(No Model.) 2 Sheets—Sheet 1.

C. E. CHAMBERLAND.

SUN DIAL.

No. 490,185. Patented Jan. 17, 1893.

Fig. 1

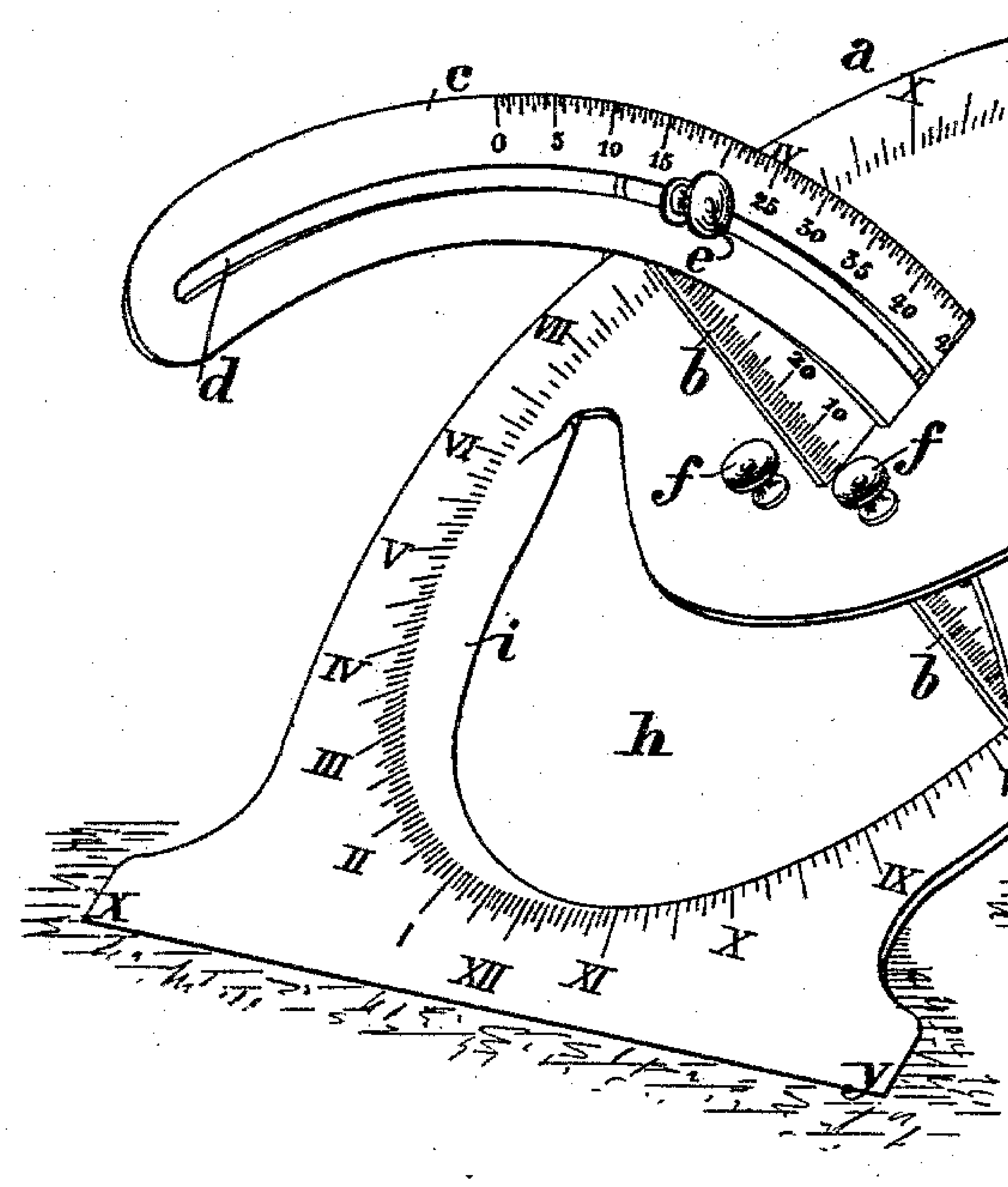

Fig. 5

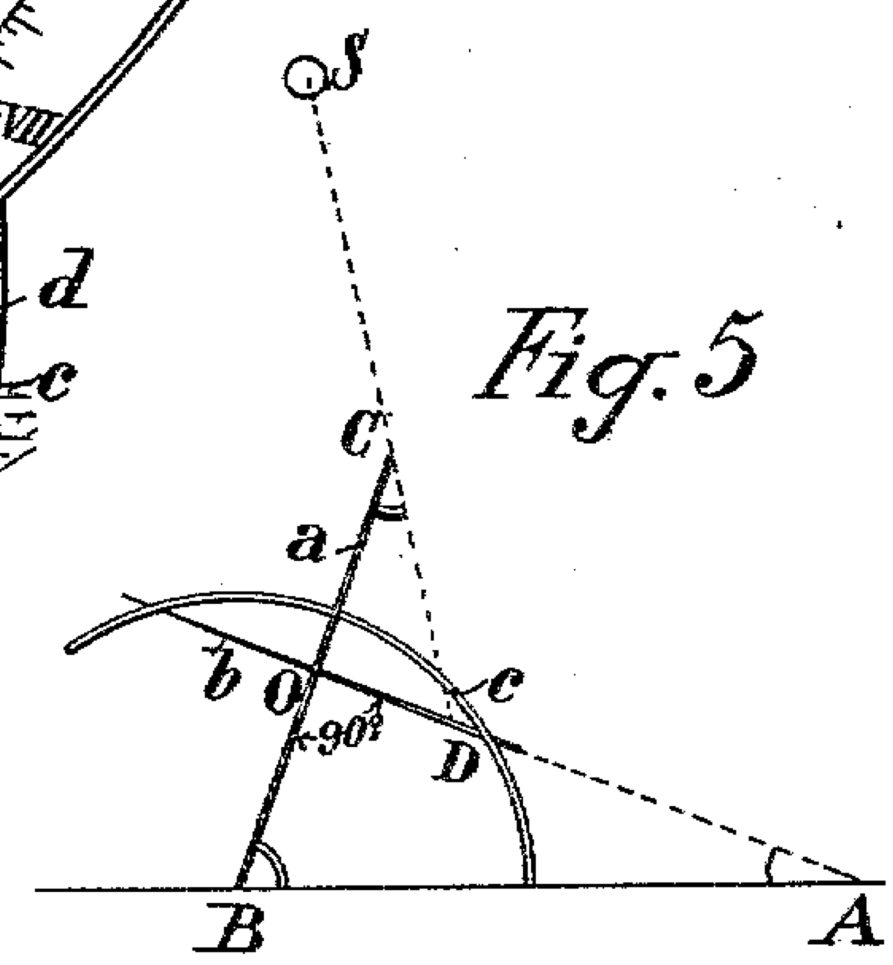

Fig. 3

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	+ 4	+ 14	+ 13	+ 4	- 3	- 2	+ 3	+ 6	0	- 10	- 16	- 11
6	+ 6	+ 14	+ 11	+ 2	- 4	- 2	+ 4	+ 6	- 2	- 12	- 16	- 9
11	+ 8	+ 14	+ 10	+ 1	- 4	- 1	+ 5	+ 5	- 3	- 13	- 16	- 7
16	+ 10	+ 14	+ 9	0	- 4	0	+ 6	+ 4	- 5	- 14	- 15	- 4
21	+ 12	+ 14	+ 7	- 1	- 4	+ 1	+ 6	+ 3	- 7	- 15	- 14	- 2
26	+ 13	+ 13	+ 6	- 2	- 3	+ 2	+ 6	+ 2	- 9	- 16	- 13	+ 1

Witnesses:
J. A. Rutherford.
Robt Everett.

Inventor:
Charles E. Chamberland
By James L. Norris.
Attorney.

(No Model.)

2 Sheets—Sheet 2.

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SUN DIAL.

No. 490,185. Patented Jan. 17, 1893.

Fig. 2

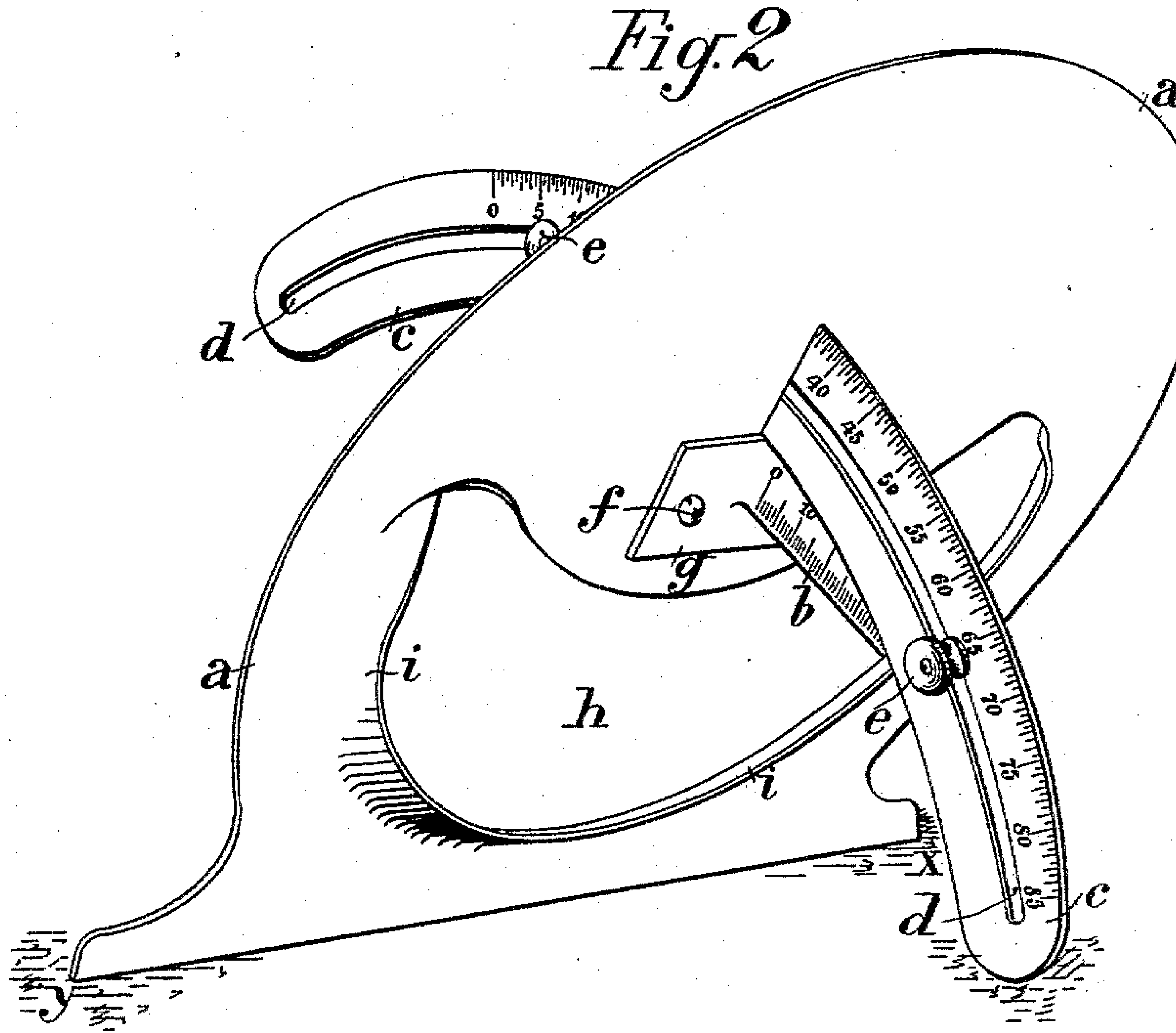

Fig. 4

	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	4,25	3,05	1,30	0,80	2,70	4,05	4,25	3,25	1,45	0,60	2,60	4,00
6	4,15	2,75	1,00	1,15	2,95	4,15	4,15	3,00	1,15	0,90	2,90	4,15
11	4,00	2,50	0,65	1,45	3,25	4,25	4,05	2,70	0,80	1,25	3,15	4,25
16	3,80	2,15	0,30	1,80	3,45	4,30	3,90	2,45	0,45	1,55	3,40	4,30
21	3,60	1,85	0,05	2,15	3,70	4,35	3,75	2,15	0,10	1,90	3,65	4,35
26	3,40	1,50	0,40	2,40	3,85	4,35	3,55	1,85	0,25	2,25	3,85	4,35

Witnesses:
J. A. Rutherford.
Robert Everett.

Inventor:
Charles E. Chamberland
By James L. Norris.
Attorney.

UNITED STATES PATENT OFFICE.

CHARLES EDOUARD CHAMBERLAND, OF PARIS, FRANCE.

SUN-DIAL.

SPECIFICATION forming part of Letters Patent No. 490,185, dated January 17, 1893.

Application filed August 23, 1892. Serial No. 443,919. (No model.)

To all whom it may concern:

Be it known that I, CHARLES EDOUARD CHAMBERLAND, of 145 Rue de Rennes, Paris, France, manager at the Pasteur Institute, Paris, France, have invented a certain new and useful Improvement in Sun-Dials; and I do hereby declare that the following is a full, clear, and exact description of the same.

The invention has for object to provide a cheap portable sun dial capable of being located at any part of the globe and of being adjusted by means of the indications of the apparatus itself, without it being necessary to have recourse either to the indications of the compass, or to know the solar time. My improved apparatus thus constitutes a real solar clock.

The improved sun dial is illustrated, by way of example only, in the accompanying drawings in which:—

Figure 1 is a perspective view of the apparatus from the side of the front face of the dial; Fig. 2 shows in perspective the same apparatus seen from the side of the rear face of the dial; Fig. 3 is a table or scale preferably inscribed upon the front face of the dial and giving the corrections in minutes which are to be made in the actual solar time indicated by the apparatus, in order to know the mean time corresponding to the indications of ordinary clocks; Fig. 4 is another table or scale to be preferably inscribed on the rear face of the dial, giving the necessary indications for adjusting the apparatus; Fig. 5 is a diagram to which reference will be made hereinafter in explaining the principle of the apparatus.

The use of the two tables will be clearly described hereinafter.

The apparatus consists of the dial proper *a* which may be constructed of any suitable material, such as metal, glass, wood, pasteboard, &c. and which rests with its straight edge *x*—*y* on a horizontal plane. The dial *a* is traversed by a flat stem *b* which is perpendicular to the plane of the dial and one of the edges of which passes through the center of the said dial. Upon the stem *b* there slides an arc-shaped link *c* in which is formed an arc-shaped slot *d*; into this slot enter the spindles of two screws *e*, *e* which are screwed into the stem *b* near the ends of the latter, and the heads of which allow of fixing the movable arc in any desired position with relation to the dial *a* and to the stem *b*. The stem *b* may be fixed to the dial *a* either (as shown in the drawings), by means of two set screws *f* which pass through the dial *a* and engage in a shoulder *g* formed in one with the stem *b* or in any other suitable manner.

The link *c* (whose object is to allow of imparting more or less inclination to the apparatus according to the latitude of the place where the apparatus is located) is illustrated in the drawings as passing through the dial *a*. It is obvious that this link need not pass through the dial. It could for instance constitute a simple extension of the rear part of the stem *b* upon which it might be rigidly fixed (in such manner as to impart to the apparatus an inclination determined once for all to correspond to a given latitude) or upon which it might be mounted in link fashion as shown in the drawings, so as to allow of using the instrument in all latitudes.

The dial *a*, the stem *b*, and the link *c* are provided with scale divisions, the object of which will be explained hereinafter. Assuming that at a given place on the earth the apparatus be arranged in such a manner that the edge passing through the center of the dial (which edge I shall term "hour-axis") be placed in the direction of the axis of the earth. The plane of the dial will then represent the plane of the equator. The sun will turn around the axis in twenty-four hours, so that the shadow projected by the hour axis on the dial will move in one hour through a distance of three hundred and sixty twenty-fourths or fifteen degrees. The subdivisions of the arc of fifteen degrees will give the subdivisions of the hour. The dial *a* will then bear a regular graduation of twenty-four hours and subdivisions.

The principal question is to adjust the dial in such a manner that the "hour-axis" shall be in the same direction as the axis of the earth. Assuming this adjustment to have been made, then if the "hour-axis" is prolonged until it meets the horizontal plane A (Fig. 5); the angle A is the angle of latitude, and as in the triangle A O B, the angle O is a right angle, the angle B is consequently the complementary angle of the latitude. Now according to the construction of the apparatus, the center of the movable arc c is at B, then the portion of the arc c comprised between the horizontal plane and the dial a is a known arc, because the latitude of the place is given either by the Annual of the Office of Longitudes, or by geographical maps, and it will be sufficient to take the compliment thereof in order to obtain the length of the arc which should be comprised between the horizontal plane and the dial a. It will then be easy, by sliding the arc c upon the stem b, to determine (with the aid of the graduation in degrees inscribed thereon) the position of the said arc with relation to the dial and to fix it in position by tightening the screws e, e. The apparatus being thus regulated for the latitude of the place where the observer is situated, the hour axis must then be directed along the line north—south, in order to bring it into the direction of the axis of the earth. Assuming always that the apparatus be adjusted at a certain spot on the globe and let S (see Fig. 5) be the position of the sun for a specified day, the rays of the sun in just touching the border C of the dial, will project upon the "hour-axis" a certain shadow O D, and the angle O C D will be the angle of declination of the sun for the day. If the length O C is fixed, that is to say, if the dial is in the form of a circle, as in Figs. 1 and 2, the result will be that the length O D will remain practically fixed during the whole of the day, because the declination of the sun does not vary appreciably in the course of the day. Then if the length O D for a given day were known, it would be sufficient, in order to adjust the sun dial (previously adjusted to the latitude of the place) on said day, to turn it on the horizontal plane (about the point B) until the shadow projected by the border C of the dial upon the hour axis coincides with the length O D assumed to be known. Now, in the right-angle triangle O C D, O D=O C tg C. O C is known, also the angle C is known, because the angle of declination of the sun is given every day in the year by the Annual of the Office of Longitudes. It is therefore easy to make a table giving the lengths O D for the several days of the year. Moreover it should be remarked that the angles of declination of the sun for the various days of the year do not vary appreciably from one year to the other. In fact calculation shows that if the table of the averages of the angles of declination for a great number of years be made, the greatest difference between the mean angles thus obtained and the true angles is about ten minutes, which corresponds to the variation of about one-third millimeter in the length of O D, assuming the radius O C of the dial to be equal to ten centimeters. This difference may therefore be neglected in practice and it is easy to make a perpetual table giving the lengths O D for every day in the year.

The table shown in Fig. 4 (and which is preferably printed on the rear face of the dial) indicates in millimeters the lengths O D for the first, sixth, eleventh, sixteenth, twenty-first, and twenty-sixth of each month. By interpolation it will be easy to obtain the length corresponding to an intermediate day. With the object of effecting ready adjustment of the dial, the stem b carries inscribed upon the line "hour axis" a scale in millimeters, the divisions of which start from O from the front face of the dial in one direction, and from the rear face of the same dial in the other direction. It will therefore be easy, when the apparatus has been regulated as to latitude, to make it rotate on its base about a vertical axis, until the shadow O D produced by the border C of the dial from the hour axis, reaches, on the scale, the length indicated by the table, (Fig. 4) for the respective day. The apparatus will then be normally adjusted, and it will only be necessary to read the indications thereof. For this purpose, it may be stated that the sun in turning around the hour axis does not remain constantly on the same side of the plane of the dial, On March 21, the day of the spring equinox, the sun moves exactly in the plane of the dial; then on the following days, it rises forward of the plane of the dial in such a manner that the angles of declination increase, and in consequence the lengths O D increase. This is so until June 21, the time of the summer solstice, when the angle of declination is at the maximum (about 23° 23′); then the sun moves down again, passes anew through the same phases as before, and is again in the plane of the dial on the 21st of September, the day of the autumn equinox. It thus continues to descend, and passes to the rear of the plane of the dial. From that moment, the lengths O D are projected upon the hour axis forward of the dial, and the whole front face of the dial is in shadow. The sun continues to descend so as to reach, on the 21st of December the day of the winter solstice, a maximum declination equal to, but in a contrary direction, the declination of the summer solstice. Then the sun commences to reascend and returns into the plane of the dial on the 21st of March to recommence the same course as before.

After the preceding explanations, it will be understood that during six months in the year, (from 21st of September to 21st of March) the sun turns to the rear of the plane of the dial so that during that time, the shadow cast by the hour axis is projected upon the rear face of the dial. In order to avoid having to inscribe a scale upon said rear face, and especially in order to be able to read off the shadow conveniently, the apparatus may be constructed of a translucent material, such as dull glass, &c. I however prefer to employ the mode of construction illustrated in the accompanying drawings, recessing or cutting out the lower part of the dial (as shown at h in Figs. 1 and 2) along the inner border of the scale. The lower edge of the recess h

thus formed is folded back in such a manner as to form a border *i* upon which is projected a part of the shadow cast by the hour axis upon the rear face of the dial; the shadow thus becomes into direct contact with the divisions of the forward face and can be very easily read off from said latter face. It will be noted that it is sufficient to recess the dial along the line six o'clock in the morning—six o'clock in the evening, because in the winter, the days are of less than twelve hours duration. Finally, regard should be had to whether the time indicated by the dial is the exact solar time or true time. This hour is not that which ought to be indicated by clocks, because the duration of the solar day is not the same at different times of the year. Clocks therefore could not be set to the solar time; they would have to be sometimes put forward and sometimes put back. It is for this reason that ordinary clocks indicate the mean time, that is to say, the time of a fictitious sun, which, starting from the same point of the ecliptic as the true sun, would return to the same point at the end of the year. As the differences between true solar time and mean time do not vary appreciably from one year to the other, I have made a second table, shown in Fig. 3. This table, which is preferably printed on the front face of the dial, gives for the first, sixth, eleventh, sixteenth, twenty-first, and twenty-sixth of each month the number of minutes which should be added to or subtracted from the solar time indicated by the dial, in order to have the mean time. By interpolation, it will be easy to obtain the intermediate numbers corresponding to each day in the year. The numbers which are preceded by the sign (+) in the table (Fig. 3) should be added to the solar time read off the dial. The numbers which have the sign (−) prefixed should be subtracted from the time indicated by the dial.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is:—

A sun dial, consisting of a circular dial *a*, an hour axis *b*, fixed perpendicularly to the plane of the dial, provided with a straight scale and having one edge passing through the center of said dial, and a graduated arc-shaped link *c* mounted on the hour axis and having its rear end adapted to rest on a horizontal plane, substantially as described.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CHARLES EDOUARD CHAMBERLAND.

Witnesses:

R. H. BRANDON,

LEOPOLD ROEBER.