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July 2010

GENERAL INFORMATION
AND
DESCRIPTION OF UNITS

LIST OF CHAPTERS

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CHAPTER 1

INTRODUCTION

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CHAPTER 1

INTRODUCTION

GENERAL

1. H2S Mk. IVA (ARI. 5715) is an X-band airborne radar equipment used for navigation and blind bombing. The equipment employs a PPI display similar to that used in earlier marks of H2S, but incorporating new features for the purpose of wind finding and more accurate blind bombing. In the earlier H2S 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 PPI scan, being at the centre of the map. As the aircraft moves through the air the features of the PPI map change in accordance with the land or sea scape below it. In H2S Mk. IV and 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 PPI scan moves across the display with the 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. H2S Mk. IVA is a modified version of the H2S Mk. IV system, the chief modification being the replacement of the electrostatic CRT by an electromagnetic type and corresponding changes in the timebase circuits.

3. H2S Mk. IVA uses scanning unit, type 109 which has a 5 ft. 8 in. linear array with a cylindrical reflector and two-position adjustable tilt. Roll stabilisation of the scanner is not provided in H2S Mk. IVA, but the equipment has been so designed that it can easily be added at a later date if desired.

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

PPI DISPLAY

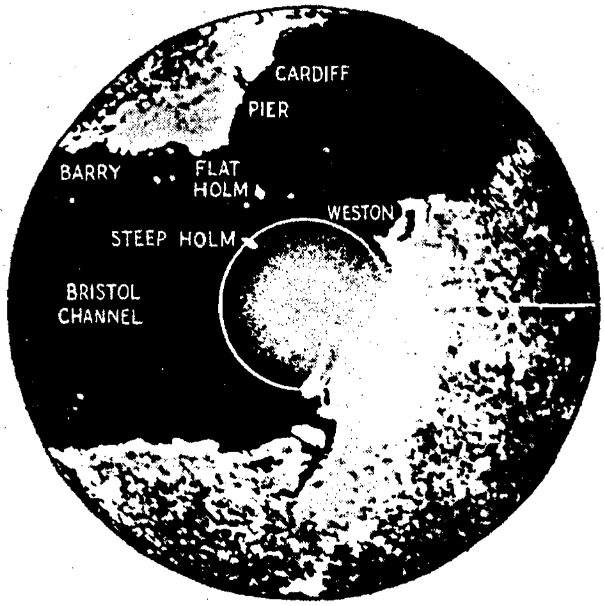
5. Some typical H2S Mk. IVA displays are shown in fig. 1; the new features associated with the PPI display are as follows:—

(1) Display of a true map representation of the ground below the aircraft.
(2) Display of the ground track of the aircraft.
(3) Display of the bomb release point.
(4) Stabilised PPI display permitting bombing in the absence of a signal from the target and measurements of wind velocity and direction.

Ground range display

6. In the early H2S equipments the PPI 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 timebase scan started at the same time as the transmitter pulse, resulting in a " hole " on the PPI 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 range and not ground range being displayed.

7. In H2S Mk. IVA the distortion of the map is removed by delaying the start of the scan for a time corresponding to the height of the aircraft, then causing it to start rapidly and to approach the waveform it would have had if the scan had been linear and had started with the transmitter pulse: in other words, the scan waveform is hyperbolic. The amount of distortion introduced into the linear scan depends, of course, on the height, so that for every height a different hyperbola is required.



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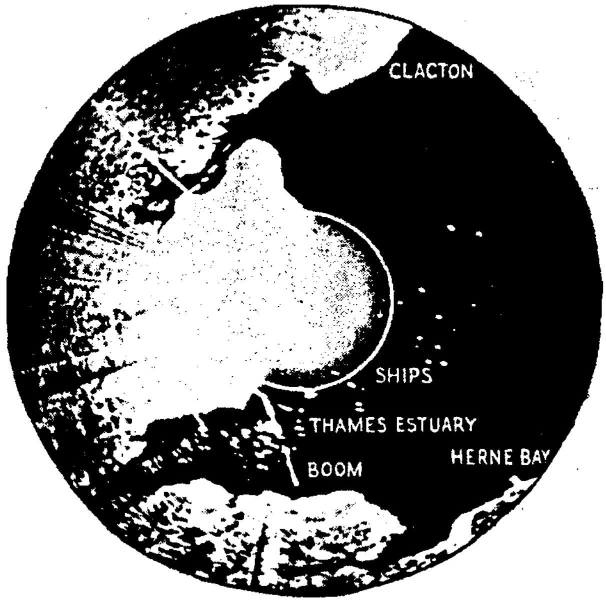
SCALE:- ½ M



HEIGHT:- 7,000 FT.

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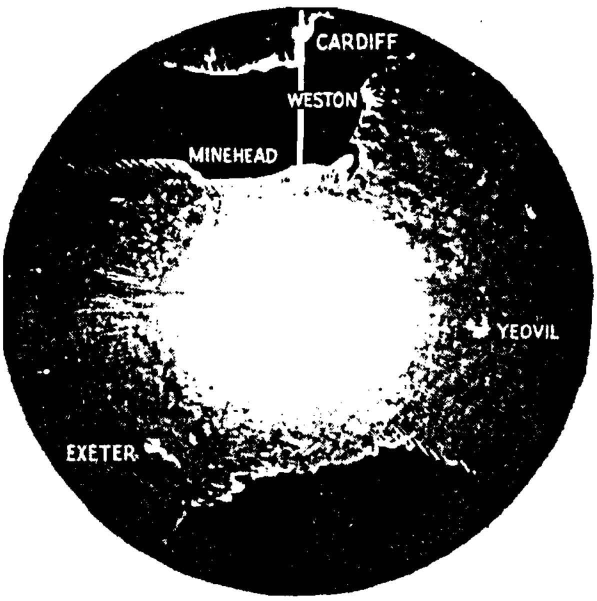

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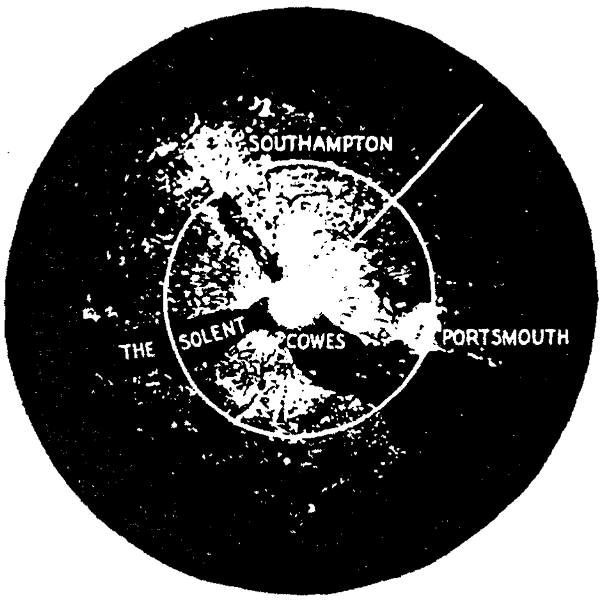
SCALE:- 1 M



HEIGHT:- 15,000 FT.

SCALE:- ½ M

Fig. 1.—Typical H2S Mark IVA displays

8. Automatic circuits in the equipment generate a pulse of length proportional to the height of the aircraft, and the end of this pulse is used to trigger the scan generating circuits. An amount of distortion, proportional to the length of the triggering pulse, is introduced into the scan waveform which would otherwise be linear. The result of the distortion introduced into the timebase scan is that the PPI picture displayed is one of true ground range.

9. The scale of the PPI picture may be set to correspond to any one of four map scales, so that distances measured on the PPI are equal to distances measured on the appropriate map. No electrical range marker is provided, as in earlier marks of H2S: distances on the PPI can be transferred to a map by means of a pair of dividers. The four PPI scales correspond exactly to the $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 million map scale series. Since the useful radius of the CRT is about $2\frac{1}{2}$ in. the PPI 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 PPI, a switch enabling the desired marker to be selected. Constant north heading of the PPI picture is obtained in the same manner as in earlier marks of H2S, that is by means of the DR compass repeater motor which adjusts 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 PPI.

11. A second contact on the scanner is variable in position up to ± 40 deg. about the position at which the course marker contact closes. The computer of the bombsight Mk. XIV 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 PPI and will show the aircraft's ground track, allowing for any variation in air speed or course, *but not in wind.*

Bomb release point display

12. A bombing marker is displayed on the PPI as a circle with centre at 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 would make impact if released at that instant.

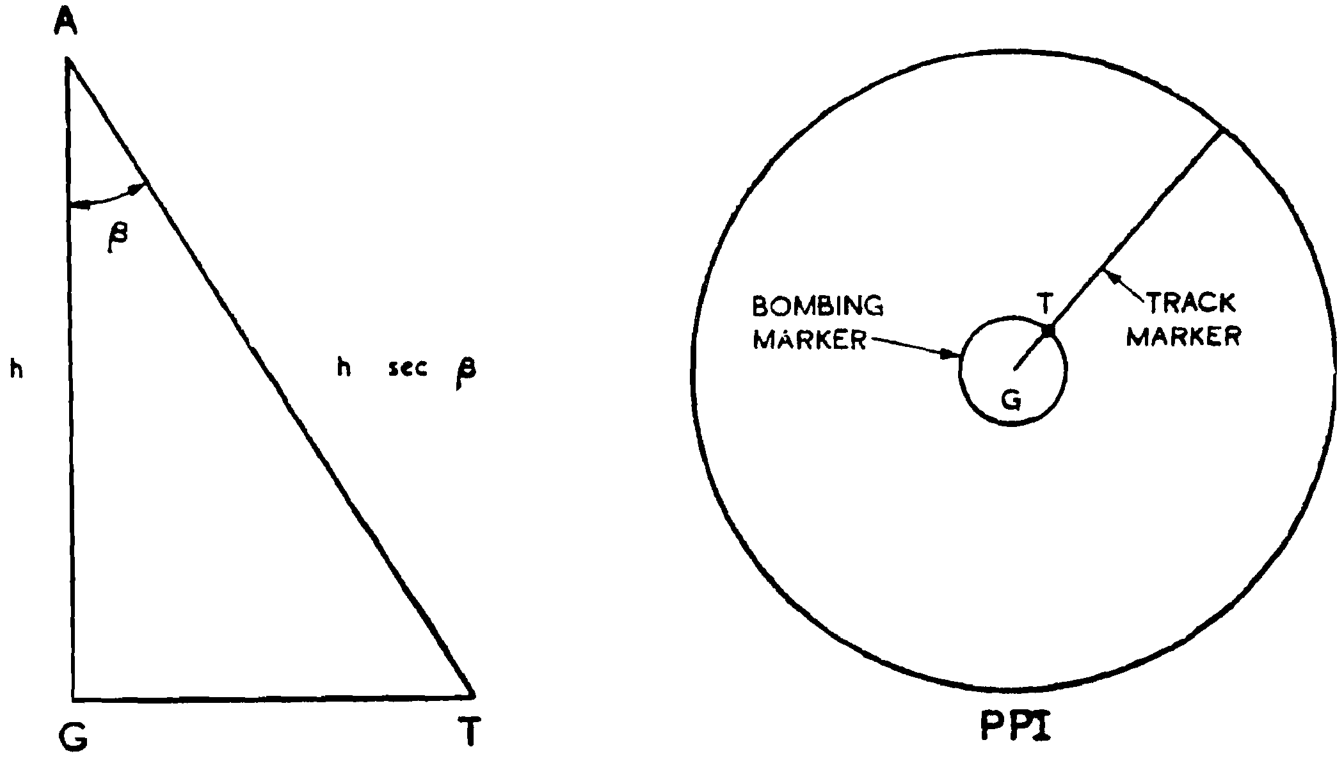


Fig. 2.—Bomb release point displa

13. Let A (fig. 2) be the position of the aircraft at the given instant, G be the point on the ground immediately beneath the aircraft, and T the point on the ground which the bomb would hit if released at this instant. The angle GAT is called the bombing angle and is dependent on the aircraft's height and ground speed and on the terminal velocity of the bomb in use. Information on the size of this angle is fed to the H2S equipment from the bombsight Mk. XIV. The equipment combines this information with the information on the height of the aircraft to produce a pulse at a time h sec β after the transmitter pulse. This signal represents an echo from the theoretical point T whose slant range is h sec β. Occurring on every timebase this signal appears as a marker ring (the bombing marker), showing all the points whose slant range is h sec β; but the point T is, of course, the point at which the track marker intersects the bombing marker. 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.

Stabilised PPI display

14. Normally, the ground, as seen on the PPI, is moving over the face of the CRT in accordance with the ground speed and track of the aircraft, while the centre of the scan, representing the aircraft 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 CRT are fed with shift currents which are 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 PPI picture of the ground 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 PPI display.

15. The method by which this display is obtained is as follows. The air position indicator Mk. IA supplies the equipment with information, in the form of M-type transmissions, on the air miles travelled in N-S and E-W components. The equipment converts these M-type transmissions into shift currents, and feeds them to the deflection coils of the CRT. The relation between the API drive and the shift currents gives an exact correspondence between air miles ravelled and shift in miles as seen on the PPI.

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 has to be applied. The equipment generates two voltages which, if applied as shift currents to the deflection coils of the CRT, 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 wind N-S and the other with wind E-W. The potentiometers are calibrated and enable any desired amount of the 100 knots wind voltages to be selected. The outputs from the sliders are converted to shift currents and fed to the deflection coils of the CRT. Thus if the correct wind components are set on the wind rate potentiometers the PPI picture will again be completely stabilised. Fig. 3 shows four views, taken at intervals of approximately 1 minute, of the PPI when stabilised.

17. Two co-ordinate shift potentiometers, calibrated in nautical miles, are also provided; these enable the PPI map to be shifted by any definite distance.

18. A switch enables the PPI picture to be moving or stabilised but the stabilised picture can only be maintained for five minutes.

USE OF THE STABILISED DISPLAY

19. The ability to stabilise or "freeze" the PPI display permits of:—

(1) Wind measurement.

(2) Bombing in the absence of a signal at the release point.

(3) Co-ordinate bombing.

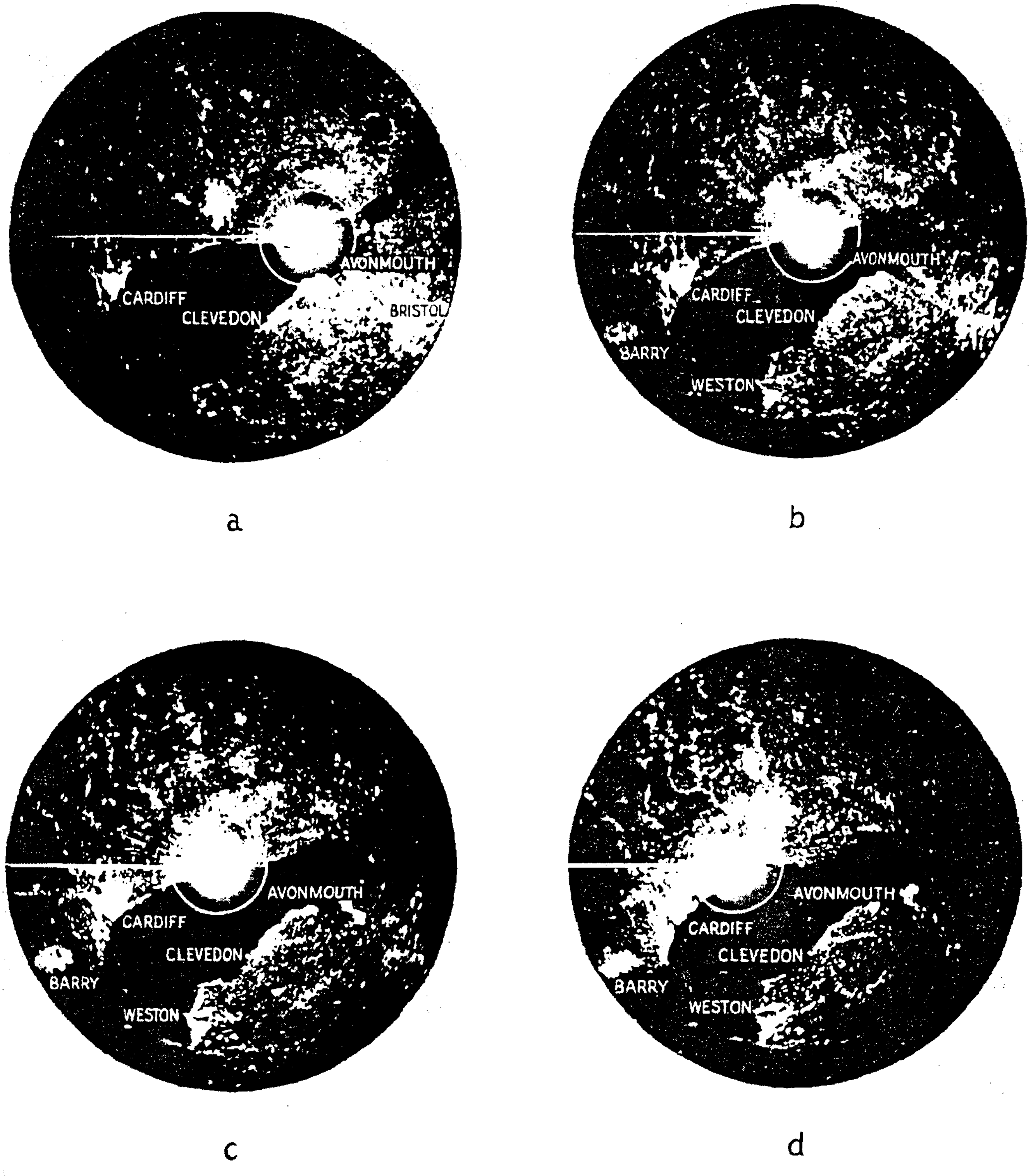


Fig. 3.—Stabilised display

Wind measurement

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

21. The method of measuring wind is as follows. The wind rate controls are set to zero, or, preferably, in accordance with the best available knowledge of the wind, for example, a Met. wind or wind determined from API and Gee or H2S fixes, if these can be obtained. A signal (normally one ahead of the aircraft) is selected on the PPI, and this signal is moved by means of the manual shift controls to coincide with cross wires in the centre of the perspex scale covering the front of the CRT ; at the same time the PPI picture is stabilised. If the wind was incorrectly estimated, the signal will drift away from the cross wires. At the end of the run, which cannot exceed 5 minutes and may be less if the air speed is greater than 200 knots, the signal is recentred by means of the wind controls thus setting the correct N-S and E-W components of the wind just measured.

22. Alternatively, instead of allowing the signal to drift for the maximum time and then resetting the controls to recentre it, it is possible to use a decay method of measurement by making continual adjustments to the wind controls during the run, so as to keep the signal central.

23. When 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 by the operator. 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

24. Assume that the wind strength and direction have been correctly determined and that the wind rate controls have been set correctly so that the picture can be completely stabilised. The aiming point in a target can usually be observed most favourably at a range 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. When the required aiming point is identified at the optimum range it is moved, by means of the calibrated shift controls, until it coincides with the cross wires at the centre of the tube and the picture is stabilised. From this time onwards the aiming point will remain stationary at the centre of the tube face and it is immaterial whether it later becomes a more indefinite signal or whether it disappears entirely. The cross wires mark the aiming point and the bombs are released when the intersection of the track and bombing markers coincides with the cross wires.

25. 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 PPI and the picture stabilised. It is not necessary to fly straight and level in order to avoid losing sight of the aiming point on the PPI.

Co-ordinate bombing

26. This method of bombing is used when the required aiming point does not give a response or when the response is very poor. Suppose that P in fig. 4 represents the target and that it is at a known range and bearing from the reference point Q which gives a good response ; this range and bearing can be converted into N-S and E-W co-ordinates, for example, 2·7 nautical miles South and 9·2 nautical miles East. The signal from the reference point is first identified and is moved to coincide with the cross wires (*see* fig. 4c) 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. The settings of 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 instead of Q (*see* fig. 4d). Applying this alteration to the existing shift 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. The bombs are released when the intersection of the track and bombing markers coincides with the cross wires as shown in fig. 4e.

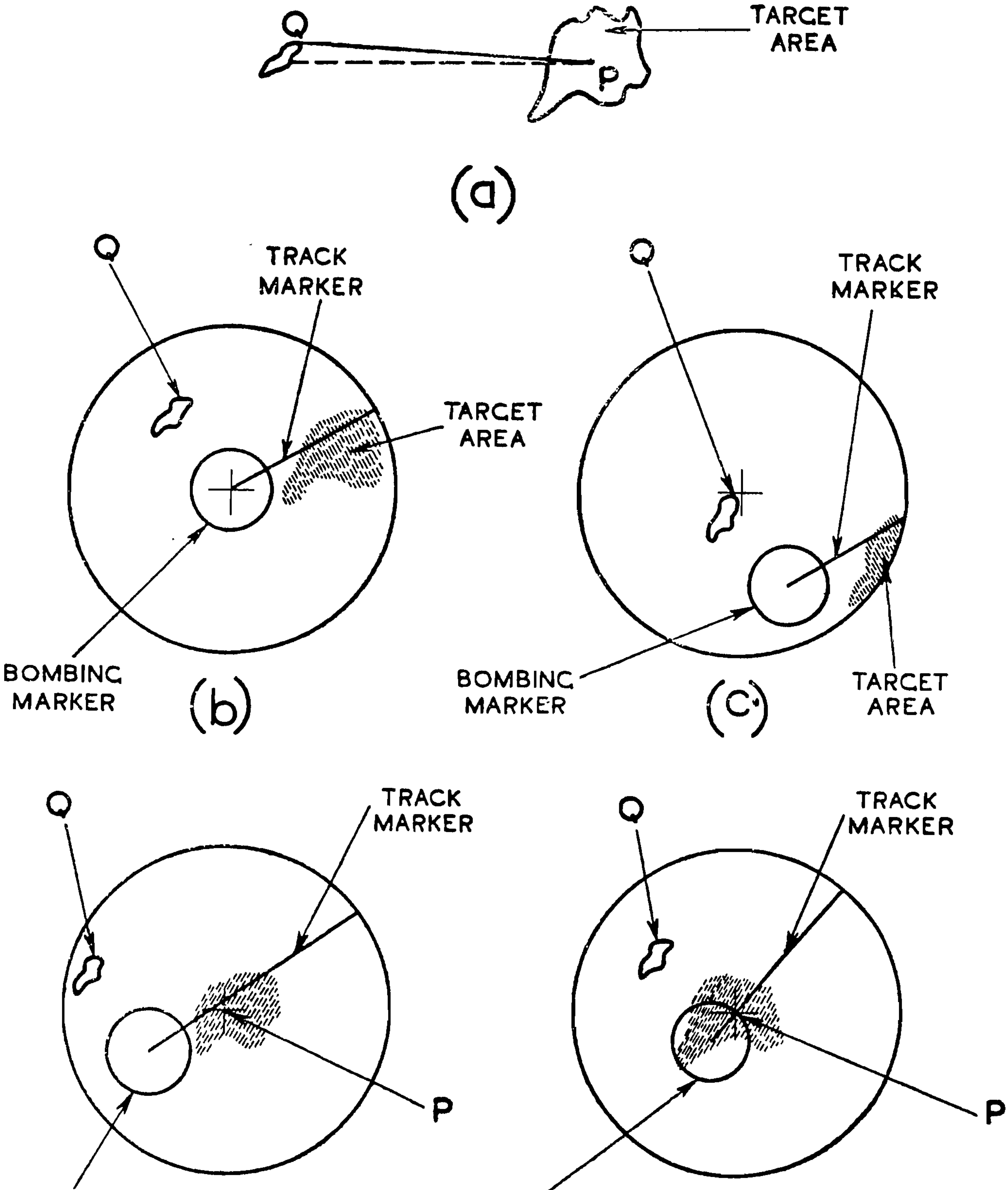


Fig. 4.—Reference point bombing

Chapter 2

GENERAL DESCRIPTION

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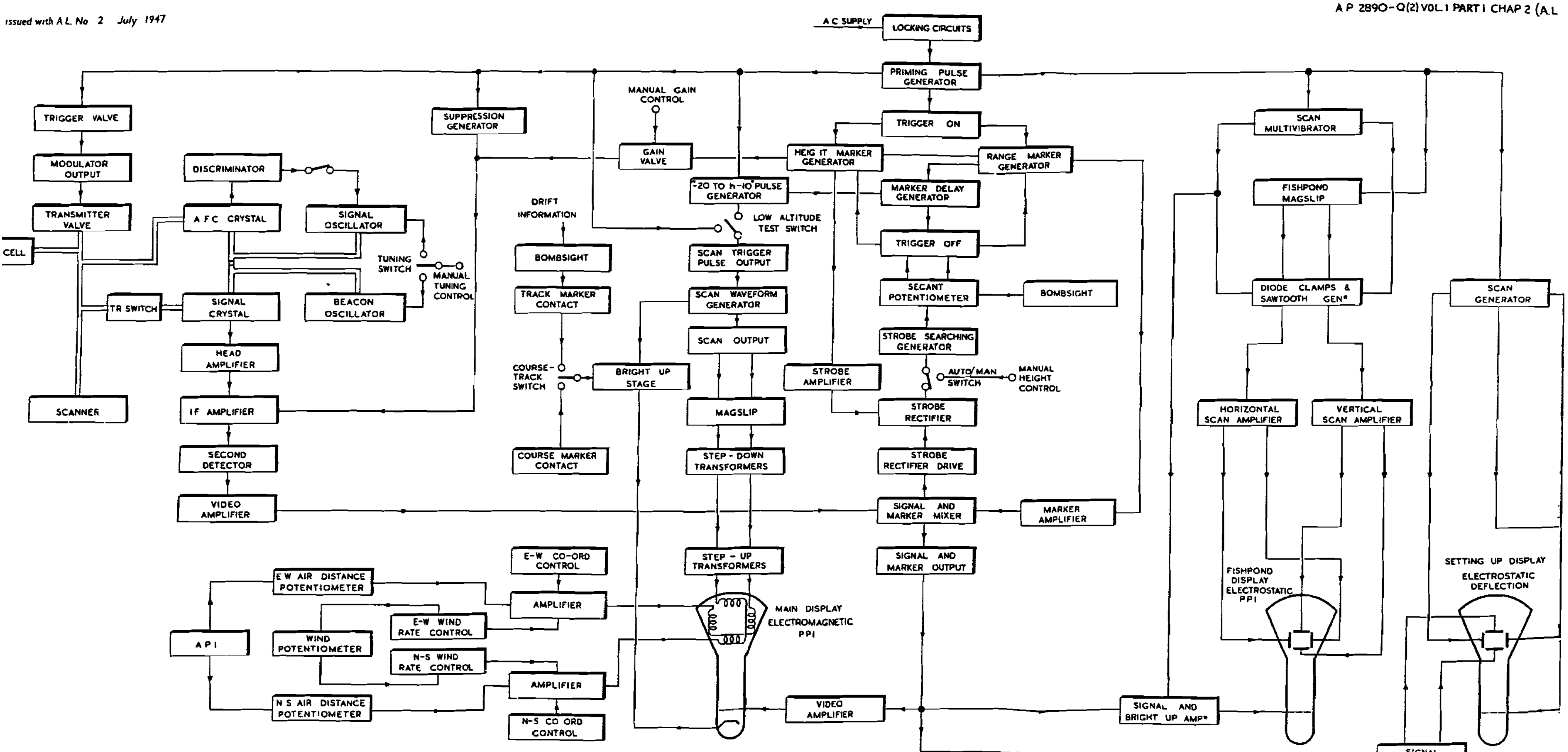

FIG. 1.— H2S MARK IVA BLOCK SCHEMATIC

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METHOD OF WORKING

Introduction

1. A brief description of the method of working of the H2S Mark IVA equipment is given in this chapter. To facilitate a conception of the equipment as a whole no reference is made to the units into which it is divided. For a full circuit description reference should be made to later chapters of this document which describe the individual units in detail.

2. Fig. 1 is a block schematic of the equipment showing the stages into which it can be divided; fig. 2 to 6 (inclusive) are simplified waveforms developed by some of these stages.

Transmitter chain

3. A multivibrator, known as the priming pulse generator, is the master timing circuit of the H2S Mark IVA equipment. A locking circuit is used to control the PRF of this multivibrator by developing a trigger pulse from the 80 V. AC supply. The locking circuit counts down from the supply frequency at a rate of two to one on the ¼, ½ and 1M ranges of the equipment, of four to one on the 2M range and of six to one for beacon operation. As the nominal frequency of the supply voltage is 2,000 c/s the PRF of the trigger pulse (and, therefore, of the multivibrator) is 1,000 p.p.s. on the ¼, ½ and 1M ranges, 500 p.p.s. on the 2M range, and 335 p.p.s. (approximately) for beacon operation. The multivibrator output consists of a 20-microsecond square wave (*fig.* 2, *inset* A); all the measuring circuits in the equipment are timed from the back edge of this priming pulse which is regarded as time "O," (*fig.*2 *et seq.*).

4. A negative 20 μs output from the priming pulse generator is fed to the modulator trigger valve and causes it to produce a high potential short duration pulse at time "O" (*fig.* 2, *inset* B). This latter pulse is used to trigger a spark gap to initiate the formation of a ½ μs* 3·6 kV modulating pulse (*fig.* 2, *inset* C) which is stepped up to 14 kV by a pulse transformer and applied to the cathode of a magnetron transmitting valve. The ½ μs* pulse of energy from the transmitting valve, at a wavelength of 3 cm. (*fig.* 2, *inset* D), is fed through a waveguide system to the scanner array.

5. The scanner array has a high azimuthal definition and the direction of maximum radiation can be set at 3 or 10 degrees down from the horizontal. The speed of revolution of the scanner can be varied betwen 30 and 60 r.p.m.(*A.L. 18*)

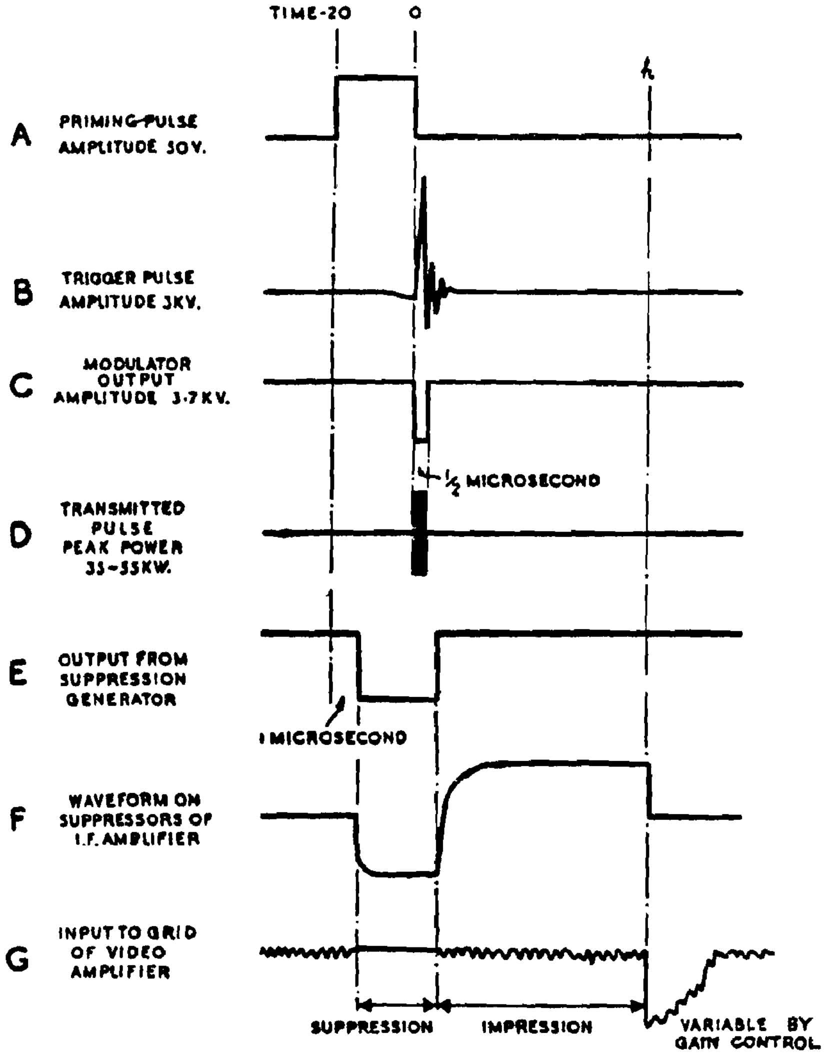

Fig. 2. Simplified waveforms (1)

Receiver chain

6. Signals received by the scanner array are fed through the TR cell to the crystal mixer. The same waveguide system is

*The length of the modulating pulse, and consequently of the transmitter pulse, is increased to 1 μs on the 2M scale and to 2½ μs for beacon operation.(*A.L.*18) used to feed the transmitter pulse to the scanner and the received signals from the scanner to the mixer. The TR cell prevents the transmitter pulse from entering the receiver branch arm of the waveguide and thus damaging the crystal mixer. An anti-TR cell prevents the returning signals from being lost in the transmitter branch arm of the waveguide. The crystal is fed with a continuous UHF oscillation from a local oscillator so that the signals are heterodyned to an intermediate frequency of 45 Mc/s.

7. The local oscillator frequency is determined by the voltage applied to its reflector and this is variable for tuning purposes. A subsidiary crystal is used to mix an attenuated output of the transmitter valve with the local oscillations and the result of this heterodyning is fed to a discriminator circuit. If the resultant frequency differs from 45 Mc/s (the correct IF) the discriminator alters the voltage fed to the reflector of the local oscillator until the intermediate frequency is correct. In this manner the difference between the local oscillator and transmitter (and, therefore, the signal) frequency is kept constant at 45 Mc/s and no signals are lost through bad tuning. A subsidiary local oscillator is provided which can be used for receiving beacon signals. Manual tuning of either of these oscillators is possible but only the signal local oscillator can be tuned automatically.

8. After two stages of IF amplification in the head amplifier the signals are fed to the main five-stage IF amplifier. The gain of the first three stages of the latter is controlled by feeding a variable voltage (—70 to 0 V.) to the suppressor grids. This voltage can only be varied by the operator after the time of reception of the first ground return. Before this time the value of the voltage fed to the suppressors is determined automatically as detailed in subsequent paragraphs.

9. An output from the priming pulse generator is fed to the suppression generator which produces a pulse similar to the priming pulse but reversed in phase and delayed by approximately one microsecond. This waveform (*fig.* 2, *inset* E) is fed to the suppressor-grids of the first three stages in the main IF amplifier, reducing the gain to zero for a period of 20 μs overlapping the transmitter pulse, and thus preventing damage to the IF amplifier due to breakthrough of the transmitter pulse. The purpose of the delay is to allow for the time lag of the transmitter pulse behind the priming pulse. A pulse from the height marker generator is fed to the gain control valve and ensures that the gain of the IF amplifier is maintained at maximum from the end of the suppression pulse until the time of reception of the first ground return (time " h ") by holding the suppressor grids at zero volts; the reason for this is given in para. 17. The combined gain and suppression waveform is shown in *fig.* 2, *inset* F.

10. The signals at the intermediate frequency are fed to a diode second detector, the video frequency output of

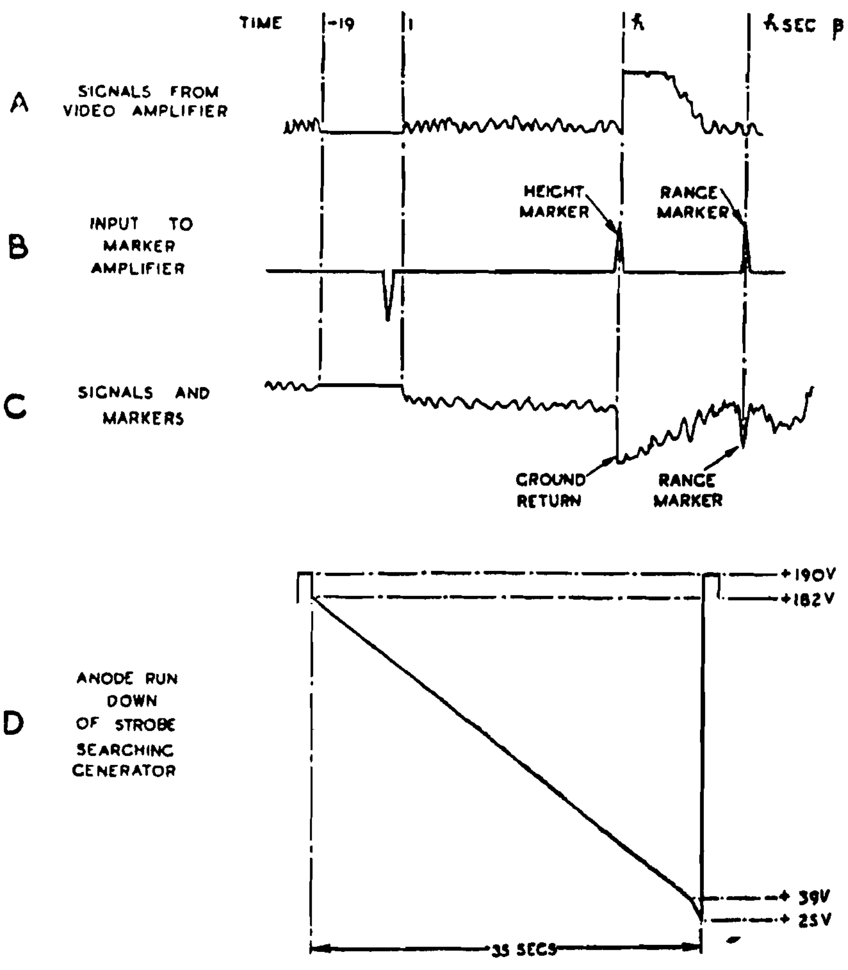

Fig. 3. Simplified waveforms (2)

which (*fig.* 2, *inset* G) is fed to a video amplifier and, thence, to the signal and marker mixer stage. The markers are mixed with the signals on the anode load of this stage which is common to the marker amplifier stage (*see* para. 14). The signals and markers (*fig.* 3, *inset* C) are fed to the strobed rectifier drive stage (*see* para. 15), and to the signal and marker output stage. Outputs from the signal and marker output stage are fed to the three display systems of the equipment. To serve the main PPI display the signals and markers are fed through a video amplifier to the grid of the CRT.

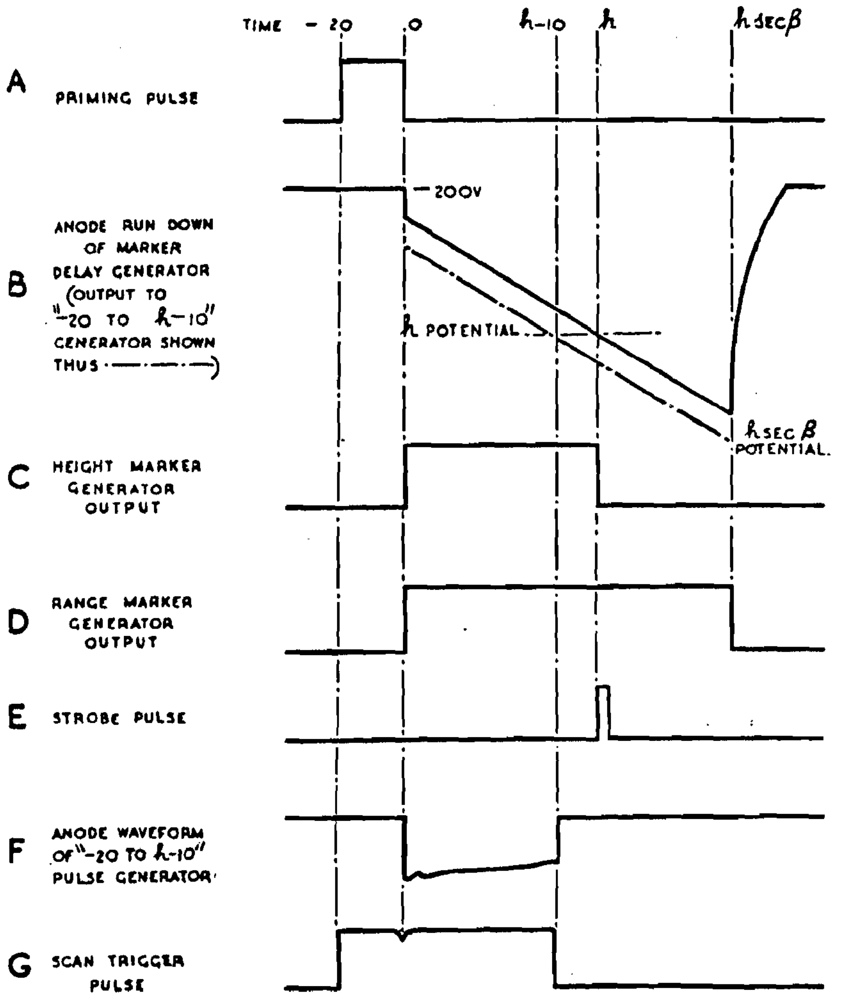

Fig. 4. Simplified waveforms (3)

Marker circuits

11. A self-triggered Miller circuit, known as the strobe searching generator, produces a linear voltage run-down on its anode (*fig.* 3, *inset* D). The value of this voltage at any instant (known as the "3h" potential) determines the time of production of the height marker. When the strobe searching generator is not affected by the strobed rectifier drive stage (*see* para. 15) the run-down of its anode voltage is such that the variation in the time of production of the height marker corresponds to a variation in height of from 3,000 ft. to 27,000 ft. during the run-down period of 35 seconds.

12. The "3h" potential is applied across the ends of a stud potentiometer having its elements graded according to a secant law. The position of the slider of the potentiometer is controlled by the bomb-sight computer so that it represents the bombing angle (β) at any instant; the voltage on the slider is consequently "h sec β." Two voltage outputs corresponding to "h" and "h sec β" are fed from the secant potentiometer to the trigger-off stage. (*A.L.18*)

13. The height and range marker generators of the H2S Mark IVA equipment consist of flip-flop circuits which are switched on by the trigger-on stage. An output from the priming pulse generator is fed to the trigger-on stage, which passes the negative back edge (corresponding to time "O") to trigger the marker generators. The generators are switched off by the combined action of the marker delay generator and the trigger-off stage. The marker delay generator is a Miller stage, the anode run-down of which is initiated by the range marker generator at the same time as the latter is triggered (that is, at time "O"). This voltage run-down (*fig.* 4, *inset* B) is fed to the cathodes of a double diode which forms the trigger-off stage. The anodes are fed with the "h" and "h sec β" voltages and are connected to the height and range marker generators. When the voltage run-down on the cathodes reaches the "h" potential one half of the diode conducts and switches off the height marker generator. The run-down continues until the "h sec β" potential is reached when the other half of the diode conducts and switches off the range marker generator. The range marker generator then terminates the run-down of the marker delay generator. The outputs from the height and range marker generators consist of positive square waves beginning at time " O " and ending at at times " h " and " h sec β " respectively (*see fig.* 4, *insets* C and D).

14. The negative square waves from the screen grids of the marker generators are fed through a delay network to the grid of the marker amplifier. The delay network differentiates the square waves to give a negative pip at time " O " and positive pips at times " h " and " h sec β " (*fig.* 3, *inset* B). The marker amplifier removes the negative pip but passes the positive pips. The anode load of the marker amplifier is common to the signal and marker mixer and consequently the markers are fed with the signals to the signal and marker output and strobed rectifier drive stages. (*see* para. 10).

15. The " O-h " positive square wave, from the anode of the height marker generator is differentiated by a delay network and fed to the strobe amplifier which produces a 0·5 μs negative pulse at time " h." This pulse (*fig.* 4, *inset* E) is applied to the strobed rectifier circuit and causes it to operate for the period of the pulse. The strobed rectifier acts as a bridge circuit, one end being fed with signals from the strobed rectifier drive stage (*see* para. 10) and the other being connected to the grid of the strobe searching generator. The bridge only conducts for the period of the strobe and, in consequence, signals arriving outside this period have no effect on the grid of the strobe searching generator. The anode run-down of the latter stage continues, and the time of formation of the strobe relative to time " O " gets later until eventually the strobe pulse renders the bridge conducting at the same time as the first ground return is fed to it from the strobed rectifier drive. The action of the circuit is then to arrest the run-down of the strobe searching generator, and the " 3h " potential at its anode will be proportional to the height of the aircraft. The strobe pulse will lock on to the front edge of the first ground return and, if the height of the aircraft varies, the strobe range will vary with it. In this manner it is assured that the height marker generator is triggered off at a time (" h ") corresponding to the height of the aircraft and similarly that the range marker generator is triggered off at a time (" h sec β ") corresponding to the slant range of the target.

16. The strobe searching generator can be controlled manually as well as by the strobed rectifier. When the AUTO/MANUAL switch is in the *manual* position the grid of the strobe searching generator is disconnected from the strobed rectifier and fed instead with a variable voltage from the manual height control. This voltage will determine the voltage at the anode of the strobe searching generator, and consequently the time of formation of the height marker. In the event of a fault in the strobed rectifier the manual height control can be used by the operator to set the height marker on the first ground return.

17. It is essential to ensure that the gain of the IF amplifier is at maximum from the end of the suppression pulse until time " h " so that the first ground return may be as large as possible for the strobe to lock on. This is achieved by feeding a positive " O-h " pulse from the height marker generator to the gain valve which holds the suppressor grids of the first three IF stages at zero volts for the period of the pulse.

Timebase circuits

18. The " O-h sec β " range marker generator pulse, used to switch the marker delay generator on and off, is fed by the latter stage to the " —20 to h-10 " pulse generator. The anode run-down of the marker delay generator is DC-restored to a level 10 V. below its original value and fed to the cathode of a diode, the anode of which is held at the " h " potential and coupled to the grid of the " —20 to h-10 " pulse generator. Due to the change in the DC level of the run-down waveform a potential corresponding to time " h " at the anode of the marker delay generator will correspond to a time " h-10 " at the cathode of the diode. Thus the " —20 to h-10 " pulse generator is switched on at time " O " by the " O-h sec β " pulse and off at time " h-10 " when the run-down at the cathode of the diode enables it to conduct and so to cut off the generator. The resulting " O to h-10 " pulse at the anode of the generator is mixed with an output from the priming pulse generator to produce a " —20 to h-10 " pulse. The 10 μs time advance is introduced to allow for delays in the scan-generating circuits so that the actual trace on the PPI tube will start at time " h."

19. The " —20 to h-10 " pulse (*fig.* 4, *inset* F) is fed to the scan trigger pulse

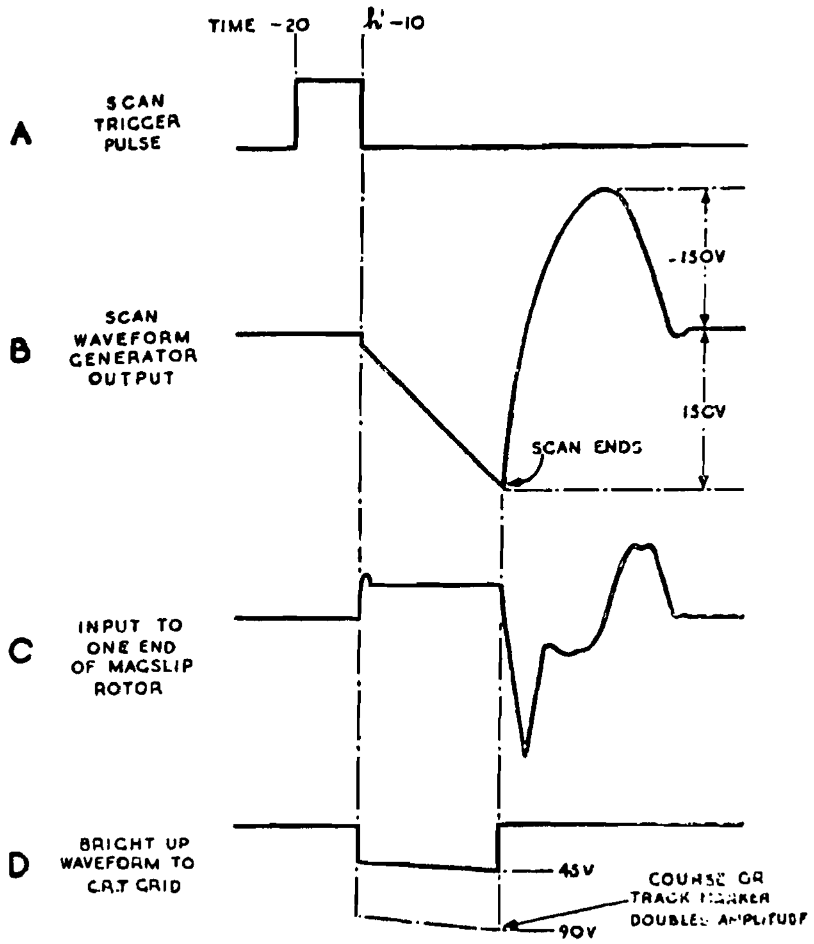

Fig. 5. Simplified waveforms (4)

output stage and thence to the scan waveform generator. For test purposes, instead of the "—20 to h-10" pulse, an output from the priming pulse generator can be fed to the scan trigger pulse output stage. This procedure is used for setting-up as the PPI trace will start at time "O" and the timing of the height marker can be checked on the PPI.

20. The scan waveform generator produces a timebase waveform which commences at time "h-10" and is corrected for height, so that, although the equipment measures slant range, true ground range is displayed on the PPI. By switching circuit components the duration of the scan waveform can be varied to give timebases corresponding to the ¼, ½, 1 and 2M map scales.

21. The scan waveform (*fig.* 5, *inset* B) is fed to the scan output stage where it is converted to a current waveform and fed to the rotor of the magslip in the scanner (*fig.* 5, *inset* C). The output from the magslip stators consist of current waveforms similar to those at the input to the rotor but modulated in quadrature at the aerial rotation frequency. These outputs are stepped-down in amplitude by transformers to decrease distortion arising in the cable which feeds them to the indicator. The waveforms are stepped-up in amplitude by transformers in the indicator and applied to the deflection coils of the PPI to produce a rotating radial timebase.

22. The CRT used as the plan position indicator employs electro-magnetic deflection and electrostatic focusing. A negative square wave (*fig.* 5, *inset* D) from the scan waveform generator is fed to the cathode of the CRT and brightens up the tube for the duration of the working stroke of the timebase scan.

Course and track markers

23. Constant north heading of the PPI is obtained by means of the DR compass repeater motor which adjusts the setting of the magslip stators. When the scanner passes through the dead-ahead position the course marker contact closes and alters the bright-up circuit of the PPI so that at least one radial timebase is brightened (*fig.* 5, *inset* D). Thus, the course of the aircraft appears as a radial marker on the PPI.

24. On the scanner, a second contact, known as the track-marker contact, is variable in position up to ± 40 degrees about the position at which the course marker contact closes. The position of the track-marker contact is determined by the bombsight computer so that the angle between it and the course marker is equal to the drift of the aircraft. The bombsight computer automatically determines drift having previously had wind information set into it. The track marker is displayed on the PPI in the same way as the course marker, the desired marker being selected by a switch. (*A.L. 18*)

25. Normally the position of the course and track markers is automatically determined by the DR compass and bombsight respectively. Manual control of the markers for setting-up purposes is provided by a hand-operated M type transmitter and a three position switch labelled "SET COURSE," "NORMAL," and "SET TRACK."

Stabilised display circuits

26. The air position indicator Mark IA supplies information, in the form of M-type transmissions, on the air miles travelled in N-S and E-W components. When the stabilised picture is switched on, the wipers of two potentiometers, which are connected across a ± 40 V. stabilised supply, are driven by two M-type motors connected to the API drive. One potentiometer is associated with the N-S component, and the other with the E-W component, of the air miles travelled. In their *rest* positions the wipers are at zero volts and, when driven, rotate in a negative or positive direction (in terms of voltage) depending on whether the API drive is N or S and E or W. Thus the voltages on the wipers are proportional to the air miles travelled on cardinal headings from the reference time at which the stabilized picture was switched on.

27. The air miles voltages are fed to two DC-shift amplifiers which convert the voltages to currents and feed them to the deflection coils of the PPI. A voltage input to one amplifier results in an E-W or horizontal shift of the picture and to the other, in a N-S or vertical deflection of the picture. The voltage limits on the air-miles potentiometers and other circuit components are so chosen that there is an exact correspondence between the air miles travelled as recorded by the API and the shift of the PPI picture.

28. To allow for wind, which must be done in the form of wind miles travelled, additional voltages must be fed to the shift amplifiers. These voltages are obtained as follows. A double ganged potentiometer known as the " wind miles " potentiometer, has a pair of wipers driven at the same speed by a constant-speed ratchet motor. The potentiometer is connected across a balanced supply and the junction point of its two elements is earthed. In their *rest* positions both wipers are at the junction point of the two elements and are consequently earthed. When the stabilized picture is switched on, the ratchet motor rotates and drives one wiper in a negative direction (in terms of voltage) and the other in a positive direction ; at any instant the voltages on the wipers are balanced about earth. At the end of 5 minutes the ratchet motor has driven the wipers to the limits of their travel and the voltages on them will be + 20 V. and —20 V. If the voltages on the wipers were fed to the DC shift amplifiers the variation of from 0 to + 20 V. and from 0 to —20 V. would cause the picture to shift by an amount corresponding to the drift experienced by the aircraft for 5 minutes with a wind the components of which were 100 knots. Actually two wire-wound potentiometers, known as the " wind rate " potentiometers are connected in parallel across the wipers of the wind-miles potentiometer. The wind-rate potentiometers are calibrated in knots from 0 to 85 in both directions about their mean positions. The position of the wipers is controlled by the operator and the voltage outputs from them are fed to the DC-shift amplifiers, thus causing N-S and E-W shifts. When the wipers of these potentiometers are in their central positions there will be no output to the shift amplifiers as the ratchet motor rotates, since the voltages at each end of the potentiometers are balanced about earth. At any other setting the wipers pick off positive or negative fractions of the varying voltage from the wind-miles potentiometer. These voltages, when applied to the shift amplifiers consequently shift the PPI picture by a fraction of the shift which would be caused by the wind-miles potentiometer. By a suitable choice of circuit components it is arranged that the shift corresponds to the drift of the aircraft due to a wind having the N-S and E-W components which provide the settings of the potentiometers. (*A.L. 18*)

29. If the correct wind components are set up on the wind-rate controls the shift introduced by the wind-miles and air-miles voltages will oppose the motion of the PPI due to the aircraft ground speed to give a stabilized picture. This stabilized picture can only be maintained for a maximum of 5 minutes as, by the end of that time, the wipers of the wind-miles potentiometer will have reached the end of their run. The duration may be shorter if the airspeed is large as, then, the wiper of one of the air-miles potentiometers may reach the end of its travel in less than 5 minutes. In any event the wiper first reaching the end of its run will spring back to its *rest* position at the same time resetting all the other wipers. An orange warning lamp lights up when any one of the wipers is approaching the end of its travel. The maximum warning time is 30 seconds, the minimum 15 seconds, if the airspeed never exceeds 400 knots.

30. Two other variable voltages are fed to the DC-shift amplifiers from the co-ordinate shift controls. These controls are calibrated in nautical miles and enable the PPI picture to be shifted by any known distance.

Fishpond

31. The Fishpond scan is produced independently of the main timebase. The 20 μs priming pulse is fed to the rotor of a second magslip on the scanner. In this manner sin θ and cos θ voltages (θ being the azimuth angle of the scanner) are obtained from the stators; the stators are fixed with respect to the aircraft so that the top of the Fishpond display always represents the aircraft heading.

32. Another output from the priming pulse generator is used to trigger a scan multivibrator producing positive and negative square waves, the leading edges of which occur at time " O " (*fig.* 6, *inset* B). The duration of these square waves is fixed by a scan-length control to approximately 62 μs, corresponding to a 5 nautical miles timebase. The square waves control an arrangement of diodes, one for each axis, which clamp the sawtooth generating circuits in the intervals between the priming pulses. At time " O " the square waves unclamp the diodes allowing the sawtooth generating circuits to charge up from the sin θ and cos θ voltages from the magslip stators. The sawtooth waveforms are fed to a pair of cathode-coupled push-pull amplifiers, the paraphase outputs (*fig.* 6, *inset* C) from which are applied to the deflection plates of the CRT to give a rotating timebase synchronised to the scanner rotation. Shift voltages are applied to the grids of one valve in each pair of scan amplifiers to allow the picture to be moved horizontally and vertically over the tube face.

33. Signals from the signal and marker output stage (*see* para. 10) and a bright-up waveform developed from an output of the scan multivibrator are fed to a signal and bright-up amplifier. The resultant output of the latter stage (*fig.* 6, *inset* D) is fed to the grid of the CRT giving an intensity-modulated presentation of signals received at ranges less than the height of the aircraft. The signals displayed will always be at maximum amplitude since the receiver gain is automatically at maximum until time " h " (*see* para. 17).

Setting up display

34. The priming pulse is used to trigger a scan generator

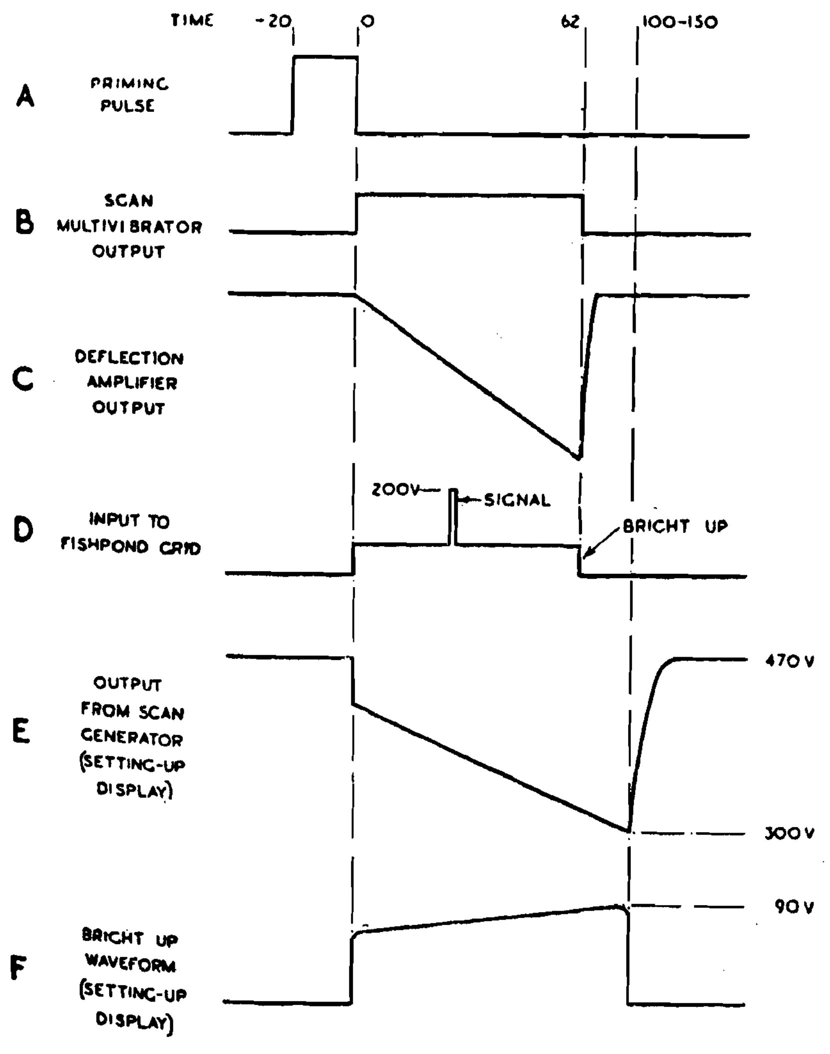

Fig. 6. Simplified waveforms (5)

the paraphase outputs from which are fed to the X plates of a small CRT. The timebase scan thus produced has a length corresponding to a range of 8 nautical miles (*fig.* 6, *inset* E). The scan generator also feeds a square wave (*fig.* 6, *inset* F) to the grid of the CRT which brightens up the working stroke of the timebase.

35. Signals are fed from the signal and marker output stage to a cathode-coupled amplifier whose paraphase outputs are fed to the Y plates of the CRT. Signals and markers consequently appear as deflections of the straight line timebase.

36. The AUTO/MANUAL switch and manual height control which are described in para. 16 are mounted on the main PPI indicator which is not near the receiver in the aircraft. The indicator containing the setting-up display is mounted near the receiver and provides duplicate controls for use when setting-up the latter unit. A LOCAL/REMOTE switch enables either set of controls to be brought into use.

UNITS

General

37. The Table 1, included herein, sets out the component units of the H2S Mark IVA (ARI.5715) installation.

TABLE 1
Component units of H2S Mark IVA

Unit	Stores Ref.	Remarks
Modulator unit, Type 196/WW ...	10DB/8185	
Transmitter-receiver, Type TR.3523E	10DB/8706	Universal unit with AFC
Scanning unit, Type 109	10BB/6922	
Control unit, Type 565A	10LB/6343	Scanner speed and tilt control unit
Receiver, Type R.3647 .... *including*	10DB/8573	
Receiving unit, Type 153A	10DB/8456	Universal 45 Mc/s IF strip
Control unit, Type 455A	10LB/6336	For use with bombsight Mark XIV
Indicating unit, Type 300	10QB/6492	Main indicator
Waveform generator, Type 61	10VB/6226	
Computer	10DB/8463	
Control unit, Type 552	10LB/6313	
Air position indicator Mark IA	6B/278	See A.P.1275 B, Vol. I, Sect. 1, Chap. 5
Control unit for API	6B/310	
Indicating unit, Type 188A	10QB/6442	Fishpond indicator
Indicating unit, Type 277	10QB/6429	Used mainly for setting-up purposes
Power unit, Type 567D	10DB/8794	2 off
Transformer unit, Type 166A	10KB/6330	
Jack unit, Type 51 ... . *or*	10H/18302	2 off ; for measuring power supplies
Jack unit, Type 51A	10H/18355	2 off ; for measuring power supplies
Junction box, Type 341	10DB/8806	
Junction box, Type 325	10DB/8571	
Junction box, Type 326	10DB/8572	
Tubular feeder, Type 205	10BB/8001	For connecting TR.3523E to the scanner
Tubular feeder, Type 72 *or*	10AB/6373	For connecting TR.3523E to the scanner
Tubular feeder, Type 72A	10AB/8556	For connecting TR.3523E to the scanner
Aircraft connector set, Type ARI.5715/FU	10HA/7694	| (*A.L.18*)

CONTROLS

Modulator unit, Type 196/WW

Pre-set controls

40. The following pre-set controls are provided :—

(1) Modulator power pack switch (EHT ON/OFF). This switch is used to switch off the EHT circuits when servicing but must be left in the *on* position.

(2) Lock switch (INTERNAL/EXTERNAL LOCK). This switch enables the priming pulse generator to be triggered by the stabilized PRF circuits in the modulator or by an external locking pulse. The switch must be in the *external lock* position when the unit is used in H2S Mark IVA.

(3) Pulse length control. The variable resistor RV4 (ADJUST 20 μs) controls the length of the priming pulse.

(4) Overload adjustment. The variable resistor RV5 controls the current which can be passed by the EHT rectifier before the overload relay operates.

(5) Stabilized PRF controls. The variable resistors RV1 (ADJUST 350), RV2 (ADJUST 850-950-1,200), and RV3 (ADJUST 600) control the p.r.f. of the modulator internal locking circuits. As these circuits are not used in H2S Mark IVA the settings of these controls are not important.

(6) Free PRF control. When the modulator is switched to *external lock* but no locking pulse is fed to the unit, RV6 (FREE PRF) can be used to control the PRF of the priming pulse generator if link 3 is in the *cont.* position. The setting of this control is not important in H2S Mark IVA as link 3 is in the *lock* position.

(7) Modulator output power. The 80V taps on the EHT transformer must be set for minimum output.

Links

41. Six links are incorporated in the modulator circuit.

(1) Links 1 and 2 control the various stabilized frequencies of the internal locking circuits. The positions of the links are not important in H2S Mark IVA.

(2) Link 3 must be in the *lock* position for internal or external locking of the modulator. When the INTERNAL/EXTERNAL switch is in the *external lock* position, but there is no locking pulse and link 3 is in the *cont.* position, the PRF of the priming pulse generator is controlled by the FREE PRF control. For use in H2S Mark IVA link 3 must be in the *lock* position.

(3) Link 4 enables a meter to be connected in series with the EHT power pack so that the overload adjustment can be set correctly. The link must be closed for normal operation of the modulator.

(4) Link 5 must be closed (*Var. PL* position) for use in H2S Mark IVA. If it is left open (½ *μs only* position) the pulse length will remain ½ μs when switching to the 2M scale instead of increasing to 1 μs.

(5) Link 6 is in parallel with R50 in the external —4kV DC supply ; its position is not critical in H2S Mark IVA as this supply is not used.

Transmitter-receiver, Type TR.3523E

Pre-set controls

42. There are eleven pre-set controls on this unit.

(1) Function switch. This switch selects the local oscillator in use and the method of tuning. When the switch is in the *manual* position the frequency of the signal oscillator is controlled by the manual tuning control on the unit. In the *AFC* position the frequency of the signal oscillator is determined by the output of the discriminator circuit. In the *beacon* position the frequency of the beacon oscillator is controlled by the manual tuning control. The *remote* position of the switch enables the above switching arrangements to be made from control unit, Type 565A. For operation in the aircraft this switch must be left in the *remote* position.

(2) Manual tuning control (R71). This control can be used for setting up purposes when the function switch is in the *manual* or *beacon* positions.

(3) Discriminator output control. Resistor R38 is used to adjust the voltage output from the discriminator to the signal oscillator when the latter is on tune.

(4) Discriminator cathode bias control. Resistor R75 is used to ensure that the discriminator cuts off the sweep valve when the latter has brought the IF within the range 43-47 Mc/s.

(5) Oscillator HT control. Resistor R58 is used to set the resonator-cathode voltage of the local oscillators.

(6) Signal oscillator mechanical tuning.

(7) Beacon oscillator mechanical tuning.

(8) Anti-TR cell tuning plunger.

(9) TR cell tuning.

(10) SIGNAL crystal current control.

(11) AFC crystal current control.

Links

43. There are two links in the circuit of TR.3523E.

(1) The —100V/—150V bias supply link which must be in the —150V position.

(2) The C relay shorting link in the magnetron filament supply circuit which must be open.

Scanning unit, Type 109

Pre-set control

44. The marker phasing control must be set so that the course marker brightens up the trace on indicating unit, Type 300 when the scanner passes through the electrical dead-ahead position.

Control unit, Type 565A

Operator's controls

45. The following operator's controls are provided :—

(1) SCANNER SPEED control. This determines the DC supply fed to the armature winding of the scanner driving motor.

(2) SCANNER TILT control. In the *normal* position of this switch the direction of maximum radiation from the scanner is set at 3 degrees below the horizontal; in the *down* position it is fixed at 10 degrees below the horizontal. The *up* position is not used.

(3) Tuning switch. In the *manual* position of this switch the signal oscillator can be tuned by means of the tuning control on this unit. In the *beacon* position the beacon oscillator can be tuned using the same control. In the *AFC* position the frequency of the signal oscillator is determined by the discriminator circuits.

Note . . .

This control is not operative if the function switch on TR.3523E is not in the " remote " position.

(4) Tuning control (TUNE). This control determines the frequency of the signal oscillator when the tuning switch is in the *manual* position or the frequency of the beacon oscillator when the tuning switch is in the *beacon* position.

Links

46. The links in this unit must be in position for scanning unit, Type 109.

Receiver, Type R.3647

Pre-set controls

47. The following pre-set controls are provided :—

(1) LOW ALTITUDE TEST switch. This enables the scan to be triggered from the back edge of the priming pulse instead of the " —20 to h-10 " pulse. In this way signals occurring before time " h " can be displayed on the PPI. The switch must be left in the *normal* position.

(2) SET DRIFT RATE. This button must be pressed when adjusting the DRIFT RATE control.

(3) DRIFT RATE control. Resistor VR4 is adjusted to give the correct rate of sweep of the strobe circuits.

(4) HEIGHT ZERO control (VR2). This is used to ensure that the height marker generator triggers off at the correct time.

(5) HEIGHT RATE control (TC1). This controls the rate of run-down of the marker delay generator and consequently affects the timing of the markers and the scan triggering time.

(6) SET RANGE ZERO. This button must be pressed when adjusting the RANGE ZERO control.

(7) RANGE ZERO control (VR3). This is used to ensure that the range marker generator triggers off at the correct time.

(8) MAX. GAIN control (VR1). This control must be set so that when the manual GAIN control (indicating unit, Type 300) is at maximum the ratio of maximum signals to noise is 2 : 1.

(9) MARKER AMPLITUDE control. Resistor VR5 controls the bias on the grid of the marker amplifier.

(10) 10 μs DELAY potentiometer (VR6). This control is set so that the timebase on indicating unit, Type 300 starts at the correct instant.

Indicating unit, Type 300

Operator's controls

48. There are seven operator's controls on this unit.

(1) BRIGHTNESS control (RV14).

(2) GAIN control (RV7). This control determines the gain of the IF amplifiers after the time of reception of the first ground return.

(3) SCALE switch. This switch selects the scale of the PPI display and has four positions which give PPI displays corresponding to the ¼M, ½M, 1M, and 2M map scales.

(4) COURSE/TRACK switch. This enables either the course or track marker to be displayed.

(5) Stabilization switch (COMPR. ON/OFF). This switch enables the operator to select a moving or stabilized PPI picture.

(6) AUTO/MANUAL switch. In the *auto* position of this switch the height marker locks on the first ground return. In the *manual* position the position of the height marker is determined by the MANUAL HEIGHT control.

(7) MANUAL HEIGHT control (RV8). This control determines the position of the height marker when the AUTO/MANUAL switch is in the *manual* position. It can be used for setting up or in the event of failure of the height marker locking circuits.

Note . . .

The "auto/manual" switch and "manual height" control are not operative when the "local/remote" switch on indicating unit, Type 277 is in the "remote" position.

Pre-set controls

49. The following pre-set controls are provided :—

(1) FOCUS (RV13).

(2) CONTRAST (RV16).

(3) ¼M CENTRE BALANCE (RV2). This control determines the pivot point of the timebase along its length on the ¼M scale.

(4) ½M CENTRE BALANCE (RV3). This control determines the pivot point of the timebase along its length on the ½M and 1M scales.

(5) CENTRE N-S control (RV9). Vertical shift control for centring the PPI picture.

(6) CENTRE E-W control (RV10). Horizontal shift control for centring the PPI picture.

(7) N-S SENSITIVITY control (RV11). Vertical sensitivity control affecting the shift amplifiers.

(8) E-W SENSITIVITY control (RV12). Horizontal sensitivity control affecting the shift amplifiers.

(9) SCAN MATCHING control (RV18). This control is provided to remove any irregularities in the timebase due to unequal coupling between the magslip rotor and the two stators.

(10) ¼M CORRECTION control (RV1). Set so that the correct amount of distortion is introduced into the linear scan on the ¼M scale.

(11) ½M CORRECTION control (RV17). Set so that the correct amount of distortion is introduced into the linear scan on the ½M and 1M scales.

(12) ¼M SCALE SET control (RV6). Used to obtain the correct scale on the PPI for the ¼M scale.

(13) ½M SCALE SET control (RV5). Used to obtain the correct scale on the PPI for the ½M scale.

(14) 1M SCALE SET control (RV4). Used to obtain the correct scale on the PPI for the 1M scale.

(15) HUM ADJUST (RV5). This control is used to reduce ripple on the scan waveform.

Computer

Pre-set controls

50. There are five pre-set controls in the computer, but only two of these must be adjusted under normal maintenance conditions.

(1) WIND RATE control (RV1). Used to control the speed of the ratchet motor which drives the wind potentiometer.

(2) SHIFT VOLTAGE control (RV2). Used to ensure that the correct voltage is applied across the air distance and wind potentiometers.

Note . . .

The resistors RV3, RV6, and RV7 must not be adjusted unless the air distance or wind potentiometers are changed.

Control unit, Type 552

Operator's controls

51. The following operator's controls are provided :—

(1) N-S WIND KNOTS control (RV1). Controls the amount of vertical PPI shift due to wind.

(2) E-W WIND KNOTS control (RV2). Controls the amount of horizontal PPI shift due to wind.

(3) N-S CO-ORD control (RV4). Calibrated vertical shift control.

(4) E-W CO-ORD control (RV5). Calibrated horizontal shift control.

(5) SET COURSE/NORMAL/SET TRACK switch. In the first position of this switch the position of the course marker can be adjusted by means of the COURSE/TRACK ALIGNMENT control on this unit and in the third position the position of the track marker can be adjusted using the same control. In the *normal* position of the switch the position of the course marker is determined by the DR compass and that of the track marker by the bombsight computer.

(6) COURSE/TRACK ALIGNMENT control. This control is used to adjust the position of the course and track markers when the SET COURSE/NORMAL/SET TRACK switch is in the *set course* and *set track* positions respectively.

(7) TRANSMITTER ON/OFF switch. Due to a delay in the +330V supply from the computer to the modulator this switch is not operative until three minutes after the 80V AC supply to the equipment has been switched on.

(8) ILLUMINATION switch. This switch controls the brightness of the dial lamps on the unit.

Pre-set controls

52. The resistors RV3 and RV6 must not be adjusted unless a co-ordinate shift or wind rate potentiometer is changed.

Indicating unit, Type 188A

Operator's control

53. The BRIGHTNESS control (VR506) is the only operator's control on this unit.

Pre-set controls

54. The following pre-set controls are provided :—

(1) FOCUS (VR507).

(2) SCAN TIME (VR500). Controls the length of the timebase scan.

(3) H CENTRE (VR503). Horizontal shift control.

(4) V CENTRE (VR504). Vertical shift control.

(5) H SCALE (VR505). Controls the gain of the horizontal scanning amplifier.

(6) V SCALE (VR502). Controls the gain of the vertical scanning amplifier.

(7) CONTRAST (VR501).

(8) HUM BALANCE (VR510). Set for minimum hum on the scan waveform.

Note . . .
The "H centre balance" (VR509) and "V centre balance" (VR508) controls are not used when this unit is used in H2S Mark IVA ; they must be locked in their maximum anti-clockwise positions.

Links

55. The links in this unit must be in the H2S Mark IVA position.

Indicating unit, Type 277

Pre-set controls

56. Some of the controls listed below are not actually pre-set but are listed under this heading because they are not used by the operator in flight.

(1) LOCAL/REMOTE switch. In the *remote* position of this switch the height marker circuits are under the control of the AUTO/MANUAL switch on indicating unit Type 300 and the AUTO/MANUAL switch on this unit has no effect. In the *local* position of the switch the height marker circuits are under the control of the AUTO/MANUAL switch on this unit. The LOCAL/REMOTE switch is designed to enable the receiver controls to be set up while using indicating unit, Type 277 as a monitor ; for operation in flight the switch must be left in the *remote* position.

(2) AUTO/MANUAL switch. This switch is operative only when the LOCAL/REMOTE switch is in the *local* position. When it is in the *manual* position it enables the position of the height marker to be adjusted, using the MANUAL HEIGHT control on this unit.

(3) MANUAL HEIGHT control (VR4). This control can be used to adjust the position of the height marker when the LOCAL/REMOTE switch is in the *local* position and the AUTO/MANUAL switch in the *manual* position.

(4) SCAN TIME (VC1). Controls the length of the timebase scan.

(5) GAIN (VR1). Controls the gain of the signal amplifier.

(6) BRIGHTNESS (VR3).

(7) FOCUS (VR2).

Waveform generator, Type 61

Pre-set controls

57. The following pre-set controls are provided :—

(1) Counting-down switch. This switch controls the rate of counting down from the supply frequency on the ¼M, ½M, and 1M ranges. When the switch is open the PRF of the locking pulse on these ranges is 2,000 p.p.s. and when the switch is closed it is 1,000 p.p.s.; the switch must be kept closed for operation in H2S Mark IVA.

(2) Counting-down rate. Potentiometer VR2 must be set so that the circuit counts down by four-to-one on the 2M scale and by six-to-one or beacon operation within the frequency limits of the AC supply.

(3) +150V adjustment (VR1).

Power units, Type 567D

Pre-set controls

58. The following adjustments are provided :

(1) —150V adjustment (RV1).

(2) +200V adjustment (RV2).

Links

59. There are two links in each power unit.

(1) 330V supply link. This link must be in the intermediate current (360V) position for use in H2S Mark IVA.

(2) The EHT link must be in position 1 in both units. Power unit No. 1 will then deliver a —4 kV supply but some re-arrangement of the circuit in power unit No. 2 is necessary before the +4 kV supply can be obtained.

POWER SUPPLIES

60. Two motor driven generators, Type 4B which are fed with aircraft's 24V DC supply develop two 2 kW supplies at 80V, 2,000 c/s. The two independent supplies are fed, via two control panels, Type 11, to a switch box at the operator's position, where either supply can be switched to the H2S equipment. The selected 80V AC supply and the aircraft's 24V DC supply are fed to junction box, Type 341 where they are distributed to the other units of the equipment; the units contain their own filament transformers. The 24V DC supply is also fed to junction box, Type 325.

61. The 80V supply is fed from the junction box through two jack units, Type 51A to two power units, Type 567D. These units develop all the HT and EHT supplies for the equipment apart from an EHT power pack in the modulator, a 300V power pack in transmitter-receiver, Type TR.3523E, and a ± 150V power pack in waveform generator, Type 61. The HT outputs from the power units are fed back through the jack units to the junction box where they are distributed to the other units. The EHT supplies of +4 kV and —4 kV for the CRT's in indicating units, Type 300 and 188A are fed directly from the power units to the units concerned.

62. A test point on the junction box enables the 80V AC and 24V DC supplies to be checked. The nominal values of the HT supplies from the power units are :— +550V, +330V, +200V, ± 100V (floating), —150V and —300V DC, and these can be checked by means of jacks provided on the jack units.

63. The modulator power pack develops the 3·5 kV supply for the modulating pulse and is controlled by an on/off switch on control unit, Type 552. Delay circuits in the modulator and computer prevent this supply from being switched on until 3 minutes after the main HT supplies have been switched on.

64. The 300V power pack in transmitter-receiver, Type TR3523E is used to supplement the 330V supply from the power units to obtain the correct operating voltages for the klystron local oscillators.

65. The power pack in waveform generator, Type 61 is used to provide $\pm$ 150V supplies for use in indicating unit, Type 300. The shift circuits in the indicator require more current at these voltages than can be obtained from the power unit supplies.

66. Details of the distribution of the power supplies and other inter-connections between the H2S Mark IVA units can be seen from fig. 7.

INSTALLATION IN LINCOLN AIRCRAFT

67. The layout of the H2S Mark 4A units in a Lincoln aircraft is shown in fig. 8. It can be seen that the equipment is split up in the following manner :—

(1) The bombsight control unit (Control unit, Type 455A) which is attached to the bomb sight Mark XIV in the nose of the aircraft.

(2) The radar operator's units which include indicating unit, Type 300, control units, Type 565A and 552, and the API forward of former 1.

(3) Indicating unit, Type 188A which is mounted in front of the radio operator.

(4) Those units associated directly with the scanner which are mounted in the scanner well. These comprise transmitter-receiver, Type TR3523E, transformer unit, Type 166A and junction box, Type 325.

(5) Those units remaining which are not required to be under the control of a member of the crew during flight are contained in a crate between formers 12 and 19.

68. Fig. 9 is a cable connector diagram of the H2S Mark IVA equipment showing the positions of the plugs and sockets on the units. It should be noted, however, that the lengths of the cables are not drawn to scale. Details of the connectors are given in Table 3.

38. The following equipment is associated with the ARI.5715 installation :—Bombsight Mark XIV
Camera, Type F60 or camera, Type F67

39. The location of the stages of the equipment described in para. 3 to 36 can be seen by reference to Table 2.

TABLE 2

Location and function of stages

Name of stage	Location		Type of circuit	Outputs
	Unit	Valves		
Locking circuit	Waveform generator	V1 (VR91) V4 (VR91) V6 (VR91) V8 (VR91)	Amplifier Miller valve Amplifier Cathode follower	Locking pulse to priming pulse generator. PRF is normally 1,000 p.p.s., but is reduced to 500 p.p.s. on the 2 M range and to 335 p.p.s. for beacon operation.
Priming pulse generator	Modulator	V3 (6SN7) V6 (6AG7)	Multivibrator	20 μs priming pulse to the trigger valve, suppression generator, trigger-on, Fishpond scan multivibrator, setting-up display scan generator, " —20 to h-10 " pulse generator, and scan trigger pulse output stages. (The last-named in the low altitude test position only).
Trigger valve	Modulator	V9 (CV276)	Ringing circuit	High voltage ring to the modulator output stage.
Modulator output	Modulator	V3 (CV6008)	Spark gap and artificial line	—3·7 kV. $\frac{1}{2}$ μs pulse to the transmitter pulse transformer which steps it up to —14 kV. and feeds it to the transmitter valve Length of pulse increased to 1 μs on the 2M scale and to $2\frac{1}{4}$ μs for beacon operation. (*A.L. 18*).
Transmitter valve	Transmitter-receiver	V14 (725A)	Magnetron	UHF pulse to the aerial array.
Aerial array	Scanner			UHF pulse transmitted, signals received.
Anti-TR cell	Transmitter-receiver	V20 (CV115)	Spark gap	
TR cell	Transmitter-receiver	V17 (CV221)	Spark gap	
Signal crystal	Transmitter-receiver	V21 (CV253)	Mixer	Signals at IF to head amplifier.

Name of stage	Location		Type of circuit	Outputs
	Unit	Valves		
Signal oscillator	Transmitter-receiver	V19 (723A/B)	Klystron oscillator	Continuous oscillation to the signal and AFC crystals.
Beacon oscillator	Transmitter-receiver	V18 (723A/B)	Klystron oscillator	Continuous oscillation to the signal crystal for beacon operation only.
AFC crystal	Transmitter-receiver	V22 (CV253)	Mixer	Difference frequency of transmitter valve and signal oscillator to the discriminator.
Discriminator	Transmitter receiver	V3 (VR91) V5, V6, V8 (VR91) ; V4, V7 (VR92)	Sweep valve, IF amplifiers, and long-tailed pair	DC voltage to reflector of the signal oscillator.
Head IF amplifier	Transmitter-receiver	V1, V2 (VR91)	IF amplifiers	Signals at IF to main IF amplifier.
IF amplifier	Receiving unit, Type 153 (Part of R.3647)	V1, V2, V3, V4, V5 (VR91)	IF amplifiers	Signals at IF to detector
Suppression generator	Receiver	V30 (VR91)	DC pulse amplifier	Suppression pulse to IF amplifier.
Gain valve	Receiver	V29 (VR91)	Cathode follower	Gain voltage to IF amplifier.
Detector	Receiving unit, Type 153 (part of R.3647)	V6 (VR92)	Series-fed diode	Video frequency signals to video amplifier.
Video amplifier	Receiving unit, Type 153 (part of R.3647)	V7 (VR91)	Amplifier	Video frequency signals to the signal and marker mixer.
Signal and marker mixer	Receiver	V10 (VR91)	Amplifier	Signals and markers to the receiver output and strobed rectifier drive stages.
Signal and marker output	Receiver	V9 (VR91)	Cathode follower	Signals and markers to all display systems.
Video amplifier	Indicating unit, Type 300	V14 (CV173)	Amplifier	Signal and markers to the grid of the main PPI.

	Location		Type of circuit	Outputs
	Unit	Valves		
Strobe searching generator	Receiver	V15 (VR91)	Miller valve	"3h" potential to secant potentiometer.
Secant potentiometer	Control unit, Type 455A		Stud potentiometer	"h" and "h sec β" potentials to the trigger-off stage.
Bombsight computer	Bombsight Mark XIV		Mechanical	Bombing angle (β) drive to secant potentiometer.
Trigger-on stage	Receiver	V21 (VR55)	Switching valve	Trigger pulse to height and range marker generators at time "O."
Height marker generator	Receiver	V23, V24 (VR91)	Flip-flop	"O-h" pulse to the gain valve and differentiated pulses to strobe amplifier and marker amplifier.
Range marker generator	Receiver	V27, V28 (VR91)	Flip-flop	"O-h sec β" pulse to the marker delay generator and a differentiated pulse to the marker amplifier.
Marker delay generator	Receiver	V16 (VR91)	Miller valve	(1) "O-h sec β" pulse to the "—20 to h-10" pulse generator. (2) Anode run down to the trigger-off stage and to the "—20 to h-10" pulse generator.
Trigger-off stage	Receiver	V31 (VR54)	Catching diodes	Conduct to cut off height and range marker generators at times "h" and "h sec β" respectively.
Strobe amplifier	Receiver	V25 (CV173)	DC pulse amplifier	Short duration pulse to the strobed rectifier at time "h."
Strobed rectifier drive	Receiver	V11 (VR91)	Cathode follower	Signals to the strobed rectifier.
Strobed rectifier	Receiver	V12, V13 (VR91)	Bridge circuit.	Arrests the run down of the strobe searching generator when the strobe pulse occurs at the same time as the first ground return.

Name of stage	Location		Type of circuit	Outputs
	Unit	Valves		
Marker amplifier	Receiver	V19 (VR91)	DC pulse amplifier	Short duration pulses to the signal and marker mixer at times " h " and " h sec β."
" —20 to h-10 " pulse generator	Receiver	V33 (VR91)	DC pulse amplifier	" —20 to h-10 " pulse to the scan trigger pulse output stage.
Scan trigger pulse output stage	Receiver	V20 (VR91)	Cathode follower	Scan trigger pulse to the scan waveform generator.
Scan waveform generator	Indicating unit, Type 300	V1 (VR91) V2 (VR91) V3, V4 (VR91)	Pulse amplifier Miller valve flip-flop	Voltage scan waveform to the scan output stage ; bright-up waveform to the bright-up stage.
Scan output stage	Indicating unit, Type 300	V5 (VR91) V6 (VR91) V7, V8 (CV1572's)	Amplifier Phase-splitter Current generator	Current scan wavefor [illegible] the magslip
Magslip	Scanner		Rotary transformer	Sine and cosine components of the scan waveform to transformers.
Step-down transformers	Transformer unit, Type 166A		Transformer	As above, but reduced in amplitude.
Step-up transformers	Indicating unit, Type 300		Transformer	As above, but increased in amplitude, to the deflection coils of the main display tube.
Main display	Indicating unit, Type 300	V25 (VCR530)	Electromagnetic PPI	(A.L.18).
Bright-up stage	Indicating unit, Type 300	V23 (VR92)	DC restorer	Bright-up square wave to the cathode of the main display
Course marker contact	Scanner		Mechanical	Pulse to bright-up stage when the scanner goes through the dead-ahead position.
Bombsight computer	Bombsight Mark XIV		Mechanical	Positions track marker contact to allow for drift.

Name of stage	Location		Type of circuit	Outputs
	Unit	Valves		
Track marker contact	Scanner		Mechanical	Pulse to bright-up circuit when the contact makes.
API	API Mark IA		Mechanical	M transmissions, proportional to air miles travelled, to air distance potentiometers
Air distances potentiometers	Computer		Mechanically-driven potentiometers	Voltages, proportional to air distance travelled in N-S and E-W components, to shift amplifiers.
Wind potentiometer	Computer	V2 (VR91)	Miller driven ratchet motor driving potentiometer	Voltages proportional to a wind having components of 100 knots to wind-rate potentiometers.
Wind-rate potentiometers	Control unit, Type 552		Padded potentiometers	Fraction of above, depending on the setting of the controls, to shift amplifiers.
Co-ord. controls	Control unit, Type 552		Potentiometers	Variable DC voltage to the shift amplifiers.
Shift amplifiers	Indicating unit, Type 300	V9, V10 (VR91) V11, V12 (CV345)	Amplifiers Current generators	Shift currents to deflection coils of main display
Fishpond scan multivibrator	Indicating unit, Type 188A	V500, V501 (VR91)	Multivibrator	Squarewaves to sawtooth generator.
Magslip	Scanner		Rotary transformer	Sin θ and cos θ voltages to the sawtooth generator.
Sawtooth generator and diode clamps	Indicating unit, Type 188A	V502 to V504 (VR54)	CR charging circuit	Sawtooth waveform to the scan amplifiers.
Scan amplifiers	Indicating unit, Type 188A	V505 to V508 (VR91)	Paraphase amplifiers	Sawtooth voltage waveforms to the deflection plates of the Fishpond display.
Signal and bright-up amplifier	Indicating unit, Type 188A	V 509, V510 (VR91)	Amplifier	Signals and bright-up to the grid of the Fishpond display.

Name of stage	Location		Type of circuit	Outputs
	Unit	Valves		
Fishpond display	Indicating unit, Type 188A	CRT500 (VCR517)	Electrostatic PPI	
Scan generator	Indicating unit, Type 277	V1 (VR91) V2 (VR91)	Miller valve paraphase valve	Timebase waveform to the X-plates of the setting-up display bright-up square wave to the grid.
Signal amplifier	Indicating unit, Type 277	V3, V4 (VR91)	Paraphase amplifier	Paraphase signals to the Y-plates of the setting-up display.
Setting-up display	Indicating unit, Type 277	V7 (VCR522)	Electrostatic deflection	

TABLE 3

Connector set, Type ARI. 5715/FU Mk. 2 (Stores Ref. 10HA/7694)

No. of Cable	Connector		Socket		Length of Cable	Cableform	Marking of connector sleeves		Colour of sleeve
	Type	Ref. No.	End "A"	End "B"			End "A"	End "B"	
1	8051	10HA/5947	W164	W164	7 ft. 9 in.	18-way screened	Junction box, Type 341	Indicator 277	White
2	8052	10HA/5948	W164	W164	3 ft. 9 in.	18-way screened	Receiver	Indicator 277	White
3	8053	10HA/5949	W164	W164	23 ft. 2 in.	18-way screened	Junction box, Type 341	Indicator 188A	Black
4	8054	10HA/5950	W502	W502	28 ft. 5 in.	18-way screened	Junction box, Type 341	Indicator 300	Yellow
5	8055	10HA/5951	W164	W164	31 ft. 4 in.	18-way screened	Junction box, Type 341	Control unit, Type 552	Brown
6	8056	10HA/5952	W164	W164	5 ft. 3 in.	18-way screened	Junction box, Type 341	Computer	Green
7	8057	10HA/5953	W502	W502	20 ft. 11 in.	18-way screened	Junction box, Type 341	Junction box, Type 325	Blue
8	8204	10HA/7097	W502	W502	2 ft. 9 in.	18-way screened	Junction box, Type 325	Transformer unit	
9	8205	10HA/7098	W502	W502	1 ft. 5 in.	18-way screened	Transformer unit	Scanner	Red
10	8000	10HA/5896	W492	W492	3 ft. 6 in.	12-way screened	Junction box, Type 341	Junction box, Type 326	Violet
11	8001	10HA/5897	W492	W492	1 ft. 5 in.	12-way screened	Junction box, Type 325	TR.3523E	Red
12	8002	10HA/5898	W492	W492	1 ft. 2 in.	12-way screened	Jack unit, No. 1	Power unit, No. 1	Black

TABLE 3 *(cont.)*

No. of Cable	Connector Type	Connector Ref. No.	Socket End "A"	Socket End "B"	Length of Cable	Cableform	Marking of connector sleeves End "A"	Marking of connector sleeves End "B"	Colour of sleeve
13	8003	10HA/5899	W492	W492	9 ft. 6 in.	12-way screened	Jack unit, No. 1	Junction box, Type 341	Black
14	8004	10HA/5900	W492	W492	1 ft. 3 in.	12-way screened	Jack unit, No. 2	Power unit, No. 2	Black/ Green
15	8005	10HA/5901	W492	W494	8 ft. 9 in.	12-way screened	Jack unit, No. 2	Junction box, Type 341	Black/ Green
16	8006	10HA/5902	W492	W492	29 ft. 8 in.	12-way screened	Junction box Type 341	Indicator 300	Yellow
17	8007	10HA/5903	WW570A	WW570A	5 ft. 3 in.	18 Corevinmet No. 3	Modulator	Junction box, Type 326	
18	8152	10HA/7068	Pye 213	Pye 213	5 ft. 2 in.	Uniradio 31	Receiver	Indicator 277	Orange/ White
19	8009	10HA/5905	W162	W162	32 ft. 8 in.	12-way screened	Junction box, Type 341	Control unit, Type 552	Brown
20	8010	10HA/5906	W492	W492	16 ft. 3 in.	12-way screened	Control unit, Type 552	Control unit, Type 455A	
21	8011	10HA/5907	W492	W492	19 ft. 7 in.	12-way screened	Junction box, Type 341	Junction box, Type 325	Blue
22	8012	10HA/5908	W154	W153	29 ft. 0 in.	Sextomet 4	Computer	Junction switch box	
22A	8013	10HA/5909	W154	W153	34 ft. 9 in.	Sextomet 4	Computer	Test set, Type 294	
23	8014	10HA/5910	W154	W153	48 ft. 4 in.	Sextomet 4	Control unit, Type 565A	Junction box, Type 325	
24	8652	10HA/7778	W154	W154	34 ft. 9 in.	Sextomet 4	Computer	Control unit, Type 552	Red

			Socket		Length of Cable	Cableform	Marking of connector sleeves		Colour of sleeve
		Ref. No.	End "A"	End "B"			End "A"	End "B"	
25	8542	10HA/7543	W310	None	17 ft. 0 in.	Quadramet 4	Control unit, Type 552	Junction box, Type A	
26	8017	10HA/5913	Pye 213	Pye 214	8 ft. 7 in.	Uniradio 31	Indicator 277	Junction box, Type 326	Violet
27	8018	10HA/5914	W310	W310	47 ft. 10 in.	Quadramet 4	Control unit, Type 565A	TR.3523E	
28	8538	10HA/7536	W310	None	53 ft. 0 in.	Trimet 7	Control unit, Type 565A	Suppressor Type D	Red
29	8537	10HA/7535	W310	None	8 ft. 0 in.	Trimet 7	Scanner	Suppressor, Type D	Red
30	8632	10HA/7695	W291	None	38 ft. 0 in.	Dumet 37	Junction box, Type 341	A.C. supply switches	Black
31	8022	10HA/5918	W165	None	8 ft. 0 in.	Dumet 19	Junction box, Type 341	D.C. supply	Red
32	8023	10HA/5919	W165	None	8 ft. 0 in.	Dumet 19	Junction box, Type 325	D.C. supply	
33	8024	10HA/5920	Plug W354	Plug W354	22 ft. 9 in.	Uniplugmet 1	Indicator 188A	Power unit, No. 1	White/ Green
34	8025	10HA/5921	Plug W354	Plug W354	30 ft. 5 in.	Uniplugmet 1	Indicator 300	Power unit, No. 1	Green
36	8027	10HA/5923	Pye 213	Pye 213	6 ft. 7 in.	Uniradio 31	Receiver	Junction box, Type 326	Violet
37	8028	10HA/5924	Pye 213	Pye 213	20 ft. 9 in.	Uniradio 31	Indicator 188A	Junction box, Type 326	Violet
38	8029	10HA/5925	Pye 213	Pye 213	24 ft. 1 in.	Uniradio 31	Receiver	TR.3523E	Black

TABLE 3 (cont.)

No. of Cable	Connector		Socket		Length of Cable	Cableform	Marking of connector sleeves		Colour of sleeve
	Type	Ref. No.	End "A"	End "B"			End "A"	End "B"	
39	8030	10HA/5926	Pye 213	Pye 213	32 ft. 10 in.	Uniradio 31	Receiver	Indicator 300	Blue
40	8031	10HA/5927	Pye 386	Pye 213	33 ft. 4 in.	Uniradio 31	Receiver	Indicator 300	White
41	8032	10HA/5928	Pye 213	Pye 213	13 ft. 8 in.	Uniradio 31	Indicator 188A	Indicator 300	White
42	8033	10HA/5929	Pye 213	Pye 213	35 ft. 1 in.	Uniradio 31	Receiver	Test set, Type 296	
43	8034	10HA/5930	Pye 386	Pye 213	18 ft. 7 in.	Uniradio 31	Receiver	Monitor, Type 56	White
44	8153	10HA/7069	Pye 213	Pye 213	33 ft. 10 in.	Uniradio 31	Test set, Type 296	Receiver	Yellow
45	8036	10HA/5932	Pye 213	Pye 213	18 ft. 2 in.	Uniradio 31	Monitor, Type 56	Junction box Type 326	Violet
46	8037	10HA/5933	W468	None	4 ft. 0 in.	Twelveflexmet 2·5	GPI	Junction switch box	
47	8040	10HA/5936	5C/1318	None	4 ft. 0 in.	Sextomet 4	WFA	Junction switch box	
48	8038	10HA/5934	Pye 213	Pye 213	6 ft. 1 in.	Uniradio 31	Waveform generator	Junction box, Type 326	Blue
49	8039	10HA/5935	W309	None	6 ft. 0 in.	Dumet 7	Scanner	Suppressor, Type P	
50	8729	10HA/7908	Plug WW608A	Plug W354	25 ft. 0 in.	Uniplugmet 1	Modulator	TR.3523E	
51	8539	10HA/7537	W150	Plug W198	29 ft. 6 in.	Dumet 4	Junction box, Type 341	Test set, Supply skt.	

			End "A"	End "B"	Length of Cable		Cableform	Marking of connector sleeves End "A"	Marking of connector sleeves End "B"	Colour of sleeve
				W217	14 ft.	9 in.	Dumet 4	Junction box, Type 341	Monitor, Type 56	
				Plug W204	29 ft.	6 in.	Dumet 4	Junction box, Type 341	Test set Supply skt.	
52	8207	10HA/7100	W152	W151	5 ft.	6 in.	6-way screened	Scanner	Junction box, Type 325	Red
53	8208	10HA/7101	W244	W244	6 ft.	9 in.	Quadramet 4	Scanner	Junction box, Type 325	
54	8044	10HA/5940	Plug W354	Plug W354	29 ft.	8 in.	Uniplugmet 1	Power unit, No. 2	Indicator 300	Yellow
55	8045	10HA/5941	W492	W492	4 ft.	9 in.	12-way screened	Waveform generator	Junction box, Type 341	Red/ Black
56	8046	10HA/5942	W291	None	38 ft.	0 in.	Dumet 37	Control panel No. 1	A.C. supply switches	
57	8047	10HA/5943	W291	None	38 ft.	0 in.	Dumet 37	Control panel No. 2	A.C. supply switches	
58	8048	10HA/5944	W244	W244	4 ft.	0 in.	Quadramet 4	Test set Supply skt.	Test set, Type 296	
59	8049	10HA/5945	W527	W527	4 ft.	0 in.	Dumet 19	Test set Supply skt.	Test set, Type 294	

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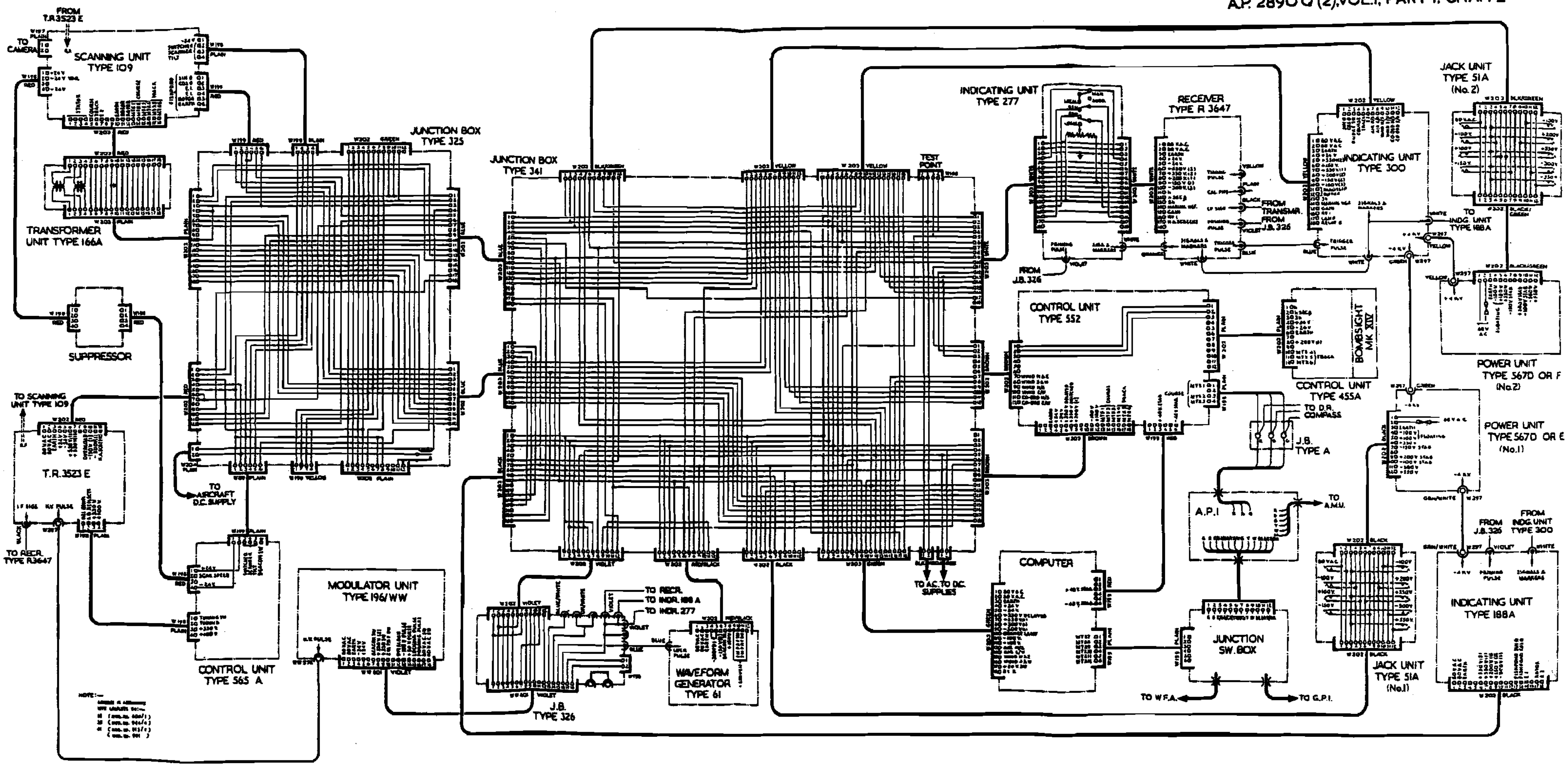

FIG. 7. — H2S MK.4 A INTERCONNECTION DIAGRAM

G4425 M4604 3/51 130 C.B.& Sipe Gees.

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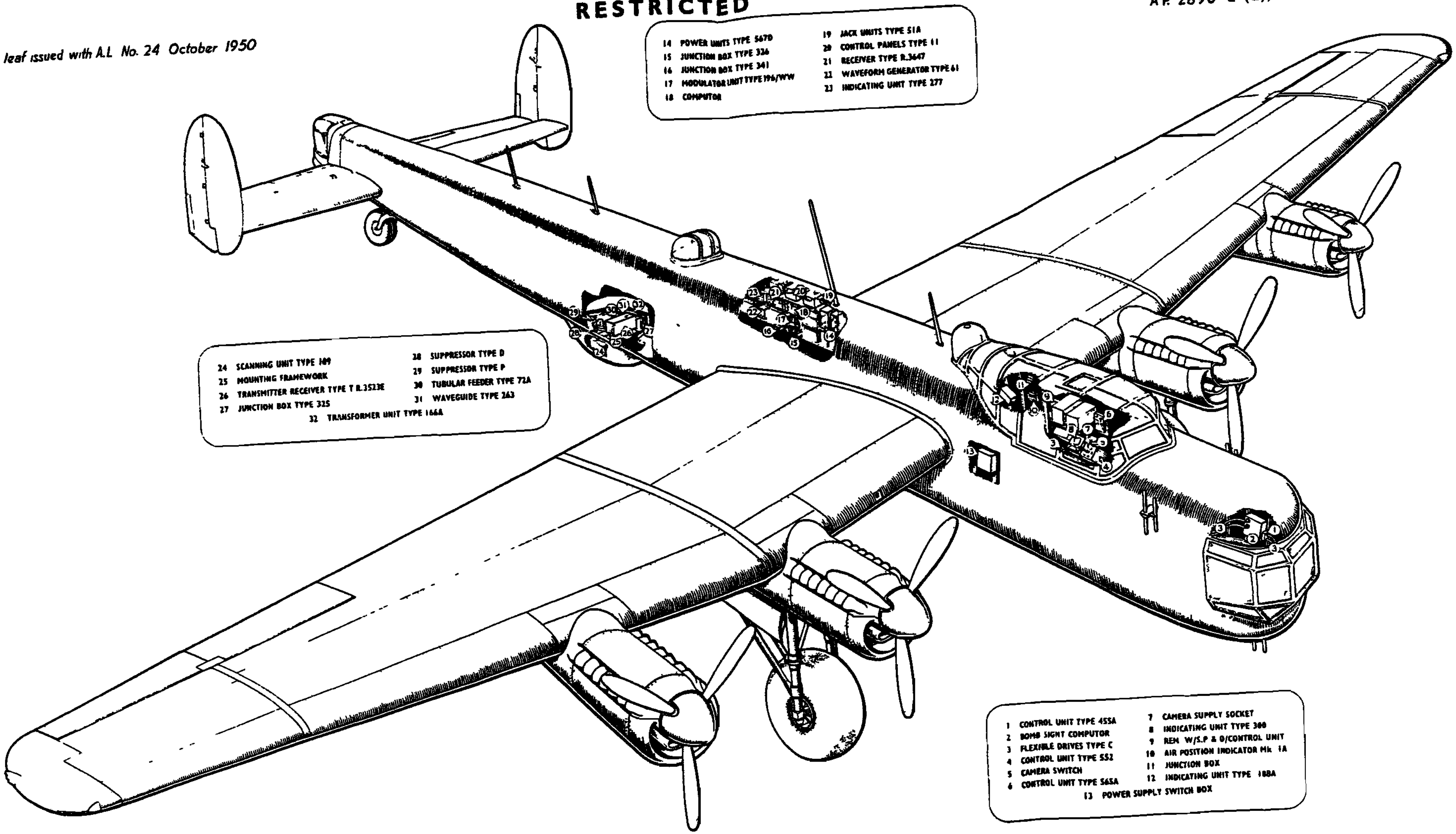

FIG. 8

ARI.5715/FU: H2S Mk. 4A IN LINCOLN

FIG. 8

NOTE.- AMENDED IN ACCORDANCE WITH LEAFLETS No.- 14 (MOD. No. 647/1) 30 (MOD No. 944/4)

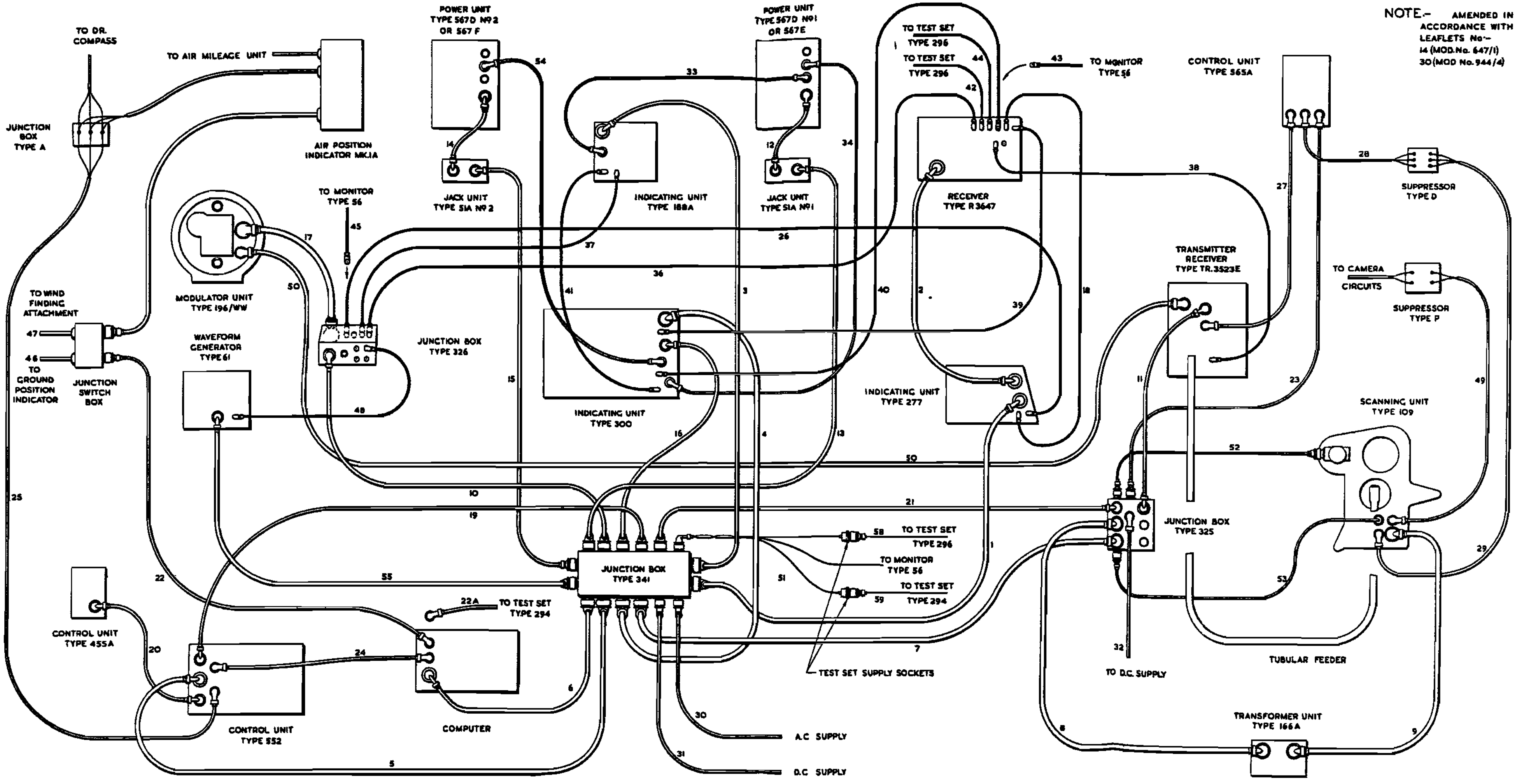

FIG.9.- CONNECTOR DIAGRAM

Chapter 3

MODULATOR UNIT, TYPE 196/WW

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LIST OF ILLUSTRATIONS

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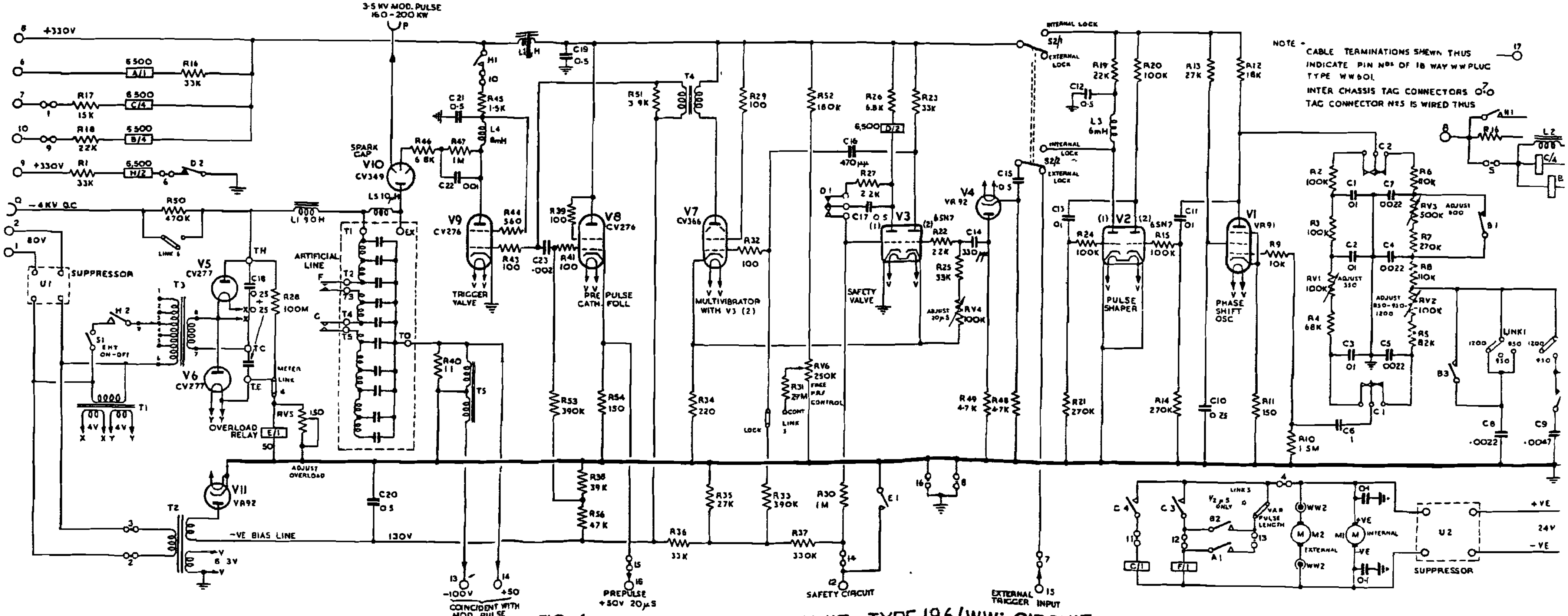

FIG. 1. MODULATOR UNIT TYPE 196/WW: CIRCUIT

G4485 M46643 3/52 130 C.B & S.Ltd Gp.85

GENERAL

oduction

Modulator unit, Type 196/WW contains circuits necessary for generating the 20 priming pulse and the EHT modulating se. The modulator was designed for use several radar equipments and in conuence contains some circuits which are used in H2S Mk. 4A. This chapter cribes the operation of the unit in H2S . 4A, for details of the method of ration in other equipments reference should be made to the publication on the equipment concerned.

2. The modulator can be set to run freely at a pulse recurrence frequency determined by an internal phase-shift oscillator or to run locked to a trigger waveform from an external source. In H2S Mk. 4A the modulator is locked to a trigger waveform from waveform generator Type 61 (*Chap.* 14) and the p.r.f. of the equipment is con-

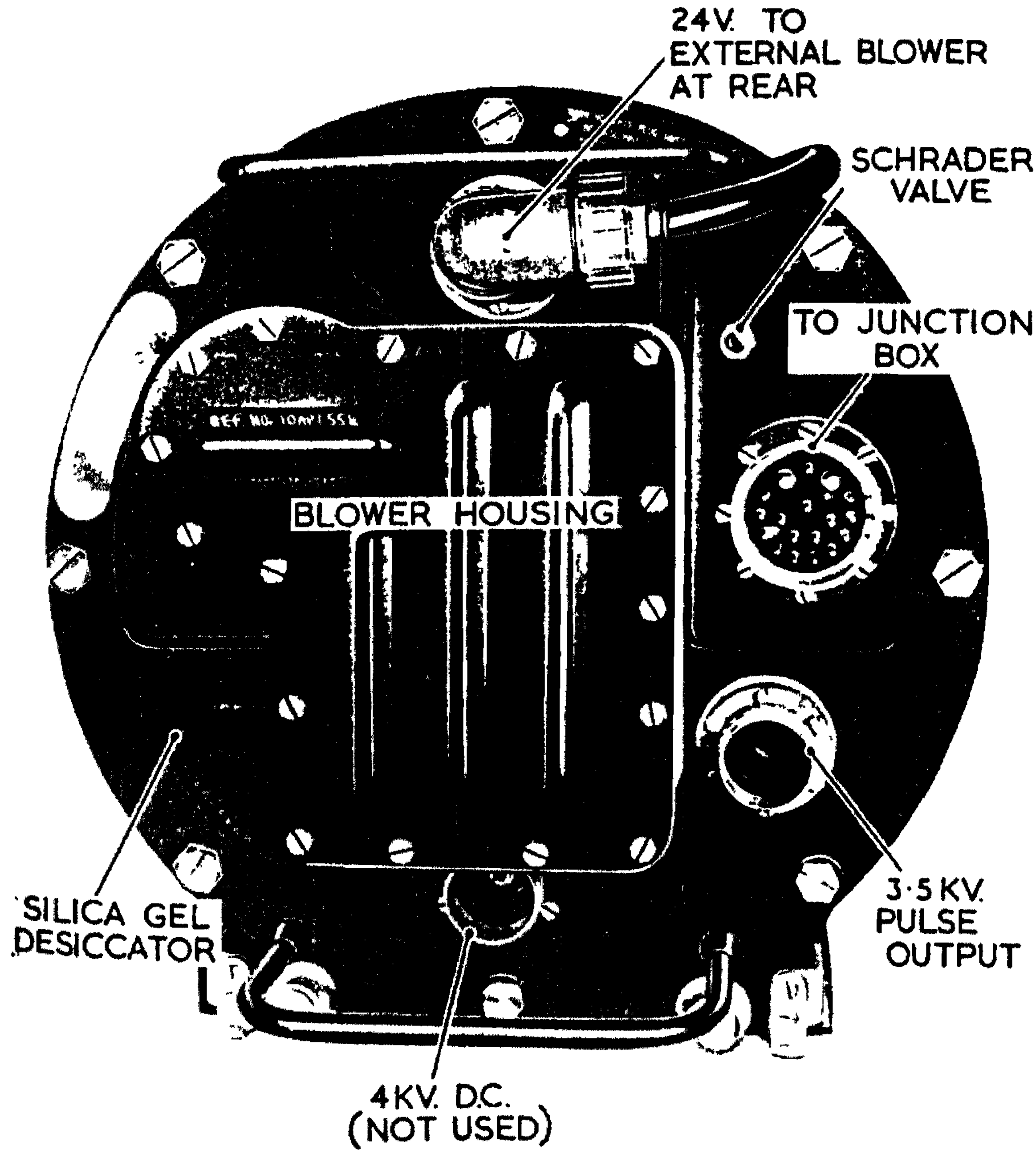

Fig. 2. Modulator unit, Type 196/WW : front panel

(A.L.24)

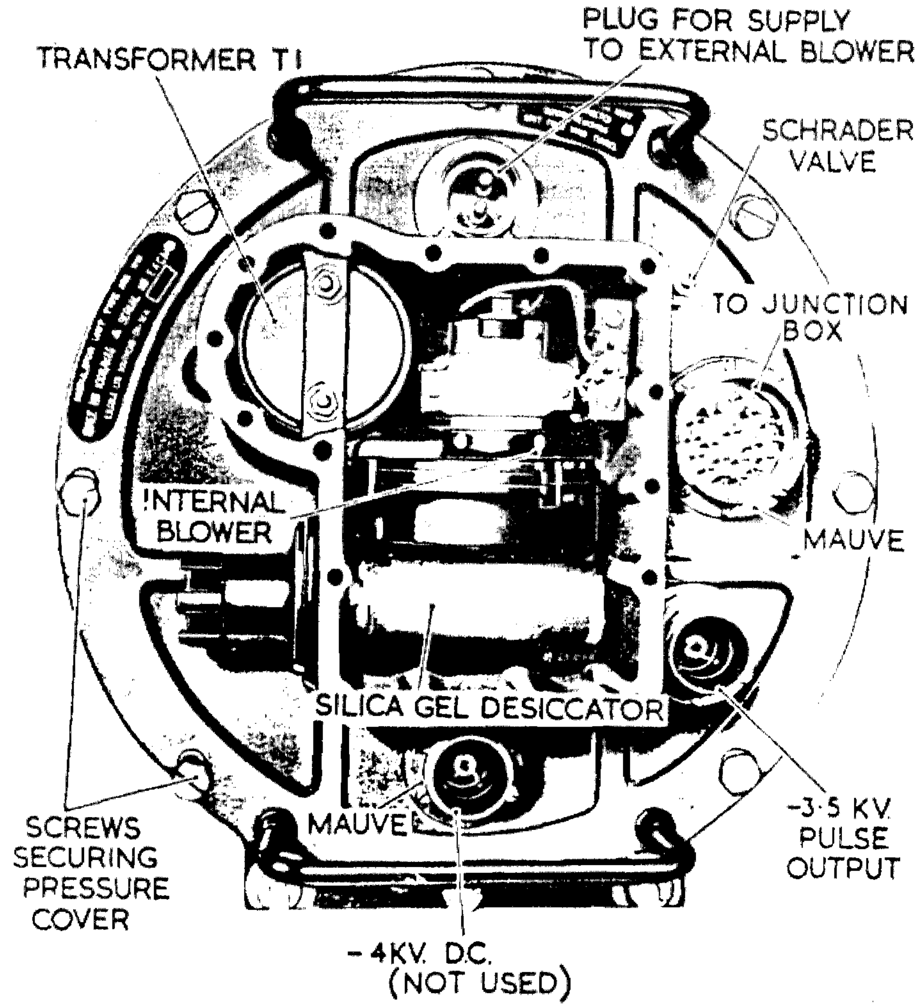

Fig. 3. Front panel with internal blower cover removed

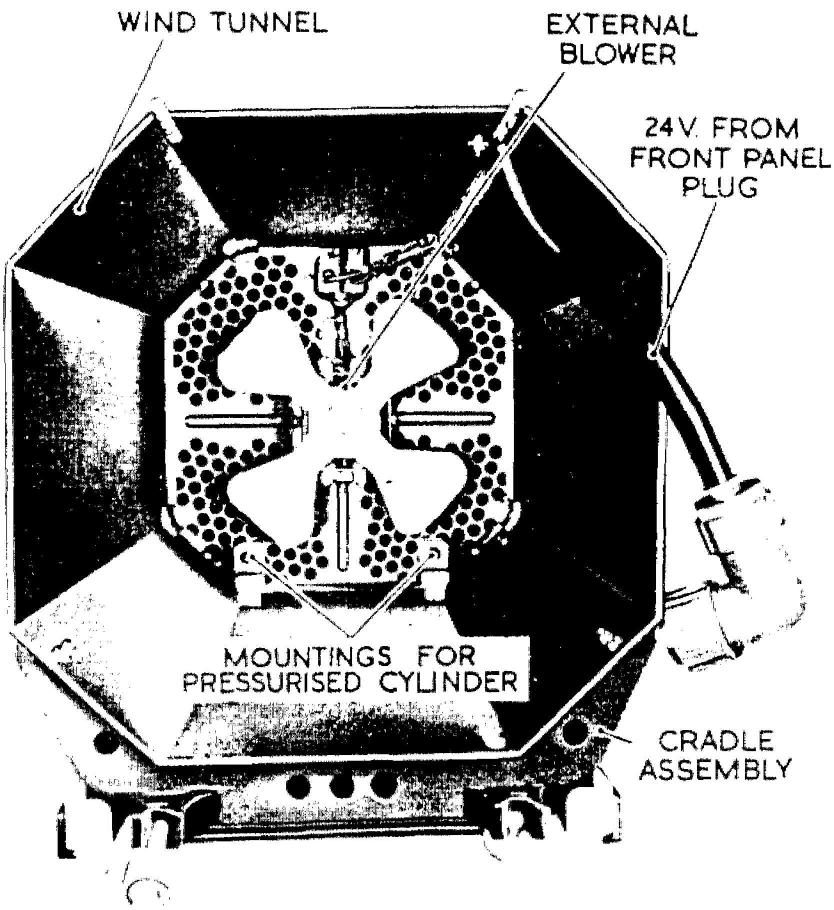

Fig. 4. Wind tunnel assembly

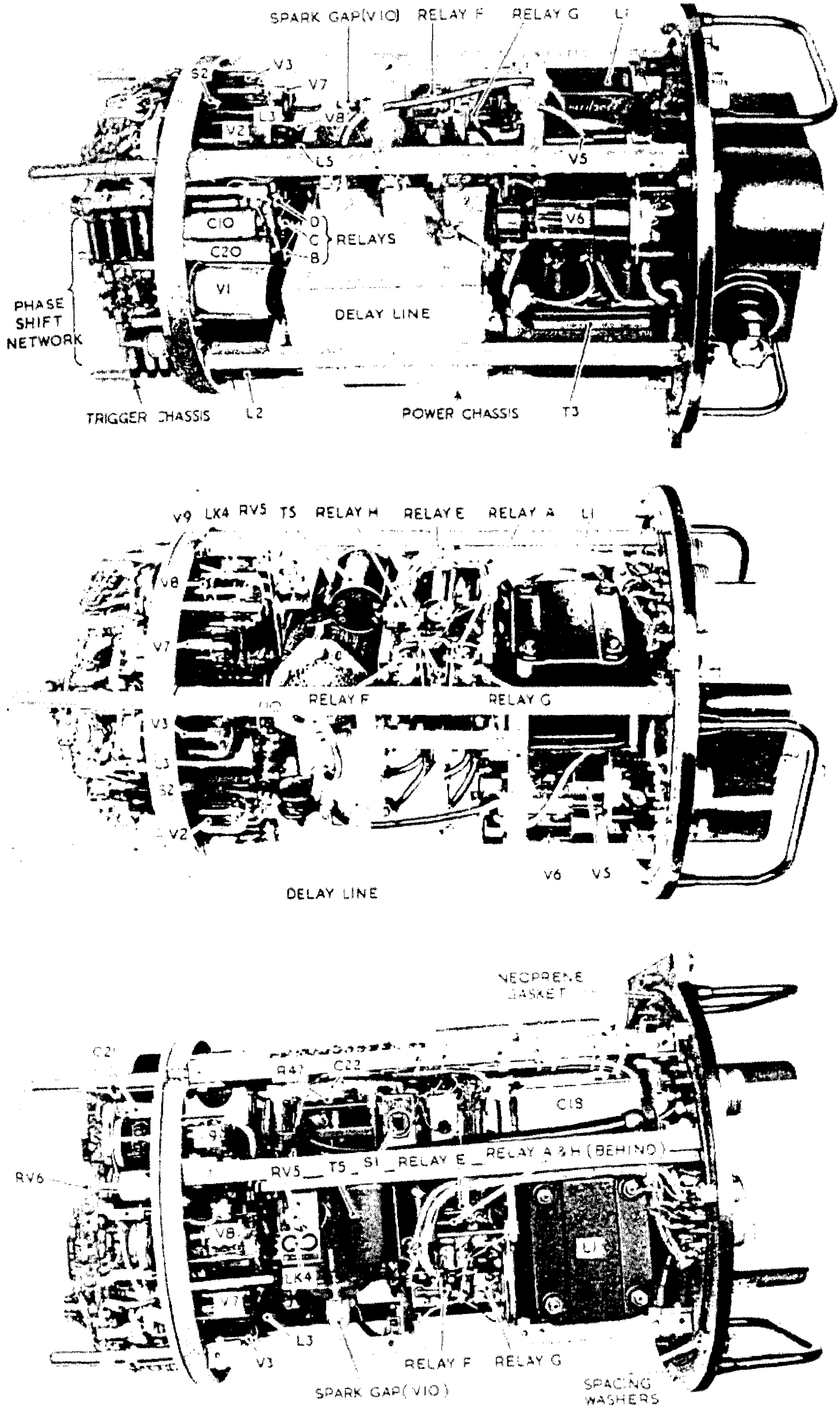

Fig. 5. Side views of chassis, showing principal components

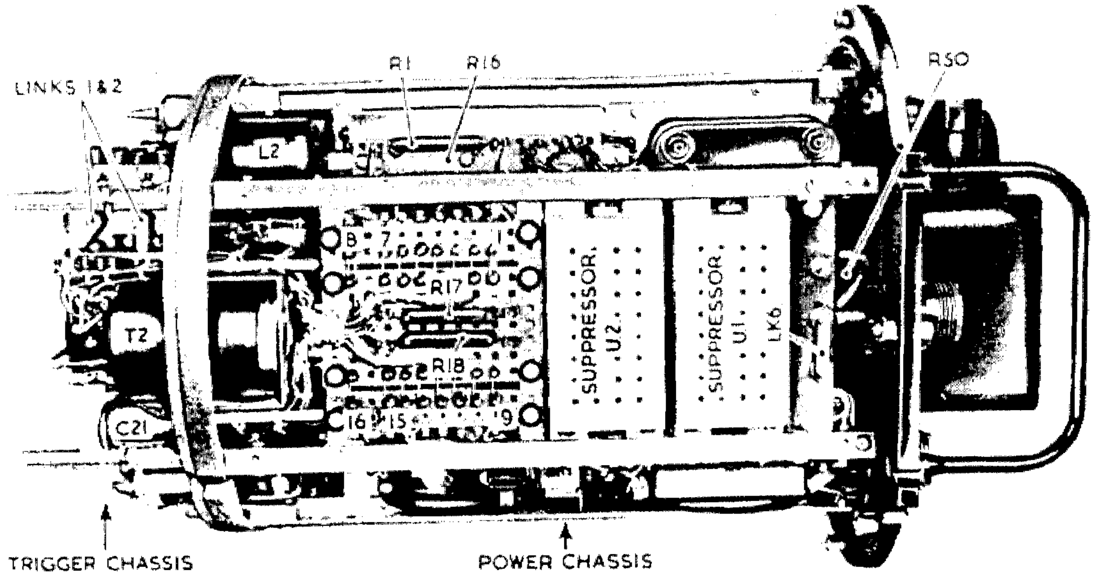

Fig. 6. View of chassis showing tagboard

sequently determined by the latter unit. The width of the modulating pulse is normally ½ μs but can be increased to 1 μs or 2¼ μs by external switching. This external switching is combined with the switching of the p.r.f. of the trigger waveform in the waveform generator. The following combinations of pulse length and p.r.f. are used :—½ μs pulses at 1,000 p.p.s. on the ¼M, ½M, and 1M scales of the PPI display, 1 μs pulses at 500 p.p.s. on the 2M scale of the display, and 2¼ μs pulses at 335 p.p.s. (approximately) for beacon operation. The peak power of the modulating pulse is adjustable in steps between 160 and 200 kW.

3. As modulator unit, Type 196 is fitted with WW plugs and the rest of the H2S Mk. 4A units are fitted with W plugs, junction box, Type 326, (*Chap.* 16) is included in the equipment to break down the WW connectors to W connectors and Pye leads.

Mechanical details

4. The modulator (*fig.* 2–6, 15, 17) consists of a main chassis containing all the power circuits and a trigger unit which is mounted on a circular chassis attached to the rear of the main chassis ; connections between the two are made by means of a tagstrip (*fig.* 6 *and* 17) and one flying lead. The complete unit is enclosed in an airtight cylinder which is attached to the front panel by securing screws and the joint made airtight by a neoprene seal. A small blower mounted on the front panel circulates the air within the pressurized cylinder which is normally pumped up to 5 lbs./sq.in. above atmospheric pressure. A silica-gel desiccator is also mounted on the front panel and separate seals enable this to be changed or the blower motor to be examined without removing the cylindrical cover.

5. To cool the cylinder it is mounted in a wind tunnel (*fig.* 3) which has a large blower motor mounted at the rear. The wind tunnel is octagonal in cross section and is provided with fittings which enable it to be accommodated in a standard 9 in. by 21in. aircraft mounting tray. The cylinder rests on mountings at the rear of the tunnel and is secured to a cradle at the front of the tunnel by two toggle screws. The DC supply for the blower at the rear is fed to it by a length of cable from a 2 pin WW plug on the front panel. The overall height and depth of the complete modulator is 12in. and its weight is approximately 60 lbs.

Outline of operation

6. A block schematic of the unit is given in fig. 7. The trigger waveform from waveform generator, Type 61, which consists of a series of negative pips, is fed to a multivibrator in the modulator and locks it to run at the same frequency. This multivibrator is known as the priming pulse generator and its output consists of a positive 20 μs square wave. All the measuring circuits in the equipment are timed from the back edge of this priming pulse which is regarded as time "0." The priming pulse is fed via a cathode follower to other units of the equipment but is also fed directly to the grid of the modulator trigger valve.

7 The trigger valve has a choke in its anode circuit which is tuned by stray capacities; the valve is normally cut off by a large negative bias on its grid. The positive priming pulse causes the valve to conduct and when the pulse ends the sudden cessation of current through the valve causes the choke in its anode to ring. This ring, which initially is of considerable amplitude, is applied to the trigger electrode of a spark gap.

8. The spark gap is in series with the primary of the pulse transformer in the transmitter (*Chap.* 4) and both are connected across an artificial line charged to 8kV. When the ring from the anode of the trigger valve reaches the trigger electrode it causes the main gap to arc over and the artificial line discharges through the spark gap and the primary of the pulse transformer. The resulting high voltage across the secondary of the pulse transformer is applied to the cathode of the magnetron transmitting valve which generates a radio frequency pulse whose duration is determined by the time of discharge, and thus by the length, of the artificial line.

9. Normally, the p.r.f. of the locking waveform from the waveform generator is 1,000 p.p.s. and the length of the modulating pulse ½ μs. When the SCALE switch on indicating unit, Type 300 is put to the 2M position the p.r.f. of the locking pulse is reduced to 500 p.p.s. by a relay in the waveform generator and at the same time relays in the modulator increase the length of the artificial line to give a 1 μs modulating pulse. Switching to *beacon* on control unit, Type 565A reduces the p.r.f. of the locking

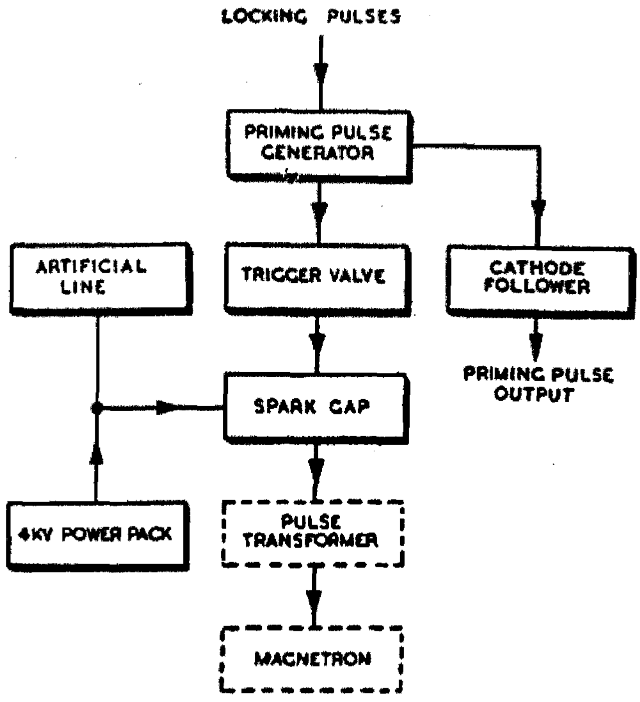

Fig. 7. Block schematic

pulse to 335 p.p.s. (approximately) and at the same time operates relays in the modulator which increase the length of the modulating pulse to 2¼ μs. Switching to *beacon* overrides switching to the 2M scale as far as the pulse length and p.r.f. of the equipment are concerned. It should be noted that if transmitter-receiver, Type TR.3523E is not fitted with a pulse transformer capable of handling the 2¼ μs pulse a modification to control unit, Type 565A (*Chap.* 6) prevents switching to a pulse length of 2¼ μs at a p.r.f. of 335 p.p.s.

10. A relay in the modulator in conjunction with delay circuits in the computer (*Chap.* 10) ensures that the 80V. AC supply to the 4 kV power pack and the HT supply to the trigger valve cannot be switched on before the modulator and transmitter EHT circuits have warmed up. A protective circuit switches off these supplies in the event of an overload in the transmitter or modulator.

CIRCUIT DESCRIPTION

General

11. A complete circuit diagram of the modulator is given in fig. 1. The parts of the circuit which are not used in H2S Mk. 4A are mentioned below but for a full description reference should be made to the publication on an equipment which does use these parts.

Priming pulse generator

12. The locking waveform from the waveform generator, consisting of 50V negative

pips (*fig.* 9A) at a p.r.f. dependent on the setting of the SCALE control on indicating unit, Type 300 and the tuning switch on control unit, Type 565A, is fed to pin 15 of the 18 way WW plug on the modulator. In the H2S Mk. 4A equipment switch S2 (*fig.* 1) is kept in the *external lock* position and these pips are fed through C15 (0·05 μF), the diode V4 (VR92), C14 (330 pF), and R22 (2·2K) to the grid of V3(2) (6SN7). Valves V3(2) and V7 (CV366) form a multivibrator (*fig.* 8) with a common cathode load of 220 ohms (R34). The grid of V3(2) is connected to its cathode through R25(33K) and RV4 (100K), and the anode is coupled to the grid of V7 through C16 (470 pF) and the stopper R32 (100 ohms). In H2S Mk. 4A link 3 (*fig.* 1) is closed so that the grid of V7 is returned to a potential of approximately —60V through the leak R33 (390K).

13. Consider the circuit just before the arrival of a pip at the grid of V3(2). V7 will be cut off owing to the large negative bias on its grid and V3(2) will be passing about 10 mA cathode current with its grid and cathode at about 2V; the anode potential of V3(2) will be very low.

14. The negative pip from pin 18/15 decreases the grid potential of V3(2) very sharply thus cutting down the current through the valve. The consequent rise in anode potential (*fig.* 9C) is fed to the grid of V7 and is large enough to overcome the negative bias and bring the valve into conduction. As a result the common cathode potential will rise (*fig.* 9B) increasing the bias on V3(2) still further. The effect is cumulative and V3(2) is soon cut off.

15. Immediately the leading edge of the trigger pip ceases the diode V4 is cut off and the rising edge does not affect the grid potential V3(2). Valve V3(2) remains cut off until the grid potential rises to within the grid base and this interval is dependent on the values of C14, R25, and RV4 (ADJUST 20 μs). When the grid crosses cut-off the anode of V3(2) falls and this fall is fed through C16 to the grid of V7. Consequently current through V7 decreases and the common cathode potential falls causing V3(2) to pass more current and its anode potential to fall further. The effect is again cumulative until V7 is cut off and V3(2) is passing heavy current. The circuit

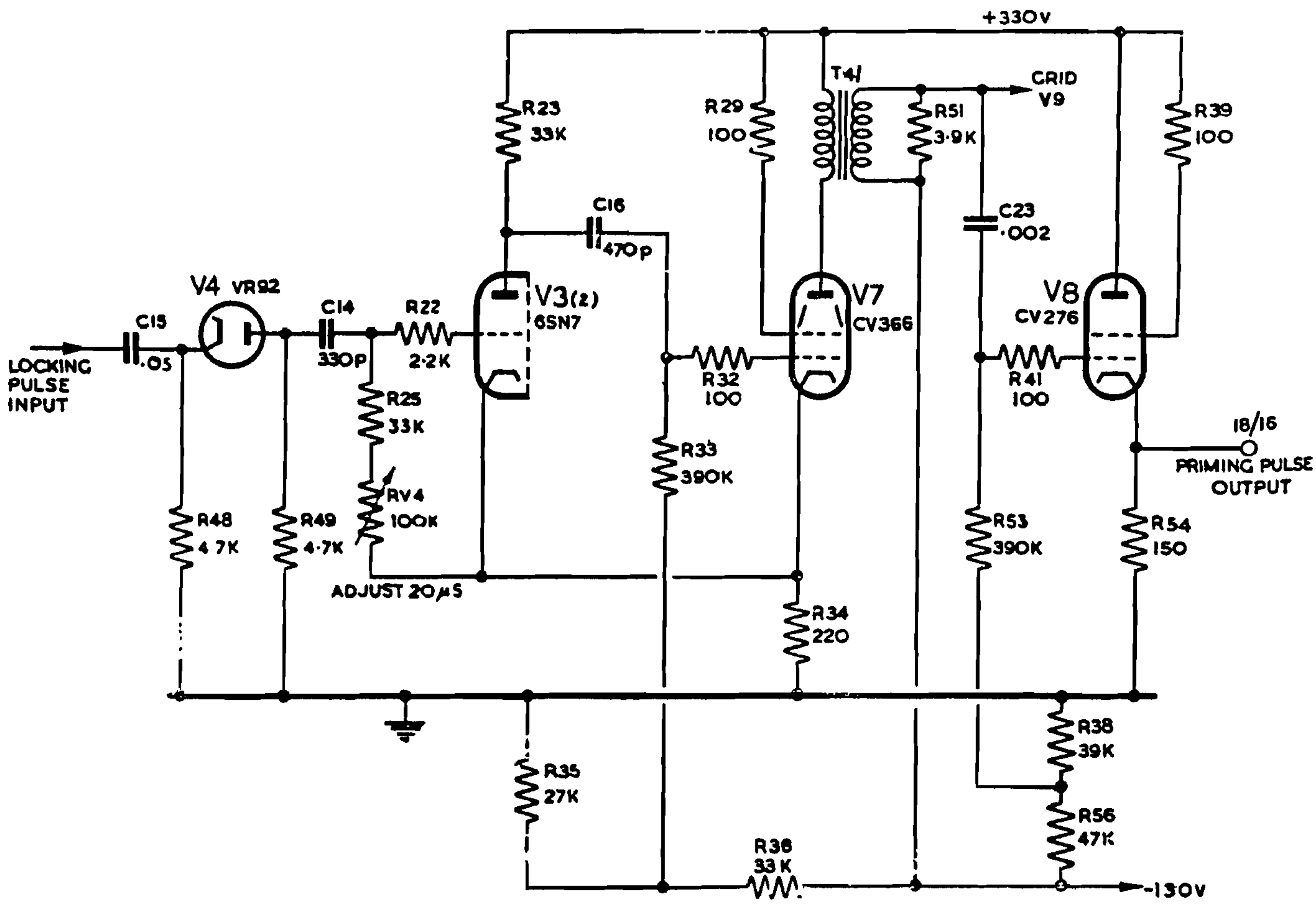

Fig. 8. Priming pulse generator and output stages

remains in this condition until the arrival of the next trigger pip.

16. The output from the multivibrator is taken from the anode circuit of V7 and consists of a negative square wave (*fig* 9D) whose length is determined by the time that V7 is conducting and V3(2) is cut off. This time is set by RV4 to be 20 μs. The anode load of V7 consists of the pulse transformer T4 and is partly resistive and partly inductive; the resistive component is the resistance reflected into the primary by R51 (3·9K) connected across the secondary, and the inductive component is due to the fact that some of the primary flux does not thread the secondary. As a result of the inductive component the rise in anode potential at the end of the pulse overshoots the HT level but decays to it fairly quickly because of the damping introduced by R51.

17. If no external locking waveform is fed to pin 18/15, and link 3 (*fig.* 1) is in the *cont.* position, the grid of V7 is returned to the positive potential at the slider of RV6 and the multivibrator free-runs at a p.r.f. determined by this potential. RV6 (FREE PRF) is calibrated to give recurrence frequencies of 1,200 (blue dot), 1,000 (green dot), 800 (yellow dot), and 600 (red dot) p.p.s. If the link is in the *lock* position and switch S2 in the *internal lock* position the frequency of the multivibrator is determined by the locking waveform fed to the cathode of V4 from the anode of V2(1). For use in H2S Mk. 4A switch S2 must be in the *external lock* position and link 3 in the *lock* position; the internal locking circuits and the FREE PRF control are not used.

Priming pulse output

18. The negative square wave from the anode of V7 (*fig.* 9D) is phase reversed by the pulse transformer T4 (turns ratio 1 : 1) and fed through C23 (0·002 μF) and R41 (100 ohms) to the grid of V8 (CV276). Valve V8 (*fig.* 8) is connected as a cathode follower with a cathode load of 150 ohms (R54) and its anode returned directly to HT. The valve is normally cut off as its grid is returned to a potential of approximately −60V fixed by the chain R38 (39K) and R56 (47K) between earth and −130V.

19. The positive 20 μs pulse from T4 (*fig.* 9E) is approximately 150V in amplitude

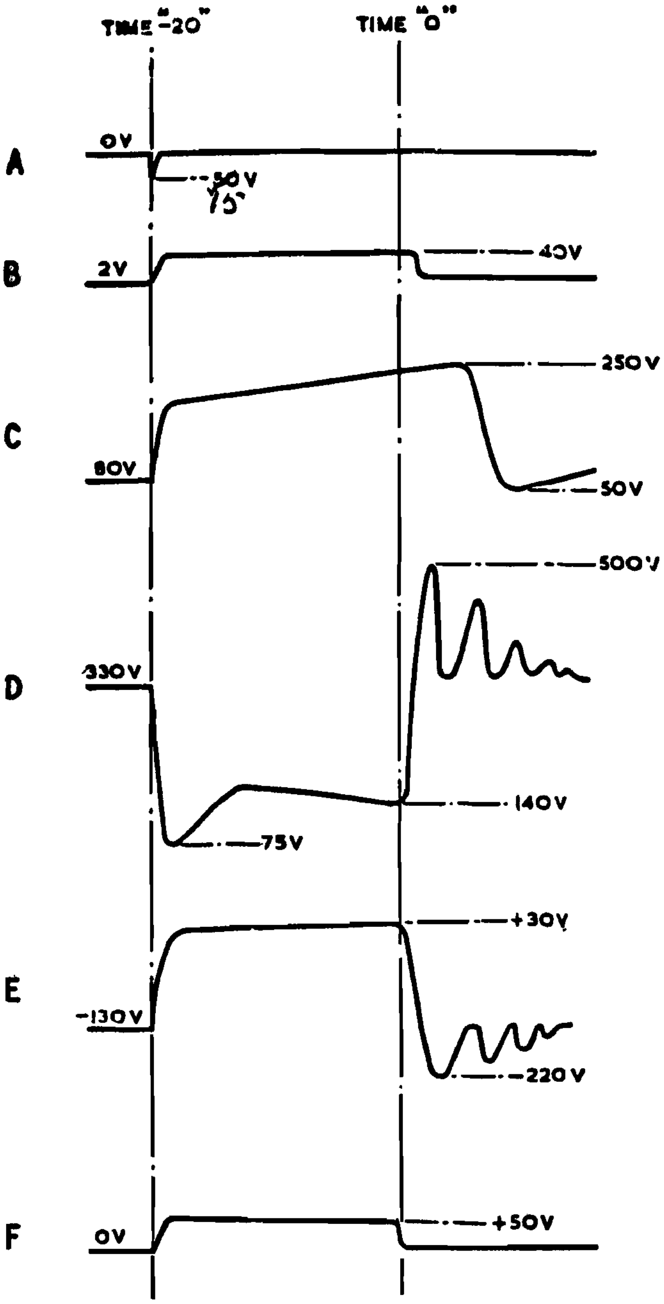

Fig. 9. Priming pulse generator : waveforms

and causes V8 to conduct heavily. The output from the cathode (*fig.* 9F) is about 50V in amplitude and is fed to other units of the equipment via pin 15 of the modulator 18 way WW plug. The back edge of this pulse is very nearly co-incident with the transmitter pulse (*para.* 24–34) and is regarded as time " 0 " for the measuring circuits in the equipment.

Trigger valve

20. The 150V, 20 μs positive pulse from the secondary of T4 is also fed to the grid of V9 (CV276) through R43 (100 ohms);

the circuit of the trigger valve is given in fig. 10. V9 is normally cut off as its grid is returned to −130V through R51 and the cathode is earthed. The anode load consists of the choke L4 (8 mH) which is connected to a decoupled HT potential developed from the +330V line by R45 (1·5K) and C21 (0·5 μF); the screen is also returned to this potential through R44 (560 ohms).

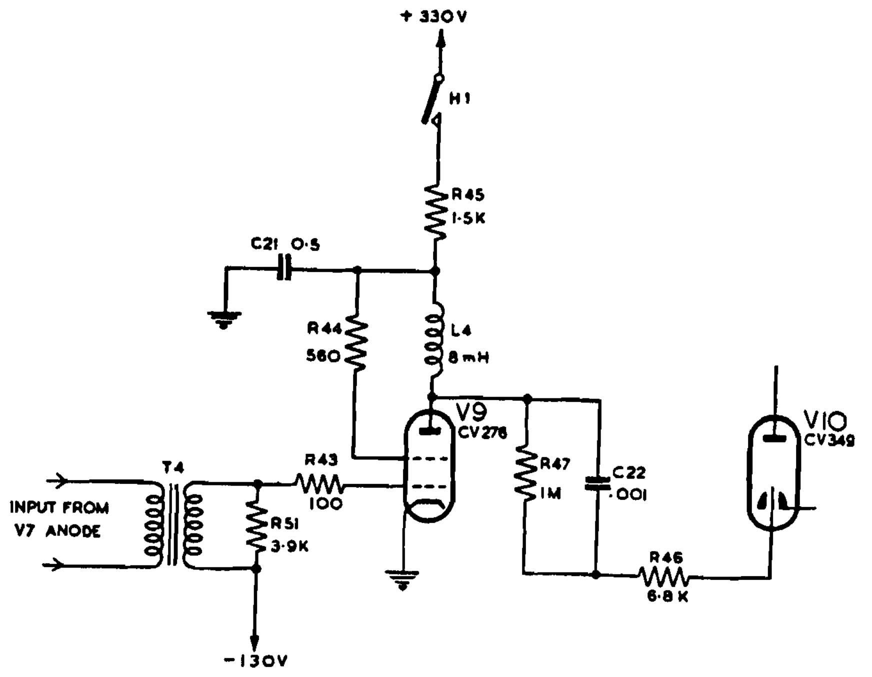

Fig. 10. Trigger valve

21. The leading edge of the positive priming pulse (*fig.* 11A) carries the grid of V9 about 15 volts above earth so that the valve conducts heavily. Anode current builds up through L4 and by the end of the pulse an almost steady state is reached with the valve passing about 700 mA. There will thus be a considerable amount of energy stored in the magnetic field of L1 at the instant when the grid is carried below cut-off by the back edge of the pulse.

22. When the anode current is cut off the collapsing field in L4 generates a large

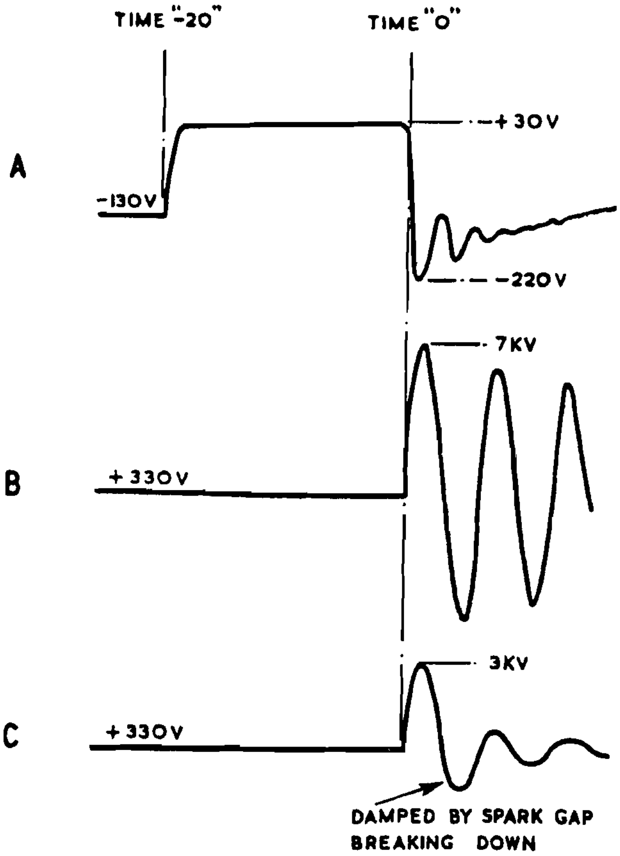

Fig. 11. Trigger valve : waveforms

overswing in the anode potential. If undamped (that is, if no output is taken from the anode of V9) this ring would reach an amplitude of about 7 kV in a time determined by the resonant frequency of L4 with stray capacities; this time is of the order of 2 μs. In practice the positive swing causes the trigger gap of V10 to break down when the amplitude reaches a value of about 3 kV. The current flow to the trigger electrode then damps the ring so that there is no further increase in amplitude. Fig. 11B shows the ring when V10 is removed and the only damping introduced is due to the resistance of L4; fig. 11C shows the damping caused by conduction in the spark gap. No ring occurs at the beginning of the priming pulse as the heavy current passed by the valve when it runs into grid current provides sufficient damping.

23. The high voltage ring at the anode of V9 is fed through R47 (1M) and C22 (0·001 μF) in parallel and then through R46 (6·8K) to the trigger electrode of the spark gap V10.

Modulator output circuit

24. When the 30V AC supply to transformer T3 is switched on, valves V5 and V6 (CV277) develop a 4 kV DC supply which is applied across the spark gap and the artificial line connected in parallel (*fig.* 12). The condensers in the network which forms the artificial line charge up and the potential across them is developed across the main electrodes of the spark gap. This potential is not sufficient to break down the main gap unless a spark is first produced at the trigger gap.

25. The ring from the anode of V9 (*para.* 22) causes the trigger gap to arc over, the main gap breaks down and the condensers of the network discharge through it; the duration of the discharge is determined by the number of sections in the network, that is, the length of the artificial line. The primary of the pulse transformer in the transmitter (*Chap.* 4) is connected between the spark gap and earth by means of a high voltage cable. Consequently during the discharge of the artificial line a heavy current flows through the pulse transformer primary and the resulting high voltage pulse across the secondary is fed to the cathode of the magnetron transmitter valve. This cathode is thus taken very negative (14 kV) with respect to earth for a period determined by the length of the artificial line each time the trigger gap in the spark gap arcs over. When the artificial line completes its discharge the spark gap ceases to conduct and the line charges up until the next ring from the anode of the trigger valve.

26. The discharge time of the artificial line is normally $\frac{1}{2}$ µs but when contacts of relay F close the number of sections in the network is increased to give a discharge time of 1 µs and when, in addition, contacts of relay G close the number of sections is further increased to give a discharge time of $2\frac{1}{4}$ µs. The switching of the pulse length by relays F and G is described in para. 35-40.

27. Valve V10 (CV349) is filled with argon and oxygen at a pressure of approximately 3 atmospheres. The main gap consists of two saucer-shaped molybdenum electrodes the lower one having a hole formed in it in which is inserted the tungsten trigger electrode. The small clearance between the trigger electrode and the main gap electrode forms the trigger gap.

28. When the potential across the trigger gap rises to about 3 kV the gap breaks down to give free electrons which will flow to the positive trigger electrode and positive ions which will flow to the negative electrode of the main gap. If a sufficiently high voltage exists across the main gap these positive ions will travel fast enough to knock electrons off the neutral molecules in the main gap. These molecules will be under a considerable electrical strain owing to the potential across the gap, but this is not sufficient to cause breakdown. The collision of the high-speed positive ions with the strained neutral molecules will, however, cause breakdown and as a result more positive ions are produced. There is thus a progressive ionisation once the trigger gap has arced over. As the trigger pulse takes a definite time to break down the trigger gap and also because the ionisation of the main gap introduces a lag, the modulating pulse occurs slightly later than the back edge of the priming pulse.

29. After the delay network has completed its discharge through the spark gap the voltage across the main gap is zero and the positive ions tend to move towards the trigger electrode which has a slight negative charge due to electrons which flowed into C22 (0·001 µF) when the trigger gap arced. The positive ions are neutralized at the trigger electrode to become neutral molecules and the gap returns to its non-conducting state.

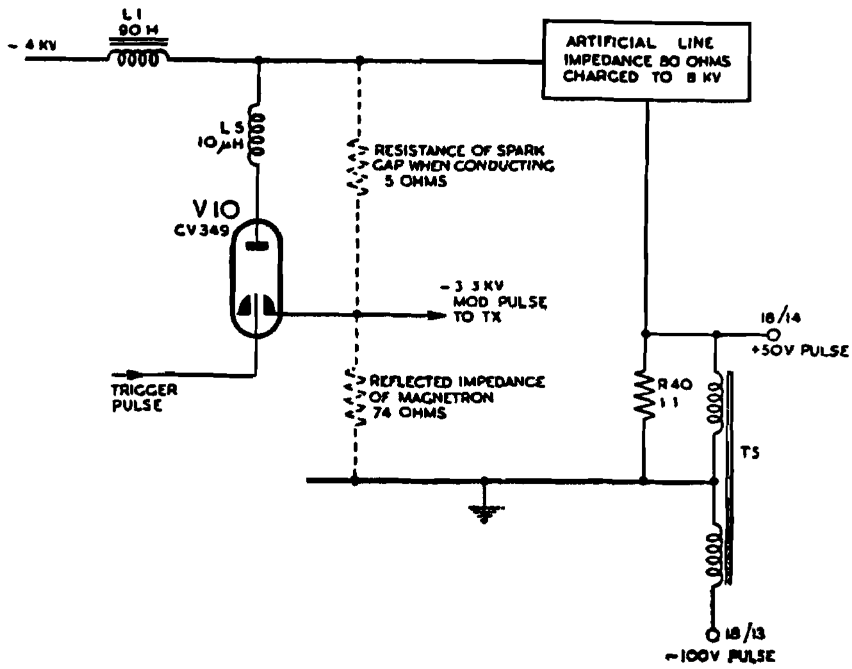

Fig. 12. Modulator output circuit

30. A small percentage of oxygen is included in the gas filling of the valve to initiate the flash-over of the gap as oxygen is much more readily ionised than argon. When the oxygen is largely used up in the formation of oxides of tungsten and molybdenum during the flash-over intervals the gap will become erratic and unserviceable.

31. The method of charging the artificial line between pulses is known as resonant charging as the action of the charging choke L1 (90H) and the components of the artificial line when the —4 kV supply is connected in series is similar to that of a resonant circuit. Immediately the condensers of the line have discharged and the spark gap de-ionised the —4 kV supply is connected in series with the 90 henry choke, the discharged line, resistor R40 (1·1 ohms), and the variable resistor RV5 (*shown in fig.* 14). The condensers of the line begin to charge and the charging current is approximately sinusoidal. When the condensers have charged to —4 kV it might be expected that the charging would cease but the energy stored in the magnetic field of the choke causes it to continue until the condensers are charged to —8 kV. This potential exists across the spark gap at the moment it becomes conducting.

32. Assuming the resistance of the spark gap when conducting to be 5 ohms and the reflected impedance of the transmitter circuit to be 74 ohms, there is a total impedance of about 80 ohms across the artificial line when the main gap arcs over. The line can be regarded as a battery charged to —8 kV and with an internal resistance of 80 ohms. The current flowing n the circuit is consequently 8,000/160 or 50 amps. Thus the voltage drop across the artificial line is 4 kV and that across the pulse transformer primary 3·7 kV. The output from the secondary of the pulse transformer to the cathode of the magnetron is approximately —14 kV. The components of the line are so chosen that the energy stored is discharged in ½ μs (or 1 or 2¼ μs by increasing the number of sections in the network) when the line is matched to its load. The current discharged should build up to its maximum value of 50 amps in about 0·1 μs.

33. An overload relay (relay E) is connected in parallel with potentiometer RV5 in the 4 kV rectifier circuit (*fig.* 14). This relay operates when the current in the circuit exceeds the safety limit, its action and the setting of the safety limit by RV5 (ADJUST OVERLOAD) is described in para. 49. Excessive current may be caused by prolonged ionisation of the spark gap, too high a p.r.f., or any fault in the transmitter which causes the pulse transformer primary to present a mismatch in the spark gap circuit.

34. Since resistor R40 (1·1 ohms) is in series with the artificial line a positive 50V pulse co-incident with the modulating pulse is developed across it; this pulse is fed to pin 18/14. The auto-transformer T5 develops a —100V pulse which is fed to pin 18/13. Neither of these outputs is used in H2S Mk. 4A.

Pulse length switching

35. Changes in the length of the modulating pulse, by altering the number of sections in the network which forms the artificial line, take place at the same time as changes in the p.r.f. of the pulse by altering the counting-down circuit in the waveform generator (*Chap.* 14) which develops the modulator locking waveform (*para.* 12) from the 80V AC supply. The pulse length switching circuits are shown in fig. 13; normally neither relays F nor G in the modulator are operated and the number of sections in the artificial line gives a pulse length of ½ μs. The locking pulses from the waveform generator occur at 1,000 p.p.s. and consequently the modulating pulse is also generated at this p.r.f.

36. When the SCALE switch on indicating unit, Type 300 is put in the 2M position card S8 earths pin 12/3 which is connected through junction box, Type 341 to pin 12/10 on the waveform generator thus energizing relay B which is connected between pin 12/10 and +330 V. Contacts B2 and B3 (*not shown in fig.* 13) reduce the p.r.f. of the locking pulse from 1,000 to 500 p.p.s. and at the same time contact B1 earths pin 12/11 which is connected through junction boxes, Type 341 and 326 to pin 18/10 on the modulator. This energizes relay B in the modulator and contacts B2 close connecting relay F across the 24V DC supply (link 5 is kept closed for use in H2S Mk. 4A). When relay F operates its contacts increase the number of sections in the artificial line to

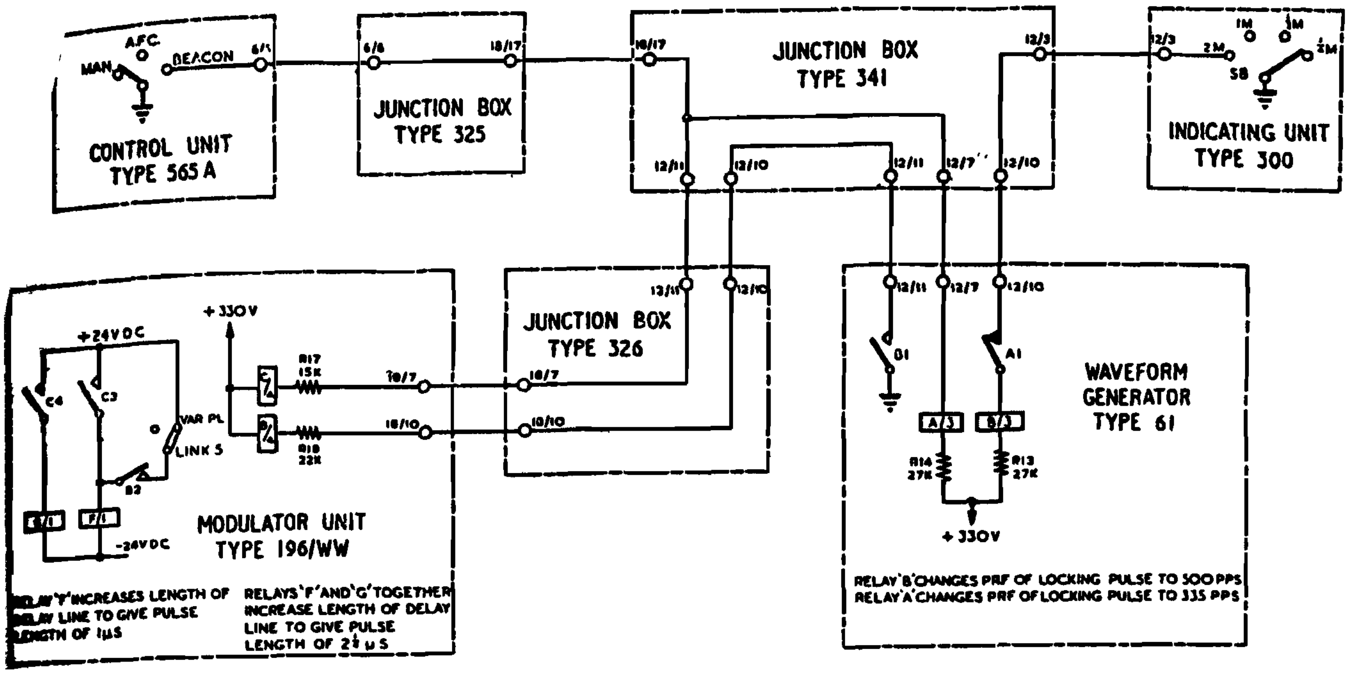

Fig. 13. Pulse length switching

give a discharge time of 1 μs. Thus the length of the modulating pulse is increased to 1 μs and its p.r.f. reduced to 500 p.p.s.

37. When the tuning switch on control unit Type 565A is in the BEACON position pin 6/6 on the control unit is earthed. This pin is connected to pin 12/7 on the waveform generator and to pin 18/7 on the modulator. In the waveform generator this energizes relay A, two contacts of which (*not shown in fig.* 13) reduce the p.r.f. of the locking pulse to 335 p.p.s. At the same time contact A1 opens, preventing relay B from operating.and thus overriding the action of the SCALE switch on indicating unit, Type 300, described in para. 36. When pin 18/7 on the modulator is earthed, relay C operates and contacts C3 and C4 connect relays F and G across the 24V DC supply. The contacts of relays F and G increase the number of sections in the artificial line to give a pulse length of 2¼ μs. [illegible] the length of the modulating pulse is increased to 2¼ μs and its p.r.f. reduced to [illegible].

38. Early models of transmitter-receiver, TR.3523E are fitted with pulse transformers which are not capable of handling the length of 2¼ μs at a p.r.f. of about [illegible] p.p.s. When these transmitter-receivers [illegible] a modification to control unit, Type 565A prevents pin 6/6 being earthed and consequently the switching in the modulator and waveform generator described in para. 37.

39. In addition to operating relays F and G, relays B and C in the modulator also vary the p.r.f. of the internal locking circuits, but as these circuits are not used, this function is not described. If link 5 is open, relay F will not be operated when the equipment is switched to the 2M scale and the pulse length will be ½ μs as on the other scales. For operation in H2S Mk. 4A this link must be closed.

40. When pin 18/6 is earthed relay A (*fig.* 1) is operated and contact A1 operates relay F (if link 5 is closed) thus giving a 1 μs pulse length. This switching is used to change the pulse length but not the p.r.f. when the internal locking circuits of the modulator are employed; pin 18/6 is not externally connected in H2S Mk. 4A.

Power supplies

41. The 80V AC supply enters the unit on pins 18/1 and 18/2 and is fed through an interference suppressor (U1) to the primary windings of transformers T2 and T4 (*fig.* 14). Transformer T4 has two 4V secondary windings which supply the

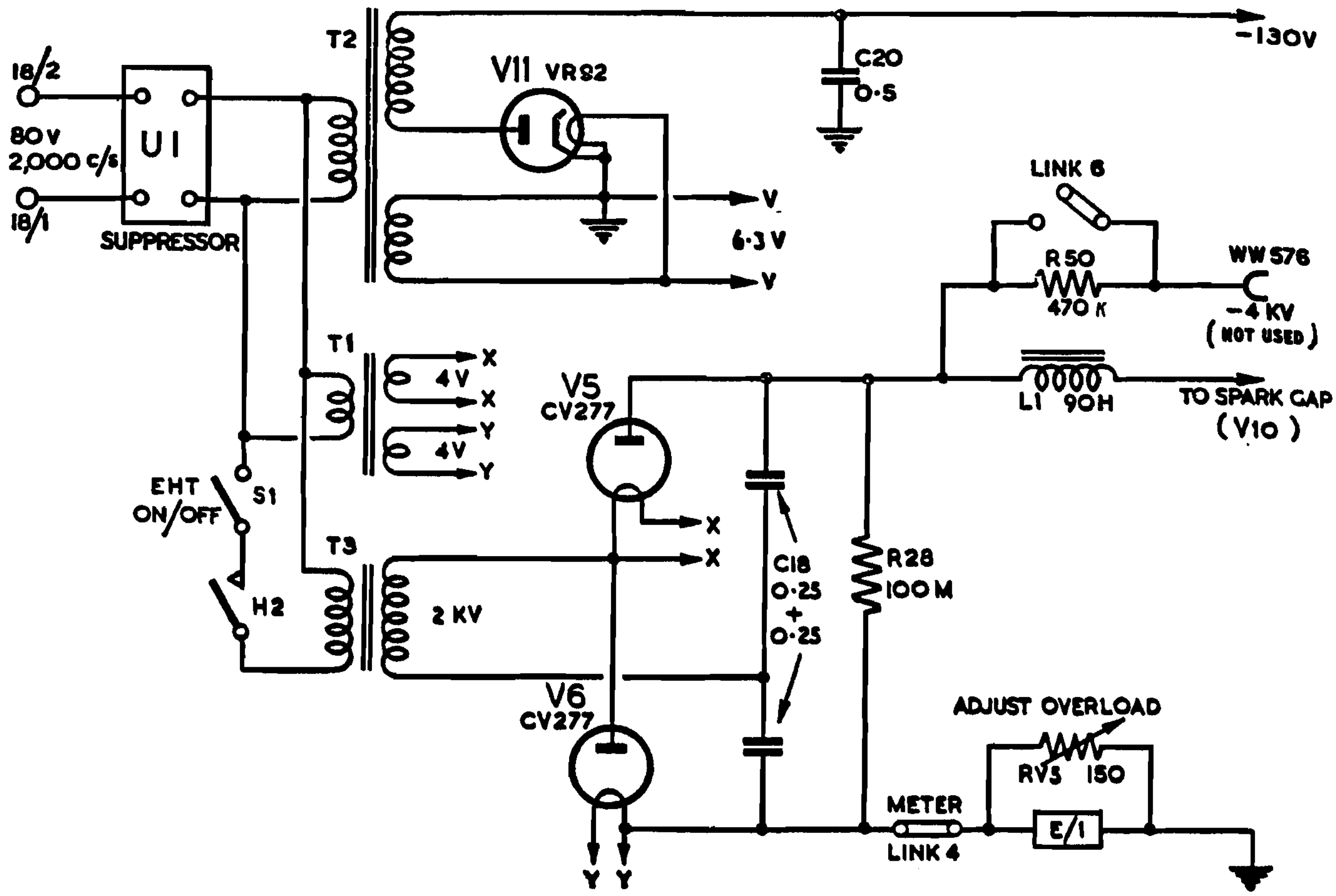

Fig. 14. Power pack

heaters of the high voltage rectifiers V5 and V6. The heaters of the remainder of the valves in the unit are supplied by a 6·3V winding on T2 which has one side earthed. A separate secondary winding on T2 is connected to a low-current rectifier (V11, VR92) which develops a —130V bias supply; this supply is smoothed by condenser C20 (0·5 μF).

42. The AC supply is also fed through switch S1 (EHT ON/OFF) and relay contact H2 to the primary of transformer T3 which is connected with V5 and V6 (CV277) and condenser C18 (0·25 + 0·25 μF) in a voltage doubler circuit generating —4 kV for the modulator output circuit. The input taps on transformer T3 are adjustable and enable the peak output power of the modulating pulse to be varied between 160 and 200 kW. The —4 kV supply is fed through the 90 henry choke (L1) to the artificial line and spark gap, and also through resistor R50 (270K) to a high voltage WW socket on the front panel of the unit. The output from this socket is 4·5 kV DC at a maximum current of 2 mA when the modulator is on full load and R50 is shorted by link 6. If link 6 is open, a reduced voltage output is obtained, depending on the current drawn which must not exceed 1·2 mA. As this supply is not used in H2S Mk. 4A the position of link 6 is not important.

43. The 330V HT supply for the modulator is fed from the power units via junction boxes, Type 341 and 326 to pin 8 of the 18-way WW plug. When the internal locking circuits are not used the supply to valves V1 and V2 is broken by switch S2.

44. The 24V DC supply is fed from pins 18/4 and 18/5 through a suppressor to the internal blower motor. This supply is also fed from the suppressor to a two pin WW plug on the front panel of the unit, and this plug is connected through a length of cable to the external blower motor at the rear of the wind tunnel.

HT switching and protective circuits

45. Details of the modulator HT switching and protective circuits can be seen from fig. 16. This figure also shows the overload

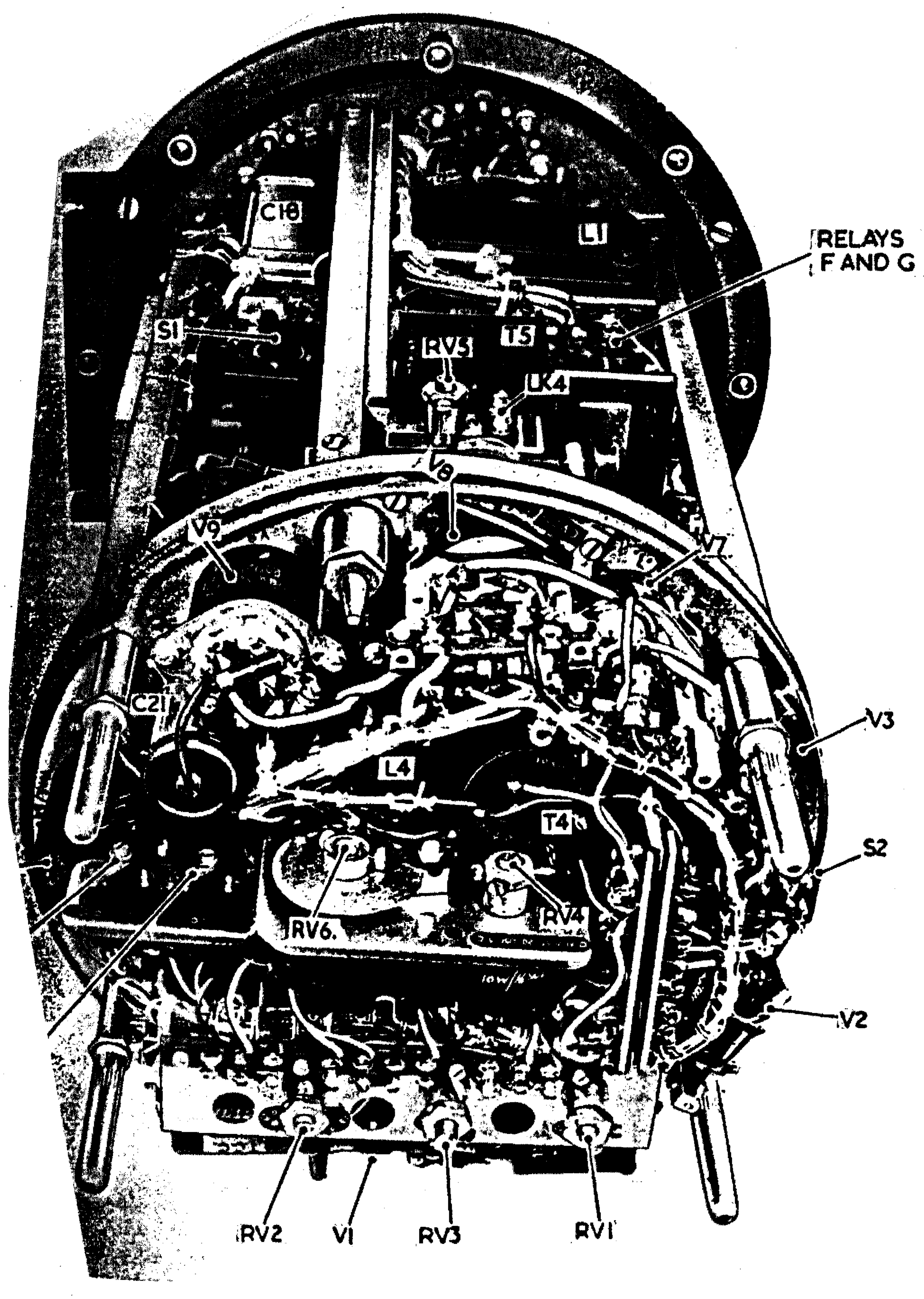

Fig. 15. View showing rear of trigger chassis

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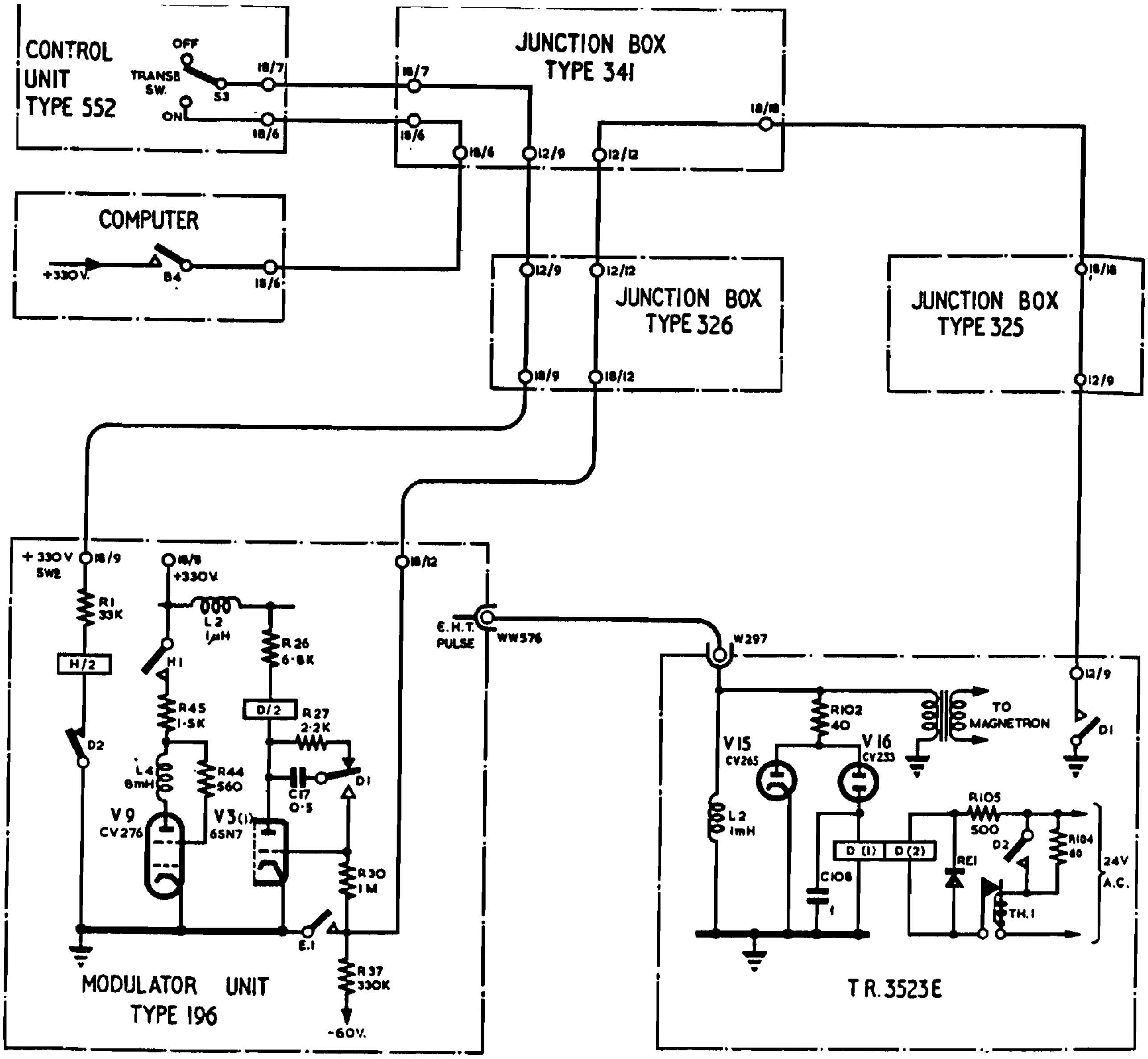

(A.L. 22)

Fig. 16. HT switching and protective circuits

circuit in transmitter - receiver, Type TR.3523E and the switching circuits in control unit, Type 552 and the computer for the sake of clarity.

46. The safety valve (V3 (1)) switches off the modulator if an overload develops in the modulator or transmitter high voltage circuits and keeps it switched off for 10 seconds. Normally, this valve is cut off by a grid bias of —60V so that relay D is not energized and its contacts are in the positions shown in fig. 16.

47. When the H2S Mk. 4A equipment is switched on the 80V AC supply to pins 18/1 and 18/2 and the 330V HT supply to pin 18/8 are completed. Thus all the valve filaments warm up and the priming pulse generator begins to operate. Relay H is not energized, however, as there is no 330V supply to pin 18/9 and in consequence the HT supply to the trigger valve is broken by contact H1 and the 80V supply to the EHT transformer (T3) by contact H2 (*fig.* 14).

48. Three minutes after the H2S equipment is switched on, relay contact B4 in the computer (*Chap.* 10) closes, completing a 330V supply to a switch in control unit, Type 552. This switch is the TRANSMITTER ON/OFF switch and when it is in the *on* position the 330V supply from the computer is fed to pin 18/9 on the modulator thus operating relay H (relay contact D2 is normally closed). When relay H operates contact H1 completes the HT supply to the trigger valve and contact H2 completes the 80V supply to the EHT transformer provided that switch S1 is closed. Switch S1 (EHT ON/OFF) is used to switch the modulator power circuits on and off during servicing, but must be left in the closed position for operation in aircraft. The modulator is now fully switched on but the modulating pulse can be switched off by means of the TRANSMITTER ON/OFF switch on control unit, Type 552. Details of the action of the delay circuit in the computer are given in Chap. 10. The purpose of the three minutes delay is to prevent damage in the modulator or transmitter circuits due to the development of high voltages before the valves have properly warmed up.

49. As described in para. 33 the overload relay E is connected in parallel with the variable resistor RV5 (150 ohms) in the voltage doubler circuit (*fig.* 14). The variable resistor RV5 (ADJUST OVERLOAD) is set by the manufacturer so that the relay operates when the current flowing through the relay and resistor in parallel reaches 100 mA ; link 4 enables this current to be measured by connecting an ammeter in series with the power pack and the relay.

50. The normal mean current in the modulator output circuit is less than 100 mA but a fault may occur which causes it to rise above this level. Relay E then operates and initiates the following chain of events.

(1) Contact E1 connects the grid of V3 (1) to earth through the leak R30 (1M). The valve conducts and relay D in its anode circuit is energized.

(2) Contact D1 connects the feedback condenser C17 (0·5 μF) between the anode and grid of V3 (1). Contact D2 opens, thus breaking the earth connection to relay H which releases.

(3) Contact H1 disconnects the 330V HT supply to the trigger valve and contact H2 breaks the 80V supply to the EHT transformer. As a result the 4 kV power pack stops operating, the current through relay E falls to zero, and the relay releases.

(4) When relay E releases, contact E1 opens and the grid of V3 (1) is returned to —60V through R30 (1M) and R37 (330K). This tends to cut the valve off but the rise in anode potential is fed back to the grid through C17 thus delaying the fall in anode current. In about 10 seconds the anode current will have fallen sufficiently, however, for relay D to release.

(5) Relay D releases and contact D1 restores the safety valve circuit to its normal state. Contact D2 remakes the earth connection to relay H which operates, provided that the TRANSMITTER ON/OFF switch on control unit, Type 552 has not in the meantime been put in the *off* position.

(6) Relay H operates and contact H1 reconnects the HT supply to the trigger valve. Contact H2 restores the 80V AC supply to the EHT transformer and the modulator is again fully switched on. If the fault which caused relay E to operate has now cleared normal operation will be resumed. If the fault persists, however, relay E will trip again and the cycle will repeat.

51. An overload relay (relay D in *fig.* 16) is also connected in the primary circuit of the pulse transformer in transmitter-receiver, Type TR.3523E. A full description of the method of operation of this circuit is given in Chap. 4. When an overload develops relay D operates and contact D1 earths pin 9 of the transmitter 12-way W plug. This pin is connected via junction boxes, Types 325, 341, and 326 to pin 12 of the modulator 18-way WW plug and thence to the grid circuit of the safety valve V3 (1). The operation of relay D in the transmitter consequently has the same effect as the operation of relay E in the modulator in initiating the cycle described in para. 50. The modulating pulse is cut off for at least 10 seconds giving the transmitter circuits time to recover.

Internal locking circuits

52. In H2S Mk. 4A the modulator priming pulse generator runs at a p.r.f. which is determined by the locking waveform fed to it from waveform generator, Type 61 and the internal locking circuits of the

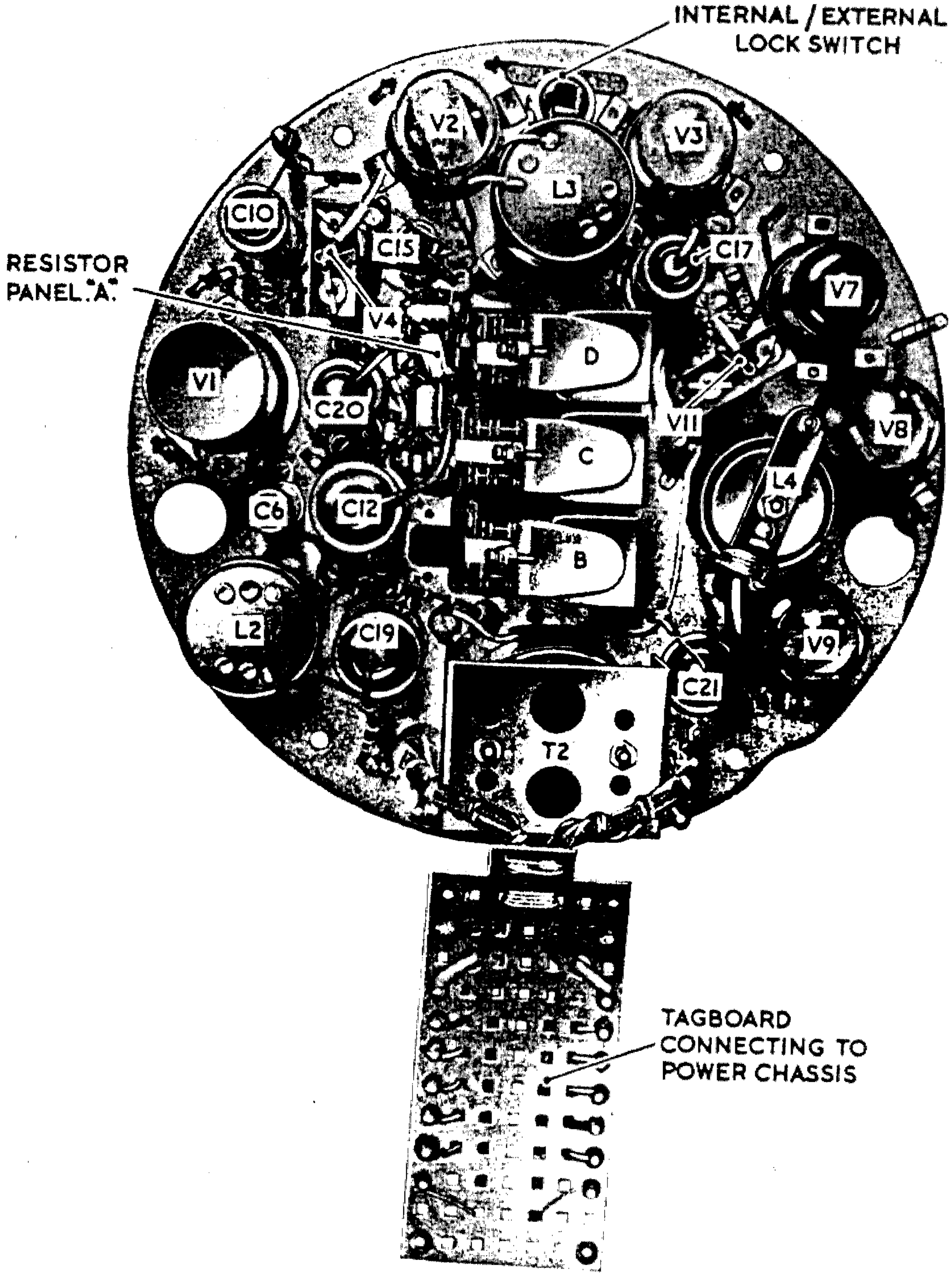

Fig. 17. Front view of trigger chassis separated from power chassis

modulator are not used. A brief description of these circuits (*fig.* 1) is given below, however, as it may be desired to use them when setting up the transmitter without using the whole equipment.

53. Valve V1 (VR91) is a phase-shift oscillator which produces a sinusoidal waveform at its anode. The frequency of the output is determined by the resistance-condenser network between anode and grid and can be set to 1,200, 950, or 850 c/s for normal operation by altering the positions of links 1 and 2; a fine control of the p.r.f. is provided by RV2. By earthing pin 18/10 relay B is operated and the p.r.f. of the circuit is reduced to 600 c/s by switching in a different network; a fine adjustment of the p.r.f. is provided by RV3. Similarly, by earthing pin 18/7 relay C is operated and the p.r.f. reduced to 350 c/s., RV1 providing a fine adjustment.

54. The sine wave from the anode of V1 is fed through a long time-constant circuit (R14, C11) to the grid of V2 (2) (6SN7) which is a squaring stage. The square waves from the anode of V2 (2) are fed to the grid of V2 (1) which has a ringing circuit in its anode. The output from V2 (1) consequently consists of positive and negative rings which are fed through the INTERNAL/EXTERNAL LOCK switch to the priming pulse generator. The positive voltage rings are removed by a diode (V4, VR92) and the negative rings lock the priming pulse generator to run at the same p.r.f. as the phase-shift oscillator.

CONTROLS AND CONNECTIONS

Pre-set controls

55. Although other settings may be used when setting-up the H2S Mk. 4A equipment on the bench the pre-set controls in the modulator must be set as described below before the unit is inserted in its pressurized cylinder.

Modulator power pack switch

56. Switch S1 (EHT ON/OFF) is used to switch off the —4 kV power pack when servicing, but must be finally left in the *on* position.

Lock switch

57. Switch S2 (INTERNAL/EXTERNAL LOCK) must be in the *external lock* position so that the priming pulse generator runs at the same p.r.f. as the locking pulses from the waveform generator.

Pulse length control

58. The variable resistor RV5 (ADJUST 20 μs) must be set so that the length of positive priming pulse at pin 18/16 is 20 μs at half amplitude.

Overload adjustment

59. The variable resistor RV5 (ADJUST OVERLOAD) must be set so that relay E operates when the current in the voltage-doubler circuit reaches 100 mA. Link 4 enables a meter to be connected in series with the overload circuit to check the current.

Modulator output power

60. The 80V input taps on transformer T3 must be set for minimum output from the voltage doubler circuit.

Stabilized p.r.f. controls

The variable resistors RV1 (ADJUST 850) RV2 (ADJUST 850-950-1200), and RV3 (ADJUST 600) control the p.r.f. of the modulator internal locking circuits. As these circuits are not used in H2S Mk. 4A the settings of the controls are not important.

Free p.r.f. control

62. When the modulator is switched to *external lock* but no trigger pulse is fed to the unit RV6 (FREE PRF) can be used to control the p.r.f. of the priming pulse generator if link 3 is in the *cont.* position. The setting of this control is not important in H2S Mk. 4A as link 3 is in the *lock* position.

Links

63. Links 1 and 2 control the various stabilized frequencies of the internal locking circuits. The position of the links is not important in H2S Mk. 4A.

64. Link 3 must be in the *lock* position for internal or external locking of the modulator. When the INTERNAL/EXTERNAL LOCK switch is in the *external lock* position but there is no locking pulse on pin 18/15 and link 3 is in the *cont.* position the p.r.f. of the priming pulse generator is controlled by the FREE PRF control. For use in H2S Mk. 4A link 3 must be in the *lock* position.

65. Link 4 enables a meter to be connected in series with the voltage doubler circuit so that the overload adjustment can be set correctly. The link must be closed for normal operation of the modulator.

66. Link 5 must be closed (*Var PL* position) for use in H2S Mk. 4A. If it is left open (½ μs *only* position) the pulse length will remain ½ μs when switching to the 2M scale instead of increasing to 1 μs.

67. Link 6 is in parallel with R50 in the external —4 kV DC supply; its position is not critical in H2S Mk. 4A as this supply is not used.

Connections

68. Connections to the modulator are made via one 18-way WW plug and two single pole high voltage WW sockets; details are as follows:—

(1) Plug, Type WW601; 18-way *violet*, connected to junction box, Type 326.

Pins 1 and 2	80V, 2,000 c/s.
Pin 3	Earth.
Pin 4	—24V DC.
Pin 5	+24V DC.
Pin 6	This pin is not connected externally.
Pin 7	Earthed when the equipment is switched to beacon operation if control unit, Type 565A has not been modified.
Pin 8	+330V.(2)
Pin 9	+330V(1) when the TRANSMITTER ON/OFF switch on control unit, Type 552 is in the *on* position and the 80V supply to the equipment has been switched on for at least 3 minutes.
Pin 10	Earthed when the SCALE switch on indicating unit, Type 300 is in the 2M position.
Pin 11	Blank.
Pin 12	Transmitter overload. This pin is earthed if relay D in TR.3523E operates.
Pin 13	—100V, 1μs pulse } Co-incident with the modulating pulse.
Pin 14	+50V, 1 μs pulse } Co-incident with the modulating pulse.
Pin 15	External locking pulse from waveform generator, Type 61.
Pin 16	+50V, 20 μs priming pulse output.
Pins 17 and 18	Blank.

(2) Socket, Type WW576; *plain* —3·5 kV modulating pulse to transmitter-receiver, Type 3523E. (*A.L. 18*).

(3) Socket, Type WW576; *violet*, —4 kV DC output. This socket is not externally connected.

69. In addition to the above plug and sockets there is a 2 pin WW plug (Type 556A) on the front panel which carries the 24V DC supply to the blower motor at the rear of the wind tunnel.

Chapter 4

TRANSMITTER RECEIVER TYPE TR. 3523 E

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

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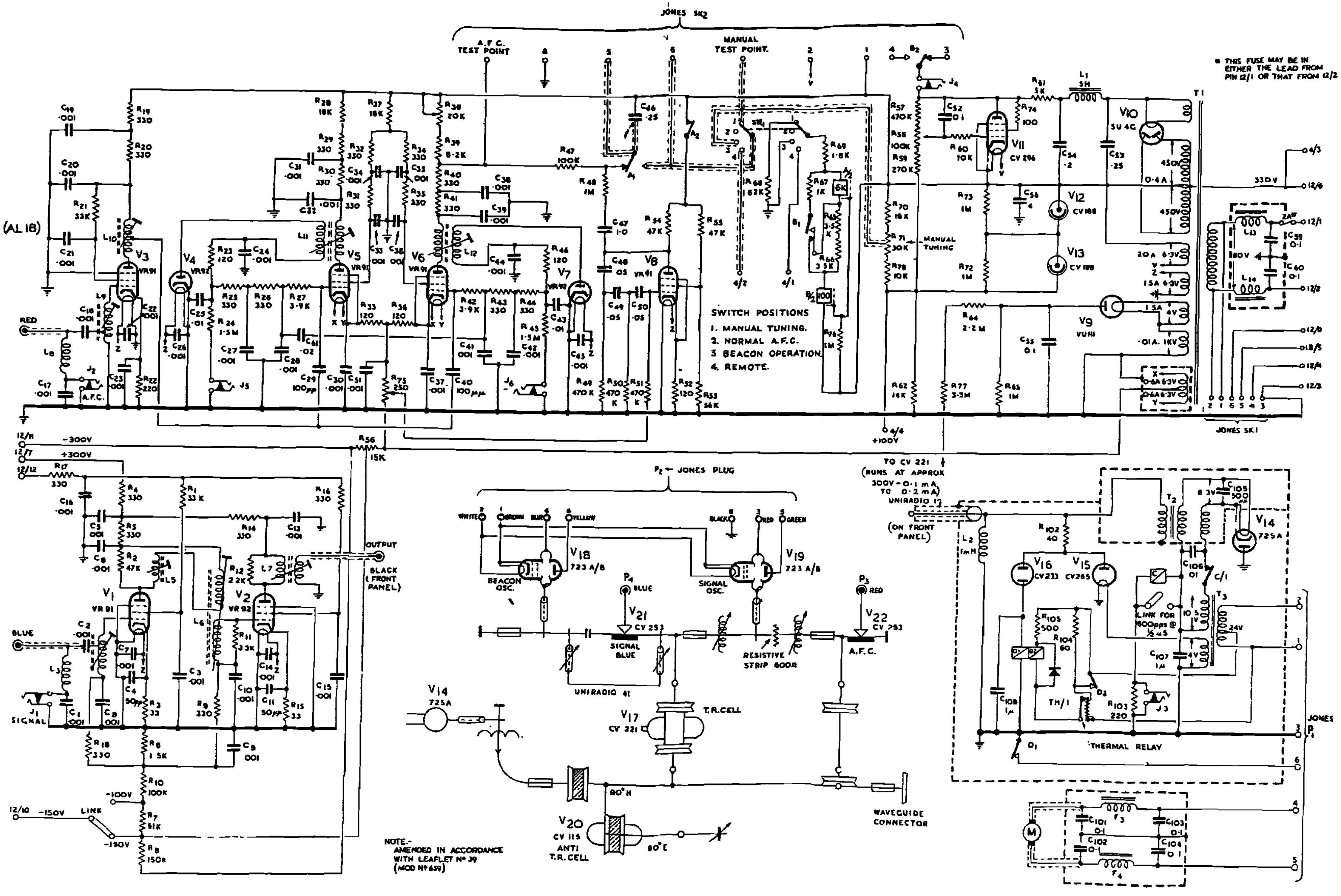

NOTE.- AMENDED IN ACCORDANCE WITH LEAFLET No 39 (MOD No 659) on again until the circuit has had time to recover. If the fault persists the action of the circuit will be to continue switching off the modulating pulse each time it s) re-applied. The 1 μf condenser (C108) in parallel with the winding of relay D(1) smooths the current pulse passed by the spark gap. A transient high voltage will not operate the safety circuits because of the delaying effect of this condenser.

Output waveguide

31. The portion of the output waveguide which is in the TR.3523E is made up of three sections, the first section forming an inteeral part of the magnetron assembly. The magnetron output probe extends about half way across the guide which has a rectangular section. The probe launches an H_0 wave in the guide ; a fixed matching stub is used.

32. The second section of waveguide includes a right angle bend and is sealed off from the third section by means of a mica seal. The first two sections of the guide can thus be kept at atmospheric pressure regardless of the height at which the aircraft is flying ; a Schrader valve is provided in the second section. The mica window is supported by a backing plate and the window must be inserted with the mica facing the magnetron. RF arcing is unlikely in the pressurised sections if the joints are airtight.

33. The third section of the waveguide runs from the pressure seal to the front panel of the unit. This section has three branch arms leading to the anti-TR cell, TR cell, and AFC mixer.

COMMON T AND R SYSTEM

34. The physical details of the waveguide assembly are shown in *fig.* 9 ; the final section of guide passing to the front panel forms the common T and R system.

35. The anti-TR cell (V20) is mounted in a stub which is coupled to the main wave guide in the H plane ; a $\frac{\lambda g}{2}$ plate mounted opposite maintains a 0·5 : 1 coupling over a $\pm$ 2 per cent. frequency band, without introducing appreciable reflection along the waveguide. The cell itself is an argon-filled, type CV115, having a tuning piston which may be adjusted to obtain the maximum flow of echo signal energy into the TR cell.

36. During the period of the transmitter pulse, flash-over of the tuned slot in the type CV 115 effectively makes the side of the main guide continuous and the stub has no effect. When the signals return the tuned slot cannot arc with the low potentials and the effect of the stub is that of an impedance which when added vectorially to that of the arm leading to the magnetron causes the signals to see a high impedance in the direction of the magnetron when they reach the junction of the TR cell branch arm.

37. The TR cell (V17) coupling occurs $\frac{\lambda_g}{2}$ further along the guide, and is in the E plane. The cell is a CV 221 or 1B24 type of valve, an improved type having a wider pass-band than the earlier corresponding type CV114. The probe or " keep-alive " electrode of the cell is supplied with a negative potential from a separate rectifier V9 in the power pack contained in the unit, which produces —1,000 V. ; a series resistance of 5·5M is used to limit the current drawn to a safe value of 100 - 200 microamps, and the probe is then at about —300V. The 5·5M resistance is composed of two resistors in series, one being mounted close to the probe to prevent squegging. The TR cell has a tuning control, so that it may be correctly tuned to magnetron frequency for maximum flow of signal energy to the crystal mixer.

38. During the period of the transmitter pulse the tuned rhumbatron in the cell flashes over and effectively makes the side of the main guide continuous. Only a small amount of energy leaks through the cell to the signal mixer and this is insufficient to damage the crystal. During reception the rhumbatron cannot arc over and signals are fed through the cell to the mixer. The probe and " keep alive " voltage are used to ensure speedy ionisation and deionisation of the cell so that the period of flash-over is as nearly as possible coincident with the period of the transmitter pulse.

SIGNAL MIXING

39. *Incoming signals are mixed with the* CW output from a klystron local oscillator

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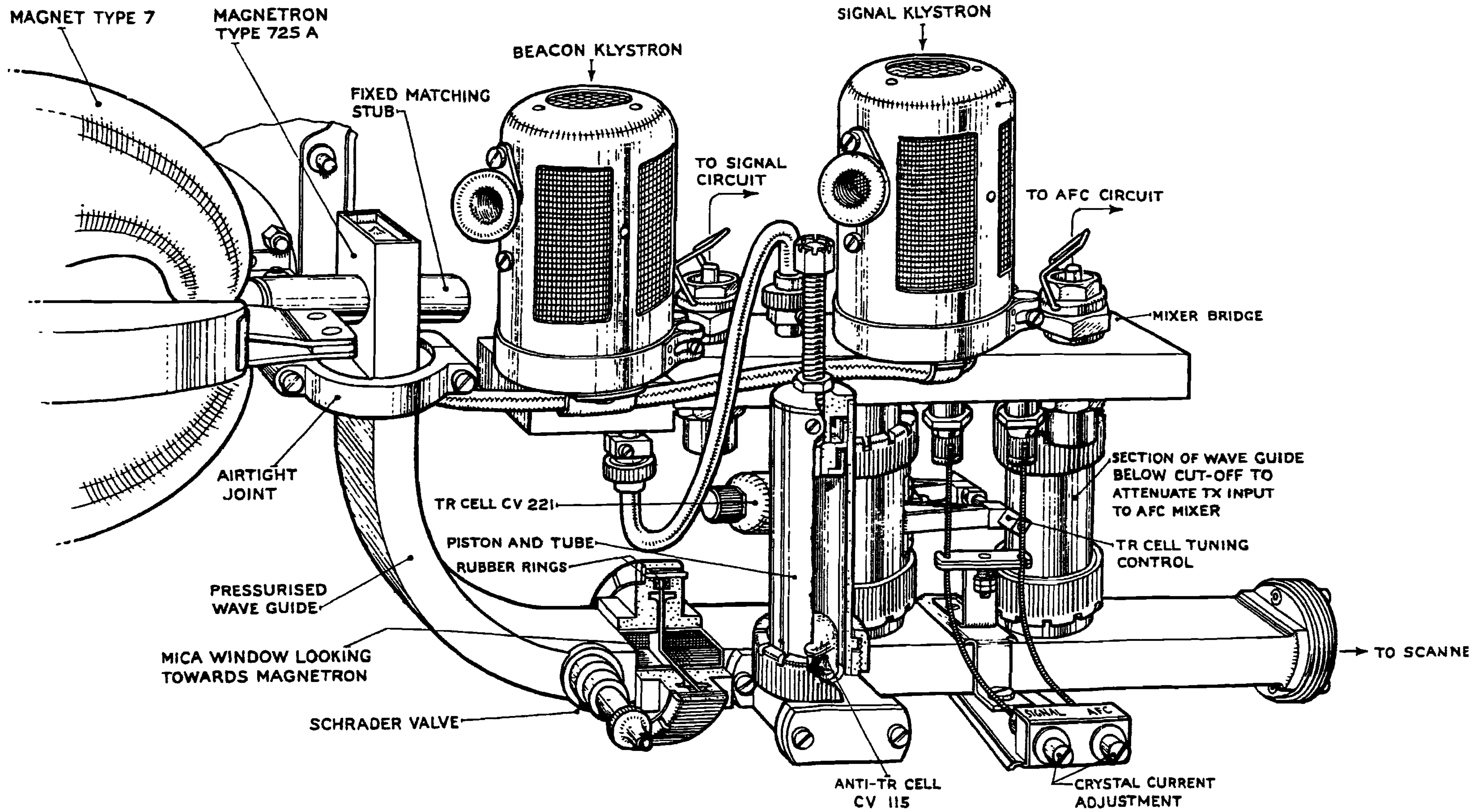

FIG.9. - T.R. 3523 E, WAVE GUIDE ASSE

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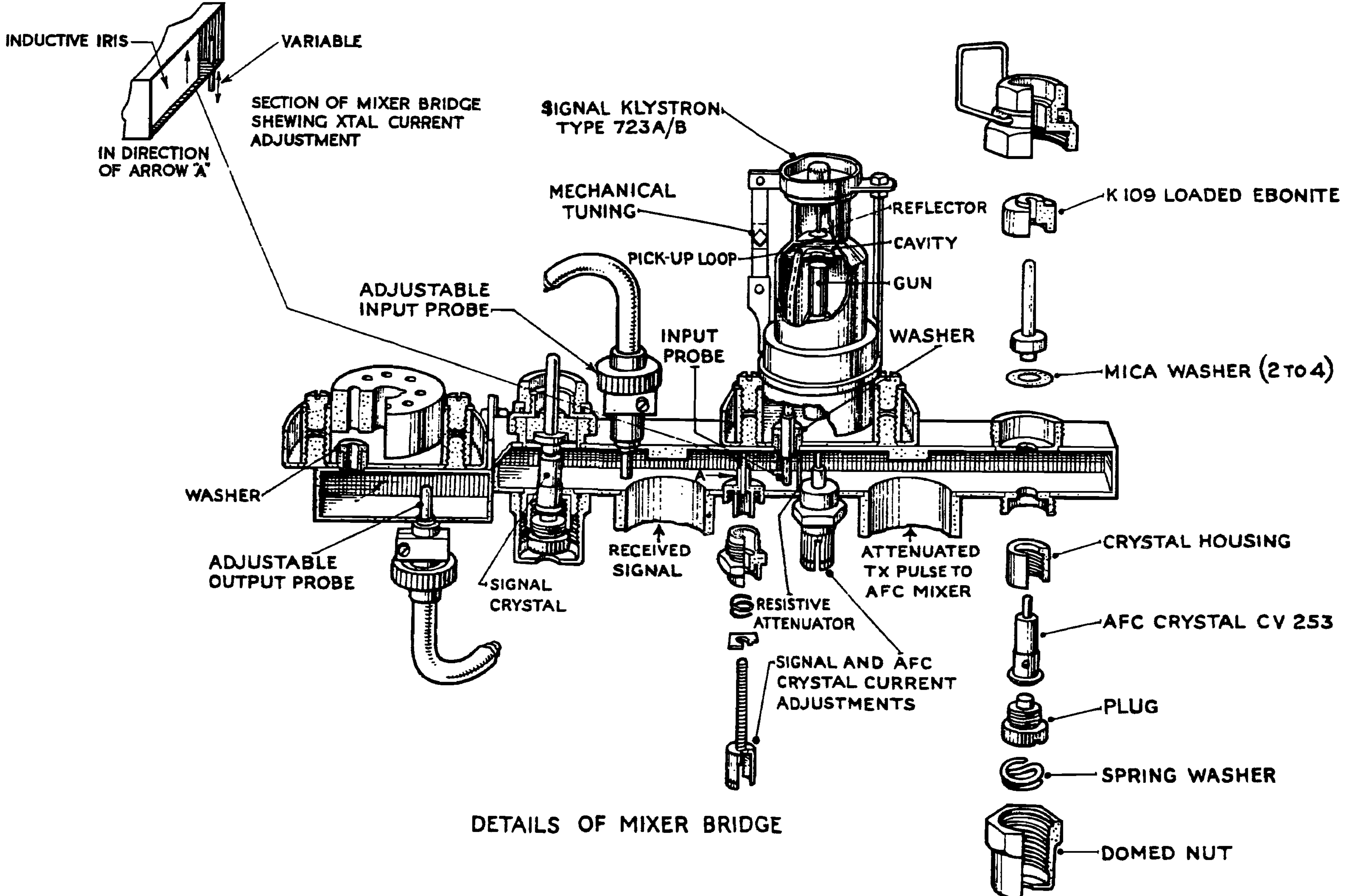

DETAILS OF MIXER BRIDGE

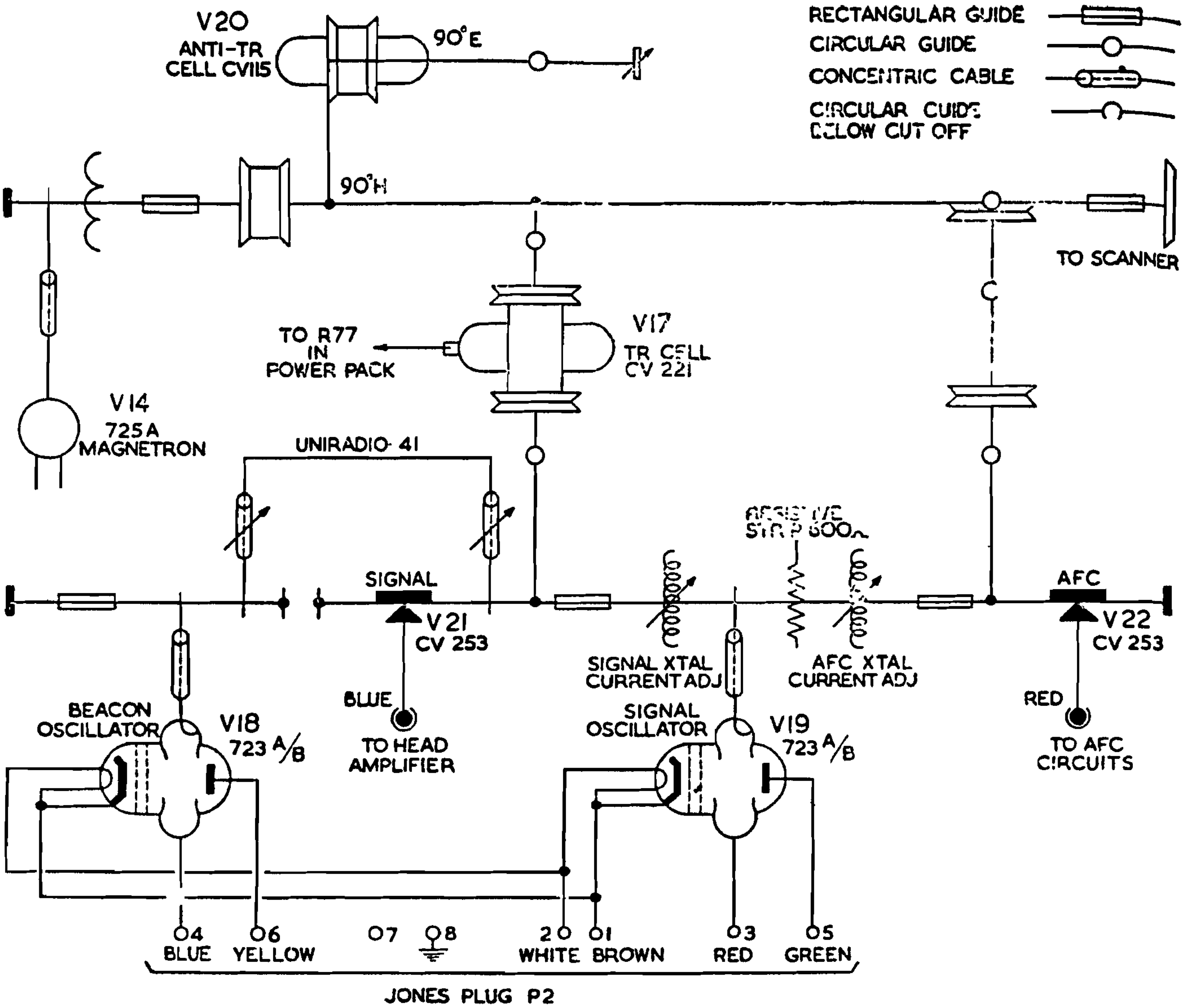

Fig. 10. Waveguide schematic of mixer bridge

(V19, type 723 A/B) details of which are given in para. 49 to 61, to give an intermediate frequency of 45 Mc/s. Reference to *fig.* 9 will show that mixing occurs in one part of a section of waveguide which forms the " mixer bridge." The crystal (V21, type CV 253) is mounted in the guide, and the signal local oscillator, mounted on top, has an output probe brought out through the valve base and into the guide through a hole in its upper surface. The probe is insulated from the guide by a polythene bush.

40. The TR cell coupling is in the E plane, at a point between the crystal and the local oscillator probe, and a plate opposite the junction provides the necessary match between circular and rectangular guide, at the same time improving the degree of coupling.

41. For the best possible heterodyning there is an optimum level of local oscillator feed to the mixer, and this may be checked by observing the resulting crystal current at the jack on the front panel. The correct reading is 0·6 mA, and the method of regulating the local oscillator feed to adjust the current reading is as follows. An iris is fixed across the narrow dimension of the mixer guide, so as to form an inductive slot, at a point near the local oscillator input probe and exactly half a wavelength distant from the centre line of the matching plate mentioned in the last paragraph. The inductive slot is tuned by a variable capacitance formed by an adjustable screw in the lower surface of the mixer guide; this screw may be adjusted by means of a flexible coupling as seen in *fig.* 9.

42. In addition to controlling the amount of local oscillator feed, the presence of the inductive iris and its tuning capacity half a wavelength from the TR coupling has the effect of directing the received signal energy towards the crystal, with very little loss into the local oscillator itself and the AFC mixer section of the guide.

43. The impedance of this tuned circuit in the waveguide will depend on the frequency of the klystron, so any appreciable change of frequency will cause a change in the energy flow to the mixer, varying the crystal current. Final adjustment of the crystal current must therefore be made after the klystron frequency is known to be correct.

Resistive attenuator

44. When the coupling screw is adjusted for correct crystal current, the impedance of the tuned circuit will not be equal to the wave impedance of the guide, so there will be a standing wave between the klystron probe and the diaphragm. This means that the mixer presents a load to the klystron which is partly resistive and partly reactive; the value of the reactive component varies with the frequency, and may, over parts of the required frequency range, be large enough to cause frequency jumps instead of a smooth variation as the reflector voltage of the klystron is varied

45 To minimise this effect a resistive attenuator, consisting of a small strip of panilax coated on one side with graphite, is inserted through two slots in the ½ in. sides of the waveguide. This reduces the standing wave to small proportions, so that no serious difficulty due to frequency jumping is encountered.

Mixer output

46. The output from the signal crystal is rectified CW with a modulation envelope at 45 Mc/s, the difference frequency. A mica washer, in the assembly of the *blue* Pye plug which takes the output, bypasses the RF to the earth provided by the waveguide wall; so the output taken by cable to the head amplifier (para. 92) consists of received signals at 45 Mc/s superimposed on the DC component due to the CW oscillations.

Mixing on "Beacon"

47. There are certain differences in the mixer stage when the beacon klystron (V18, type 723 A/B) is operating. The beacon klystron is mounted on a separate section of waveguide (*fig.* 9) and probe-coupled into it; a nine-inch length of Uniradio 41 terminated in a probe at each end completes the coupling to the mixer. Both probes on the cable can be adjusted, and this provides for setting the crystal current to the correct value of 0·6 mA.

48. In practice, the probe at the klystron end of the cable (the output probe) is always kept in the position of maximum coupling, and adjustment is made only to the input probe; sufficient feed to the crystal can then be obtained with very loose coupling to the mixer. The arrangement minimises loss of signal energy from the mixer to the klystron.

THE LOCAL OSCILLATORS

49. The local oscillators are both American reflector klystrons (valves, type 723A or B). V18 is the beacon and V19 the signal oscillator; both operate in exactly the same manner.

Voltage supplies

50. Details of the supplies to the oscillators are as follows. In the TR.3523E power pack (para. 95) a full-wave rectifier (V10, type 5U4G) develops a 300 volt stabilized supply and the negative side of this is connected to the positive side of the 330V. supply from power unit, type 567D *via* pin 12/6, so that a total HT voltage of 630 volts is available for the klystron resonators. This is applied to one or the other by relay contact B2 (details of switching are given in paragraphs 57 to 61). The cathodes are connected to the + 330 volt line, and the heaters are supplied with 6·3V. AC, one side being tied to the cathode. The reflector voltage is variable, and is controlled on normal operation by the AFC circuit, and on manual tuning by a potentiometer connected between + 330V. and earth; in both circumstances the mean reflector potential is about 90 to 100 volts negative with respect to the cathode. All of these supplies are brought to the mixer bridge *via* a small eight-pin Jones plug and socket at the rear of the amplifying unit sub-chassis.

51. Supplied with the voltages stated above, the klystron oscillates. Its frequency of oscillation may be varied by mechanical means over a range of about 1,000 Mc/s, and when this has been pre-set a variation of about ± 40 Mc/s can be obtained electrically; for the purpose of this equipment the oscillators are mechanically pre-set to a frequency 45 Mc/s below transmitter frequency, and the electrical means of variation is used in automatic frequency control and manual tuning.

Tuning mechanically

52. In mechanical tuning, the shape of the resonant cavity in the valve is distorted; this is achieved by turning a square-ended screw provided on the valve (see the sectioned drawing in fig. 9), which puts a varying pressure on the top of the resonator by flexing a pair of spring bows; clockwise rotation of the screw decreases and anti-clockwise increases the frequency.

WARNING

A special insulated tuning tool is provided, and must always be used when altering the mechanical tuning, because the tuning control screw is at the resonator potential of 630 volts positive with respect to earth.

Tuning electrically

53. In general terms, for any given mechanical setting and the given resonator-cathode potential of 300 volts, these klystrons will oscillate at five different ranges of reflector-cathode potential; this is described as oscillating in five " modes." The mode chosen for use in the TR.3523 series is the third, which means that the valves will oscillate at a range of reflector-cathode potential somewhere between —75 and —135 volts, the mean value usually about —90 to —100 volts. The amplitude of oscillation is a maximum at the mean value, and falls away to either side; the

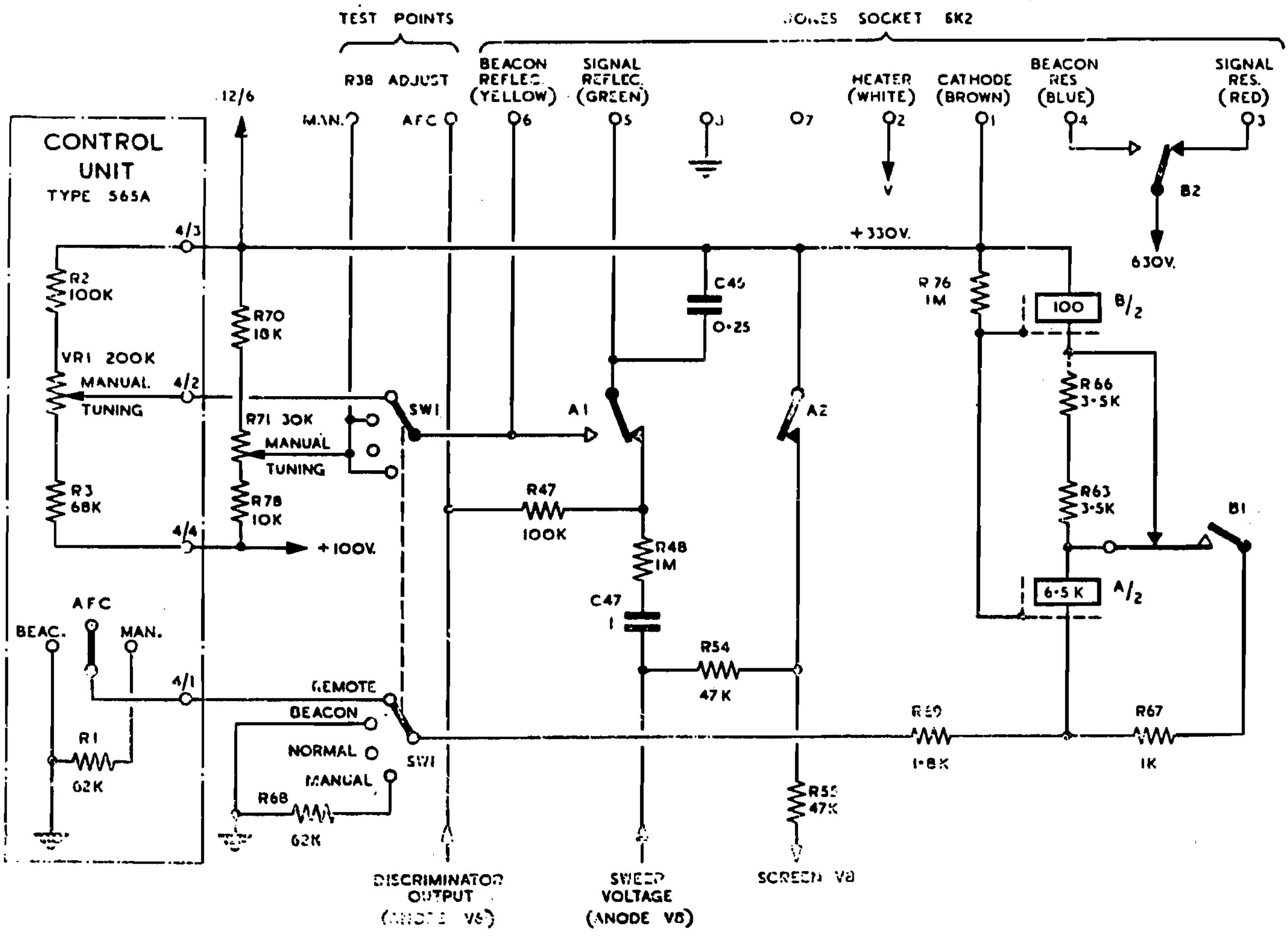

Fig. 11. Local oscillator switching

frequency varies through this point, increasing as the reflector-cathode potential is increased and decreasing as it is decreased. The diminishing amplitude limits the useful range, which also depends to some extent on the loading of the klystron and the coupling; in the conditions of operation in this equipment the useful range of tuning by this method is centre frequency plus or minus 40 Mc/s.

54. As stated in paragraph 50 the cathode of the klystron is held at +330 volts, so tuning is carried out by varying the voltage fed to the reflector. When the reflector potential is brought up towards that of the cathode, frequency falls, and when the voltage is driven down lower, frequency increases.

Manual tuning

55. When the function switch (SW1) on the front panel of the TR.3523E is in the BEACON or MANUAL positions the variable voltage for manual tuning is obtained from the potentiometer chain R70 (18K), R71 (30K), and R78 (10K). This chain is connected in parallel with two neons (V12, V13, type CV188) which are in series with R62 (14K) across the 330V. supply; the voltage drop across the neons and therefore across the chain is approximately 200V. The voltage from the slider of the tuning potentiometer (R71), which is fed to the reflector of the appropriate local oscillator, can consequently be varied from about 50 to about 150 volts below that of the cathode which is at +330V.

56. Reference to *fig.* 11 will show that a potentiometer chain consisting of R2 (100K), VR1 (200K) and R3 (68K) in control unit, type 565A is connected in parallel with the chain in TR.3523E. When switch SW1 is placed in the REMOTE position and the switch on the control unit in the BEACON or MANUAL position the slider of R71 is out of circuit and the voltage from the slider of VR1 in the control unit is fed to the reflector of the appropriate local oscillator.

Switching

57. Details of the local oscillator switching circuits can be seen from fig. 11. In the aircraft installation, as has been explained in paragraph 9 above, the function switch (SW1) and manual tuning control (R71) on TR.3523E are duplicated by controls on control unit, type 565A mounted near the operator. The control unit is connected directly to TR.3523E by means of a 4-way cable and switch SW1 is kept in the REMOTE position. For bench setting-up, however, switch SW1 and R71 can be used and the control unit dispensed with as far as TR.3523E is concerned.

58. When the function switch (SW1) on TR.3523E is in the NORMAL position the windings of relays A and B are open-circuited and the relay contacts are in the positions shown in *fig.* 11. The resonator of the signal local oscillator is connected to the +630V. line and its reflector to the output of the AFC circuit which supplies the tuning voltage (para. 62-91). The beacon local oscillator has no HT supply to its resonator and so cannot operate.

59. In the MANUAL position of switch SW1 the relay windings are connected in series with R68 (62K) between +330V. and earth. Enough current flows through the windings to energize relay A but not relay B which requires a much higher operating current. The resonator of the signal klystron is still fed with 630V. but contact A1 disconnects the reflector from the AFC circuits and connects it instead to the slider of R71; contact A2 cuts off the HT supply to the sweep valve in the AFC circuit.

60. In the BEACON position of switch SW1 the relay windings are connected directly between +330V. and earth and both relays operate. Contact B1 at once brings R66 (3·5K) and R63 (3·5K) into the circuit to limit the current to a suitable holding value and shunts the winding of relay A by R67 (1K) to avoid overloading it. At the same time contact B2 switches the 630V. HT from the resonator of the signal klystron to that of the beacon klystron. The reflector of the beacon local oscillator is already connected to the slider of R71 through SW1. Contacts A1 and A2 disconnect the AFC circuit as described in paragraph 59.

61. When switch SW1 is in the REMOTE position the slider of R71 is disconnected and the voltage from the slider of VR1 in the control unit is used instead. Relay switching is carried out by means of the three-position switch on the control unit. In the AFC position of this switch the circuit is as described in paragraph 58; in the MANUAL and BEACON positions the circuit is as described in paragraphs 59 and 60 respectively except for the change in the manual tuning potentiometer.

AUTOMATIC FREQUENCY CONTROL

62. In normal operation of the equipment the reflector voltage of the signal klystron is varied about its mean value by an automatic frequency control circuit, whose purpose is to ensure that the local oscillator frequency remains always at a constant difference from magnetron frequency. In order to do this, some of the magnetron output is mixed with the local oscillations and passed through a discriminator circuit which is arranged to give a positive or negative-going voltage output as the beat frequency varies from 45 Mc/s towards 43 or 47 Mc/s; this voltage is applied to the klystron reflector, and alters its potential in the sense required to correct the variation. If the beat frequency varies outside the 43 - 47 Mc/s range, a sweep valve comes into operation to bring it in again.

AFC mixing

63. The transmitter feed to the AFC mixer can be seen in *fig.* 9. A circular waveguide is coupled in the E plane between the main guide and the mixer bridge; a section of the coupling guide, near the lower end, has a diameter below cut-off, and the coupling to the main guide is through a small hole. This arrangement feeds only a very small amount of transmitter energy to the mixer bridge. The AFC crystal (V22, type CV253) of the same type as the signal crystal, is mounted in the mixer bridge, and the local oscillator output passing to this mixer is controlled by an inductive iris and tuning screw just as in signal mixing (para. 39). The iris is half a wavelength $\frac{(\lambda)}{2}$ distant from the centre of the circular waveguide input, and this prevents loss of the attenuated transmitter pulses towards the oscillator and signal mixer; the E-plane coupling from the main guide presents a low impedance in series with the mixer and local oscillator, and conveys the local oscillator feed to the crystal.

64. The correct setting of the mixer tuning screw is that which gives a crystal current of 1 mA, and the final adjustment should be made after the klystron frequency has been set up correctly.

65. The AFC mixer output is taken off by the *red* Pye plug, and this has a mica washer incorporated to by-pass the RF component, so that the output passed to the discriminator circuit consists of half microsecond pulses at the beat frequency superimposed on the DC component due to the klystron oscillations, recurring continuously at the PRF of the equipment.

Video amplifier

66. The beat frequency output from the AFC mixer is fed through C18 (0·001 μF) to the grid of V3 (type VR91), a 45 Mc/s pulse amplifier. The DC component of the mixer output is bypassed to earth through the choke L8 and the AFC crystal current jack, J2. When a meter is inserted in J2 the DC component of the mixer output is developed across C17 (0·001 μF) and can be read as a current indication on the meter. The output from the anode of V3 is fed through C29 and C40 (100 $\mu\mu$F) to the grids of V5 and V6 respectively.

Discriminator

67. The pulses applied to the grids of V5 and V6 (type VR91) cause voltages to be induced in the secondaries of the transformers L11 and L12; these are rectified by V4 and V7 (type VR92), which conduct on the positive swings, and smoothed into negative DC voltages, the smoothing time-constants being C25 (0·01 μF), R24 (1·5M), for V4, and C43 (0·01 μF), R45 (1·5M) for V7. The negative voltages are fed back to the grids of V5 and V6.

68. L11 is tuned to 47 Mc/s and L12 to 43 Mc/s. If, therefore, the applied pulses are at 45 Mc/s (that is, equally off-tune for both circuits), the voltages induced in the secondaries of these transformers will be equal, and the negative DC voltages ultimately fed back to the grids of the valves

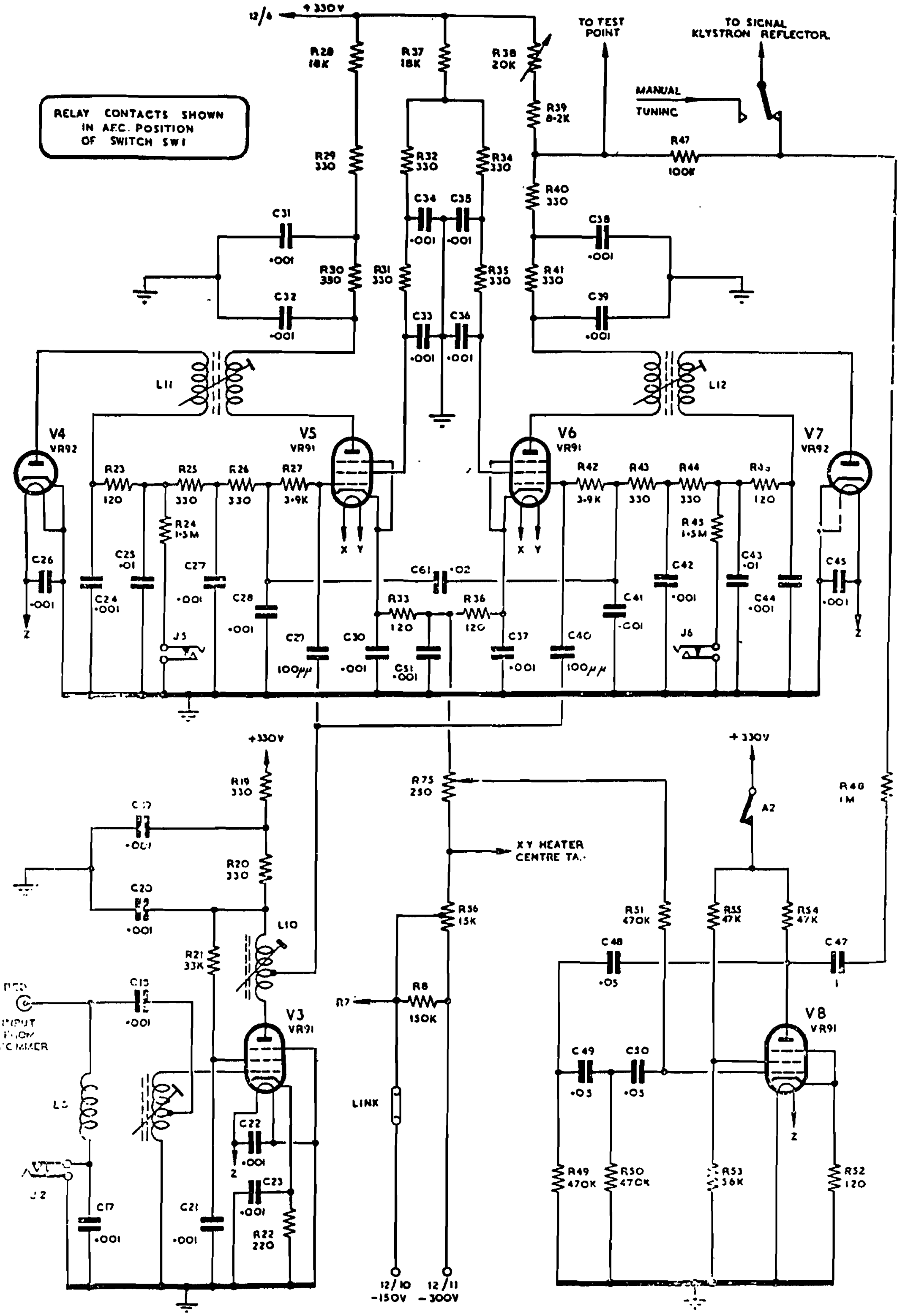

Fig. 12. AFC circuits

will be equal. But if the input drifts towards 47 Mc/s, the voltages induced in the secondary of L11 will be greater, and those in L12 smaller; and the grid of V5 will go more negative while that of V6 rises. Conversely, a drift towards 43 Mc/s will make the grid of V6 more negative, while that of V5 rises.

69. The grids of V5 and V6 are connected through C61 (0·02 μF). If it could be certain that the time-constants C25, R24 and C43, R45 were exactly equal, there would be no need for C61; but component tolerances must be allowed for, and there is a possibility of a greater exponential decay at one grid than at the other in the interval between pulses, upsetting the balance upon which the successful operation of the circuit depends.

70. V5 and V6 also operate as a cathode-coupled DC amplifier, having a common cathode load, R75 and R56, returned to a negative voltage point. The anode load of V5 is fixed, but that of V6 is variable by means of R38 in whose halfway position the valves are equally loaded. Both valves are normally conducting, and if the voltages at the grids are equal, with equal anode loads, the total cathode current will be shared equally between them. This is so when the beat frequency input is at 45 Mc/s.

71. Now, if the input from V3 drifts towards 47 Mc/s, the increased negative voltage on the grid of V5 will cut down the current taken by that valve, and this (assisted by the fact that V6 grid is now less negative) causes an increase in the current taken by V6, and there is a fall in potential at V6 anode.

72. When operating on AFC the anode potential of V6 is applied *via* a suitable smoothing circuit to the reflector of the signal klystron V19. The klystron cathode is at +330 volts, the same as the discriminator HT voltage, and the circuit values have been chosen so that the voltage fed from V6 anode to the reflector when V5 and V6 are balanced is the correct value to tune the oscillator to a frequency 45 Mc/s below that of the magnetron. Exact adjustment of this is made by means of R38 (20K) when setting-up.

73. A fall in potential at the anode of V6 will send the klystron reflector more negative with respect to the cathode, and this will increase the local oscillator frequency (para. 54). Since the local oscillator is tuned below magnetron frequency, an increase of oscillator frequency will decrease the beat frequency, and so tend to correct the original drift which was towards 47 Mc/s.

74. It is easy to follow through the argument in the case of a drift towards 43 Mc/s, and find that the resultant rise at V6 anode decreases local oscillator frequency and again corrects the drift. It will be apparent that the circuit as designed would not function if the klystron were tuned to a frequency 45 Mc/s above that of the magnetron, since the discriminator output would then always tend to increase the error.

75. To obtain the right amount of correction with such a circuit involves careful design and choice of suitable component values; some details of the result achieved are of importance to the user, and will now be more closely considered.

76. When setting-up the equipment, the local oscillator is first manually tuned to the correct frequency; R38 is then pre-set (with no input to V3) to produce at the junction of R39 (8·2K) and R40 (330 ohms) a potential equal to that at the slider of the manual tuning control. When the equipment is operating on AFC this potential is applied to the klystron reflector, and (if the magnetron is correctly tuned) the beat frequency pulses arriving at V3 are at exactly 45 Mc/s. The discriminator circuit is in a balanced condition, since the anode circuits of V5 and V6 are equally off-tune, and the potential at the junction of R39 and R40 is at its mean value as pre-set, known as the mean reflector potential. In this condition the discriminator is regarded as having no output.

77. If a frequency drift now occurs which sends the beat frequency off 45 Mc/s, each off-frequency pulse produces a momentary rise or fall of potential at R39, R40; the discriminator output then consists of large positive or negative-going voltage pulses superimposed on the mean potential. The parallel CR circuit R47, C46, with a time-constant of ·025 second smoothes this output so that the effect at the klystron [illegible] a slight rise or fall above or its mean potential. This does not have to be large; the klystron frequency may change by anything from 2 to 7 Mc/s for one volt change in potential.

78. Now if the correction applied from the discriminator were the exact value required to re-tune the klystron to bring the beat frequency back to 45 Mc/s, the arrangement would be unstable. This is because as soon as the beat frequency returns to 45 Mc/s there is no output from the discriminator to keep the klystron tuned on the corrected frequency, so the beat frequency drifts off again. To produce a stable effect the circuit has been planned so that if a drift occurs the discriminator output immediately produces a slight over-correction. This in turn produces a proportionately slighter overswing in the other direction, and so on, until the beat frequency settles to an approximately stable value, very close to 45 Mc/s.

79. Note that the beat frequency can never be exactly 45 Mc/s so long as any correction is required to be maintained, since at 45 Mc/s the discriminator gives no corrective output. But it will be seen more clearly in the course of the next few paragraphs that it is never so far off 45 Mc/s as to be outside the bandwidth of the head amplifier and IF stages.

Sweep valve

80. The discriminator circuit cannot compensate for a drift of beat frequency beyond 43 or 47 Mc/s. It will be remembered that the amplifier stage V3 is tuned to 45 Mc/s and its output therefore diminishes in amplitude as the input goes off tune. Up to 47 or down to 43 Mc/s this is offset by the tuned circuits in the anodes of V5 and V6 giving a bigger response; at about 47 and 43 Mc/s the potential at V6 anode reaches its lowest and highest values, but beyond these points both V3 and the discriminator valve circuits are going further out-of-tune, and the discriminator output rapidly becomes too small to apply the necessary correction to the oscillator. It is to cover this contingency that the sweep valve has been included in the circuit.

81. The sweep valve V8 (type VR91) is a phase-shift oscillator producing a sine-wave voltage output at a frequency of about 2 c/s. Its anode is coupled back to the grid by the CR combinations C48, R49; C49, R50; and C 50, R51 (each 0·05 μF and 470K), the sum of the phase-shifts introduced by the condensers provides positive feedback of sufficient amplitude to cause sustained oscillation. The grid leak of the valve (R51, 470K) is connected to the slider of the potentiometer R75 (250 ohms) in the common cathode load of the discriminator valves V5 and V6.

82. When there is an appreciable input from V3 to the discriminator the grids of V5 and V6 are fed with negative voltages developed across the diode loads R24 and R45; but when the beat frequency is far off tune the grid potentials can assume a higher value, since the negative voltages across the diode loads are negligible. That is to say, V5 and V6 conduct more heavily when the beat frequency input is far off tune. The values of the components in the circuit ensure that when the input is within 43-47 Mc/s, the reduced current in the valves keeps the potential at the slider of R75 low enough to cut V8 off on its grid; but when the frequency of the input is outside the 43-47 Mc/s range, the increased current in V5 and V6 raises the cathode potential until V8 comes into operation. The actual point at which this occurs is controlled by the setting of R75.

83. The anode of V8 is connected to the klystron reflector *via* C47 (1 μF), R48 (1M), and when V8 oscillates the reflector potential is made to vary sinusoidally over a large range about the mean potential set by R38. The klystron then sweeps through its electrical tuning range, and reaches a point at which a beat frequency within the range of the discriminator is produced. As soon as this occurs, a corrective output is obtained at V6 anode; and the grids of V5 and V6, going more negative, cut down the common cathode current and drive V8 grid below cut-off. The discriminator circuit then continues to hold the beat frequency stable, locking at the point where the beat frequency sits off 45 Mc/s to the extent necessary to correct the klystron frequency by the amount required to give this offset.

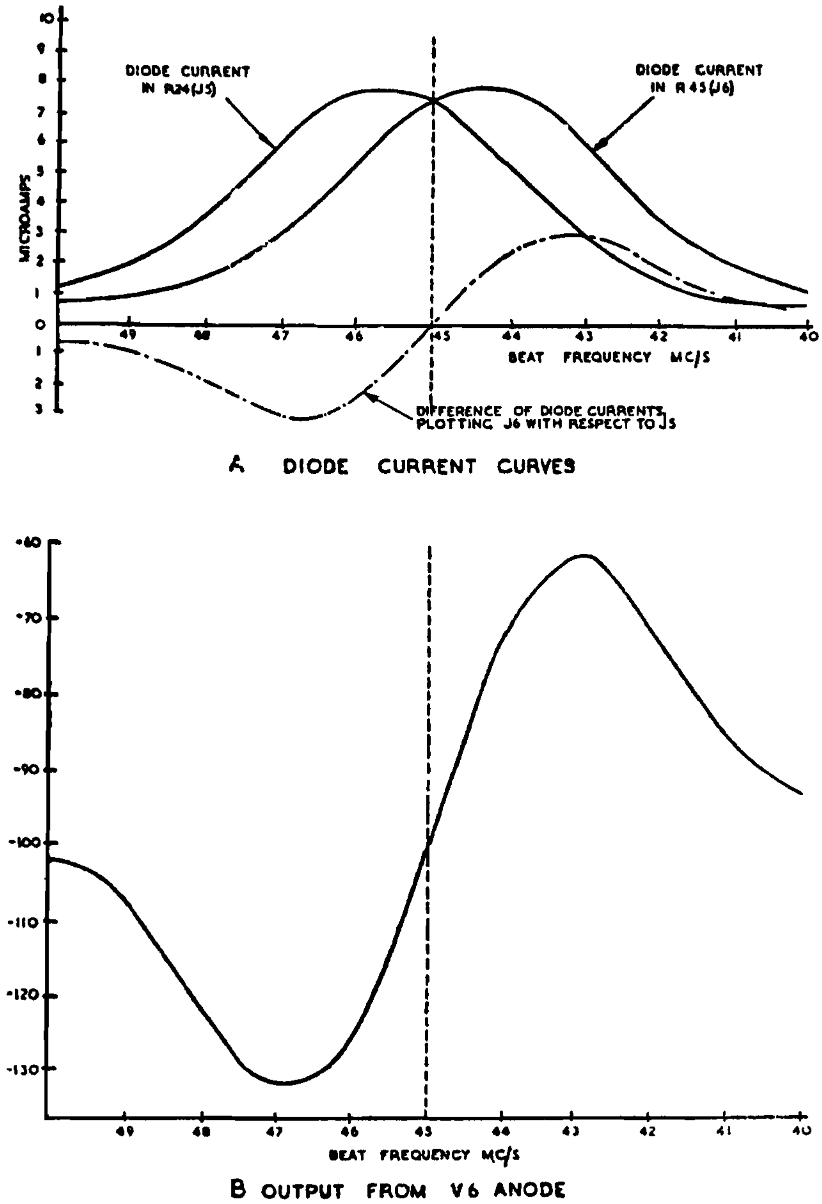

Fig. 13. Discriminator curves

84. The setting of R75, which determines the point at which the sweep valve cuts on and off, is critical because two requirements must be fulfilled; V8 must cut off before it can sweep the klystron frequency through and beyond the band that will give a beat frequency of 43 to 47 Mc/s; but V8 must not cut off if a beat frequency on the subharmonic of 22·5 Mc/s is obtained.

85. The type of condition in which the sweep valve may come into operation is, for example, when the set has been lined-up on the bench but is later switched on in the air, where pressure and temperature are materially different, so that the initial input to V3 from the mixer is so far off 45 Mc/s as to apply negligible negative voltages to the discriminator valve grids. The amount of correction which will be continuously applied by the discriminator in these circumstances may be quite large; and the larger the correction, the greater will be the amount by which the beat frequency sits off 45 Mc/s. An example will show, however, that with this circuit the deviation will not be large enough to matter.

86. The graph in fig. 13B is an idealised static discriminator characteristic curve, plotted by injecting a series of different frequencies into V3 and noting the anode potential of V6, at the junction of R39 and R40, in each instance. The curve therefore shows the steady correction voltage output arrived at when the circuits have settled down to a given off-tune frequency, and *vice versa*.

87. Suppose that, on switching on in the air, the initial beat frequency fed to V3 from the mixer were 55 Mc/s. The sweep valve would come into operation and the local oscillator frequency would vary sinusoidally until it came within (say) 47 Mc/s of the magnetron frequency, when the discriminator would take charge and quickly bring the beat frequency to a value near 45 Mc/s. To bring the beat frequency from 55 to 45 Mc/s, the local oscillator frequency would require to be increased by 10 Mc/s; since the klystron tuning varies anything from 2 to 7 Mc/s per volt change on the reflector, the correction required from the discriminator is a drop of at most 5 volts; and reference to *fig.* 13*B* shows that this output is obtained when the beat frequency input is at about 45·15 Mc/s. So that even if a 10 Mc/s shift of klystron frequency has to be maintained, the beat frequency remains satisfactorily close to the tuned value of the IF stages.

General

88. It can be seen from *fig.* 12 that two jacks, J5 and J6, are connected in series with the diode loads R24 and R45. These permit measurement of the diode currents on a suitable micro-ammeter (0-50 microamp. full-scale deflection); C24, R23 and

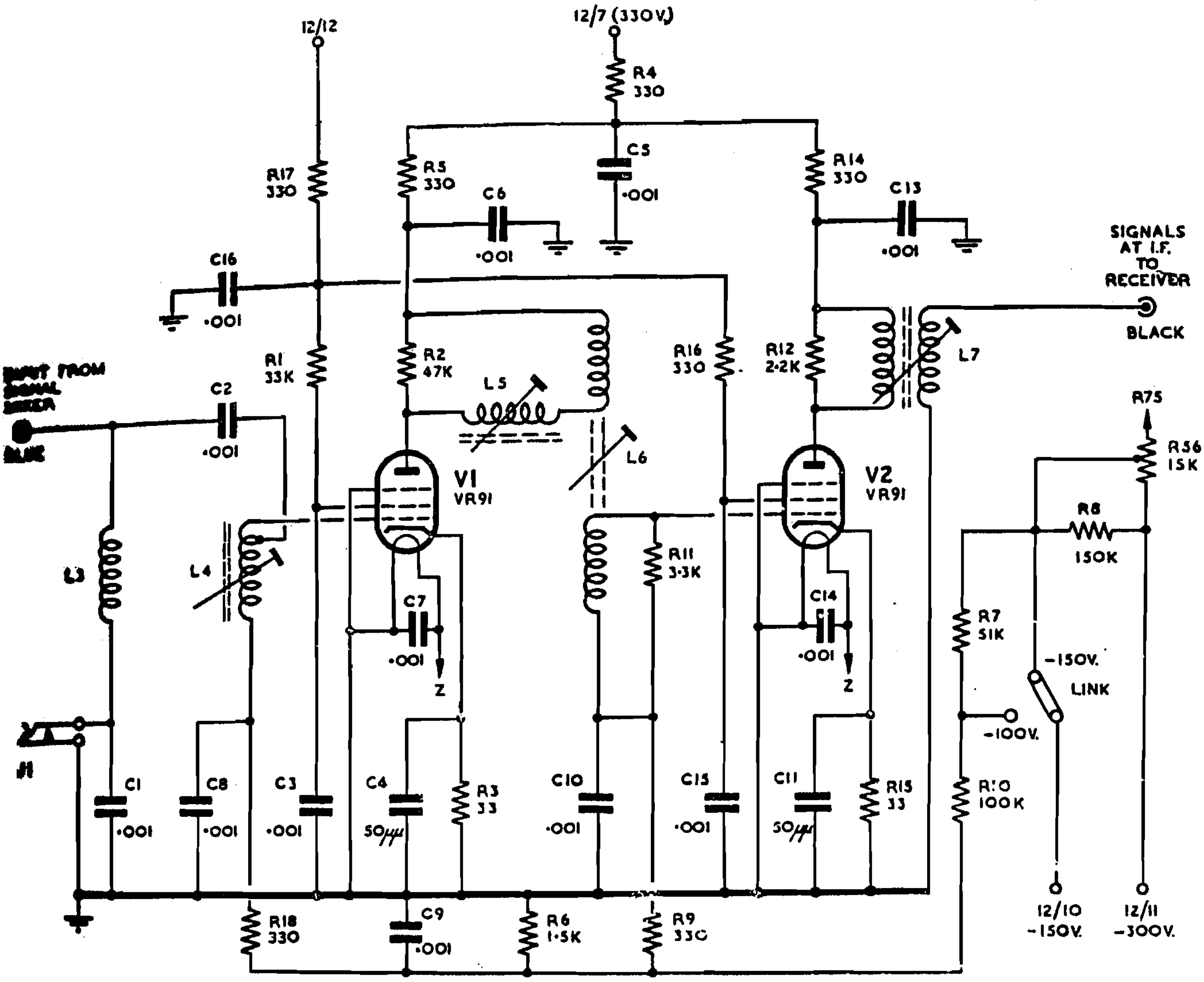

Fig. 14. Head amplifier circuit

C44 R46 (each 0·001 μF and 120 ohms) act as filters to keep the IF voltages off the jacks. In the operating conditions of the equipment, that is, with a PRF of 1,000 and a pulse width of ½ μsec. the value of diode current should be 5-7 μamp. when the signal klystron is tuned to correct frequency. In these conditions the grids of V5 and V6 will be at about —10·5 V., and the cathodes at about —8 V., with respect to earth; the common cathode current is approximately 20 mA.

In *fig.* 13*A*, the current in each diode has been plotted against changes in beat frequency applied to the circuit; difference (that is, the current in with respect to that in V4) is shown by broken line. This graph and that in *fig.* 13*B* are linked by the fact that the diode current is a measure of the negative voltage applied to the grid of its associated discriminator valve. It will be noted that the diode current maxima are not at exactly 43 and 47 Mc/s, although the circuits are tuned to these frequencies; this is because V3 is tuned to 45 Mc/s, so that the fall in input to V5 and V6 due to mis-tuning at V3 tends to outweigh the increasing response from L11 and L12 before 43 or 47 Mc/s is reached.

90. The design of the AFC circuits to give a suitable discriminator output depends on the co-ordinated performance of all the valves from V3 to V8. It is important that the valves, especially V3, V5 or V6, should not be haphazardly changed. If a valve is unserviceable, it is best to change

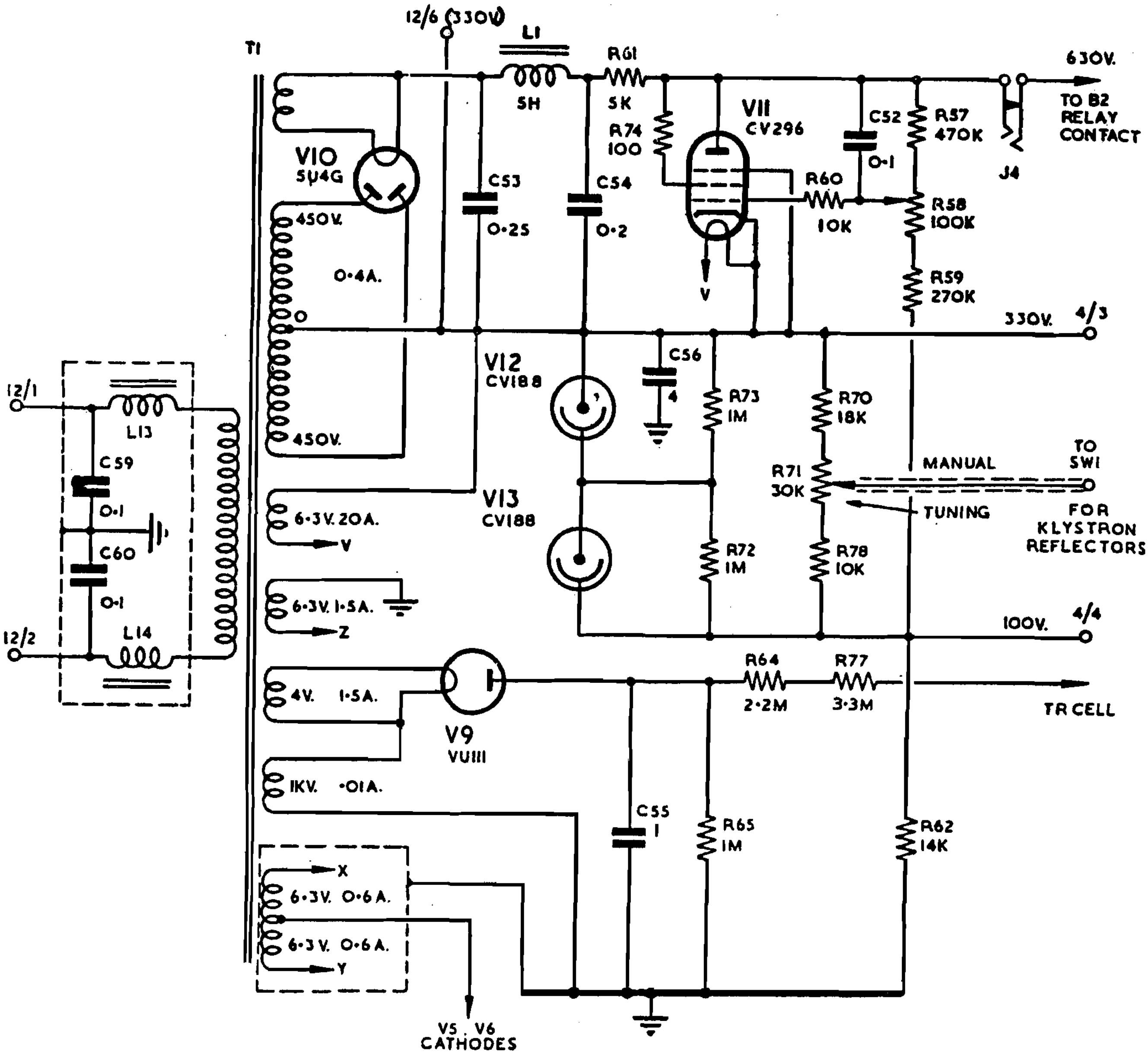

Fig. 15. Power pack

(AL24) A 2-amp fuse has been inserted in either the lead from pin 12/1 or that from pin 12/2

the whole unit, returning it for maintenance, but if this is not possible, then select from several the valve which appears to give the best results, and re-align the circuit carefully.

91. The method of setting-up the mean klystron reflector voltage has been mentioned in paragraph 76. The test points provided for the purpose of equalising the potentials at the slider of R71 and the AFC output are mounted on a panel on the right-hand side of the unit, where the potentiometer R38 and the diode current jacks are also to be found. It is of interest to note that the adjustment of R38 is carried out with no input applied to V3; this is possible because of the relation between anode current and grid voltage in the cathode-coupled amplifier V5, V6. When there is no input on the grids, they are at earth potential and the cathodes at about —2·5 V., whereas with a 45 Mc/s input the grids rest at about —10·5 V., and the cathodes at about —8 V; but the small increase in cathode current when there is no input is mostly taken up as an increase in screen current, and the effect on the current passed by the anode of V6 is negligible. To affect this current it is necessary to shift the potential on the grid of V6 relative to that of V5, by injecting an input whose frequency differs from 45 Mc/s.

THE HEAD AMPLIFIER

92. The beat frequency output from the signal mixer (para. 46) is fed through C2 (0·001 μF) to V1 and V2 (type VR 91) which form a 45 Mc/s head amplifier. The DC component of the mixer output is by-passed to earth through the choke L3 and the signal crystal current jack, J1. When a meter is inserted in J1 the DC component of the mixer output is developed across C1 (0·001 μF) and can be read as a current indication on the meter.

93. The HT supply for the valves is obtained from the 330V. supply to TR. 3523E from the power, units but the screen supply

94. The input and output circuits of the head amplifier are tuned to 45 Mc/s and the coupling between V1 and V2 to 47·5 Mc/s. The overall gain of the two stages is about 17 times and the bandwidth is slightly in excess of 4 Mc/s at 3 dB down from maximum response. The output from the coil L7 in the anode of V2 is taken to a *black* Pye plug on the front panel of TR.3523E. This plug is connected to a *black* Pye plug on receiver type R. 3647 by a length of 95-ohm cable.

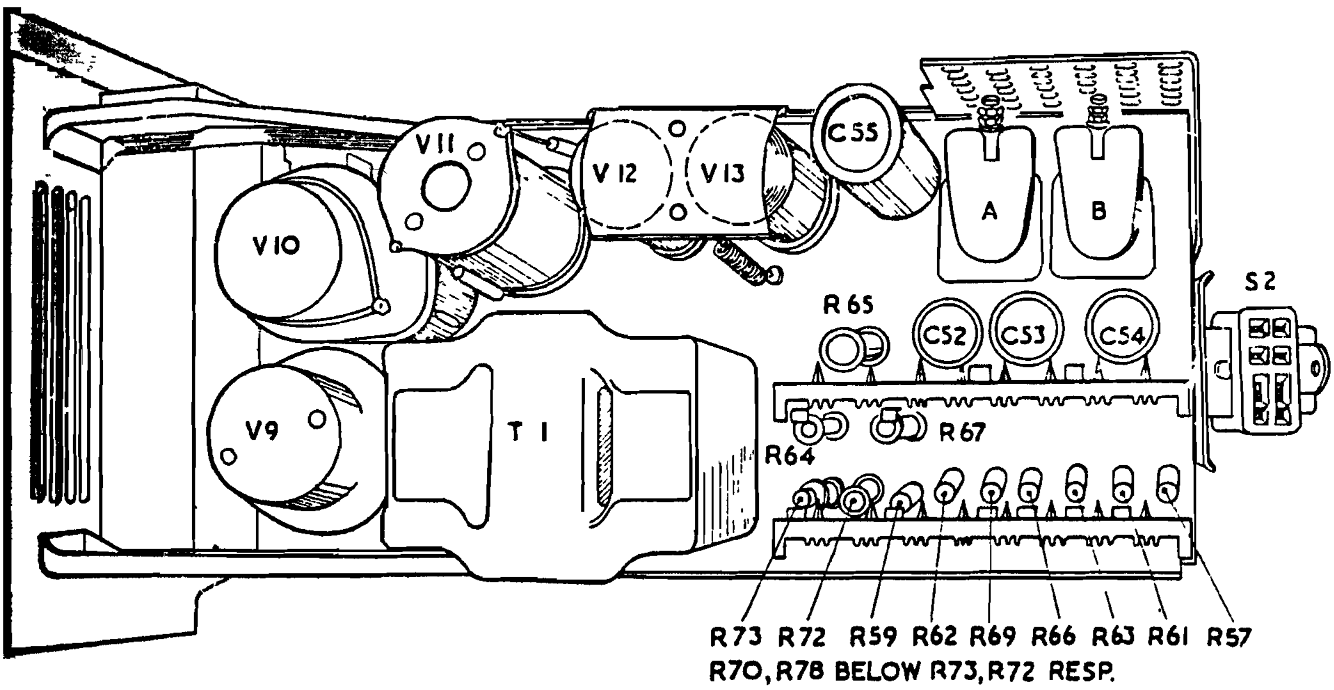

Fig. 16. Amplifying unit, type 226 : top of chassis

is obtained from a potentiometer chain in the receiver ; the latter supply is fed to TR. 3523E via the junction boxes and enters the unit on pin 12/12. A grid bias supply of —1·5V. is obtained by means of a bleeder chain consisting of R8 (150K), R7 (51K) ; R10 (100K) and R6 (1·5K) between the —300V line and earth. A lead is taken from the junction of R7 and R8 through a two-position link to the —150V. stabilized supply (pin 12/10) ; this arrangement has the effect of increasing the stabilization of the —300V. and bias supplies. If the link is changed over, pin 12/10 is connected to the junction of R7 and R10 and this arrangement can be used in equipments having a —100V. and not a —150V. this supply ; in H2S Mark IVA the link must be kept in the —150V. position.

POWER SUPPLIES

95. Supplies for TR. 3523E are fed into the unit via the 12-way plug on the front panel ; the unit contains a subsidiary power pack which develops +300V. and —1000V. supplies.

96. A winding of transformer T1, the full-wave rectifier V10 (type 5U4G) and the smoothing network C53 (0·25 μF), C54 (0·2 μF) and L1 (5H) develop a +300V. supply. This supply is stabilized by V11 (type CV 296) and its value can be adjusted by means of the potentiometer R58 (10K). The negative side of the supply is connected to the +330V. line from power units type 567D and also to the cathodes of the local oscillators. The positive side of the supply is consequently at +630V. and this is fed

to the resonators of the local oscillators; a jack (J4) enables the current drawn by the local oscillator in use to be measured.

97. The top of the manual tuning potentiometer chain is connected to +330V. and the bottom to +100V.; the latter potential is obtained by the action of the neons V12 and V13 in parallel with R72 and R73 (each 1M) and in series with R62 (14K) between +330V. and earth.

98. A second winding of transformer T1 and a half-wave rectifier (V9, type VU 111) develop a —1kV. supply for the ionising probe of the TR cell; the current drawn from this supply varies from 0·1 to 0·2 mA.

99. Transformer T1 also develops all the filament voltages used in the unit with the exception of those for the magnetron and overswing diode which are obtained from the special heater transformer, T3. The heater winding for the discriminator valves has its centre-tap connected at the bottom end of the discriminator cathode bias resistor (R75).

100. Power supplies to the local oscillators are fed via a Jones socket at the top rear of the amplifying unit sub-chassis. Power supplies to transformer T3 and the HF circuits are fed via a similar socket at the bottom of the same sub-chassis.

CONTROLS AND CONNECTIONS

PRE-SET CONTROLS

101. (1) Function switch (SW1). This switch selects the local oscillator in use and the method of tuning. When the switch is in the MANUAL position the frequency of the signal oscillator is controlled by the manual tuning control (R71) on the unit. In the AFC position the frequency of the signal oscillator is determined by the output of the discriminator circuit. In the BEACON position the frequency of the beacon oscillator is controlled by the manual tuning control (R71). The REMOTE position of the switch enables the above switching arrangements to be made from control unit, type 565A. For operation in the aircraft this switch must be left in the REMOTE position.

(2) Manual tuning control. This control (R71) can be used for setting-up purposes if the function switch is in the MANUAL or BEACON positions.

(3) Discriminator output control (R38). With the unit switched to MANUAL and the signal oscillator tuned correctly by R71, resistance R38 is adjusted until the voltages at the AFC and manual test points are equal.

(4) Discriminator cathode bias control (R75). This control is set so that the discriminator cuts off the sweep valve when the latter has brought the IF within the ange 43-47 Mc/s.

(5) Oscillator HT supply control. Resistor R58 must be adjusted until the difference between the +630V. and +330V. lines is exactly 300V.

(6) Signal oscillator mechanical tuning; set so that the frequency of the oscillator is 45 Mc/s below that of the magnetron.

(7) Beacon oscillator mechanical tuning; set so that the frequency of the oscillator is 45 Mc/s below that of the beacon transmitter.

(8) Anti-TR cell tuning plunger; set for maximum flow of signal energy into the TR cell.

(9) TR cell tuning control. This control is adjusted to obtain maximum signal energy in the signal mixer.

(10) Signal crystal current control: set to give a current of 0·6 mA.

(11) AFC crystal current control: set to give a current of 1 mA.

LINKS

102. (1) The —100V/—150V bias supply link must be in the —150V. position.

(2) The C relay shorting link in the magnetron filament supply circuit must be open.

(A.L. 18)

CONNECTIONS

Connections to TR.3523E are made one 12-way and one 4-way W plug, Pye plug, one high voltage W socket a waveguide connection. Details of connections are as follows :—

Plug, type W202 : 12-way *red*, connected to junction box, type 325.

Pins 1 and 2	80V., 2,000 c/s (fused in one line)
Pin 3	Earth
Pin 4	+24V. DC
Pin 5	—24V. DC
Pins 6 and 7	+330V(1).
Pin 8	Blank
Pin 9	Transmitter overload. This pin is earthed when relay D operates and as a result the pulse circuits in the modulator are switched off.
Pin 10	—150V. (1)
Pin 11	—300V(1).
Pin 12	Screen voltage for head amplifier from receiver.

(2) Plug, type W198 : 4-way *plain*, connected to control unit, type 565A.

Pin 1	Relay switching ; connected to the function switch on the control unit.
Pin 2	Tuning voltage from the slider of the tuning control on the control unit.
Pin 3	+330V. } Voltages for the potentiometer chain in the control unit.
Pin 4	+100V. }

(3) Plug, type 229 : Pye *black* ; feeds signals at the IF to receiver, type R.3647.

(4) Socket, type W297 : *plain*. Modulating pulse input, connected to modulator unit Type 196/WW.

(5) Waveguide connector. This carries the RF output to the scanner and the returning signals from it. (*A.L. 18*)

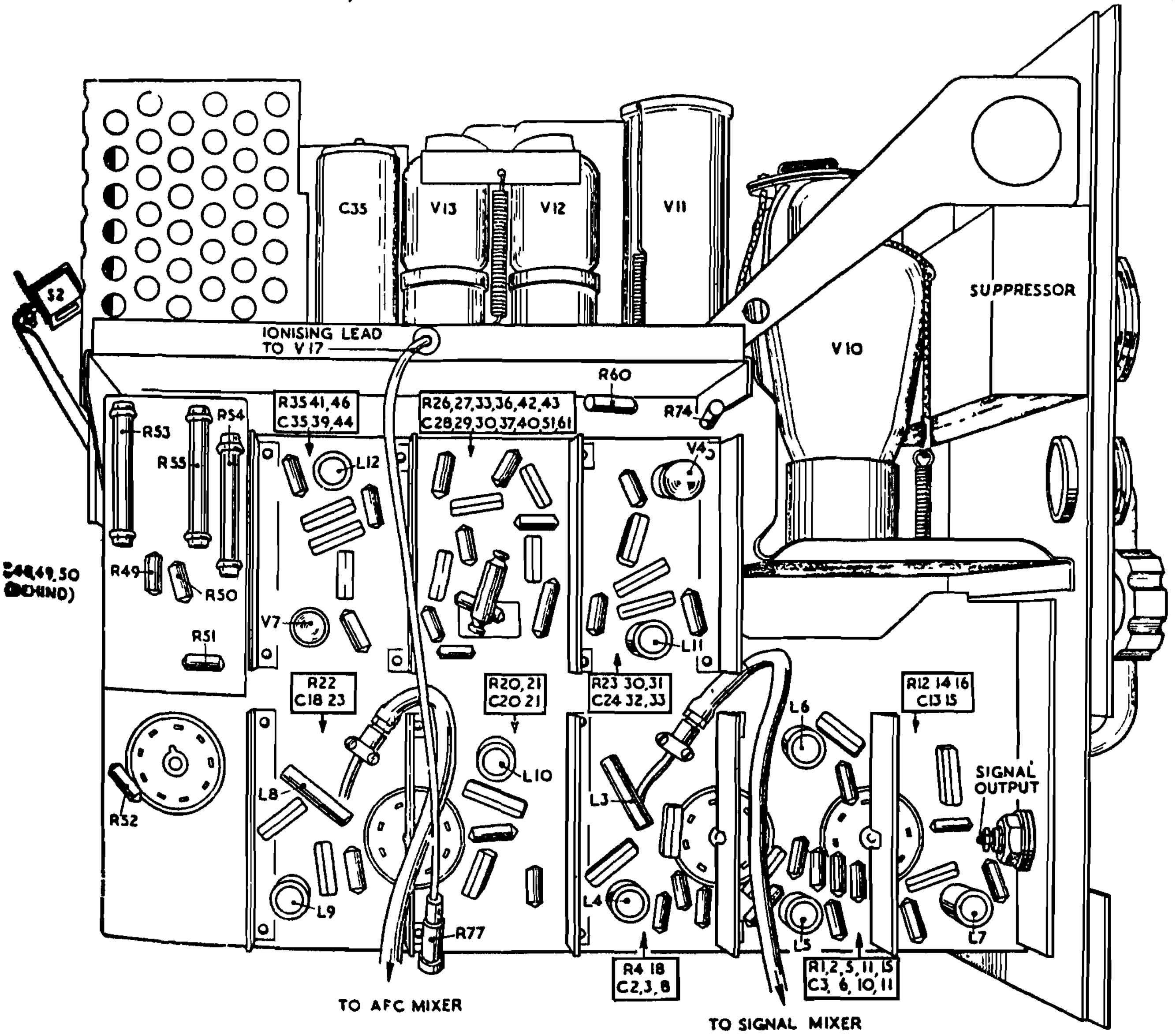

Fig. 17. Amplifying unit, type 226 : left-hand side of chassis

Chapter 5

SCANNING UNIT TYPE 109

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LIST OF ILLUSTRATIONS

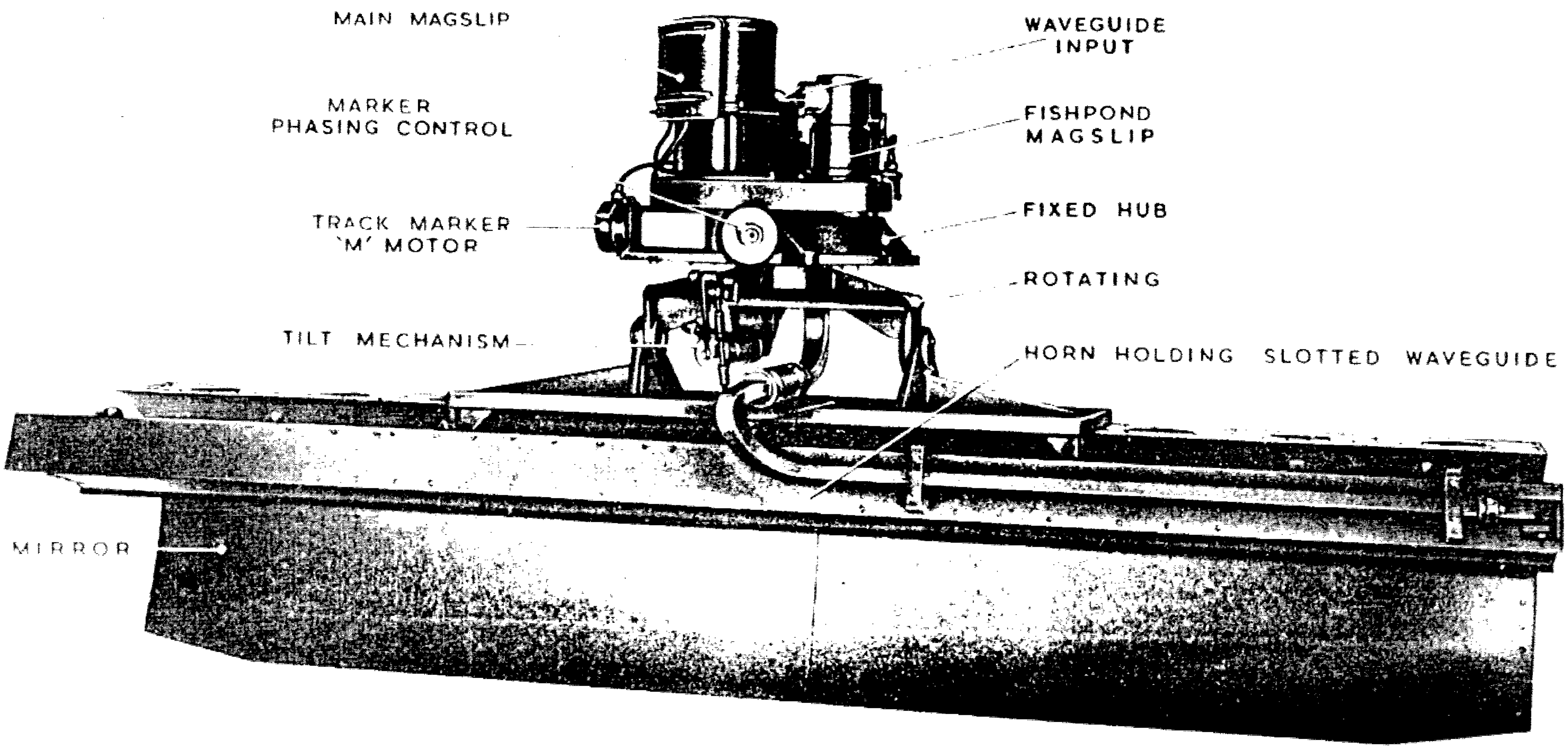

Fig. 1. Scanning unit Type 109 : general view

GENERAL

Introduction

1. Scanning unit Type 109 radiates the UHF energy developed by the transmitter and receives returning signals from the ground. The unit is mounted in a nacelle which projects below the airframe of the Lincoln aircraft aft of the bomb bay. The fixed scanner hub is attached to the underside of the airframe by a mounting framework on which are also mounted transmitter-receiver Type TR.3523E and transformer unit Type 166A. The rotating section of the scanner, consisting of a waveguide array and mirror, projects into the nacelle below the framework.

2. The nacelle entrance and the units on the mounting framework are covered by a strong metal cylinder which projects upwards into the fuselage; the top of this cylinder is removable giving access to the units on the framework. Junction box Type 325, which contains most of the interconnections between the units, is mounted on the wall of the cylinder as are suppressors Type D and P associated with the scanner camera and driving motor circuits respectively; three heaters are also mounted in the cylinder.

3. Scanning unit Type 109 gives a much narrower beam width than scanners used in earlier Marks of H2S with a consequent improvement in azimuthal definition. The beam width is approximately 1·5 degrees at 6 dB down from maximum field strength; this is maintained at large angles of depression, reducing the tendency for echoes from targets at short ground ranges to spread and become blurred. Ground returns are received at ranges of up to 45 nautical miles and coastlines can be distinguished at ranges of up to 65 nautical miles.

General description

4. The scanner (*fig.* 1) can be conveniently separated into its fixed and rotating assemblies. The fixed hub assembly comprises:—

(1) The drive motor which rotates the shaft of the hub and with it the array and mirror attached to its bottom end.

(2) Magslip Type 3 which synchronizes the PPI timebase on indicating unit Type 300 with the rotating mirror.

(3) Course repeater motor. This is an M-type receiver motor which is connected to the DR compass system of the aircraft and positions the stators of magslip Type 3 so that the top of the display on indicating unit Type 300 always represents true north.

(4) The course and track marker contacts. These are mechanical contacts which are earthed once per revolution of the scanner mirror. When either contact is earthed the radial timebase in indicating unit Type 300 is brightened, thus giving a radial marker which indicates the position of the scanner mirror at that instant. The course marker contact is earthed when the mirror sweeps through the dead-ahead position; the track marker contact is displaced from the course marker contact by an angle equal to the drift of the aircraft.

(5) Track repeater motor. This is an M-type repeater motor which is fed with drift information from the computor of the bombsight Mk. 14. It positions the track marker contact relative to the course marker contact.

(6) Magslip Type 7 which synchronizes the PPI timebase on indicating unit Type 188A with the rotating mirror. The stators of the magslip are fixed so that the top of the display always represents the line of flight; no track or course marker is provided.

(7) The centre shaft which is hollow and in two sections. The upper section is fixed to the hub and the UHF energy is fed into it by a section of rectangular waveguide at right angles to the shaft. The lower section is driven by the scanner motor and the rotating assembly of the scanner is fixed to a plate at its bottom end. Slip-rings on the rotating shaft and brushes mounted on the casting which surrounds it convey DC supplies to the tilt mechanism on the rotating assembly. A switch on the shaft controls the mechanism of the PPI camera.

5. The rotating assembly of the scanner consists of :—

(1) The waveguide feed from the bottom of the centre shaft to one end of the array.

(2) The array. This is a 5 ft. 8 in. non-resonant waveguide with edge slots mounted in a horn. The array determines the azimuth polar diagram of the radiated energy, a slight flare on the horn directing the energy on to the mirror.

(3) The mirror which consists of a cylindrical metal reflector shaped in the vertical plane. This is designed to give the correct vertical polar diagram.

(4) Tilt mechanism. It is not possible to design a reflector which gives at the same time maximum ground range for navigating and even illumination of targets at short ranges for bombing. This difficulty is overcome by enabling the tilt of the array and mirror relative to the hub to be adjusted by the operator. The operator can select either of two tilt positions by means of a switch on control unit Type 565A. The *normal* position of the switch sets the direction of maximum radiation to 3 degrees below the horizontal giving maximum ground range ; the *down* position sets the direction of maximum radiation to 10 degrees below the horizontal giving even illumination of targets at short ranges. The switch controls an electric actuator mounted on the rotating section of the scanner.

MECHANICAL AND ELECTRICAL DESCRIPTION

General

6. Throughout the following description, numbers are used to refer to items of the scanner assembly ; in general, items 1 to 93 will be found on the detailed view of the hub assembly (*fig.* 3) and items 94 to 113 on the view of the horn and reflector assembly (*fig.* 7). Items not shown on these two illustrations will be found on the views of the sub-assemblies referred to in the appropriate parts of the description.

Motor and drive

7. Fig. 2 shows the connections to the scanner motor. The 24V DC supply is fed from control unit Type 565A (*Chap.* 6) to a *red* 4-way W plug on the scanner hub through a suppressor Type D which prevents interference from being introduced into the supply. The motor is shunt wound ; the field winding is connected between pins 1 (+24V) and 4 (—24V) and the armature winding between pins 1 and 2. The speed of the motor can be varied up to 10,000 r.p.m. approximately by means of the SCANNER SPEED control on the control unit which determines the negative potential at pin 2 and thus the voltage across the armature winding ; in the extreme anti-clockwise position of the control the supply to the armature winding is broken.

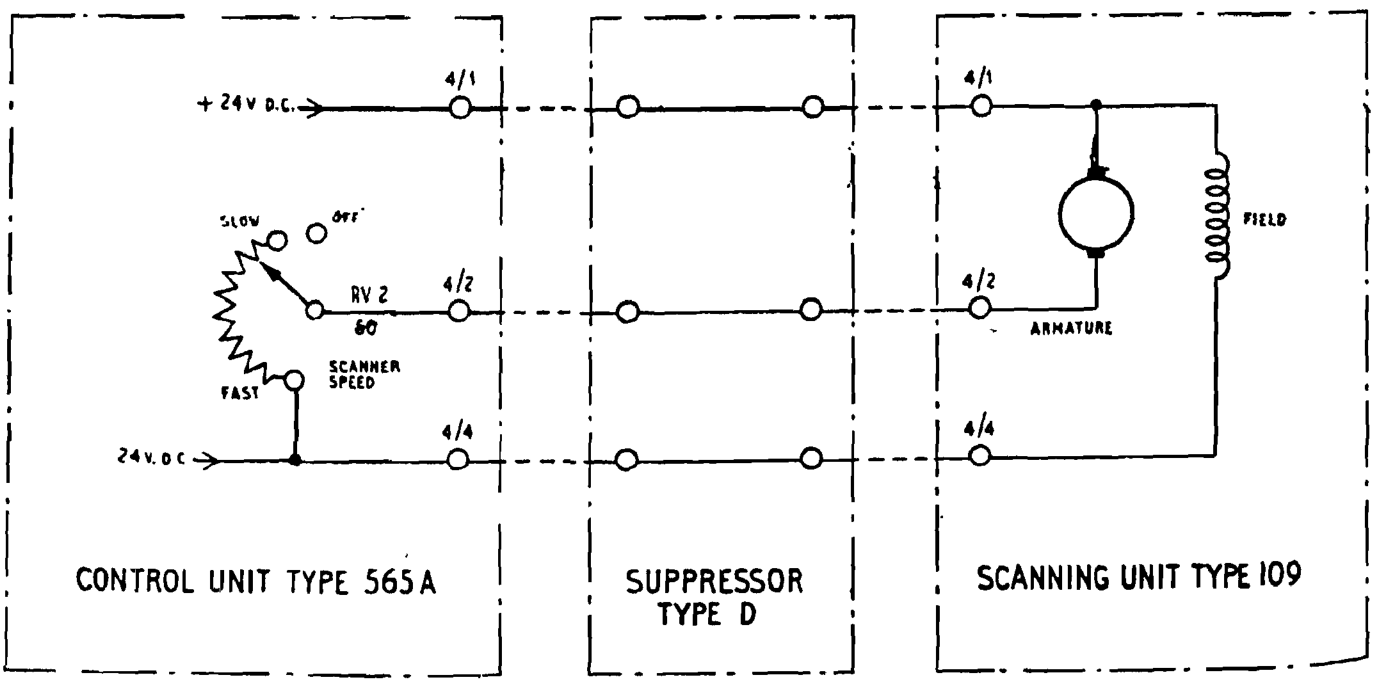

Fig. 2. Drive motor circuit

motor (35 in *fig.* 3) is attached to ...er hub casting (62) by a flange ...ter casing and three bolts. A ...(37) keyed to the motor spindle (36) the drive to a spur wheel (42) two reduction stages (40 and 41). ... intermediate stage consists of a gear and pinion mounted integrally on an oilite bearing running on a spindle (38 and 39). Two lock nuts (49) fix the spur wheel to the shaft assembly (51) which passes the drive to the array and mirror system attached to the plate at its lower end. The bottom of the shaft runs in a ball bearing (46) and the top in an oilite bearing (51). The overall reduction ratio between the motor spindle and the shaft is approximately 128 : 1. Thus for the normal scanning speed of 60 r.p.m. the motor runs at approximately 7,500 r.p.m.

Magslip Type 3

Operation

9. The function of magslip Type 3 is to synchronize the PPI timebase on indicating unit Type 300 with the rotating scanner mirror. The sawtooth current waveform from the timebase generating circuits in the indicator is fed to the rotor of the magslip in the scanner where it is resolved into sine and cosine components in the following manner.

10. The magslip has two stator windings; in these the rotor induces currents which are 90 degrees out of phase with each other. When the rotor is making full coupling with the first stator it makes zero coupling with the second stator; the output from the first stator is equal to the input to the rotor and that from the second stator is zero. When the rotor has turned through 90 degrees the output from the first stator is zero and that from the second is at maximum, equal to the rotor input. During the next quarter turn the output from the first stator rises to maximum and that from the second falls to zero but the polarity of the output is reversed. In other words, in one turn of the rotor, the output from each stator goes through the following cycle: zero to maximum amplitude in one direction: maximum to zero: zero to maximum in the other direction: maximum to zero. The maximum amplitude in each case is equal to the maximum amplitude of the input to the rotor; the two outputs are 90 degrees out of phase, and the vector sum of the outputs at any instant is equal to the input at that time.

11. The current waveforms from the stators are fed to the deflection coils of the CRT in the indicator. The result of feeding these waveforms in correct relative phase to the appropriate coils is to produce a radial timebase, the orientation of which depends at all times on the position of the magslip rotor. The rotor is geared to the centre shaft of the scanner and the timebase consequently rotates in synchronism with the mirror.

12. In order to give a reference bearing on the PPI display it is necessary for the stators of the magslip to be in a fixed relationship either to the aircraft's axis or to a compass bearing. In many systems the top of the PPI display is made to represent the aircraft's heading, but in the case of the display on indicating unit Type 300 it is made to represent true north. This is done by linking the stators of magslip Type 3 to the DR compass system of the aircraft as described in para. 30-32. The stators are positioned like a repeater compass card; if the aircraft turns they are kept in the same angular relationship to true north as they were before the turn.

13. In practice, magslip Type 3 has twh rotor windings and although in earlier H2S scanners only one of these was used, both are used in scanning unit Type 109. The windings are connected in parallel to reduce the input impedance to the current sawtooth and thus to reduce distortion of the output waveforms. The stator windings are fixed to the body of the magslip, so the latter is made free to turn in the hub casting and is linked to the DR compass system.

Mounting and connections

14. Magslip Type 3 (2) is mounted in a housing (24) bolted to the adaptor casting (14) of the scanner hub; details of the housing are shown in fig. 4. The body of the magslip is free to rotate in the housing and runs on ball bearings (17) at top and bottom. The inner ball races (10A and 11A) are held together by screws (28) and a grub screw, bearing on a serrated segment, locks them to the magslip body. Details of the drive from the course repeater motor to the magslip body are given in para. 32.

This leaf issued with A.L. No. 17, May, 1949

1	MAGSLIP TYPE 7	40	GEAR (84 TEETH) AND PINION (18 TEETH)
2	MAGSLIP TYPE 3	41	GEAR (72 TEETH) AND PINION (20 TEETH)
3	COURSE REPEATER MOTOR	42	GEAR (153 TEETH)
4	GEAR (105 TEETH)	43	PINION (10 TEETH) ON SHAFT OF ITEM 3
5	GEAR (63 TEETH)	44	LEADS TO TILT MECHANISM
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12	COUPLING PLATE	51	SHAFT ASSEMBLY
13	MAGSLIP ROTOR BALL RACE	52	RING SPACERS, INSULATING
14	ADAPTOR CASTING	53	WASHER, INSULATING
18	TERMINAL COVER (TYPE 279)	54	WASHER, METAL
19	COVER, MAIN MAGSLIP (TYPE 278)	55	SLEEVE, FIXED
20	COVER, FISHPOND MAGSLIP	56A	FILTER UNIT TYPE 153, TOP
23	HOUSING, FISHPOND MAGSLIP	56B	FILTER UNIT TYPE 153, BOTTOM
24	HOUSING, MAIN MAGSLIP	57	TUBULAR FEEDER TYPE 200
25	PIN, PIVOT FOR ITEM 5	59	CLAMPING PIECE
27	PLUG TYPE W199 (6 PIN, RED)	60	HOUSING, CENTRE SHAFT
30	SPINDLE FOR ITEM 9	61	HOUSING, BEARING SUB-ASSEMBLY
31	MAGSLIP ROTOR SHAFT	62	HUB CASTING
34	RETAINING PLATE	63	PLUG TYPE W197 (2 PIN, PLAIN)
35	DRIVING MOTOR	64	PLUG TYPE W198 (4 PIN, PLAIN)
36	MOTOR SHAFT	65	PLUG TYPE W198 (4 PIN, RED)
37	PINION (20 TEETH)	66	PLUG TYPE W203 (18 PIN, RED)
38	SPINDLE FOR ITEM 40	81	MARKER PHASING CONTROL
39	SPINDLE FOR ITEM 41	93	TUBULAR FEEDER TYPE 225

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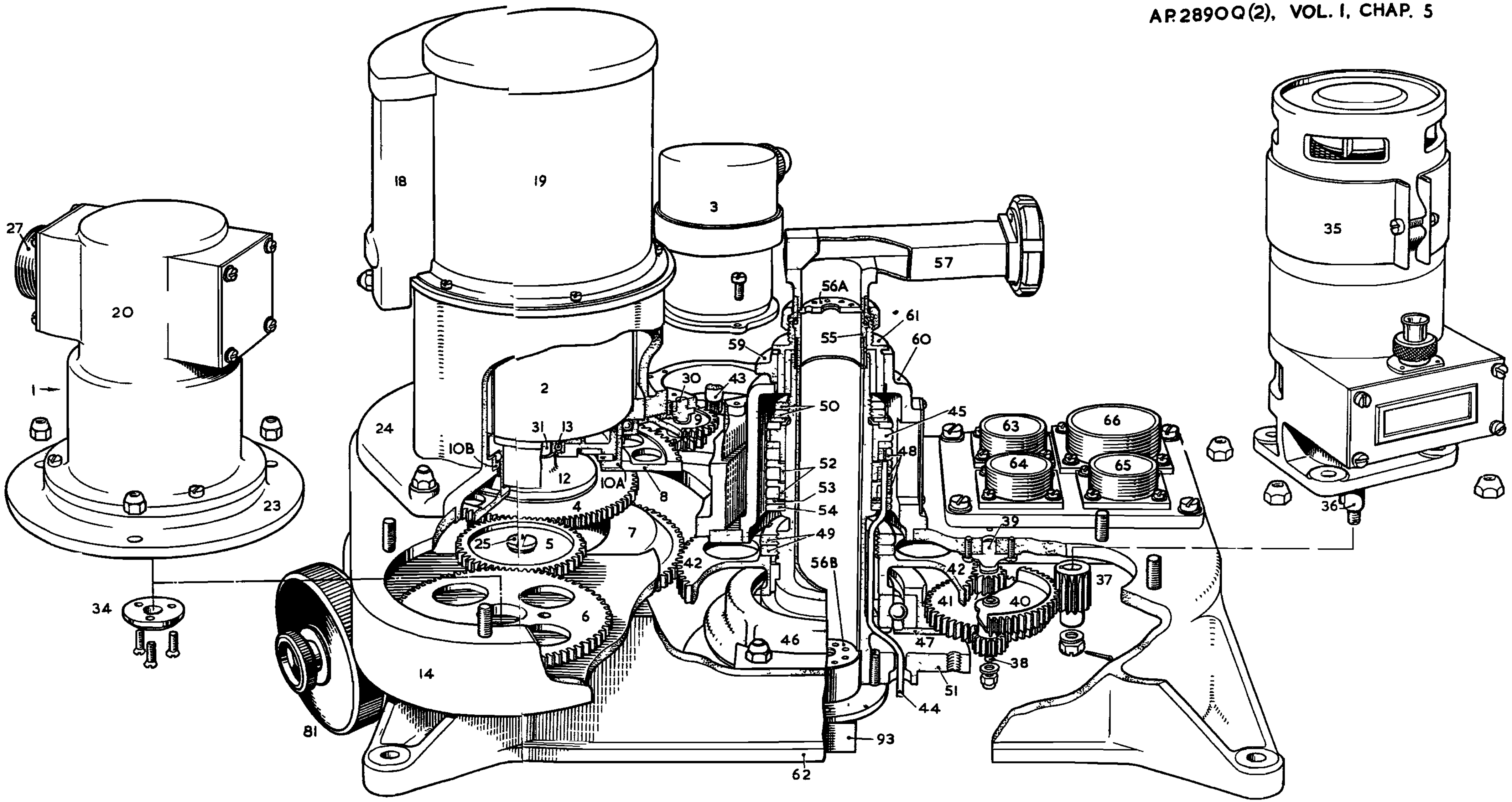
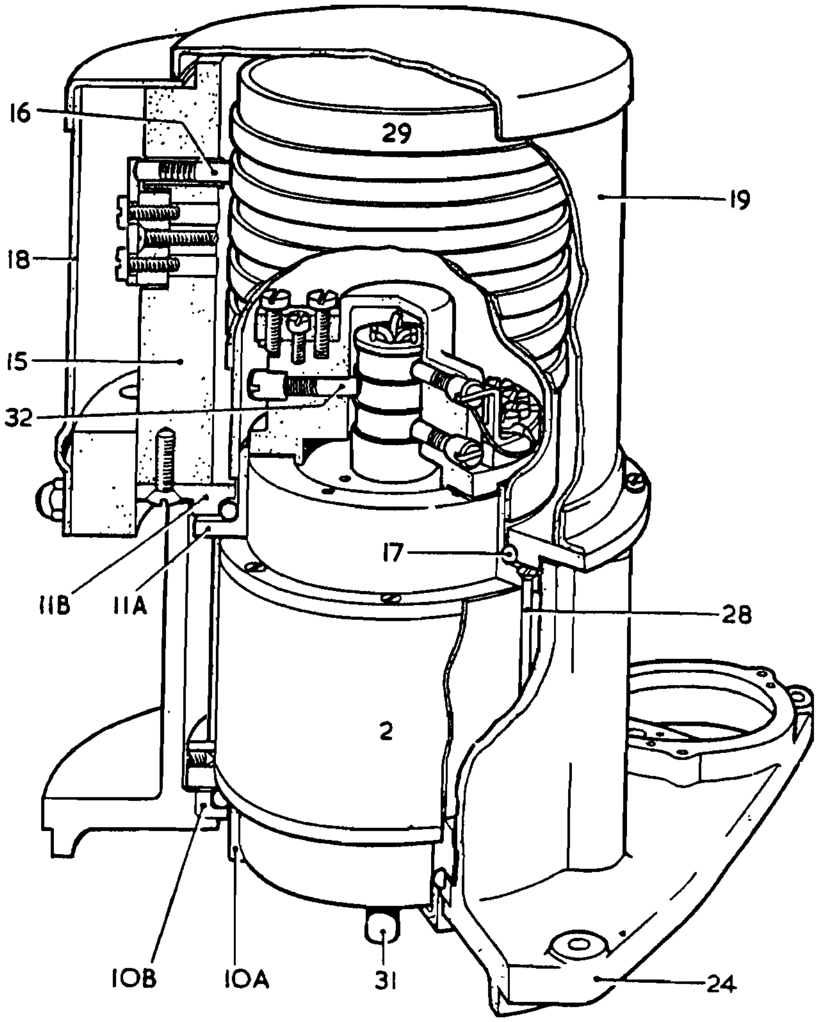


FIG. 3 HUB ASSEMBLY

15. The rotor windings are brought out to three slip-rings at the top of the rotor shaft and three brushes (32) mounted in a bakelite cover connect them to terminals on the top of the magslip body. The stator windings are connected directly to four similar terminals.

16. A resin-bonded fabric drum (29) bearing six slip-rings is attached to the top of the magslip body. The terminals are connected to the slip-rings by short leads, two of the rotor terminals being connected to the same slip-ring so that the windings are in parallel (*para.* 13). Brushes (16) bearing on the slip-rings connect the windings to a terminal block (15) mounted on the magslip housing (24). The fabric drum is surrounded by a cylindrical cover to exclude dust and the terminal block has a separate cover (18) to give easy access.



2	MAGSLIP TYPE 3	18	TERMINAL COVER (TYPE 279)
10A	BALL RACE, INNER BOTTOM	19	COVER, MAIN MAGSLIP (TYPE 278)
10B	BALL RACE, OUTER BOTTOM	24	HOUSING, MAIN MAGSLIP
11A	BALL RACE, INNER TOP	28	SCREWS, CLAMPING
11B	BALL RACE, OUTER TOP	29	SLIP-RING ASSEMBLY
15	TERMINAL BLOCK (TYPE 121)	31	MAGSLIP ROTOR SHAFT
16	BRUSHES	32	MAGSLIP ROTOR BRUSHES
17	BALLS, BEARING, FOR ITEMS 10 AND 11		

Fig. 4. Magslip Type 3

17. Two cableforms connect the terminal block to the 18-way W plug on the scanner hub. The sawtooth current waveform from the indicator is fed to pins 11 and 12 of this plug, which are connected to the magslip rotor. The outputs from the stators are fed to pins 1-4 and thence through step-down transformers in transformer unit Type 166A back to the indicator. The waveforms are reduced in amplitude by the transformers to decrease distortion in the cables which feed them to the indicator ; special low-capacity leads are used between the indicator and the magslip rotor and stators.

Rotor drive

18. The bottom of the rotor shaft (31 in *fig.* 3) of magslip Type 3 runs in a ball bearing (13) and is pinned to a circular metal plate (12) which is attached to a gear (4). This gear is separated by a collar from a second gear (7) which is meshed with the spur wheel (42) driving the main shaft of the scanner. The two gears (4 and 7) are not fixed to each other in any way but are normally prevented from slipping relative to each other by being clamped together very tightly; further details of this gear assembly are given in para. 34.

19. It should be noted that there is no definite relationship between the position of the rotor at any instant and the position of the scanner mirror. This is compensated for by adjusting the position of the magslip stators relative to the rotor. The spur wheel (42) and the gear (7) meshing with it have the same number of teeth so that ratio exists between the scanner and magslip rotor.

Magslip Type 7

20. The function of magslip Type 7 is to synchronize the PPI timebase on indicating unit Type 188A with the rotating scanner mirror. The CRT used in this indicator employs electrostatic deflection and the rotating timebase is formed by feeding the deflection plates with sawtooth voltages whose phase depends on the position of the scanner mirror. These voltages are obtained by charging condenser networks from sinusoidal voltages generated by the magslip in the following manner.

21. A 40V, positive, 20 μs pulse at the p.r.f. of the equipment is applied to the rotor of the magslip; the stators are tuned by condensers (in the indicator) so that low-frequency sine waves are produced in them. The amplitude of the output from each stator will depend on the coupling between that stator and the rotor and will vary as the rotor turns. In one turn of the rotor the output from each stator goes through the following cycle; zero to maximum amplitude in one direction : maximum to zero : zero to maximum amplitude in the other direction : maximum to zero. The outputs from the stators are 90 degrees out of phase with each other and the vector sum of the outputs at any instant is constant. A 10K resistor is connected across each stator winding to damp out the sine waves before the arrival of the next pulse at the rotor.

22. The sawtooth voltages from the condenser networks in the indicator have the same phase relationship as the charging voltages from the magslip stators and are fed through vertical and horizontal scan amplifiers to the deflection plates of the CRT. The orientation of the radial timebase thus produced depends at all times on the position of the magslip rotor and as this is geared to the centre shaft of the scanner, the timebase rotates in synchronism with the mirror.

23. The stators of magslip Type 7 are fixed with respect to the aircraft's axis so that the top of the Fishpond display on indicating unit Type 188A always represents the heading of the aircraft.

Mounting and connections

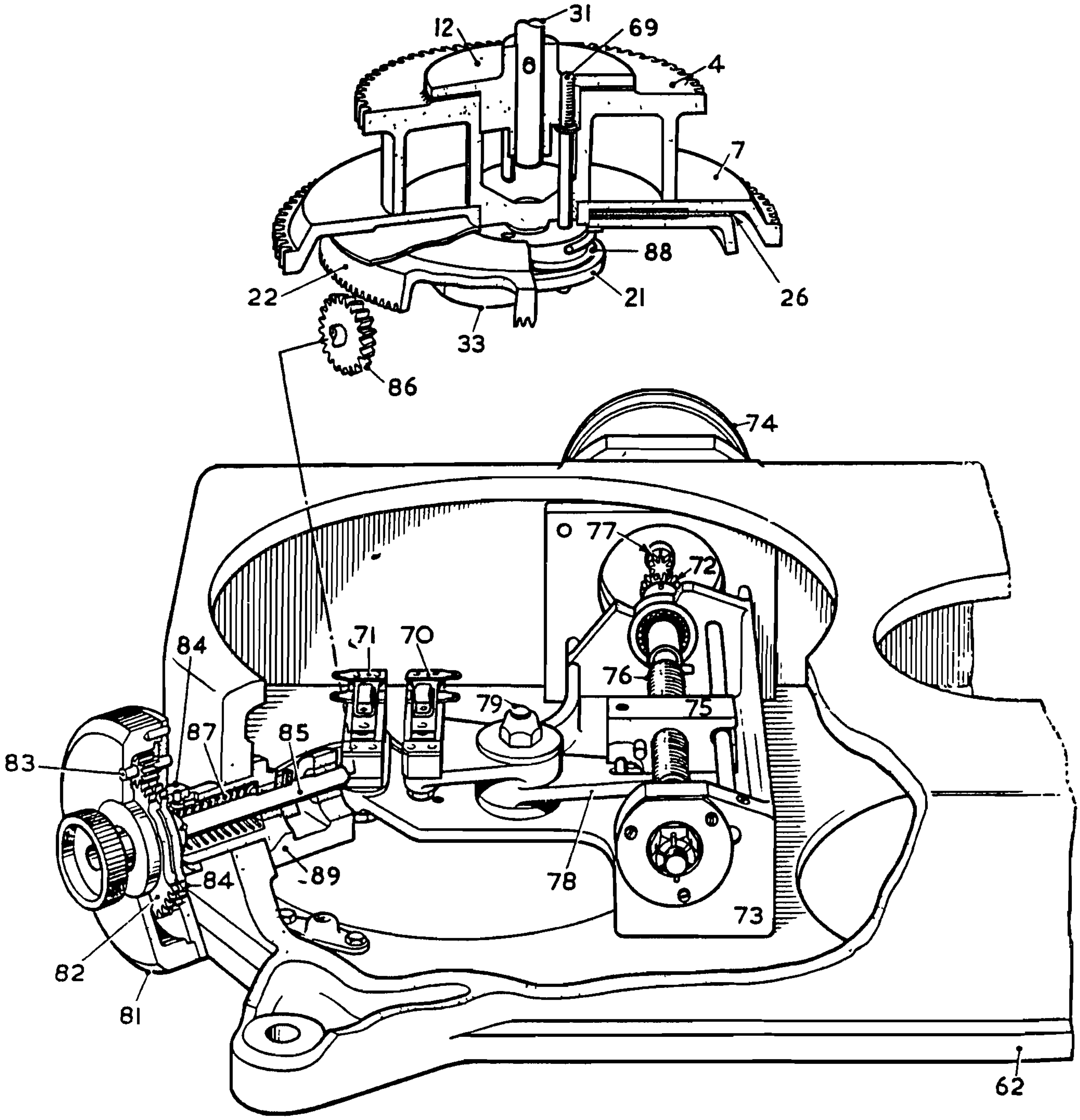
24. Magslip Type 7 (1 in *fig.* 3) is mounted in a housing (23) which is bolted to the adaptor casting (14) on the scanner hub (62). A cylindrical cover (20), closed at one end, is attached by screws to the housing and the magslip body is gripped sufficiently tightly between a shoulder on the cover and the rim of the housing to prevent it turning.

25. The rotor winding is brought out to two slip-rings at the top of the rotor shaft and brushes mounted in a bakelite cover connect them to terminals on the top of the magslip body; the stator windings are connected directly to four similar terminals. Leads from these terminals pass to a 6-way W-plug (27) on the magslip cover (20) which is connected directly to junction box Type 325. Pins 5 and 6 of this plug feed the 40V priming pulse from the indicator to the rotor and pins 1-4 feed the sine waves from the stators back to the indicator; the stator damping resistors are connected between pins 1 and 3 and between pins 2 and 4 at the back of the plug.

Rotor drive

26. The bottom of the rotor shaft runs in a ball bearing and is pinned to a circular metal plate; a gear wheel (6) is clamped between this plate and a retaining plate (34). The two plates are held together by screws which pass through a hole in the centre of the gear; only the tightness of the clamp so formed prevents the gear from slipping. A gear (5) running on a separate spindle (25) transmits the drive from the gear (4) on the main magslip rotor shaft to the gear (6) on the Fishpond rotor shaft. The gears on the rotor shafts have the same number of teeth so that a 1 : 1 ratio exists between the Fishpond magslip rotor and the main magslip rotor, and consequently between the Fishpond magslip rotor and the scanner mirror.

27. It should be noted that there is no definite relationship between the position of the Fishpond magslip rotor at any instant and the position of the scanner mirror. This is due to the method of fixing the gears to the magslip rotor shafts. The error can be compensated for by adjusting the position of the magslip stators relative to the magslip rotor. This is done by undoing the bolts holding the



4	GEAR (105 TEETH)	75	NUT
7	GEAR (153 TEETH)	76	SCREWED SHAFT
12	COUPLING PLATE	77	PINION (10 TEETH) ON SHAFT OF ITEM 74
21	RETAINING PLATE	78	ARM MOUNTING ITEM 70
22	GEAR (136 TEETH)	79	PIVOT FOR ITEM 78
26	FRICTION DISC	81	MARKER PHASING CONTROL
31	MAGSLIP ROTOR SHAFT	82	KNOB WITH GEAR (98 TEETH)
33	MARKER CAM	83	PINION (16 TEETH)
62	HUB CASTING	84	GEAR (96 TEETH) PINNED TO ITEM 89
69	SCREWS, CLAMPING	85	SHAFT FOR ITEM 86
70	TRACK MARKER CONTACTS	86	BEVEL GEAR (24 TEETH)
71	COURSE MARKER CONTACTS	87	SPRING
72	GEAR (25 TEETH)	88	SPRING
73	HOUSING, DRIFT LINE ASSEMBLY	89	HOUSING, MARKER PHASING ADJUSTMENT
74	TRACK REPEATER MOTOR		

Fig. 5. Marker contacts and phasing control

[illegible] the Fishpond magslip to its housing, [illegible] the cover, and turning the magslip [illegible] by hand until the trace on indicating unit Type 188A is in its correct position. Do not lift the magslip body, because the spur wheel (6) may then disengage and permit the rotor to turn as well as the stators.

Course and track markers

Constant north presentation

28. In order to give a reference bearing on the PPI display it is necessary for the stators of the magslip to be in a fixed relationship either to the aircraft's axis or to a compass bearing. In many systems the top of the display is made to represent the aircraft's heading. This is done by turning the scanner to the dead-ahead position and then locking the stators in the position which gives a vertical timebase pointing to the top of the tube face. In flight, the echo pattern of the landscape travels across the tube face at an angle to the vertical equal to the drift of the aircraft; when the aircraft turns the echo pattern turns with it. This "constant heading" presentation is used on the Fishpond indicator of H2S Mk. 4A, the stators of magslip Type 7 being fixed with respect to the aircraft's axis.

29. The presentation described above is not very suitable if constant reference has to be made to maps, because the bearing of north with respect to the top of the tube face will vary with changes in the course of the aircraft. To make it easier for the operator to compare the display on indicating unit Type 300 with maps, the top of the tube face is made to represent true north. The echo pattern travels across the tube face in accordance with the track of the aircraft but does not rotate if the aircraft changes course. This "constant north" presentation is obtained by linking the stators of magslip Type 3 to the DR compass system of the aircraft. The stators are positioned like a repeater compass card; if the aircraft turns they are maintained in the same angular relationship to true north as they were before the turn.

Course repeater motor

30. The DR compass system of the aircraft is described in A.P.1275B, Vol. 1, [illegible] Chap. 7 but in outline the operation is as follows. In the master unit of the compass a bar magnet controls the action of a gyroscope. The combination, which can be visualized as averaging out the true magnetic heading from a series of magnetic observations, drives the inner frame of the master unit. This frame is consequently azimuth stabilized, that is, the direction of any line drawn on its base will remain fixed in space. There will be relative motion, therefore, between the container and the inner frame of the master unit when the aircraft turns and the amount of movement will be equal to the change in heading. The motion is transmitted through a gear train having a step up ratio of 1 :60 to an M-type transmitter. The M-type transmissions are fed to the variation setting corrector (VSC) which is in effect a repeater motor driving a transmitter, with a means of adjusting the phase relationship of the incoming and outgoing transmissions. By making the phase difference between incoming and outgoing transmissions equal to the magnetic variation, the cards in the DR compass repeaters controlled by the VSC can be made to indicate true north instead of magnetic north. The VSC transmitter also drives azimuth mechanisms in the API and the bombsight computer and the course repeater motor in scanning unit Type 109.

31. The M-type transmissions from the VSC are not fed directly to the scanner, but via control unit Type 552. A circuit in the latter unit enables the course repeater motor to be synchronized to the VSC after the aircraft has taken off. Details of this circuit and of the connections between control unit and scanner are given in para. 42-46.

32. The course repeater motor (3 in *fig.* 3) is bolted to the main magslip housing (24) on the scanner hub. As described in para. 13 the stator windings are fixed to the body of magslip Type 3 which is free to rotate in its housing. A large spur wheel (8) is attached by screws to the base of the magslip body and this is driven through a reduction gear (9) from a pinion (43) on the shaft of the repeater motor. The reduction gear consists of a gear and pinion having differently shaped teeth but mounted integrally on the same shaft (30). A change in heading of half a degree turns the repeater motor shaft through 30 degrees

owing to the step-up gear train in the DR compass master unit (*para.* 30), but the reduction gear ratio between the repeater motor shaft (43) and the spur wheel (8) is 60 : 1 so the magslip stators are turned through half a degree. Thus the stators of magslip Type 3 are directly linked to the inner frame of the DR compass master unit and consequently the PPI display on indicating unit Type 300 is azimuth stabilized.

Course marker contacts

33. As described in para. 29 the main PPI display is azimuth stabilized with true north at the top of the tube face. Consequently, provision has to be made for showing the course of the aircraft on the PPI map and this is done by means of mechanically operated contacts in the scanner. When the scanner mirror passes through the dead-ahead position, the course marker contacts close and alter the bright-up circuit of the PPI so that at least one radial timebase is brightened. Thus the course of the aircraft appears as a radial marker on the PPI display. A course marker is not used on the Fishpond display as the " constant heading " presentation makes it unnecessary.

34. The course marker contacts (71) are mounted at the bottom of the scanner hub casting (62) directly beneath the main magslip as shown in fig. 5. A circular metal plate (12) is pinned to the magslip rotor shaft (31) and between this and a retaining plate (21) are mounted three gears (4, 7, and 22). The upper gear (4) drives the rotor of the Fishpond magslip and the central gear (7) conveys the drive from the centre shaft of the scanner to the rotor of the main magslip. The clamping plates (12 and 21) and the upper gear (4) are held together by screws (69) but the central gear (7) is mounted on the hub of the upper gear and is only prevented from slipping relative to it by the tightness of the clamp. The lower gear (22) is mounted on the hub of the central gear and the gears are separated by a friction disc (26). The lower gear is not gripped by the clamping plates but a spring (88) on the lower clamping plate (21) holds it sufficiently tightly against the friction disc to prevent it slipping relative to the central gear under normal running conditions.

35. The course marker contacts (71) consist of two strips of metal mounted one above the other and normally not in contact. Once in each revolution of the magslip rotor an insulated cam (33), which is mounted on the under surface of the lower gear (22), bears on a roller on the upper metal strip and pushes it into contact with the lower metal strip. When the contacts close, the radial timebase on the PPI is brightened, indicating the position of the magslip rotor at that instant.

36. In order that the radial marker produced in this manner may indicate the course of the aircraft, the course marker contacts must close when the scanner mirror passes through the dead-ahead position. It has previously been mentioned (*para.* 19) that no definite relationship exists at any instant between the position of the magslip rotor and the scanner mirror. Therefore the angular position of the cam operating the contacts must be adjustable with respect to the magslip rotor. Normally the friction disc and the spring loading prevent the gear carrying the cam from turning with respect to the gear driving the magslip rotor ; but by pushing the marker phasing control (81), the gear (86) on the end of its shaft (85) can be engaged with the cam gear (22), and by turning the large knob of the control, the cam gear can be turned with respect to the magslip rotor. Using this control, the position of the cam gear can be set so that it closes the course marker contacts when the scanner mirror passes through the dead-ahead position ; the procedure is described in para. 88. Details of the electrical connections to the course marker contacts are given in para. 47 and the operation of the circuit in indicating unit Type 300 is described in Chap. 9.

37. The bevel gear (86) on the shaft (85) of the marker phasing control is normally kept out of mesh with the cam gear (22) by spring loading (87). The shaft runs in a housing (89) which is fixed to the hub casting (62) and projects from it just below the magslips. At its outer end the shaft carries two spur wheels (82 and 84), the outer of which is mounted integrally with a small knob and pinned to the shaft ; the inner spur wheel (84) is pinned to the housing (89) and not fixed to the shaft. Enclosing the spur wheels is a large milled knob which is free to rotate on a collar of the inner knob and contains a small jockey pinion (83) running on both spur wheels. The spur wheels have the same diameter,

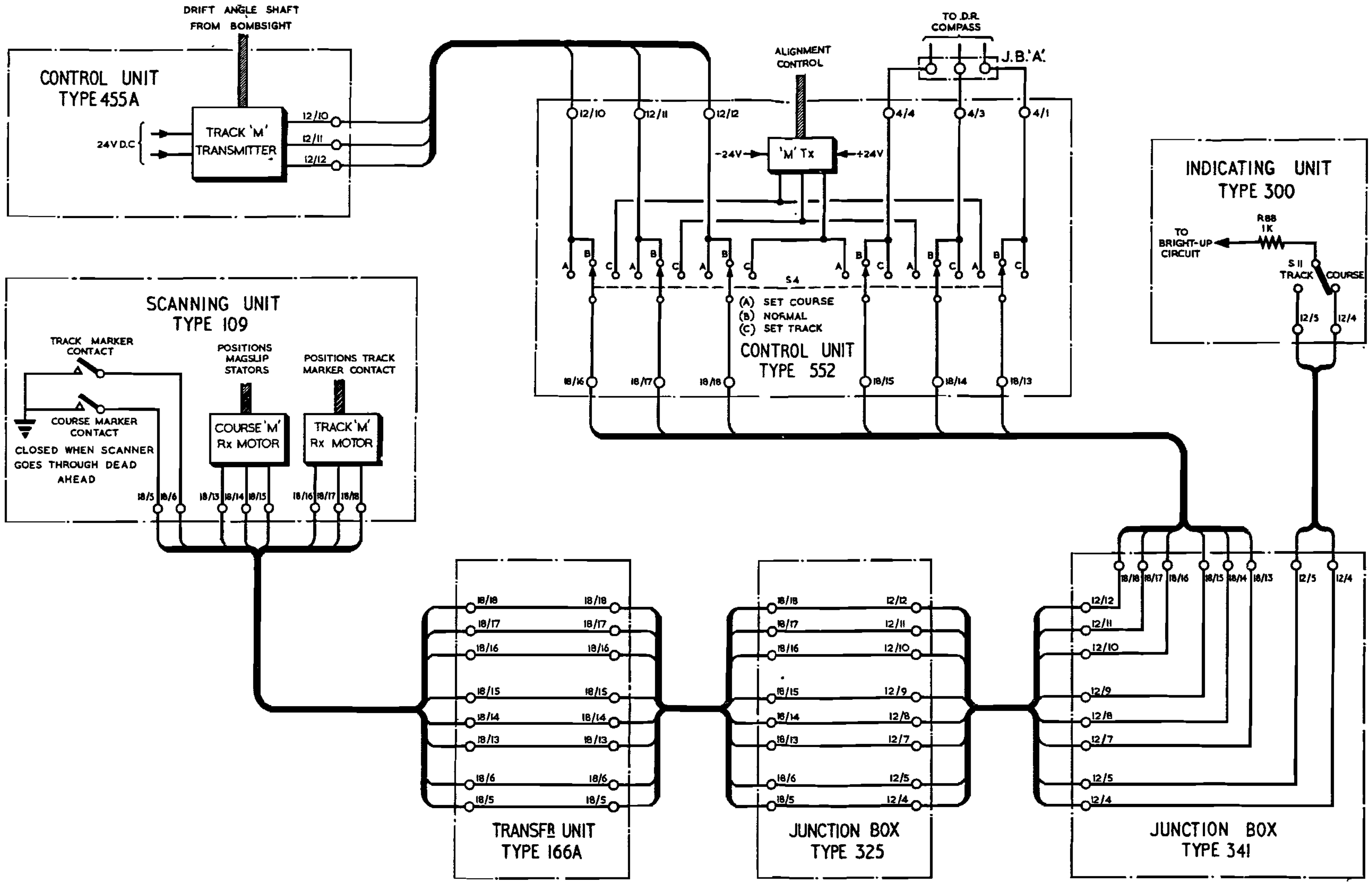


FIG. 6. COURSE AND TRACK MARKER CIRCUIT

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...wheel has two teeth more than the ... these teeth are cut in such a ... however, that the jockey pinion ... on both wheels.

[illegible] When the large knob is turned, the ... rotates on the fixed inner spur wheel and in doing so turns the outer spur wheel and consequently the shaft. This arrangement gives a step-down ratio of 48 : 1 between the large knob and the shaft. The gear ratio between the bevel gear (86) at the other end of the shaft and the cam gear is approximately 6 : 1 so that the overall step-down ratio of the control is 288 : 1. It should be noted that the shaft of the control cannot be turned directly by the small knob, as the reduction gear inside the large knob is not reversible. The most convenient method of operating the control is to use the thumb of one hand on the small central knob to keep the bevel gear and cam gear in mesh while turning the large knob with the other hand to adjust the position of the cam. The control must not be used when the scanner mirror is rotating or damage to the gears will result.

Track marker

[illegible] In early Marks of H2S the only method of determining the track of the aircraft on the PPI map was by setting the bearing line on the perspex cursor at an angle to the course marker equal to the drift angle as calculated by the operator. This method is unsatisfactory as the drift angle varies with the course of the aircraft, necessitating a calculation and adjustment each time the aircraft changes course. If the aircraft does not make a direct approach to a target it is almost impossible to obtain an accurate ground track in this manner. In H2S Mk. 4A a radial marker is used to display the track of the aircraft on the PPI map. The operator can select either the track or the course marker by means of a switch on the front panel of the in-

... computer of bombsight Mk. 14 ... the drift angle from information ... airspeed and course of the aircraft ... obtained automatically) and from ... on the speed and direction of ... which is set into the computer ... operator. The drift angle shaft from the bombsight computer to the sighting head passes through control unit Type 455A where it is used to turn an M-type transmitter. This transmitter is connected to an M-type repeater motor in the scanner which positions the track marker contacts. The track marker contacts are operated by the same cam as the course marker contacts (*para.* 33-38) but are variable in position up to ± 40 degrees from them. When the operator selects the track marker (by means of the front panel switch on the indicator), the track marker contacts are connected to the bright-up circuit of the PPI instead of the course marker contacts. When the contacts close, the bright-up circuit is altered so that at least one radial timebase is brightened. Thus the track of the aircraft appears as a radial marker on the PPI display. This marker will show the correct track in spite of variations in the speed and course of the aircraft as these are automatically allowed for by the bombsight computer. If the wind speed or direction changes, however, the marker will not show the correct track until the wind controls on the bombsight (or remote control unit if fitted) have been re-set by the operator. Details of the electrical connections to the track marker contacts are given in para. 47 and the operation of the circuit in indicating unit Type 300 is described in Chap. 9.

41. The track marker contacts (70) are mounted near enough the course marker contacts to be operated by the same cam, but instead of being fixed relative to the hub casting are mounted on a metal arm (78) which is pivoted at a point (79) near its centre. The track repeater motor (74) turns a screwed shaft (76) through a step-down gear train (77 and 72); the shaft runs in a housing (73) mounted at the bottom of the hub casting. A nut (75), free to move on the screwed shaft, carries a pin which engages in a slot on the arm (78) carrying the contacts. As the repeater motor rotates the nut travels along the screwed shaft and in doing so turns the arm, thus moving the track marker contacts relative to the course marker contacts. The computer of bombsight Mk. 14 actually calculates the tangent of the angle of drift and the track repeater motor is fed with this information. The mechanism just described is often referred to as a tangent arm drive, as its action consists of a movement of the arm carrying the contacts through an angle whose tangent is equal to the amount of rotation of the screwed shaft.

Repeater motor circuits and contact connections

42. The circuit of the course and track repeater motors and connections to the marker contacts are shown in fig. 6. The output from the drift angle (or track) transmitter in control unit Type 455A, and that from the VSC in the DR compass system, are both fed to control unit Type 552. Each output consists of switched 24V connections which, when fed to the appropriate repeater motor in the scanner, turns it in step with the transmitter. An M-type transmitting and receiving system is not self-synchronous and, in order to ensure that a transmitter and its appropriate repeater can be initially aligned, a hand-operated M-type transmitter and a three-position switch are incorporated in control unit Type 552.

43. The shaft of the M-type transmitter in control unit Type 552 is turned by means of a knob on the front panel labelled COURSE TRACK ALIGNMENT and the output of the transmitter is fed with the outputs of the VSC and drift angle transmitters to the SET COURSE NORMAL/SET TRACK switch (S4). From the switch, two groups of three leads each connect it through the junction boxes to the repeater motors in the scanner. Pins 13, 14, and 15 of the scanner 18-way W-plug are connected to the course repeater motor and pins 16, 17 and 18 to the track repeater motor.

44. When the switch is in the *normal* position, the position of the stators of magslip Type 3 is determined by the VSC transmitter, and the position of the track marker contacts by the drift angle transmitter; turning the COURSE/TRACK ALIGNMENT control has no effect. When the switch is in the *set course* position, the position of the track marker contacts is controlled by the drift angle transmitter as before, but the position of the magslip stators can be adjusted by means of the COURSE TRACK ALIGNMENT control. In the *set track* position, the position of the magslip stators is determined by the VSC transmitter and the position of the track marker contacts can be adjusted by the COURSE TRACK ALIGNMENT control.

45. The course and track repeater systems can only be aligned when the aircraft is in the air, the marker phasing control and PPI displays having been previously set up on the ground. The procedure is as follows:

(1) Instruct the pilot to fly on a compass heading and if possible check that the DR compass system is working correctly.

(2) Rotate the perspex cursor in front of the main PPI display until the bearing line indicates the course flown by the aircraft. Put the COURSE/TRACK switch to the *course* position.

(3) Switch to *set course* on control unit Type 552 and adjust the COURSE/TRACK ALIGNMENT control until the course marker coincides with the bearing line. Switch to *normal* on the control unit.

(4) Check that the wind speed and direction controls on the bombsight computer (or remote control unit if fitted) are set to zero. Put the COURSE/TRACK switch to the *track* position.

(5) Switch to *set track* on control unit Type 552 and adjust the COURSE/TRACK ALIGNMENT control until the track marker coincides with the bearing line. Switch to *normal* on the control unit.

(6) Using the switch on the indicator, change from *course* to *track* several times and check that the radial marker appears in the same place in either position of the switch. If this is not the case, repeat the above procedure.

46. When this procedure has been carried out, the constant north presentation will be maintained by the DR compass and the course marker will show the correct course of the aircraft. If the wind speed and direction are subsequently determined and set into the bombsight computer by the operator, the drift angle transmitter will position the track marker to show the correct ground track of the aircraft.

47. One contact of each of the course and track marker contacts is earthed, but not directly in the scanner as shown in fig. 6. The common lead is connected to pin 18/7 on the scanner and thence through the junction boxes to pin 18/18 on indicating unit Type 188A and pin 12/6 on indicating unit Type 300; these pins are earthed in their respective units. The other marker contacts are connected to pins 5 (course contact) and 6 (track contact) of the scanner 18-way W-plug and thence through the junction boxes to pins 4 and 5 respectively of the 12-way W-plug on indicating unit Type 300. The COURSE/TRACK switch enables either of these pins to be connected to the PPI bright-up circuit, the action of which is described in Chap. 9.

Waveguide feed to array

Input to scanner hub

48. The UHF output of transmitter-receiver Type TR.3523E is fed through a waveguide Type 263 and a tubular feeder Type 72 or 72A to the waveguide input at the top of the scanner hub. Waveguide Type 263 is rectangular in section and has a pressure seal at the end remote from the transmitter; a nozzle just behind the pressure seal is connected by rubber tubing to a desiccator mounted on the scanner framework. Thus the air in the section of the guide between the mica window in the TR.3523E and the pressure seal is kept dry and approximately at atmospheric pressure. Tubular feeder Type 72 is a short flexible feeder which allows for a slight variation in the relative positions of the scanner hub and transmitter, but must not in any event be twisted; tubular feeder Type 72A is a direct replacement for tubular feeder Type 72.

49. Tubular feeder Type 200 (57 in *fig.* 3) forms the waveguide input to the scanner. It consists of a rectangular guide followed by a right-angle bend into a circular guide which feeds the UHF energy vertically downwards into the hub. The end of the rectangular section is bevelled at an angle of 45 degrees to direct the energy downwards without causing reflections in the direction of the transmitter.

Rotating joint

50. The circular guide in the scanner hub is divided into two sections, the first of which (55) is a sleeve fixed relative to the hub. The second section is also a sleeve, forming the inner of the scanner centre shaft. This shaft is driven through gearing from the scanner motor (*para.* 8) and carries the array and mirror assembly at its bottom end; details of the shaft assembly are given in para. 75-78.

51. The fixed and rotating sections of the circular guide are separated by a distance of 1 mm. which is too small to cause any interference with the wave in the guide. A mode filter (filter unit Type 153) is included in each section; the upper of these (56A) prevents the H wave used for conveying the power in the rectangular guide from appearing in the circular guide. The lower filter (56B) prevents the E wave used in the circular guide from being fed to the array.

Feed from hub to array

52. The circular guide in the scanner hub feeds into tubular feeder Type 225 (93 in *fig.* 7). This consists of a right-angle bend with a bevel to prevent reflections, followed by a section of rectangular guide. The rectangular guide bends fairly gradually through 180 degrees in the vertical plane and is connected to a tubular feeder Type 72 or 72A (92). This flexible feeder lies almost directly beneath the centre shaft of the hub and permits movement between the fixed and tilting assemblies of the scanner (*para.* 61).

53. The UHF energy then passes through tubular feeder Type 224 (94) to the waveguide array (90). This feeder has a right-angle bend in the horizontal plane combined with a 90 degrees twist to maintain the correct polarization of the feed to the end of the array.

Array and reflector

Principles of the waveguide array

54. Full details of the design and theory of the waveguide array cannot be given in this publication and reference should be made to textbooks and reports on these subjects if information is required. An outline of the general principles is included to give the reader a coherent description of the scanner.

55. When a wave is propagated in a waveguide, electric currents flow on the inside walls. In the particular case of an H wave in a rectangular guide, these currents flow along the centre of the wide walls and transversely across the narrow walls. The longitudinal currents may be regarded as carrying the power along the guide and the transverse currents as shunt currents which help to sustain the wave pattern but do

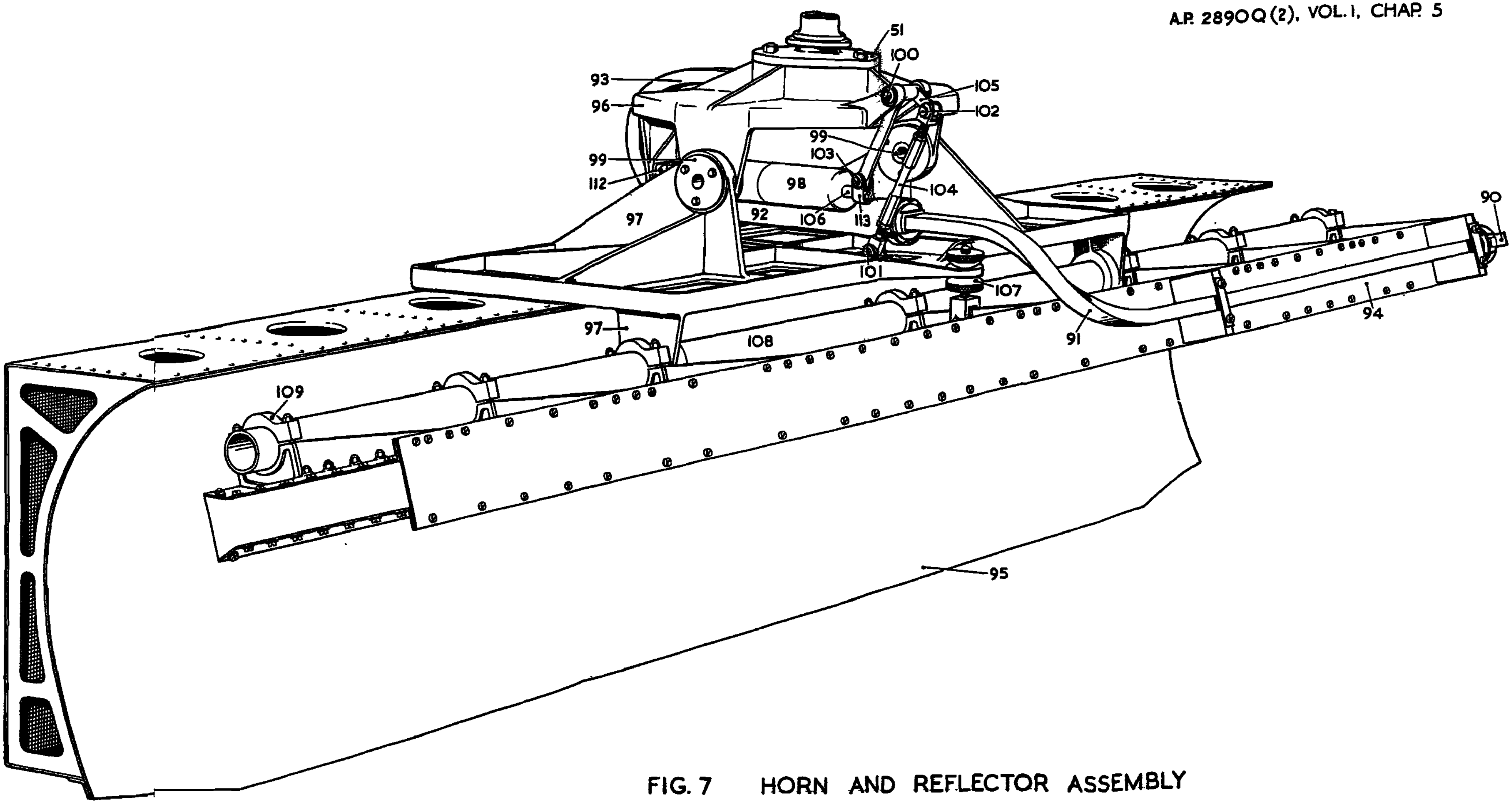


FIG. 7 HORN AND REFLECTOR ASSEMBLY

not normally take part in the flow of power. Narrow slots cut in the walls of the guide so that they interrupt the current flow radiate power. The strength of the radiation is determined by the angle that the slot makes with the direction of current flow; a transverse slot cut in the narrow wall of the guide does not interrupt current flow and does not radiate, but a longitudinal slot causes maximum interruption to the current flow and radiates fiercely.

56. The array used in scanning unit Type 109 has 79 slots cut in the narrow side of the waveguide at a spacing of slightly more than half a wavelength to reduce the standing wave in the guide. Any two adjacent slots are cut at opposite inclinations to the transverse dimension of the guide and the further the slot from the input end of the guide the greater the angle of inclination; the arrangement of the slots at the input end of the guide is shown in fig. 8. In this manner, each slot is made to radiate the same amount of energy and by the time the travelling wave reaches the end of the guide it is almost completely attenuated and no reflection takes place; this type of array is termed non-resonant. The slots of the array are protected by two layers of self-adhesive polythene.

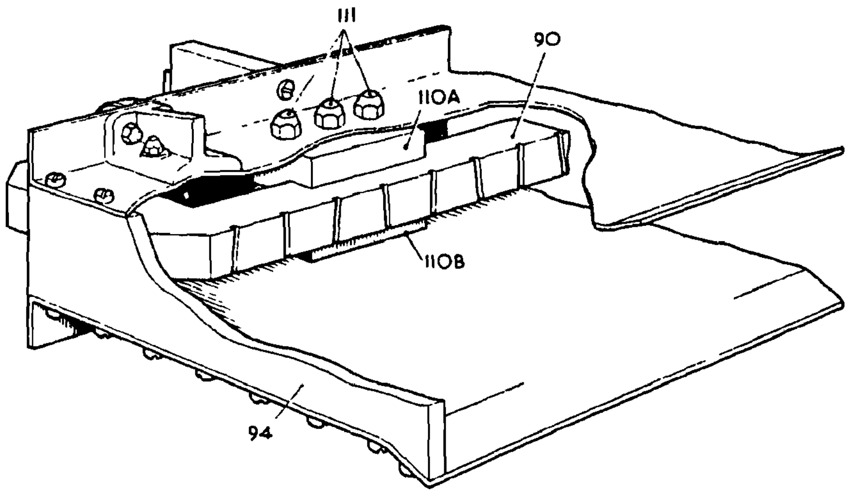
Details of the array and horn

57. The array determines the azimuth polar diagram of the scanner. The beam width at the nominal frequency of the transmitter is 1·5 degrees at 6 dB down. The direction of maximum radiation is not normal to the array but is offset by an angle of approximately 2·6 degrees; this "squint" is corrected by mounting the array at a skew angle of 3 degrees in the horn (*para.* 58). Changes in the transmitter frequency cause the direction of the beam to vary, but if the transmitter does not vary by more than 1 per cent. of the nominal frequency, the beam error will not exceed 0·7 degree. In the assembled scanner a beam width of 1·6 degrees is maintained between 10 and 70 degrees depression.

58. The array (90 in *fig.* 7) is mounted in a horn (94) which directs the radiated energy on to the reflector. The horn consists of two flat plates approximately 1½ in. apart but flared to 2 in. apart at the edges near the reflector. The array is supported by mounting pieces (110A and B) which are fixed by bolts to the horn. As stated in para. 57, the array is at a skew angle of 3 degrees to the horn to counteract "squint." The equiphase point of the radiation is approximately ⅛ in. from the mouth of the horn and this point is at the focus of the reflector.

Elevation polar diagram

59. To give the best PPI picture for bombing it is essential that targets at different ranges should experience an equal intensity of radiation from the scanner. Electromagnetic radiation obeys the inverse square law; that is, the power density is inversely proportional to the square of the distance from the scanner. If P is the output power of the equipment then the power density at a target whose slant range is r is proportional to P/r^2. It can be seen from fig. 9 that r is equal to h cosec θ, and thus it follows that the power density is proportional to $P/h^2 \operatorname{cosec}^2 \theta$. Assuming that the height of the aircraft is constant, this expression can only be constant if P varies as $\operatorname{cosec}^2 \theta$. Consequently, for an even distribution of power, the scanner output must vary as the square of the cosecant of the angle of depression from the horizontal. Power is proportional to the square of the field strength and thus the field strength diagram of the scanner must be of the form cosec θ in the vertical plane.



90 TUBULAR FEEDER TYPE 223
94 HORN ASSEMBLY
110A MOUNTING PIECE, UPPER
110B MOUNTING PIECE, LOWER
111 BOLTS SECURING ITEMS 110 A and B

Fig. 8. Input end of array

scanner reflector determines the polar diagram and is designed to sec θ field strength pattern. Details design are too complicated for in- this publication, but in practice is cylindrical in shape with the radius of curvature increasing from top to bottom. Reflector is constructed from aluminium mounted on a backing plate by means of web supports of light magnesium. The reflector assembly is suspended from a lattice framework (97 in *fig.* 7) ; the securing bolts pass through slots in the framework to allow the distance between and reflector and horn to be adjusted. Two lugs on the front edge of the framework carry a rod (108) holding the horn assembly (94) which is tilted downwards at an angle of approximately 16 degrees to the framework ; a thumb screw (107) enables small adjustments to be made to this setting.

61. The lattice framework (97) is attached to a casting (96) by two pivot pins (99) which enable the complete horn and reflector assembly to be tilted with respect to the base of the scanner hub ; the casting (96) is bolted to the lower end of the scanner centre shaft. A description of the scanner tilt mechanism is given in para. 67-70.

62. For bombing, the horn and reflector assembly is set so that the lattice framework is parallel to the base of the hub (in this position the assembly is said to be horizontal, although this actually depends on the mounting of the scanner to the airframe and the flying attitude of the aircraft). This fixes the direction of maximum radiation at 10 degrees depression and gives a cosec² distribution of power from 10 to 70 degrees depression. Variations of ± 1 dB may appear in the cosec² pattern ; these are due to interference between primary radiation from the array and secondary radiation from the reflector.

63. When flying at 20,000 ft. this setting of horn and reflector gives a PPI picture on which the ground returns are of even intensity from a range of 20 nautical miles to a range of 5 nautical miles. At a range of 5 miles the intensity increases slightly and then again remains constant to a range of less than 1 mile.

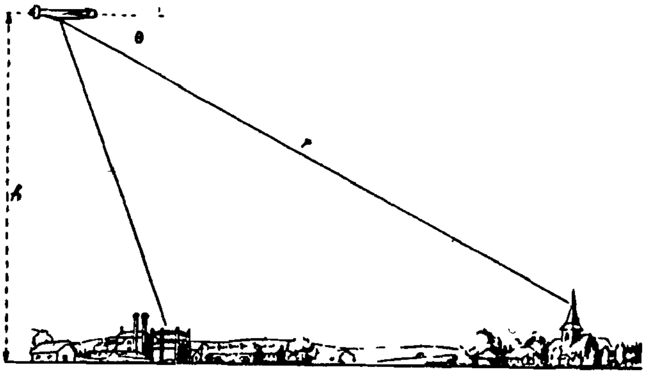


Fig. 9. Illumination of landscape by aircraft

Tilt mechanism

Need for two-position tilt

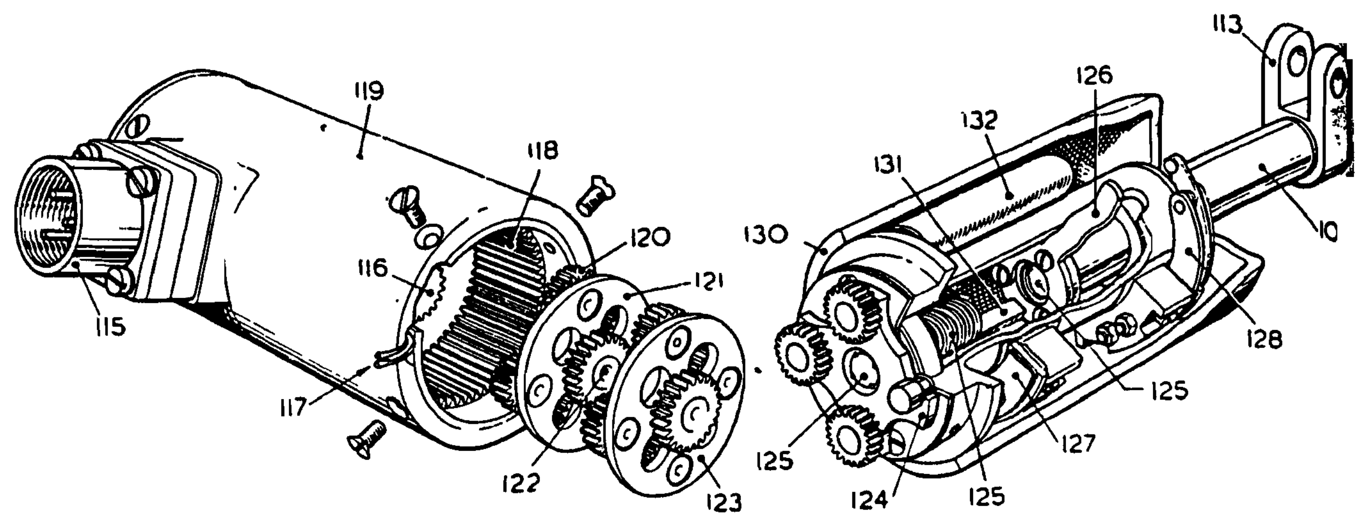
64. As stated in para. 62, the direction of maximum radiation is set at 10 degrees depression to give the best PPI picture for bombing. This is not suitable for navigating and provision is made, by enabling the tilt of the horn and reflector assembly to be set at an angle of 7 degrees above the horizontal, to set the direction of maximum radiation at 3 degrees depression giving a greater maximum range.

65. When flying at 20,000 ft. this setting gives a PPI picture on which the ground returns extend to between 35 and 40 nautical miles and towns can be recognised at ranges of up to 50 nautical miles. The intensity of the ground returns is constant from their maximum range to a range of approximately 15 miles, where it increases slightly and then remains constant to a range of less than 1 mile.

66. The operator can set the position of the horn and reflector assembly to give the best PPI picture for either bombing or navigating by means of a switch on control unit Type 565A. This switch controls the DC supply to an electric actuator which is mounted on the rotating assembly of the scanner close to the flexible feeder.

Electric actuator

67. Mechanical details of the electric actuator are shown in fig. 10. The actuator consists of a 24V reversible permanent magnet motor driving a screwed shaft through an epicyclic gear train. The screwed shaft (125) engages with the threaded inner of the main actuator shaft



106	ACTUATOR SHAFT	123	PLATE, SIMILAR TO ITEM 121
113	U BRACKET ON ITEM 106	124	PLATE, SIMILAR TO ITEM 121
115	BREEZE PLUG	125	SHAFT, SCREWED
116	GEAR ON MOTOR SHAFT	126	CONTACT ARM
117	LEADS TO CONTACTS (ITEMS 127 and 128)	127	CONTACTS, INNER (DOWN)
118	TOOTHED INNER OF MOTOR HOUSING	128	CONTACTS, OUTER (NORMAL)
119	MOTOR HOUSING	130	SHAFT HOUSING
120	PLANET WHEELS	131	GUIDE FOR ITEM 106
121	PLATE MOUNTING PLANET WHEELS	132	WIRE RESISTANCE
122	GEAR (INTEGRAL WITH ITEM 121)		

Fig. 10. Electric actuator

(106) and as it revolves propels the latter in or out of its housing (130).

68. The DC supply for the actuator motor is fed to a 3-pin breeze plug (115) on the motor housing (119). One end of the armature winding of the motor is connected to pin 1 of this plug and the other end, through a wire-wound resistance, to two sets of contacts (127 and 128) operated by an arm (126) on the actuator shaft. The inner set of contacts (127) connects the winding to pin 3 of the breeze plug but this connection is broken when the actuator is retracted. The outer set of contacts (128) connects the winding to pin 2 of the plug but this connection is broken when the actuator is extended. The wire-wound resistance reduces the DC supply voltage from its actual value (about 28V) to its nominal value (24V) to prevent over-running of the motor.

Scanner tilt assembly

69. The actuator (98 in *fig.* 7) is attached by a pivot pin (112) to a bracket on the casting (96) at the lower end of the scanner shaft; the pivot permits the actuator to move slightly in the vertical plane as it extends or retracts. A U-bracket (113) on the actuator shaft is linked by a pin (103) to an arm (105) which is pivoted about a point (100) higher up on the casting. The arm is L-shaped and its other end (102) is attached by a turnbuckle (104) to a U-bracket (101) on the horn and reflector assembly.

70. As described in para. 61, the horn and reflector assembly is attached by pivot pins to a casting at the lower end of the scanner shaft. When the actuator is retracted, the top plate of the reflector is parallel to the base of the scanner hub and the reflector and horn are regarded as being in the horizontal position; the turnbuckle enables small adjustments to be made. When the actuator shaft is extended, the horn and reflector assembly is pulled upwards and the amount of shaft extension results in the top plate of the reflector being tilted at an angle of 7 degrees above the horizontal.

Tilt control

71. The circuit of the tilt switch on control unit Type 565A and its connections in the scanner are shown in fig. 11; for clarity

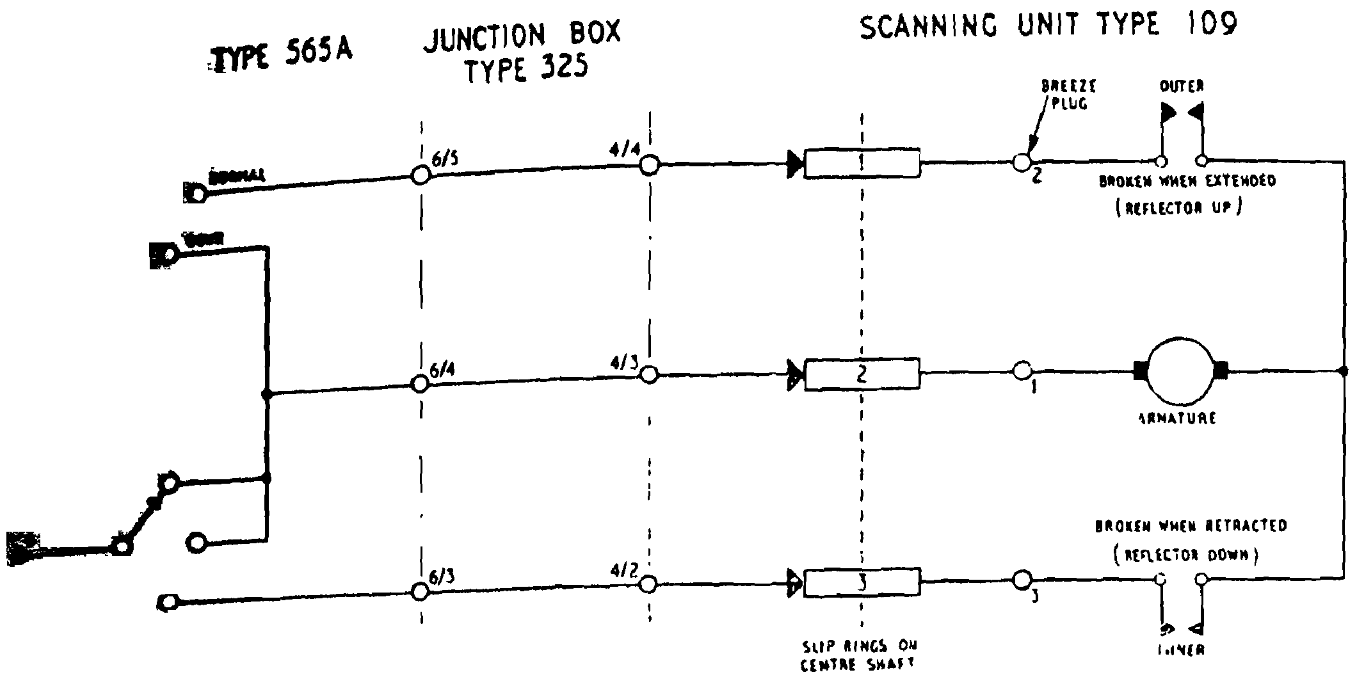


Fig. 11. Tilt switching circuit

the links in the control unit are not shown. The switch has three positions but the first of these (*Up*) is not used in H2S Mk. 4A and has no effect. In the *normal* position the 24V DC supply is fed to pins 6/4 (positive) and 6/5 (negative) and in the *down* position to pins 6/3 (positive) and 6/4 (negative); these pins are connected through junction box Type 325 to pins 2, 3, and 4 of the *plain* 4-way W-plug on the scanner hub and thence via brushes and slip-rings on the scanner centre shaft to the breeze plug on the electric actuator.

72. When the switch is in the *down* position, the actuator is retracted, setting the horn and reflector to the horizontal position. By tracing the connections on fig. 11 it can be seen that the DC supply is connected to pins 1 (negative) and 3 (positive) on the actuator breeze plug. The lead from pin 3 to the motor is broken, however as the inner contacts on the actuator shaft are broken by the contact arm, and in consequence the actuator does not operate.

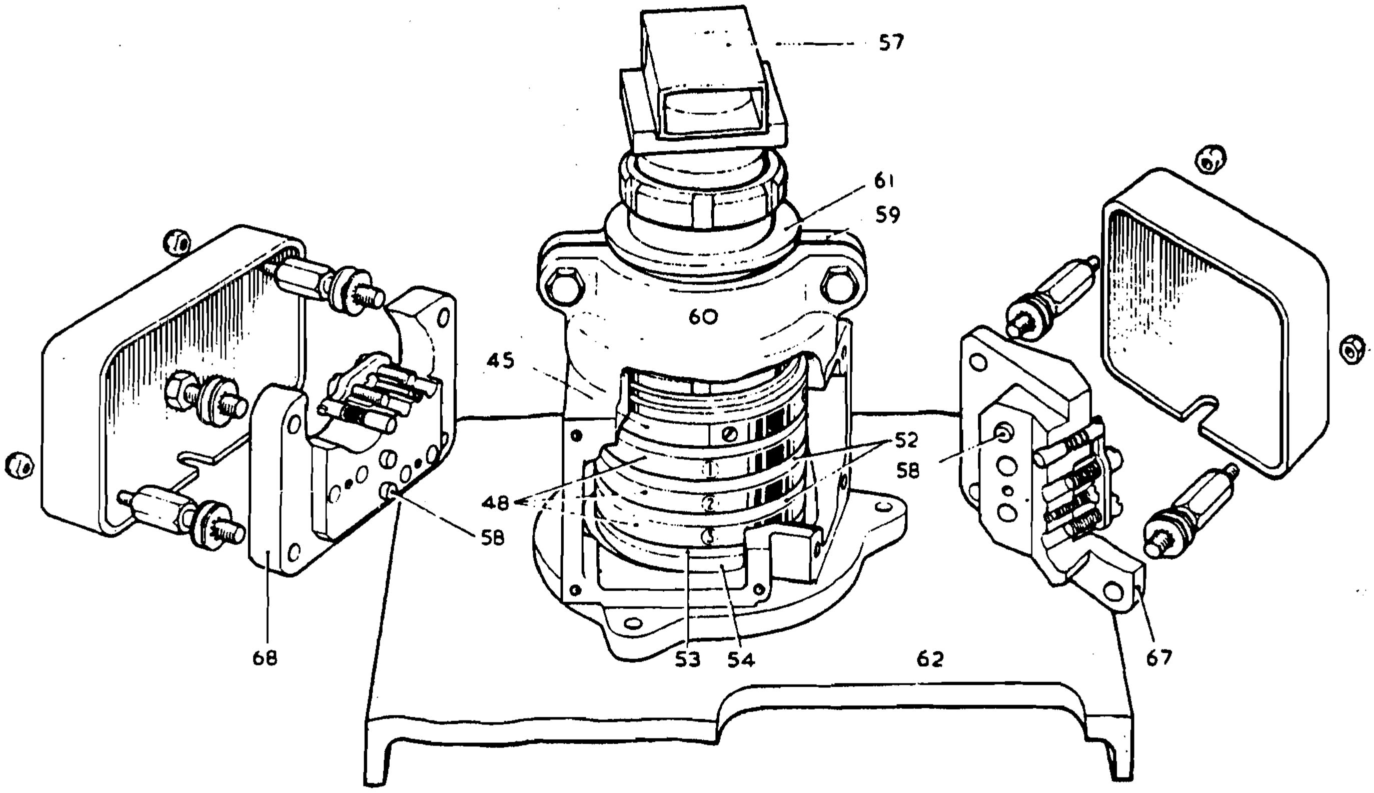
73. If the switch is now put in the *normal* position the DC supply is connected to pins 1 (positive) and 2 (negative) of the actuator breeze plug. The lead from pin 2 is connected to the outer contacts on the actuator shaft and, therefore, as these are closed to the actuator motor. The actuator motor drives the shaft out of its housing and in doing so tilts the horn and reflector assembly above the horizontal. When this tilt is equal to 7 degrees, the actuator shaft is fully extended and the contact arm breaks the connection between pin 2 and the motor, thus stopping the action.

74. The reflector and horn will remain in this position until the switch is put in the *down* position when the DC supply is re-connected to pins 1 (negative) and 3 (positive) on the actuator plug. The contacts between pin 3 and the motor are closed, so the motor rotates but in the reverse direction to that described in para. 73 because of the reversal in DC polarity. Thus the actuator shaft is retracted bringing the reflector and horn back to the horizontal position.

Centre shaft assembly

75. Details of the assembly of the scanner centre shaft can be seen from fig. 3; an exterior view showing the camera switch and tilt mechanism brush blocks is given in fig. 12.

76. The circular waveguide inside the scanner hub is actually a sleeve inside the metal casting (51 in *fig.* 3) which forms the centre shaft. The upper end of this shaft runs in an oilite bearing (61), which is mounted in the centre shaft housing (60),



45	COLLAR WITH CAMERA SLIP-RING	59	CLAMPING PIECE
48	SLIP-RINGS (TILT MECHANISM)	60	HOUSING, CENTRE SHAFT
52	RING SPACERS, INSULATING	61	HOUSING, BEARING SUB-ASSEMBLY
53	WASHER, INSULATING	62	HUB CASTING
54	WASHER, METAL	67	CAMERA BRUSH BLOCK
57	TUBULAR FEEDER TYPE 200	68	TILT MECHANISM BRUSH BLOCK
58	BRUSHES		

Fig. 12. Centre shaft assembly

and the lower end in a ball bearing (46) at the bottom of the hub casting (62). The drive to the centre shaft (*para.* 8) is transmitted by means of a large spur wheel which is clamped to the inner ball race by two lock nuts (49). The casting holding the horn and reflector assembly (96) is bolted to the circular plate which forms the bottom of the shaft casting.

77. A slip-ring assembly is clamped on the centre shaft between a rim of the casting and two lock nuts (50). The assembly consists of a slip-ring forming the camera switch (45) and three slip-rings (52) which are connected to the electric actuator on the rotating assembly of the scanner.

78. The upper section of the centre shaft is enclosed in a housing (60) which is bolted to the top of the hub casting. The top of the housing contains the oilite bearing (61) and is clamped around the shaft; tubular feeder Type 200 is attached to the top of the housing by an ordinary waveguide locking ring. The brushes for the centre shaft slip-rings are mounted in two brush blocks (67 and 68) set at an angle of approximately 90 degrees to each other.

Connections to tilt mechanism

79. The leads from the actuator breeze socket are combined in a cableform which runs to the circular plate at the bottom of the centre shaft. The leads then divide and pass through slots in the shaft casting to the slip-rings. The slip-rings are numbered in fig. 12 and 13 but not on the actual scanner; they are insulated from each other and from the centre shaft by fabric washers. The tilt mechanism brush block (68) mounts three brushes (58), one running on each slip-ring, and the brush terminals are connected through a PVC cableform to pins 2, 3, and 4 of the plain 4-way W-plug on the scanner hub.

Camera switch

80. The camera switch consists of two brushes (58) both running on the upper slip-ring (45) of the centre shaft. This "slip-ring" consists of a collar of insulating material which has a metal strip let into its outer circumference over an arc subtending an angle of 85 degrees. The two brushes subtend an angle of 25 degrees at the centre of the shaft and are connected via the pins of a 2-way W-plug to the PPI camera circuits.

81. It can be seen that the pins of the W-plug will be connected together when both brushes are bearing on the contact strip and that this occurs over 60 degrees of revolution of the shaft. The short circuit between the pins will last for one-sixth of a second for the normal scanner speed of 60 r.p.m. and is used to operate the film turning mechanism in the camera.

Nacelle

82. The section of the scanner projecting below the airframe is enclosed in a nacelle constructed of a material which is transparent to the beam of UHF energy. Three types of nacelle are at present in use on Lincoln aircraft fitted with H2S Mk. 4A. The earliest type is constructed of solid perspex and is very heavy; a later version is made of "expanded perspex" and is considerably lighter; the latest type is constructed of "expanded rubber" and is the most satisfactory.

83. At present all three types of nacelle are being fitted, but eventually the two earlier types will be replaced by the "expanded rubber" version. This nacelle is much thicker than the earlier types and there is insufficient clearance between its inner surface and the rotating mirror. A modification to the scanner has consequently become necessary and this is described in a leaflet to Volume 2 of this publication. This modification need not be carried out until the "expanded rubber" nacelle is fitted.

CONTROLS AND CONNECTIONS

Controls and adjustments

84. Certain of the adjustments described below are only necessary when a scanner is first put into service or when assembling after a major overhaul; maintenance procedures are given in Part 2 of this Volume.

Reflector adjustments

85. Before mounting the reflector assembly on the scanner base, the horn and reflector must be carefully aligned to give the correct vertical polar diagram. Two adjustments are provided.

(1) Adjustment of the angle of tilt of the horn by means of the two knurled nuts (107 in *fig.* 7).

(2) Adjustment of the distance between horn and reflector by slackening the hexagonal-headed bolts holding the reflector to the lattice framework (97 in *fig.* 7) and sliding it along the slots provided.

86. Two templates are provided for aligning the horn and reflector and must be placed, one at each end of the reflector, so that the curved edge of the template fits into the curved profile of the reflector and no light is visible between them. The tilt of the horn must then be adjusted until its lower edge is parallel with the reference edge of the template and the distance between horn and reflector adjusted until the edge of the horn just touches the edge of the template. When the distance between horn and reflector is correct, the lip of the horn should be in line with the mark on the template. These conditions must be satisfied at both ends of the reflector or beam squint will result.

Tilt adjustment

87. The angle between the two tilt positions of the horn and reflector assembly is fixed by the geometry of the linkages to 7 degrees, but the turnbuckle (104 in *fig.* 7) must be adjusted until the reflector framework (97) is parallel to the base of the hub when the assembly is in the down position. This can be done by mounting the scanner on a bench stand, adjusting the stand until a spirit level shows that the base of the hub is horizontal, and then adjusting the turnbuckle until a spirit level on the reflector framework shows that it is also horizontal.

Marker phasing control

88. In order to set this control, the electrical dead-ahead position of the scanner must first be determined. This is normally done when the scanner is first installed in an aircraft and the position is then marked by two lines scribed on the scanner base and reflector bracket similar to those made by the manufacturer to indicate the mechanical dead-ahead position. The procedure used to determine the electrical dead-ahead position is described in Part 2 of this Volume.

89. To set the marker phasing control proceed as follows :—

(1) Set the scanner to the electrical dead-ahead position and centre the PPI trace on indicating unit Type 300.

(2) Switch to set course on control unit Type 552 to freeze the magslip stators and set the bearing line over the PPI trace.

(3) Start the scanner rotating and check that the course marker appears exactly under the bearing line. If it does not, stop the scanner, adjust the marker phasing control and check again. Repeat until the course marker appears exactly under the bearing line.

Note . . .

The marker phasing control must not be used when the scanner is rotating or serious damage will result. Do not use force to engage the gears.

Fishpond magslip

90. When the scanner is in the electrical dead-ahead position, the stators of magslip Type 7 must be adjusted to give a vertical trace pointing to the top of the tube face on indicating unit Type 188A ; proceed as follows :—

(1) Set the scanner to the electrical dead-ahead position and check the position of the trace on indicating unit Type 188A.

(2) If the trace is not pointing vertically upwards within 2 or 3 degrees remove the bolts securing the body of the Fishpond magslip, lift up the casting, and rotate the body of the magslip until it does.

(3) Replace the cover and tighten the bolts, so clamping the magslip in the correct position.

Note . . .

Do not lift the magslip cover any further than necessary or the wiring to the terminals at the top may be damaged.

Connections

91. Connections to the scanner are made via one 18-way W-plug, one 6-way W-plug, two 4-way W-plugs, one 2-way W-plug, and a waveguide connection. Details of the connections are as follows :—

(1) Plug Type W203 ; 18-way *red*, connected to transformer unit Type 166A

Pins 1 and 3	sin θ	Outputs from the stators of magslip Type 3. Pins 3 and 4 are earthed in junction box Type 325
Pins 2 and 4	cos θ	
Pin 5	Course marker	
Pin 6	Track marker	
Pin 7	Earth (E2) for marker contacts	
Pins 8 and 9	Blank	
Pin 10	Earth (not connected in the scanner)	
Pins 11 and 12	Scan waveform to rotor of magslip Type 3	
Pins 13, 14 and 15	Switched DC impulses to the course repeater motor	
Pins 16, 17, and 18	Switched DC impulses to the track repeater motor	

(2) Plug Type W199 ; 6-way *red*, connected to junction box Type 325

Pins 1 and 3	sin θ	Outputs from the stators of magslip Type 7. Pins 3 and 4 are earthed (E1) in indicating unit Type 188A
Pins 2 and 4	cos θ	
Pins 5 and 6	Pulse input to the rotor of magslip Type 7. Pin 6 is earthed in junction box Type 325.	

[illegible] Type W198; 4-way *plain*, connected to junction box Type 825

[illegible] 24V DC (not used).

[illegible] Switched scanner tilt voltages.

[illegible] Type W198; 4-way *red*, connected to control unit Type 565A through a suppressor.

Pin 1 +24V DC to the armature and field windings of the drive motor.

Pin 2 Variable negative DC voltage to the armature winding of the drive motor.

Pin 3 Blank.

Pin 4 —24V DC to the field winding of the drive motor.

(5) Plug Type W197; 2-way *plain* connected to the PPI camera circuits through a suppressor.

Pin 1, Pin 2 — 24V DC connection to the film turning mechanism in the PPI camera once per revolution of the scanner mirror.

(6) Waveguide connector. This carries the RF output from transmitter-receiver Type TR.3523E to the scanner and feeds the received signals from the scanner back to the transmitter-receiver.

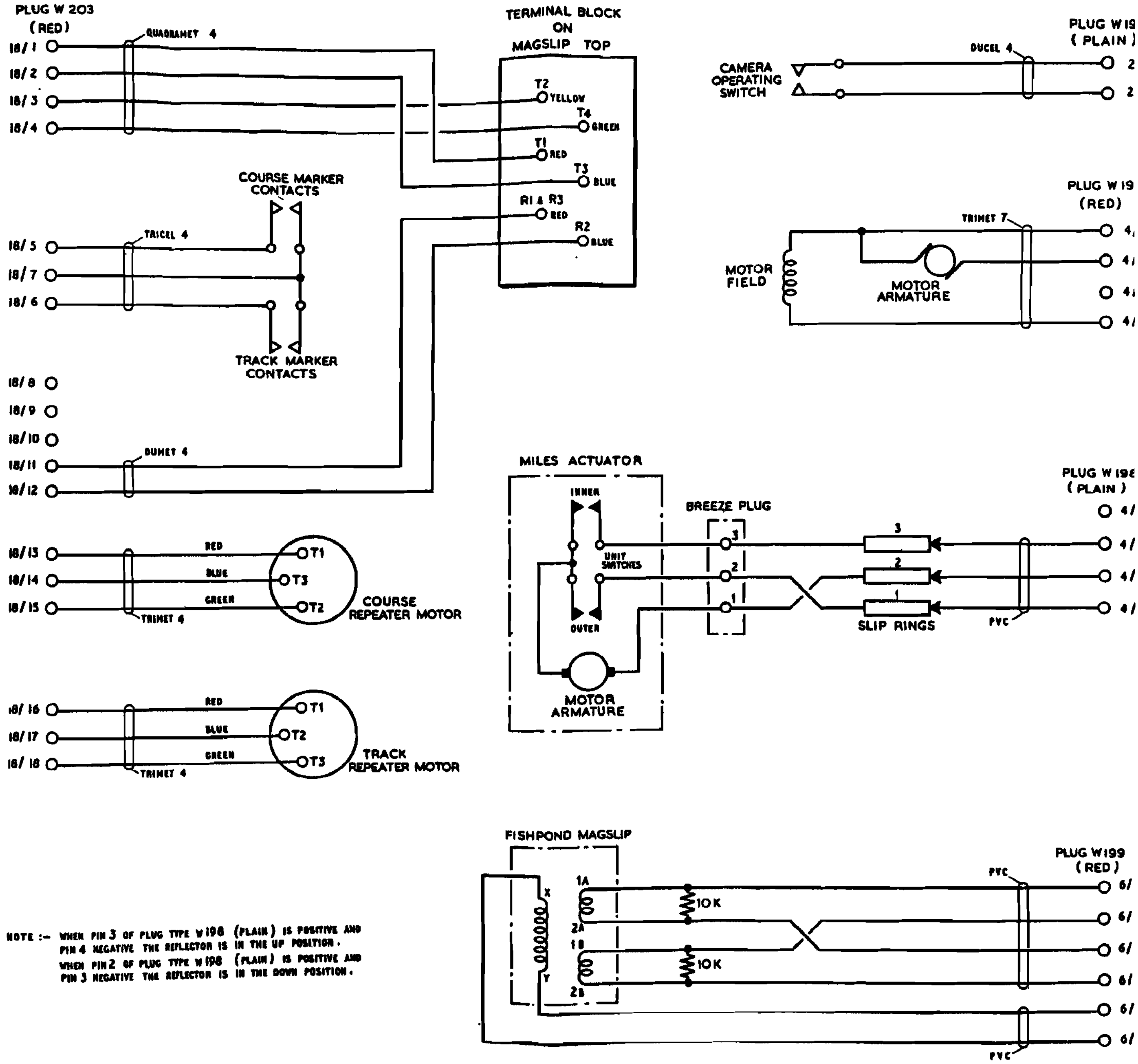
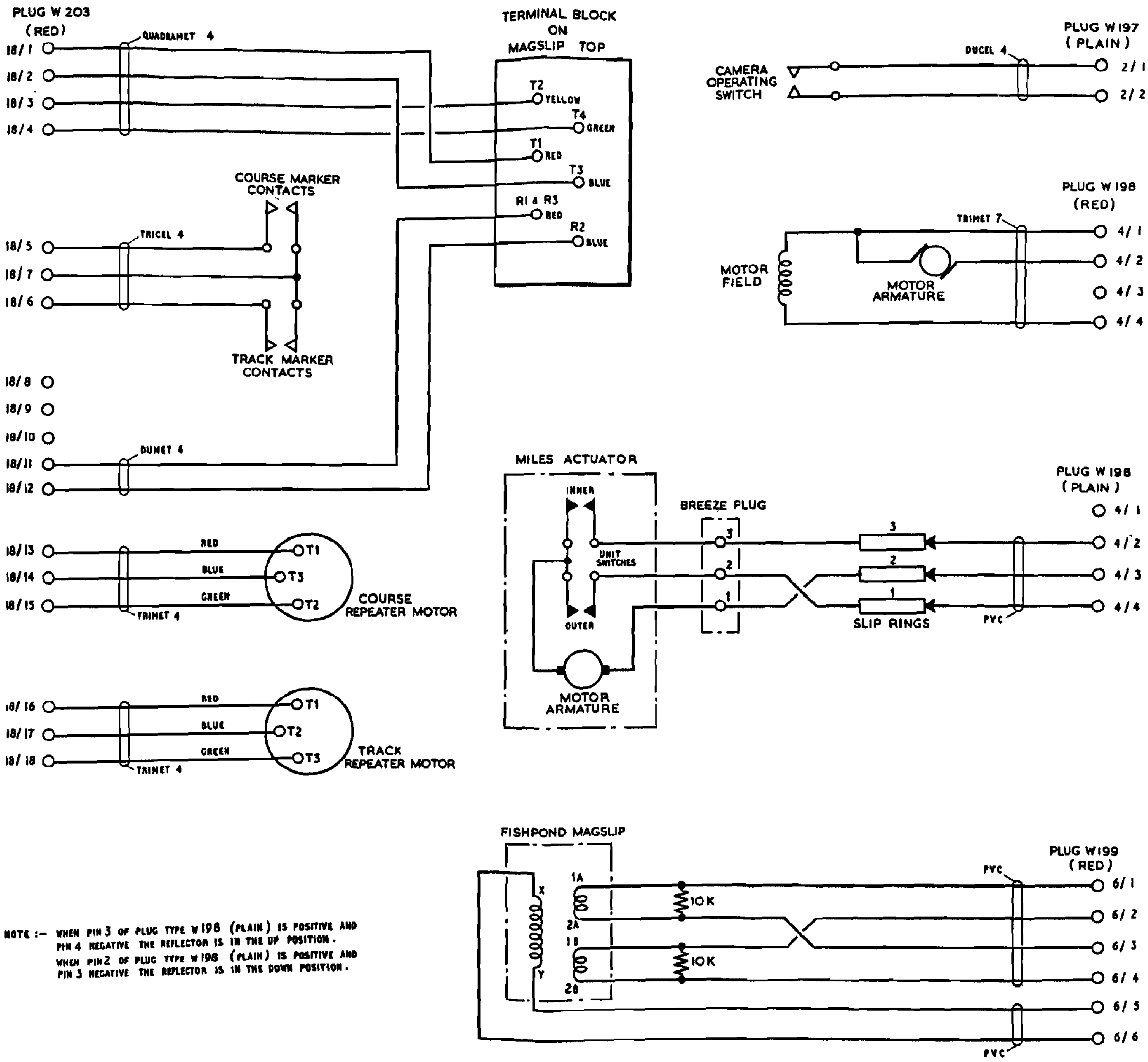


FIG. 13. SCANNING UNIT TYPE 109: WIRING.

G4483 M44648 3/52 130 C.B.& S.Ltd. Gp88.



NOTE :– WHEN PIN 3 OF PLUG TYPE W198 (PLAIN) IS POSITIVE AND PIN 4 NEGATIVE THE REFLECTOR IS IN THE UP POSITION.
WHEN PIN 2 OF PLUG TYPE W198 (PLAIN) IS POSITIVE AND PIN 3 NEGATIVE THE REFLECTOR IS IN THE DOWN POSITION.

FIG. 13. SCANNING UNIT TYPE 109: WIRING.

G4465 M46645 3/52 130 C.B.& S.Ltd. Gp.88.

Chapter 6

CONTROL UNIT TYPE 565A

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

GENERAL

1. Control unit, Type 565A contains all the controls associated with the transmitter and scanner, which are required by the navigator in the aircraft.

2. The controls provide the following functions :—

(1) Varying the speed of rotation of the scanner.

(2) Selecting the angle of downward tilt of the scanner.

(3) Selecting automatic or manual tuning of the signal local oscillator or switching to beacon operation and providing manual tuning of the beacon local oscillator. A control is provided on the unit for manual tuning of either of the local oscillators.

3. The tilt switching circuits in the control unit are fitted with a six-pole two-way link. This link must always be in the position marked for scanning unit, Type 109; the other position (marked for scanning unit, Type 111) is not used in H2S, Mk. 4A.

CIRCUIT DESCRIPTION

Scanner speed control

4. The 6-way W-plug on the control unit is connected to junction box, Type 325, and the *red* 4-way W-plug through the scanner bulkhead and a suppressor to the scanner. The 24V DC supply is fed to the control unit via pins 6/1 (—24V) and 6/2 (+24V), and thence to the field winding of the scanner motor via pins 4/4 and 4/1, the latter being positive. A variable voltage is fed from the resistor RV2 via pins 4/1 and 4/2 to the armature winding of the motor. RV2 is a 10-ohm variable resistance incorporating an on/off switch at one end, the DC supply to pin 4/2 being broken when the slider is in its fully anti-clockwise position. The speed of rotation of the scanner can be varied from 0 to 60 r.p.m. by means of RV2.

Scanner tilt control

5. Switch S2 is a two-pole, three-way heavy duty switch providing remote control of the preset angles of tilt of the scanner. Links L1 to L6 enable the tilt switching circuit to be altered if the control unit is used with other scanners.

6. Normally, the links must be in position for scanning unit, Type 109 (shown dotted in *fig.* 3) and position 1 (UP) of the switch is not used. In position 2 (NORMAL) + 24V is applied to pin 6/4 and —24V to pin 6/5 ; in position 3 (DOWN) + 24V is applied to pin 6/3 and — 24V to pin 6/4. Pins 3, 4 and 5 of the six-way W-plug are connected

through junction box, Type 325 to the scanner where they are connected to the Miles electric actuator (*Chap.* 5).

7. Leaflet 10 to Vol. 2, Part 1, of this publication describes a modification to the control unit which involves changes to the DC polarity in the scanner tilt switch and speed control circuits. These changes have been incorporated in this chapter but it should be noted that the position of the links marked for scanning unit, Type 111 (shown by the full lines in *fig.* 3) is no longer correct for that unit. This is not important, as scanning unit, Type 111 will not be used in H2S, Mk. 4A.

Tuning switch and tuning control

8. When the facility switch on transmitter-receiver, Type TR.3523E is in the REMOTE position, its functions are assumed by the tuning switch (S1) on the control unit.

9. In position 1 (MANUAL) of the switch, the relay circuit in the transmitter is earthed through R1 (62K) and the high-resistance relay operates. As a result, the signal local oscillator is in circuit and its reflector is connected to the slider of RV1 in the control unit. In position 2 (AFC), the relay circuit is not connected to earth and in consequence the signal local oscillator is in circuit and its reflector potential is controlled by the AFC circuits. When the switch is in position 3 (BEACON) the transmitter relay circuit is earthed directly and both relays operate. As a result the HT supply is switched from the signal to the beacon local oscillator and the reflector of the latter is connected to the slider of RV1.

10. The tuning control RV1 (200K) is connected in series with R2 (100K) and R3 (68K) between + 330V and + 100V. The transmitter is connected directly to the control unit by means of a 4-way cable.

11. In the BEACON position of the tuning switch, pin 6/6 is earthed. This pin is connected through junction boxes, Type 325 and 341 to waveform generator, Type 61 and modulator unit, Type 196/WW. When the pin is earthed, a relay in the waveform generator reduces the p.r.f. to 350 p.p.s. and relays in the modulator increase the pulse length to 2¼ μs. Full details of the action of these circuits can be found in Chap. 3 and 14. It should be noted that the scale switch on indicating unit, Type 300 has no effect on the p.r.f. when the tuning switch is in the BEACON position. If the transmitter is not fitted with a pulse transformer capable of handling the 2¼ μs pulse, the earth connection to the second card of the tuning switch is removed, thus preventing the change in pulse length and p.r.f. described above. This modification is described in a leaflet to Vol. 2, Part 1, of this publication.

CONNECTIONS

12. Connections to the control unit are made via one 6-way and two 4-way W-plugs; details are as follows :—

(1) Plug, Type W199: 6-way *plain* connected to junction box, Type 325.

Pin 1	—24V DC
Pin 2	+24V DC
Pin 3, 4 and 5	Switched scanner tilt voltages.
Pin 6	This pin is earthed when the tuning switch is in the BEACON position and consequently the p.r.f. of the equipment is changed to 335 p.p.s. and the pulse length to 2¼ μs. If the pulse transformer in the transmitter cannot handle the 2¼ μs pulse, a modification to the switch prevents this pin being earthed.

(2) Plug, Type W198; 4-way *red*, connected to the scanner through a suppressor.

Pin 1	+24V DC to the armature and field windings of the scanner motor.
Pin 2	Variable negative DC voltage to the armature winding of the scanner motor.
Pin 3	Blank.
Pin 4	—24V DC to the field winding of the scanner motor.

(3) Plug, Type W198, 4-way *plain*, connected to transmitter-receiver, Type TR.3523E.

Pin 1	Relay switching in the transmitter.
Pin 2	Tuning voltage.
Pin 3	+330V(1) DC
Pin 4	+100V DC.

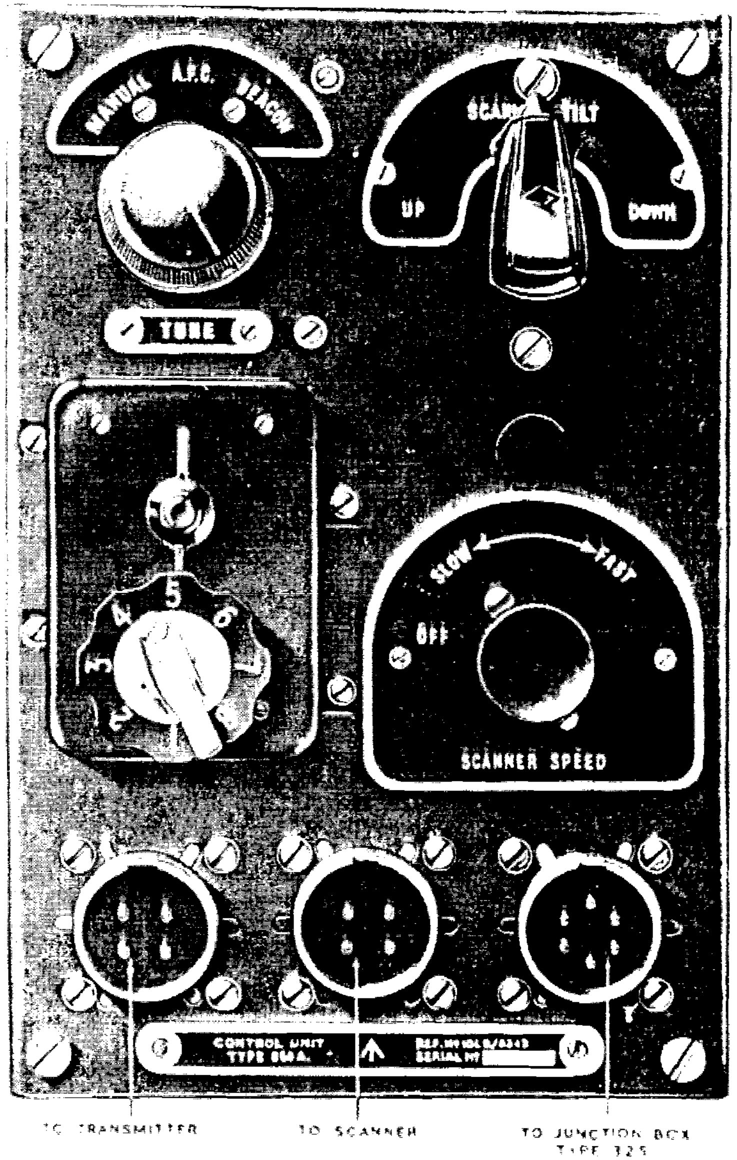


Fig. 1. Control unit, Type 565A : front panel

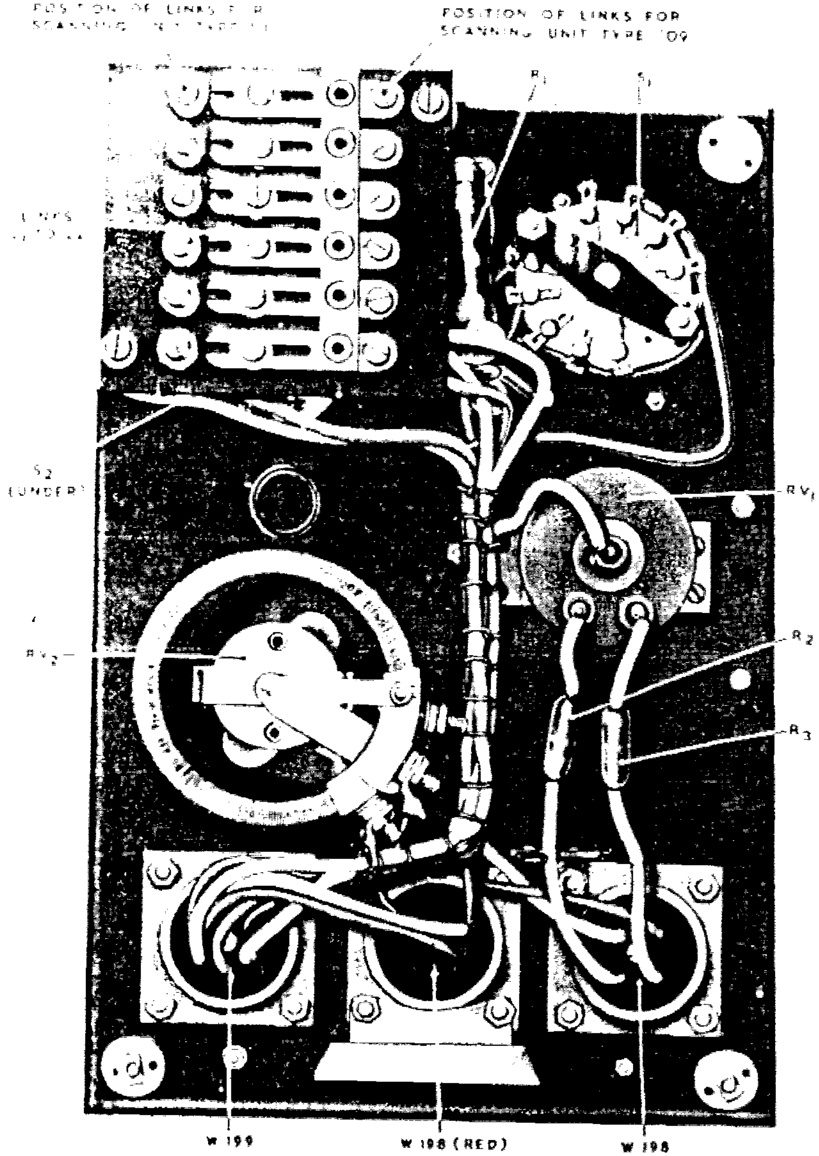


Fig. 2. Control unit, Type 565A : interior