The author arrives at Stansted, in a Mooney Mark 21, to fly as a fourth crew member in the Trident, G-ARPM, seen behind

NAVIGATION — 5

Airways

by Richard Serjeant

NAVIGATION ON AIRWAYS differs in several fundamental respects from the types described in the previous articles. The entire flight is conducted in controlled airspace, with the closest possible liaison with the ground at all times. Airways are great corridors in the sky, ten miles wide and extending from several thousand feet above the ground to 35,000 ft. or more. They funnel into the various main Control Zones—London, Manchester and Prestwick are examples in this country—as well as leading to the main overseas routes. A pilot flying on Airways is assigned his exact altitude and he must be able to maintain it; these altitudes are determined by Air Traffic Control after consideration of all the other traffic on Airways, and of course every movement is known because you cannot fly Airways without filing a very precise Flight Plan.

IFR

The entire procedure is carried out under what are known as Instrument Flight Rules (IFR), which in effect mean that there are no mandatory restrictions as to weather except those affecting take-off and landing. Indeed the majority of such flights entail a climb through cloud, cruising in calm sunshine at a height of several miles, and a descent through cloud again for the final visual approach and landing. This is no amateur business, and a requirement for IFR flying is that the pilot shall hold an Instrument Rating. This entails a searching theoretical examination, a prolonged and detailed flying test; moreover it has to be renewed with a flying test every six months.

All this knowledge and experience would be useless without a suitably equipped aeroplane, and in fact very strict regulations govern every detail of the radio and other equipment that must be carried. The *minimum* is one 360-channel VHF radio-telephony set, a 90-channel standby, a radio-compass, VOR with ILS, and Markers, all of specified standard (Class 1). Since altitudes of 10,000 ft. or more may be assigned even to piston-engined aircraft, these must be fitted with full de-icing; and finally for full IFR flying there must be at least two engines. In effect, all airline flying is done under IFR, and most private flying is not. There is nothing to stop a private pilot from flying Airways and taking advantage of all the facilities provided, so long as he has an Instrument Rating and is flying a suitably equipped aeroplane, but you will see that such a combination is rare.

However, once these various difficulties have been overcome there is a majestic quality about Airways flying that is quite unlike any other kind. The corridor of sky allotted to you is yours alone, and as you cruise along perhaps thousands of feet above a complete carpet of cloud you can completely ignore prohibited areas, danger areas, control zones and other aircraft, so long as you make the necessary position reports and follow your instructions from Air Traffic Control, particularly terminally. Of course, with the high approach speeds of modern airliners there must be adequate separation between them, so wide diversions and holding patterns may be required, and the exact position of every aircraft in controlled airspace within 30 miles or so of a busy airport must be known. This is determined by a combination of position reports from the aircraft and radar information from the ground.

In previous articles I have described progressive navigational methods as a pilot who has personal knowledge of using them. But what is it like to conduct a flight in a modern luxury airliner? Most of us have flown in these machines as passengers, with the usual qualms on take-off and landing, the tension of a descent through cloud, and the profound relief of knowing one has finally landed. What is all this like from the pilot's point of view?

Recently BEA were kind enough to allow me to fly in one of their Tridents as a fourth member of the crew during a training flight from Stansted, and also as an observer on a routine flight to Nice. Readers will be familiar with this magnificent aeroplane with its three rear-mounted Spey engines, and which carries over eighty passengers and a normal crew of seven. There are three pilots, each of whom is fully trained to undertake the combined duties of pilot, co-pilot and engineer-navigator. In passing, it costs £12,000 to train one of these men from command of a Viscount to command of a Trident, and it would cost a lot more if most of the initial training were not done on a simulator. It is not until one goes behind the scenes that one appreciates the enormous care and meticulous attention to detail that is applied to every airline flight. The Nice flight is perhaps typical.

Navlog

Flight planning at Heathrow proceeds on standard lines. The crew assemble in the briefing room, and full details of passengers, load and fuel are considered, leading to a calculation of the different speeds involved in take-off and landing. "Met." information is studied with care over the entire route. A special "Navlog" is prepared by Flight Operations at Heathrow, one for every airliner on each different route. It contains carefully calculated data about headings, beacons, elapsed times between reporting points, and periods of climb or descent. The figures are corrected for an averaged prevailing wind over the whole route. A short section of the Trident Navlog for London-Nice is shown here.

Meanwhile the aircraft itself is being refuelled and various ground checks are carried out. Cockpit checks, with the engine-starting procedure, involve over 150 items. These are carried out by the pilots, who start going aboard 45 minutes before the time scheduled for take-off.

The flight-deck of a Trident looks vastly complex compared with the ordinary light aircraft, but after a short time many familiar instruments can be identified, and of course the controls are orthodox,

with the captain in the left-hand seat. Now let us see what navigational aids will be used on this flight to Nice. So far as ground services are concerned these are precisely those I have described already in previous articles—ADF, VOR, ILS, and the coverage provided by radar. This is hardly surprising, since they were all developed for airline flying. It goes without saying that all the aircraft equipment is of the highest possible class.

The Navlog gives precise information on the route between Seaford and St. Tropez; at each end of the flight the procedure will vary according to local conditions of weather and traffic. The pilot is usually given his final instructions as he taxies out to the holding point; he may be directed to Seaford *via* Dunsfold, or *via* Epsom and Mayfield, and the instructions will include the altitudes to be attained at these points. The Navlog includes diagrams of all the procedures that might be called for, with headings, distances and frequencies.

Take-off

Take-off from the flight deck is spectacular compared with the little aeroplanes I usually fly, but it is a scientifically co-ordinated two-man procedure. The throttles are opened to maximum power; then the brakes are released, and the aircraft is steered down the runway with a small wheel under the captain's left hand. The howl of those jets is simply not heard—indeed the flight-deck must be about the quietest place for miles around during take-off! As the aircraft accelerates down the runway three critical velocities are called out by the second pilot, and the second and third of these have been carefully worked out for each particular take-off. Up to a certain speed take-off can be abandoned if this is indicated for any reason; then comes the point when it cannot be abandoned for any reason at all, even fire (V1); finally the speed for "rotation"—pulling back on the yoke to raise the nosewheel and initiate the climb. His eyes glued to the airspeed indicator, the co-pilot calls out "100 knots . . . V one . . . VR!".

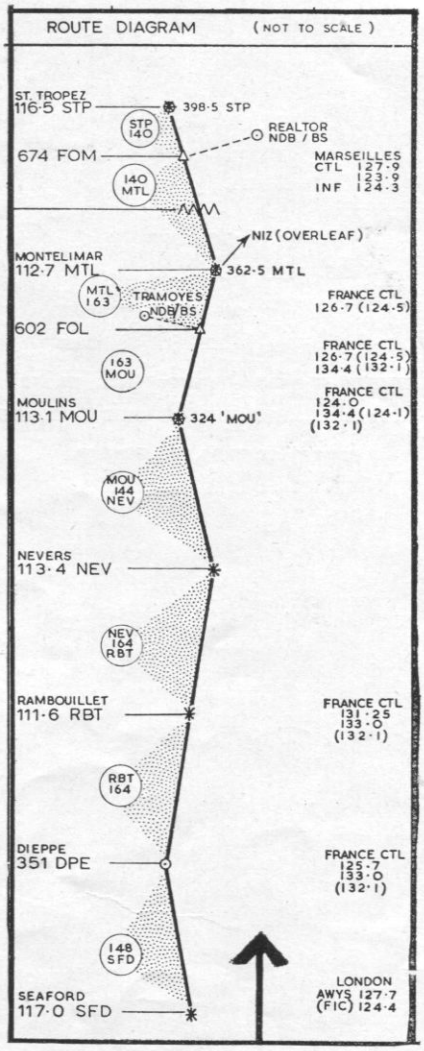
The Trident takes the air and climbs steeply away. Clearance has been given to Nice *via* Dunsfold and Seaford. At Seaford itself the Navlog gives a heading of 148 deg. magnetic for Dieppe, with a distance of 64 miles and an elapsed time of 9 minutes (still climbing). The radio-compass is set on the beacon at Dieppe, and we get a positive indication when overhead so that the time can be checked and the heading changed to 164 deg. for Rambouillet. Here there is a VOR beacon, and with the auto-pilot locked on it we reach our cruising altitude of 29,000 ft. by the time we get to Dieppe.

The Trident now settles down to its cruising speed of 600 m.p.h., and the 97 miles between Rambouillet and Nevers are covered in 12 minutes. Each "leg" is indeed only a matter of a few minutes, which just gives time for any necessary corrections of course or ETA, and for making the mandatory radio calls. Between Seaford and St. Tropez these are normally simple position reports, made immediately after passing each reporting point. The form is basically "Bealine G-ABCD, Seaford one five (*that is, 15 minutes past the hour*), Flight level two nine zero (29,000 *feet*), estimating Dieppe two four", perhaps with additional information about weather conditions. The fixed part of the planned route ends at St. Tropez, 40 nautical miles south-west of Nice, and the approach pattern to the airport then varies with the wind direction and other local factors. Terminally the pattern may be complex, especially if "holding" is required in a race-track pattern based on a beacon, but instructions are positive and definite.

Doppler

An additional aid is provided on the Trident in the form of the so-called Doppler display. During the flight the position of the aircraft in relation to the ground is shown pictorially by means of a pen moving on a map. This apparatus does not depend on ground stations at all, but computes the position from radar signals emitted by the aircraft and reflected from the ground (giving ground-speed) while heading information is derived from a gyro device. This display is visible in the centre of the instrument panel in my flight-deck photograph.

Flight deck of the Trident during a circuit at Stansted. The Doppler display can be seen in the centre, behind the throttle bank



A section of the Trident Navlog for the route between Seaford and St. Tropez. Note that these charts read upwards

Finally, diversions may be forced because of fog or other conditions making a landing impossible at the assigned destination. The printed Navlog includes precise data for reaching a number of alternative aerodromes, all within the fuel range of the aircraft.

On a normal routine run nothing appears easier than this airline navigation: everything is worked out for you; between take-off and landing the whole of the flying is done by a highly competent automatic pilot, with radio-beacon locks and rigid altitude control; where ILS is installed the final approach down the beams to the runway is also locked by the auto-pilot, and on the Trident another computer controls the throttles here so that a constant approach speed is maintained.

It is really the unusual and the unexpected conditions that necessitate the extreme complexity of airliners and the intensive training of the men who fly them, men whose job is surely one of the most responsible and most skilful in the world.

The end