

U. S. COAST AND GEODETIC SURVEY
TIDE-PREDICTING MACHINE
AUTOMATIC READ-OUT ATTACHMENT

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IHB Note. — Mr. Burt W. WILCOX was born in Columbus, Ohio. He attended public schools and the Ohio State University there. He received a B. Sc. degree in mathematics and physics and then had a year of graduate work in mathematics.

He joined the staff of the Tides and Currents Division, Coast and Geodetic Survey, U.S. Department of Commerce, as a mathematician in 1930.

He is presently Chief of the Predictions Branch of that Division, which is responsible for the predictions of tides and currents, and the publishing of tide tables covering the world and current tables for United States waters, together with some places in Japan, China, and the Philippines.

The Coast and Geodetic Survey tide-predicting machine was hand-operated for many years — the data being read visually from dials and tabulated by hand. This made it necessary to set the data in type for the tables or make special typewritten copy for offset printing. In January 1958 the installation of an attachment which produced electrically typewritten copy for offset printing was completed. Hereafter this attachment will be called *Data Logger* or *Logger*.

The principal components of the Data Logger or digital converter are housed in a cabinet (fig. 1) which is about two feet square and seven feet high. Air is forced through the cabinet to keep the temperature from exceeding a reasonable operating level. One of the two Digi-Coders in the Logger fixes the pattern for time read-out, and the other controls the height read-out. Two servo systems cause the Digi-Coders to follow precisely the changes in position of the time and amplitude shafts on the tide-predicting machine.

The motor drive of the predicting machine is controlled by the Logger. The speed is maintained almost constant for regular predictions of tides and currents except for a regulated slowdown as the 15th and end of each month are approached. Power to the motor will be shut off and the machine will slow to a stop when the first derivative of the function on the tide predictor is zero. If currents are being predicted a similar stop will be made also when the velocity is zero. When hourly heights or velocities are being tabulated the motor drives the machine at a slower speed and no stops are made for read-out. An adjustable speed control is provided for machine operation when no read-outs are being made or curves only are being drawn.

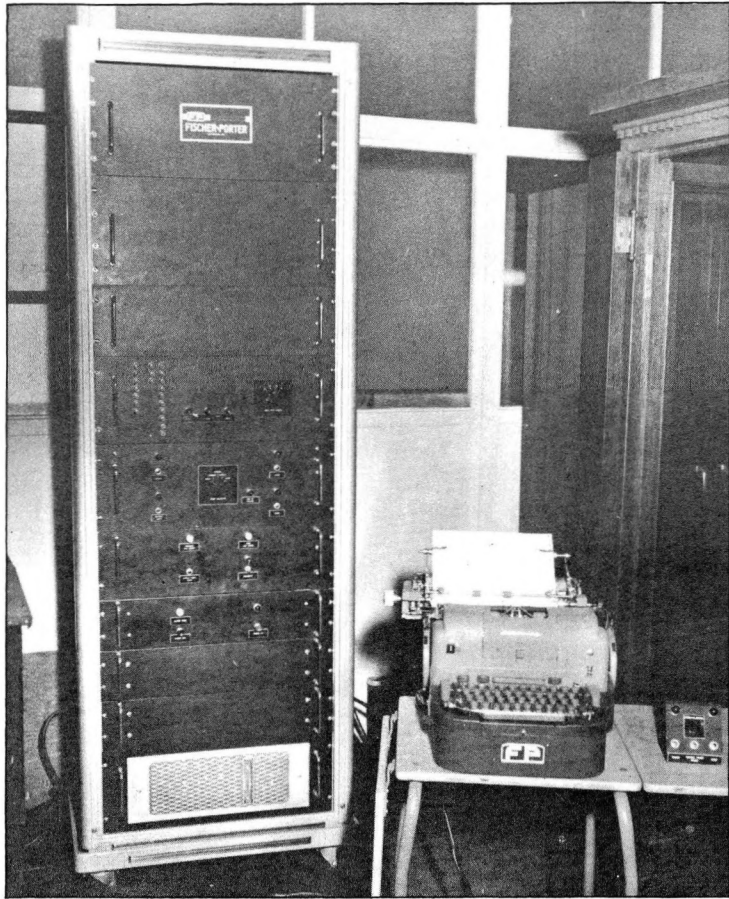


FIG. 1. — Data Logger Cabinet and Typewriter.

Two servo systems pick up the changes in angular position of the time and amplitude shafts on the predicting machine and transmit these changes to the Logger bringing the Digi-Coders into positions corresponding to the predictor's time and amplitude shafts. Two sets of information are picked up from the time shaft: one is a count of 25 pulses to measure each day, and the other is a measure of the hours and minutes in the day. The pickup on the amplitude shaft is more complex (see fig. 2) because the shaft oscillates as the tide or current changes direction; a datum correction must be allowed for, and reducing factors have to be applied.

A solenoid-operated electric typewriter tabulates the data in different formats fixed by the circuitry in the Logger. Figures 3 and 4 show the forms for tides and currents respectively. The new formats of the tide and current tables which had been adopted a year before contributed to the simplification of the Logger. In the tide format (fig. 3) time advances down the column which contains times and heights of high and low waters. These phases are identified by numerical size of the heights. With currents (fig. 4) there is a double column, one for slack-water times, and one for strengths of flood and ebb. Flood and ebb currents are identified by the

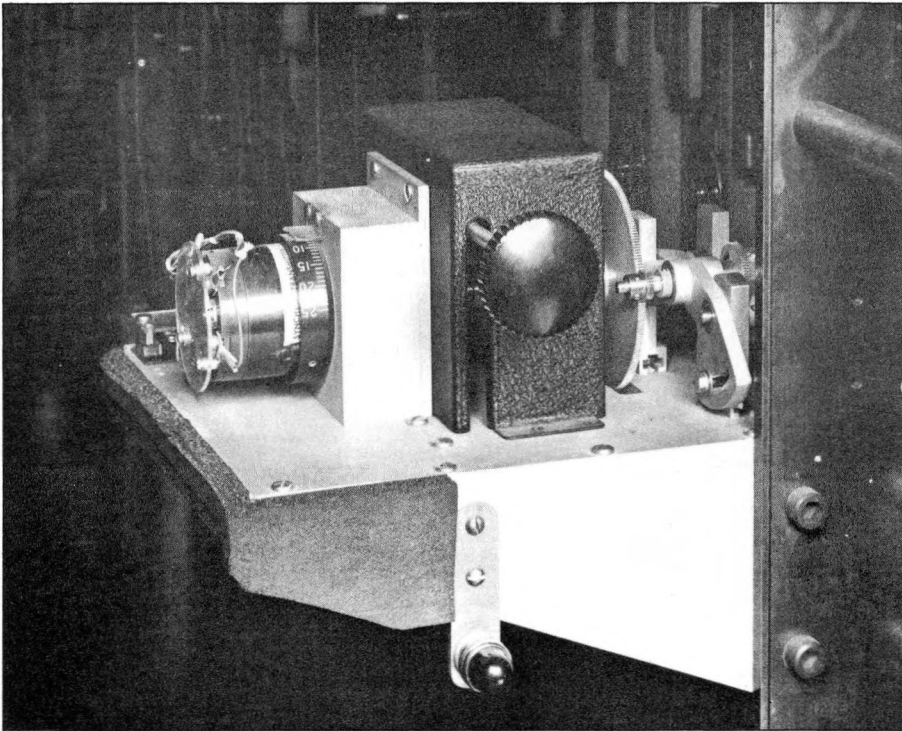


FIG. 2. — Height Synchro Attachment.

symbols f and e respectively.

The Logger reduces the time of predicting a tide-station year by about one hour and eliminates the special typing of hand copy. The pages of tide and tidal-current predictions, after stripping in headings and footnotes, are ready for photographing for offset printing.

Times and Heights of High and Low Waters

JANUARY				FEBRUARY				MARCH						
DAY	Time	Ht.		DAY	Time	Ht.		DAY	Time	Ht.		DAY	Time	Ht.
	<i>h. m.</i>	<i>ft.</i>			<i>h. m.</i>	<i>ft.</i>			<i>h. m.</i>	<i>ft.</i>			<i>h. m.</i>	<i>ft.</i>
M 1	0029	0.3		T16	0119	-0.1		T 1	0138	0.0		F16	0247	0.1
	0646	6.2			0736	6.7			0756	6.6			0901	6.5
	1309	0.2			1400	-0.4			1420	-0.4			1523	-0.3
	1915	5.5			2009	5.9			2028	5.9			2131	5.9
T 2	0119	0.2		W17	0214	-0.1		F 2	0233	-0.3		S17	0336	0.0
	0737	6.5			0830	6.7			0849	6.9			0947	6.6
	1400	-0.1			1455	-0.5			1512	-0.8			1608	-0.4
	2005	5.7			2103	5.9			2120	6.3			2215	6.0
W 3	0208	0.0		T18	0306	-0.1		S 3	0326	-0.7		S18	0420	-0.1
	0826	6.8			0921	6.8			0939	7.3			1029	6.6
	1450	-0.4			1545	-0.6			1603	-1.2			1649	-0.6
	2056	5.9			2152	6.0			2209	6.8			2255	6.2
T 4	0258	-0.3		F19	0355	-0.2		S 4	0417	-1.0		M19	0501	-0.2
	0914	7.0			1006	6.8			1029	7.6			1110	6.7
	1538	-0.7			1631	-0.7			1651	-1.5			1727	-0.5
	2144	6.2			2237	6.0			2259	7.1			2332	6.3
F 5	0347	-0.5		S20	0440	-0.2		M 5	0507	-1.3		T20	0540	-0.3
	1001	7.3			1051	6.8			1119	7.7			1149	6.6
	1625	-1.0			1714	-0.7			1740	-1.6			1803	-0.4
	2231	6.5			2319	6.1			2347	7.3				
S 6	0435	-0.8		S21	0523	-0.2		T 6	0558	-1.4		W21	0609	6.4
	1048	7.5			1152	6.8			1209	7.8			0619	-0.3
	1712	-1.3			1754	-0.7			1828	-1.7			1227	6.5
	2318	6.8											1840	-0.4
S 7	0524	-0.9		M22	0600	6.1		W 7	0636	7.5		T22	0646	6.4
	1136	7.6			0603	-0.2			0648	-1.4			0658	-0.2
	1800	-1.4			1213	6.6			1259	7.6			1304	6.3
					1834	-0.6			1917	-1.6			1917	-0.2
M 8	0607	6.9		T23	0640	6.1		T 8	0126	7.4		F23	0123	6.3
	0613	-1.0			0645	-0.1			0740	-1.3			0737	-0.1
	1225	7.6			1254	6.5			1350	7.3			1344	6.1
	1848	-1.5			1913	-0.4			2007	-1.3			1953	0.0
T 9	0657	7.0		W24	0119	6.0		F 9	0218	7.2		S24	0202	6.3
	0705	-1.0			0727	0.0			0834	-1.0			0818	0.0
	1316	7.4			1334	6.3			1445	6.9			1425	5.8
	1939	-1.4			1952	-0.3			2100	-0.9			2033	0.2
W10	0148	7.0		T25	0200	6.0		S10	0313	7.0		S25	0245	6.2
	0759	-0.9			0809	6.1			0931	-0.7			0903	0.2
	1409	7.2			1416	6.0			1542	6.4			1511	5.6
	2030	-1.2			2032	-0.1			2155	-0.5			2117	0.3
T11	0242	6.9		F26	0242	5.9		S11	0410	6.7		M26	0333	6.1
	0856	-0.7			0855	0.3			1031	-0.4			0955	0.3
	1506	6.9			1502	5.7			1642	6.0			1603	5.4
	2125	-0.9			2114	0.1			2254	-0.2			2208	0.5
F12	0340	6.8		S27	0328	5.9		M12	0510	6.5		T27	0427	6.0
	0955	-0.5			0943	0.4			1134	-0.2			1052	0.4
	1604	6.5			1550	5.5			1745	5.8			1701	5.4
	2221	-0.6			2200	0.3			2355	0.1			2308	0.5
S13	0438	6.7		S28	0417	5.9		T13	0612	6.3		W28	0527	6.1
	1057	-0.4			1036	0.4			1237	-0.1			1153	0.3
	1706	6.2			1642	5.3			1848	5.6			1803	5.5
	2321	-0.4			2251	0.4								
S14	0538	6.7		M29	0509	5.9		W14	0656	0.2			0544	6.2
	1200	-0.3			1132	0.4			0713	6.3			1209	0.2
	1809	6.0			1738	5.3			1337	-0.1			1824	5.6
					2345	0.4			1949	5.6				
M15	0020	-0.2		T30	0604	6.1		T15	0154	0.2			0032	0.6
	0638	6.6			1230	0.2			0809	6.4			0646	6.1
	1302	-0.3			1836	5.4			1433	-0.2			1310	0.2
	1911	5.9							2043	5.7			1924	5.7
				W31	0042	0.2								
					0701	6.3								
					1325	0.0								
					1933	5.6								
												S31	0052	0.2
													0705	6.6
													1326	-0.2
													1941	6.6

FIG. 3. — Tides.

f - flood, direction * true. e - ebb, direction * true.

JANUARY							FEBRUARY												
DAY	SLACK WATER		MAXIMUM CURRENT			DAY	SLACK WATER		MAXIMUM CURRENT			DAY	SLACK WATER		MAXIMUM CURRENT				
	Time	Time	Vel.			Time	Time	Vel.			Time	Time	Vel.						
	<i>h. m.</i>	<i>h. m.</i>	<i>kn.</i>			<i>h. m.</i>	<i>h. m.</i>	<i>kn.</i>			<i>h. m.</i>	<i>h. m.</i>	<i>kn.</i>						
M 1	0531 1154 1736	0211 0828 1412 2052	1.3f 1.6e 1.2f 2.0e		T16	0029 0638 1256 1842	0352 0959 1613 2216	1.8f 1.9e 1.5f 2.2e			T 1	0045 0646 1307 1854	0325 0944 1537 2206	1.6f 1.9e 1.5f 2.4e		F16	0154 0802 1422 2004	0516 1132 1737 2339	1.7f 1.8e 1.4f 2.1e
T 2	0027 0627 1247 1829	0318 0924 1511 2144	1.5f 1.7e 1.3f 2.2e		W17	0123 0736 1352 1936	0447 1059 1706 2308	1.9f 1.9e 1.5f 2.2e			F 2	0138 0741 1403 1951	0430 1042 1644 2303	1.9f 2.2e 1.7f 2.6e		S17	0241 0846 1507 2050	0602 1212 1821	1.7f 1.9e 1.5f
W 3	0117 0720 1338 1921	0413 1016 1608 2235	1.7f 1.9e 1.5f 2.4e		T18	0215 0826 1444 2024	0538 1148 1756 2354	1.9f 2.0e 1.5f 2.2e			S 3	0229 0834 1458 2046	0528 1136 1744 2356	2.1f 2.4e 2.0f 2.8e		S18	0323 0925 1548 2132	0017 0644 1245 1901	2.1e 1.8f 2.0e 1.6f
T 4	0205 0809 1429 2012	0501 1107 1702 2325	1.9f 2.1e 1.7f 2.6e		F19	0301 0911 1529 2108	0624 1230 1841	1.9f 2.0e 1.5f			S 4	0321 0924 1549 2138	0619 1228 1838	2.4f 2.7e 2.3f		M19	0403 1001 1626 2210	0051 0721 1314 1937	2.1e 1.8f 2.1e 1.6f
F 5	0253 0857 1518 2103	0545 1157 1753	2.1f 2.4e 2.0f		S20	0345 0951 1611 2150	0033 0706 1306 1922	2.2e 1.9f 2.0e 1.6f			M 5	0411 1012 1639 2230	0047 0708 1318 1930	3.0e 2.6f 2.9e 2.4f		T20	0441 1035 1703 2249	0121 0751 1343 2002	2.2e 1.7f 2.1e 1.7f
S 6	0341 0944 1607 2152	0013 0630 1245 1843	2.8e 2.3f 2.5e 2.1f		S21	0425 1028 1652 2230	0108 0745 1338 1957	2.2e 1.9f 2.1e 1.6f			T 6	0501 1101 1730 2322	0137 0756 1408 2020	3.1e 2.6f 3.0e 2.5f		W21	0518 1108 1741 2327	0153 0807 1414 2017	2.2e 1.7f 2.2e 1.7f
S 7	0428 1032 1656 2243	0102 0717 1334 1934	2.9e 2.5f 2.7e 2.2f		M22	0504 1104 1731 2311	0142 0816 1410 2024	2.2e 1.8f 2.1e 1.5f			W 7	0549 1150 1820	0228 0844 1458 2111	3.0e 2.6f 3.0e 2.5f		T22	0554 1143 1819	0228 0823 1448 2043	2.1e 1.7f 2.2e 1.7f
M 8	0517 1120 1747 2335	0150 0804 1424 2024	2.9e 2.5f 2.8e 2.3f		T23	0543 1140 1810 2351	0217 0837 1445 2042	2.2e 1.7f 2.1e 1.5f			T 8	0613 1239 1913	0319 0933 1548 2203	2.9e 2.5f 2.9e 2.3f		F23	0004 0632 1218 1857	0303 0854 1525 2119	2.1e 1.7f 2.2e 1.7f
T 9	0606 1209 1839	0241 0853 1515 2118	2.9e 2.5f 2.8e 2.2f		W24	0622 1216 1850	0254 0854 1521 2111	2.1e 1.7f 2.1e 1.5f			F 9	0107 0733 1330 2006	0411 1024 1640 2303	2.7e 2.2f 2.8e 2.1f		S24	0045 0710 1256 1939	0343 0931 1603 2159	2.1e 1.7f 2.2e 1.7f
W10	0027 0659 1300 1934	0334 0944 1607 2214	2.8e 2.4f 2.8e 2.1f		T25	0032 0702 1254 1933	0333 0926 1559 2149	2.0e 1.6f 2.1e 1.5f			S10	0202 0828 1422 2102	0506 1122 1734	2.4e 2.0f 2.5e		S25	0127 0752 1337 2024	0423 1013 1646 2244	1.9e 1.6f 2.2e 1.6f
T11	0123 0754 1352 2030	0428 1039 1703 2320	2.6e 2.2f 2.6e 2.0f		F26	0116 0745 1334 2018	0414 1003 1640 2232	1.9e 1.6f 2.0e 1.4f			S11	0259 0926 1517 2202	0007 0604 1229 1834	1.9f 2.1e 1.7f 2.3e		M26	0215 0839 1425 2115	0510 1101 1735 2335	1.9e 1.5f 2.1e 1.5f
F12	0222 0850 1448 2129	0526 1143 1802	2.4e 2.0f 2.5e		S27	0202 0830 1417 2105	0459 1048 1725 2320	1.8e 1.5f 2.0e 1.4f			M12	0403 1027 1616 2303	0117 0711 1341 1940	1.7f 1.9e 1.4f 2.1e		T27	0308 0933 1520 2212	0603 1153 1832	1.8e 1.4f 2.0e
S13	0324 0950 1546 2229	0033 0629 1257 1903	1.8f 2.1e 1.7f 2.3e		S28	0252 0919 1504 2158	0547 1135 1815	1.7e 1.4f 2.0e			T13	0507 1132 1717	0225 0825 1449 2051	1.6f 1.7e 1.3f 2.0e		W28	0408 1035 1622 2313	0031 0704 1252 1934	1.5f 1.7e 1.4f 2.0e
S14	0430 1053 1645 2330	0145 0738 1408 2009	1.8f 2.0e 1.6f 2.2e		M29	0349 1013 1558 2253	0012 0642 1228 1910	1.3f 1.6e 1.3f 2.0e			W14	0005 0611 1233 1817	0328 0940 1550 2158	1.6f 1.7e 1.2f 2.0e					
M15	0536 1156 1745	0251 0851 1514 2116	1.7f 1.9e 1.5f 2.2e		T30	0447 1111 1655 2348	0109 0742 1325 2009	1.4f 1.6e 1.3f 2.0e			T15	0102 0711 1331 1914	0424 1042 1647 2254	1.6f 1.8e 1.3f 2.0e					
					W31	0547 1210 1755	0213 0844 1429 2109	1.5f 1.7e 1.4f 2.2e											

FIG. 4. — Tidal Currents.