bination speedometer and dynamometer, Dr. Hopkins has also invented an electric speedometer indicator and tachometer of great sensitiveness and accuracy.

THE SOLAR AND LUNAR ECLIPSES OF 1909.

BY PROF. FREDERIC R. HONEY, TRINITY COLLEGE.

The intervals of time between the dates of the eclipses of the sun and moon this year, which occur alternately, illustrate the effect of the rotation of the plane of the moon's orbit in a direction contrary to her orbital motion. If this plane moved parallel to itself, there would never be more than two eclipse seasons in the year; and eclipses would occur when the earth would be at or near opposite points in its orbit, at average intervals alternately of a little more and a little less than six months. This inequality, due to the eccentricity, would evidently disappear if the line of nodes were always parallel to the axis of the orbit.

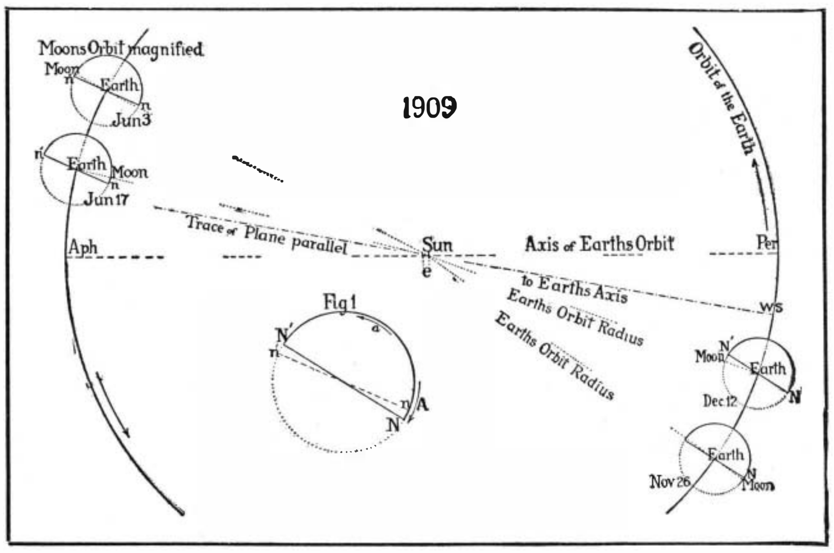
Fig. 1 illustrates the rotation of the moon's orbit between the months of June and December this year. The lines *nn'* and *NN'* are drawn parallel respectively to the line of nodes for these months. The angle included between them is about 9 degrees. The arrow *A* shows the direction of rotation of the orbit; the arrow *a*, that of the moon's motion. The rotation of the line of nodes into the position *NN'* obviously will bring it into coincidence with the radius of the earth's orbit at an earlier date than the line *nn'*, which will coincide with the orbit radius when the earth has reached the opposite point in its orbit.

The eclipses of both the sun and moon in June occurred when the moon was in that part of her orbit which was *above* the plane of the ecliptic. The eclipses in November and December will occur when the moon will be *below* that plane. In order to show this clearly, it is necessary to represent the moon's orbit on a scale very much greater than that of the earth's orbit, only a portion of which, including perihelion and aphelion, is plotted. The position of the earth is shown for the dates of the eclipses on June 3 d. 13.3 h. and 17 d. 11.5 h.; also for November 26 d. 20.75 h., and December 12 d. 8.15 h., Greenwich mean time. Since the diameter of the moon's orbit is less than a half a million miles, it would be correctly represented in the plot by a diameter a little less than a third of the linear eccentricity of the earth's orbit (= *e*). The dimension has been magnified forty times, in order to show the earth's and moon's orbit radii and the line of nodes clearly, which would be indistinguishable by the smaller scale. It should be noted that in magnifying the moon's orbit, the relation between these lines is not disturbed, that is, the angles included between them are preserved. In the drawing the diameter is enlarged sufficiently to show that on June 3rd, the date of the first lunar eclipse this year, when the earth's and moon's orbit radii were projected in the same line on the plane of the ecliptic, the moon was approaching the descending node *n'*, and was above the plane of the ecliptic. On June 17th, the date of the solar eclipse, the plot shows that the moon had recently passed the ascending node *n*; but her distance was so far from the node and above the plane of the ecliptic, that while the eclipse was central, the moon's shadow was projected on the earth very near the north pole.

On November 26th, the date of the total eclipse of the moon, the plot shows that the moon will be below the ecliptic and approaching the ascending node *N*. On December 12th, the date of the partial eclipse of the sun, the moon will be below the ecliptic, and will have recently passed the descending node *N'*. The distance below the ecliptic will be so great, that the eclipse will be visible principally in the region of the south pole.

The enlarged plot of the moon's orbit shows the position of the moon at Greenwich noon for each day from November 21st to December 18th; and also at the dates of the eclipses. On November 26th, when the moon will be near perigee, *P*, and very nearly a minimum distance from the earth, she will come wholly within the earth's shadow. On December 12th the enlarged plot shows more clearly the great distance between the moon and the node at the time of the eclipse of the sun. These plots may be compared with those printed in the Scientific American for May 15th, 1909 ("The Lunar and Solar Eclipses in June, 1909"). Figs. 2 and 3 are projections of the earth on a plane parallel to its axis, and perpendicular to the plane of the ecliptic. Its trace on the plane of the ecliptic drawn through the sun evidently intersects the earth's orbit at points which the earth reaches at the dates of the summer and winter solstices. In these projections less than one-half the visible hemisphere is illuminated between the autumnal equinox and the winter solstice.

The direction in which the eclipse of the moon will be seen, Fig. 2, is shown by the arrows. It will be visible at Washington; the beginning visible generally in North and South America, and northeastern Asia; the ending generally visible in North America, northwestern South America, eastern and northern Asia, and Australia.

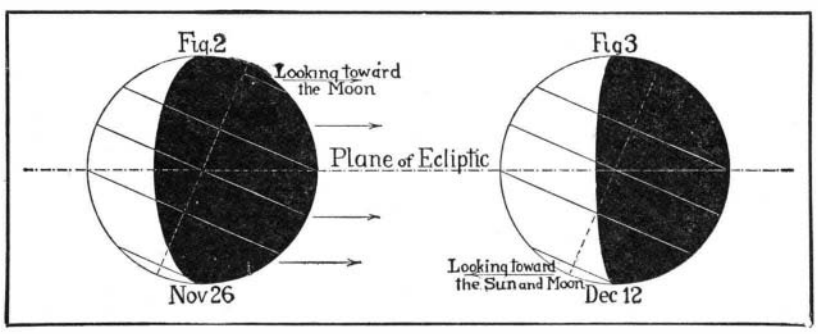


ROTATION OF MOON'S ORBIT BETWEEN JUNE AND DECEMBER.

In Fig. 3 the arrow shows the direction in which the eclipse of the sun will be seen. The limit of visibility will include a very small part of Australia, New Zealand, Tasmania, and the South Shetland Islands.

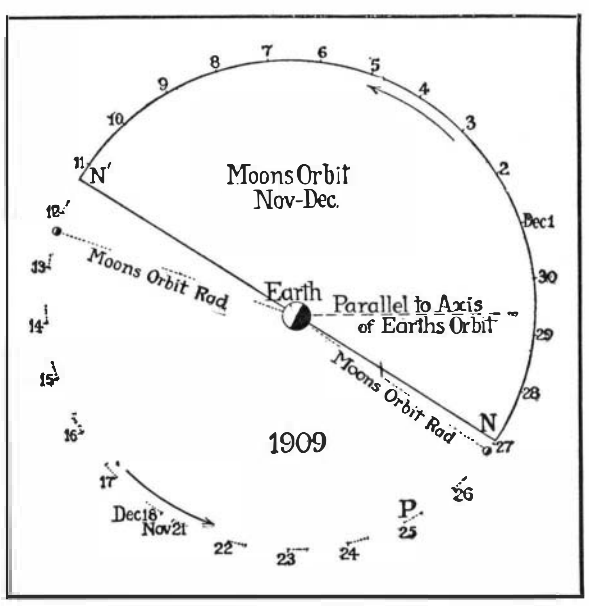
Why the Pole Shifts.

It is well established that, at least during historic times, no changes of any considerable magnitude have occurred in the latitudes of places on the earth. It has long been suspected by astronomers, however, that minute changes of latitude were taking place, but it is only during the last quarter century that the methods of observation and calculation have reached that degree of refinement necessary to detect these small changes.



DIRECTION IN WHICH ECLIPSES WILL BE SEEN.

In 1884 and 1885 Dr. Küstner, astronomer at the Royal Observatory of Berlin, made a series of observations upon certain stars for the purpose of determining the constant of aberration—the maximum apparent displacement of a star due to the finite ratio between the speed of the earth in its orbit and the velocity of light. One of the quantities used in the reduction of these observations is the latitude of the place of observation. Dr. Küstner found his results to be discordant, much more so than he had good reason to believe that they should be from the known care and precision with which the observations were made. Upon investigation it was found that these discrepancies could be almost entirely explained away by assuming a change in the latitude. Dr. Küstner, therefore, in 1888, made the bold announcement that the latitude of the Berlin Observatory had changed during the period over which his observations extended.



ENLARGED PLOT OF MOON'S ORBIT.

This announcement aroused widespread interest, and steps were immediately taken by the International Geodetic Association to test the reality of the announced variation. Through the co-operation of the observatories at Berlin, Potsdam, Prague, and Strasburg, observations for latitude were begun in 1889 and carried on continuously over a year. These observations agreed in showing a minute but appreciable change in the latitude. In order to test the matter still further, an expedition was sent in 1891-2 to Honolulu, and observations for latitude were made there simultaneously with others made at the observatories just named. As Honolulu is on the opposite side of the earth from Europe, it is seen at once that if the latitude were increasing at the European observatories, a corresponding decrease should be shown at the Honolulu station. The results came out as expected, and this was generally accepted as a complete demonstration of the reality of this phenomenon.

What is the cause of this wandering of the Pole? In an article by Dr. Sidney Dean Townley of Stanford University, this explanation is given:

In 1765 Euler, a famous Swiss mathematician, demonstrated, as a proposition in dynamics, that if a free rigid oblate spheroid rotates about an axis which differs slightly from the axis of figure, or shortest axis, then the axis of figure will revolve about the axis of rotation in a period the length of which will depend upon several factors. He computed that, if the assumed conditions obtained for the earth, then the period of revolution of the axis of figure above the axis of rotation would be 306 days. Obviously, however, the earth is not rigid; the oceans are quite plastic and the ground itself is possessed of some elasticity. Prof. Newcomb computed some years ago that, if we assume the earth as a whole to possess the rigidity of steel, then the period of revolution of the one axis about the other would be 441 days, as against 306 days found by Euler on the assumption that the earth is perfectly rigid. The actual observed period is fourteen months, or 427 days, and the legitimate conclusion to be drawn is that the earth as a whole is somewhat more rigid than steel—a conclusion that agrees with that derived by Lord Kelvin and others from entirely different considerations.

Now the question arises, Why does the earth not rotate upon its shortest axis? The explanation is simple. If the earth ever did rotate upon its shortest axis it could not continue to do so because of the shifting of matter upon and within the surface. Winds, rains, rivers, and ocean currents are ceaselessly transporting matter from point to point, and during the winter great masses of snow and ice accumulate in the temperate and frigid zones only to disappear again in the summer. Although these effects will, to a large extent, neutralize each other, the sum total can not be other than to produce at least a theoretical lop-sidedness to the earth; and as soon as this takes place there must be a shifting of the axis of rotation. The time of revolution of the one axis about the other could be accurately computed if the exact form of the earth, the structure of the earth's interior, and its coefficient of elasticity were known.

In addition, there are other phenomena, namely, volcanoes and earthquakes, through which considerable quantities of matter may be displaced. That the amplitude of the polar motion might be affected by earthquakes was pointed out by Prof. Milne ten or fifteen years ago and a French scientist has more recently compiled a table showing the number of severe earthquakes each year and the amplitude of the polar displacement. A rough proportionality between the two seems to exist; that is, the greater number of earthquakes each year, the greater the amplitude of the polar displacement. Such results, however, are to be taken with several grains of allowance. The term "severe earthquakes" is rather indefinite and by modifying the definition quite a variety of results may be obtained from the given data. It might be pointed out that in 1906, the year of the great earthquakes in California and Chile, the amplitude of the polar displacement was small.

We have then a rational explanation of the phenomenon of the variation of latitude. The axis upon which the earth rotates is not in exact coincidence with the shortest axis; such being the case, according to the principles of dynamics, the axis of figure must revolve around the axis of rotation, giving rise to the changes of latitude. But on account of the changes incessantly taking place in the distribution of matter upon the earth's surface, and perhaps also within the surface, the amplitude of the polar displacement, and perhaps the principal period of revolution of the one axis about the other, are changeable, the changes taking place in an undetermined way.

In connection with this explanation we should not lose sight of the fact that all the material moved through meteorological, volcanic, and seismic agencies is probably almost infinitesimal as compared with the total mass of the earth, and no one has as yet shown that the shifting masses are sufficient in magnitude to account properly for the observed annual and other unexplained components of the polar motion.—Abstracted from the Popular Science Monthly.

An International Sport Exposition.

An exposition devoted to sports and games is to be held in Frankfort-on-the-Main in 1910. Frankfort is annually the scene of many sporting contests, for which reason the selection of the city for the purpose of an international exposition is certainly wise. An executive committee has been formed, the first task of which was to give the organization its name, which rings imposingly "Verein Internationale Ausstellung fuer Sport und Spiel." The exposition will be divided into the following groups: 1. Horses and vehicles (harness, riding and driving equipment, stables, horse breeding and care). 2. Automobiles and motor-driven vehicles. 3. Turf sports, such as gymnastics, fencing, open-air athletics (tennis, football, golf, handball, polo, cricket, gymnastic apparatus, weapons, etc.). 4. Aquatic sports (rowboats, sailboats, motor boats, swimming, and fishing). 5. Winter and Alpine sports (skates, skis, snowshoes, sleds, huts, climbing outfits). 6. Hunting (guns, sportsmen's apparatus, stuffed animals). 7. Aerial sports (free balloons, dirigible airships, flying machines, models, aeronautic instruments). 8. Tourists' exhibits, such as photographic and optical apparatus (charts, guide books, history and literature of traveling, telescopes, etc.). 9. Application of sport to therapeutics (gymnastic apparatus, life-saving devices, transportation of invalids). 10. Sporting outfits of all kinds. 11. The artistic side of sport. 12. Toys. 13. Miscellaneous.

Award of a Medal for the Discovery of Bakelite.

At the second regular session of the New York Section of the American Chemical Society, held at the Chemists' Club, 108 West 55th Street in this city, on the evening of November 5th, Dr. Leo H. Baekeland, president of the Electro-Chemical Society, was awarded and presented with the Nichols medal for his papers on "The Synthesis, Constitution, and Industrial Application of Bakelite" and "Soluble and Fusible Resinous Condensation Products of Formaldehyde and Phenol."

In accepting the medal Dr. Baekeland expressed his thanks for this expression of regard for his work, and alluded feelingly to the friendly co-operation and aid he had received from the fellow members of the section. He then exhibited several industrial applications of the new compound bakelite, and made an experimental comparison of the resiliency of a ball of bakelite the size of a billiard ball with an ivory billiard ball. A stand three feet high was set upon the lecture table. The ivory ball was then dropped from the upper side of the stand to the table, the height of its rebound was noted, and the length of time of the rebound until it came to rest, which was six seconds, by the use of a stop watch. The ball of bakelite passing through the same height to the table rebounded at least six inches higher and came to rest in ten seconds, showing much greater resiliency than ivory.

Bakelite is used very successfully in the manufacture of electro-magnet spools, and is claimed to be superior to gutta percha in that it will stand a greater degree of heat, in the event of a short circuit.

The Current Supplement.

The opening article in the current SUPPLEMENT, No. 1768, deals with Henry Farman's new biplane. An excellent picture of the machine with Farman seated in it is presented. The first installment of an article on bakelite, a new composition, is given by L. H. Baekeland, its inventor. Samuel K. Patteson writes instructively on the measurement of humidity. The relation of Charles Darwin to Mendelism is set forth by Dr. A. E. Shipley. Recent models of superheated steam locomotives are described and illustrated. An illustrated description of the fast turbine yacht "Winchester" is published. Major H. L. Hawthorne critically points out the advantages and defects of balloons and dirigibles in war. Mr. Snowden B. Redfield concludes his article on the making of automobile tires. Hervey J. Skinner tells how tar is applied to the surface treatment of roads. The usual electrical, engineering, and trade notes and formulæ will be found in their accustomed places.

Correspondence.

FIGHTING POWER OF THE "INFLEXIBLE."

To the Editor of the SCIENTIFIC AMERICAN:

May I call the attention of your correspondent, Emerson B. Manley, whose letter appeared in your issue of October 23rd, to the fact that the "Inflexible" is not a sister ship of the "Dreadnought"? The "Inflexible," despite the number and power of her guns, is not rated as a battleship, but belongs to the cruiser class.

In an engagement between such a ship and a battleship carrying four 12-inch guns and a powerful secondary battery of 8's and 7's, it is most improbable that the ship of the "Inflexible" type would engage—and her excessive speed would give her the range decision—at such a range that her enemy's secondary battery could be effective. Her preponderance in big gun power—eight 12's against four—would enable her to demolish the secondary battery before the 8-inch and 7-inch guns could get a single effective shot home.

M. LATOUCHE THOMPSON.

St. John's Rectory, Manitou, Man.

WHY WATCH SPRINGS BREAK.

To the Editor of the SCIENTIFIC AMERICAN:

Being an old subscriber to your most valuable paper, I take the liberty of writing you regarding the unusual, or I should say peculiar, action of main springs in watches. My father, an horologist of over fifty years, and I, who learned the trade from him, have had some, as we think, remarkable experiences in the main-spring line. We think climate has much to do with their breakage; but if a watchmaker with sweaty hands handles a spring, there will be trouble. Also one who uses gasoline or any of the similar fluids will have the same trouble.

Our trouble has been mostly in the season when electric storms prevail, or a sudden change of temperature. We always advise our customers not to put watches on a marble dresser or any cold surface, but leave them in their pocket. The temperature in the vest or other garment changes gradually, and thus does away with any sudden expansion or contraction. We have been in the Mississippi Valley for many years, and our experience has been that, specially during the fall and spring seasons, during thunder storms we have more trouble with main springs. Sweaty hands do no good to a main spring. Tissue paper, in our experience, is the proper thing to wipe a spring with. May be slightly oiled. My father has been very successful in that line of watch repairing.

Natchez, Miss. F. T. BESSAC, M.O.

RAILWAY MOTOR CARS.

To the Editor of the SCIENTIFIC AMERICAN:

In your last issue I notice that you are to have a special issue on the middle West. I wish you would call attention through your valuable magazine to the need of some kind of a motor car that will run on railway tracks. It should be an independent motor car, run by its own engines. There is an opening for thousands of miles of so-called interurban railways in Iowa and other middle West States, where it would not pay to build an electric railway line on account of the large expense; but if some economical and reliable form of independent motor car could be perfected, such cars could be used for passenger traffic, and small steam locomotives for freight cars, and such roads would pay well. The track should be built on modern lines, with easy grades and curves and independent right of way, so that trains and cars can make good time for passenger service and can also handle freight cheaply, by use of regular freight cars from the steam roads, and thus would be valuable feeders and distributers for the steam roads, where branch steam lines would hardly pay. Such motor cars for passenger service should also be used on many branch steam railway lines, where better passenger service is badly needed, and where steam passenger trains are too expensive to run often enough to give good service.

Motor cars of this sort to use gasoline for power have been perfected and are in use in several places, but they are gradually being abandoned on account of the constantly increasing cost of gasoline. It seems that little or no progress is being made in perfecting such motor cars to use alcohol or kerosene. Might not the producer-gas engines for small boats requiring less than 500 horse-power be adapted for these motor cars? In your issue of September 18th, 1909, on page 191, you made mention of a very remarkable demonstration of the possibilities of producer-gas engines of this sort by Mr. H. L. Aldrich, using pea-anthracite, which at a cost of $4 per ton is stated to be one-tenth the cost of operation of a gasoline engine with gasoline at 15 cents a gallon, to produce equivalent power.

For a long time it has seemed to me that there is an excellent opportunity for invention in the production of such an independent motor car, operated by some power other than gasoline. Some cars of this sort are in apparently successful operation which generate electric power by means of a gasoline engine, but it seems that in so roundabout a system, there must be a large waste of power.

Equipped with motor cars of the sort suggested, such railways could be built much cheaper than trolley lines, and also operated much cheaper, until the business grows to a point where it would pay to change to electric power. The perfecting of such a car would mean the building of many miles of new railways, and possibly the cars would also be adopted in time by the steam railways to give better local passenger service. Many good towns in Iowa are made "whistling stations" by the steam roads in their mad race for through business.

Lack of better railway facilities, and lack of many miles of new railways that should have been built long ago, are factors that are holding back the development of a great deal of this middle West country.

Steam railways want through business, long hauls, and great tonnage; electric railways are too expensive as yet in many places; if a motor car that is light, reliable, and not expensive to operate, can be perfected, using producer-gas engines, there is no question but that there is a great opportunity and opening for such a car, as above suggested.

I trust that you will deem this communication as important as the number of our ancestors, for instance.

Belle Plaine, Iowa. H. R. MOSNAT.

ANOTHER EVIL OF DEFORESTATION.

To the Editor of the SCIENTIFIC AMERICAN:

One of the recognized evils produced by the woodmen who spare no tree (but leave where once the lord of the forest stood, the earth all bleak and bare) is the reduction in the yield of water power. But it seems that the fact that deforestation also increases the cost of what water power you do get, has never been mentioned.

Suppose that the flood level of a normal river is such as to require a 25-foot dam for power purposes. After the valley has been skinned of its foliage, the flood level will be so much greater that a dam 30 feet or more in height will be necessary.

As the cost of dams increases with the squares of the heights (because the higher up the thicker), the 30-foot dam will cost nearly fifty per cent more than the 25-foot, and yet it will yield less power than the 25-foot would yield in the normal river, because deforestation has diminished the flow of water in the dry season.

The yield in the dry season is the available yield, because the larger yield at other seasons is of little value, for almost all users of power want power all the year around.

It is true, as I showed in my article in Cassier's Magazine of September, 1909, that if we would use both turbines and current motors in the same dam, high dams would not be necessary in many rivers; but this truth may be disregarded, because it will probably be a hundred years before the system there mentioned will meet the right man—the man who will introduce it. SYLVESTER STEWART.

Brooklyn, N. Y.

The Death of Theodore R. Timby.

Theodore R. Timby died on November 9th, 1909, at Brooklyn, N. Y. He was chiefly known because of his claim to having invented the revolving turret of the famous "Monitor," and that, accordingly, he should have received the fame history accorded to John Ericsson. For more than forty years he had tried to collect $500,000 from the United States for two inventions, one the revolving turret on warships and the other a device that points and fires heavy guns with electricity. Other things which Timby invented, and from which he obtained both recognition and financial reward, were a floating drydock, a system of coast defense, and a turbine wheel which proved especially successful.

A Book of Fourth-Dimension Essays.

The subject of the fourth dimension seems to have aroused so much interest among the readers of the SCIENTIFIC AMERICAN that we have decided to publish in book form the prize essay, the three essays that received honorable mention, and about sixteen of the best essays which were submitted in the recent Fourth Dimension Contest. The entire collection will be edited by Prof. H. P. Manning, who will prepare an introduction of considerable length, in which the subject of the fourth dimension will be simply and lucidly discussed. The book will be ready about the latter part of December.

The meeting of the British Association in Winnipeg on August 25th, is the third which has been held in the Dominion. The first Canadian meeting took place in 1884 at Montreal; the second thirteen years later at Toronto. The fact that the third was held at Winnipeg may be regarded as significant of the enormous development of the West during the past few years.