PART 3 : SECTION 2

CHAPTER 1

VOICE ROTATING BEACONS AND DISTANCE MEASURING EQUIPMENT

VOICE ROTATING BEACONS

Function

1. The V.H.F. Voice Rotating Beacon (V.R.B.) is a short-range navigational aid which provides magnetic homing bearings to aircraft fitted with a standard V.H.F. receiver tuned to the beacon frequency. Any number of aircraft can use the V.R.B. simultaneously. The equipment is mobile and fully tropicalized.

Principle of Operation

2. Two transmitters, one with its carrier modulated by speech and the other with its carrier modulated by a steady audible note, operate on the same fixed frequency. The speech modulation is provided by a magnetic tape recording, and the steady note by a local oscillator. The complete aerial system rotates at a constant speed, completing one revolution every 72 seconds. The aerial system consists of two separate aerials :—

(*a*) An array that produces a beam approximately 30° wide on which the speech-modulated carrier is transmitted.

(*b*) An aerial that possesses a heart-shaped (cardioid) polar diagram with maximum transmission in the opposite direction to that of the speech-modulated beam. By this arrangement the speech radiated on the back beam of the directional aerial is obliterated by the tone transmission, thus preventing sense ambiguity.

3. The magnetic tape recording system, synchronized to the rotation of the aerial system, announces a homing bearing every 10°, interspaced with the station callsign which is a single letter of the phonetic alphabet.

4. The heart-shaped polar diagram fills the area not covered by the 30° beam. Therefore a pilot flying at a position from which his magnetic track to the beacon is 090° will hear a continuous tone until the modulated 30° beam begins to pass his aircraft ; he will then hear "Zero-eight-Able" faintly against the continuous tone, then "Zero-nine-Able" clearly without background tone, then faintly "One-Zero-Able" with increasing

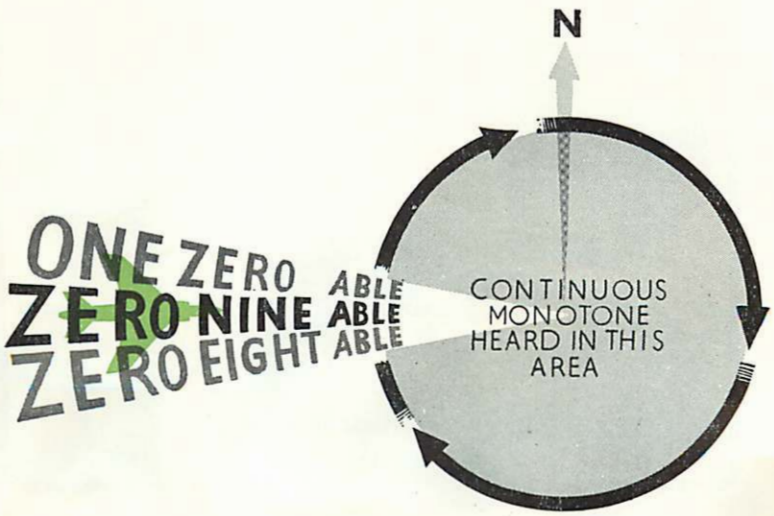

Fig. 1. Voice Rotating Beacon.

background tone, followed soon by the steady note as the aerial system rotates. Since the verbal announcements are made every 10°, they have to be multiplied by 10; thus, "Zero-eight-Able" means 080°, and so on. The magnetic track to the beacon is obtained by averaging the tracks heard. In the example given above, the tracks heard were 080°, 090°, and 100°, giving an average of 090°. Magnetic or true bearings from the beacon may be determined by applying the usual calculations.

Operational Limitations

5. Voice rotating beacons are subject to the following limitations :—

(*a*) *Range*. Subject to the V.H.F. optical horizon limitations, the equipment has a power output permitting an average maximum range of 90 miles.

(*b*) *Accuracy*. ± 5°.

(*c*) *Security*. Aircraft do not disclose their positions by transmitting when using the beacons, but enemy aircraft can also use the beacons.

DISTANCE MEASURING EQUIPMENT

Function

6. Rebecca Mk. 7 (A.R.I. 5849) is an airborne interrogator-responder which operates in the 190 to 240 mc/s waveband. It functions in conjunction with a Eureka Mk. 7 (M.G.R.I. 5861) ground transponder beacon and shows on a meter in the aircraft the distance from, and limited heading information relative to, the Eureka beacon. This particular Rebecca/Eureka combination is generally known as Distance Measuring Equipment (D.M.E.).

Principle of Operation

7. **Distance Indication.** Pulses from the Rebecca transmitter are received by the Eureka beacon and retransmitted on a different frequency. The time interval between the initial pulse transmission from the aircraft and the time of reception of the retransmitted pulse (from the Eureka beacon) by the aircraft is measured and converted into a reading indicated to the pilot as a distance in nautical miles.

8. **Heading Indication.** The heading pointer gives some indication of the direction in which the Eureka beacon lies relative to the aircraft heading. The needle pointer is at zero whenever the aircraft is heading at, or 180° away from, the transponder (Eureka) beacon, but gives a full-scale deflection towards the beacon whenever aircraft heading is 2° or more away from the above headings. QDM/QDR ambiguity can be resolved by the pilot making a turn to starboard

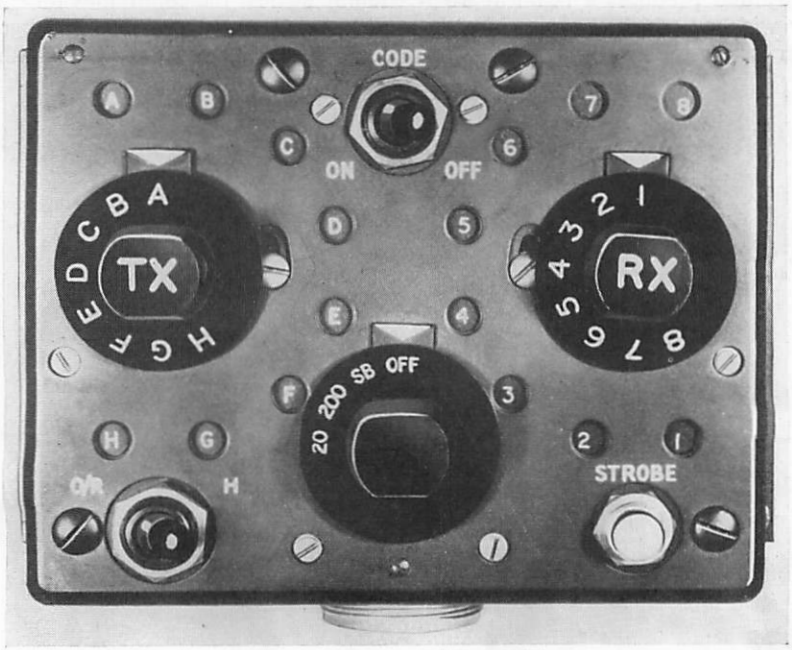

Fig. 2. Rebecca, Mk. 7, Control Unit, Type 909.

and watching the needle reaction. Needle deflection in the opposite direction to the turn indicates that the beacon lies ahead of the aircraft.

Operating Modes

9. The airborne Rebecca equipment has two modes of operation, namely :—

(*a*) Searching for a transponder.

(*b*) Locked to a transponder.

10. During the searching mode no signal is received back from any transponder, and searching continues. This mode is indicated by the range pointer (Fig. 3) rising slowly from zero to 200 nautical miles, an operation taking 25 seconds. Having swept the full scale the range pointer returns quickly to zero and a new sweep begins. In this 25-second period 5,000 interrogating pulses are radiated. When the equipment is switched to the 20-mile (short-range operating) position, the search period is eight seconds, corresponding to 1,600 interrogating pulses.

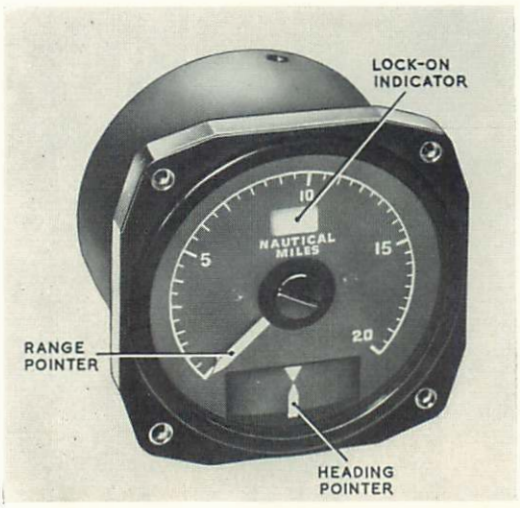

Fig. 3. Rebecca, Mk. 7, Range and Heading Meter.

11. When signals are received back from a Eureka beacon the Rebecca will automatically lock on to this responsor. A steady indication of range will then be given by the range pointer and the lock-on indicator (Fig. 3) will show ON.

Eureka Beacon Coding

12. Each Eureka beacon gives audible coding in the pilot's headphones. Should the pilot find that the code signal is not that of the transponder on which he means to home, he can release his equipment from the lock-on condition to permit it to search for another transponder.

Memory Circuit

13. Should the response signals be lost, a memory circuit maintains the lock-on condition for a period of eight seconds to allow the signals to be regained. Should the signals still be lost after this period the equipment resumes searching.

Frequencies

14. The transmitter and receiver operate on a choice of eight spot frequencies between 190 mc/s and 240 mc/s. The transmitter and receiver frequencies differ to prevent self-triggering.

Airborne Equipment

15. Apart from the transmitter and receiver, the aircraft carries a control unit (Fig. 2) and a range and heading meter (Fig. 3).

16. **Control Unit.** The control unit is mounted in a position readily accessible to the pilot and carries all the equipment operating controls, namely :—

(*a*) *Function and Range Control Switch.* This is a four-position rotary switch used to select the following operating conditions :—

(i) OFF. All power off.

(ii) S.B. With S.B (Stand-by Switching) selected, *i.e.* when warming up, power is applied to all valve heaters, frequency-changing motor circuits, aerial switching relay, and the strobe lock indicator.

(iii) 200. When this, the long-range operating position, is selected, searching takes place over a range of 200 nautical miles.

(iv) 20. In this, the short-range operating position, searching takes place over a range of 20 nautical miles.

(*b*) *Transmitter Tuning Switch* (*TX*). This switch is used to select any one of eight frequencies designated by the letters A to H.

(*c*) *Receiving Tuning Switch* (*RX*). This switch is used to select any one of eight frequencies designated by the figures 1 to 8.

(*d*) *Code Switch* (*CODE ON/OFF*). When this switch is ON, the coding signals from the Eureka beacon are audible in the pilot's headphones.

(*e*) *Omni-Range-Homing Switch* (*O/R-H*). When this switch is set to O/R, normal ranging takes place and no heading indication is given ; but in the H position, in addition to ranging, the beam switching that occurs between the port and starboard aerials causes the heading pointer (Fig. 3) to show any deviation from a true course laid on the Eureka beacon.

(*f*) *Strobe Release Push-Button.* The strobe release push-button is a switch which releases the locking circuit and allows the equipment to resume the searching mode.

Limitations

17. Ranges up to 200 nautical miles can be measured with an accuracy of the order of ±2%. When the range decreases sufficiently to make reading difficult, the equipment can be switched to short-range operation, so that the full-scale reading of the meter represents 20 miles.

18. A single Eureka beacon can be worked satisfactorily by up to 73 aircraft simultaneously. When any number of aircraft greater than 73 are using the equipment simultaneously, however, those farthest away from the Eureka beacon may not be locked to the transponder. The Rebecca equipment in such aircraft will start searching, but the rate of search will be slowed down. It may be possible to obtain some indication of range even under these conditions, since the range pointer sweep will be slowest immediately before the position where locking should take place.

V.R.B./D.M.E.

19. V.R.B./D.M.E. is a combination of the two radio aids described in this chapter. It enables pilots to obtain both bearing and distance from a common point.