Apollo Navigational Star Chart

Kollsman Instrument Corporation

NAVIGATION INSTRUMENTS FOR APOLLO

Kollsman Instrument Corporation
SYOSSET, NEW YORK
Subsidiary of Standard Kollsman Industries Inc.

THE STARS

In space travel, man makes use of the only constant he has — the stars — to determine his precise position and direction.

Any change in the known position of the stars during space flight in our galaxy is imperceptible, although the stars do have some movement. By using an optical instrument to measure the angle between selected guide stars and a known reference, astronauts can determine precisely where they are with relation to the center of the earth.

To make space navigation easier, NASA has chosen 37 stars — nearly all of first or second magnitude — uniformly distributed throughout the firmament. Normally, three stars are used for navigational checks.

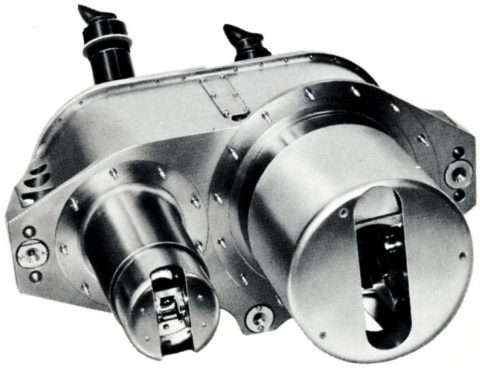
THE STAR CHART

The numbers and names of the 37 guide stars are outlined in rectangular boxes on the chart. The constellations are identified to assist in locating the guide stars.

The ecliptic, which is represented on the chart by a curved dotted line, traces the apparent path of the sun among the stars in the course of a year. It crosses the celestial equator at the autumnal and vernal equinoxes.

The rectangular shape of the chart distorts the relative positions of the stars in the polar regions, as a Mercator projection distorts polar land masses on a map of the Earth. For a completely accurate representation of polar constellations, the star chart should be printed in the form of a sphere, with the observer located at the center.

OPTICAL UNIT ASSEMBLY (OUA)



The OUA, a sextant-telescope package, is used to sight on known reference stars and landmarks for the fine angle measurements needed in navigational checks. In most operations, the Command Module pilot will use the telescope to locate a target star, then sight the selected star in the magnified field of view of the sextant to make precise measurements.

Measuring the angle from the stars to the base line of the optical sub-system yields information for aligning the Inertial Measurement Unit of the Guidance and Navigation System. This accurately establishes the spacecraft's orientation. Measuring the angle from reference stars to earth or lunar landmarks checks the position of the spacecraft.

In both cases, when the star is accurately located in the sextant cross hairs, the astronaut presses a Mark button, feeding the information to an onboard guidance computer. The computer calculates and performs the alignment of the Inertial Measurement Unit and provides course correction information to the pilot.

SPECIFICATIONS

More than 50 optical elements

Dimensions .....21¾ x 11½ x 14½ inches
Total Weight .....53 pounds

The OUA Sextant

Image Magnification .....28 power
Field of View .....1.8 degrees
Angular Measuring Accuracy...10 arc seconds

The OUA Telescope

Image Magnification .....1 power
Field of View .....60 degrees
Angular Measuring Accuracy....4 arc minutes

1K/269 Printed in U.S.A.

ALIGNMENT OPTICAL TELESCOPE (AOT)

The AOT is part of the guidance and navigation system of the Lunar Module and is mounted in the LM cabin on a common base with the Inertial Measurement Unit (IMU). It is used to align the Inertial Measurement Unit during separation in earth orbit and as the LM returns to the Command Module.

The navigator in the LM selects a known navigational star within the field of view of the telescope, then adjusts the instrument's reticle until the star is bracketed by two radial lines engraved on the reticle's surface. The angular position of the star is then read from an attached digital counter and punched into the LM Guidance Computer.

Another adjustment is then made to bracket the star between two spiral lines on the same reticle. When similar data is read from the counter and entered into the LM Guidance Computer, the computer calculates and performs the alignment of the IMU.

SPECIFICATIONS

23 Optical Elements

Image Magnification .....1 power
Field of View .....60 degrees
Weight .....25 pounds
Dimensions .....34¾ x 12 11/16 x 7⅜ inches

APOLLO RANGEFINDER

The rangefinder will provide the Command Module pilot with a reading of the distance to the Lunar Module during the rendezvous maneuver.

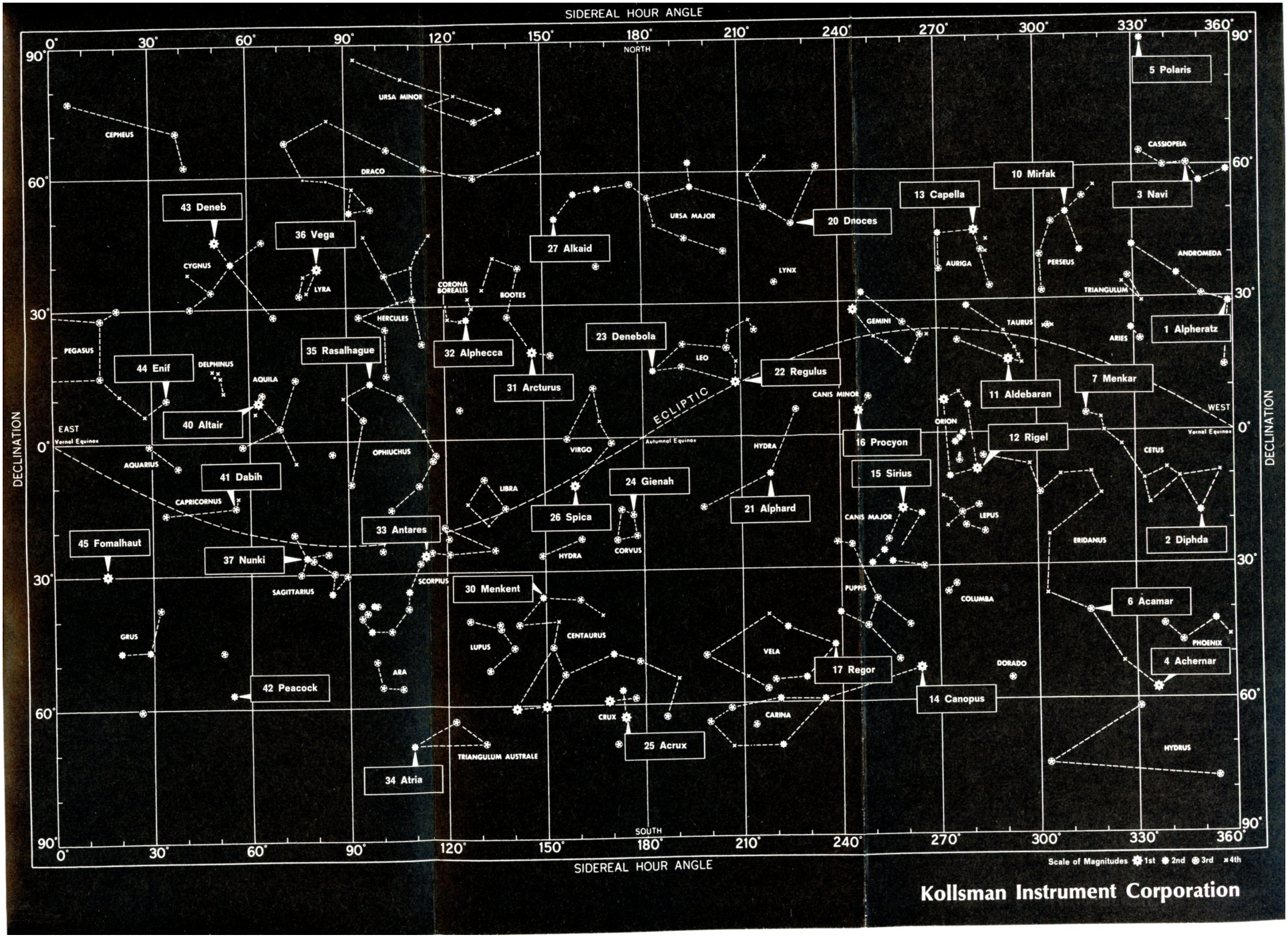
The astronaut sights the Lunar Module through a rendezvous window and turns an adjustment control until a movable image of the LM is tangent to a second, fixed image. The adjustment rotates a pair of wedges which are calibrated in terms of range and mechanically linked to a drum scale. As the astronaut monitors the rendezvous he takes distance readings without computation on his part.

The rangefinder is designed for either hand-held or bracket-mounted operation. On the Apollo 9 mission, it will be mounted above the headrest of the flight commander's couch.

SPECIFICATIONS

21 Optical Elements

Image Magnification .....8 power
Field of View .....7 degrees
Weight .....6 pounds, 13 ounces
Dimensions .....8½ x 6 x 6 inches
Range ....0.15 to 4.0 nautical miles measured to an accuracy of 5%


SIDEREAL HOUR ANGLE
0° 30° 60° 90° 120° 150° 180° 210° 240° 270° 300° 330° 360°
NORTH
SOUTH
90° 60° 30° 0°
DECLINATION
EAST
Vernal Equinox
WEST
Vernal Equinox
Autumnal Equinox
ECLIPTIC
5 Polaris
CEPHEUS
URSA MINOR
DRACO
CASSIOPEIA
10 Mirfak
13 Capella
3 Navi
43 Deneb
36 Vega
CYGNUS
LYRA
27 Alkaid
URSA MAJOR
20 Dnoces
AURIGA
PERSEUS
ANDROMEDA
TRIANGULUM
LYNX
CORONA BOREALIS
BOOTES
HERCULES
GEMINI
TAURUS
ARIES
1 Alpheratz
PEGASUS
44 Enif
DELPHINUS
35 Rasalhague
32 Alphecca
23 Denebola
LEO
22 Regulus
31 Arcturus
7 Menkar
AQUILA
CANIS MINOR
11 Aldebaran
40 Altair
ORION
16 Procyon
12 Rigel
AQUARIUS
OPHIUCHUS
VIRGO
HYDRA
CETUS
41 Dabih
24 Gienah
15 Sirius
CAPRICORNUS
LIBRA
26 Spica
21 Alphard
CANIS MAJOR
LEPUS
33 Antares
45 Fomalhaut
37 Nunki
CORVUS
ERIDANUS
2 Diphda
SCORPIUS
SAGITTARIUS
30 Menkent
PUPPIS
COLUMBA
6 Acamar
GRUS
CENTAURUS
LUPUS
VELA
PHOENIX
4 Achernar
ARA
17 Regor
DORADO
42 Peacock
14 Canopus
CRUX
CARINA
25 Acrux
HYDRUS
TRIANGULUM AUSTRALE
34 Atria
Scale of Magnitudes 1st 2nd 3rd 4th
Kollsman Instrument Corporation

APOLLO GUIDE STARS

NUMERICAL		ALPHABETICAL	
1	Alpheratz	Acamar	6
2	Diphda	Achernar	4
3	Navi	Acrux	25
4	Achernar	Aldebaran	11
5	Polaris	Alkaid	27
6	Acamar	Alphard	21
7	Menkar	Alphecca	32
10	Mirfak	Alpheratz	1
11	Aldebaran	Altair	40
12	Rigel	Antares	33
13	Capella	Arcturus	31
14	Canopus	Atria	34
15	Sirius	Canopus	14
16	Procyon	Capella	13
17	Regor	Dabih	41
20	Dnoces	Deneb	43
21	Alphard	Denebola	23
22	Regulus	Diphda	2
23	Denebola	Dnoces	20
24	Gienah	Enif	44
25	Acrux	Fomalhaut	45
26	Spica	Gienah	24
27	Alkaid	Menkar	7
30	Menkent	Menkent	30
31	Arcturus	Mirfak	10
32	Alphecca	Navi	3
33	Antares	Nunki	37
34	Atria	Peacock	42
35	Rasalhague	Polaris	5
36	Vega	Procyon	16
37	Nunki	Rasalhague	35
40	Altair	Regor	17
41	Dabih	Regulus	22
42	Peacock	Rigel	12
43	Deneb	Sirius	15
44	Enif	Spica	26
45	Fomalhaut	Vega	36