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A.C.D. 2005 (2)

MANUAL OF A.S.V. MK. II (AUST.)

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Directorate of Radio Services (Radar), R.A.A.F. Headquarters, MELBOURNE

AIR FORCE HEADQUARTERS.

DIRECTORATE OF RADIO.

AMENDMENT LIST NO. 1

to

ACD.2005(2)

MANUAL OF A.S.V. MARK II (AUST).

1. The following amendments are to be made to the above Manual.

(i) Reference: Chapter 1.

Remove Page 7 from the Manual and in its place insert the corresponding page of this Amendment.

(ii) Reference: Chapter 2.

Remove Pages 1 and 2 from the Manual and in their place insert the corresponding sheet of this Amendment.

(iii) Reference: Chapter 4.

Remove Page 9 from the Manual and in its place insert the corresponding sheet of this Amendment.

2. The three (3) sheets removed from the Manual (sub-paras (i), (ii) and (iii) above) together with this Instruction Sheet are to be destroyed by fire. No Certificate of Destruction is required.

3. The Amendment Sheet in the front of the Manual is then to be suitably endorsed by the Officer in Charge of Secret and Confidential Publications.

June, 1945.

(f) Loosen the set screw of the shorting bar on the anode Lechers thus enabling the bar to slide along them. To increase frequency move the bar towards the front panel—to reduce frequency move it nearer the back of the chassis. As a guide, a movement, of approximately ⅛ inch will alter the frequency by 1 megacycle. Tighten the screw after each adjustment has been made.
Check the frequency with a wave-meter. If too much or too little change has taken place, repeat the operation until the correct frequency is obtained. When this condition is reached, retune the filament tuning condensers for minimum current.

(g) Remove the short from the aerial Lecher and connect the Transmitter either to an attenuator which presents the same effective load as the aircraft aerial system, and peak diode voltmeter, or to a matched aerial, as a load.

(h) i. With the aerial Lecher coupling still reduced (as in para. (c)) adjust the aerial tapping point on the aerial Lecher until the P.R.F. is 300-400 with the aerial tuning condenser C1 adjusted for maximum anode current. This will almost certainly be less than 5 m.a.

ii. Lower the aerial Lechers a little by turning the adjusting screw anti-clockwise, and move the tapping point towards the open end of the Lechers until the P.R.F. is again 300-400. Check the anode current, which will have increased in value. Repeat this process until the anode current is increased to 3·5-5 m.a. with the P.R.F. still as above. It is essential to replace the metal top of the Transmitter when making readings of anode current and P.R.F., as its absence will affect them both.

(j) Check frequency, and readjust if necessary to 176 mc. Run through the aerial adjustments once more if a slight frequency change has been made. When the Transmitter is correctly adjusted, the P.R.F. will be between 300 and 400, the anode current between 3·5 and 5 mills, the frequency 176 Mc., plus or minus ·25 Mc. the filament condensers peaked for minimum anode current, and the aerial tuning condenser peaked for maximum anode current.

(k) Check the power output with a peak diode voltmeter and attenuator, if these are available. The peak voltage after passing through the attenuator should be 115 volts, plus or minus 12 volts.

(l) Connect a standard matched aerial and check performance on local echoes.

If difficulty is encountered in adjusting the Transmitter to the above P.R.F. and current, proceed as follows—

(a) Check the H.T. voltage. This should be about 7500 volts. If less than this, probably the 80 volt A.C. supply is also too low. It should be tested with a reliable A.C. meter, the accuracy of which is not affected by frequency (see Chapter 3, para. 12). If no such meter is available the standard meter from another Transmitter can be used as a check.

(b) Replace the VT90 valves by a pair of matched valves.

From the above it will be seen that the positions of both the aerial Lechers and the tapping point are important for maximum efficiency, and these should not be altered except by competent mechanics who thoroughly understand the procedure.

Variations to the above procedure, and to the values mentioned may become necessary from time to time. These will be detailed in Radar Maintenance Instructions (Air).

General Characteristics of A.S.V. Mk. II (Aust.) Blower Motors.

Ident No.	Power Requirements
Y10AB/500800	30 watts at 24 volts
Y10KB/500002	30 watts at 12 volts

CHAPTER TWO

POWER SUPPLY ALTERNATORS, TYPE "AR," "QH" AND "ARV."

General Description — Characteristics and Installation Details — Operation — Connection and Controls.

GENERAL DESCRIPTION

1. The equipment used for A.S.V. requires a wide range of A.C. and D.C. voltages, from 2·5 volts A.C. to 8,000 volts D.C. It is essential therefore to provide a source of alternating current to operate the power supplies of the various units.

This alternating current is obtained from specially designed alternators having an output of 80 volts A.C· at a maximum current of 6·25 amps, and a frequency varying from 866 cycles to 2,600 cycles, according to the type of alternator, and the speed of the rotor.

The stardard alternator now used with aircraft fitted with A.S.V. (Beaufort, Mariner, Anson and Hudson) has an " AR " or " ARV " type mounted on the port engine, and the Anson has an " ARV " type mounted on the port engine. The other aircraft have alternators driven by D.C. motors connected to the 24 volt aircraft supply and mounted inside the fuselage.

TYPES IN USE.

2. Earlier installations were fitted with type " QH " alternators. These are now largely superseded by types " AR " and " ARV," but may still be encountered. The following tables give details of all three types and where they are used :—

TABLE I — General Characteristics of A.S.V. Alternators.

Type	Frequency Range	Speed Range	Weight	Power Factor Condenser	Field Current at 28V. D.C.
AR	1300–2600 c.p.s.	3000–6000 r.p.m.	26 lbs.	5 mf.	3·0 max.
ARV	1300–2600 c.p.s.	3000–6000 r.p.m.	26 lbs.	5 mf.	1·25 max.
QH	1300–2600 c.p.s.	3000–6000 r.p.m.	52 lbs.	0 mf.	5·6 max.
RC	1300–2600 c.p.s.	3000–6000 r.p.m.	—	5 mf.	1·5 amps. at 14V. D.C.

All types are similar in appearance with the exception of " QH " which carries an extra winding to supply 24–28 volts D.C. for use elsewhere in the aircraft.

" SV " and " ARV " types use forced draught cooling with a fan drawing air through the air gap.

TABLE II. — Installation Details of A.S.V. Alternators.

Type	Aircraft Fitted	Remarks
AR	Hudson Mk. IV. Mk. III.	Driven by a D.C. motor connected to the 24 volt aircraft accumulator and fitted as a complete unit (motor and alternator).
	Beaufort (Aust.)	Used in all but early and latest installations. Early were fitted with QH and latest with ARV. Driven from the port aircraft engine.
ARV	Beaufort (Aust.)	Used in latest installations to replace AR.
	Anson	Used in all installations. Driven from port engine. Regulation of Control Panel is sufficient to compensate for the 12 volt aircraft accumulator.
A	Mariner	Driven by a D.C. motor connected to the 24 volt aircraft accumulator and fitted as a complete unit (motor and alternator).
QH	Beaufort (Eng.)	Used in all English-built Beauforts in Australia.
	Beaufort (Aust.)	Fitted to all the first ninety aircraft built in Australia in which A.S.V. is installed.

OPERATION

3. Although the specifications of each alternator type are not the same, all are of similar general design and construction. This is illustrated by Fig. 2, which is a simplified cross-sectional drawing of type AR.

The armature or rotor is made up of a toothed section A, and a cylindrical section B. The stator has a correspondingly toothed section C, and a cylindrical section D, a small air gap being provided in each case.

Section D is hollow to accommodate the field or exciter winding, which is connected to the 24 volt aircraft accumulator.

The rotor is made completely of metal, and has no coils, but the teeth of the stator are wound, the coils being connected in series. Actually not all the stator teeth are wound, nor are there exactly the same number of teeth as on the rotor, but neither of these facts affects the general theory of operation.

When the exciter coil is connected to the accumulator by operating the switch on the control panel, it creates a magnetic field. When the rotor revolves, the variation of the magnetic field through the stator teeth causes a voltage to be developed in the windings. This voltage is alternating, rising and falling as the magnetic flux. linking the teeth builds up and collapses across the air gap.

Since the windings are in series, the induced voltages are added together, so that the required A.C. output is obtained.

The end plates of the alternator are made of aluminium. The magnetic circuit therefore, is confined to A and B of the rotor, and C and D of the stator. The rotor shaft at the driving end is splined for connection to the D.C. driving motor, or to the aircraft engine, whichever is used.

4. This type of alternator has several advantages when used in aircraft. It is efficient, which means that despite an output of 500 watts, it is small and light in weight. It is easily cooled — ribs for this purpose are provided on the housing. It will run at high speeds for long periods without attention, and its method of construction allows a comparatively high frequency — up to 2,600 cycles per second — to be obtained without difficulty.

5. The main reason for the high frequency of the supply is to allow small power transformers and chokes to be used with the equipment. For example, the Transmitter requires a high tension transformer to provide 3,200 volts. The standard 50 cycle supply used commercially would call for a unit of considerable size and weight. The use of the higher frequency in conjunction with a potentiol of 80 volts gives a good compromise between weight and size on the one hand and reasonable insulation requirements on the other.

CONNECTIONS AND CONTROLS.

6. The alternator is connected to the Control panel by P & S2. This is a 6-pin plug and socket. The 80-volt connection is made by wiring pins 1 and 3, and pins 2 and 4, in parallel, to keep the total resistence of the leads as low as possible. The remaining pins 5 and 6 provide a 24-volt connection for the exciter field winding.

7. The switch in the 24 volt circuit is mounted on the Control panel at the right hand side. The switch must not be turned on unless the alternator itself is running, and must be turned off again before the alternator is stopped.

Failure to do this will impose a heavy strain on the D.C. driving motor, which is then stopping and starting under load. Also there is in consequence, a risk of leaving the field winding switched on when the equipment is not being used, and this would soon discharge the aircraft battery under the drain of approximately 2·5 amps.

Contact Spring Adjustment

22. Exact alignment of the switches may best be carried out with the aid of a C.R.O. An alternative method is to use a Bridge Tester as described in A.C.D. 2023.

However, it is possible to reach a satisfactory adjustment by using a continuity meter, such as an ohmmeter, to indicate when the spring contacts open and close. Any motors so badly worn as to render this latter method ineffective are best returned to R.I.M.U. for complete overhaul.

The circuit to be used when adjusting contacts with a continuity meter, is shown in Fig. 6. One terminal of the meter is connected to the output socket of the switch bank, and the other terminal is connected to each of the input sockets in turn, as its respective contact is adjusted. The lower or aerial switch section is adjusted first.

As it is essential to see that both contacts should never be closed at the same time, a 16 degree overlap or dead-spot is provided for each change-over. This means that, during this period, both springs are lifted clear of their pillars. In order that each contact should be closed for the same length of time, this dead-spot must occur twice for each complete revolution, at an interval of 180 degrees.

This point is made clear in Fig. 6. The contacts are closed at B for 164 degrees from points F to E, and at A from points C to D. Both contacts are open from points E to C, and points F to D. This adjustment is made by rotating the insulation piece carrying the contact studs, which should be perfectly upright.

If the screw which fits to the end of the motor shaft extension is left in place, its slotted head may be used to indicate the degree of dead-spot, and the angular positions of each make and break. The circular edge of the metal housing may be marked with a pencil to show the positions of the makes and breaks as indicated by the continuity meter. Alternatively a length of wire may be temporarily attached to the shaft as a pointer to mark out these positions more exactly on the edge of the housing.

The upper or C.R.T. output switch section should be closed for approximately 160 degrees and open for 20 degrees.

Synchronizing the Switch Sections

23. Synchronization of the switch sections may be checked with the continuity meter by connecting it to each section in turn. If it is possible to use two meters, one connected to each section, more accurate results may be obtained. Correct synchronization is achieved when the aerial switch makes contact just before the C.R.T., and breaks contact just after it. It may be necessary to loosen and rotate the upper housing to achieve this. This means that the contacts in the aerial section are closed for a slightly longer period than those of the C.R.T. section. This is provided for so that at no time will there be a noise indication on the screen without blips as well, as would be the case if the aerial switch made contact after the C.R.T. and broke contact before it.

In practice, it is almost impossible to obtain perfect adjustment either of contacts or of synchronism, but accuracy should be possible to within a few degrees. About 2 degrees will be sufficient lead and lag on the make and break of the aerial switch section.

Elimination of Common Faults

24. Weak or poor quality springs will frequently cause bouncing, which prevents positive contact of springs and pillars on the " make," and as a result, lack of precision on indications or blips. This condition cannot be observed with a continuity tester, as the switch revolves too quickly when the equipment is in operation for the meter to follow the contacts. A C.R.O. is the only instrument by which the action of bounce may accurately be observed. If serious, however, its effects will be noticeable on the Indicator screen.

Occasionally, metal particles may collect inside the input and output sockets, short-circuiting the centre contact pin to the frame. This will be indicated by failure of the section concerned to register an open circuit condition on the meter. The remedy is to clean the sockets. The switch sections should also be examined, and any small metal particles removed.

If the insulating material on the ball race is of varying thickness, this will affect the period during which the springs make contact with their pillars, as the ball race tends to revolve slowly when the motor is running. Replacement of the ball race is the only remedy.

General Characteristics of A.S.V. Mk. II (Aust.) Switching Motors.

Ident No.	Power Requirements
Y10F/80151	50 watts at 24 volts
Y10KB/500003	50 watts at 12 volts

A.C.D. 2005 (2)

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MANUAL OF A.S.V. MK.II (AUST.)

A.S.V. Transmitter Type AT300, Receiver Type AR301 Indicator Unit Type AI, Control Panel Type PI and Auxiliary Equipment.

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CHAPTER THREE — CONTROL PANEL TYPE PI

CHAPTER FOUR — RECEIVER TYPE AR301

CHAPTER FIVE — INDICATOR UNIT TYPE AI

CHAPTER SIX — A.S.V. AERIAL SYSTEMS

CHAPTER SEVEN — OPERATING THE EQUIPMENT

CHAPTER EIGHT — FAULT-FINDING IN EQUIPMENT

APPENDIX "A" — EQUIPMENT SCHEDULE

September, 1944

D.R.S. (RADAR)
R.A.A.F. H.Q., MELBOURNE

Amendments to this publication have been made as below:—

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Number	Date		
No 1.	June 1945	J Somers Cpl.	20.6.45.

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APPENDIX "A" — EQUIPMENT SCHEDULES.

INTRODUCTION

Development of A.S.V.— General Principles — Use of Equipment — Units comprising Equipment.

1. Aircraft to Surface Vessel (A.S.V.) equipment is a development of Radar, or Radio Location, specially designed for installation in aircraft to locate vessels at sea. It will also indicate the aircraft's distance and bearing from land, and detect objects such as other aircraft which come within its range. In conjunction with the A.S.V. Beacon, it enables the operator to determine the aircraft's position, and guides him back to his base, or to some safe landing.

2. As with all forms of Radar, A.S.V. depends on the principle that a radio wave travels at a constant speed, and will be reflected from any object in its path with no change in velocity.

3. This principle is applied in the following manner. An ultra-high frequency Transmitter in the aircraft generates short pulses of high power. These pulses are radiated by directional aerials, the field patterns of which are known. When these radiated waves are reflected by some object, they arrive back at the aircraft and are picked up by directional aerials. They are then fed to a special Receiver, the output voltages of which are connected to the horizontal deflecting plates of a Cathode Ray Tube (C.R.T.) in the Indicator Unit.

In some cases, the same aerials are used for transmitting and receiving, the switching from Transmitter to Receiver being carried out by an arrangement known as a T–R Switch. In the case of other installations, separate transmitting and receiving aerials are used.

The vertical plates of the C.R.T. are connected to a linear time base, the trace of which sweeps the screen from the bottom to the top, commencing the instant the transmitter pulse has ceased. The output voltage from the receiver is fed to the horizontal plates, and will cause a deflection or " blip " to appear on the vertical trace. The distance of this blip from the commencement of the trace will represent the time taken for the pulse to travel to the object and to return to the aircraft. As the rate of travel of electro-magnetic waves is constant at 186,000 miles per second, it is possible by controlling its speed to make the trace represent a definite distance in miles. A suitably calibrated scale slipped over the screen of the C.R.T. enables the operator to make a direct distance reading, showing how far from the aircraft the reflecting object is lying.

4. High frequencies are used because their propagation characteristics are most suitable for the purpose, and because as a result they allow better reflections than do low frequencies. In addition, the aerials required are small enough to be mounted on standard aircraft.

5. The direction of the reflecting object with respect to the aircraft is indicated by the relative strength of the blips on either side of the vertical trace. Those on the left-hand side are the result of reception by the port side or left-hand aerials, and those on the right from the starboard or right-hand aerials. Switching systems are used to connect port and starboard aerials alternately to the receiver, so that the C.R.T. screen may indicate them both for purposes of comparison.

6. There are two distinct aerial systems known as " Searching " and " Homing " aerials. The searching aerials transmit and receive from both sides of the aircraft over a narrow beam approximately at right angles to the line of flight. They are used to give a first indication of the presence, direction, and distance of the reflecting object.

The Homing aerials are situated at the aircraft nose, or under the wings, and are used when the object has been detected and approached. A switching system changes from Searching to Homing aerials. The latter give indications ahead of the aircraft, allowing the pilot to home on the object, correcting for direction according to the indications on the C.R.T.

7. The equipment is designed to operate on four different ranges — 4½, 9, 36, and 90 nautical miles. All distances in A.S.V. technique are expressed in nautical miles.

8. The complete A.S.V. equipment is comprised of the following units—

(a) The Alternator which supplies 80 volts A.C. at frequencies up to 2,600 cycles per second, driven either from a D.C. motor connected to the aircraft accumulator, or by one of the aircraft engines.

(b) The Control panel and Regulator unit, which maintains the alternator output at 80 volts, and distributes the input voltages to the various units.

(c) The Transmitter and its power supply.

(d) The Indicator unit, which provides visual indication of the presence of ships, etc.

(e) The Receiver and Power supply. The power supply for the Indicator unit is also mounted on this chassis.

(f) Aerial systems for Searching and Homing.

The block diagram illustrates the relation of the units with each other, and the connections between them.

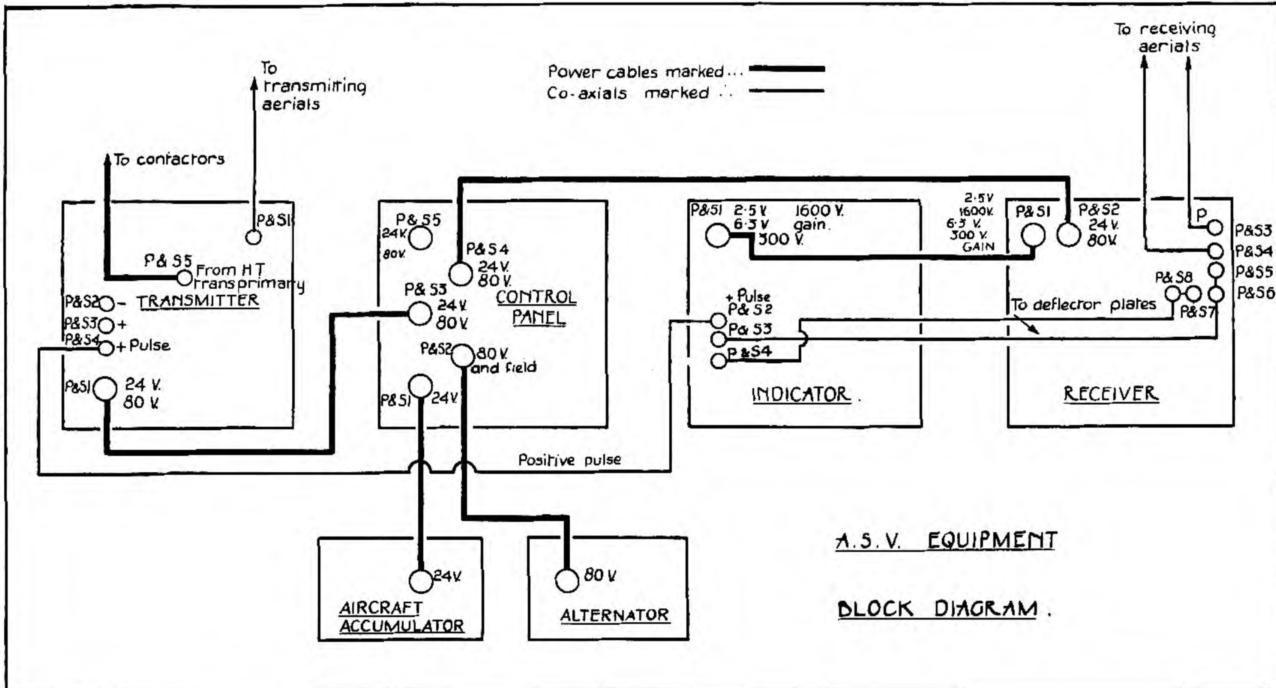


Fig. 1 — Block diagram of A.S.V. Equipment.

CHAPTER ONE.

A.S.V. TRANSMITTER TYPE AT300

General Description — Operation — Power Supply — Connections and Controls — Switching On — Changing Frequency.

GENERAL DESCRIPTION

1. The Transmitter chassis is divided into two compartments. The left hand compartment contains the power supply and blower motor, and the right hand compartment the Transmitter itself.

2. The Transmitter has been designed to supply a high output in a series of short pulses recurring at regular intervals. The length of the pulses, called the "Pulse Duration," is from 2·5 to 3 microseconds, and the number of pulses, called the " Pulse Repetition Frequency " (P.R.F.) is between 300 and 400 per second.

3. Two triode valves are used in a push-pull oscillator circuit of the tuned-anode tuned-cathode type. The anode circuit uses a Lecher line composed of two silver-plated tubes, forming a high-Q, high-stability circuit tuned by the internal capacity of the transmitting valves. A sliding shorting bar adjusts for frequency. The cathode circuit is made up of the inductances L1, L2, L3, and L4 tuned to approximately the same frequency as the anode circuit by fixed condensers C3, C4, C5, C6, C7, and C8, and the variable condensers C9 and C10. The grid circuits are composed of looped, silvered strips mounted on the grid condenser (5000 volts working) and connected to a 19 meg. resistor bank, to form R1. This is supported on a strip at the bottom of the transmitter compartment.

4. The aerial is coupled through a second pair of Lechers tuned with a small air condenser C1. Aerial coupling is adjusted by varying the distance of these Lechers from the anode circuit, and the power is delivered to the aerials using a " balanced to unbalanced " transformer connection. A special tool is provided for the adjustment of C1, which is reached through a hole in the right hand side of the Transmitter chassis.

In early Transmitters, adjustment of C1 frequently brought the plates very close together, and under certain conditions of aerial loading, arcing sometimes took place between them. To avoid this, two plates similar to those used for C1 are now attached to the ends of the aerial Lechers to form a fixed condenser, C1A, of low capacity, in parallel with C1. Under these conditions, C1 peaks with greater spacing between the plates, and arcing is thus prevented.

5. The transmitting valves, type VT90 (E1046) known as " Micropups," have been specially developed for Radar work.

Their anodes are metal cylinders provided with deep radiating fins for air cooling. These are clamped directly into the ends of the Lecher tubes. Coupled with the fact that the valves oscillate for only a fraction of each second, this is the reason why such small valves can handle such a relatively high output (8 Kw. peak).

It is essential that both valves used should have similar characteristics — i.e., they should be " matched." Unless matched valves are used, it will not be possible to get good output or stability from the Transmitter.

The glass ends of each valve are fused directly to the anode. One of the ends supports the spiral filament, and also the flexible filament leads. Through the other end runs a metal rod which carries the grid structure. When the valves are mounted in the Transmitter, the grid inductances clip directly to the ends of these rods, while the filament leads are clamped under terminals mounted on the filament tuning condensers.

Great care must be taken with these valves to avoid cracking the glass at the pinches by undue strain, which might also damage the fusing between the glass ends and the anodes.

OPERATION

6. The operation of the Transmitter is explained as follows.

Normally, an oscillator generates a continuous wave. If, however, a high value of grid resistance and a low value of grid condenser are used, of such magnitudes that C x R is large, intermittent or " squegging " oscillations are produced.

When the circuit oscillates, there is a flow of grid current which causes the grids to become negatively charged. This is the method normally used for obtaining grid bias for oscillator valves. In the A.S.V. Transmitter however, the high grid resistance will not allow electrons to leave the grid quickly enough for the bias voltage to stabilize at a constant value. It continues to increase until it is sufficient to prevent the flow of anode current, at which point oscillation ceases.

The condenser C2, which is negatively charged to the same potential as the grids, now begins to discharge through R1. Eventually the grid bias will fall to a certain less negative value at which oscillation will recommence. Grid current flows again, the grid bias and the condenser charge begin to build up, and the process is repeated.

The Transmitter thus oscillates for a very small period of time (2·5 to 3 microseconds) until C2 has been sufficiently charged, after which it stops oscillating until the time constant of C2–R1 allows the grid voltage to fall approximately to 500 volts negative, the voltage at which oscillation re-commences. The value of C2 determines the pulse duration or pulse width, and the time constant of C2–R1 determines the P.R.F. Fig. 6 illustrates this in a graph of voltage against time.

7. In order to keep the P.R.F. as stable as possible, the grid resistor is returned directly to the high tension voltage of 8,000 volts positive. This means that the discharge of the condenser C2 will be from 5,000 volts negative to 8,000 volts positive, a total of 13,000 volts. Therefore the section of the discharge curve between 5,000 and 500 volts negative will be essentially linear. It will cut the line representing 500 volts negative at a sharp angle, instead of a shallow angle as would be the case were the condenser discharging to zero.

8. The average current registered by the milliameter is between 3·5 and 5 mills for a high tension of approximately 8,000 volts. This current must not be exceeded for any length of time — about 6 mills should be regarded as the maximum reading. If for any reason oscillation should cease, or the circuit oscillate continuously, high anode current will be drawn, and the valves eventually damaged. They must never be allowed to operate in this manner for more than a few seconds.

Damage to the valves may also take place if they are operated without the blower motor in operation. The air blast it provides is required to keep the anodes at a safe temperature. Correct functioning of the motor should always be checked each time the Transmitter is switched on.

TRANSMITTER POWER SUPPLY

9. The Transmitter power supply delivers an output of approximately 8,000 volts D.C. for the transmitting valve anodes, and 8·25 volts A.C. for the filaments. The supply operates from the 80 volts A.C. output of the Alternator and Control Panel.

10. There are three transformers in the supply. One of these, T2, supplies the rectifiers V1 and V2 with 2·5 volts at 1·75 amps. for the filaments, and is mounted near the rectifiers. The transformer T3 feeds the transmitting valve filaments, which require 8·25 volts at 14 amps., and is mounted just behind the front panel, and below the anode current meter. The filament winding is rated at 8·7 volts, so that a resistor of ·027 ohms is included in one of the filament leads to reduce the voltage to the correct figure. The high voltage transformer T1, delivers 3,200 volts to the rectifiers.

The terminal marked with a red spot is connected to the high voltage side of the circuit, which is the AV11 Filament. This is the outside end of the winding, and therefore the best insulated. Should the transformer connections be reversed, there is a danger of breakdown between the winding and the transformer core.

11. As the current drain from the rectifiers is quite low, a voltage doubling circuit is possible, thus conserving space and reducing the ratings necessary for the high tension transformer. Condensers C1 and C2 complete the doubler circuit, while the 5,000 ohms resistor and C3 smooth the output. The Transmitter current drain is indicated on the 0–50 m.a. meter wired in the transmitter filament circuit. The meter is bypassed for R.F. by C4 and C5.

12. The positive unidirectional pulse required to sychronise the Indicator Unit with the Transmitter is obtained from a 40 ohm resistor wired in the filament circuit of the transmitting valves. On each period of oscillation, the valves draw a sudden, heavy current. This means that a sudden positive voltage in the form of a pulse will appear across R3. This pulse is fed to two output sockets P & S3 and 4 on the front panel.

13. A negative pulse of similar nature is required to operate the Calibrator. It is obtained from the voltage change across R5, in the negative lead of the power supply, which occurs with each pulse of the Transmitter. A length of cable connects this point to P & S2 on the front panel of the Transmitter.

CONNECTIONS AND CONTROLS

14. The Transmitter and its power supply are housed in a metal cabinet 17⅝ inches deep, 17 15/16th inches wide and 11⅛ inches high. The front panel measures 12 inches high and 18 inches wide, and is attached to the chassis. The Transmitter is protected by a metal housing which fits over the chassis, and is held in place by two locking screws at the rear. A quarter-turn of each with a screw driver releases the housing.

The power input socket, P & S1, is located at the left hand corner of the front panel. This particular socket has four pins, 1 and 2 making the 80 volt A.C. connection, 3 and 4 the 24 volt D.C. connection. Immediately above this socket are three pye co-axial sockets, the lower two having orange coloured rings, (P & S3 and 4) and the third a white ring, (P & S2). The orange sockets are connected in parallel, and provide positive pulses for two Indicator Units should two be required. The white socket provides a negative pulse for the Calibrator unit.

In the upper left hand section of the panel are two meters. One registers the average cathode current of the Transmitter, and the other, the A.C. input voltage. Mounted between these two meters is an indicator light and either a two-pin or a toggle switch. The toggle switch is an " On-Off " Switch, and the two-pin socket is used in connections where a remote " On-Off " Switch is required. In this latter case, the Transmitter may be switched on and off by removing the two-pin plug from the socket, a method which may be necessary in test set-ups on occasions when a close watch must be kept on the Transmitter anode current when switching. For bench testing, a special plug may be kept for this purpose, either short-circuited internally, or connected by an insulated lead to a shielded switch. In this manual, " switching " refers to either of these methods, whichever should be most convenient.

To the right of the meters are two moveable plates behind which are the screw adjustments for the filament choke tuning condensers. Between the plates is the aerial socket, (P & S1), a Pye coaxial type.

Across the lower half of the panel are two louvred, removable sections, one opening into the power compartment and the other giving access to the transmitting valves and their mountings.

SWITCHING ON THE TRANSMITTER.

15. To avoid damaging the equipment, it is important that the correct procedure be observed when switching on and off.

(a) If the alternator is motor-driven, switch on the motor. If it is driven from the aircraft engine, the equipment cannot be used until the engine is running, unless a special external unit is used to supply the required 80 volts A.C.

(b) Switch on the 24 volts D.C. exciter field supply by throwing the switch on the control panel. The alternator should now generate 80 volts A.C. and this voltage should be indicated by the A.C. meter on the Transmitter front panel. At the same time, the Transmitter valve filaments should light, (visible through the louvred panel), and the blower motor and receiver switching motor should start.

(c) Check the blower motor by feeling for the air blast through the louvre in the front panel.

(d) After a minimum of 30 seconds, the high tension may be switched on. The D.C. milliammeter should read between 3·5 and 5 mills. if the Transmitter is operating correctly. If the current reading is appreciably higher than this, the high tension switch should be turned off immediately, and the cause of the trouble ascertained.

(e) When the equipment is no longer required, first switch off the high tension to the Transmitter, then the D.C. input from the Control panel, and finally, the input to the D.C. motor, in the case of motor-driven alternators.

It is essential that the correct switching procedure should be impressed on all who operate the equipment, particularly non-technical personnel.

The current drain required by the equipment from the 24 volt accumulator is very high. Consequently the accumulator will very quickly be discharged if the equipment is operated while the aircraft is on the ground. For this reason, an auxiliary accumulator should always be used if testing periods of more than a few minutes are required.

A.S.V. TRANSMITTER — VIEW FROM FRONT PANEL

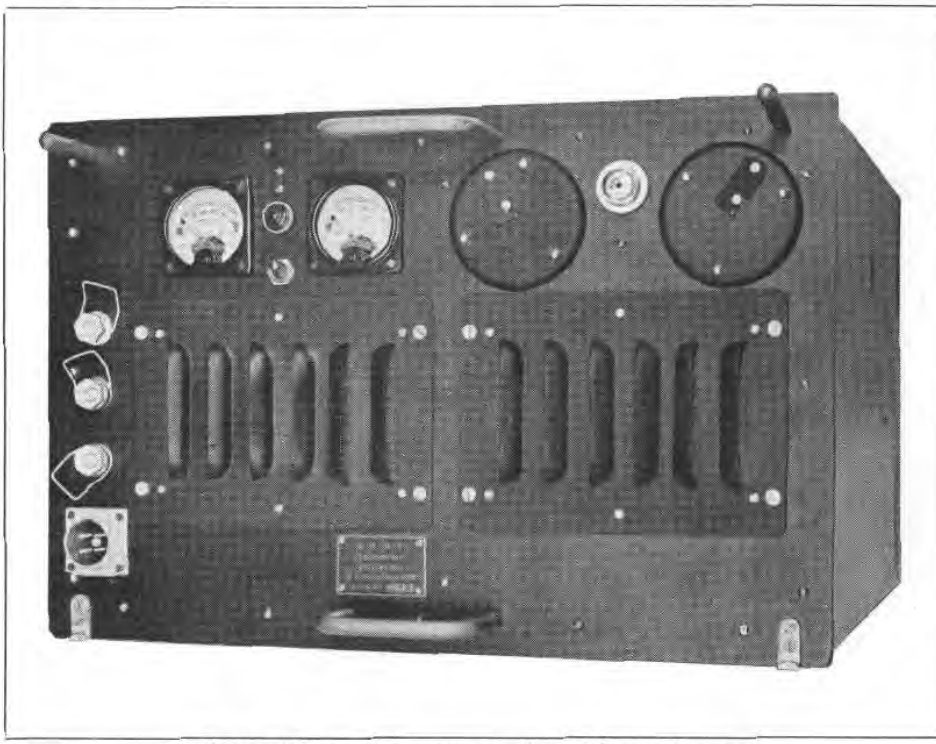


Fig. 1 — This transmitter mounts a toggle switch between the meters

A.S.V. TRANSMITTER — LAYOUT OF PANEL CONTROLS

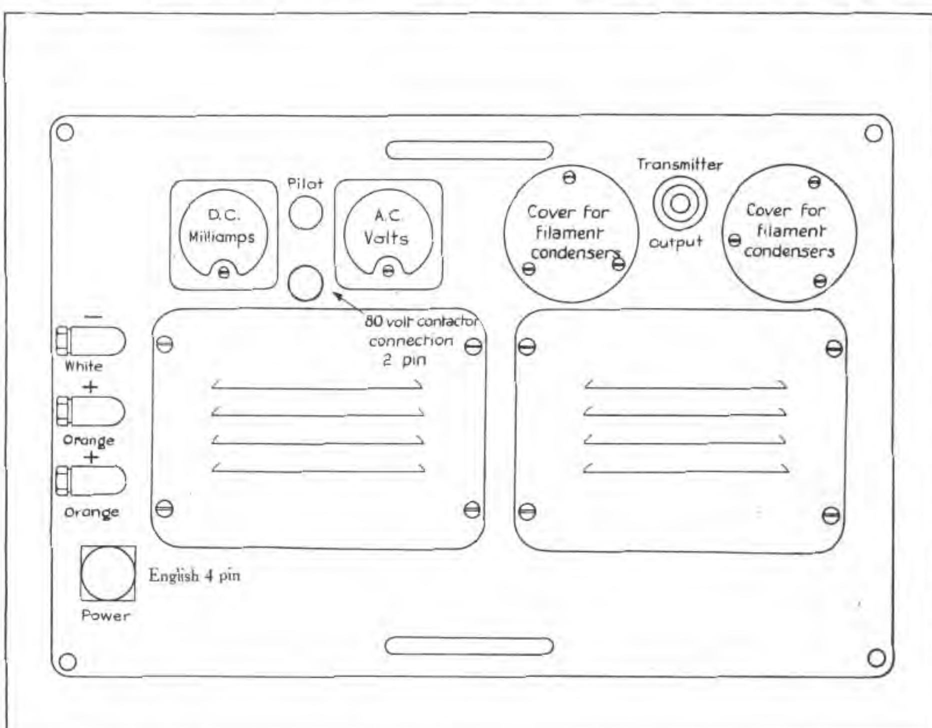


Fig. 2 — This diagram shows the position of the two-pin socket for manual switch connection.

A.S.V. TRANSMITTER — VIEW FROM THE REAR

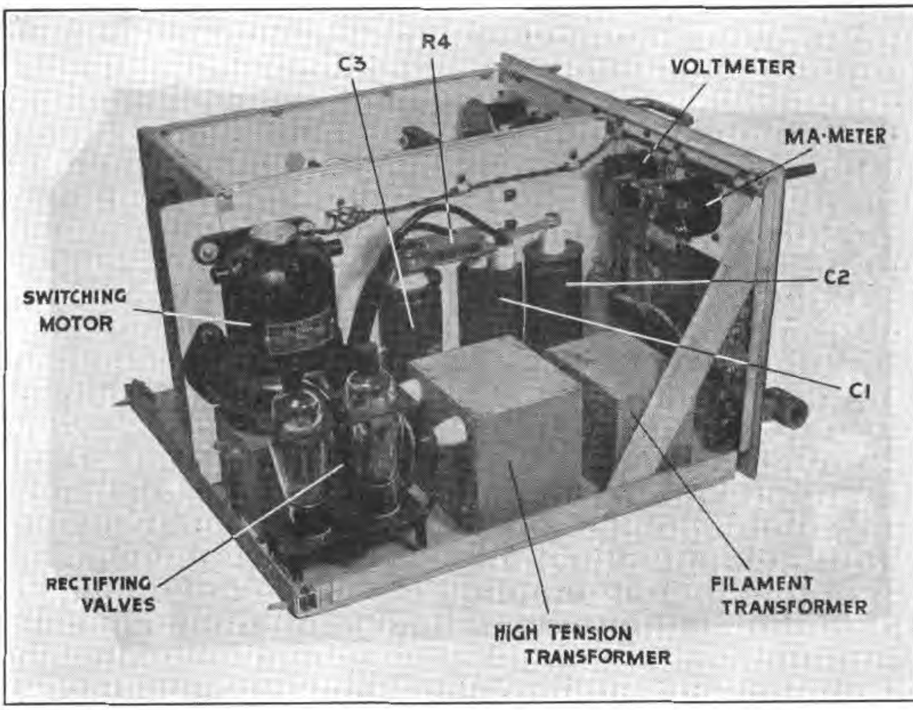


Fig. 3 — Power supply of transmitter.

VIEW OF A.S.V. TRANSMITTER COMPARTMENT

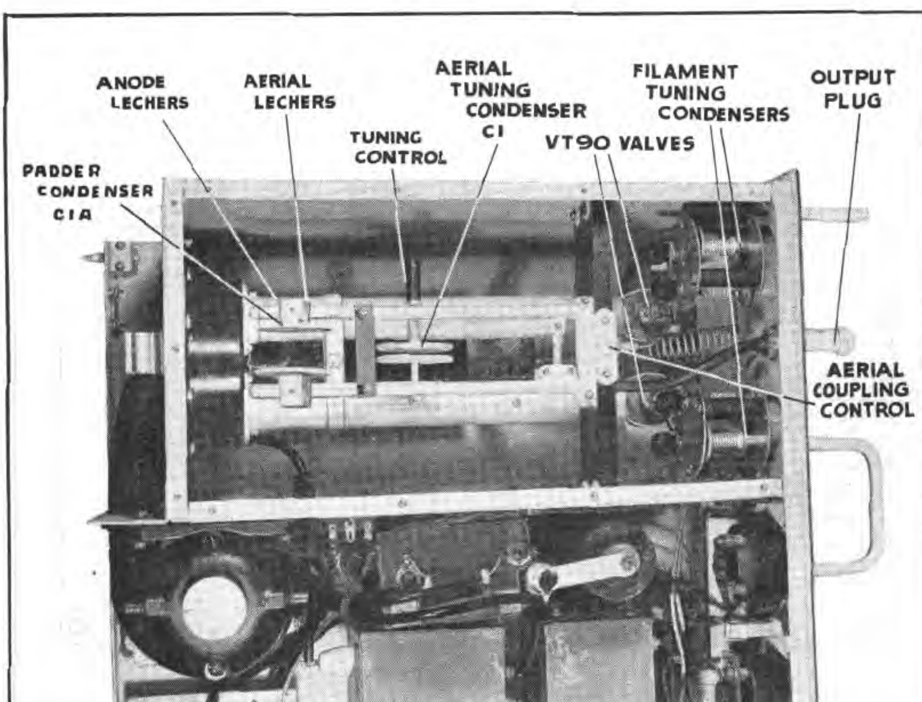


Fig. 4 — Transmitter compartment as seen from above.

CIRCUIT DIAGRAM OF A.S.V. TRANSMITTER

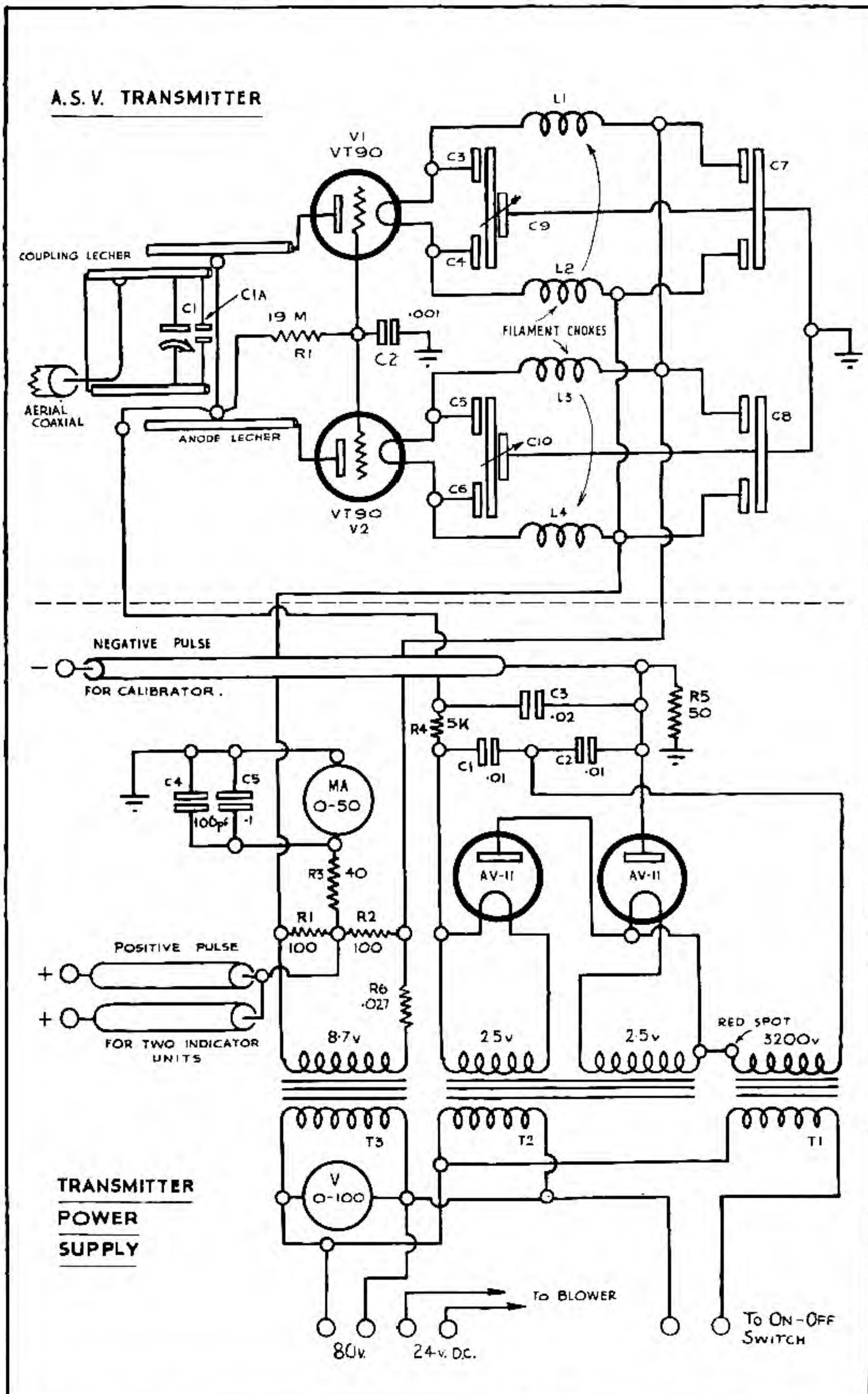


Fig. 5 — Transmitters have been made having R.1 *as* 38 *half-watt,* 19 *one-watt and* 38 *one-watt grid resistors.*

TO CHANGE THE TRANSMITTER FREQUENCY.

16. The Transmitter operates with a high tension supply giving 8,000 volts. This is dangerous to life. No adjustments or alterations are to be made to the Transmitter until the high tension is switched off. The only controls or components which may be adjusted while the Transmitter is operating are the filament tuning condensers which are accessible through the front panel, and the aerial tuning condenser, accessible through a hole in the side of the Transmitter case.

17. During the normal course of inspections, it will be necessary to check the frequency of the Transmitter, which must be maintained at its correct frequency of 176 megacycles. No changes or corrections to frequency are to be attempted unless a wave-meter is available for checking. Frequency must be correct to within plus or minus ·25 megacycles.

18. The Transmitter frequency may be changed as follows :—

(a) Remove the case from the Transmitter by loosening the locking screws at the rear. Unscrew the top plate from the Transmitter compartment. Take great care to avoid lifting the chassis by one corner when handling the Transmitter. This will cause it to distort, and the increased tension on the filament leads if these are too tight may damage the valves. It is advisable to loosen these filament connections while the Transmitter is removed from its case.

(b) Switch on the Transmitter, and check the present frequency. It is essential that during this operation the lid of the Transmitter compartment is on.

(c) Switch off the Transmitter, and reduce the aerial coupling to a minimum by turning the aerial Lecher adjusting screw clockwise. This screw is located in the centre of the aerial Lecher support towards the front of the Transmitter. The looser aerial coupling will reduce the milliammeter reading to approximately 2 mills, and will avoid possible overcoupling when the transmitter is set to the new frequency. Short out the aerial Lechers.

(d) More sensitive indication of anode current for the purpose of Transmitter adjustment may be obtained by inserting a 0-10 m.a. meter in series with the 0-50 m.a. meter already fitted to the Transmitter, or alternatively connecting a 0-10 m.a. meter from the negative pulse terminal of the Transmitter to ground.

(e) Switch on the Transmitter, and adjust the filament tuning condensers one by one to obtain the lowest possible milliammeter reading. As this tuning is fairly flat, it should only be necessary to readjust it when finally on correct frequency.

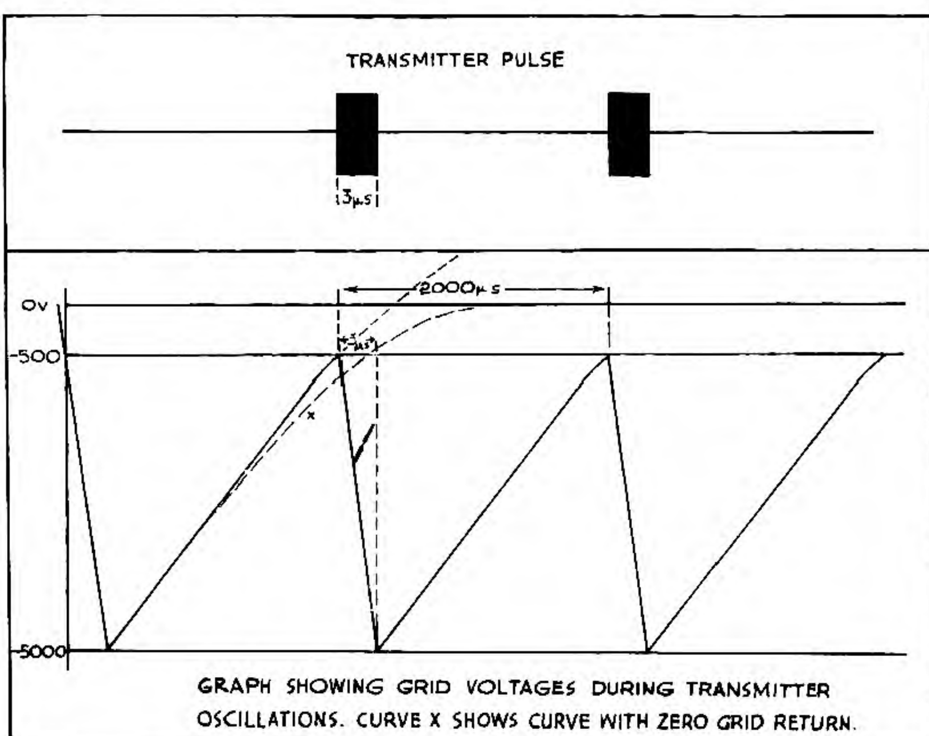


Fig. 6 — Illustrating the " squegging " action of the A.S.V. Transmitter.

(f) Loosen the set screw of the shorting bar on the anode Lechers thus enabling the bar to slide along them. To increase frequency move the bar towards the front panel—to reduce frequency move it nearer the back of the chassis. As a guide, a movement, of approximately ⅛ inch will alter the frequency by 1 megacycle. Tighten the screw after each adjustment has been made.
Check the frequency with a wave-meter. If too much or too little change has taken place, repeat the operation until the correct frequency is obtained. When this condition is reached, retune the filament tuning condensers for minimum current.

(g) Remove the short from the aerial Lecher and connect the Transmitter either to an attenuator which presents the same effective load as the aircraft aerial system, and peak diode voltmeter, or to a matched aerial, as a load.

(h) i. With the aerial Lecher coupling still reduced (as in para. (c)) adjust the aerial tapping point on the aerial Lecher until the P.R.F. is 300-400 with the aerial tuning condenser C1 adjusted for maximum anode current. This will almost certainly be less than 5 m.a.

ii. Lower the aerial Lechers a little by turning the adjusting screw anti-clockwise, and move the tapping point towards the open end of the Lechers until the P.R.F. is again 300-400. Check the anode current, which will have increased in value. Repeat this process until the anode current is increased to 3·5-5 m.a. with the P.R.F. still as above. It is essential to replace the metal top of the Transmitter when making readings of anode current and P.R.F., as its absence will affect them both.

(j) Check frequency, and readjust if necessary to 176 mc. Run through the aerial adjustments once more if a slight frequency change has been made. When the Transmitter is correctly adjusted, the P.R.F. will be between 300 and 400, the anode current between 3·5 and 5 mills, the frequency 176 Mc., plus or minus ·25 Mc. the filament condensers peaked for minimum anode current, and the aerial tuning condenser peaked for maximum anode current.

(k) Check the power output with a peak diode voltmeter and attenuator, if these are available. The peak voltage after passing through the attenuator should be 115 volts, plus or minus 12 volts.

(l) Connect a standard matched aerial and check performance on local echoes.

If difficulty is encountered in adjusting the Transmitter to the above P.R.F. and current, proceed as follows—

(a) Check the H.T. voltage. This should be about 7500 volts. If less than this, probably the 80 volt A.C. supply is also too low. It should be tested with a reliable A.C. meter, the accuracy of which is not affected by frequency (see Chapter 3, para. 12). If no such meter is available the standard meter from another Transmitter can be used as a check.

(b) Replace the VT90 valves by a pair of matched valves.

From the above it will be seen that the positions of both the aerial Lechers and the tapping point are important for maximum efficiency, and these should not be altered except by competent mechanics who thoroughly understand the procedure.

Variations to the above procedure, and to the values mentioned may become necessary from time to time. These will be detailed in Radar Maintenance Instructions (Air).

General Characteristics of A.S.V. Mk. II (Aust.) Blower Motors.

Ident No.	Power Requirements
Y10AB/500800	30 watts at 24 volts
Y10KB/500002	30 watts at 12 volts

CHAPTER TWO

POWER SUPPLY ALTERNATORS, TYPE "AR," "QH" AND "ARV."

General Description — Characteristics and Installation Details — Operation — Connection and Controls.

GENERAL DESCRIPTION

1. The equipment used for A.S.V. requires a wide range of A.C. and D.C. voltages, from 2·5 volts A.C. to 8,000 volts D.C. It is essential therefore to provide a source of alternating current to operate the power supplies of the various units.

This alternating current is obtained from specially designed alternators having an output of 80 volts A.C· at a maximum current of 6·25 amps, and a frequency varying from 866 cycles to 2,600 cycles, according to the type of alternator, and the speed of the rotor.

The stardard alternator now used with aircraft fitted with A.S.V. (Beaufort, Mariner, Anson and Hudson) has an "AR" or "ARV" type mounted on the port engine, and the Anson has an "ARV" type mounted on the port engine. The other aircraft have alternators driven by D.C. motors connected to the 24 volt aircraft supply and mounted inside the fuselage.

TYPES IN USE.

2. Earlier installations were fitted with type "QH" alternators. These are now largely superseded by types "AR" and "ARV," but may still be encountered. The following tables give details of all three types and where they are used :—

TABLE I — General Characteristics of A.S.V. Alternators.

Type	Frequency Range	Speed Range	Weight	Power Factor Condenser	Field Current at 28V. D.C.
AR	1300–2600 c.p.s.	3000–6000 r.p.m.	26 lbs.	5 mf.	3·0 max.
ARV	1300–2600 c.p.s.	3000–6000 r.p.m.	26 lbs.	5 mf.	1·25 max.
QH	1300–2600 c.p.s.	3000–6000 r.p.m.	52 lbs.	0 mf.	5·6 max.
RC	1300–2600 c.p.s.	3000–6000 r.p.m.	—	5 mf.	1·5 amps. at 14V. D.C.

All types are similar in appearance with the exception of "QH" which carries an extra winding to supply 24–28 volts D.C. for use elsewhere in the aircraft.

"SV" and "ARV" types use forced draught cooling with a fan drawing air through the air gap.

TABLE II. — Installation Details of A.S.V. Alternators.

Type	Aircraft Fitted	Remarks
AR	Hudson Mk. IV. Mk. III.	Driven by a D.C. motor connected to the 24 volt aircraft accumulator and fitted as a complete unit (motor and alternator).
	Beaufort (Aust.)	Used in all but early and latest installations. Early were fitted with QH and latest with ARV. Driven from the port aircraft engine.
ARV	Beaufort (Aust.)	Used in latest installations to replace AR.
	Anson	Used in all installations. Driven from port engine. Regulation of Control Panel is sufficient to compensate for the 12 volt aircraft accumulator.
A	Mariner	Driven by a D.C. motor connected to the 24 volt aircraft accumulator and fitted as a complete unit (motor and alternator).
QH	Beaufort (Eng.)	Used in all English-built Beauforts in Australia.
	Beaufort (Aust.)	Fitted to all the first ninety aircraft built in Australia in which A.S.V. is installed.

OPERATION

3. Although the specifications of each alternator type are not the same, all are of similar general design and construction. This is illustrated by Fig. 2, which is a simplified cross-sectional drawing of type AR.

The armature or rotor is made up of a toothed section A, and a cylindrical section B. The stator has a correspondingly toothed section C, and a cylindrical section D, a small air gap being provided in each case.

Amendment List No. 1

Section D is hollow to accommodate the field or exciter winding, which is connected to the 24 volt aircraft accumulator.

The rotor is made completely of metal, and has no coils, but the teeth of the stator are wound, the coils being connected in series. Actually not all the stator teeth are wound, nor are there exactly the same number of teeth as on the rotor, but neither of these facts affects the general theory of operation.

When the exciter coil is connected to the accumulator by operating the switch on the control panel, it creates a magnetic field. When the rotor revolves, the variation of the magnetic field through the stator teeth causes a voltage to be developed in the windings. This voltage is alternating, rising and falling as the magnetic flux. linking the teeth builds up and collapses across the air gap.

Since the windings are in series, the induced voltages are added together, so that the required A.C. output is obtained.

The end plates of the alternator are made of aluminium. The magnetic circuit therefore, is confined to A and B of the rotor, and C and D of the stator. The rotor shaft at the driving end is splined for connection to the D.C. driving motor, or to the aircraft engine, whichever is used.

4. This type of alternator has several advantages when used in aircraft. It is efficient, which means that despite an output of 500 watts, it is small and light in weight. It is easily cooled — ribs for this purpose are provided on the housing. It will run at high speeds for long periods without attention, and its method of construction allows a comparatively high frequency — up to 2,600 cycles per second — to be obtained without difficulty.

5. The main reason for the high frequency of the supply is to allow small power transformers and chokes to be used with the equipment. For example, the Transmitter requires a high tension transformer to provide 3,200 volts. The standard 50 cycle supply used commercially would call for a unit of considerable size and weight. The use of the higher frequency in conjunction with a potentiol of 80 volts gives a good compromise between weight and size on the one hand and reasonable insulation requirements on the other.

CONNECTIONS AND CONTROLS.

6. The alternator is connected to the Control panel by P & S2. This is a 6-pin plug and socket. The 80-volt connection is made by wiring pins 1 and 3, and pins 2 and 4, in parallel, to keep the total resistence of the leads as low as possible. The remaining pins 5 and 6 provide a 24-volt connection for the exciter field winding.

7. The switch in the 24 volt circuit is mounted on the Control panel at the right hand side. The switch must not be turned on unless the alternator itself is running, and must be turned off again before the alternator is stopped.

Failure to do this will impose a heavy strain on the D.C. driving motor, which is then stopping and starting under load. Also there is in consequence, a risk of leaving the field winding switched on when the equipment is not being used, and this would soon discharge the aircraft battery under the drain of approximately 2·5 amps.

A.S.V. ALTERNATOR TYPE "AR" FROM DRIVING END

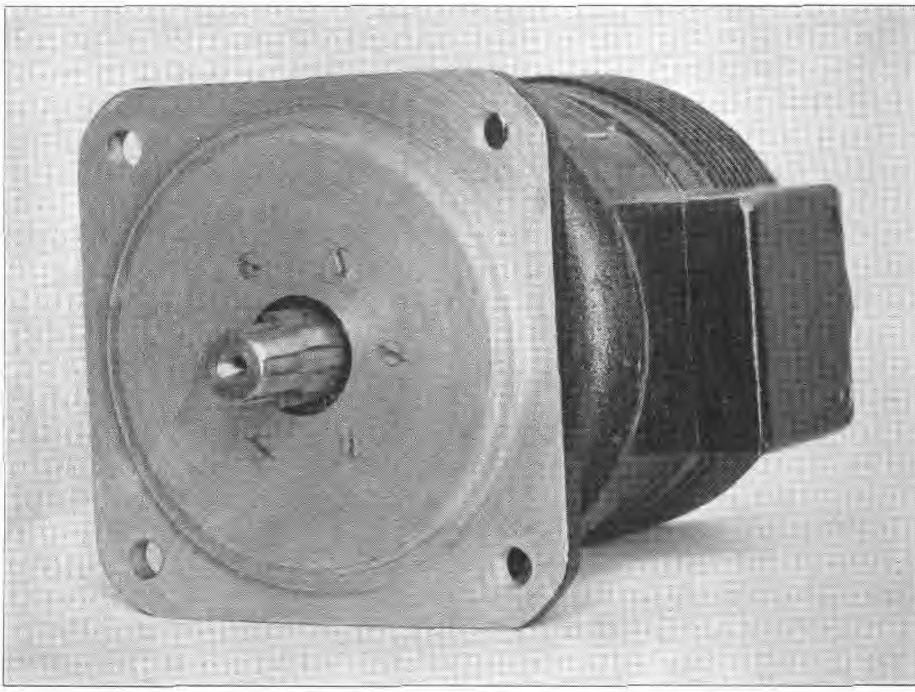


Fig. 1 — The splined shaft allows fitting to aircraft engine or D.C. driving motor.

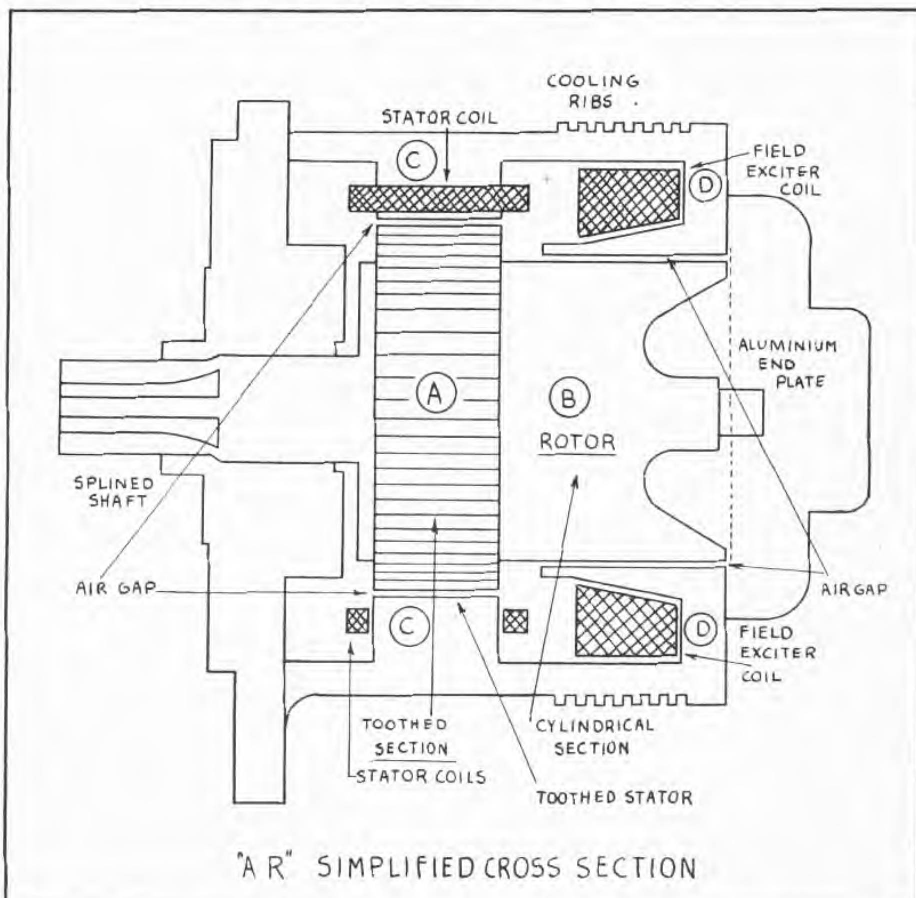


Fig. 2 — This diagram illustrates the theory of the A.S.V. type " AR " alternator.

CHAPTER THREE

CONTROL PANEL AND REGULATOR UNIT TYPE P1

General Description — Connections to Control Panel — The Regulator, Type "E" — The Regulator, Type "8H."

The repair, adjustment and maintenance of voltage regulators, is the responsibility of the electrical section.

The following description is given for information only and should not be read as a definite instruction. Detailed instructions are issued in Electrical Orders.

GENERAL DESCRIPTION

1. The Control panel receives the power input for the equipment from the 24 volt accumulator and the 80 volt alternator, and distributes it to the various units. It also includes the carbon pile Voltage Regulator which compensates for possible variations in alternator speed and output, and maintains the output voltage between 79 and 81 volts.

2. The regulating action of the unit is brought about by automatically varying the alternator field excitation to compensate for change in output. The exciter field supply obtained from the aircraft accumulator has a spring-loaded carbon pile connected in its positive lead. The resistance of the pile can be varied by altering the pressure which is applied to it by the spring.

3. There are two types of Regulator in use — Type "E" and the later type "8H." With both types a portion of the alternator output is rectified and applied to the Regulator. Each of these brings about the variable carbon pile pressure in a different manner, and is described in detail later in this chapter.

A variable resistor, R1, app. 300 ohms, is included in one lead between the rectifier and the solenoid. Apart from providing a certain degree of voltage adjustment, the value of this resistance is much larger than the reactance of the solenoid, and as a result, it helps to keep the total impedance of the circuit constant.

4. An adjustable link in one of the input leads from the alternator provides a choice of connections — one direct and two via C5 and C6. These are power factor correction condensers, and allow adjustments for any of the alternators produced for A.S.V. work. C6 is required for type "AR," and "ARV" alternators. No series condenser is required for type "QH."

5. The input leads from the accumulator are led through the R.F. filter box which includes four R.F. chokes, L1, L2, L3, L4, and four condensers C1, C2, C3 and C4. The filter box effectively prevents R.F. interference from reaching the remainder of the aircraft wiring.

6. There are three power outlets from the Control panel, each supplying 80 volts A.C. and 24 volts D.C. for the various units of the equipment. A 5 amp. fuse is included in each of the 80 volt circuits.

7. A switch S1, mounted on the front panel, is included in the circuit of the 24 volt supply to the exciter field coil of the alternator. With this switch turned off, there is no excitation, and no output from the alternator.

In addition to supplying the current for the alternator field coil, the 24 volts D.C. is used to drive the receiver switching motor and the blower motor in the Transmitter.

CONNECTIONS TO CONTROL PANEL

8. The chassis measures 8 5/16ths inches wide, 7⅜ inches high, and 10⅝ inches deep. A metal cover slides over the chassis from the rear, and is held in place by two locking screws. The front panel measures 9 inches wide by 7⅞ inches high.

The connector sockets are mounted in two vertical rows, one at the left with three sockets, P & S1, 3, and 5, and one to the right of this, consisting of two, P & S2 and 4.

9. The 24 volt input is connected to P & S1, a 2-pin socket, nearest the bottom left-hand corner of the front panel. Pin 1 (negative) and pin 2 (positive) are used for these leads.

The lower socket of the pair, P & S2, has 6 pins, and connects the alternator. Pins 5 and 6 are connected to the exciter field winding. Pins 1 and 3, and pins 2 and 4, are connected in parallel as a single pair to carry the 80 volts A.C. input.

The three remaining sockets, P & S3, 4, and 5, have their connections in parallel, so that they are interchangeable. Pins 1 and 2 are the 80 volt connections, and pins 3 and 4 the 24 volt connections. These are 4-pin sockets.

10. There are six 5-amp. fuses mounted under the removeable fuse panel. The top three are connected in the 80 volt circuits of P & S3, 4, and 5. The remainder are spares.

THE REGULATOR — TYPE "E"

11. The only component in the Control panel likely to need adjustment is the Carbon Pile Regulator. The original A.S.V. sets were fitted with Type "E" Regulator, which has now been superseded by Type "8H."

The Type "E" Regulator is made up of two sections—(a) the carbon pile assembly, and (b) the solenoid assembly.

The solenoid is supplied with rectified A.C. from the selenium rectifier. It has an iron core, one end of which is threaded into the housing, and slotted so that it may be screwed slightly in and out of the solenoid. The core is provided with two locking screws to hold its adjustment when finally set.

An iron armature is held in place by a spring so that it is almost touching the solenoid core, being separated by a small air gap. In this position, the armature is attracted towards the magnetised core in opposition to the spring, the attraction being greater or less according to variations in the amount of current flowing through the solenoid.

REAR VIEW OF CONTROL PANEL AND REGULATOR

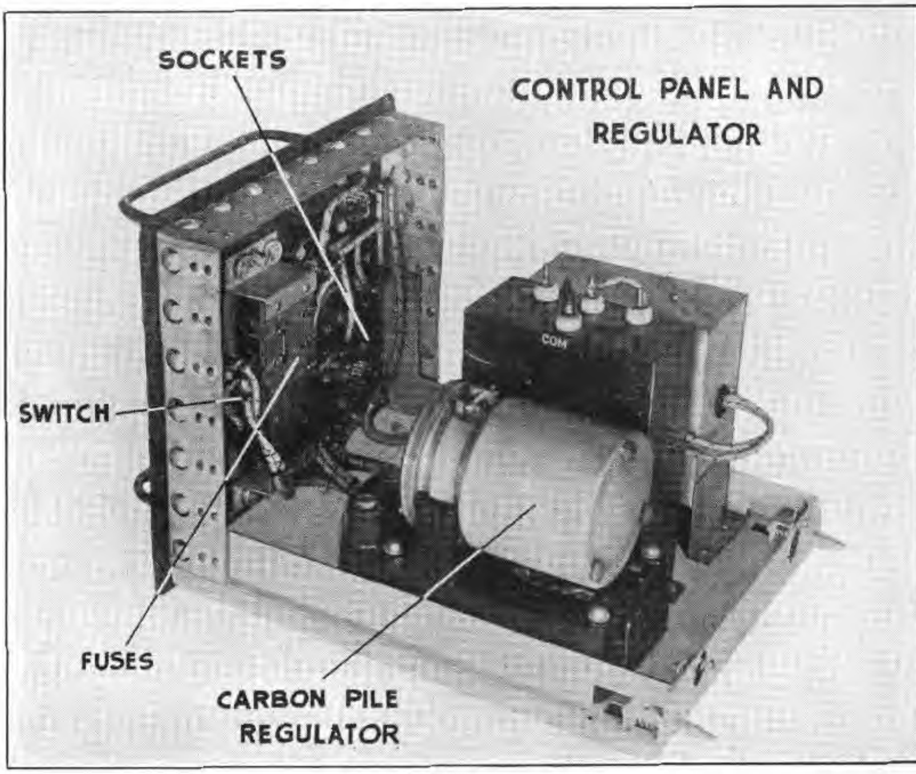


Fig. 1 — The Regulator shown in this photograph is type " E " detailed below.

ADJUSTMENT DETAILS FOR TYPE " E " REGULATOR

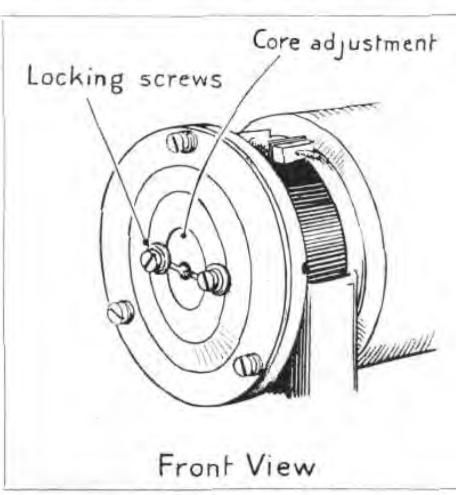


Fig. 2a — Showing core adjustment for voltage.

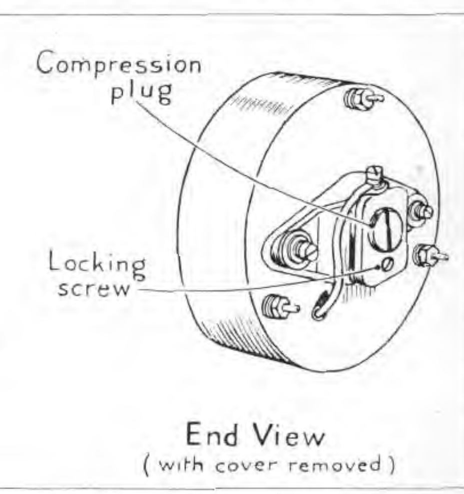


Fig. 2b — Adjustment to pile rarely needed.

A.S.V. CONTROL PANEL — VIEW FROM THE FRONT

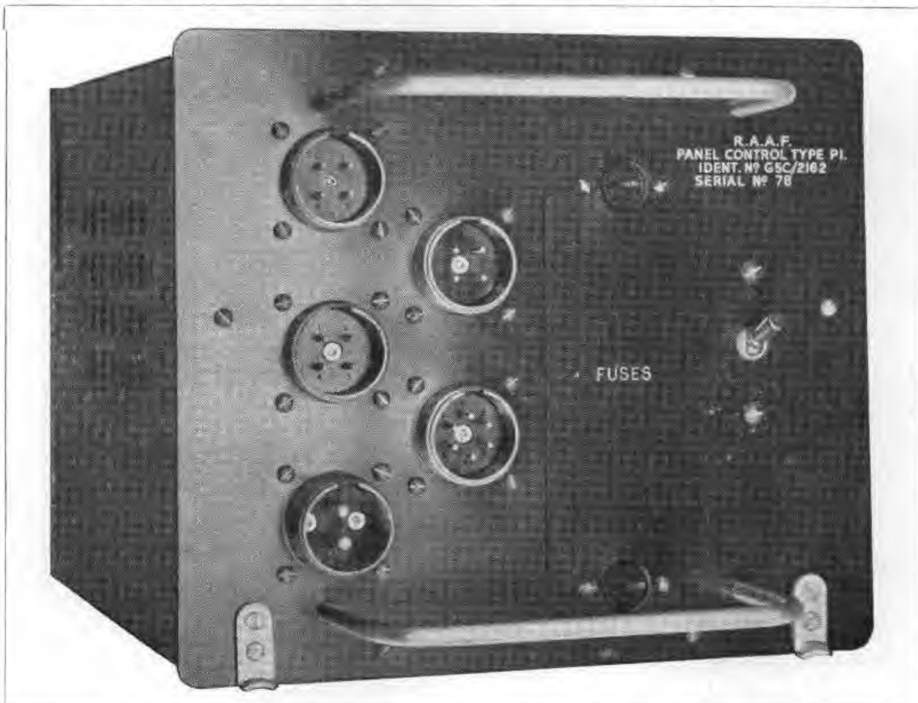


Fig. 3 — English sockets are fitted to the unit shown in the above photograph.

CONNECTIONS FOR A.S.V. CONTROL PANEL

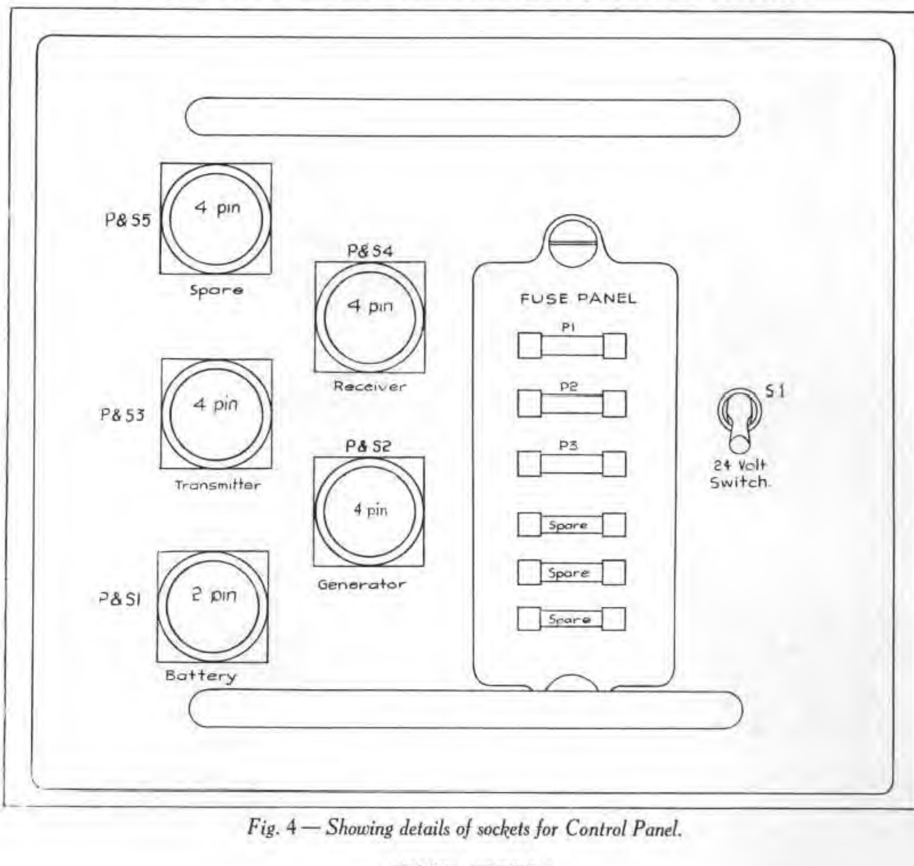


Fig. 4 — Showing details of sockets for Control Panel.

CIRCUIT OF CONTROL PANEL AND REGULATOR

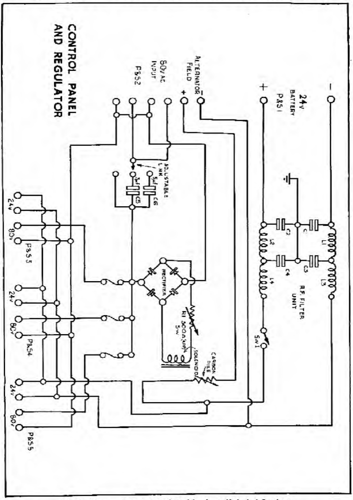


Fig. 5 — The general circuit of the Control Panel, suitable for both Regulators.

The armature is fixed to, but insulated from, a metal plug which fits into the end of a ceramic tube containing the carbon pile. At the far end of the pile is an adjustable plug "B", insulated from the housing. This plug sets the pressure which the carbon pile bears against the spring-loaded armature.

If the alternator speed increases, its output voltage will tend to rise, with a corresponding rise in current flow through the solenoid. The armature being more strongly attracted towards the core as a result, is pulled forward against the spring mounting, thus reducing the pressure on the pile, and increasing its resistance. As the pile is in series with the alternator field coil, the increased voltage drop across it reduces the field excitation, and lowers the output from the alternator.

Should the alternator speed and output fall, the armature is not strongly attracted to the core, and the spring exerts greater pressure on the pile. This decreases its resistance, permitting a higher current flow and a higher field excitation, which automatically increases the alternator output.

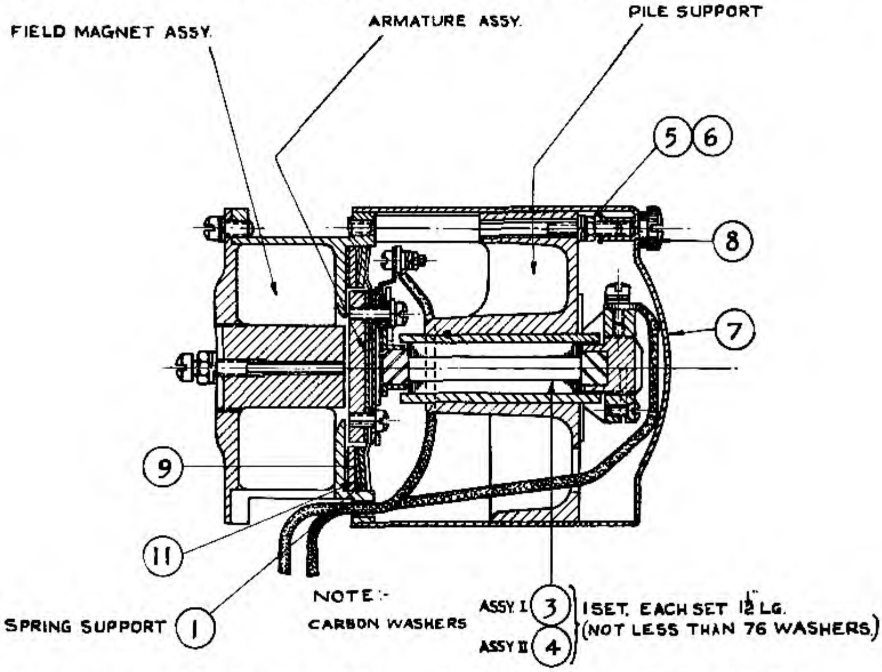


Fig. 6 — Cross-section of Regulator Type " E." 1. *Spring Support.* 3. *Carbon Washers of the Pile.* 5. *Spring Washer.* 6. *Locknut.* 7. *Cover.* 8. *Non-removeable nut.* 9. *Spacing Washer.* 11. *Packing shim.*

Regulator Adjustment — Type " E "

12. There are two points of adjustment to the Regulator unit — the core " A " of the solenoid, and the plug " B " at the end of the pile. A position for each will be found which gives almost constant output under operating conditions.

When the control panel is first put into service, the output voltage should be checked. Normal operating voltage should not rise higher than 81 volts, or drop lower than 79 volts. If it does, the Regulator will need adjustment.

Because of the high frequency of the supply, a thermal type meter is recommended for checking this voltage. If a rectifier type meter is used, it should indicate 83·5 volts to correspond with an R.M.S. value of 80 volts. Under no circumstances should a standard moving iron meter be used.

13. The normal procedure for voltage adjustment is as follows—

(a) Slacken the two locking nuts which hold the core adjustment "A" using a short handled screwdriver.

(b) Rotate the core clockwise to reduce voltage, and counter-clockwise to increase it. Only a very small movement is needed to give quite a large change in voltage.

(c) When the voltage has been adjusted, tighten the locking nuts.

14. If this adjustment does not give correct voltages, output, and regulation, it may be necessary to reset the pressure on the carbon pile. This is done by means of plug " B ".

Moreover, when the Regulator has been in operation for 150-200 hours, the voltage will rise owing to shrinkage of the carbon pile. If this is found to be the case, a very slight adjustment of plug "B" will bring the voltage back to its normal value, so that the final setting will once more be within the range of the core movement.

15. In the case of a Regulator badly out of adjustment, it may be necessary to reset both the core " A " and the plug " B " to restore it to normal. Satisfactory operation is obtained when the voltage variation is not greater than 2 volts between minimum and maximum loads. For the purpose of adjustment, minimum load can be represented by running the equipment with only the Transmitter filaments alight, and maximum load with the Transmitter, Receiver, and Indicator unit all in operation.

The procedure to adopt is as follows—

(a) With minimum load, adjust the core " A " on the solenoid until the alternator supplies 80 volts A.C. to the equipment.

(b) Apply maximum load. The A.C. input will probably decrease. Adjust plug " B " on the carbon pile until the input again reads 80 volts.

(c) Apply minimum load, and once again adjust core " A ".

(d) Apply maximum load, and if necessary again adjust core " B ".

(e) Continue the operation until the voltage remains within limits under both conditions.

Once the unit has been adjusted in this way, the plug " B " should rarely call for attention. Any slight variation which might occur should be compensated for by the adjustment " A ", the core of the solenoid.

The plug " B " is threaded into a slotted block. A small locking screw is provided which must be slackened off before adjustments are made. The lock must be tightened after each alteration to the setting of the plug.

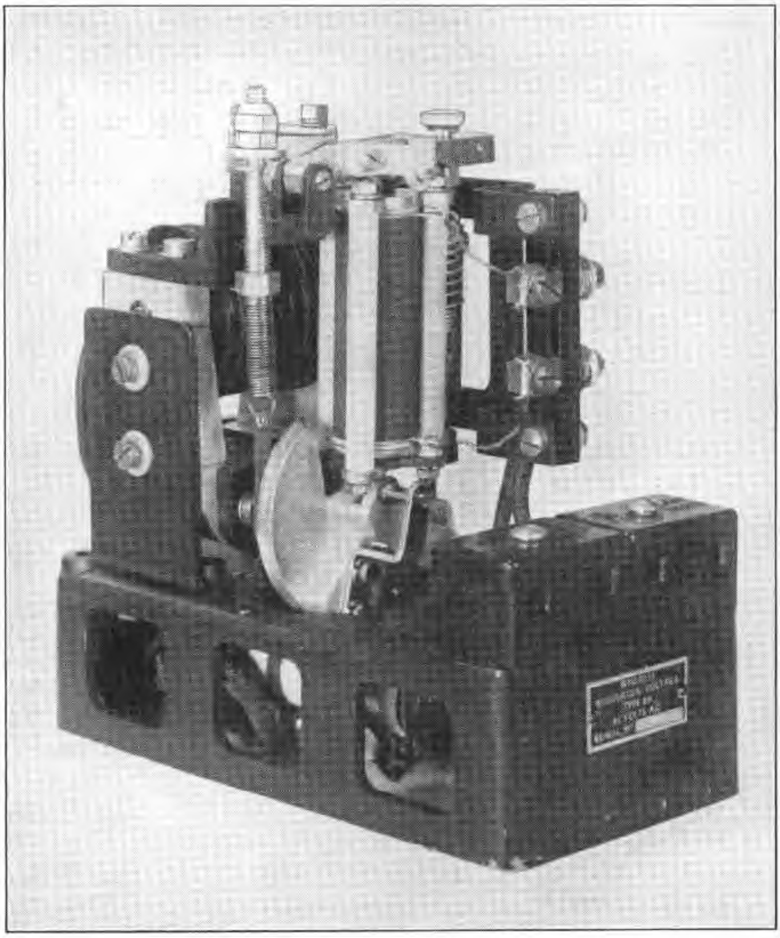


Fig. 7 — General view of Type " 8H " Regulator.

REGULATOR TYPE 8H.

15. The type " 8H " Regulator serves the same purpose as does the type " E " in that it brings about a variation in the pressure applied to a carbon pile wired in series with the exciter field coil of the Alternator. Its construction, operation and adjustment are completely different.

It stands on a metal base underneath which are mounted the metal rectifier and the tapped swamp resistor R1. Connections are made to two terminal boxes on the top of the base—one for the 80 volts circuit, and one for the 24 volts circuit to the Alternator.

16. The variation in pressure on the carbon pile is obtained by movement of a rotor between the pole pieces of a stator, the magnetic field of which is controlled by the current flowing through an exciting coil. The rotor is of solid metal, and has two poles which normally would be attracted by the poles of the stator, causing it to take up a horizontal position at right angles to them.

It is prevented from assuming this position by the resistance of a tension spring. This spring is hooked to a metal strap attached to the pile operating crank, which is mounted at one end of the rotor spindle. Also attached to the crank, but on a different centre from the rotor spindle, is one end of the carbon pile, the other end of which is fixed as explained in para. 17.

The exciting coil wound on the stator is fed with D.C. from the rectifier which picks it up from the 80 volt output of the alternator. Thus when the alternator is switched on, the current through the exciting coil causes the rotor to turn, extending the tension spring until a state of balance is reached, at which it remains stationary.

The movement of the rotor causes the lower end of the pile to swing to the left and downwards, releasing some of the pressure and increasing its resistance. This resistance being in series with the Alternator 24v. D.C. field supply controls the field excitation, the A.C. output, and also the energization of the stator coil. Thus it is the balance between the rotor movement, pile resistance, and stator coil energization which governs the Regulator operation.

Should the Alternator speed increase, its output rises as a result. A higher voltage is rectified and fed to the stator coil, and the rotor poles are more strongly attracted to the stator poles. This increased attraction causes the rotor to move in an anti-clockwise direction, and lowers the pressure on the pile. The pile resistance increases, the current flow through it is lowered, the field energisation of the Alternator falls, and its A.C. output is reduced to the normal value of 80 volts.

Conversely, if the Alternator speed decreases, the stator coil energization is reduced, the rotor moves in a clock-wise direction under the spring tension, and the pile pressure is therefore greater. Its lessened resistance allows a higher energization of the Alternator field, and a higher A.C. voltage output to compensate for its reduced speed.

17. The end of the pile operating crank is connected to the piston of a " dash-pot " with an adjustable air-release valve at the top. The dash-pot damps out the movement of the crank, and prevents hunting of the rotor action as the Regulator operates.

In order that the resistance of the pile should commence from a standard " reference value," the pressure upon it when the Regulator is inoperative is controlled by a loading spring. This is connected between the frame of the unit and the pile lever, which is hinged at the opposite end. Pressure is applied to the pile through a knife-edge mounting at the centre of the pile lever. The gap adjusting screw is set so that when the tension spring has fully compressed the pile, it lifts the pile lever just enough to provide a gap of ·0015 inches between the adjusting screw and the Invar steel vertical rod just below it.

Under these conditions, it is the pile loading spring which sets the initial pile pressure, and this is adjusted so that its resistance is not greater than 2 ohms.

Once the regulator begins to operate, however, and the rotor revolves, it first lowers the pile lever until the adjusting screw comes hard up against the Invar steel rod. Once this occurs, and it does so almost instantaneously as the gap is very small, the only function of the pile loading spring is to hold the pile lever stationary, while the pile pressure is varied from the bottom by the movement of the rotor.

18. When the regulator is in operation, the temperature of the exciting coil rises, and the heat is transmitted in some degree to the entire unit. In the case of the coil, an increase in temperature brings about a small increase in resistance, which would upset the accuracy of the Regulator unless corrected.

Correction is applied by suspending the tension spring from a bi-metallic strip, which bends slightly as the temperature rises, thus applying a little extra tension on the spring, and therefore pressure on the pile. This lowers the pile resistance just enough to allow extra energization for the Alternator field coil to compensate for the reduction in current through the stator coil.

The Invar steel rod has an extremely low temperature co-efficient, so that its expansion with temperature rise is neglible, and the gap remains constant at all times.

ADJUSTMENTS — REGULATOR TYPE " 8H "

The initial adjustments to the regulator are made at the factory.

These include : —

(a) adjustment of the gap to ·0015 inches.

(b) adjustment of the pile loading spring to give a pile resistance of not less than 2 ohms.

(c) adjustment of the tension spring.

(d) setting of the dash-pot adjusting screw to give the correct degree of damping.

If the voltage from the Regulator does not fall within the limits of 79—81 volts, it should be adjusted as follows :—

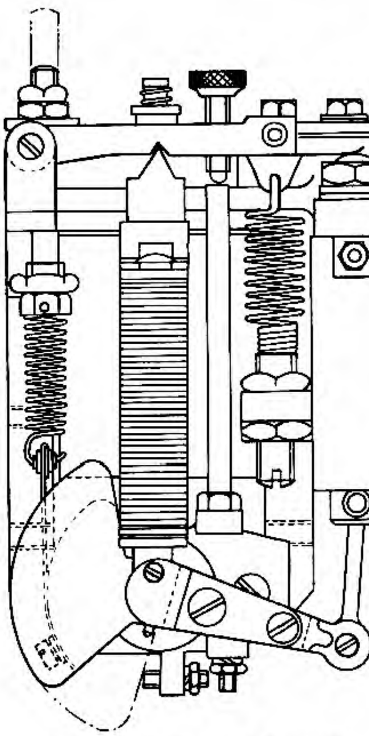
(a) With the generator at rest, set the gap adjusting screw on the pile lever to provide the correct clearance (·0015 inches) between the screw and the top of the Invar steel rod. A feeler gauge for this adjustment will be found clipped to the base of the unit. Under these conditions the pile resistance should not be greater than 2 ohms.

(b) If the voltage under load is greater than 81 or lower than 79 volts, the only adjustment necessary is to move the slider on the variable resistance in the base of the regulator.

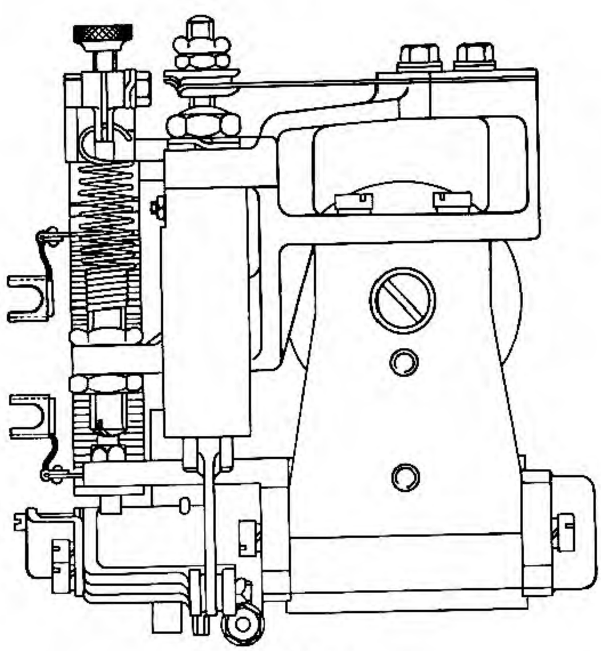
(c) If the Regulator action has a tendency to hunt, the dash-pot adjusting screw which controls the air release valve should be reset until the required amount of damping is obtained. This adjustment is critical as too much damping may hamper the smooth operation of the regulator.

Should the resistance of the pile be other than 2 ohms when the gap has been correctly set, the tension of the pile loading screw may be altered from below by loosening the lock nuts and rotating the slotted screw which secures the lower end of the spring. The lock nuts must be tightened again when the correct setting has been found.

The pile loading spring and the resistor R1 beneath the base should rarely need attention except when the pile or rectifier has been replaced.



Outline showing Rotor and Carbon Pile.



General Outline.

Fig. 8 — Outline diagrams of Regulator Type " 8H "

CHAPTER FOUR

A.S.V. RECEIVER TYPE AR301

General Description — The Circuit — Receiver and Indicator Unit Power Supplies — Connections and Controls — The Receiver Switching Motor.

GENERAL DESCRIPTION

1. When the reflected transmitter pulses arrive at the aircraft, they are picked up by directional aerials and fed to the Receiver. The Receiver amplifies and rectifies these minute pulses, and they are presented to the operator as an indication or blip on the C.R.T. trace of the Indicator unit.

As the vertical trace of the Indicator represents a definite distance — (4½, 9, 36, or 90 miles) — the distance between the blip and the start of the trace represents the distance between the aircraft and the reflecting object. For instance, a blip appearing half-way along the 9 mile trace would indicate an object 4½ miles away.

AERIAL SWITCHING

2. The Searching and Homing aerial systems each consist of two directional aerials, with their axis of pick-up to port and to starboard of the aircraft. The direction in which the object lies is indicated by comparison between the amplitude of the indications from one side of the aircraft with those from the other. Indications from the port side appear on the left, and those from the starboard on the right of the vertical trace.

This is accomplished by switching the Receiver input circuit rapidly from port to starboard aerials, and, arranged in synchronism, the output circuit is switched from one C.R.T. deflecting plate to the other. The two rotary switches used are mounted in two banks directly on the housing of a 24 volt D.C. electric motor, and are actuated by two cams fixed to the motor shaft. Adjustments are provided so that the sections may be perfectly synchronised (see para. 23).

The exact speed of the motor is not important, as long as it is sufficient to prevent any flickering of the C.R.T. trace.

3. The A.S.V. receiver uses 11 valves, including the rectifier for its high tension supply. It is complete on one chassis with the exception of the gain control. This is mounted on the Indicator unit so that it may be grouped conveniently with the other operational controls.

4. The power supply for the C.R.T. in the indicator unit is also mounted on the receiver chassis.

REQUIREMENTS OF A.S.V. RECEIVER

4. The main requirements of an A.S.V. receiver are —

(a) Low noise level.
(b) High amplification.
(c) A wide intermediate frequency channel band width.
(d) A low impedance output.
(e) Stability and rugged construction.
(f) Ability to operate under all climatic conditions.
(g) Exceptionally short time constants in the circuits concerned to handle short, steep-fronted pulses.

5. A superheterodyne circuit is used. There are two radio frequency amplifiers (954), a triode mixer (955) a triode oscillator (955), four intermediate frequency amplifiers (6AC7), a diode detector (6H6), and a cathode follower output stage (6AC7 triode connected). The intermediate frequency is 30 megacycles.

Standard valves are unsuitable for A.S.V. Receivers because of the high frequencies used. The "Acorn" type valves are employed in tuned input circuits because of their low inter-electrode capacities, high input impedance, shorter electron transit time, and easier connection with short leads. The 6AC7 valves are used as I.F. amplifiers mainly because of their high gain at 30 mc.

6. The use of two R.F. stages together with a step-up of voltage in the aerial coil due to the auto-transformer effect provides a maximum gain of about 35 db. ahead of the mixer stage. This gain is valuable in obtaining a high signal-to-noise ratio at the grid of the mixer, thus to a great extent overcoming mixer noise, and allowing the mixer valve to operate under more satisfactory conditions.

A triode is used as a mixer which, mainly owing to its low grid current, and low gain, still further reduces noise level. The oscillator operates 30 megacycles lower in frequency than the frequency of the input circuits.

7. As the Receiver is handling steep-fronted waves, it is essential that a wide-band I.F. channel be used. This bandwidth is obtained by using high-Q coils in the intermediate frequency transformers, damped by low resistance loads in the preceding anode circuits, a practice which effectively provides a flattened response curve for the I.F. channel. The gain of each stage is reduced considerably by this design, and four stages are required to provide the required amplification. The actual bandwidth is given as ·5 megacycles.

Because rapidly recurring pulses of such a short duration are involved, it is necessary that the time constants of all circuits handling these pulses should be short also. Otherwise paralysis might occur due to the fact that the circuits would not have time to discharge in the very short time interval between pulses.

8. The output valve is a 6AC7 connected as a triode, and used as a cathode follower. As the Receiver output must feed a length of coaxial cable connected to the Indicator Unit mounted some distance away, a low impedance output is essential. The impedance of a normally loaded valve is much too high for connection to a relatively high-capacity cable, if 2-3 micro-second pulses are to be handled without loss and distortion of the wave form.

9. The cathode follower has no anode load, the load resistor being connected between cathode and ground. Under these conditions, there is virtually 100% negative current feedback, which reduces the gain approximately to unity. The output impedance, however, is extremely low (for practical purposes equal to 1/Gm), and due to the fact that the cathode voltage "follows" the grid voltage, the effective grid input resistance is much higher than normal.

Using this method of coupling, there is virtually no mutilation of the pulses with the lengths of cable used in A.S.V. installations.

THE CIRCUIT

The Receivers used in Australian A.S.V. equipment are made by His Master's Voice (H.M.V.) and A. G. Healing (A.G.H.). There are a few slight differences between the two circuits as well as in the actual construction —for instance, the H.M.V. receiver employs paralleled resistors in some cases where the A.G.H. receiver does not. This has made it necessary to include a complete circuit for each Receiver to avoid possible confusion. The maker's identification mark will be found stamped on the left-hand side of the chassis.

The numeration of components in the following paragraphs refers to the A.G.H. circuit, although no difficulty should be experienced in identifying corresponding components in the H.M.V. circuit.

10. The input connection to the Receiver is made to a tapping on the aerial tuning coil L1, which is in the grid circuit of V1. The grid inductances, L1, L5, and L10 are tuned to the same frequency, and have adjustable brass cores by which the circuits may be aligned. Resistors R1 and R8 bypassed with C2 and C12 provide bias for V1 and V2. Screen voltages are fed through R2 and R4, which form decoupling circuits with C3 and C11. The screen circuit is fed from high tension through R33 and R34, with C4 and C54 providing for further decoupling. R39 is a bleed resistor to ground.

The R.F. Chokes L4 and L7 with decoupling circuits R5 and C8, and R6 and C9 comprise the anode circuits of V1 and V2. C7 is a bypass across high tension. The R.F. Chokes are termed " quarter-wave " chokes — they are designed so that with one end bypassed to ground, and effectively at ground potential, the other end offers a high impedance to the circuit in a manner similar to that of a quarter-wave transmission line. This method of feed allows the highest practicable voltage transfer to the following grid circuits. V1 is coupled to V2 through C6, and V2 coupled to the mixer V3 through C15.

The high frequency oscillator V4 mounted above the chassis uses a modified Hartley circuit, L9 being the tapped inductance, and C13 the tuning condenser. The grid condenser is C14, and the grid leak is made up of R10 and R10A in series. The junction of these two resistors forms a handy point from which portion of the oscillator grid voltage may be measured as a check on oscillation without seriously affecting the operation of the oscillator. Anode voltage is obtained through R9 and R5, C8a acting as a decoupling condenser.

Coupling to the mixer valve V3 is made by a single turn L8 loosely coupled to L9, and a length of cable shielded to prevent radiation and unwanted coupling into the remainder of the circuit. The cable connects to a tapping on coil L10, selected so that the oscillator input voltage always exceeds the maximum signal input, but avoiding too high damping of the tuned circuit by the coupling line.

The mixer valve V3 has an extra bypass condenser (C17, of ·001 mfd.) across the filament leads. This valve is handling three frequencies — the signal, oscillator, and intermediate frequencies. C17 is included to provide a low reactance path at 30 mc. For the same reason, all decoupling condensers in the I.F. circuits are much larger in capacity than those in the input frequency circuits.

The I.F. amplifiers are almost identical. Anode load resistors are R12, R14, R19, and R24, decoupled by R7, R13, R18, and R23, and C20, C24, C30, and C36. The condenser C18A (5 pf.) provides a low reactance path for signal and oscillator frequencies without greatly affecting the 30 mc. intermediate frequency. Thus it reduces unwanted R.F. energy entering the I.F. channel.

Resistor R11 bypassed by C18 provides bias for the mixer V3, which operates as an anode bend detector. V5, V6, and V7 have two bias resistors, R16, R21 and R26 of 300 ohms each, and R15, R20, and R25 of 30 ohms each. The 300 ohms resistors are bypassed by C25, C31, and C41, but the 30 ohms resistors have no bypass. They provide a small negative feedback which helps to stabilize the I.F. stages, and reduce Miller effect, due to the effective variation of grid-anode capacity with changes in gain. An additional precaution is the inclusion of R45 and R46 in the grid leads to V7 and V8 as parasitic suppressors.

Condensers C21, C27, C33, and C43 couple anode and grid circuits with tuned inductances L12, L13, L15, and L17 tuned to 30mc. The 5,000 ohm anode resistors are effectively in parallel with their respective inductances, and their damping effect provides the exceptionally wide bandwidth required for the I.F. channel.

A gain control is included in the cathode circuits of V5, V6, and V7. It consists of a potentiometer R45 in series with R46, mounted in the Indicator Unit, to form a voltage divider across the high tension. The voltage drop across R45 may be applied positively to the cathodes to provide extra bias and reduce the total gain.

The final I.F. amplifier V8 handles considerably higher input voltage than the preceding stages. To prevent overloading in this stage, a higher anode voltage is therefore applied through the R.F. choke L20, and the decoupling network R29, R31, C47, and C49. The resistor R47 damps the 30 Mc. R.F. Choke L20 to prevent resonance peaks causing instability. Bias is provided by R30, which is decoupled by C48.

The screen voltage for V5, V6, and V7 is obtained through R17, R22, and R27 bypassed by C26, C32, and C42, V8 has a decoupled screen circuit in R32A, R32, C49A and C49B.

The second detector is a duo-diode of which only one section is used. Condenser C50 feeds the input to the tuned circuit L21. The output is fed through a load and filter circuit comprised of two 30 mc. R.F. chokes L23 and L24, a bypass C55, R43, R44, and C65. Two small condensers C53 and C55a provide a low reactance path for any signal or oscillator frequencies which may still be present in the output. R36 and C56 act as a filter in the anode circuit of V10, which is connected as a triode. This valve is the cathode follower output valve, R37 being the cathode resistance, and R48 a parasitic suppressor which in some cases is included. Condenser C59 is the output blocking condenser.

The output from this condenser is fed through a shielded cable to the switching motor which in turn feeds it to the Indicator Unit's video amplifiers.

The filament circuits of all valves are fitted with R.F. chokes to prevent R.F. currents entering the power supply, and with bypass condensers to keep filament leads at ground potential. The chokes are L2, L3, L6, L11, L14, L16,L19, L22, and L26, with the condensers C1, C10, C16, C17A, C19, C29, C35, C45, C46, C52, C56A, and C62A.

A.S.V. RECEIVER – VIEW OF FRONT PANEL

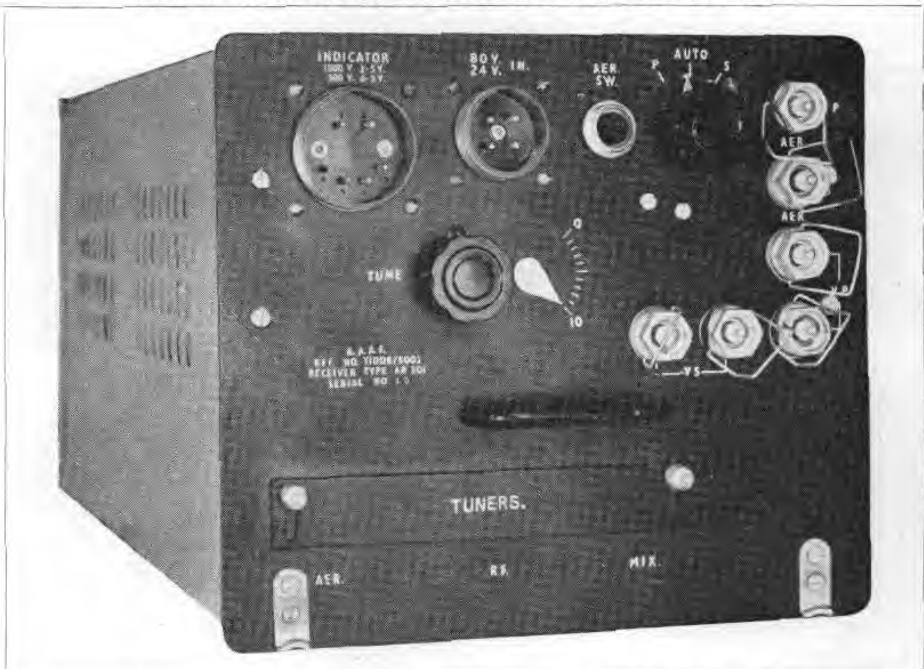


Fig. 1 — In new Receivers the Multivibrator Switch and Aerial Switch are omitted.

FRONT PANEL CONTROLS OF A.S.V. RECEIVER

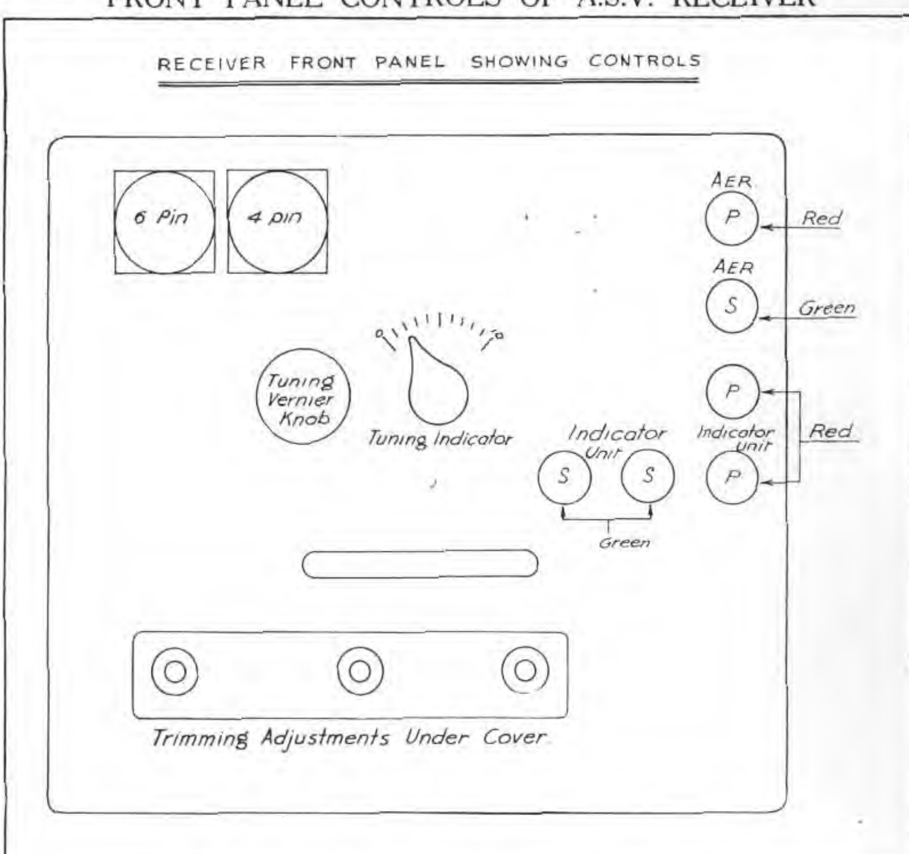


Fig. 2 — Diagram of a new type Receiver showing details of sockets.

CLOSE-UP VIEW OF OSCILLATOR COMPARTMENT

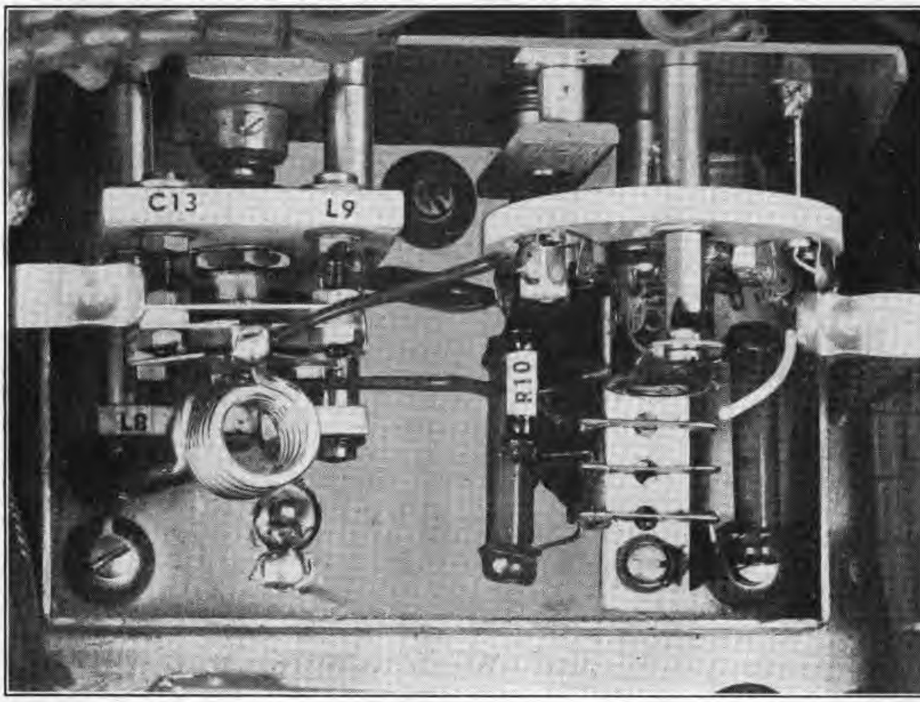


Fig. 3 — The oscillator section above the chassis behind the front panel.

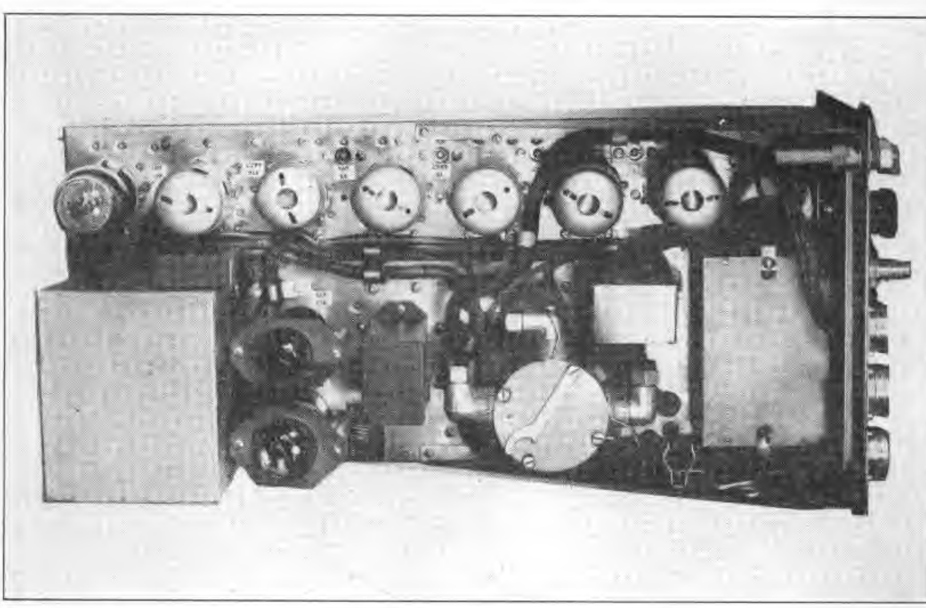


Fig. 4 — Top view of Receiver showing layout and switching motor. The 6N7 valve in the upper left hand corner does not appear in new Receivers. In due course it will be removed from old Receivers.

RECEIVER AND INDICATOR UNIT POWER SUPPLIES

11. The receiver requires a D.C. high tension of 300 volts and a 6·3 volt A.C. supply for the filaments of the valves. These are supplied from the power transformer, which delivers 300 volts to the anodes of the 5V4G full wave rectifier. Smoothing is carried out by a filter choke, L18, of 3 henries, and two ·5 mf. condensers, C37 and C40. The supply has a current rating of 150 milliamps.

12. The 1450 volts D.C. required by the cathode ray tube of the Indicator Unit is also supplied from the Receiver power transformer. A half-wave rectifier circuit is used with an 879 valve. The supply is smoothed with two ·01 mf. condensers C38 and C39, and a 100,000 ohms resistor R28.

The transformer is mounted just behind the two rectifiers on the rear left side of the chassis.

CONNECTIONS AND CONTROLS

13. The power input connections, and the connection to the Indicator Unit are made via two sockets at the top left-hand corner of the front panel. The extreme left-hand socket, P & S1, has 6 pins, and carries the power connections for the Indicator unit. Pin 2 is connected to one of the 2·5 volt filament leads for the C.R.T. Pin 1 is the second 2·5 volt filament lead, and also makes the negative 1450 volt connection for the C.R.T. circuit. Pins 3 and 4 are the 6·3 volt filament connections for the receiving type valves, pin 4 being grounded to the chassis. Pin 5 connects the 300 volt positive high tension for the valves, and pin 6 is the lead to the Gain control, which is mounted on the Indicator Unit front panel.

The second socket, P & S2, has 4 pins, and is the input socket from the Control panel. Pins 1 and 2 are connected to the 80 volts A.C., and pins 3 and 4 to the 24 volts D.C.

Immediately to the right of these sockets was the connection for the multivibrator lead to the aerial side-to-side switch, made via a 2-pin socket, P & S9. Just below and to the right of this socket was the three position switch for the multivibrator. As the multivibrator is not now used, latest Receivers omit both socket and switch.

Grouped at the right hand side of the panel are six Pye coaxial sockets, P & S3, 4, 5, 6, 7, and 8. The first two from the top are coloured red and green. Red is the input connection for the port aerials, and green for the starboard aerials. The four remaining sockets, two red and two green connected in parallel, are the output sockets for two Indicator Units should two be used, red for the port or left-hand indications, and green for the starboard or right-hand indications on the screen of the Indicator Unit.

15. Near the bottom of the front panel, under a removeable cover, are three trimming adjustments for aligning the aerial and R.F. stages. These are in the form of three slotted screws, provided with locking rings, and their adjustment changes the inductance of the coils by varying the position of brass cores running through their centres. The oscillator frequency may be varied by a variable condenser operated from the front panel.

16. The chassis layout has been arranged for easy recognition of components and easy servicing. The I.F. cans, which provide shielding between the stages, clip into place, and are further secured by a spring guard. Great care should be taken when replacing these to prevent accidental damage to wiring and components.

The R.F. stages are located at the front of the chassis, under a shield can held in place by a spring clip. A shield also covers the oscillator stage, located above the chassis behind the front panel. Special tools for removing the I.F. cans, and for aligning the trimmers, are found clipped to the inside of the left-hand side piece of the chassis.

Lining the Circuits

17. The circuits of the receiver are aligned as follows :—

(a) Switch on the equipment, and adjust for a clear, steady echo or blip from some near-by object.

(b) Set the tuning control on the front panel until the largest echoes are obtained.

(c) Adjust the trimmers through the front panel with the special tool until a peak is found for each, as indicated by a position beyond which no further improvement can be made. This adjustment should also give best noise indication if the receiver is correctly lined to the Transmitter frequency. Best results are obtained with the gain control moderately advanced. Too much gain will give too strong a noise indication, and may cause confusion in obtaining the best blips.

When setting up an A.S.V. installation, particularly when a Receiver or Transmitter has been changed, it is essential to make certain the receiver is lined to the exact frequency of the Transmitter. The setting of the tuning control which gives the highest noise indication on the C.R.T. screen should coincide with that which gives the largest echoes or "blips." If the blips are strongest with the receiver "off tune," obviously the full sensitivity of the receiver is not being utilized.

Should this be the case, first tune the receiver for best reception of some permanent echoes or blips, disregarding for the moment the comparative strength of the noise indications. Reduce the gain control till the blips are about half-an-inch long, and adjust the aerial and R.F. trimmers until once again they are brought up to the greatest possible strength. The noise indications should have increased at the same time, until both noise and blips peak at the same setting of the trimmers. The full sensitivity of the receiver is now occurring at the same frequency as that of the Transmitter, and as a result, the equipment will operate at its highest efficiency.

Should it be necessary temporarily to use a receiver not lined exactly to the transmitter frequency, the tuning control should always be set to give maximum amplitude of the blips, and not of the noise level. The blips will not be as large as when the receiver and transmitter are correctly lined up, but they might be lost altogether in some cases, if the receiver is operated with the control set to give highest noise level indications. The receiver should be re-adjusted to the transmitter frequency as soon as circumstances will permit.

UNDER-CHASSIS VIEW OF A.S.V. RECEIVER

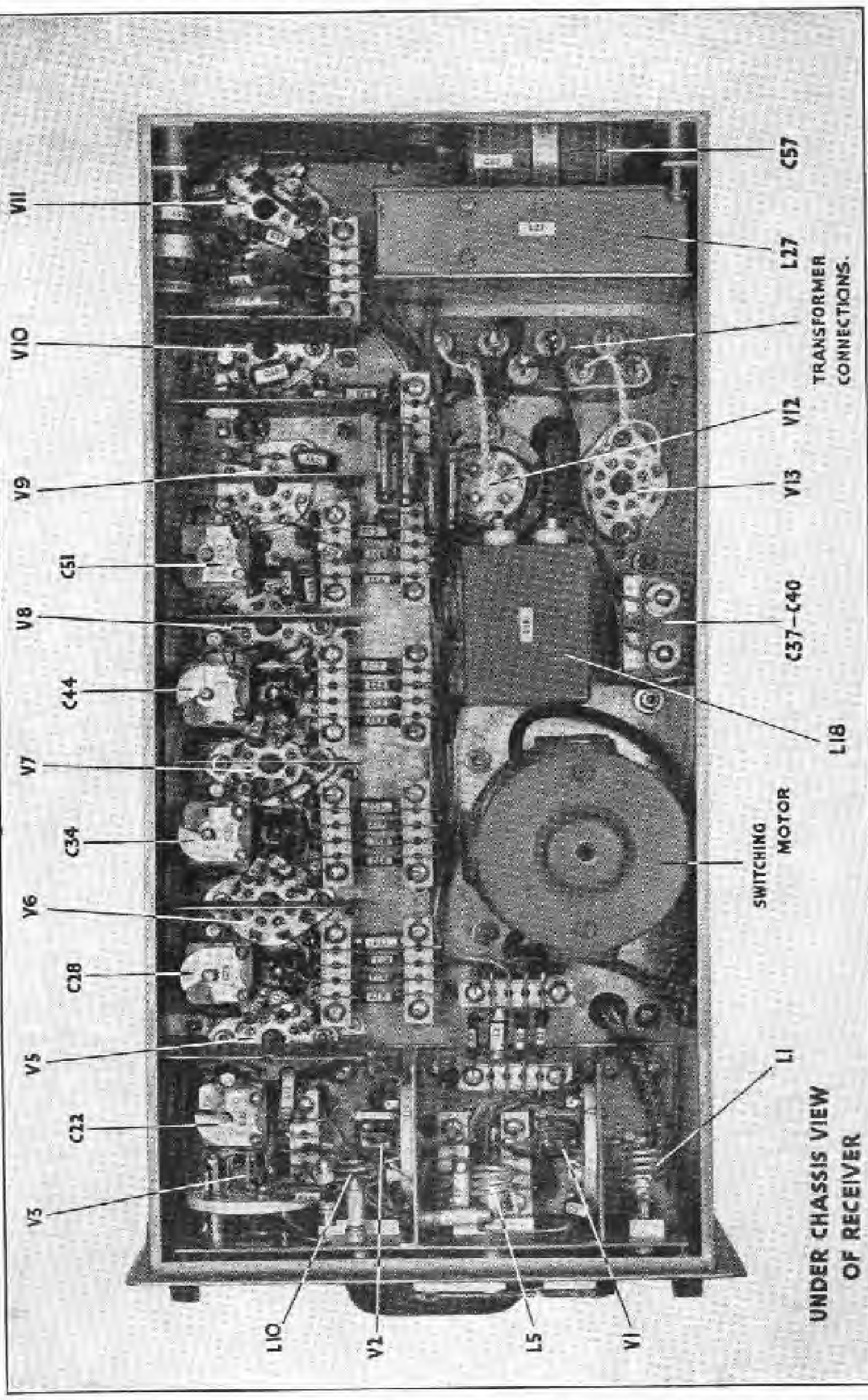


Fig. 5 — Showing layout and position of main Receiver components. New receivers do not have the relay L27, and V11 is omitted as these are part of the multi-vibrator circuit not now used.

CIRCUIT FOR ADJUSTING SWITCH CONTACTS

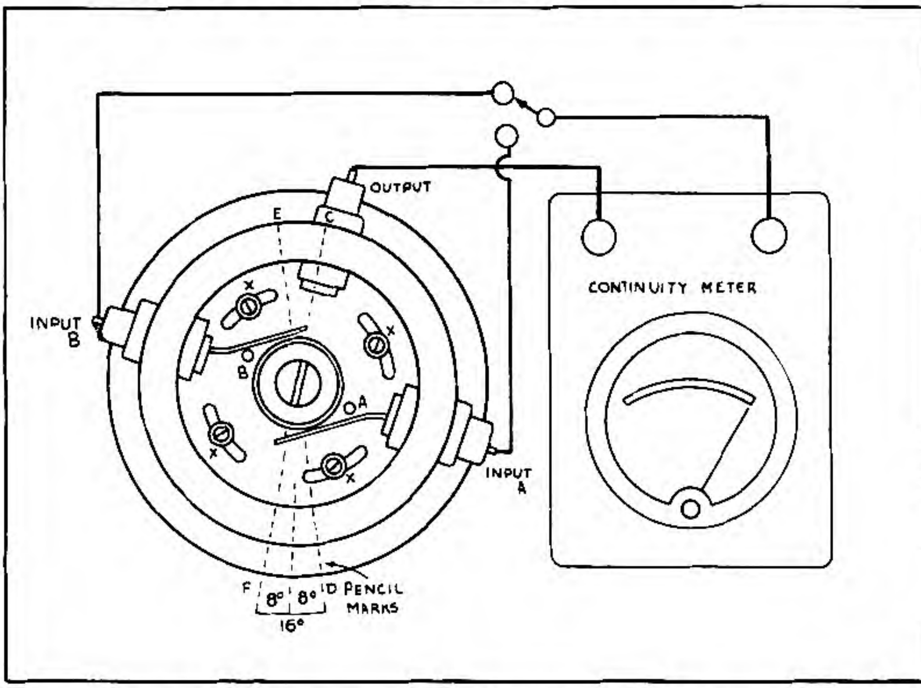


Fig. 6 — How a continuity meter is used to check switch contact alignment.

THE MULTIVIBRATOR

18. In order to make full use of the available power while searching, arrangements were made in the case of some aircraft to switch the Transmitter output from port to starboard transmitting aerials, so that only one of them was operating at the same time. This system, however, was rather unsatisfactory and was eliminated.

All H.M.V. and early A.G.H. Receivers however, still have the multivibrator circuit incorporating a 6N7G valve, a relay, and the two pin socket and selector switch on the front panel. In the later model A.G.H. Receivers all the component parts of the multi-vibrator circuit, except the valve socket have been omitted. H.M.V. Receivers are no longer being produced.

THE RECEIVER SWITCHING MOTOR

19. The switching motor which changes the Receiver input from port to starboard aerials, and the output from one C.R.T. deflecting plate to the other, is mounted near the centre of the receiver chassis.

It comprises an electric motor, driven from the 24 volt aircraft accumulator, and two switch sections mounted directly on the motor housing. The switches are operated from the motor shaft by an extension piece mounted eccentrically upon it. A small ball race in each section is fitted inside an insulating ring and is held on the extension shaft between two spring contacts and their contact pillars. As the shaft revolves, it moves the race bodily from side to side, because of its eccentric mounting. This movement lifts the springs away from their respective pillars once for each revolution. Two aerial input sockets are provided, one for each of the contact springs. The pillars are both connected to a third socket leading to the Receiver input. Thus the pillars are connected alternately to each of the input circuits. The insulating ring itself does not revolve with the shaft, so there is very little frictional wear on the contact springs. Actually its movement between the springs causes it to revolve slowly in the opposite direction to the main shaft, and the wear which does occur is due mainly to this fact.

Some switch motors do not have an insulating ring enclosing the ball race, but have instead, the spring contacts insulated at the points of contact with the ball race.

Adjustments to the Switching Motor

20. Adjustments to the switching motor may be required for two reasons — (i) to preserve the correct switching relationship between the two contacts in each switch section, and (ii) to maintain synchronism between the sections themselves so that Aerial and Indicator circuits are switched at the correct time.

21. Before any adjustments are made, it is advisable to clean the contact springs and pillars. To dismantle the switch for cleaning, remove the screw on the end of the shaft extension, and lift out the ball race. Loosen the clamps holding the switch sections together and lift out the upper bank. Remove the insulating sleeve and the second ball race from the extension shaft. Clean the springs and contact pillars, preferably with pure carbon tetrachloride, taking care not to spill any fluid into the motor bearings.

The contact springs of the bottom section may now be adjusted. The top section is then replaced and adjusted in the same manner as was the bottom section.

CONSTRUCTIONAL DETAILS OF SWITCHING MOTOR

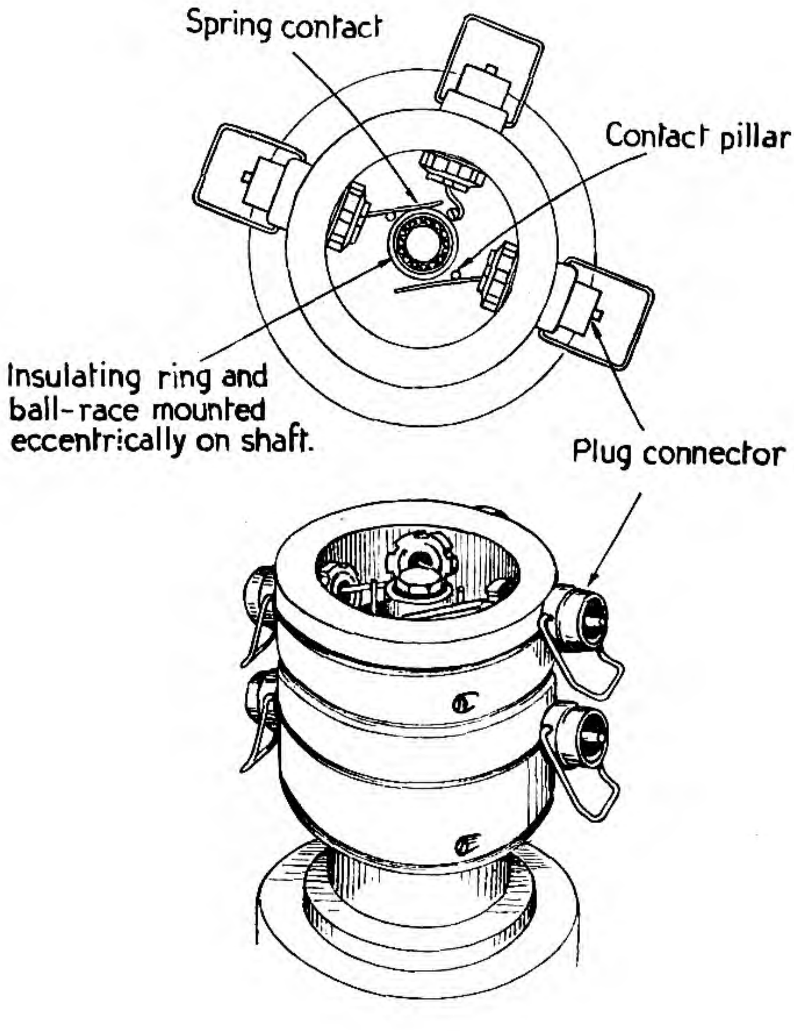


Fig. 7 — Detailed drawing showing essential components of Switching Motor.

Contact Spring Adjustment

22. Exact alignment of the switches may best be carried out with the aid of a C.R.O. An alternative method is to use a Bridge Tester as described in A.C.D. 2023.

However, it is possible to reach a satisfactory adjustment by using a continuity meter, such as an ohmmeter, to indicate when the spring contacts open and close. Any motors so badly worn as to render this latter method ineffective are best returned to R.I.M.U. for complete overhaul.

The circuit to be used when adjusting contacts with a continuity meter, is shown in Fig. 6. One terminal of the meter is connected to the output socket of the switch bank, and the other terminal is connected to each of the input sockets in turn, as its respective contact is adjusted. The lower or aerial switch section is adjusted first.

As it is essential to see that both contacts should never be closed at the same time, a 16 degree overlap or dead-spot is provided for each change-over. This means that, during this period, both springs are lifted clear of their pillars. In order that each contact should be closed for the same length of time, this dead-spot must occur twice for each complete revolution, at an interval of 180 degrees.

This point is made clear in Fig. 6. The contacts are closed at B for 164 degrees from points F to E, and at A from points C to D. Both contacts are open from points E to C, and points F to D. This adjustment is made by rotating the insulation piece carrying the contact studs, which should be perfectly upright.

If the screw which fits to the end of the motor shaft extension is left in place, its slotted head may be used to indicate the degree of dead-spot, and the angular positions of each make and break. The circular edge of the metal housing may be marked with a pencil to show the positions of the makes and breaks as indicated by the continuity meter. Alternatively a length of wire may be temporarily attached to the shaft as a pointer to mark out these positions more exactly on the edge of the housing.

The upper or C.R.T. output switch section should be closed for approximately 160 degrees and open for 20 degrees.

Synchronizing the Switch Sections

23. Synchronization of the switch sections may be checked with the continuity meter by connecting it to each section in turn. If it is possible to use two meters, one connected to each section, more accurate results may be obtained. Correct synchronization is achieved when the aerial switch makes contact just before the C.R.T., and breaks contact just after it. It may be necessary to loosen and rotate the upper housing to achieve this. This means that the contacts in the aerial section are closed for a slightly longer period than those of the C.R.T. section. This is provided for so that at no time will there be a noise indication on the screen without blips as well, as would be the case if the aerial switch made contact after the C.R.T. and broke contact before it.

In practice, it is almost impossible to obtain perfect adjustment either of contacts or of synchronism, but accuracy should be possible to within a few degrees. About 2 degrees will be sufficient lead and lag on the make and break of the aerial switch section.

Elimination of Common Faults

24. Weak or poor quality springs will frequently cause bouncing, which prevents positive contact of springs and pillars on the "make," and as a result, lack of precision on indications or blips. This condition cannot be observed with a continuity tester, as the switch revolves too quickly when the equipment is in operation for the meter to follow the contacts. A C.R.O. is the only instrument by which the action of bounce may accurately be observed. If serious, however, its effects will be noticeable on the Indicator screen.

Occasionally, metal particles may collect inside the input and output sockets, short-circuiting the centre contact pin to the frame. This will be indicated by failure of the section concerned to register an open circuit condition on the meter. The remedy is to clean the sockets. The switch sections should also be examined. and any small metal particles removed.

If the insulating material on the ball race is of varying thickness, this will affect the period during which the springs make contact with their pillars, as the ball race tends to revolve slowly when the motor is running. Replacement of the ball race is the only remedy.

General Characteristics of A.S.V. Mk. II (Aust.) Switching Motors.

Ident No.	Power Requirements
Y10F/80151	50 watts at 24 volts
Y10KB/500003	50 watts at 12 volts

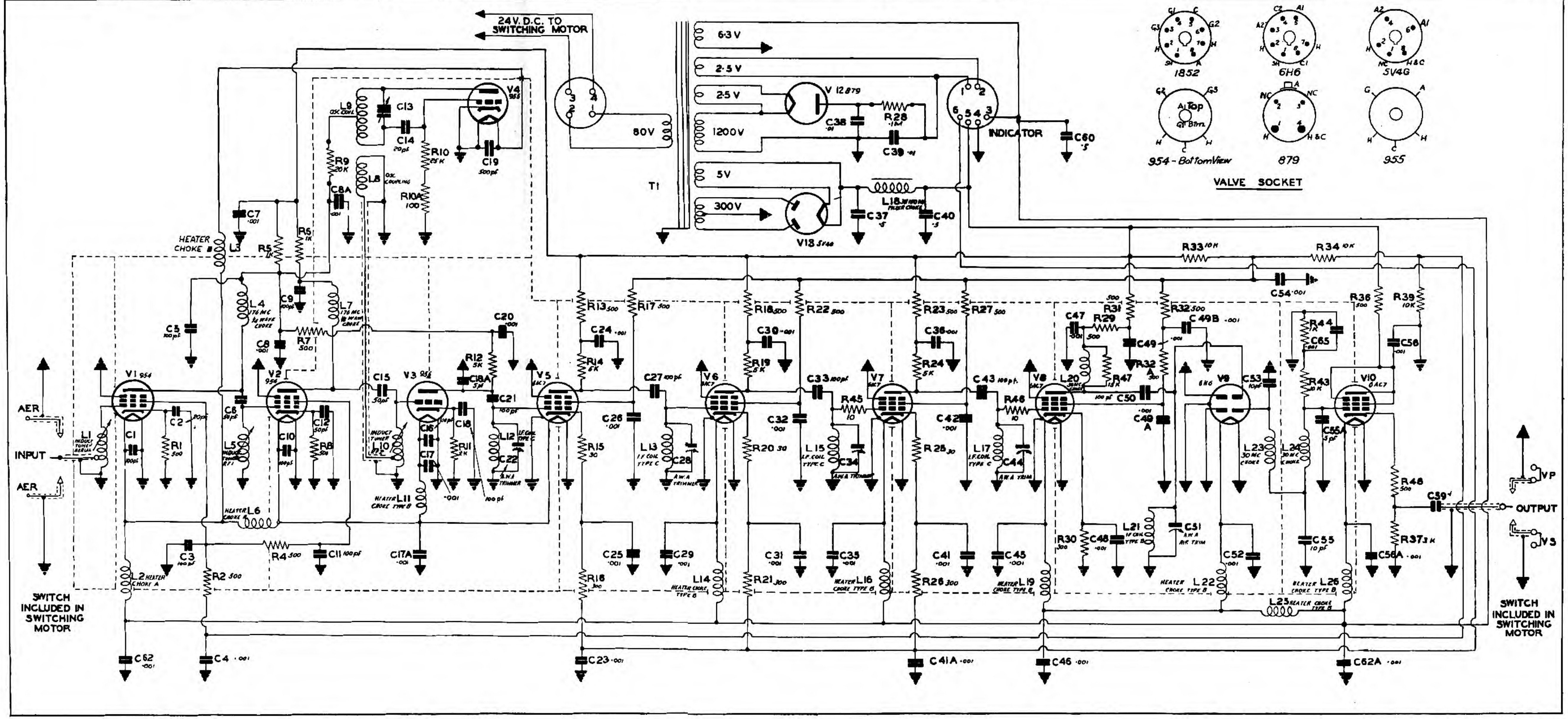
 Amendment List No. 1

RESISTORS: R1 R2 R5 R4 R6 R7 R9 R8 R10A R10 R11 R12 R13 R14 R16 R15 R17 R18 R19 R20 R21 R22 R45 R28 R23 R24 R26 R25 R27 R46 R29 R30 R31 R47 R32A R32 R33 R43 R44 R34 R36 R48 R39 R37

CONDENSERS: C1 C62 C5 C2 C3 C4 C7 C6 C8 C9 C10 C8A C12 C11 C15 C13 C16 C14 C17A C17 C18A C18 C19 C21 C20 C22 C23 C24 C25 C26 C27 C218 C219 C30 C32 C31 C33 C38 C34 C35 C37 C39 C36 C42 C41 C40 C41A C43 C44 C45 C47 C60 C46 C50 C49 C48 C49A C51 C49B C53 C52 C55 C54 C65 C55A C62A C56 C56A C59

INDUCTANCES: L1 L2 L3 L4 L6 L5 L7 L9 L8 L10 L11 L12 L13 L14 L15 L18 L16 L17 L19 L20 L21 L22 L23 L24 L25 L26

MISCELLANEOUS: V1 V2 V3 V4 V5 T1 V16 V13 V12 V7 V8 V9 V10



CHAPTER FIVE

A.S.V. INDICATOR UNIT TYPE A1

General Description — The Circuit — Connections and Adjustments — Setting up the Indicator — Operating the Indicator.

GENERAL DESCRIPTION

1. The function of the Indicator Unit is to record the presence of reflected waves and therefore the presence of the object which has reflected them. It receives and amplifies the voltage output from the Receiver, generates a linear vertical sweep to represent a definite distance in miles, and combines the two on the screen of a Cathode Ray Tube. By viewing the indications on the screen, the operator may read off the distance of the object from the aircraft, and the general direction in which it lies.

2. There are three main sections of the unit —

(a) The time base circuit of 6 valves which generates the vertical trace.
(b) The video amplifier of 3 valves which amplifies the receiver output.
(c) The Cathode Ray Tube which provides the visual indication.

3. The time base is divided into four units centred round four valves. V1 generates the necessary saw-tooth wave form when energized from the transmitter, V3 provides an adjustment for velocity and amplitude of the trace, V4 is a phase-inverter to provide a push-pull deflecting voltage, and V5 " blacks out " the trace by preventing the C.R.O. from operating except during the actual period of the trace. V2 and V6 are double-diodes used as voltage limiter and D.C. restorers. In the video amplifier, V9 and V10 are signal amplifiers, and V8 is a D.C. restorer.

V1, V3, V4, V9, and V10 are 1852 valves with anode, suppressors, and screens connected together so that they operate as triodes. V5 is an 1852 connected as a pentode. V2, V6 and V8 are 6H6 duo-diodes.

4. The time base circuit is required to produce four different traces which will move from bottom to top of the screen in times corresponding to ranges of 4½, 9, 36, and 90 miles.

The propagation of electro-magnetic waves takes place at a velocity of 186,000 miles per second. Thus 6·18 micro-seconds are required for a wave to travel one nautical mile. So the time taken to reach an object 4½ miles away and return is 55·6 microseconds. Similarly for 9 miles, the time is 111·2 microseconds, for 36 miles, the time is 444·8 microseconds and for 90 miles, the time is 1112 microseconds. The four traces therefore, must occupy 55·6, 111·2, 444·8 and 1112 microseconds to represent distances of 4½, 9, 36 and 90 miles on the C.R.T.

THE CIRCUIT

Saw-Tooth Generator

5. The saw-tooth generator V1 is not an oscillator. It will operate only when supplied with a regular positive pulse from the transmitter. This pulse is applied to the grid of V1 through C1, and the circuit composed of R1 and one half the diode V2. The diode section acts as a voltage limiter. Its cathode is maintained 45 volts positive with respect to ground through the voltage divider R6 and R7. Positive voltages in excess of this amount applied to the anode cause the diode to conduct, and prevent any further voltage rise. Thus the voltage applied to the grid of V1 is independent of the actual voltage of the pulse.

The grid of V1 is given a positive potential by the connection of R2 to the potentiometer R5 and the bleed resistor R4. The grid being positive with respect to the cathode which is at ground potential, attracts electrons from the cathode. The value of R2 is 2 megohms and the grid current it allows to flow is not enough to prevent a negative charge accumulating on the grid. This negative charge almost balances out the positive voltage applied, leaving the grid approximately ·5 volts positive with respect to ground.

The anode circuit consists of the load resistor R3, and a three-position switch connected to the fixed condensers, C3, C4, and to another switch selecting either C2 or a network consisting of R59, C17, C17A, and C2.

The positive voltage of ·5 volts causes an anode current a little higher than normal to flow, so that there is a fairly large voltage drop across the anode load resistor R3. This reduces the effective anode voltage to quite a low figure. The condenser (C2, C2A, C3, or C4) in the anode circuit is, of course, also charged by this amount.

When the positive pulse from the Transmitter is applied to C1, its amplitude is limited by the diode to about 45 volts. The grid of V1 cannot rise by this amount however, as a positive increase in grid voltage causes an increase in grid current, a further collection of electrons, and a higher negative bias developed at the grid as a result. Thus the former state of balance is preserved, in which the value of the negative bias is almost equal to the applied positive voltage.

After 2·5-3 microseconds, the Transmitter stops oscillating, and the pulse ceases. The positive voltage is immediately removed from C1, and the grid of V1 is left negatively charged by approximately 45 volts, the amplitude of the applied pulse voltage. This is sufficient bias to " cut-off " the valve, and no further grid or anode current can flow.

The valve will remain in this condition until the negative charge has had time to leak away through R2, and reduce the bias to a voltage which will once more allow anode current to flow. It cannot leak away via the valve while in its cut-off condition, as the valve circuit resistances are practically infinite.

As soon as the anode current ceases, the voltage at the anode commences to rise, its rate controlled by the time constant of R3, and whichever condenser (C17, C17A, C2, C3, or C4) happens to be switched into the circuit. The voltage will continue to rise until the excessive negative charge has leaked away from the grid, its bias reduced in consequence, and anode current flows again. As soon as this happens, the condenser discharges through the anode impedance of the valve, which is quite low now that its original state has been restored.

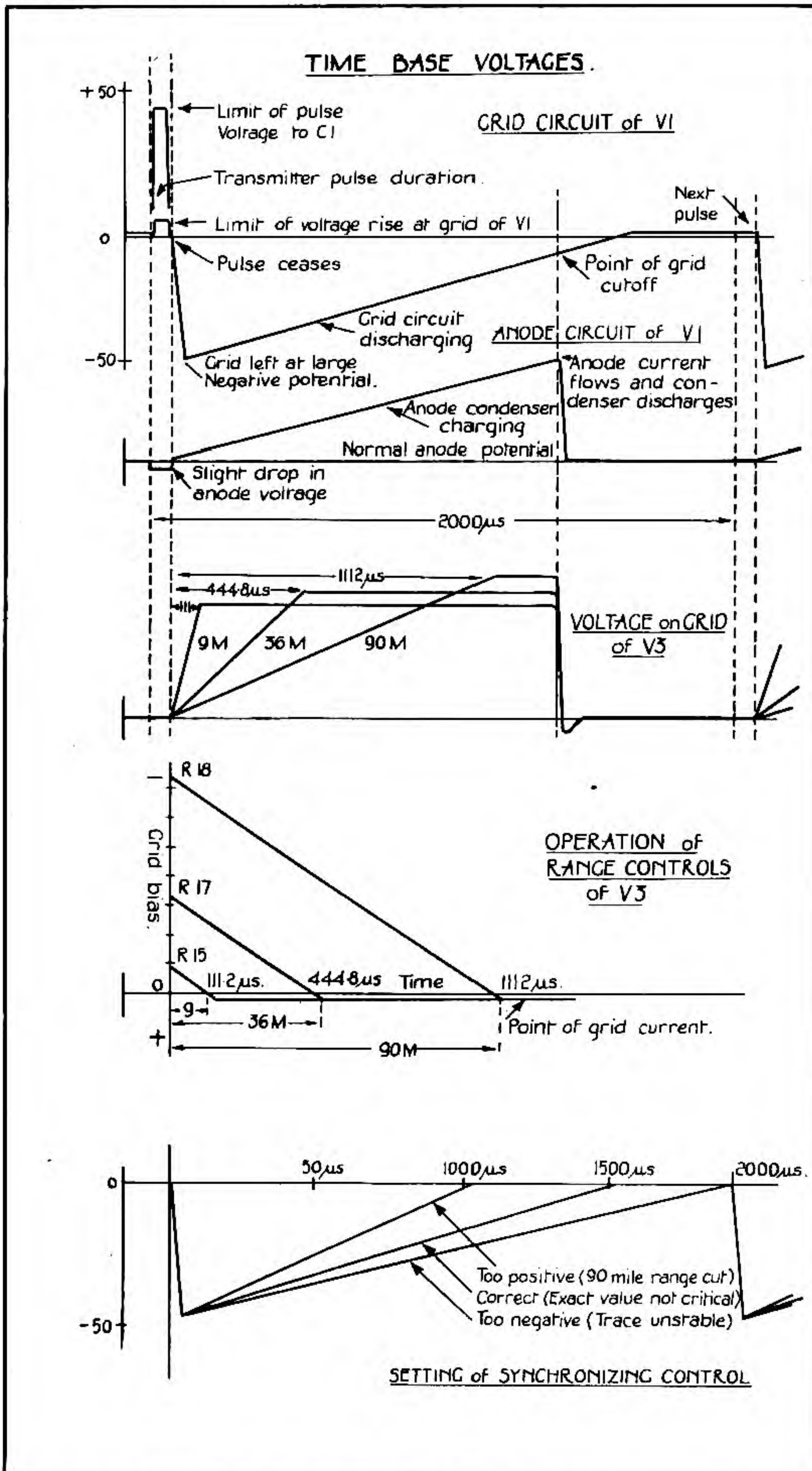


Fig. 1 — Graphs illustrating the operation of Pulse-generator and Range Values.

As the time constant of the grid circuit is much shorter than that of the anode circuit, only the first portion of the anode condenser's discharge curve is used, and this is essentially linear. An almost perfect saw-tooth wave form is therefore produced in the anode circuit of V1. (See Fig. 1.)

The selection of anode condenser values determines the time constant of the anode circuit, and therefore the speed at which the anode circuit will become charged. The grid voltage adjustment will determine the actual grid time constant, being the time interval before which the anode condensers can discharge.

This is always made longer than the time required for the longest range — 1112 microseconds. Too short a grid time constant will not allow the trace to develop fully, and too long a time constant will not stop the trace before the next pulse arrives.

The control in the grid circuit is called the **Synchronizing** control. The output from V1 is applied to the grid of the Range valve V3, through condenser C6.

The Range Valve

6. The Range valve V3 has two specific functions and two controls. The first, the **Calibration Control,** gives fine, accurate adjustments of the time taken by the trace (already roughly determined in the anode circuit of V1) so that it will correspond exactly with the correct time interval required for each range.

The second, the **Range Control,** enables the length of the trace to be adjusted for each range so that the full width of the screen is utilized.

The grid circuit of V3 consists of two resistors, R8 and R9, which act as filters, and the second section of the diode V2, which has its anode connected to ground. This valve acts as a D.C. restorer for the pulse.

7. A series of unidirectional pulses applied to the coupling condenser in the grid circuit of V3 will produce similar pulses at the grid itself, but these will no longer be uni-directional. They will have equal positive and negative excursions as with a normal A.C. input. The action of the diode restores these pulses to their original character.

In this particular case, the cathode of the diode section is connected to the grid, and its anode to ground. On the negative excursions of the pulse input, the diode will conduct, and prevent any negative voltage build-up. The grid of the valve is robbed of negative electrons under these conditions, which is equivalent to leaving it positively charged. On the positive excursions of the pulse, the diode is non-conducting, and the pulse voltage is added to the amount by which the grid has been left positive. By this process, the voltage reference level is moved so that the negative component is almost eliminated, and a series of positive pulses only appears at the grid.

This condition will continue as long as the positive pulses are fed to the circuit, providing its time constant is sufficient to maintain between pulses the positive voltage developed at the grid.

Had the anode of the diode instead of the cathode, been connected to the grid, the resulting voltage reference level would have moved so as to eliminate the positive instead of the negative component of the wave.

8. The valve V3 is a normal amplifier with negative feedback, due to the lack of bypass condensers across the cathode bias resistors. In addition to R16, there are three such resistors, R15, R17, and R18, each of which may be adjusted to provide a different value of negative bias for the valve.

It is obvious that if we apply a positive voltage to the grid of V3 from the anode of V1, under three different values of negative bias, the grid will swing positively, commencing at three different positions along its grid base.

As soon as the positive voltage exceeds the amount of cathode bias, thus tending to make the grid positive with respect to the cathode, the valve will draw grid current, and no further voltage increase can take place. The diode will not permit the grid to become negatively charged with respect to ground, as under such conditions it will conduct.

Thus the positive voltage applied to the grid cannot exceed the amount of negative cathode bias originally applied to the valve. As the time taken for the grid voltage to reach this zero point is proportional to the bias, it can be accurately controlled by using the three adjustable resistors to set the bias voltage for each range. The highest value of bias naturally is used for the 90 mile range, which requires the longest time interval for the trace.

Since the cathode resistors are in the return of the valve high tension circuit, adjustment of them alters the stage gain of the valve. The gain is reduced as the resistance increases, so that it compensates to some extent for the increased input voltage which occurs when the higher resistance is present in the cathode circuit. As these cathode resistances control a time interval, they are used in calibrating the equipment and are labelled " Calibration ".

The Amplitude, or, as it is marked, " Range " control is comprised of three paralleled potentiometers R10, R12, and R14, in series with the normal anode load R11, parallelled in the case of the 1802-P1 C.R.T. by R11A. They control the amplitude of the voltage actually applied to the Y plates of the C.R.T. for each range, and hence the length of the scan. Their adjustment ensures that the full trace length appears on the screen for each range. The position of the bottom end or start of the scan is fixed by the diodes V6, and thus the effect of increasing the resistance of these potentiometers is to elongate the scan upwards.

The output from V3 is applied to the grid of V5 through C10, to the grid of V4 through C8, and to one of the C.R.T. deflecting plates.

The Phase-Changer

9. The third or Phase-changer valve V4 provides an output equal and opposite to that of V3, to allow push-pull deflection for the trace on the C.R.T. Push-pull deflection improves linearity, reduces astigmatism, and provides twice the scanning voltage with the same H.T. supply voltage as would a single deflection voltage.

The valve V4 is a triode amplifier with negative feedback, and its stage gain equals 10. Therefore R19 and R20 in the grid circuit are so proportioned as to provide the grid with one-tenth the voltage output from V3. Thus the output voltages of V3 and V4 are the same, but 180 degrees out of phase. By applying the output voltage from each valve to the opposite deflecting plates of the C.R.T. push-pull deflection is obtained.

The Black-out Valve

10. The fourth valve V5 is the " Blackout " valve. It is connected as a pentode, R27 and R28 supplying the screen, and R25 and R26 the anode. The screen is not bypassed. A bypass condenser would introduce a time delay which would prevent the output voltage from rising and falling almost instantaneously, a necessary condition for correct operation of the blackout.

There is no bias resistor for V5, the grid resistor R24 being connected to ground. Under these conditions, a fairly high anode current flows, and, due to the voltage drop across R26, the anode is therefore at some voltage considerably less than the applied voltage. Lack of initial bias allows a larger grid swing of V5, and consequently a larger variation in anode voltage, than if the grid were given a standing bias.

Each negative pulse supplied by V3 to the grid of V5 is, in effect, a sudden negative bias, causing an immediate drop in anode current, and a corresponding rise in the positive voltage actually to be found at the anode. The actual voltage variation is about 35 volts.

The " blackout " operates as follows—The grid of the C.R.T. is given a standing D.C. negative bias greater than it normally requires, by placing the cathode at a fixed potential positive with respect to the grid. This high bias reduces the electron flow through the tube below its normal operating value, and as a result, no indications of any kind can appear on the screen. As C11 connects the output of V5 to the C.R.T. grid, the sudden positive voltage which appears at the anode of V5 for the duration of the trace balances out enough of the C.R.T. bias to reduce it to normal. Under these circumstances, the electron flow through the C.R.T. rises to its correct operating value, and indications appear on the screen. As soon as the trace voltages are removed, the balancing-out voltage from V5 ceases, the C.R.T. is again overbiassed, and everything is blacked out from the screen until the arrival of the next trace.

Thus the blackout circuit eliminates any trace of " flyback " or return of the spot to its original position, and avoids the appearance of a bright spot at the bottom of the trace, which otherwise would appear during the idle micro-seconds between traces.

The voltage available from the anode circuit of V3 varies from one range to another. As a result, if no compensation were provided, the output voltage available from V5 will also vary, and adjustments to the bias control would be necessary with each switch from one range to another.

The output from V3 is normally smallest on the 90 mile range. In order to increase it, an extra resistance (R25 and R58 in parallel) is connected in series with the anode load resistor R26 for this range. On the 4½, 9 and 36 mile ranges, R25 and R58 are short circuited, as in practice, the same setting of the Bias or Brilliance control will serve for each.

The output voltage from V3 is applied to one of the vertical plates of the C.R.T. through C7. One half of V6 is used as a D.C. restorer, and a vertical shift voltage is also applied to this plate from R31, R32, and R55. The output of the phase changer is applied to the other plate through C9, the second half of V6 providing D.C. restoration.

THE VIDEO AMPLIFIERS

11. The voltages for the C.R.T. are obtained from the divider comprised of R33, R33A, R34 and R34A, R35, R44, and R36. R13 is the grid resistor. Focus and Bias controls are potentiometers R35 and R36 respectively.

12. The video amplifiers provide extra gain for the horizontal deflecting plate voltages from the Receiver. There are two amplifiers V9 and V10. They are connected as low gain triode amplifiers with inverse feedback. Input for their grids is from the switching motor on the Receiver. R39 and R43 are the grid resistors, R56 and R57 are small R.F. stoppers. Bias resistors R40 and R47 have no bypass so that negative current feedback is obtained. R41 and R42, and R48 and R49 are the anode loads and C12 and C13 couple the voltage output to the plates of the C.R.T. A D.C. restorer is used in V8, which also ensures that no voltages of the incorrect potential are applied to the respective plates.

A fixed horizontal shift voltage is applied to one plate from the voltage divider R52, R53, R60, and a variable shift to the other from the voltage divider consisting of R50, the potentiometer R51, and R60. R60 may be varied from zero to ·25M, so that the mean potential of the horizontal deflecting plates may be raised or lowered with respect to the vertical deflecting plates. This effect was found to be necessary with 905 and 1802-P1 C.R.T.'s in order to eliminate astigmatism between the trace and blips. C15 and C16 bypass the two cathodes of V8.

Switches associated with V1, V3 and V5 are ganged together and operated by one control which indicates the range – 9, 36, or 90 nautical miles – for which the unit is required. In order to switch from 9 to 4½ miles, an extra toggle switch marked 4-10 is located beside the main switch. The actual panel markings are 10, 40 and 100 miles, indicating the maximum distances to which the unit may be adjusted for each range, and also to coincide with the marking on the Calibrator. It should be remembered, that although the ranges used in A.S.V. are actually 4½, 9, 36 and 90 nautical miles the equipment may be used for other types of installation where different working ranges are employed.

The gain control for the Receiver is also included in the Indicator unit. This is composed of R45 and R46, which are wired in the cathode circuits of the receiver intermediate amplifier valves.

FRONT PANEL VIEW OF A.S.V. INDICATOR

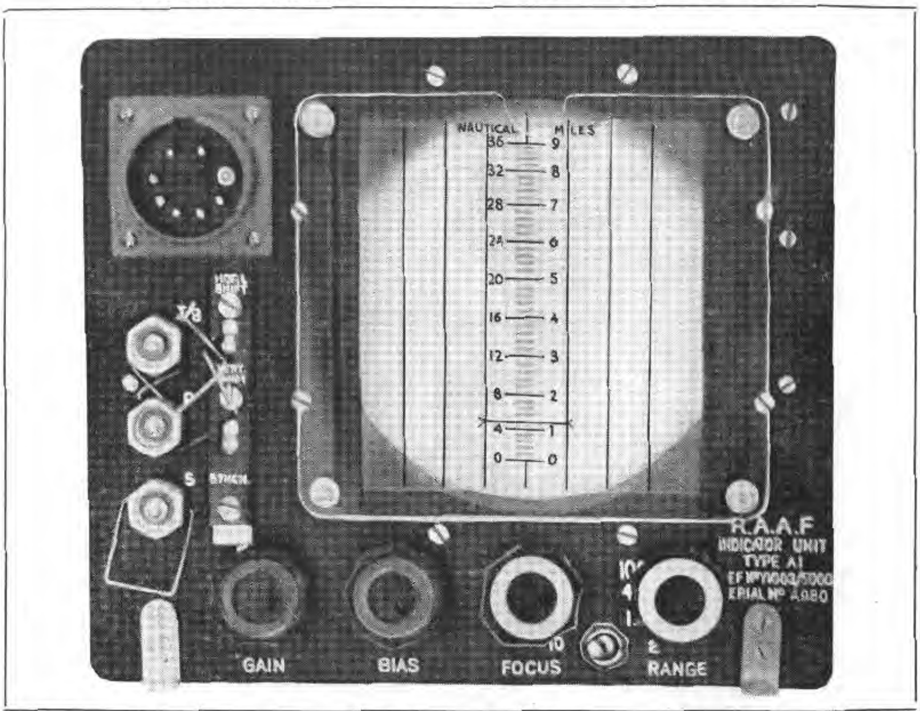


Fig. 2 — In A.S.V. equipment, the 10, 40 and 100 ranges are calibrated to read 9, 36 and 90 miles. In later indicators the 2 m. range marking is altered to 4.

A.S.V. INDICATOR — FRONT PANEL CONTROLS

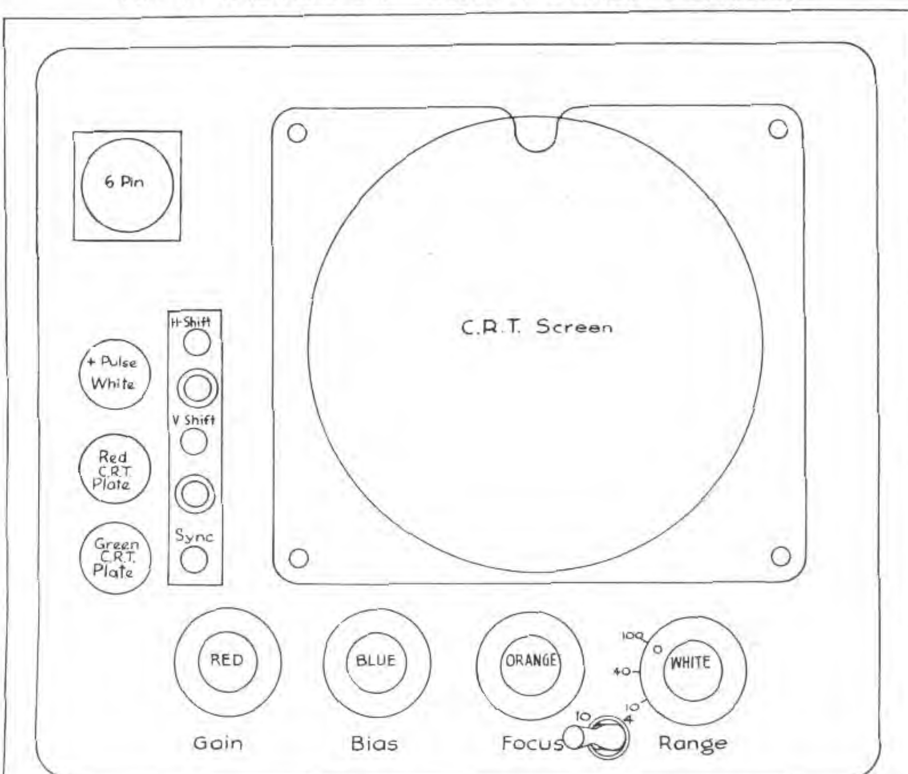


Fig. 3 — Diagram showing socket types.

UNDER-CHASSIS VIEW OF INDICATOR UNIT

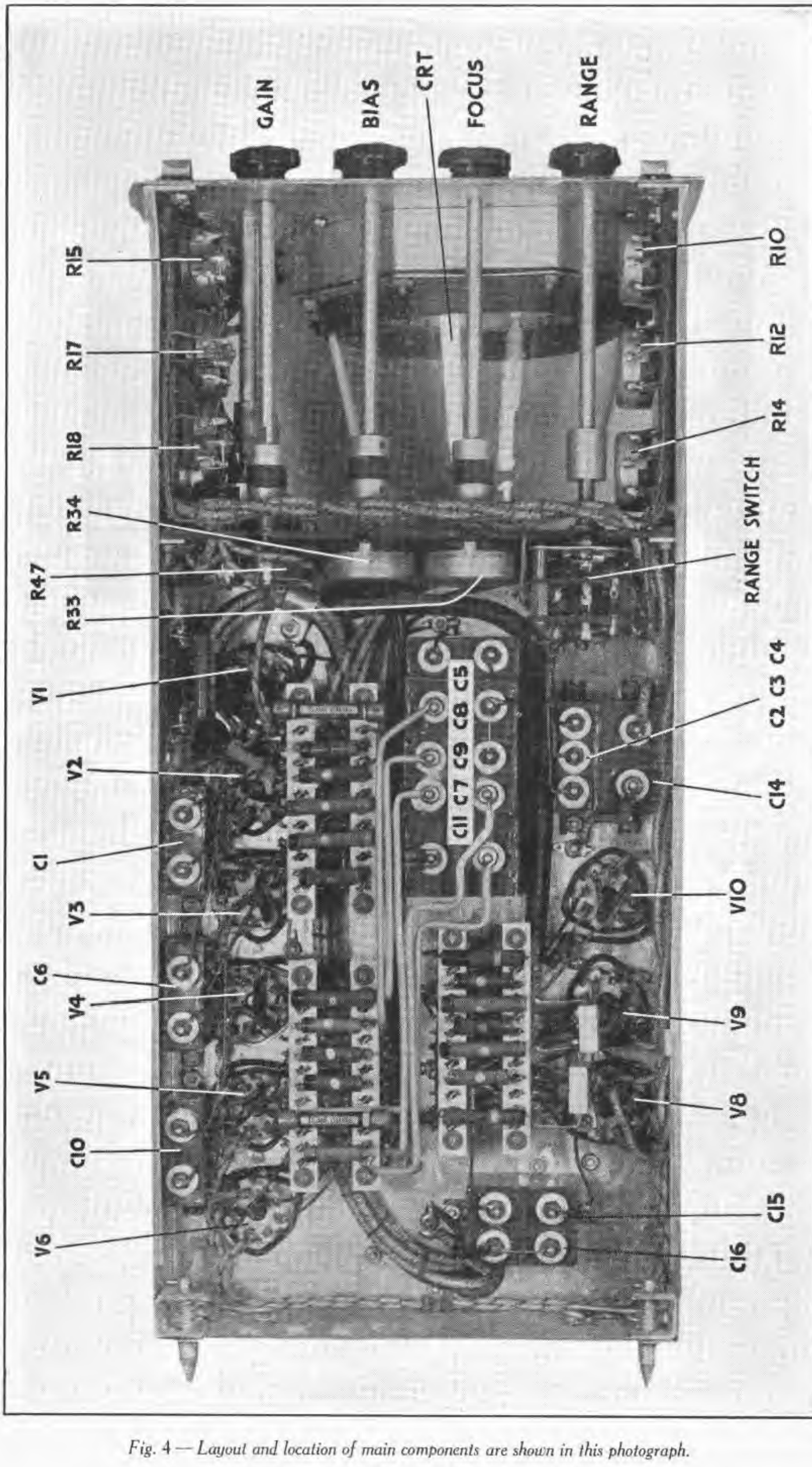


Fig. 4 — Layout and location of main components are shown in this photograph.

A.S.V. INDICATOR UNIT — VIEW FROM TOP

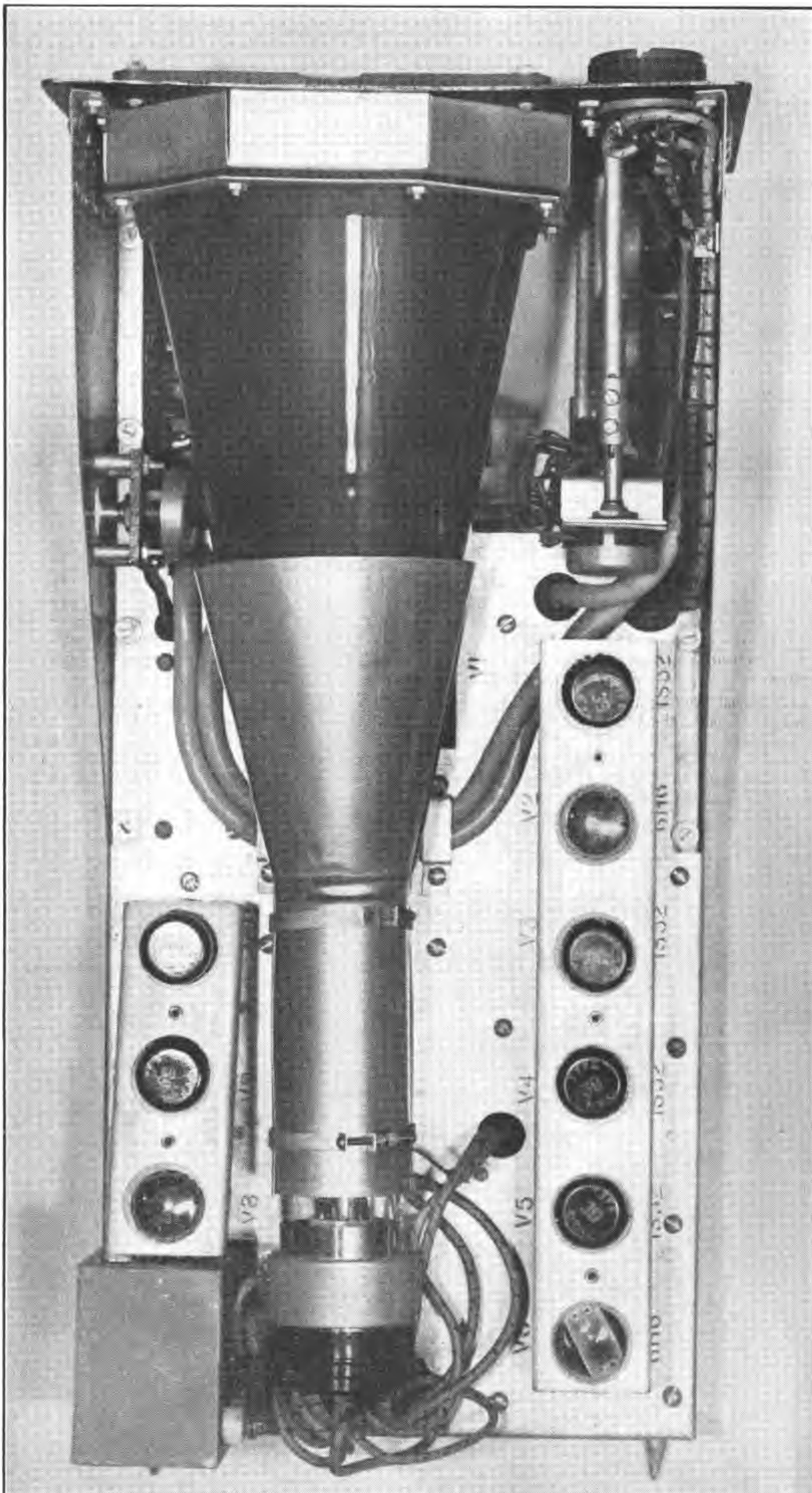


Fig. 5 — Mounting of the C.R.T. and above chassis layout shown in this photograph.

CONNECTIONS AND CONTROLS

13. The Indicator Unit chassis measures 18 inches deep, 8¼ inches wide, and 7 7/16th inches high. It is fitted with a metal case which slides off the back, and held in position with a locking screw.

The Cathode Ray Tube is mounted a little to the right of the chassis centre line. It is supported by a Steatite 5 or 11-pin socket at the rear of the chassis, and a rubber moulding fixed to the front panel. The tube is fitted with a metal shield of high permeability iron to prevent it being affected by any electrostatic or electro-magnetic fields around the unit.

The valves in the time base circuit (V1, V2, V3, V4, V5, and V6) are located in line to the left of the C.R.T. and the video amplifier valves (V10, V9, and V8) to the right in that order from the front panel.

Three of the Calibration potentiometers R15, R17, and R18 are mounted in that order under the chassis on the left-hand side, so that their slotted spindles may be adjusted with a screwdriver. The fourth calibration potentiometer R59, is mounted on a flange at the right-hand side of the unit. The Range controls, R10, R12, and R14, are mounted in a similar position on the right-hand side of the chassis. These controls can be reached through holes in the case.

14. The controls governing Horizontal shift, Vertical shift, and the Synchronizing control are mounted on a bracket to the left of the C.R.T. Extension spindles are fitted so that their slotted ends may be adjusted with a screwdriver through the front panel. A cover plate protects these controls, and must be slid back before they can be reached.

The main controls for the unit are mounted on the front panel immediately below the C.R.T. The extreme left-hand knob colored red, is the Gain control of the receiver, and regulates the amplitude of the signal fed to the unit. Next on the right is a blue knob which varies the Bias of the C.R.T. and thus the intensity of the trace. The third knob, orange-colored, is the Focussing control which varies the voltage on the C.R.T. focussing anode. The extreme right hand knob operates the ganged switches associated with the three ranges — 9, 36, and 90 miles, and is colored white. The 4½ mile switch is set between the Focus and Range knobs.

15. Power connections are made by P & S1, located at the top left-hand corner of the front panel. A 6-pin socket is used, pin 1 connecting one 2·5 volt C.R.T. filament lead, as well as the 1,450 volt negative bias for the C.R.T., and pin 2 connecting the second 2·5 volt lead. Pins 3 and 4 are for the 6·3 volt filament leads, pin 4 also being grounded to the chassis. Pin 5 connects the 300 volt high tension, and pin 6 the receiver Gain control.

A special filament transformer for the C.R.T. will be found mounted on the chassis, with the primary connected direct to the 2·5 volt input leads from the transformer on the Receiver. The secondary is a tapped winding, providing 2·5 volts to 6·3 volts as required for the type of C.R.T. in use. This procedure also isolates the actual connections to the C.R.T. filament from the input leads of the transformer, so that one of them can also be used for the 1450 volts negative connection. The total number of input leads is by this means kept down to six, and the use of two power input sockets instead of one is avoided.

At the extreme left-hand side of the front panel are the three Pye co-axial sockets. The top one of these, P & S2, colored white, is the connection for the positive pulse from the Transmitter. The remaining two, P & S3 and P & S4, are the input connections from the Receiver to the C.R.T. deflecting plates, the port side being colored red, and the starboard green.

P & S2 is a Pye co-axial socket located in the centre left-hand side of the front panel, and is colored white. Immediately below it are P & S3 and 4, also Pye co-axials, which connect the leads to the C.R.T. plates, red for port and green for starboard.

The screen of the C.R.T. is masked by a heavy, transparent shield, which also supports the rubber eye-piece, and protects the operator should the glass envelope be shattered.

SETTING UP THE INDICATOR UNIT.

17. (a) The controls of the Indicator Unit are in two groups — those which are adjusted by the operator while the equipment is being used, and those which are pre-set and subject to periodical checking to maintain efficiency and accuracy.

The operational controls are — (i) Range switch, (ii) Bias (Intensity) control, (iii) Focussing control, and (iv) Receiver Gain control.

The pre-set controls are (i) Synchronizing control, (ii) Range potentiometers, (iii) Amplitude potentiometers, (iv) Horizontal and Vertical shift. Before the Indicator Unit is put into operation, it is necessary to adjust the pre-set controls.

(b) With the P.R.F. meter, check the P.R.F. of the transmitter. This should be 300-400 cycles per second. Too high a P.R.F. will not allow time for reflected pulses to travel to and from the reflecting object on the 90 mile range, which in consequence will be cut short. The theoretical limit would be about 900 cycles per second, but this would not allow nearly enough margin for variations in P.R.F. Also, calibration starts to change outside the limits stated above.

(c) The Synchronizing control sets the time constant of the pulse-generator's grid circuit (V1.) If this is too short, the anode circuit will be discharged too quickly, and the trace will be suppressed before it has time to develop fully. This will have the same effect as too high a P.R.F., and will not allow the 90 mile trace to be completed.

Too long a time constant will allow the next pulse to arrive before the trace associated with the first has been extinguished. This will cause an unsteady and blurred trace, incapable of providing satisfactory results.

A position for the Synchronizing control should be found which will allow the 90 mile trace full development, but which will discharge the anode circuit before the next pulse is delivered by the Transmitter.

The Synchronizing control adjustment is as follows —

(i) Remove the Receiver input connections from the sockets on the Indicator front panel, and set switch to the 90 mile range. Switch on the Transmitter, and advance the Bias control. Focus the trace, using enough brilliance to give a well-defined line. Rotate the Synchronizing control clockwise, until the trace begins to shorten in length.

(ii) Make a note of this setting, and turn the control until the trace begins to exhibit instability.

(iii) Turn the control back to a position midway between these two settings. Unless the P.R.F. of the transmitter should change radically from its correct figure, there should be no need to re-adjust the Synchronizing control between regular checking periods, as when set as above, there is a good tolerance on each side of the correct position.

This mid-way position should coincide with that required to start the trace at the same position on the screen for each range, as this position is determined also by the setting of the Synchronizing control. It is important that all three traces should commence at the same point if the calibrated scale which is placed over the C.R.T. screen is to indicate distance as accurately as possible. The exact position for the start of the trace is 2 inches below the centre of the screen.

(d) The horizontal and vertical shift controls move the trace bodily in a horizontal and vertical direction. They are used to keep the trace running vertically through the centre of the screen, and once the correct length has been set by the Range control, to maintain the limits of the trace equi-distant from it. Note that while the Range control varies the length of the trace in an upwards direction, the vertical shift does not alter the trace length, but simply moves it as a whole up or down the centre line of the screen.

If operating correctly, the horizontal shift control should move the trace 1 inch to either side of the screen centre, with a tolerance of plus or minus ¼ inch, and the vertical shift should move the bottom of the trace from ½ inch to 3 inches below the screen centre, with a tolerance of plus or minus ¼ inch. Its correct position is 2 inches below the centre.

(e) To make sure the trace represents the correct time interval for each of the three ranges, the Calibrator is used. When connected to one of the Receiver input connections, and energised with a negative pulse from P & S2 on the Transmitter panel, it supplies a series of pulses which appear on the screen in the form of small pips or blips. If the Calibrator and the Indicator are operating correctly, these should not be less than ¼ inch long through each video amplifier, ascertained by connecting the Calibrator to each of the Receiver input sockets in turn. They should also be within 1/16th inch of each other in amplitude.

There are three ranges on the Calibrator, the first giving pips the space between which represents one nautical mile, the second with 4 mile spaces, and the third with 10 mile spaces. Thus when there are ten pips visible on the screen for each range, corresponding with 9 spaces, the ranges will be correctly adjusted for 9, 36, and 90 miles.

The first is always a little shorter and less clearly defined than the others due to the method of obtaining the oscillations in the Calibrator, and for the same reason, the first pip is not actually seen, but is assumed as being present near the start of the trace.

ADJUSTING THE INDICATOR UNIT

18. The method for adjusting the Indicator Unit is as follows.

(a) Ensure that the Transmitter is adjusted so that when tuned for maximum output and on the correct frequency, the P.R.F. lies between 300 c/s and 400 c/s.

(b) Connect the Receiver, and with the tuning adjusted for maximum echo, adjust the gain control setting on the Indicator until the noise level is about normal. The port or starboard output lead to the Indicator may be left connected and the test calibrator later connected to the unconnected side. The gain control should not be touched while the following adjustments are being made.
N.B. — Normal noise level will be decided in conjunction with the operator normally working the equipment, but is usually about one-quarter inch.

(c) Line up the Cathode Ray Tube so that the trace is vertical.

(d) Adjust the horizontal shift control until the trace lies along the calibrating scale. (i.e. passes through the centre point of the Cathode Ray Tube).

(e) Adjust the synchronisation control so that the trace commences at the same point for all ranges. This should also correspond to maximum amplitude on the 100 mile range.

(f) Connect the Calibrator Unit and adjust the output control to give suitable " pips " on each range.

(g) By combined adjustment of vertical shift, range and calibration controls on the Indicator Unit, set the trace so that it is of the right overall length ; with the leading edges of all pips after the first coincident with the calibration marks on the celluloid scale. To achieve this on all ranges, it will be necessary to reset the vertical shift control while calibrating each range. The adjustment for correct length of trace is not absolutely essential and with certain indicators may be difficult to obtain, but the other adjustments should be correctly executed.

(h) On completion of (g) the vertical shift control should be reset so that the trace starts at the zero calibration mark on the celluloid scale. The previous synchronisation adjustment (e) will ensure that this applies to all ranges. It should however be rechecked by turning the range switch.

The following points should be noted. The adjustment (g) ensures that the trace is made by the moving electron beam at the correct speed over all portions of the trace. The adjustment (h) is essential since the circuit of the calibrator does not accurately fix the position of the first " pip " from the start of the trace, although the spacing of successive pips is accurate to within 1%.

When the adjustments described have been correctly carried out there will still be a residual error of approx. 500 yards or ¼ nautical mile on all ranges. This is due to the fact that the trace commences at the end of a three microsecond pulse, whereas all echoes are read on the leading (steepest) edge of blips due to echoes.

It is not possible to set the trace so as to eliminate this error on all ranges. The simplest method is merely to instruct operators to add ¼ mile to indicated ranges on the 10 mile range. The error will not be of any consequence on other ranges.

For special work where it is known in advance that accurate distances are required on the 10 mile range, it is possible to set the start of the trace at a distance of ¼ mile up the calibration scale. If this is done, it should be remembered that the indicated ranges on the 100 mile range will be too great by (10/4–¼) or 2¼ miles, and on the 40 mile range these will be too great by (4/4–¼) or ¾ mile.

The 4½ mile range is calibrated as follows.

With the toggle switch set at 10, ensure that the Indicator is calibrated in the normal manner. It is important that the 10 mile range be properly calibrated in this operation.

The 10 mile range of the Calibrator is used. Five pips only should appear on the screen, and should correspond to the 0, 2, 4, 6 and 8 mile markings on the scale.

Variations to the above procedure which may become necessary from time to time will be covered in Radar Maintenance Instructions (Air).

TO OPERATE THE INDICATOR UNIT

19. (a) Before switching on the equipment, make sure the Bias control is in zero position, i.e., fully anti-clockwise. This will avoid possible damage to the screen by accidental operation with too bright a spot or trace.

(b) Turn the Range control knob to the range on which it is desired to operate.

(c) After making sure the Transmitter is operating correctly, by checking the milliameter reading, advance the Bias control until a vertical trace appears on the screen. If the transmitter H.T. is not switched on, a single spot will be seen at the bottom of the screen instead of a vertical line, as there will be no transmitter pulse to trigger the time base.

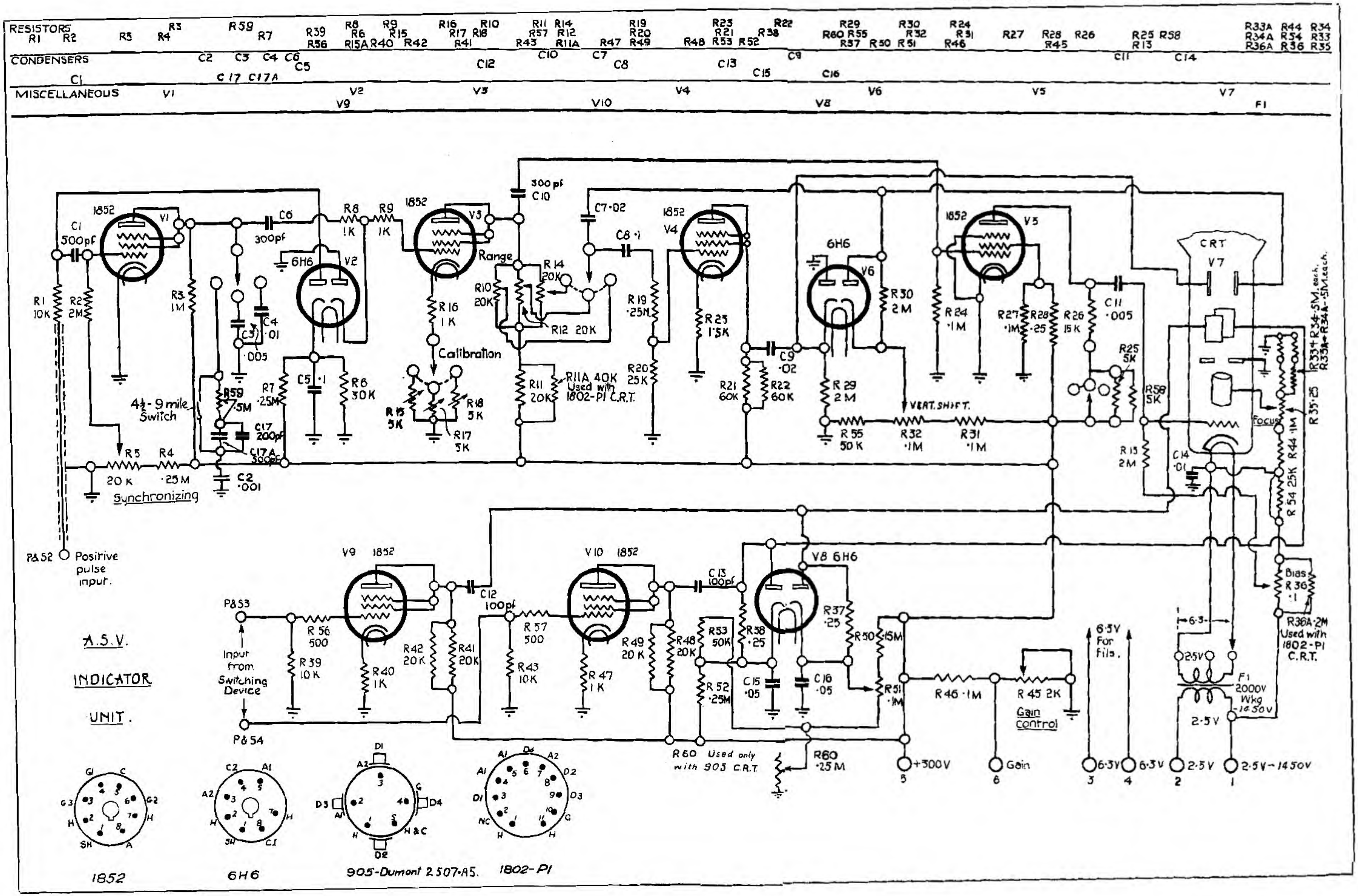
(d) Adjust the Focussing control until the trace is sharply defined at the required degree of brilliance. Do not use a brilliance greater than necessary.

(e) Advance the Receiver Gain control until the indications on the screen are of the desired amplitude.

(f) When switching from one range to another, the brilliance of the trace may vary. Always turn back the Bias control if the trace is too bright to avoid damage to the C.R.T. screen.

When blips are present, adjust the Receiver tuning until a setting is found at which their amplitude is highest, irrespective of the amplitude of the noise indications. If this position does not also give the highest noise level, the Receiver is not lined to the same frequency as the Transmitter and should be readjusted. Instructions for this adjustment are given in Chapter 4, para. 17.

A.C.D. 2005 (2) Circuit Diagram of A.S.V. Indicator Unit



CHAPTER SIX.

A.S.V. AERIAL INSTALLATIONS—BEAUFORT, MARINER, HUDSON, ANSON.

General Description — Beaufort aerials, Mariner aerials, Hudson aerials, Anson aerials, Aerial switching.

GENERAL DESCRIPTION.

1. The function of the A.S.V. aerials is :—

(a) To radiate power delivered by the Transmitter.

(b) To receive reflected pulses as they arrive at the aircraft.

For this purpose, some aircraft use the one set of aerials for transmitting and receiving, controlled by a T–R Switch, while other aircraft mount separate aerials for each purpose.

Two independent sets of aerials are usually required, known as Searching and Homing aerials. The operator may change from one set to the other by operating the Manual Switch.

Searching Aerials.

2. The Searching aerials have been designed to transmit and receive in a comparatively narrow beam on each side of the aircraft fuselage and at right angles to it. This is accomplished by using multi-element directional arrays, mounted on the sides of the aircraft.

Arrays of this type are much more efficient than simple half or quarter-wave aerials, and are nearly always made up of a number of driven half-wave elements arranged and phased to radiate in the required direction.

Moreover, in many cases the metal aircraft skin may be used as a reflector for the array, still further increasing its efficiency and directivity.

By concentrating radiation in this manner, best use is made of the available power, and the greatest efficiency and range is obtained from the equipment.

Homing Aerials.

3. Single quarter-wave elements — In most older installations the Homing aerials are mounted on the nose of the aircraft. They are single elements approximately a quarter-wave long, and are used because of their size, low wind resistance, and because they are easy to feed.

The transmitting aerials are mounted well towards the front of the nose. Their combined field patterns are such as to give radiation almost uniformly ahead of the aircraft.

The receiving aerials are mounted on the side of the nose and are bent at right angles so that the main element lies parallel with the fuselage. Each aerial responds best to signals from some 22½° to port or starboard.

4. Yagi Aerials — Yagi Homing aerials have been introduced on Beaufort, and Anson aircraft to provide increased range and improved D/F properties on Homing.

In the case of the Beaufort aircraft, the aerials are mounted under the wings, outboard of the motors, so that the aerials receive best in a direction of about 22½° to port or starboard.

5. As the input from each may be observed on the C.R.T. at the same time, a comparison between the amplitude of the blips on either side of the trace will indicate on which side of the aircraft the object lies.

The operator instructs the pilot to turn the aircraft to port or starboard in accordance with what he sees. When the object is exactly ahead, the blips will be of equal amplitude on either side of the trace.

The exact patterns of the Homing aerials are determined largely by reflections from the aircraft itself, which distorts them considerably in comparison with the patterns of similar aerials in free space. This fact had to be considered when the aerials were designed.

6. All A.S.V. aerials are fed by a system of non-resonant coaxial cables, which may be placed in almost any part of the aircraft without picking up or causing interference. This is a most important aspect of the installation, and special apparatus is used for feeder adjustment and test. The cable used has an inner conductor insulated with Polythene, an outer conductor in the form of copper braiding, and an insulated covering of rubber compound. A standard type, PT29M, of 75 ohms characteristic impedance is used for almost all aerial connections.

In some installations, short lengths of PT11C, PT7R, and 50 ohm U.S. Navy cable have been used.

BEAUFORT AERIALS

7. Beaufort installations must be divided into two classes :—

(a) Early installations with parallel fed port and starboard Searching transmitting aerials, with single element Homing aerials.

(b) Later installations with parallel fed searching transmitting aerials, alternately fed searching receiving aerials, parallel fed single element homing transmitting aerials, and Yagi homing receiving aerials.

Searching Aerials.

8. The Searching aerials are the same type for transmitting as for receiving.

Each set of Searching aerials consists of four half-wave elements fed in phase. An array of this type has directional characteristics at right angles to the plane of the array, or broadside to it. The aerials are spaced ·104 of a wavelength from the aircraft skin— i.e. 7 inches. Each element is 34 inches long, and the spacing between pairs is approximately 30 inches, the exact distance depending upon the fuselage design of the aircraft concerned. In the case of the Beaufort the maximum intensity of radiation occurs at an angle of 0° to 5° behind the broadside position.

9. The exact spacing of the elements from the skin was determined by calculation and experiment in order to obtain the highest gain over a simple dipole, and at the same time to provide a low impedance point at the centre of each element. The gain in practice has been measured and calculated to give a mean of 11 decibels, and the impedance at the centre of each element is 34·6 ohms.

This low impedance allows each element to be mounted on the aircraft by a solid metal stand-off support. The reactance of the support will present itself as a shunt on the impedence at the centre of the element, but as it is considerably higher than 34·6 ohms (approximately j183 ohms) it will not greatly affect the impedance at this point. As a result, losses introduced by the support are negligible. The advantages of a rugged mounting are considerable, for obvious reasons.

10. Of the four arrays found on the aircraft, the two nearest the tail are used for receiving, and the others for transmitting.

The four elements in each array are end-fed from the centre in pairs and are connected to the transmitter and receiver by 75 ohm cable. In order to achieve correct in-phase connections for adjacent elements, the ends of which are 2 inches apart, a quarter-wave phasing stub is used.

This stub may be considered as a third half-wavelength folded back on itself to cancel radiation from it, and representing the centre half-wave in a radiator three half-wavelengths long.

11. The phasing stub also provides a means of matching the array to the feed line. In the case of the searching aerials, there are two pairs of elements to be connected. As they are wired in parallel, each pair must present a load of 150 ohms, or in the case of the parallel fed arrays, a load of 160 ohms, to the feed line. Moreover, this load must be a pure resistance, as the presence of a reactive component would prevent the maximum transfer of energy. By making the phasing stub a little longer than a quarter-wavelength, and providing a shorting bar near the end, an impedance transformer is formed, varying from zero impedance at the bar itself to a few thousand ohms at the other end. When a half-wavelength of coaxial cable is attached to the stub at a point of 150 ohms or 160 ohms impedance, an equal impedance is found at the opposite end of the cable, since any value connected to one end of a half-wave transmission line will appear at the other end.

12. Normally this point on the stub will represent a reactive load, and steps must be taken to cancel the reactance found there. Being less than a quarter-wave length from the high impedance point at the aerial elements, and being in effect a section of open line, its reactance will be capacitive (Xc.). The reactance of the remaining portion of the stub down to the shorting bar, however, is portion of a quarter-wave closed at one end, and its reactance is therefore inductive (X_L). Thus by correct adjustment of the position of the shorting bar, and the impedance tapping point, it is possible to find a position on the phasing stub which presents the correct impedance of 150 ohms or 160 ohms as the case may be, the two opposite values of reactance cancelling to provide a purely resistive termination for the cable.

However, when the half-wavelength sections from the upper and lower elements are connected together, the impedance of the two in parallel will be quite reactive due to the mutual reaction between the upper and lower aerial elements. Identical adjustments for the shorting bar and impedance tapping points must now be made to both matching stubs until the impedance is non-reactive and of the correct value.

The length of 75 ohm cable between this point of parallel connection and the rest of the equipment does not matter when the impedance of both arrays in parallel is adjusted to 75 ohms, as is the case with separately fed arrays. However, with parallel fed arrays, the impedance at this point is 80 ohms, i.e. the array is not matched to the cable which is 75 ohms (PT29M). Thus, if this impedance is to be maintained, the connecting cables must be a number of half-wavelengths long. These lengths are made a half-wavelength in the case of the port arrays, and two wavelengths for the starboard.

When these two impedances of 80 ohms are connected in parallel, the resulting impedance is 40 ohms. This is now connected to the Transmitter by a quarter-wavelength of PT7M cable of 55 ohms characteristic impedance, the impedance at the far end being 76 ohms near enough to 75 ohms to be satisfactory.

This adjustment is carried out with the specially developed Impedance Measuring equipment, which also enables the reactive component to be detected and removed.

Balance-to-unbalance Transformers.

13. If a coaxial cable is connected directly to a balanced aerial the E.M.F. across the feed point would be unbalanced.

A balanced-to-unbalanced transformer is therefore necessary to connect the feedline to the stubs. This is incorporated in the matching stub (Fig. 5). The half-wavelength of cable which forms the initial section of the feed line to each pair, is stripped of its insulating rubber covering for a few inches and threaded through the end of one stub line, as shown in Fig. 5. A section at the side of this stub is cut away at an appropriate distance from the end so that the cable may be threaded through, and the inner conductor connected across to the other stub line at a point directly opposite. Suitable clips keep the cable in position.

Now as the shorting bar connects the two stub lines together, their E.M.F. at this point must be equal. It will also be equal at any two points along the stub lines equidistant from the shorting bar. Obviously two such points are A and B (Fig. 5) to which the feed lines are attached.

The fact that the cable is threaded through one leg of the stub, and the outer conductor connected to it at point B, means that over this section the braid has the same E.M.F. as the stub itself. The inner conductor makes contact with point A, which is at the same E.M.F. as point B. Thus we have succeeded in providing a balanced connection to the stub with a normally unbalanced cable.

The two half-wavelength cables from each pair of elements are connected in parallel, and held in position by a three-way clamp.

HOMING AERIALS ON HUDSON AIRCRAFT

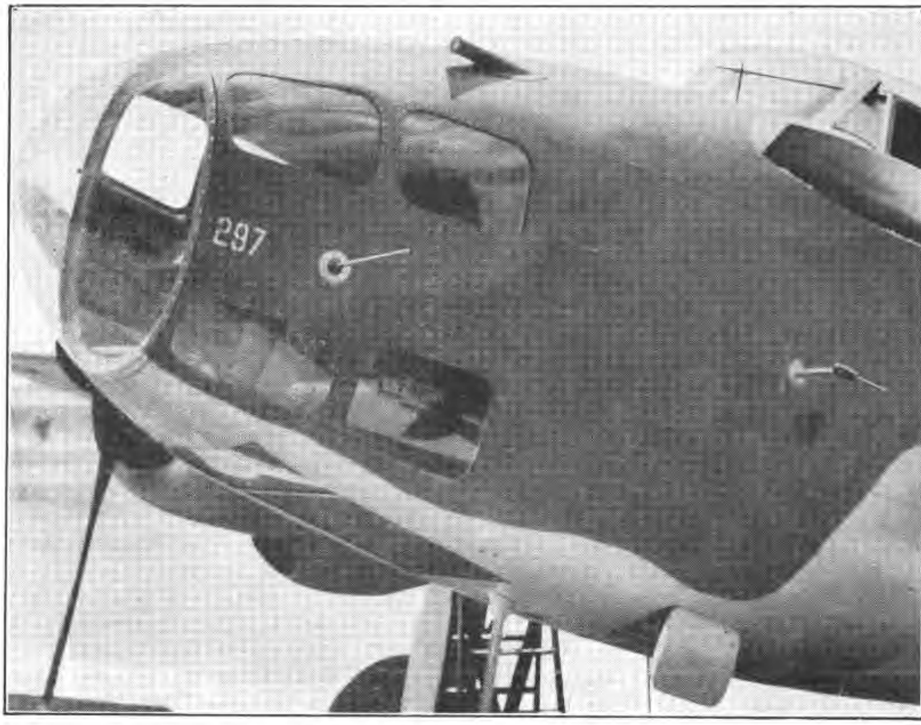


Fig. 1 — Transmitting dipole and Receiving " dogleg " as used on Hudson and Beaufort.

SEARCHING AERIALS ON HUDSON AIRCRAFT

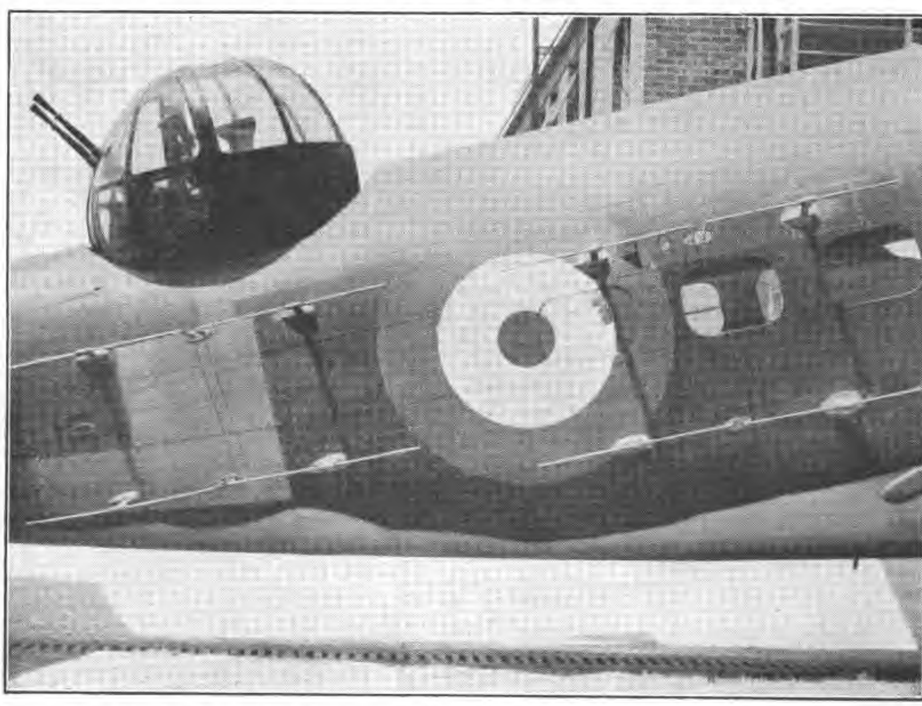


Fig. 2 — This type of Searching aerial is used on both Hudson and Beaufort aircraft.

HOMING AERIAL CONNECTIONS — HUDSON

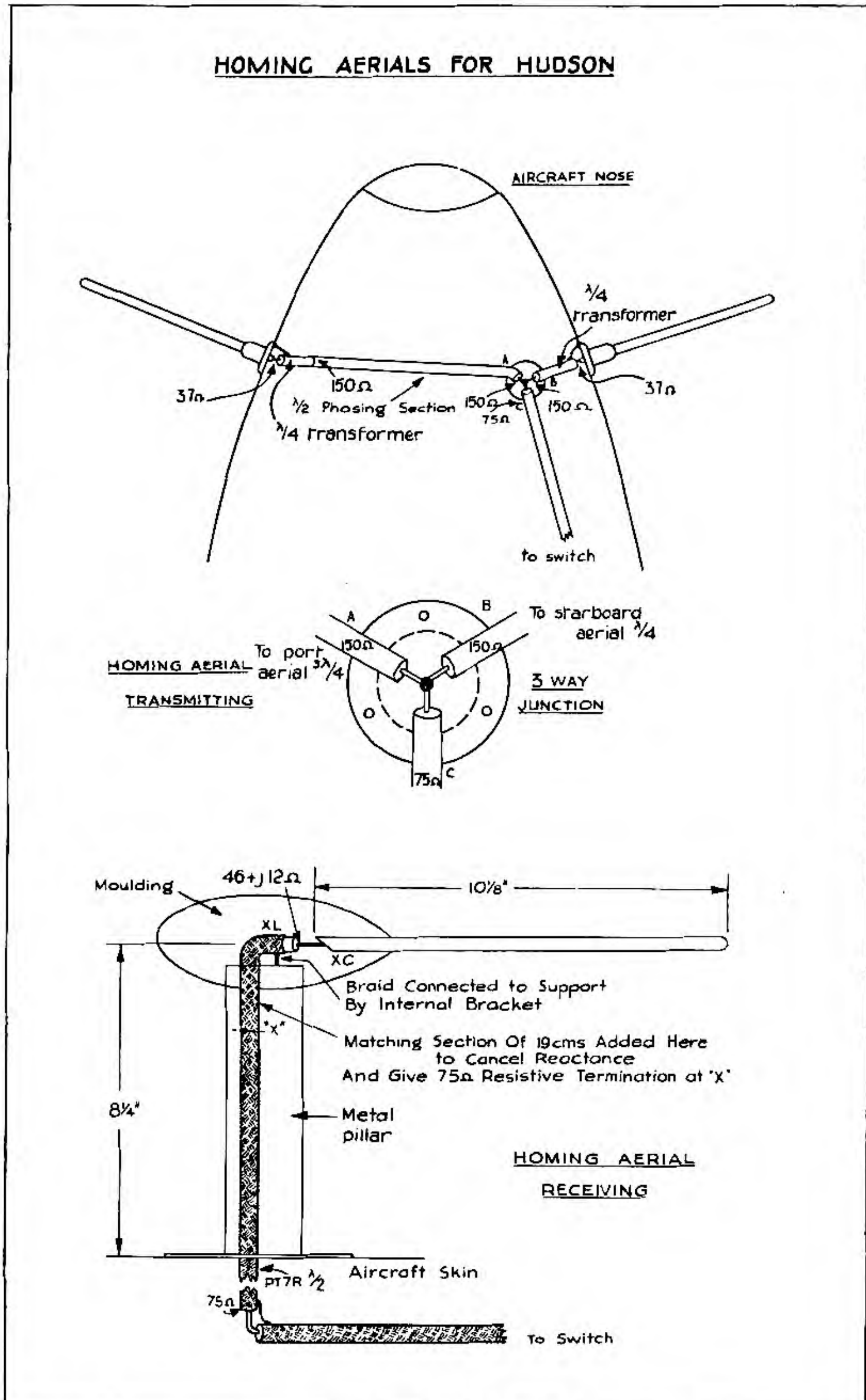


Fig. 3 — Aerial layout and impedance values for Hudson Homing aerials.

HOMING AERIAL CONNECTIONS — BEAUFORT

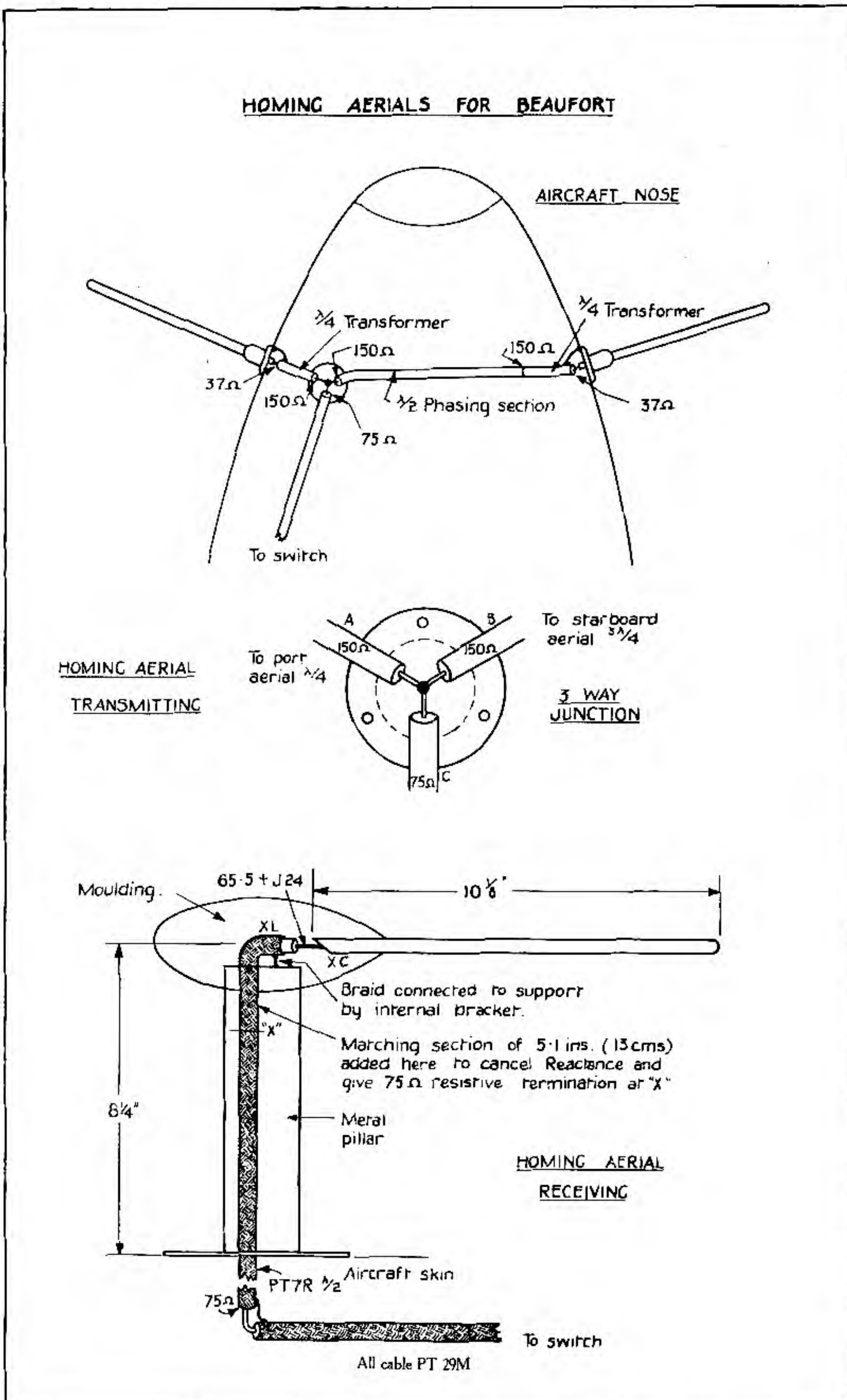


Fig. 4 — Aerial layout and impedance values for Beaufort Homing aerials.

HUDSON AND BEAUFORT SEARCHING – RECEIVING AERIALS

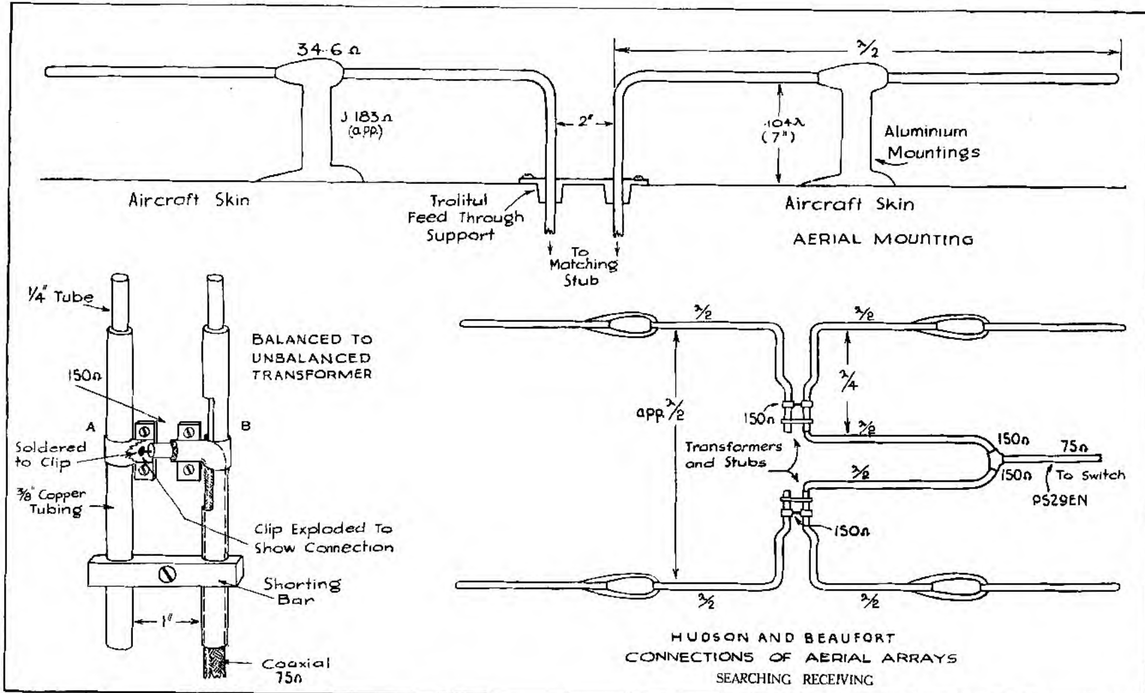


Fig. 5 – Details of Searching-Receiving aerials as used in Hudson and Beaufort aircraft.

Homing Aerials — Simple Type.

14. Transmitting aerials.—These aerials consist of two, end-fed elements approximately a quarter-wave-length long, mounted on the nose of the aircraft by moulded, insulating supports. Their ends are accessible from inside the fuselage for attachment to the coaxial cables.

To obtain the field pattern required for a reasonably uniform radiation ahead of the aircraft, the aerials are fed in parallel, but in opposite phase.

The impedance of the feed line is 75 ohms, which means that each aerial must present to it an impedance of 150 ohms if the matching is to be correct. As the impedance at the base of the aerial is 37 ohms a quarter wavelength of cable is connected to each aerial to serve as an impedance transformer.

The impedance relationship between the ends of a quarter-wavelength of cable is given by the standard formula Zo equals $\sqrt{ZnZt}$, where Zo is the characteristic impedance of the cable, Zt the terminating impedance and Zn the impedance at the open end. In this case with a 75 ohm cable connected to a 37 ohm aerial, the impedance at the open end will be 152 ohms, near enough to 150 ohms to provide a good match. As the cable is an exact quarter-wavelength, it does not introduce any unwanted reactive component.

The out-of-phase connection for the two elements is made by attaching the end of the port aerial transformer direct to the feed line, and connecting the starboard aerial transformer from the same point by means of a half-wavelength of the same cable, which operates as a 1—1 phase-reversing Transformer. Thus there are three quarter-wavelengths in the lead from the feed line to the starboard aerial, and one quarter-wavelength from the feed line to the port aerial.

15. Receiving aerials — these aerials consist of two sections. The first is a hollow, oval-shaped metal pillar or mast about $8\frac{1}{4}$ inches long, mounted on the metal fuselage and connected to it. At the end of this pillar is a bakelite moulding which supports the second section, a brass tube $10\frac{3}{8}$in. long and $\frac{3}{8}$ in. in diameter, at right angles to the pillar.

The feeder connection is made by a length of cable threaded through the pillar. The top of the pillar is connected to the outside covering of the cable, and the brass tube is connected to the inner conductor. The rubber outside covering of the cable insulates it from the pillar up to the clamp, which makes connection at the top.

The impedance between the top of the pillar and the brass tubing is reactive, and equal to 65 — j24 ohms. A 5·1 in. (13 cm) section of 55 ohm cable is used as a matching stub to remove the reactive component, and to increase the impedance to approximately 75 ohms for connection to the feed line. In order to avoid an awkward junction between the 55 ohm and 75 ohm cables inside the pillar, an extra half-wavelength 55 ohm cable is added to 5·1 in. This half-wavelength forms a 1–1 impedance transformer (see Para. 11) and the total length is sufficient to allow connection with the 75 ohm cable to be made outside the pillar.

Homing Aerials — Yagi type

16. This type of aerial is used on some new installations. The Beaufort Homing Yagi aerials are five-element arrays, consisting of a radiator and four directors, and are used for homing receiving.

The aerials are mounted one under each wing, outboard of the motors. Each aerial has a line of shoot of $22\frac{1}{2}^{\circ}$ outwards from the line of flight. This is arranged so that the sides of the lobes are quite steep in the dead ahead position and consequently good D–F properties are obtained. The gain of this array is 9 db.

The aerial is so designed that an impedance of approximately 75 ohms is presented at the base of the radiating element. Consequently the 75 ohm cable used, PT29M, may be connected directly to this element.

17. The balance-to-unbalance transformer necessary between the unbalanced coaxial feeder and the driven element is built into the aerial support tube. Details of the manner in which this is carried out are shown in Fig. 12. Over the last quarter-wavelength the coaxial cable is bared and fits neatly inside the metal tube shown. This tube forms the inner conductor of a quarter-wave line, of which the external conductor is the outer metal tubing. This outer section of coaxial line is a quarter-wavelength long and is shorted at one end, thus providing a high impedance at the open end, and allowing equal current feed into each half of the aerial.

Great care must be exercised when assembling the Yagi aerial and matching unit to ensure a proper seal between all mating surfaces.

HUDSON AERIALS

18. **Searching Aerials** — The Hudson Searching aerials are very similar to those on the Beaufort. The transmitting port and starboard aerials are parallel fed.

The maximum intensity of radiation is at 100° to the line of flight and the gain of the array is 11 db.

19. **Homing Transmitting**—These aerials are similar to the simpler type of aerial used on the Beaufort except that they are 13/16 in. shorter. They are mounted in a similar position on the aircraft and present the same impedance to the feeder cables. However in this aircraft the quarter-wavelength impedance transformer is connected to the starboard aerial and the three quarter-wavelength to the port aerial.

20. **Homing Receiver**—The Homing receiving aerials are physically identical with those of the Beaufort, but the impedance at the point of connection to the top of the pillar is not the same. For the Hudson, this impedance is 46 — j12 ohms and the small matching stub of 55 ohm cable is $7\frac{1}{2}$ in. long instead of 5·1 in. This section removes the reactive component and increases the impedance to about 80 ohms, which is a near enough match to the 75 ohm cable. An extra half wavelength is added as in the Beaufort to avoid making the junction with 75 ohm cable inside the pillar.

YAGI AERIAL INSTALLATIONS

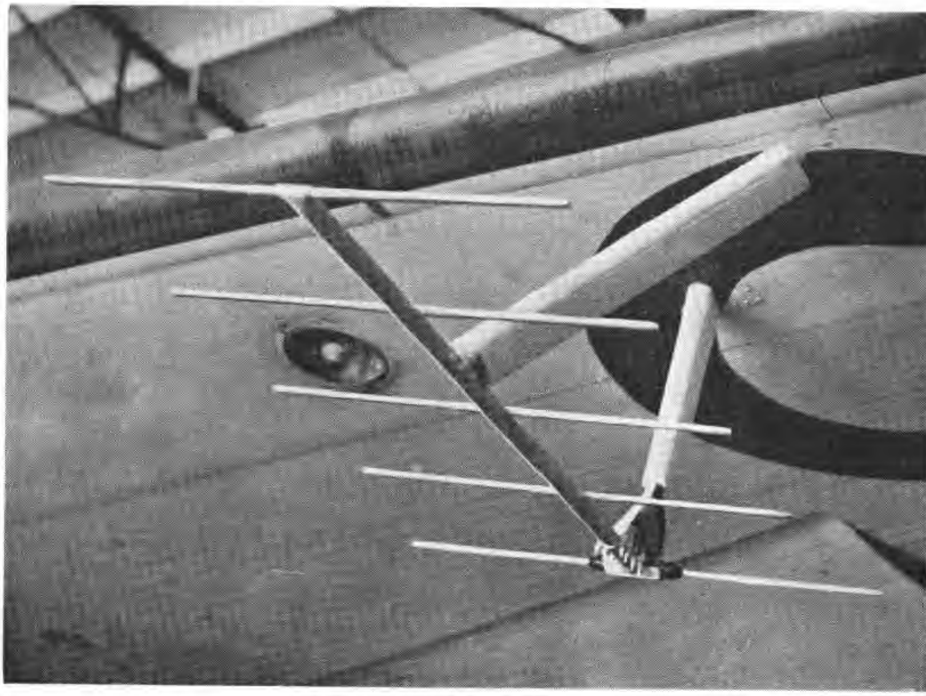


Fig. 6 — Yagi aerial as installed on Beaufort.

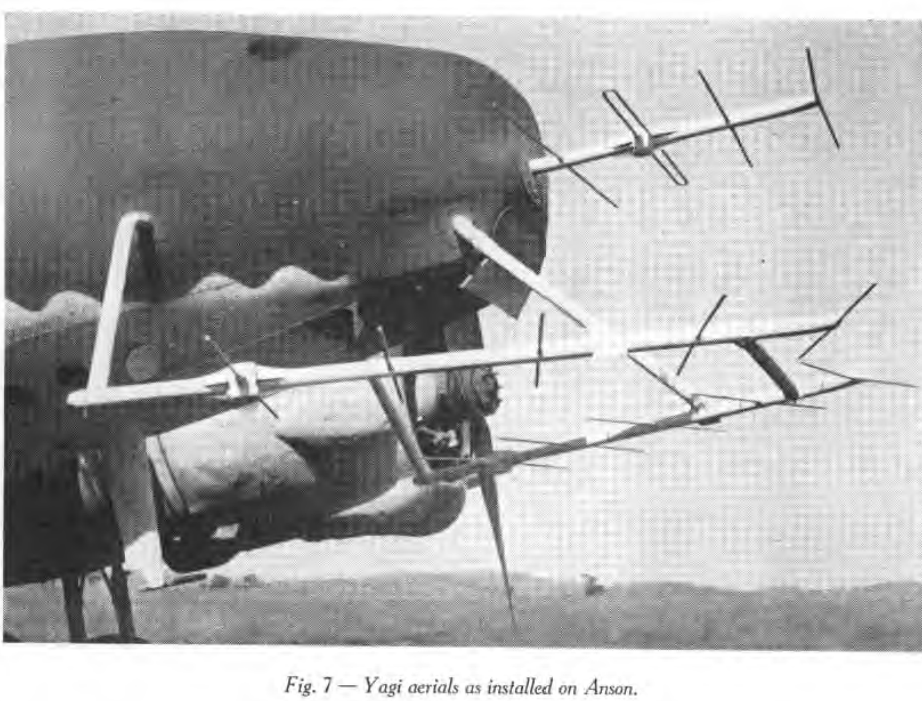


Fig. 7 — Yagi aerials as installed on Anson.

YAGI AERIALS

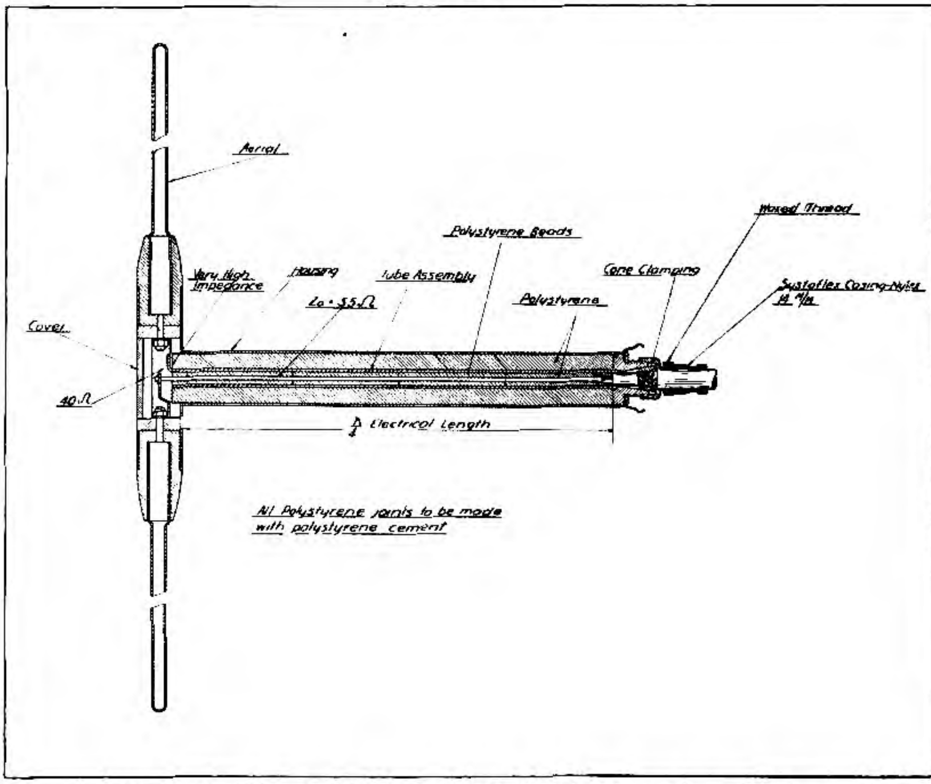


Fig. 8 — Aerial layout and impedance values for Yagi Receiving aerial as used on Anson.

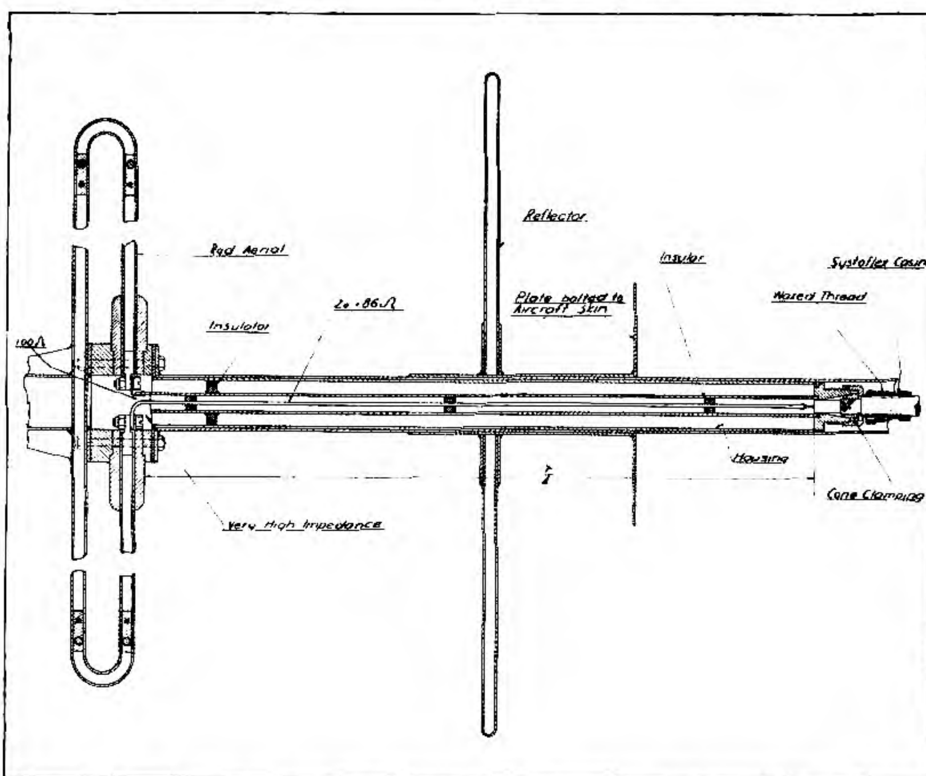


Fig. 9 — Aerial layout and impedance values for Yagi Transmitting aerial as used on Anson.

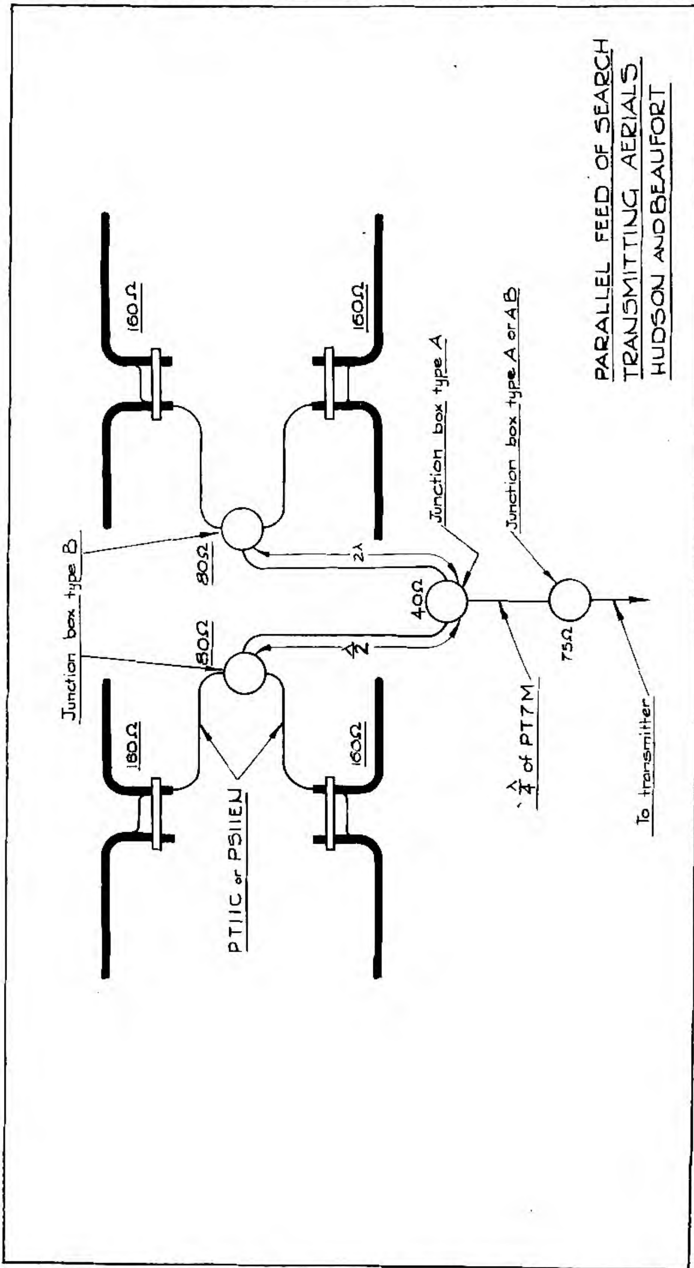


Fig. 10 — Details of Searching-Transmitting aerials as used in Hudson and Beaufort aircraft.

HOMING AERIAL CONNECTIONS — Mariner

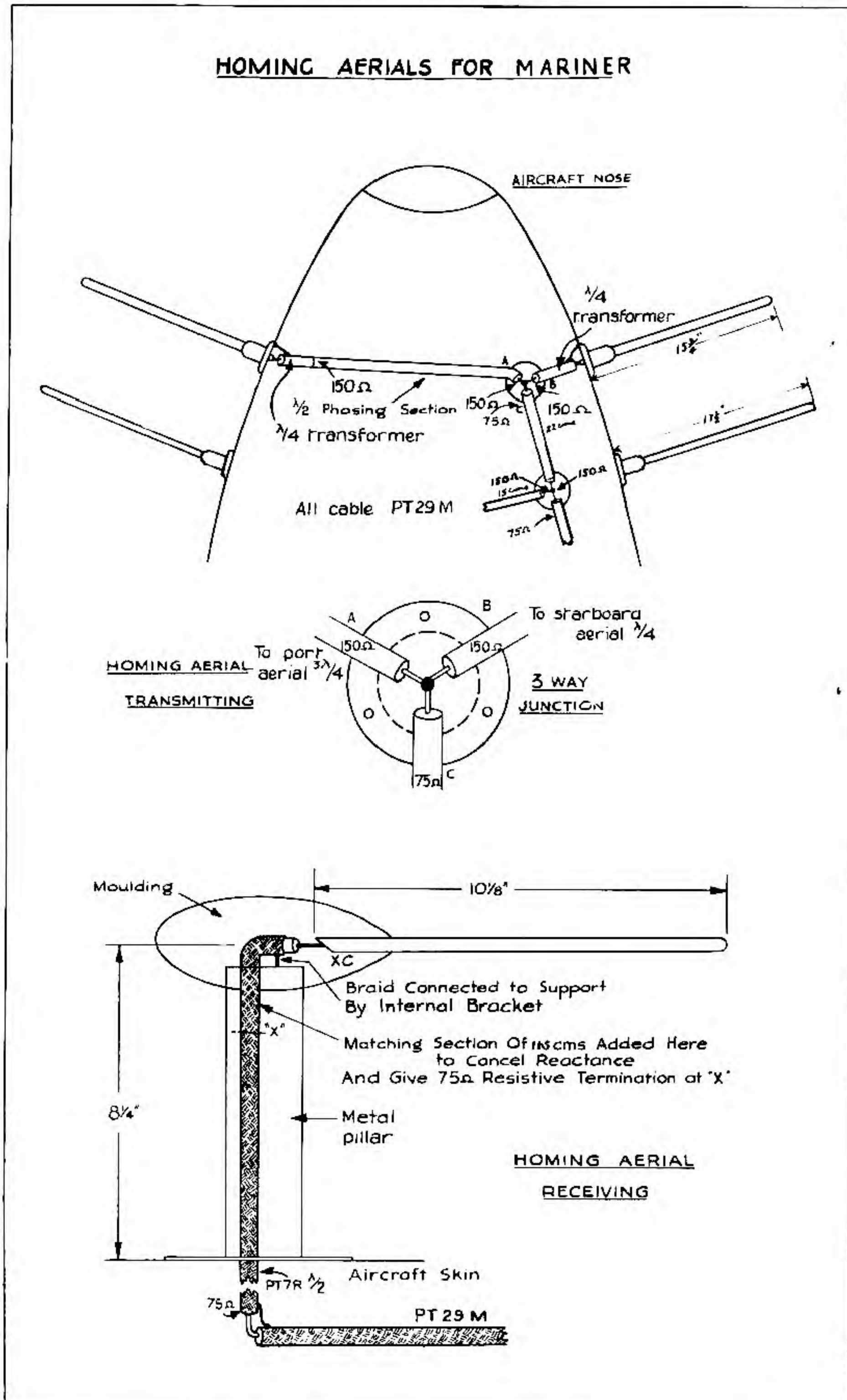


Fig. 11 — Details of Homing aerials as used on Mariner aircraft.

ANSON AERIALS

21. **Searching Aerials**—The Anson does not employ Searching aerials.

22. **Homing Transmitting**—The Anson Homing transmitting aerial comprises a folded dipole with reflector and two directors mounted on the nose of the aircraft, its line of shoot being along the line of flight of the aircraft.

23. The balance-to-unbalance transformer necessary between the unbalanced coaxial transmitter feeder and the folded dipole is built into the transmitting aerial support tube. The impedance of the folded dipole is approximately 100 ohms non-reactive. This is matched to the 75 ohms surge impedance of the PT29M cable by means of a quarter-wavelength of coaxial line of 86 ohms impedance, which forms the centre section of the coaxial balance-to-unbalance transformer. This is derived from the standard formula, Zo equals $\sqrt{ZnZt}$.

The balance-to-unbalance effect is achieved through the medium of a quarter wavelength of coaxial line, the centre conductor of which forms the outer conductor of the quarter-wave impedance transformer. This outer section of coaxial line is a quarter-wavelength long and is shorted at one end, thus providing a high impedance at the open end. This prevents currents flowing on the outer surface of the coaxial feeder and thus ensures equal current feed to each half of the aerial.

Details of the Yagi aerial and its coaxial balance-to-unbalance matching unit are shown in Fig 15.

Great care must be exercised when assembling the transmitting Yagi aerial and matching unit to ensure a proper seal between all mating surfaces.

24. **Homing Receiving Aerials**—Each Yagi receiving aerial comprises a centre fed half-wave dipole and four directors. They are mounted on each side of and below the nose of the aircraft, the port looking aerial being mounted on the starboard side and the starboard looking aerial on the port side of the aircraft nose. The impedance of each receiving half-wave dipole aerial is approximately 40 ohms non-reactive, and each is matched to the 75 ohm characteristic impedance of the PT29M aerial feeder by means of a quarter-wavelength of coaxial line of 55 ohms characteristic impedance. The outer conductor of this transformer forms the centre section of the transmitter balance-to-unbalance transformer previously described.

25. **Balance-to-Unbalance Transformer** — Each receiver aerial matching unit is reduced in length by the use of a polystyrene dielectric so that it can be built into the rear end of each receiving Yagi aerial support tube. The dielectric constant of polystyrene is 2·4, having a wavelength reduction factor of ·645, thus reducing the effective length of the quarter-wave section of the receiving aerial balance-to-unbalanced matching unit.

The balance-to-unbalance effect is achieved in the same manner as for the transmitting aerial matching unit previously described.

Details of the receiving aerial and its coaxial balance-to-unbalance matching unit are illustrated in Fig. 8

26. The Transmitting aerial looks straight ahead, while the receiving aerials look outward at an angle of about 20°. Due to the comparative narrowness of the transmitting aerial lobe, targets more than about 30° off the aircraft's course cannot be expected to be detected at long ranges.

MARINER AERIALS

27. The transmitting aerials are a simple two element type. Each aerial consists of two quarter-wave spikes. They are mounted parallel and in the same horizontal plane. The forward one is the radiator and the other a reflector. The aerials are fed in parallel but out of phase.

This type of aerial has a sharper radiation pattern and greater sensitivity than the single element type.

Each radiator is matched to 150 ohms by means of a quarter-wavelength of PT29M. The out-of-phase connection is made by adding a half-wavelength to the port aerial. The impedance of the two aerials in parallel is then 75 ohms. The reactance is balanced out by means of a matching transformer 22 cms. in length and an open stub 15 cms. in length in parallel at the feed point.

The radiator is 15¾ inches in length and the reflector 17½ inches.

HOMING AERIALS

29. The standard Homing " Dogleg " as fitted to the Beaufort is used. A quarter-wave matching transformer plus a half-wavelength of PT7R of approximately 70 cms. overall length is attached to the base of the aerials to give an impedance match of 75 ohms. to the feed line.

AERIAL SWITCHING CIRCUITS

30. To change from Homing to Searching aerials, and *vice versa*, a manual switch of one or another type must be provided.

31. Beauforts and Hudsons are provided with a small manual switch in the form of a Yaxley switch which operates the relays of two contactor switches. Voltage for these relays is obtained from the 24 volt aircraft accumulator.

Both contactor switches are of the double pole, double throw variety. They are spring loaded so that, at rest, the contacts are closed in the Searching position.

The first contactor switches the leads from the receiver to the Searching or Homing aerials as required, using one section for each. The second uses one circuit to switch the transmitter lead from Homing to Searching, while the second circuit breaks the primary connection to the H.T. transformer. This removes the H.T. from the Transmitter while switching is taking place, to avoid contact sparking and voltage surges as the transmitter load is removed. To achieve this, it is important that the contacts for the H.T. circuit should close after, and open before, those switching the aerials. This can be provided for by loosening the lock nuts on the contact screw adjustments for this section, and setting them to give the appropriate time lag. This should be as small as possible—it is only necessary to avoid the possibility of the transmitter being switched on with no aerial load applied to it.

In the Beaufort, the manual switch is at the left hand side of the operator, and the contactors are with the equipment on the rack behind him.

In the Hudson aircraft, the manual switch is mounted on a panel in front of the operator. The contactor switches are inside the fuselage, the transmitting switch being on the port side near the transmitting Searching aerials, and the receiving switch being in the starboard side, just outside the door into the W/T compartment.

The Anson and Mariner do not need Homing-Searching contactors, as they do not employ Searching aerials. The On-Off Switch consists of the toggle switch mounted on the Transmitter.

YAGI AERIALS

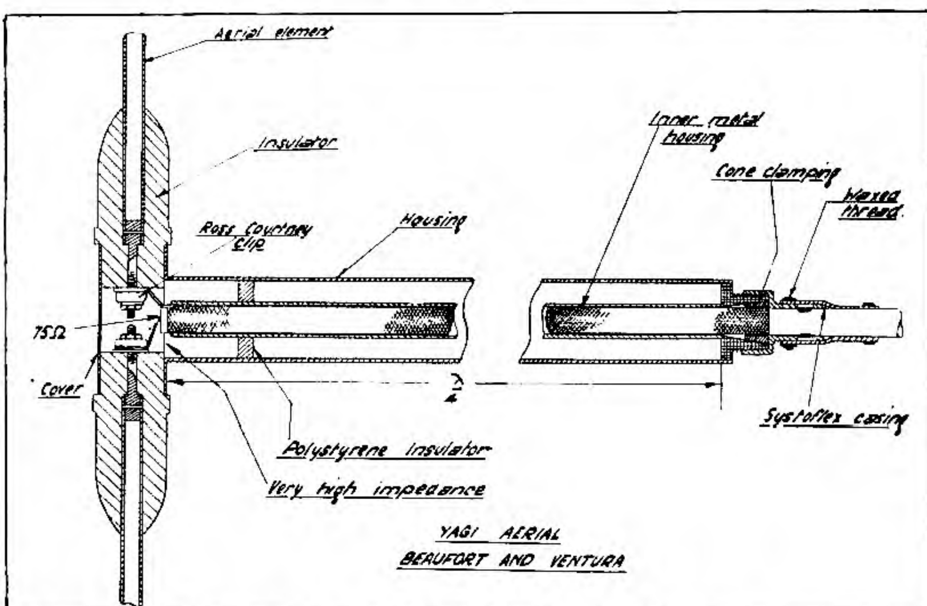


Fig. 12 — Aerial layout and impedance values for Yagi aerial as used on Beaufort.

CHAPTER SEVEN

OPERATING THE EQUIPMENT

Introduction — Factors Affecting Range — Searching Procedure.

INTRODUCTION

1. The operation of A.S.V. equipment is normally carried out by the W.T. operator of the aircraft, although other members of the crew may operate it according to crew policy. The Indicator unit is commonly mounted so that its controls are accessible from the W/T. operator's seat..

The performance of the equipment varies with different types of aircraft, as the radiation patterns and general characteristics of the aerials are not similar.

2. When flying over the land, there are so many irregular surfaces to reflect transmitter pulses that the trace is almost completely filled with them, so much so that echoes from small objects in which the pilot might be interested are swamped. However the Beacon may be received by turning the gain down, so that other echoes disappear.

When flying over the sea, echoes will be received from the surface of the water, and from waves. The sea however is practically a flat surface. Its echoes are therefore quite strong at the bottom of the trace where reflection is more or less direct, but taper off at a short distance up the trace. Echoes from a rough sea will extend about twice as far up the trace as those from a calm sea, due to reflection from the waves.

The higher the aircraft the further the echoes will extend up the trace, as the angle of incidence of the radiation on the surface of the sea will be relatively large up to much greater ranges.

As a guide, the sea echoes will extend about 3 miles up the trace when the aircraft is flying at a height of 1,500 feet.

Thus when over the sea, the C.R.T. indications or blips, will resolve themselves into sea echoes at the bottom of the trace, and land echoes at the top, assuming that land is within range. Echoes from ships, islands etc. will be present between these two, provided the range is not too small, in which case the blips will be hidden by the sea return.

When the Gain control is advanced, the trace will widen into a regular but roughly outlined band as the noise level output of the receiver increases. The gain control should normally be advanced until this band is about ¼ in. wide on each side of the centre line, to ensure efficient sensitivity to detect weak echoes. Once a strong blip has been received, the gain may be reduced. Eventually this will be necessary to avoid running the blip right off the screen.

FACTORS AFFECTING RANGE

3. The maximum range at which objects may be detected depends on several factors. The most important of these are : —

(a) The nature and size of the ship or object.
(b) The orientation of the ship or object.
(c) Its position relative to the aircraft's track.
(d) The height of the searching aircraft above the sea.
(e) The relative performance cf the A.S.V. set.
(f) The relative skill of the operator.

(a) **Nature of the Object** —As a rule, the largest indications or blips are obtained from objects which present the largest and most efficient radiating surfaces for the transmitter pulses. In this respect, metal objects are better than wood or fabric. Should there be any elements or surfaces whose length equals a half-wavelength or a multiple of a half-wavelength of the frequency used, these will re-radiate energy, and increase the power of the reflected pulse. In such a case, movement of the object or of the aircraft will cause the amplitude of the blip to vary according to the direct nature or otherwise of these strong reflections. The stays of a ship, or small sections of an aircraft fuselage, might represent such reflectors.

A coast line with steep, high cliffs will give large blips often up to maximum range. Large ships will give good indications, particularly if they have a high superstructure. Low-lying coast and small ships give correspondingly smaller blips, while small rocks will frequently be detected over short distances.

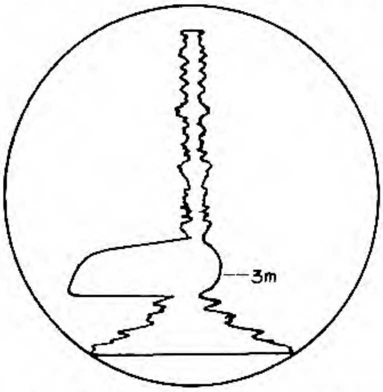
Single objects will almost invariably give single blips, unless these are large, irregular in shape, and detected at close range. In such cases, the shape of the blip may give the impression that it is caused by the combination of two or more blips very close together, as against the clearly outlined single peak generally obtained. The object will most probably be in view however, when its blip is strong enough to exhibit anything but a single peak.

Several objects close together will give several blips in a group, varying in strength according to their comparative sizes. When the homing aerials are used, not only can their distances from the aircraft be estimated, but also their bearing to port or starboard, as shown by the relative amplitude of the blips on either side of the trace. Due to effects of changing polarization and phasing, such grouped reflections may tend to add or subtract, and even to exchange their positions, if very close together. This is particularly noticeable with blips from a number of small fishing boats, for instance, which have not the stability exhibited by those from larger ships.

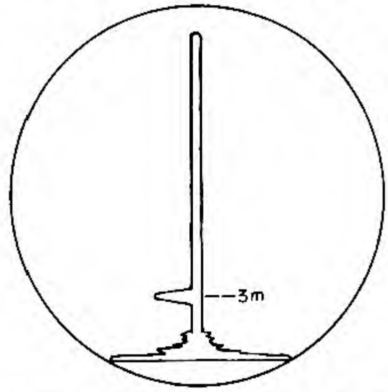
While indications from ships, large rocks, islands, etc., are steady and well defined, those from other aircraft are usually of a different character and vary rapidly in amplitude, thus making it possible to identify them. An aircraft flying round a ship will be seen as a blip of changing amplitude and position moving across a larger and steadier blip representing the ship itself.

Surfaced submarines can also be detected over distances depending on their size, and their bulk above the surface. Their indications are similar to those of a small ship, but may frequently appear and disappear at intervals as the hull is more or less submerged beneath the waves.

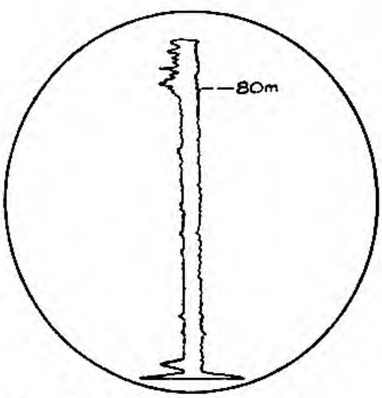
TYPICAL INDICATIONS ON CRT WITH ASV EQUIPMENT



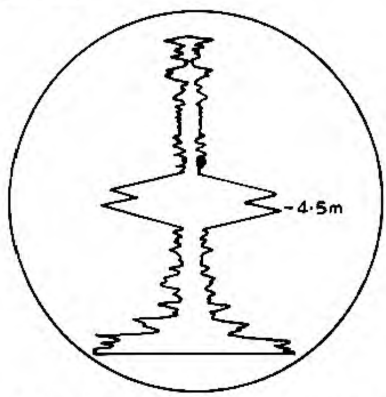
1. ON 9 MILE RANGE BLIP SHOWS OBJECT ABOUT 3 MILES TO PORT GAIN CONTROL ADVANCED AND RECEIVER OVERLOADING



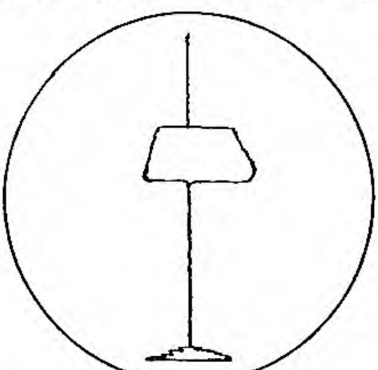
2. SAME BLIP AS IN FIG. 1 BUT WITH GAIN CONTROL RETARDED. BLIP HAS REGULAR SHAPE, SEA ECHOES WELL DEFINED, NOISE LEVEL INDICATION REDUCED



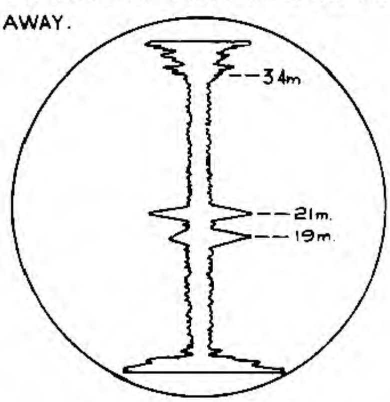
3. BLIP AS IN FIG. 1&2 WITH LAND ECHOES ABOUT 80 MILES (90M RANGE)



4. TWO OBJECTS 4·5 MILES AHEAD ON HOMING, EACH ABOUT SAME DISTANCE AWAY.



5. BEACON 5 MILES AHEAD ON HOMING SLIGHTLY TO STARBOARD GAIN LOW (9 M RANGE)



6. TWO OBJECTS 19 AND 21 MILES AHEAD ON HOMING AERIALS & NEARER OBJECT SLIGHTLY TO STARBOARD. LAND ECHOES 34 MILES AHEAD (36 M RANGE)

Small echoes similar to those produced by submarines may be obtained from: —

(i) Large waves.
Such responses however do not persist for more than a few seconds.

(ii) Small objects in the water such as floating barrels, spars, etc.
These echoes will only be obtained if the objects project noticeably from the water.

(iii) Clouds — Certain types of clouds, particularly concentrated rain squalls, may produce echoes up to a few miles. These echoes are usually rather diffuse and can thus be distinguished from ship echoes.

(b) Orientation —As most objects are not symmetrical in shape, their orientation with respect to aircraft will have a considerable bearing on the size of the blip received from them. For instance, a large ship approached from the bow or the stern may give a smaller indication than a small ship approached from a broadside direction. This must always be considered when attempting to gauge the size of the object from the size of the blip. As a result, half the range obtained when a ship is approached broadside will be obtained when approached head on.

In this connection, it must be remembered that as the position of the aircraft with respect to a large ship approached from the bow or stern changes, the blip might be expected to increase in size, while in the case of a small ship broadside on, movement of the aircraft may effect a change in aspect which will probably cause the blip to become smaller. When the operator has had sufficient experience to interpret such changes correctly, he may be able to extract this information from them, bearing in mind all the factors which tend to affect the size of the blips he is observing.

(c) Bearing — The aerials used in A.S.V. have moderately good directional properties, and objects will be detected only when they come within the field patterns of these aerials. It is essential therefore that all personnel concerned in the operation of A.S.V. should understand the coverages obtained with the various aerials.

(d) Height above the Sea — The range of the equipment will increase as the height above sea level is increased. At the same time, due to the increased extent of the sea return, the blind spot beneath the aircraft will increase with height, and the danger of missing an object in this region will be greater. A height of 3,000 ft. may be expected to give the best all-round results. If an object is detected from a greater height, it can be located and picked up on the Homing aerials more easily from a lower altitude, particularly when the distance involved is small.

(e) Performance of set.— This is probably the chief factor causing variation of range. It is essential that efficient maintenance should be carried out, if consistent results are to be obtained.

(f) Skill of operators — A good operator will see and report even a very small blip; an untrained or inattentive one will do nothing until the blip forces itself upon his attention.

Another point is that operators should not view the screen continuously for more than an hour. Over longer periods than this, blips are likely to be missed, even although the operator thinks he is still quite efficient.

Efficient shielding of the C.R.T. screen from direct light is most important, as this is very distracting besides requiring over-illumination of the screen.

4. From the preceding paragraphs, the danger of placing too much reliance on the size of the blip as an indication of the size of the object will be understood. Only when the blip has been observed for a sufficient time and under suitable conditions can the operator gain much useful information on this point.

5. The use of A.S.V. on reconnaissance aircraft does not introduce any new principles as far as search is concerned.

It is necessary however, that all concerned should be acquainted with the performance of the particular installation and with the factors determining the optimum flying height.

It should be understood that A.S.V. has very definite limitations, and unless these are understood the best use will not be obtained from it.

Aircraft using A.S.V. are searching in two ways — using the A.S.V. and visually. Sometimes the A.S.V. is more efficient; sometimes the reverse is the case. A few points on the matter are discussed below: —

(a) By day, when the visibility is good, visual search is almost always more efficient than A.S.V. search, particularly for small objects. This is not the case when visibility is bad.

(b) A.S.V. equipped aircraft may frequently make use of convenient cloud cover by flying just above it, concentrating on A.S.V. search. Thus the advantage of surprise is obtained, this being most important in the case of submarines.

(c) At night, the A.S.V. distance is usually greater than the visibility distance.

(d) In operations using Rooster, I.F.F., or for homing on a Beacon, the range obtained will almost always be greater than visual range, even by day, so (a) will not apply.

6. Different types of search demand different flying heights and different techniques of search.

There is an optimum height at which each A.S.V. installation gives it maximum range on a given target. Height is not critical, and any height above 1,500 feet will give reasonable results. Below 1,500 feet and more particularly below about 1,000 feet ranges begin to fall off rapidly.

7. **Anti-submarine** — In this case it is necessary for the aircraft on making its initial detection to deploy for the attack with the minimum delay. Since attacks are usually made from heights giving a very limited A.S.V. range, the problem is rather difficult. Whatever height is chosen it is essential that the aircraft should be able to reach attacking height in a straight dive starting at the moment of detection. Fortunately, the range on submarines does not increase much above 1,500 ft., a height which is usually exceeded during a visual search.

On A/S patrols, unless the visibility is bad, best results will usually be obtained with Homing aerials. Otherwise the aircraft may fly past the submarine before the submarine is detected, thus giving it ample time to detect the aircraft and dive.

The conclusion is that if the visibility exceeds the A.S.V. side aerial range—about 8 miles from 2,000 ft. —Homing aerials are best. In this case the A.S.V. merely reinforces the visual watch. If the visibility is less than this, the side aerials may be used and the central (sea-return) channel covered visually.

8. **Shipping search** — The height of search in this case is limited by a new set of factors: —

(a) Optimum A.S.V. height.

(b) Navigational problems. Landfalls etc., cannot be accurately made from great heights.

(c) Cloud level — Thin layers of cloud should be made use of to provide cover.

The guiding principle from the A.S.V. point of view is to fly at the greatest height possible under the circumstances up to the A.S.V. optimum. The best compromise is usually a height of 2,000-3,000 feet.

9. **General technique of search** — The problem to be solved is that of manipulating aerials and height so as to cover the greatest possible area of sea per sortie. The two factors contributing to this are the range of the aircraft and the channel swept by the A.S.V.

This channel may well be taken as the width of path swept by the aircraft, when the edges of the path are taken as being at the average maximum range on the Searching aerials. Naturally, no hard and fast rules can be laid down, and some targets outside this range may be located and some within it may be missed.

The range of pick-up will depend upon the distance of the target from the aircraft and will vary from very short range in the case of a target near the plane track to maximum range of the set in the case of a target at this distance from the track. Assuming that targets are distributed uniformly over the width of the swept track, the average range of pick-up will be roughly half the maximum range. It will actually be rather greater than half because targets of very short ranges (0-5) may be obscured by sea returns. In the present instance the value for maximum range has been calculated from the formula: —

$$\text{Mean Range} = \tfrac{1}{2}\,(\text{Maximum Range} - \text{Sea Return Range})$$

$$\text{or Maximum Range} = 2 \times \text{Mean Range} + \text{Sea Return Range.}$$

Naturally the channel swept must be less with the Homing than the Searching aerials, partly because the radiation is largely in a forward direction, and partly because the range is less. Hence these aerials are used mostly for sweeping when looking for submarines.

Conservative estimates of the channel swept would be as follows:—for simple Homing aerials, 1·8 times the average maximum range; for Anson aircraft, the average maximum range.

If side aerials only are used for searching, a blank central area remains unswept due to the sea return. Hence the effective channel, as indicated in the tables later is somewhat less than the overall channel.

In certain circumstances it is possible to combine both types of search. This is done by periodically switching on the forward aerials for a short interval. An area ahead of the aircraft is thus scanned momentarily up to the maximum range of those aerials under the circumstances. Side aerial search is then resumed and continued until the aircraft has covered a distance equal to the forward aerial maximum range. The interval between successively switching on to Homing aerials can be calculated, knowing the range on these aerials, the distance covered by sea-return, the speed of the aircraft and the time for which the Homing aerials are actually employed.

This type of search (forward-and-side) is not profitable when searching for submarines, as it would be necessary to switch from Searching to Homing too frequently.

10. **Technique of Homing.** With all types of Homing aerials, the basic procedure for homing is to turn the aircraft toward that side on which the blips appear largest on the tube, until the blips on both sides of the trace are equal. It should be remembered that if the target is picked up in the tip of a lobe—*i.e.* 20° – 30° off course, it may be temporarily lost if the aircraft is turned towards it due to the range of pick-up dead ahead being considerably less.

If a target is detected on the Searching aerials, it is necessary to turn the aircraft through 90°—100° in the appropriate direction before Homing can be carried out.

Yagi Homing aerials possess very good D/F properties which render homing comparatively simple. *E.g.* in the Beaufort installation the ratio of the blips is 1·5 : 1 for a target about 3° off course, which high ratio is conducive to accurate homing. However, with simple Homing aerials, as much as 10° off course may be only just noticeable. Hence much greater care is necessary.

In the final stage of Homing, height should always be reduced:

(a) To reduce the sea returns and provide a lower minimum range.

(b) To improve the D/F properties of the aerials.

(c) To place the aircraft in position for its attack.

As the range decreases, the gain control should be turned down, so the blip never saturates. If this is not done, D/F estimation will be false.

A final point is that if the aircraft has a drift on, it will not be heading exactly towards the target even when it is making good a track towards it. If no allowance is made for this, the target is bound to be reached in the end, but by a curved instead of a straight path. An experienced operator knowing the drift should be able to make the necessary allowance in an aircraft equipped with Yagi aerials.

11. **Navigational use of A.S.V.**—A.S.V. can be a most important supplement to ordinary navigational methods, particularly where there are many islands, or where the aircraft is flying near a coastline, or where Beacons are available.

12. **Searching Aerials.**—These aerials are of the greatest navigational use. This is because of the narrow width of the beam, so that any echo observed is known to be between about 75° and 110° from the aircraft's heading. Since all land masses give similar echoes, no immediate identification of any portion of coast is possible. However by observing various capes and bays over a period and comparing them with the map, the aircraft's position can frequently be deduced. The best fix naturally is a Beacon, as explained later, and better still is two Beacons.

13. **Homing Aerials.**—Here unfortunately no such checks are possible, because unless an object happens to be dead ahead, its bearing from the aircraft cannot be accurately estimated from the echo.

If however, the aircraft is attempting to make good its track on an island or a Beacon, the Homing aerials may be used as follows. If at E.T.A. nothing has been seen, the best procedure is to turn the aircraft through 360°, thus sweeping the horizon and securing the best chance of detection. Once found, the object can be homed on in the usual way. Side aerials are even more useful in this connection due to the superior ranges obtained. In this latter case it is necessary to make a flat turn so as not to lift the beam into the air, or depress it into the sea.

A further use of the Homing aerials is when approaching landfall under conditions of bad visibility, as early warning of the proximity of mountains can be obtained.

A.S.V. BEACON.

14. The A.S.V. Beacon is a transceiver which is triggered by each pulse of the A.S.V. and re-radiates a pulse about 10 microseconds long. This pulse is coded, and the blip may be seen and the code read on the A.S.V. screen. Thus the particular Beacon may be identified and the aircraft's bearing and distance from it ascertained.

15. Due to the fact that re-radiation occurs at the Beacon, much greater power is available than would be in a normal reflected pulse. Hence a beacon should be picked up at maximum range provided it is in the radiated beam, and the aircraft is flying not lower than from 2000–5000 feet depending on the height of the beacon above its surrounding.

TABLE I

AVERAGE MAXIMUM RANGE AT 2000 FEET

Target	Simple Homing	Yagi Homing	Searching	Effective Channel Swept on Search
	Hudson Beaufort Mariner	Beaufort Anson	Beaufort Hudson	
Ships less than 1000 tons	10	14	15	22
Ships 1000–11,000 tons	12	17	21	34
Battleship	20	28	40	72
Coastline	35	50	65	122

16. The above information has been compiled from Australian and overseas reports, and is included purely as a guide to probable performance.

CHAPTER EIGHT

FAULT-FINDING IN EQUIPMENT

Correction of Common Faults — Individual Units Tests — Voltage Analysis of Units — Plug and Socket Assemblies.

CORRECTION OF COMMON FAULTS

1. It is impracticable to make a full list of all possible faults which may occur in the equipment, with instructions for their remedy. Experience is the best teacher where the recognition and diagnosis of symptoms are concerned. The purpose of this chapter is to tabulate some of the troubles most likely to occur, together with a list of faults which cause them, and the adjustments or repairs likely to be required.

It is generally difficult to make tests of the equipment while it is mounted in the aircraft. For this reason, it is desirable to have spare units on hand, which may be used to replace those which appear to be faulty. A thorough overhaul of the defective unit may then be made in the workshop. For the same reason, spare interconnecting plugs and cables should be available, and a complete set should be kept on the bench to enable immediate checks to be made.

When making voltage checks, the greatest care must be taken owing to the presence of high voltages in the equipment. Voltage tables for each unit are given at the end of this chapter.

FAULT.	TESTS.
1. Vertical Scan normal, receiver noise (grass) normal, but signals (blips) weak or absent	1. Disconnect aerial from red or green plug on receiver. Signals on touching centre contact should be weaker than with aerials on, if aerials are satisfactory. If aerials appear faulty, make standard inspection. 2. If milliammeter in Transmitter reads less than 3·5 mills., check aerial tuning and check transmitter aerials and cables. 3. Check frequency of transmitter and alignment of receiver. 4. Check aerial section of switch motor. 5. Type 954 may be defective.
2. Vertical scan normal, both noise and echoes weak.	1. Check cables and plugs connecting receiver to indicator unit. 2. If two indicators are used and both give faulty images, trouble almost certainly lies in receiver. If the receiver is suspected — (a) R.F. valves may be faulty. (b) R.F. oscillator valve may be faulty. (c) I.F. valves may be faulty. (d) Make a voltage check. (e) Check switching motor contacts. The switch may be left out of circuit by connecting either aerial or signal generator directly to the receiver input. (f) Check alignment and sensitivity of receiver by means of signal generator.
3. Vertical scan normal, both noise and echoes absent.	If out-put to cathode follower faulty — 1. Check all connections. 2. Check switch motor. 3. Make a valve and voltage check. 4. Check alignment as receiver may be oscillating. 5. I.F. Trimmer condensers may be shorting. 6. Range switch may be shorting. 7. Components may be shorting to the shielding cans. If output to cathode follower normal : — (1) Check switch motor. (2) Video leads. (3) Check video valves and voltages.
4. Vertical scan absent, or small, but spot or line visible near bottom of screen.	1. Check to see that anode voltage is reaching the indicator. 2. C1 may be open. 3. Type 879 valve faulty. 4. Resistor R55 high. 5. Range valve defective. 6. Check all voltages. 7. No pulse from transmitter. 8. Shorted C.10.
5. Spot in centre of screen.	1. Faulty 5V4G valve. 2. Open H.T. circuit particularly choke L.18.

	FAULT.	TESTS.
6.	Nothing visible on screen.	1. Bias control turned down. 2. No H.T. voltages. 3. Faulty C.R.T. 4. C.R.T. filament transformer primary open circuited. 5. R.47 or R.53 open.
7.	Vertical scan present, echoes normal in strength but blurring or "shiver" on the indications.	1. P.R.F. too high. 2. Microphonic C.R.T. This will be more pronounced in the air. 3. Faulty filtering of power supply. 4. Incorrect adjustment of voltage regulator. 5. Dirty switch motor contacts.
8.	Picture normal on one side of the centre line, but on the other side, noise normal but no blips.	1. Faulty aerial connections. 2. Faulty aerial section of switch motor.
9.	Indications normal on one side, but receiver noise and echoes absent on the other.	1. Faulty coaxial leads between receiver and indicator. 2. Faulty switch motor.
10.	Picture otherwise normal but left and right hand indications (port and starboard) do not keep entirely to their own side of the centre line and/or centre line split in two over part or all of its length.	1. Faulty diode V8 in indicator. 2. Switch motor overlapping. Faint mirror images of indications on one side can be seen on the other side.
11.	Trace split both noise and echoes absent.	1. Receiver oscillating.
12.	Bright spot at each end of trace.	1. C11 open. 2. R1 in transmitter high. 3. Faulty black-out tube.
13.	Impossible to calibrate trace.	1. Range Valve faulty. 2. R.11 high. 3. P.R.F. high. 4. Plate condenser in range valve circuit faulty. 5. Faulty V4. 6. 19 meg. strip in Transmitter high. 7. Sync control faulty.
14.	No focus control trace wide and blurred.	1. R.33 R.33A R34 R34A high in value. 2. Focus potentiometer faulty. 3. R.44 high. 4. Faulty C.R.T. 5. Weak type 879 valve.
15.	No bias control or poor brilliance.	1. Bias pot faulty. 2. Resistor R13 too high. 3. C14 leaky. 4. R36 (bias control) faulty. 5. Weak C.R.T. 6. Low C.R.T. voltages.
16.	Flyback excessive.	1. Black out valve defective. 2. C11 open circuited.
17.	Intermittent and distorted trace.	1. Transmitter filament micas punctured.
18.	Trace appears to move up and down screen.	1. Faulty damping adjustment of voltage regulator.
19.	Trace shortens when switched from homing to searching or vice versa.	1. Faulty matching of aerials.
20.	Max. blip does not coincide with max. noise.	1. Transmitter off frequency.
21.	Trace half length.	1. Faulty V4. 2. C7, C9, R19 or R23 open circuited. 3. Faulty Range switch.
22.	No horizontal shift control.	1. V8 U/S. 2. R37 open circuited.
23.	No vertical shift control.	1. V6 U/S. 2. R30 open circuited.
24.	Fishbone or fir tree trace.	1. Oscillation in 1st R.F. stage.
25.	Lower end of trace contracted on all ranges.	1. Faulty phase change valve.
26.	Bias and focus uncontrollable.	1. 6·3V Filament of C.R.T. shorted to earth.

FAULT.	TESTS.
27. Brilliance varies without altering control.	1. C11 intermittent. 2. Faulty voltage regulation.
28. High P.R.F.	1. Faulty VT90's. 2. Moisture in resistor strip R1 of Transmitter. 3. Incorrect matching. 4. Incorrect aerial coupling. 5. Faulty transmitter grid condenser.
29. Gain control ineffective.	1. R15, R20 or R25 open circuited.
30. Transmitter drawing overload causing fuse to blow.	1. Faulty VT 90's. 2. Tapping point on aerial Lechers incorrectly set causing incorrect loading. 3. 19 meg. strip high. 4. Transformer 987B windings shorted to frame. 5. Transformer TP1115 C windings shorted to frame. 6. Short in H.T. cable. 7. Condenser C1 shorted to earth.
31. Low P.R.F.	1. 19 Meg. strip high. 2. Faulty V.T. 90's. 3. Incorrect loading and coupling. 4. Low H.T. Voltage.
32. Trace moves with variation of bias and focus control.	1. Resistor R30 high in value.
33. Poor voltage regulation.	1. Tapped swamp resistor open circuited. 2. Faulty damping adjustment. 3. Faulty filter circuit in control panel.
34. Smell from control unit.	1. Rectifier burnt out.
35. Low output from Transmitter.	1. Low H.T. voltage. 2. Weak V.T.90's. 3. High 19 meg. strip. 4. Insufficient aerial coupling. 5. Incorrect loading.
36. Unstable Trace.	1. Switch motor needs adjustment. 2. Voltage regulator hunting. Adjust damping control. 3. Transmitter output unsteady. 4. Faulty filter choke L18 in H.T. circuit of receiver. 5. 24 volt. input low.
37. Trace off centre and very poor brilliance.	1. Resistor R29 (filter circuit of 879 power supply) open circuited. H.T. at pin. 2 reads 450v.
38. Receiver output unbalanced.	1. Poorly synchronised motor. 2. Dirty switch motor contacts. 3. Faulty video valve. 4. Faulty video lead.
39. Apparent loss of sensitivity through the switch motor.	1. Caused by excessive hash from switch motor brushes. Clean brushes and commutator.
40. Type AV11 valve or valves do not light up.	1. Open transformer lead or more probably leads shorted at transformer terminal.

INDIVIDUAL UNIT TESTS

2. When the faulty unit has been isolated, the following notes should be helpful in determining the exact nature of the trouble. If it is obvious that an appreciable amount of work is involved, the unit should be removed to the test bench.

The Transmitter.

3. The defective transmitter may be tested as follows :—

1. Make sure the blower is working, and that the transmitting valves V1 and V2 have their filaments alight.

2. Check the rectifiers, whose filaments should be visibly glowing a dull red.

3. If the H.T. current is zero, check the H.T. voltage. To do this, switch off the H.T. switch on the transmitter, connect a suitable meter across C3 of the power supply, switch on again and take a reading. This should be approximately 7500 v. A suitable meter would be an electrostatic type reading to 10,000 volts. The greatest care must be taken concerning the insulation of leads, etc., when making this test.

4. The power supply condensers, C1, C2, and C3 should be checked, with their associated wiring, for short circuits.

5. Peak the transmitter tuning. The current should read 3·5-5 mills.

6. Measure the P.R.F. (300-400), the frequency, and peak volts output.

The Receiver.

4. The defective receiver may be tested as follows :—

1. Check H.T. voltage at suitable points in the circuit, also the filament voltages at the sockets of the valves.

2. If the H.T. voltage is low, or absent, check the power supply condensers for possible short circuits. Check all condensers connected from a high voltage point to the chassis, a breakdown in which could cause abnormal current drain from the supply. If all condensers are sound, and no partial or complete short-circuits are found, replace the rectifier valves.

3. If receiver is still unsatisfactory, the remaining valves should be tested. A simple test is to measure the cathode voltage for each, and compare with the rated value. Any serious discrepancy indicates a fault in the associated circuit of the valve concerned, and possible low emission.

4. Make a resistance check of all co-axial cables.

The Indicator Unit.

5. If the initial testing points to a fault in the Indicator Unit, the following procedure should be adopted :—

(a) Inspect connections from the two input plugs through the video amplifiers to the horizontal plates of the C.R.T. Check components and voltages associated with them.

(b) Replace V8, and if necessary, V9 and V10.

(c) Replace C.R.T.

If the vertical scan is small, or absent —

(a) Check all H.T. and filament voltages. When testing H.T. voltages, first switch off the unit, then connect the meter and switch on again to take a reading. The unit must be switched off before the meter is removed.

(b) The stage in which the fault occurs may usually be found by applying a low-frequency voltage to —

(i) The orange plug.
(ii) The grid of V1.
(iii) The cathode of the second section of V2 (connected via R9 to the grid of V3).
(iv) The grid of V3.

After first ascertaining that there is no H.T. voltage present on these points, sufficient low-frequency voltage may be applied to elongate the spot in the screen into a line by touching the points with a length of about 6 feet of insulated, unscreened cable.

(c) If the scan is blurred or " shivery," check components connected with the input to V1 and also V2, and the associated wiring. Capacity between the unearthed heater wire, and V2 second section cathode and associated wiring must be kept low, and the correct section of the diode must be used.

(d) If no picture at all is visible —

(i) Check the presence of correct voltage across the heaters of the C.R.T. These are above earth potential by 1600v.
(ii) Replace C.R.T.

RECEIVER TYPE AR301

Paton 1000 ohm per volt multimeter.

	Voltages measured to earth		Position of gain control Max.	Min.
	Heaters A.C. Anode Supply Moving arm of gain control		6·3 290 0 v	 7·5v across control
1st R.F.	954	Anode Screen Cathode	270 v 67 v 1·55 v	
2nd R.F.	954	Anode Screen Cathode	290 v 67 v 1·55 v	
Mixer	955	Anode Cathode	222 v 14·3 v	
1st I.F.	6AC7	Anode Screen Cathode	240 v 154 v 2·65 v	
2nd I.F.	6AC7	Anode Screen Cathode	250 v 154 v 2·5 v	
3rd I.F.	6AC7	Anode Screen Cathode	238 v 154 v 2·6 v	300 v 185 v 6·3 v
4th I.F.	6AC7	Anode Screen Cathode		195 v 184 v 2·85 v
Cathode Follower	6AC7	Cathode Anode		7·6 v 300 v

Note :— Voltages (0-10) v measured on 0-10 v range, (10-50) v on 0-50 v range, (50–250) v on 0-250 v range, (250-1000) v on 0-1000 v range.

Tolerances :— Plus or Minus 15% on all voltages.

INDICATOR UNIT TYPE A1

Paton 1000 ohm per volt multimeter

Voltages measured to earth	Dumont	905	1802–P1.
Heaters A.C. Positive Anode Supply Negative C.R.O. Supply 1430 v (Measured with 20,000 ohms/volt meter)	6·3 v 300 v	6·3 v 300 v	6·3 v 300 v
		Sync. Pot.	
V.1. Anode V.2. Cathode	Min. 10 v Max. 6 v 28 v	Min. 10 v Max. 6 v 28 v	Min. 10 v Max. 6 v 28 v
		Cal. Pot.	
V.3. Anode V.3. Cathode	Min. 83 v Max. 118 v 8 v 41·5 v	Min. 85 v Max. 120 v 8 v 52 v	Min. 95 v Max. 165 v 9 v 38 v
V.4. Anode V.4. Cathode	200 v 4·5 v	200 v 4·5 v	200 v 4·5 v
		Range Sw.	
V.5. Anode V.5. Screen	9-36, 255 v 90, 250 v 37 v	9-36, 255 v 90, 250 v 37 v	9-36, 255 v 90, 250 v 37 v
		Vert. Shift	
V.6. Cathode	Min. 54 v Max. 150 v	Min. 54 v Max. 150 v	Min. 54 v Max. 50 v
V.7. Focus pot	Min. 560 v Max. 750 v	Min. 795 v Max. 1000 v	Min. 670 v Max. 990 v
Bias. pot	Min. 1100 v Max. 1250 v	Min. 1100 v Max. 1250 v	Min. 1150 v Max. 1250 v
		Hor. Shift.	
V.8. Cathode 1 Cathode 2	Min. 0 v Max. 95 v 42 v 42 v	Min. 0 v Max. 95 v 42 v 42 v	Min. 0 v Max. 95 v 42 v 42 v
V.9. Anode Cathode	245 v 5 v	245 v 5 v	245 v 5 v
V.10. Anode Cathode	245 v 5 v	245 v 5 v	245 v 5 v

Note : — All voltages between (0-25) v measured on 0-50 v scale, between (25-250) v on 0-250 v scale, between (250-1000) v on 0-1000 v scale. Voltages above 1000v not readable on standard 1000 ohms per volt meter, and therefore bias pot. readings and focus pot. for C.R.T. cannot be checked unless a suitable meter is available or an extra series resistor is used to increase the range of the standard multimeter.

Tolerances : — Filaments plus or minus 5%. Cathodes plus 25% minus 20%.
All others plus or minus 15%. Oscillator Grid Current not less than 1·5 mills.

PLUG AND SOCKET ASSEMBLIES.

Plug Assembly.

Preparation of cable.—The cable should be cut into lengths ½ inch longer than required. The prepared length of cable should be at least ⅛ inch longer than the distance between the plug centres. It should lie flat for 24 hours before assembling the socket, to allow the insulation to contract, since this will have stretched slightly due to coiling.

Attachment of Pye plug to cable.

(i) Remove the protective covering over the braid for a distance of ⅞ inch from the end of the cable, and push the clamping screw (7) in Fig. 1 over the end of the covering. It must be kept in this position throughout the assembly.

(ii) The protruding braid should be unwoven with a blunt instrument and splayed before passing the sleeve (8) under the braid into the clamping screw (7). The sleeve should be pressed into the clamping screw as hard as possible by hand. The protruding strands of braid should be cut off as close as possible to the clamping screw. The clamping screw should be held in a vyce having a pair of semi-circular jaws, just large enough to fit round the cable, and sufficiently strong to support the clamping screw, while the clamp sleeve is pressed home by means of the tubular tool passing over the insulation. This operation should be made in a suitable press. The braid should then be trimmed.

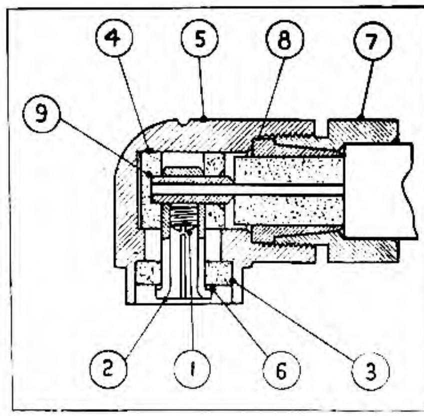


Fig. 1.

1. Grub screw
2. Socket
3. Moulded Washer
4. Moulded spacer
5. Socket body
6. Spring Ring
7. Clamping screw
8. Sleeve
9. Conductor ferrule

(iii) The insulation should not protrude more than 3/32 inch from the sleeve and the length of the bare conductor should protrude ⅛ inch.

(iv) In the case of cables with a single-wire conductor, a conductor ferrule (9) should be fitted securely by soldering. Stranded conductors should be twisted tightly with flat nose pliers and lightly tinned.

(v) Fit a moulded spacer (4) in the socket body (5) so that the small hole mounting is open to the cable entrance, and the large hole positioned to receive the socket (2).

(vi) Place a spring ring (6) and a moulded washer (3) in turn over the socket before fitting it into the moulded spacer already in position in the socket body (5).

(vii) The clamping screw should be held in a vyce with the cable hanging downwards, while the socket body with the spacer and socket in position is screwed on to it. Make sure that the conductor, or conductor ferrule if fitted, is visible through the grub screw hole in the socket before tightening, so that it passes to the end of the hole in the insulated spacer when the socket body is tightened on to the clamping screw. Care should be taken to ensure that the taper is not damaged during assembly.

(viii) Insert and tighten the grub screw (1).

Front Mounting Single Ended Pye Plug Assembly.

This is illustrated herewith. Panels with thickness of $\frac{1}{16}$ inch, ⅛ inch, $\frac{3}{16}$ inch and ¼ inch need respectively, 3, 2, 1, or no packing washers (4).

(i) Pass the brass bush (2) through a $\frac{21}{32}$ inch hole in the panel, using the number of packing washers specified above to make up the panel thickness to ¼ inch.

(ii) Place a spring retaining ring (6) over a plug mounting (7) and screw the latter on to the bush (2) and tighten up.

(iii) Place a washer (11) and an insulated washer over a single-ended plug (1), pass the stem through the plug mounting, and secure with a nut (3) on top of two insulated washers (5) and a shakeproof washer (8).

(iv) Fit a soldering tag (9) and secure with a shakeproof washer and nut (3).

(v) Clip a spring (10) into the slots of the spring retaining ring.

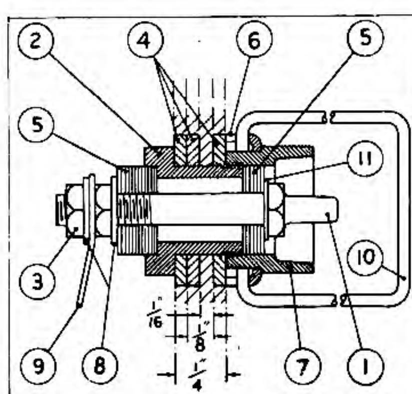


Fig. 2.

1. Plug
2. Brass bush
3. Nut
4. Packing washers
5. Insulated washers
6. Retaining ring
7. Plug mounting
8. Shakeproof washer
9. Soldering tag

Front and Back Mounting Pye Plug Assembly.

Panels of $\frac{1}{16}$ inch, $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, and $\frac{1}{4}$ inch, need respectively 3, 2, 1, or no packing washers.

(i) Screw one of the plug mountings (7) on to the screwed sleeve (2) and after fitting one spring retaining ring (6) pass through a $\frac{29}{64}$ inch hole in the panel, using the number of packing washers (4) specified to make the panel thickness equal to $\frac{1}{4}$ inch. Secure the screwed sleeve with another plug mounting with the spring retaining ring (6). When the plug mountings are tightened up, it is important that the screwed sleeve (2) should be threaded an equal amount in each.

(ii) Place a N.P. washer (9) and an insulated washer (5) on the double-ended plug (1), pass it through the assembly, and secure with another insulated washer (9) and N.P. washer and nut (3).

(iii) Clip a spring (8) into the slots of each spring retaining ring (6).

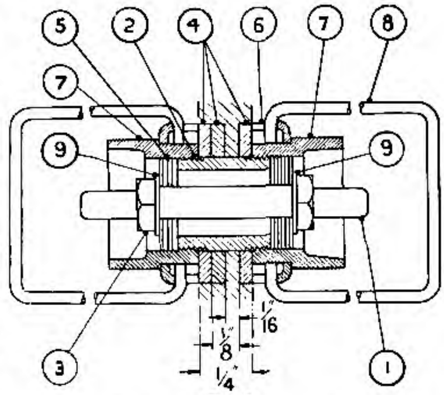


Fig. 3.

1. **Double plug**
2. **Screwed sleeve**
3. **Nut and washer**
4. **Packing washers**
5. **Insulated washer**
6. **Retaining ring**
7. **Plug mounting**
8. **Spring**
9. **N.P. washer**

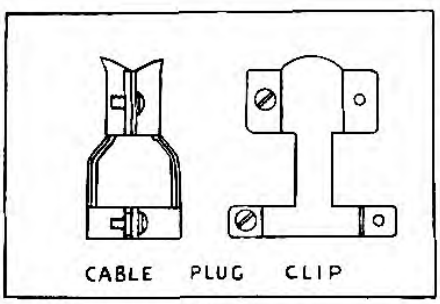


Fig. 4.

CABLE PLUG CLIPS.

This clip is made into two parts. It is necessary to unscrew the four screws before fitting and then fix the large portion of the clip around the Pye plug, finally screwing up the smaller portion of the clip around the coaxial cable. The variations in the size of the coaxial cable may necessitate packing of the cable until it can be held firmly in the smaller portion of the plug grip. This clip must be attached to all Pye plugs on all Units. The use of the clip must not in any way detract from the attention given to the normal fixing in the cable of the Pye plug. It is intended that the plug clip shall add to the strength of the join thereby minimising the chance of breakage.

4 Pin Socket Assembly, Type W 150.

This is illustrated herewith. The method of attachment to the cable follows.

(i) Unscrew the socket, tin the ferrule all over and slip it and the gland nut over the cable.

(ii) Remove the braid, cabtyre and rubber insulation to a suitable length, as indicated. Tin the last **1** in. of braid.

(iii) Slide the ferrule up over the tinned braid, so the braid just does not protrude through the ferrule. Sweat the two together.

(iv) Now tin the ends of the wires, and the socket pins.

(v) Slip a length of 4 mm. Nylex over each conductor as shown. Pass the lot through the elbow fitting and clamping ring.

(vi) Ensure that the locking ring and bushing are relatively correctly positioned, and solder each wire to its pin. Push the Nylex forward so as to cover the entire bared portion of cable.

(vii) Screw the plug together.

2 Pin, 6 Pin large and 6 Pin small sockets are all very similar to these, and are prepared similarly.

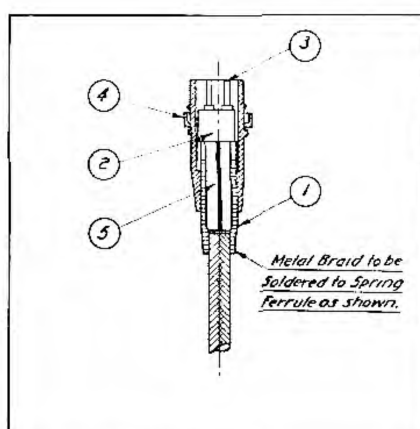


Fig. 5

1. **Spring ferrule**
2. **Insulator**
3. **Pin**
4. **Locking ring**
5. **Conductor**

4 Pin Socket Assembly, Type W 310A.

This socket is similar to Type 150 and is interchangeable with it. The only difference is that the ferrule is replaced by three segments which clamp tightly to the braid.

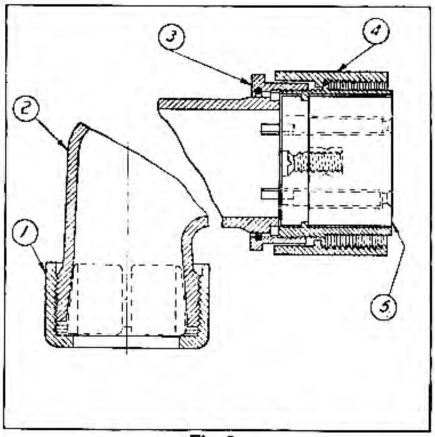


Fig. 6.

1. Gland nut
2. Elbow fitting
3. Clamping ring
4. Locking ring
5. Bushing

2 Pin Socket Assembly Type W 204.

This is illustrated herewith. The method of attachment to the cable follows.

(i) Unscrew the socket and tin the socket contacts.

(ii) Unscrew the gland nut and take out the three segments.

(iii) Remove the braid, cabtyre and rubber insulation to a suitable length, as indicated. Tin the last **1** in. of braid.

(iv) Slip a length of Nylex tubing over each conductor.

(v) Pass the conductors through the gland nut, fit the segments, pass the conductors through the socket assembly and tighten the gland nut. The segments will clamp to the braid and ensure a good contact.

(vi) Solder the conductors to the socket pins.

(vii) Finally tighten the clamping ring.

Plug, Type MC2M.

This is illustrated herewith. The method of connection to the cable follows.

(i) Remove the insulator together with the two pins, by undoing the small grub screw. Remove the spring ferrule likewise, and slip it over the end of the cable.

(ii) Remove the braid, cabtyre and rubber insulation as shown, the latter to a length of **1** in.

(iii) Tin the last **1** in. of braid.

(iv) Now pass the cable through the body of the connector and slip a length of 4 mm. Nylex over each conductor.

(v) Carefully insert each conductor in its pin, and secure it there by running solder down through the opposite end of the pin.

(vi) Push the Nylex up so as completely to cover the bared wire.

(vii) Now place the insulator and pins in position and screw up the grub screw.

(viii) Push up the spring ferrule into its correct position and sweat it on to the tinned braid. Screw up the remaining grub screw.

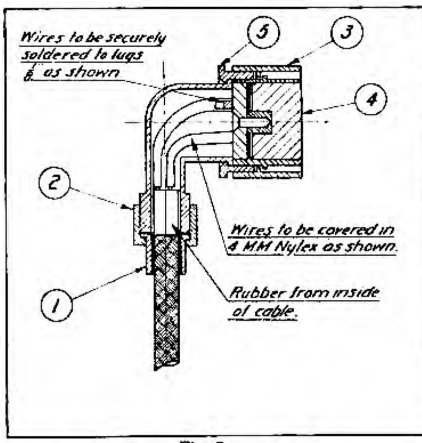


Fig. 7.

1. Ferrule
2. Gland nut
3. Locking ring
4. Bushing
5. Clamping ring

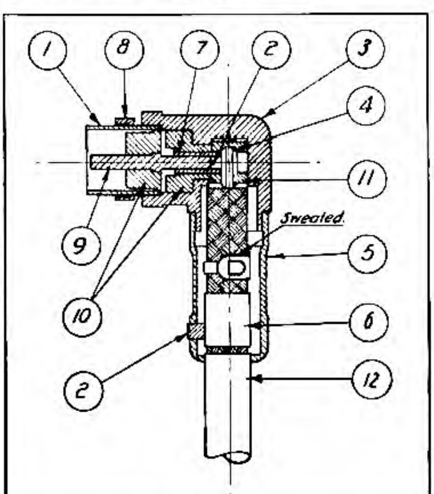


Fig. 8.

1. Sleeve ring
2. Grubscrew
3. Elbow fitting
4. Conductor ferrule
5. Socket body
6. Shield
7. Conductor
8. Locking ring
9. Conductor
10. Spacing washers
11. Spacing washer

Amphenol Plug, Type 93MA (right angled).

This is illustrated herewith. The method of connection to the coaxial cable follows.

(i) Dismantle the connector by
 (a) Unscrewing the sleeve ring.
 (b) Removing both grub screws.
 (c) Unscrewing the elbow fitting.

(ii) Prepare the cable by
 (a) Removing **1** in. of rubber.
 (b) Removing **1** in. of braid and dielectric and tinning the end of the braid.
 (c) Tinning the inner conductor very lightly.

(iii) Now pass the conductor ferrule over the conductor and sweat them together.

(iv) Pass the socket body over the cable.

(v) Wrap the metal shield around the cable and sweat the smaller portion of the shield onto the braid.

(vi) Now slide the socket body into position, and screw up the grub screw.

(vii) Screw the elbow fitting onto the socket body, so that the conductor ferrule is inside the socket.

(viii) Screw up the remaining grub screw.

(ix) Finally screw the sleeve ring and locking ring into the elbow fitting.

APPENDIX "A"

EQUIPMENT SCHEDULE.

INDICATOR TYPE A1.

PART NO.	IDENT NO.	DETAIL
R1	Y10C/66379	10 K, 1W, I.R.C.
R2	Y10C/65582	2M, 1W, I.R.C.
R3	Y10C/65238	1M, 1W, I.R.C.
R4	Y10-C65299	·25M, 1W, I.R.C.
R5	Y10C/65700	20K, 1W, AEROSTAT CARBON POT.
R6	R10C/66380	30K, 1W, I.R.C.
R7	R10C/65299	·25M, 1W, I.R.C.
R8	Y10C/65573	1K, 1W, I.R.C.
R9	R10C/65573	1K, 1W, I.R.C.
R10	Y10C/65700	20K, 1W, AEROSTAT CARBON POT.
R11	Y10C/66593	20K, 2W, I.R.C.
R11A	Y10C/65577	40K, 1W, I.R.C.
R12	Y10C/65700	20K, 1W, AEROSTAT CARBON, POT.
R13	Y10C/65238	1M, 1W, I.R.C.
R14	Y10C/65700	20K, 1W, AEROSTAT CARBON POT
R15	Y10C/65702	5K, W.W. AIRZONE, POT. 1 Watt
R16	Y10C/65573	1K, 1W, I.R.C.
R17	Y10C/65702	5K, W.W. AIRZONE, POT.
R18	Y10C/65702	5K, W.W AIRZONE, POT.
R19	Y10C/65299	·25M, 1W, I.R.C.
R20	Y10C/65576	25K, 1W, I.R.C.
R21	Y10C/65754	60K, 1W, I.R.C.
R22	Y10C/65754	60K, 1W, I.R.C.
R23	Y10C/66303	1·5K, 1W, I.R.C.
R24	Y10C/65298	·1M, 1W, I.R.C.
R25	Y10C/66273	5K, 1W, I.R.C.
R26	Y10C/66442	15K, 1W, I.R.C.
R27	Y10C/6529	·1M, 1W, I.R.C.
R28	Y10C/65299	·25M, 1W, I.R.C.
R29	Y10C/65582	2M, 1W, I.R.C.
R30	Y10C/65582	2M, 1W, I.R.C.
R31	Y10C/65298	·1M, 1W, I.R.C.
R32	Y10C/65703	·1M. AEROSTAT CARBON POT 1 Watt
R33	Y10C/65580	·5M, 1W, I.R.C.
R33A	Y10C/65580	·5M, 1W, I.R.C.
R34	Y10C/65580	·5M, 1W, I.R.C.
R34A	Y10C/65580	·5M, 1W, I.R.C.
R35	Y10C/65704	·25M, 1W, AEROSTAT CARBON POT.
R36	Y10C/65703	·1M, 1W, AEROSTAT CARBON POT.
R36A	Y10C/65299	·25M, 1W, I.R.C.
R37	Y10C/65299	·25M, 1W, I.R.C.
R38	Y10C/65299	·25M, 1W, I.R.C.
R39	Y10C/66379	10K, 1W, I.R.C.
R40	Y10C/65573	1K, 1W, I.R.C.
R41	Y10C/65575	20K, 1W, I.R.C.
R42	Y10C/65575	20K, 1W, I.R.C.
R43	Y10C/66379	10K, 1W, I.R.C.
R44	Y10C/65298	·1M, 1W, I.R.C.
R45	Y10C/65705	2K, 1W, w.w. AIRZONE POT.
R46	Y10C/65298	·1M, 1W, I.R.C.
R47	Y10C/65573	1K, 1W, I.R.C.
R48	Y10C/65575	20K, 1W, I.R.C.
R49	Y10C/65575	20K, 1W, I.R.C.
R50	Y10C/65578	·15M, 1W, I.R.C.
R51	Y10C/65703	·1M. AEROSTAT CARBON POT. 1 Watt
R52	Y10C/65299	·25M, 1W, I.R.C.
R53	Y10C/66381	50K, 1W, I.R.C.
R54	Y10C/65576	25K, 1W, I.R.C.
R55	Y10C/66381	50K, 1W, I.R.C.
R56	Y10C/66307	500 ohm, ½W, I.R.C.
R57	Y10C/66370	500 ohm, ½W, I.R.C.
R58	Y10C/66273	5K, 1W, I.R.C.
R59	Y10C/66481	·5M, 1W, AEROSTAT CARBON POT.
R60	Y10C/65704	·25M, 1W, AEROSTAT CARBON POT.
C1	Y10C/65674	500pf. 400V. w. DUCON
C2	Y10C/65657	·01-·005-·001 mfd. 600V. w. DUCON
C3	Y10C/65657	·01-·005-·001 mfd. 600V. w. DUCON
C4	Y10C/65675	·01-·005-·001 mfd. 600V. w. DUCON
C5	Y10C/65883	·1 400V. w. CHANEX
C6	Y10C/65677	300 pf. 600V. w.
C7	Y10C/65678	·02-·02 600V. w. DUCON
C8	Y10C/65679	·1 600V. w. DUCON
C9	Y10C/65678	·02-·02 600V. w. DUCON
C10	Y10C/65677	300 pf. 600V. w.
C11	Y10C/65680	·005 2500V. w. DUCON
C12	Y10C/66433	100 pf. 400V. w. SIMPLEX
C13	Y10C/66433	100 pf. 400V. w. SIMPLEX
C14	Y10C/65681	·01 2,500V. w. DUCON
C15	Y10C/65682	·05-·05 mfd. 400V. w. DUCON
C16	Y10C/65682	·05-·05 mfd. 400V. w. DUCON
C17	Y10C/66735	200 pf. 400V. w. AWA silvered mica Type 57946 (or Simplex)
C17A	Y10C/66023	500 pf. 400V. w. AWA silvered mica Type 57946 (or Simplex)

APPENDIX "A"

EQUIPMENT SCHEDULE

INDICATOR TYPE A1 (*continued*)

PART NO.	IDENT NO.	DETAIL
V1	Y11OE/55	Valve type 1852 (6AC7)
V2		Valve type 6H6 GT
V3		,, ,, 1852 (6AC7)
V4		,, ,, 1852 (6AC7)
V5		,, ,, 1852 (6AC7)
V6		,, ,, 6H6 GT
V7		,, ,, C.R.T. Type 1802-P1
V8		,, ,, 6H6 GT
V9		,, ,, 1852 (6AC7)
V10		,, ,, 1852 (6AC7)
	Y1OKB/500041	Transformer type TP1223A (For 1802-P1 only)
	Y1OAB/502400	Reflex extension
	Y1OAB/502300	Mask, rubber
	Y1OAB/503500	Scales, Indicator, Type P1.
P and S1	Y1OH/414	Socket, 6 pin large, Type W160
	Y1OH/394	Plug, 6 pin large, type W201
P&S2 } P&S3 } P&S4 }	Y1OH/90373	Plug, Type D402013, Pye single ended
	Y1OHB/500400	Plug, Type E1 (Pye)
		ALTERNATIVELY
P and S1	Y1OHB/503400	Socket, 6 pin large, Type W160A **NOTE** that W type sockets as above are on cables, plugs are on units.
	Y1OQB/500100	Tray Indicator mounting, type A1.
	Y1OQB/500300	Tray Indicator mounting, type A1 B (Hudson)
	Y10QB/5000	Indicator Unit, type A1.

APPENDIX "A"

EQUIPMENT SCHEDULE

RECEIVER AR301.

PART No.	IDENT No.	DETAIL
R1	Y10C/66307	500 ohm, ½W, I.R.C.
R2	Y10C/66307	500 ohm, ½W, I.R.C.
R4	Y10C/66307	500 ohm, ½W, I.R.C.
R5	Y10C/66261	1 K, ½W, I.R.C.
R6	Y10C/66261	1 K, ½W, I.R.C.
R7	Y10C/66307	500 ohm, ½W, I.R.C.
R8	Y10C/66307	500 ohm, ½W, I.R.C.
R9	Y10C/66593	20 K, 2W, I.R.C.
R10	Y10C/66266	25 K, ½W, I.R.C.
R10A	Y10C/65718	100 ohm, ½W, I.R.C.
R11	Y10C/66308	2 K, ½W, I.R.C.
R12	Y10C/66264	5 K, ½W, I.R.C.
R13	Y10C/66307	500 ohm, ½W, I.R.C.
R14	Y10C/66264	5 K, ½W, I.R.C.
R15	Y10C/65673	30 ohm, ½W, I.R.C.
R16	Y10C/66586	300 ohm, ½W, I.R.C.
R17	Y10C/66307	500 ohm, ½W, I.R.C.
R18	Y10C/66307	500 ohm, ½W, I.R.C.
R19	Y10C/66264	5 K, ½W, I.R.C.
R20	Y10C/65673	30 ohm, ½W, I.R.C.
R21	Y10C/66586	300 ohm, ½W, I.R.C.
R22	Y10C/66307	500 ohm, ½W, I.R.C.
R23	Y10C/66307	500 ohm, ½W, I.R.C.
R24	Y10C/66264	5 K, ½W, I.R.C.
R25	Y10C/65673	30 ohm, ½W, I.R.C.
R26	Y10C/66586	300 ohm, ½W, I.R.C.
R27	Y10C/66307	500 ohm, ½W, I.R.C.
R28	Y10C/66635	2 x ·2M, 1W, I.R.C.
R29	Y10C/66307	500 ohm, ½W, I.R.C.
R30	Y10C/66586	300 ohm, ½W, I.R.C.
R31	Y10C/66307	500 ohm, ½W, I.R.C.
R32	Y10C/66307	500 ohm, ½W, I.R.C.
R32A	Y10C/66307	500 ohm, ½W, I.R.C.
R33	Y10C/66380	3 x 30 K, 1W, I.R.C.
R34	Y10C/66380	3 x 30 K, 1W, I.R.C.
R36	Y10C/66307	500 ohm, ½W, I.R.C.
R37	Y10C/65661	3 K, 1W, I.R.C.
R39	Y10C/65575	2 x 20 k, 1W, I.R.C. each resistance
R43	Y10C/66265	10 K, ½W, I.R.C.
R44	Y10C/66261	1 K, ½W, I.R.C.
R45	Y10C/65665	10 ohm, ½W, DUCON
R46	Y10C/65665	10 ohm, ½W, DUCON
R47	Y10C/66442	15 K, 1W, I.R.C.
R48	Y10C/66307	500 ohm, ½W, I.R.C.
C1	Y10C/65649	100 pf. 400V. w. midget mica
C2	Y10C/65647	20 pf. 400V. w. midget mica
C3	Y10C/65649	100 pf. 400V. w. midget mica
C4	Y10C/65650	·001 400V. w. midget mica
C5	Y10C/65649	100 pf. 400V. w. midget mica
C6	Y10C/65648	50 pf. 400V. w. midget mica
C7	Y10C/65650	·001 400V. w. midget mica
C8	Y10C/65650	·001 400V. w. midget mica
C9	Y10C/65649	100 pf. 400V. w. midget mica
C10	Y10C/65649	100 pf. 400V. w. midget mica
C11	Y10C/65649	100 pf. 400V. w. midget mica
C12	Y10C/65648	50 pf. 400V. w. midget mica
C13	Y10C/65656	Split stator 2/4 pf. (oscill. tuner)
C14	Y10C/65647	20 pf. 400V. w. midget mica
C15	Y10C/65648	50 pf. 400V. w. midget mica
C16	Y10C/65649	100 pf. 400V. w. midget mica
C17	Y10C/65650	·001 400V. w. midget mica
C18	Y10C/65649	100 pf. 400V. w. midget mica
C19	Y10C/66023	500 pf. 400V. w. silvered mica
C20	Y10C/65650	·001 400V. w. midget mica
C21	Y10C/65649	100 pf. 400V. w. midget mica
C22	Y10C/65657	Air trimmer 7-plate I.F. tuner
C23	Y10C/65650	·001 400V. w. midget mica
C24	Y10C/65650	·001 400V. w. midget mica
C25	Y10C/65650	·001 400V. w. midget mica
C26	Y10C/65650	·001 400V. w. midget mica
C27	Y10C/65649	100 pf, 400V. w. midget mica
C28	Y10C/65657	Air trimmer 7-plate I.F. tuner
C29	Y10C/65650	·001 400V. w. midget mica
C30	Y10C/65650	·001 400V. w. midget mica
C31	Y10C/65650	·001 400V. w. midget mica
C32	Y10C/65650	·001 400V. w. midget mica
C33	Y10C/65649	100 pf. 400V. w. midget mica
C34	Y10C/65657	Air trimmer 7-plate I.F. tuner
C35	Y10C/65650	·001 400V. w. midget mica
C36	Y10C/65650	·001 400V. w. midget mica
C37	Y10C/65652	·5-·5 600V. w. DUCON Com. type
C38	Y10C/65651	·01 ·01 mfd. 3000V. w. DUCON Com. type
C39	Y10C/65651	·01 ·01 mfd. 3000V. w. DUCON Com. type
C40	Y10C/65652	·5-·5 mfd. 600V. w. Com. type
C41	Y10C/65650	·001 400V. w. midget mica
C41A	Y10C/65650	·001 400V. w. midget mica
C42	Y10C/65650	·001 400V. midget mica
C43	Y10C/65649	100 pf. 400V. w. midget mica

APPENDIX "A"

EQUIPMENT SCHEDULE

RECEIVER AR301 (*continued*).

PART No.	IDENT No.	DETAIL.
C44	Y10C/65657	Air trimmer 7 plate I.F. tuner
C45	Y10C/65650	·001 400V. w. midget mica
C46	Y10C/65650	·001 400V. w. midget mica
C47	Y10C/65650	·001 400V. w. midget mica
C48	Y10C/65650	·001 400V. w. midget mica
C49	Y10C/65650	·001 400V. w. midget mica
C49A	Y10C/65650	·001 400V. midget mica
C49B	Y10C/65650	·001 400V. w. midget mica
C50	Y10C/65649	100 pf. 400v. w. midget mica
C51	Y10C/65657	Air trimmer 7 plate I.F. tuner
C52	Y10C/65650	·001 400V. w. midget mica
C53	Y10C/66286	10 pf. 600V. w. mica
C54	Y10C/65650	·001 400V. w. midget mica
C55	Y10C/66286	10 pf. 600V. w. mica
C55A	Y10C/65646	5 pf. 400V. w. midget mica
C56	Y10C/65650	·001 400V. w. midget mica
C56A	Y10C/65650	·001 400V. w. midget mica
C59	Y10C/65883	·1 400V. w. paper dielectric CHANEX
C62	Y10C/65650	·001 400V. w. midget mica
C62A	Y10C/65650	·001 400V. w. midget mica
C65	Y10C/65650	·001 400V. midget mica
V1	Y110E/39	Valve type 954
V2	Y110E/39	Valve type 954
V3	Y110E/40	Valve type 955
V4	Y110E/40	Valve type 955
V5	Y110E/55	Valve type 1852 (6AC7)
V6	Y110E/55	Valve type 1852 (6AC7)
V7	Y110E/55	Valve type 1852 (6AC7)
V8	Y110E/55	Valve type 1852 (6AC7)
V9	Y10E/75158	Valve type 6H6GT
V10	Y110E/55	Valve type 1852 (6AC7)
V12	Y10E/75095	Valve type 879
V13	Y10E/75094	Valve type 5V4G
L1		Aerial coil
L2	Y10C/65642	Heater choke type A
L3	Y10C/65642	" " " "
L4	Y10C/65644	Quarter-wave choke type RP 9/53
L5		R.F. Coil
L6	Y10C/65642	Heater choke type A
L7	Y10C/65644	Quarter-wave choke type RP 9/53 R.F.
L8		Oscillator coil
L9		Oscillator coupling
L10		Mixer coil
L11	Y10C/65643	Heater choke type B R.F.
L12	Y10C/70413	I.F. coil type C
L13	Y10C/70413	I.F. coil type C
L14	Y10C/65643	Heater choke type B R.F.
L15	Y10C/70413	I.F. coil type C
L16	Y10C/65643	Heater choke type B R.F.
L17	Y10C/70413	I.F. coil type C
L18	Y10C/65641	Choke, filter, type TZ162
L19	Y10C/65643	Heater choke type B R.F.
L20	Y10C/65645	30 Mc. choke R.F. type RP/9/57 (Control panel)
L21	Y10C/70414	I.F. coil type D
L22	Y10C/65643	Heater choke type B R.F.
L23	Y10C/65645	30 Mc. choke R.F. type R.P. 9/57 (Control panel)
L24	Y10C/65645	30 Mc. choke R.F. type; RP. 9/57 (Control panel)
L25	Y10C/65643	Heater choke type B R.F.
L26	Y10C/65643	Heater choke type B R.F.
	Y10KB/500044	Transformer type TP1151A
	Y10F/80151	Motor, switching, 24 volt type ZD3
	Y10KB/500003	Motor, switching, 12 volt
	Y10KB/500005	Brushes, carbon, Type 29235 for switching motor
P & S1	Y10H/414 Y10H/394	Socket, 6 pin large, Type W160 Plug, 6 pin large, Type W201
P & S2	Y10H/404 Y10H/391	Socket, 4 pin, Type W150 Plug, 4 pin, Type W198
P & S3 P & S4 P & S5 P & S6 P & S7 P & S8	Y10H/90372 Y10HB/500400	Pye double ended plug Plug, Type E.I. elbow (Pye)
P & S9	Y10H/90371 Y10HB/500600	Socket, Type PC2F Amphenol Plug, Type MC2M Amphenol
		ALTERNATIVELY
P & S1	Y10HB/503400	Socket, 6 pin large, Type W160A
P & S2	Y10HB/503300	Socket, 4 pin, Type W310A
		NOTE that W type sockets as above are on cables, plugs are on units.
	Y10DB/500200	Receiver, Type AR301 (24V)
	Y10DB/505900	Receiver, Type AR301 B (12V)
	Y10DB/500400	Tray Receiver mounting, Type AR301
	Y10DB/501200	Tray Receiver mounting, Type AR301 A (Hudson)

APPENDIX "A"

EQUIPMENT SCHEDULE

TRANSMITTER AT300.

PART NO.	IDENT NO.	DETAIL
R1	Y10C/65580	38 x ·5M 1W I.R.C.
C1	See	
	Y10AB/503600	Condenser tuning
C1A	Y10AB/509900	Plates condenser padding
C2	Y10C/65466	·001, 5000V, mica DUCON
	Y10DB/500500	Choke assembly, filament tuning
	Y10AB/506700	Mica discs
	Y10DB/500600	Aerial lecher assembly, type A127
	Y10AB/500600	Chamber, air, type 25
	Y10AB/500700	Gland and Lecher tube assembly, type A109
	Y10DB/500900	Tube support assembly
V1	Y10E/97	Valve type VT90
V2	Y10E/97	" " "
P and S1	Y10HB/501400	Plug, type 93MA (right angled)
	Y10HB/501500	Socket, type 93LC
	Y10DB/500100	Transmitter, type AT300
	Y10DB/505900	Transmitter, type AT300..A (12V)
	Y10DB/500300	Tray, Transmitter mounting, Type AT300
R1	Y10C/66272	100 ohm, 1W, I.R.C.
R2	Y10C/66272	100 ohm, 1W, I.R.C.
R3	Y10C/66378	40 ohm, 1W, I.R.C.
R4	Y10C/65464	5K, 8W, I.R.C.
R5	Y10C/66272	2 x 100 ohm, 1W, I.R.C.
R6	Y10C/	·027 ohm.
C1	Y10C/66436	·01 5000V. w., 2 terminals, CHANEX
C2	Y10C/65459	·01 5000V. w., 1 terminal, CHANEX
C3	Y10C/65460	·02 10,000V. w., CHANEX and DUCON, 15,000V. tested Com. Type
C4	Y10C/65683	100 pf. Ceramic, DUCON
C5	Y10C/65654	·1 400V. w. paper dielectric CHANEX
V1	Y10E/75122	Valve, type AV11
V2	Y10E/75122	Valve, type AV11
	Y10F/80102	Switch, toggle H.T. Type P.M.
	Y10KB/500036	Transformer, type TP987B
	Y10KB/500021	" " TP1114B
	Y10KB/500037	" " TP1115C
	Y10A/55527	Meter, 0-50 ma, D.C., type K216
	Y10A/55528	Meter, 0-100 volts, A.C., type K216
	Y10AB/500800	Motor, blower, type A (24V)
	Y10KB/500002	Motor, blower, type B (12V)
	Y10AB/508900	Brush, carbon
	Y10AB/509000	Holder, Brush
P and S1	Y10H/404	Socket, 4 pin, type W150
	Y10H/391	Plug, 4 pin, type W198
P and S2, P and S3, P and S4	Y10H/90373	Pye single ended Plug, Type D402013.
	Y10HB/500400	Plug, Type E1 (Pye)
P and S5	Y10H/90371	Socket, Type PC2F
	Y10HB/500600	Plug, Type MC2M
		ALTERNATIVELY
P and S1	Y10HB/503300	Socket, 4 pin, type W310A

APPENDIX "A"

EQUIPMENT SCHEDULE.

CONTROL PANEL D1.

PART NO.	IDENT NO.	DETAIL
R1	Y10C/66796	Resistor, 500 ohm, 5W, variable
C1	Y10C/65706	·1 _ ·1 200V. w. DUCON
C2	Y10C/65706	·1 _ ·1 200V. w. DUCON
C3	Y10C/65706	·1 _ ·1 200V. w. DUCON
C4	Y10C/65706	·1 _ ·1 200V. w. DUCON
L1	Y10C/65708	Choke, for filter unit
L2	Y10C/65708	Choke, " " " } 150 M A—300V. Inductance 35H (L1–L4)
L3	Y10C/65708	Choke, " " "
L4	Y10C/65708	Choke, " " "
	Y10D/70415	Rectifier full wave, selenium
	Y10DB/500014	Voltage regulator, carbon pile, type 8H.
SW1	G56/12654	Switch, toggle, 5 amp., 24 volt.
F1	Y10H/90222	Fuse, 5 amp
P and S1	Y10H/419	Socket, 2 pin, type W 165
	Y10H/397	Plug, 2 pin, type W 204
P & S2	Y10H/500100	Socket, 6 pin small, type W 154
	Y10H/392	Plug, 6 pin small, type W 199
P & S3	Y10H/404	Socket, 4 pin, type W 150
	Y10H/391	Plug, 4 pin, type W 198
P & S4	Y10H/404	Socket, 4 pin, type W 150
	Y10H/391	Plug, 4 pin, type W 198
P & S5	Y10H/404	Socket, 4 pin, type W 150
	Y10H/391	Plug, 4 pin, type W 198
		ALTERNATIVELY
P and S1	Y10HB/503100	Socket, 2 pin, type W 165A
P & S2	Y10HB/503200	Socket, 6 pin small, type W 154A
P & S3	Y10HB/503300	Socket, 4 pin, type W310A
P & S4	Y10HB/503300	" " " " "
P & S5	Y10HB/503300	" " " " "
	G5C/2162	Panel control type P1
	G5C/2163	Tray, panel control mounting, type P1
		Note :—that W type sockets as above are on cables, plugs are on units.

APPENDIX "A"

EQUIPMENT SCHEDULE.

MISCELLANEOUS.

IDENT NO.	DETAIL
Y10BB/503400	Aerial, Type HR (Dogleg)
Y10BB/500100	Aerial, Type HT (Spike)
Y10BB/500200	Aerial, Type SH (curtain rod)
Y10BB/500300	Aerial, Type SRC (Catalina)
Y10BB/500400	Aerial, Type STC (Catalina)
Y10BB/500500	Support Type A (Standoff)
Y10BB/500600	Support, Type B
Y10BB/500700	Insulator, Type A (Polystyrene)
Y10BB/503300	Insulator, Type B (Catalina)
Y10BB/500900	Feeders, Type H
Y10BB/501000	Feeders, Type C
Y10BB/501100	Guards, Type A
Y10BB/501200	Guards, Type B
Y10BB/501300	Guards, Type C
Y10BB/501400	Boxes, Junction, Type A (3 large)
Y10BB/501500	,, ,, ,, B (2 small, 1 large)
Y10BB/501600	,, ,, ,, C (3 small)
Y10BB/501700	,, ,, ,, D (6 way)
Y10BB/501800	,, ,, ,, F
Y10AB/507700	,, ,, ,, G (night search)
Y10BB/501900	,, ,, ,, R
Y10AB/508400	Boxes, Junction, Type AB (Polystyrene)
Y10AB/508500	Boxes Junction, Type BB (Polystyrene)
Y10AB/508600	Boxes, Junction, Type CB (Polystyrene)
Y10BB/502200	Collar, stub, Type A (for insulator type A)
Y10BB/503000	Clip, Type CX54/4 (for aerial feeders, Type H)
Y10BB/503100	Bar, shorting, type CX54/1 (for aerial feeder type H)
H28C/5870	Wire steel drogue standard
G5A/1510	Cable thimbles
H128F/1799	Links Antenna (rubber)
G5E/30053	Braid copper ¾ in. (for relay)
Y10B/60280	Cable, coaxial, Type PT29M
Y10B/60287	,, ,, ,, PT11M
Y10B/60244	,, ,, ,, PT7M
Y10B/60277	,, ,, ,, PT7C
Y10B/60026	,, ,, ,, PT5M
G5E/156	Cable, braided, Type S2
G5E/167	,, ,, ,, S4
G5E/30048	,, ,, ,, S6
G5E/30021	Cable, electric, LTAWG6
Y10H/90220	Socket, valve, 5 pin Amphenol, bakelite
Y10H/90281	,, ,, 8 ,, ,, ,,
Y10H/90109	,, ,, 4 ,, ,, ,,
Y10H/90218	,, ,, 8 ,, ,, ceramic
Y10H/90070	,, ,, 8 ,, Ducon ,,
Y10H/90186	,, ,, 4 ,, amphenol steatite
Y10H/90213	,, ,, 5 terminal, Acorn type, ceramic