man on watch throws his switch which places the automatic broadcaster in control of the broadcast through distant control. At exactly five minutes of the hour, the automatic broadcaster begins and transmits the signal with the accuracy of one one-thousandth of a second.

After the signal is on the air, and in order that we can determine any errors in the actual emission of the time broadcast, we receive over our own antenna the broadcast. Our receiving sets in the time service office, also made by naval personnel, then convert the signals into mechanical energy and operate a printing chronograph, which was invented by Mr. SOLLENBERGER some years ago. This gives us a permanent record of every signal from this Observatory. We can also receive and record signals from other sources.

One of the many advantages of this new automatic broadcaster is that by installing duplicate sets at distant points we can accurately rebroadcast our signals from those points. When the apparatus is installed at distant points, the neon light is flashed by the reception of the time signal by radio instead of by the beat of the standard clock in our vault. The operator at the distant points then corrects the broadcaster in the same manner we do here, using the radio broadcast signal received. When he has his broadcaster in step with the radio time signal received and has absorbed the lag due to the time of radio transmission, his apparatus is ready for rebroadcast, and he likewise goes about his other duties. At five minutes of the hour, at the times designated for his station, his apparatus rebroadcasts the Washington signal with the same accuracy.

In contrast with the 16 minutes consumed in preparation for broadcast under the old method, the automatic method can be set within five or ten seconds. As a result, with no increase in our astronomical staff, we are now able to broadcast signals once an hour. As soon as the new sets are completed and installed at Panama and at Honolulu, we will be able to reach naval vessels and American merchantmen any place in the world.

Our original automatic broadcaster was placed in service in May 1934, and has been used continuously ever since. We are now building a new set, approximately the same in general design, but differing in some mechanical details, in order to reduce wear of parts, insure greater durability, and reduce risk of interruption. The fundamental principles involved are identical.

In closing I wish to pay just tribute to the unfailing energy and loyal cooperation of all the personnel at this institution who so ably assisted in perfecting and machining all the parts for this rather complicated apparatus. In particular, I wish to emphasize the wholehearted cooperation of Mr. Paul SOLLENBERGER in the completion of this broadcaster.

During the International Astronomical Union's Convention in Paris, in July 1935, the Naval Observatory's automatic broadcaster occasioned considerable comment by the assembled delegates. Three representatives from foreign countries have already visited this institution and observed its operation.

THE CENTENARY OF THE POSITION LINE

Several publications have recently alluded to a memorable date in the history of Navigation — that of Monday, 18th December 1837, at the hour of 10 p.m. — which marks the wholly unexpected discovery by the American Captain Thomas Hubbard SUMNER of the position line, known as the "Sumner Line" or as the "line of position".

It has been considered appropriate to mention this memorable centenary in the *Hydrographic Review*, and to say a few words concerning the inventor and the circumstances in which he made his discovery.

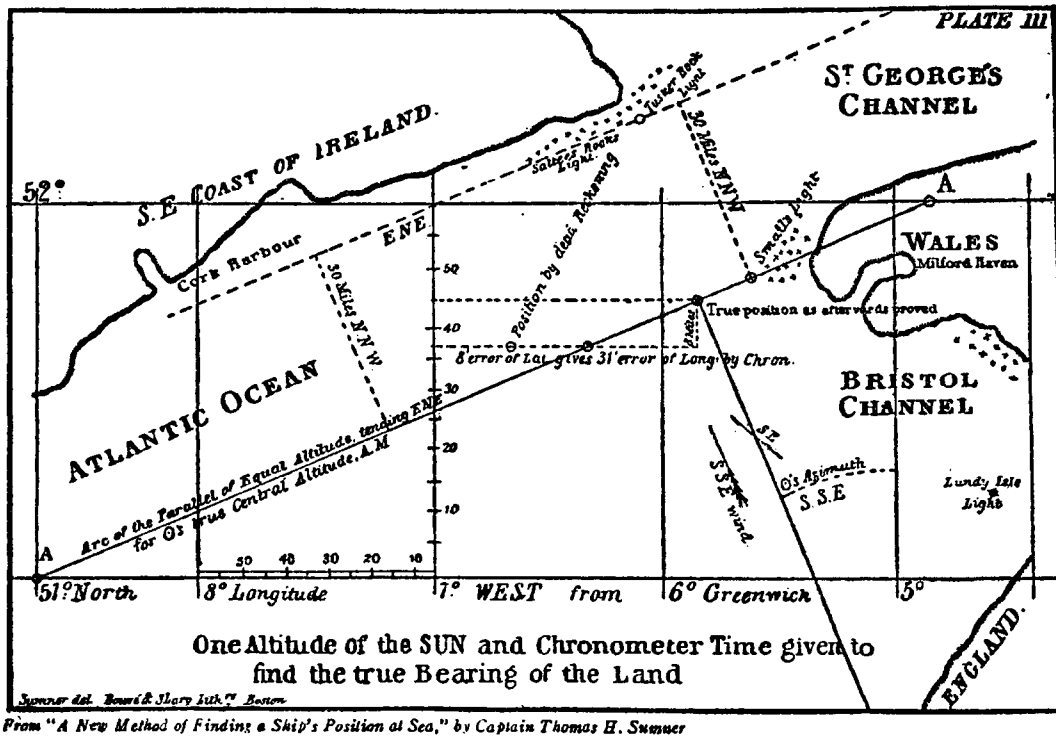
Thomas Hubbard SUMNER was born at Boston on 20th March 1807 one of the eleven children of Thomas WALDRON and Elizabeth Hubbard SUMNER. His forefather, William SUMNER, was a navigator who had immigrated in 1636 to New England. His father, Thomas Waldron SUMNER, was an architect and Member of Congress for the State of Massachusetts from 1805 to 1811 and from 1816 to 1817. Young SUMNER attended Harvard University where in 1826 he obtained his degree of B. A., and it is recorded in the archives of the University that in the same year he shipped for Canton as a common sailor, sailing on the American clipper ships which at that time were circling the globe. On 10th March 1834, he married Selina Christiana MALCOLM, who bore him four children.

Lieutenant Commander P.V.H. WEEMS, of the U.S.A. Navy, very judiciously remarks in an article published in the United States Naval Institute Proceedings, Annapolis, January 1938, that Captain SUMNER's discovery of the Sumner Line or the correct concept of what the line of position means, is an excellent example of a discovery as opposed to an invention. In his own words, he was placed in a position which indicated the principle of the Line of Position and he was shrewd enough to observe the meaning of it.

The following extract from Captain SUMNER's log-book indicates better than any other account of the event could do, the exact circumstances under which this important discovery was made :-

"Having sailed from Charleston, S.C. 25th November, 1837, bound to Greenock a, series of heavy gales from the Westward promised a quick passage; after passing the Azores, the wind prevailed from the Southward, with thick weather; after passing Longitude 21° W., no observation was had until near the Land; but soundings were had not far, as was supposed, from the edge of the Bank. The weather was now more boisterous, and very thick; and the wind still Southerly; arriving about midnight, 17th December, within 40 miles, by dead reckoning, of Tuskar light; the wind hauled S.E., true, making the Irish coast a lee shore; the ship was then kept close to the wind, and several tacks were made to preserve her position as nearly as possible until daylight; when nothing being in sight, she was kept on E.N.E. under short sail, with heavy gales; at about 10 A.M. an altitude of the sun was observed, and the Chronometer time noted, but, having run so far without any observation, it was plain the Latitude by dead reckoning was liable to error, and could not be entirely relied on.

"Using, however, this latitude, in finding the Longitude by Chronometer, it was found to put the ship 15' of Longitude, E. from her position by dead reckoning; which in Latitude 52° N. is 9 nautical miles; this seemed to agree tolerably well with the dead reckoning; but feeling doubtful of the Latitude, the observation was tried with a



From "A New Method of Finding a Ship's Position at Sea," by Captain Thomas H. Sumner

FIG. 1

Latitude 10' further N., finding this placed the ship E.N.E. 27 *nautical* miles, of the former position, it was tried again with a Latitude 20' N. of the dead reckoning; this also placed the ship still further E.N.E., and still 27 *nautical miles* further; these three positions were then seen to lie in the direction of *Small's light.* It then at once appeared, that the observed altitude must have happened at all the three points, and at

Small's light, and at the ship, at the same *instant of time*, and it followed, that Small's light must bear E.N.E., if the Chronometer was right. Having been convinced of this truth, the ship was kept on her course, E.N.E., the wind being still S.E., and in less than an hour, Small's light was made bearing E.N.E. ½ E., and close aboard.

"The latitude by dead reckoning was erroneous 8 miles, and if the Longitude by Chronometer had been found by this Latitude, the ship's position would have been erroneous 31 ½ *minutes* of Longitude, too far W., and 8 *miles* too far S. The ship had, from current, tide, or error of log, overrun her reckoning, 1 mile in 20.

"Thus it is seen, that an observation taken at *any* hour of the day, and at any angle between the meridian and E. or W. points, is rendered practically useful, inasmuch as the Chronometer can be depended on."

Captain SUMNER afterwards devoted himself to the development of his discovery, and he drew up a few notes which were published for the first time at Boston in the form of a pamphlet entitled: "New Method of Finding a Ship's Position at Sea" (*). At the time, April 1843, this work was favourably reported upon by a Committee which had been appointed in this connection by the Naval Library and Institute of Boston.

In 1844 an article entitled: "On Captain SUMNER's Method of determining the position of a ship", by Lieutenant H. RAPER, published in the *Nautical Magazine*, gave great credit to this method which still further enhanced "the utility of the chronometer at sea".

Speaking at Glasgow of the SUMNER method, Lord KELVIN took up the question most enthusiastically, remarking that it would be to the advantage of navigators, whether old or young, if this new method of navigation should supplant all others.

In 1847, Thomas Hubbard SUMNER was promoted to the rank of Captain in recognition of his important contribution to the science of navigation.

It was in 1850 that the tragedy of SUMNER's life became apparent; it was found necessary to place him in a Mental Home near Boston.

His family was left in financial distress and in 1852 his widow addressed a petition to the U.S.A. Congress in order to obtain help "in consideration of the discovery by her husband of a new method of finding a ship's position at sea"; in 1854 she obtained authorisation for the purchase of the "copyright of a work published by Thomas H. SUMNER, wherein he describes his New Method of ascertaining a Ship's Position at Sea".

Towards 1847, SUMNER's discovery became known in France and was discussed in the *Annales Maritimes* in an article by a navigator named BARTHET, who announced that he was going to present a new graphical method for determining the position of the ship at sea which he had found in a small publication by Thomas H. SUMNER.

Nearly forty years had to pass before Admiral Marcq DE SAINT-HILAIRE, extracting from SUMNER's discovery all that it held, gave to navigators a practical method of calculating the fix, using a single altitude sight. This method which he devised on board the frigate *La Renommee* is explained in a Paper which he published in the *Revue Maritime et Coloniale* in August 1875 concerning the method of D.R. altitudes. When he proposed his method, which compares a computed altitude with an observed altitude, the era of the new astronomical navigation was consecrated; it marked the definite victory of the chronometer over the former method of lunar distances. But it was in fact in St George's Channel, on a cold winter morning, that the *Position Line* came into being on 18th December 1837.

H. B.

(*) During a research as to the origin of the method, an allusion was found to a similar method which seems to have been practised in the Royal British Navy at a still earlier period; this method bore the expressive name of "Cross Bearing of the Sun". The chief mention of this fact is found in the "Treaty on Navigation and Nautical Astronomy" by Staff Commander W. R. MARTIN, Instructor at the Royal Naval College of Greenwich.