W. MacL. HOMAN.

SUN DIAL.

APPLICATION FILED AUG. 21, 1907.

946,223. Patented Jan. 11, 1910.

2 SHEETS—SHEET 1.

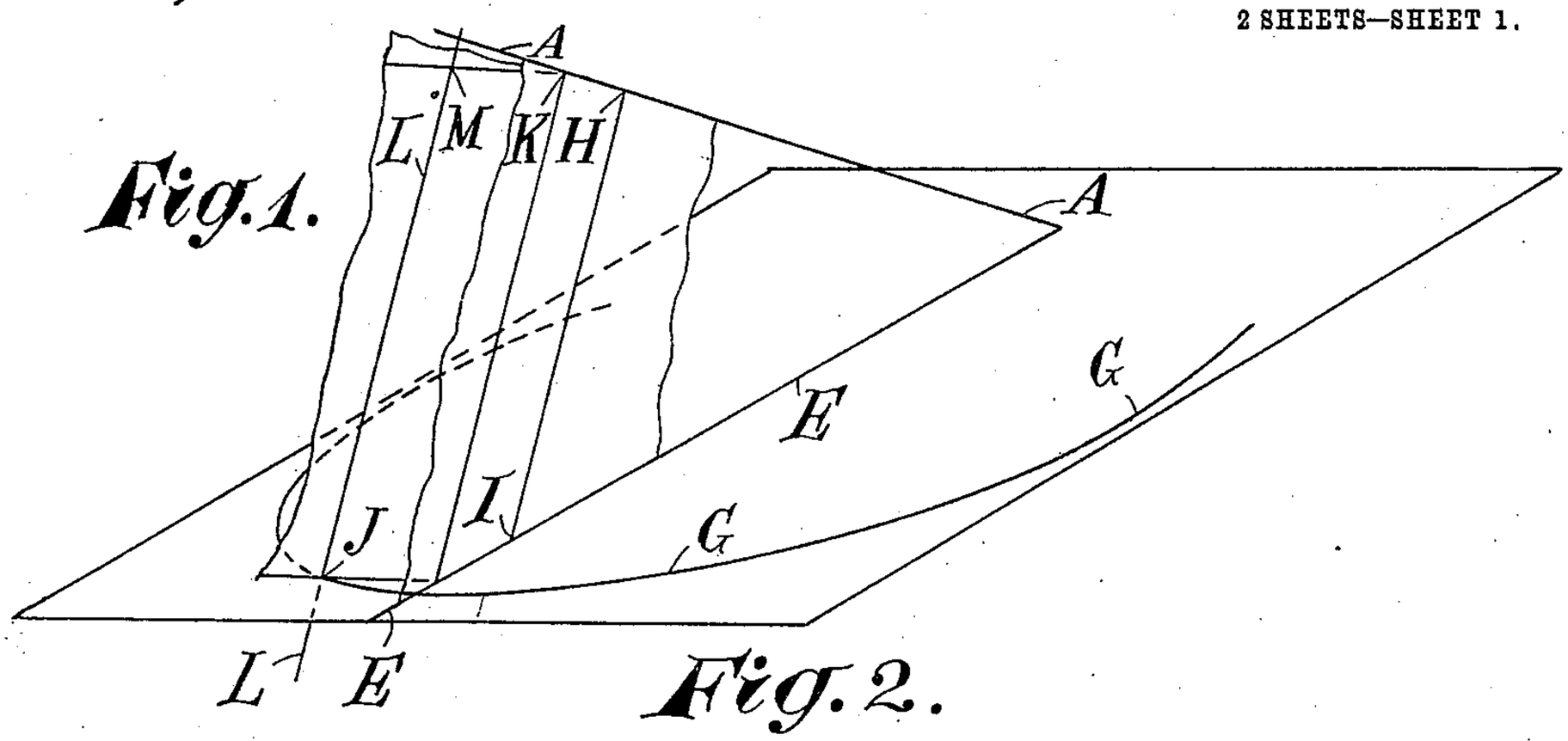


Fig. 1.

Fig. 2.

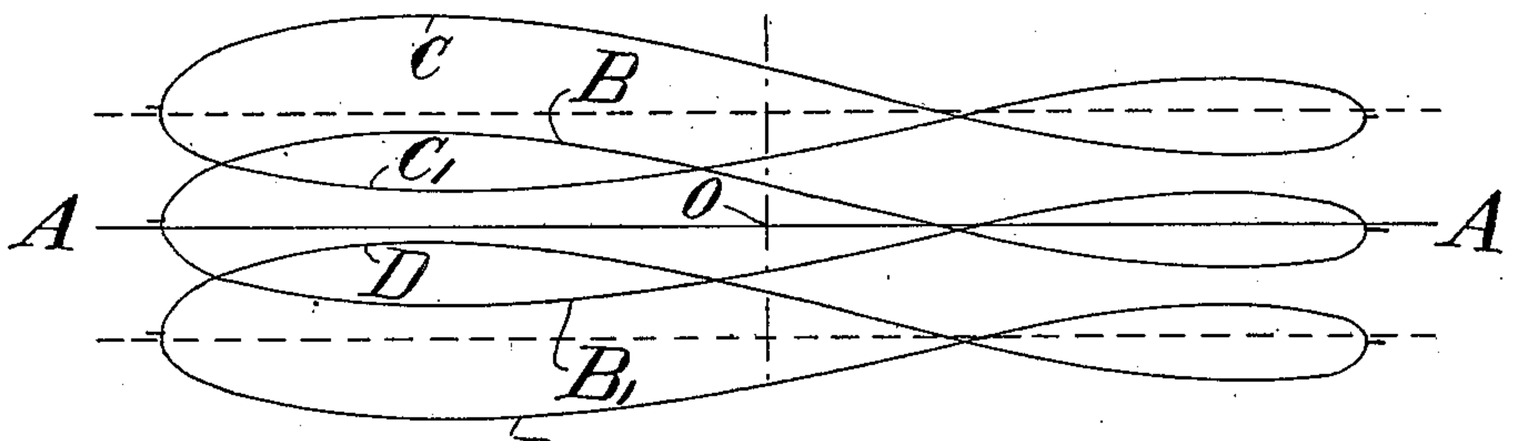


Fig. 3.

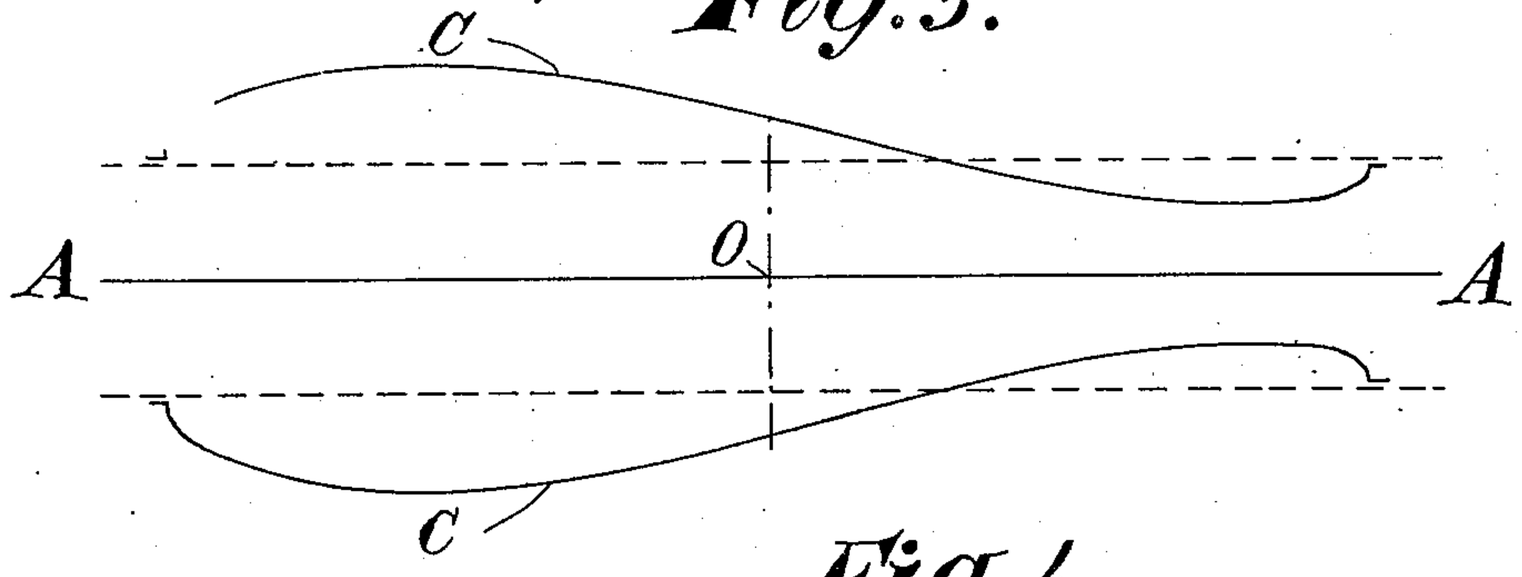
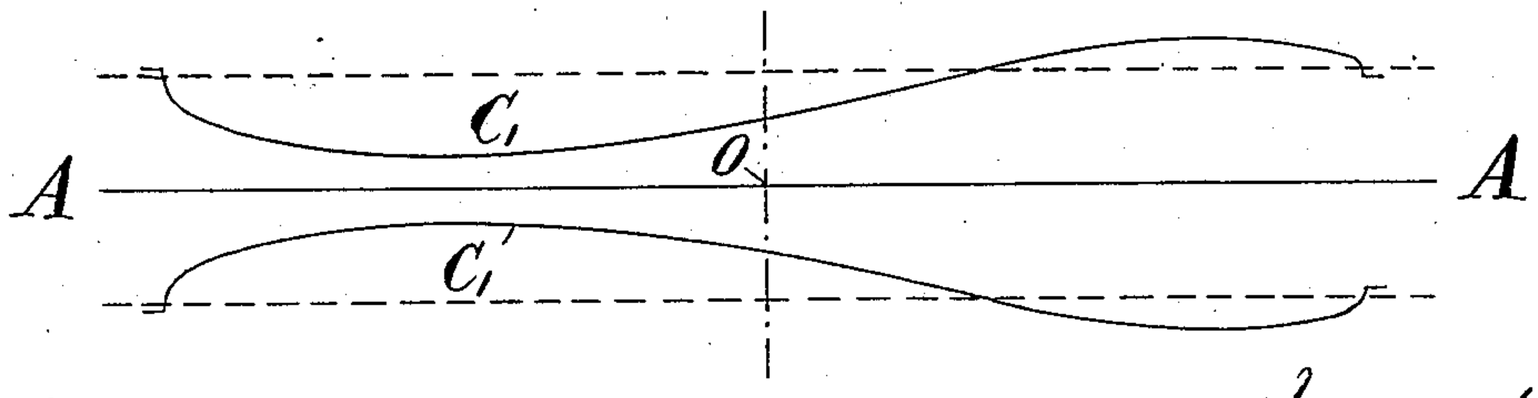


Fig. 4.



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2 SHEETS—SHEET 2.

Fig. 5.

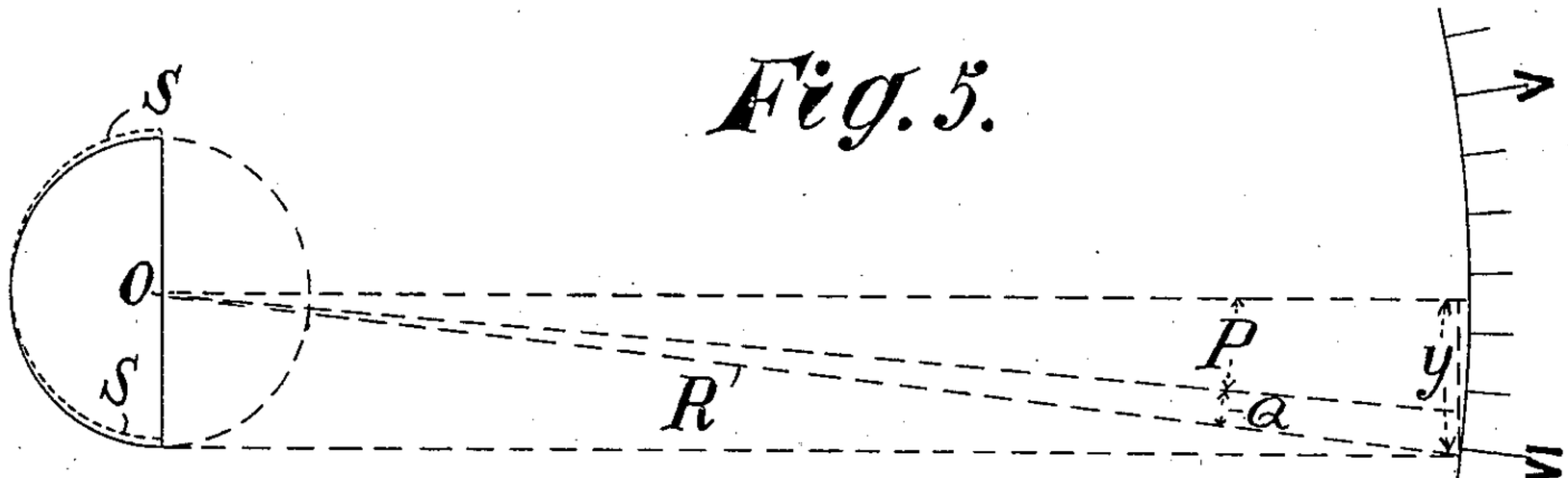


Fig. 6.

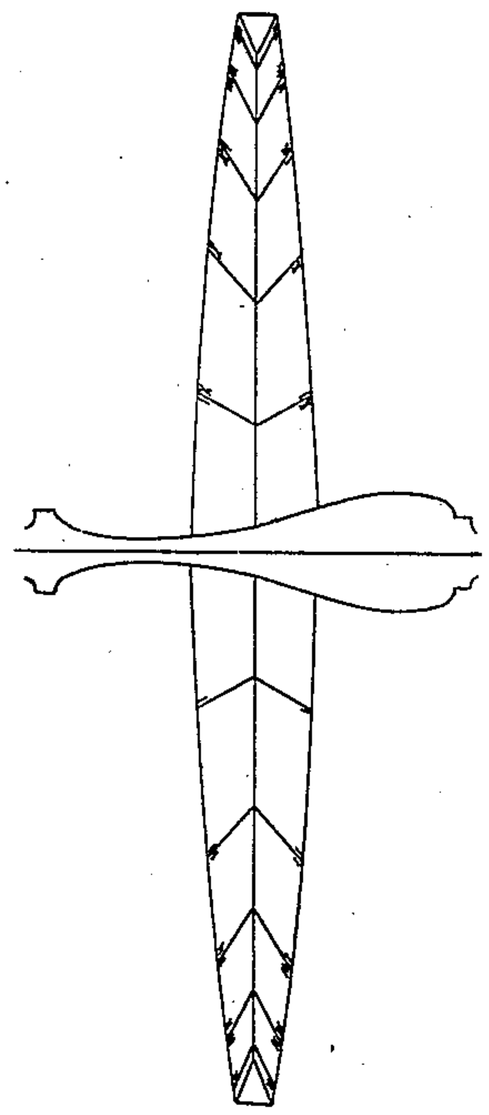
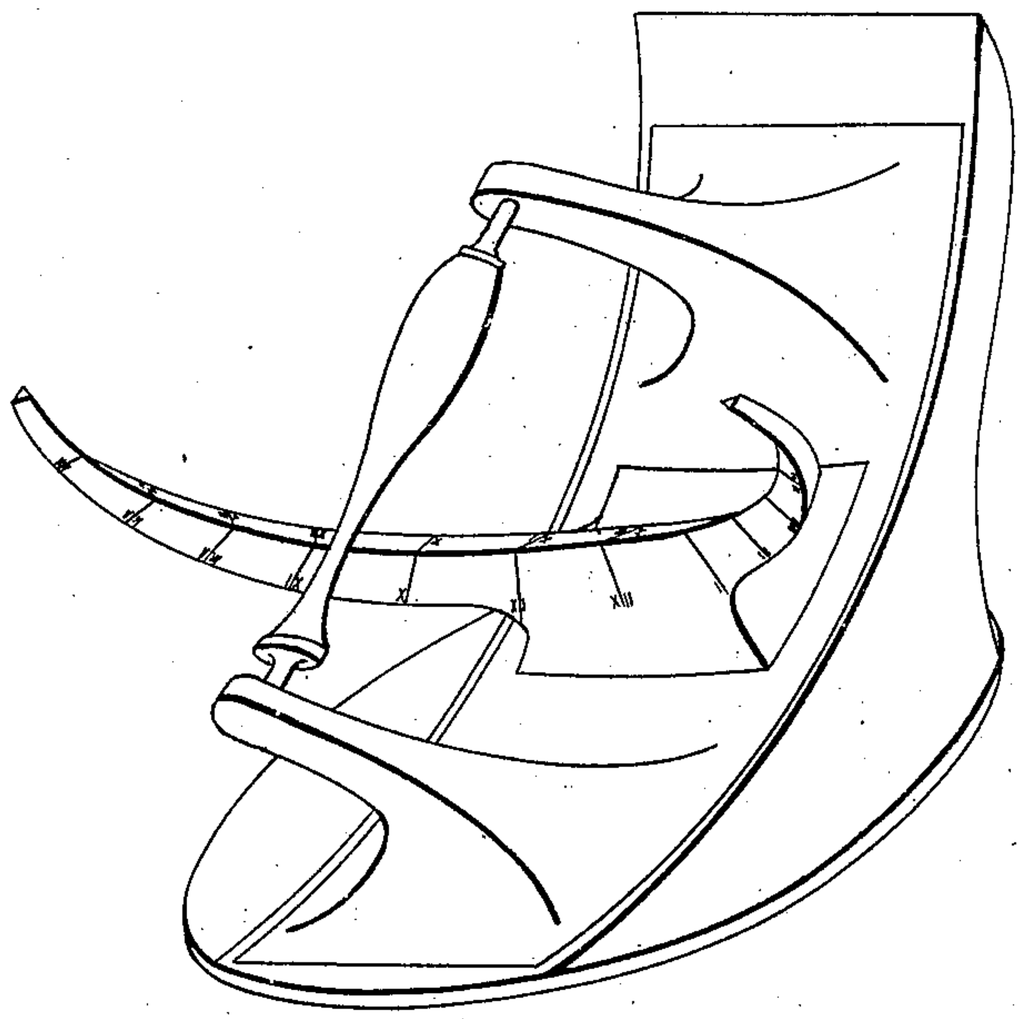


Fig. 7.



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UNITED STATES PATENT OFFICE.

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SUN-DIAL.

946,223. Specification of Letters Patent. Patented Jan. 11, 1910.

Application filed August 21, 1907. Serial No. 389,471.

To all whom it may concern:

Be it known that I, WILLIAM MacLEAN HOMAN, a subject of the King of Great Britain and Ireland, residing at Bethlehem, in the Orange River Colony, South Africa, have invented certain new and useful Improvements in Sun-Dials; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

This invention relates to improvements in sun dials and consists in the use of gnomons of a special design to be used in connection with dials, more particularly those of the equatorial arc or equinoctial type.

The object of the invention is to provide a sun dial showing mean solar time (either local time, civil time, or the time of any desired longitude) instead of solar time, and also so constructed that the time may be read either entirely from the eastern or entirely from the western edge of shadow, according to the design of dial and gnomons.

On the accompanying drawing Figure 1 is a diagram, illustrating the manner in which the contour of the gnomons in general is derived. Fig. 2 is an illustration of the manner in which the section of gnomons for use with an equatorial arc and equinoctial dials may be derived. Figs. 3 and 4 show the longitudinal sections of gnomons shown in Fig. 2. Fig. 5 is a cross section of the gnomon shown in Fig. 3, looking toward the south, in combination with an equatorial arc. Fig. 6 illustrates the relative positions of gnomon and dial, shown as an equatorial arc. Fig. 7 is a perspective view of my new sun dial.

The shape of the gnomons, of which two should be used, one from summer solstice till winter solstice and another during the remainder of the year, may be determined as follows: On the dial surface are described one or more suitable curved or straight lines G, G as shown in the diagram Fig. 1, on which the hour and minute divisions are laid off, at suitable, but, within certain limits, arbitrary intervals (and the time is read at intersection of this line or of one of these lines with the edge of the shadow of the gnomon). The position of the dial relatively to the axis or base line of the gnomon A—A on the diagram Fig. 1, which axis must be parallel to the axis of the earth, is chosen so that the shadow of said axis will either always fall in advance of or always fall in the rear of the time division indicating the mean time at which the shadow is observed. Supposing that in Fig. 1, the axis or base line of the gnomon is indicated by A—A and that J is a certain time division; also that at the mean time indicated by J the shadow of A—A will fall along the line E—E, when the sun is at a certain declination, then the contour point M of the gnomon for the time J and this declination of the sun will be determined as follows: Imagine a plane through A—A and E—E. Imagine H—I to be the shadow of a point H on the line A—A. Imagine a plane passing through J at right angles to the first plane A—A, E—E and parallel to H—I. This second plane will cut A—A at K. Imagine a line L—L passing through J and parallel to the intersection line of the two above mentioned planes. Imagine a line through K at right angles to L—L, and consequently at right angles to A—A. The point M where this line intersects L—L is the contour point of the gnomon which is sought. The form of a gnomon is determined by a sufficient number of such contour or surface points.

The shape of the gnomons may be expressed by the following formula:

$$\text{Abscissa } x = R \times \tan. N - (R \times \text{versed sine } (P+Q) \times \tan. N).$$

$$\text{Ordinate } y = R \times \sin (P+Q),$$

where—

x=abscissa along polar axis,
y=ordinate,
R=distance between time mark and axis,
P=constant angle,
N=declination of sun,
Q=angular value of equation of time corresponding to declination of sun N.

As a zero point for x and y is taken in every instance the intersection point of the axis with a plane at right angles to the axis and passing through the time point on dial. If the dial surface is of the equatorial arc or equinoctial type and the line on which time divisions are marked is an arc or circle in a plane parallel to the equator uniformly divided into 24 hours each of 15 degrees, the

gnomons become bodies of revolution about an axis at right angles to the center of the arc or circle. Each of the two gnomons, the one for use from summer solstice till winter solstice and another during the remainder of year, is determined by the revolution about its axis of one of the curves drawn through points determined in the following manner: Along a straight line A—A, the polar axis, in both directions from a point chosen as zero, O, the equatorial zero hereafter referred to, abscissæ, at sufficiently close intervals to insure accuracy, are laid off, each abscissæ being equal to: Radius of equatorial arc multiplied by the tangent of sun's declination minus radius of equatorial arc by versed sine of the angle which is the sum of the constant angle referred to below, by which length of ordinates is defined, plus angular value of equation of time corresponding to sun's declination multiplied by tangent of sun's declination. At each point thus found an ordinate, at right angles to the polar axis, is laid off equal to: Radius of equatorial arc multiplied by the sine of an angle, which is the sum of a constant angle and the angular value of the equation of time corresponding to the declination of sun used in laying off abscissa, "before clock" and "after clock" of equation of time being treated as plus and minus or minus and plus quantities respectively.

The novelty of invention consists in the introduction of above mentioned constant angle P. This angle, when suitably chosen, has a very material effect on the practicability of design of the gnomon and on the facility in reading the time on the dial. The constant angle should be chosen so, that the resulting gnomon is of a practicable thickness and strength throughout, and so that the time may be read throughout the whole year from the shadow tangent either to the western or the eastern half of the gnomons alone. Whether the eastern or the western shadow is used depends on the sign applied to "before clock" and "after clock" of the equation of time in designing the gnomon. Although the gnomon for use with an equatorial arc is described as a body of revolution it must be understood, that the shadow of only either the western or the eastern half is used, and that the other half of the gnomon may consequently be omitted in practice. A correction for the refraction of the rays of the sun may be applied to shape of the gnomons by suitably enlarging or decreasing the upper and lower halves of the gnomons. An approximate correction for refraction may also be made by raising or lowering the position of the axis of the gnomons. The application of correction for refraction is shown by line S—S in Fig. No. 5.

In order to secure horizontality or any desired inclination of the base of the dial, and in order to suit the dial to show local mean time, civil time, or the mean time of any desired longitude, adjustments of the position of the gnomon and the equatorial arc or dial are necessary. These adjustments may be made by making the dial in different pieces, which can be assembled and fixed in permanent or temporary relationship. The axis of the gnomon when adjusted is parallel to the axis of the earth. In the case of equatorial arc or equinoctial dials it is at right angles to the plane in which the time line of the equatorial arc is situated, the equatorial zero of the axis of gnomon being situated in the above plane and, unless where the approximate correction for refraction is made, in the center of the equatorial time curve.

Fig. 2 illustrates the manner in which the section of gnomons for use with equatorial arc and equinoctial dials may be derived. B–B_1 is the curve of the equation of time. The curves C and C_1 are derived by taking "before clock" as positive and "after clock" as negative. The curves D and D_1 are derived by taking "before clock" as negative and "after clock" as positive. From curves C and D gnomons are derived for use between June solstice and December solstice. From C_1 and D_1 gnomons are derived for use during remainder of year. C and C_1 form one set of gnomons where the shadow tangent to the eastern half of gnomon indicates the time. D and D_1 form one set of gnomons, where the shadow tangent to the western half of the gnomon indicates the time. The end of gnomon shown on the left hand of diagram should point toward the south, and the right hand end should point toward the north.

Figs. 3 and 4 show the longitudinal sections of gnomons derived from the curves C and C_1. The former is for use from June solstice till December solstice, and the latter for use during the remainder of year.

Fig. 5 shows a cross section of the gnomon shown in Fig. 2 looking toward the south, in combination with an equatorial arc. It indicates how ordinates of gnomon curves are derived. R is the radius of the equatorial arc, P is the constant angle, Q is the angular value of the equation of time (corresponding in drawing to declination of sun 0°). The full lines of cross section show the necessary half of the gnomon (the eastern half), the large dotted lines indicate the western half of the gnomon. The small-dotted lines S—S indicate correction for refraction of sun's rays.

To sum up the essential features of my invention are: (*a*) The shape of the gnomon, determined in the manner described, whereby the result is obtained that the dial indi-

cates local mean time, civil time, or the mean time of any required longitude with greater accuracy than hitherto obtained with sun dials of known construction. (*b*) Gnomons of a practicable shape and rigidity allowing the correct time to be observed on the dial without adjustment or correction. (*c*) The time is observed throughout the year by the shadow tangent to either the western or the eastern half of the gnomon alone, according to the design of the dial, and the error due to reading the time from the wrong shadow is thus avoided.

I claim.

In a sun dial a gnomon of such shape that by increasing or reducing its thickness the shadow of the gnomon, without any adjustment, will indicate mean time and that according to the design of the gnomon the time can be read during the entire year either exclusively from the western or eastern edge of the gnomon's shadow, this object being obtained by designing the gnomon according to the following formula:

Abscissa x=R×tang. N−
(R×versed sine (P+Q)×tang. N).
Ordinate y=R×sin (P+Q),
in which the formula is—
x=abscissa along the polar axis.
y=ordinate
R=distance between time mark and axis,
P=constant angle
N=declination of sun
Q=angular value of equation of time corresponding to declination of sun (N), and where as a zero point for x and y is taken in every instance the intersection point of the axis of the gnomon with the plane at right angles to the said axis and passing through the time point on the dial.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

WILLIAM MacLEAN HOMAN.

Witnesses:
J. M. MUNTER,
M. ALGER.