July 24, 1956 H. ALKEMA 2,755,565

STAR FINDER

Filed July 3, 1953 3 Sheets-Sheet 1

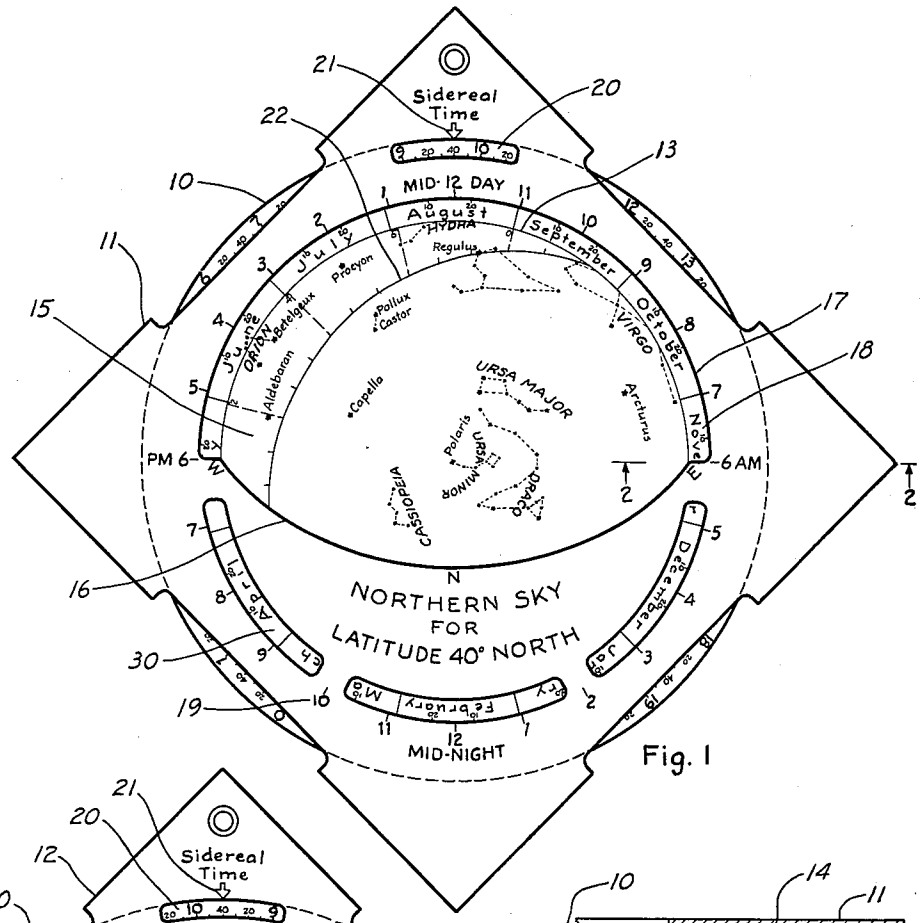


Fig. 1

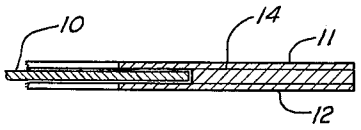


Fig. 2

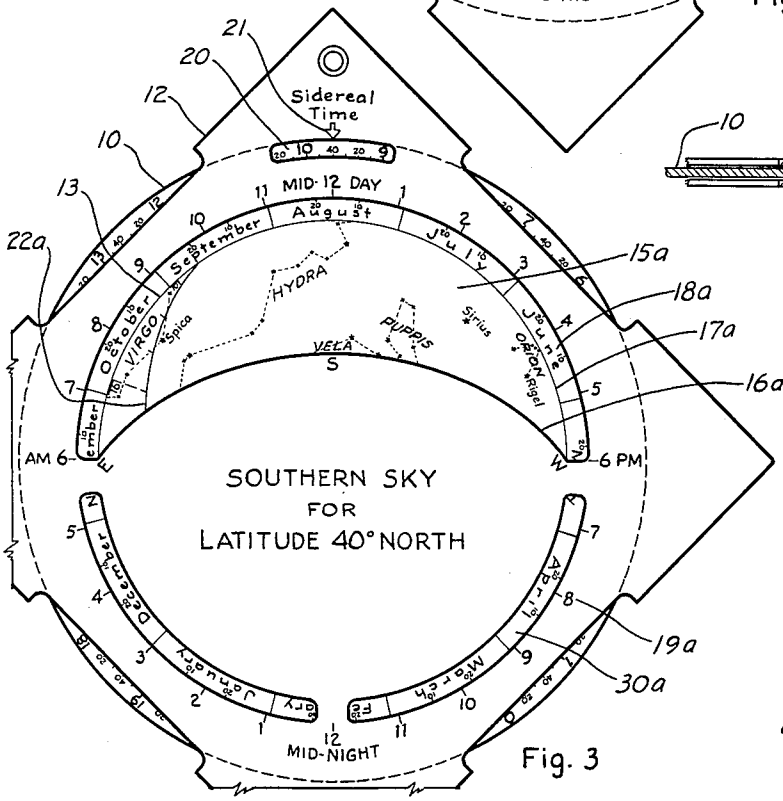


Fig. 3

INVENTOR.

H. Alkema

July 24, 1956 H. ALKEMA 2,755,565

STAR FINDER

Filed July 3, 1953 3 Sheets-Sheet 2

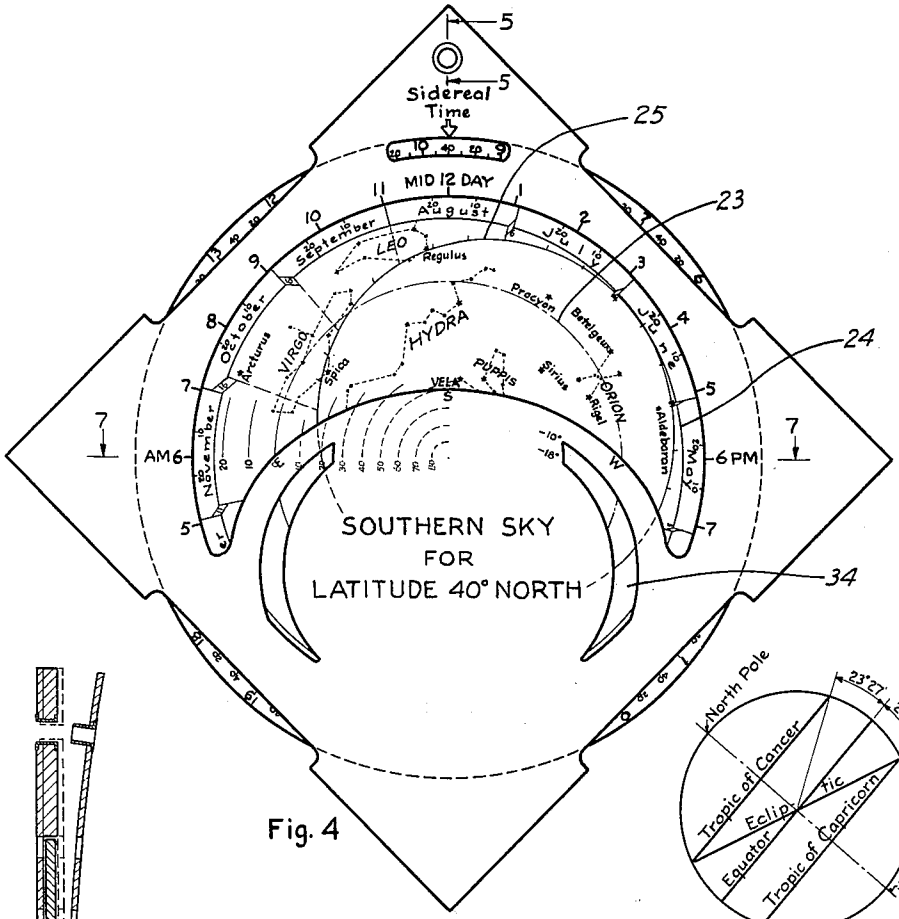


Fig. 4

Fig. 5

Fig. 6

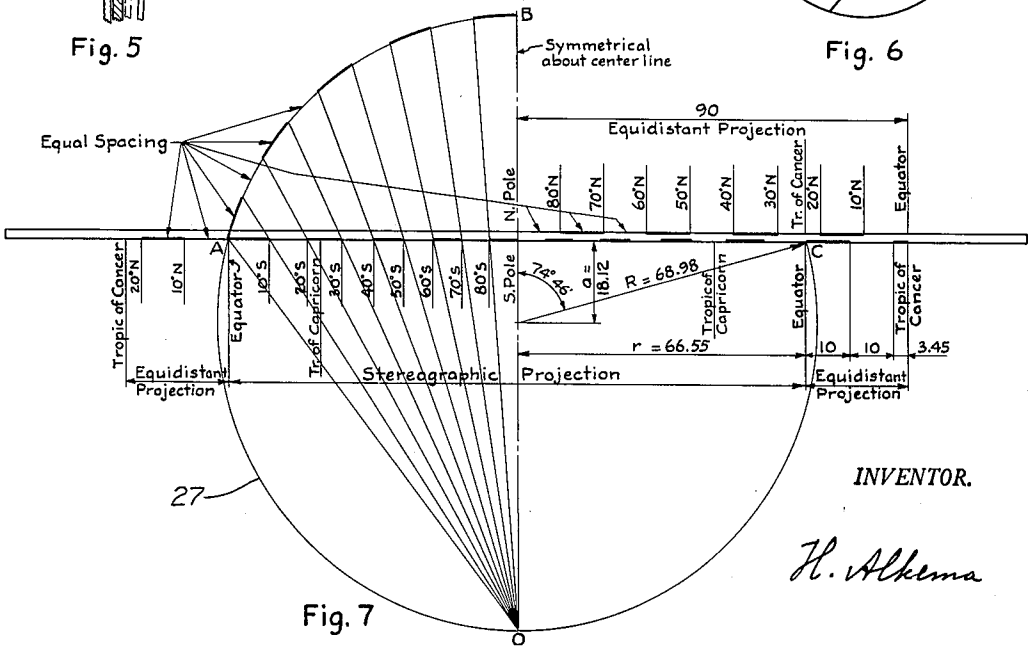


Fig. 7

INVENTOR.

H. Alkema

July 24, 1956 H. ALKEMA 2,755,565

STAR FINDER

Filed July 3, 1953 3 Sheets-Sheet 3

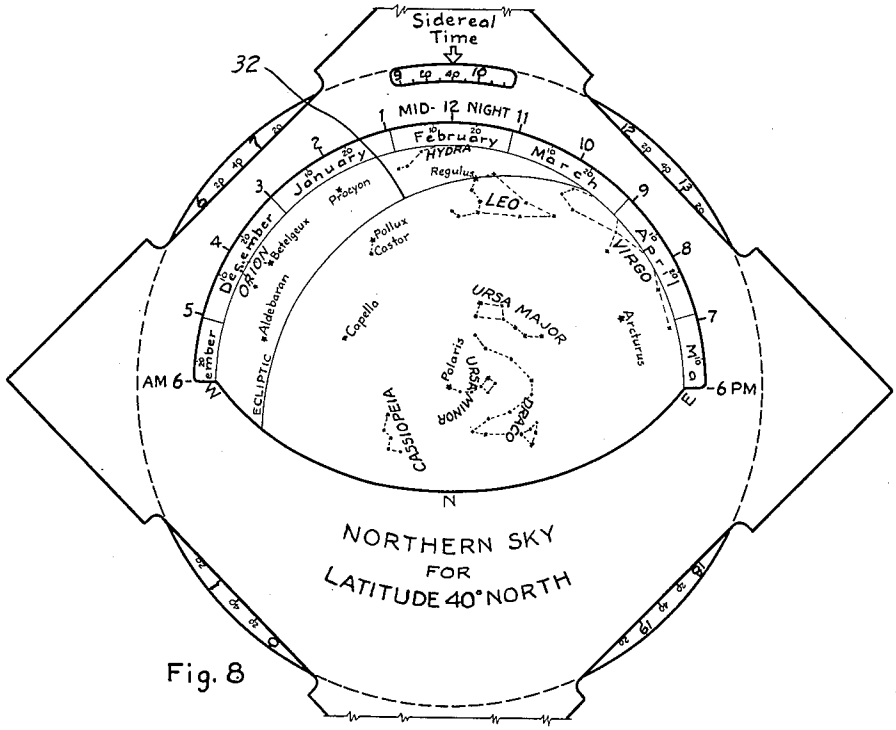


Fig. 8

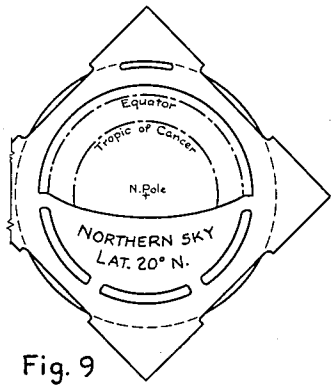


Fig. 9

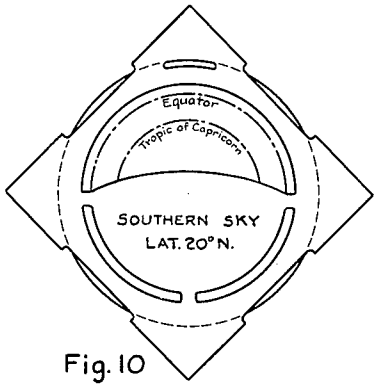


Fig. 10

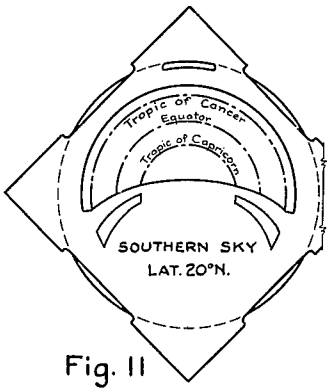


Fig. 11

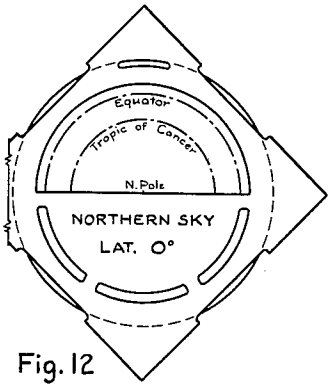


Fig. 12

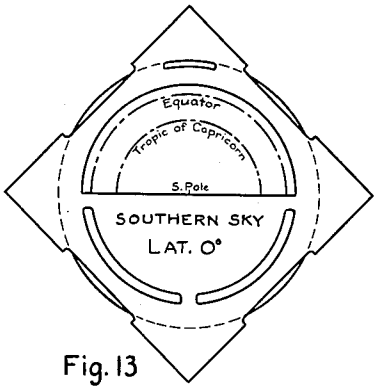


Fig. 13

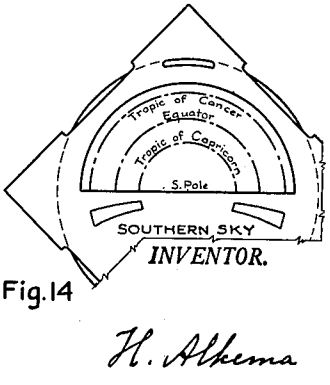


Fig. 14

INVENTOR.

H. Alkema

United States Patent Office

2,755,565

Patented July 24, 1956

2,755,565

STAR FINDER

Hendrik Alkema, Baltimore, Md.

Application July 3, 1953, Serial No. 365,803

17 Claims. (Cl. 35—44)

This invention relates to new and useful improvements in star finders and more particularly to improvements in a simple, efficient and inexpensive star finder adapted for use by amateur astronomers or by teachers and students, and aims to afford a larger scale and, therefore, a more legible star chart than is possible with existing devices of this nature but without increasing its size. This is accomplished by using both sides of the device, one side showing the northern sky and the other side showing the southern sky.

Another object of the invention is to provide a picture of the sky that is comparatively free from distortion, such as occurs on existing devices, thus making the constellations easily recognizable in all quarters of the sky.

Another object of the invention is to provide a device that is adaptable to all latitudes, including equatorial regions.

Another object of the invention is to provide a device that is easy to use, and that can be related to any portion of the sky more readily than the usual type of device that is required to be held overhead.

Another object of the invention is to provide a device clearly indicating sidereal time, giving for any day in the year the position of the sun in the ecliptic, showing clearly the relation between mean sun and true sun in its effect on the times of sunrise, sunset, and meridian passage, thus making this device of considerable educational value.

Another object is a device that will indicate at least two limits of twilight, one when the constellations are beginning to appear and another when twilight may be considered ended.

Still another object is achieved in a modified form of the device, on which the southern portion of the sky has been extended to include part of the northern hemisphere as far as the Tropic of Cancer, yet without increasing the size of the device and with a minimum sacrifice of scale, thereby assuring that the ecliptic will appear as a whole on that side of the device, while at the same time, providing ample overlapping of the two star charts.

Further objects and advantages will be pointed out as the description proceeds. In the accompanying drawings:

Fig. 1 is a plan view showing the north side of the device;

Fig. 2 is an enlarged section taken along line 2—2 of Fig. 1;

Fig. 3 is a plan view showing the south side of the device;

Fig. 4 is a plan view showing the south side of a modified form of the device;

Fig. 5 is an enlarged section taken along line 5—5 of Fig. 4 with parts separated;

Fig. 6 is a diagram of the celestial sphere (for reference only);

Fig. 7 is an enlarged section taken along line 7—7 of Fig. 4 (omitting the face plates), showing the geometrical construction of the varying scale used in the modified form of Fig. 4;

Fig. 8 is a plan of the north side of the modified form of the device;

Figs. 9 and 10 show the device in its regular form for latitude 20° north;

Fig. 11 shows the south side of the device in its modified form for latitude 20° north;

Figs. 12 and 13 show the device in its regular form for latitude 0°;

Fig. 14 shows the south side of the device in its modified form for latitude 0°.

The star finder of Figs. 1 and 3 has a star disk **10**, which is rotatable between the northern face plate **11** and the southern face plate **12**. Star disk **10** has a polar azimuthal equidistant projection of the northern sky on one side (Fig. 1) and a polar azimuthal equidistant projection of the southern sky on the other side (Fig. 3). Both projections are bounded by the celestial equator **13**. The two face plates **11** and **12** are connected in suitable manner, as by spacing plates **14** (Fig. 2), allowing the star disk to rotate freely. Face plate **11** has an opening **15** bounded by the northern horizon **16** and a half circle **17** slightly beyond the equator. Face plate **12** has an opening **15***a* bounded by the southern horizon **16***a* and half circle **17***a*. The advantage of this arrangement is that rather than concentrate the whole sky within the space available for it, here the sky of one hemisphere only is placed within that space, thus resulting in a much larger scale.

The method of setting the star disk in its correct position for a certain time consists of bringing the correct day of the year, as indicated by the date scale **18**, into registry with the time of day or night as indicated by the hour scale **19**. Thus, the northern sky of April 2 at 9:00 p. m., for instance, is as shown in Fig. 1. Now it can be seen at a glance that the southern sky on the reverse side, as shown in Fig. 3, is also correct for that date and hour as indicated by the data scale **18***a*, and the hour scale **19***a*. This means that only one side of the device requires setting. When this is done, the other side automatically is set correctly also. This also follows from the fact that the sidereal time is the same on both sides at all times. The sidereal time is indicated by the reading of the Right Ascension scale **20** at the arrow **21**, which is placed at the upper branch of the meridian. Both sides read 9 hours 40 minutes in the present case. case.

The northern half **22** of the ecliptic is shown in Fig. 1, and the southern half **22***a* in Fig. 3. The ecliptic is divided into months and parts of months (here of 10 days each, but they may be subdivided into smaller parts) to aid in locating the position of the true sun. The names of the months and numerals indicating days of the months have been omitted at the ecliptic since this data would unnecessarily obscure the star field. They are simply read on the date scales **18** and **18***a* which are in fairly close proximity and the date scale divisions are in sufficiently close correspondence with those of the ecliptic. The position of the mean sun, as indicated by the date scales **18** and **18***a*, however, may differ as much as 16 minutes (or 4°) from that of the true sun. This difference is what is known as the "Equation of Time," and the instant arrangement makes it readily visible. Numerals shown at the beginning of each month, such as 10, at October 1, 16 at November 1, etc., indicate the equation of time in minutes. The approximate value at other dates may be found by interpolation. It is suggested to mark the position of the true sun in the ecliptic with a pencil when it should be desired to find or demonstrate the times of sunrise or sunset and the time of meridian passage of the sun.

The date scale is here placed adjacent the star field so that toward the inside it aids in plotting the position of the true sun and along the outside it cooperates with the hour scale. This double function is possible because because the opening **15** is in part bounded by a semicircle (**17**). Due to this arrangement, the area available for the star chart is somewhat larger than it would otherwise be so that the scale can be still further enlarged. Openings **30**, **30***a* have been provided below the horizon to make visible as much as possible of the date scale. These openings are preferably of different sizes on the two sides so that, if the date one is looking for is obscured on one side, it will be visible on the other (compare Figs. 1 and 3).

In addition to the provision of larger scale star charts, an equally important advantage is the practical elimination of distortion generally occurring on existing devices, when the southern constellations, especially those south of the Tropic of Capricorn, are distorted so that they can hardly be recognized. This defect has been overcome in the present device where the southern sky is placed on the reverse side of the star disk. In this way these southern constellations appear as nearly in their true shape as do those of the northern hemisphere.

Then, by using interchangeable sets of face plates, this device becomes adaptable to all latitudes. The conventional form only works reasonably well for latitudes such as 40° or higher. It would, indeed, be difficult to make one for say, latitude 20° or for the equator. This is no problem here, see Figs. 9 to 14, and the device is equally adaptable to southern latitudes which will be discussed below.

On the present device, one side is for the northern and one for the southern sky and each side is thus clearly labeled. It is always held with the top simply pointing up, thus eliminating the tiresome manner of holding the device over one's head, and the confusion often resulting when switching from one portion of the sky to another.

All the above also applies to a modified and preferred form of the device, shown in Fig. 4, where the star projection takes in a larger area of the heavens, which is achieved by a reduction in scale of the center portion of it and substantially normal scale in the peripheral area. The scale is at a minimum at the south pole and increases gradually outward until at the celestial equator **23** and from there on outward normal scale is used. What this amounts to is that the area within the equator has been condensed into a smaller space, in order to gain room for an extra 23° 27′ outside of it. This places the Tropic of Cancer **24** where the equator was before, and it becomes now possible to show the ecliptic **25** in its entirety.

Fig. 7, which essentially is an enlarged section of the star disk, shows the geometry in detail. For the area within the equator on the southern projection the stereographic projection is used, while outside of it the scale becomes equidistant, with the same number of degrees per inch as on the northern chart side. The equidistant portion, being 23° 27′ in width, leaves for the radius r of the stereographic portion 66° 33′ or 66.55 equidistant degree units. A circle **27**, with a radius $R=68.98$ equidistant degree units, representing an imaginary sphere, is drawn as shown in Fig. 7. The arc AB is divided into 9 spaces each equal to 10 equidistant degree units, and these equal spaces are projected from point 0 to the southern face of the star disk. Fig. 7 has been so calculated that the resulting varying scale will blend unnoticeably into the equidistant outside area. The disadvantage of a reduced scale, which at its minimum at the south pole is 63% of normal, is very minor, since for a large range of northern latitudes a considerable area around the south pole is never seen anyway.

The ecliptic **25** of Fig. 4 is divided into months and parts of months as explained above for Figs. 1 and 3, and the names of the months are again simply taken from the date scale. The Equation of Time is again shown at the

beginning of each month. This arrangement, besides having the advantage of showing the ecliptic **25** in its entirety on one star chart, also provides an area of overlapping between the two star charts. An example will make this clear. The constellation of Orion, which straddles the equator, is in part shown in Fig. 1 and in part in Fig. 3. In Fig. 4, however, it is fully shown, plus a considerable extra area, thus demonstrating ample overlapping between the charts of Figs. 1 and 4.

Fig. 6, being a simple diagram of the celestial globe, has been added as a guick reference in locating the Tropics of Cancer and Capricorn.

The geometrical construction shown in Fig. 7 should be fairly self-explanatory, since all the necessary figures are given. It will be understood that a method other than that shown in Fig. 7 may be used to obtain an area of reduced scale around the south pole increasing gradually outward, and it would not be wrong, only less advantageous, to use the stereographic projection throughout for the southern chart.

Although, as explained above, the regular form of Fig. 1 for the northern side would work very well with the modified form of Fig. 4 for the southern side of the device, the modified northern side shown in Fig. 8 is nevertheless recommended. The star chart is unchanged, but the date scale has been rotated through 180°. For instance, whereas in Fig. 1 the name of the month occurring at Orion, is June, in Fig. 8 it is shown as December. In order to make this new date scale cooperate with the hour scale, this too had to be rotated through 180°, which in this case only meant interchanging a. m. and p. m. The advantage of this arrangement is that during the hours of night between 6:00 p. m. and 6:00 a. m. we can use the northern side and take advantage of the full uninterrupted half-circle present here. During the hours from 6:00 a. m. to 6:00 p. m. we use the southern side, which affords a similar full half-circle. In consequence, the openings **30** of Fig. 1 can be and are dispensed with in Fig. 8. It will be noted that the ecliptic **32** is not provided with date divisions as was the ecliptic **22** of Fig. 1. If it was, the names of the months would have to be printed alongside since a close correspondence between the date divisions of the date scale and of the ecliptic no longer exists here. The ecliptic **32** remains useful, however, mainly as a guide indicating where one may expect to find planets.

To determine the time when the constellations will begin to appear and the time when twilight is ended, the face plate of Fig. 4 has been provided with a pair of openings **34**, the upper edge of which is located at minus 10° altitude and the lower edge at minus 18°. When the pencil mark representing the sun in the ecliptic, after disappearing behind the western horizon, reappears in opening **34** it will be 10° below the horizon. This is the "observational" limit of twilight, so called by navigators, at which time the horizon is still visible although it is beginning to dim. It is roughly at this time that stars of lesser magnitude will start to appear in the sky and the constellations are beginning to become recognizable. When the mark of the sun disappears at the lower edge of opening **34** the "astronomical" limit of twilight has been reached and full darkness will set in. Between the two limits are varying degrees of good observation of the sky and the user of the device will know in advance the relative degree of twilight he can expect. In the hours before sunrise the same sequence of events will take place in reversed order.

The openings **34** are preferably made no longer than necessary to make the sun visible through them, and since the maximum declination of the sun is 23° 27′ north and south, the openings should extend at least to or slightly beyond those declinations.

Although openings **34** are shown in Fig. 4 only, similar openings may be cut for the regular form of Figs. 1 and 3, and the principle of their use would be as described for Fig. 4. However, since Figs. 1 and 3 already have

openings 30 and 30*a*, the face plates would be weakened, which could be remedied only by shorter openings 30 and 30*a*, but this would in turn result in a more often obstructed view of the date scale through them. As an alternate method, openings 30 and 30*a*, including perhaps 34, might be covered for reinforcing by a transparent material, or the face plates themselves could be made out of such material with areas that should not be transparent opaqued, in which case openings 30 and 30*a* would not have to consist of a series of separate windows but they would naturally be made continuous for a full half-circle. It is doubtful, however, that the use of transparent material is justified in the present device. All this becomes very simple in the case of the modification of Fig. 4 when combined with that of Fig. 8. Together they offer the most advantages.

In Figs. 9 to 14 is shown how face plates adapted for varying latitudes can be used in conjunction with the same star disk. Figs. 11 and 14 represent the modified form as explained in connection with Fig. 4. Special emphasis has been placed on the Equator and the Tropics of Cancer and Capricorn. This, together with the labeling, should make these figures self-explanatory.

As stated above, this device is adaptable also to southern latitudes. In the case of the regular form of Figs. 1 and 3, this is a simple matter, since the southern face plate for any southern latitude, e. g., 40° S, is shaped exactly like the northern face plate for the same northern latitude, in this case 40° N (see Fig. 1), the only difference being that the hours would run in the opposite direction, the way they should for the "southern sky" side of the device. Similarly, the points N, E and W would become S, W and E, respectively. But the star disk is the same in every respect for both northern and southern latitudes.

For the modified form, however, it is imperative to use one star disk for each geographical hemisphere. The geometry for the star disk for southern latitudes would be as shown in Fig. 7, except that north and south (and the Tropics of Cancer and Capricorn) would have to be interchanged.

In Fig. 5, which is an enlarged section along line 5—5 of Fig. 4, a method is indicated whereby the face plates can be made interchangeable. At one corner, preferably the top, one face plate has been made detachable so as to make possible removal of the star disk. This detachable feature can be combined with a hollow fastening, which provides a hole for wall mounting, if desired.

The star disk may be provided with a pivot at its center to facilitate rotation and possibly simplifying correct centering. However, if the face plates are at the same time desired to be interchangeable, as explained above, such a pivotal arrangement would have to be made of a detachable type.

It is also desirable, and in any case highly educating, to be able to plot the positions of the planets and the moon in the ecliptic, but this requires tables such as are found in the Nautical Almanac, and unfortunately, most amateur astronomers usually do not have a copy of the Nautical Almanac at hand, therefore, it would be desirable to have the information that is needed put into a simple and concentrated form, and available at low cost. It should be possible to give planet and moon data for a whole year, adaptable to a device like this, within a four-page booklet or leaflet. This leaflet would then give the RA (Right Ascension) at conveniently spaced intervals. The star disk of Fig. 4 is then rotated so that the correct RA appears in the opening marked "Sidereal Time" and by means of a straight edge, the intersection of a radial line with the ecliptic marked with a pencil.

While certain forms of the invention have been shown for purposes of illustration, it is to be clearly understood that various changes of the details of construction and arrangement of parts may be made without departing from the scope and spirit of the invention as set forth in the appended claims.

I claim:

1. A star finder for selective use at or near a predetermined north or south latitude and comprising a star disk having a polar azimuthal equidistant projection of the northern sky on one side thereof and a similar projection of the southern sky on the other side thereof, each projection having a radius of not more than substantially 113½°, said star disk having on each side a date scale disposed in circular form thereon and exteriorly of the sky projection, a pair of face plates, one face plate disposed on each side of said star disk which is rotatable therebetween, and each face plate having an opening defined by a concentric half circle exteriorly of the date scale on the star disk and the northern horizon for one face plate and the southern horizon for the other face plate, and a circular hour scale cooperable with one of the said date scales, said hour and date scales being positioned respectively on the face plates and star disk in mutual interrelation such that a setting for a particular time on one side will result in a corresponding correct setting on the other side, and whereby to enlarge the scale of the sky representations on the star disk by having the northern sky on one side and the southern sky on the other side and requiring only a single setting.

2. A star finder as claimed in claim 1, wherein the star disk and face plate have mutually cooperable indicia to indicate correct sidereal time at least on one side.

3. A star finder as claimed in claim 1, wherein the star disk has at least on one side thereof a representation of the ecliptic which is date-divided in relatively close association with the date scale on the star disk for locating the position of the true sun.

4. A star finder as claimed in claim 3, wherein the date-divided ecliptic of the star disk is projected radially to the date scale for giving a readily visible indication of the differential between mean and and true sun.

5. A star finder as claimed in claim 4, wherein the date scale on the star disk is intermediate the ecliptic and the hour scale on the face plate for interior cooperation with the ecliptic in locating the true sun and for exterior cooperation with the hour scale.

6. A star finder for selective use at or near a predetermined north or south latitude and comprising a star disk having a polar azimuthal projection of the northern sky on one side thereof and a similar projection of the southern sky on the other side thereof, each projection having a radius of not more than substantially 113½°, a pair of face plates, one for each side of the star disk, which is rotatable therebetween, each of said face plates having an opening defined by a concentric half circle disposed exteriorly of but not necessarily adjacent to the sky projection and by an arcuate edge representing the northern horizon on one side and the southern horizon on the other, said star finder having at least on one side a date scale and an hour scale, one of which scales occurs on the star disk and the other on the face plate, the one occurring on the star disk being fully circular in form, the other being at least semi-circular in form and extent, said scales being cooperable the one with the other, the said arcuate edges and sky projetcions being positioned respectively on the face plates and star disk in mutual interrelation such that for a setting for any particular time, simultaneously correct sky representations are obtained on both sides of the star finder, and whereby the visible sky projections are greatly enlarged in scale on the star disk since the northern sky is shown on one side and the southern sky on the other in a single setting.

7. A star finder as claimed in claim 6 wherein the star disk and at least one of the face plates have mutually cooperable indicia to indicate correct sidereal time.

8. A star finder as claimed in claim 6, wherein the said date scale occurs on the star disk and is disposed exteriorly of and adjacent to the star projection and interiorly of the concentric half circle defining in part the opening in the face plate on that side, while the hour scale

occurs on the face plate exteriorly of and adjacent to the said concentric half circle.

9. A star finder as claimed in claim 8, wherein the star disk has at least on one side thereof a representation of the ecliptic which is date-divided in relatively close association with the date scale on the star disk for locating the position of the true sun.

10. A star finder as claimed in claim 9, wherein the date-divided ecliptic of the star disk is projected radially to the date scale for giving a readily visible indication of the differential between mean and true sun.

11. A star finder as claimed in claim 9, wherein the date scale on the star disk is intermediate the ecliptic and the hour scale on the face plate for interior cooperation with the ecliptic in locating the true sun and for exterior cooperation with the hour scale.

12. A star finder as claimed in claim 1, having at least in one of its face plates a pair of openings of oblong shape, the upper edge of which is defined by the minus altitude of the sun when stars of lesser than first magnitude are beginning to become visible to the naked eye, and the lower edge by the minus altitude of the sun when twilight is just ended, to indicate, by means of the plotted position of the true sun in the ecliptic, anticipated varying degrees of twilight.

13. A star finder as claimed in claim 6 having at least in one of its face plates a pair of openings of oblong shape, the upper edge of which is defined by the minus altitude of the sun when stars of lesser than first magnitude are beginning to become visible to the naked eye, and the lower edge by the minus altitude of the sun when twilight is just ended, to indicate, by means of the plotted position of the true sun in the ecliptic, anticipated varying degrees of twilight.

14. A star finder as claimed in claim 6, the star disk of which has on the side having the same name as the latitude of the observer a sky projection with a radius substantially of 90° and on the reverse side a sky projection with a radius of substantially 113½°, the latter projection drawn to a scale which is minimum at the center of the projection and which scale increases gradually outward so as to become substantially equal to that on the other side as the periphery is approached, whereby the area covered by one of the said sky projections is sufficient to show the ecliptic in its entirety, the projection being drawn to a scale approaching that used on the other side.

15. A star finder as claimed in claim 6, having at least in one of its face plates a pair of openings of oblong shape the upper and lower edges of which each are defined by a particular minus altitude of the sun, to indicate, by means of the plotted position of the true sun on the star disk, anticipated varying degrees of twilight.

16. A star finder as claimed in claim 12, wherein the areas described as openings are made up of transparent portions of the face plate.

17. A star finder as claimed in claim 15, wherein the areas described as openings are made up of transparent portions of the face plate.

References Cited in the file of this patent

UNITED STATES PATENTS

832,527	Barritt	Oct. 2, 1906
1,873,595	Johnson	Aug. 23, 1932
2,397,002	Hagner	Mar. 19, 1946
2,543,815	Waller et al.	Mar. 6, 1951