of the tides begins by assuming a solid earth surrounded by a shallow, frictionless ocean. In such an ocean the attraction of the moon would cause waves to travel around the earth from east to west. For many years the complete mathematical solution of this simple problem taxed the ability of the ablest scientists, and when finally solved the solution did not materially advance the theories and explanations of the actual tides in the oceans as they exist on the earth.

To pass from this ideal world to actuality; from a simple all pervading ocean of uniform depth, to oceans separated by continents, and varying in depth, defies the skill of the mathematician. Yet Newton, Laplace, and a succession of brilliant mathematicians have all tried to do this; to pass from the simple to the complex. They consider the tides as a world phenomenon—as an ideally simple wave, modified, broken up, and delayed by the continental barriers; by the varying depths of the oceans. Sir George Darwin considers the great earth tides as formed in the broad, deep waters of the Southern Pacific. From here the tidal wave spreads east and west, around Cape Horn and past Cape of Good Hope, and sweeps through the Atlantic at a rate depending solely upon the depth of the water.

This simple world idea of the tides was evolved and elaborated from observations of the tides of Europe. In the days of Laplace there was little knowledge of the tides in other parts of the world, and it was naturally thought that the European tides were fairly representative. The dynamical or world wave theory fitted and explained the simple tides, and thus became the basis of all tidal work and theories. Later the tides in the Pacific and Indian oceans were studied and were found to differ greatly from those of Europe; in fact, the tides of the North Atlantic are exceptional in their simplicity.

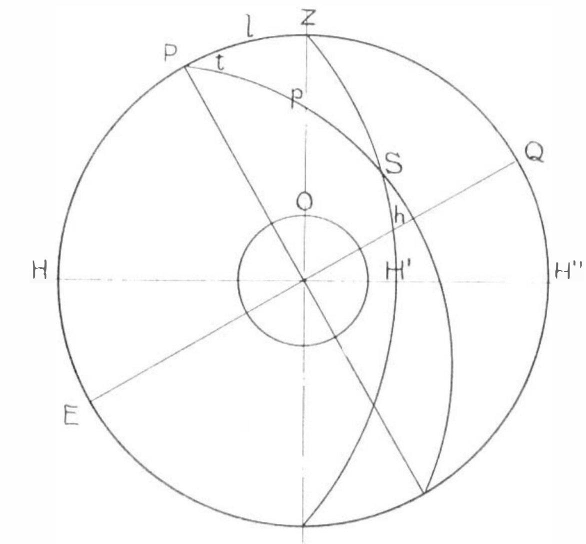


Fig. 9.—Formula for finding the Hour Angle.

Yet as each new complication was found, it was explained away, as a modification of the general grand wave, due to some local condition. The theory that the tides are a world phenomenon has the support of the world's greatest mathematicians and all the prestige their names can lend.

Certain investigation of the Coast and Geodetic Survey would indicate that this theory may not be the correct explanation of the oceanic tides. During the century of its existence this body of skillful observers and able investigators has collected and discussed an enormous amount of tidal data in both the Atlantic and the Pacific oceans. As these observations were collected and brought together, discrepancies were found; the tides of one port could not be fitted into and made to harmonize with the tides of another place. A few such discrepancies could be explained as modifications of the general tidal wave, but as observations were increased in number, discrepancies multiplied, and to fit all conditions, the general tidal wave would have to writhe and squirm and change its form and character from place to place until it lost all semblance of a single uniform progressive wave. Gradually there has been evolved the feeling that the tides are not a world phenomenon, but are strictly local in character and in being; that the tides of the Atlantic Ocean are due to the oscillations in the waters of the Atlantic, independent of what has or may happen in the waters of the Pacific.

This idea of the tides as purely local phenomena, as opposed to the theory of a grand earth-wide wave, has been elaborated and developed by the Coast and Geodetic Survey into a thoroughly consistent theory. And this explanation of the tides stands out as the great scientific contribution of the Coast and Geodetic Survey to the theories of oceanic tides.

*From an address by Dr. Charles Lane Poor at the Centennial Exercises of the United States Coast and Geodetic Survey.

A Method of Drop Measuring Liquids and Suspensions*

By R. Donald, B.Sc., N.Z., D.P.H., Oxf.

The following article gives some practical details of a method of measuring liquids in uniform drops of any standard size by means of ordinary simply drawn pipettes quickly and accurately gaged. The apparatus was briefly described in a communication[1] to the Royal Society in 1913. A more detailed account was in preparation when the outbreak of war restricted work to the immediately necessary. Under this category the method has been brought by the increased importance of an accurately quantitative form of the Widal test.

For the measurement of small quantities graduated pipettes have hitherto been largely used. But although the worker proposes to deliver small volumes from a graduated capillary pipette, and although he displaces the liquid column downward the exact amount proposed, yet nature disposes the outflowing liquid in drops, and if the last portion expelled does not form a complete drop and fall spontaneously at its complete phase, then the incomplete drop clings with more or less pertinacity to the pipette point. Even when allowable, touching the pipette point on the side of the receiving vessel is uncertain[2] in its result.[3]

But just in the very conditions where surface-tension or capillary force hinders us most if we try to work independently of it, there that very force will act in our favor if we give it play. Thus, if instead of difficultly and uncertainly aborting drops at various phases of their formation-cycle we allow the rhythmic delivery of mature drops, those drops will be of wonderfully uniform size. Indeed, for delivering successive small equal quantities drop-measuring is superior in quickness and in accuracy to any other method. And the smaller the quantities concerned the greater is this superiority. This may have been more or less generally admitted. The problem hitherto has been how to get easily a supply of reliably uniform pipettes. That problem may be solved very simply.[4]

This method of drop-measuring depends on the fact that the size of a drop of a given liquid yielded by a clean pipette is determined by the outer circumference of the pipette at the level where the contact edge of the drop clings round the glass, the pipette being held vertical or nearly so, and due allowance being made for the rate at which the drop is detached and for the temperature.

The simple process of gaging calibrates quickly and efficiently ordinary pipettes drawn from glass tubing. Thus the difficulty of getting a pipette quickly and thoroughly cleaned after use is obviated by the simple plan of taking a fresh clean pipette from the easily replenished stock. The size of drops producible by this method varies from 1/200 cubic centimeter or less up to the maximum drop possible for watery solutions —namely, nearly ¼ cubic centimeter.

The tubing for making the pipettes ought, of course, to be such as can be most quickly worked up—that is to say, it ought to be the smallest that will allow the capacity of pipette for the work concerned. Thus, for doing the Wassermann reaction with 1/10 the ordinary quantities only two drops, each 1/100 cubic centimeter of each serum, are needed. For this purpose pipettes with body some 3 centimeters long and 3 millimeters in outer diameter suffice. But for measuring out the normal saline for 60 or 70 test-tubes in such a micro-Wassermann test some 10 centimeters of tubing 7 or 8 millimeters in diameter may conveniently form the body of each pipette. The stock of glass tubing may advantageously be kept covered up from dust and fog.

For making the pipettes a length of tubing suitable for two pipettes is heated at the middle and is then drawn out so that the capillary portion is nearly cylindrical, that is, tapering very gently at the place where it is to be cut off when gaged.

The wire gage used in this investigation is the Morse drill and wire gage, made by the L. S. Starrett Company and by other makers. It has holes size 1 to size 80, from 5.79 to 0.34 millimeters in diameter. A very similar commonly used gage is the Lancashire pinion wire-gage or Stubbs gage. A comparative table of the most useful sizes in these gages is given below. A capillary is gaged by gently pushing it down into the suitable hole until arrested. The capillary is then cut close above the steel plate with a glass-cutting knife. The gaged pipettes ought to be kept on a layer of grease-free cotton-wool in a box lined with clean blotting paper. The capillary ought not to be touched with the finger or with anything else that has a trace of grease. Tubes larger than 5.79 millimeters may be gaged by a vernier slide gage, e. g., the Columbia. Holes less than 0.34 millimeter may be found in a draw-plate for drawing fine wire. Such draw-plates may require to be calibrated by the user—by low-power microscope micrometer measurement of holes and of capillary or at least by determining, as described later, the drop-volume corresponding to that hole. Both wire gage and knife ought to be thoroughly freed from grease, e. g., by repeated washing and swabbing with benzine and grease-free cotton-wool, and to be kept wrapped in clean blotting paper.

The volume of a drop of a given liquid yielded by any given pipette at any one convenient rate of dropping and at any convenient temperature may be easily determined by the worker as follows: A measuring pipette, e. g., 1 cubic centimeter or ½ cubic centimeter, is tested by weighing it first empty and then filled to the mark with water and laid horizontally in the scale pan. Now, as the cut-off capillary is to be joined to the point of the measuring pipette, with 1 centimeter or less of washed bicycle valve tubing, the volume of water has to be displaced in the measuring pipette until the lower meniscus can be seen above the upper edge of the valve tubing and the new position of each meniscus has to be marked by a scratch. As the lower meniscus strongly tends to return to the narrow point of the measuring pipette, the volume of water will have to be kept displaced by steady suction with such a device as a glass rod lubricated with glycerine and sliding in a short rubber tube slipped on to the upper end of the pipette.

The rate of dropping—that is, particularly the degree of steadiness in the discharge or release of the drop—has an appreciable effect on the size of the drop. Rapid or sudden discharge produces rather larger drops than does steady dropping at a slow rate. When a certain slowness is reached further slowing produces no appreciable change in the drop size. For pipettes as small as Morse 80 (0.34 millimeter diameter) this constancy is reached as soon as slowing reaches 1 second per drop. The desirable steadiness of pressure may be attained by working against the resistance of a suitably long capillary portion in the smaller pipettes, or against a capillary throttle or a tight cotton-wool plug in the upper end of the larger pipettes in which it may not be convenient to have a long enough capillary tip.

For more exact work, such as stalagmometry for determination of surface tension, my constant-pressure stand apparatus[5] may be used. Also for the fairly exact measuring of a few drops of cerebro-spinal fluid in counting the cells a hand pattern of the constant-pressure apparatus[6] is suitable. But for serological work an ordinary rubber teat suffices. The teat, if of ample capacity, is best managed, not by having the worker's finger and thumb vibrating on the unsteady inflated teat-walls, but by steadying the ulnar edge of the thumb-tip against the radial edge of the forefinger with the teat fundus collapsed between them, compression on the teat being accomplished by rolling more and more of the thumb pulp over the forefinger pulp and inflation by rolling contrariwise.

Using a teat in this way at fairly rapid hand-dropping I have, for instance, at my study table just tested three pipette points gaged in the same hole (Morse 75) and joined, as above described, to a 0.5 cubic centimeter pipette filled with tap water. No. 1 gave 41½ drops, but the drops formed asymmetrically, indicating slight soiling at the non-wetted part of the point; No. 2, clean, gave 40½ and again 40½; No. 3 gave 40⅔ drops.

The discrepancy between 81 drops per cubic centimeter and the 87 drops per cubic centimeter for Morse 75, as given in the table, is accounted for thus: 1. The study temperature, 11 deg. Cent., is 9 degrees lower than the temperature, 20 deg. Cent., for which the table was made. The drop count increases with the fall of the surface tension about ¼ per cent for each 1 deg. Cent. rise of temperature. 2. The trace of "grease" in the non-alkaline distilled water makes the drop count rather higher than that of tap water. 3. The drop rate, though fairly uniform, was less than ½ second per drop.

If only a couple of drops, with an interval between them, have to be delivered from a small pipette of serum, then instead of a teat a few centimeters of rubber tubing may be used, like a teat with a hole in it.

If, on the other hand, considerable quantities of the liquid have to be dropped, then the pipette reservoir may advantageously consist of a separator cylinder held vertical in a clamp on a stand. This becomes a convenient constant-pressure reservoir by the addition of a Mariotte tube.[7] Thin tubing suffices, say, 3 millimeters in outer diameter, passing air-tight through a rubber cork in the upper aperture of the cylinder. If the tube passes down to the tapered outlet of the cylinder then (1) the liquid, if a suspension, is kept well stirred from the bottom, and (2) the whole height of the cylinder may be emptied at constant pressure. The effective "head" of liquid is measured from the lower aperture of the Mariotte tube to the dropping outlet, the tube between being kept full of liquid. Various sizes of dropping-nozzle may be fitted to the lower end of the delivery tube by ferrules of rubber tubing or of cork. When these nozzles do not provide enough resistance to slow the drop-rate sufficiently, then a suitable "throttle" of glass tube with one capillary end may be fitted in the down-tube below the stopcock, or else a second stopcock[8] may be provided on the down-tube and easily adjusted, once for all with each nozzle, to give the necessary throttling, the other stopcock being used purely as a stopcock.

This constant-pressure reservoir will give such regularity of drops at any required rate as to allow the use of dropping-nozzles even as large as 14.5 millimeters outside diameter giving ¼ cubic centimeter drops. To prevent these large nozzles from emptying out, a rubber diaphragm consisting of a slice of pressure tubing may be inserted a little inside the level of the aperture.

The drop count per cubic centimeter of distilled water, at 20 deg. Cent., at a drop rate of 60 per minute at-

Gage No.	Diameter in Millimeters. Stubbs.	Morse.	Morse. Drops per c.c.
80	0.330	0.343	131.0
79	0.356	0.368	122.0
78	0.381	0.406	112.9
77	0.406	0.457	101.0
76	0.457	0.508	90.0
75	0.508	0.533	87.0
74	0.559	0.572	81.2
73	0.584	0.610	—
72	0.610	0.635	73.5
71	0.660	0.660	—
70	0.686	0.711	65.5
69	0.737	0.743	63.3
68	0.762	0.787	58.5
67	0.787	0.813	—
66	0.813	0.838	56.5
65	0.838	0.889	—
64	0.889	0.914	54.0
63	0.914	0.940	—
62	0.940	0.965	51.6
61	0.965	0.991	—
60	0.991	1.016	49.8
59	1.016	1.041	—
58	1.041	1.067	48.3
57	1.067	1.092	47.9
56	1.143	1.181	45.0
55	1.270	1.321	—
54	1.397	1.397	38.9
53	1.473	1.511	—
52	1.600	1.613	34.0
51	1.676	1.702	32.6
50	1.753	1.778	31.4
49	1.829	1.854	29.8
47	1.956	1.994	28.2
46	2.007	2.057	27.3
43	2.235	2.261	25.5
33	2.845	2.872	20.3
28	3.531	3.569	16.7

tained by constant-pressure apparatus, stand pattern, was found to be as shown above for Morse-gaged pipettes. The diameters of the Stubbs holes are given merely for comparison with those of the Morse gage. Small differences of dropping-point diameter have proportional differences of drop-count.

For measuring out rapidly a number of small equal volumes either of living cultures or of sterile liquids,

* *The Lancet.*

[1] Also various published articles have dealt with some applications of the method: Donald, R.: Proceedings of the Royal Society, B, vol. lxxxvi, 1913, pp. 198-202. Idem: A Comparison (of two Wassermann methods). The Lancet, June 29th, 1912, p. 1752. Idem: A Method of Counting Bacteria in Water, The Lancet, May 24th, 1913, p. 1447. McIntosh, J., and Fildes, P.: The Wassermann Reaction and its Application to Neurology, Brain, vol. xxxvi, November, 1913, pp. 213, 227. Benians, T. H. C.: The Resistance of Various Bacteria to the Disinfecting Action of Toluol, etc., Zeitschrift für Chemotherapie, Or., ii, 1913, p. 32. Donald, R.: A Method of Estimating Numerically and Qualitatively the Cells in Permanent Preparations of Cerebro-spinal Fluid, Folia Hæmatologica, Or. B, vol. xvii, 1913, pp. 139-166. Harrison, Major L. W.: Wassermann Test, Technique, Journal of the Royal Army Medical Corps, vol. xxii, 1914, p. 615. Donald, R.: Drop-methods of Counting the Cells of Cerebro-spinal Fluid; the Relation of the Cell-count to the Wassermann Reaction, Review of Neurology and Psychiatry, August, 1914, pp. 333-369. Head, H., and Fearnsides, E. G.: The Clinical Aspects of Syphilis of the Nervous System in the Light of the Wassermann Reaction and Treatment with Neosalvarsan, Brain, vol. xxxvii, September, 1914, p. 2.

[2] Even greater uncertainty may be found in (1) the amount removed and in (2) the amount delivered as a "loopful" of liquid taken by a platinum loop—usually for qualitative but sometimes for quantitative purposes.

[3] For *delivering* an exact amount of a non-wetting liquid, such as mercury, Wright's ingenious capillary 5 cubic millimeters pipette is excellent. Also for measuring, without delivering, the quantity *contained*, capillary pipettes, such as Wright's multiple dilution pipettes and the hæmocytometer pipette, have not the weakness above mentioned. Even this weakness may be overcome by the skill and care of an experienced worker. As regards the hæmocytometer pipette, its 101 mark ought to be not below the narrowest point of the narrowed bore, as the upper meniscus is vigorously drawn up to that point by capillary force.

[4] This brief article omits the extensive bibliography of the subject and the discussion of the physical phenomena connected with drop formation.

[5] Donald: Proceedings of the Royal Society, B, vol. lxxxvi, 1913, pp. 199, 201.

[6] Idem: The Lancet, May 24th, 1913, p. 1447.

[7] A Mariotte tube was used by Rosset, Bulletin de la Société Chimique de Paris, vol. xxiii (1900), p. 245.

[8] Such separator cylinders with two stopcocks may be obtained from Messrs. Baird and Tatlock, Cross Street, Hatton Garden, E. C., London.

nutrient or otherwise, into cultures the dropping pipettes may easily be sterilized. The plugging material may be either cotton-wool or asbestos fiber. Sterilization may be done either before or after calibration. If sterilization precedes calibration the capillary may be lightly flamed before use. If sterilization follows calibration the pipettes may be kept in the copper sterilizing can. Plugging with previously ignited asbestos fiber has the advantage of allowing sterilization of the whole pipette to be done quickly over the Bunsen flame and of altogether obviating the development of tarry fumes from overheated cotton, which fumes would render the dropping point "greasy," and might have appreciable antiseptic action.

Energy Transformations During Horizontal Walking*

By Francis G. Benedict and Hans Murschhauser

No form of muscular exercise enters so universally the lives of all individuals as does horizontal walking, but most of the earlier researches on the energy transformations consider walking on a horizontal plane as incidental to or as a base-line for the work of ascent, particularly in connection with mountain climbing. From the fundamental contributions of Zuntz and Durig and their associates, it has been concluded that for an individual walking on a horizontal plane the energy required to move one kilogramme, either of body-weight or of superimposed load, one meter in a horizontal direction is equivalent to 0.55 gramme-calorie. These workers likewise noted the distinct influence of increased velocity upon the energy requirement for the same amount of work.

Prior to a direct calorimetric study of the influence of walking in a horizontal direction, as well as the work of ascent and descent, the present study was made to elaborate the earlier researches on horizontal walking. A modified form of the universal respiration apparatus was employed and a specially designed treadmill. The factors measured were the oxygen consumption, the carbon-dioxide production, the respiration-rate, the distance walked, the number of steps taken by the subject, and without food, in Table II. It will be seen from the latter table that the average value found in 110 periods with these two subjects was, in round numbers, 0.5 gramme-calorie.

The results obtained in experiments after a meal showed that the ingestion of food raised somewhat the resting metabolism but was without material effect upon the forward progression constant of 0.5 gramme-calorie per horizontal kilogramme meter.

In the prolonged experiments without food, in one of which the subject walked 22 kilometers, successive periods showed very little, if any, change in the constant, thus suggesting the absence of a fatigue effect. Singularly enough the 22-kilometer experiment with food showed a distinctly lower constant than the comparable experiment without food on the preceding day.

The influence on the constant of an increase in the rapidity of walking and particularly of the change in type of locomotion from walking to running is shown in Table III. In calculating these values, the metabolism in the standing relaxed position was used for the basal metabolism. It will be seen that with increased velocity the height to which the body was raised, the number of steps, and the length of each step were all increased. The constant for the motion of forward progression was also increased in value, especially at the highest speed.

A more profound effect on all the factors of locomotion is noted when the change was made from walking to running. With essentially the same speed for each method of progression, the height to which the body was raised in running was nearly double that in walking; the number of steps was increased 20 per cent, but the length was correspondingly decreased. Of most significance is the decided fall of 15 per cent in value of the constant, i. e., from 0.932 gramme-calorie for rapid walking to 0.806 gramme-calorie for running. Since in running the body is lifted much higher than in walking, this is surprising. On the other hand, in the walking experiments there was, as is customary with trained walkers, considerable arm motion which was absent in the running experiments. Basal experiments made while the subject was standing still but swinging the arms in essentially the same amplitude and rhythm as when walking showed a great

TABLE I

SUBJECT NO.	AGE	NUDE WEIGHT	HEIGHT	CARBON DIOXIDE PER MINUTE	OXYGEN PER MINUTE	HEAT-PRODUCTION PER MINUTE
	yrs.	*kilos.*	*cm.*	*cc.*	*cc.*	*cals.*
I..........	29	69.7	180	223	280	1.34
II..........	31	68.3	177	214	258	1.25

TABLE II

SUBJECT NO.	NO. OF PERIODS	WEIGHT WITH CLOTHING	AVERAGE RATE OF WALKING PER MINUTE	INCREASE IN HEAT OUTPUT OVER STANDING	HEAT OUTPUT PER HORIZONTAL KILOGRAMMETER
		kilos.	*meters*	*cals.*	*gm.-cals.*
I.......	53	73.10	75.9	2.81	0.507
II.......	57	71.45	71.5	2.52	0.493

TABLE III

METHOD OF PROGRESSION	NO. OF PERIODS	(a) AVERAGE DISTANCE PER MINUTE	(b) AVERAGE RAISING OF BODY PER MINUTE	(c) AVERAGE NUMBER OF STEPS PER MINUTE	(d) LENGTH OF STEP $\frac{100\ a}{c}$	(e) HEAT (COMPUTED) PER HORIZONTAL KILOGRAMMETER
Without food		*meters*	*meters*		*cms.*	*gm.-cals.*
Walking:						
Slow............	57	71.5	2.94	111	64.4	0.493
Medium.........	6	106.3	5.87	131	81.1	0.585
Fast............	7	144.1	7.75	152	94.8	0.932
Running..........	15	147.5	13.75	182	81.0	0.806

the height to which the body of the subject was raised in the up and down motion of walking. The values for the resting metabolism as determined for both the lying and the standing relaxed positions were taken as base lines for comparison with the values obtained with the subject while walking. A few experiments were made when the subject was walking at a high rate of speed and likewise when running.

The preliminary observations were made on one subject by Dr. Carl Tigerstedt of Helsingfors during his short sojourn at the Nutrition Laboratory. A more extended investigation was carried out on a second subject with special emphasis upon change in velocity and the influence of food, including experiments with uncontrolled diet and diets containing a preponderance of protein, fat, or carbohydrate. A few experiments were prolonged for the purpose of studying the possible influence of fatigue.

The metabolism found for the standing relaxed position, with the subject in the post-absorptive condition, is given in Table I, and for walking at moderate speed, increase in the resting metabolism. The use of this base-line reduces the progression constant for walking to 0.780 gramme-calorie with an average speed of 144 meters per minute. This debatable procedure seems to emphasize the fact that for the most economical transport of the body, with or without superimposed load, some type of gait which reduces to a minimum the elevation of the body and the extraneous arm motion is most desirable.

The details of this research are reported in Publication No. 231 of the Carnegie Institution of Washington.

*From the *Proceedings* of the National Academy of Sciences.

A New Bunsen Burner

A recent issue of the *Chemiker Zeitung* contains a description of a new form of Bunsen burner for which special advantages are claimed. There are two concentric tubes mounted on a suitable base, and the air is drawn down through the annular space between the tubes, being preheated in its passage. Gas is supplied in the usual way to a jet at the base of the inner tube, but the amount of gas admitted can be regulated by a pointed screw that controls the gas passage before the jet is reached. The air supply is adjusted by screwing the outer tube up or down, thus opening or closing the passage at its base, connecting with the inner burner tube. Both tubes are opened out cone shape at both top and bottom. This form of burner gives a short, thick flame that completely envelops a crucible; but if a long, slim flame is desired, a short length of straight cylindrical tube is slipped into the inner tube of the lamp.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, JUNE 17th, 1916.

Published weekly by Munn & Company, Incorporated

Charles Allen Munn, President; Frederick Converse Beach, Secretary; Orson D. Munn, Treasurer; all at 233 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) . . . . " 3.00

The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 233 Broadway, New York

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