AP1234E

CHAPTER IX —

REBECCA AND EUREKA

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Introduction

1. During the first years of development of airborne radar equipments in the R.A.F. the advantages of providing airfields with radar beacons which could be picked up by means of the radar locating equipment in the aircraft were soon realised. Unfortunately, due to the continual introduction of new equipment or new marks of old equipments, all operating on different wavelengths, and with them new radar beacons to work on these wavelengths, the state of affairs was reached whereby there were only a limited number of beacons in any area which could be utilised with any particular equipment, and the disadvantages of lack of standardisation became obvious.

2. Rebecca and Eureka are the airborne and ground equipments respectively which have been chosen for use at all airfields and in almost all R.A.F. aircraft to achieve standardisation. They provide a means of homing to an airfield from distances up to sometimes as much as 90 miles, and further, Rebecca can also be used in conjunction with a special ground beacon known as B.A.B.S., to give blind approach facilities. The obvious advantage over non-radar homing aids is that a continuous indication of range from the homing point is also given.

3. Fixes are obtainable either by measuring ranges from two suitable beacons and plotting the two range circles, or by turning the aircraft until one beacon is indicated as dead ahead when the aircraft's heading provides the bearing of the beacon for a bearing and distance fix.

4. It is of interest to note that Rebecca was originally designed for use in small-scale tactical operations such as the dropping of arms and supplies to resistance movements in enemy-occupied territory, and also in parachute or glider operations. A light portable Eureka beacon was used and was normally set up at the point at which the supplies or troops were to be dropped.

Principle

5. The principle of operation is that the Rebecca equipment in the aircraft emits a pulse, which is picked up by the Eureka receiver on the ground, and which, after a delay of approximately $\frac{3}{4}$ of a microsecond causes the Eureka beacon to transmit a similar pulse which is in turn picked up by the airborne Rebecca. Thus, by timing the interval between transmission and reception of a pulse by means of a straight line time base on a cathode ray tube, the Rebecca operator is able to measure the range of the beacon. It will be noted that the error in range caused by regarding the beacon's response as instantaneous is only of the order of 100 yards, and this is too small to be detected on the Rebecca range scale.

6. The pulse recurrence frequency of Rebecca is approximately 300 per second, and it can be seen that there must be a limit to the number of aircraft to which a beacon can respond at the same time. This limit—above which the beacon becomes paralysed—is, in practice, between 35 and 40 aircraft. Further, each aircraft not only " triggers " the beacon to which it is required to home but also all other beacons on the same frequency which are within range. This means that there is a limit to the number of aircraft which can use Rebecca (or any other equipment on the same frequencies such as Lucero) at the same time in any area. This difficulty is overcome for most practical purposes by the use of several different radio frequencies within the equipments. Thus the navigator can, while in the air, select the frequencies of the beacon he requires, leaving other beacons in the vicinity inoperative.

7. A further advantage of this facility is that it is usually possible to arrange for Rebecca to transmit to the Eureka on one frequency and for it to respond to the aircraft on a second frequency. The Rebecca receiver, set to this latter frequency, then rejects all echoes from the ground and other objects on the transmitting frequency, and selects only the beacon responses, thereby avoiding the risk of losing these responses amongst a mass of other blips.

Presentation

8. The Rebecca receiving aerial system consists of an aerial mounted on each side of the aircraft. These two aerials are directional, the starboard aerial receiving most strongly signals returning from a relative bearing of approximately 045°, and the port aerial those from approximately 315°. Thus, echoes from dead ahead of the aircraft are received with equal strength by both aerials, but echoes from the starboard are received more strongly by the starboard than the port aerial and vice-versa.

9. By means of a special switch motor inside the receiver it is possible to display first the returns received by the starboard aerial as deflection blips to the right of the vertical straight line time base, and then returns received by the port aerial as blips to the left of the time base. Since this motor switches the display from side to side approximately 20 times per second, the impression of a continuous display is created (fig. 1). Thus comparison of the relative amplitudes (or sizes) of the blips on each side of the time base gives the relation between the strength of signal being received by each aerial, and from this a very rough approximation to the bearing relative to the aircraft may be derived. What is more important, however, is that

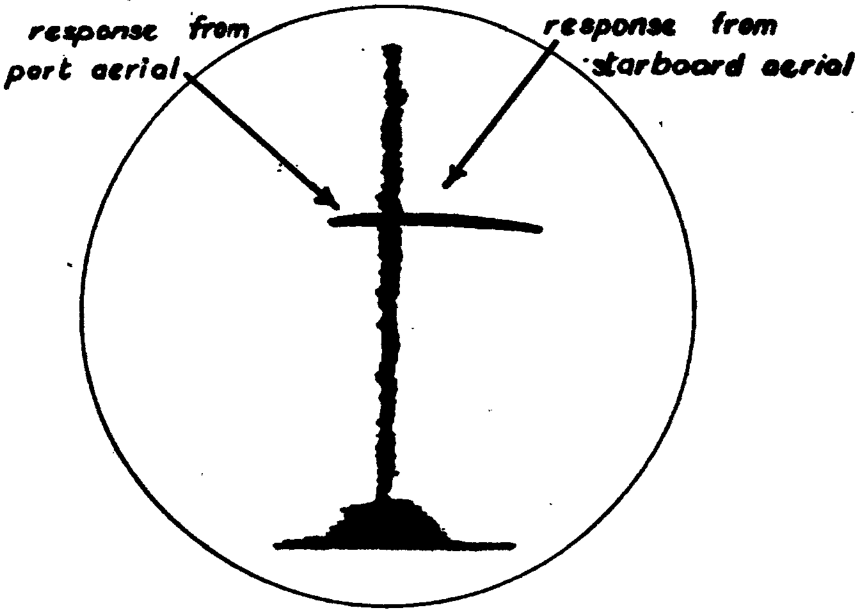

FIG. 1. Presentation of Responses.

it is possible, by turning the aircraft towards the larger blip so that the amplitudes become and remain equal, to home on to the beacon producing the blip. It should be mentioned here that if the beacon is very far to port or starboard of the aircraft it is probable that the response will be received in one aerial only, hence a blip will be produced on one side of the time base only.

10. The distance between the bottom of the time base and the bottom of the blip represents the range of the beacon.

Identification of Beacons

11. There are various types of beacons, including B.A.B.S. (Blind Approach Beacon System), that can be interrogated by the different marks of Rebecca. A table showing the main types, and the frequencies on which they operate, is given below :—

Type of Beacon.	Beacon Receiving Frequency.	Beacon Transmitting Frequency.
Eureka, Mk. II (normal Eureka) .. .. Eureka, Mk. III (lightweight Eureka) .. B.A.B.S., Mk. II	one of { 214 mc/s. 219 mc/s. 224 mc/s. 229 mc/s. 234 mc/s.	one of { 214 mc/s. 219 mc/s. 224 mc/s. 229 mc/s. 234 mc/s.
Coastal Command 176 mc/s Beacons (including Eureka, Mk. IIC).	176 mc/s.	177 mc/s.
B.A.B.S., Mk. IC (Coastal Command version) ..	176 mc/s.	173·5 mc/s.
Fighter Command 193 mc/s Beacons (including Eureka, Mk. IIF).	193 mc/s.	196·5 mc/s.
B.A.B.S., Mk. IF (Fighter Command version) ..	193 mc/s.	190·5 mc/s.

These comprise the main types in use at present (April 1946), and, while it is probable that new marks and submarks of beacon will be designed, it is unlikely that they will employ any other frequencies differing greatly from those listed above. It has been proposed, however, that the frequency allocation for Rebecca/B.A.B.S./Eureka will be extended in the future to cover the band 200–235 mc/s.

12. To provide a means of identification, the transmissions from all beacons (except B.A.B.S. beacons) are coded so that a distinctive blip appears on the time base. In the case of B.A.B.S. it is assumed that there is also a homing beacon installed (suitably coded) which the navigator will have used for reaching the airfield; thus when he switches over to B.A.B.S. he knows his range from the beacon and can easily identify the blip required. Further, due to the fact that B.A.B.S. beacons are low-powered equipments, it is unlikely that more than one will appear on the time base at any one time.

13. The type of coding normally employed for Eureka beacons is known as "width coding." This is effected by periodically increasing the duration of the pulses transmitted to approximately three times their normal length. The effect on the blip on the time base is that

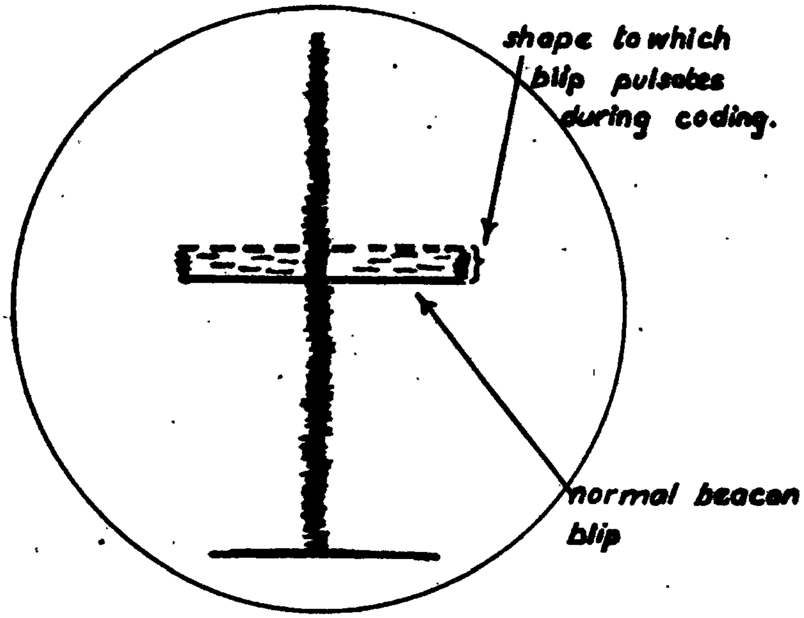

FIG. 2. Appearance of "Width Coding" on the Time Base.

approximately once every twenty seconds the blip pulsates by increasing its width (fig. 2), the pulsations being easily read as very slow morse letters. The usual coding employed is a combination of two morse letters.

14. A second type of coding which is used in nearly all Coastal Command and many Fighter Command beacons is known as "gap coding." In this case there are actual breaks in the transmissions from the beacons, the resulting indication on the time base being that of a blip which, approximately every 20 seconds, collapses and then blinks two letters (or very occasionally, when the beacon is controlled by the Royal Navy, a letter and a numeral) in morse.

15. There is one kind of coding which is at present (April 1946), rarely used, but with which the navigator should be acquainted. It is sometimes known as "pulse displacement coding" or "phase coding" and employs a circuit within the beacon whereby the transmission of pulses from the beacon is intermittently delayed by an amount of the order of 50 microseconds. The result is that the blip periodically jumps a little way up the time base and back, its movements corresponding to the two identifying morse code letters.

Beacon Aerial Systems

16. Most of the beacons in para. 11 were designed for use with equipments, such as Rebecca, fitted with vertically polarised aerial systems (*i.e.*, with the aerial rods running vertically). The Coastal Command beacons, however, have horizontally polarised aerials (*i.e.*, horizontal aerial rods) since they were originally intended for use with A.S.V., Mk. II (now obsolete). The importance of this lies in the fact that if the airborne aerials are of different polarisation to those of the beacon, then a reduction in performance must be expected.

The Equipment

17. Rebecca, Mk. II, consists of—

(*a*) transmitter/receiver ;
(*b*) aerial system ;
(*c*) Indicator unit ;
(*d*) Control unit ;
(*e*) Voltage Control Panel ;

and weighs approximately 160 lb. Its total power consumption is 200 watts A.C. and 15 watts D.C.

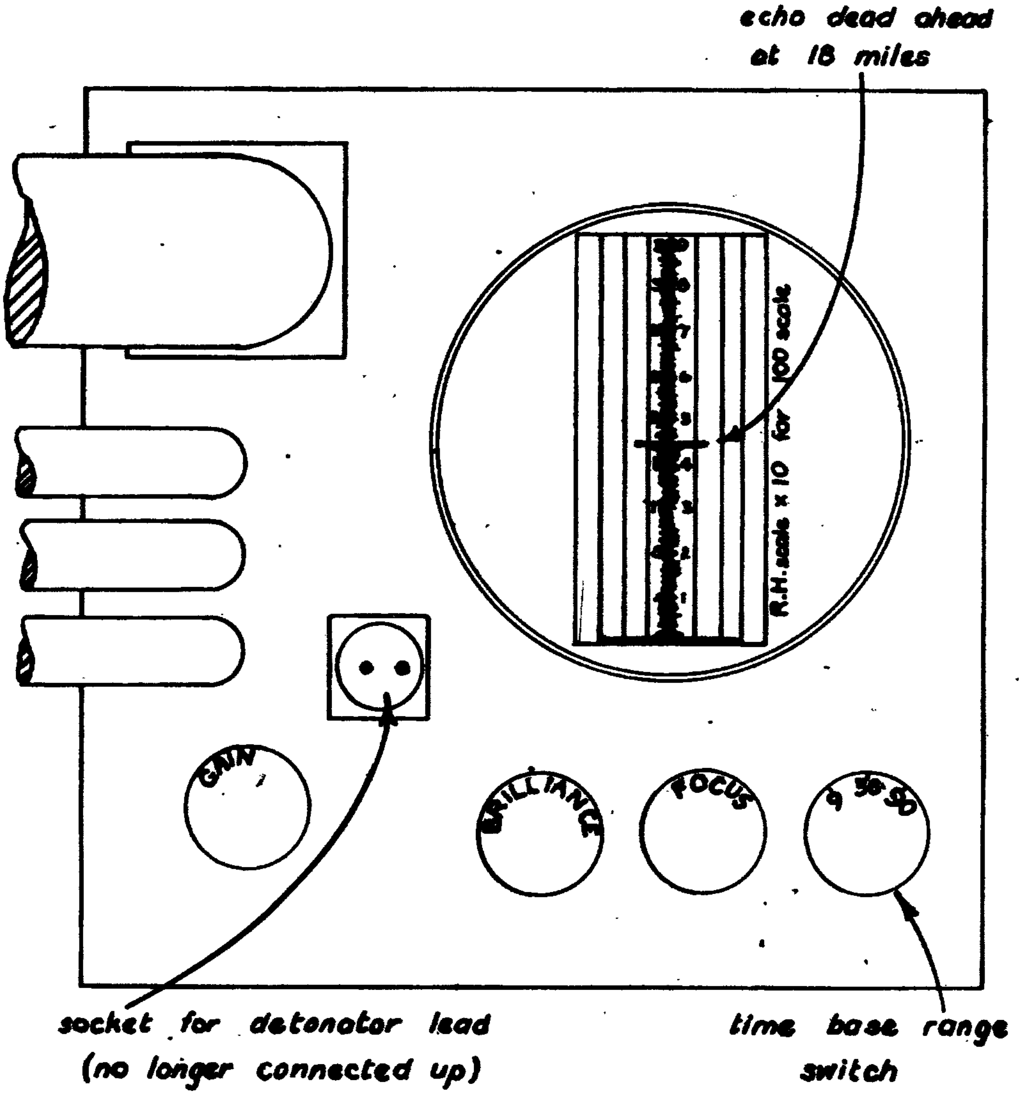

FIG. 3. Indicator Unit, Type 6E.

The Aerial System

18. The aerial system is vertically polarised and consists of a transmitting aerial, usually beneath the nose, and two receiving aerials, usually mounted each side of the nose (para. 8).

19. It is found that when these receiving aerials are in use the blip tends to pulsate slightly due to the effect of the rotating propellers on the incoming signal. This is very undesirable when the equipment is being used for blind approach with B.A.B.S. ; and further, the directional properties of the aircraft's aerials are not needed under these circumstances (Section III, Chapter X —B.A.B.S.). A single vertical receiving aerial has, therefore, been fitted beneath the fuselage, where the effect of the propellers is less, for use when Rebecca is being used in conjunction with B.A.B.S. A switch, normally mounted beneath the Indicator unit, enables the changeover

to be made from the normal receiving aerials to the B.A.B.S. receiving aerial. A switch is also usually provided for stopping the switch motor (para. 9), since a single-sided presentation is all that is required for a B.A.B.S. approach, and a brighter and steadier picture may be obtained in this fashion.

The Indicator Unit

20. The Indicator unit houses the cathode ray tube on which is displayed the vertical straight line time base. Fig. 3 illustrates the layout of the Type 6E Indicator unit which is fitted to Rebecca, Mk. II, at present (April 1946). A range switch enables the speed of the time base to be altered so that it can be made to represent 9, 36 or 90 miles, depending upon which figure is uppermost on the switch, and over the face of the tube is located a perspex screen on which are engraved scales for measuring the range of the blips. The operator will remember that ranges must be measured from the bottom of the blip; and it should be noted that when the 90 mile time base is in use, the right-hand scale must be employed and the ranges multiplied by 10. The calibration is usually in statute miles but may be in nautical miles. There is no indication on the equipment to show how it has been calibrated and the operator should always ascertain this from the mechanic before taking off.

21. Brilliance and Focus controls are provided to regulate the brightness and sharpness of the picture, and, as in all equipments employing straight line time bases, may be adjusted to suit the operator. The Gain control governs the strength of signals being passed from the receiver to the cathode ray tube, and hence the amplitude (*i.e.*, length) of the blips. This is especially important to prevent "saturation" of the blips, *i.e.*, prevent them growing to such a size that the construction of the tube prohibits further growth, which would not permit accurate comparison of the relative sizes of the blips on each side of the time base. Manipulation of the Gain control is also essential when searching for weak responses; it will be appreciated that the Gain control also governs the amount of "grass" visible on the time base.

22. The Indicator, Type 6E, will however, be replaced in the Service by the Indicator, Type 233 (fig. 4) which has a far more stable and accurate time base. Other differences between it and the Type 6E, are the provision of four time base ranges of 3, 12, 30 and 120 miles and facilities for introducing calibrator marks on the time base. These may be switched on (by pulling out the time base range switch) whenever the accuracy of the equipment is in doubt,

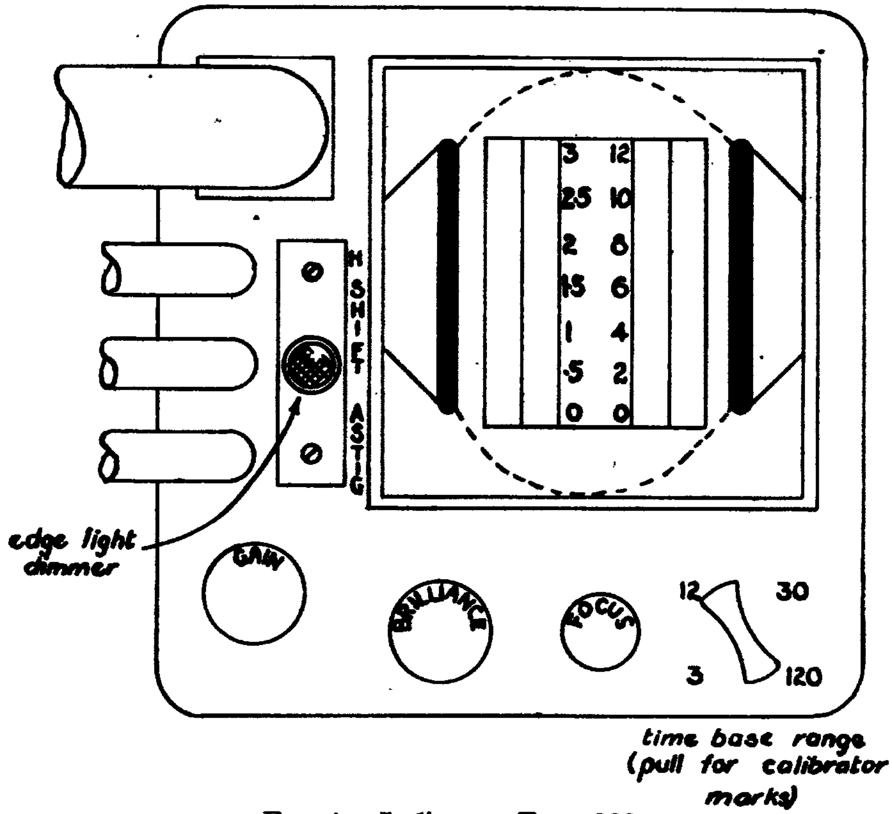

FIG. 4. Indicator, Type 233.

their coincidence with the engraved scale providing a check on the calibration. It is probable that a variable delay unit will also be incorporated so that by operation of a switch it will be possible, when using B.A.B.S., to delay the start of the time base by an amount preset by the mechanic in a manner similar to that of Rebecca, Mk. IV (para. 57). Lastly, edge lights are provided to illuminate the scale over the tube face, these being controlled by a dimmer switch.

The Control Unit

23. The Control unit enables the correct frequencies to be selected in the transmitter and receiver; two banks of five push buttons, each labelled A to E, being provided for that purpose. The left hand buttons set up the transmitter, the right hand the receiver, and pilot bulbs indicate which buttons have been selected at any one time. Both banks of buttons are normally set up to the following table :—

Button A	214 mc/s.
Button B	219 mc/s.
Button C	224 mc/s.
Button D	229 mc/s.
Button E	234 mc/s.

Due to the mechanism involved, however, it is only possible to have four out of the five buttons operative during any one sortie. Any four may be selected and should be connected up by the mechanic before take-off. It can be seen that, owing to the frequencies involved, Rebecca, Mk. II is incapable of operating with Coastal or Fighter Command type beacons.

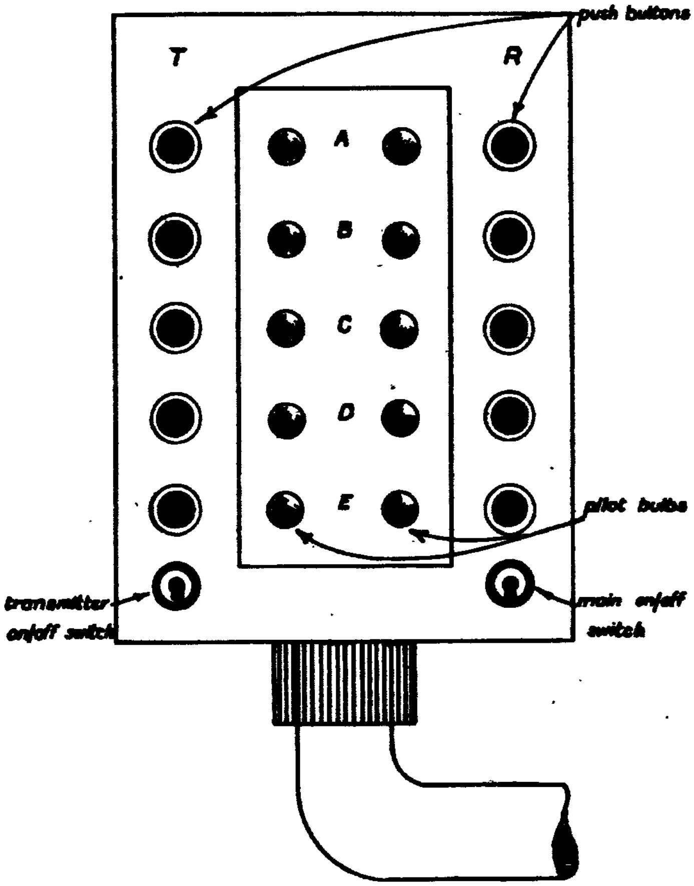

FIG. 5. The Control Unit.

24. The unit also houses two on/off switches, the first allowing the supply voltages to reach the equipment, the second switching on the transmitter. To enable the equipment to warm up, two minutes should be allowed to elapse between the operating of these two switches, the main switch being placed on first.

The Voltage Control Panel

25. This unit is provided to regulate to a constant value the voltage supplied from the generator, and is fitted with an on/off switch and, possibly, a pilot lamp. Within the panel on the front of the unit are the fuses for the equipment together with correct replacements; it should, however, be noted that there will usually be further fuses for the equipment on the aircraft fuse panel.

Use as a Homing Aid

26. Search should be made for the required beacon on the 90-mile time base. The transmitter should not be left on continuously, however, as it may be " triggering " other beacons and so helping to overload them if there are many other aircraft in the vicinity (para. 6). The correct procedure is to switch on the transmitter every few minutes, carefully adjusting the Gain control and examining the time base on each occasion until the beacon's returns appear. The aircraft should then be turned towards the larger blip until the two blips are equal in amplitude. It should be noted that, since the aerial system is mounted rigidly to the aircraft, comparison of the relative sizes of the blips should only be made when the aircraft is flying straight and level. If the homing is being carried out from any great distance, it is advisable at this stage to adjust the course to allow for the D.R. drift as calculated by the navigator for the required track, and so prevent the aircraft following a long and unnecessary " curve of pursuit."

27. During the homing run the Gain control must be manipulated to keep the edges of the blips beneath one of the vertical lines on the perspex screen over the cathode ray tube, thus facilitating comparison of the blips. It is essential too that the Gain control is used to ensure that the blips do not reach " saturation " (para. 21). As before, the transmitter must not be left on continuously, but should be switched on every few minutes for just sufficient time to note the necessary information, in order that the chance of overloading the beacon is reduced to a minimum. When a range of 15 miles has been reached, however, the transmitter may be left on continuously, and at this stage the slightest inequality in the relative sizes of the blips should be corrected immediately by an appropriate alteration of course. Throughout the homing, not only alterations of course, but also frequent indications of range should be passed to the pilot.

28. Once the aircraft has been turned towards the beacon the blip should move down the time base, enabling change to be made to first the 36-mile and then the 9-mile time base, until the aircraft passes over the beacon. It is possible, however, especially at short ranges, that the beacon may be picked up when it is behind the aircraft. The navigator would soon become aware of this since, due to the increasing range, the blip would move up the time base instead of down it.

29. The specialised technique used when miniature light-weight Eurekas are being employed for supply dropping and other tactical uses need not be detailed here, though it may be mentioned that, in general, the Rebecca is not usually switched on in such cases until the aircraft is approximately 10 to 15 miles from the dropping zone.

Use as a Fixing Aid

30. If two beacons are suitably situated relative to the aircraft a fix can be obtained. This is done by noting the ranges of the two beacons and plotting them as arcs centred at the respective beacons. It is often possible in practice to read the two ranges within a few seconds of each other and obtain what is, for all practical purposes, a simultaneous fix. It may, however, be necessary to take a second fix, or a position line from a third beacon, to resolve any ambiguity due to the fact that the two range circles intersect in two points. In the event of the beacons being unfavourably sited, a single position line is still obtainable which should be of use to the navigator.

31. A less accurate fix can be obtained from a single beacon by turning the aircraft until the blips are of equal size on each side of the time base, noting the reading of the pilot's compass and the range, and plotting a bearing and distance fix.

32. One other procedure which has a very limited application, is that of using the equipment to locate coastlines. By setting the transmitter and receiver to the same frequency (any frequency in the band may be chosen) echoes are received from the ground beneath the aircraft;

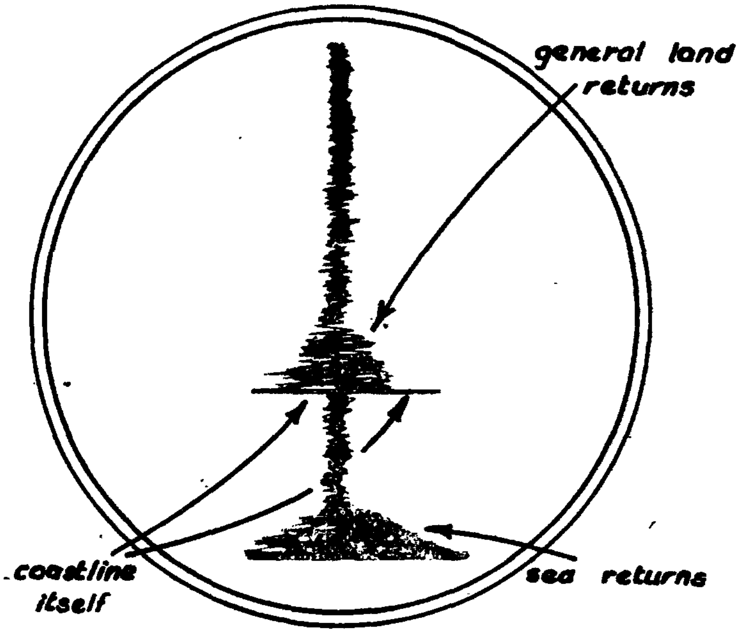

FIG. 6. Approaching a Coastline from the Sea (para. 32).

but, whereas sea gives very little echo, land gives a fairly strong response, so that it should be possible to detect coastlines at ranges up to 10 to 20 miles, when approaching from the sea at an altitude of 4,000–5,000 feet (fig. 6), provided they are not too flat and indeterminate.

Use as a Blind Approach Aid

33. After the airfield has been located by homing on to the ordinary Eureka beacon, the local B.A.B.S. beacon is selected by pressing the appropriate buttons on the Control unit. Operation of the switches beneath the Indicator unit to their " up " position selects the special receiving aerial and provides the one-sided presentation. In the event of the switch motor stopping in such a position that blips appear on neither side of the time base, it must be switched on and off until the required one-sided presentation is obtained. A normal B.A.B.S. approach may then be made (Section III, Chapter X—B.A.B.S.). It should be noted that B.A.B.S., Mks. IC and IF cannot be used with Rebecca, Mk. II.

Operating Drill

34. The following operating drill should be adopted (note that the equipment must not be switched on until after take-off and must be switched off before touching down).

(*a*) *Switching on*

(i) Voltage Control Panel switch " on."
(ii) Check that Transmitter switch on Control Panel is " off."
(iii) Main switch on Control Panel " on."
(iv) Allow two minutes to elapse after switching Main switch on, then put Transmitter switch to " on."
(v) Adjust Brilliance and Focus controls to give clear picture.

(*b*) *Homing to a Beacon*

(i) When 100 miles or less from beacon, switch on as in sub-para. (*a*) above.
(ii) Set Range switch to 90-mile position.
(iii) Check that both switches below the Indicator unit are in the " down " position.
(iv) Press appropriate buttons on Control unit to select frequencies of required beacon.
(v) Manipulate Gain control and watch for signals on time base.

receiver button A on Rebecca, Mk. IIB, it is possible to receive these pulses. Transmitter button A must also be selected, although the transmitter is not needed, in order that the horizontal aerial system may be selected (para. 41) and connected to the receiver. Due to the much greater pulse recurrence frequency of Walter, not one but many blips will appear on each time base and these will not necessarily be locked to the time base but may drift up and down. In practice, however, it is found that at fairly short ranges, due to technical reasons beyond the scope of this manual, the pulses do in fact tend to become locked to the time base (fig. 7).

43. Since Walter is not "triggered" by the airborne equipment no indication of range appears on the Rebecca screen but it is possible to use the normal indications of relative bearing to home on the Walter (by turning to equalise the blips on each side of the time base). The possibility of the beacon being *behind* the aircraft instead of ahead when the blips have been equalised must be taken into account and if the returns fade completely then a 180° turn must be made; the returns should then reappear. The easiest method of finding whether the aircraft is approaching Walter is to swing the aircraft, say, to the right. If Walter is ahead the left-hand blips will increase in amplitude, if behind the right-hand blips will increase. In connection with the lack of range determination it should be mentioned that with experience the operator may be able to use a series of "fades" that occur at various ranges during homing to estimate when the aircraft is actually over the Walter transmitter.

44. Walter, Mks. I and II, employ a horizontally polarised aerial system and it has been found that results will only be obtained with Rebecca when the horizontal aerial system of that equipment is used. Provided this is done, maximum ranges of 10 to 20 miles should be obtained but performance depends largely on height (poor results of only 4 or 5 miles are obtained at 500 feet) and the type of aircraft.

REBECCA, MK. IV

The Equipment

45. Rebecca, Mk. IV, has been designed as a replacement for Lucero and all other marks of Rebecca, it covers all frequencies in use, and incorporates all improvements suggested by the experience gained with the earlier marks. It is capable of operating with all the beacons mentioned in para. 11 and can also be used to receive transmissions from Walter (paras. 42, 43). Since it is to be fitted to nearly all R.A.F. aircraft, including most fighter aircraft, weight is an important consideration and use had been made of newly developed light-weight components to reduce the total weight to approximately 45 lbs. (as against 160 lbs. in the case of Rebecca, Mk. II). A further 15 lbs. for a generator must be added if the aircraft normally has no 80-volt A.C. supply. It may be added that the normal power consumption is 200 watts A.C., and 36 watts D.C.

46. Since Rebecca, Mk. IV is to be used all over the world, and at all altitudes, the components have been designed to withstand the most intense tropical temperatures. In addition the transmitter/receiver has been pressurised (*i.e.*, enclosed in an airtight cylinder in which the air pressure is kept at a level slightly above M.S.L. pressure), a measure which not only prolongs the life of the equipment in tropical areas but enables it to operate satisfactorily at altitudes up to 35,000 to 40,000 feet, where pressure is too low for unpressurised equipment to operate correctly.

47. The equipment consists of three units (apart from the aerial system):—

(*a*) Transmitter/receiver;
(*b*) Indicating unit;
(*c*) Control unit.

The Aerial System

48. The aerial system is vertically polarised; and no attempt is made to fit horizontally polarised aerials; this means there will be a reduction in performance when using the few beacons which are horizontally polarised. However, it is considered that this reduced performance is more acceptable than the increased drag which would result if both types of aerial system were fitted. The receiving aerials are mounted on each wing tip, and the transmitting aerial on top of the port wing. The Rebecca, Mk. II, aerial system may, however, be found on heavy aircraft.

The Transmitter/Receiver

49. This unit is cylindrical in shape and has no manual controls on it. It is usually located in a position where it will cause least inconvenience. The transmitter/receiver tends to become very hot during operation and for this reason a fan is attached to its exterior to assist in cooling it. The operation of this fan when the equipment is switched on provides a very useful check that the 24 volts, D.C., supply is reaching the equipment.

The Indicating Unit

50. The Indicating unit houses the cathode ray tube only, and in single-seater aircraft is mounted on the pilot's instrument panel, this is possible due to the small size (approximately 3 ins. in diameter). The C.R.T. is of a special new type, known as a " daylight cathode ray tube," in which technical development has enabled the brilliance to be increased to such an extent that the tube picture can be seen quite clearly without a visor in all light conditions except those of strong sunlight. The small size of the tube does tend to reduce the accuracy of the

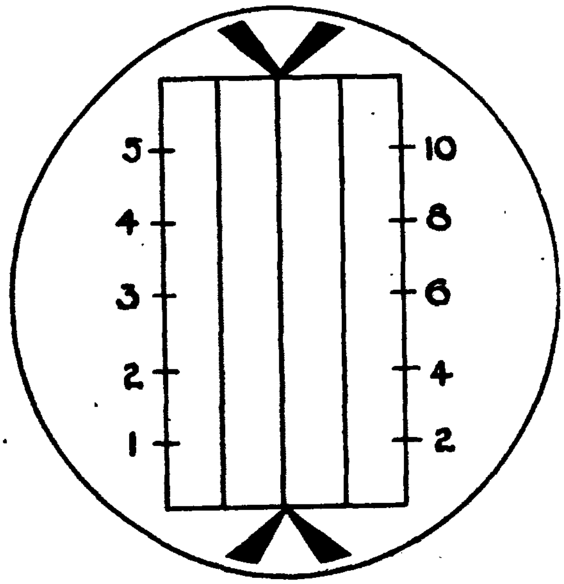

FIG. 8. The Indicating Unit.

reading, however, and for this reason, when it is mounted for the navigator's use, a special magnifying lens is normally fitted over the face to bring its apparent size up to that of the usual C.R.T. in airborne equipments. A visor must be used with this lens. A range scale is fitted over the face of the tube (fig. 8), but this will be mentioned later when the Control unit is considered (para. 52).

The Control Unit

51. The Control unit (fig. 9), on which are located *all* the controls, is mounted on a wedge plate and is readily detachable for maintenance purposes.

52. Brilliance and Focus controls are provided and need no explanation. The Range Selector switch has four positions, namely, 6 n.m., 12 n.m., 60 n.m., and 120 n.m. To ascertain the range of any blip, a rough estimate can be made by using the appropriate scale on the front of the cathode ray tube, either direct or multiplying by 10 according to the time base in use ; but a more accurate reading can be obtained by pressing the Calibration push-button. This presents calibration pips on the time base in addition to the signals, and these are at one mile intervals on the 6 and 12 n.m. ranges and at 10-mile intervals on the 60 and 120 n.m. ranges. By pushing the button a second time the calibration pips are removed from the time base.

53. The Transmitter and Receiver Frequency Selector switches are each capable of selecting any 6 preset frequencies in the 170–240 mc/s band. The six transmitter frequencies are coded A, B, C, D, E, F and the six receiver frequencies 1, 2, 3, 4, 5, 6. Such an arrangement precludes

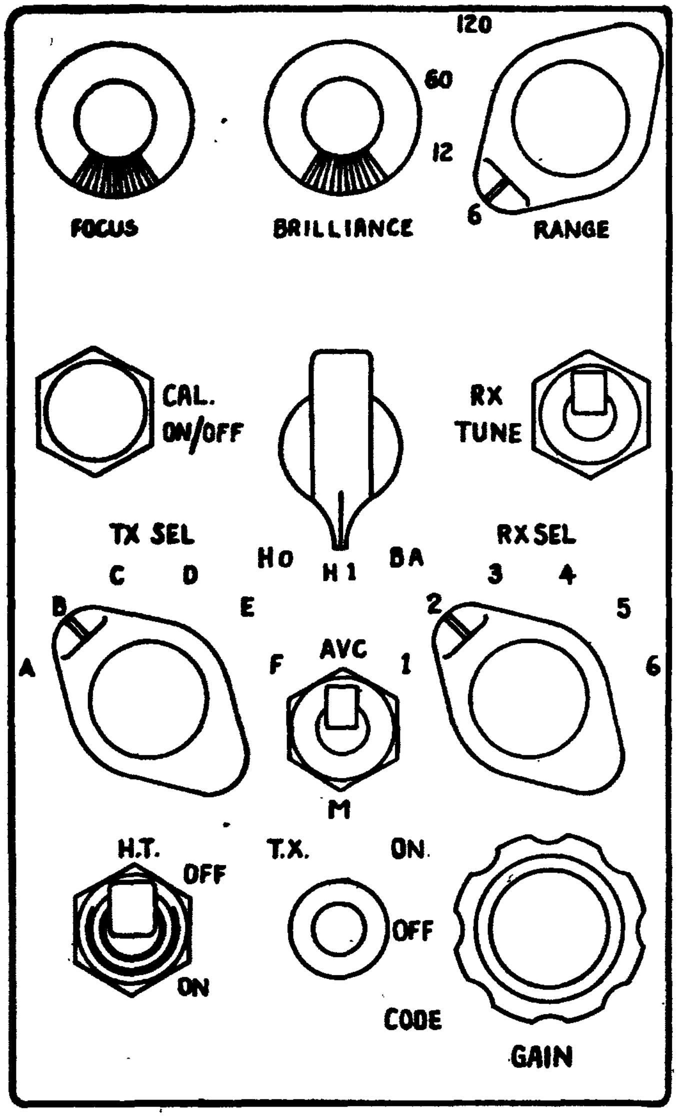

FIG. 9. The Control Unit.

the possibility of ambiguity when referring to frequency combinations. The usual combinations of frequencies preset are, as follows :—

(*a*) For general use :—

	Transmit.		*Receive.*
A	.. 176 mc/s.	1	.. 177 mc/s.
B	.. 214 mc/s.	2	.. 214 mc/s.
C	.. 219 mc/s.	3	.. 219 mc/s.
D	.. 224 mc/s.	4	.. 224 mc/s.
E	.. 229 mc/s.	5	.. 229 mc/s.
F	.. 234 mc/s.	6	.. 234 mc/s.

(*b*) For aircraft requiring to use B.A.B.S., Mk. IC :—

	Transmit.		*Receive.*
A	.. 176 mc/s.	1	.. 177 mc/s.
B	.. 214 mc/s.	2	.. 173 mc/s.
C	.. 219 mc/s.	3	.. four out of 214 mc/s., 219 mc/s., 224 mc/s., 229 mc/s., 234 mc/s.
D	.. 224 mc/s.	4	..
E	.. 229 mc/s.	5	..
F	.. 234 mc/s.	6	..

(*c*) For aircraft requiring to use Fighter Command beacons :—

Transmit.		*Receive.*	
A ..	176 mc/s.	1 ..	177 mc/s.
B ..	193 mc/s.	2 ..	196 mc/s.
C .. D .. E .. F ..	four out of 214 mc/s., 219 mc/s., 224 mc/s., 229 mc/s., 234 mc/s.	3 .. 4 .. 5 .. 6 ..	four out of 214 mc/s., 219 mc/s., 224 mc/s., 229 mc/s., 234 mc/s.

Other combinations are of course possible for special purposes.

54. One cause of inefficiency in earlier marks of Rebecca was the inability to tune the receiver exactly to the incoming signal ; this was due to the push-button selector system. To overcome this snag, which is especially noticeable when searching for Walter (paras. 42, 43) the Receiver Frequency Fine Control is provided. When this switch is put to the " on " position the receiver starts to sweep $1\frac{1}{2}$ mc/s. on each side of the frequency to which the receiver is, at that instant, tuned. The beacon responses on the screen will, under these circumstances, grow to a peak as the receiver passes through the exact beacon frequency and then subside again. The operator, by selecting the Fine Control switch to the " off " position as the desired signal reaches its peak, can set his receiver exactly to the beacon frequency. Selection of another frequency by means of the Frequency Selector switch automatically cuts out any adjustments made to the previous frequency by the Fine Control.

55. This Fine Control in addition to being used for improving a response already on the screen, is of the greatest use when searching for a response, since by leaving it sweeping the operator ensures that he picks up the beacon at the maximum possible range.

56. Three operations take place when the Function switch is moved from the normal " Homing " to the " B.A.B.S." position. They are, as follows :—

(*a*) The special B.A.B.S. aerial (if fitted) is brought into circuit.

(*b*) The display is changed to the one-sided type preferred for B.A.B.S.

(*c*) The start of the time base is delayed by 25 microseconds.

57. The need for the special B.A.B.S. aerial with Rebecca, Mk. II, was discussed in para. 19. This aerial may also be necessary in certain aircraft fitted with Rebecca, Mk. IV. Para. 19 also mentions the purpose of the single-sided display. The reason for the delay in the start of the time base is fully discussed in Section III, Chapter X, which deals with B.A.B.S. ; briefly, however, it may be put as follows. If a small delay is incorporated in the B.A.B.S., Mk. II beacon it is possible, on the delayed time base, to read the range of the *near* end of the runway (the beacon being at the *far* end) direct from the scale. When using Rebecca, Mk. II a mental numerical correction to the ranges shown was necessary. This method also eliminates the transmitter pulse from the picture, thereby enabling range to be read down to zero miles.

58. The third position of the Function switch (" Delay ") provides the same presentation as " Homing " except that the start of the time base is delayed as for B.A.B.S. This is to meet a possible future development to incorporate delays in *all* beacons in a similar manner to that of the present B.A.B.S. beacons, thereby eliminating the transmitter pulse from the picture on the airborne equipment.

59. The Main on/off and Transmitter on/off switches are self-explanatory though it must be mentioned that the latter is a three position switch. In its centre position, the transmitter is off, and to turn it on, the switch must be put to its upper position. The lower position also switches on the transmitter but is a spring-loaded position enabling the switch to be used as a morse key to code the outgoing transmissions. It is possible for the radar mechanic on the Eureka beacon to listen in to the " triggering " transmissions ; he will, therefore, be able to read any messages sent by the airborne operator, provided that the aircraft is the only one triggering the beacon. It is of interest to note that he is able to reply to any message from the aircraft by coding the responses from his Eureka beacon with a special morse key provided. His coding usually takes the form of " width coding " (para. 13) and is read visually from the screen by the Rebecca operator.

60. A toggle lever switch is also included in the Control unit to provide manual or A.V.C. (Automatic Volume Control) of the Receiver Gain. With the switch in the latter position the Gain is automatically adjusted to keep the amplitudes of the blips at an optimum level. This obviates the necessity of adjusting the Gain control, especially during the latter part of a homing, a great advantage in an equipment which on occasions has to be pilot-operated.

Navigational Use

61. In conclusion it may be said that the general navigational use of Rebecca, Mk. IV, is the same as that of Rebecca, Mk. II from which it differs only in technical details. Its performance is similar. So far as fault finding is concerned there is very little that can be done in the air beyond checking the aircraft fuses and ensuring that all leads are secure.

Operating Drill

62. The drill is similar to that laid down for Rebecca, Mk. II (para. 34), *except* when using B.A.B.S., Mk. II (para. 34 (*d*)); the revised procedure is given in the following paragraph. There are several other points of difference between Rebecca, Mks. II and IV, which must be remembered, they are :—

(*a*) There may be no normal Type V.C.P. fitted to Rebecca, Mk. IV, the duties of this unit being performed within the supply system itself.

(*b*) The position of the range switch on Rebecca, Mk. IV give time bases representing 6, 12, 60 and 120 nautical miles as against the 9, 36 and 90 mile time bases of Rebecca, Mk. II.

(*c*) When searching for a beacon, use must be made of the Radio Frequency Fine Control (paras. 54, 55);

(*d*) There is no need to manipulate the Gain control on the 6 and 12 n.m. ranges provided the A.V.C. gives satisfactory results (para. 60).

(*e*) Electrical calibration pips, giving greater accuracy of range measurement, may be introduced on to the Rebecca, Mk. IV indicator (para. 52).

63. To use Rebecca, Mk. IV with B.A.B.S., Mk. II the following drill should be adopted :—

Having homed to the station Eureka beacon—

(*a*) Select, on the Control unit, frequencies of station B.A.B.S. beacon.

(*b*) Select B.A.B.S. position on the Function switch on the Control unit.

(*c*) Presentation now enables normal B.A.B.S. approach to be carried out (*see* Section III, Chapter X—B.A.B.S.).

Remember that ranges read off from the Indicating unit are ranges from *near* end of runway—*no correction is required.*