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Charted Clipper's Course On First Pacific Hop

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Navigator Who Guided The China Clipper On Its Initial Flight Across The Pacific Tells Of Problems Faced In Keeping Proper Course Over Vast Ocean

The navigator who accompanied the China clipper on its initial flight from San Francisco to Manila, and return, tells here of the navigation problems peculiar to flying and contrasts them with his experience twenty years ago as navigation officer of one of the old sailing clipper ships. Mr. Noonan is navigating instructor of the Pacific division of Pan American Airways.

By FREDERICK NOONAI

ALAMEDA, CALIF.

FLYING those Pan-American clippers 150 miles an hour through all kinds of weather, how in the world do you ever find those tiny islands out in the middle of 65,000,000 square miles of Pacific?" Literally hundreds have asked us that question in one form or another.

A steamship can take its time at such a task or in making any landfall. If clouds or fog make accurate navigation difficult, it can lie-to or creep along until conditions improve. An airplane, on the other hand, must arrive at its destination and proceed with its landing within a few hours of its schedule. The contrast has struck no one with more force than it has struck me.

ONLY OTHER TRIP

Until the clipper flights started last year, my only trip across the Pacific was made twenty years ago as navigation officer on a square rigger, one of the last of the old sailing clipper ships.

On a surface vessel the navigator's job is comparatively simple—a sextant's sight at the sun and a little trigonometry at high noon, another sight at sundown, an occasional reading of the ship's log whirling at the rail, then a bearing or two to plot from a coastline radio compass station should the ship run into fog near shore. That much suffices, because even a fast surface vessel travels only five or six hundred miles in a full day. The flying clipper ships go that far in three or four hours. Even if our problems were as simple as those of a steamer's officers, we would therefore have some six times as much navigating work to do.

But it isn't even that easy. Fundamentally, we use the same three methods to find our way as they do—observations of sun and stars, estimations of our movement in relation to the ocean's surface, the directional guidance of radio. But each of these takes on its own new complexities when used from the air.

STILL MAINSTAY

Celestial navigation is a case in point. It is still the mainstay in our technique, as it was in that of the old sailing clipper ships. As most people know, it consists of measuring the angle above the horizon of the sun or a star at an exactly known time, and from that angle computing one's latitude and longitude by means of mathematical formulae.

It is not overly simple even on surface ships. In the air it becomes complicated from the fact that the observer is not at sea level, the proper point from which to measure the angles above the horizon, but anywhere up to four miles above it. Sometimes, too, haze or clouds will entirely obscure the horizon from an airplane navigator. But we have developed for our use a specially designed instrument, an octant instead of a sextant, whose "level-bubbles" create an "artificial horizon" at the plane's level. That means extra "correctives" to allow for the altitude point.

GREATER SPEED

Then the speed of the airplane itself demands greater speed in working up one's data into a position "fix." A ship's mate might thumb through his tables for half an hour to get the ship's noon position. The ship would still be within a few miles of the "fixed point" when he had finished. But in the same interval an airplane would have traveled seventy or eighty miles—and seventy or eighty miles is a long way to be off course.

To cut this time, our flight officers responsible for navigation have spent long months in training and in research to abstract from tables and almanacs the material which would be of use in each particular region of the Pacific.

We worked out in advance the correctives we had to make for altitude. We devised special tables to cut down on other mathematical manipulations. In many cases we prepared graphs to replace these tables. Then each flight officer was required to spend hours on practice routines. As a consequence, the average time needed for computing sights and plotting positions has been cut from thirty minutes to six.

DEAD RECKONING

Routine navigation is done by means of "dead reckoning"—a process for keeping track of one's progress over the ocean by straight compass reading in relation to the surface speed being made. A ship's officer gets an accurate measure of the vessels speed by use of a log which trails from a cable attached to the rail on the stern. He gets the ship's heading from the master compass.

But even this dead reckoning system, which, before the ocean transport operations of the clipper ships, was relied upon for most trans-ocean flights, is far more complicated from the air than it is from the deck of a steamer.

An airplane's crew knows only its speed through the air in the direction in which it is pointing. Head winds, cross winds, tail winds, are constantly on hand to make the speed and direction of the plane's progress over the ocean something entirely different. To find the latter the airplane's navigator must take periodic sights at some fixed point on the ocean's surface. That means, first of all, the fixing of some point on the surface to sight at. This Problem is solved, at night, by the use of high-powered flares which drop from the plane and burn for several minutes after striking the water.

For daytime targets, Pan-American developed glass bombs filled with aluminum powder. A split second after one of these has shattered after striking the water, the aluminum has spread out in a big shining patch, distinctly visible against the ocean's green or blue. A new instrument, which, by simple triangulation, affords an almost instantaneous check on the ground speed, has been developed, greatly simplifying older and cumbersome mechanics of "drift sights."

RADIO ELEMENT

The third element—radio—is perhaps the most remarkable development of all. Radio direction finders for surface vessels have been in use for years. Heavy and cumbersome, they are seldom used for any appreciable distance off shore, because of their limited range and the inaccuracy of their bearing as distances from the short stations increase.

Pan-American engineers, eight years ago, when international air transport service was first undertaken, attacked the problem of providing positive radio flight control over the relatively great distances required on scheduled flight between North and South America. They were successful in perfecting radio direction finders, employing both short and long wave frequencies for distances up to 600 miles—or better than six times the consistent range of the standard ship's radio compass or the airway radio beam used on transcontinental lines within the United States.

RANGE INCREASED

As one of the preparations for trans-Pacific operations, the engineers were successful in increasing the range of these direction finders to the remarkable distance of 2,000 miles. So the flying clipper ships, even in mid-ocean, have the same positive radio guard that surface vessels have near shore.

The signals from the airliner are measured by their minimum at the receiving station, where they are registered on a dial. The resultant reading gives the true bearing of the clipper from that station. This is then relayed to the clipper.

Thus, a single station can tell a plane whether it is to the left or right of its course. Two stations can give it intersecting bearings to fix its position exactly, or even one station, by directing the clipper to fly at right angles to its course and then make a second change of direction, can determine such a fix. With the range of the direction finders, there are always two stations "on guard" at each stage of a transpacific flight.

In addition to the radio direction finders on the surface, a modified form of this system has been developed for the aircraft itself, so that each clipper carries a direction-finding station with a range up to 1,000 miles and with which the clipper can tune in ships or any fixed stations to obtain bearings of its own.