plane of the ecliptic. Now our clock and all measurements of time must depend upon the earth's rotation, the plane of which always remains parallel to itself, and we have seen that our start-point for geocentric and heliocentric longitude depended upon the fact that at a certain point in its revolution the earth passed through a node, and that the node at which the sun with its apparent motion crossed the equator northward was called the ascending node. In the diagram this is represented by ♈ in the upper figure, and the descending node is indicated by ♎ in the lower figure. It will be seen that if we have equal intervals along the ecliptic the motion along the equator is represented by bases of successive triangles, of which the hypothenuses lie along the ecliptic. Now the hypothenuse must be

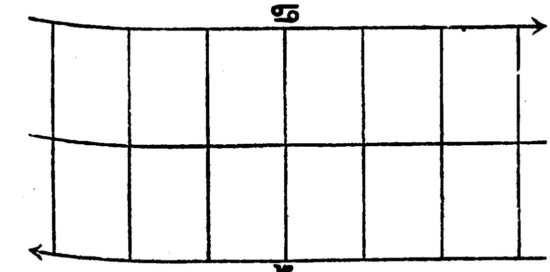

Fig. 51.—Diagram showing how the sun's apparent motion along the ecliptic, now parallel with the earth's equator (the central line of the figure) at the summer (♋) and winter (♑) solstices, is represented by equal intervals along the equator.

greater than the base, so that we have at the ascending node the motion of a body along the ecliptic represented only by the base of a triangle of which the motion itself represents the hypothenuse; and the same thing happens in the opposite manner at the descending node; whereas if we take the other positions shown in Fig. 51, for a short time at all events the motion will be parallel, and motion along the ecliptic will be represented by an equal amount along the equator.

These then are the difficulties we have to face when we come to fix our sun-time, first, the unequal velocity of the earth round the sun; and secondly, those variations which are brought about by the fact that the two motions of the earth—its axial rotation and yearly revolution—take place in different planes. How are these difficulties got over? They are got over by pretending a sun, as a child would say. Astronomers pretend that there is a sun moving along the equator, or, in other words, they pretend that the earth's movement of revolution takes place in the same plane as its movement of rotation. It is further imagined that this imaginary sun travels at precisely that rate which it would if the average of all its rates along the ecliptic during a year were taken, so that we get something like this (see Fig. 52); first of all we have the curve B B B B, which shows the variation which would take place providing we only had to deal with the obliquity of the ecliptic. Where that curve crosses the horizontal line, we get at those moments (if we disregard the elliptic motion) the same time shown by the mean sun as we should get if the true sun had been taken; it will be seen this occurs four times during the year—on March 20, June 21, September 23, and December 22. Then there is another curve, C C C C, which represents another relation between the mean sun and the true sun. Providing that the two planes were coincident, and that the movement of the earth under these conditions were exactly the same as under the present conditions, namely, that she moved in an ellipse and that the radius vector swept over equal areas in equal times, then we should have the true and mean sun coincident on December 31 and July 1 only. Then the algebraic mean of these two curves, B B B B and C C C C, is taken, and we get as a result the lower curve D D D D, which is a compound of the two other curves, and as the result it will be seen that where we got the curve C. giving us a difference of nearly five minutes, and the curve B, giving a difference of about nine minutes in the same direction, we have a very great departure between the motions of the real and mean suns. Above and below the datum line, which is marked zero, we have 5, 10, and 15, which represent the difference in minutes at which the southings of our real and fictitious suns really take place. Early in the month of February we have a difference of very nearly fifteen minutes between the two suns, and it is at this time of the year of course that the sun dial is most in error. At other points where the effect of curve B is to cause a great difference, the effect of curve C will be to minimise that difference, and so in the compound curve D the difference is very slight. About the middle of June we get them together, then towards the end of July we get another separation, and about November 1 we come

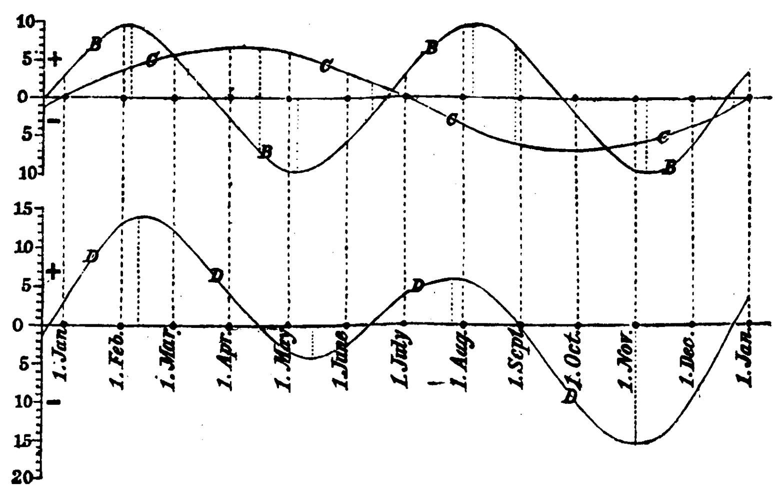

Fig. 52.—Diagram showing how the equation of time (curve D D D D) results rom the combination of curve B B B B representing the vairation due to the obliquity of the ecliptic, and curve C C C C representing the difference between the mean and true suns.

to another difference even greater than that in February. In this way a correction has been introduced, which is known as the "equation of time," and this added to the motion of the true sun, or added to that of our imaginary sun, brings them together, and by this means the mean sun is kept as nearly as possible to the average position of the true sun throughout the year. Another diagram (Fig. 53) will enable us to understand some of the considerations which have brought this about. Let P represent the position of the sun in one of the foci of the ellipse, P e A, round which the earth is supposed to be travelling. Now while we have the real radius vector going from P to e, with its unequal motion along the orbit, we have a fictitious radius vector going with absolute constancy along the circle. We get what is called the true anomaly in the angle P F e, and the mean anomaly in P F e', and the difference e F e' is called the equation of the centre. This equation helps us to determine those curves to which reference has been made, and the chief object in calling attention to this diagram is to explain the meaning of the term anomalistic year, which it will be necessary to introduce presently. It has already been said that it is imperative, if we are to gain any advantage from it, that real sun-time and apparent sun-time should never be widely separated, because if so we might have