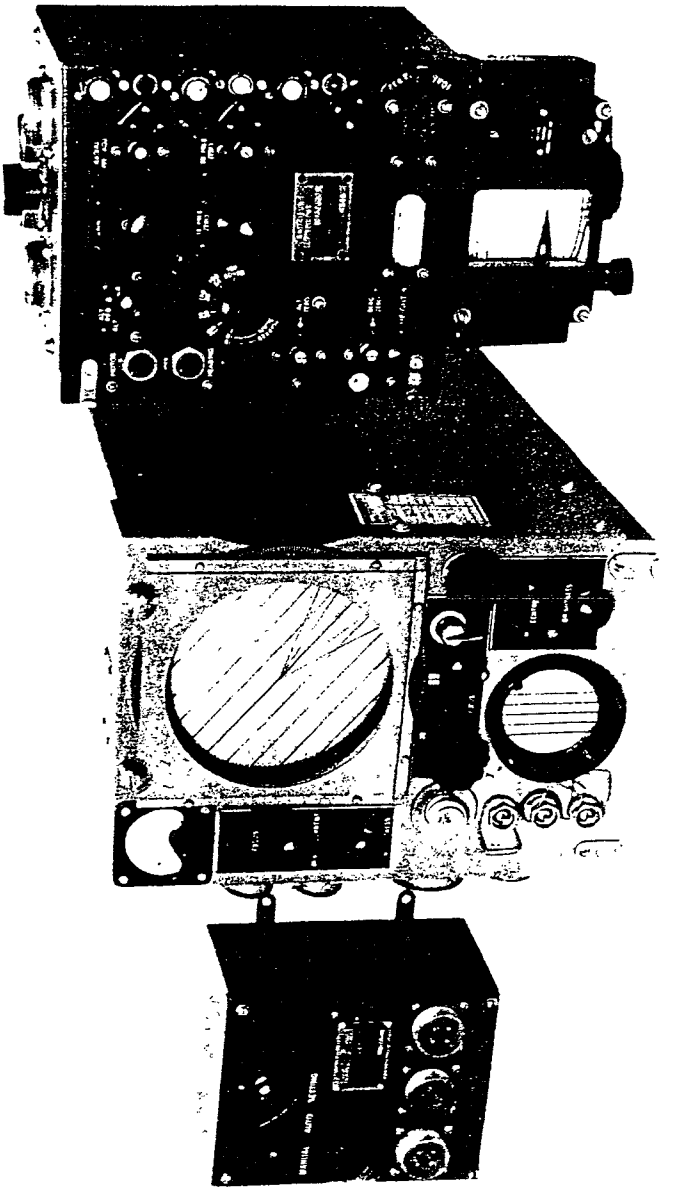


H2S Mk. IIB.

AP1234E

CHAPTER VII — H2S Mk IIB

ARI 5560

CHAPTER VIII — H2S Mk IID

ARI 5598

H2S Mk IIIG

ARI 5757

H2S Mk IVA

ARI 5715

CHAPTER VII

H2S MK. IIB
(A.R.I. 5560)

The Equipment

1. The equipment consists of eleven units, including the aerial system or "scanner," the total weight being approximately 600 lbs. Of these eleven units, only five are of direct interest to the navigator, containing as they do all the operating controls used in flight. They are the indicator, switch unit, heading control unit, voltage control panel and modulator. The operator should be familiar with the location of other units in the aircraft in order that he can carry out certain checks if faults develop.

2. The equipment operates on a wave length of between 9 and 10 centimetres, in the "S" band.

Indicator Unit

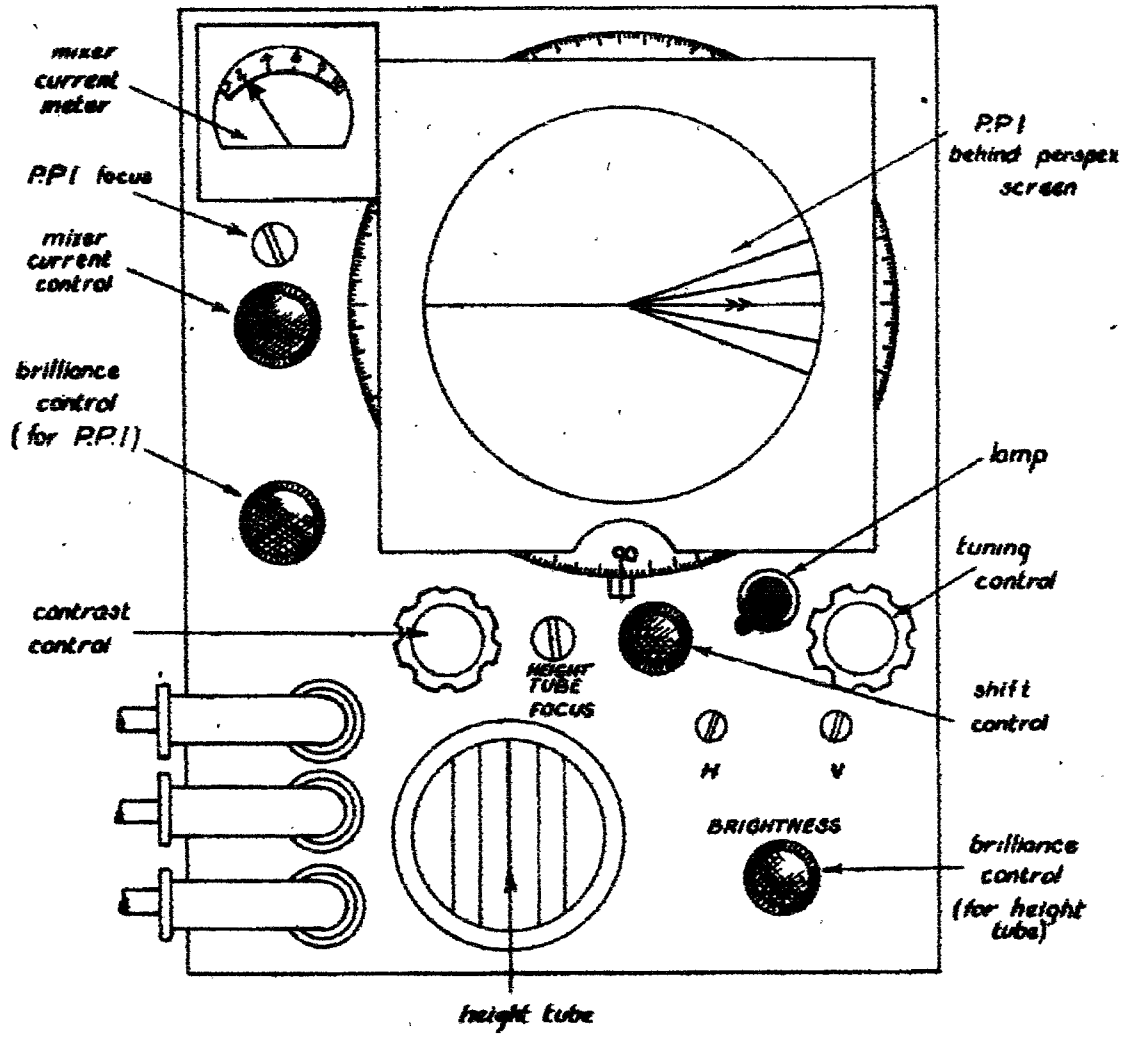


FIG. 1. H2S Mk. IIB, Indicator.

3. The Indicator (fig. 1), which should be mounted in a position in the aircraft where it can be operated and read with ease by the navigator or other operator, incorporates the main cathode ray tube screen on which the P.P.I. display appears, together with the subsidiary cathode ray height tube, and most of the controls necessary for their operation.

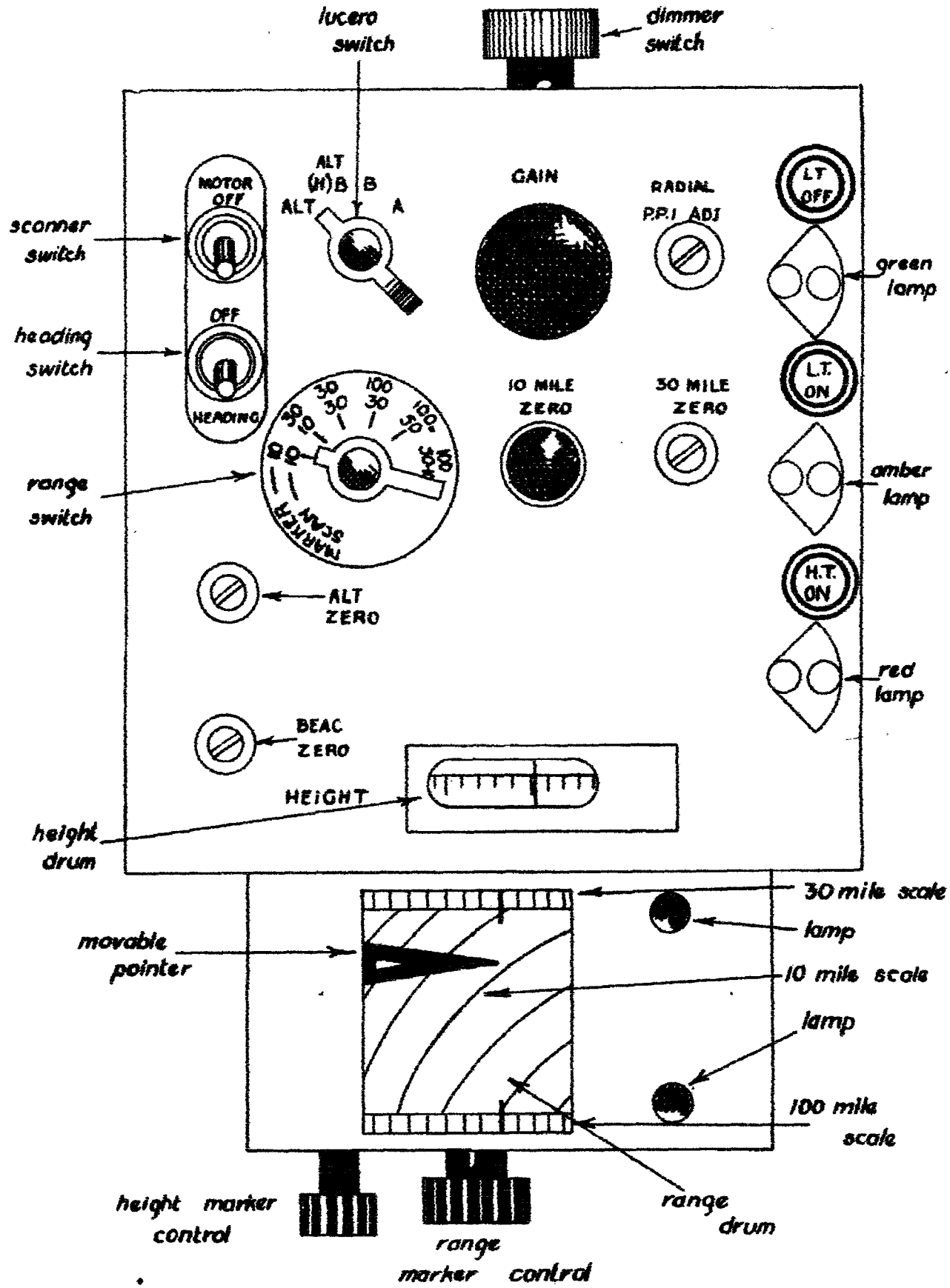
4. It is necessary to tune the equipment to secure optimum results, and this is achieved by adjustment of the Tuning control. Best results are secured when the meter reading is between 0·3 and 0·5 milliamps. The meter reading must never exceed 0·6 milliamps.

5. Brilliance and Contrast controls are provided and these, together with the Gain control on the Switch unit, must be carefully adjusted to produce the best picture (para. 26). It will be remembered moreover that a P.P.I. employs a time base that has been almost " blacked-out," only echoes appearing on it (the fact that the line of the time base is actually visible is due to " noise " causing a brightening of the time base in the same manner as echoes); in this way the greatest contrast between signal and background is achieved. Therefore it must be remembered that turning the Brilliance control up too far only makes the time base visible and lessens this contrast, flooding the screen with light ; it does *not* increase the brightness of the picture itself making it easier to read under conditions of strong exterior lighting, as is the case with the type of presentation used, for example, in Gee. The indicator is also provided with four screwdriver adjustments, two of which are marked " focus " and the others " centre H " and " centre V." These should normally be accurately preset on the ground by maintenance personnel, but can be adjusted if necessary in flight. The upper left hand focus adjustment controls the sharpness of the picture on the P.P.I. screen. The lower focus adjustment controls the sharpness of the time base trace on the height tube. The " centre " adjustments control the position of the centre of the display on the screen. Clearly, unless this is accurately centred, bearings will be in error. Once accurate positioning of this has been carried out on the ground, the operator is ill advised to make any adjustment in flight unless absolutely necessary.

6. The height tube is provided with a Brilliance control, to regulate its brightness, and a Shift control. The operation of the equipment on different range scales (selected by the Range switch on the Switch unit—para. 11 below) affects the circuit arrangements of the height tube and causes the signals on this to appear at different points on the trace, or even to disappear. The Shift control regulates the position of the trace bringing the end of the trace to the bottom of the tube when necessary.

7. To enable the orientation of the display to be achieved and bearings of echoes to be determined, a rotatable perspex disc, with grid ring and centre line, is placed in front of the main screen.

Switch Unit



Note : "Radial P.P.I adj.", "30 mile zero", "Alt. zero" and "BEAC zero", screw controls are for mechanics' use only.

FIG. 2. The Switch Unit.

8. The Switch unit (fig. 2) is an important item of the equipment carrying many of the controls necessary for its operation, and should be mounted as close to the indicator as possible.

9. Three push buttons, " L.T. on," " H.T. on," and " L.T. off," are provided to switch the power on and off. When switching on, the " L.T. on " button is first pressed, and an adjacent green pilot lamp immediately lights up. After a short time (about 30 seconds), necessary for the circuits to reach the required operating temperature, the " H.T. on " button is pressed, whereupon an amber lamp lights up and just under a minute later a red lamp comes on. These three lamps are adjacent to the push buttons, and when all three are glowing the equipment is provided with the necessary power. The " L.T. off " button is used when switching off.

10. In order that the beam from the aerial system (called the scanner) may rotate around the aircraft, the electric motor which drives the scanner is switched on by the Scanner switch.

11. The scale of time base it is desired to use is varied by the Range switch. This has six positions, known as 10/10, 30/10, 30/30, 100/30, 100/50 and 100/50–100. The first figure in each case indicates the scale from which the distances are to be read on the Range Drum, and the second figure the radius in statute miles of the display on the screen.

12. The Range Drum bears three range scales reading from 0–10 miles, 0–30 miles and 0–100 miles. The 30 mile scale is on the side of the drum next to the main part of the switch unit ; the 100 mile scale is at the opposite end, and the 10 mile scale consists of curves drawn between the other two scales. The 0–30 and 0–100 miles scales read slant ranges only, while the ground range is given by the curves on the 10 mile scale. Two pilot lights are fitted ; one above the 30 mile scale and one above the 100 mile scale. These lamps function in accordance with the setting of the Range switch and when one of these is lit the scale it indicates is to be used when reading off the range ; when neither is lit, the 10 mile scale is to be used. The Range Drum is calibrated on one side in statute miles and on the other in nautical miles. The scale can readily be reversed by maintenance personnel. The operator should always check whether this has been done by observing the maximum readings obtainable on the scales. If the calibration is in nautical miles, the 10, 30 and 100 mile scales read up to approximately 8½, 26 and 84 miles respectively and there is a large " N " printed in the space at the top of the 10 mile scale. The 30 and 100 mile scales are provided with pointers against which distance is read. The Range Drum is automatically rotated when the Range Marker control is manipulated. This also varies the radius of the range marker on the screen so that the pointer on the appropriate Range Drum scale always indicates in geographical terms the range represented by the range marker circle on the screen.

13. The 10 mile scale distance is indicated by a pointer which is controlled by the Height Marker control. When this is set so that the pulses on the height tube are aligned (paras. 34 and 35 below) the 10 mile scale pointer moves across the drum to select the appropriate distance curve on the Range Drum. Thus allowance is automatically made for height, and the correct ground distance is read directly from the curve indicated on the 10 mile scale on the Range Drum. The graphs marked on the 10 mile scale in red are intended for use when the equipment is being employed for blind bombing, with which we are not primarily concerned in this navigational manual.

14. Movement of the Height Marker control also operates the Height Drum, from the pointer on which can be read the aircraft's approximate height above ground as found by alignment of the pulses on the height tube.

15. To adjust the height circle at the centre of the 10 mile picture (*see* H2S and A.S.V. General Principles, para. 59) the " 10 Mile Zero " control is provided. If the hole is adjusted to ¼ inch to ½ inch diameter, the overall distortion of the picture is reduced to the minimum possible on this mark of H2S. It should be emphasised that this control only operates, and is only necessary, on the 10 mile picture. Furthermore, its use is merely to reduce distortion of the display, due to the height of the aircraft above the ground ; incorrect adjustment of this control does not affect the accuracy of ranges and bearings taken on objects clearly identifiable on the screen.

16. To bring out the various responses at the optimum strength for identification and following on the screen, a Gain control is provided to regulate the amplification of the signals fed to the screen from the receiver. When using responses from objects at close range it is advantageous to reduce the Gain, so that weaker responses (*i.e.*, those from long range, and normal ground returns from short range) are lost, leaving the stronger responses from close range clearly visible. When searching for responses from objects at greater distances, Gain is turned well up, whereupon short range responses are lost in ground returns, but the longer range responses can be used.

17. So that the Line of Flight Marker may be made to appear on the screen at the will of the operator, a Heading switch is provided. When this is off, no Line of Flight Marker appears; when it is switched on, the marker appears on the screen to indicate the aircraft's course.

18. A dimmer switch controls the brilliance of lamps illuminating the Range and Height drums, and a Lucero switch, with four positions, enables ground beacons on frequencies other than that used in the H2S equipment to be employed (paras. 48–68 below).

Heading Control Unit

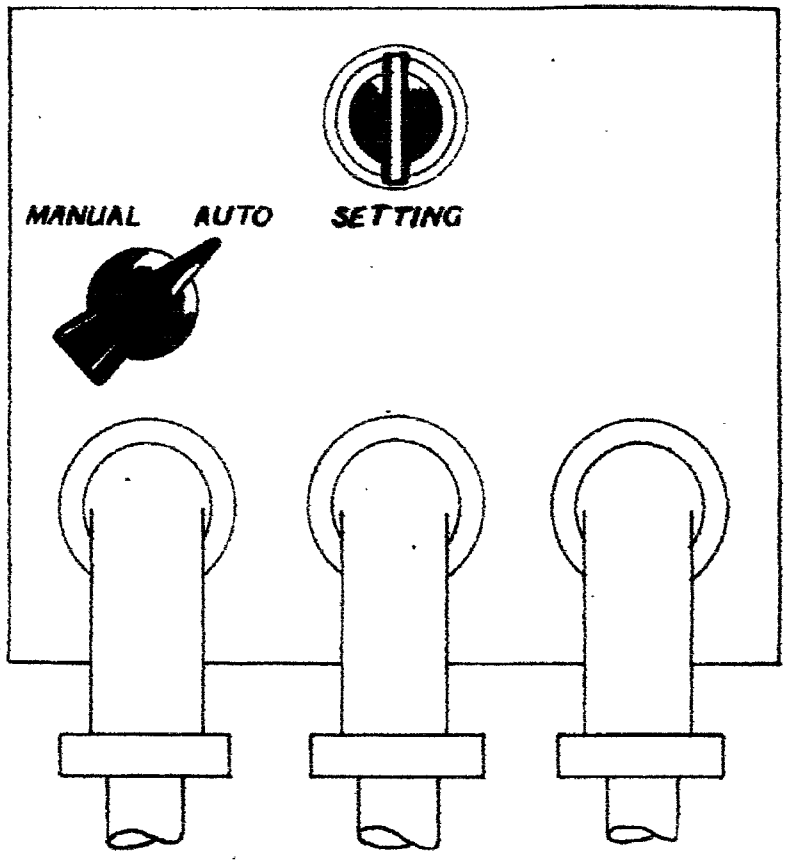


FIG. 3. The Heading Control Unit.

19. The Heading Control Unit (fig. 3) is the means by which the display on the screen is orientated, and is the link between the screen and the D.R. compass. It should be mounted somewhere conveniently near the operator so that he can set the controls whilst watching the display on the screen. The unit carries a switch with two positions, " Manual " and "Auto," and a " Setting " control. The " Manual " position of the switch leaves the display on the screen, including the Line of Flight Marker when this appears (*i.e.*, when the Heading switch is on), free to be rotated by the Setting control. To link the display up with the D.R. compass, the switch is turned to "Auto."

Voltage Control Panel

20. The Voltage Control Panel is usually fitted with an on-off switch by which the power supply for the whole equipment is controlled ; there is also a pilot light and a fuse box with spare fuses. It can be mounted anywhere in the aircraft so long as access is possible after take-off and before landing. In some installations an aircraft master switch is fitted near the H2S operator's position, fulfilling the same function as the switch on the V.C.P., which may then be left on permanently. Before using the equipment, however, a check should always be made that it has not been accidentally switched off. Lastly cases will also be found where there is no switch on the V.C.P., its function being entirely replaced by that of a master switch.

Modulator

21. The Modulator carries an on-off switch, which is normally kept in the " on " position. If it should be accidentally moved to the " off " position, the display will disappear from the screen. Its location in the aircraft in relation to the operator is not normally important, but he should be familiar with its position, and with the switch, so that he can check that it is on when necessary.

Operation

22. The method of operating the equipment in flight is discussed in the following paras. 23 to 68, and a detailed operating drill is given at para. 70 below.

Switching On

23. The current is first switched on at the V.C.P. and/or aircraft master switch (having checked that the Modulator switch is on), the " L.T. on " button on the Switch unit is pressed and about 30 seconds after the green lamp lights, the " H.T. on " button is pressed, to supply current to the receiver and transmitter. When the amber and red lamps indicate that current is being supplied, the equipment is ready for the setting up of the picture and tuning.

Setting Up and Tuning

24. It is important that setting up and tuning be carried out carefully if satisfactory results are to be secured.

25. The scanner motor is first started by the switch on the Switch unit, causing the beam to rotate around the aircraft. With the Line of Flight Marker off and range and height markers at zero to keep the screen clear, and with Brilliance, Contrast and Gain controls at zero to commence with, the equipment is ready for the setting up of the screen.

26. The Brilliance control is now turned up until a full diameter time base appears. It must then be turned *down* until the point is found at which the time base just fails to appear on the screen. The control should then be turned down beyond this point by a further amount corresponding to two " clicks " of the ratchet control. The Contrast control is next turned up, producing a radial time base. This also is then turned down to the point at which the time base just vanishes, but in this case it is finally adjusted to only one " click " beyond this point. The Gain may then be turned up and adjusted to give the picture required (para. 16).

27. This method of setting up may be regarded as somewhat stereotyped, but is particularly recommended to the inexperienced operator. When he has gained considerable experience, however, he may be able to produce a slightly better picture by small adjustments of the Brilliance and Contrast controls. For example, a coastline may be more clearly defined on the screen by slightly advancing the Contrast control and at the same time reducing the Gain control, but such refinements of operation should only be attempted after experience has been gained, and the operator is warned against indiscriminate " twiddling " of the Brilliance and Contrast controls.

28. To tune for optimum results, the biggest time base expansion (that of the 10 mile scale), is used. With the 10 mile zero control, the height circle at the centre of screen is adjusted until it is between $\frac{1}{4}$ inch and $\frac{1}{2}$ inch diameter. The scanner motor is then switched off so that the beam is fixed in the direction of any clearly defined object, whereupon the time base will remain on the response from the object which appears on the screen. If no object can be clearly seen,

the Tuning control should be turned fully to the right, and then rotated slowly and smoothly to the left until a response appears. The Height Tube will be found useful for checking the reception of echoes when responses are not clearly indicated on the P.P.I. Once echoes have been detected, the equipment is sending and receiving signals which can be used for tuning. This is achieved by adjustment of the tuning control so that pulses on the Height Tube reach their maximum length, and by adjustment of the Mixer Current control till a steady reading of about 0·4 milliamps is registered on the mixer current meter. It will probably be found that there are two positions of the Mixer Current control giving a reading of 0·4 milliamps on the meter. One, however, will be stable (*i.e.*, turning of the control causes only a small alteration of the meter reading), the other unstable (*i.e.*, a small rotation of the control causes a large fluctuation in the reading). It is always the stable position that is required.

Orientation

29. The display is now ready for orientation. In order that true north shall appear at the top of the screen—so that all measured bearings are true and direct comparison of the P.P.I. picture can be made with a map—the perspex disc must first be rotated until the aircraft's true course is shown on its grid ring opposite the pointer below the screen. The Line of Flight Marker is next switched on and the switch on the Heading Control unit set to " Manual." By means of the setting control on the Heading Control unit, the display is turned until the Line of Flight Marker is aligned with the arrowed half of the centre line on the perspex disc. The Heading Control unit switch is now placed at "Auto," when the D.R. compass takes over automatic orientation of the display. The picture will remain correctly orientated, with true north at the top of the picture (but *see* para. 30 below), alterations of course producing movement of the Line of Flight Marker only. This completes the setting up of the equipment which is now ready for use.

30. In the event of the D.R. compass becoming unserviceable, the top of the picture would no longer represent true north. In such case the picture should be orientated with the top of the screen representing the aircraft's course. To do this, set zero on the grid ring of the perspex disc, and set the switch on the Heading Control unit to " Manual." Rotate the setting control until the Line of Flight Marker is again correctly aligned, and *leave the switch in the " Manual " position.* Thus the defective D.R. compass is no longer in circuit and, when course is altered, the Line of Flight Marker remains pointing to the top of the screen, and the picture itself rotates. All bearings measured are bearings relative to the top of the screen, that is, in this case, relative to the heading of the aircraft. To obtain true bearings, therefore, the aircraft's true course must be applied to the reading obtained, an operation previously performed continuously for the navigator by linking the D.R. compass to the display.

Bearing and Distance Measurement

31. With the picture correctly orientated, bearings can be obtained by rotating the perspex disc until the centre line bisects the response. When the arrowed end of this line is used the bearing of the object from the aircraft is indicated at the pointer at the bottom of the screen ; when the other end is used, the bearing of the aircraft from the object is given.

32. To measure the range of the object, the Range Marker circle is adjusted by means of the Range Marker control until the inside edge corresponds exactly with the inside edge of the response. The range is then read off the appropriate range scale.

33. The time of the readings being noted it is now possible to plot the aircraft's position as a bearing and distance fix from the nearest part of the object giving the response.

Use of the Height Tube

34. It will be remembered that when measuring ranges of less than 10 miles the difference between slant and ground range must be taken into account, and this difference is a function of height. To measure height, therefore, a Height Tube is provided on which is presented a vertical straight line time base to measure the aircraft's distance from the ground. A small scale time base serves the purpose adequately within the limits of accuracy required for determination of ground distances from slant ranges—an error of 600 feet in height results in an error of less than 0·1 miles in ground distance, and the accuracy of the time base used is of the order of $\pm$ 200 feet.

35. This Height Tube time base is synchronised with the main H2S transmitter, and presents all echoes (which are also, of course, fed to the radial time base on the P.P.I.) as deflection blips to the right (*see* fig. 4). Since the scanner is rotating, however, each pulse transmitted produces a different train of echoes, and thus each sweep of this time base shows a different pattern of blips. The pulse recurrence frequency of the equipment is of the order of 670 per second so that the actual picture seen on the tube as the scanner rotates is a series of blips flickering in and out. Fairly constant returns are received in all positions of the scanner, however, from directly beneath the aircraft, so that a relatively steady mass of blips appears near the bottom of the time base. The distance of these from the beginning of the time base represents the aircraft's height, and this can be measured as follows. On the left-hand side of the time base appears a movable Height Marker blip, and the position of this is governed by the Height Marker control on the Switch Unit. If this is adjusted on one of the 10 mile time bases so that its lower edge is opposite the first (or bottom) returns on the Height Tube, not only can height be read off the height drum on the Switch unit, but the 10 mile scale pointer is correctly positioned relative to the ground range curves of the 10 mile scale.

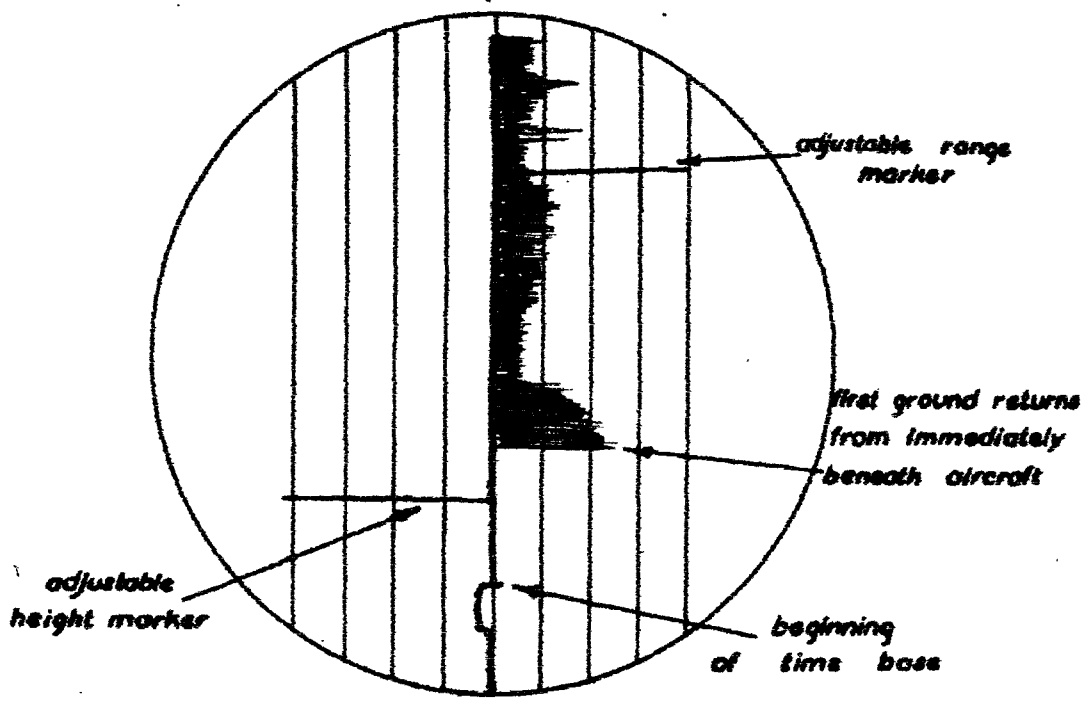


FIG. 4. Height Tube Time Base.

36. The Range Marker circle on the P.P.I. is formed by a spot of light on the rotating time base. This spot of light is represented on the Height Tube by a large deflection blip on the right hand side of the time base which moves up and down as the Range Marker control is manipulated. It is used in connection with Lucero (para. 63 below). It must not be confused with the other blips on the time base, from which it differs in that it is a steady blip and moves with rotation of the Range Marker control. The Shift control is used to adjust the time base so that the required returns, height and Range Marker blips are all visible on the height tube.

37. It is important to notice that adjustment of the Height Marker on the 10/10 Range switch position moves the Range Marker as well as the Height Marker. When measuring ranges on the 10 mile scale, therefore, the Height Marker must always be aligned before the Range Marker.

Identifying Responses

38. Unless the aircraft's position is known within very close limits it is desirable to commence searching for identifiable responses on the 30 or 50 mile pictures. As the distance to an object decreases it becomes possible to change from the 50 mile picture to the 30 mile and then the 10 mile picture.

39. In doing so, unless care is taken, it is easy when the display changes to lose the particular response which is being used.

40. Careful operation of the Range switch helps to reduce the risk of losing the response, and two intermediate positions (the 100/30 and the 30/10 positions) are provided between its three main positions (the 100/50, 30/30 and 10/10 positions) for this purpose. Their use is as follows. A response which has been identified on the 100/50 position is followed until it is at a range of less than 30 miles. The perspex disc should then be turned until the arrowed line bisects the response, and the range circle should be placed on it by adjusting the range marker control. If the range switch is now set to the 100/30 position, the picture changes, the response moves out towards the edge of the screen, and, because the 100 mile scale is still in use and the correct range of the object is still set on that scale, the range circle must move with the response. Thus the response can easily be identified on the new picture since it is very close to the new intersection of the range circle and the arrowed line on the perspex disc. Once this has been done the switch can be turned to the 30/30 position ; there is no chance of the response being lost on this occasion since the picture does not change, although the Range Marker moves to take up its correct position according to the reading on the 30 mile scale at the time.

41. The change over from the 30/30 to the 10/10 position via the 30/10 position may be effected similarly.

42. The attention of the navigator is again drawn to the necessity of keeping a track plot for the purpose of identifying future responses. An H2S fix should be plotted at least every four minutes wherever possible, so that the operator always knows his position within sufficiently fine limits to be able to identify positively any response by reference to its bearing and distance from the aircraft.

Routine Checks during Operation

43. Once the equipment is correctly set up, there are only two main checks which require to be carried out during operation :—

(*a*) Tuning.

(*b*) Synchronisation of the line of flight marker with the D.R. compass.

44. It is essential that about once every half hour a check is made that the receiver is still tuned to exactly the same frequency as that of the transmitter (*see* para. 28), since the equipment goes out of tune relatively quickly due to vibration and other causes.

45. The Line of Flight Marker is virtually another repeater in the D.R. compass system, but in practice it is found that it becomes desynchronised more frequently than other D.R. compass repeaters, and should therefore be checked (*see* para. 29) after every major alteration of course, and approximately once an hour on long straight legs. It may be assumed that a check is being kept on the pilot's repeater so that it is found sufficient, in practice, to check the H2S against the pilot's repeater on these occasions. It will be realised that the accuracy of all bearings obtained from the equipment depends directly on the synchronisation of the picture with the D.R. compass.

46. A third but less important check may have to be carried out if the picture is unsatisfactory, when it should be confirmed that the settings of the Brilliance and Contrast controls are still correct (*see* para. 26). There are, of course, other reasons for the picture becoming unsatisfactory, and this check may not provide a solution to the problem.

Switching Off

47. To switch the equipment off, the " L.T. on " button is first pressed (this operates a relay which cuts off the H.T. supply) ; the " L.T. off " button is pressed and the power is cut off at the switch on the V.C.P. or the aircraft master switch if fitted. Switching on should be done after take-off or shortly before the equipment is required, and the equipment should be switched off before landing.

Use of Lucero Mk. I

48. The Lucero switch has four positions, marked "Alt," "Alt (H)B," " B " and " A." On the "Alt " position, both the P.P.I. screen and height tube function as part of the normal H2S display, *i.e.*, they are used for measurement of distance, bearing and height. On position "Alt (H)B " the P.P.I. tube operates normally as H2S, but the Height Tube displays racon

responses as well as H2S responses and does not indicate height. Considerable interference is experienced, moreover, on the P.P.I. screen display, emanating from a switch motor which operates in conjunction with the Lucero transmitter.

49. On the " B " position, there is no picture on the P.P.I. screen, although the radial time base will still be seen sweeping round the screen. The Height Tube displays racon responses.

50. On the "A" position there is no display on the P.P.I. screen, and the Height Tube functions as a Blind Approach Beacon System display.

51. The change from " B " to "A" positions serves simply to change the frequency from 176 megacycles on which Lucero Mk. I, normally operates to that of the B.A.B.S. Mk. I. It must be noted that B.A.B.S. Mk. II, cannot be used with Lucero Mk. I, due to the different frequencies involved (*see* para. 54).

Use of Lucero Mk. II

52. A modification, known as Lucero Mk. II, enables a wide range of frequencies to be employed for use with racons. When this is provided, there is an additional Beacon Switch unit, with five push buttons down each side (fig. 5), and pilot lamps to indicate which frequencies have been selected. There is also a main on/off switch and a transmitter on/off switch.

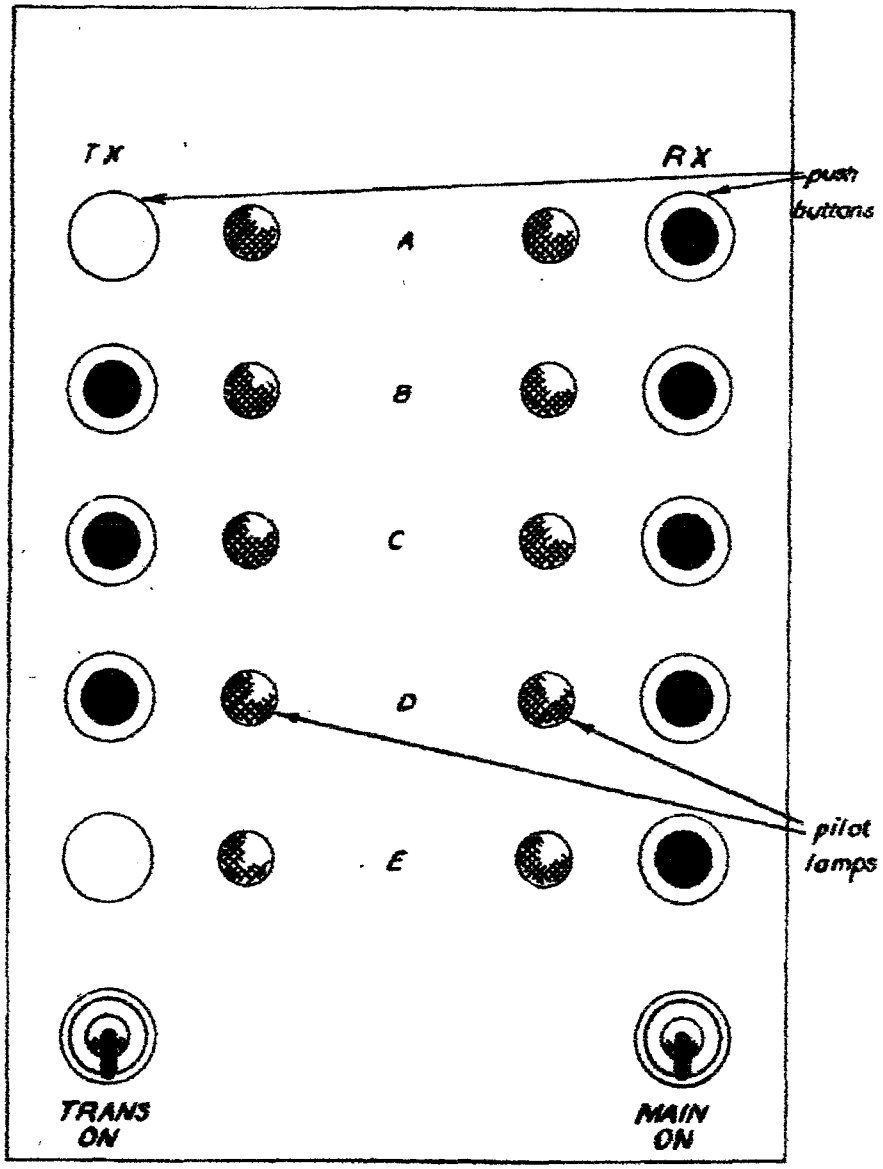


FIG. 5. Lucero Mk. II, Beacon Switch Unit.

53. This unit is brought into operation when the Lucero switch is in positions "Alt (H)B," " B " or " A." As before, in position "Alt (H) B " both H2S and Lucero signals are displayed on the height tube and in position " B " Lucero signals only appear. Position " A," however, produces the same result as position " B," all frequency changing being effected by means of the push buttons on the Beacon Switch unit. The frequency ranges within which the various buttons can be set to operate are :—

	Transmitter (TX).	*Receiver (RX).*
A	171–181 mc/s.	171–181 mc/s.
B	210–228 ,,	168–178 ,,
C	220–238 ,,	210–228 ,,
D	220–238 ,,	220–238 ,,
E	Not operative on this equipment.	

54. Not all of the radar beacons can be triggered by Lucero Mk. II, which is designed to operate with three main types :—

Type of Beacon.	*Beacon Receiving Frequency.*	*Beacon Transmitting Frequency.*
(*a*) 176 mc/s beacons of Coastal Command.	176 mc/s	176 mc/s or 177 ,,
(*b*) B.A.B.S. Mk. Ic beacons of Coastal Command.	176 mc/s	173·5 mc/s
(*c*) Eureka beacons and B.A.B.S. Mk. II beacons.	One of { 214 mc/s, 219 ,, 224 ,, 229 ,, 234 ,, }	One of { 214 mc/s, 219 ,, 224 ,, 229 ,, 234 ,, }

N.B.—The beacon may not transmit on same frequency as that on which it receives.

Thus the Lucero transmitting circuit A is the only one that can be set up to trigger Coastal Command beacons, and receiving circuits A and B are normally used to receive the 176 mc/s and B.A.B.S. Mk. Ic beacons respectively. Transmitter circuits B, C and D and receiver circuits C and D are normally set to a selection of the Eureka and B.A.B.S. Mk. II frequencies, and the navigator should always ascertain from the radar mechanic before take-off to which frequencies the buttons have been set in order that he may know which to use to select the beacons whose frequencies have been given to him at briefing.

55. It can be seen from para. 54 that B.A.B.S., Mks. I and II, can both be used with Lucero Mk. II, and that these are selected by means of the Beacon Switch unit with the Lucero switch normally in either position " B " or " A." When using B.A.B.S., however, a very steady blip is required, steadier in fact than that given by the signals received via the Lucero aerials (whose directional properties are not required when B.A.B.S. is being used). A special B.A.B.S. receiving aerial is therefore mounted beneath the aircraft, and this is selected by means of the B.A.B.S. aerial switch mounted near the H2S operator's position. This, being a single aerial, produces only a one sided presentation, but a much steadier blip is obtained.

Securing Beacon Ranges

56. The racons which can be used in conjunction with H2S Mk. IIB, fitted with Lucero fall into two classes—

(*a*) Centimetric beacons operating on the " S " band, triggered by the main H2S pulse.

(*b*) Metric beacons operating on the Lucero frequency band.

57. To employ " S " band racons, the equipment is operated in the normal way as for detecting ground responses, *i.e.*, with the Lucero switch at position " Alt." Return transmissions from racons within range (usually up to about 90 miles) appear as arcs at the appropriate distance and bearing on the P.P.I. tube, and a distance and bearing fix can be secured.

58. When searching for racon responses on the P.P.I. screen, it is useful to adjust the Tuning control slightly to bring the receiver frequency exactly to that of the racon transmitter. Care must be taken to ensure that the meter reading does not exceed 0·6 milliamps.

59. By careful manipulation of the Tuning control racons which may not normally be visible can be brought out on the screen. Each racon gives a characteristic response on the screen enabling it to be readily identified (*see* Section III, Chapter VI, para. 36).

60. To employ racons on other frequencies, it is necessary to put the Lucero switch on either of the positions "Alt (H)B" or "B." Unless it is desired to employ the P.P.I. screen at the same time as a racon is being used (*e.g.*, when homing to a racon), it is better to employ position "B."

61. When Lucero Mk. I, is fitted, only racons which receive and transmit on 176 megacycles can be employed.

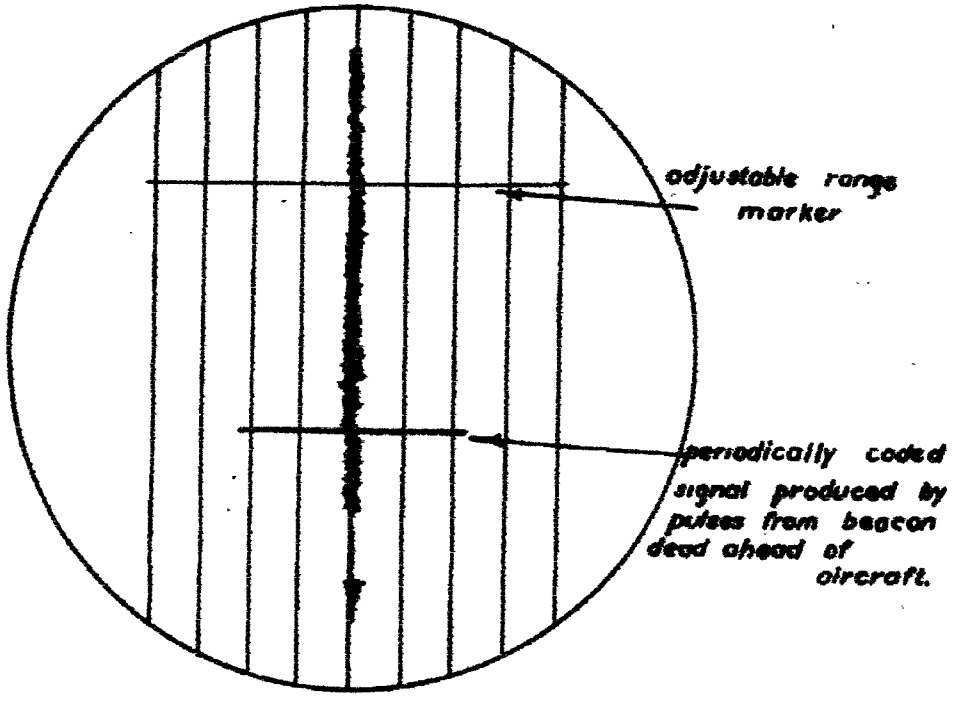


FIG. 6. Racon Signals on Height Tube.

62. Responses from these appear as signals on the height tube. Such signals blink characteristically, in morse characters, by which they are identified. A separate fixed serial system is automatically brought into operation, and when a racon is dead ahead, signals from it appear as blips of equal length on each side of the time base (fig. 6). If the racon is to the port side of the aircraft, signals appear mainly on the left-hand side of the trace and if on the starboard side, mainly on the right-hand side. This is of little value in determining bearing except that the aircraft can be turned until the signals are equal on each side of the time base. The heading of the aircraft is then the bearing of the racon from the aircraft correct to about $\pm 2°$.

63. To determine the distance of a racon whose signals are displayed on the time base, the Range Marker control is used to adjust the range marker blip. The height marker blip is eliminated automatically when the Lucero switch is moved from the "Alt" position and the range marker blip spreads out so that it is of equal width on both sides of the time base. By means of the Range Marker control, the blip is aligned with the signals from the racon it is desired to use. The distance is then given on the appropriate scale of the Range Drum, depending on the setting of the Range Switch, as with normal H2S range determination (para. 11 above).

64. If two or more racons on the same frequency are within range, signals from these appear on the time base at the same time. When two beacons are precisely the same distance away their signals overlap and identification is difficult. At other times, however, each beacon can be identified by its characteristics. Manipulation of Gain control gives the signals a convenient

amplitude for matching with the range marker blip and reduces or eliminates unwanted signals. It must also be used to prevent the blips reaching " saturation " (*i.e.*, growing to such an amplitude that the size of the cathode ray tube prohibits further increase) which would prevent comparison of the relative sizes of the blips on each side of the time base.

65. When two or more beacons are creating signals on the time base, rapid manipulation of the Range Marker control so that the distance of each beacon is measured in turn at only a few seconds interval, enables the distances to be plotted to give what for practical purposes is a simultaneous fix.

66. When Lucero Mk. II is fitted, the main on/off switch on the Beacon Switch unit must be placed to the " on " position, and after an interval of two minutes the Transmitter on/off switch is also turned " on." Then, once the required frequencies have been selected, the signals from racons appear on the height tube time base in exactly the same way as with Lucero Mk. I, and distances and bearings are similarly measured.

67. It is frequently arranged that racons receive on one frequency and transmit on another. This has the advantage that ground returns are eliminated from the time base, as the receiver is selecting only signals transmitted by the racon, and is not picking up echoes returned from the ground on the frequency transmitted.

68. After manipulation of the Gain control when using racons, it is necessary to reset the control for optimum results on the P.P.I. If " S " band beacons have been employed, it is necessary to retune the H2S receiver, which may have been off-tuned slightly for better reception of the beacons.

Fishpond

69. Provision is also made for the fitting of Fishpond to H2S Mk. IIB. For further information on this ancillary equipment, which has no navigational application, *see* chapter on H2S and A.S.V. General Principles.

Operating Drill

70. The following operating drill should be adopted :—

(*a*) *Switching on.*

(i) Check that Modulator switch is on.	(Modulator.)
(ii) Voltage Control Panel switch " on " (if fitted).	(V.C.P.)
(iii) Aircraft master switch " on " (if fitted).	(Near H2S operator's position.)
(iv) Push " L.T. on " button (green lamp lights immediately).	(Switch unit.)
(v) Wait 30 seconds, then push " H.T. on " button (amber lamp lights immediately, followed just under a minute later by red lamp).	(Switch unit.)

(*b*) *Setting up the Picture.*

(i) Switch scanner motor " on."	(Switch unit.)
(ii) Switch line of flight " off."	(Switch unit.)
(iii) Set Lucero switch to "Alt."	(Switch unit.)
(iv) Set Range and Height Markers to zero.	(Switch unit.)
(v) Set " Brilliance " and " Contrast " to zero.	(Indicator.)
(vi) Turn " Gain " to zero.	(Switch unit.)
(vii) Turn " Brilliance " up until a full diameter time base appears, then down to two " clicks " beyond point at which it just vanishes.	(Indicator.)
(viii) Turn " Contrast " up until a radial time base appears, then down to one " click " beyond point at which it just vanishes,	(Indicator.)
(ix) Turn " Gain " up to obtain a picture.	(Switch unit.)

(*c*) *Tuning.*

(i) Adjust Range switch to give 10 mile picture. (Switch unit.)

(ii) Adjust 10 Mile Zero control to give a $\frac{1}{4}$ inch–$\frac{1}{2}$ inch diameter hole in centre of 10 mile picture, to reduce distortion to a minimum. (Switch unit.)

(iii) Turn Tuning control fully to the right ; turn it slowly to the left, watching P.P.I. and height tube until responses appear. (Indicator.)

(iv) Stop scanner so that time base is on an echo on the screen. (Switch unit.)

(v) Adjust Tuning control for maximum length of echo blip on height tube. (Indicator.)

(vi) Adjust Mixer Current control until a steady reading of about 0·4 milliamps is obtained on the Mixer Current meter (reading must not exceed 0·6). (Indicator.)

(*d*) *Orientation of Picture.*

(i) Turn perspex scale in front of screen until the aircraft's true course is read against the pointer below the screen. (Indicator.)

(ii) Switch line of flight " on." (Switch unit.)

(iii) Set Manual/Auto switch to " Manual." (Heading Control unit.)

(iv) Turn Setting knob until line of flight marker is aligned with the arrowed half of the centre line on the perspex disc. (Heading Control unit.)

(v) Set Manual/Auto switch to "Auto." (Heading Control unit.)

(*e*) *Measurement of Range.*

(i) Check whether scale is calibrated in statute or nautical miles (para. 12 above).

(ii) Ranges in excess of 10 miles are given as slant ranges by the 30 or 100 mile scales according to the setting of the Range switch. Set the range marker ring so that it is on the response and read the slant range from the appropriate scale on the Range Drum.

(iii) To measure ground distance when range is less than 10 miles, put Range switch to 10/10 position ; adjust Height Marker so that it is coincident with the first ground returns on the height tube ; adjust the Range Marker correctly on the echo ; read ground distance from the curve on the Range Drum intersected by the end of the pointer.

(*f*) *Measurement of Bearing.*

(i) Place the centre line on the perspex screen over the centre of the response. To read the bearing of the object from the aircraft on the grid ring against the pointer below the screen use the arrowed end of the line. To read the bearing of the aircraft from the object use the non-arrowed end of the line.

(*g*) *Measurement of " S " Band Racon Distance and Bearing.*

(i) Manipulate Tuning control carefully (Mixer Current meter not to exceed 0·6 milliamps) to bring out racon responses clearly defined. Identify on P.P.I. screen.

(ii) Read off distance and bearing as with normal response (sub-paras. (*e*) and (*f*) above).

(*h*) *Use of Lucero Mk. I.*

(i) Set Lucero switch to position "Alt (H) B " if P.P.I. display is still required, or to position " B " if only racon reading is desired.

(ii) Identify required beacon from its characteristic signal on the time base of the height tube.

(iii) Manipulate Gain control to produce clearly defined beacon signals.

(iv) Manipulate Range Marker control until range marker blip is aligned with beacon signals.

(v) Read off distance from scale on Range Drum corresponding to scale at which Range switch is set.

(vi) If bearing of beacon is required, cause aircraft to be turned so that the beacon signals are exactly equal on each side of time base : aircraft's heading or its reciprocal is then the bearing of the beacon from aircraft.

(*i*) *Use of Lucero Mk. II.*

(i) Set Lucero switch to position "Alt (H)B " or " B," as with Lucero Mk. I.

(ii) Main on/off switch to " on." (Beacon Switch unit.)

(iii) Check B.A.B.S. aerial is *not* connected. (Aerial Switch unit.)

(iv) Select appropriate frequencies for beacon it is desired to use by means of the press buttons. (Beacon Switch unit.)

(v) After Main Switch (step (ii) above) has been on two minutes, switch Transmitter on. (Beacon Switch unit.)

(vi) Determine distance and bearing, when desired, as at sub-para. (*h*) (ii) to (vi) above.

(*j*) *Use of B.A.B.S. Mk. I, with Lucero Mk. I.*

(i) Set Lucero switch to position "A" and use height tube time base to carry out normal blind approach procedure.

(*k*) *Use of B.A.B.S. Mks. I and II, with Lucero Mk. II.*

(i) Set Lucero switch to positions " B " or " A."

(ii) Main on/off switch to " on." (Beacon Switch unit.)

(iii) Switch B.A.B.S. receiving aerial into circuit. (Aerial Switch unit.)

(iv) For B.A.B.S. Mk. I, press transmitter button "A" and receiver button " B " on the Beacon Switch unit.

(v) For B.A.B.S. Mk. II, press the buttons on the Beacon Switch unit appropriate to the particular B.A.B.S. beacon required.

(vi) After Main switch (step (ii) above) has been on two minutes, switch Transmitter on. (Beacon Switch unit.)

(vii) Use the height tube time base to carry out normal blind approach procedure.

(*l*) *Switching Off.*

(i) Press " L.T. on " button.

(ii) Press " L.T. off " button.

(iii) Switch off V.C.P. or aircraft master-switch if fitted.

General Hints on Operation

71. It is desirable that the equipment should be switched on below 6,000 feet to avoid the possibility of arcing over on condensers caused by the sudden surge of power which occurs when switching on. The effects of this are more serious under conditions of low temperature and pressure.

72. Once the equipment is switched on it should not be switched off again (unless it becomes unserviceable) so long as it is needed, if this can be avoided.

73. In flight a " blind spot " consisting of a sector about 2° wide may be noticed on the display. In this responses will be weak and poorly defined. It is due to the screening effect on the scanner of the aircraft's flying position. It may be largely eliminated by stopping the scanner so that the radial time base stops on the blind spot ; such responses as are apparent on this part of the screen should be used for careful tuning, to bring them out and secure clearer definition.

74. It may not always be possible to eliminate the " blind spot " entirely, but it is usually found that tuning on to it will move it to some other part of the screen. Thus, if it is ahead of the aircraft, where it would probably prove more inconvenient than elsewhere, it can be moved round to a less inconvenient point even if it cannot be eliminated entirely.

Fault Finding

75. There are very few actual faults that can be remedied in the air. If the equipment is not working, however, the following checks may be made :—

(*a*) Check that correct operating drill has been followed (para. 70 (*a*) to (*d*)).

(*b*) Check the fuses behind the panel on the front of the Voltage Control Panel.

(*c*) Check the fuses on the aircraft's main fuse panel.

(*d*) Check that Lucero switch on Switch unit is in correct position.

(*e*) Check the leads to all units to ensure none have worked loose.

Performance and Accuracy

76. The polar diagram of the H2S Mk. IIB beam is designed so that it sweeps the ground below and around the aircraft to an angular distance of about 88° from the vertical. The effective range of the equipment, however, is very limited under 5,000 feet. Coastlines can be identified at heights of more than 5,000 feet at distances up to about 30–50 miles ; at 8,000 feet and above the outline of towns and similar features can be identified at distances of from 30 to 40 miles.

77. Racons can normally be read from heights over 5,000 feet up to about 90 miles.

78. In general, the equipment is well screened from outside interference, but there are one or two possible forms of which the operator should be aware.

79. A fairly common type of interference which may be due to a variety of causes, but which does not cause the operator much inconvenience, appears as a spot of light which recurrently moves outwards along the radial time base as it rotates ; the effect produced is that of a flecked spiral line or lines on the screen.

80. Interference on some aircraft installations may be caused by the generator used to provide power for other equipments (*e.g.*, Gee). Sometimes this can be overcome by switching off the equipment concerned or removing its fuse from the aircraft's main fuse-box, if this other equipment is not needed during the time H2S is being used.

81. The H2S equipment itself when switched on may cause interference with other electrica installations. For instance, extensive railings appear on the screen of the Loran indicator when both are operating simultaneously, and the trailing aerial is used for Loran.

82. Interference may also occur on the aircraft's intercommunication system. This takes the form of a high-pitched howl which, although not preventing the use of the inter-com., can prove extremely annoying to the aircraft's crew. This interference may be reduced if suppressors are fitted in the inter-com. system, or more usually by separating the inter-com. cabling from the H2S cabling.

83. Similar interference is sometimes experienced at the normal W/T receiver. Interference should not occur on the Gee Indicator screen.

84. In general, distances may be regarded as accurate to about $\pm$ 1 mile.

85. Bearings are liable to error from a variety of causes, of which possible distortion of the display and the width of the sector representing the beam (approximately 6°) are the chief. The error to be expected is of the order of $\pm$ 3°.

86. Used as a target-finding device on towns, it has been found that the average operational error of H2S Mk. IIB fixes taken at short range is 2 miles.

87. One factor affecting the performance of Lucero should be noted. Most Coastal Command beacons operating on or about 176 mc/s use horizontally polarised aerials (*i.e.*, the rod of the aerial is horizontal), but most beacons operating on the 214–234 mc/s band employ vertically polarised aerials (*i.e.*, the rod of the aerial is vertical). With regard to the airborne equipment, Lucero Mk. I, is generally fitted with horizontally polarised aerials, whereas Lucero Mk. II, generally uses a vertically polarised system. A reduction in performance must be expected whenever the polarisation of the ground beacon and airborne equipment differs.

CHAPTER VIII

H2S MK. IID

(A.R.I. 5598)

(For H2S Mk. IIIG, *see* paras. 28–31)

The Equipment

1. H2S Mk. IID, is basically similar to the Mk. IIB installation, but incorporates certain other facilities and features. It operates on the same wavelength of between 9 and 10 centimetres in the " S " band.

2. The primary modification lies in the introduction of the Type 184 Indicator Unit, by the use of which distortion on the P.P.I. is considerably reduced in comparison with the Mk. IIB equipment. This reduction is achieved by the adjustment of two controls :—

(*a*) The Height Marker control.

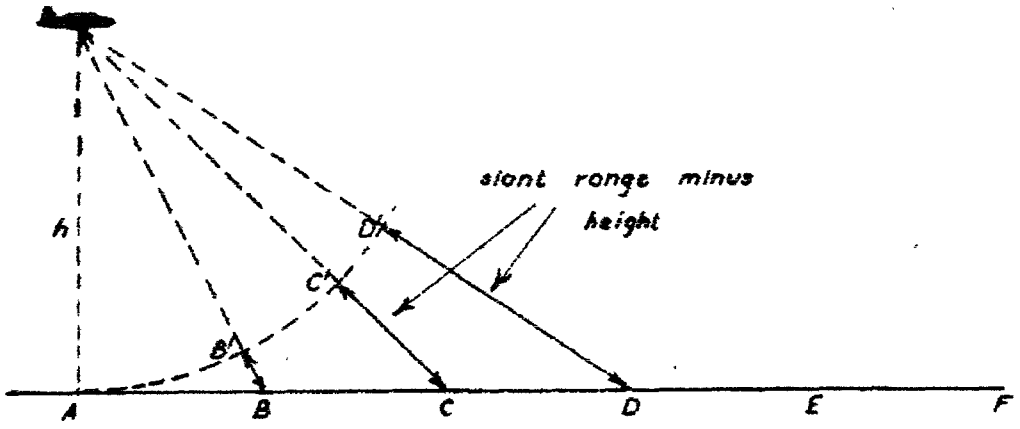
(*b*) The Distortion Corrector control.

3. The setting of the Height Marker control at the correct height not only positions the pointer on the 10-mile scale as in previous marks but, in the Mk. IID, also controls the timing of the radial time base on the P.P.I., arranging that the time base starts from the centre of the tube at the instant the first echo returns from the ground beneath. Thus adjustment of this control eliminates the " hole " in the centre of the P.P.I. and removes the necessity for manipulation of the " 10-mile zero " control used on the Mk. IIB installation.

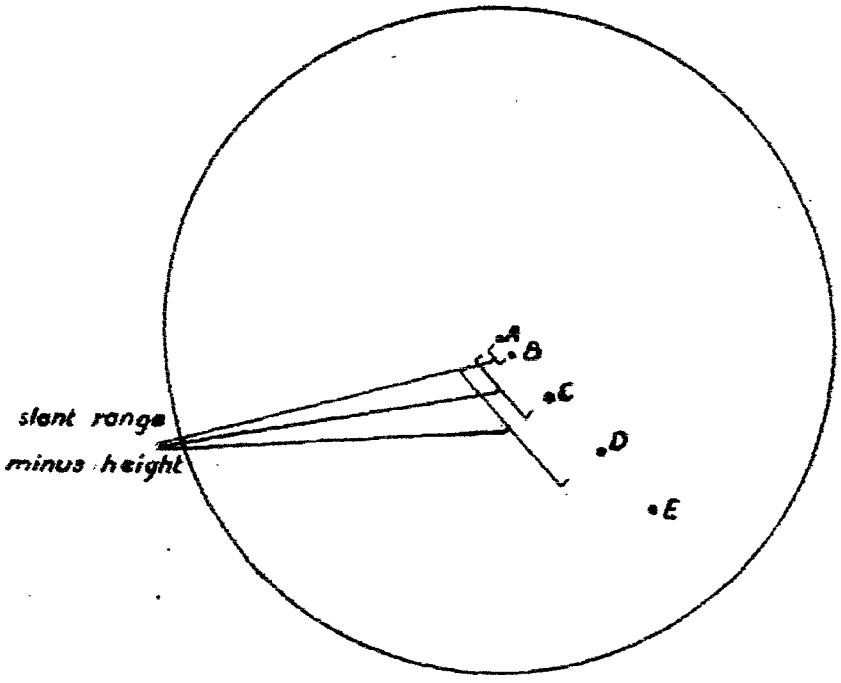
4. The Distortion Corrector control governs the actual rate of the time base, which does not move out from the centre at a constant speed but at a speed which is initially very fast and which falls off towards the end of its sweep.

5. The necessity for the Distortion Corrector control can be seen by reference to fig. 1 (*a*). It will be appreciated that if the start of the time base was delayed as above until the echo from point A had returned to the aircraft, and if the time base was formed at a constant (or linear) rate, then the echo from point B would appear on the P.P.I. at a distance proportional to B'B from the centre, and those from C, D, etc., at distances proportional to C'C, D'D, etc. The representation on the screen of these equidistant points would thus approximate to fig. 1 (*b*). It can be seen, therefore, that the speed of formation of the time base must be increased at the centre of the tube to correct this distortion. If this varying speed of the time base is plotted as a graph it will be seen that the curve is a hyperbola.

6. If the distance AB is considered as one mile, it can be readily calculated by Pythagoras' theorem that the distance $B'B = (\sqrt{h^2 + 1} - h)$ where h is the height of the aircraft. It is obvious, therefore, that the amount of distortion depends on the height. By setting the correct height on the Distortion Corrector control, a time base is generated at a rate approximating to the appropriate hyperbolic curve for that height. Although this does not exactly correspond to the rate required to eliminate distortion, for practical navigation purposes distortion from this source may be regarded as negligible.



(a) Distances actually measured by time base with height circle eliminated (A,B,C,D, etc being equidistant points.)



(b) Representation on constant speed time base (with height circle eliminated.)

FIG. 1. Necessity for Distortion Corrector Control.

7. When the Mk. XIV bomb sight is fitted and is connected to the H2S Mk. IID, and a wind velocity is set on the bomb sight computor, the drift, automatically computed by the bomb sight, is applied to the H2S equipment, and the D.R. track of the aircraft can be displayed on the screen in place of the course marker if the operator so desires. The accuracy of the track so indicated depends entirely on the accuracy of the D.R. compass and of the wind set on the bomb sight, and is not produced by responses reaching the aircraft from the ground below.

8. The setting-up of the equipment is slightly different from that of H2S Mk. IIB, but the general method of operation does not differ markedly. The full operating drill is given at para. 25 below.

9. The only outward difference between the Mk. IID and the Mk. IIB (apart from a slightly modified Indicator unit, Switch unit and Heading Control unit) are the provision of two small extra units, the Tuning unit and the Scanner Speed Control unit in the former. It should, however, be noted that some Mk. IID installations are not fitted with this latter feature. The total weight is approximately the same as H2S Mk. IIB.

Indicator Unit

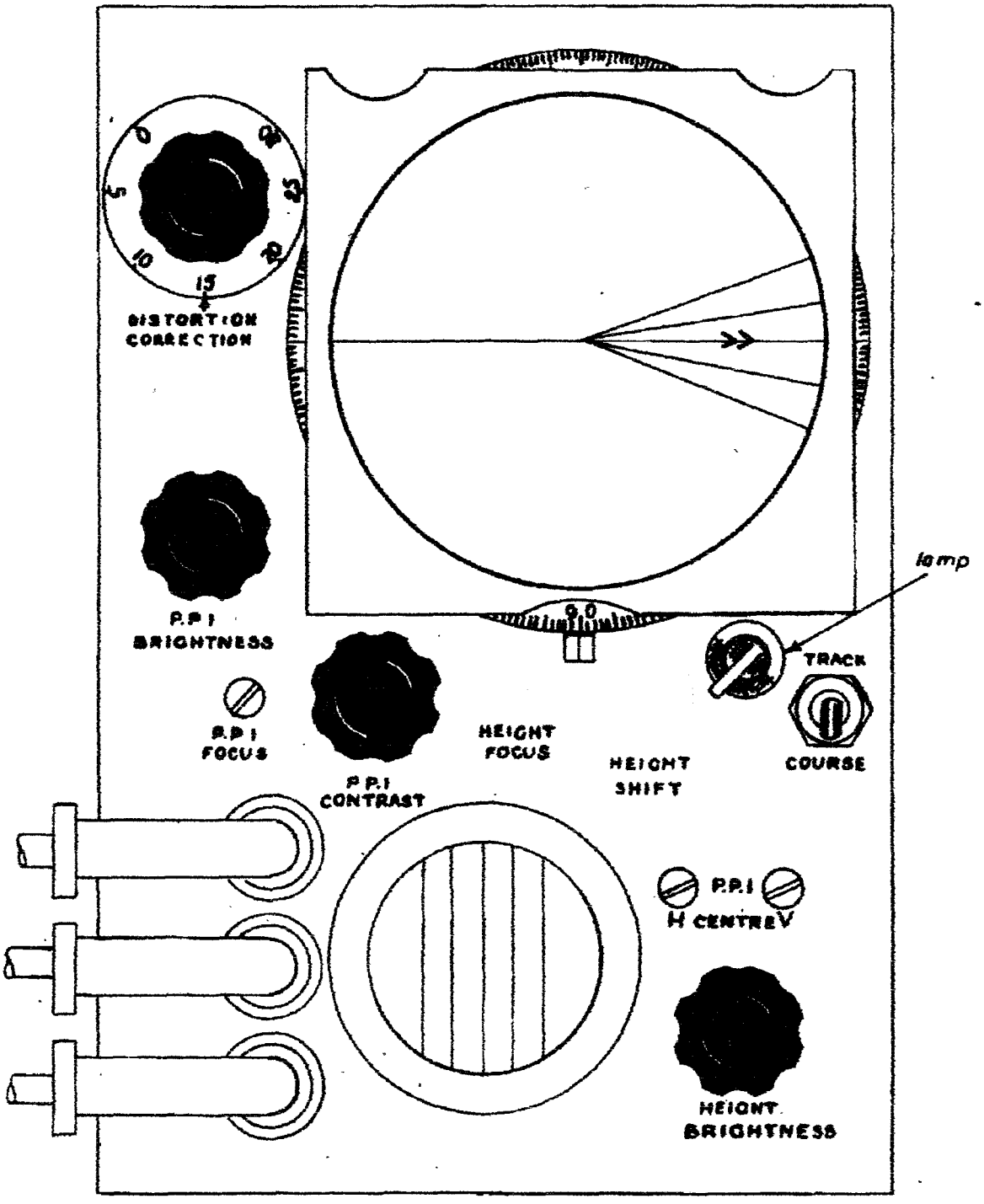


FIG. 2. Indicator Unit.

10. The Indicator unit (fig. 2) is known as the Type 184 indicator. It incorporates the main cathode ray tube screen on which the P.P.I. display appears, and the subsidiary cathode ray height tube, along with a number of the controls necessary for their operation. Brilliance (or "Brightness") and Contrast Controls are provided and the Distortion Corrector control is also situated here (paras. 4–6). A switch is fitted to enable track or course to be indicated on the display as desired (para. 7). The height tube is provided with a Brightness control and a Shift control. There are also four screwdriver adjustments. These are marked "P.P.I. focus," "Height focus," "P.P.I. centre H" and "P.P.I. centre V." These should normally be accurately pre-set on the ground, by maintenance personnel, but can be adjusted if necessary in flight. The P.P.I. focus adjustment enables a sharp picture to be secured on the screen. The height focus controls the sharpness of the time base trace on the height tube. The P.P.I. centre controls are used to adjust the position of the centre of the display on the screen. Clearly, unless this is accurately centred, bearings will be in error. Once accurate positioning of this has been carried out on the ground, it is ill-advised to make any adjustment in flight unless absolutely necessary.

11. The screen is provided with the same form of perspex disc, grid ring, pointer and lamp as the Mk. IIB Indicator.

12. The mixer current control and meter with which the Mk. IIB equipment is provided are omitted on the Mk. IID, as the mixer current is controlled by a screwdriver adjustment at the transmitter, and this should not require adjustment in flight.

Switch Unit

13. The switch unit is similar to that used in Mk. IIB equipment, but the Range switch selects rather different combinations of scales on the range drum and sizes of picture on the P.P.I. (para. 14). It is customary, too, for the knob of the 10-mile zero control to be removed, since its manipulation is now confined to the radar mechanic's setting-up procedure and it should not be touched by the operator, its functions having been superseded by the new function of the Height Marker control (para. 3).

14. The table below gives the six positions of the range switch on the H2S Mk. IID, Switch unit :—

Position.	Radius of Picture on P.P.I.	Scale in use on Range Drum.
10/10	10 stat. m. (ground range)	10 m.
10/20	20 ,, ,, ,, ...	10 m.
30/20	20 ,, ,, ,, ...	30 m.
100/20	20 ,, ,, ,, ...	100 m.
100/40	40 ,, ,, ,, ...	100 m.
100/40–80	Not usable on P.P.I., but gives 40–80 m. time base on Height Tube.	100 m.

The reason for the changeover to 20- and 40-mile pictures is that the various pictures on the screen are now "painted" to scales corresponding to those of maps in use in the R.A.F. ; *i.e.*, the 10-mile picture is on a scale of 1 : 250,000, the 20-mile on one of 1 : 500,000, and the 40-mile on one of 1 : 1,000,000. The range scales used on the drum in the switch unit are the same as those fitted to H2S Mk. IIB, and, as in that equipment, are normally reversible, the reverse being calibrated in nautical miles. It can be seen from the above table that the second or 10/20 position of the range switch permits the use of the 10-mile range scale, and hence of the bombing lines, with the 20-mile picture. This was incorporated to enable the H2S operator to use the bombing scales when attacking targets which are too large to handle on the 10-mile picture. Lastly, it may be added that the 100/40–80 position is used solely for Lucero, facilities for the use of which are identical to those provided by H2S Mk. IIB.

Heading Control Unit

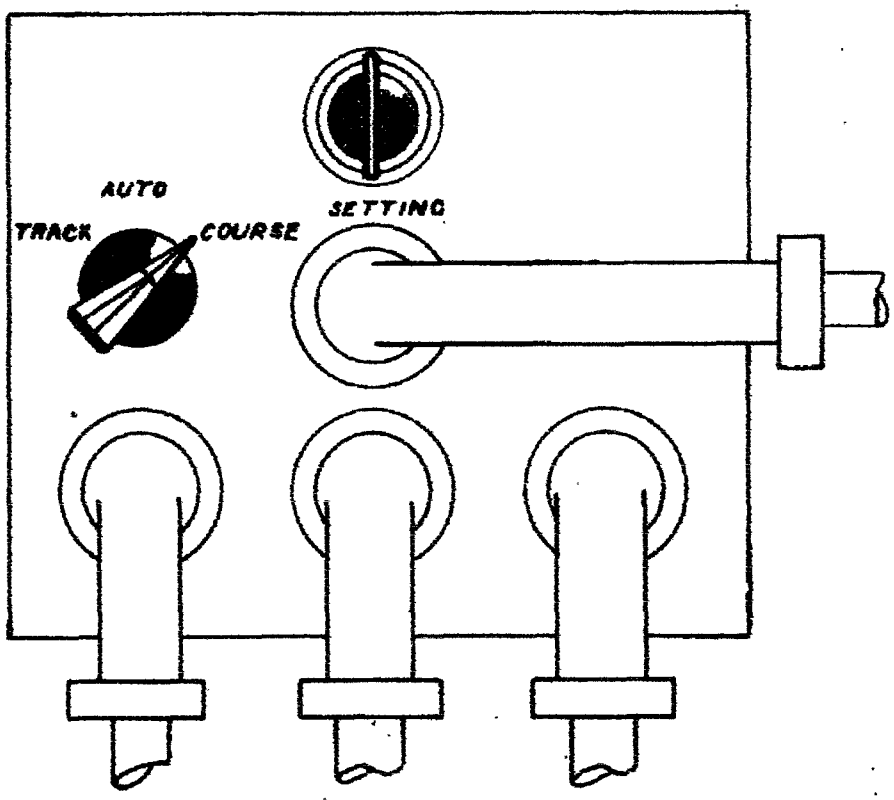


FIG. 3. Heading Control Unit.

15. The Heading Control unit (fig. 3) is very similar to that of the Mk. IIB equipment, except that there is no " Manual " position on the equivalent of the " Manual/Auto " switch. This has three positions, " Track," "Auto " and " Course," for use when orientating the display (paras. 21 and 22 below).

Tuning Unit

16. The Tuning unit is a simple piece of apparatus with one control, marked " Tuning."

Scanner Speed Control Unit

17. This also is a small simple piece of equipment, mounting one rheostat control by means of which the speed of the scanner can be varied from zero to 90 revs. per min. This is of use when a very weak return is being received, since by slowing down the speed of rotation of the scanner, the number of pulses striking the object each time the beam sweeps across it, and hence the intensity of the return, is increased. It should normally be set to give approximately 50 revs. per min.

Operation

18. Switching on is performed as with the Mk. IIB equipment.

19. Setting up is somewhat different. The Height Marker control is first set to read zero height, thereby ensuring that no responses from close range are lost in the centre of the tube. After the scanner motor has been switched on, the Brightness and Gain controls are placed at zero and the Contrast control is turned up to a maximum. The Brightness control is then turned up until a radius appears. (*Note.*—A full diameter time base will not be seen, and at first the radius may appear to be complicated by another short radius also generated in a different direction from the centre of the screen.) The Brightness control is turned down until the radius just vanishes. The Contrast control is also turned *down* until the radius re-appears as a clean, single radius, and is then turned up again until this in turn just vanishes. Finally, Gain is turned up until a complete picture is obtained.

20. In setting up, the setting of the aircraft's height on the Height Marker control and on the Distortion Corrector control has automatically adjusted the time base, and the mixer current control functions have been automatically performed. Excluding the manipulation of the 10 mile zero and mixer current controls, the tuning is the same as with Mk. IIB equipment, except, of course, that the tuning control is no longer mounted on the Indicator unit, but on a separate unit.

21. For orientation, the perspex disc in front of the screen is rotated so that the direction of the true course is shown on the grid ring opposite to the pointer below the screen. The switches on the Indicator and the Heading Control unit are set to " Course." The Setting control on the Heading Control unit is rotated until the course marker coincides with the arrowed half of the centre line on the perspex disc. The Heading Control unit switch is set at "Auto," and the D.R. compass takes over automatic orientation. True north is then indicated by the top of the screen. If it becomes necessary to have the direction of the aircraft's course at the top of the screen (due to a breakdown of the D.R. compass) the grid ring must be set to zero opposite the pointer, and alignment made with both switches at " Course."

22. When it is desired to indicate track instead of course, orientation is first carried out as outlined above (para. 21). Zero wind is then set on the bomb sight, and the switches on the Indicator and Heading Control unit are set to " Track." The track marker functions independently of the rest of the display, and may thus appear at any point on the screen. By means of the Setting control on the Heading Control unit it is moved round until it coincides with the centre line on the perspex screen. It is then indicating the same direction as the course. The switch on the Heading Control unit is then placed at "Auto." If the wind velocity which has been computed for that area is now set on the bomb sight, the Track Marker on the P.P.I. is displaced by the number of degrees of drift appropriate to the course being steered and indicates the D.R. track of the aircraft, continuing to do so even if the course is altered. Note that the adjustments made with the Heading Control unit switch at " Course " and " Track " must be carried out while the aircraft maintains a steady course, since the picture is only being stabilised by the D.R. compass when the switch is in the "Auto " position. Once the above alignment has been effected, the marker can be made to indicate " Course " or " Track " by the placing of the Track/Course switch on the Indicator unit to the appropriate position. As new wind velocities are found these may be set on the bomb sight, and the Track Marker (if selected) then indicates the new D.R. track. If it is desired to check the alignment of the Track Marker, zero wind should once again be set on the bomb sight, when operation of the " Track/Course " switch on the Indicator unit should cause no displacement of the marker on the P.P.I. This should not require checking in flight once it has been correctly aligned, but it should be realised that the synchronisation of the D.R. compass repeater in the Mk. XIV bomb sight will need occasional checking, especially if there is reason to suspect desynchronisation of the other repeaters, as if it is in error it will be calculating the D.R. drift incorrectly.

23. Adjustment for minimum distortion (and incidentally for setting up the pointer on the 10 mile scale also) is achieved by using the height tube to measure the height and transferring this reading to the Distortion Corrector control. The operator should remember to readjust the Height Marker and Distortion Corrector controls whenever the aircraft alters height. Once the equipment has been set up it is used in a similar manner to Mk. IIB.

Homing

24. The Track Marker is of great use when carrying out a homing. Course is altered until the Track Marker exactly bisects the response to which it is desired to home. If the wind velocity set on the bomb sight is the actual wind velocity being experienced, then the response moves straight down the Track Marker and the aircraft tracks over the object. In the event of this computed wind velocity being incorrect, however, the target may not move down the Track Marker, but may drift slightly away from it. In this case, since there is insufficient time to calculate a new wind velocity, it is recommended that the operator estimates the number of degrees of error in the D.R. drift and alters course a sufficient amount to displace the target this number of degrees on the opposite side of the Track Marker to that on which it is. If the estimation is correct the target then moves directly towards the centre of the tube and an accurate homing is carried out.

Operating Drill

25. The following operating drill should be adopted with H2S Mk. IID :—

(*a*) *Switching On.*

(i) Check that Modulator switch is on.	(Modulator.)
(ii) Voltage Control Panel switch " on " (if fitted).	(V.C.P.)
(iii) Aircraft master switch " on " (if fitted).	(Near H2S operator's position.)
(iv) Push " L.T. on " button (green lamp lights immediately).	(Switch unit.)
(v) Wait 30 seconds, then push " H.T. on " button (amber lamp lights immediately, followed just under a minute later by red lamp).	(Switch unit.)

(*b*) *Setting up the Picture.*

(i) Set Height Marker control to read zero height.	(Switch unit.)
(ii) Switch scanner motor " on."	(Switch unit.)
(iii) Heading switch " off."	(Switch unit.)
(iv) Set Lucero switch to "Alt."	(Switch unit.)
(v) Set Range Marker to zero.	(Switch unit.)
(vi) Set " Brightness " and " Gain " to zero.	(Indicator and Switch unit.)
(vii) Set " Contrast " to maximum.	(Indicator.)
(viii) Turn " Brightness " up until a radius appears, then down again until it just vanishes (but no further).	(Indicator.)
(ix) Turn " Contrast " down until radius appears and then up until it just vanishes (but no further).	(Indicator.)
(x) Turn " Gain " up to obtain a picture.	(Switch unit.)

(*c*) *Tuning.*

(i) Adjust Range switch to give 10 mile picture.	(Switch unit.)
(ii) Turn Tuning control fully to the right ; turn it slowly to the left, watching P.P.I. and height tube until responses appear.	(Tuning unit.)
(iii) Stop scanner so that time base is on an echo on the screen, and the responses appear on the height tube.	(Switch unit.)
(iv) Adjust Tuning control for maximum length of echo on height tube.	(Tuning unit.)

(*d*) *Orientation of Picture.*

(i) Turn grid ring of perspex disc until the aircraft's true course is read against the pointer below the screen.	(Indicator.)
(ii) Heading switch " on."	(Switch unit.)
(iii) Track/Auto/Course switch to " Course."	(Heading Control unit.)
(iv) Track/Course switch to " Course."	(Indicator.)
(v) Turn Setting knob until the marker on the screen is aligned with the arrowed half of the centre line on the perspex disc.	(Heading Control unit.)
(vi) Track/Auto/Course switch to "Auto."	(Heading Control unit.)

(*d*) *Orientation of Picture*—contd.

(vii) If a vector/bomb sight is connected to the equipment and it is desired to display the D.R. track as an alternative to the true course, first orientate the display as described at (i) to (v) above. Warn the pilot to maintain the same course until the setting is complete. Set zero wind on bomb sight; set Track/Auto/Course switch to "Track" (Heading Control unit); set Track/Course switch to "Track" (Indicator). With the Setting control (Heading Control unit), align Track Marker on the screen with arrowed half of the centre line on the perspex disc (checking that true course is still indicated on grid ring against pointer below the screen), and set Track/Auto/Course switch to "Auto" (Heading Control unit). Set wind on bomb sight (Track Marker is offset by appropriate amount of drift). Operate Course/Track switch (Indicator) to display course or D.R. track as desired.

(*e*) *Adjustment for Minimum Distortion.*

(i) Set Range switch at 10/10 position. (Switch unit.)

(ii) Adjust Height Marker control so that height marker on height tube is coincident with the first ground returns on the time base. (Switch unit.)

(iii) Read off aircraft's height above ground from the Height Drum, and set this figure on the Distortion Corrector. (Indicator.)

26. Measurement of range (apart from the amended range switch positions), bearing, "S" band racon distances and bearings; use of Lucero Mks. I and II; use of B.A.B.S., switching off, and fault finding are as for Mk. IIB. Also, as in Mk. IIB, provision is made for the fitting of Fishpond.

27. Performance and accuracy are similar to H2S Mk. IIB.

H2S MK. IIIG

(A.R.I. 5747)

Introduction

28. The Mk. II series of H2S, operating on the "S" band, was found to be unsatisfactory when used as a blind bombing aid against large built-up areas, a particular case being that of Berlin during the war of 1939–1945. The chief difficulty experienced was that of identifying the mass of returns that were received on the screen. To overcome this the Mk. III series was introduced, employing a wave length of approximately 3 cm. in the "X" band. Use of this wave length makes it practicable to reduce both the duration of the pulse and the width of the beam (to approximately 3°) and thus produces better definition on the screen. In this manner it is possible to locate, and use as H2S landmarks, such features as lakes and parks within a large built-up area; and in the case of Berlin it was possible to identify Templehof Aerodrome. It is also possible to pick out more rivers than with an "S" band equipment.

Comparison with H2S Mk. IID

29. Apart from the improved picture, however, there are very few differences between H2S Mks. IIIG and IID, that concern the navigator. Such as exist may be summarised as follows :—

(*a*) H2S Mk. IIIG, operates on the " X " band, thus producing a more clearly defined picture (this, of course, necessitates a different transmitter, receiver and scanner).

(*b*) With Mk. IIIG it is possible to use the 40–80 mile base on the P.P.I. as well as on the height tube.

(*c*) A different Tuning unit is used, but externally it is similar to that used in Mk. IID and serves the same purpose.

30. The new 40–80 mile time base on the P.P.I., which appears when the range switch is put to its sixth position (*see* para. 14 above), was introduced to enable coastlines to be detected at greater ranges, a matter of importance in a large number of overseas areas where there are fewer H2S landmarks. The scanner used in this particular submark has, in addition, been designed to obtain greater maximum ranges rather than a good picture at short range beneath the aircraft.

31. The use of the equipment and its operation is in all other respects identical to that of H2S Mk. IID, except that in this case at least three minutes should be allowed to elapse between the pressing of the "L.T. on " and the " H.T. on " buttons.

H_2S, Mk. IVA (A.R.I. 5715)

Introduction

1. H_2S, Mk. IVA (A.R.I. 5715), is an X-band airborne radar equipment used for navigation and blind bombing. The equipment employs a P.P.I. display similar to that used in earlier marks of H_2S, but incorporating new features for wind finding and more accurate blind bombing. In the earlier H_2S equipments the display takes the form of a circular " map " of the terrain beneath the aircraft, the position of the aircraft, represented by the centre of the P.P.I. scan, being at the centre of the map. As the aircraft moves through the air the features of the P.P.I. map change in accordance with the land or seascape below it. In H_2S, Mk. IVA, the same type of display is used, but provision is also made for the display to be " stabilised " at will. When this is done the map of the ground beneath the aircraft remains stationary and the centre of the P.P.I. scan moves across it with the ground speed and track of the aircraft. This type of display enables off-set bombing, and bombing in the absence of a signal from the target at the release point to be carried out. Wind strength and direction can also be measured approximately.

2. The Mk. IVA equipment is a modified version of H_2S, Mk. IV, the chief differences being the replacement of the electrostatic C.R.T. by an electromagnetic type with corresponding changes in the circuiting.

3. A 5 ft. 8 in. scanner is used with a two position adjustable tilt of 3° and 10° to the horizontal, and a variable scanner speed of 0 to 60 revs/min. This provides for increased definition and range. Roll stabilisation of the scanner is not provided, but the equipment has been so designed that it can easily be added at a later date, if desired.

4. The Mk. XIV or XIVA bombsight and the air position indicator (A.P.I.) Mk. IA are integral parts of the equipment. The bombsight provides information on drift and bombing angle, and the air position indicator on air miles travelled.

Features Common to H_2S, Mk. IIIG

5. The following features are common to both Mk. IVA and Mk. IIIG :—
   (*a*) X-band (3 centimetres) transmission frequency.
   (*b*) Azimuth stabilised P.P.I. produced by linking to a distant reading compass.
   (*c*) Uniform ground illumination.
   (*d*) Manual height distortion correction.
   (*e*) Track marker produced by linking to Mk. XIV or XIVA Bombsight.
   (*f*) Variable scanner speed (0–60 revs/min.)
   (*g*) Automatic frequency control.

New Technical Features, not Common to H_2S, Mk. IIIG

6. The following new features are incorporated in H_2S Mk. IVA :—
   (*a*) Narrow pulse ($\frac{1}{2}$ microsecond) and beam width $1\frac{1}{2}$° azimuth, thus giving greater definition.
   (*b*) 5 ft. 8 in. scanner for increased definition and range.
   (*c*) Variable scanner tilt (two tilt positions of 3° and 10°).
   (*d*) Electromagnetic cathode ray tube for higher brilliance and better focus.
   (*e*) True map scale presentation ($\frac{1}{250,000}$, $\frac{1}{500,000}$, $\frac{1}{1,000,000}$, $\frac{1}{2,000,000}$).
   (*f*) Automatic height distortion correction (hence no requirement for height tube).
   (*g*) Ground speed stabilised picture for any time up to 5 minutes (*i.e.* P.P.I. picture remains fixed).
   (*h*) Offset centre P.P.I.
   (*j*) Electronic bombing circle produced by linking to Mk. XIV bombsight.
   (*k*) Wind velocity computor.

New P.P.I. Features

7. The new features associated with the P.P.I. display may be summarised as follows :—

(*a*) Display of true map representation of the ground below the aircraft.

(*b*) Display of the ground track of the aircraft.

(*c*) Display of the bomb release point.

(*d*) Stabilised P.P.I. display, permitting bombing in the absence of a signal from the target and measurements of wind velocity and direction.

Ground Range Display

8. In the early H_2S equipments the P.P.I. display was not a true map representation of the ground below the aircraft. There were two reasons for this deficiency, the first being that the time base scan started at the same time as the transmitter pulse, resulting in a " hole " on the P.P.I. of radius equal to the range of the first ground returns. The second reason was that the scan was linear, resulting in a distortion of the map due to slant and not ground range being displayed.

9. In H_2S, Mk. IVA, map distortion is automatically removed in a manner similar to that described in Chapter 6, paras. 60 and 61, of this Section. The scale of the P.P.I. picture may be set to correspond to any one of four map scales, so that distances on the P.P.I. are equal to distances measured on the appropriate map. No electrical range marker is provided as in earlier Mks. of H_2S : distances on the P.P.I. can be transferred to a map by means of a pair of dividers. The four P.P.I. scales correspond exactly to the $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 million map scale series. Since the useful radius of the C.R.T. is about $2\frac{1}{2}$ inches the P.P.I. maps cover circular areas of approximately 8, 16, 32, and 64 nautical miles radius respectively.

Course and Track Markers

10. The course and track of the aircraft can be displayed on the P.P.I., a switch enabling the desired marker to be selected. Constant north heading of the P.P.I. picture is obtained in the same manner as in earlier marks of H_2S, that is by means of a repeater motor from the Distant Reading Compass to adjust the setting of the Magslip stators. When the scanner passes through the dead-ahead position the course marker contact closes and causes the aircraft course to be shown as a radial line on the P.P.I.

11. A second contact marker on the scanner is variable in position up to $\pm$ 40° about the position at which the course marker contact closes. The computor of the Mk. XIV bombsight controls the position of this contact, and, when the correct wind information is fed to it, will offset it from the course marker contact by an angle equal to the drift of the aircraft. The track marker also appears as a radial line on the P.P.I. and will show the aircraft's ground track, allowing for any variation of air speed or course, but not of wind velocity.

Bomb Release Point Display

12. A bombing marker is displayed on the P.P.I. as a circle with centre the start of the scan and radius corresponding to the forward throw of the bomb. The point on the map at which the track marker intersects this circle at any instant is the point at which the bomb should make impact if released at that instant.

13. Let A (fig. 1 (a)) be the position of the aircraft at the given instant, G the point on the ground immediately beneath the aircraft, and T the point which the bomb would hit if released at this instant. GAT is called the bombing angle and is dependent on the aircraft's height and ground speed and the terminal velocity of the bomb in use. Information on the size of this angle is fed to the H_2S from the Mk. XIV bombsight. The H_2S equipment combines this information with the information on the height of the aircraft to produce a bright-up on the time base at a time h sec. β after the transmitter pulse (fig. 1(b)). This signal represents an echo from the theoretical point T whose slant range is h sec. β. Occurring on every time base, the signal appears as a marker ring (the bombing marker). The point T is, however, the point at which the track marker intersects the bombing marker. Thus, due to the corrected scan, the radius of the marker ring will represent the ground range of the theoretical target T, and, when bombing, it is only necessary to wait until the actual target is aligned with the intersection of the track and bombing markers to release the bomb. This is referred to as the bomb release point.

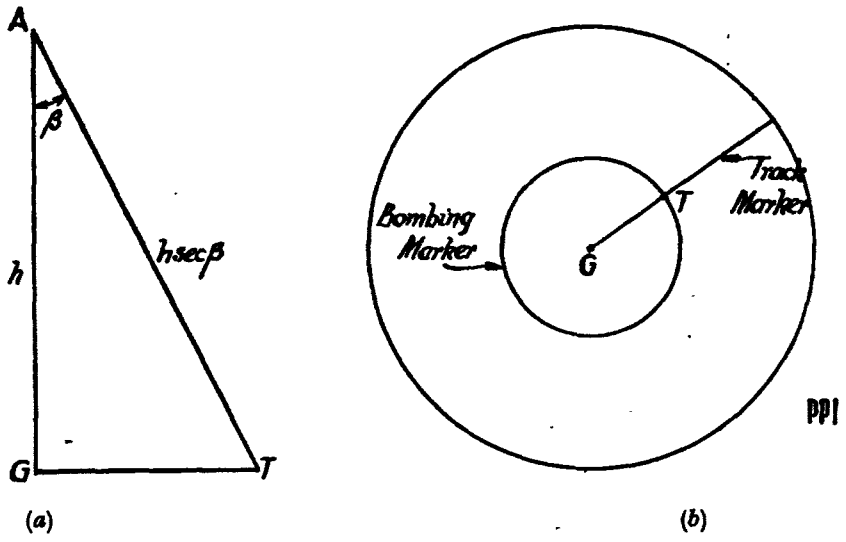


FIG. 1. Bomb Release Point Display.

Stabilised P.P.I. Display

14. Normally, the ground, as seen on the P.P.I. moves over the face of the C.R.T. in accordance with the ground speed and track of the aircraft, while the centre of the scan, representing the aircraft's position, remains at the centre of the tube with the bombing marker round it and the track marker originating from it. If, starting from a fixed reference time, the deflection coils of the C.R.T. are fed with shift currents proportional to the N–S and E–W components of the ground distance travelled by the aircraft, the resultant will oppose the normal shift of the picture. Then, from that time onwards, the P.P.I. picture will remain stationary while the centre of the scan will move over the tube face in accordance with the ground track of the aircraft, taking with it the bombing and track markers. This type of presentation is known as a stabilised P.P.I. display.

15. The method by which this display is obtained is as follows. The A.P.I., Mk. IA supplies the H_2S with information in the form of M type transmissions (*see* Vol. IV, Section III, Chapter 1, paras. 37–47) of the air miles travelled in N–S and E–W components. The equipment converts these into shift currents and feeds them to the deflection coils of the C.R.T. The relation between A.P.I. drive and shift currents gives an exact correlation between air miles travelled and shift in miles as seen on the P.P.I.

16. In the absence of wind, the above system would provide complete stabilisation of the display. To allow for wind, however, an additional shift of the correct sense must be applied. The equipment generates two voltages which, if applied to the deflection coils of the C.R.T. as shift currents, would shift the scan centre by an amount corresponding to a wind whose N–S and E–W components were 100 knots. These voltages are actually applied across a pair of "wind rate" potentiometers, one associated with N–S and the other with E–W wind. The potentiometers are calibrated and enable any desired amount of the 100 knots wind voltages to be selected; the outputs of these potentiometers are converted to shift currents and fed to the deflection coils of the C.R.T. Thus if the correct wind components are set on the wind rate potentiometers, the P.P.I. picture will again be completely stabilised. Fig. 2 shows four views, taken at intervals of about one minute, of the stabilised P.P.I.

17. Two co-ordinate shift potentiometers, calibrated in nautical miles, are also provided; these enable the P.P.I. map to be shifted by any definite distance. A second method of fixing aircraft position is to shift the picture until an identified return appears under the cross hairs at the centre of the tube face. The aircraft position relative to the identified return then appears as nautical miles N–S and E–W on the calibrated scales of the shift knobs.

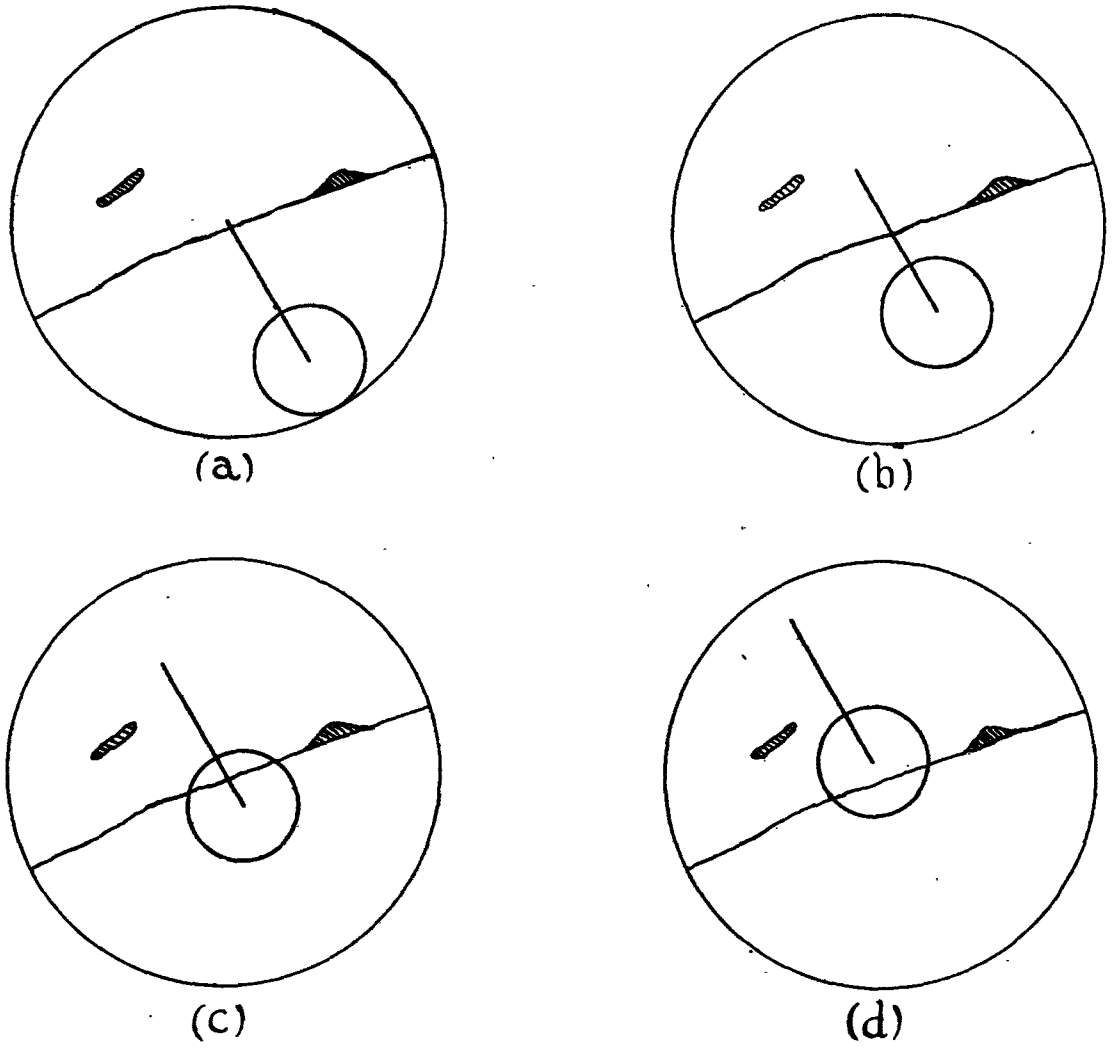


FIG. 2. Stabilised P.P.I.

18. A switch controls the operation of the P.P.I. as a moving or stabilised picture. The stabilised picture can only be maintained for five minutes.

The Mk. IVA Equipment

19. H_2S, Mk. IVA works on the same principle as the earlier marks of H_2S, and the equipments are therefore fundamentally the same. However there are differences in the number, size and appearance of the units making up the equipments, and the controls associated with them.

20. The three units of direct concern to the navigator are :—

(*a*) *The Indicator.* This embodies most of the controls used in obtaining the required picture on the C.R.T.

(*b*) *The Control Unit.* This carries the controls used in accurate fixing, bombing and wind finding operations.

(*c*) *The Tuning Control Unit.* This contains the tuning and scanner controls.

These units are described in the following paragraphs.

(*e*) *Course/Track Switch.* This enables either a course or track marker to be displayed as a radial line on the P.P.I.

(*f*) *Stabilization Switch.* (COMPR ON/OFF). This switch controls the stabilization of the P.P.I. picture. In the OFF position the picture is unstabilized and moves across the P.P.I. face. In the ON position the picture is held steady while the aircraft's position moves across it (*see* para. 30 et seq.).

(*g*) *Amber Warning Light.* When this is illuminated it warns the operator that the stabilisation of the display is reaching the end of its run.

(*h*) *Height Controls.* These consist of the two position AUTO/MANUAL switch and the setting knob marked MANUAL HEIGHT. These controls are only in circuit when the LOCAL/REMOTE switch on Indicator, Type 277, is on REMOTE. Use of them is described in paras. 27–29.

(*j*) *Centre Controls.* These are the only two pre-set controls on the Indicator (apart from focus) which need ever be touched by the operator. When the large shift knobs on the control unit are reading zero, the centre of the P.P.I. should exactly coincide with the centre of the bearing plate. If this is not the case, the necessary adjustment may be carried out by means of the pre-sets marked " N–S CENTRE " and " E–W CENTRE ".

Control Unit, Type 552

22. Control Unit, Type 552, contains some of the controls used by the operator, and is mounted in the navigator's compartment of the aircraft near the indicating unit, Type 300. A view of the front panel of this unit is shown in fig. 4.

23. The controls on this unit are as follows :—

(*a*) *The Co-ordinate Controls or Shift Knobs.* Situated near the top of the panel, these consist of two large knobs marked " N–S CO-ORD " and " E–W CO-ORD ". They are calibrated from 0 to 16·6 nautical miles in both directions from their centre positions and provide means of shifting the P.P.I. display vertically and horizontally on both the $\frac{1}{4}$ m. and $\frac{1}{2}$ m. scales.

(*b*) *Wind-rate Controls.* Labelled " N.S. WIND-KNOTS " and " E.W. WIND-KNOTS ", these controls can be used to set on a given wind in N–S and E–W components, or to find a wind in the manner described in paras. 31–34. When the switch marked " COMPR " on the indicator is set to " ON ", the computor unit combines the information from the A.P.I. with the wind information set in by means of these knobs, and applies the result in the form of shift voltages to the deflector coils of the P.P.I. As a result, assuming a given signal to be placed under the centre of the bearing plate by means of the shift knobs, it will remain in that position providing the wind set on is correct. This has important applications as will be seen later.

(*c*) *COURSE/TRACK Alignment.* This knob, together with the switch to the right of it, serves the same purpose as the heading control unit in earlier marks of H_2S equipment.

(*d*) *Transmitter OFF/ON Switch.* This switches on the high voltage to the transmitter.

(*e*) *Illumination Control.* This varies the amount of light available for reading the scales.

Control Unit, Type 565A

24. Control Unit, Type 565A, contains all the controls necessary for operation of the transmitter and scanner.

25. The controls on this unit are as follows :—

(*a*) *Tuning Switch and Tuning Control.* These consist of a three position switch marked " MANUAL–A.F.C.–BEACON " and a knob engraved numerically from 1 to 8, The three position switch is normally used in the " A.F.C." position, thus obviating the necessity for retuning. If the A.F.C. is suspected of faulty operation however, it is possible to switch over to " MANUAL " and use the knob marked " TUNE " in the normal manner. When working with beacons, it is necessary to switch to " BEACON " and tune to the beacon frequency with the tuning control.

Wind Measurement

31. If the P.P.I. picture does not remain stationary when stabilised, there is an error in the setting of the wind controls. The amount by which the picture drifts over a definite time is a measure of the error in wind estimation.

32. The method of measuring wind is as follows. The wind rate controls on control unit, Type 552, are set to zero or, preferably, to the co-ordinates of the best wind available, *e.g.* a forecast wind, or wind determined from A.P.I. and Gee or H_2S fixes. A signal (normally one ahead of the aircraft) is selected on the P.P.I. and shifted by the manual shift controls (co-ordinate controls) to coincide with the cross wires in the centre of the perspex scale covering the front of the C.R.T. ; at the same time the P.P.I. picture is stabilised. If the wind is incorrectly estimated, the signal will drift away from the cross wires. At the end of the run, the signal is recentered by means of the wind-rate controls, thus setting the correct N–S and E–W components of the wind just measured.

33. It is possible to use an alternative method of measurement by making continual adjustments to the wind controls during the run, so as to keep the signal central.

34. Where the wind has been found as described above it is converted to " indicated ", changed from cartesian to polar co-ordinates, and set into the bombsight. This ensures that the track marker is offset from the course marker by the correct drift angle.

Bombing in the Absence of a Signal at the Release Point

35. The aiming point in a target can usually be observed most favourably at ranges of between 7 and 10 miles ; at shorter ranges the signal from the target does not show as a coherent whole but as individual returns from different parts of it and the required aiming point becomes indefinite. Thus, when the required aiming point is identified at the optimum range it should be moved, by means of the calibrated shift controls, until it coincides with the cross wires at the centre of the tube and the picture stabilised. From then on the aiming point will remain stationary at the centre of the tube face providing the wind velocity has been correctly determined and set. It is thus immaterial if the signal later becomes more indefinite or disappears entirely. The cross wires mark the aiming point and the bombs should be released when the intersection of the track and bombing markers coincides with the cross wires.

36. An added advantage of this type of display is that considerable tactical freedom exists once the aiming point has been placed at the centre of the P.P.I. and the picture stabilised. It is not now necessary to fly straight and level in order to avoid losing sight of the aiming point on the P.P.I.

37. If, while the target is still clearly defined, the aiming point has obviously drifted off centre it should be moved back. This resetting should be done by the wind rate controls, provided that the aiming point is easy to identify. On a larger target, with an ill-defined aiming point, it would be advisable to make any resetting by means of the co-ordinate controls, otherwise serious wind errors might be introduced.

Co-ordinate or Reference-point Bombing

38. This form of bombing can be carried out using H_2S IVA with an accuracy not far short of that obtainable by direct methods on a medium sized town. The method is used when the required aiming point does not give a response or when the response is very poor, and will, perhaps, be most easily understood by outlining the procedure in a typical case.

39. In fig. 7, P is the aiming point in the centre of a large and ill-defined town ; Q is the reference point at the northern tip of a lake. The aiming point is 2·7 nautical miles south and 9·2 nautical miles east of Q. The bombing run will be made from the south west.

40. The action to be taken in flight is as follows :—

(*a*) Find a wind in the manner described in para. 32. This should be done preferably on the same course as that on which the attack will be carried out. Suppose that the wind co-ordinates shown by the control unit are 23k. north and 16k. west. This means that the wind is 23k. from the north and 16k. from the west. It takes about half a minute to convert this, using the squared Section of the Dalton Computor, to the normal form of wind in polar co-ordinates (325°/29k). This should be set on the Mk. XIV Bombsight.

(*b*) Check that the COURSE/TRACK switch on the indicator is on TRACK.

(*c*) At this point it is assumed that the aircraft is heading in the direction of the aiming point by normal navigational methods.

(*d*) As soon as the signal from the reference point Q has been identified it is moved to coincide with the cross wires (*see* fig. 7 (*c*)) by the shift controls and at the same time the picture is stabilised. Suppose that, after this has been done, the readings on the shift controls are 6·3 nautical miles north and 1·2 nautical miles west.

(*e*) If time permits wait a minute or two to see if Q drifts from the centre, and if necessary reset by means of the wind knobs.

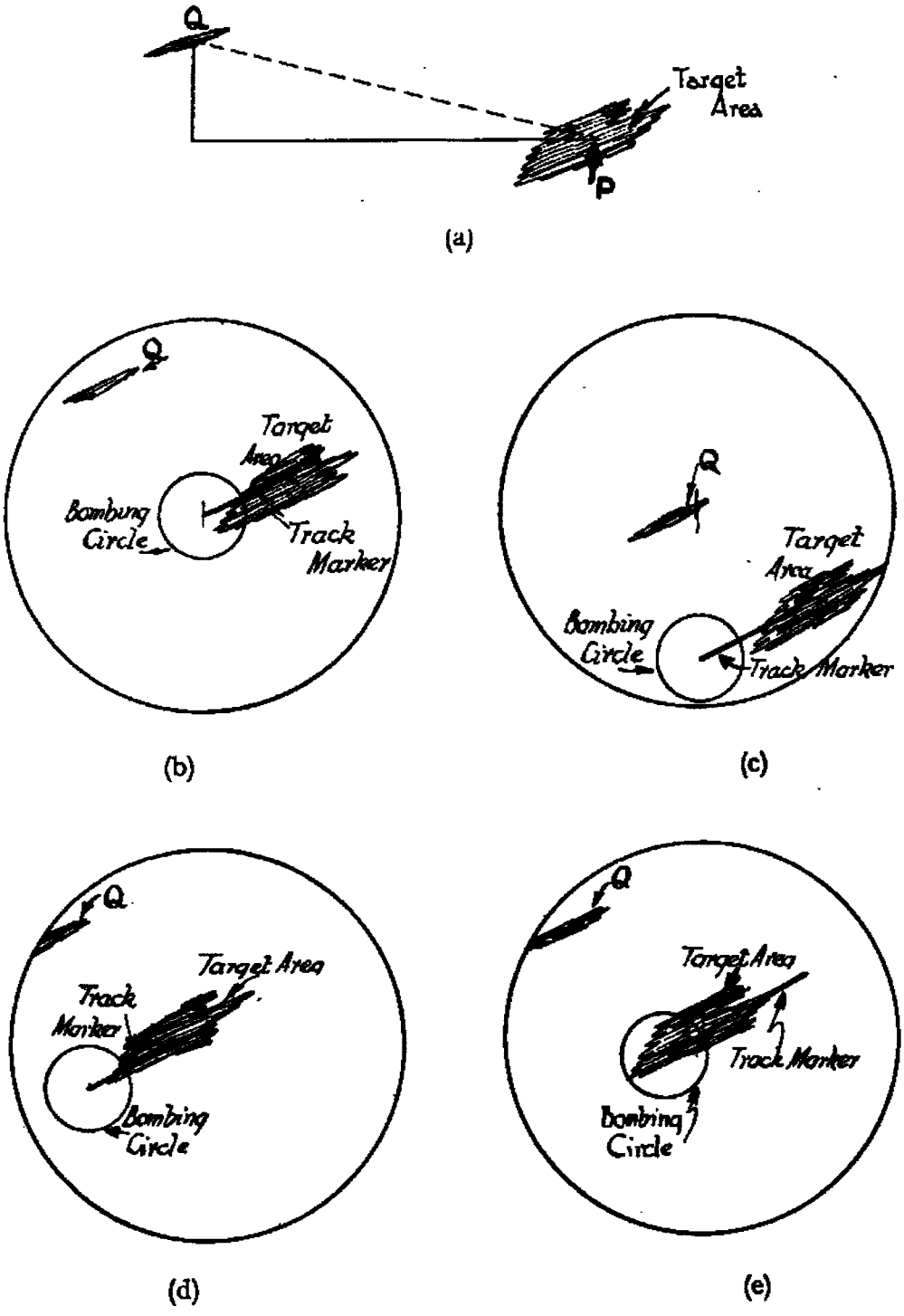


FIG. 7. Reference-point Bombing.

(*f*) The settings on the shift controls are now altered by the required amounts of 2·7 nautical miles south and 9·2 nautical miles east, thus placing P (although invisible) at the intersection of the cross wires (*see* fig. 7 (*d*)). Applying this correction to the existing readings (6·3 nautical miles north and 1·2 nautical miles west) gives new shift control readings of 3·6 nautical miles north and 8·0 nautical miles east. Set these last figures on the scales by means of the shift knobs.

(*g*) The correct amount of shift has now been applied to move the point P to the centre of the bearing plate. As the centre of the bearing plate is now directly over the aiming point and the picture is stabilised, it only remains to direct the pilot so that the track line lies over the centre. The bombs are released when the intersection of the track and bombing markers coincides with the cross wires, as shown in fig. 7(*e*).

Fishpond

41. A fishpond indicating unit, Type 188A, is also provided for use in conjunction with H_2S Mk. IVA. The function of fishpond is the same as in previous Mks. of H_2S, that is, to provide a display of signals from aircraft within the volume swept by the scanner and at distances less than the height of the H_2S aircraft.

42. The unit has a single P.P.I. display limited to a range of five nautical miles. The time base is produced independently of the main time base on indicating unit, Type 300, and its rotation is synchronised with the scanner by means of a separate magslip, the stators of which are fixed so that the top of the display always represents the aircraft heading. The centre of the P.P.I. represents the aircraft's position and a signal is displayed as a bright arc at its appropriate slant range and bearing. If the aircraft is flying at a height of less than 5 miles the first ground returns will appear as a ring on the tube face and signals at greater ranges will be obscured.

Manual Height Distortion Correction

43. If the automatic height distortion correction circuits become unserviceable it is possible to correct for height manually. This type of height correction is, however, not particularly accurate and in subsequent operation a reduced accuracy must be accepted.

44. The method employed (assuming that the LOCAL/REMOTE switch on the Indicating Unit, Type 277, is switched to REMOTE) is to set the AUTO/MANUAL switch on the Indicator Unit, Type 300, to MANUAL and then rotate the MANUAL HEIGHT knob until the first ground returns appear as a ring leaving a " hole " in the centre of the tube face. The knob is then turned in the reverse direction until the " hole " just disappears and then back a further two notches.

45. This operation should be made at frequent intervals, and certainly before taking a fix, since the height of the ground beneath the aircraft is unlikely to remain constant.

Operating Drill for Lincoln Type Aircraft

46. *Switching On.*

(*a*) The switching on procedure is as follows :—

(i) Start required Motor Generator by pressing switch " ON " on navigator's panel.

(ii) Rotate H_2S Master switch behind Navigator to ON position for Motor Generator already selected.

(iii) Check that time base appears by turning the Brilliance up. After three minutes transmitter will come on automatically. While waiting, check the following :—

(*b*) On Control Unit, Type 565A.

(i) Manual—A.F.C.—Beacon switch set to A.F.C.

(ii) Scanner tilt as required.

(iii) Set Scanner Speed control to maximum.

(*c*) On Control Unit, Type 552.

(i) Set N–S, E–W controls to ZERO.

(ii) Set Transmitter OFF/ON switch to ON.

(iii) Set COURSE/TRACK control to NORMAL.

(iv) Set wind controls to ZERO.

(v) Set Illumination as required.

(*d*) On Indicator, Type 300.

(i) Set COURSE/TRACK switch to COURSE.

(ii) Put Height MANUAL/AUTO switch to AUTO and check that Bombing Release circle moves out on P.P.I.

(iii) Put Computor ON/OFF switch to OFF.

(iv) Set Scale switch to ½ million.

47. *Setting up Picture.* When transmitter comes on, proceed as follows :—

(*a*) Set Gain and Brilliance to ZERO.

(*b*) Turn Brilliance up until radial time base appears.

(*c*) Adjust N/S E/W centre presets until the time base pivots around the centre cross on tube face. NOTE : Do NOT touch N/S E/W sensitivity presets by mistake.

(*d*) Reduce Brilliance Control until heading and bombing marker alone are visible.

(*e*) Turn Gain Control up until desired signal level is achieved.

(*f*) Check that the automatic height circuit is functioning correctly, if above 3,000 feet. (Bomb release circle should now be stationary.)

(*g*) Adjust Focus preset on Indicator if necessary.

48. *Orientation of Picture.*

(*a*) Turn perspex scale in front of screen until the aircraft's true course is registered against the pointer just below screen.

(*b*) Put SET TRACK/COURSE switch on Control Unit, 552, to SET COURSE, and rotate SET COURSE knob until course marker is aligned with the arrowed half of the centre line on the perspex disc.

(*c*) Return SET COURSE/TRACK switch to NORMAL.

The equipment is now set up for normal navigation purposes. Note that N/S E/W centre presets may need readjustment from time to time during the course of a long flight.

49. *Setting up for Bombing.*

(*a*) Switch on the Mk. XIVA Bombing Computor.

(*b*) Set Remote Wind controls on Navigator's Panel to ZERO.

(*c*) Align arrowed half of engraved line on perspex disc with the Course Marker.

(*d*) Set COURSE/TRACK control on Indicator, 300, to TRACK.

(*e*) Put SET COURSE/TRACK control on Control Unit, 552, to SET TRACK.

(*f*) Turn Setting Knob until Track Marker is aligned with arrowed half of centre line of perspex disc.

(*g*) Return Set Track on Control Unit, 552, to NORMAL.

(*h*) The Track Marker should now give the same indication of heading as the Course Marker. Check this by operation of COURSE/TRACK Switch on Indicator, 300.

Equipment is now set up for normal bombing procedure.

50. *Switching Off.*

(*a*) Turn H_2S Master switch behind Navigator to OFF position.

(*b*) Stop motor generator in use by pressing switch OFF on Navigator's Panel.

Simple Fault Finding

51. Few real faults can be remedied in the air. The following points may, however, be of interest :—

(*a*) If equipment fails to come on, check fuses under the H_2S Master switch and also the fuses in the aircraft's main fuse panel.

(*b*) If the scanner does not rotate, check fuse in fuse panel on the port side of the aircraft just to the rear of the scanner well.

(*c*) Should signals fail to appear when transmitter comes on, check that the white and black Pye plugs are firmly home on the receiver and indicator.

(*d*) Should no scan appear on the P.P.I., check blue Pye Plug on receiver and indicator, and also violet Pye Plug on receiver and Junction Box, 326.

(*e*) Should AUTO/MANUAL switch and Manual Height control on Indicator, 300, appear inoperative, check that LOCAL/REMOTE switch on Indicator, 277 (near the Receiver), is set to REMOTE.

(*f*) Should Height circuit fail to lock after transmitter has come on, set AUTO/MANUAL switch on Indicator, 300, to MANUAL, and set up as described.

(*g*) Should the Bomb Releasc circle be missing or visible only at the centre of tube, check that Set Range Zero button on Receiver Unit is OUT.

(*h*) Should signals appear intermittent, set Manual —A.F.C.—Beacon switch on Control Unit 565A to MANUAL, and adjust Manual Tuning control until signals are steady.

(*j*) Should the picture appear unduly distorted, with a large hole at the centre, check that the Low Altitude TEST/NORMAL switch on the receiver is on NORMAL.

Note.—Should height circuit fail to lock over the sea, manual height setting procedure should be used until over land again. The failure to lock will be due to weak sea returns.

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