AIRBORNE

A Sentimental Journey

WILLIAM F. BUCKLEY, JR.

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Who will win the landfall pool? All it takes is the stamina to go up the mast with binoculars and sit for a few hours.

Then a burst of wind, giving WFB the enlightening flash that it's time for the gollywobbler. Again, General Quarters. Van and I attach the mainstaysail halyard, where we should have attached the gollywobbler halyard. This understandably creates great confusion. We set the sail, finally, sweating and pulling on lines. Ahead the sky is clearing, but still no sight of our beloved Horta.

[V] We looked and looked and looked but never did see the big mountain on Pico, shrouded by clouds. We finally spotted Faial way to port at about 1630. It was exciting and reassuring. We sailed along the coast for a couple of hours escorted by 100 dolphins. We docked very smartly alongside the quay, and went ashore for dinner at about 8:45.

9.

Shortly after returning from our passage I received a letter from an amateur sailor greatly vexed by the challenge of celestial navigation. He asked where he might find a totally comprehensible essay on the subject that would equip him to navigate celestially. I replied that so far as I knew, no such treatise—absent the full explanatory textbooks—existed; and gave it as my opinion that the principal reason for the failure of those I have read is that they endeavor to explain to the reader *why* celestial navigation works rather than—simply—*how* it works.

Professor Hugh Kenner is one of those rare creatures, endowed at once with a vocabulary so extensive and a facility for using it so resourceful, who can describe—anything ("Nothing is *indescribable*," said Harold Ross of *The New Yorker*). One could, from a paragraph by Kenner, deduce the blueprint of an eggbeater. It is, of course, more than a working vocabulary that equips him to write as he does: It is a gift of mechanical understanding and congruent conceptualization. It is not really surprising that the most lucid exegete of Pound, Yeats, and Eliot should also have written a book explaining the architectonics of Buckminster Fuller.

It is perhaps because all inscrutable matters yield so easily to him that he has for many years patronized the Heath-Kit Company in Chicago, which manufactures the constituent parts from the appropriate assortment and arrangement of which a purchaser can assemble a woman's hair dryer or a color television set (the most satisfactory radio direction finder I ever had was out of Heath-Kit, by Hugh Kenner). Hugh explained to me, enthusiastically, the steps the manufacturer takes before issuing an instruction manual.

Let us suppose the company decides to add to its do-it-yourself line an electric typewriter. The people charged with writing out assembly instructions come up with a first draft. (With luck, they are unrelated to the people who have lately undertaken to explain Christianity.) Then two or three white-collar women are located. It is required of them only that they should be—virgins. They must never ever before have put together anything more complicated than a children's jigsaw.

In the presence of a supervisor, notebook in hand, the selected woman sets out to put together an electric typewriter, starting out with Instruction No. 1. Whenever she hesitates, she is interrogated, and a notation is made, giving the reason for that hesitation. Perhaps the instruction sheet said, "Reach for the needle-point pliers," and she looks worriedly about her. The psychologist is there to ask her what it is that troubles her. . . . "What are needle-point pliers?"

The revised instructions will carry a picture of needle-point pliers. By the time the tribulations of the prototypical assemblers are collated, an instruction sheet evolves which—if you take Hugh Kenner's word for it, and I do—can be followed by anybody who can read simple English.

It is my ambition to do this for celestial navigation—Heath-Kit-wise.

Those curious to know *why* it works can consult the breviaries; though, as a matter of fact, they might, if it happens that their curiosity is of that bent, even deduce why it works. Meanwhile—so help me God—they can set out to sea with *these* pages, and, setting out from anywhere in the world, arrive anywhere in the world they want to.

To begin with, some generalities:

There are several "systems" of celestial navigation. If you learn one, it is easy enough to adapt to others. I like best H.O. 249—because it is the easiest. It makes use of the *Air Almanac* (as opposed to the yearly *Nautical Almanac*), which is issued three times a year, each issue covering a four-month period. The Almanac tells you what is he Geographical Position, at any given second of any day covered by he Almanac, of: the Sun; the constellation Aries; the planets Venus, Jupiter, Saturn; the Moon; and 57 stars.

If you draw a line from a celestial body to the center of the earth, the point at which that line touches the surface of the earth is that body's Geographical Position (GP).

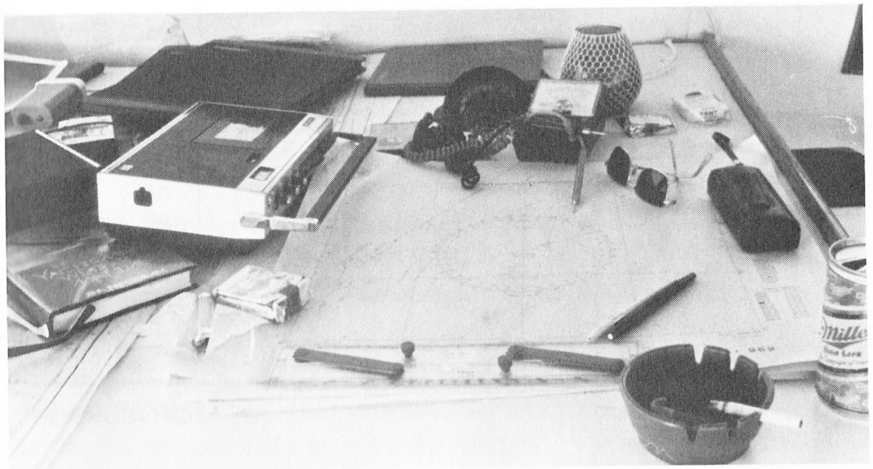
A sextant is an instrument that measures the angle between the horizon and the observed body.

The tables (H.O. 249) are for the purpose of advising you what is the difference between the assumed position of your vessel—on the basis of which you have made your calculations—and the *actual* position of your vessel, based on the angle your sextant has given you.

Let us assume you are sitting in a boat exactly one hundred miles east of the Empire State Building late in the afternoon, without, however, knowing where you are (hecklers are, without any ill will whatever, invited to leave the room, and are invited back for cakes and ale, which resume on page 181). You (mis)estimate that you are 105 miles east of the Empire State Building. When you bring the figures from your Almanac on over to the tables, the Almanac will say to you: It cannot be that you are on a line that runs through a point 105 miles east of the Empire State Building. You are in fact on a line that runs through a point *one hundred* miles east of the Empire State Building.

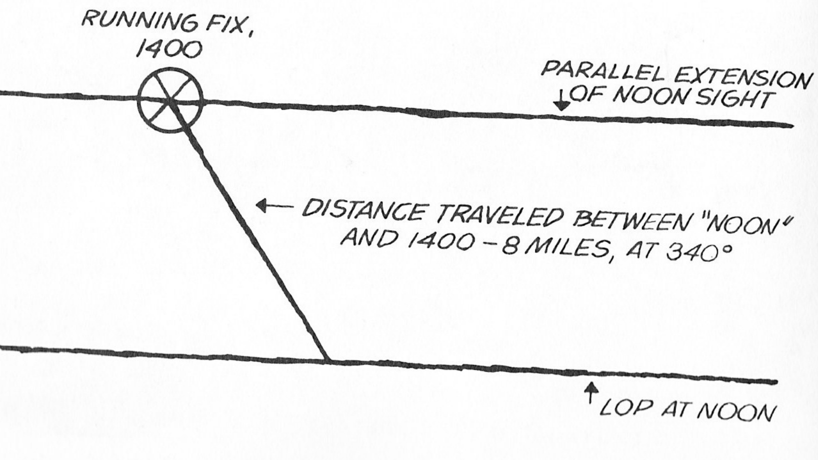
This, clearly, is the opportune moment to reveal that what you get from a celestial sight isn't a *point*. It is a *line*. They call it a *line of*

The navigator's table, unposed.



position (LOP). You are somewhere on that line. You do not know
where. You need a second line to establish that. But, as you would
expect, a second line taken immediately after the first would give
you a line almost parallel to the first, since there hasn't been
much angular movement of the celestial body. You have two alterna-
ives. The first is to take a sight on a different celestial body (let us
ssume the stars are out, or the planets, or the moon, and that a hori-
on is still visible, i.e., that it is shortly before dawn or after sunset).
Iaving plotted that second line, you will know that where it intersects
ne first one is where you are.

The second alternative (let us assume it is only the Sun you are
orking with, which is more often than not the case) is to wait: an
our, say. Then shoot the Sun again. The LOP, reflecting the move-
ent of the Sun westward, will come in at a substantially revised
gle. Again, where the two lines intersect is where you are. If during
e interval of that hour you have yourself been moving in your
at—rather than, say, anchoring and fishing—you will calculate
w far and in what direction you traveled during that hour. Let us
eight miles due east. You will take the first line of position and
w a line parallel to it eight miles along your course—that is done
ough the use of parallel rules. Where that line intersects your fresh
P is—where you are. You have just achieved what they call a
nning Fix. Ninety percent of celestial navigation in small boats
sists in getting Running Fixes.



Stars are nice, and by all means go on and develop the technique for bringing them down. But they are harder to handle, harder to spot, and you need to work faster. No sweat, in particular; but concentrate on the Sun.

Now, back to the Almanac.

In order to know the Geographical Position of the Sun you must know the exact time of day. In celestial navigation, for conceptual convenience, it is assumed that the earth is motionless, and all the activity is celestial. *The Sun is continuously moving*, and in the course of twenty-four hours travels 360°, right around the globe. This means (figure it out—360° divided by 24 hours) that in one hour it must move 15°. (That is why one moves one's watch forward, or back, by one hour, every fifteen degrees of longitude traversed.)

Now, one degree is equal to sixty "minutes." And a minute is equal to sixty "seconds." We deduce that the Sun moves one degree every four minutes. One 1/60th of one degree is one minute. One 1/60th of four minutes is four seconds.

CONVERSION OF ARC TO TIME

°	h m	°	h m	°	h m	°	h m	°
60	4 00	**120**	8 00	**180**	12 00	**240**	16 00	300
61	4 04	**121**	8 04	**181**	12 04	**241**	16 04	301
62	4 08	**122**	8 08	**182**	12 08	**242**	16 08	302
63	4 12	**123**	8 12	**183**	12 12	**243**	16 12	303
64	4 16	**124**	8 16	**184**	12 16	**244**	16 16	304
65	4 20	**125**	8 20	**185**	12 20	**245**	16 20	305
66	4 24	**126**	8 24	**186**	12 24	**246**	16 24	306
67	4 28	**127**	8 28	**187**	12 28	**247**	16 28	307
68	4 32	**128**	8 32	**188**	12 32	**248**	16 32	308
69	4 36	**129**	8 36	**189**	12 36	**249**	16 36	309
70	4 40	**130**	8 40	**190**	12 40	**250**	16 40	310
71	4 44	**131**	8 44	**191**	12 44	**251**	16 44	311
72	4 48	**132**	8 48	**192**	12 48	**252**	16 48	312
73	4 52	**133**	8 52	**193**	12 52	**253**	16 52	313
74	4 56	**134**	8 56	**194**	12 56	**254**	16 56	314
75	5 00	**135**	9 00	**195**	13 00	**255**	17 00	31

Therefore, for every four seconds that go by on your watch, the Sun has moved by one mile west in the heavens: one nautical mile. One nautical mile (approximately 1.15 of a statute mile) is the distance subtended on the surface of the earth by an angle of one minute at the center of the earth.

It is a pity that the word "minute" is here being used in two senses. There is the degree-minute (one 1/60th of a degree), and the time-minute (one 1/60th of an hour). On the other hand, it is happy that there should be the correspondence: one (degree) minute equals one mile on the earth's surface.

Now all Geographical Positions are given with reference to Greenwich, England, which lies on 0° longitude. The equator is on 0° latitude. The "coordinates" of a vessel's location are given in latitude and longitude. Thus, our boat off the Empire State Building would be located at (say), 44° 18′ 30″ north latitude, 72° 10′ 18″ west longitude. Tip: Drop the seconds from your coordinates. You need seconds when you are talking about Watch Time—remember, an error of four seconds will put you a mile away. But sixty seconds of longitude equals one minute, which equals only one mile—so just take the nearest minute. You aren't plotting the location of an oil rig.

The terminology of coordinates changes, however, when you are dealing with the Geographical Position of a celestial body. Instead of latitude and longitude, you are given it in *Declination*—Dec. (latitude) and *Greenwich Hour Angle*—GHA (longitude).

The Geographical Positions of the heavenly bodies are also given with reference to the time at Greenwich. The time at Greenwich is five hours ahead of Miami (remember the time zones—one hour for very 15°). As a navigator, you have two alternatives. Either set our watch to the time in Greenwich, and always read the time off it. Or simply remember how many hours you have to add to your Watch Time in order to get the time in Greenwich. I prefer to do the latter, ounting it no great strain to remember what time zone I am in. Needless to say, if you are on Eastern Daylight Time, you add only our hours, rather than five, to arrive at the time in Greenwich.)

We set out from Miami at exactly 1919 Local Watch Time. At sea, in Europe, you use a twenty-four-hour-a-day watch dial. To trans-te 1919 into the vernacular, subtract 12; and you will see that the ne is 7:19 P.M. EDT. But to the figure 1919 we must now add four urs to establish the time in Greenwich. That is, 2319.

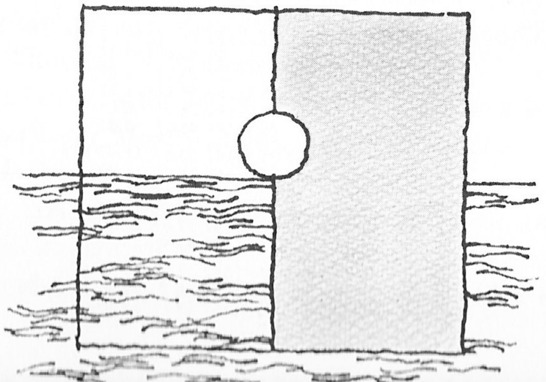
The *Air Almanac* gives you the GHA for the Sun for every ten

minutes of the day. For 2310 on May 30, 1975, it is 168° 08′.2. (I shall henceforward round off the fraction.) You are given, in the adjacent column, the Declination of the Sun at the same time (North 21° 47). Now the Declination changes gradually, so you need not interpolate it. Just grab it that once, when you take your sight, and make a note of it—it is the latitude of the Sun.

You are left knowing the GHA of the Sun at 23h 10m; but you desire the GHA of 23h 19m—a larger figure—so you need to interpolate. The Almanac does this for you. At the back of the book is a table called "Interpolation of GHA Sun." Under 9 minutes, 0 seconds, you find 2° 15′. You add this increment and establish that the GHA of the Sun at the moment of departure was 170° 23′. We therefore know the exact Geographical Position of the Sun at the moment we sailed out of Miami. (It had just passed Honolulu, directly overhead.) Though I promised not to explain *why* it works, I cannot forbear a hint here, which the reader might find instrumentally helpful. If the Sun is *directly* overhead, it will obviously show up at 90° on your sextant scale. If the Sun is exactly on the horizon, it will be 0° on your sextant scale. We know that one degree is equal to sixty miles. It follows that 90° is equal to 5,400 miles. If you have a sextant angle and you know the Geographical Position of the Sun, you can deduce exactly how far away from a fixed point you are. Where it gets tricky is determining not how far away you are, but in *exactly* what direction.

We'll take now a concrete situation, several hundred miles west of Horta, on June 19, 1975, beginning with the Watch:

1. Your assistant is keeping his eyes on the watch while you ease the Sun down on the horizon as seen through the horizon glass. When it is *just* right, you shout, "*Mark!*"

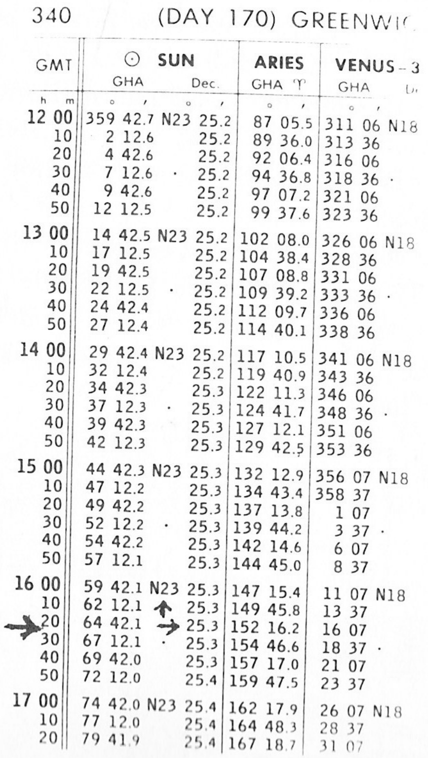


He instantly writes down the time on his watch which is: 2h 23m 37s. However, radio checks on continuous time signals establish that his watch, which tends to lose 1/3 of a second per day, is at this point 14 seconds slow. Moreover, we are two hours behind Greenwich. And this being afternoon, 2h 23m 37s becomes, on the twenty-four-hour system, 14h 23m 37s.

We therefore add to	14	23	37
a Watch Error of (plus)			14
and a Zone Correction of (plus)	2		
For a Greenwich Mean Time of	16h	23m	51s

We now consult the Almanac.

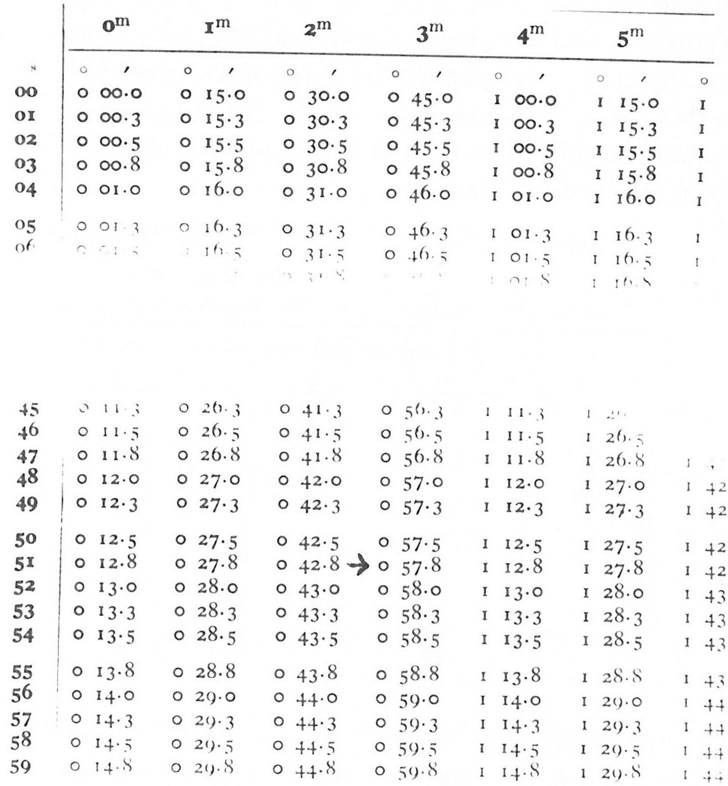
16h 20m gives us 64° 42′—and a North (the Declination of the Sun is North during spring and summer) Declination of 23° 25′.



340 (DAY 170) GREENWI(

GMT	☉ SUN		ARIES	VENUS -3	
	GHA	Dec.	GHA ♈	GHA	D
h m	° ′	° ′	° ′	° ′	
12 00	359 42.7	N23 25.2	87 05.5	311 06	N18
10	2 12.6	25.2	89 36.0	313 36	
20	4 42.6	25.2	92 06.4	316 06	
30	7 12.6	· 25.2	94 36.8	318 36	·
40	9 42.6	25.2	97 07.2	321 06	
50	12 12.5	25.2	99 37.6	323 36	
13 00	14 42.5	N23 25.2	102 08.0	326 06	N18
10	17 12.5	25.2	104 38.4	328 36	
20	19 42.5	25.2	107 08.8	331 06	
30	22 12.5	· 25.2	109 39.2	333 36	·
40	24 42.4	25.2	112 09.7	336 06	
50	27 12.4	25.2	114 40.1	338 36	
14 00	29 42.4	N23 25.2	117 10.5	341 06	N18
10	32 12.4	25.2	119 40.9	343 36	
20	34 42.3	25.3	122 11.3	346 06	
30	37 12.3	· 25.3	124 41.7	348 36	·
40	39 42.3	25.3	127 12.1	351 06	
50	42 12.3	25.3	129 42.5	353 36	
15 00	44 42.3	N23 25.3	132 12.9	356 07	N18
10	47 12.2	25.3	134 43.4	358 37	
20	49 42.2	25.3	137 13.8	1 07	
30	52 12.2	· 25.3	139 44.2	3 37	·
40	54 42.2	25.3	142 14.6	6 07	
50	57 12.1	25.3	144 45.0	8 37	
16 00	59 42.1	N23 25.3	147 15.4	11 07	N18
10	62 12.1	↑ 25.3	149 45.8	13 37	
→ 20	64 42.1	→ 25.3	152 16.2	16 07	
30	67 12.1	· 25.3	154 46.6	18 37	·
40	69 42.0	25.3	157 17.0	21 07	
50	72 12.0	25.4	159 47.5	23 37	
17 00	74 42.0	N23 25.4	162 17.9	26 07	N18
10	77 12.0	25.4	164 48.3	28 37	
20	79 41.9	25.4	167 18.7	31 07	

We need now the interpolation for 3m and 51 seconds. It is 58′.



	0^m	1^m	2^m	3^m	4^m	5^m	
s	° ′	° ′	° ′	° ′	° ′	° ′	°
00	0 00·0	0 15·0	0 30·0	0 45·0	1 00·0	1 15·0	1
01	0 00·3	0 15·3	0 30·3	0 45·3	1 00·3	1 15·3	1
02	0 00·5	0 15·5	0 30·5	0 45·5	1 00·5	1 15·5	1
03	0 00·8	0 15·8	0 30·8	0 45·8	1 00·8	1 15·8	1
04	0 01·0	0 16·0	0 31·0	0 46·0	1 01·0	1 16·0	1
05	0 01·3	0 16·3	0 31·3	0 46·3	1 01·3	1 16·3	1
06	0 01·5	0 16·5	0 31·5	0 46·5	1 01·5	1 16·5	1
			0 31·8		1 01·8	1 16·8	
45	0 11·3	0 26·3	0 41·3	0 56·3	1 11·3	1 26·3	
46	0 11·5	0 26·5	0 41·5	0 56·5	1 11·5	1 26·5	
47	0 11·8	0 26·8	0 41·8	0 56·8	1 11·8	1 26·8	1 [illegible]
48	0 12·0	0 27·0	0 42·0	0 57·0	1 12·0	1 27·0	1 42·0
49	0 12·3	0 27·3	0 42·3	0 57·3	1 12·3	1 27·3	1 42·3
50	0 12·5	0 27·5	0 42·5	0 57·5	1 12·5	1 27·5	1 42·5
51	0 12·8	0 27·8	0 42·8 →	0 57·8	1 12·8	1 27·8	1 42·8
52	0 13·0	0 28·0	0 43·0	0 58·0	1 13·0	1 28·0	1 43·0
53	0 13·3	0 28·3	0 43·3	0 58·3	1 13·3	1 28·3	1 43·3
54	0 13·5	0 28·5	0 43·5	0 58·5	1 13·5	1 28·5	1 43·5
55	0 13·8	0 28·8	0 43·8	0 58·8	1 13·8	1 28·8	1 43·8
56	0 14·0	0 29·0	0 44·0	0 59·0	1 14·0	1 29·0	1 44·0
57	0 14·3	0 29·3	0 44·3	0 59·3	1 14·3	1 29·3	1 44·3
58	0 14·5	0 29·5	0 44·5	0 59·5	1 14·5	1 29·5	1 44·5
59	0 14·8	0 29·8	0 44·8	0 59·8	1 14·8	1 29·8	1 44·8

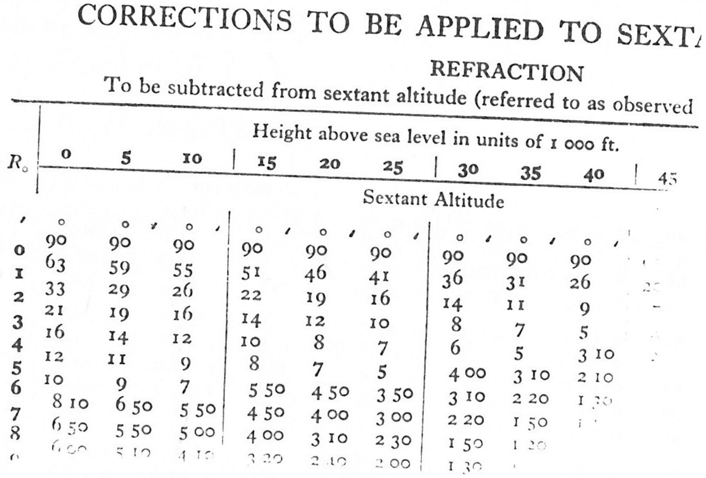
Adding the two, we get the figure 65° 40′—the GHA of the Sun at that particular moment, its Declination already noted. We know its Geographical Position.

2. We need now to concern ourselves with the sextant angle. At the moment you shouted "Mark!" it read 58° 10′.

When shooting the Sun, it is required that four plus or minus corrections be applied to perfect so crude a finding as the "Hs." "H" is the symbol for Altitude; "s" for sextant.

a. The first of these is the Index Error (IE). By how much is your particular sextant off? Most sextants, like most watches, are slightly discalibrated. It is very easy to establish the extent of your sextant's basic problem. You simply look at the horizon mirror and twirl the fine-tuning index knob until the horizon is exactly continuous on your horizon glass and mirror. Then look at your scale. If it reads 0 00, you have no Index Error. Mine reads *plus* 4 minutes, so I need always to *subtract* 4′.

b. You *think* you are seeing the Sun directly, in a straight line. In fact this is an illusion—unless the Sun is higher than 63° from the horizon there is a Refraction factor (Ref.). In this case, at 58°, you are required to subtract one minute—a datum you take from the inside back cover of the Almanac.


CORRECTIONS TO BE APPLIED TO SEXT

REFRACTION

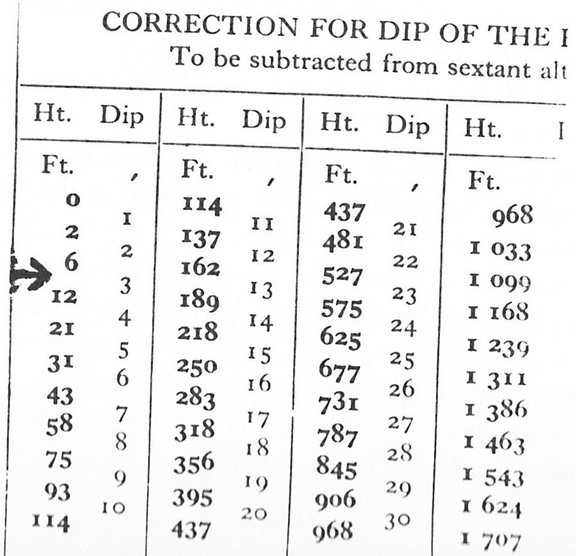
To be subtracted from sextant altitude (referred to as observed

Height above sea level in units of 1 000 ft.

Sextant Altitude

$R_{\circ}$	0	5	10	15	20	25	30	35	40
′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	90	90	90	90	90	90	90	90	90
→ 1	63	59	55	51	46	41	36	31	26
2	33	29	26	22	19	16	14	11	9
3	21	19	16	14	12	10	8	7	5
4	16	14	12	10	8	7	6	5	3 10
5	12	11	9	8	7	5	4 00	3 10	2 10
6	10	9	7	5 50	4 50	3 50	3 10	2 20	1 30
7	8 10	6 50	5 50	4 50	4 00	3 00	2 20	1 50	[illegible]
8	6 50	5 50	5 00	4 00	3 10	2 30	1 50	1 20	
	6 00	5 10	4 10	3 20	2 40	2 00	1 30		

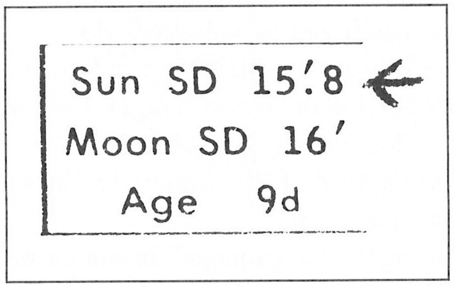
c. It makes a difference how *high* you are ("Dip") from the water. The higher you are, the larger the sextant angle. At a mere ten feet above the water, which is where I am, you subtract three minutes, a figure you take from a table on the back cover of the Almanac.


CORRECTION FOR DIP OF THE

To be subtracted from sextant alt

Ht.	Dip	Ht.	Dip	Ht.	Dip	Ht.
Ft.	′	Ft.	′	Ft.	′	Ft.
0		114		437		968
	1		11		21	
2		137		481		1 033
	2		12		22	
→ 6		162		527		1 099
	3		13		23	
12		189		575		1 168
	4		14		24	
21		218		625		1 239
	5		15		25	
31		250		677		1 311
	6		16		26	
43		283		731		1 386
	7		17		27	
58		318		787		1 463
	8		18		28	
75		356		845		1 543
	9		19		29	
93		395		906		1 624
	10		20		30	
114		437		968		1 707

d. When you dangle the Sun in your horizon mirror, you let it down until it *just* glances off the horizon—touching it as lightly as possible. In so doing, you measure an angle from the horizon, to your eye, to—the bottom of the Sun. But the Almanac and tables take their measurements, quite logically, on the center of the Sun. It is therefore necessary to add to your sextant angle one half the diameter of the Sun, which is called the SemiDiameter (SD). It is 16′, as seen on the Almanac page you are working on.


Sun SD 15′.8 ←

Moon SD 16′

Age 9d

We are left, then, with:

Hs	58° 10′
IE	—4′
Ref	—1′
Dip	—3′
SD	+16′
Ho	58° 18′

What you have now is the true vertical angle of the Sun, the Height observed—Ho.

Your mind is perhaps racing at this point to capture the evolving structure of the argument. If you *know* where the Sun is at a particular moment, and you know how far away you are, then you must be somewhere on a circle from which the Sun is measurable at the angle we have just caught. But, of course, this could be a very large circle (the smaller the angle, the larger the circle) stretching to over seven thousand miles in diameter. There is work left to do, but we are getting there.

3. You must now *estimate* a position for your vessel at the moment you took your sight. *Celestial navigation* (like some forms of logical

argumentation) *functions by proving that you aren't where you say you are*—and doing so so fastidiously as to give you the exact measure of your misjudgment.

Since you don't particularly care what your Estimated Position (EP) is (it having a purely hypothetical function), you select a *convenient* position. A "convenient" position is a position that (a) conforms with the whole numbers around which the tables are constructed, and therefore (b) eliminates unnecessary arithmetic.

You begin by selecting the nearest whole-numbered latitude to where you think you are. In our case, latitude 38°.

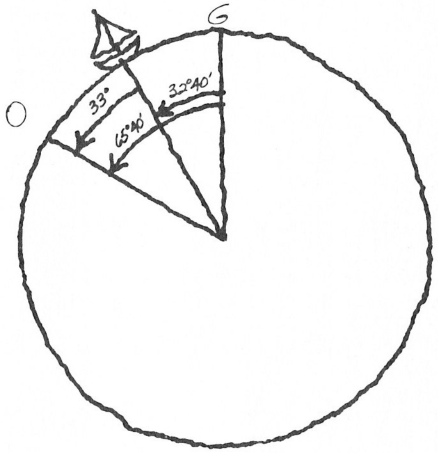
For longitude, we select a meridian that ends with *exactly as many minutes as the Sun's GHA at the moment we took the sight.*

The Sun's GHA (longitude) was 65° 40′. Our dead reckoning position puts us slightly west of 32° longitude. So we put the vessel's EP at 32° 40′ (West) longitude.

4. We are arranging the "arguments" in such a way as to discover the one remaining datum we need in order to consult the tables. That is the angle formed at the center of the earth by the two lines that rise up, the one to the sun, the other to the vessel. It is known as the Local Hour Angle (LHA). What it does for you is supply the missing trigonometric factor needed to crack the triangle—which is done for you in the tables. The LHA should be thought of as the discrepancy-detector. But never mind, just compute it.

Here you have to remember something. There are other ways of saying this (page A6 of the *Air Almanac* gives you an alternative formulation). But I find it easier to remember how to measure the angle in question by following this procedure:

Plot the position of the Sun on a free-drawn circle at the top of which you put down "G," representing Greenwich. Draw a tiny circle (the Sun) approximately as far west (counterclockwise) from Greenwich as your GHA: in this case (65° 40′), at about ten o'clock. Then draw a little hull (your vessel), approximately as far west from Greenwich as your vessel's longitude: in this case (32° 40′) at about eleven o'clock. Your LHA is the angle formed between the vessel and the sun *measured westward only*. In this case the LHA is, simply, 32° 40′ subtracted from 65° 40′—33°. But if it happened that your vessel's estimated longitude had been, let us say, 66° 40′, then to calculate your LHA you would need to travel *all the way around the circle* (remember: counterclockwise only) until you hit the Sun—for an LHA of 359°. It is instantly apparent that when you selected an estimated position ending in forty minutes you positioned yourself to come up with a clean, minute-free LHA—as is required to enter the tables.



5. You arrive now at the tables, and in order to find the relevant information you must:

a. Turn to the section in the tables volume (H.O. 249) that gives you information for latitude 38°.

b. Turn to the page within that section that gives you figures that relate to your sun sight's Declination, 23°.

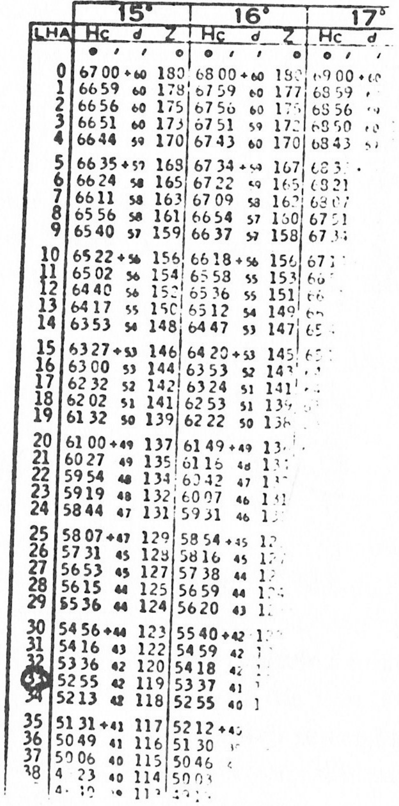
c. Turn to the page within that subsection that is headed "DECLINATION SAME NAME AS LATITUDE."

6. "SAME NAME" is the Merrie Olde Englishe way of saying that your vessel and the Sun are in the same hemisphere; in our case, the northern hemisphere. The opposite is "CONTRARY NAME." That would apply in the fall or winter, when the sun sinks below the equator. Needless to say, if you are sailing in the southern hemisphere between September and March, you are SAME-ing it.

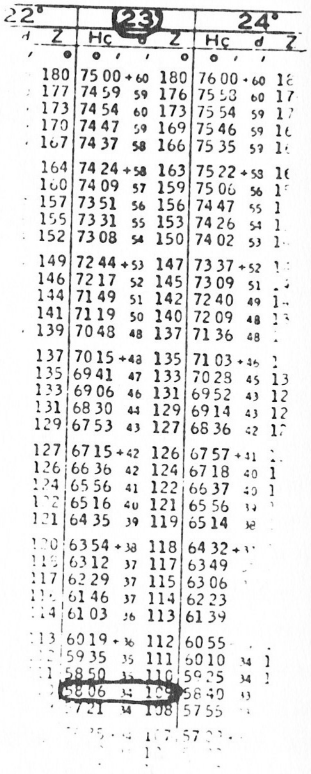
Having located the page in the 38°-section, covering the LHA 33° beat, under the SAME NAME rubric, you run your eye across from

LHA 33° until you reach the vertical column that descends from Declination 23°. You write down what appears in the space where these two intersect.

58° 06′ + (34)   109

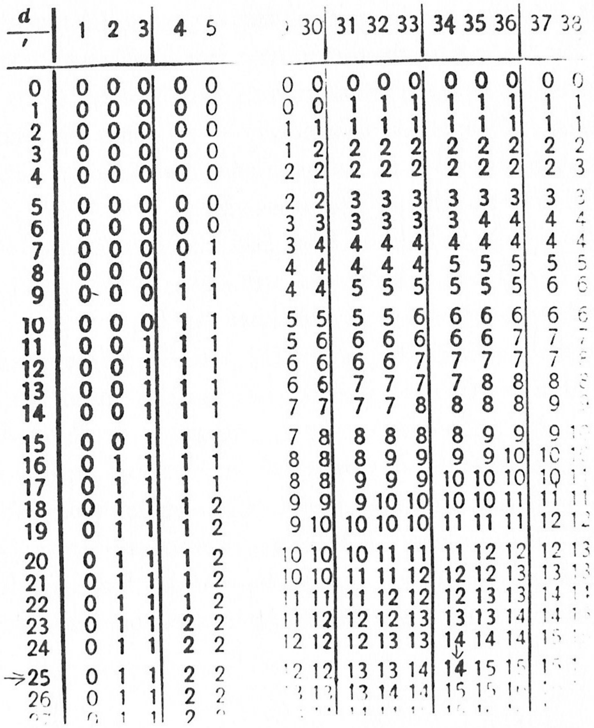


	15°			16°			17°	
LHA	Hc	d	Z	Hc	d	Z	Hc	d
	° ′	′	°	° ′	′	°	° ′	′
0	67 00	+60	180	68 00	+60	180	69 00	+60
1	66 59	60	178	67 59	60	177	68 59	[illegible]
2	66 56	60	175	67 56	60	175	68 56	[illegible]
3	66 51	60	173	67 51	59	172	68 50	[illegible]
4	66 44	59	170	67 43	60	170	68 43	[illegible]
5	66 35	+57	168	67 34	+59	167	68 3[illegible]	
6	66 24	58	165	67 22	59	165	68 21	
7	66 11	58	163	67 09	58	162	68 07	
8	65 56	58	161	66 54	57	160	67 51	
9	65 40	57	159	66 37	57	158	67 3[illegible]	
10	65 22	+56	156	66 18	+56	156	67 [illegible]	
11	65 02	56	154	65 58	55	153	[illegible]	
12	64 40	56	152	65 36	55	151	[illegible]	
13	64 17	55	150	65 12	54	149	[illegible]	
14	63 53	54	148	64 47	53	147	[illegible]	
15	63 27	+53	146	64 20	+53	145	[illegible]	
16	63 00	53	144	63 53	52	143		
17	62 32	52	142	63 24	51	141		
18	62 02	51	141	62 53	51	139		
19	61 32	50	139	62 22	50	138		
20	61 00	+49	137	61 49	+49	[illegible]		
21	60 27	49	135	61 16	48	[illegible]		
22	59 54	48	134	60 42	47	[illegible]		
23	59 19	48	132	60 07	46	[illegible]		
24	58 44	47	131	59 31	46	[illegible]		
25	58 07	+47	129	58 54	+45	[illegible]		
26	57 31	45	128	58 16	45	[illegible]		
27	56 53	45	127	57 38	44	[illegible]		
28	56 15	44	125	56 59	44	[illegible]		
29	55 36	44	124	56 20	43	[illegible]		
30	54 56	+44	123	55 40	+42	[illegible]		
31	54 16	43	122	54 59	42	[illegible]		
32	53 36	42	120	54 18	42	[illegible]		
33	52 55	42	119	53 37	41	[illegible]		
34	52 13	42	118	52 55	40	[illegible]		
35	51 31	+41	117	52 12	[illegible]			
36	50 49	41	116	51 30	[illegible]			
37	50 06	40	115	50 46	[illegible]			
38	4[illegible] 23	40	114	50 03				



22°		23°			24°		
d	Z	Hc	d	Z	Hc	d	Z
′	°	° ′	′	°	° ′	′	
	180	75 00	+60	180	76 00	+60	[illegible]
	177	74 59	59	176	75 58	60	[illegible]
	173	74 54	60	173	75 54	59	[illegible]
	170	74 47	59	169	75 46	59	[illegible]
	167	74 37	58	166	75 35	59	[illegible]
	164	74 24	+58	163	75 22	+58	[illegible]
	160	74 09	57	159	75 06	56	[illegible]
	157	73 51	56	156	74 47	55	[illegible]
	155	73 31	55	153	74 26	54	[illegible]
	152	73 08	54	150	74 02	53	[illegible]
	149	72 44	+53	147	73 37	+52	[illegible]
	146	72 17	52	145	73 09	51	[illegible]
	144	71 49	51	142	72 40	49	[illegible]
	141	71 19	50	140	72 09	48	[illegible]
	139	70 48	48	137	71 36	48	[illegible]
	137	70 15	+48	135	71 03	+46	[illegible]
	135	69 41	47	133	70 28	45	[illegible]
	133	69 06	46	131	69 52	43	[illegible]
	131	68 30	44	129	69 14	43	[illegible]
	129	67 53	43	127	68 36	42	[illegible]
	127	67 15	+42	126	67 57	+41	[illegible]
	126	66 36	42	124	67 18	40	[illegible]
	124	65 56	41	122	66 37	40	[illegible]
	122	65 16	40	121	65 56	39	[illegible]
	121	64 35	39	119	65 14	38	[illegible]
	120	63 54	+38	118	64 32	[illegible]	
	[illegible]	63 12	37	117	63 49		
	117	62 29	37	115	63 06		
	[illegible]	61 46	37	114	62 23		
	114	61 03	36	113	61 39		
	113	60 19	+36	112	60 55		
	[illegible]	59 35	35	111	60 10	34	[illegible]
	[illegible]	58 50	35	110	59 25	34	[illegible]
	[illegible]	58 06	34	109	58 40	33	
		[illegible] 21	34	108	57 55	[illegible]	
		[illegible]	[illegible]	107	57 [illegible]		

a. The first of these figures is the Altitude (H) of the Sun *assum-ng* that its Declination was a flat 23°; which of course it is not—it is, n our case, 23° 25′. Once again we need to interpolate. The center igure, in small type, is the key we take with us to the Interpolation Schedule at the back of the tables. We project the figure 34 over until t hits the line across from 25, isolating the increment to be added. he table yields the figure 14′. You add 14′ to 58° 06′, and you get 8° 20′.



d / ′	1	2	3	4	5		30	31	32	33	34	35	36	37	38
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
2	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
3	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2
4	0	0	0	0	0	2	2	2	2	2	2	2	2	2	3
5	0	0	0	0	0	2	2	3	3	3	3	3	3	3	3
6	0	0	0	0	0	3	3	3	3	3	3	4	4	4	4
7	0	0	0	0	1	3	4	4	4	4	4	4	4	4	4
8	0	0	0	1	1	4	4	4	4	4	5	5	5	5	5
9	0	0	0	1	1	4	4	5	5	5	5	5	5	6	6
10	0	0	0	1	1	5	5	5	5	6	6	6	6	6	6
11	0	0	1	1	1	5	6	6	6	6	6	6	7	7	7
12	0	0	1	1	1	6	6	6	6	7	7	7	7	7	[illegible]
13	0	0	1	1	1	6	6	7	7	7	7	8	8	8	[illegible]
14	0	0	1	1	1	7	7	7	7	8	8	8	8	9	[illegible]
15	0	0	1	1	1	7	8	8	8	8	8	9	9	9	[illegible]
16	0	1	1	1	1	8	8	8	9	9	9	9	10	10	[illegible]
17	0	1	1	1	1	8	8	9	9	9	10	10	10	10	[illegible]
18	0	1	1	1	2	9	9	9	10	10	10	10	11	11	11
19	0	1	1	1	2	9	10	10	10	10	11	11	11	12	12
20	0	1	1	1	2	10	10	10	11	11	11	12	12	12	13
21	0	1	1	1	2	10	10	11	11	12	12	12	13	13	13
22	0	1	1	1	2	11	11	11	12	12	12	13	13	14	[illegible]
23	0	1	1	2	2	11	12	12	12	13	13	13	14	14	[illegible]
24	0	1	1	2	2	12	12	12	13	13	14	14	14	15	[illegible]
→25	0	1	1	2	2	12	12	13	13	14	↓14	15	15	15	[illegible]
26	0	1	1	2	2	13	13	13	14	14	15	15	16	[illegible]	
[illegible]	0	1	1	2	[illegible]										

This is your *Calculated Altitude* (Hc). It is the angle you would have spotted the Sun at, at the moment you shouted “Mark!”—*if the vessel had indeed been located where you hypothetically placed it.*

b. The figure 109 is followed by Z. You must now look up at the top left-hand corner of the page. There you will see the legend: “*LHA greater than 180°, Zn = Z. LHA less than 180°, Zn = 360—Z.*” Since our LHA, at 33°, is less than 180°, we subtract the table’s Z of 109° from 360°, and come up with a Zn of 251°.

The Zn is the *Azimuth*—the exact direction (“west by south three-quarters south” was once the vernacular) toward which you are to draw a line originating at your Estimated Position, as now you near the end of the search for the vessel’s LOP.

7. But having drawn the line from your Estimated Position of lat. 38°, long. 32° 40′, how far along that line do you travel? And what then do you do?

The LOP is a line drawn perpendicular to the Azimuth line. The distance along the Azimuth you must travel before plotting the perpendicular LOP is called the *Intercept* (yes, "Int.").

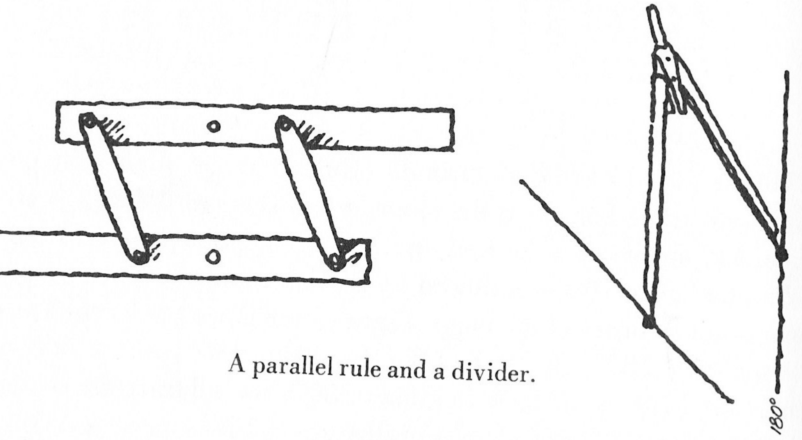
a. The Intercept is the difference between your Ho and your Hc. Ve know that the Ho was not lying to us—that was the *actual* vertical ngle of the Sun at the chronicled moment.

The Ho was 58° 18′.
The Hc was 58° 20′.

The difference is: 2′. That is to say, two miles.

Since the Ho is smaller than the Hc, you are *farther* from the Sun an you thought—after all, if you were directly under the Sun, your o would be 90°. Therefore, the Intercept is designated as *Away* rom (as distinguished from *Towards*) the celestial body.

You take your dividers and measure two miles along the Azimuth ne. Put a pencil dot there. Then take a ruler and place it perpendicu- r to the Azimuth, running across the sacred dot, and draw a line cross the ruler's edge. Your vessel is located on that Line of Posi- on.



A parallel rule and a divider.

he entire exercise, from the time you shout "Mark!" until the e you draw your LOP, will take you about 3–4 minutes.

et those who too easily despair submit, for the exercise, to the owing drill:

—Measure the distance from the left end to the right end of the o keyboard, and divide it by two. Then measure the distance from that point to your right until you come to the first black key in the clusters of two black keys (which, you will note, alternate with clusters of three black keys). Having noted that distance, go back and measure from the same starting point but moving this time to the left, until you reach the furthest of the black keys in the nearest two-black-key cluster. Now compare these distances. Move your finger to the closer of the two; and then move your finger left to the adjacent white key. Take a stopwatch, and adopt a rhythmic beat timed by the stroke of every second, except where a different interval is specified.

Begin the exercise: (1) Strike the key already located. (2) Strike the same key again. (3) Strike the fifth white key to the right. (4) Again. (5) Strike the next higher white key. (6) Again. (7) Return to the preceding key—but hold it down for *two* seconds. (8) Strike the next white key to the left. (9) Strike the same key again. (10) Strike the next lower white key. (11) Strike that key again. (12) Move down another white key, and strike it. (13) Again. (14) Down another white key (to the original), strike, and hold it for two seconds.

These are literal instructions, formulated on the assumption of a reader's total unfamiliarity with the piano keyboard, for tapping out the opening bars of *Twinkle, Twinkle, Little Star* (How I wonder/ What you are). And the pedagogic point of the exercise is to demonstrate that it is as easy, having casually familiarized oneself with the sextant and the tables, to transform the apparently forbidding instructions above into an LOP as it is to transform the paragraph above into the simple melody, with only a few minutes' application.

The big enemy (I suppose this is a matter of temperament. More safely: My big enemy) is silly arithmetical errors. I specialize in these, especially in the rusty, early stages of a trip; and I almost always come up, once or twice, with a preposterous LOP. Fortunately, these are exactly that—preposterous. When such a thing happens, you simply go back and check your figures, and inevitably you identify an arithmetical mistake. (That, by the way, takes much more time than working out the sight in the first instance.) The figures are all indelibly set down in your notebook. After a while you develop

kind of operative confidence that permits you quickly to exclude
ain hypotheses. If—say—you end up with an LOP that is twenty
hirty miles off your dead-reckoning position, you can usually feel
ven retroactively, in the seat of your pants that your sun sight was
tle—blasé; caused, perhaps, by the pitching of the boat. If your
res are okay, and the LOP is bum, *either* the sight was bad *or* the
keeper was inaccurate. It is *extraordinary* how often the latter is
case. Misreading the minute hand by one minute will put you off
en miles. But after a while you start knocking them down, no
at. *All* the instructions you need are given in these words. Master
n, and you have hold of everything you need to go on to the stars
the planets. And, of course, the “noon sight,” taken at that glori-
moment when the sun squats over your meridian (i.e., the sun is
tly south or north)—it has no other recourse than to do so: for the
oitation of which benefaction you do not even need a sundial, let
e a chronometer. A piece of cake.

10.

Bermuda is a blur, best captured in Christopher's log, and thank God I am old enough to be spared the temptation to the bacchanalian excesses. I think I don't really enjoy what the jet age makes possible: the quickie reunions with one's wife, which are more poignant than exhilarating. A reunion on a transatlantic stop is really defined as a recapitulated departure, because one arrives, really, only for the sake of leaving again. If the schedule were otherwise and you planned to sail to Bermuda in order, say, to spend a week there, only then sailing on, it would be different. At least we'll spend four days in the Azores, but one and one half of these will be spent in traveling along the 350-mile length of the islands. The indomitable Pat and Marvin will not attempt to meet us there, under the circumstances.

Her arrival gave us something of the feeling of the annual visitation of the steamboat in Nome, Alaska, bearing the necessities for the entire winter. She bore the replacement loran unit; the spare propeller (the one that had been blasted off in Miami, pitched now to the desired amplitude); and her own personal little color Sony to remedy the Buckley Home Entertainment Service. To anticipate: the loran did not work, though we gave it another two days' trial. The propeller we did not need. The new barometer failed—Van feels that our imperfect barometer is the saddest commentary on our defective gear, and I try to console him by telling him that I have hardly ever seen a defective barometer before, so simple is the mechanism. It is on the order of having a defective screwdriver. When I *think* of the barometers and altimeters I possess, scattered about, none of which I thought to bring. The television didn't work. My frustration was such that I have suggested to my companions that on arriving at Marbella,