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STANDARD NOTES

FOR

WIRELESS OPERATORS, WIRELESS OPERATORS AIR GUNNER

AND

OBSERVERS W/T

Issued for the information and guidance of all concerned.

By Command of the Air Council,

AIR MINISTRY

GENERAL INSTRUCTIONS FOR GOOD OPERATING

GENERAL OPERATING

1. Procedure

Accurate procedure is essential. It is the shortest method of conveying instructions. Inaccurate procedure throws doubt on the authenticity of the message and increases the receiving operator's difficulties during bad conditions.

The efficiency of W/T communication depends upon :—

(i) Accurate procedure.

(ii) Good operating.

(iii) The intelligent co-operation of all operators.

2. Transmission

All transmissions are to be strictly confined to official communications. Important points to note when transmitting are :—

(i) Transmission must be made at a speed which will allow messages to be received by ALL receiving stations at FIRST transmission and which is consistent with the operator's receiving ability. Repetitions cause more delay than slow sending. Accuracy is always more important than rapidity.

(ii) Call signs must be made distinctly and not run together. There should be word spacing between each call sign and between call signs and the letter " V ".

(iii) Each call sign is to be made once only except when establishing communication with a preliminary call (see " Transmission and Reception " para. 4) or when communication conditions are unfavourable.

(iv) If call signs in the preliminary call are made twice the call signs in the answer are also to be made twice.

(v) Every transmission must end with prosign " K " or " $\overline{AR}$ ". K signifies " Go ahead, transmit " or " This is the end of my transmission to you, and an answer is necessary." $\overline{AR}$ signifies " This is the end of my transmission to you and NO answer is required or expected."

3. Immediate Answer

IT IS IMPOSSIBLE TO OVER-ESTIMATE THE VALUE OF AN IMMEDIATE ANSWER. Failure to answer a call or message immediately, causes confusion and delay. If a message cannot be receipted immediately due to doubt of the accuracy of reception the prosign $\overline{AS}$ must be used at once to indicate that fact.

4. Answering Calls

(i) If doubt exists as to the call sign of the station addressed, the operator must on no account answer. He should await a repetition of the call.

(ii) If an operator hears his station called but cannot distinguish the call sign of the transmitting station, he is to answer the call immediately, making use of the call sign for unknown station $\overline{AA}$ in doing so.

(iii) If a called station fails to answer promptly the preliminary call is to be repeated. If the second call is not answered calling station will wait a reasonable time and then call again making call signs twice, due consideration being given to prevailing circumstances.

When two or more stations are called, the stations will answer in proper sequence unless instructed otherwise. Each station is allowed five seconds in which to answer. A station which fails to answer in its turn must wait until all other stations have had time to answer.

5. Control Stations

(i) Control stations are responsible for the efficient conduct of wireless signalling between stations in the group or section which they control. They will issue all necessary directions for stations to " Go on " or " Wait ".

(ii) THE CONTROL STATION MUST CONTROL THE WIRELESS COMMUNICATION OF ITS SECTION IN ALL CIRCUMSTANCES. This fact cannot be too strongly impressed on operators.

(iii) Control stations may regulate the work of their group or section by ordering a station to :—

(*a*) " Wait ", in which case the operator at the station addressed must maintain receiving watch on its normal frequency until ordered by the control station to " Go on ". The operator at the station which has been so ordered to " Wait ", who has a priority message on hand, must ask for permission to transmit and must wait for permission before actually transmitting such message.

(*b*) Pass its message on another frequency, in which case the operator at the station addressed must re-tune receiver and transmitter to the frequency ordered, pass his message and, unless orders have been received to the contrary, revert to his normal frequency as soon as the message is clear.

6. Obedience to Control Stations

To maintain efficient communication, the control station MUST have the intelligent co-operation and unfailing obedience of all operators. It is therefore the duty of every wireless operator whilst keeping W/T watch to :—

(i) Observe the strictest accuracy in the use of W/T procedure as laid down in Signal Manual, Part III (A.P. 3032).

(ii) Avoid unnecessary signalling, but where it is essential to communicate with the control or other stations in the group, the permissible " Prosigns " must be used.

Information which cannot be conveyed by " Prosigns " must be made the subject of a " Signal Service " message.

(iii) Be considerate, remembering that the control station operator has to deal with a number of stations in rotation; and receive and transmit messages in their order of priority.

(iv) Maintain constant W/T watch until properly relieved or until permission is received from the control station to close down. The time at which such permission is received must be entered in the W/T log and Signal Office diary. The only exception to this rule will be those cases where a station is compelled to close for tactical considerations when it is impossible to await instructions, or when compelled to close during periods of wireless silence. In both instances the control station must be informed at the earliest moment by any means available.

(v) Conform to the W/T routine in force in the group or section. No deviation from this routine is permissible without the concurrence of the control station except as detailed in (iv) above. Operators are reminded that control stations should be regarded as immediate superiors, who are responsible for reporting all cases of irregularity. Such reports will be investigated and disciplinary action taken against the offenders.

7. The Seven Deadly Sins of W/Ops. on M/F D/F

(i) Failure to listen out and search before calling.

(ii) Failure to obey " Control ".

(iii) Failure to tune transmitter correctly.

(iv) Answering and acknowledging traffic for other aircraft.

(v) Excessively long " run " for a " fix " and failure to send call signs during the run (listen for the " break-in " by control).

(vi) Monopoly of an M/F section by one $\overline{\text{SOS}}$ aircraft when there may be others in an even worse plight.

(vii) " Rugby scrum " or " Dogs breakfast "—type of bunch calling which usually ends in the survival of the slickest.

8. W/T Log Book (Ground)

(i) The completeness of his W/T log when compared with those of other stations on the same frequency is the operator's proof of an efficient look out during his tour of duty.

(ii) In the case of messages addressed to the station, which are written direct on to a message pad, the following are to be entered in the log :—

(*a*) Call and preface.

(*b*) Address (unless concealed).

(*c*) Time of origin or date-time group.

(*d*) " P/L " " Code " or " Cypher " to denote type of message received.

(iii) All calls, answers, procedure messages and particulars of messages not covered under (ii) above are to be entered in full in the W/T log.

(iv) Times are to be entered in the appropriate column at frequent intervals ; no interval is to exceed five minutes.

(v) Call signs made twice may be written twice, but this is not necessary. On no account are doubly made call signs to be entered thus—$A5N^2$ or $A5N_2$.

9. W/T Log Book (Air)

The W/T Log Book (Air) is the subject of special instructions and is to be kept strictly in conformity with the orders issued by the various Commands.

The following standard entries in the W/T log book are required by one of the Commands, and are given as an example.

(i) Time on watch (or watch opened). Signature of operator.

(ii) Time W/T and I/C O.K.

(iii) Time I.F.F. on.

(iv) Time airborne.

(v) Time W/T and I/C O.K. pilot informed.

(vi) Time voltages and I.F.F. readings or aural test made—(every 30 minutes).

(vii) Time any signals received and time captain informed.

(viii) Times of switching I.F.F. on and off during flight.

(ix) Times of half-hourly broadcasts or reasons for missing.

(x) Times of any changes of frequency. The station to which change is made should be referred to by its call-sign.

(xi) Time and place landed.

(xii) Time I.F.F., W/T and I/C off.

(xiii) Time batteries disconnected. Signature of operator.

WIRELESS OPERATORS,

ESS OPERATORS AIR GUNN

AND

OBSERVERS W/T

SECTION I

STANDARD NOTES FOR WIRELESS OPERATORS, WIRELESS OPERATORS (AIR) AND NAVIGATORS (W)

These notes are issued for the assistance of airmen under training as wireless operators. They are not intended to form a complete textbook, but are to be used in conjunction with lectures and demonstrations at Radio Schools.

The notes are intended to cover, in a general way, the subjects with which a wireless operator should be familiar. They are not to be considered as official authority for detailed adjustments, for which the appropriate Air Publication is to be consulted.

The notes cannot be issued to each trainee as his personal property, owing to the increased need for economy in paper. They are to be returned at the end of each course, and at all times must be handled carefully. No alterations may be made without the authority of official amendment lists, which will be issued from time to time.

Wireless operators, after leaving their instructional course, will be able to refer to these notes, if necessary, as a limited number of copies has been distributed to all stations.

Many circuit diagrams in this publication show crossing wires not making electrical contact, broken; in future all diagrams will conform to the British Standard Specification No. 530 whereby *all* crossing wires are shown unbroken and those making contact are indicated with a dot.

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TRANSMISSION AND RECEPTION

1. **Types of Messages**

Most traffic consists of one of the following :—

(i) Calls and answers.
(ii) Procedure messages.
(iii) Operating signals.
(iv) Routine messages.
(v) Signal Service messages.
(vi) Operational reports.

2. **Call Signs**

All radio stations are identified by call signs.

(i) Individual Call Sign. A call sign representing a single Command Headquarters, Station, Unit, etc.
(ii) Collective Call Sign. A single call sign representing two or more individual call signs.
(iii) Group Call Sign. A single call sign covering all the W/T stations working in a particular group.

3. **Sequence of Call Signs**

Call signs must appear in alphabetical order; for this purpose the figures 1 to 0 are the 27th to 36th letter of the alphabet respectively.

Call signs take priority according to the order in which their component symbols appear in the 36-letter alphabet.

4. **Preliminary Call**

Made to establish communication between two stations or to ensure the attention of another station or stations prior to transmitting traffic.

To establish communication or to ensure attention as above, call signs are made twice, e.g., **QB9 QB9 v 3FR 3FR K.**

In other cases call signs are only made once, e.g., **QB9 v 3FR K.**

If message to follow is of priority " P " or higher, priority may be transmitted in the preliminary call, e.g., **QB9 QB9 v 3FR 3FR P K.**

5. **Signal Strength and Readability**

Strength.	*Readability.*
1. Hardly perceptible ..	Unreadable.
2. Weak	Readable now and then.
3. Fairly good	Readable, but with difficulty.
4. Good	Readable.
5. Very good	Perfectly readable.

6. **Procedure Messages**

A procedure message is a short Plaindress (plain address) message, used to expedite signalling. Procedure messages consist of the Heading and the Body.

(i) *The Heading* will always contain a call and may contain an address, indication of priority and/or message instructions.
(ii) *The Body* of a procedure message may consist of Prosigns and/or Operating Signals, Address Signs or Call Signs identification data of a message or part(s) of a message and an ending sign. It may also contain final instructions.

The group count is not used in procedure messages. The long break sign is not used to separate the text of a procedure message from the other components.

A procedure message may carry that degree of priority considered necessary to ensure accomplishment of its purpose.

7. Component Parts of a W/T Message

A W/T message consists of two main divisions, the Heading and the Body.

(i) *The Heading* consists of :—

(*a*) The call.
(*b*) The preamble.
(*c*) The address.
(*d*) The message instructions.

(ii) *The Body* consists of :—

(*a*) The text.
(*b*) The message ending.

8. Priority Prosigns

Authorized Priority Markings		Prosigns	
British	American	British	American
Most immediate	—	OU	—
Emergency enemy aircraft	—	OA	—
Emergency	Urgent	O	O
Immediate	Operational priority ..	OP	OP
Important	Priority	P	P
Ordinary	Routine	—	R
Deferred	Deferred	D	D

9. Phonetic Alphabet

When necessary to identify any letter of the alphabet the standard phonetic alphabet is to be used. This alphabet is listed below :—

(i) *Letters*

Letter.	*Spoken as.*	*Letter.*	*Spoken as.*
A	Able	N	Nan
B	Baker	O	Oboe
C	Charlie	P	Peter
D	Dog	Q	Queen
E	Easy	R	Roger
F	Fox	S	Sugar
G	George	T	Tare
H	How	U	Uncle
I	Item	V	Victor
J	Jig	W	William
K	King	X	X-Ray
L	Love	Y	Yoke
M	Mike	Z	Zebra

(ii) *Numerals* :—

Figure.	*Spoken as.*	*Figure.*	*Spoken as.*
0	Zero	5	Fi-yiv
1	Wun	6	Six
2	Too	7	Seven
3	Thuh-ree	8	Ate
4	Fo-wer	9	Niner

USE OF MESSAGE PAD

1. A specimen message form in which the spaces have been numbered for reference is shown in the diagram. Spaces 1 to 9 inclusive are the only spaces which concern the originator of the message, he is to complete all these spaces and is not to make entries in the others. Accuracy, Brevity and Clarity must be watchwords when filling in message forms.

2. **Space 1 and 2.** The message is to be addressed to the unit or formation, never to individual or section and block capitals will be used. Signals are "addressed" for action.

"Repeated" addresses are to be written in space 2. This space is for the names of units who are to receive the signal but from whom no action is required. Signals are "repeated" for information only.

3. **Space 3.** This address is to be from the unit or formation and not from yourself or section. No signature is to be inserted here but in the space 9 or 10 at the foot of the form.

4. **Space 4.** Originator's Number and Date. Reference number of one or two letters and up to three figures. Air Ministry and Record Office use four figures.

Date is to be written in plain Arabic figures with the first three letters of the month in block capitals, as "14 APR". No oblique strokes are now used. Date is to be that on which the message is signed ready for dispatch.

5. **Space 5.** Subject Matter. Write clearly and briefly with only one word in each space. Names in block capitals and plain Arabic figures. Full stops are to be encircled thus ⊙, no other punctuation marks will be used. When essentially for the attention of an individual the message may commence "For F/L PLUM" etc. Reference to past communications may be made at the beginning of the text. Equipment prefixes :—"A.O.G." = Aircraft on Ground, "I.O.R." = Immediate Ops Requirement.

6. **Space 6.** This space is to be completed when transmission may be sent as written ; it has three alternatives, two of which are to be struck out.

(i) "*By ANY Signal method*". Used only in emergency where need for speed outweighs all other considerations, or when the message contains material intended for publication.

(ii) "*NOT by wireless*". Used when a landline is known to exist and the subject matter of the message may be seen by the transmitting personnel. If it is desired to confine transmission of the message to Service Teleprinter it must also be marked "SECRET" or "CONFIDENTIAL" in the Originator's instructions.

The Signals Service have authority to convert P/L messages so marked to cypher messages and to dispose of them by W/T without reference to the originators. (A.M.O. A.938/40 refers).

(iii) "*But if liable to Interception or Capture SEND in CYPHER*". Must be used when not essential to send the message in cypher and alternatives (1) and (2) do not supply. Should be used for a large percentage of all messages. Enables "Sigs" to use discretion and send such signals in P/L to all addressees to whom secure means of transmission exist. Where such secure means are not available, the message will be passed back to the cypher office for encyphering.

7. **Space 7.** Space to be completed when transmission must be in cypher i.e., when contents of the message must be concealed from Signals personnel in the course of transmission, however secure such transmissions may be from enemy interception. The alternative not required is to be struck out.

(i) "*By ANY Signal Method*" is the normal marking for messages in cypher.

(ii) "*NOT by Wireless*". Used only if the message is of exceptional secrecy.

8. **Space 8.** This space is for the originator's instructions and the degree of priority of the message. If no originator's instructions or degree of priority are required, a line should be drawn through this space.

"Deferred"—permits a delay of transmission till after midnight for delivery by 0900 hours next day (48 hours overseas); "Top Secret"—authority Wing Commander upwards; "Secret", "Confidential", "Restricted", "Nodeco", handled by commissioned ranks only.

9. **Space 9.** Date-time group. To consist of six figures and one letter. First two figures consist of date: second two represent the hour; last two show minutes.
E.g., 1130 on the 15th of the month in Double Summer Time would read "151130B". (A = B.S.T. B = D.S.T. Z = G.M.T.)

R.A.F. Form 96. MESSAGE FORM Signal Office File No.......

MESSAGE HEADING	IN	No. of Groups GR	Office Date Stamp
	OUT		

(Above this line is for Signals use only)

FROM	3
TO	1
REPEATED	2

Originator's Number 4	Date	(Write horizontally)		
				5
				10
				15
		5		20
				25
				30
				35
				40
				45
				50

May be sent AS WRITTEN *(1) By ANY Signal Method *(2) NOT by Wireless *(3) But if liable to Interception or Capture SEND IN CYPHER	Send in CYPHER *(1) By ANY Signal Method *(2) NOT by Wireless	Date-Time Group
6	7	9
Signature	Signature........	Originator's Instructions Degree of Priority
Rank........	Rank........	8

(* Strike out methods which do not apply. Below this line is for Signals use only.)

System in	Time in	Reader	Sender	System out	Time out	Reader	Sender	System out	Time out	Reader	Sender	T.O.R.

D.4255 Wt.15534,0535 207,000 Pads 7/43 T51-7162 D&Co.(5)Ltd.

SECTION I

Article 1

5. **Control Stations.**—(*a*) Control stations are responsible for the efficient conduct of wireless signalling between stations in the group or section which they control. They will issue all necessary directions for stations to " Go on " or " Wait ".

(*b*) THE CONTROL STATION MUST CONTROL THE WIRELESS COMMUNICATION OF ITS SECTION IN ALL CIRCUMSTANCES. This fact cannot be too strongly impressed on operators.

(*c*) Control stations may regulate the work of their group by :—

(i) Ordering a station to " Wait " in which case the operator at the station addressed must maintain receiving watch on its normal frequency until ordered by the control station to " Go on ". The operator at the station which has been so ordered to " Wait ", who has a priority message on hand, may make the special preliminary call, but must wait for permission before actually transmitting such messages.

(ii) Ordering a station to pass its message on another frequency, in which case the operator at the station addressed must re-tune receiver and transmitter to the frequency ordered, pass his message, and unless orders have been received to the contrary, revert to his normal frequency as soon as the message is clear.

(iii) Ordering wireless silence. As soon as the necessity for such silence has passed, the control station ordering it will make the " Negative Silence " sign. It is obvious that on the relaxation of wireless silence, a considerable rush of messages is likely to be experienced, and the only way in which delays and congestion of traffic can be avoided is by the rigorous observance of para. 6 (*a*) to (*f*).

6. **Obedience to Control Stations.**—To maintain efficient communication, the control station MUST have the intelligent co-operation and unfailing obedience of all operators. It is therefore the duty of every wireless operator whilst keeping W/T watch :—

(*a*) To observe the strictest accuracy in the use of W/T procedure as laid down in Signal Manual, Part III.

(*b*) Always to transmit at a speed which will allow messages to be received by all receiving stations at first transmission and which is consistent with his own receiving ability.

(*c*) To avoid unnecessary signalling, but where it is essential to communicate with the control or other stations in the group, the permissible operating or procedure signals must be used.

Information which cannot be conveyed by " Operating " or " Procedure " signals must be made the subject of a " Signal Service " message.

(*d*) To be considerate, remembering that the control station operator has to deal with a number of stations in rotation ; and to receive and transmit messages in their order of priority.

(*e*) To maintain constant W/T watch until properly relieved or until permission is received from the control station to close down. The time at which such permission is received must be entered in the W/T log and Signal Office diary. The only exception to this rule will be in those cases where a station is compelled to close for tactical considerations when it is impossible to await instructions, or when compelled to close during periods of wireless silence. In both instances the control station must be informed at the earliest moment by any means available.

(*f*) To conform to the W/T routine in force in the group or section. No deviation from this routine is permissible without the concurrence of the control station except as detailed in (*e*) above.

(*g*) Operators are reminded that control stations should be regarded as immediate superiors, who are responsible for reporting all cases of irregularity. Such reports will be investigated and disciplinary action taken against the offenders.

GENERAL INSTRUCTIONS FOR GOOD OPERATING

1. **Accurate Procedure** is essential. It is the shortest method of conveying instructions. Inaccurate procedure throws doubt on the authenticity of the message and increases the receiving operator's difficulties during bad conditions.

2. **Transmission.**—(*a*) Make call signs distinctly.

(*b*) Transmit at such a speed that *all* receiving stations receive the message at the *first* transmission. Repetitions cause more delay than slow sending. Accuracy is always more important than rapidity.

3. **Immediate Answer.**—Failure to answer a call or a message immediately causes confusion and delay. If a message cannot be receipted immediately due to doubt of the accuracy of reception, the correct " procedure " signal (Q or H—*see* Page 7, paragraph 3(*b*)) must be used at once to indicate that fact.

4. **Answering Calls.**—(*a*) If doubt exists as to the call sign of the station *addressed*, the operator must on no account answer. He should await a repetition of the call.

(*b*) If an operator hears his station called but cannot distinguish the call sign of the transmitting station, he is to answer the call immediately, making use of the call sign for unknown station (AA) in doing so.

5. **Obedience to Control Stations.**—(*a*) The control station has to maintain order and ensure efficient signalling by all stations within the group. Such an attainment requires the intelligent co-operation and unfailing obedience of all operators.

(*b*) Unnecessary signalling causes interference and delay, and is a sign of bad operating.

(*c*) Communications to control and other stations in the group must be done by using " operating " and " procedure " signals where possible. If the point in question cannot be covered by this method, it must be made the subject of a " Signal Service " message.

W/T LOG BOOK

1. The completeness of his W/T log when compared with those of other stations on the same frequency is the operator's proof of an efficient look out during his tour of duty.

2. In the case of messages, addressed to the station, which are written direct on to a message pad, the following are to be entered in the log :—

Call and preface, address (unless concealed), time of origin, and " P/L ", " code ", or " cypher ", to denote the type of message received.

3. Enter in full in the W/T log all calls, answers, procedure messages and particulars of messages not covered under (2).

4. Times are to be entered in the appropriate column at frequent intervals ; no interval is to exceed five minutes.

5. Call signs made twice may be written twice, but this is not necessary. On no account are doubly made call signals to be entered thus—$A2N^2$ or $A2N_2$.

USE OF MESSAGE PAD

A specimen message form, in which the spaces have been numbered for reference, is shown at fig. 1.

1. Spaces 1 to 8 are the only spaces which concern the *originator* of the message ; he is to complete all these spaces, and is not to make entries in the others.

(*a*) Spaces 1 and 2. Address " To " and " From ". Recognised abbreviations may be used. When the message is addressed to formations or units, numerals must be written in plain arabic figures. Place

R.A.F. Form 96.
S 575 (Naval)

MESSAGE FORM.

Office Serial No. 10

Call and:— Preface		No. of Groups GR	Office Date Stamp.
IN / OUT	12	11	15

(Above this line is for Signals use only)

TO* 1

FROM*	Originator's Number	Date	In Reply to Number and Date
2	3		

4

This message must be sent AS WRITTEN and may‡..........be sent by W/T. Signature 5	This message must be sent IN CYPHER and may‡..........be sent by W/T. Signature 6	Originator's Instructions.* Degree of Priority.* 7	Time of Origin. 8

‡ Originator to insert "NOT" if message is not to go by W/T over any part of the route.

(Below this line is for Signals use only.)

T.O.R. 14

System in	Time in	Reader	Sender	System out	Time out	Reader	Sender	System out	Time out	Reader	Sender	T.H.I.
						13						9

* The Signal Department is responsible that these details are transposed to the appropriate portion of the message form and that all possibility of compromising distinguishing signals, etc., by omitting to remove their signification from the address, etc., is avoided. Before delivery of the message these details are to be re-inserted in P/L.

names should be omitted unless essential for accurate transmission. For multiple address messages, a separate form will be made out for signals staff for each addressee, in order that all available channels of communication may be used simultaneously. Each form is to contain all the addresses in space 1.

Space 3. The originator's number will usually consist of a letter to indicate the branch or department, followed by not more than three figures. The date is to be written "31/10". The message under reply is to be referred to briefly, e.g. "Your M/31. 24/10" or by time of origin and date if there is no reference number. Similarly "My . . . ." is to be used to refer to previous messages from the originator.

Space 4. The subject matter is to be written with only one word in each space provided. No punctuation marks other than full stop and comma will be used. These are to be indicated by the appropriate mark with a ring drawn round it. Dates in the subject matter will be written as "2 JAN", not 2/1. (This does not apply to dates following reference numbers.) Roman figures, underlinings and signs such as those for feet and inches must not be used. Recognised abbreviations may be used.

Spaces 5 and 6. The originator *signs* in one of these spaces to authorise the message. He must sign in the appropriate space depending upon whether the message is to be sent "as written" or "in cypher", and he must indicate whether it is to be sent by W/T or not.

Space 7. Instructions "To be acknowledged" or "For exercise" will be inserted here, together with the degree of priority, if any, and the "Method of despatch" if the originator considers it essential to specify the method to be used.

Space 8. The time of origin must always be inserted by the originator. It will be the nearest minute in the 24-hour system.

paces 9 to 15 are for the use of the signal staff who are responsible following items in any message handed in at a signal office :—

Inserting in space 9 the time message was handed in.

Scrutinising the message and ascertaining that all instructions in paragraphs 1(*a*) to 1(*f*) have been complied with. If there is any doubt as to the subject matter or the instructions in spaces 5, 6 and 7, the message will be referred to the originator.

Space 10. The office serial number.

Space 11. The number of groups is to be counted and space 11 filled in. (*See* Page 11, paragraph 2.)

Space 12. The call "Out" and the "Preface" (comprising originator's instructions, delivery instructions, and number of groups) will be filled in after the route has been decided. In multiple address messages the call signs will be arranged in correct sequence by the signal staff. Instructions from space 7 will be transferred, in the correct form (*see* Page 7, paragraph 3(*b*)) to appropriate positions in space 12. After the call, preface, address and "Instructions to acknowledge" have been transferred to space 12 in the correct form and sequence (as above), a line should be drawn through spaces 1 and 2 to avoid compromise of call signs as the result of addresses in these spaces being transmitted in error.

Space 13. *After transmission* :—

System out : This space to contain an abbreviation of the system used, e.g. "W/T", "L/T".

Time out : The time the message was despatched (in normal working the time that "R" is received for the message (*see* Page 7, paragraph 3 (*b*)).

Reader: When using "W/T", "R/T" (radio-telephony), "L/T" (line telegraphy, teleprinter), "V/S" (visual signalling by lamp or flag) this space should contain an abbreviation of the name (not call sign) of the receiving stations. In telephone messages the initials of the receiving operator are inserted.

Sender: This space should contain the initials of the sending operator.

Space is available to duplicate these entries in the case of a message sent by more than one channel or at different times.

3. **Received Messages.**—(*a*) The signal staff is responsible that a message is correctly received and is written correctly and legibly on the message form. All call signs and procedure signals in the call, preface and address are to be written in block letters.

(*b*) "*In*" *messages.*—The call, preface and address will be entered in space 12 by the *receiving* operator, care being taken that when carbons are used the call signs appear on the original copy only. The address will be transposed to plain language and inserted in spaces 1 and 2 on original and copies. In multiple address messages the call signs of *all* addressees will be transposed to P/L and inserted in spaces 1 and 2.

Copies delivered to the addressees must be clear of all call signs: the original copy bearing call signs is to be retained in the signal Office. The originator's instructions, degree of priority and "Instructions to acknowledge" to be stamped on the message form in a prominent position, without obliterating any details of the subject matter or of the address in spaces 1 and 2. Spaces 10 and 15 to be filled in as for an "Out" message.

Space 13:—

System in: "W/T", "R/T" etc.
Time in: Time message was received.
Reader: Initials of receiving operator.
Sender: Left blank except in telephone messages, when the initials of the sending operator are inserted.

(*c*) "Through messages", i.e. messages received through one channel of communication for re-transmission by another, are dealt with in a similar manner to "In" messages and "Out" messages.

(*d*) Space 14. The use of time of receipt (T.O.R.) is followed by four figures which may be followed by a date, as in the case of the time of origin. It is *not* counted as a group. The T.O.R. is employed by the transmitting station to indicate to the receiving station the time at which the transmitting station received the message from another station, and will only be employed when the difference between it and the time of despatch at the linking station exceeds 30 minutes.

TRANSMISSION AND RECEPTION

1. **Types of Messages.**—Most traffic consists of either:—
   - (*a*) Calls and answers.
   - (*b*) Procedure messages.
   - (*c*) Operating signals.
   - (*d*) Routine messages.
   - (*e*) Signal service messages.
   - (*f*) Operational reports.

2. **Calls and Answers.**—(*a*) *Preliminary call,* consisting of:—

Commencing sign	$\overline{VE}$ (made as one group).
Call sign of station being called	A2C A2C
From	V
Call sign of station calling	L6N
Ending sign	$\overline{AR}$

(*b*) *Multiple call.*—Similar to preliminary call but is used where two or more stations are being called. Call signs to be made in alphabetical or numerical sequence (if first letter the same, the numeral decides, if numeral the same, the last letter decides), e.g. :

Example : $\overline{\text{VE}}$ A2C A2C A2L A2L B3Q B3Q v L6N $\overline{\text{AR}}$

(*c*) *Collective call.*—Where a group of stations is being called with group call sign, e.g. :

R6D
S2V } No. 1 Section collective call A2N
L3O

Example : $\overline{\text{VE}}$ A2N A2N v L6N $\overline{\text{AR}}$

Stations answer in alphabetical order, each station allowed 10 seconds to answer.

Note.—All " receiving " call signs are made twice in these calls.

(*d*) *Answer to a call.*—Consists of signal K (" carry on signalling ") followed by a numeral to indicate signal strength.

1. Just audible.
2. Very faint, unreadable.
3. Just readable.
4. Faint.
5. Rather faint.
6. Fair.
7. Good.
8. Strong.
9. Very strong.

Example : H3U makes $\overline{\text{VE}}$ A4L A4L v H3U $\overline{\text{AR}}$

A4L answers $\overline{\text{VE}}$ H3U v A4L K7 $\overline{\text{AR}}$

(*e*) *Failure to answer a call.*—A transmitting operator calling should wait 10 seconds and call again. If no answer is received, call again in one minute, after which repeat call every five minutes. In the case of multiple or collective calls, should a station fail to answer within 10 seconds, the next in sequence answers. Stations missing their turn wait until all other stations have answered.

3. (*a*) **Procedure messages** are used between W/T stations to convey certain signalling instructions, usually relative to messages transmitted or received at the moment, or in the immediate past or future.

The *subject matter* consists of procedure letters (*see* list below).

(*b*) *Procedure letters* are also used in routine messages ; the following list gives the meaning and use of all such letters.

Letters	Used in	Meaning	Remarks
A	(i) Procedure ..	(i) For plain language messages : " Verify and repeat ".	
	(ii) Procedure ..	(ii) For code or cypher messages : " Verify, check from decode and repeat ".	(ii) Requires reference to the originator for confirmation.

Letters	Used in	Meaning	Remarks
B	(i) Procedure .. (ii) Other messages. (iii) Final instructions.	(i) "Has message . . . been received ?" (ii) "This ends the portion just transmitted up to and including word or group number. . . ." (iii) "I have a further message for you (or for the station whose call sign is indicated)".	(i) Example : B NR3. (ii) For transmitting a message in portions. Used at the end of each portion (except the last). Example : B.39. (iii) Example : = 1030—B.$\overline{\text{AR}}$
C	(i) Procedure .. (ii) Procedure .. (iii) Final instructions.	(i) "You are correct". (ii) "Correct version of message . . . is . . .". (iii) "Following is the correct version of . . .".	(ii) Example C NR6 etc. (iii) Used to correct an error.
D	Originator's instructions.	"Important".	
$\overline{\text{E}}$	Final instructions	"I am about to transmit a further message without waiting for an answer to this one".	
F	Delivery instructions.	"Not to be answered".	
G	(i) Delivery instructions. (ii) Procedure ..	"Repeat back". "Repeat back message . . . ."	(ii) Example G.NR4
H	Procedure ..	"I am counting the groups in the message just transmitted by you".	
J	Procedure ..	"Check from decode and repeat".	For code or cypher messages *only*. Requires reference to the cypher staff.
K	Procedure ..	"Go on".	
L	Delivery instructions.	"Pass this message to those of the addressees for whom you are responsible".	
M	Delivery instructions.	"Pass via".	Example : M—D4B—
$\overline{\text{N}}$	Procedure ..	(i) "Nothing received". (ii) When followed by identity of message. "Message . . . has not been received".	(ii) Example $\overline{\text{N}}$ NR5
O	Originator's instructions.	"Emergency".	May be used in a special preliminary call.
O–A	Originator's instructions.	"Emergency—enemy aircraft".	As for O.
O–U	Originator's instructions.	"Most immediate".	As for O.

Letters	Used in	Meaning	Remarks
P	Originator's instructions.	"Immediate".	As for O.
Q	(i) Procedure .. (ii) Any message.	(i) "Wait". (ii) "Am obliged to wait".	(ii) Used at any point of a message by a transmitting station.
R	(i) Procedure .. (ii) Procedure ..	(i) "Message received". (ii) When followed by identity of message. "Message . . . has been received".	(ii) Example: R NR4.
S	(i) Procedure .. (ii) Originator's instructions.	(i) "Am W/T guard on the frequency you are using for the station(s) you have called (or for . . .)". (ii) "Signal service message".	(i) Example: VE D4B v K6O S–K $\overline{\text{AR}}$ or VE D4B v K6O S–A4L–K $\overline{\text{AR}}$
T	Delivery instructions.	"Pass to".	Example: T—D4B.
V	Call	"From".	
W	Address	"Repeated to . . . . for information".	
X	(i) Procedure .. (ii) Procedure .. (iii) Originator's instructions.	(i) "Am experiencing interference". (ii) Followed by a figure: "Interference is due to atmospherics of the strength denoted". (iii) "This message is for exercise".	Example X7.
Y	(i) Address .. (ii) Procedure .. (iii) Procedure ..	(i) "Message which follows to be acknowledged as soon as W/T may be used, or V/S or L/T become available. (ii) Followed by identity of message. "Message . . . understood". (iii) Precede by interrogative sign, followed by identity of message. "Is message . . . . understood".	Example: —Z D4B v K6O—Y AAA Example: Y1030 or YA28 Used to hasten or call for an acknowledgment. Example: $\overline{\text{INT}}$ Y1100.
Z	Address	"Addressed to".	

4. **Operating Signals** contain the letter X followed by figures, made as one group and used to convey more detailed signalling instructions in relation to messages, or to discuss technical points of operating or equipment. A special code of numbers is used. Example: $\overline{\text{VE}}$ H3U v A4L X278 $\overline{\text{AR}}$, where X278 is assumed to mean "What is my signal strength ?"

5. **Routine Messages.**—(*a*) (i) Used between departments of one H.M. service station and departments of any other H.M. service station for brief correspondence or for correspondence which must not be subject to postal delay.

(ii) The originator is responsible for handing in the message, correctly signed and addressed, to the signal office.

(iii) The signal staff is then responsible for routeing, clearing and delivering the message to the appropriate addressees with the minimum delay.

(*b*) (i) The call sign used by a W/T station is usually that allotted to the H.Q. of the service station at which it is situated. Messages between headquarters of stations may need only the call signs of the W/T stations as an address :—

e.g. :	The call	$\overline{\text{VE}}$ S8T v R3O NR4
	Number of words ..	GR15
	Subject matter	Q/641. Stores despatched, etc.
	Time of origin	1020
	Ending sign	$\overline{\text{AR}}$

Assume that S8T is the call sign of Detached Flight, Chipping, and R3O is the call sign of R.A.F. Station, Melkton. Message would be originated by the C.O. Melkton or his deputy and would be passed to the C.O. at Chipping. No further address is required.

(*c*) *Addressed messages—Routeing.*—(i) It is often necessary to pass a message to one or more addressees through linking stations.

(ii) In the case of P/L messages, it is the responsibility of the signals staff to decide, and clearly indicate, the route by means of procedure letters and call signs (plain language cannot be used for this).

(*d*) (i) *Automatic responsibility.*—Any W/T station to whom a message is passed is *automatically responsible* for delivering the message to all authorities or departments included in the address belonging to the R.A.F. station where the W/T station is situated. No " Delivery instructions " are required to indicate this.

(ii) *Responsibility.*—Must not be confused with " Automatic responsibility " above. It is the responsibility that a control station has for the stations in its section.

6. **A Signal Service Message** originates from the signal staff at a station, is addressed to the signal staff at another station, and deals only with the control, operation and maintenance of the signal communication system.

7. **Operational Reports** are similar to routine messages, but may have slight variations peculiar to different types of work.

COMPONENT PARTS OF A MESSAGE

1. A W/T message is divided into two parts :—
   (*a*) The call ;
   (*b*) The body.

2. The body is divided into two parts :—

(*a*) The preface, comprising ..	(i) Originator's instructions.
	(ii) Delivery instructions.
	(iii) Number of groups.
(*b*) The text, comprising ..	(i) Address.
	(ii) Subject matter.
	(iii) Time of origin.
	(iv) Ending.

IDENTIFICATION, GROUPS AND SPECIAL SIGNS IN MESSAGES

1. **Identifying a Message.**—A message may be identified by reference to :—
   (i) Series number (together with the rest of the CALL if necessary).
   (ii) Time of origin (together with the address, if necessary).

(*a*) *Series number.*—NR followed by a number indicates " Series number of transmitting station ". Used to indicate the daily sequence of messages passed between a transmitting station and each W/T station with which it *revised by A.L. 2*

		No.	Name of Component	Code Message	Code Message	P/L Message	Procedure Message
CALL		1	Call	H3K K3W v D5B NR2 NR4—	F5R v P3T NR9—	G6L v D8S NR2	M5Q v B3R
BODY	PREFACE	2	Originator's instructions	P—	OP—		
		3	Delivery instructions	K3W—T—B3R—		T—L3F—	
		4	No. of words or groups	GR 25—	GR 42=	GR 16—	
	TEXT	5	Address	Z—H3K K3W— W—B3R v K3G		Z—M5R v C3Q— Y AAA	
		6	Subject matter	A462—29 AUG GYBUS, etc.=	RAXUP, etc.=	M321—14 OCT Following airmen, etc.=	N̄—B NR8—X261
		7	Time and date of origin	291425B	291426B—	141806A	
		8	Ending: Time of receipt		TOR 1456		
			Ending: Final instructions	H3K—B2–K	K	K	K

Table I

		No.	Name of Component		Code Message	Code Message	P/L Message	Procedure Message
CALL		1	Call		VE H2K K6W v D4B NR2 NR4–	VE F4R v P3T NR9–	VE G6L v O8S NR2	VE M4Q v B2R
BODY	PREFACE	2	Originator's instructions		P–	O–P–		
		3	Delivery instructions		K6W–T–O3R–		T–L3F–	
		4	No. of words or groups		GR 25–	GR 42=	GR 16–	
	TEXT	5	Address		Z–H2K K6W–W–O3R v K2G=		Z–M4R v C2Q–Y AAA	
		6	Subject matter		A462–29/8–GYBUS, etc.=	RAXUP, etc.=	M321–14/10 Following airmen, etc.=	N–B NR8–X261
		7	Time and date of origin		1425B/29–	1426B/29–	1906A/14	
		8	Ending	Time of receipt		TOR 1456		
				Final instructions	H2K–B2+	+	+	+

DEGREES OF PRIORITY

Originator's Priority Marking	Application	Procedure Equivalent	Delay Allowed	Remarks
(*a*) Most Immediate	Messages of vital importance. Used only in strained relations or in time of war.	O—U	None	If delay allowed is exceeded originator should be informed; meanwhile every effort should be made to clear message. If further delay is obvious message should be passed by some other means, the originator's authority being obtained when possible. If delay occurs at a linking station, office of origin should be informed by Operating Signal.
(*b*) Emergency—Enemy Aircraft ..	Reports of enemy aircraft (3 or more). One or more enemy aircraft seen to be attacking. Not to be used for any other purpose.	O—A	None	
(*c*) Emergency	Operational messages of vital importance not coming under (*b*) above.	O	15 mins.	
(*d*) Immediate	Messages of extreme importance. Operational messages of less importance than (*c*) above.	O—P	30 mins.	Deferred (D) messages may be handed in at any time during the day, transmitted after 0001 hrs. the following morning and delivered to addressee by 0900 hrs. If not cleared by 0900 hrs. deferred messages are to be treated as ordinary signal traffic
(*e*) Important	Messages which are important but do not justify use of "Immediate" but which should be given precedence over ordinary signal traffic. Movement of own aircraft, weather reports and requests for same when necessary.	P	45 mins.	

is in direct communication. A record ("Check sheet") is kept of all series numbers, both "IN" and "OUT"—commencing at 00.01 hours daily. When a message is received for transmission the next number on the check sheet for that particular station should be used. When the signal has been cleared the number should be crossed off. For the "IN" check sheet the numbers are crossed off as messages are received.

Examples :—

"Out" Check Sheet

Out	R.A.F. Station, Melkton	Date....
YAPTON ..	~~1~~ 2 ~~3~~	
LYATT ..	~~1~~ ~~2~~ ~~3~~ ~~4~~	
MINTY ..	~~1~~ ~~2~~ ~~3~~ 4 ~~5~~ 6	
CORTON ..	1	

For YAPTON NR2 awaiting transmission, NRs 1 and 3 cleared.

For LYATT four messages cleared.

For MINTY NRs 1, 2, 3 and 5 cleared, NRs 4 and 6 awaiting transmission.

For CORTON NR 1 awaiting transmission.

"In" Check Sheet

In	R.A.F. Station, Melkton	Date....
YAPTON ..	~~1~~ ~~2~~ ~~3~~ ~~4~~ 5 ~~6~~ 7 8 9 10 etc.	
LYATT ..	~~1~~ ~~2~~ ~~3~~ 4 5 6 7 8 9 10 etc.	
MINTY ..	1 2 3 4 5 6 7 8 9 10 etc.	
CORTON ..	1 2 3 4 5 6 7 8 9 10 etc.	

From YAPTON NRs 1 2 3 4 and 6 received, NR 5 still outstanding.

From LYATT NRs 1 2 and 3 received.

(*b*) *Multiple calls.*—A series number must be allotted for each station in the call and made in the same sequence as the call signs.

Example : $\overline{\text{VE}}$ ABC DEF GHK v HPU NR3 NR5 NR4 etc.

(*c*) *Collective calls.*—A series number must be allotted for each station in the group and made in correct sequence.

Example : $\overline{\text{VE}}$ DLN v HPU NR1 NR4 NR3 NR6 etc.

(DLN is a group of four stations, ABC DEF GHK and LMN).

2. **Group Sign (GR).**—Followed by a number so as to form one group, signifies : Message contains the number of words or groups indicated, e.g. GR45.

(*a*) *Brief method of counting groups.*

Count as one group : Full stop sign ($\overline{\text{AAA}}$) (.)
Comma signs (III) (,)
Pair of brackets ($\overline{\text{KK}}$)
Inverted commas ($\overline{\text{RR}}$) (" ")
All recognised abbreviations, i.e., R.A.F., G.P.O., L.S.D. OR 1/7/40
Time of origin.

Hyphenated words are counted separately ; the hyphen is part of the word before it.

Do not count : Full stop sign ($\overline{\text{AAA}}$) commencing subject matter.
Long break before time of origin.
Time of receipt (when sent).
Any other punctuation signs.

Note.—Comma and full stop should be "ringed" when written.

3. **Originator's Number.**—This consists of a letter (indicating the originating department) and a number (the departmental serial number). Previous messages are referred to by the originator (but not by the signal staff) by the originator's number. It is the first group of the subject matter of a message.

4. **Punctuation Signs :**

Ø $\overline{\text{AAA}}$	=	Full stop	.
$\overline{\text{BT}}$	=	Long break	=
II	=	Separative	—
Ø III	=	Comma	,
$\overline{\text{EX}}$	=	Fraction separative : e.g. 14¾ is made 14 $\overline{\text{EX}}$ 3 $\overline{\text{XE}}$ 4	
$\overline{\text{XE}}$	=	Oblique stroke	M/24
Ø $\overline{\text{KK}}$	=	Left and right hand parenthesis (brackets)	( )
Ø $\overline{\text{RR}}$	=	Inverted commas	" "
$\overline{\text{UK}}$	=	Underline or block letters	Not or NOT
$\overline{\text{FI}}$	=	Decimal point	·5
$\overline{\text{DU}}$	=	Hyphen	Under-carriage.

N.B.—Only those signs marked Ø are counted as groups.

5. **Degree of Priority.**—In order to indicate to addressees and to signalling staffs the degree of urgency of any message, the originator may mark them "Important", "Immediate" etc. The priority is transposed to the originator's instructions by the signals staff, certain procedure letters being allotted for this purpose. (*See* Page 7, paragraph 3(*b*).)

TELEPRINTER OPERATING

1. **Tariff "D".**—This system operates over normal telephone speech lines and communication is established by means of the telephone. Thus the calling operator asks his exchange for the exchange to which the addressee, or responsible station, is connected.

When the exchange answers, he is to identify himself and say "Traffic for you. Over". The station called is to acknowledge by saying "Over", when both operators are to switch over to teleprinter and the calling operator is to press "Figures" and "D" (Who are you ?) key. This will cause the name of the station called to be typed out on both machines. The operator called will then press "Figures" and "D" (Who are you ?) key on his machine, which will cause the name of the calling station to be printed on both machines. This is called "taking the answer back".

The transmitting operator is then to transmit his message. (*See* part 3, Teleprinter Instructions, D.T.N. procedure for layout of message.)

On conclusion of the message, i.e., having sent the time of origin, the transmitting operator is to add any final instructions and his initials.

The receiving operator is then to ask for any repetitions required and when satisfied as to correct reception, is to make "R" followed by the time of receipt and his initials, giving "K" if transmitting operator has made "B" in final instructions.

On conclusion of traffic both stations are to switch over to "telephone".

2. **Defence Teleprinter Network (D.T.N.).**—*Originating a call.* (*a*) The space-bar of the teleprinter is to be depressed continually to call the exchange. The relative calling lamp on the switchboard will flash and the switchboard operator is to plug into the associated line jack, and then print the code of the centre, followed by "SWBD", e.g., HUC SWBD—Hucknall switchboard.

(*b*) The name of the required station, as shown in the "Answer back" column of the D.T.N. Directory, is then to be teleprinted to the switchboard. The switchboard operator is to connect the call and print "THRU" if the call is set up through another exchange, or " K " if the call is completed direct to the required station, and will then come out of the circuit.

(*c*) If " THRU " is received from the switchboard, continue to depress the space-bar to call the next exchange and repeat the above procedure until " K " is eventually received.

(*d*) Then depress space-bar twice. This will start the T/P motor at the distant station. Allow a few seconds to elapse until the distant motor has reached the correct speed.

(*e*) Then press successively " Figs " and " Who are you ? " keys.

Note.—It is very important to verify that the " answer back " is correct, to ensure that the message is sent to the correct station. Messages must not, in any circumstances, be signalled to switchboards, i.e., where the code name is followed by " SWBD ". Where " SWBD " is received, the name of the required station must be repeated.

(*f*) On receipt of the distant station's answer back the " Car ret. " (carriage return), " Line feed " and " Ltrs " keys should be depressed successively.

(*g*) The name of the calling station and the message should then be teleprinted.

3. **Completion of Transmission.**—On completion of transmission, the " Figs " key and then the " Bell " key should be depressed.

(*a*) *Clearing.* When both stations have completed traffic, the " Ack-Local " key should be thrown to the " Ack " position for at least 5 seconds by both operators.

(*b*) *Line engaged or out of order.* On receipt of " Engd " from the switchboard the " Ack " key should be thrown to " Ack " to clear. The message should be endorsed " Engaged ", initialled and timed, and handed to the superintendent.

(*c*) " OOO " received from the switchboard indicates that every means of reaching the required station is out of order.

(*d*) The groups " INT ", " IMI ", or " PSE ", etc., are *not* to be used in any circumstances.

4. **Teleprinter Procedure.**—The following procedure letters and abbreviations are to be used :—

AA = All after	AB = All before
WA = Word after	WB = Word before

B = More messages

K = Carry on

Q = Wait

RPT = Repeat ($\overline{\text{IMI}}$ not to be used)

Nr in R.A.F. messages precedes the series number.

SWBD = Switchboard	Switchboard procedure.
THRU = Through	
Engd = Engaged	
OOO = Out of Order	

GR ? = Are the groups correct ?

e.g., GR50 ? = Are there 50 groups ?

Symbol θ (0 with hyphen) signalled as O followed by hyphen

Symbol $\overline{\text{P}}$ signalled as P followed by hyphen

RECEIVER R 1082

1. **Service Requirements.**—A compact light-weight receiver capable of receiving all types of wireless signals, that is to say, CW, I.C.W. or R/T over a wide frequency band. Used as a general purpose aircraft receiver. Normally accompanied in aircraft by the T.1083 transmitter.

2. **Frequency Range.**—111 kc/s to 15 Mc/s.

3. **Power Supplies.**—High tension : 120-volt dry battery. Low tension : Accumulator type B (2 volt, 20 A.H., or 2 volt 14 A.H.).

4. **Power Consumption.**—Low tension : 1·25 amps. with dial lights. 1·05 amps. without lights. High tension : 15 milliamps. (approx.).

5. **Aerials.**—Air crew operators, on joining a squadron, will have to learn the lay-out and uses of the aerials on the particular aircraft with which the squadron is equipped. Broadly speaking, a 200/250 feet trailing aerial may be used for reception on all frequencies, but a long trailing aerial is *not* suitable for transmitting on high frequencies. (*See* paragraph 10 for D/F.)

6. **Valves.** Six : five, plus 1 limiter :—

One V.R.18 screen-grid R.F. amplifier ..	2 volts 0·15 amp.
One V.R. 27 grid detector..	2 volts 0·1 amp.
Two V.R. 21 A.F. amplifiers	2 volts 0·1 amp. each.
One V.R. 22 A.F. power output.. ..	2 volts 0·2 amp.
(Above are in valve chamber.)	
One V.U.33 diode limiter (inside receiver case and not accessible without lifting the receiver out of its box).	2 volts 0·4 amp.
	Total 1·05 amps.

7. **Circuit Arrangement.**—Aerial may be tightly or loosely coupled by inserting aerial plug in appropriate socket on receiver. Loose coupling decreases signal strength, and is only used when more selectivity is required. Use tight coupling in aircraft for loudest signals.

Fourteen pairs of plug-in coils enable the required frequency range to be obtained. The range of each pair of coils, " A " the highest, is marked inside the valve compartment lid. Tuning is effected by means of two variable condensers, " aerial' ' and " anode ". A pair of special coils, covering 4·5 to 6 Mc/s, and known as S50, may be found in use at certain squadrons. (Details of how to handle these coils will have to be learnt by operators after joining such squadrons.) Certain aerial coils, J, K, L, M, N and P, covering 111 kc/s to 1·5 Mc/s, are fitted with a two-pin socket for connection to a screened direction finding aerial.

Volume or gain control is obtained by means of a potentiometer which adjusts the voltage applied to the screening grid of the V.R.18.

Reaction control is obtained by means of a potentiometer which adjusts the voltage applied to the anode of the detector.

The limiter valve prevents damage to the receiver under " listening through " conditions when the transmitter is radiating. Hence the importance of ensuring that the receiver is always switched on first when using " listening through ".

8. **Maintenance and Operation.**—(*a*) H.T. battery should be changed when voltage on load falls to 100 volts.

(*b*) Limiter valve should be locked in position by screw provided on the valve base.

(*c*) Limiter valve should be tested every ten hours inspection, or at least once per week, as follows : Tune in steady weak signal, then remove the limiter valve. If there is any increase in the signal strength, the valve should be changed. If no increase is noted the valve filament must then be tested for continuity.

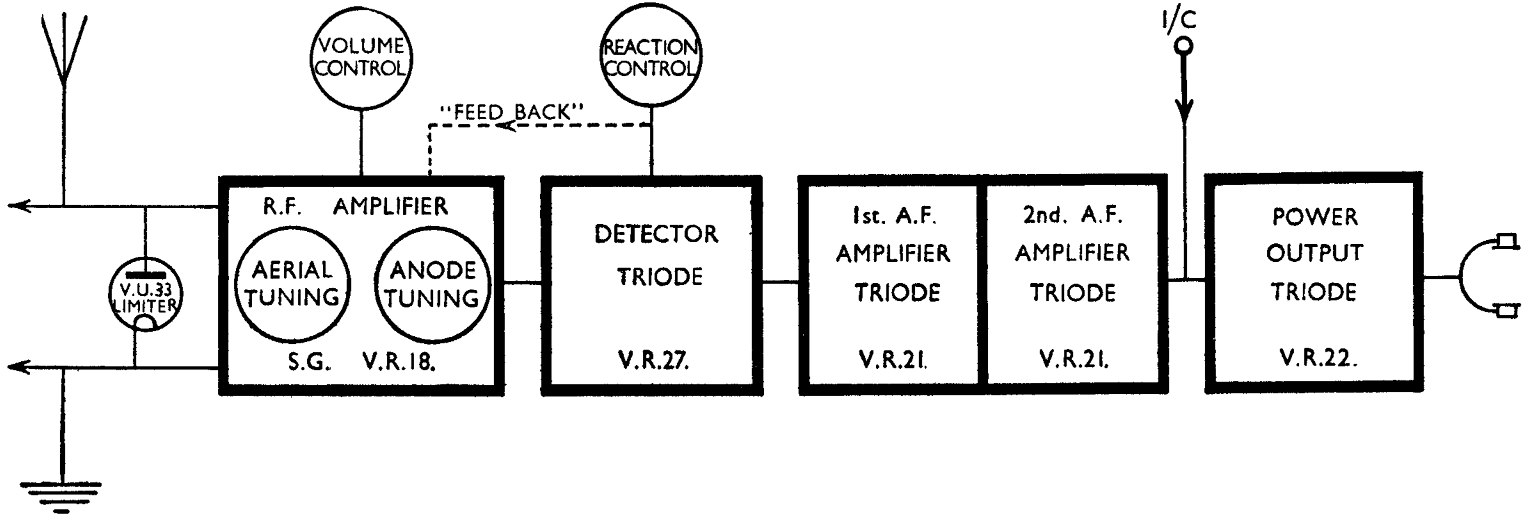
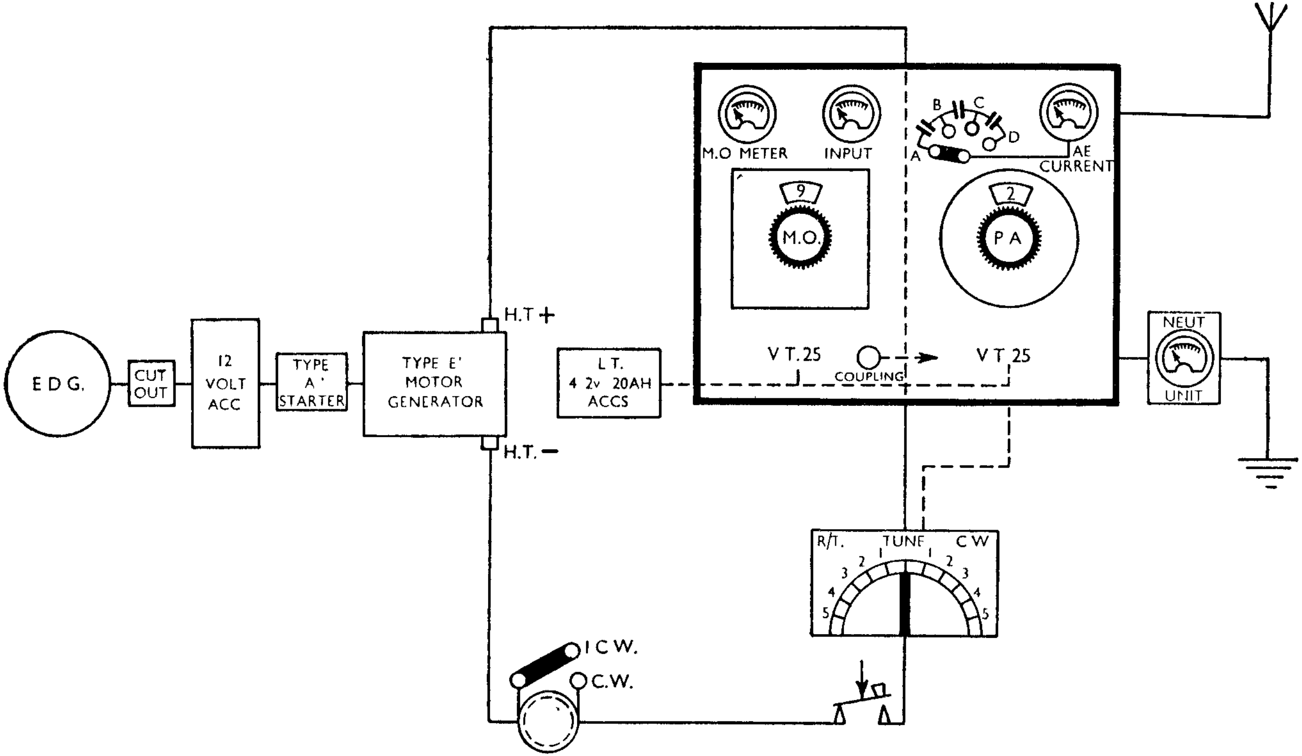


FIG. 1.—RECEIVER R.1082.

14A


E D G.
CUT OUT
12 VOLT ACC
TYPE 'A' STARTER
TYPE 'E' MOTOR GENERATOR
H.T +
H.T. −
L.T. 4 2v 20AH ACCS
M.O METER
INPUT
B
C
D
A
AE CURRENT
9
M.O.
2
P A
V T. 25
COUPLING
V T 25
NEUT
UNIT
R/T.
TUNE
C W
1 2 3 4 5
1 2 3 4 5
I C W.
C.W.

(*d*) Never change a valve with the LT/HT switch in the " on " position. This is especially important in respect of the VR18 S.G. valve, as the flexible anode connection may brush against the earthed case, causing H.T. short circuit and risk of damage to automatic bias resistance.

(*e*) Accidental earthing of H.T. battery positive terminal can damage the automatic bias resistance whether LT/HT switch is on or off.

(*f*) Ineffective volume control usually indicates defective S.G. valve.

(*g*) In emergency, operating may be continued though the S.G. valve is defective, by disconnecting aerial from socket on receiver panel and making connection to flexible anode lead of S.G. valve, care being taken to prevent possibility of accidental earth in this connection.

9. **Tuning Notes.**—(*a*) Check all the external connections.

(*b*) Plug in the correct coils.

(*c*) Switch on receiver and set volume control to " maximum ", aerial in " tight " coupling position.

(*d*) For C.W. reception, the reaction control must be set so that the receiver is just oscillating, and for I.C.W. or R/T, just off the oscillation point. If searching for C.W. signal, test frequently for oscillation. Receiver may go out of oscillation as the tuning controls are rotated.

(*e*) Search carefully for required signal with both the tuning condensers, keep aerial and anode circuits in tune with each other.

(*f*) When required signal is heard, adjust reaction control and aerial tuning condenser for maximum signal strength.

(*g*) Adjust volume control and aerial coupling as required, and correct tuning as necessary.

Note.—Before commencing a flight, tune to the station you are to work, if this is possible. The setting of the anode tuning condenser so obtained should not require altering when the aircraft is airborne, though the aerial condenser may require a slight readjustment.

10. **Direction Finding with R.1082.**—(*a*) Connect R.1082 to a " fixed aerial " on free receiver. Check loop aerial connected to sense unit.

(*b*) Set selector switch on sense unit to " traffic " and tune in required station. N.B.—Aerial tuning must be accurately set.

(*c*) Set selector switch to " D/F " and rotate loop for minimum signal. Adjust volume control to give definite zero signal setting of loop. Note reading on white scale. If, with weak signals, no definite zero can be found, note white scale readings at two points either side of minimum where signal strengths are equal, and take the average.

(*d*) To find " sense " set selector switch to " sense " and turn loop so that red scale is set to the reading already found on the white scale. Swing sense switch to " bearing " and " reciprocal ". If signal strength is minimum at " bearing ", the scale reading is the bearing. If minimum at " reciprocal " subtract 180 degrees from scale reading, or if this is impossible, add 180 degrees to obtain bearing. If no difference at either position of the switch adjust volume control and aerial resistance control until a difference is heard.

TRANSMITTER T. 1083

1. **Service Requirements.**—General purpose aircraft transmitter (C.W., I.C.W., or R/T), for use with receiver R.1082 in bomber, general reconnaissance and fleet aeroplanes.

2. **Frequency Range.**—136 to 500 kc/s and 3 to 15 Mc/s.

3. **Power Supplies.**—Filament 8v. (usually 4 type B, 2v. 20 a.h. accumulators). High tension : Type " E " motor generator. Low tension for motor generator from E.D.G. and 12v. type B accumulator, which also supplies a/c general electrical services. Accumulator capacity according to type of aircraft.

4. **Power Consumption.**—Filament: 4·4 amps. (2·2 per valve). High tension: 1200v. 50–70 milliamps (approx.) P.A. 30–50 milliamps. M.O., 20–30 milliamps. Low tension to motor generator: 4–6 amps. " off load ", 12–13 amps. on 70 watt load.

5. **Aerials.**—136 to 500 kc/s: 200/250 ft. 7/28 S.W.G. stainless steel trailing aerial.

H.F. ranges use fixed aerial, type according to aircraft.

Note.—Receiver and transmitter normally employ same aerial, but in certain circumstances a short fixed aerial may provide insufficient pick-up for receiver. Hence provision may be made for connection of long trailing aerial to R. 1082 on high frequencies whilst transmitter works independently on the appropriate fixed aerial.

6. **Valves.**—Two—Type V.T.25.

Maximum anode dissipation	60 watts.
Maximum anode voltage	1500 volts.
Normal anode voltage	1000 volts.

7. **Circuit Arrangement.**—Master oscillator—power amplifier circuit. Frequency covered in four ranges. P.A. neutralised, except on low frequency. (range D.)

(*a*) *Range " A "* (10–15 Mc/s).—Hartley type master oscillator, inductively coupled to P.A. Two-position switch on coupling coil adjusts turns of coils in circuit to suit frequency. M.O. and P.A. stages are tuned by variable inductances. Power amplifier coil may be plugged in one of the two alternative positions, so permitting adjustment of neutralising and anode taps to suit frequency.

(*b*) *Ranges " B " and " C "* (6–10 and 3–6 Mc/s).—Similar to range " A ", except that tuned anode-tuned grid master oscillator is employed. M.O. grid tuned by variometer.

(*c*) *Range " D "* (136–500 kc/s).—Colpitts type M.O. capacity coupled to un-neutralised P.A. Each stage tuned by variable tapped inductances and fine tuning variometer.

(*d*) *Selector switch.*—Marked C.W. 1–2–3–4–5—" Tune "—R/T 1, 2, 3, 4, 5. Makes necessary circuit alterations for C.W. or R/T transmission, and adjusts the automatic grid bias on the P.A. to a suitable value. For I.C.W. switch must be on C.W. position.

(*e*) *" Tune " position.*—Key shorted, and high negative bias applied to P.A. valve, which is thus rendered inoperative.

(*f*) *C.W. position.*—Key circuit opened, and negative bias progressively reduced as switch moved from 1 to 5, which increases the power output.

(*g*) *R/T position.*—Key circuit closed, and P.A. negative bias adjusted to approximately 180 volts at R/T1. This bias can be reduced as in C.W. position, but positions 3, 4 and 5 should not be used, as modulation will be greatly reduced.

(*h*) *Modulation.*—Grid modulation of power amplifier valve. Secondary of microphone transformer, in series with P.A. grid bias, superimposes on " steady " grid-bias a " speech frequency " component. An improvement may be obtained by reducing coupling.

(*i*) *Neutralising unit.*—Consists of 0–0·5 amp. thermo-ammeter and switch marked " Transmit " and " Tune ". A " pea " lamp in series with meter acts as a safety fuse. In " Tune " position meter connects in earth lead and indicates R/F current in aerial due to transfer of energy from M.O. via inter-electrode capacity of P.A. stage. In " Transmit " position unit is disconnected from circuit. Wiring of transmitter is so arranged that it is **not** possible to transmit if neutralising switch is inadvertently **left in the " Tune "** position.

(*j*) *External earth condenser.*—Fitted with drain resistance, may be used if necessary to reduce capacity of aerial system in large aircraft when using H.F.

(*k*) *Listening through.*—Possible when transmitter and receiver use the same aerial and the same frequency. Made possible by :—(i) L/T condenser ; (ii) limiter valve in R. 1082 ; (iii) careful smoothing of type E motor generator; (iv) keying M.O. as well as P.A. stage. It is also possible if transmitter and receiver are permanently connected to separate aerials, in which case transmitter and receiver may work if necessary on different frequencies. When using former method R. 1082 MUST BE SWITCHED ON BEFORE TRANSMITTING, so that the limiter valve is operating (*see* R. 1082 notes). Listening through is not available when using R/T.

(*l*) *" Free receiver " operation.*—When only one aerial is employed, " free receiver " operation may be obtained by mating the knurled plug and socket associated with the listening through condenser. Aerial may be connected to either transmitter or receiver directly by moving the send-receive switch. Receiver is always " free " if separate aerials are used.

(*m*) *M.O. bias.*—Obtained by means of grid-leak in M.O. circuit.

(*n*) *Keying.*—Effected by interrupting grid return of M.O. and H.T. negative lead on both valves.

(*o*) *Functions of send-receive switch.*

In " Send " position.—Connects aerial, H.T. positive, H.T. negative, L.T. positive, L.T. negative, and earth, to transmitter.

In " Receive " position.—Changes aerial over to receiver, and disconnects remaining connections detailed above from transmitter. Connects microphone to receiver for intercommunication purposes.

8. **Maintenance and Operation.**—(*a*) Simple faults may be readily located by intelligent use of the meters incorporated in transmitter.

(*b*) If P.A. appears to tune normally, but aerial current is low, P.A. may be tuned to a harmonic of M.O., or coupling may be too tight or too loose. If coupling altered, M.O. and P.A. must be readjusted to the correct frequency.

(*c*) If P.A. tunes for maximum aerial current at two adjacent points (double hump), coupling is too tight, causing unstable note at receiver. Reduce coupling and re-tune until aerial current shows a single *sharply defined maximum.* The " double hump " is most readily observed on the neutralising meter, particularly on range A.

(*d*) Optimum setting of aerial condenser (ABCD) switch and use of external earth condenser are matters for experience on a particular aircraft and frequency.

(*e*) Beware of reversed accumulator leads to M.G., as this changes polarity at M.G. H.T. end, and is indicated by no input reading. Reversing leads from starter to M.G. L.T. terminals causes machine to run in reverse direction, also a short circuit of the field takes place and machine races, which results in serious damage.

(*f*) An " earth " on transmitter case (which might occur accidentally if transmitter sagged in its suspension so that metal work touched earthed W/T crate of aircraft) would short circuit external earth condenser and neutralising unit. Consequently tuning would be impossible. If already tuned correctly, an intermittent short on earth condenser would result in a broken transmission.

(*g*) Do not attempt to use studs 3, 4 or 5 of G.B. switch when R/T in use, as depth of modulation will be greatly reduced.

9. **Tuning Notes.**—*Method* (1).—(*a*) Switch on receiver (if listening through is fitted).

(*b*) Connect suitable aerial. (Artificial aerial settings, range A 25 $\mu\mu$F, B and C. 120 mmfds., range D, 250 mmfds.)

(*c*) Set grid bias and neutralising unit switches to " tune ".

(*d*) Set aerial condenser switch to appropriate position.

(*e*) Set neutralising condenser to zero.

(*f*) Plug in P.A. coil at correct anode tap, and set tuning control to zero.

(*g*) Plug in M.O. coil with coupling switch at correct letter according to anode tap of P.A. coil.

(*h*) Set M.O. tuning and coupling control as per calibration chart.

(*i*) Switch on and check for input current.

(*j*) If on ranges B or C tune grid variometer for maximum current in M.O. meter.

(*k*) Tune P.A. for maximum reading in neutralising meter. (If reading exceeds ·3 ampere, reduce by adjusting neutralising condenser.)

(*l*) Adjust neutralising condenser until reading is reduced to zero (except on range D).

(*m*) Put grid bias switch to C.W. or R/T position and neutralising unit switch to " transmit ".

(*n*) Press key, if on C.W., and adjust P.A. coil for maximum aerial current, which corresponds approximately to minimum input.

(*o*) Lock all tuning controls.

Method (2) (*tuning by wavemeter*).—Operations (*a*) to (*g*) as in method (1), then as follows :—

(*h*) Estimate the approximate tuning adjustment and set the control accordingly (remembering that H.F. end of coil is obtained with indicator reading minimum inductance, and L.F. when maximum number of turns are indicated). If on ranges B or C tune the grid variometer for maximum M.O. current. Set coupling coil to some low value.

(*i*) Tune P.A. for maximum current in neutralising meter.

(*j*) Adjust coupling control to give maximum reading in neutralising meter without " double hump " (except on range D).

(*k*) Neutralise P.A. stage (except on range D).

(*l*) G.B. switch to C.W. 1 and neutralising meter switch to "transmit".

Press key and re-tune P.A. for maximum aerial current.

(*m*) Measure frequency roughly with W.1081 and if more than 50 kc/s out, re-tune the transmitter. When within 50 kc/s set the wavemeter accurately to the required frequency and adjust the M.O. and P.A. for maximum deflection in wavemeter microammeter.

(*n*) Lock all controls.

Tuning with crystal monitor.—Operations (*a*) to (*g*) as in method (1).

(*h*) Set M.O. tuning to maximum or minimum, whichever is nearer the frequency required.

(*i*) Select the correct setting of crystal monitor switch for frequency desired, and switch on.

(*j*) Switch on transmitter, and adjust grid tuning for maximum reading in M.O. ammeter. Then adjust M O. control for loudest heterodyne note in telephones, maintaining maximum reading in M.O. ammeter throughout the operation by means of the grid tuning control on B and C ranges. Readjust M.O. tuning slightly for " dead space ".

(*k*) Complete tuning of transmitter as usual, remembering to adjust M.O. anode tuning for dead space before finally tuning for maximum aerial current. (Reason for readjusting M.O. is that tuning and neutralising of P.A. alters frequency of M.O. slightly.)

(*l*) Lock all tuning controls.

Method (3).—To " tune back " to the frequency of a received station by tuning M.O. to receiver. It is assumed that the station received is listening on his transmitter frequency.

(*a*) Tune in received station carefully on R.1082, using " free receiver", finally setting anode tuning condenser to give zero beat (dead space) with received signal. From the setting of anode tuning condenser estimate approximate frequency of received signal and note.

(*b*) Set T.1083 : G.B. and neutralising switched to " tune ".

(*c*) Plug appropriate coils in T.1083, choosing suitable anode and coupling coil taps.

(*d*) Set ABCD switch, and insert or remove external earth condenser as found necessary by experience with particular aircraft and frequency.

(*e*) Set neutralising condenser to zero.

(*f*) Set volume control of R.1082 to zero ; reaction control to maximum.

(*g*) If transmitter and receiver work on same aerial and "listening through" operation is required, couple the receiver to the transmitter through the L/T unit. (If separate aerials are used "listening through" is always possible on W/T).

(*h*) Set M.O. tuning to maximum or minimum, whichever is nearer the frequency of received signal. Switch on transmitter and adjust grid tuning for maximum reading in M.O. ammeter. Then adjust M.O. control for loudest heterodyne note in the telephones, maintaining maximum reading in M.O. ammeter throughout the operation by means of the grid tuning control. Readjust M.O., tuning slightly for dead space.

(*i*) Adjust P.A. tuning, and then coupling control, for maximum deflection in neutralising ammeter, consistent with freedom from "double hump" effect. At this stage, if doubt exists as to whether the anode tap and coupling taps as chosen are the correct ones, alternate adjustments, with consequent slight tuning readjustments, may be tried, noting whether they result in an increased reading in neutralising ammeter.

(*j*) Adjust neutralising condenser until neutralising meter reads zero. (Not range D.)

(*k*) Readjust M.O. to give zero beat (dead space) with local oscillations of R.1082.

(*l*) Set G.B. switch to R.T.1 (or C.W.1, and press key), neutralising switch to "Transmit", and readjust P.A. to give maximum aerial current (approx. minimum input).

(*m*) Lock all controls.

(*n*) Return R. 1082 volume control to maximum, and anode tuning control to one side of dead space for desired pitch. Reaction control to be adjusted carefully for "just oscillating" conditions.

(*o*) Call required station during a convenient pause. If no answer is obtained on C.W., call again using I.C.W.

Method (4). *"Tuning back" on range D.*—To "tune-back" to the frequency of a received station on range "D", when each stud of the M.O. coarse tuning control is calibrated.

(*a*) to (*g*) As for method (3).

(*h*) Set M.O. coarse tuning to appropriate stud for frequency desired (as per range "D" M.O. calibration chart). Switch on transmitter, and adjust fine tuning control on the M.O. for loudest heterodyne note, then obtain zero beat (dead space).

(*i*) Set P.A. coarse tuning to the same setting as the M.O. coarse tuning, and with fine control on P.A. adjust for maximum deflection in neutralising ammeter. (If unable to obtain maximum reading in neutralising meter, then adjust P.A. coarse tuning to one turn either side of original setting.)

(*j*) Readjust M.O. fine tuning to give zero beat (dead space).

(*k*) Set neutralising meter switch to "transmit"; G.B. switch to C.W.I., and press key; with fine tuning control on P.A. readjust for maximum aerial current (approximately minimum input).

(*l*) As for (*n*) and (*o*) in method 3.

Method (5). *"Tuning back" to the frequency of a received station by tuning P.A. to receiver.*—This method is only of use on range "D" of T. 1083 when the transmitter and receiver work on the same aerial system and the received station signal is stable and reasonably free from fading. It is assumed that the received station is listening in on his transmitter frequency.

(*a*) to (*d*) As for method (3).

(*e*) Tune in received station carefully on "free receiver".

(*f*) Couple transmitter and receiver through L/T unit.

(*g*) Set S/R switch to " send ".

(*h*) Now tune transmitter P.A. coil for maximum received signal strength.

(*i*) Switch on motor generator, and tune M.O. for maximum deflection in neutralising meter.

(*j*) Call required station, using I.C.W. for calling if first call remains unanswered.

Emergency Tuning.—Recommended when actually in flight and no spare VT25 is available, transmitter being already tuned to required frequency.

Method (1).—If P.A. valve is unserviceable, simply de-neutralise and carry on ; this will give a low power output. If, however, M.O. valve is unserviceable, change the valves over.

Method (2).—Power output can be increased by using serviceable valve in P.A. and unserviceable valve in M.O.

(*a*) Put grid bias switch on C.W.1.

(*b*) Coupling to maximum.

(*c*) Neutralising condenser to zero.

(*d*) Tune on M.O. only for maximum aerial current, consistent with a low input current.

(*e*) If the above fails, tighten the coupling by moving the tap from A to B.

(*f*) Frequency can be checked against receiver or by crystal monitor.

(*g*) On range A, results may be obtained by simply increasing neutralising condenser towards 100.

MAINTENANCE OF VALVE VOLTMETER TYPE WAVEMETERS

1. These wavemeters are precision instruments and should be treated with great care. Mechanical shocks are liable to destroy accuracy of calibration.

2. As interelectrode capacity of valve affects the calibration, wavemeters must be used *only* with one of the three valves supplied. Valves, cartons and valve transit cases are engraved with serial number of instrument for which they are intended. When two valves become unserviceable, a replacement should be requisitioned at once.

3. Full scale reading of micro-ammeter should never be exceeded. This condition may arise if wavemeter is too tightly coupled to transmitter or if a defect occurs in grid-filament circuit which causes removal or reduction of negative bias voltage. Check battery plugs for correct positioning, good connection and cleanliness, and valves for good connection and cleanliness of pins and sockets.

4. When wavemeter is in good order, a very slight deflection of micro-ammeter needle should be observed when the wavemeter is switched " ON " and a " KICK " of the needle when it is switched " OFF ".

WAVEMETER W.1081

1. **Service Requirements.**—Accurate measurement of frequency of aircraft transmitters, for use on the ground only. Capable of indicating within 2 kc/s on frequencies up to 6 Mc/s.

2. **Frequency Range.**—135–500 kc/s, and 3–15 Mc/s.

3. **Battery Supplies.**—L.T. 2 volts 7 A.H. accumulator, type A. H.T. and grid bias: two 15-volt dry batteries tapped to give 27 volts anode voltage and 3 volts grid bias. All batteries are housed inside instrument case, and a diagram showing connections to dry batteries is pasted on battery compartment.

4. **Valves.**—One V.W. 36, 2 volts 0·2 amp. (specially selected V.R.22).

5. **Circuit Arrangements.**—Calibrated closed circuit across which is connected a valve voltmeter of the anode bend type, which acts as a resonance indicator. Frequency covered in five ranges, any one of which may be selected by switch on front panel. Switch designed to operate without breaking grid circuit when changing range, so preventing damage to micro-ammeter in anode circuit. It also acts as a filament switch. On high frequency range (1 and 2), closed circuit is tuned by variable inductance, and on low frequency ranges (3, 4 and 5), by variable condenser. Micro-ammeter may be removed from wavemeter and connected by flexible lead for convenience of tuning in difficult places. Three selected valves V.W. 36 supplied with each instrument. A 2-volt pilot lamp is connected across filament circuit.

Lamp does not necessarily indicate that wavemeter is in working order.

6. **To set the wavemeter correctly to a particular frequency, i.e. when the transmitter is already approximately correct for frequency and you want to adjust the transmitter finally to the wavemeter.**—(*a*) Find the frequency in the main range table.

(*b*) Read off the " degree " between 0 and 360, and the line letter.

(*c*) Now look at the correction curve and find the same frequency as in (*a*) above.

(*d*) Read off the correction in degrees.

(*e*) If positive, *add* the correction to the answer in (*b*). If negative, *subtract* the correction.

(*f*) Put this corrected reading on the wavemeter.

*Example. To set W.*1081 *to* 6–5 *Mc/s.*—(i) Setting of coil in main range table is given as M.189 degrees.

(ii) Now look up correction curve. The correction for 6·5 Mc/s is given as plus 11 degrees.

(iii) The correct wavemeter setting for 6·5 Mc/s is therefore M.200 degrees (189 plus 11).

7. **To use the Wavemeter for Measuring the Frequency of a Transmitter.**—(*a*) Tune the wavemeter for resonance, i.e. to a peak of deflection, and note the setting of the wavemeter in letter and degrees at the peak point.

(*b*) From the main range table read the frequency against this setting.

(*c*) *Now look at the correction curve and find the same frequency as in* (*b*).

(*d*) Read off the correction in degrees.

(*e*) If positive, *subtract* from the degrees in (*a*). If negative, *add* to the degrees in (*a*).

(*f*) Look up this corrected answer in degrees in the main range table and read off the frequency. This is the real frequency of the transmitter.

Example. To determine the frequency of a transmitter.—(i) The setting of wavemeter when tuned to a transmitter is found to be K.287·5 degrees.

(ii) From main range table, frequency against this setting is 7·245 Mc/s.

(iii) From correction curve, the correction for 7·245 Mc/s is plus 4 degrees.

(iv) Subtracting this correction in degrees in (i) we obtain K.283·5 degrees.

(v) Opposite K.283·5 degrees on main range table, read off the correct frequency, i.e. 7·250 Mc/s.

TRANSMITTER-RECEIVER TR.9F

1. **Service Requirements.**—Lightweight, low power, crystal controlled radio telephony set for use in aircraft, having a range of at least 35 miles between air and ground and five miles between aeroplanes. The TR.9F is used in addition to G.P. equipment, in bombers, and may be used as a portable ground station.

Frequency stabilization is achieved by means of quartz crystals. Two such crystals are incorporated in the transmitters so that either of the two pre-determined frequencies may be transmitted; these are known as the "normal" and "special" frequencies. R/T may be transmitted on both "normal" and "special" in the TR.9F.

2. **Frequency Range.**—4·3 to 6·6 Mc/s.

3. **Power supplies :—**

Filaments (A.1134)	One 2 volts 14 A.H. accumulator.
Filaments (transmitter and receiver).	One 2 volt 20 A.H. accumulator (type B).
H.T. (transmitter and receiver)..	One 120-volt dry battery.
H.T. (A.1134)	One 120-volt dry battery.
Grid bias (transmitter)	15-volt dry battery tapped at $10\frac{1}{2}$ volts for modulator valve.
Grid bias (receiver)	$4\frac{1}{2}$-volt dry battery housed inside receiver.
Grid bias (A.1134)	6-volt dry battery tapped at 3 and 6 volts.

The TR.9 120-volt and 15-volt batteries are housed in a tray which may be withdrawn from the combined transmitter-receiver case. Connections from the tray are made by spring contacts, which break automatically when the tray is withdrawn.

4. **Power Consumption :—**

L.T. in "normal" frequency position.	1·25 amps. transmit or receive.
L.T. in "special" frequency position.	1·6 amps. transmit or receive.
H.T. in "transmit" position ..	26–28 milliamps.
H.T. in "receive" position ..	13–15 milliamps.

5. **Aerial.**—A small fixed aerial, usually from a stub mast to tail fin. In some aircraft the mast is retractable.

6. **Valves.**—(*a*) *Transmitter unit :—*

One, type VT.50, 2-volt ·1 amp. triode in the oscillator stage. Maximum anode voltage 150, normal 120. Dissipation, 1 watt. Anode current about 3 milliamps.

Two, type VT.51, 2-volt ·2 amp. pentodes, in the modulator and power amplifier stages. Maximum anode voltage 150, normal 120. Dissipation 3 watts. Anode current about 9 milliamps each and screen current about 2·5 milliamps.

The crystals and V.T.51's are accessible from the front of the transmitter panel, but the transmitter must be removed from its case to locate the VT.50.

(*b*) *Receiver unit :—*

Two, type VR.18 ..	Tetrodes, R.F. amplifier stages.
One, type VR.27 ..	Detector.
Two, type VR.21 ..	Audio-frequency amplifiers.
One, type VR.22 ..	Output.

(*c*) *A*.1134 :—

One, type VR.21 ..	Audio-frequency amplifier.
One, type VR.35 ..	Quiescent push-pull output valve.

SECTION I

Article 4

TRANSMITTER-RECEIVER T.R.9H

1. **Requirements.**—A lightweight low power crystal controlled R/T set for use in aircraft.

2. **Frequency Range.**—4·3 to 6·6 Mc/s.

3. **Communication Range.**—At least 35 miles air to ground and 5 miles air to air.

4. **Valves.**—(i) Transmitter; oscillator, triode, V.T.50; power amplifier, pentode, V.T.51; modulator, pentode, V.T.51.

(ii) Receiver, six; R.F. amplifiers, two V.R.18; detector, V.R.27; A.F. amplifiers, two V.R.21; output, triode, V.R.22, or pentode, V.R.118.

5. **Power Supplies.**—(i) 2-volt 20 A.H. accumulator. Current, on "transmit", 2 amps., on "receive" 1·15 amps.

(ii) H.T., 120-volt dry battery or Power Unit Type 173. The latter is a vibrator unit consisting of vibrator, transformer, metal rectifier, filter units, and stabiliser (V.S.110). The unit takes approximately 1 amp. from the aircraft 24-volt supply. No adjustment is possible; change the stabiliser after 500 hours flying and the vibrator after 1,000 hours.

(iii) Grid bias.

(*a*) Transmitter; 15-volt dry battery, tapped at 10·5 volts for the modulator stage.

(*b*) Receiver; 4·5-volt dry battery.

Note.—H.T. battery (or power unit) and G.B. battery are fitted internally in the set.

6. **Aerial System.**—A small fixed aerial, type depending on aircraft. When necessary the aerial may be connected via a co-axial cable; this may necessitate a matching unit at the transmitter.

7. **Transmitter Circuit.**—(i) A crystal controlled oscillator drives an anode modulated R.F. power amplifier.

(ii) Oscillator and power amplifier use grid leak and condenser bias.

(iii) No neutralising is required for the P.A.

(iv) A "Pierce" circuit is employed, and so the oscillator requires no tuning.

(v) The P.A. is tuned by a continuously variable inductance, which is part of the aerial circuit for both transmitter and receiver.

(vi) The output from the microphone is amplified by a sub-modulator consisting of the external amplifier A.1134, before application to the input of the modulator valve.

8. **Receiver Circuit.**—(i) As the aerial circuit of the receiver is tuned when tuning the transmitter, the two main tuning controls are the variable condensers in the two tuned anode circuits.

(ii) The volume control is external to the set, and is a potentiometer which adjusts the potential on the screen grid of both R.F. valves; it is normally remotely controlled by the pilot.

(iii) Regeneration is provided by a 10 $\mu\mu$F condenser between the two tuned circuits.

(iv) Battery bias is used on the A.F. and output stages.

9. **Control of T.R.9H.**—There are three methods of control:—

(i) "Local." For this method of control the "Yaxley" pattern "send-receive" switch is used.

(ii) " Push to talk." By leaving the S/R switch at " receive ", " push to talk " operation is available.

(iii) " Remote." By leaving the S/R switch at " off ", complete electrical remote control is available at one point, and " push to talk " operation at several others, providing the remote switch is " on ".

10. **Tuning** (*N.B.*—The transmitter must be tuned first).—(i) Transmitter.

(*a*) Set the aerial tuning inductance to 0 if frequency required is greater than 5 Mc/s, or to 16 if it is less.

(*b*) Switch on set, and switch on supply to power unit if fitted.

(*c*) Press " P.T.T." switch, and tune A.T.I. until a dip is noticed in input milliamps ; set to greatest dip and release " P.T.T." switch.

(ii) Receiver.

(*a*) Ensure that the transmitter is correctly tuned.

(*b*) Set volume control to maximum and leave it there during the whole process of tuning.

(*c*) Ensure that the set is switched " on ", and the power unit is " on " if fitted.

(*d*) Switch on and adjust R/T tester to frequency required.

(*e*) Adjust the two main tuning condensers carefully (keeping them in step) until the modulated signal is heard at full strength.

(*f*) When correctly tuned in, attenuate the signal input until the note is barely audible. This is done by moving the R/T tester, closing the lid, or both.

(*g*) Tune again very carefully, attenuating the signal to ensure absolutely accurate tuning.

(*h*) Turn the regeneration control up until the receiver commences to oscillate, then turn it back one complete turn.

(*j*) Re-adjust main tuning condensers slightly for maximum signal.

(*k*) Lock receiver tuning.

Note.—Fine and accurate tuning of the T.R.9 receiver is an essential factor in the success of air operations.

11. **Maintenance of T.R.9H.**—(i) Change the L.T. battery after every flight.

(ii) Test the H.T. battery on load before every flight by inserting a voltmeter between lower crystal socket and earth terminal with switch at " send ". Battery must be changed when reading is 100 volts or less.

(iii) Before tuning a new transmitter for the first time or when changing the V.T.50 valve, plug in crystal and oscillator valve only, and check that the anode current does not exceed 5 mA.

(iv) Maintenance of the intercommunication apparatus is extremely important and great attention is to be given to the following points ; especially when high impedance intercommunication systems are fitted :—

(*a*) Test the helmets of all members of the crew before each flight. Apart from testing the sensitivity with the tester provided, see that the insulation resistance between microphone and telephone leads, and between both of these and the earthed screen is greater than 10 megohms and that the screening is serviceable and correctly connected to the microphone and telephone negative.

(*b*) Ensure that all telephone-microphone sockets are correctly anchored, clean, and lightly smeared internally with petroleum jelly.

(*c*) The insulation resistance to all i/c wiring is greater than 10 megohms (or as specified for a particular aircraft).

Note.—Ask the crew to refrain from idly swinging helmets and plugs, whilst walking about the aerodrome, etc.

12. **Faults and Remedies.**—(i) Excessive input or no output

(*a*) Aerial circuit not in tune.

(*b*) No crystal in.

(*c*) Aerial or earth disconnected.

(ii) No input milliamps.

(*a*) S/R switch not making contact.

(*b*) Batteries disconnected (dirty terminals), or run down.

(iii) Correct output but incorrect input milliamps.

(*a*) Incorrect bias.

(*b*) Set not properly tuned.

(iv) Receiver oscillates when adjusting volume control or control. Regeneration control not properly set.

(v) Weak signals.

(*a*) Transmitter tuned to harmonic.

(*b*) Receiver not correctly tuned on the ground.

(vi) Distorted speech.

(*a*) Incorrect bias on V.R.22 (should be 4·5 volts).

(*b*) L.T. leads crossed.

(vii) Noisy receiver.

(*a*) Bad connections to L.T. or H.T.

(*b*) H.T. run down.

(*c*) Defective valves.

(viii) Excessive background noises.

Other members of the crew have microphones switched interference.

7. **Remote Control.**—The transmitter-receiver is invariably mounted in a position which is inaccessible to the pilot, but a special controller fitted in the pilot's cockpit gives him remote control over the S/R switch, fine tuning and volume control of the receiver. The two former are controlled by mechanical means, and the latter by an extension lead from a three-way socket on the receiver to a potentiometer in the remote controller.

8. **Circuit Arrangements.**—(*a*) *Transmitter unit.*—A crystal controlled oscillator drives a screened-grid modulated radio frequency power amplifier. An electro-magnetic microphone is used and, as this is very insensitive, a separate external amplifier (A.1134) is used to amplify the output of the microphone before application to the input of the modulator valve. When performing this function the amplifier is referred to as the sub-modulator.

A side-tone arrangement enables the operator to hear his own speech in the telephones when transmitting.

A switch marked " tune " and " transmit " is normally set at " transmit " for both tuning and transmitting.

The " normal " frequency is tuned by a continuously variable inductance which also forms the aerial circuit of the receiver (hence the necessity for tuning the transmitter first), the " special " frequency by tappings on the inductance for coarse, and a variable condenser for fine tuning.

Small relays incorporated in the transmitter energised by the accumulator (L.T.) make the necessary changes from " normal " to " special " frequency in conjunction with an " ON–OFF " switch (special frequency switch).

(*b*) *Receiver unit.*—Consists of two tuned anode, screened-grid R.F. stages; detector; two resistance-capacity coupled A.F. amplifying stages; and an output stage employing choke capacity output circuit. Volume control is by means of a potentiometer which adjusts potential on screen-grids of both R.F. valves. Regeneration (or reaction) is by means of a small (10 $\mu\mu$F) condenser, coupling output and input of second R.F. valve.

The two main tuning controls are the variable condensers in the two tuned anode circuits, the dials being on the front panel. Connected in parallel with these are two much smaller condensers which are " ganged " and form the pilot's fine tuning control.

(*c*) *A.1134.*—Consists of a two-stage audio-frequency amplifier primarily intended for inter-communication. The first stage is transformer coupled to the output valve, and the output is carried to the telephones through a second transformer. The A.1134 also serves as the submodulator for transmitting R/T and, due to the intercommunication arrangements, functions as the output circuit of the receiver in addition to the normal receiver output circuit. The electro-magnetic microphone is permanently connected to the amplifier input circuit, and the operator's and crew's telephones to the amplifier output circuit.

A separate on-off switch is fitted in the bottom right-hand corner of the panel for controlling the amplifier.

A multi-contact switch will be seen on the panel with three positions, marked " A ", " B " and " C ". This is to allow the A.1134 to be used with the G.P. equipment, if necessary. For use with the TR 9F the switch is locked in the " B " position.

N.B.—The A.1134 must be switched on all the time the aircraft is in flight, otherwise inter-communication is impossible. Inter-communication can be carried out whether or not the TR.9F is switched on.

(*d*) *Send/Receive switch.*—This makes the necessary connections to the transmitter and receiver and breaks all supplies at " OFF ", in which position it should be locked at the remote control when the aircraft is on the ground, to prevent wastage of batteries.

9. **Procedure to be carried out in Bomber Aircraft equipped with TR.9F before every Flight.**—A signal generator of some description is required, crystal controlled on normal frequency, for tuning receiver.

An R/T tester is most commonly used, but a W.39A, crystal controlled, may be employed.

(*a*) Ensure that the R/T tester is functioning with a crystal of the " normal" frequency to be used.

(*b*) Ensure that the two volt accumulators are fit for use in aircraft, especially with reference to cleanliness of the terminals, also the terminal tags from TR.9F.

(*c*) Volume control to maximum, pilots tuning to 90 degrees.

(*d*) Inspect pilot's headset and plug in.

(*e*) Special frequency switch to " ON ". Tune-transmit switch to " transmit " (" tune " position not normally used).

(*f*) Send-receive switch to " send ", and tune special frequency for MAXIMUM OUTPUT (AE current) using a minimum amount of capacity on fine tuning, i.e., set fine tuning to zero and adjust coarse tuning for maximum possible output, then adjust fine to increase output to its maximum. If only a decrease in output can be obtained, reduce coarse tuning by one stud and re-adjust for MAXIMUM OUTPUT on fine tuning.

(*g*) Special frequency switch to " OFF ".

(*h*) S/R switch to " send " and tune " normal " frequency for MAXIMUM OUTPUT. The H.T. battery should be changed if the input is less than 25 mA.

(*i*) Test modulation by a *LOUD* shout or whistle in microphone ; there should be at least a 25 per cent. increase in the aerial current.

(*j*) S/R switch to " receive ", place R/T tester near the aircraft, and switch it in to T.T. using normal frequency crystal.

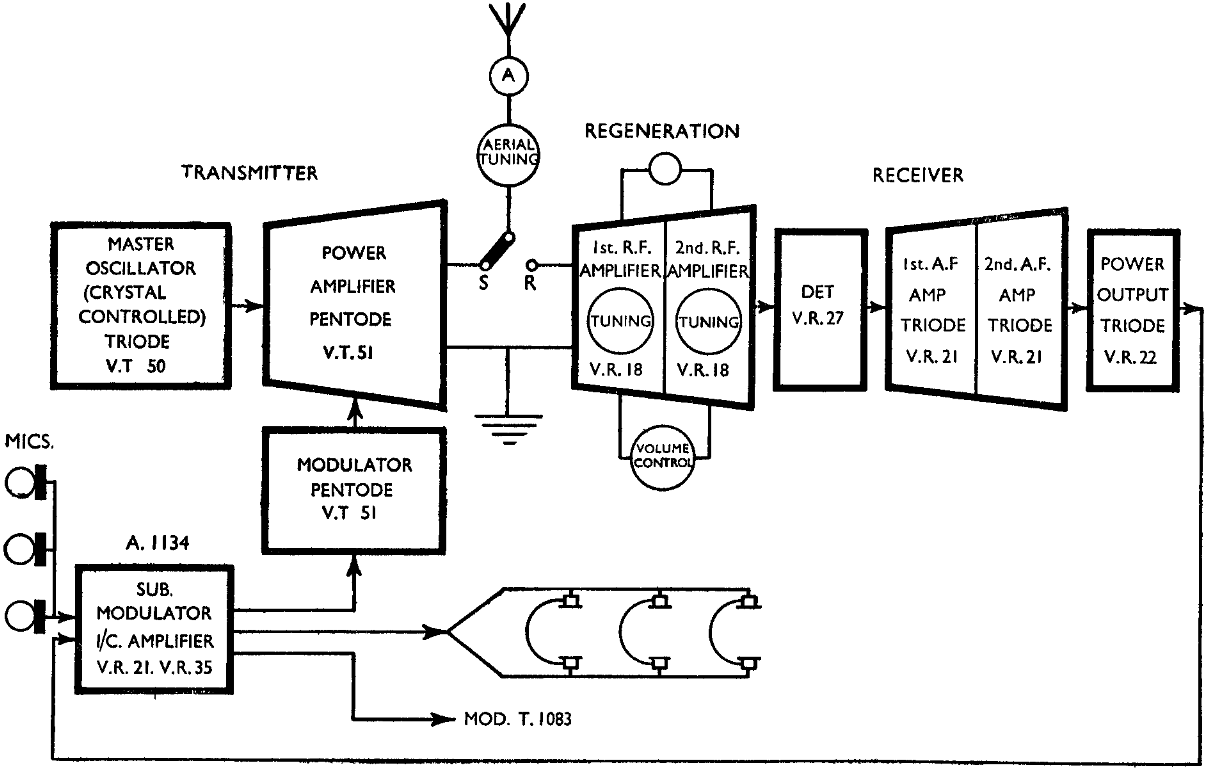
(*k*) Tune T.T. note from tester with regeneration control *just off oscillation*, and then progressively increase distance of tester from the aircraft, retuning each time. Alternatively the lid of R/T tester may be gradually closed, to weaken its signal, but the former method is to be preferred. This step is most important and should be carried out until T.T. note is only just audible with the receiver at its maximum sensitivity.

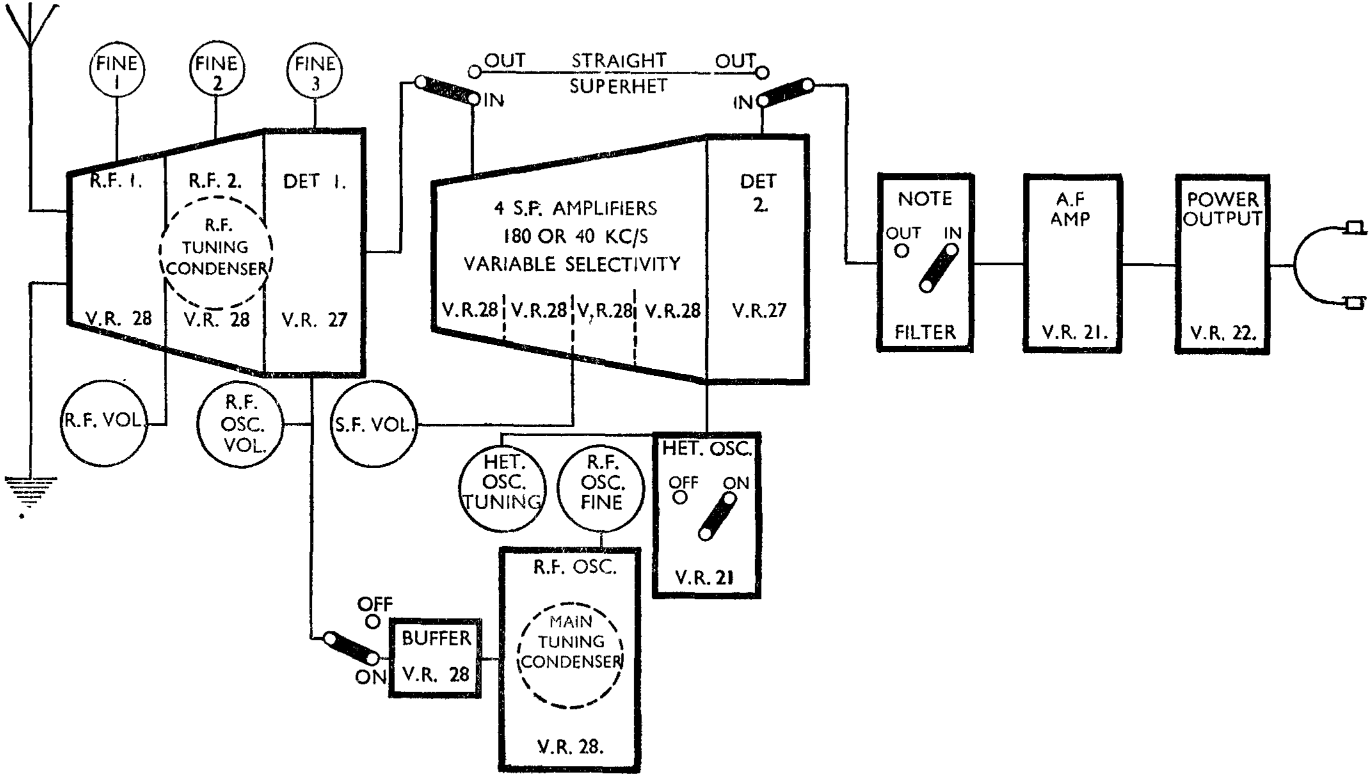
(*l*) Turn regeneration control $\frac{3}{4}$ of a turn away from oscillation point. The signal will probably disappear, but this step ensures that there is no risk of oscillation.

(*m*) Give the side of the receiver a sound slap with the palm of the hand and note that it does not go into oscillation. There should also be no ringing in the phones which will denote a " microphonic " valve(s), or crackling noises denoting bad connections or faulty bonding.

Note.—The accuracy of crystals is such that the pilot should be told that it is seldom, if ever, necessary to adjust the receiver tuning control. This control should *never* be used to decrease strength of a loud signal (i.e., by mis-tuning) but the volume control itself should be employed.

(63413)


TRANSMITTER
MASTER OSCILLATOR (CRYSTAL CONTROLLED) TRIODE V.T 50
POWER AMPLIFIER PENTODE V.T. 51
A
AERIAL TUNING
S
R
REGENERATION
RECEIVER
1st. R.F. AMPLIFIER
TUNING
V.R. 18
2nd. R.F. AMPLIFIER
TUNING
V.R. 18
VOLUME CONTROL
DET V.R. 27
1st. A.F AMP TRIODE V.R. 21
2nd. A.F. AMP TRIODE V.R. 21
POWER OUTPUT TRIODE V.R. 22
MICS.
MODULATOR PENTODE V.T 51
A. 1134
SUB. MODULATOR I/C. AMPLIFIER V.R. 21. V.R. 35
MOD. T. 1083


FINE 1
FINE 2
FINE 3
OUT
STRAIGHT
OUT
SUPERHET
IN
IN
R.F. 1.
R.F. 2.
DET 1.
R.F. TUNING CONDENSER
V.R. 28
V.R. 28
V.R. 27
4 S.F. AMPLIFIERS
180 OR 40 KC/S
VARIABLE SELECTIVITY
V.R.28
V.R.28
V.R.28
V.R.28
DET 2.
V.R.27
NOTE
OUT
IN
FILTER
A.F AMP
V.R. 21.
POWER OUTPUT
V.R. 22.
R.F. VOL.
R.F. OSC. VOL.
S.F. VOL.
HET. OSC. TUNING
R.F. OSC. FINE
HET. OSC.
OFF
ON
V.R. 21
R.F. OSC.
MAIN TUNING CONDENSER
V.R. 28.
OFF
ON
BUFFER
V.R. 28

RECEIVER R. 1084

1. **Description.**—(*a*) General purpose ground station receiver.

(*b*) Frequency range—120 to 20,000 kc/s.

(*c*) Provision is made for either superheterodyne or straight reception.

(*d*) Power supplies—L.T. 2-volt 90 A.H. accumulator. H.T. 120 volts from A.C. mains unit or Milnes alkaline battery. Normal anode current, about 25 milliamps.

2. **Circuit Notes.**—Frequency range is covered by 11 sets of plug-in coils and two sets of S.F. coils. The supersonic frequency is 40 kc/s for the 120–600 kc/s band and 180 kc/s for the remainder of the range. Volume controlled by varying the bias of the variable-mu valves used in the R.F., isolator, and S.F. stages.

All S.F. stages are provided with two alternative tuned-anode circuits of same stage gain but different selectivity. This permits a wide variation in the overall selectivity of the set. The anode circuit of the second detector has a 1,000 cycle note filter as an alternative to the normal resistance load, for obtaining maximum selectivity when receiving C.W. All S.F. stages, second detector, and heterodyne oscillator may be cut out, the receiver then becoming a straight set, with the R.F. oscillator providing heterodyne for C.W. reception. Suitably shunted jacks are provided at various points in the receiver for fault checking by means of a milliammeter. Normal readings obtained at these points are to be memorised. Potentiometer across filament circuit of first detector (operated by means of key attached to receiver lid) allows for adjustment of grid bias of this valve when a VR.27 is not available. Correct adjustment is that which provides maximum dip in second detector H.T. milliamps when signal has been correctly tuned in. A 6-volt 40 mA fuse bulb is fitted in the negative H.T. lead. (Do not confuse with 2-volt pilot lamp.)

3. **Tuning Notes.**—(*a*) *Superhet operation.*—Connect aerial and earth to appropriate sockets (A1 normal, A2 for low capacity aerial, A3 and 4 for dipole), and ensure switches at each end of receiver are set to superhet " in ".

(*b*) Plug in appropriate coils. Set switch on first S.F. coil to " tune " and the remainder to " standby ".

(*c*) *R.T. and I.C.W.*—Set R.F. and R.F. oscillator volume controls to maximum, and S.F. to approximately 6.

(*d*) Set R.F. main tuning, middle R.F. trimmer, R.F. oscillator and fine tuning from calibration chart. Set first and third R.F. trimmers to approximately same setting as middle R.F. trimmer. Heterodyne oscillator to 80.

(*e*) Switch on eliminator, observe that stabiliser is glowing, and then make H.T.–L.T. switch and R.F. oscillator switch, leaving heterodyne oscillator off. (When switching off, break eliminator switch before H.T.–L.T. switch on set.)

(*f*) Set note filter " out ".

(*g*) Search for any signal near desired frequency on R.F. oscillator main tuning, adjust R.F. tuning and first and third R.F. trimmers for loudest signal. If signal cannot be heard near desired frequency, first and third trimmers should be adjusted for maximum background noise.

(*h*) Search for desired signal with R.F. oscillator main tuning condenser, and readjust R.F. main tuning for loudest signals ; a distinctly louder signal will be heard on one side of the dead space than on the other. Increase selectivity as required by putting more S.F. switches to " tune ".

(*i*) Finally, adjust the volume controls for required volume. Unless signal is very strong this should be done by S.F. control only.

(*j*) *C.W.*—As operations (*a*) to (*f*).

(*k*) Switch on heterodyne oscillator.

(*l*) To ensure that the heterodyne oscillator is mistuned from the S.F. stages by an audio-frequency, switch off R.F. oscillator, set R.F. volume control to " O ", set all S.F. switches to " tune ", set S.F. volume control to maximum, and adjust heterodyne oscillator tuning for high-pitched background hiss—not dead space. Reduce S.F. volume control to 6, increase R.F. volume control to maximum, switch on R.F. oscillator, and set switches on last four S.F. coils back to " standby ".

(*m*) As operations (*g*) and (*h*).

(*n*) Extreme selectivity on C.W. may be obtained by switching note filter " in " and adjusting heterodyne oscillator control to give 1,000 cycle note.

(*o*) As operation (*i*).

(*p*) *Straight Operation.*—Connect aerial to appropriate socket, and ensure switches on end of receiver are set to superhet " out ".

(*q*) Plug in coils.

(*r*) *R.T. and I.C.W.*—Set R.F. volume control to maximum.

(*s*) Set R.F. tuning and R.F. middle trimmer from calibration chart. Set first and third trimmers to approximately same setting as middle trimmer.

(*t*) Switch on H.T.-L.T., leaving R.F. oscillator and heterodyne oscillator off, and note filter " out ".

(*u*) Search for signal on R.F. tuning, adjust first and third trimmers for loudest signal; and finally adjust R.F. volume control for required volume.

(*v*) *C.W.*—As operations (*p*) to (*u*), but R.F. oscillator must be switched on, R.F. oscillator tuning adjusted for desired C.W. note, and note filter switched " In " if maximum selectivity is required.

SOLDERING

1. **General.**—(*a*) Solder is a fusible alloy, i.e., a combination of one or more metals with a low melting point (" soft " solders range from 160 degrees to 600 degrees F.)

(*b*) Strength of joint is determined by *kind* of solder used, not amount.

(*c*) Electrical and radio work—high grade soft solder used (tin and lead alloy).

(*d*) You may use resin-cored solder (most common), grade " B " (50 per cent. tin, 50 per cent. lead).

2. **Practical.**—(*a*) Clean thoroughly all parts to be joined, and treat with flux. (Solder will not adhere to dirty metal).

(*b*) If possible, make a sound mechanical joint before soldering.

(*c*) Use a tinned bit, which is to be cleaned with linen or cotton rag (not woollen).

(*d*) Make sure the iron is hot enough for use (solder runs freely).

(*e*) Don't allow the iron to cool below its proper working temperature.

(*f*) Avoid waste and excess of solder. Apply solder so that it runs evenly and thinly into joint made. Remember solder is a soft metal.

(*g*) Avoid excess of flux. Too much applied will leave the job dirty after soldering, and may also damage any rubber insulation which is present.

(*h*) Don't allow the iron to overheat. A blue film on the tinned surface will warn you that is happening.

N.B.—These rules apply generally to all forms of soldering (hard and soft), but particularly in radio work and electrical work in aircraft.

3. **Fluxes.**—(*a*) A flux (i) protects the cleaned surface from the air (thus preventing oxidisation) ; (ii) it also helps the solder to flow more easily ; and (iii) it sometimes has a cleansing effect.

(*b*) Only *resin*, in its various forms, to be used in electrical and radio work.

(*c*) For hard metals and rough work, borax or corrosive fluxes (acids or salts), *may* be used, but always in small quantities, carefully.

(*d*) Clean off excess flux after soldering.

4. **Essential Tools.**—(*a*) Soldering " iron " : electrically or otherwise heated.

(*b*) Cleaning tools : files, abrasive paper (usually emery cloth), etc.

(*c*) Wiring tools : shears, pliers, etc.

SECTION I

Article 7

CALLIGRAPHY

Printing of Block Capital Letters and Figures

1. **Purpose.**—The importance of legible handwriting in the reception of Morse signals cannot be too highly stressed and with the introduction of mixed letter and figure groups the careful formation of characters is essential. The following method of printing letters and figures is approved for use throughout the R.A.F. and is designed to :—

(*a*) Avoid confusion between letters and figures which may appear similar, e.g. Z and 2, U and V, and I, 1 and 7. These latter are often confused in mixed letter and figure groups.

(*b*) Obtain a standard style throughout the service.

(*c*) Aid wireless operators in printing letters and figures quickly. This is especially important at higher Morse speeds.

2. **Method of Printing.**—Fig. 5 indicates the motion of the pencil to be adopted when printing. The " dot " shows where each stroke of the pencil begins. The " arrow " shows where each stroke ends.

Fig. 5.—Method of Printing Letters and Figures.

3. **Important Letters and Figures.**—Particular attention should be paid to the correct formation of the following letters and figures :—

(*a*) The letter I and figures 1 and 7. There should be no " tails " to the letter I, a plain downward stroke only being used. The figure 1 on the other hand is written like an inverted " T ", with a pronounced cross bar at the foot, and should not be confused with " L ". The figure 7 should have a pronounced horizontal top, like an inverted " L ".

(*b*) The letters " O ", " Q " and figure " 0 ". The circular portions of all these are formed in the same manner. The " tail " of the " Q " should be short and almost vertical and should cross the circular line. The " cross bar " of figure " 0 " on the other hand should be horizontal and completely cross the figure but not project beyond the circle.

(*c*) The letters " U " and " V ". The letter " U " should be formed with a square bottom and not curved. The letter " V " on the other hand should come to a point at the bottom where the pencil reverses its motion.

(*d*) Letter " Z " and figure " 2 ". The letter " Z " is formed with a flat horizontal top, whereas the figure " 2 " has a pronounced " hook " top.

(*e*) The figures " 5 " and letter " S ". The figure " 5 " is formed with two strokes. The top should be long and flat, this will avoid confusion with letter " S ", which is formed with one stroke only and should have a good " hook " top.

(*f*) Figure " 9 " should be printed with a long straight " tail " and the top circle should be completed.

Hints.—Methods of taking down W/T code messages :—

(*a*) As the letter " E " is the shortest letter in the Morse code but one of the longest to write down, it is recommended that operators insert a " dot " when receiving this and fill in the letter after the message has been received.

(*b*) In " SYKO " messages the letter " P barred " sometimes appears, this should be printed in the usual way as " $\overline{\text{P}}$ " making only one character in a group.

(*c*) If a character is not immediately recognised the operator is recommended to write down a small " dash " and go on to the next character. In this way the proper code groups will be preserved and the error limited to the omission of the one character.

TRANSMITTER-RECEIVER T.R.1196–T.R.1196A

1. **Service Requirements.**—Crystal controlled transmitter and receiver for R/T and M.C.W. use in aircraft, having a range of 30 miles between aircraft at 2,000 feet, and 50 miles between aircraft and ground at 2,000 feet. Remote push button tuning is employed (controllers, electric, type 4) and the set may be tuned to a maximum of four pre-set frequencies.

2. **Frequency Range.**—4·3 to 6·7 mc/s.

3. **Power Supplies.**—(*a*) *Transmitter.*—L.T., 6·3 volts, 1·3 amps. H.T., 250 volts, 60 to 70 m.a.

(*b*) *Receiver.*—L.T., 6·3 volts, 1·2 amps. H.T., 275 volts, 35 m.a.

(*c*) All the above supplies are derived from a self-contained power unit (type 87 or 104) driven by the aircraft G.S. batteries :—

T.R.1196—24 volts at 2.5 amps.

T.R.1196A—12 volts at 5 amps.

4. **Aerial System.**—Short capacitive type variable from 45 to 140 $\mu\mu$F.

5. **Valves.**—(*a*) *Transmitter unit* (*three*). Oscillator—pentode V.R.91, 6·3 volt, 0·3 amps., maximum anode voltage 300, dissipation, 3 watts, anode current about 10 m.a. Power amplifier—beam tetrode, V.T.501, 6·3 volts, 0·8 amps., maximum anode voltage 300, dissipation, 7·5 watts, anode current about 30 m.a. Modulator—pentode, V.T.52, 6·3 volts, 0·2 amps., maximum anode voltage 300, dissipation, 7·5 watts, anode current about 30 m.a.

(*b*) *Receiver unit* (*six*). R.F. amplifier—pentode V.R.53, 6·3 volts, 0·2 amps., maximum anode voltage 300, dissipation, 7·5 watts. Frequency changer—octode, V.R.57, 6·3 volts, 0·2 amps., anode voltage 225 to 300, dissipation about 1·0 watt. I.F. amplifier—pentode, V.R.53, 6·3 volts, 0·2 amps., maximum anode voltage 300, dissipation, 2·0 watts. A.F. amplifier—pentode, V.R.56, 6·3 volts, 0·2 amps., maximum anode voltage 300, dissipation 1·0 watt. A.G.C. amplifier—pentode, V.R.56 ; 6·3 volts, 0·2 amps., maximum anode voltage 300, dissipation, 1·5 watts. Detector A.G.C. and output—double-diode triode V.R.55, 6·3 volts, 0·3 amps., maximum anode voltage 300, dissipation 1·5 watts.

6. **Remote Control.**—The transmitter-receiver is invariably mounted in a position which is inaccessible to the pilot, a controller electric, type 4 (located in pilot's cockpit) is employed to carry out all switching of the receiver and transmitter. Controller, type 4, has five press buttons—A, B, C, D and OFF—these are electrically connected to a step-by-step motor driving a " Yaxley " type switch, which selects the appropriate crystal and P.A. tuned circuit. A switch marked T–RA–R is provided to switch from " transmit " to " receive " and a socket, type 315, for remote control (press to transmit).

7. **Circuit Arrangements** (Fig. 5A).—*Transmitter unit.*—A crystal controlled Pierce oscillator drives an anode and screen modulated class " C " R.F. amplifier. An electro-magnetic microphone is used ; the output from the microphone is amplified before feeding to the modulator valve, by the last two A.F. stages of the receiver (not by A.1134).

A side-tone arrangement enables the operator to hear his own speech in the telephones while transmitting.

Tuning of the P.A. is carried out by a continuously variable inductance common to the aerial circuit of the receiver (hence the necessity for tuning the transmitter first), a separate inductance being supplied for each range.

Range D may be employed for a special purpose when the range, air to ground at 2,000 feet, is reduced to 35 miles.

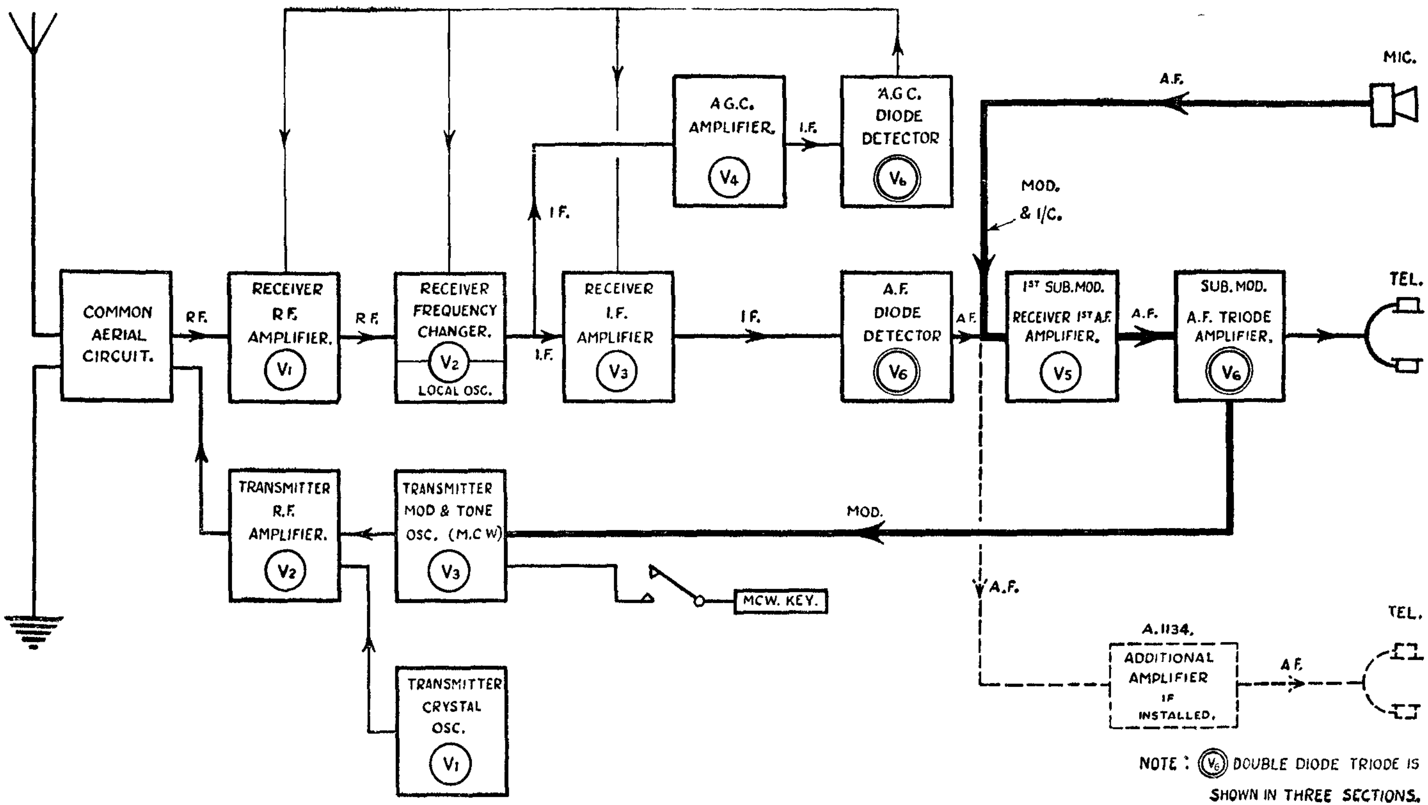


Fig. 5a.—Block Schematic T.R. 1196

Receiver circuit.—(*a*) Superhet for reception of R/T and M.C.W. only. A.G.C. is employed, and attenuation to reduce back ground noise when no signal is being received. Aerial tuning is common to transmitter and receiver, and all frequencies are crystal controlled, crystals being 460 kc/s above or below the corresponding transmitter crystal frequency. Variable condensers are connected in the grid circuit of V.2 and selected together with correct crystal by the step-by-step motor.

(*b*) *A.G.C.* is obtained by feeding part of the I.F. signal across the I.F. transformer via a condenser to the control grid of the A.G.C. amplifier V.4. A diode portion of V.6 acts as the rectifier to obtain the D.C. component.

(*c*) *Attenuation.*—Obtained by connecting a pre-set variable resistance in series with bias resistance of V.3 on the R.A. position (remote controller), thereby reducing the stage gain of V.3. This resistance is " shorted out " on R position.

8. **Tuning** is very simple in both receiver and transmitter, being crystal controlled : always tune transmitter first.

(*a*) *Transmitter*—

(i) Insert crystals in transmitter and receiver.

(ii) Switch on supply.

(iii) Press button "A" set " TR " switch to " T " and wait 15 to 20 seconds for valve heaters to warm up.

(iv) Turn control "A" to 0–0.

(v) Press red button (on transmitter) and tune "A" control for maximum brilliance in tuning indicator pea lamp.

(vi) Switch on A.1134, press red button again, and blow into " mike " ; if the transmitter is modulating, the indicator will increase its brilliance.

(vii) Repeat (iii) to (vi) for channels B, C and D.

(viii) The tuning indicator on range D is of too high a resistance to " glow ". It is necessary to employ one of two other methods of tuning, i.e. press the key and tune P.A. coil for lowest note, or connect an unshunted pea lamp in series with the aerial.

(*b*) *Receiver.*—Two correct and two incorrect tuning positions may be found, the two which give " max." background noise are correct, and either may be used :—

(i) Switch " TR " switch to " R ".

(ii) Adjust " vol. increase " to max., loosen locking collar around receiver "A" tuning control.

(iii) Adjust with screwdriver for max. background noise.

(iv) Adjust " vol. increase " as required (when working nearby station 20 miles, 2,000 ft. until output is same level as i/c.)

(v) With engines running and " TR " switch in " RA " position, adjust " RA " control (on back of receiver) until background noise is reduced, but not sufficient to prevent incoming signals being heard.

(vi) Repeat (ii) and (iii) for channels B and C.

N.B.—Screened cables with sockets attached (Jones' type) are employed throughout the installation.

9. **General Servicing.**—T.R.1196–T.R.1196A :—

(*a*) Check all external connections.

(*b*) Ensure all plugs and sockets are securely mated and in good condition.

(*c*) Inspect screened cables for fracture, chafing or undue strain.

(*d*) Test G.S. 12 or 24-volt supply.

(*e*) Ensure " tel/mike " sockets are securely anchored and in good condition.

10. **Faults and Remedies.**—(i) *No output from transmitter.*—Ensure :—

(*a*) G.S. fuse is serviceable and internal P.U. is running.

(*b*) Aerial connected.

(*c*) Crystal in.

(*d*) Correctly tuned.

(*e*) Correct channel selected.

(*f*) T–RA–R switch in correct position.

(ii) *No modulation or side tone.*—(*a*) Press tuning indicator button and blow into microphone ; if the brilliance increases, transmitter is correct.

(*b*) Check for break in telephone circuit.

(*c*) If the brilliance does not increase, but set is correct on M.C.W., check for break in microphone circuit.

(iii) *Transmitter correct,* but no signals in the receiver :—

(*a*) No crystal in.

(*b*) T–RA–R switch in incorrect position.

(*c*) Volume control too low.

(*d*) Incorrect channel selected.

BASIC PRINCIPLES OF RADIO COMMUNICATION

GENERAL INFORMATION

1. Definitions

(i) *Electric Current.* An orderly movement of electrons from one part of a circuit to another.

(ii) *Coulomb.* Unit of quantity of electricity. An enormously large but perfectly definite number of electrons.

(iii) *Ampere.* Standard unit of current. A rate of flow of one coulomb per second.

(iv) *E.M.F.* (Electro-Motive Force.) The force or pressure causing an electric current to flow in a circuit, measured in volts.

(v) *Conductor.* A substance with many free electrons, which readily permits the flow of electrons under electrical pressure (i.e., when an E.M.F. is applied).

(vi) *Insulator.* A substance with few free electrons, which does not readily permit the flow of electrons when an E.M.F. is applied.

(vii) *Potential Difference.* (P.D.) The difference in voltage between two points in a circuit.

(viii) *Means of producing E.M.F.*
  (*a*) Chemical energy, as in batteries.
  (*b*) Heat, as in thermo-couples.
  (*c*) Mechanical, as in dynamos.

(ix) *Ohm's Law.* Ohm's Law states that the current in a conductor is proportional to the applied potential difference. Thus, if we double the applied potential difference we obtain double the current.

2. Resistance

The resistance of a conductor (i.e. its "opposition" to a flow of current) is the ratio of the current produced to the potential difference applied to its ends. According to Ohm's Law this ratio is always the same for a given conductor, because if we make the applied potential difference twice as great, the current becomes twice as great. The resistance of a conductor is measured in Ohms and is obtained by dividing the applied potential difference (in volts) by the current produced (in amperes). Expressed in symbols :—

$$R \text{ (ohms)} = \frac{V \text{ (volts)}}{I \text{ (amperes)}}$$

Other methods of expressing the formula are :—

$$V = I \times R$$

$$I = \frac{V}{R}$$

If the conductor gets warm its resistance usually increases. The Law is generally applicable to metal conductors.

3. Resistances in Series and Parallel

In circuits containing a number of resistances in series R (total) $= R_1 + R_2 + R_3 +$ etc.

If the resistances are in parallel $\frac{1}{R}$ (total) $= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} +$ etc.

4. Energy (or Work)

We say that energy is expended (or that work is done) when something is moved by a force, e.g. work is done when a weight is pulled to the ground by the action of gravitational force. In the same way energy is expended, i.e. work is done, by an electromotive force in moving electrons from one point to another. This energy is, of course, supplied by the battery or other source of E.M.F.

5. Power

Power is the rate at which energy is used up or the rate at which work is done. We can therefore define Power as the number of units of energy used up per second. The electrical unit of power is the "watt." If a voltage "V" is applied to a resistance of "R" ohms then the rate of using up energy, i.e. the power, is calculated by multiplying V by I (the current in amperes) :

$$W = V \times I$$

Since by Ohm's Law $I = \frac{V}{R}$, it follows also that

$$W = \frac{V^2}{R} \quad \text{and}$$

$$W = I^2R$$

6. Effects of a current

Effects of a current are as follows :—

(i) *Heating :* All current-bearing conductors become heated. (Used in lamps, radiators, etc.)

(ii) *Magnetic :* A current-bearing conductor has a magnetic field surrounding it. (Used in electro-magnets, telephones, etc.)

(iii) *Chemical :* In solutions conveying currents chemical changes occur. (Used in electro-plating, secondary cells, etc.)

7. Primary Cells

The type in common use in the Service is the dry Leclanche cell (E.M.F. 1.5 volts). It consists of carbon and zinc electrodes, sal-ammoniac electrolyte, and manganese dioxide depolariser. These cells are suitable for very low discharge rates, or intermittent work at higher rates. They cannot be re-charged.

8. Accumulators

The proper care and operation of accumulators is of vital importance to wireless operators ; the safety of aircraft and their crews depends on them. The type in common use in the Service is the lead acid accumulator (E.M.F. about 2 volts) which consists of an acid-proof container, lead peroxide positive plates, spongy lead negative plates, diluted sulphuric acid electrolyte. Accumulators for aircraft use are fitted with unspillable vents. To enable these to function properly the electrolyte must be kept at the correct level.

(i) *Discharge.* During discharge the sulphuric acid combines with both plates to form lead sulphate, thus weakening the electrolyte. It is extremely important that a discharged accumulator should be recharged immediately, otherwise the lead sulphate hardens and the accumulator may become unserviceable.

(ii) *Charge.* By passing a current through the cell in the opposite direction to that of discharge, the lead sulphate is driven off the plates, forming sulphuric acid and strengthening the electrolyte, and the plates are re-converted to lead peroxide (positive) and spongy lead (negative) respectively.

(iii) *State of Charge.* The strength of the electrolyte indicates the state of charge of an accumulator, and is measured by taking its Specific Gravity with a hydrometer. In aircraft accumulators this varies between about 1.270 (fully charged) and 1.100 (fully discharged).

The voltage of a fully charged accumulator should be about 2.2 volts and service accumulators should not be discharged below 1.8 volts on load. In the discharged condition, the internal resistance of the accumulator rises, and although a voltmeter will show a reading of 1.8 volts when placed across it, a discharged accumulator should never, under any circumstances, be used since permanent damage will result.

For an Initial Charge the makers' instructions should be strictly complied with. If none are available, the general instructions in Form 480 should be followed

(iv) *Capacity*. This is the quantity of electricity which can be drawn from an accumulator at a given rate of discharge. In the Service it is generally stated in ampere-hours at the 10 hour rate. E.g. a 20 ampere-hour accumulator can give 2 amps for 10 hours. At higher rates the capacity is reduced, and this accumulator would give 11 amps for 1 hour only. At lower rates a slight increase in capacity is obtained. It is inadvisable to exceed the 10 hour rate of discharge except for brief periods.

Charging Instructions are displayed on R.A.F. Form 480.

9. Electric Generators and Motors

It can be shown by experiment that a conductor carrying a current sets up a magnetic field. (Maxwell's Corkscrew Rule.) If placed in another magnetic field it tends to move across it in a direction given by Fleming's Left Hand Rule. A conductor moving across a magnetic field has an E.M.F. induced in it in the direction given by Fleming's Right Hand Rule. If the conductor forms part of a closed circuit, then the induced electromotive force will produce a current. This current sets up another magnetic field. The interaction between this magnetic field and the original field is such as to oppose the motion inducing the E.M.F. (Lenz's Law). Notice that there is no opposing force unless an induced E.M.F. gives rise to a current. The E.M.F. induced depends on the rate of change of flux linkage.

If a conductor is wound into a coil and a current applied, a magnetic field similar to that of a permanent magnet is set up, the end at which the current runs clockwise having South polarity, and the anti-clockwise end North polarity.

If two coils are wound on the same former, a changing magnetic field set up by a changing current in one (primary) will induce a changing E.M.F. in the other (secondary).

Note.—No E.M.F. will be induced by a steady current—it must be changing (increasing or decreasing).

10. Transformer Effect

If an iron core is placed inside the coils concentrating the field so that practically all the lines of magnetic force set up by the primary link with all the turns of the secondary we have an efficient transformer in which the voltage induced across the secondary terminals will be equal to the voltage across the primary terminals multiplied by the turns ratio, e.g. if the secondary has 3 times the turns of the primary, the secondary voltage will be 3 times the primary voltage.

When a loop of wire is rotated in a magnetic field E.M.F.s are induced. The E.M.F.s in the two sides are in series and add together. After half a turn the sides will have changed places and the E.M.F.s will have reversed in each side. If the loop is connected directly to an external circuit alternating currents will be obtained reversing at each half-revolution.

To get direct current, flowing one way only, the two ends of the loop are connected to separate segments of a commutator. In this case whichever side of the loop is positive at the brush end is connected via the brush to the positive output terminal, and the other (negative) side to the negative output terminal.

11. Practical D.C. Generator

A generator consists of the following main parts :—

(i) *Carcase* or main frame (iron), with pole pieces to carry field windings and concentrate the magnetic field.

(ii) *Armature.* Revolving with its shaft. Laminated iron core, with grooves to carry the armature coils, the ends of which are led out to commutator segments.

(iii) *Carbon brushes* in brush holders collect current from revolving commutator and lead it to fixed terminals.

The generated E.M.F. varies with the strength of the magnetic field, number of turns on the armature coils, and speed of rotation.

If the field windings are in shunt or series with the armature windings, the machine is self-excited. If the field windings are supplied from some other source, or permanent magnets are used, it is separately excited.

Some source of mechanical power is required to drive the armature round.

12. Practical D.C. Motor

Construction is the same as a generator, but the following points must be noted with regard to operation.

(i) External supply is needed to provide current for the armature windings (and also for the field if permanent magnets are not used) to cause the armature to rotate. Speed depends on field strength, number of turns on the armature coils, supply voltage and load.

(ii) *Back E.M.F.* When the motor is running the armature coils act as in a generator and produce an E.M.F. which increases with the speed, and opposes the supply voltage, limiting the amount of current through the armature, which has only a very low resistance. To prevent a heavy current which might damage the machine, when the armature is stationary, a motor is started through a resistance in series with the armature, which is cut out when the speed and back E.M.F. have built up to a safe value.

13. The Motor Generator

For W/T equipment we require high voltage D/C supplies. One way of obtaining this is to use a low voltage source (e.g. a 12-volt accumulator) to drive a motor which is coupled to a generator having a large number of turns on the armature windings. Such an arrangement is called a "motor generator." Where space is an important consideration one machine is made to serve two functions by putting two separate windings on the same armature, i.e., a low resistance winding (motor winding) and a winding with a large number of turns (H/T generator winding). These windings are brought out to separate commutators. usually one at each end of the armature. The motor commutator is the one with segments of large area and large brushes : the H/T output is obtained from the commutator with a large number of segments and small brushes. For W/T purposes, this H/T supply must be smoothed, and to do this the ripple is removed by the use of condensers and chokes. Sparking at the commutators produces interference, and this is minimised by the use of suppressor condensers. It is essential to keep the commutator clean and the brushes in good condition.

14. Vibrator, H/T Supply

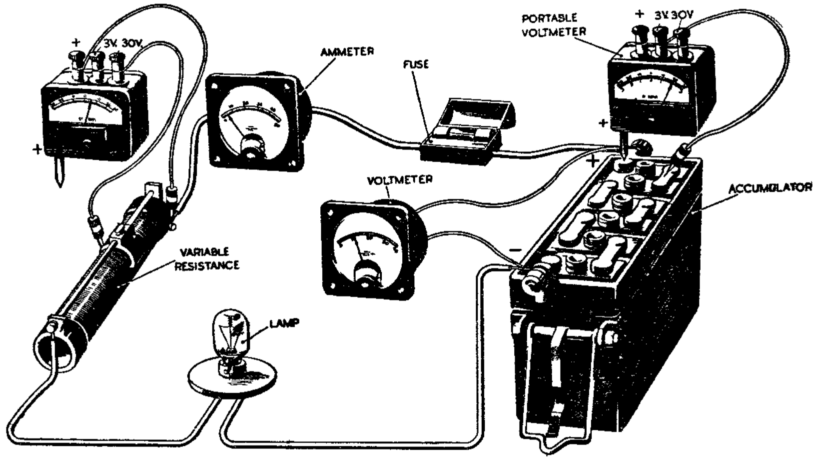
This is an alternative method of obtaining H/T from a low voltage supply when the power requirements are small. The vibrator consists of two windings on an iron core, one of low resistance carrying a primary current which is interrupted by a trembler, and a second winding consisting of a large number of turns across which a high H/T voltage is induced by the flux changes due to the interrupted primary current. The output from the vibrator requires smoothing.

15. Meters

Meters are classified according to the units which they measure.

(i) *Ammeter.* Measures current in a circuit, and is therefore placed in series with it. Its resistance should be as low as possible. Ammeters are usually sensitive instruments with a low resistance shunt across them to carry a large proportion of the main current.

(ii) *Voltmeter.* Measures the Potential Difference between any two points in a circuit. Usually has a very high resistance. These are really sensitive ammeters with a high resistance connected in series.



USES OF AMMETER AND VOLTMETER

16. Types of Meters

TYPE	ADVANTAGE	DISADVANTAGE	SERVICE REMARKS
Moving coil.	Even scale, accurate.	Suitable for D.C. only (excepting those with metal rectifiers used for A.C. of less than 1000 c.p.s.)	Commonly used (also as basis of test-meters types D & E). Voltmeter or Ammeter.
Moving iron.	Cheap, robust.	Uneven scale.	Seldom used. Voltmeter or Ammeter.
Thermo-couple.	Suitable for A.C., D.C. and R.F.	Easily damaged by slight overloads.	Commonly used. Ammeter only.
Electrostatic.	Low power consumption.	Unsuitable for low voltage or as ammeter.	Used. Voltmeter only.
Hot wire.	Suitable for A.C., D.C. and R.F.	Requires frequent calibration. Accuracy unreliable.	Used. Ammeter only.

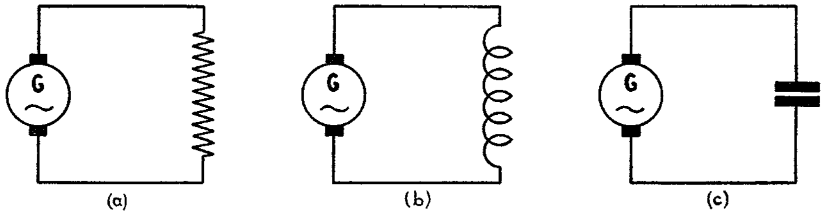
(i) *Moving Coil Meter.* Works on the motor principle. Springs oppose the turning moment, and a pointer attached to the coil is made to travel over a calibrated scale.

(ii) *Hot Wire Ammeter.* Operated by the expansion of a wire when heated by an electric current.

ALTERNATING CURRENT THEORY

1. Introduction

An alternating current varies continuously in direction and magnitude. Peak or amplitude is maximum value in either direction. From one peak to the next in the same direction is one cycle. The number of complete cycles in one second is the Frequency (f).



SIMPLE A.C. CIRCUITS

(i) *Resistance*. A.C. circuits of pure resistance follow Ohm's Law—current increases and decreases with voltage. Current and voltage are said to be in phase.

(ii) *Inductance*. As A.C. is continuously changing it will induce a back E.M.F. in the inductance coil, opposing the applied E.M.F. and so reduce the current. This opposition is called Inductive Reactance and is measured in ohms. Induced E.M.F depends on rate of change of current, therefore in a given inductance the higher the frequency the greater the Inductive Reactance. Also as the rate of change is greatest when the current is passing zero, induced E.M.F. will be greatest at this point, i.e. current and voltage are out of phase, current lagging 90 deg. behind the voltage.

(iii) *Calculation of Reactance of an Inductance*. The current through an inductance of L Henries when a voltage V is applied may be calculated from :—

$$I = \frac{V}{2\pi fL}$$

The expression $2\pi fL$ is known as the Reactance of the inductance and is expressed in ohms. The reactance of an inductance of 1 Henry at a frequency of 50 c.p.s. is 314 ohms. The reactance increases as the frequency increases, and at 500 c.p.s. is 3142 ohms.

(iv) *Capacity*. Two conductors separated by an insulator form a condenser, and can store a charge of electricity when an E.M.F is applied The ratio of charge to voltage is called Capacity, measured in Farads For practical purposes the microfarad (μF) is the unit.
As applied voltage rises, the condenser becomes more and more charged until when voltage reaches a maximum no more current flows into it, Current and voltage are again out of phase, current leading the voltage by 90°. The opposition of a condenser to flow of A.C. is called Capacitive Reactance and is measured in ohms. The greater the number of charges per second the greater the current, therefore the higher the frequency the less the Capacitive Reactance.

(v) *Calculation of Reactance of a Condenser*. The current through a condenser of capacity C farads when a voltage V is applied is given by :—

$$I = \frac{V}{\frac{1}{2\pi fC}}$$

The expression $\frac{1}{2\pi fC}$ is called the reactance of the condenser. This decreases as the frequency increases, e.g. the reactance of a 1 microfarad condenser at 50 c.p.s. is 3180 ohms ; at 500 c.p.s. the reactance is 318 ohms.

(vi) *Impedance*. Where the opposition consists of both resistance and reactance the total opposition is called impedance (Z).

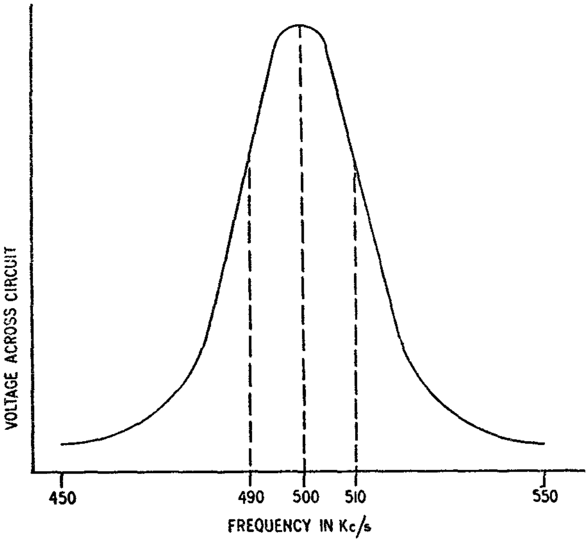
In A.C. circuits $I = \frac{E}{Z}$ If the circuit contains resistance, inductance and reactance, the calculation of Z is rather complicated.

Resonance

(i) *Series-tuned Circuits.* These consist of an inductance in series with a capacity. At low frequencies the reactance of the inductance is small whilst the reactance of the condenser is large. Thus, at low frequencies the voltage across the coil is much smaller than that across the condenser. At very high frequencies the reverse is true, because the reactance of the coil is much larger than the reactance of the condenser. At one particular frequency, called the "Resonant Frequency", the voltages across the coil and condenser are exactly equal, and opposite in phase. Total voltage drop across the two components in series is therefore zero, and the circuit behaves as though it had only resistance. At the resonant frequency the voltage across the coil (or condenser) may greatly exceed the applied voltage (i.e. the series-tuned circuit gives voltage magnification) and the impedance is then a minimum.

(ii) *Parallel-tuned Circuits* consist of a condenser and an inductance in parallel. If an alternating voltage is applied across this arrangement then at low frequencies the current through the inductance is greater than the current through the condenser due to the higher reactance of the latter. At very high frequencies the reverse is true. At some definite frequency the currents through each branch are equal but will be opposite in phase. Thus, the nett current drawn from the supply would be zero. In actual fact the currents in the respective arms may be equal but are never exactly opposite in phase, because each arm has a certain amount of resistance. The frequency at which the reactance of the coil is equal to the reactance of the condenser is called the "Resonant frequency". At this frequency the current drawn from the source is small, i.e. the impedance of parallel-tuned circuit is at its maximum at the resonant frequency.

(iii) *Tuning.* An increase in either inductance or capacity will decrease the resonant frequency, and vice versa, so that a circuit can be tuned to any frequency required by altering either or both A parallel-tuned circuit behaves like a very high resistance at the resonant frequency so that for a given input current the alternating voltage across it will be great. At any frequency other than the resonant frequency the impedance will be small and the voltage set up proportionately lower. Thus a tuned circuit can discriminate between signals on the frequency to which it is tuned and signals on any other frequency. The extent to which a tuned circuit responds to signals to which it is resonating to the exclusion of signals on other adjacent frequencies is termed its "selectivity."



SELECTIVITY OF A TUNED CIRCUIT

Oscillatory Circuit

(i) *Closed Oscillatory Circuit.* Consists of an inductance and condenser connected in parallel. If a charge is given to the condenser it will discharge through the inductance, setting up a magnetic field around the coil.

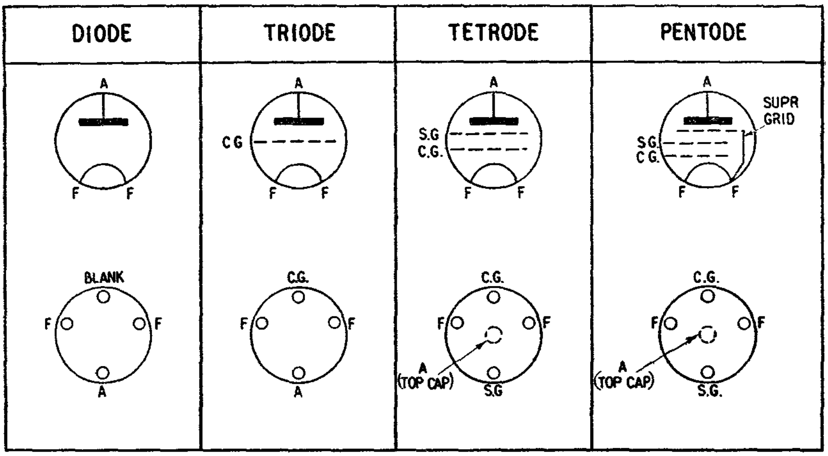
When the condenser is discharged the field will collapse, maintaining the current in the same direction and so charging up the condenser with opposite polarity. The operation then repeats itself in the reverse direction, making a complete cycle or oscillation. The alternating current will thus be set up at the resonant frequency of the tuned circuit and will persist with decreasing amplitude until all the energy given to the condenser has been used up either in the form of heat (since the circuit has resistance) or been radiated away in the form of electromagnetic waves. If sufficient power is fed to the circuit at the right frequency (e.g. from a valve oscillator) continuous oscillation can be maintained.

(ii) *Open Oscillatory Circuit.* In a closed oscillatory circuit very little energy is radiated away in the form of electromagnetic waves. If the condenser arm of an oscillatory circuit is opened out to occupy a large space, e.g. aerial and earth of a wireless transmitter, the process of charge and discharge sets up electromagnetic stresses in the space between them, which are radiated outwards as electromagnetic waves at the velocity of light (186,000 miles per second) and at the frequency of oscillation. Power must be supplied to the circuit to compensate for this radiation loss. When these electro-magnetic waves meet a similar circuit tuned to the same frequency (e.g. aerial and earth of a wireless receiver) they cause currents to flow in this circuit which can be amplified and detected to give an intelligible signal.

VALVES AND THEIR USES

1. Action of Valve

When a conductor is heated sufficiently, free electrons tend to shoot off from it. A hot conductor (called the filament or cathode) is enclosed in a vacuum bulb with another electrode (the anode). This can be connected to the cathode via a source of A.C. voltage. When the anode is positive, electrons will be attracted to it and current will flow round the circuit. When the anode is negative, electrons will be repelled and no current will flow. This gives current in one direction only from an A.C. supply, hence the name "valve". This valve, having two electrodes (cathode and anode) is called a "diode", and is used as a rectifier or detector.



RADIO VALVES : Symbols and base arrangement

2. Triode Valve (3 electrodes)

The anode is kept at a high positive potential with respect to the filament or cathode, so that electrons tend to flow from cathode to anode all the time (anode current) and a control grid of open mesh is placed between them. If the grid is made positive it assists the flow of electrons to the anode and if negative it opposes the electron current. When an A.C. voltage is applied to the grid the anode current increases or decreases as the grid is made positive or negative. If a load such as a resistance is placed in the anode circuit the changing current will cause changing voltages across it, and it can be arranged that a small change in grid voltage gives a large change in voltage across the anode load, so that the valve can be used as an amplifier. In practice the grid is given a permanent negative bias and swings more or less negative. This reduces anode current and so increases efficiency by reducing the load on the H/T supply and by avoiding wasteful heating of the anode.

3. Tetrode Valve (4 electrodes)

The triode valve is not satisfactory for amplification at radio frequencies, as instability is caused by feedback through the anode-grid capacity (see para 13), so a screening grid is placed between control grid and anode. This grid is connected to cathode through a large capacity condenser and neutralises the anode-grid capacity. It is given a positive D.C. potential usually less than that of the anode to prevent it from stopping the electron flow to the anode completely.

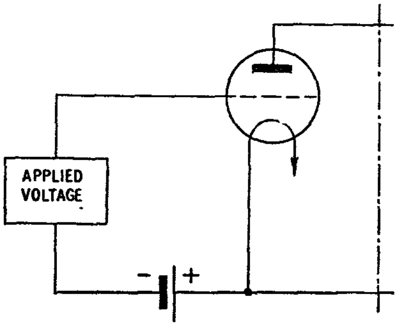
It is chiefly used as a radio frequency amplifier.

4. **Pentode Valve** (5 electrodes)

When large power is being handled the electrons strike the anode with such force as to dislodge electrons already there and these "secondary" electrons are attracted to the screening grid, causing reduction in anode current and increase in screening grid current. To prevent this, in a pentode valve a suppressor grid is placed between anode and screening grid, and connected to cathode. This is very negative compared to the anode, and repels the secondary electrons back to the anode. This valve is used for handling high power at both radio and audio frequencies.

5. **Grid Bias**

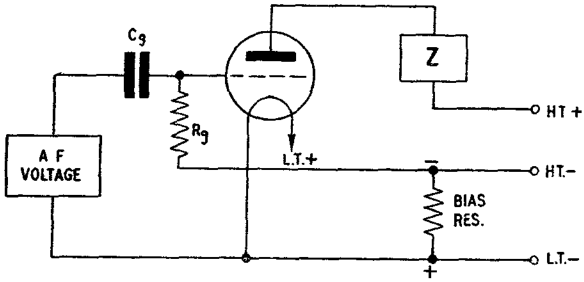
Various methods are used to give the control grid a standing negative bias.



BATTERY BIAS

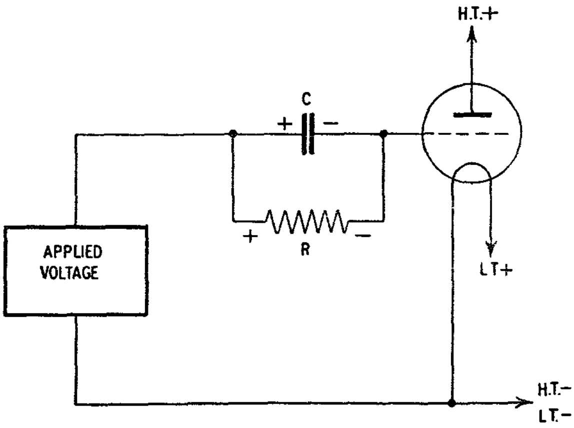
(i) *Battery Bias.*

A small battery is connected, positive to cathode and negative to grid.



AUTOMATIC BIAS—Receiver

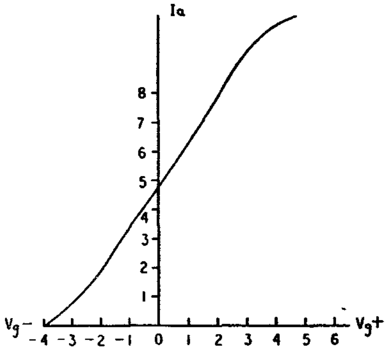
(ii) *Automatic Bias.* The anode current flows through a resistance in the cathode return lead, the grid being connected to the negative end. This automatically adjusts the grid voltage, as increased anode voltage and current causes a greater voltage drop across the resistance, giving more negative bias.



SELF BIAS

(iii) *Self Bias.* A charge is built up on the condenser C by electrons attracted to the grid during positive half-cycles. These leak away through the resistance R, so that the potential is always less than the peak signal voltage, and is negative with respect to the cathode. It is self-adjusting, and is chiefly used in oscillators.

6. Valve Characteristics

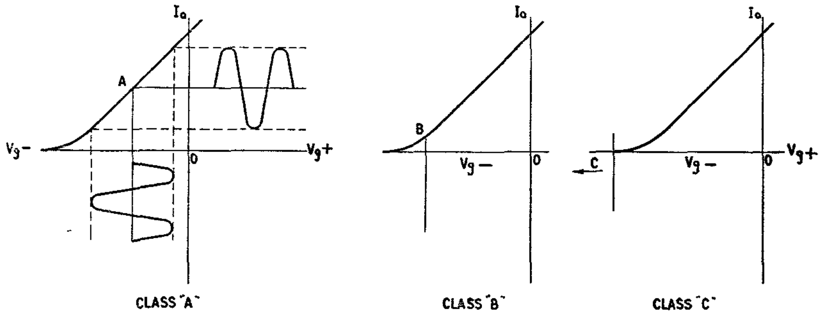


Ia—Vg CURVE

A curve showing the relation of anode current to grid voltage can be drawn. In the diagram the curve is given of a valve which passes 4.7 m/a at zero bias (grid at same voltage as cathode) and no anode current at —4 volts grid bias. This is called the "cut off" point. Between 0 and —2 volts the curve is practically a straight line and operation in this part gives undistorted amplification. The steeper the slope of the characteristic curve the greater the change in anode current produced by a given change in grid voltage and hence the higher the amplification.

7. Operating Conditions

Valves are usually worked under one of three sets of grid bias conditions.



CLASSES OF GRID BIAS

(i) *Class A :* Grid biased to middle of straight part of curve. Gives undistorted amplification provided the amplitude of the applied signal is not too great. The standing anode current is fairly high and therefore the efficiency is low. Used in receiver R.F. and A.F. amplifiers.

(ii) *Class B :* Grid biased to cut-off point so that anode current only flows during positive half-cycles of signal voltage. There is therefore no standing anode current, with the result that the efficiency is much higher than with Class A operation. Class B operation is used in R.F. power amplifiers, the tuned circuit connected to the anode of the valve having the effect of restoring the wave form. For purposes of A.F. amplification the tuned anode circuit cannot be used and the only method of ensuring that the anode current wave form is similar to the wave form of the applied signal is to use a pair of valves in push-pull, so that each amplifies alternate half-cycles.

(iii) *Class C :* Grid biased beyond cut-off point so that anode current flows only during part of the positive half-cycles of the signal. Standing anode current zero. Class C operation is used in R.F. amplification since the shape of the original wave form can be restored by the use of a tuned anode circuit. Class C operation is of no use for A.F. amplification because it is impossible to avoid very serious distortion. Gives high efficiency in R.F. power amplifiers.

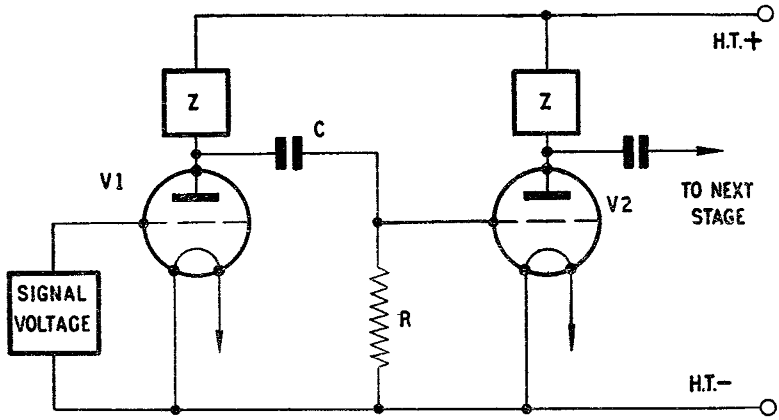
8. Amplification

In order to use a valve as a voltage amplifier it is necessary to make the variations in anode current produce variations in voltage; this is done by using an anode load. In the case of A.F. amplifiers the anode load may be either a resistance, the reactance of a choke, or the primary of a transformer. In the case of R.F. amplifiers the anode load is usually a tuned circuit. To obtain maximum voltage amplification, the anode load resistance (or impedance) should be as large as possible.

The output stage in a receiver or a transmitter is a power amplifier, i.e. it is designed to give the maximum power output from the stage. In the case of power amplifiers the anode load should be as nearly equal to the valve impedance as convenient.

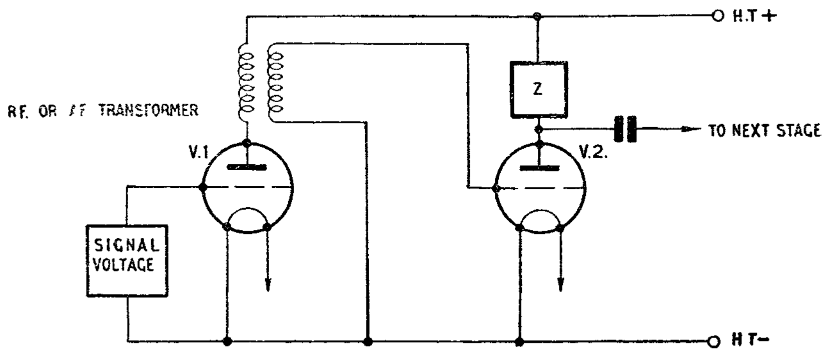
9. Coupling Circuits

To make use of the amplified voltages produced across the valve anode load, this must be coupled to the next stage. When the anode load is a resistance, choke, or tuned circuit, the anode end is connected to the grid of the next valve. A condenser C, having low impedance to the signal frequency, is inserted to prevent H.T. being applied to the next grid, and a resistance R, across which the amplified signal voltages are applied in parallel with the anode load, connects grid to cathode of V2 and enables grid bias to be applied if necessary.



INTERVALVE COUPLING

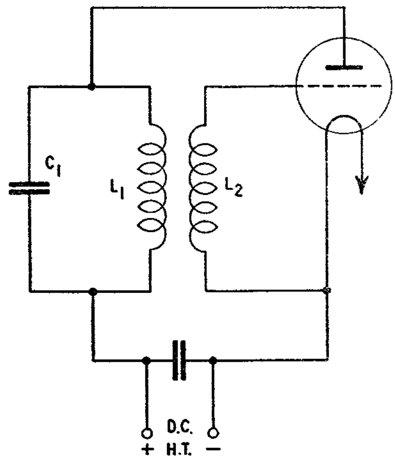
The anode load may also be the primary of a transformer with the secondary connected between grid and cathode of the next valve. In a radio-frequency stage the transformer primary, or secondary, or both, may be tuned. An audio-frequency transformer (iron cored) is not tuned. No coupling condenser is required, as the secondary is insulated from the H.T. in the primary.



TRANSFORMER COUPLING

10. Transmitter Principles

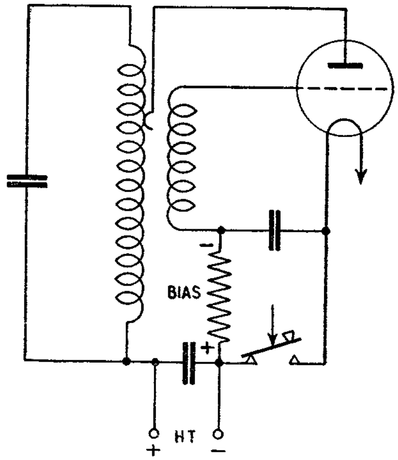
Radio transmission makes use of R.F. alternating currents generated by a valve or crystal oscillator, of one of the following types.



SIMPLE OSCILLATOR

(i) *Simple Oscillator.*

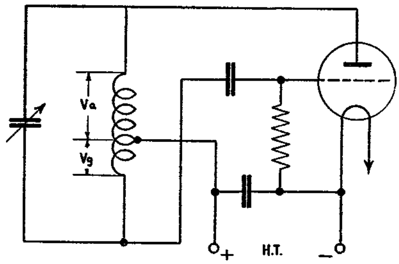
L_1C_1 is a closed oscillatory circuit forming the anode load of a valve. Switching on H.T. will charge up condenser C and start the circuit oscillating. L2 is coupled to L1 and changing current in L1 induces voltages in L2 between grid and cathode so that grid is going more positive when anode current is increasing (anode voltage going less positive) and vice versa, thus maintaining oscillation as long as sufficient power is supplied from the H.T.



PRACTICAL MEISSNER OSCILLATOR

(ii) *Practical Meissner Oscillator.*

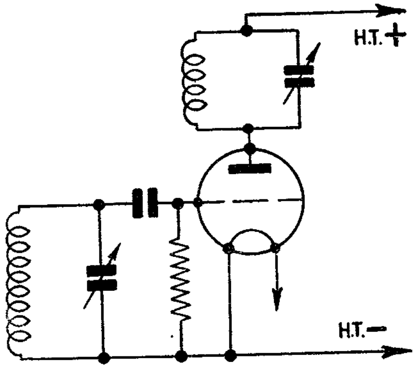
Better efficiency is obtained by tapping the anode lead into L1, so that the load matches the valve resistance, and by using a condenser and resistance to give self-bias to the grid. The key enables Morse signals to be transmitted and a large condenser by-passes R.F. currents from the H.T. supply.



HARTLEY OSCILLATOR

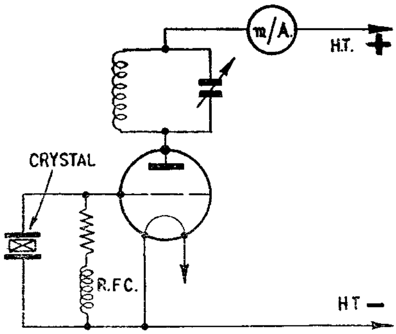
(iii) *Hartley Oscillator.*

Tuned circuit between anode and grid with tapping from inductance to cathode ensures that anode and grid voltages are always of opposite sign with respect to cathode. A simple and stable oscillator suitable for all frequencies.



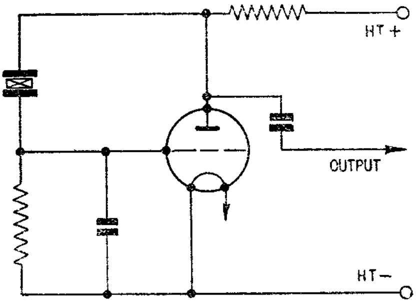
T.A.T.G. OSCILLATOR

(iv) *Tuned Anode—Tuned Grid Oscillator.*
When both circuits are tuned there is sufficient coupling through the anode and grid of a triode valve acting as the plates of a condenser, to set up oscillation.



CRYSTAL OSCILLATOR

(v) *Crystal Oscillator.*
Suitably cut quartz crystals show "piezo-electric" effects by vibrating in an alternating electric field, or producing an alternating electric field by vibration, at a fixed frequency, depending on the crystal dimensions. The crystal is equivalent to a tuned circuit with very high stability and circuit magnification. Circuit in diagram, is similar to T.A.T.G. oscillator, but much more stable.



UNTUNED "PIERCE" OSCILLATOR

(vi) *"Pierce" Oscillator.*
Used in some Service transmitters. Somewhat similar to the Hartley oscillator. Suitable for Low-power circuits only. Requires no tuning.

11. **Master Oscillator-Power Amplifier** (M.O.P.A.) Transmitter

Any of the above oscillators, connected to an aerial, would produce signals, but crystal oscillators operate only on low power, and the frequency of the others is affected by aerial variations.

A practical transmitter has a Master Oscillator, generating a stable frequency at low power, and a Power Amplifier which both isolates the M.O. from the aerial and enables higher power to be fed to the aerial.

12. **Frequency Stability**

It is extremely important that the frequency of a transmitter should remain stable, i.e. it should not drift. Important factors liable to cause drift are :—

(i) Variation in inductance or capacity of tuned circuit (this would occur if a swaying aerial were directly connected to an oscillator).

(ii) Variation in the supply voltages to the oscillator.

(iii) Temperature variations which cause changes in the dimensions of the tuning inductance and capacity.

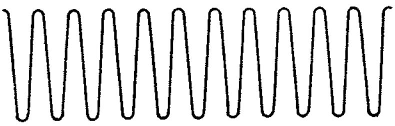
13. Instability in R/F Amplifiers

If a triode with a tuned anode circuit is used as an R.F. amplifier, then as the anode circuit is brought into tune with the input to the grid circuit, the arrangement becomes a T.A.T.G. oscillator and will commence self-oscillation due to feed-back from anode to grid circuit via the grid-anode inter-electrode capacity of the valve. An amplifier which goes into self-oscillation is said to be unstable. Instability may be cured in one of two ways :—

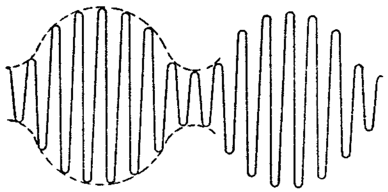
(i) *By Using a Tetrode Valve* (this is described under "Valves"). Tetrode valves are used for R.F. voltage amplification in receivers. They are also often used in R.F. Power amplifier stages of transmitters.

(ii) *By Neutralisation.* In this case the feed-back is deliberately introduced from the anode-to-grid circuits via a small neutralising condenser. Its phase is such that it completely cancels the feed-back via the anode-to-grid capacity. This method is now only used in the case of transmitters.

14. Types of Signal



C.W.



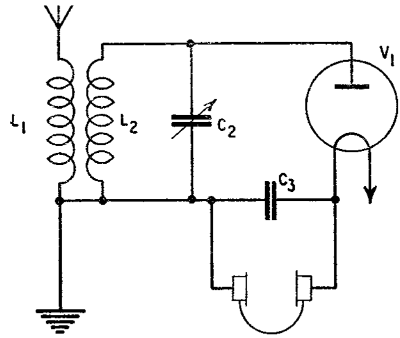
M.C.W.

(i) *C.W.* Simple Oscillator generates a signal of constant frequency and amplitude—continuous wave (C.W.) In a C.W. W/T transmitter this signal is radiated all the time the key is pressed, and no signal whilst key is up. The frequency is always much too high to be heard directly on reception, and so an audio frequency must be produced locally in the receiver (as described in para. 16).

(ii) *M.C.W.* The C.W. signal can be caused to vary in amplitude at a constant audio frequency, and is then called a Modulated Continuous Wave. This is received as a note of constant pitch when key is pressed.

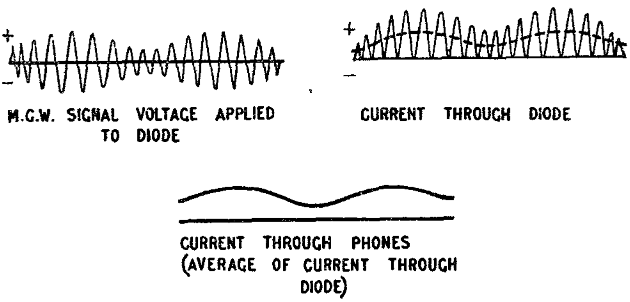
(iii) *R/T.* (Radio telephony). The C.W. signal is radiated all the time, and is made to vary in amplitude at speech (audio) frequencies. At the receiver the audio frequencies are separated from R.F. by the detector, and speech is reproduced.

15. Receiver Principles



ELEMENTARY RECEIVER FOR R/T OR M.C.W.

The following diagram illustrates a very simple Receiver. Signals picked up by the aerial circuit induce voltages in L_2C_2. The tuned circuit L_2C_2 virtually short-circuits all signals except those on the frequency to which it is tuned and to which it therefore offers its maximum impedance (see "A.C. Theory", para. 2). Oscillatory voltages due to signals on the resonant frequency are applied to the diode V_1.



DETECTION

16. Detection

The action of the diode is to allow current to flow through the phones only on the positive half-cycles of the signal. The action of the condenser in conjunction with the phones is to ensure that the R.F. ripple is smoothed out so that the phones only respond to the "average" value of the current through them.

(i) If an M.C.W. signal is received, the "average" value of the current through the phones rises and falls at modulation frequency and an audible note is heard.

(ii) If an R/T signal is received, the "average" current through the phones rises and falls according to the modulation of the carrier and speech is reproduced.

(iii) If a C.W. signal is received, the "average" current through the phones assumes, a steady value with the result that no sound is heard unless steps are taken as described below.

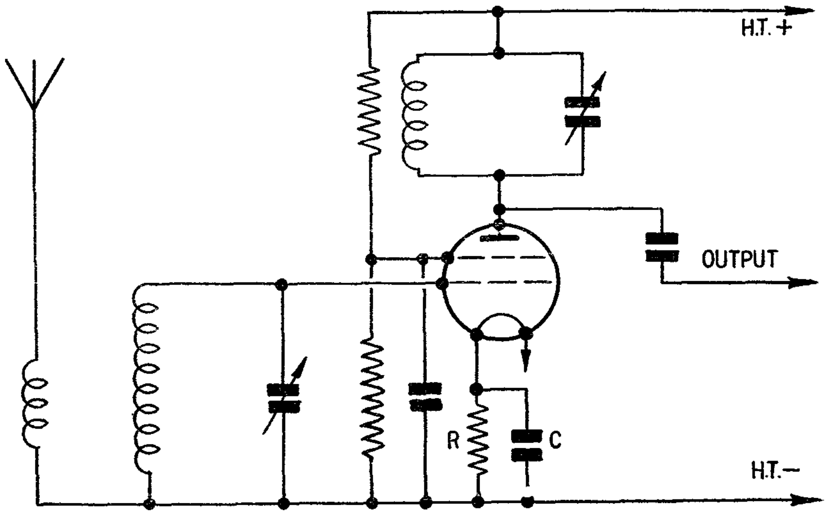
17. Reception of C.W. Signals

If signals of two different frequencies are mixed, a signal of a third frequency, equal to the difference between the two, is produced; this process is known as heterodyning. To obtain an audible note from a C.W. signal the received signal is applied to a detector valve to which is also fed an R.F. oscillation, produced in the receiver and differing from the signal by an audio frequency. Hence this audio frequency will appear in the anode circuit and operate the phones.

The pitch of this note (known as the beat note) depends on the difference between signal and oscillator frequencies. If there is a difference of only a few cycles per second there is no sound ("dead space").

If a diode is used to detect C.W. a separate oscillator valve is necessary. If, however, a triode is used as a detector it may be used at the same time as the oscillator.

18. R.F. Amplification

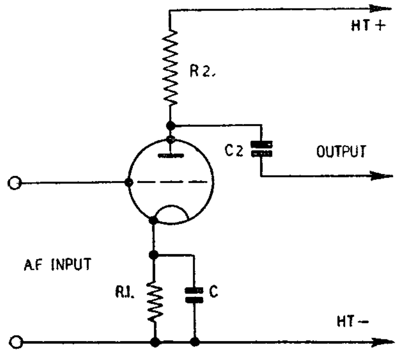


R.F. AMPLIFIER

Both grid and anode circuits are tuned to signal frequency to give increased selectivity. A screened-grid valve is therefore necessary.

Automatic grid bias is provided by voltage drop across resistance R, which is by-passed for R.F. by condenser C.

19. A.F. Amplification



R.C.C. A.F. AMPLIFIER

For audio frequency amplification untuned circuits are used for which a triode is suitable.

Automatic bias provided by R1, by-passed to A.F. by C.

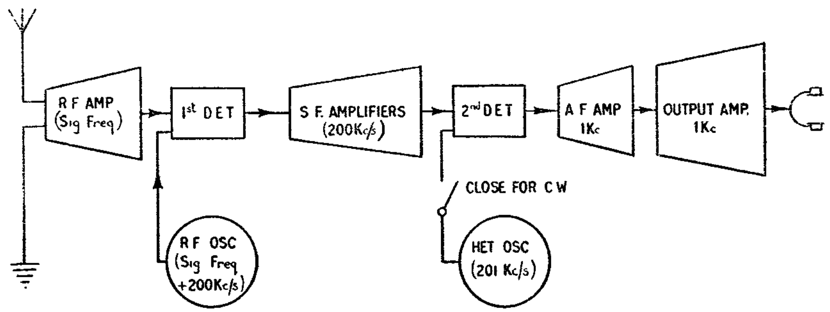
Amplified A.F. voltages appear across R2, and are applied through C2 to the grid of the next valve.

20. Superheterodyne Receiver

It is difficult to obtain a high degree of selectivity and sensitivity on high radio frequencies even if several stages of amplification are used. Furthermore, selectivity can only be increased by the use of a number of separate tuned circuits, and it is impracticable to use these when rapid changes in tuning have to be carried out. The principle of the superheterodyne receiver is to change the frequency of all incoming signals to a fixed value by mixing the input with an oscillation derived from a local oscillator. The resulting frequency should be a comparatively low R.F. and this is amplified in a radio frequency amplifier with fixed tuning and having high gain and selectivity. This portion of the receiver is known as the I.F. (Intermediate frequency) or S.F. (Supersonic frequency) amplifier.

21. Action of a Superhet

The Signal frequency is amplified and then applied to a mixer valve, together with oscillations generated in the receiver and differing from the signal by a fixed supersonic frequency. The resulting difference frequency is amplified by as many tuned stages as are required before detection, and passed to an audio frequency amplifier. If the signal is C.W., a local oscillation (Beat Frequency Oscillator) differing from the supersonic frequency by an audio frequency, must also be applied to the detector.



BLOCK DIAGRAM TYPICAL SUPERHET RECEIVER

TESTMETER TYPE "E"

1. **Use.** A compact moving coil instrument for measurement of wide ranges of current, voltage, and resistance, D.C. only, for general electrical measurements and testing.

2. **Ranges**—fourteen as under.

0—2	Volts	Switch at "K.1"
0—20	,,	
0—200	,,	
0—1000	,,	
0—4	,,	Switch at "K.2"
0—40	,,	
0—400	,,	
0—2000	,,	

0—20	m/AMPS	Switch at "AMPS & OHMS"
0—100	,,	
0—200	,,	
0—2	AMPS	
0—20	,,	
0—10,000 OHMS		

Last range (0—10,000 OHMS) may also be used as continuity tester.

3. **Precautions in use.** Leads should be treated with care and replaced when showing excessive wear. They are liable to fracture and the insulation frays after long use.

The instrument is delicate and should be treated as such, and not subjected to mechanical shocks.

When measuring unknown quantities of current or voltage the highest ranges should be chosen moving on to lower ranges if the deflection is insufficient to give accurate reading.

4. **General Operation.** The meter must be used when lying on its back, since in any other position its accuracy is affected.

Pointer should rest at 0 when no reading is being taken and if necessary adjustment should be made by means of the "Z" screw immediately below the scale on the instrument front.

The milled knob marked "E" holds the fuse which is in series with the meter. If this fuse is blown, connections to the circuit under test should be removed and fuse complete replaced by another one bearing letter "E" only. In no circumstances is anything but the correct fuse to be used.

5. **Voltage Measurement**

(i) Insert negative plug in negative socket and positive plug in appropriate socket for range in use.
(ii) Place switch in "K1" or "K2" position.
(iii) Connect meter in parallel with supply to be measured. *The supply must be on load.*
(iv) Scale reading is carried out as follows :—

2v.	switch at K1 read on	20 scale ÷ 10
20v.	,, ,, ,, ,,	20 scale direct
200v.	,, ,, ,, ,,	20 scale × 10
1000v.	,, ,, ,, ,,	10 scale × 100
4v.	switch at K2 read on	40 scale ÷ 10
40v.	,, ,, ,, ,,	40 scale direct
400v.	,, ,, ,, ,,	40 scale × 10
2000v.	,, ,, ,, ,,	20 scale × 100

(v) After completing reading disconnect leads from the supply. *Remove the plugs from the testmeter.*

6. **Current Measurement**

(i) As above.

(ii) Place switch in "AMPS & OHMS" position.

(iii) Connect meter in series with supply to be measured, preferably in negative lead. Ensure polarity is correct and neg. of supply is connected to neg. lead of meter.

(iv) Switch on apparatus and note reading.

(v) Scale reading is carried out as follows :—

20 m/AMP	range	read	on	20 scale	direct
100 m/AMP	,,	,,	,,	10 scale	× 10
200 m/AMP	,,	,,	,,	20 scale	× 10
2 AMP	,,	,,	,,	20 scale	÷ 10
20 AMP	,,	,,	,,	20 scale	direct

7. **Resistance Measurement.** Cell of 1.5v in back of testmeter is in series with the meter and resistance to be measured. Value of current flowing depends on value of resistance, and meter is calibrated direct on special scale for OHMS.

(i) Negative plug in neg. socket, positive in "10,000 ohms" socket.

(ii) Switch to "AMPS & OHMS" position.

(iii) Unite positive and negative clips, thus completing the circuit with no external resistance in series.

(iv) Adjust milled knob in base of meter until pointer registers "Zero" ohms.

(v) Release positive and negative clips, connect to ends of resistance to be measured and read directly on "OHMS" scale.

The 1.5 volt cell must be replaced when, in (iv) above, the pointer cannot be adjusted to Zero.

Note.—The measurement of any resistance to which a source of E.M.F. is connected must not be attempted.

8. **Reading of the Scale.** The eye must be directly opposite the pointer when a reading is being taken otherwise errors will be introduced.

9. **High current ranges.** The 20 AMP range should be used for intermittent testing only, and should not be left in circuit for long periods.

WIRELESS OPERATORS,

ESS OPERATORS AIR GUNN

AND

OBSERVERS W/T

SECTION II

MARCONI G.P. SET—T. 1154/R. 1155

1. **Service Use.**—General purpose aircraft transmitter and receiver for C.W., M.C.W., and R/T communication, with visual and aural D.F. and homing. (T. 1154A is not fitted for R/T transmission.)

2. **Frequency Range.**

T. 1154 and T. 1154A :—

Range 1	10 to 5·5 Mc/s	H.F.	Blue controls.
Range 2	5·5 to 3 Mc/s	H.F.	Red controls.
Range 3	500 to 200 kc/s	M.F.	Yellow controls.

R. 1155 :—

Range 1	18·5 to 7·5 Mc/s	H.F.
Range 2	7·5 to 3 Mc/s	H.F.
Range 3	1,500 to 600 kc/s	M.F.
Range 4	500 to 200 kc/s	M.F.
Range 5	200 to 75 kc/s	M.F.

3. **Power Supplies.**—Obtained from two motor generators supplied from a separate E.D.G., which maintains the associated 12 or 24 volt battery in a fully charged condition. For ground testing purposes the aircraft starter trolley battery is used.

(*a*) *L.T. power unit* (*M.G.*) *supplies.*—6·3 volts for heating all receiving and transmitting valves. 220 volts approximately for anodes of receiving valves.

(*b*) *H.T. power unit* (*M.G.*) *supplies.*—1,200 volts for anodes of transmitting valves.

Both units have type A starters, but the H.T. starter relay is energised from the 6·3 volts supply, so that H.T. cannot be applied to the transmitter before the filaments are alight.

The power consumption is approximately 250 watts at " receive " and 500 watts at " transmit ".

4. **Resistance Unit**

To ensure correct L.T. voltage for filaments the L.T. power units are designed to run at lower than nominal voltages, i.e., 10·5 volts on 12-volt systems and 18·5 volts on 24-volt systems. Whenever the E.D.G. is charging the battery, the cut-out is made to operate a pair of contacts to insert a resistance in series with the supply to the L.T. power unit. Attention is drawn to Section IV, Art. 1, paras. 5 and 6 for further details. These contacts are generally on Londex relay, Type 219 (12-volt systems), Type 220 (24-volt systems) or hand operated by means of switch unit, Type 378.

Resistance units, Type 47 and 52, are designed for 12-volt and 24-volt systems respectively.

Note.—As in some cases the unit is hand-operated, care should be taken to ensure that this is brought to the notice of the operators.

5. **Aerials.**—A fixed aerial is used for H.F., and a trailing aerial for M.F. operation. Normally the correct aerial is automatically selected, but if one becomes unserviceable the other can be connected for either range by means of the aerial selector switch, type J, or aerial plug board.

The keying relay transfers the aerial connections to transmitter or receiver as required, so that " listening through " is available without need of a limiter valve in the receiver.

6. **Aerial Selector Switch, Type J.**—This is a separate unit which has the following positions :—

(*a*) *D.F.*—Fixed aerial connected through a 25 $\mu\mu$F condenser to receiver circuits for " sense ".

Receiver H.T. connected only on D/F positions of receiver master switch.

Transmitter H.T. disconnected.

Loop to receiver.

(*b*) *M/F on fixed.*—Fixed aerial connected through keying relay to M.F. on set, with 80 $\mu\mu$F condenser in parallel to enable P.A. tuning to cover the frequency range.

(*c*) *Normal.*—Fixed aerial to H.F. circuits, and trailing aerial to M.F. circuits.

(*d*) *H.F. on trailing.*—Trailing aerial connected through keying relay to H.F. on set. P.A. tuning will need readjusting.

(*e*) *Earth.*—Both aerials earthed for safety during static. Transmitter H.T. disconnected. Reception possible on loop aerial.

7. **Valves.**—M.O. and modulator. VT.105 (M.L.6) heater, 6·3 volts 0·7 amperes. Maximum anode voltage 250, dissipation 5 watts.

P.A. VT.104 (PT.15) heater, 6·3 volts 1·3 amperes. Maximum anode voltage 1,250, dissipation 40 watts. Maximum screen voltage 300, dissipation 10 watts.

8. **Circuit.**—M.O. indirectly heated triode, Hartley oscillator, capacity coupled to P.A. stage of two directly heated pentodes in parallel. No coupling or neutralising adjustments are required. A second indirectly heated triode oscillating at 1,200 cycles provides side tone, and also modulation for M.C.W.

On R.T. this valve functions as a modulation amplifier and applies the speech voltages to the suppressor grids of the output pentodes.

9. **Tuning Arrangements.**—Tuning is simplified by giving the range switch and the tuning controls distinctive colours for each range.

Range 1	Blue.
Range 2	Red.
Range 3	Yellow.

In addition each range is provided with a system of eight click stops, each of which possess an identifying letter, the latter being marked, together with the appropriate frequency, on the calibration chart.

Twenty-four frequencies can, therefore, be set up on the ground, any one of which can be selected by setting the range switch and the appropriate letter in the click stop position.

The M.O. is tuned by means of calibrated variable condensers on all ranges, with a fine adjustment on the H.F. ranges giving a variation of plus or minus 0·1 per cent. to allow for frequency drift due to temperature variation.

The P.A. is tuned on the H.F. ranges by variable condensers and loaded by variable aerial taps.

The anode tap is fixed on installation on ranges 1 and 2.

On the M.F. range P.A. coarse tuning is by tapped aerial inductance, and fine tuning by an iron dust core which slides in and out the coil. Loading by a variable anode tap.

10. **Keying Relay.**—Energised from 6·3 volt output of the L.T. power unit. Performs the following operations :—

Key open.—Relay in receive position connects fixed and trailing aerials and telephones to the receiver.

Key closed.—Aerials connected to transmitter, telephones to side tone generator, cut-off bias removed from transmitter control grids. Receiver aerial connections earthed.

From the above it can be seen that *listening through* facilities are available.

11. **Meters.**—*Input Meter* measures H.T. current to P.A. anodes only. With master switch in the "tune", M.C.W. or R.T. positions, the needle should never be allowed to pass the *green* line on the scale. In the C.W. position the needle should not move over that part of the scale coloured *red.*

Aerial ammeters.—On M.F. the one fitted to the panel of the set indicates aerial current.

On H.F. the external aerial ammeter is used.

12. **Master Switch.**—Has the following positions :—

(*a*) *Off.*—Supply disconnected from both power units.

(*b*) *Stand-BI.*—L.T. power unit running. Filaments of all valves heated. H.T. supply to receiver only. Aerials and phones connected to receiver.

(*c*) *Tune* :—

(i) *KEY OPEN*.—H.T. power unit running. Modulator valve oscillating at 1,200 cycles. M.O. and P.A. valve control grids biased beyond cut-off. Aerials and phones connected to receiver. (Listening through.)

(ii) *KEY CLOSED*.—Cut-off bias removed from M.O. and P.A. control grids. M.O. generates R.F. oscillations. P.A. suppressor grids biased negative, to prevent excessive current if P.A. circuit is mistuned. Transmission on reduced power is available. Aerials connected to transmitter, phones to side tone circuit.

(*d*) *C.W.*—As for *Tune,* except that P.A. suppressor grids are biased positive, giving transmission on full power. (About 80 to 90 watts on M.F.)

(*e*) *M.C.W.*—As for *Tune,* except that 1,200 cycles output of modulator valve is applied to suppressor grids of P.A. valve.

(*f*) *R.T.* (not T.1154A).—As for *Tune,* except that speech signals from microphone are applied to the grid of the modulator valve (not now oscillating), and its output taken to suppressor grids of P.A. valves.

Note.—For R.T. transmission the key must be closed or short-circuited by pilot's switch.

TUNING NOTES

13. Tuning Transmitter to Pre-Set Frequency During Flight

(*a*) Set aerial selector switch, type J, to NORMAL. (If plug board fitted, check aerial connections.)

(*b*) Set frequency range switch to required range.

(*c*) Set M.O. and P.A. tuning controls so that pencilled letter on control scale corresponding to required frequency is opposite the calibration line, ensuring that the click stops are engaged. M.O. vernier lever to second mark from bottom.

(*d*) Set aerial tap switch (on range 3 also anode tap switch) to the pencilled figure marked beside the letter on the P.A. tuning dial.

(*e*) Set master switch to STAND-BI, and when valves are warm (shown by green light, appearing in receiver tuning indicator) switch to TUNE.

(*f*) Press key and check input and aerial current meter readings on TUNE and C.W.

(*g*) Set master switch to required type of transmission and carry on. *M.O. Vernier lever*.—At low temperature (high altitude), frequency tends to increase, and vice-versa. Movement of the vernier lever upwards gives a small *decrease* of frequency; movement downwards gives a small *increase*.

14. Tuning without Click Stops

The calibration of the M.O. controls is reliable, but difficult to read accurately. Frequency can be checked by tuning back to the receiver, which is very accurate and more easily readable. (*See* Receiver Notes).

(i) **Ranges 1 and 2** :—

(*a*) Release click stop control.

(*b*) Set range switch to required range. Set M.O. tuning by calibration on dial. Vernier lever to second mark from bottom of scale.

(*c*) Set master switch to STAND-BI and when valves are warm, to TUNE.

(*d*) Set aerial tap switch to 1, and P.A. tuning control fully anti-clockwise.

(*e*) Press key. Observe milliammeter reading. Swing P.A. tuning for dip. (There may be two dips, in which case use the lower which is invariably the first one as the control is moved clockwise.

(*f*) Increase aerial tap one step at a time, readjusting P.A. tuning until minimum reading comes on or just below *green* line. (Key must not be pressed when altering aerial tap switch.) Check aerial current in external ammeter.

(*g*) Check frequency by W.1117 or receiver, readjust M.O. and P.A tuning, if necessary.

(*h*) Set master switch to C.W., press key and verify that the feed meter reading does not exceed 100.

(*i*) Transmit as required.

(ii) **Range 3 :—**

(*a*) to (*c*) as for ranges 1 and 2.

(*d*) Set aerial tap switch at 17. Anode tap switch at 18.

(*e*) Press key and observe Feed Meter reading.

(*f*) Swing P.A. fine tuning control for dip. Adjust aerial tap downwards step by step from 17, readjusting fine tuning each time, for lowest possible dip. (Key must not be pressed when operating tap switches.)

(*g*) Adjust anode tap upwards step by step from 18, and also fine tuning control, until minimum comes on or near *green* line. Check aerial current in built-in ammeter.

(*h*) Check frequency as before, readjusting M.O. and P.A. as necessary.

(*j*) Set master switch to C.W.; press key and verify that Feed Meter reading does not exceed 100.

GROUND TESTING

15. Using an Aircraft Starter Trolley Battery, proceed to test as follows :—

(i) **Ranges 1 and 2 H.F. :—**

(*a*) Set aerial selector switch, type J, to NORMAL.

(*b*) Set frequency range switch and tuning controls to required frequency.

(*c*) Set master switch to STAND-BI. (Allow valves to warm up.)

(*d*) Set master switch to TUNE.

(*e*) Press key and observe milliammeter. Reading should be on or just below *green* line. If necessary, adjust output tuning for minimum feed, and aerial tap to bring milliammeter reading to correct working point. Check reading in external ammeter.

(ii) **Range 3 M.F. :—**

(*a*) Set aerial selector switch, type J, or plug board connections to M.F. on fixed.

(*b*) Proceed as above, checking aerial in built-in ammeter.

Note.—If there is no milliammeter reading at TUNE with key pressed, *switch off*, check H.T. fuse. Check brushes on H.T. power unit. Check aerial switch in correct position. Check L.T. fuses on aircraft electrical installation.

RECEIVER R.1155

1. **Service Use** superheterodyne receiver, capable of receiving C.W., M.C.W. and R/T, with provision for visual and aural D/F and homing. During visual D/F and homing, the signal is audible in the telephones.

2. **Power Supplies and Frequency Range** dealt with under transmitter.

3. **Valves.**

Valve	Service Type	Commercial Type	Functions
V.1, V.2	VR.99	X.66	Visual D/F switching.
V.3	VR.100	KTW.62	R.F. amplifier.
V.4	VR.99	X.66	Frequency changer.
V.5, V.6	VR.100	KTW.62	I.F. amplifier.
V.7	VR.101	MHLD.6	A.V.C. and beat frequency oscillator.
V.8	VR.101	MHLD.6	Detector, output, visual meter limiter.
V.9	VR.102	BL.63	Visual meter control.
V.10	VI.103	Y.61	Tuning indicator.

(69954) Wt. 48788/L.3904 28,050 2/45 Hw. G.371

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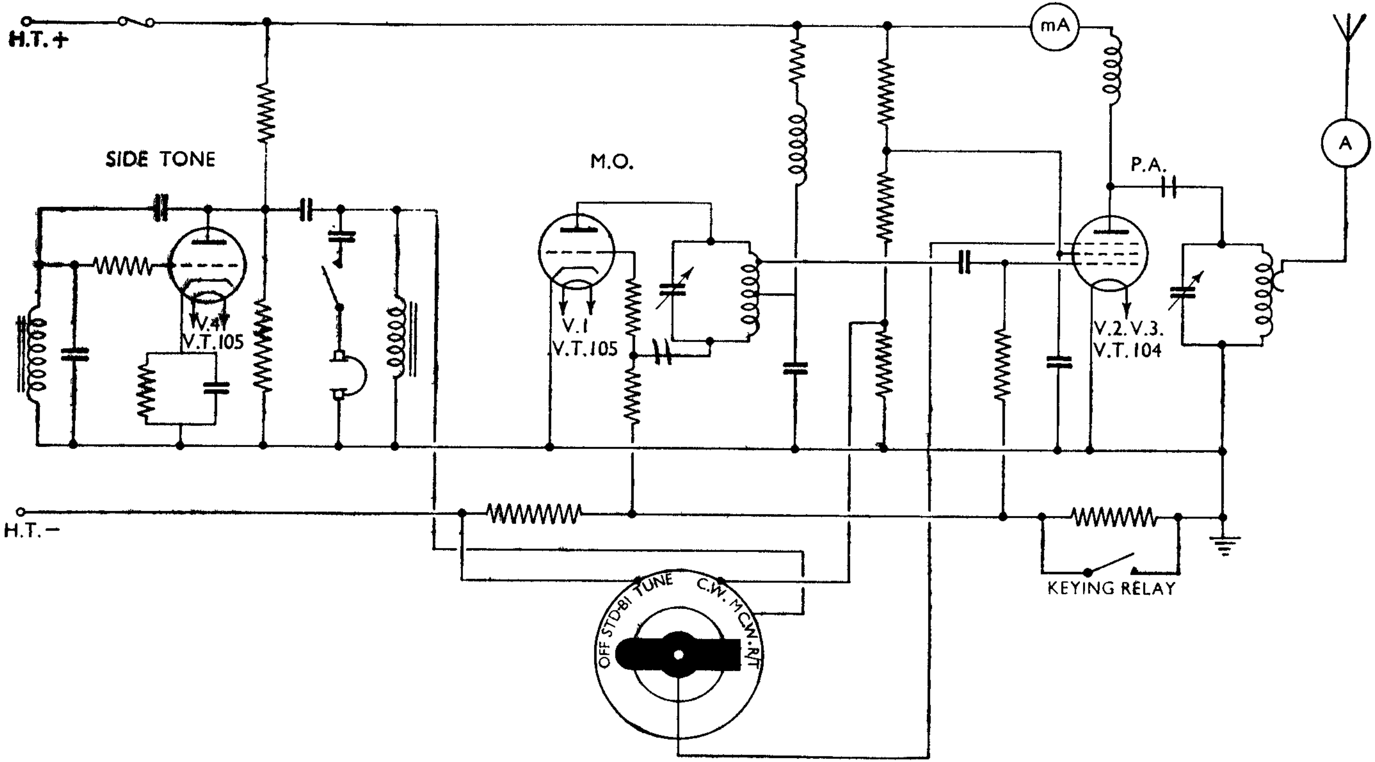
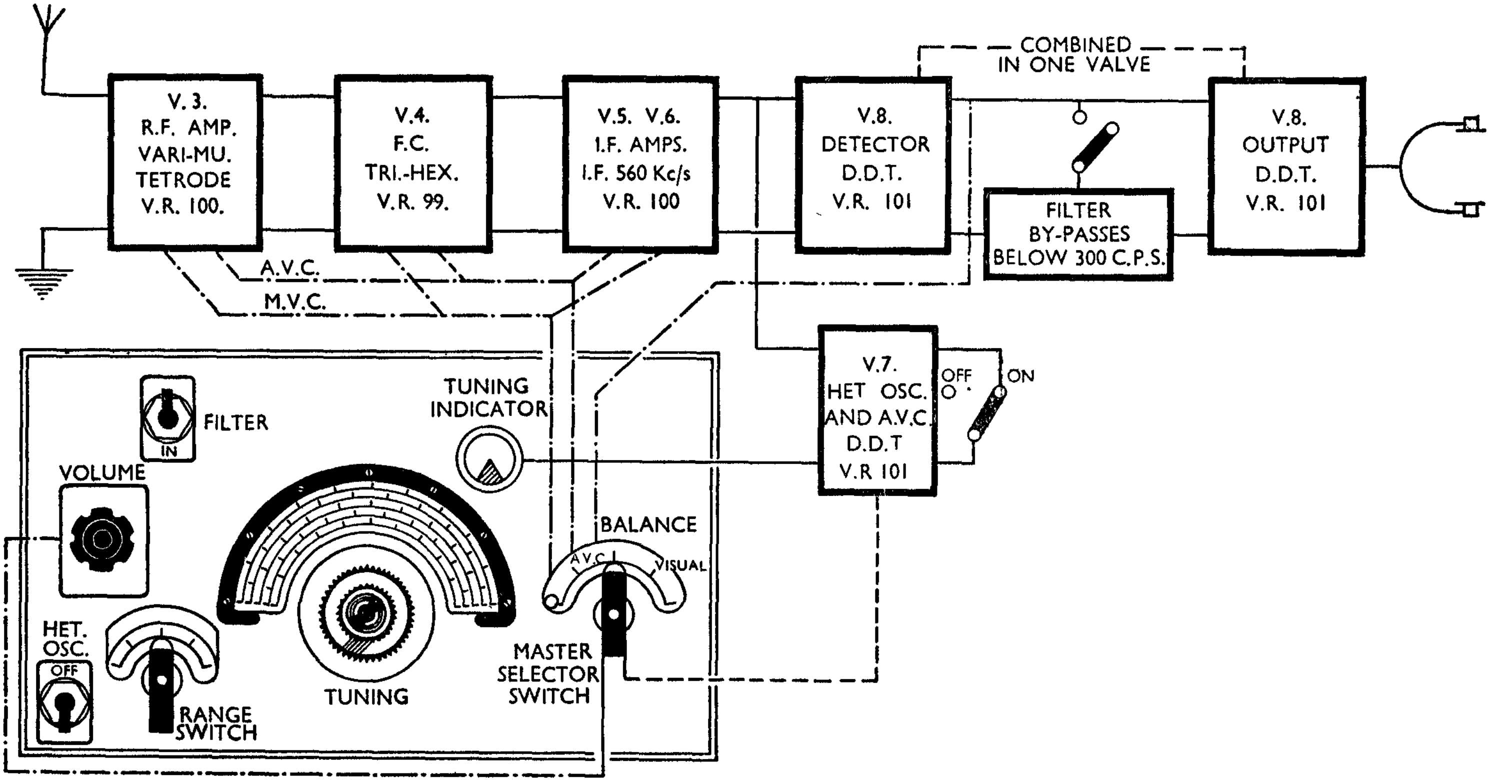

H.T. +
SIDE TONE
M.O.
mA
A
P.A.
V.4
V.T.105
V.1
V.T.105
V.2. V.3.
V.T. 104
H.T. –
OFF STD-BI TUNE C.W. MCW. R/T
KEYING RELAY

4A


V. 3.
R.F. AMP.
VARI-MU.
TETRODE
V.R. 100.
V.4.
F.C.
TRI.-HEX.
V.R. 99.
V.5. V.6.
I.F. AMPS.
I.F. 560 Kc/s
V.R. 100
COMBINED
IN ONE VALVE
V.8.
DETECTOR
D.D.T.
V.R. 101
FILTER
BY-PASSES
BELOW 300 C.P.S.
V.8.
OUTPUT
D.D.T.
V.R. 101
A.V.C.
M.V.C.
V.7.
HET OSC.
AND A.V.C.
D.D.T
V.R 101
OFF
ON
FILTER
IN
TUNING
INDICATOR
VOLUME
BALANCE
A.V.C.
VISUAL
HET.
OSC.
OFF
RANGE
SWITCH
TUNING
MASTER
SELECTOR
SWITCH

4. **Circuit Description.**—(*a*) Communications circuit employs one stage of R.F. amplification, combined frequency changer and R.F. oscillator, two stages of I.F. amplification, diode detector, triode output, A.V.C. and tuning indicator.

(*b*) *R.F. amplifier.*—V.3, indirectly heated, aligned grid, variable mu tetrode.

(*c*) *Frequency changer.*—V.4, triode hexode. Triode portion functions as R.F. oscillator. Electronic mixing of the signal and R.F. oscillator frequencies takes place in the valve and the resultant frequency of 560 kc/s appears in the anode circuit.

(*d*) *I.F. amplifier.*—V.5 and V.6. Operates on 560 kc/s. Employs three band-pass coupling units, giving a high degree of adjacent channel selectivity.

(*e*) *Detector and output.*—V.8. One of the diodes functions as detector and the triode portion acts as an output valve, with transformer coupling to the telephones.

(*f*) *Beat frequency oscillator.*—V.7, double diode triode. To receive C.W. the triode portion is made to oscillate at 280 kc/s, the second harmonic being used to " beat " with the I.F. The required beat frequency can be set by means of a screwdriver adjustment at the front of the panel. When this B.F.O. is working it can be heard as a spurious signal with the receiver tuned to 280 kc/s.

(*g*) *Tuning indicator.*—V.10. Correct tuning is indicated when the shadow is minimum.

5. **Controls.**—(*a*) *Master selector switch.*—Has five positions :—

(i) *OMNI.*—Normally for W/T reception and back tuning. Gain of R.F., frequency changer and I.F. stages manually controlled.

(ii) *A.V.C.*—Normally for R/T reception. Automatic control of gain of R.F., and F.C. and I.F. stages with manual control of A.F. gain.

(iii) *Balance.*—To enable the gain of the valves associated with visual D.F. to be matched. (A.V.C. working.)

(iv) *Visual.*—D/F visual indicating meter in use, A.V.C. working.

(v) *oo* (figure of eight).—Aural D/F. working. Manual gain control. No A.V.C.

(*b*) *Frequency range switch.*—Selects frequency range and aerial connections as required.

(*c*) *Tuning.*—Three gang condenser tuning aerial, R.F. and R.F. oscillator simultaneously. Direct and 100 to 1 slow motion drive. Five scales corresponding to frequency ranges, coloured same as transmitter controls for those parts of the scale which coincide. Calibration is accurate irrespective of valve changes.

(*d*) *Volume control.*—Dual potentiometer giving :—

(i) Manual control of gain of R.F., F.C. and I.F. stages in omni and figure of eight positions, by variation of grid bias.

(ii) Manual control of A.F. gain in all other positions.

(*e*) *Heterodyne oscillator switch.*—Brings in B.F.O. for C.W. reception.

(*f*) *Filter switch.*—Cuts out interference due to engine noises when receivi ng R/F from aircraft.

6. **Additional Controls for D/F only.**—(*a*) *Meter balance control.*—For operation *see* note (*d*) under heading " D/F by Visual Meter " (paragraph 9).

(*b*) *Meter amplitude control.*—Adjusts the height at which the needles intersect on the centre line of the visual meter.

(*c*) *Meter deflection control.*—High for visual D/F. Low for homing and aural D/F.

(*d*) *Meter frequency switch.*—To adjust the frequency at which the frequency valves work.

High	.. ..	For Morse (80 cycles).
Low	.. ..	For R/T (30 cycles).

(*e*) *Aural sense switch.*—To determine sense on aural D/F.

(*f*) *A.V.C.*—Maintains the output to the telephones practically constant despite large changes of signal input.

VISUAL D/F AND HOMING

7. **Visual Meter.**—Has two movements, the pointers of which intersect over the same scale, each movement being operated by one-half of the double triode visual meter control valve.

The signals picked up by the D/F loop are fed to the receiver on ranges 3, 4 and 5 (in some cases on range 2 also), and combined with signals from the fixed aerial, which is coupled to paralleled grids of hexode portions of the two switching valves. The triode portions of these valves form a low frequency push pull oscillator which renders the hexodes alternatively operative in synchronism with corresponding sections of the visual meter control valve, so that the fixed aerial signals are applied in alternate phase with respect to the loop signals.

With the loop at right angles to the transmitting station bearing, the effective loop voltage is nil, therefore equal voltages due to the fixed aerial are fed to the two movements of the visual meter, and the needles intersect on the centre line of the scale.

If the loop is offset from the bearing, it will pick up signals which will assist one phase of the fixed aerial signals, causing the corresponding needle to rise ; and oppose the other phase, causing the corresponding needle to fall, so that they will now intersect on one side or other of the centre line.

The bearing is read off the LOOP scale when the needles intersect on the centre line.

Sense.—The R.R.R. rule.

*R*educe reading of LOOP scale. If the needles move to
*R*ight, sense is
*R*ight.
If needles move to the left of the centre line, loop must be rotated through 180 degrees for bearing.

8. **Receiver Tuning, Normal Communication.**—(*a*) Check all external connections. Set transmitter master switch to " stand-bi ". Receiver master switch to " omni ", and frequency range switch to required range.

(*b*) When green light shows in tuning indicator, turn up volume control until " mush " is heard.

(*c*) Set tuning control to required frequency and, for C.W., heterodyne switch " ON ".

(*d*) Adjust tuning for maximum signal (in the case of R/T for minimum shadow in the tuning indicator).

(*e*) Adjust volume control for convenient strength.

9. **D/F by Visual Meter** (ranges 3, 4 and 5 and in some cases 2).—(*a*) Set aerial selector switch, type J, to " D/F ". If an aerial plug board is fitted, fixed aerial must be on " H.F.", and care must be taken by the operator not to switch on the transmitter.

(*b*) Tune in required station as above.

(*c*) Set receiver master switch to " balance ", meter deflection switch to " high ", meter frequency switch to " LOW " for R/T and " HIGH " for Morse.

(*d*) Adjust meter balance control until needles intersect on the centre line. Use meter amplitude control if necessary to get the intersection about midway up the line.

(*e*) Set receiver master switch to " visual ".

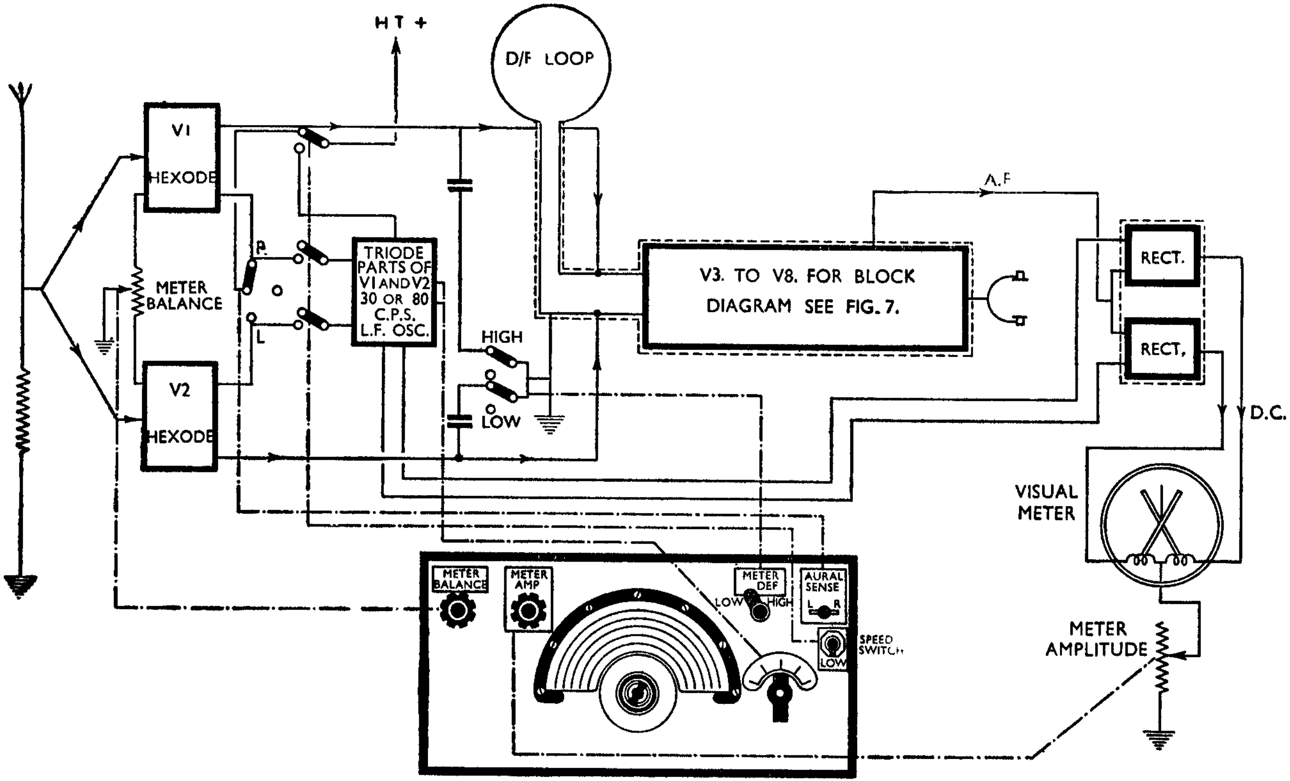
(*f*) Rotate the LOOP until the needles intersect on the centre line.

(*g*) Reduce loop scale reading slightly. If needles move to the right, sense is right. If not, rotate loop 180 degrees and repeat operation.

10. **Homing by the Visual Meter.**—(*a*) to (*e*) as above, except meter deflection switch to " LOW ".

(*f*) Set loop to " 0 " degrees on loop scale. (Athwartships.)

(68413)


H T +
D/F LOOP
V1
HEXODE
V2
HEXODE
METER BALANCE
P
L
TRIODE PARTS OF V1 AND V2 30 OR 80 C.P.S. L.F. OSC.
HIGH
LOW
A.F.
V3. TO V8. FOR BLOCK DIAGRAM SEE FIG. 7.
RECT.
RECT.
D.C.
VISUAL METER
METER AMPLITUDE
METER BALANCE
METER AMP
METER DEF
LOW
HIGH
AURAL SENSE
L
R
SPEED SWITCH
LOW

6A

(*g*) Request pilot to turn aircraft until needles intersect on the centre line of his visual meter.

(*h*) Request pilot to make further slight turn to *left*. If needles swing to the *right*, aircraft is heading *towards* transmitter. If needles swing to the *left*, aircraft is heading *away* from transmitter and 180 degrees turn will be required.

(*i*) During homing, adjust meter amplitude and re-check balance when necessary.

(*j*) Needles will collapse under the following conditions :—

(i) If transmission ceases.

(ii) While aircraft is actually passing over transmitter.

11. **Aural D/F.**—(*a*) and (*b*) as for visual.

(*c*) Set receiver master switch to " figure of eight ". Meter deflection switch to " LOW ".

(*d*) Rotate loop for minimum signal and adjust volume control to obtain zero.

(*e*) *Reduce* scale reading slightly. Move sense switch to R and L and if louder signal occurs at *R* sense is *R*ight.

If signal strength louder at L rotate loop through 180 degrees and repeat (*d*) and (*e*).

12. **Tuning Back.**—*Receiver to transmitter.*—(*a*) Set receiver range switch and tuning control to required frequency. Selector switch to omni, volume control half way.

(*b*) Set transmitter master switch to TUNE. Press key. Adjust receiver tuning for minimum shadow in tuning indicator. Check that the receiver is tuned to the correct signal by sending a long dash and observing minimum shadow in tuning indicator, until key is released.

N.B.—Owing to slowness of A.V.C. action, the indicator may flicker on any frequency due to shock excitation, therefore the sending of dots is not a reliable check.

Transmitter to receiver.—(*a*) Tune transmitter, using M.O. calibration, to required frequency.

(*b*) Set receiver selector switch to omni, volume control half way.

(*c*) Set transmitter master switch to TUNE, press key and adjust M.O. tuning for minimum shadow in receiver tuning indicator.

(*d*) Check tuning as above.

(*e*) Readjust P.A. tuning for correct feed current if necessary.

N.B.—If the edges of the light in the tuning indicator overlap during tuning operations, reduce volume control. If shadow cannot be reduced, increase volume control.

INTERCOMMUNICATION AMPLIFIER A.1134

1. **Service Use.**—(*a*) Used with TR.9 and G.P. installation, to amplify microphone current when electric-magnetic microphones are used. That is, it is used as a " sub-modulator ".

(*b*) The output from the receiver of the TR.9 is also fed into the amplifier before being distributed to the telephones, giving additional amplification of the TR.9 signals ; the output from the GP. receiver is not passed through the A.1134.

(*c*) The intercommunication system in the aeroplane is also supplied by the A.1134. Magnetic microphones are used by the entire crew. All the microphones are in parallel across the input transformer, and a switch, fitted on the amplifier, is used to select the combinations of facilities required from time to time.

2. **Power Supplies.**—L.T. : one 2-volt 20 A.H., type B, accumulator. H.T. : 120-volt dry battery. Grid bias : a 6-volt grid bias battery fitted inside case.

3. **Circuit.**—The circuit consists of a VR.21 operating as a driver, followed by a VR.35, Class B, pentode.

A three-position switch is incorporated, which is under the control of the wireless operator, the positions being marked A, B and C. The function of this switch is explained below :

(*a*) *Position A.—Wireless operator.*—The operator's microphone is completely out of circuit, and his phones are connected to G.P. receiver output. In this position the operator is entirely disconnected from the intercommunication system of the aircraft, as well as from the TR.9. He can use W/T on the G.P.I. only.

In view of this fact, and the necessity for keeping in touch with the rest of the crew, a call system is brought into use in this position of the switch. Each member of the crew has a bell push, all of which are wired in series, together with a pea-lamp in the operator's cabin.

When any push is depressed the lamp is extinguished, thereby calling the attention of the wireless operator.

Position A is also used when taking bearings on D/F loop.

Crew.—The crew can use TR.9, and are also in intercommunication amongst themselves, but are unable to communicate with the wireless operator.

(*b*) *Position B.—Wireless operator.*—The operator is still connected to G.P.I. for W/T work, but his phones and microphone are also connected to intercommunication. He is also connected to TR.9.

This is the normal position of the switch for keeping a listening watch. Should any signals be heard on G.P. receiver, the operator switches to position A.

Crew.—Crew can now communicate with the operator in addition to previous facilities, and are also able to receive signals from G.P. receiver.

(*c*) *Position C.—Wireless operator and crew.*—In this position all members of the crew can transmit on R/T, on either G.P. set or TR.9, provided transmitter is switched on. Full intercommunication facilities are also available to all.

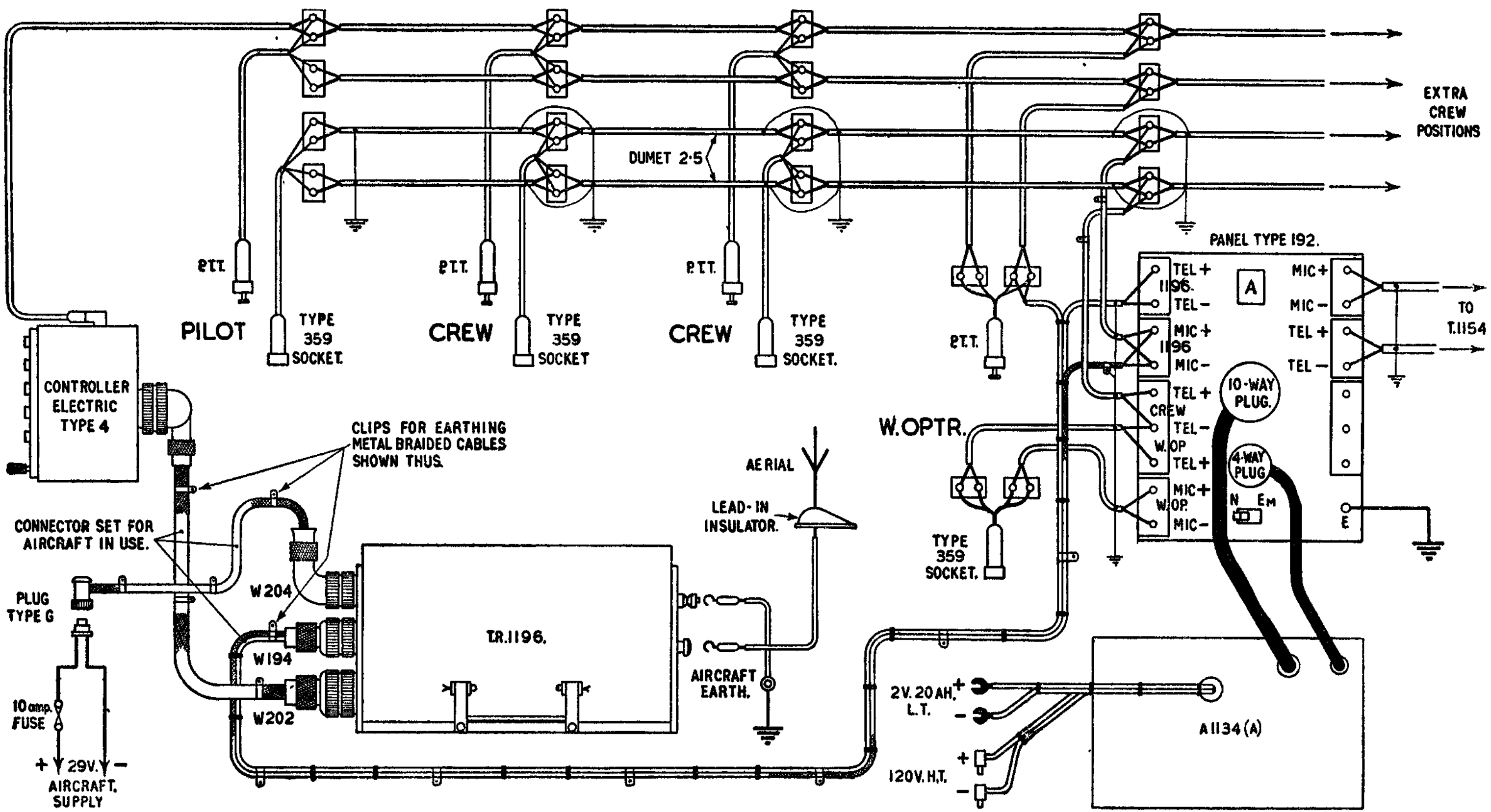
4. **A.1134A**

This is an intercommunication amplifier exactly similar to A.1134 except that an output winding connected to the crew telephones matches the amplifier to an impedance of about 150 ohms instead of the 20,000 ohms impedance of the A.1134.

The A.1134A having a low impedance output is less likely to become unstable than A.1134, and for this reason it is used wherever possible, particularly in the larger aircraft where many I/C points are used. The connections are precisely the same as for A.1134.

5. **Panel, Type 192**

This is a junction box fitted in the aircraft, accommodating the microphone and telephone leads from T.R.1196 and R.1155, also the 10-pin and 4-pin plugs from the A.1134 (A). From this panel, microphone and telephone leads go out to the W/T operator and the various crew positions. A switch on the panel provides an additional intercommunication facility, i.e., the use of the A.F. stages of the T.R.1196 receiver as an inter-communication amplifier. This is useful if the A.1134 becomes unserviceable or is damaged in action, although the output is only sufficient for two or three pairs of telephones.


EXTRA
CREW
POSITIONS
DUMET 2·5
P.T.T.
PILOT
TYPE
359
SOCKET.
P.T.T.
CREW
TYPE
359
SOCKET
P.T.T.
CREW
TYPE
359
SOCKET.
PANEL TYPE 192.
TEL +
1196.
TEL −
A
MIC +
MIC −
TO
T.1154
MIC +
1196
MIC −
TEL +
TEL −
TEL +
CREW
TEL −
W.OP
TEL +
MIC +
W.OP.
MIC −
10-WAY
PLUG.
4-WAY
PLUG
N
EM
E
P.T.T.
W.OPTR.
TYPE
359
SOCKET.
CONTROLLER
ELECTRIC
TYPE 4
CLIPS FOR EARTHING
METAL BRAIDED CABLES
SHOWN THUS.
AERIAL
LEAD-IN
INSULATOR.
CONNECTOR SET FOR
AIRCRAFT IN USE.
PLUG
TYPE G
W 204
W 194
W 202
T.R.1196.
AIRCRAFT
EARTH.
10 amp.
FUSE
+ 29V. −
AIRCRAFT.
SUPPLY
2V. 20 AH.
L.T.
+
−
120V. H.T.
+
−
A 1134 (A)

SECTION II

Article 3

CRYSTAL MONITOR TYPE 2

1. **Service Requirements.**—Rapid and accurate initial adjustment and subsequent monitoring of C.W. transmitters and receivers in aircraft.

2. **Frequency Range.**—Six quartz crystals selected by a rotary switch give "spot" frequencies between one and 7·5 Mc/s. A seventh or "extra" position is provided on the panel. Higher frequencies can be obtained by use of harmonics of crystal frequencies.

3. **Power Supplies.**—L.T. 2 volts, normally from receiver accumulator. H.T. 120 volts, normally from receiver H.T. battery. Grid bias may be automatic or battery, to correspond with the receiver. Separate supplies may be used if necessary. Current consumption H.T. 3·5 mA., L.T. 0·3 to 0·5 amps.

4. **Valves.**—Three V.T.50 triodes (2 volt 0·1 amp.) are used. V1 generates oscillations at the frequency determined by the selected crystal, V2 and V3 act as A.F. amplifier and output valves respectively.

5. **Circuit Arrangement.**—A small aerial picks up the radiation to be monitored, and also provides emission for adjusting receivers. The aerial terminal is connected to the grid of V1, which acts as an oscillating detector. If the received frequency differs slightly from the crystal frequency heterodyne beats are set up which are rectified by V1 and amplified by V2 and V3.

6. **Precautions and Maintenance.**—H.T. and L.T. supply leads must be connected directly between batteries and the plug and socket on the monitor, and *not* taken via the receiver battery leads. Check, by inserting each valve separately in its holder, for filament and anode current, with selector switch at EXTRA CRYSTAL, but no crystal inserted. Replace any valve passing excessive current. (*N.B.*—Maximum anode current for V1 is 1·5 mA.) When the same H.T. battery is used for receiver and monitor it should be replaced when voltage on load drops to 105 volts. If a crystal refuses to oscillate, check by testing another crystal. If still no oscillation check for valve failure or bad pin contact.

7. **Operation.**—(i) *General.*—Check that valves and crystals are in position, and battery connections and voltages correct. Plug in telephones and switch on. If the monitor is oscillating, clicks will be heard in the telephones on tapping the aerial terminal.

(ii) *To set up Receiver R1082.*

(*a*) Plug telephones into receiver. Switch monitor and receiver ON.

(*b*) Set reaction control just oscillating, volume control about midway.

(*c*) Adjust anode condenser until beat note is heard.

(*d*) Increase volume control and adjust aerial condenser for maximum output, readjusting anode condenser as necessary.

(*e*) Switch off monitor.

(iii) *To set up Transmitter T.1083.*

(*a*) Plug telephones into monitor.

(*b*) Set transmitter G.B. switch and neutralising unit to TUNE, and coupling as required.

(*c*) Switch monitor and transmitter ON.

(*d*) Adjust M.O. tuning until beat note is heard, and tune to dead space.

(*e*) Tune and neutralise P.A. stage.

(*f*) Set transmitter G.B. switch and neutralising unit to TRANSMIT. Press key and readjust M.O. and P.A. for dead space.

(*g*) Switch off monitor.

SECTION II

Article 4

WAVEMETER W1117

1. **Service Requirements.**—Accurate measurement of frequency of aircraft transmitters, for use on the ground only. Capable of indicating within 2 kc/s. on frequencies up to 6 Mc/s.

2. **Frequency Range.**—125 kc/s. to 20 Mc/s. in 7 ranges, selected by a range switch.

3. **Power Supplies.**—L.T. 2-volt 7 A.H. accumulator type A. H.T. 120-volt dry battery. G.B. 4·5-volt dry battery. All batteries housed inside the instrument case.

4. **Valves.**—Isolator VW48 (tetrode); voltmeter valve VW36 (triode). Three of each supplied with the wavemeter, to be used only with the instrument for which they are matched.

5. **Circuit Arrangement.**—Each range consists of a calibrated closed circuit which can be connected to a valve voltmeter of the anode bend type, with a micro-ammeter in the anode circuit which acts as an indicator of resonance. To prevent the constants of the circuit being affected by coupling to the transmitter, it is isolated by the VW48 tetrode interposed between it and the input circuit.

Frequency ranges 1 to 4 (125 kc/s to 2 Mc/s.) are tuned by a variable condenser and ranges 5 to 7 (2 Mc/s. to 20 Mc/s.) by a continuously variable inductance. There is a separate ON–OFF switch, and a gain control for the isolator valve. A pilot lamp indicates when the set is switched on, but not necessarily that it is in working order.

Micro-ammeter may be removed from the case and connected by a flexible lead for greater convenience of tuning.

6. **Operation.**—Before use, check that batteries are in position and correctly connected. Test condition with voltmeter. It is particularly important that the grid bias battery is in good condition and properly connected. Switch on, and check that the micro-ammeter shows a very small reading not exceeding 4 micro-amperes. Switch off until actually required.

7. **To set a Transmitter to a Definite Frequency.**—(i) Set selector switch to required range, and the appropriate tuning control to the setting given by the calibration chart, taking care to apply the correction from the curve.

(ii) Place the wavemeter near the transmitter and connect a suitable length of wire to the aerial terminal.

(iii) Set sensitivity control to minimum. Switch on. Adjust transmitter whilst watching micro-ammeter for maximum deflection. If deflection exceeds 450 micro-amps. switch off and reduce pickup, e.g. by shortening aerial or moving wavemeter farther away. Most accurate tuning is obtained when, with the sensitivity control at the middle of its travel, a deflection of 300 micro-amps. is obtained at resonance.

(iv) If tuning at resonance appears to be flat with a micro-ammeter reading of say 310 micro-amps., detune the transmitter until the micro-ammeter reads 300 micro-amps. and note the setting. Then retune through resonance until micro-ammeter again reads 300 micro-amps. and note the setting. The correct transmitter setting is midway between the two.

8. **To Measure the Frequency of a Transmitter.**—Proceed as in (i) and (ii) above.

(iii) Tune W1117 for maximum deflection in micro-ammeter. If deflection exceeds 450 micro-amps., reduce reading as in (iii) above.

(iv) Read off the frequency corresponding to the wavemeter setting on the calibration chart. *N.B.*—A positive correction must be subtracted, and a negative correction added, in this case, to the calibration reading.

SECTION II

Article 5

TRANSMITTER T.1333

1. **Uses.**—The transmitter is to enable one-way emergency communication to be made from a dinghy with ship or shore stations.

2. **Frequency Range.**—The frequency is crystal controlled on a frequency of 500 kc/s.

3. **Power Output.**—The power output into the aerial is 5 watts and under the most suitable conditions the range is approximately 100 miles.

4. **Valves.**—(i) Oscillator; tetrode 6 V6G; (ii) modulator, pentode, 6J7G. A neon tuning indicator is also used.

5. **Power Supplies.**—A hand-driven generator supplies (i) L.T. 6 volts and (ii) H.T. 300 volts. A voltage regulator being used to maintain a smooth output.

6. **Aerial System.**—The aerial consists of 208 ft. of stainless steel wire wound on a reel which fits into a case in the front of the set. A spring loaded folding handle and a brake button are fitted to the reel to control the aerial when reeling in and out.

The aerial is suspended from a rubber balloon filled with hydrogen, the other end of the aerial being connected to a length of insulated wire which acts as the lead-in.

A 10-ft. length of wire with sinker attached is immersed in the water and acts as an earth lead.

7. **Circuit.**—The oscillator circuit employs a beam power tetrode used as an electron-coupled crystal controlled oscillator, the screen grid and cathode forming the elements of an inverted Hartley oscillator. The crystal is inserted in the grid circuit and keying is accomplished by breaking the screen supply to the oscillator. For use on M.C.W. a pentode A.F. modulator is employed, with a transformer providing feed back between anode and grid circuits. The primary of the transformer is tuned to give a modulating tone of approximately 1,000 c.p.s. and this is fed to the oscillator valve via a grid leak and R.F. choke by means of another winding on the transformer.

The modulator is not keyed and oscillates continually when in circuit.

The aerial coil is capacity tuned and is provided with two taps which are selected while operating the tuning control, the effect being to double approximately the range of the tuning condenser.

Tuning indication is provided by a neon lamp connected in series with a small condenser across the aerial coil, maximum output being indicated at maximum lamp brilliance. The transmitter is designed to transmit automatically or by hand operation, a push button key being fitted on the front panel.

The automatic transmission consists of three S.O.S. signals followed by twelve long dashes, and both the automatic and hand-controlled transmissions can be either C.W. or M.C.W.; the type and method of transmission being selected by a 4-position switch on the front panel.

Note.—The transmitter is watertight and will float, but in addition a silica-gel drying unit is fitted, which will absorb a limited amount of moisture which may get into the case, by condensation from the atmosphere. It will not, however, cope with an actual leakage of sea water. The drying unit must be revitalised after operational use or at periodic intervals.

8. **Hydrogen Generator.**—The hydrogen gas necessary for the inflation of the aerial balloon is generated by immersing a special canister, which is charged with calcium hydride, in water. The time taken to inflate the balloon fully is about twenty minutes.

The canister has an inlet and an outlet hole each sealed with a tear-off metal patch.

The hydrogen gas is generated by removing the sealing patches from the top and bottom and immersing the generator in water to a depth of about 7 in. When the water comes into contact with the calcium hydride, hydrogen gas is given off and is passed from the outlet hole through a hollow rubber plug to the balloon. A handle of stout wire is fitted to the canister and can be bent upwards into a convenient position.

9. **Operation.**—(i) *Inflation of Balloon.*

(*a*) Bend handle of hydrogen generator to a convenient position.

(*b*) Tear off sealing patches and plug in balloon-filling tube to top outlet hole.

(*c*) Immerse generator in water to level of black line on generator until balloon is fully inflated. Shake occasionally *but keep the generator in the water.*

(*d*) Inflation is complete when the distance between the two knots on the cord (one end of which is attached to the balloon) measures approximately one quarter the circumference of the balloon.

(*e*) Pinch balloon inlet tube, remove inflator tube, and insert the loose stopper plug into balloon inlet tube.

(ii) *Transmitter.*

(*a*) Open aerial winch door by withdrawing retaining pin and hook the end of the aerial on to the inflated balloon and release.

(*b*) Throw the weighted earth line overboard.

(*c*) Slip the leather thong of the aerial lead-in round the wrist in order to relieve the strain when the aerial is connected.

(*d*) Pull winch handle out of recess and unreel the aerial, controlling the speed by the brake under the leather grip. When fully unwound, unhook the wire from the reel and attach it to the end of the lead-in, taking care not to release hold on the aerial wire until the two are securely connected.

(*f*) Set selector switch to the required transmitting position.

(*g*) Sling the strap over one shoulder and under arm to be used for turning the handle, and grip the case between the knees with the handle on top, and controls away from the operator. Turn handle steadily for half a minute to warm up the filaments.

(*h*) If only one operator is available, set the selector switch to " Auto " (C.W. or M.C.W.) and tune for maximum brightness of the neon lamp. If two operators are available tuning will be simplified by setting the selector switch to " hand " (C.W. or M.C.W.) and while one operator keeps the generator working the other operates the controls and presses the key.

Notes.—(i) It should suffice to turn the generator handle for periods of five minutes every quarter of an hour at a speed of approximately 120 r.p.m. Care should be taken to avoid contact with the uninsulated portion of the aerial while the transmitter is being operated.

(ii) Tuning is liable to vary with variations from the perpendicular of the aerial in strong winds, owing to alteration of capacity; repeated checks of the maximum brightness of the neon lamp should therefore be made whilst the equipment is in operation.

WAVEMETER W.1191

1. Requirements

A precision instrument for ground and airborne use in setting up and monitoring transmitters and receivers.

The W.1191 may be used as a substitute for any of the following wavemeters :—W.39 A & B, W.42 A & B, W.61, W.63, W.66, W.67, W.69, W.75, W.1081, W.1095, and W.1117.

2. Frequency Range

The wavemeter is designed to operate over a continuous frequency range of from 100Kc/s to 20 Mc/s.

3. Power Supplies

The wavemeter has two battery compartments designed to hold a 60 volt H.T. battery and a 2 volt 7 A.H. accumulator.

4. Functions

The instrument has six distinct uses :—

(i) As a signal generator, giving a C.W. signal continuously variable over the entire frequency range quoted above. This enables an operator to set up his receiver accurately to a predetermined frequency, using reaction or B.F.O.

(ii) As a signal generator, giving a M.C.W. signal modulated at approx. 1,200 c/s. Thus a receiver can be tuned to any particular frequency, without the use of reaction or B.F.O.

(iii) As a heterodyne wavemeter, where the signal from a transmitter will beat with the local oscillations of the wavemeter, producing beat-note and "dead space" in the W/meter telephones. When this occurs the W/meter and the transmitter are in resonance. This can be used either to calculate the transmitter's frequency from the calibration of the w/meter, or to set up the transmitter to a frequency predetermined by the setting of w/meter.

(iv) When the "Crystal Check" is switched in circuit, the calibration of the wavemeter as used in (i) (ii) and (iii) above, can be checked against the frequency of a self-contained oscillator.

(v) On "crystal control" the wavemeter functions in the same manner as the Crystal Monitor, the crystal fundamental frequency and many of its harmonics are available for setting up either transmitter or receiver on "spot" frequencies

(vi) The "crystal control" circuit as described in (v) can be used to set up a receiver, without the use of reaction or B.F.O., if the wavemeter signal is modulated by the internal A.F. oscillator at 1200 c.p.s.

5. Operation

(i) *To set up a transmitter to a certain frequency :—*

- (*a*) Rod aerial in "input" socket, plug in telephones.
- (*b*) Set "Range Selector" at range required, switch to "trans. C.W. and Receive," crystal check "on".
- (*c*) Rotate tuning control to approximate calibration of the crystal check point next below the frequency upon which the transmitter is to be set up. Tune the wavemeter until the crystal check "dead space" is noted in the telephones. Reduce "Crystal Check Coupling" until a clear dead space is found.
- (*d*) Note the reading of main and vernier dials. Calculate the number of dial divisions which must be added to the crystal check point to bring the tuning to the desired frequency. The calibration chart gives an example of these calculations.

(*e*) Add this increase of dial reading to the crystal check reading, and do not disturb the dial until the following work is completed.
(*f*) Crystal check OFF.
(*g*) The wavemeter is now tuned to the correct frequency. The transmitter should be tuned back to this frequency when a beat-note and "dead space" will be noted in the wavemeter phones, indicating that the transmitter is now on frequency.

(ii) *To measure the frequency of a transmitter* :—
(*a*) Crystal Check OFF, plug in phones, aerial in "input" socket, range selector switch to appropriate range and tuning control set to estimated frequency of transmitter. Switch to "Transmit C.W. and Receive" and switch wavemeter ON.
(*b*) Rotate tuning control of wavemeter until beat-note is heard in phones, find dead space and note dial reading.
(*c*) Switch to Crystal Check ON and find the nearest crystal check point of higher frequency (lower dial reading) and note dial reading.
(*d*) The difference between the two readings must be referred to the "Incremental Dial Divisions" column of the calibration chart, whence the transmitter frequency can be calculated.

(iii) *To set up a receiver to a certain frequency* :—
(*a*) Rod aerial in "output" socket.
(*b*) Proceed as in (i)—(*b*) (*c*) (*d*) (*e*) (*f*).
(*c*) Switch to "trans. M.C.W." only if the receiver is not fitted with either reaction or B.F.O.
(*d*) Tune receiver to dead space of wavemeter signal if on "trans. C.W." or maximum signal if on "trans. M.C.W." Reduce output control until signal from wavemeter is only just audible, and readjust receiver tuning if required.

(iv) *To measure the frequency at which a receiver is tuned* (e.g. to measure the frequency of a distant station to which the receiver has been tuned).
(*a*) Rod aerial in output socket, and proceed as in (ii)—(*a*).
(*b*) Rotate tuning control of wavemeter until a beat-note is found in the receiver telephones, note the reading in the wavemeter.
(*c*) Proceed as in (ii)—(*a*) and (*b*).

6. Precautions and Servicing

It should be understood that the wavemeter is a precision instrument and every care should be taken in handling it. Rough usage will affect the accuracy of calibration. Accumulator terminals should be kept free of corrosion, and the wavemeter should be switched off after use. An unserviceable lamp should be replaced immediately.

WIRELESS OPERATORS,

ESS OPERATORS AIR GUN

AND

OBSERVERS W/T

SECTION III

Article 1

BENDIX AIRCRAFT TRANSMITTER (TA-2J. 24)

1. **Uses.**—Long range aircraft transmitter for C.W., M.C.W., and R.T.

2. **Frequencies.**—Eight fixed frequencies in the bands 300–600 kc/s., 2·9–15 Mc/s.

3. **Power Output.**—(*a*) M.F. range: C.W., 30 watts; M.C.W. and R/T, 20 watts. (*b*) H.F. range: C.W., 100 watts; M.C.W. and R/T, 75 watts.

4. **Power Supplies.**—(*a*) L.T., 24–28 volts from aircraft generator and/or accumulators. (*b*) H.T.: 1,050 volts 300 mA. from motor generator.

5. **Current Consumption.**

Master switch on V.1, V.2, V.3, and white light ..	1 and 2 amps.
Remote control on all valves, fan, white and blue lights ..	12 amps.
Crystal heaters (if fitted)	0·25 amps. each.
C.W. and M.C.W.	45 amps.
R/T	37 amps.

6. **Valves.**

V.1 ..	Type 807	Filament	6·3-volt	250-volt H.T.	Master oscillator.
V.2 ..	Type 807	Filament	6·3-volt	400-volt H.T.	Buffer.
V.3 ..	Type 803	Filament	10-volt	1000-volt H.T.	Power amplifier.
V.4 ..	Type 801A	Filament	7·5-volt	400-volt H.T.	Sub modulator.
V.5, V.6	Type 830B	Filament	10-volt	1000-volt H.T.	Modulators
V.7 ..	Type 6H6	Filament	6·3-volt		Aerial current indicator.

Different filament voltages are obtained from 24-volt supply by dropping resistances.

7. **Circuit.**—V.1 is a beam power tetrode crystal controlled master oscillator coupled to the grid of V.2, which is a buffer or intermediate power amplifier, also frequency doubler or trebler stage. This in turn is coupled to the power amplifier, V.3, a 125-watt pentode operating as a class " C " amplifier.

On M.C.W., V.3 is modulated by a mechanical buzzer housed in the remote control unit.

On R/T, the output from the carbon microphone is amplified by V.4 operating under class " A " conditions, which feeds V.5 and V.6 working as a class " B " push-pull modulating stage.

The output from this stage is used to modulate on both anode and screen of the P.A. valve.

Side-tone is provided on M.C.W., C.W., by feeding part of the buzzer output to the telephone circuit. On R/T part of the audio output is passed to the audio stages of the receiver. A filter is provided in the microphone circuit to cut-off below 400 cycles per second.

An optional remote aerial current meter may be fitted which takes its feed from V.7, which rectifies part of the main aerial current.

Tuning of the M.O. and buffer stages is carried out by the makers for each crystal fitted. The P.A. and coupling unit are set on the ground according to the aerials fitted in the machine.

The P.A. coils are mounted on a revolving turret 3 H.F. ranges being in the transmitter, the M.F. ranges in the coupling unit. These turrets are rotated by a small electric motor, controlled by the frequency selector switch on the remote control panel. Operation of this switch places the correct P.A. coil in circuit, and also correct M.O. and buffer coils, as well as switching correct crystal.

8. **Operating Instructions.**—(*a*) Close aircraft master switch (white lamp lights).

(*b*) Close " on " switch on remote control panel (blue lamp lights).

(*c*) Select frequency required (green lamp lights, while coils are being changed).

(*d*) Put selector switch to " phone ".

(*e*) Check aerials.

(*f*) Close microphone switch and talk.

(*g*) Release microphone switch for reception.

(*h*) To switch off temporarily, open switch on remote control panel.

(*i*) Finished with set, open aircraft master switch.

C.W. and M.C.W.—As above, only selecting required transmissions.

Note.—To receive, put selector switch to " phone ". In some installations an external aerial relay is fitted, operated by the key or microphone switch, in which case it is not necessary to put switch to " phone " for reception.

Precautions.—Never shift frequency with microphone or key pressed. Crystals are not interchangeable.

9. **Setting Up Instructions.**—300–600 *kc/s.*—(*a*) Put meter plug into jack marked " amp. 1 ".

(*b*) Select channel to be used.

(*c*) Press key and note reading in m.A.

(*d*) Insert screwdriver and rotate appropriate fine tuning control for dip.

(*e*) If no dip occurs, release key and change appropriate coarse tap inside unit.

(*f*) Repeat until a good output is obtained with dip occurring at 150 mA. (Multiply meter reading by 100.)

2900–4500 *kc/s.*—(*a*) and (*b*) As above.

(*c*) Put both aerial and anode taps at centre of coil.

(*d*) Rotate coil with screwdriver for dip.

(*e*) If dip is below 150 m.A., move aerial tap (on left) back and turn coil clockwise for dip. (Multiply meter reading by 100.)

(*f*) Repeat until dip occurs at 150 m.A. This should coincide with maximum aerial current.

4500–15000 *kc/s.*—(*a*) and (*b*) As above.

(*c*) Disconnect aerial.

(*d*) Rotate coil for dip, at resonance m.A. should be about 50. A dip to 100 m.A. indicates that a harmonic has been tuned to. (Multiply meter reading by 100.)

(*e*) Replace aerial.

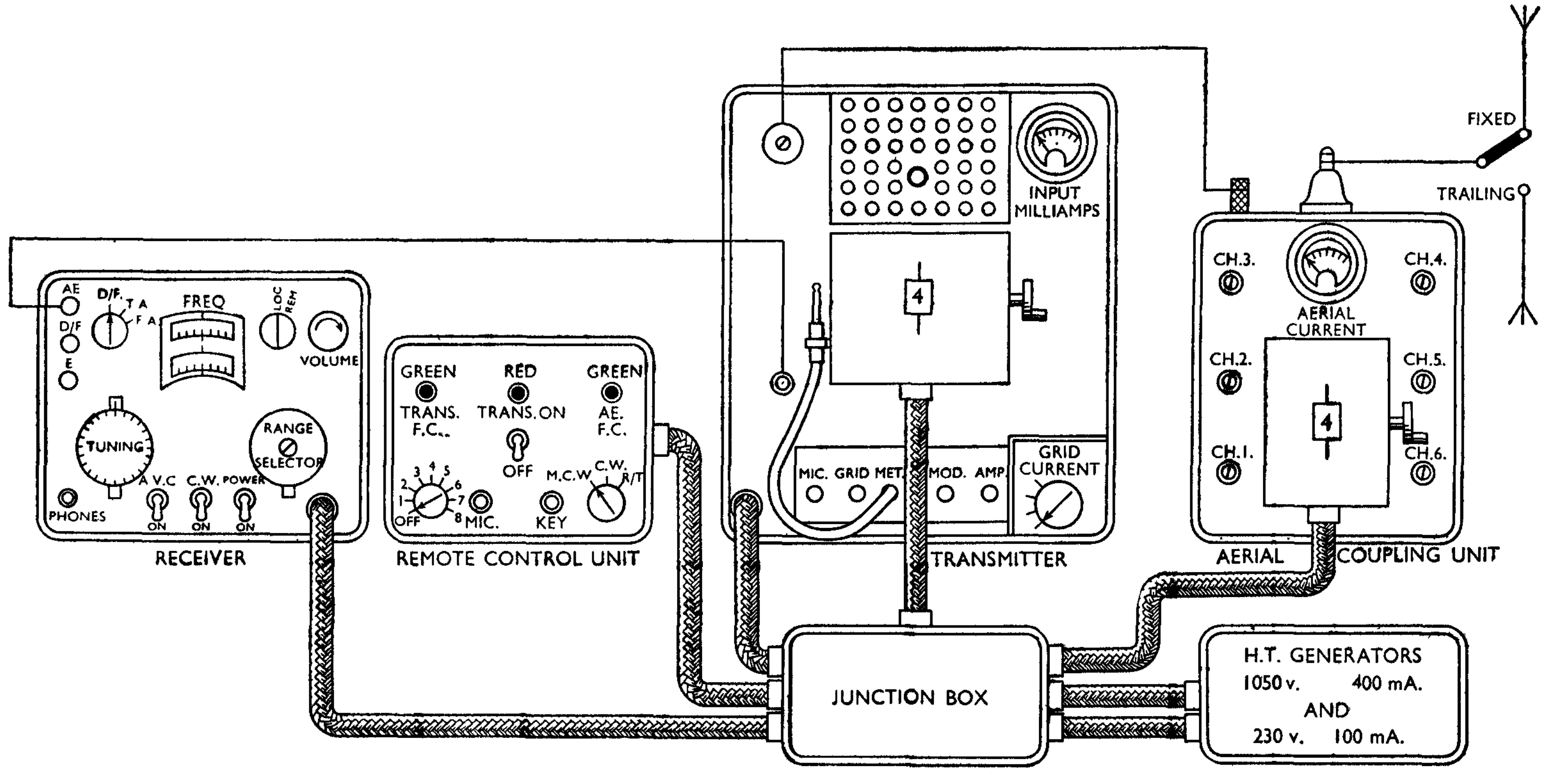
(*f*) Place aerial tap one turn from front end of coil, rotate coil for dip.

(*g*) Repeat, moving aerial tap forward and adjusting for dip, occurs at 150 m.A.

Precautions.—Do not press key for longer than 5 seconds at a time, until tuning operations have been completed.

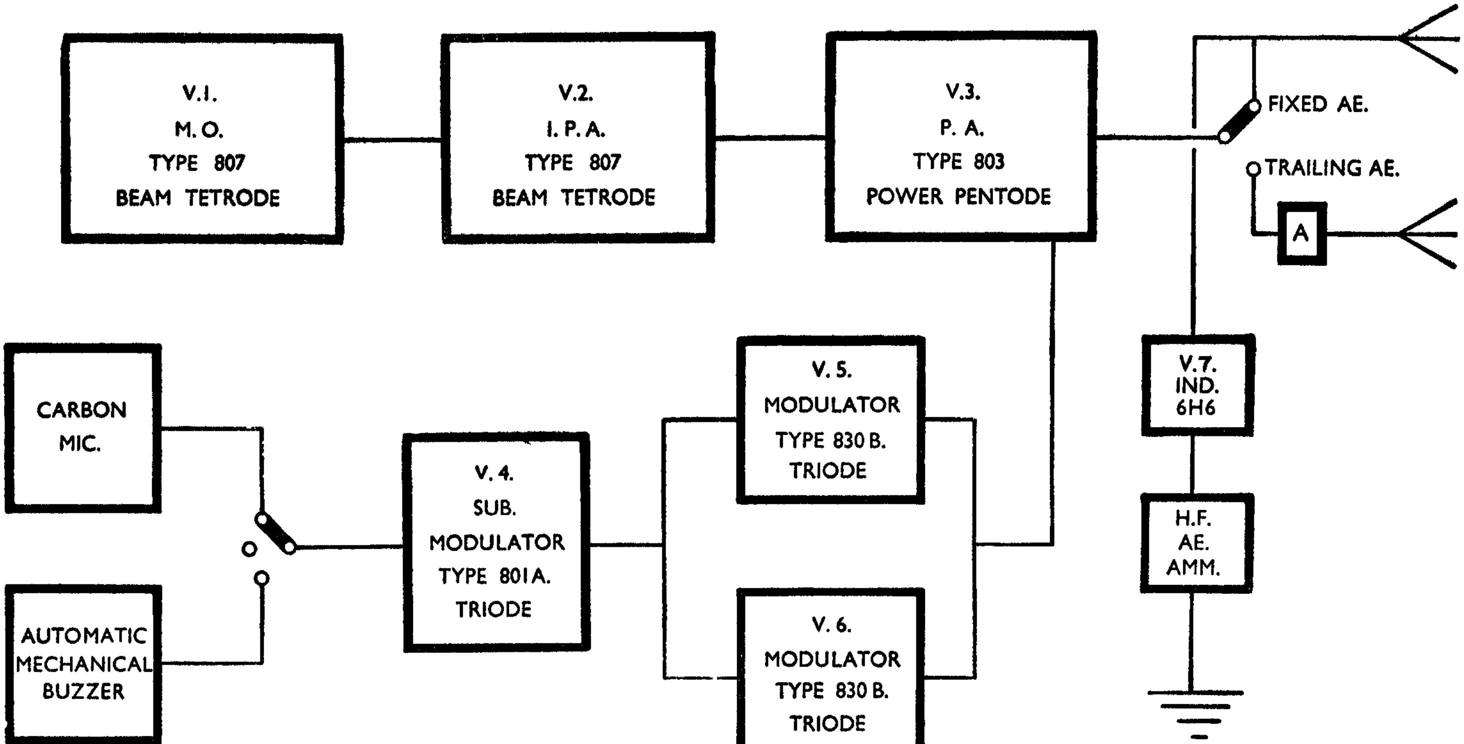
Do not make adjustments to inside of transmitter or coupling unit with key pressed.

On the H.F. ranges, after P.A. coils have been set up, and the door closed, insert screwdriver through hole provided and make a small adjustment for dip.



AE
D/F
E
D/F.
T A
F A
FREQ
LOC
REM
VOLUME
TUNING
RANGE
SELECTOR
PHONES
A V.C
C.W.
POWER
ON
ON
ON
RECEIVER
GREEN
RED
GREEN
TRANS.
F.C.
TRANS. ON
AE.
F.C.
OFF
1
2
3
4
5
6
7
8
OFF
MIC.
KEY
M.C.W.
C.W.
R/T
REMOTE CONTROL UNIT
INPUT
MILLIAMPS
4
MIC.
GRID
MET.
MOD.
AMP.
GRID
CURRENT
TRANSMITTER
FIXED
TRAILING
CH.3.
CH.4.
AERIAL
CURRENT
CH.2.
CH.5.
CH.1.
CH.6.
4
AERIAL
COUPLING UNIT
JUNCTION BOX
H.T. GENERATORS
1050 v.
400 mA.
AND
230 v.
100 mA.

2A


V.1.
M. O.
TYPE 807
BEAM TETRODE
V.2.
I. P. A.
TYPE 807
BEAM TETRODE
V.3.
P. A.
TYPE 803
POWER PENTODE
FIXED AE.
TRAILING AE.
A
CARBON
MIC.
AUTOMATIC
MECHANICAL
BUZZER
V. 4.
SUB.
MODULATOR
TYPE 801 A.
TRIODE
V. 5.
MODULATOR
TYPE 830 B.
TRIODE
V. 6.
MODULATOR
TYPE 830 B.
TRIODE
V.7.
IND.
6H6
H.F.
AE.
AMM.

2B

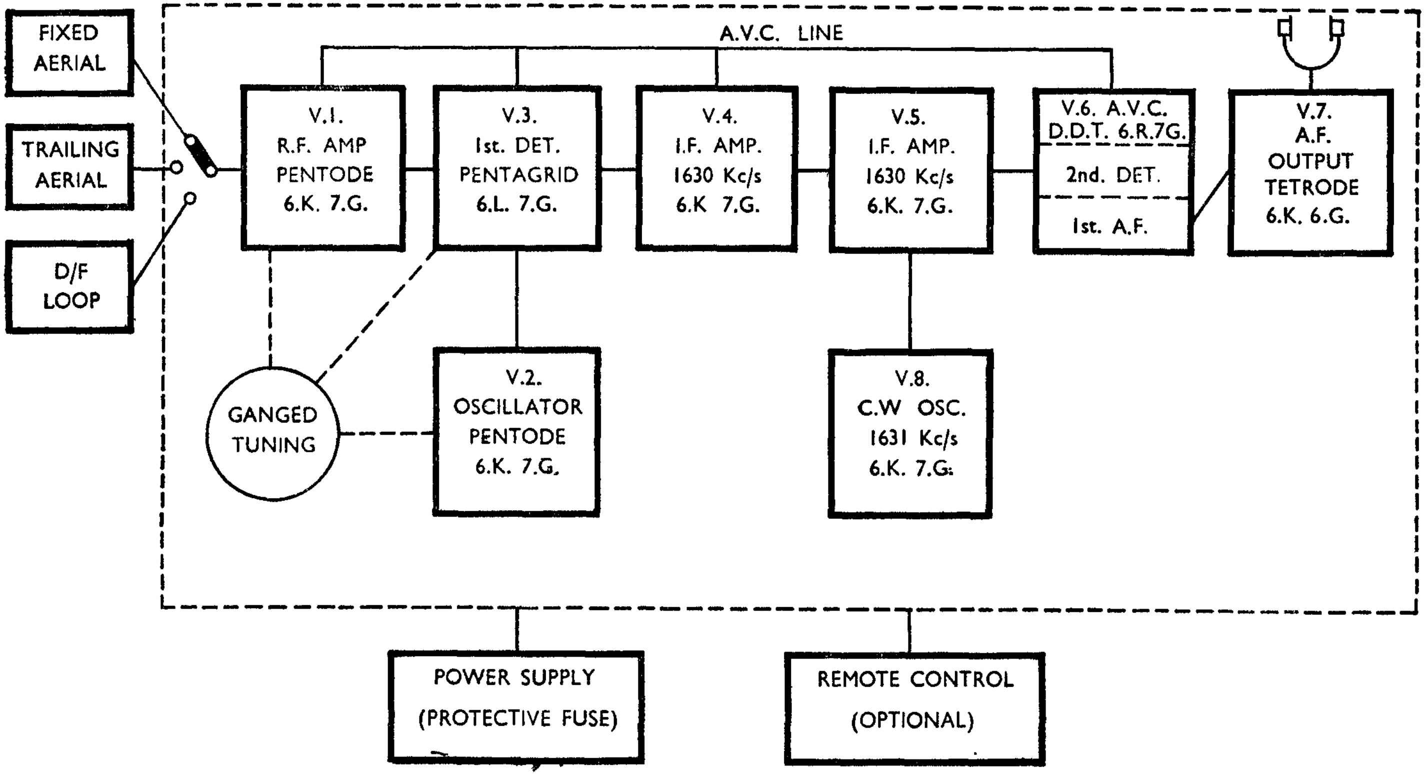


FIG. 11.—RECEIVER R.A.-1B.

2c

BENDIX AIRCRAFT RECEIVER (RA-1B. 24)

1. **Uses.**—With aircraft transmitter TA-2J. 24.

2. **Frequency Range.**—Range 1, 150 to 315 kc/s.; range 2, 315 to 680 kc/s.; range 3, 680 kc/s. to 1·5 Mc/s.; range 4, 1·5 Mc/s to 3·7 Mc/s.; range 5, 3·7 Mc/s. to 7·5 Mc/s.; range 6, 7·5 Mc/s. to 15 Mc/s.

3. **Power Supplies.**—(*a*) L.T. 6·3 volts obtained from aircraft generator and/or accumulators.

(*b*) H.T. 250 volts obtained from small motor generator working from aircraft 24-volt supply and taking 1·9 amps.

4. **Aerial Selector Switch.** Marked " D/F ", " Fixed ", and " Trailing ". When in " trail " position a small condenser is inserted in series with aerial.

Valves.	V.1, V.2, V.4, V.5 and V.8 Vari-mu R/F pentodes	6K7G
	V.3, Pentagrid mixer	6L7G
	V.6, Duo-diode triode	6R7G
	V.7, Output valve (beam tetrode)	6K6G

5. **Circuit.**—Eight valve superheterodyne receiver, capable of receiving C.W., M.C.W. and R/T.

V.1 and V.2 signal frequency amplifiers, followed by a pentagrid mixer, V.3. The intermediate frequency amplifiers V.4 and V.5 are followed by the second detector and A.V.C. valve, V.6, which also serves as a L.F. amplifier, the output valve V.7.

V.8 is the beat frequency oscillator, which is brought into use when C.W. is received.

Optional automatic or manual control is provided by the operation of a switch on the front panel. The manual volume control is also in use, to control the L.F. output, when on A.V.C.

Provision is made for either local or remote tuning control.

Testing points are brought out to the front of the panel for measuring H.T. and L.T. voltages.

BENDIX INTERCOMMUNICATION SYSTEM

This comprises an amplifier, and control boxes at the various crew positions.

1. **Amplifier, Model 3611.**—Consists of a two-valve resistance-coupled high gain amplifier, output approximately 3 watts.

Valves.—6SJ7, A.F. pentode ; 6V6, power tetrode.

Power supply.—6·3-volt heaters from 24-volt supply through suitable resistances.

230 volts H.T. from self-contained motor generator.

General.—A volume control is provided in the front panel. All circuits are filtered and well screened. Microphone leads must not be earthed. Connections are taken via six-pin socket to the various station boxes and 24-volt supply. Electro-magnetic microphones are used.

2. **Operator's Station Box, Model 3618.**—This carries the " on-off " switch for the amplifier, a green indicating light, and a four-way selector switch marked " R.1 ", " R.2 ", " I/C " and " Call ". In the first two positions the operator's telephones are connected to the appropriate receiver, in the third position to the I/C amplifier, while in the " call " position, all outputs are paralleled to all phones, and the various red lights at the different stations flash.

It will be seen that if the main I/C amplifier volume control is adjusted to over-ride the receiver output, intercommunication may take place in the " call " position without turning off the receiver.

3. **Pilot's Station Box, Model 3619.**—Similar to above, but no controls for I/C amplifier and an additional position of the selector switch marked " Compass ". This is for a radio compass, if fitted.

4. **Crew's Station Box, Model 3617.**—As above, but provision made only for I/C and call.

BENDIX RADIO COMPASS (Type MN-26C)

1. **Use.**—Use for homing, or taking bearings using the visual method.

2. **Frequency Ranges.**—Covered in three ranges: 150–325 kc/s.; 325–695 kc/s.; 695–1,500 kc/s.

3. **Power Supplies.**—(*a*) 6·3 volts from aircraft 24-volt supply; (*b*) 250 volts H.T. from self-contained motor generator running from 24-volt supply.

4. **Circuit.**—The receiver makes use of the valve-switched cardioid principle, using a single needle dynamometer type indicator.

The phase of the loop e.m.f.s is reversed at about a hundred cycles per second by means of the switching valves, which are double triodes. These switched loop e.m.f.s are combined with the fixed aerial e.m.f., and to the intermediate frequency stages of the receiver. The rectified output is then passed through the moving coil of the indicating unit.

The low frequency output from the L.F. switching valve is passed through the fixed windings of the indicating meter, so that the current through these windings reverses in phase with the receiver output.

Hence the indicating needle moves to the right or left of central position according to the position of the loop relative to the incoming signal.

A remote control is provided for the pilot's use only. The master switch on the panel has four positions: " off ", " compass ", " receiver aerial ", " receiver loop ".

Two volume controls are fitted, one for compass and one for audio. The beat frequency oscillator may also be switched " in "—in C.W. reception.

The loop and scale are also remotely controlled. An extra scale is provided on the loop scale, which may be adjusted to compensate for magnetic variation so that magnetic bearings may be read direct from the scale.

5. **Operation.**—(i) *Visual.*—(*a*) Switch master switch to " Rec. Ant ".

(*b*) Select correct frequency band.

(*c*) Select required frequency.

(*d*) C.W. switch on if required. Adjust audio volume.

(*e*) Switch to compass, put compass sensitivity control to max. position; needle will deflect.

(*f*) Turn loop to bring needle back to centre line, read off bearing or reciprocal.

6. **For Homing.**—(*a*) to (*e*) as above.

(*f*) Set loop to read zero.

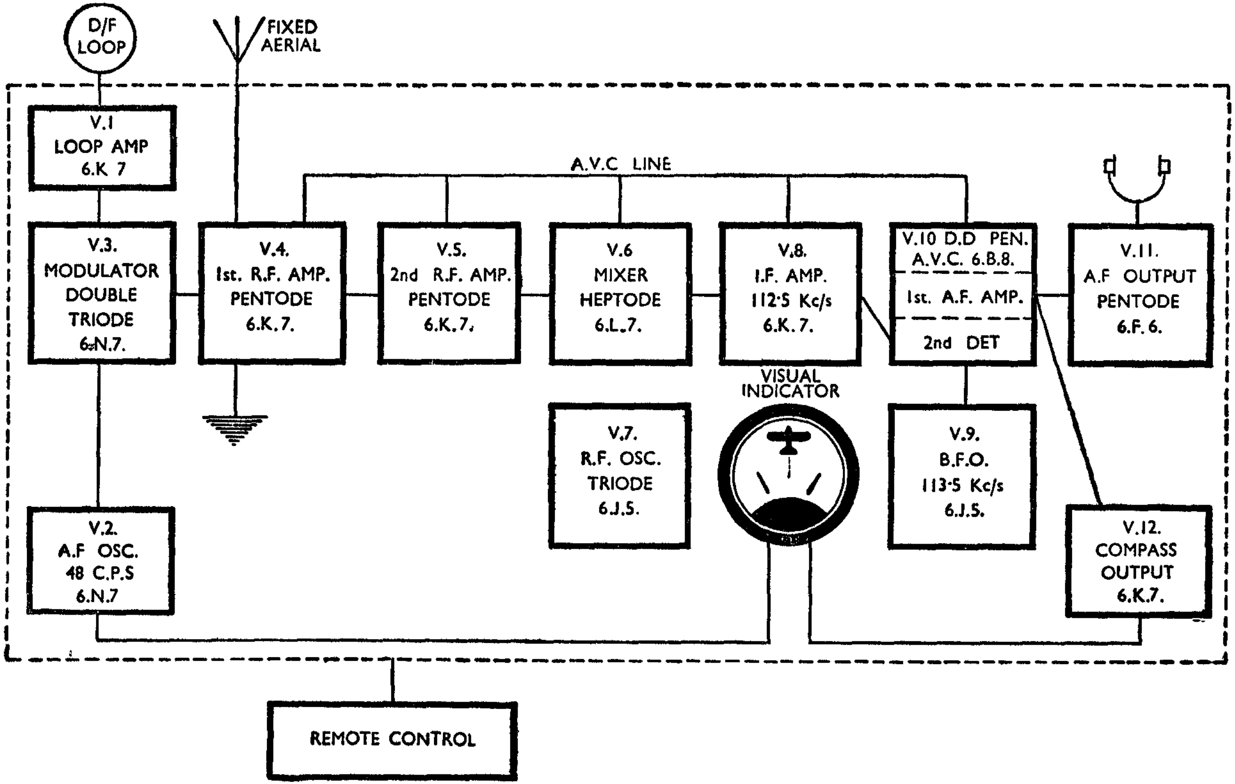
(*g*) Pilot turns aircraft to bring needle back to centre line.

7. **Aural.**—(*a*) Select frequency band and frequency required.

(*b*) Switch to " Rec. loop ".

(*c*) Turn loop for aural minimum.

(*d*) Read off bearing or reciprocal.


D/F LOOP
FIXED AERIAL
V.1 LOOP AMP 6.K 7
A.V.C LINE
V.3. MODULATOR DOUBLE TRIODE 6.N.7.
V.4. 1st. R.F. AMP. PENTODE 6.K.7.
V.5. 2nd R.F. AMP. PENTODE 6.K.7.
V.6 MIXER HEPTODE 6.L.7.
V.8. I.F. AMP. 112·5 Kc/s 6.K.7.
V.10 D.D PEN. A.V.C. 6.B.8.
1st. A.F. AMP.
2nd DET
V.11. A.F OUTPUT PENTODE 6.F.6.
VISUAL INDICATOR
V.7. R.F. OSC. TRIODE 6.J.5.
V.9. B.F.O. 113·5 Kc/s 6.J.5.
V.2. A.F OSC. 48 C.P.S 6.N.7
V.12. COMPASS OUTPUT 6.K.7.
REMOTE CONTROL

SECTION III

Article 5

BENDIX AIRCRAFT TRANSMITTER TA–12B or TA–12C

1. **Uses.**—To provide long distance C.W., M.C.W., and R/T communications on medium and high frequencies, being the American counterpart of the T.1154/R.1155 equipment.

2. **Frequency Ranges.**

Channel No.	*Model TA–12B Freq. Range*	*Model TA–2C Freq. Range*
1	300–600 kc/s	300– 600 kc/s
2	3,000–4,800 kc/s	3,000– 4,800 kc/s
3	4,000–6,400 kc/s	4,800– 7,680 kc/s
4	4,370–7,000 kc/s	7,680–12,000 kc/s

3. **Power Output.**—40 watts.

4. **Power Supplies.**—Normal L.T. input, 25 volts from aircraft generator and/or accumulators. Equipment capable of operation on any D.C. supply from 20 to 28 volts.

5. **Precautions.**—Equipment rated for intermittent service, i.e. 5 min. on, 5 min. off.

6. **Current Consumption.**—25 volts at input terminals of type MP–28B, power supply unit, 16·5 amps.

7. **Valves.**

(i) *Transmitter.*

V101	Type 12 SK7	Fil. 12·6 v.	H.T. 250 v.	Chann. 1 M.O.
V102	Type 12 SK7	Fil. 12·6 v.	H.T. 250 v.	Chann. 2 M.O.
V103	Type 12 SK7	Fil. 12·6 v.	H.T. 250 v.	Chann. 3 M.O.
V104	Type 12 SK7	Fil. 12·6 v.	H.T. 250 v.	Chann. 4 M.O.
V105	Type 807	Fil. 6·3 v.	H.T. 535 v.	BUFFER (I.P.A.)
V106	Type 807	Fil. 6·3 v.	H.T. 510 v.	P.A.
V107	Type 807	Fil. 6·3 v.	H.T. 510 v.	P.A.

(ii) *Power Unit MP–28B.*

V201	Type 6N7	Fil. 6·2 v.	H.T. 295 v.	A.F. amp. and M.C.W. Osc.
V202	Type 6F6	Fil. 6·2 v.	H.T. 300 v.	A.F. amp.
V203	Type 807	Fil. 6·2 v.	H.T. 540 v.	Modulator.
V204	Type 807	Fil. 6·2 v.	H.T. 540 v.	Modulator.

Different filament voltages obtained by series/parallel arrangement and/or dropping resistances.

8. **Circuit.**—(i) *Oscillators.*—Channel 1 oscillator comprises a typical Colpitts circuit, the frequency being controlled by a variometer and fixed condensers. This circuit operates on the same frequency as the transmitter output. Grid bias is obtained by a grid blocking condenser and grid leak. The anode of V101 is coupled to the grid of the I.P.A. (V105) via a blocking condenser and an anode choke. Channels 2, 3 and 4 comprise typical Hartley oscillators, the frequency being controlled by variable condensers and fixed inductance. These oscillators operate on one half of the output frequency. The anodes of the oscillators are coupled to the grid of the I.P.A. through their respective band pass transformers and a channel switch.

The channel switch connects the anode voltage to the oscillator circuit corresponding to the channel being used.

(ii) *I.P.A. or Buffer.*—The I.P.A. consists of one type 807 valve (V105) and its associated circuits. For channel 1 this valve is used as an untuned amplifier. For channels 2, 3 and 4 the I.P.A. serves as a frequency doubler to provide excitation for the P.A. at twice the oscillator frequency. The oscillator and I.P.A. circuits are ganged so as to give a single tuning control for each channel.

(iii) *P.A. Circuits.*—The power amplifier consists of two type 807 valves (V106 and V107) operated in parallel. The grid bias for the P.A. is obtained from the negative H.T. terminal in the type MP–28B power supply unit through a grid leak and filter.

The anodes of the P.A. are shunt fed via a choke. A condenser isolates the anode voltage from the output circuits.

Channel 1 output circuit consists of a variometer in series with a loading coil, type MT–53B (antenna loading unit), a bank of three condensers and the capacity of the aerial. The circuits for channels 2, 3 and 4 are similar except that both coils and condensers are continuously variable. On these channels, series condensers may be used to permit operation over a wide range of aerials with efficient power transfer.

(iv) *A.F. Circuits.*—V201 is used as an A.F. oscillator to provide side-tone for M.C.W. operation and modulation of the transmitter when on M.C.W. It is also used for side-tone when on C.W.

For R/T a relay is provided for switching the microphone transformer to the grid of either V201 or V202. The provision permits the use of an external pre-amplifier if desired. When this relay is not energised the input transformer is connected to amplifier V202 and the first amplifier V201 is biassed to cut off. For C.W. operation the cathodes of V203 and V204 are broken. The output from V203 and V204 on M.C.W. and R/T is fed to the transmitter for modulation of P.A. carrier.

(v) *Antenna Relay.*—This keys the anode voltage of transmitter on M.C.W. and C.W., switches the aerial from the transmitter to the receiver, and earths the receiver connection when the transmitter is on. Thus "listening through" is obtained.

(vi) *Tuning Back.*—After slight modification the above equipment is capable of providing "tuning back" facilities, when the side-tone circuit is broken and the M.O. control rotated until a note is heard in the phones, the "dead space" should then be found.

9. **Transmitter Remote Control Unit 3616.**—This is the master control unit for the transmitter and other control units. It has the following controls :—

(i) Switch 1 :—" Local–Remote ", places transmitter under direct control or from control units.

(ii) Switch 2 :—" Radio only–I/C Radio ", directs microphone to either transmitter or I/C amplifier.

(iii) Switch 3 :—" Send–Rec ". starts M.G. on " Send " position.

(iv) Switch 4 :—" Master Radio ", starts I/C amplifier and switches on filaments.

(v) Switch 5 :—" I/C ", starts I/C amplifier only.

(vi) Switch 6 :—" Channel switch ", controls channel selector motor.

(vii) Switch 7 :—" C.W., M.C.W., R/T ". On R/T, H.T. is connected to valves. On C.W. and M.C.W. motor is started but H.T. is not connected until key is pressed. A volume control is also fitted and controls the output to the telephones.

10. **Tuning Instructions.**—(i) Channel 1 :—

(*a*) Set M.O. tuning dial from calibration chart.

(*b*) Set P.A. tuning to 0.

(*c*) Put loading switches to A–A (condensers in transmitter).

(*d*) Set connector in loading unit (M.T.–53B) to extreme left-hand tap.

(*e*) Set channel selector switch to 1 and press key push button on transmitter.

P.A. current should rise to 250 mA. approximately.

(*f*) Rotate P.A. tuning and if no dip occurs release key and move connector on loading unit one tap.

(*g*) Rotate P.A. tuning through its range again until a greater dip is obtained, but if the dip is very low increase loading by moving condenser switches to B–B or C–C. Press key push button and re-tune P.A. for a dip, which should be as near to 210 mA. as possible but must not exceed that figure.

ii) Channels 2, 3 and 4 :—

(*a*) Set M.O. tuning dial from calibration chart.

(*b*) Rotate P.A. tuning control to extreme anti-clockwise position to bring in maximum inductance.

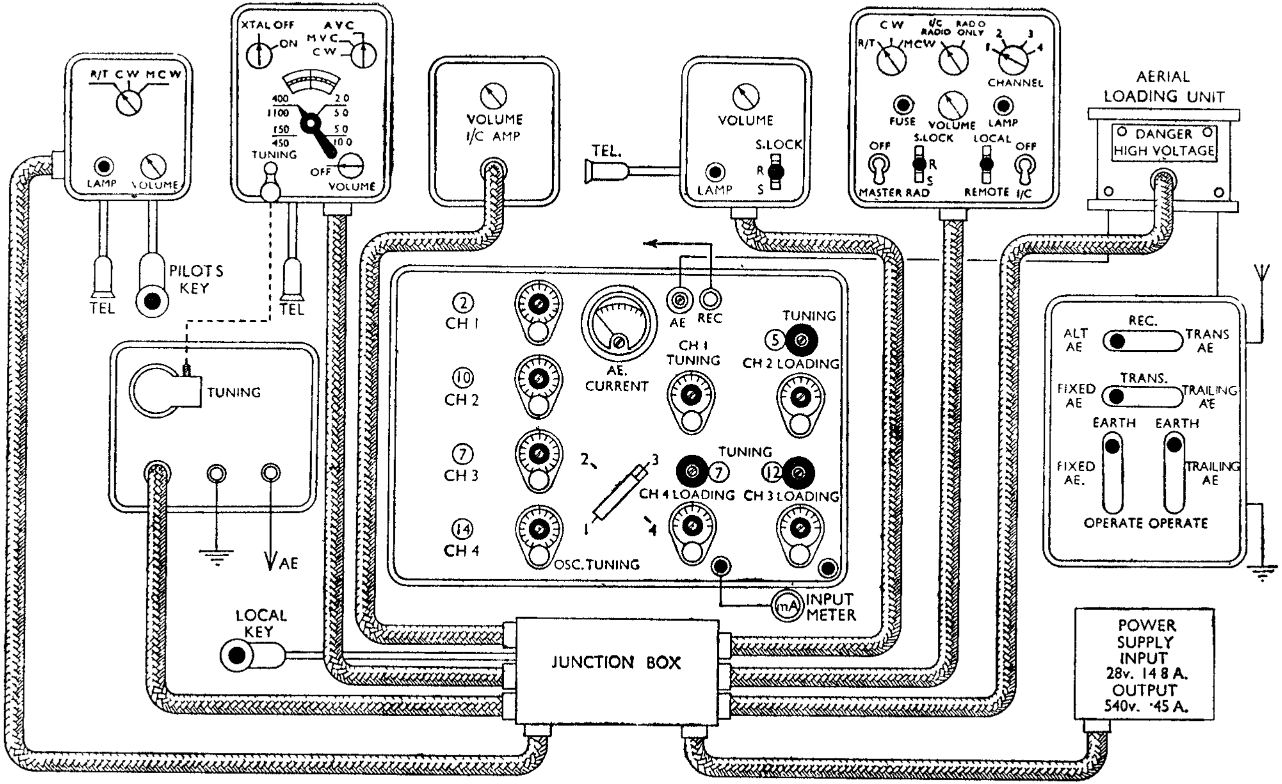
(*c*) Set series aerial condenser switches to " out " (situated next to loading switches on Channel 1).

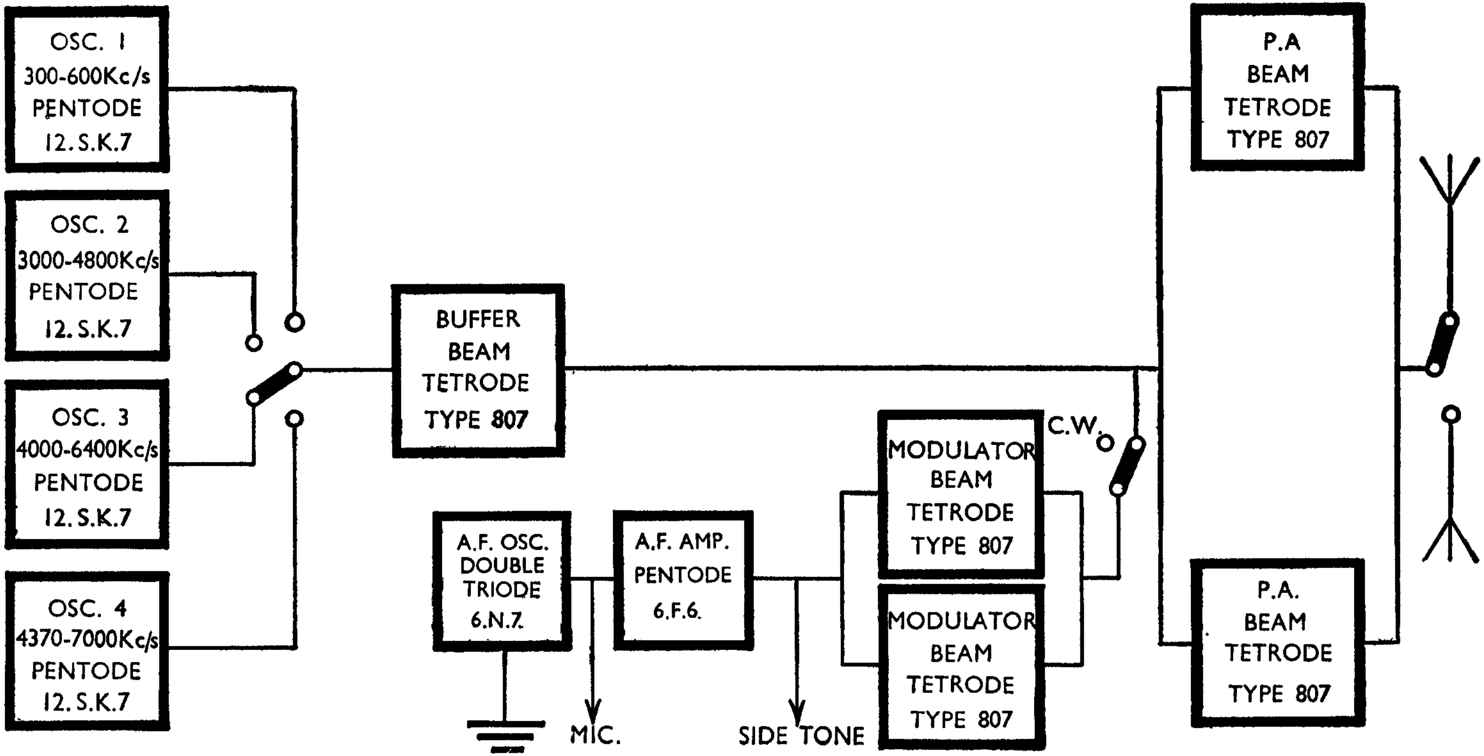
(*d*) Set P.A. fixed tuning condensers to " out " (situated on rear of P.A. tuning units).

(*e*) Set output " Channel loading " dial to 50.

(*f*) Set channel selector switch to required position and press the key.

(*g*) Rotate " channel loading " dial for a dip. If no dip occurs or if the dip is at zero, reduce the P.A. inductance. Tune again for dip, and repeat until maximum dip is obtained. A mutual setting should be found that gives a dip to 210 mA. with aerial current at maximum. It may be found necessary to include P.A. tuning fixed condensers, or with a long aerial, series aerial condensers.


R/T CW MCW
LAMP
VOLUME
TEL
PILOTS KEY
XTAL OFF
ON
AVC
MVC
CW
400
1100
150
450
20
50
50
100
TUNING
OFF
VOLUME
TEL
TUNING
AE
VOLUME
I/C AMP
TEL.
VOLUME
S.LOCK
R
S
LAMP
CW
R/T
MCW
I/C RADIO
RADIO ONLY
1 2 3 4
CHANNEL
FUSE
VOLUME
LAMP
OFF
S.LOCK
R
S
LOCAL
OFF
MASTER RAD
REMOTE
I/C
AERIAL LOADING UNIT
DANGER HIGH VOLTAGE
CH 1
CH 2
CH 3
CH 4
AE. CURRENT
AE
REC
TUNING
CH 1 TUNING
CH 2 LOADING
TUNING
CH 4 LOADING
CH 3 LOADING
OSC. TUNING
INPUT METER
mA
REC.
ALT AE
TRANS AE
TRANS.
FIXED AE
TRAILING AE
EARTH
EARTH
FIXED AE.
TRAILING AE
OPERATE OPERATE
LOCAL KEY
JUNCTION BOX
POWER SUPPLY INPUT 28v. 14 8 A.
OUTPUT 540v. ·45 A.


OSC. 1
300-600Kc/s
PENTODE
12.S.K.7
OSC. 2
3000-4800Kc/s
PENTODE
12.S.K.7
OSC. 3
4000-6400Kc/s
PENTODE
12.S.K.7
OSC. 4
4370-7000Kc/s
PENTODE
12.S.K.7
BUFFER
BEAM
TETRODE
TYPE 807
A.F. OSC.
DOUBLE
TRIODE
6.N.7.
A.F. AMP.
PENTODE
6.F.6.
MIC.
SIDE TONE
MODULATOR
BEAM
TETRODE
TYPE 807
MODULATOR
BEAM
TETRODE
TYPE 807
C.W.
P.A
BEAM
TETRODE
TYPE 807
P.A.
BEAM
TETRODE
TYPE 807

SECTION III

Article 6

BENDIX AIRCRAFT RECEIVER RA–10DA

1. **Use.**—With transmitter TA–12B and TA–12C.

2. **Frequency Range.**
(i) Range 1 : 150–400 kc/s.
(ii) Range 2 : 400–1,100 kc/s.
(iii) Range 3 : 2,000–5,000 kc/s.
(iv) Range 4 : 5,000–10,000 kc/s. The range required being selected by a range selector motor.

3. **Valves.**

V1	R.F. amplifier, pentode	6SK7
V2	Frequency changer, triode-hexode	6K8
V3	I.F. amplifier, pentode	6SK7
V4	I.F. amplifier, pentode	6SK7
V5	Detector and A.V.C. double-diode-triode	6R7
V6	B.F.O. triode	6C5
V7	Output, pentode	6K6G
V8	Limiter, double-diode	6H6

4. **Power Supplies.**—(i) L.T., 6·3 volts, from aircraft battery through a series-parallel arrangement and/or dropping resistances.

(ii) H.T. from a M.G. mounted inside the receiver. Input, 28 volts, 3 amps. Output, 230 volts, 100 mA.

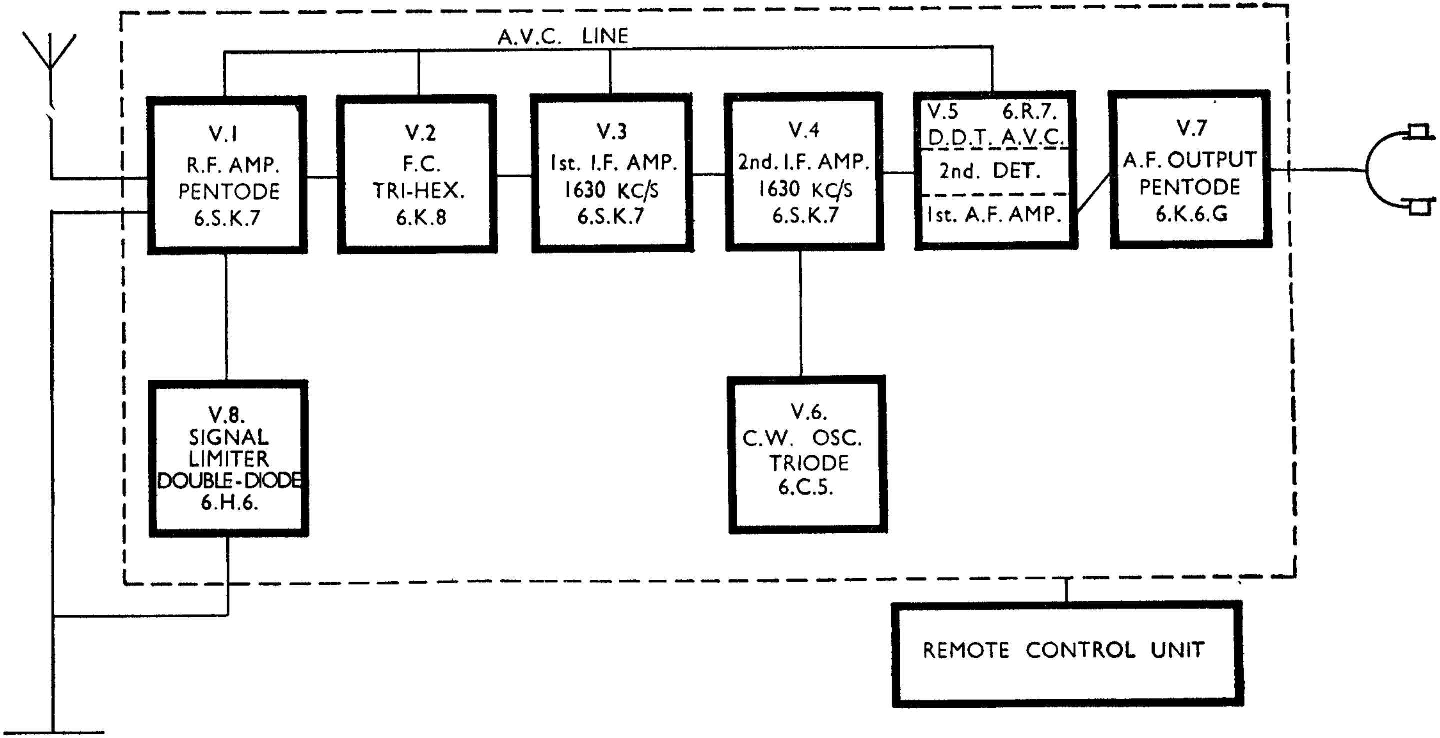
5. **Circuit.**—The receiver is a straightforward 7 valve superhet plus a limiter valve, with an I.F. of 1,630 kc/s. Volume control can be either automatic or manual, being selected by a switch on the control unit marked A.V.C.–M.V.C.–C.W.

(i) In the A.V.C. position the first three stages are controlled by a potentiometer across the output stage transformer secondary.

(ii) In the M.V.C. and C.W. position (and also on range 1 on A.V.C.) the A.V.C. is reduced and the A.F. gain fixed in the maximum position. The M.V.C. is a potentiometer tapping a variable portion of the H.T. supply, and applying positive bias to the cathodes of the R.F. and first I.F. valves. Provision is made for a lock-in crystal controlled frequency on range 3 and on range 4. When specified on order ranges 3 and 4 may be wired so that only the crystal controlled frequencies are available, thereby eliminating the necessity of tuning the R.F. circuits to approximately the crystal frequency. When the receiver is wired for general coverage of ranges 3 and 4 and the crystal is in use, lock-in occurs over a band width of at least 50 kc/s. The crystal are of a frequency 1,630 kc/s. higher than the desired frequency. To provide side-tone, part of the audio voltage from the transmitter modulator unit are applied to the output stage via a side-tone relay. The diode limiter prevents overloading of the receiver under very high signal inputs. It is across the input circuit and conducts when the signal input exceeds 0·25 volts.

6. **Remote Control Unit.**—The receiver is designed for remote control only (units MR–9B or MR–9C). The unit has :—

(i) An " Off-volume " switch, which switches the receiver on and adjusts the signal input.
(ii) A " Tuning " control, which is connected to the receiver by a flexible cable. The dial is calibrated directly in kc/s. and Mc/s.
(iii) A " Range " switch, which operates the selector motor.
(iv) An " A.V.C.–M.V.C.–C.W." switch. (*Note.*—A.V.C. is available only on ranges 2, 3 and 4, but is not available when using C.W. on any range.)
(v) A " Crystal on–Crystal off " switch, which connects the crystal into the receiver heterodyne oscillator circuit.


A.V.C. LINE
V.1
R.F. AMP.
PENTODE
6.S.K.7
V.2
F.C.
TRI-HEX.
6.K.8
V.3
1st. I.F. AMP.
1630 KC/S
6.S.K.7
V.4
2nd. I.F. AMP.
1630 KC/S
6.S.K.7
V.5 6.R.7.
D.D.T. A.V.C.
2nd. DET.
1st. A.F. AMP.
V.7
A.F. OUTPUT
PENTODE
6.K.6.G
V.8.
SIGNAL
LIMITER
DOUBLE-DIODE
6.H.6.
V.6.
C.W. OSC.
TRIODE
6.C.5.
REMOTE CONTROL UNIT

R.C.A. GROUND RECEIVER A.R.—77E (R.1188)

1. Requirements

An A.C. mains operated general purpose communications receiver for ground stations.

2. Frequency Range

540 Kc/s to 31 Mc/s in six ranges.

3. Valves

R.F. Amplifier	..	(Vari-mu pentode)	6SK7
Frequency Changer	..	(triode-hexode)	6K8.
2 I.F. Amplifiers	..	(vari-mu pentodes)	6SK7
Beat Freq. Oscillator	..	(pentode)	6SJ7
Det. & Noise Limiter	..	(double diode)	6H6
A.V.C. Rectifier and A.F. Amplifier	..	(double-diode-triode)	6SQ7
Power Output	..	(pentode)	6F6G

In addition to the above, in the power pack of the receiver are :—

Rectifier	(double-diode)	5Y3G
Voltage Regulator	(neon tube)	VR.150

4. Power Supplies

Power supply is normally from A.C. mains but the R.1188 may be met in mobile tenders, operating from an external power pack, consisting of vibrator, transformer, rectifier and smoothing, on 12 volt D.C. supplies from accumulators.

5. Controls

(i) *Frequency Range Switch,* which selects the coils required to cover the desired frequency range.

(ii) *Main Tuning* consisting of three ganged variable condensers.

(iii) *Band Spread Tuning.* Three small ganged variable condensers in parallel with the main tuning condensers. They are not in circuit on the two low frequency ranges.

(iv) *The Aerial Trimmer* is a small variable trimmer condenser, by which the aerial circuit may be tuned to give maximum efficiency on the required range.

(v) *The Volume Control and On-Off Switch* are ganged together. The volume control, which is a potentiometer, controls the A.F. voltage from the detector to the A.F. amplifier. Turn the volume control anti-clockwise to switch off the receiver.

(vi) *The Sensitivity Control* is a potentiometer by which the grid bias on the I.F. amplifier is adjusted, thus controlling the sensitivity of the receiver.

(vii) *The Transmission Selector Switch* has three positions marked :—
"NFB" — Negative feed back, for improved quality on R/T.
"AVC" — Automatic volume control for normal working.
"BFO" — Beat Frequency Oscillator for C.W. reception.

(viii) *B.F.O. Control* is brought into circuit when the selector switch is in the "BFO" position. The control consists of a small variable condenser, by the adjustment of which, the pitch of the received signal can be altered, without adjusting the receiver tuning.

(ix) *The Transmit-Receive Switch* is provided to prevent damage to the receiver in the absence of "listening-through" facilities. The switch must be put in the "transmit" position during transmission.

(x) *The Noise Limiter* is designed to reduce background noise, particularly on frequencies in the region of 30 Mc/s.

(xi) *The Crystal Selectivity Switch* gives a choice of five different degrees of selectivity, obtained by means of a "crystal-gate" in the I.F. stages. In the "out" position the filter is not connected. Of the positions marked "1 to 5" the fifth position gives the greatest degree of selectivity.

(xii) *The Crystal Phasing Control* consists of a small variable condenser and is provided to cancel out the capacitive effect of the crystal holder. It should be adjusted for minimum background noise, under "no signal" conditions, with the Crystal Selectivity Switch in the position 3.

Tuning Procedure for R/T Reception

(i) Plug in the telephones.

(ii) Put the volume control/power switch to the "on" position.

(iii) Set the frequency range switch to the desired range.

(iv) Set the band-spread tuning to the highest frequency and adjust main tuning.

(v) Set the noise limiter and Crystal Selectivity switch to "out," and the Transmit-Receive switch to "R".

(vi) Put the Transmission Selector switch to "A.V.C."

(vii) Tune in the required signal on the main tuning and adjust the band-spread control for maximum signal strength. This will also be indicated by maximum deflection in the Sensitivity Meter.

(viii) Adjust the Aerial Trimmer to give maximum signal strength.

(ix) Obtain the required output by adjusting the sensitivity control and the volume control.

Tuning Procedure for C.W. Reception

(i)—(v) As for R/T reception.

(vi) Set the Transmission Selector switch to "B.F.O." and the B.F.O. control to zero.

(vii) Tune in to the "dead space" of the required signal and adjust the B.F.O. control to give a suitable beat-note.

(viii) and (ix) as for R/T reception.

Tuning Procedure for M.C.W. Reception

(i)—(v) As for R/T reception.

(vi) Set the Transmission Selector switch to N.F.B.

(vii)—(ix) As for R/T reception.

ote.—Positions 1 and 2 only of the Crystal Selectivity switch should be used for R/T reception, and 3 to 5 for C.W. and M.C.W. reception. When using the noise limiter with C.W. and M.C.W. reception, the sensitivity control should be advanced and the volume control reduced until limiting occurs.

WIRELESS OPERATORS,

ESS OPERATORS AIR GUN

AND

OBSERVERS W/T

SECTION IV

PRECAUTIONS TO BE TAKEN TO AVOID THE RISK OF FIRE

1. Do not make or break circuits by pulling plugs out of sockets unless the circuit is first switched off.

2. Do not make or break connections to batteries or accumulators without first seeing that *all* circuits affected are first switched off.

3. Do not use stranded wire unless the wire is properly fitted with cable ends.

MAINTENANCE OF AIRCRAFT

1. Technical maintenance consists of :—

(*a*) Inspection at regular intervals, to discover faults (if any) and to clean and apply anti-corrosive treatments to parts.

(*b*) Lubrication at regular intervals, to reduce wear and tear.

(*c*) Remedying of faults discovered, by repair, replacement or modification.

2. Publications are available, giving details of what is to be done, how is to be done, who is to do it, and at what intervals :—

(*a*) Aeroplane Maintenance Regulation (Air Publication 1574) describes the maintenance system in general.

(*b*) Aeroplane Maintenance Form (Form 700) records the day-to-day history of the aircraft and its inspections, and is initialled by tradesmen to certify their job has been done.

(*c*) Unit Maintenance Orders detail the items to be inspected.

(*d*) The Log Book of the Airframe, the Aero-engine, and certain accessories contain in permanent form the history of the aeroplane, compiled from entries on Form 700, or other appropriate sources.

(*e*) Engine and Aircraft Handbooks : the Electrical Equipment Manual (A.P. 1095) ; the R.A.F. Signal Manual (A.P. 1186), contain information on the construction and use of the appropriate items.

3. Inspections are carried out at :—

(*a*) Between flights.

(*b*) Daily.

(*c*) Periodically, at 30 (or 40, for some types) hour intervals.

Details of (*a*), (*b*) and (*c*) are found in Unit Maintenance Orders ; a Maintenance Inspection Record Form is also used to list and record the items inspected at " periodical " inspections.

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ELECTRICAL POWER SUPPLIES IN AIRCRAFT

1. Source of Supply

A supply of electrical energy is required in aircraft to provide current for lighting, heating, wireless and other electrical equipment. Servicing and adjustment of components in the supply system is carried out by electricians, but brief details are given in the following paragraphs to assist in understanding the system. When the engines are running above a certain speed and at all times during flight the supply is obtained from one or more engine-driven generators (E.D.Gs.). The generator is usually bolted directly to the aero engine and driven through gearing at approximately 5,000 r.p.m.

On the ground when the engines are stationary or running at very low speed, and in the event of generator failure in the air, an alternative supply is obtained from storage accumulators; these are normally charged by the generators during flight. When carrying out tests on wireless or electrical equipment on the ground with engines stationary an external trolley accumulator must be plugged into the socket provided. This is to avoid discharging the aircraft accumulator. An automatic cut-out is fitted to prevent the accumulator discharging through the generator when the engine is stationary.

(i) *Generator Cooling.*—Owing to its high output to size ratio an E.D.G. requires special cooling arrangements, and it is placed directly in the slipstream by means of inlet and outlet pipes projecting through the aircraft skin.

(ii) *Voltage Control.*—Since the aero-engine speed and therefore the generator speed varies over a wide range, there would normally be large variations in voltage and charging current. To prevent this a shunt-wound generator with external voltage regulator and current limiter is generally used.

2. Carbon Pile Regulators

In the shunt-wound generator, voltage regulation for both varying speeds and varying loads is effected by the carbon pile regulator.

(i) *Action.*—The carbon pile is a variable resistance connected in series with the shunt field winding. An electro-magnet provides a means of automatically adjusting the resistance of the carbon pile by varying the pressure across its ends.

The voltage coil of the electro-magnet is connected across the generator output, and is adjusted so that at normal cruising speed and no load the electro-magnet will cause the resistance of the pile to be increased, hence reducing the shunt field current and field strength, so that the voltage will be reduced to its normal value.

(ii) *Type C.*—Consists essentially of two carbon pile regulators connected in series with each other and with the generator field winding. Both units are mounted side by side on the same base; they are of the cylindrical type with the carbon pile vertically over the end of the magnet pole. A spring-controlled armature conveys movement to the carbon pile when the magnet strength varies.

Power rating for Type C is 29v, 20–40 amps. for use with 500-watt or 1,000-watt generators, according to the position of the link.

(iii) *Type F.*—Similar in design to Type C but has different windings and different size carbon discs in the regulating pile. Type F 12 is rated at 14·5 volts 60 amps. for use with 750-watt generator; Type F 24 is rated at 29 volts 60 amps. for use with 1,500-watt generator.

3. Types of Installation

In general one of the following installations will be met with in service aircraft:—

(i) One E.D.G. and 24-volt 40 A.H. accumulator.

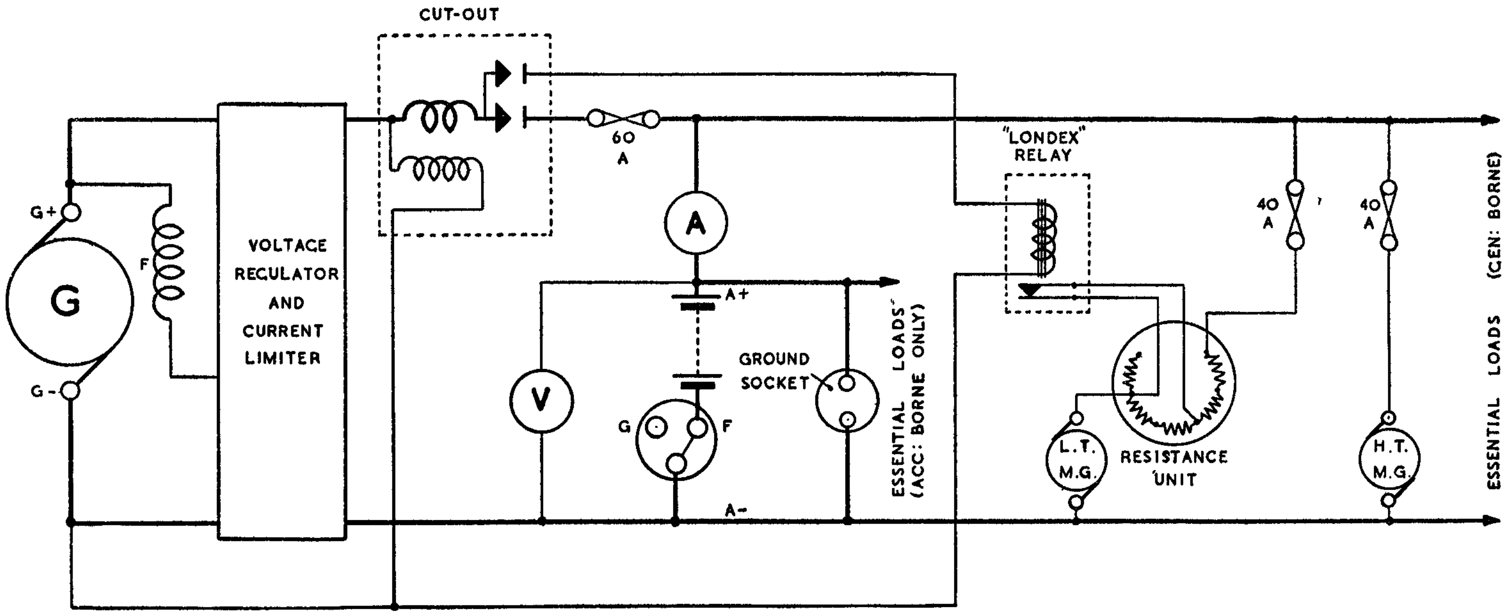

diagram issued with A.L.5

(ii) Two E.D.Gs. and 24-volt 80 A.H. accumulator (Lancaster).
(iii) Three E.D.Gs. and 24-volt 80 or 120 A.H. accumulator (Halifax).
(iv) Four E.D.G.'s and 24-volt 105 A.H. accumulator (Liberator).

4. Supply Circuit

The circuits in the aircraft are fed from the supply through fuses on the distribution panel and are connected to the accumulator and generator in the following manner :—

(i) *Essential Loads* (*Accumulator Borne*).—These are normally supplied by the accumulator and consist of heavily loaded circuits such as engine starting motors, which are connected directly across the accumulator. These circuits can be operated when the generator is stationary ; the current is not shown on the ammeter.

(ii) *Essential Loads* (*Generator Borne*).—These are normally supplied by the generator, when the engine is running at normal speeds. They include internal lighting and similar general service loads which are connected so that they can also be operated when the generator is stationary, when the discharge current is shown on the ammeter.

(iii) *Non-Essential Loads*.—These are connected directly across the generator output and can only be supplied when the generator is operating. They consist of heated clothing, heated windscreens and engine cowl gill motors.

5. Accumulator Cut-out

This automatically connects the generator positive feed to the accumulator positive, when the voltage of the generator is sufficiently high to charge the accumulator. When the generator voltage falls below that of the accumulator the cut-out automatically disconnects it, thus preventing a discharge current flowing through the generator windings.

(i) *Cut-out, Type D*.—There are several types of cut-out, all basically similar in construction, but the Type D is a typical one to be noted by wireless tradesmen. It carries an extra pair of contacts, marked W/T, which close just before the main contacts close. The purpose of these is to operate the " Londex " relay for the Marconi L.T. power unit input circuit.

6. G.P.I. Power Supply

The L.T. supply arrangements to Marconi equipment are briefly described in Section II, Article 1. It is essential that the output voltage of power units, Type 34A (12-volt) and 35A (24-volt) be maintained at constant value for the valve heaters. Since the load is fixed this means that the input voltage to the power unit must be kept at a steady value.

The " off charge " voltage from the aircraft supply will be 24 volts and the " on charge " voltage approximately 29 volts ; a voltage drop is obtained by inserting a series resistance in the supply circuit to the power unit when the E.D.G. is charging the aircraft accumulator. This resistance is switched in and out of circuit automatically by means of the Londex relay, Type 219 or 220, which is operated by the W/T contacts on the accumulator cut-out.

Note.—All the above points and the ground/flight switch are shown in the diagram, which should be studied carefully in conjunction with the text.

7. Ground/Flight Switch

This has two positions marked GROUND and FLIGHT.

(i) *GROUND*.—When the aircraft is on the ground the switch must be left in this position to disconnect the accumulator negative line from the aircraft circuits. To supply current for ground testing of wireless or electrical equipment or engine starting a ground accumulator is connected by means of a plug with the external supply socket.

(ii) *FLIGHT*.—The switch must be placed in this position after the ground accumulator has been disconnected and before the aircraft becomes airborne. The wireless and electrical services are supplied in the normal manner by the aircraft generator and accumulator.

8. **External Supply Socket**

This socket is used for the insertion of the ground accumulator plug. When the cover is rotated to insert the plug an internal switch isolates the aircraft accumulator and the installation is supplied from the ground accumulator. When used in conjunction with the ground/flight switch, as shown in the diagram, the internal isolating switch is inoperative.

After removing the ground plug, always ensure that the socket cover has rotated fully allowing the switch to close.

AIRCRAFT CABLES AND WIRING COLOUR CODE

1. L.T. Cables

Distribution of the electrical supply to the equipment in an aircraft is by means of cables which fulfil in the most efficient manner, with due regard to weight, the particular needs of each service. These cables are made up of one or more cores, insulated from each other, and bound together and protected in various ways from chemical damage, and from wear and tear.

(i) *Cores.*—The conductor usually consists of a number of strands of tinned annealed copper wire twisted together and covered with rubber; the insulated conductor is called the core of the cable. A single or uni-core cable has one of these cores; when more than one core is present it is called a multi-core cable and has a prefix in its name to indicate the number of cores, e.g., duo = two, tri = three, quadra = four, etc.

(ii) *Covering.*—The nature of the covering which binds the cores of a cable together is usually indicated by the second part of the name, e.g., -flex, -cel, etc.

Owing to the need for rubber economy and recent developments many cables will now be found with polyvinyl chloride insulation and " vin " or " P.V.C." in the name to indicate this, thus we have " uni-flex ", " du-cel " or " tri-vin ", etc., as the full name of the cable.

(iii) *Rating.*—A numeral following the name of a cable indicates the normal current rating of the core in amperes, e.g., " Uniflex 4 " will carry 4 amps, " Dusheath 19 " will carry 19 amps. The current rating of cables is based on a certain permissible voltage drop per stated length of cable with the rated current flowing.

Size 4 to 19	0·1 volt allowed.	per 1 yard.
,, 37		per 1·5 yards.
,, 64		per 2·5 yards.

(iv) *Colours.*—In older aircraft wiring systems each aircraft service has a separate colour; those affecting wireless personnel are:—

(*a*) W/T .. .. Red.
(*b*) I/C .. .. Green.
(*c*) General supply .. .. Yellow.
(*d*) Ignition .. .. Blue.

In modern aircraft, however, cables may not be identified by colours as various systems are in use where multi-core conduits terminate in special connectors. Identification is carried out by referring to a key and/or numbering.

Details of these systems are given at para. 4 below.

2. H.T. Cables

These are essentially similar to L.T. cables except that usually the cores are thinner and the insulation heavier to carry low currents at high voltages.

Cables used for aerial leads to transmitters are arranged to be as short and rigid as possible. They must be kept from earthed metal, particularly sharp edges, by a clearance of at least two inches if possible.

3. Wiring Systems

The wiring system in most modern aircraft consists of cables run in conduits with junction boxes and panels at positions where wires branch off for distribution to the various services. The installation is made up in units on a bench and can be assembled and tested before installation. After installation any faulty section of the wiring can be easily removed and replaced. A system of coding is used which simplifies circuit tracing.

4. Systems in Use

(i) ***Breeze System.***—This is the system most usually found, and is used, for example, in the Halifax, Lancaster and Stirling. The harness consists of flexible conduits (Polyvinyl, or metal braided where screening is necessary) terminating in multi-sockets which are held in position by knurled locking rings.

(ii) *G.E.C. System.*—Used in aircraft manufactured by Vickers-Armstrong Ltd., such as Wellington and Warwick. The wiring harness consists of multi-cores called looms run in the fuselage of the aircraft; panels are fitted at positions where wires branch for distribution.

(iii) *Lucas System.*—A typical installation of this type is used on the Beaufighter. Consists of separate cables assembled together and carried in a flexible tubing of synthetic material (polyvinyl chloride).

All conduits, individual cables and terminals are clearly marked for identification purposes.

5. Bonding and Screening

(i) *Bonding.*—During flight a static electrical charge is liable to be induced in the metallic parts of the aircraft. Any intermittent contact between metallic parts which are at different potentials sets up sparking, causing radio interference and risk of fire. To prevent this a bonding system is incorporated in the aircraft during construction.

The bonding connections ensure that all metal components of the aircraft are in good electrical contact and are at a uniform potential. In addition the system increases radio efficiency by providing a large constant capacity earth.

(ii) *Screening.*—Most W/T circuits are screened to prevent radiation and pick-up of interference, and to reduce the effect of stray capacitance and inductance sometimes troublesome at high frequencies.

Screened cable MUST be properly bonded at frequent intervals of 18 inches or less, particularly at the ends and across terminal blocks.

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AIRCRAFT FUSES

In the positive supply lead of every electrical circuit in aircraft there is a special type of explosion-proof fuse. It consists of a glass tube sealed with brass caps at each end, the wire being run through the tube and soldered to the end caps.

The standard ratings are : 5, 10, 20, 25, 40 and 45 amps.

100 per cent. spares should always be carried, the spares being accommodated in the covers of the fuse boxes.

AIRCRAFT AERIALS

1. As a special rule, trailing aerials are used on medium frequencies and fixed aerials for high frequencies. Stainless steel aerial wire is used throughout, and no soldered joints are permitted.

2. Fixed aerials are of various types, " T ", " Inverted L ", " Y " and " broad arrow ", the latter only being used on slow types of aircraft.

Two fixed aerials are usually carried, one for use with G.P. installation and the other for use with the TR.9.

3. The standard trailing aerial consists of 250 feet of wire attached to a winch, the free end terminating in the aerial weight, which consists of a series of lead beads on a piece of flexible steel cable.

The winch is controlled by a three-position lever, marked " Ratchet ", " Free " and " Brake ". The " Brake " position should never be used, and the " Free " position is only used when reeling out. The aerial *must* be reeled by hand and not allowed to run free.

4. A loop aerial is usually provided to enable bearings to be taken.

5. All metal parts of the aircraft are electrically connected together by bonding, to ensure that all parts of the aircraft are at the same potential, thus avoiding any risk of fire due to sparking, and also to provide a counterpoise earth for W/T equipment.

ACTION TO BE TAKEN IN CASE OF ELECTRICAL STORMS

When an aircraft is approaching an area of electrical disturbances, an increase in the strength and number of atmospherics will usually be noticed. This fact should be reported to the pilot, who will decide whether conditions are dangerous.

If it is not possible to avoid a danger area, aerials should be earthed; the trailing aerial being first *earthed*, and then wound in.

SECTION IV

Article 5

ACTION TO BE TAKEN IN CASE OF ELECTRICAL STORMS

1. When an aircraft is approaching an area of electrical disturbances, an increase in the strength and quantity of " atmospherics " will be heard in the telephones. This fact should be reported to the pilot who will decide, by observation of external conditions, whether or not a dangerous area is being approached.

2. If it is not possible to avoid such areas, all aerials should be earthed, and the trailing aerial reeled in *after* it has been earthed.

3. If a dangerous area is entered with very little warning, the aerials should simply be earthed, and the trailing aerial not reeled in. The aircraft should then be flown back on its course out of the storm, to enable the trailing aerial to be reeled in before proceeding through the storm.

SECTION IV

Article 6

PRECAUTIONS TO BE TAKEN TO AVOID THE RISK OF FIRE

There is always a possibility that an explosive mixture of petrol vapour (and/or hydrogen) and air, may exist in the vicinity of W/T and electrical equipment. The following rules must always be observed :—

(i) Do not make or break circuits by pulling plugs out of sockets, or fuses out of their holders, unless the circuits concerned are first switched off.

(ii) Do not remove valves, coils, or any other plug-in components from equipment connected to an electrical supply, unless that supply is switched off.

(iii) Do not make or break connections to batteries or accumulators, without first seeing that all circuits affected are switched off.

(iv) Do not use cable with a core of stranded wire for battery or accumulator connections unless properly fitted with cable ends.

(v) Do not carry out operational tests on W/T or electrical equipment whilst re-fuelling is taking place.

(vi) Do not expose naked lights in or near aircraft, particularly on the ground.

(vii) Earth all aerials when approaching electrical storms.

(viii) See that all fuses in use are of the correct value.

N.B.—Rubber or sewn leather soled footwear only should be worn when working on aircraft.

SECTION IV

Article 8

FAULTS ON AIRCRAFT ELECTRICAL EQUIPMENT

Generally faults on electrical systems in aircraft fall into two main classes :—

1. **Those which can be easily remedied.**—The most common causes of failure are such things as burning out of lamps, " blowing " of fuses, failure to check the meters on control panel of E.D.G., and failure to operate the generator " ON/OFF ", or charge-regulating switch correctly. Vibration can cause plugs to work out of sockets, and cause either a complete or an intermittent break in a circuit. Magnetic relays and starter switches may occasionally stick, and need a sharp tap to free the contacts. If a fuse blows it does not necessarily mean that the circuit is faulty as the fuse may have become weakened in use, especially in the case of motor and motor-generator circuits. Hence, when a fuse is found to have " blown ", a replacement of the correct value should be fitted without delay and the circuit tested by switching on again. If the circuit is faulty, the new fuse will blow immediately the switch is placed " ON ". A number of spare lamps for cockpit and instrument floodlights, and for gun reflector sights are usually carried and these can be easily fitted during flight.

2. **Those which cannot be remedied during flight.**—The most serious is when the generator supply is affected. Damage to the generator may result in the voltage produced being very low, or alternatively excessively high. Prompt action must be taken to switch " OFF " the E.D.G. and the pilot should then be informed, while the rest of the crew must be warned to economise to the utmost with all their electrical equipment. When there are two or more generators it will usually be possible to use all the electrical equipment, but not all simultaneously, care being taken to see that the remaining generator(s) is not overloaded.

There is also the possibility that individual items of equipment may become unserviceable due to such things as condensers being " punctured ", field windings breaking or burning out, internal soldered joints being fractured, etc., and in these cases there is little that can be done. If a breakdown occurs and it is found impossible to remedy during flight, the pilot should be informed, and full details reported immediately upon landing.

SECTION IV

Article 9

ACCUMULATORS AND CHARGING PROCEDURE

1. It must be realised that the correct charging and maintenance of W/T accumulators is of vital importance and is one of the greatest responsibilities of the wireless operator. The lives of the aircraft crew depends on them. Practically all the information relevant to the charging and maintenance of accumulators is contained in Forms 480 and 480A, which are exhibited in all charging rooms, and the provisions of these forms must be followed exactly.

2. The following types of R.A.F. lead acid accumulators (E.M.F. charged about 2·2 volts per cell) are likely to be used by wireless operators.

(i) Ground use :—

Volts	Capacity Ampere-hours	Case	Remarks
2	90	Glass	Plantè plates.
2	120	Glass	Stationary.
6	80	Moulded	M.T. and W/T ground use.
12	55	Moulded.	M.T. and W/T ground use.
6	180	Moulded	Aero-engine starting.
6	230	Moulded	Aero-engine starting.
2	7	Celluloid	Wavemeter use.

(ii) Air use (all with moulded case) :—

2 volts .. .. 14 ampere-hours
2 volts .. .. 20 ampere-hours
12 volts .. .. 15 ampere-hours
12 volts .. .. 25 ampere-hours
12 volts .. .. 40 ampere-hours.

Note.—All aircraft accumulators are fitted with an unspillable vent, but this is only effective when the acid level is correct. If the acid level is excessively high " syphoning " may occur.

3. Two types of nickel alkaline accumulators (E.M.F. about 1·25 volts per cell) are likely to be met. The L.T. type usually in metal containers, and the H.T. type or " Milnes Unit ".

The " Milnes Unit " is used to supply H.T. for ground station receivers ; 96 alkaline cells giving 120 volts output. The electrolyte is caustic potash, normal specific gravity 1·190 ; a special switching arrangement is fitted with two positions.

(i) Charge : 24 banks of 4 cells each are switched to " parallel " and can be charged from a 6-volt accumulator.

(ii) Discharge : 96 cells are switched to " series ".

Note (1).—Occasionally an 8-volt accumulator should be used in conjunction with a 1-ohm resistance to give a boosting charge.

Note (2).—Nickel alkaline cells must be kept apart from lead acid cells and in addition different charging accessories and distilled water must be used for each type ; if possible separate charging rooms should be used.

4. In the Service the ampere-hour capacity of an accumulator is stated at the " 10-hour " rate of discharge, i.e. the current is adjusted so that 10 hours are required to discharge the accumulator to 1·8 volts per cell (not 0 volts) ; if the current is then 2 amps. the capacity is $2 \times 10 = 20$ amp. hours, and so on. Full advantage of the ampere-hour capacity of an accumulator is taken only by discharging it at or below the manufacturer's rating, i.e. a 20 A.H. accumulator will not maintain a current of 4 amps. for 5 hours, but for about 4 hours only.

5. All aircraft accumulators must be given a capacity test at least every three months to determine their actual capacity; this must not be less than 60 per cent. of their "rated" capacity, e.g. a 20 A.H. accumulator on test may deliver 2 amperes for a period of only 7 hours, before the voltage reaches 1·8. Then amps. × hours = 14 A.H., i.e. 70 per cent. of its rating. If the capacity is only a little more than 60 per cent., a re-test is necessary before three further months elapse. Accumulators with less than 60 per cent. of the rated capacity must be plainly marked with a yellow band and may not be used in aircraft.

6. The serviceability of aircraft accumulators is essential and they must be carefully examined for:—

(i) Fully charged state.
(ii) Freedom from cracks.
(iii) Correct acid level.
(iv) Cleanliness and terminals greased.
(v) Fitted with unspillable vents.
(vi) At least 60 per cent. of rated capacity.

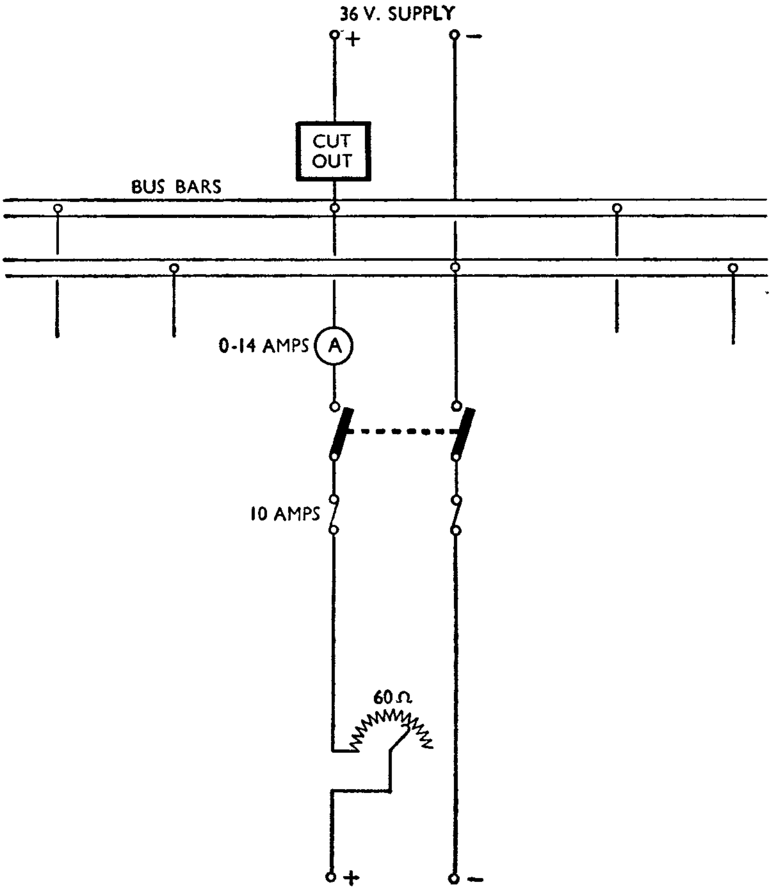

Fig. 19.—Type "B" Charging Board.

7. Fig. 19 shows the circuit diagram of the " Type B " charging board; it is a complete three-circuit charging board with protective devices, designed to operate on a 36-volt D.C. supply. A.C. mains can be employed in conjunction with a step-down transformer and rectifier.

The cut-out is to prevent cells discharging in the event of a supply failure and is really a reverse current switch; the circuit diagram is shown in Fig. 20.

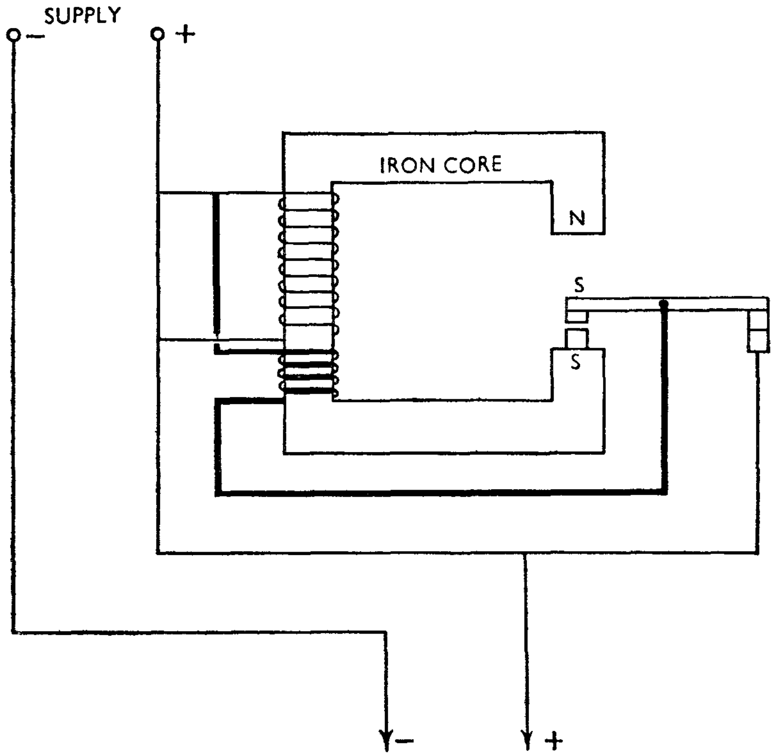

FIG. 20.—REVERSE CURRENT CUT-OUT.

SECTION IV

Article 10

THE ALDIS LAMP

1. **Definitions and Uses.**—A signalling lamp intended for signalling between two aircraft in flight, air and ground, aircraft and surface-craft, and general ground purposes in daylight or darkness.

2. **Power Supplies.**—Generally connected to a 12-volt accumulator, but for training purposes a 6-volt supply can be used successfully in order to cut down brilliancy of light when communicating over short distances.

3. **Range.**—This depends upon many variable conditions, chiefly position of signal points and weather. It can, however, be successfully employed in daylight between points within visual distance.

4. **Operation.**—There are now two types of Aldis lamps in use :—

(i) The old type, which is strongly made, is operated by altering the angle of reflection by a trigger in order to bring the constant light to bear on the receiving station.

(ii) The new type is operated by making and breaking the filament circuit of the lamp. This type is lighter but fragile in construction, so that while having the advantage of being easy to use, it must be handled with care.

5. **Sighting.**—This is the most important part of signalling with an Aldis lamp. Unless the lamp is sighted correctly, the transmission becomes unreadable. This is specially the case when using the old type with moving reflector. The old type is fitted with three means of sighting :—

(i) The open sight.
(ii) The left-hand aperture sight.
(iii) Aeroscope (telescopic sight).

The telescopic sight is, perhaps, the most important and requires practice in its use. In signalling to and from aircraft, the best results are obtained only by this means and particular attention must be paid to accurate alignment. The aircraft or ship to which you are signalling should be kept in the centre square of the telescope the whole time, if your transmission is to be readable. Lamps must be frequently tested for accurate alignment.

The new type of lamp has no telescope : it is fitted only with an aperture sight. In addition, it is not possible to transmit a message at high speed as the light, which is keyed, does not break off sharply enough, owing to the light lag in the filament.

The Aldis lamps have detachable front pieces of different colours : these are white, green and red. The white front is used for all ordinary messages ; the green and red fronts are used in flare paths and for anti-submarine patrol in convoy work. Their meanings are described in later chapters of this article. The signaller should be careful when sighting a lamp on to an aircraft on the aerodrome at night. If the lamp is sighted so that the light falls on to the pilot's face, although the supply is only 12 volts the light is so brilliant that the pilot will become blinded for several minutes. The light, therefore, should not be trained on to the front of the aircraft.

It is also difficult to read signals from an aircraft when the latter is in a position between the sun and the ground station. Another point to remember is that communication with aircraft in flight is only possible when the aircraft is occupying certain positions relative to the line of sight from the station with which it is in communication. Also remember that the signaller in an aircraft has, as a rule, no one to write down the message for him, but must write down the complete message himself.

6. **Communication.**—Since all Aldis P/L messages to and from aircraft must be regarded as of an urgent nature, the need for establishing communication with the least possible delay is essential.

VE must always be used in calling up, unless the identity of the aircraft or ship is in doubt.

It should be noted that the method of using the Call Sign in calling up is slow, because a 3 or 4 letter and figure call sign may have to be sent several times before the reader has recognised his call sign. The call sign method of calling is intended, by repetition back of the call sign, to confirm that the aircraft or ship being called is the one desired. The " Unknown Station " call sign A.A. should be used when doubtful of the identity of aircraft or ship. The " Unknown Station " answers by making his own call sign, thus establishing his identity. In dealing with code messages, the same applies, and when the identity of the aircraft or ship is known the VE can be used to establish communication, since the " call " is contained in the preface to the message.

7. **Procedure.**—(i) *General.*—The following simple examples are quoted for guidance :—

P/L Message		*Code Message*	
Sender	*Reader*	*Sender*	*Reader*
VE VE VE VE	K	VE VE VE VE or	K or
$\overline{\text{AAA}}$ (P/L Sign)	T	F7TD F7TD	F7TD
FROM	T	F7TD V QM3	K
BASE	T	GR4	T
$\overline{\text{AAA}}$	T	$\overline{\text{BT}}$	T
RESUME	T	A5NB	A5NB
EASTERN	T	C -- RU7X	RU7X
PATROL	T	C -- QCA4	QCA4
BT 1335	T	C -- $\overline{\text{BT}}$ 1335	T
$\overline{\text{AR}}$	R	$\overline{\text{AR}}$	R

(*Note.*—The letter " G " used in the preface of a P/L message directs that all which follows is to be repeated back. All code messages are repeated back.)

(ii) *Repetition.*—If repetitions are to be obtained, the letter " part identities " (if for P/L) and " group identities " (if for code) will be used in conjunction with the IMI sign, as for W/T.

(iii) *Special Signs* :—

MR = Move right.
ML = Move left.
MH = Move higher.
MO = Move lower.

(The above are intended for use in order to secure a better background for a signal from a ground station.)

LL = Your light is too powerful—Diminish your light.
OL = Open light (used to ask for a point on which to align the lamp).
NA = Am unable to answer, use " F " method.
SR = Resume normal procedure.
AA = Calling unknown station.
W = Used in succession signifies " Am unable to read you due to bad alignment ".
Q = Used following the short break, in P/L following a word, signifies " repeat back that word ".

8. **Flare Path Signalling.**—Incoming aircraft wishing to land will circle the aerodrome making their own identity letter.

Control challenges with the letter for the day.

Aircraft replies to challenge.

Control gives permission to land by calling with " green light ", the identity letter of the aircraft.

Permission NOT being granted to land is made by calling with " red light ", the identity letter of the aircraft.

The aircraft will continue to circle and again request permission to land. Until permission is granted, a white light is used for all ordinary P/L messages.

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WIRELESS OPERATORS,

RELESS OPERATORS (AIR

AND

NAVIGATORS (W)

SECTION V

FIELD TELEPHONES, TYPE "F", MK. I AND II

1. General Notes. The field telephone is an important link in the R.A.F. Communication System, for single channel communication between points on airfields or, in conjunction with Field Telephone Exchange 10-way, multi-communication from battle headquarters to a number of emergency landing grounds or defended areas.

It may be used with two lines of D.3 or D.8 wire, or under certain circumstances, one of these lines and an "earth return".

(*a*) *General Description.* The instrument consists of a "moulded" case containing the following component parts :—

- (i) Bell.
- (ii) Hand magneto generator.
- (iii) Hand-set.
- (iv) Buzzer (or microphone transformer).
- (v) Batteries and associated circuits.

It fits into a "case transit" complete with webbing carrying strap, and loop for earth rod. Two spring clips hold the instrument into its case. The first one allows it to be drawn forward to the "operating position", i.e. the hand set and H.M.G. operating handle only are visible, the remainder of the instrument being protected (in inclement weather) by the case, while the second stop prevents it falling completely out.

(*b*) *Provides the following facilities* :—

- (i) Call by buzzer (Mk. I only)
- (ii) Call by H.M.G.
- (iii) Responds by bell to H.M.G. call.
- (iv) Responds by aural indication to buzzer calling (Mk. I only).
- (v) Speech communication.

(*c*) *Ranges.*—Two lines D.3, 9 to 10 miles } Overhead lines.
Two lines D.8, 12 to 15 miles }

The use of the earth return system will increase this range if good earth connection is made.

(*d*) *Power supplies.*—Two 1·5-volt dry batteries (Stores Ref. 5J2000) connected in series giving 3 volts.

2. Details of Components.—(*a*) *Hand magneto generator.*—Is rigidly constructed; 185 r.p.m. (by hand), produces 70 volts A.C. at 17 c/s to operate the distant bell.

(*b*) *Buzzer unit* (Mk. I only).—Self-contained unit which can be readily withdrawn exposing circuit contacts. In the Mk. II instrument this is replaced by a similar unit which consists of a simple microphone transformer; hence a call by buzzer cannot be made.

(*c*) *Polarised bell.*—Works from an A.C. supply obtained from the H.M.G.

(*d*) Hand-set consists of self-contained carbon microphone and a telephone receiver, wired to a four-pin plug which is detachable from the instrument.

3. General Servicing.—(*a*) Keep good clean connections at the line terminals.

(*b*) Keep instrument dry and clean.

(*c*) Discharged batteries must not be left in the instrument. Inspect regularly for corrosion.

(*d*) The contacts on the side of the buzzer must be clean and electrically good.

(*e*) The following items will cause a failure in speech or reception :—

(i) " Tel. Mike " plug dirty or not making contact.

(ii) " Cradle Switch " sticking when handset is raised.

(iii) Mk. I press button of buzzer not releasing.

(*f*) Test for serviceability of components :—

(i) Handset—disconnect the line/s, raise handset and blow across the " mike " ; a " breathing sound " should be heard ; press cradle switch ; definite " click " should be heard as " breathing sound " is " cut off ".

(ii) Buzzer—press stud ; " buzz " should be heard.

(iii) Bell—connect to another instrument and carry out " call procedure " ; bell should ring.

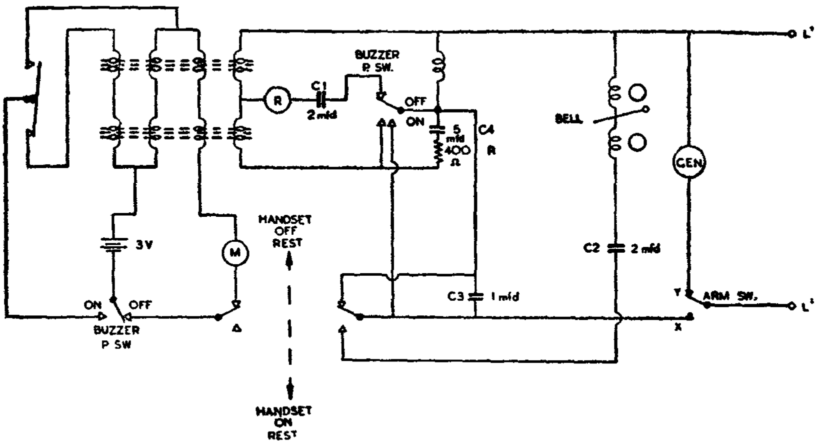

FIG. 21—FIELD TELEPHONE TYPE F.

Note.—A circuit diagram will also be found in the lid of the instrument.

FIELD TELEPHONE EXCHANGE (CORDED), 10-WAY

1. **Requirements.**—(*a*) A portable telephone exchange for emergency or local use.

(*b*) *Range.*—Approximately 15 miles radius.

(*c*) *Facilities.*—(i) Communication over any of the ten pairs of lines.

(ii) Any two or all the lines (bunching) may be connected.

(iii) Call any line by generator or buzzer.

(iv) Visual and aural indication from any line calling.

2. **General Description.**—(*a*) Housed in metal container, divided into two compartments—one containing the switchboard, consisting of two rows of ten jacks, the top row marked "A" and lower one " B ", a four-pin socket marked " M.R.R.M." for operators headset; second containing the line connections and stowage for night bell when not in use.

(*b*) Each line is fitted with numbered indicator and switching arrangement is made for calling by hand magneto generator (fitted on the right-hand side of switchboard panel).

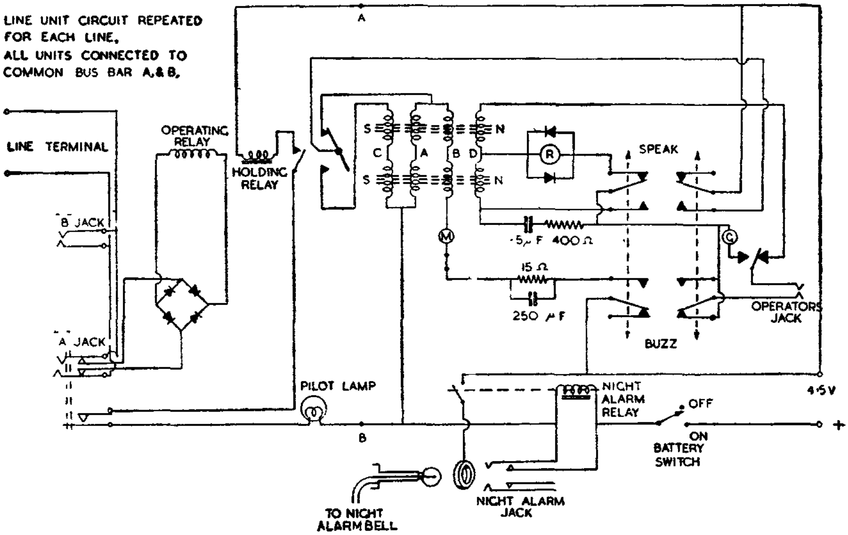

FIG. 22—CORDED TELEPHONE EXCHANGE.

3. **Operation of Switchboard.**—(*a*) *General.*—(i) Insert " O " plug in the "A" jack of the calling number ; put the " speak buzz " switch to " speak " ; enquire required number.

(ii) Transfer the " O " plug to the "A" jack of the number required, then call by generator or buzzer. (Night alarm bell must be disconnected before making buzzer calls.)

(iii) When communication is established, insert the free plug of the number called into the "A" jack of the calling number.

(iv) Immediately conversation has terminated, remove all plugs and return to " rest " position.

N.B.—There is no indication that conversation has ceased unless the extensions " ring off ", causing the light in the indicator to glow.

(*b*) *Bunching Lines.*—Connecting all, or a number of lines, together :—

(i) Join " B " jack of line 1 to "A" jack of line " 2 ".

(ii) Join " B " jack of line 2 to "A" jack of line 3 (and so on).

4. **Serviceability Tests.**—(i) Remove the plug from " O " jack.

(ii) Insert the free plug of each line unit for test into " O " jack.

(iii) Rotate the generator handle slowly; if the equipment is serviceable the indicating lamp should light and the bell ring.

(iv) Clear by inserting any free plug into the "A" jack of the line unit tested.

(v) When the test has been carried out, insert the inner plug on the left-hand side of the board into the " O " jack. The plug at the other end of this card is known as the operator's plug " O ".

FIELD TELEPHONE EXCHANGE (CORDLESS), 10-WAY

1. **Requirements.**—(*a*) and (*b*) as for corded type.

(*c*) *Facilities.*—(i) Communication over any of the ten pairs of lines.
(ii) Any two or all the lines (bunching) may be connected together.
(iii) Call any line by generator only.
(iv) Visual and aural indication from any line calling.

2. **General Description.**—Housed in wooden container, divided into two compartments (front and rear) :—

(*a*) The front panel containing—
  (i) the switchboard consisting of the indicating shutters, the black and white keys, and a battery switch ;
  (ii) connection is made to the board from the various extensions by two rows of ten brass screws, situated at the top of the panel.

(*b*) Rear panel—houses the circuit connections, bell, generator, batteries and microphone transformer.

3. **Operation of Switchboard.**—When a call is received the shutter of the "calling" line drops and the bell rings. The operator should then :—

(i) Replace shutter to disconnect the bell.
(ii) Raise calling lines black key to "speak", ascertain required number.
(iii) Return callers black key to centre position.
(iv) Depress the black key of the "called" line to "ring" and turn the generator.
(v) When "called" subscriber answers, ask him to "hold", and return his key to centre position.
(vi) To interconnect the two subscribers, raise or depress the appropriate white keys in either, but not both rows. Example :—
No. 1 line may be connected to No. 2 line by—
(*a*) Raising or depressing Nos. 1 and 2 white keys of the top row, or
(*b*) Raising or depressing Nos. 1 and 2 white keys of the bottom row.

This allows 4 pairs of lines to be interconnected at any one time, leaving two lines without this facility. These two lines may be connected in an emergency by raising their black keys to the "Speak" position ; but it should be noted that this leaves the operator on the line.

4. **General.**—(*a*) Each extension must "ring off", thereby dropping the shutter, indicating to the operator that the conversation has finished.

(*b*) It is of the utmost importance that a hand-set incorporating a "press" switch is used at all times by the operator, or the batteries will be discharged through the microphone continuously, even when the battery "ON—OFF" switch is "OFF".

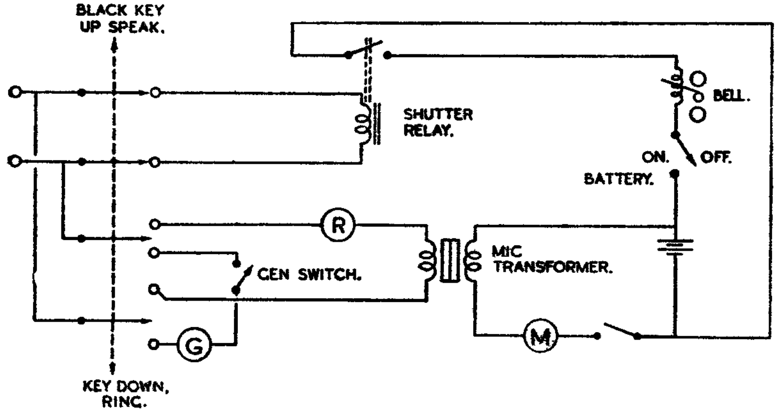

FIG. 23—CORDLESS TELEPHONE EXCHANGE.

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PETROL-ELECTRIC GENERATING SETS

1. Requirements

Petrol-electric sets are used as a portable source of low-tension supply for charging accumulators where mains supply is not available.

2. Types

The following types of Petrol-Electric Sets are in use in the R.A.F. for L.T. Supply :—

TYPE	DESCRIPTION
Lyon-Alco 360 watt.	Single cylinder air cooled $\frac{5}{8}$ h.p. engine, directly coupled to 18v—20 AMP generator. Runs for 9 to 10 hours per gallon of petrol.
J.A.P. 388 watt.	Single cylinder air cooled 1 h.p. engine, directly coupled to 14/32v—9 AMP generator. Runs for 9 to 10 hours per gallon of petrol.
Chore-Horse 352 watt.	Single cylinder air cooled $\frac{5}{8}$ h.p. engine, directly coupled to 14/32v—11 AMP generator. Runs for 9 to 10 hours per gallon of petrol.
Lyon-Norman 750 watt.	Twin cylinder air cooled $2\frac{3}{4}$ h.p. engine directly coupled to 35v—22 AMP generator. Runs for 5 to 6 hours per gallon of petrol.
Lyon-Norman 1260 watt.	Twin cylinder air cooled $2\frac{3}{4}$ h.p. engine directly coupled to 35v—36 AMP generator. Runs for 4 to 5 hours per gallon of petrol.

Makers' Instruction Manuals are provided with each set and instructions laid down must be carefully complied with.

3. The Engine

(i) *Governor*—Each engine is fitted with adjustable speed governor, the function of which is to keep engine revs. constant at all loads. Will keep engine speed constant within ± 5% when correctly adjusted.

(ii) *Lubrication*, on Lyon-Alco, J.A.P. and Chore-Horse engines is effected by the "splash" system. A "dipper" or lug on the big end of the connecting rod splashes the oil up from the crankcase bottom and it is therefore important to maintain oil at correct level in crankcase.
In Lyon-Norman engine oil pressure system is used, oil being pumped from the sump by a rotary pump driven by the engine. Minimum pressure at which engine can be safely run indicated by red mark on oil pressure gauge.
Oil in any engine must be changed at intervals. (See makers' instructions—usually after 50 hrs. running.)

(iii) *Ignition*—The magneto timing of all these small sets is fixed. The gap between the contact breaker points should be .012 inches. The points should be kept free of oil and grease and the contact surfaces may be polished, when necessary, with a very fine emery cloth.

(iv) *Carburettor*—The carburettor of the Lyon-Alco, J.A.P. and Chore-Horse engines is of the fixed jet type and cannot be adjusted. The Lyon-Norman sets are fitted with Solex carburettors which have an adjustable main jet and compensating jet for starting. All the carburettors are fitted with an air choke to provide a stronger mixture and facilitate starting when the engine is cold.

Carburettors should be cleaned out periodically, care being taken not to enlarge the small holes in the jets by poking wire, etc., into them.

(v) *Starting*—See that there is petrol in the tank and turn the petrol tap on. Check the air choke, keep the earthing button on the magneto pressed, and turn the engine over two or three times. Release the earthing button and turn the engine over sharply. When the engine starts, release the air choke and adjust the governor if necessary.

4. The Generator

The generator is usually a two-pole, shunt machine. Examine it periodically for sparking at the brushes. Sparking will blacken and pit the surface of the commutator.

Keep the commutator and brushes free from oil and grease. Use very fine glass paper *not emery cloth*, for cleaning the commutator. See that the brushes are free in their holders. When new brushes are needed, bed them in by inserting a strip of glass paper under each brush, smooth surface against the commutator. Then turn the armature backwards and forwards until the glass paper has worn the brush to the correct curvature, then wipe all trace of abrasive off.

The bearings of the generator are packed with grease and, under normal conditions, should only require attention approximately every six months. The bearings should, however, be examined during every running period to ascertain whether they are running hot.

5. The Switchboard

The switchboard is fitted with an ammeter, fuse, terminals for the accumulator connections, a field regulating resistance to vary the charging current, and a battery cut-out which automatically disconnects the accumulator should the engine stop running.

Always ensure that the regulating resistance is in the "all in" position (i.e. minimum charging current) before connecting the accumulators.

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