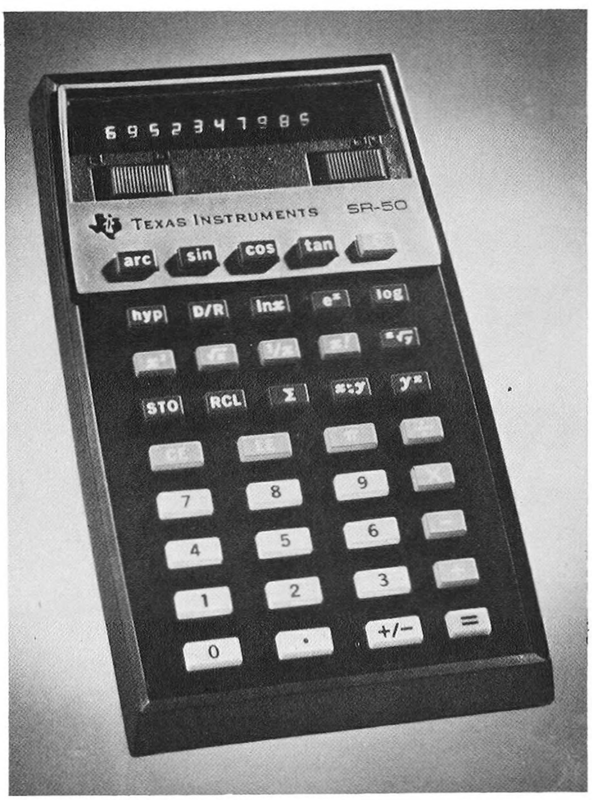
International Hydrographic Review, Monaco, LII (2), July 1975

MARCQ SAINT-HILAIRE WITHOUT TEARS

by Rear Admiral Robert W. KNOX, USC & GS (Ret.)

A Sumner line of position by the St. Hilaire method can be rapidly and accurately solved by use of a shirt-pocket slide rule calculator. There are many on the market, some with mathematical features of little or no interest to the navigator. Minimum requirements for the purpose at hand — in addition to the strictly arithmetical features — are trigonometric functions, at least one memory (storage), and recall. Should the cosine-haversine method be used, x^2 and $\sqrt{x}$ keys are necessary to convert the haversines to sines by means of the relationship haversine A = sine^2 A/2. This method permits a solution without taking a pencil in hand, but is



somewhat longer than the sine-cosine method by reason of the conversions. In the latter method, and with a calculator with but one memory, it is necessary to jot down one figure midway through the calculation. This would not be necessary with a more sophisticated computer which would have sufficient memories to store this as well as the hour angle, latitude and declination, so that once in the calculator they could be recalled by merely pressing the proper key rather than entering them a second time.

The following example was solved by a Texas Instruments SR-50 Slide Rule pocket computer. This answers to 13 significant digits and displays the results rounded off to 10 digits — vastly in excess of the needs of celestial navigation, but certainly guaranteeing the veracity of the tenth-of-a-minute in the altitude difference. The computation was carried out to 10 digits, but for the sake of brevity the listed display was rounded off to five. It was considered expedient to convert the sexagesimal system of notation of the input data to decimals before beginning the computation, although this may readily be accomplished as the calculation progresses. This example is identical with that given in an example in the 1958 edition of "The American Practical Navigator" [1] and the formulae are :

$$\sin h = \sin \mathrm{L} \sin d + \cos \mathrm{L} \cos d \cos t$$

$$\sin \mathrm{Az} = \sin t \cos d \sec h_c$$

Given :

t $80^\circ 45'.9 = 80^\circ.765$ W

L $41^\circ 12'.3 = 41^\circ.205$ S

d $21^\circ 50'.7 = 21^\circ.845$ S

h_0 $20^\circ 41'.7 = 20^\circ.695$

NOTE :

$\boxed{\text{STO}}$ = Storage

$\boxed{\text{RCL}}$ = Recall

Altitude difference

Enter	Press	Display	Remarks
41.205	$\boxed{\sin}$	0.65876	
	$\boxed{\text{STO}}$	0.65876	
21.845	$\boxed{\sin}$	0.37210	
	$\boxed{\times}$ $\boxed{\text{RCL}}$ $\boxed{=}$	0.24512	A
80.765	$\boxed{\cos}$	0.16048	
	$\boxed{\text{STO}}$	0.16048	
41.205	$\boxed{\cos}$	0.75236	
	$\boxed{\times}$ $\boxed{\text{RCL}}$ $\boxed{=}$ $\boxed{\text{STO}}$	0.12074	

21.845	$\boxed{\cos}$	0.92819	
	$\boxed{\times}$ $\boxed{\text{RCL}}$ $\boxed{=}$	0.11207	B
	$\boxed{+}$	0.11207	
0.24512 (A)	$\boxed{=}$	0.35719	A + B
	$\boxed{\text{arc}}$ $\boxed{\sin}$	20.928	h_c
	$\boxed{-}$	20.928	
20.695 (h_o)	$\boxed{=}$	0.233	a in degrees
	$\boxed{\times}$		
60	$\boxed{=}$	13.98	a in minutes

Altitude difference = <u>14′ Away</u>

Azimuth

80.765	$\boxed{\sin}$	0.98704	
	$\boxed{\text{STO}}$	0.98704	
21.845	$\boxed{\cos}$	0.92819	
	$\boxed{\times}$ $\boxed{\text{RCL}}$ $\boxed{=}$ $\boxed{\text{STO}}$	0.91616	
20.9278	$\boxed{\cos}$	0.93404	
	$\boxed{1/x}$ $\boxed{\times}$ $\boxed{\text{RCL}}$ $\boxed{=}$	0.98087	
	$\boxed{\text{arc}}$ $\boxed{\sin}$	78.7748	Az
	$\boxed{-}$	78.7748	
78	$\boxed{=}$	0.7748	Fractional degrees
	$\boxed{\times}$	0.7748	
60	$\boxed{=}$	46.49	Minutes

<u>Az = S78°46′ W</u>

The computation appears lengthy, but with familiarity with the instrument and formulae it can be solved within a minute.

REFERENCE

[1] American Practical Navigator. Nathaniel BOWDITCH. U.S. Navy Hydrographic Office, H.O. Pub. No. 9, 1958, page 529.