INSTRUCTIONS FOR USE

OF THE

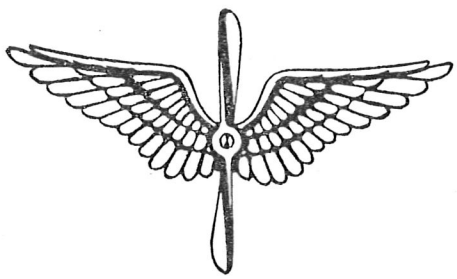
Astro Compass

MK. II

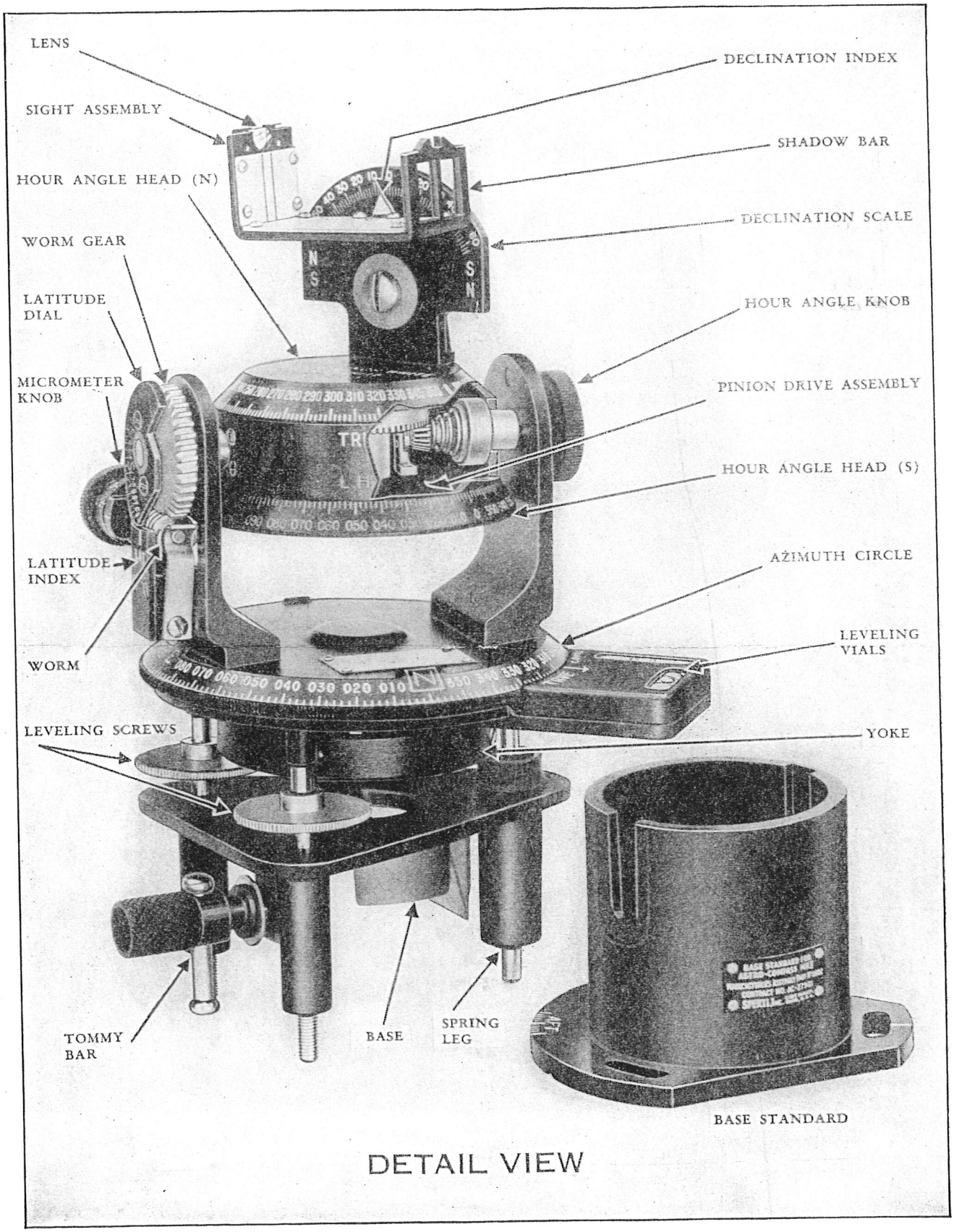
PURPOSE:

The Astro Compass is designed to provide the navigator accurately and rapidly with:

(a) the true heading of the aircraft,
(b) the true bearing of a distant object.



SPERTI, INCORPORATED
CINCINNATI, OHIO, U. S. A.


LENS
SIGHT ASSEMBLY
HOUR ANGLE HEAD (N)
WORM GEAR
LATITUDE DIAL
MICROMETER KNOB
LATITUDE INDEX
WORM
LEVELING SCREWS
TOMMY BAR
BASE
SPRING LEG
DECLINATION INDEX
SHADOW BAR
DECLINATION SCALE
HOUR ANGLE KNOB
PINION DRIVE ASSEMBLY
HOUR ANGLE HEAD (S)
AZIMUTH CIRCLE
LEVELING VIALS
YOKE
BASE STANDARD

DETAIL VIEW

The Astro Compass

MK. II

CONSTRUCTION.

The lower part of this instrument consists of an Azimuth Circle which is free to rotate against a lubber line. This part of the instrument can be levelled by means of cross levels and adjusting screws, and is mounted on a fitting designed for insertion in the Astro Compass Mk. II Standard.

Two vertical standards carry a horizontal axis lying above and parallel to the 090° - 270° line of the Azimuth Circle. One end of this axis is provided with a wormwheel driven by a worm to which the latitude scales are attached. A scale of tens of degrees is marked on a disc attached to the wormwheel while a scale of single degrees is engraved on a drum attached to the worm shaft. The scales for North latitudes are filled WHITE and the scales for South latitudes are filled RED.

Two Hour Circles graduated in opposite directions, one for North latitudes and the other for South latitudes are mounted on either side of the horizontal axis. These are rigidly connected together and driven as one by an internal bevel gear actuated by a knob placed at the end of the horizontal axis opposite the latitude worm gear. In correct use, the Hour Circle plane is maintained parallel to that of the equinoctial. The sighting device side of the Hour Circle must always be uppermost and the Hour Circle must, therefore, be turned over when crossing the equator. Since the hour angle always increases in the same direction, *i. e.* from East to West, it is necessary, since the Hour Circle is turned over when crossing the equator, to provide two hour angle scales reading in opposite directions, one for the Northern Hemisphere and one for the Southern Hemisphere.

To set the Hour angle, the knob is pushed inwards and rotated till the appropriate Hour Circle reads the required value, and then released; the knob is then held outwards by a spring which locks the Hour Circles against accidental displacement.

The Hour Circle to be used in North latitudes is filled WHITE and is read against a white index mark engraved L.H.A., N. LAT. The Hour Circle to be used in South latitudes is filled RED and is read against a red index mark engraved L.H.A., S. LAT. These two index marks are 180° apart and lie in a vertical plane passing through the 000° and 180° marks of the Azimuth Circle.

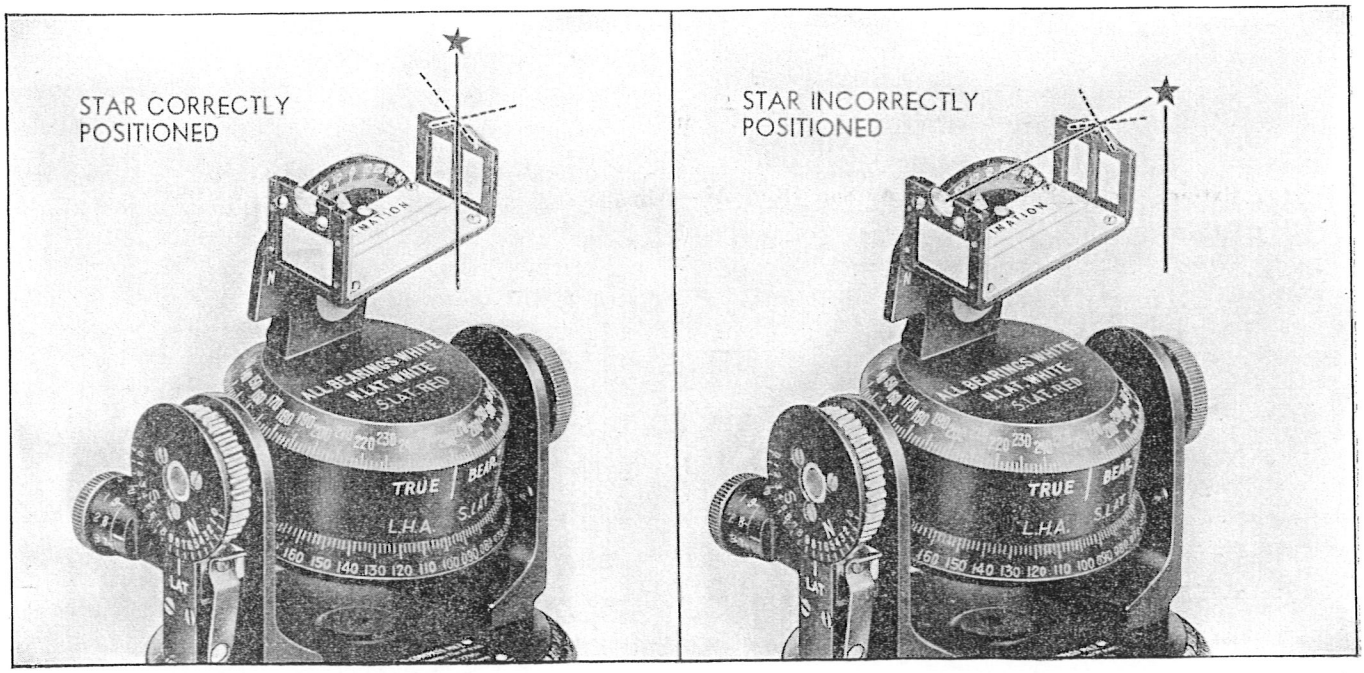
Another white index mark is placed above the red index mark and is engraved TRUE BEARING. This is used when taking bearings in both North and South latitudes.

Attached to the upper Hour Circle and aligned parallel to its 000° - 180° line is a Shadow Bar and Screen for use with the Sun and Moon, combined with a Star Sight for use with other heavenly and terrestrial bodies. It can be tilted relative to the plane of the Hour Circle and set to any degree of declination from 64° North to 64° South.

The declination is read against an engraved arc by means of the white pointer where the word DECLINATION is engraved. Below the ends of the arc are engraved the letters N and S in both white and red. In North latitude attention is to be paid to the WHITE letters, and in South latitude to the RED letters.

The Shadow Bar is at the end and over the 000° (white) and the Screen over the 180° (white) marking of the Hour Circle. The Star Sight consists of a lens mounted over the Screen and a foresight consisting of two white lines placed above the Shadow Bar. A star or terrestrial object is sighted by looking at the same time both through and over the lens when the white lines and the object are seen clearly at the same time. The object is correctly sighted when it is seen at the place where the two white lines would intersect if produced.

Should the assumed position, the setting of the latitude and hour angle and also the levelling all be exact, then the star, when the Astro Compass is rotated in azimuth, will pass through the intersection of the white lines of the foresight. This will rarely happen. When the star does not pass through the intersection of the white lines, the correct azimuth setting is when the star is *vertically above or below* the point of intersection of the white lines without paying any attention to the positioning of the lines with regard to the vertical (see illustration).



PRINCIPLE.

The local hour angle of a heavenly body is the angle, measured westwards along the Equinoctial, between the plane of the observer's celestial meridian and the plane of the body's celestial meridian.

On the instrument when the latitude is set on the latitude scale, the Hour Circle will be parallel to that of the Equinoctial, when its two datum marks are in the meridianal plane. Under these conditions, when the sights or shadow device are lined up on the body, the two L.H.A. datum marks must lie in the plane of the observer's true meridian. In North latitudes the L.H.A. datum mark, colored White, will indicate true South; in South latitudes the L.H.A. datum mark, colored Red, will indicate true North.

The datum marks are fixed in the same vertical plane as the 000° - 180° line of the azimuth circle and the white L.H.A. datum mark lies vertically above the 180° graduation and the red datum mark vertically above the 000° graduation; therefore the Azimuth Circle is automatically brought into correct orientation with the true meridian.

The Azimuth Circle can now be used as a compass card, the true heading of the aircraft being read against the lubber line.

Reversing the above procedure provides an easy means of star identification, the original arguments of local hour angle and declination being read direct from the relevant scales.

When the instrument is used for taking bearings, the Hour Circle is set parallel to the Azimuth Circle and becomes a bearing plate, using the other datum mark engraved True Bearing.

If the Azimuth Circle be set with the true course opposite the lubber line, then its 000° - 180° line must lie in the true meridian.

As the increasing direction of Azimuth is clockwise in both North and South latitudes, only one datum mark for bearings is required, and this is placed over the 0° end of the 000° - 180° diameter of the Azimuth Circle.

INSTRUCTIONS FOR USE

NOTE.—It is essential that the Base Standard in which the Astro Compass is to be used is lined up correctly with the fore and aft line of the aircraft. Two simple methods of doing this are given in this instruction book.

It is important to level the instrument as accurately as possible. An error of 1° in level may cause an error of 1° or more in observation. It is most desirable that the altitude of the body be small, especially in low latitudes.

TO CHECK THE TRUE HEADING.

a. BY THE SUN.

(1) Place instrument in standard and level each bubble in turn with appropriate screw.

(2) Set latitude to nearest degree.

(3) Extract declination and G.H.A. Sun from Air Almanac against G.C.T. and Date.

(4) Calculate L.H.A. SUN by:—

L.H.A. Sun = G.H.A. Sun $\left.\begin{matrix}+\text{E}\\-\text{W}\end{matrix}\right\}$ Longitude to ½°

(5) Set L.H.A. SUN on hour circle.

(6) Set declination.

(7) Rotate instrument until shadow of bar falls between parallel lines on shadow screen.

(8) Read true heading of aircraft against lubber line.

b. BY MOON OR PLANET.

(1) and (2) as above.

(3) Extract declination and G.H.A. MOON or PLANET from Air Almanac against G.C.T. and Date.

(4) Calculate L.H.A. of body by:—

L.H.A. Body = G.H.A. Body $\left.\begin{matrix}+\text{E}\\-\text{W}\end{matrix}\right\}$ Longitude to ½°

(5) Set L.H.A. on hour circle.

(6) Set declination.

(7) Rotate instrument until body appears in sights (the lens being nearest to the observer). With the Moon, the shadow bar and screen can often be used instead of the sights.

(8) Read true heading of aircraft against lubber line.

c. BY STAR *(Using Air Almanac).*

(1) and (2) as above.

(3) Extract G.H.A. Aries from Air Almanac against G.C.T. and Date.

(4) Extract declination and S.H.A. Star from front cover of Almanac.

(5) Calculate L.H.A. Star by:—

L.H.A. Star = G.H.A. Aries +

S.H.A. Star $\left\{\begin{matrix}+\text{E}\\-\text{W}\end{matrix}\right\}$ Longitude to ½°

(Adjust for 360° if necessary).

(6) Set declination of Star on declination scale.

(7) Rotate instrument until Star appears in sights (the lens being nearest to the observer).

(8) Read the true heading of the aircraft against the lubber line.

d. BY STAR *(Using Astrograph).*

If the aircraft is fitted with an Astrograph the following method may be used. An Air Almanac is not required.

(1) Switch on and set Astrograph.

(2) Select the Astrograph star with the lesser altitude and read altitude (to the nearest degree) at the assumed position of the aircraft.

(3) At this assumed position, a line drawn at right angles to the star curves in the direction of increasing altitude will be the true bearing of the star.

This may quickly be measured using the chart table plotter thus:

Lay the longer edge of the plotter tangential to the star curves and read the angle given by the shorter edge of the plotter when transferred to the compass rose on the chart. The true bearing of the star is in the direction of increasing altitude.

(4) Place Astro Compass in standard and level.

(5) Set latitude 90°.

(6) Set star's true bearing on Hour Circle against the true bearing datum mark.

(7) Set the star's approximate altitude on the declination scale.

(8) Rotate the instrument until the selected star appears correctly in the sights.

(9) Read the true course of the aircraft against the lubber line.

TO STEER A COURSE

(1) Obtain the true course by one of the foregoing methods.

(2) Compare this with the required true course.

(3) If they disagree, alter course the desired amount on the directional gyro.

(4) Maintain course by the directional gyro, checking at intervals of not more than 15 minutes.

TO OBTAIN THE TRUE BEARING OF A DISTANT OBJECT.

(1) Place instrument in standard and level.

(2) Set true course against lubber line.

(3) Set latitude scale to 90°.

(4) Rotate Hour Circle until object appears correctly in sights (the lens being nearest to the observer).

(5) Read true bearing on Hour Circle against bearing datum mark.

TO IDENTIFY A STAR

(1) and (2) as in "To Obtain the True Bearing of a Distant Object."

(3) Set latitude.

(4) Rotate Hour Circle and adjust sights until Star appears in sights at intersection of the lines.

(5) Read declination and L.H.A. on the respective scales.

(6) Extract G.H.A. Aries from Air Almanac against G.C.T. and Date.

(7) Determine S.H.A. Star by: —

S.H.A. Star = L.H.A. Star.

$$\left.\begin{matrix} -\text{E} \\ +\text{W} \end{matrix}\right\} \text{ Longitude to } \tfrac{1}{2}°.$$

$$-\text{ G.H.A. Aries.}$$

(Adjust to 360° where necessary).

(8) Extract name of Star from Air Almanac against S.H.A. and declination.

TO LINE UP THE ASTRO COMPASS STANDARD.

a. METHOD I.

(1) Place Astro Compass in standard and level. (This can usually be done in the tail down position).

(2) Find course of aircraft by Astro Compass by a method described previously.

(3) Find true course of aircraft by landing compass or other external means.

(4) Compare the two courses. If there is a discrepancy, rotate the standard until the Astro Compass course agrees with the correct true course.

(5) Repeat for each standard.

b. METHOD II.

If the sun is not visible, find the course by Astro Compass by the following means: —

(1) Place Astro Compass in standard and level.

(2) Set latitude to 90°.

(3) Set up landing compass at a distance and find true bearing of the Astro Compass.

(4) Set reciprocal of this true bearing against "True Bearing" datum on Astro Compass.

(5) Rotate instrument until sights are lined up on landing compass.

(6) Note "True Course" as given by Astro Compass.

(7) Compare this course with aircraft course as found by external means.

(8) Adjust as in Method I (4).

(9) Repeat for other standards.

MAINTENANCE.

In course of time the levelling screws may become too loose, and the Azimuth Circle motion and the motion of the sight gear in declination may become too free. Correct as follows: —

a. TO TIGHTEN UP THE LEVELLING SCREWS AND THE AZIMUTH CIRCLE MOTION.

(1) Push down the Azimuth Circle above the spring leg as far as it will go and fix a clamp at the bottom of the spring leg to hold it in that position.

(2) Screw down one of the two levelling screws as far as it will go; this gives access to one of the four set-screws of the yoke ring used for levelling; withdraw the set-screw; withdraw the pivot pin; repeat on the opposite side of the yoke and the upper and lower assemblies of the instrument can be separated.

(3) Remove the levelling screws and squeeze up the legs from which they have come, by means of a vise, taking care not to overdo the correction.

(4) Tighten up the nut in the center till the described amount of friction is restored to the Azimuth Circle.

(5) Reassemble in reverse order.

b. TO TIGHTEN UP THE SIGHT GEAR MOTION IN DECLINATION.

Tighten the nut on the sight gear pivot till desired friction is restored.

The Astro Compass is a precision instrument. Treat it as such.

SWINGING OF COMPASSES DURING FLIGHT.

The swinging of aircraft compasses on the ground is frequently inconvenient and nearly always inaccurate owing to the fact that the attitude and condition of the aircraft in no way resemble those prevailing in cruising flight. On the ground the undercarriage is down, the fuselage is at a considerable angle to the horizontal and the engines are either stopped or oiling up with continuous idling. Electrical circuits also will not be in normal operation. With the introduction of larger aircraft, ground swinging becomes increasingly difficult.

The answer to all these problems is the "air swing."

With the Astro Compass the operation is simple and quick, and the navigator has the satisfaction of knowing that the compass deviations so obtained are those actually prevailing in cruising flight.

A visible Sun, of altitude less than 40° if possible, calm air and a 360° field of view for the Astro Compass, preferably from a mounting in the sextant dome, are the requirements.

The following method is recommended:

(1) Before flight, draw a graph of L.H.A. Sun covering the required period.

(2) Take the aircraft up and, using the Astro Compass as indicated in "Instructions for Use," obtain the true and thence the magnetic course, noting the compass deviations on N, E, S and W. The aircraft should be flown as straight and level as possible, in the vicinity of the airport or some suitable landmark.

(3) Land. Place the aircraft's head within 5° of compass N, and correct for C. Place the aircraft's head within 5° of compass E and correct for B. Do not attempt these corrections in the air.

(4) Take the aircraft up and carry out a check swing on the cardinal and quadrantal points.

(5) Land. Correct for any coefficient A. Prepare a Deviation Card for the compass.

The whole process should occupy not more than 40 minutes.