CHAPTER 5

OBOE-9000 SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

GENERAL DETAILS

Introduction

1. Oboe is a system of blind-bombing wherein an aircraft is controlled by two ground stations. Each of these stations uses the normal radar technique to measure the range of the aircraft from it; thus it can be seen that at any time the position of the aircraft can be found by the range-cut principle. The code name Oboe covers airborne equipments whereas the ground stations are called AMES type 9000.

2. In order to increase the range of the device above that which would be obtained were the reflected waves alone used, a pulse repeater is carried in the aircraft. Thus there is a two-way transmission (compare the IFF principle); and it can be seen that without multiple equipment, any two stations will only be able to control one aircraft at a time.

3. Oboe was first used operationally in the early part of 1943. The Mk. I equipment was used at that time, but since then other Marks have been developed. These will all be described later. There are, however, certain fundamental facts common to all of them, and these will be dealt with first.

Ground stations (AMES, type 9000)

4. The two ground stations previously mentioned have different functions in an Oboe operation. One station keeps the aircraft flying along a track which will take it over the target (fig. 1). In general the track along which the aircraft is made to fly is a circle drawn about the ground station as centre with a radius equal to the target range from that station, but it is possible to arrange to have arcs of approach to the target other than circular ones. In all cases, this station is known as the *cat* or the *tracker* station, the latter being the more modern name. The tracker station measures the range of the aircraft, and so can determine whether or not the latter is on its correct track. Indications of error in track are sent out from the tracker to the aircraft in such a manner that the pilot hears a series of dashes in a pair of headphones if he is too far from ground station, or a series of dots if he is too close. If he is on the correct track the pilot hears a continuous note in his headphones. All such indications to the pilot are sent out automatically from the tracker station by a modulation of the same pulse transmission that is used for range measurement. The form assumed by this modulation will be discussed in each particular case.

5. The function of the second ground station is to send out to the aircraft (this time to the navigator or bomb-aimer) the bomb-release signals and such warning signals as are deemed necessary. This station is known as the *Mouse*. It measures the range of the aircraft and so also can obtain the velocity of the aircraft along a radius drawn towards it. Having this information, and also the height of the aircraft and bomb ballistic data, the *Mouse* can send the release warning so that the bombs fall on the target. Usually the release signal is sent by breaking completely transmission from the *Mouse*.

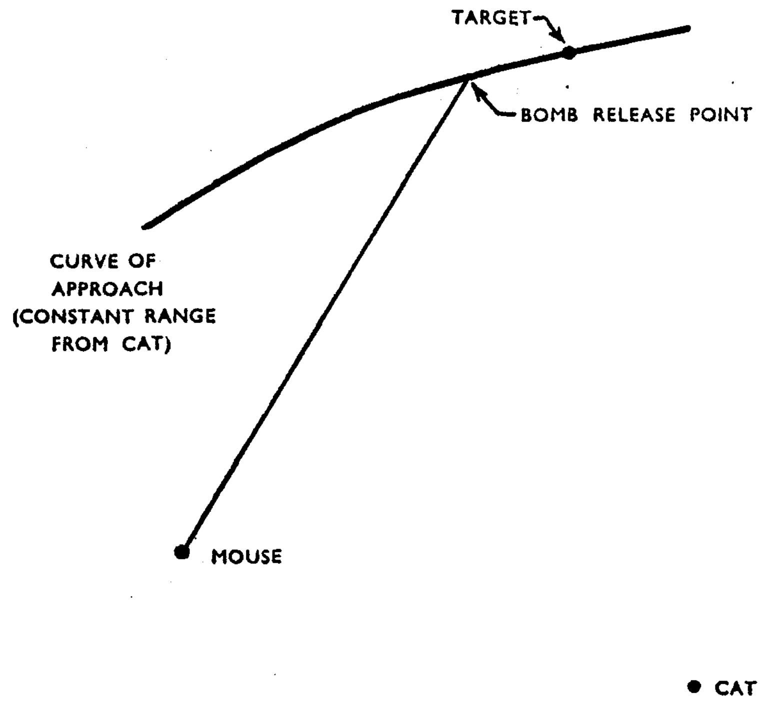


Fig. 1.—Oboe, showing general principles

Aircraft equipment

6. There is no need for any form of display in the air, all signals received by the pilot and navigator being aural. The equipment carried in the air, therefore, consists in the first place of a receiver which is used to trigger the pulse repeater transmitter. A double filter is also required to separate signals from the two ground staions and to convert the pulse intelligence received into audible indications for the aircrew, who wear headphones.

Operational technique

7. On large scale raids the Oboe equipped aircraft act as pathfinders for the main force, dropping marker flares on the target. On small scale raids on specialised targets the Oboe aircraft carry a bomb-load. Both Cat and Mouse stations can communicate with the aircraft in morse over the radar pulsed beam. This is used for the preliminary positioning of the aircraft before it starts its run-in. The range achieved is of the order of 250 miles.

Accuracy

8. Though the accuracy with different Marks of equipment may, to a certain extent, vary, it is remarkably good for all. The errors involved are usually of the order of 100 yards. The accuracy is better with a greater base line between the stations, because then the angle of cut of the Cat and Mouse circles at the target is greater.

GROUND STATION EQUIPMENTS

Mk. I (FGRI.5534)

9. In this equipment a CHL transmitter and converted CHL receiver racks are used. The frequency is about 220 Mc/s (just under 1½ metres).

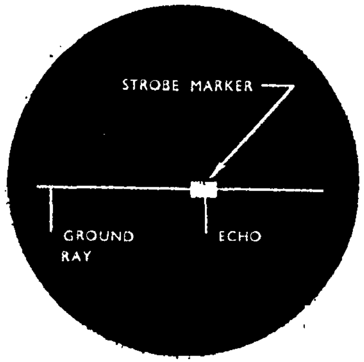


Fig. 2.—Long timebase and strobe marker

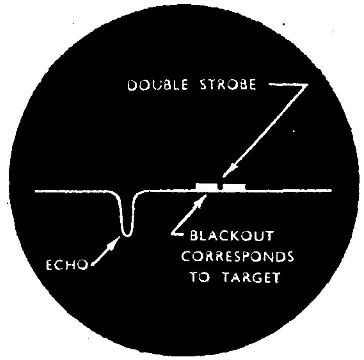


Fig. 3.—Magnified timebase (Cat) and double strobe marker

10. The display consists of two CRT presentations. On one of the tubes is a timebase of some 400 miles length which is known as the *long timebase* (fig. 2). On this timebase appears the ground ray (at the beginning) and the return pulse from the aircraft (at a point depending on the aircraft range). In addition a small part of the trace has extra brightness (*strobe marker*). This strobe marker can be moved at will

along the trace and it is the function of the other tube to give a magnified picture of the section of the long timebase so brightened. This second presentation, a timebase of something like 3 miles length, is known as the *magnified timebase* (fig. 3).

11. At a Cat station the recurrence frequency of the long timebases is 133 c/s and so also is that of the ground rays which appear at the beginning of each long timebase.

12. On the magnified timebase trace appear two brilliance markers separated by a small interval. These are known as the *double strobe* markers (fig. 3).

13. The gap between the twin strobes may be positioned accurately to correspond to target range, and it is the function of the equipment to compare the position of the aircraft return signal with the positions of the twin strobes. The two strobes define two zones, one to the inside of the target circle and one on the outside. The comparing circuits on the ground are very sensitive and can detect even the slightest difference in time overlap of the aircraft signal with the two strobe zones. Thus the circuits see automatically whether the aircraft is too close to, or too far from, the Cat station.

14. A further set of pulses is now sent out from the Cat station. These are sent out during the blackout period, so that they cause no interference to the operator. The actual position occupied by the pulses in the blackout period is controlled by the circuit which compares the position of the return pulse with the double strobes.

15. If the aircraft is at correct range from the Cat station then these second pulses remain steady at a position one-quarter the way into the blackout period. This is their mean position. As the aircraft deviates from the correct track these pulses are space modulated in a dot-dash manner about their mean position. Extreme modulation takes them from the beginning of the blackout period to halfway through the blackout (fig. 4).

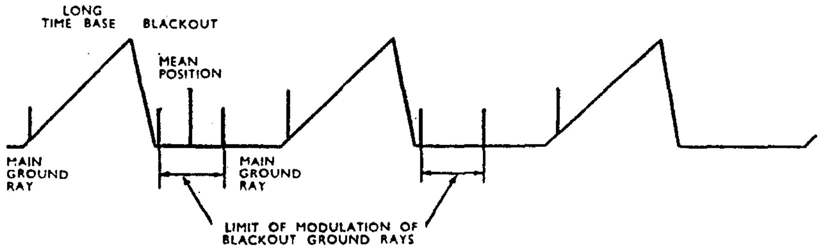
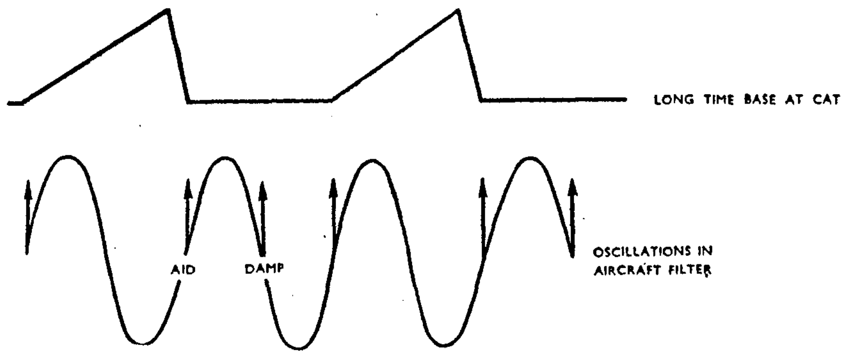


Fig. 4.—Ground rays and modulation

16. The aircraft filter consists of a ringing circuit tuned to 266 c/s This will be maintained in oscillation by the normal pulses sent from the ground. At the same time the second type of pulses from the ground will, according to their position, reinforce or damp down these oscillations. Thus it can be seen that the filter will convert dot-dash space modulation of the pulses into dot-dash amplitude modulator for the pilot. *See* fig. 5.

17. To give an example : if the aircraft is too close to the Cat station, then the blackout ground rays spend about 1/12 second at the beginning of the blackout and then about 5/12 second half-way through the blackout and so on (taking the case of extreme modulation). In this case the filter oscillations are reinforced for 1/12 second and damped for 5/12 second. This results in a series of dots heard in the aircraft (fig. 6(A)). Similarly, dashes can be obtained by reversing the timing of the dot-dash space modulation (fig. 6(B)).



Normal ground rays maintain oscillations
Blackout ground ray at beginning of blackout aids oscillations
Blackout ground ray halfway through blackout damps oscillations

Fig. 5—Aircraft ringing circuit

18. The extent of swing of the pulses is governed by the error in range of the aircraft and so the amplitude of dots or dashes will tell the pilot the extent of his error. When he is on the correct track there is no space modulation and so a constant amplitude in the aircraft filter.

19. A Mouse station has both long and magnified timebases as before. However, on the latter, a series of equidistant blackout pips appear, replacing the double strobe pulses of the Cat (fig. 7(a)). These pips can be positioned on the trace so that one of their number corresponds to target range and the others then mark out constant intervals from the target range such as PQ and QT (fig. 7(b)). The general principle adopted

is that the aircraft is timed as it covers the distance PQ, and information derived from this timing (velocity of aircraft) is then used to enable the bombs to be released at a point R in the interval QT so that they actually fall on the target (fig. 7(b)). Again, most of this work is done automatically.

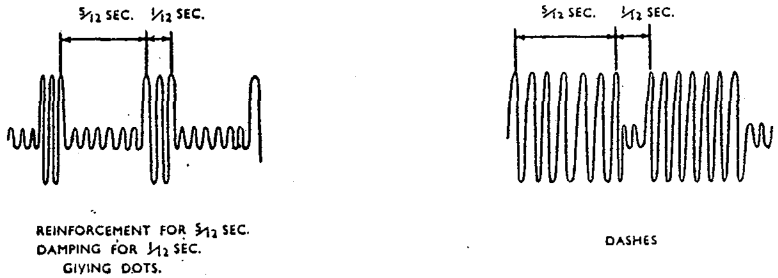


Fig. 6—Operation of ringing circuit

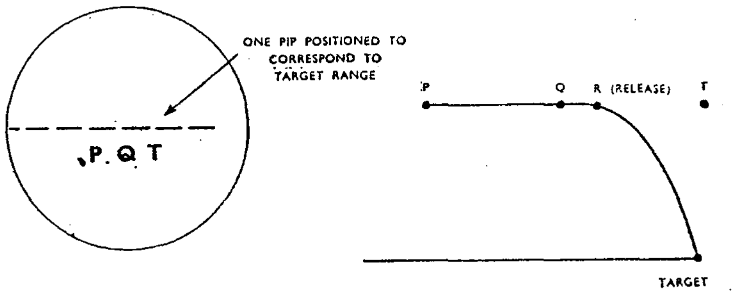


Fig. 7.—Magnified timebase (Mouse) showing blackout pips

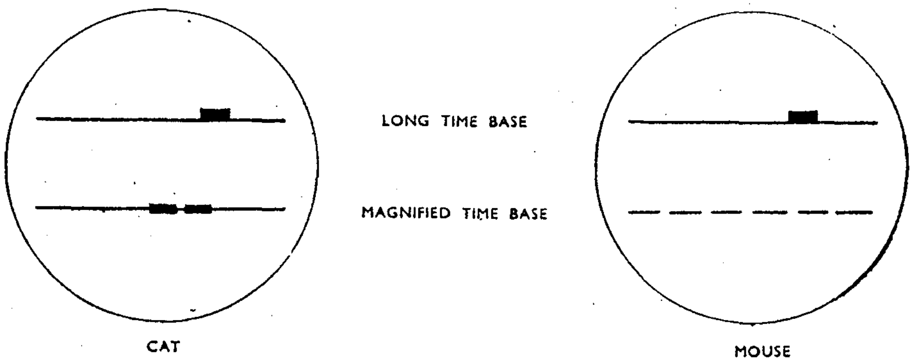


Fig. 8.—Mk. II MS display

20. The recurrence frequency of the Mouse long timebase is 97 c/s and pulses are sent out at the beginning of this timebase and at the beginning of the blackout period.

21. The aircraft filter has a ringing circuit at 194 c/s feeding the bomb-aimer's headphones, and this will clearly be kept ringing at maximum amplitude by the Mouse pulses received. The release signal is given by a complete break in transmission. Cat and Mouse arrays are directed towards the target area

Mk. II F (FGRI.5606)

22. This uses the same display scheme as for Mk. I and, in fact, differs from the latter only in radio-frequency. It uses centimetre waves (about 9·3 cm.). The transmitter used normally is an American ASG type converted for ground use.

Mk. II MS

23. This, again, uses the same principles as the Mk. I equipment. It has been possible, however, to put the equipment into a smaller space, and an interesting feature is that both long and magnified timebases are displayed on one tube (fig. 8). The equipment is designed to work with a transmitter on 1½ metres or on a centimetre wavelength, and the whole is mobile (being housed in a trailer).

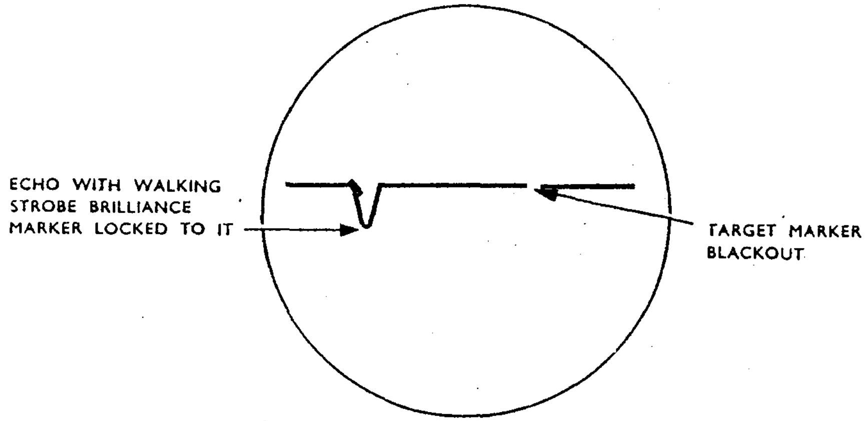


Fig. 9.—Mk. II M and Mk. III magnified timebase

Mk. II M (MGRI.5539)

24. This equipment has timing circuits which are completely different from those in the earlier type. A console display is used mounting two tubes.

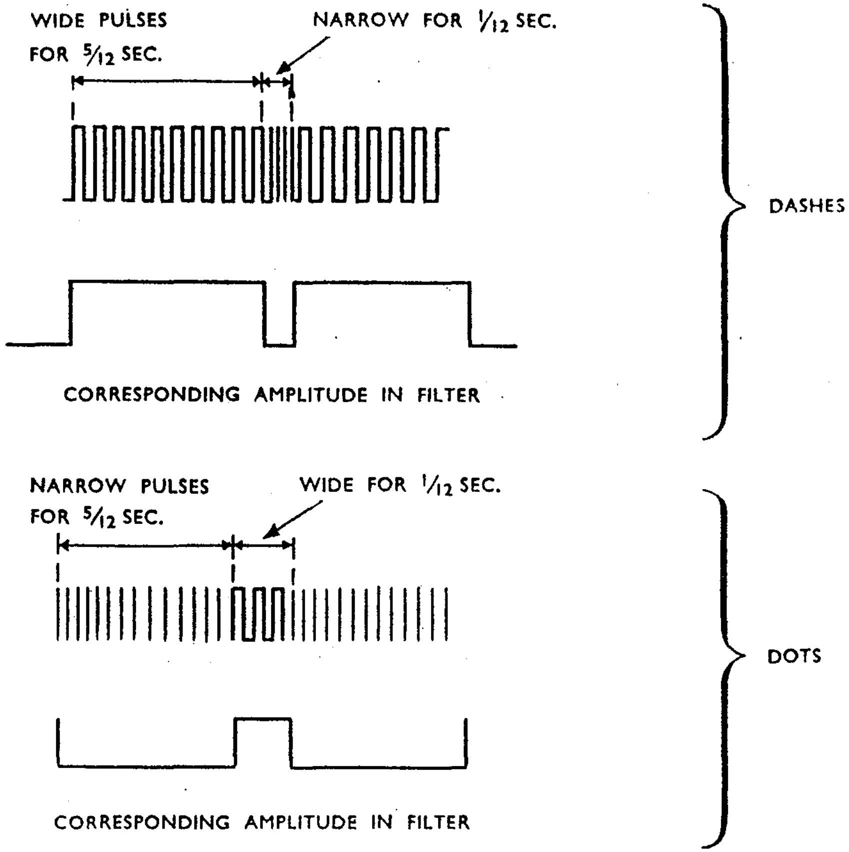


Fig. 10.—Scheme for dot-dash width modulation

25. These show respectively a long timebase with strobe marker and a magnified timebase. The magnified timebase display is now the same for both Cat and Mouse stations. A short blackout pip is used to mark out the target range and in addition there is a short brilliance marker known as the *walking strobe* pulse (fig. 9). This walking strobe has the property that it can lock to and follow any selected aircraft echo as it moves across the trace (compare the walking strobe in AI Mk. VI). Circuits then translate both range and velocity of the aircraft echo into DC voltages which are used to control those circuits which send signals to the aircraft (for either Cat or Mouse operation).

26. Space modulation of alternate ground rays is not now employed. Instead the pulse transmission is width modulated in accordance with signals to be sent. The modulation of pulse width is done in a dot-dash manner, width now being modulated exactly as position of the blackout ground rays was modulated previously (*see* fig. 10). Consequently, at a Cat station, for example, pulses of constant width are sent out if the aircraft is on track.

27. The aircraft filters are now adjusted so that they convert dot-dash width modulation into dot-dash amplitude modulation for the pilot and bomb-aimer to hear.

28. The p.r.f.'s can now be varied to a certain extent for different station pairs, but they are always of the order mentioned before (97 c/s for Mouse and 133 c/s for Cat. The transmitter is on a centimetre wavelength (about 9·3 cm.). The equipment is mobile, being housed within a trailer.

Mk. III (FGRI.5565)

29. Oboe Mk. III is really the fixed version of Oboe Mk. II M, a feature being the provision for multichannel working. The method adopted for multichannel working is to have a number of display consoles similar to those of Mk. II M, and a calibrator rack supplying a number of p.r.f.'s. A common transmitter is used for all the p.r.f. channels, each pulse train being width-modulated by the relevant console and control gear. Apart from the fact that a common transmitter is used, a Mk. III station can be said to be a Mk. II M station reproduced *n* times, where *n* is the number of p.r.f.'s used. Mk. III employs a wavelength of about 9·3 cm.

30. It will be seen that both in Mk. II M and Mk. III operation, where a number of p.r.f. pairs may be used, it is necessary to be able to discriminate between these p.r.f. pairs in the aircraft. It is necessary, therefore, for the aircraft to carry what is known as a p.r.f. selector.

SUMMARY OF AIRCRAFT EQUIPMENT

31. To summarize what has already been said, the aircraft equipment must contain a receiver which triggers the pulse repeating transmitter and which feeds also to a double filter for station selection. For multichannel operation a p.r.f. selector is needed.

32. The early gear was known as the *Pea-cock* equipment (ARI.5513) and worked on the 1½ metre band.

33. For centimetre working *Album Leaf* equipment is used (ARI.5582). This uses an American ASG type transmitter. Album Leaf is now termed Oboe Mk. II.

34. Oboe Mk. III is similar to Oboe Mk. II fitted with a p.r.f. selector, and works with width-modulated ground stations. For a summary of recent Marks of Oboe and 9000 equipments see A.P.1093C, Chapter 4.


TIME
STATE OF SQUADRONS
19
242
310
611