A.1134 AMPLIFIER

General Description

The instrument incorporates two audio-frequency stages consisting of a Class A voltage amplifier, in which a triode valve V_1 is employed, and a Class B ("quiescent push-pull") power amplifier with a twin-pentode valve V_2. The electromagnetic microphones are connected in parallel to the primary winding of a microphone transformer T_1. Two resistances R_1 and R_2 are connected, in series, across the primary winding of T_1, the junction of the resistances being earthed. This arrangement equalizes the potentials of the respective input terminals with respect to earth and thereby assists in the elimination of the undesirable A/F oscillations which would otherwise arise. The output voltage of the microphone transformer T_1 is applied to the grid of the valve V_1 via a condenser C_1. The grid of V_1 is biased negatively through a resistance R_3. The values of the condenser C_1 and of the resistance R_3 are so chosen that, together, they constitute a fixed low note attenuation circuit which comes into operation at a frequency of 500 cycles per second and so improves the signal-noise ratio.

The anode load impedance of V_1 consists of a transformer T_2 with a split secondary winding. The lead from the anode of V_1 to the output primary of T_2 is screened, the screening being earthed. The centre-tapped secondary of the transformer supplies excitation of the two grids of the twin-pentode V_2 according to the practice known as quiescent push-pull. The value of the grid bias is increased to approximately cut-off point, thus reducing the current drain upon the H.T. battery, the standing anode current remaining at almost zero until the arrival of a signal. Grid bias is applied to the mid-point of the secondary winding of T_2 via a resistance R_4 which serves as a decoupling resistance and prevents feed-back to the grid circuit of the triode V_1 by means of the common grid-bias battery.

The input terminal of the secondary winding of T_2 is connected to one control grid of the twin-pentode V_2. A connexion is made through the fixed capacitance of a condenser C_2 to the appropriate anode of V_2. A similar arrangement obtains between the lead from the output secondary terminal of T_2 and the second control grid of V_2. The significance of the two condensers C_2 and C_3 in the control grid-anode circuits will be discussed later. Leads from the anodes of V_2 are taken

to the output and the input terminals of the primary winding of a transformer T_3. The auxiliary grids of the twin-pentode V_2 are connected direct to the H.T. positive feed line and to the mid-point of the primary winding of the transformer T_3.

The transformer T_3 has three secondary windings "a", "b", and "c". Winding "a" actuates the telephone receivers of the crew other than those of the W/T operators, and is utilized to effect modulation of the transmitter T.R.9F. Winding "b" is not at present used. Modulation of the transmitter T.1154 is effected via the input terminal and the tapping point of winding "c". The isolation of the three secondary windings of T_3 enables one side of these to be maintained at earth potential. When the amplifier is used with the general purpose installations certain slight modifications are necessary to adjust the amplifier output to provide a suitable level of modulation for the transmitters concerned. An additional transformer T_4, having a transformation ratio of one to one, is provided to actuate the W/T operator's telephones.

In order to effect a reduction in the three possible kinds of distortion, harmonic, frequency and phase, with consequent loss of fidelity, provision is made in the circuit of the A.1134 to provide inverse or degenerative feed-back. In A/F practice this is often referred to as "negative feed-back", and consists of taking a proportion of the voltage from the putput circuit and feeding it back into the input circuit 180° out of phase. The overall gain of the amplifier, particularly at the higher audio frequencies, is reduced, but the benefits outweigh this loss of amplification.

The first channel of feed-back is that from the OS terminal of the winding "a" of the transformer T_3 through a resistance R_{10} to the IS terminal of T_1. The resistance R_{10}, in conjunction with a resistance R_{11}, forms in effect a potentiometer, and the tapping point, or junction of R_{10} and R_{11} determines the proportion of the output voltage from winding "a" re-introduced into the grid circuit of V_1. Having regard to the values of R_{10} and R_{11} the proportion of this reverse feed-back is approximately one-quarter per cent.

The second method of re-introducing a proportion of the output impulses into the circuit utilizes only the twin-pentode stage of V_2. A fraction of the voltage developed across each half of the primary winding of the transformer T_3

is applied to each of the control grids of the valve V_2 by means of fixed condensers C_2 and C_3. Their capacitance is so chosen that negligible feed-back exists at frequencies below 2,500 cycles per second but above this, the gain of the twin-pentode falls off rapidly. In the absence of the condensers C_2 and C_3 the frequency response of the amplifier would occupy a wider band of the audible spectrum, continuing up to the region of 6,000 cycles per second. The condensers limit the band to approximately that of the electro-magnetic microphones type 19 or type 21. The effect of this cut-off is to render the amplifier more stable and it reduces the tendency to self-oscillation caused by stray capacitance between the output and the input circuits. The use of unscreened plugs and sockets in certain portions of the aeroplane installation precludes the complete elimination of this stray capacitance, the microphone leads are balanced to earth in order to assist in this respect.

A resistance R_{12} is connected across the output winding "a" of T_3. Thus, in the absence of telephones this output stage is never entirely unloaded. This resistance also reduces the variation of the load impedance with the frequency of the telephone receivers. It has a negligible effect upon the output when the amplifier is fully loaded. This winding "a" provides for the actuation of six pairs of telephones in parallel.

When the amplifier is used as a sub-modulator of the transmitter-receiver T.R.9F, the output from the winding "a" of T_3 is applied via a step-down transformer in the T.R.9F to the control grid-filament circuit of the modulator valve. The diagrams in this illustration also incorporate the circuital changes effected by the positioning of the key switch of the A.1134 in the A,B and C positions when used with the T.R.9F or the general purpose installations.

When the amplifier is used with the T.R.9F a resistance R_5 is connected direct across the output terminals of the receiver R.1139. The resistance R_5 is in parallel with the series resistances R_6 and R_{11}. A condenser C_4 is in parallel with R_6. The junction of R_6 and R_{11} is joined to the IS terminal of the microphone transformer T_1. Thus, a fraction of the A/F voltage across R_5, as determined by the potentiometer constituted by R_6 and R_{11}, is fed into the grid circuit of the valve V_1. This fraction is so chosen that, after its amplification by V_1 and V_2, the A/F voltage available across the winding "a" of T_3 is approximately equal to the original

input A/F voltage across R_5.

The condenser C_4 is introduced into the circuit to afford a compensation capacitance. The input capacitance of the valve V_1 and the capacitance-to-earth of the transformer T_1 constitute a high note attenuation circuit which is rendered less serious by the capacitance of C_4.

Irrespective of the position of the key switch, when the A.1134 is used with the pilot-operated T.R.9F, inter-communication and R/T are at all times available to members of the aeroplane crew other than the W/T operator.

With the three-position key switch in the central B position the primary of the transmitter microphone transformer is short-circuited. The primary winding of the W/T operator's telephone transformer T_4 is now connected between the high potential output terminal of the receiver and the high potential end of the amplifier output winding "a" of T_3. The W/T operator therefore receives signals from both the amplifier and the receiver. The impedance of the winding "a" is very low in comparison with that of the primary winding of the transformer T_4 and the voltage developed across the telephones of the aeroplane crew is negligible. If the receiver is switched OFF the W/T operator still receives I/C signals, since the circuit of T_4 is connected via a resistance R_9.

When the key switch is in the A position the facilities of the aeroplane crew remain. The W/T operator's microphone is now disconnected and his telephone transformer is fed from the receiver only. He is accordingly restricted to W/T operation with the main transmitter. He is also isolated from the remainder of the crew and the aeroplane call light system must be used to attract his attention when he is required on the I/C circuit.

When the key switch is in the C position the W/T operator's microphone is connected in parallel with the remainder of the I/C line. The primary winding of T_4 is now parallel with the telephones of the crew. In effect, therefore, all telephones are in parallel across the winding "a" of T_3 and also across the resistance R_9. The modulating winding "c" of T_3 is connected to the microphone transformer of the transmitter, the resistance R_8 being in parallel with a portion of the winding. This resistance is necessitated by the requirements of the transmitter T.1154. With the key switch in the

C position, the output of the receiver is fed into the amplifier as described for the receiver portion of T.R.9F. In this instance, however, the resistance R_7 and the capacitance of C_5 replace R_6, and R_4. The resistance R_9 becomes the standard load on the receiver, corresponding in this function to R_5.

The modulation of the transmitter T.1154 is effected by a portion of the winding "c" of T_3. Position A of the key switch does not change the modulating connexions but isolates the W/T operator from the I/C line. In the C position of the key switch the modulating winding "c" of T_3 is connected to the microphone transformer of the transmitter, and the earthing of the I/C line via the resistance R_8 preserves the normal loading of the circuit. Facilities are then the same as when the key switch is positioned at B, but R/T is available both to the crew and the W/T operator.

On the ten-point plug of the amplifier provision is also made for a warning lamp circuit operated from the amplifier L.T. battery. Should the necessity for this circuit arise, it consists of a warning lamp and push switches, in series, between the positive and negative terminals of the 2-volt battery. The circuit is broken at the key switch and is only operative when the key is in the A position. Normally the push switches are ON and the warning lamp glows. The occupant of any position on the I/C line may thus attract the attention of the W/T operator by repeatedly pressing the push switch and so flashing the warning lamp.

Valves and Batteries

The amplifier is battery-operated, employing 2 volts L.T., 120 volts H.T. and 6 volts grid bias. A 2-volt 20 Ah accumulator, type B, is used for L.T. supply and a 120-volt dry battery or accumulator for H.T. supply. The transmitter batteries must not be used. The grid-bias 6-volt dry battery is fitted inside the amplifier. The valves used are a triode, as first amplifier, V.R.21, and a twin-pentode, V.R.35.

Operation

The various combinations of communication between the W/T operator and the remainder of the aeroplane crew are

governed by the three-position key switch. The facilities given are detailed in the following table:-

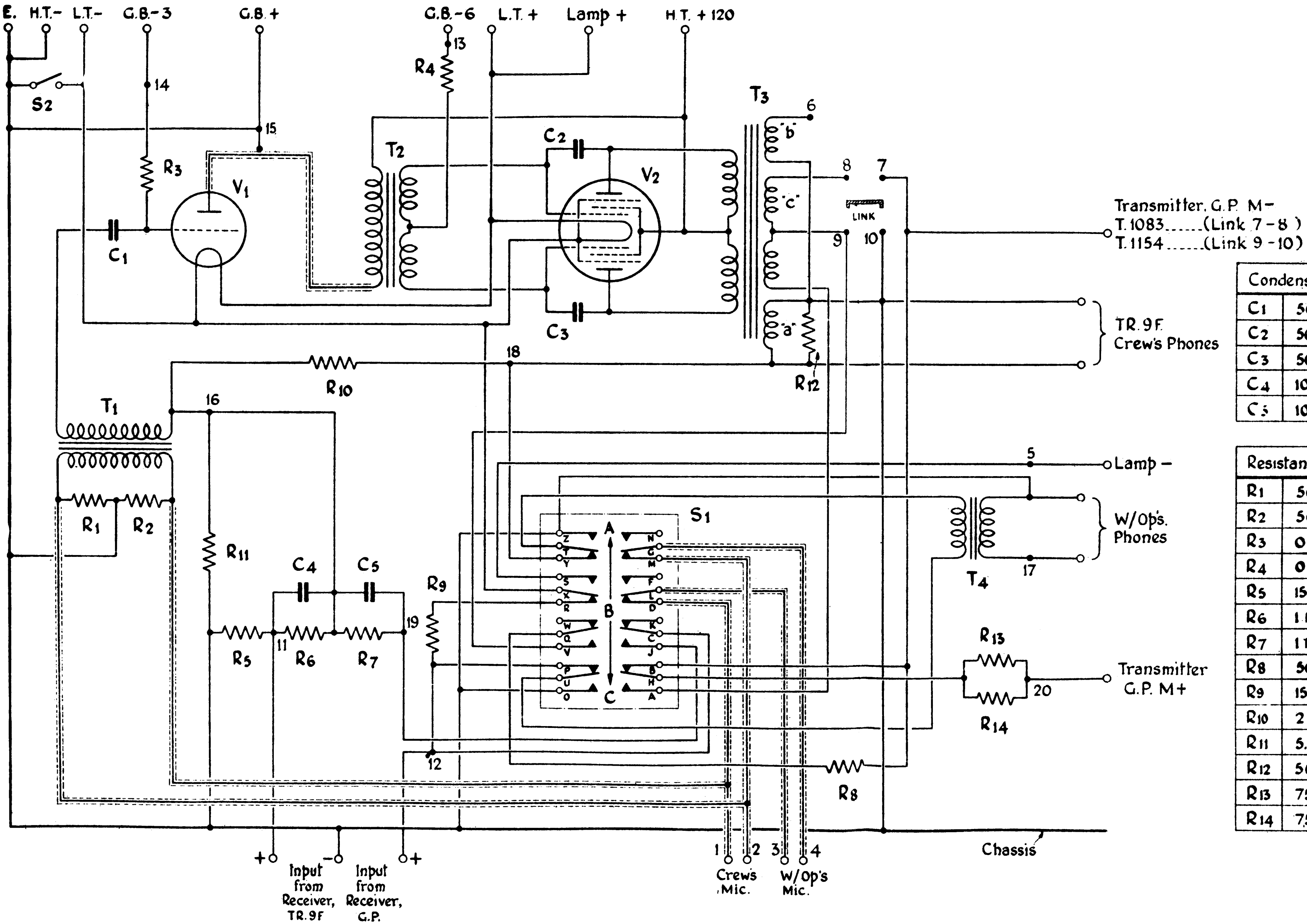
Key-switch Position	Operator			Crew		
	G.P.	T.R.	I/C	G.P.	T.R.	I/C
A	W/T	-	-	-	R/T	I/C
B	W/T	R/T	I/C	-	R/T	I/C
C	W/T R/T	R/T	I/C	R/T	R/T	I/C

When the key-switch is in position A the operator is isolated from the rest of the crew and his attention may be called by the aeroplane call-lamp system. The A.1134 should normally be used with the key-switch in the B position and locked in that position by the locking strip.

The A.1134 requires its own battery supplies. It should be switched ON during the entire time the aeroplane is in flight. A slight "chirp" will be heard when the amplifier is switched ON or OFF but this is a transient effect due to the warming up of the valve filaments and is quite normal. Care must be taken to switch OFF before leaving the aeroplane.

If instability occurs as shown by a loud howl or abnormal H.T. current and apparent loss of gain (that is, greater than 10mA with no speech input whilst varying the position of the key-switch) check that the screen of the wiring is bonded throughout. Check that all earth connexions are properly made. Check the batteries, for low voltages may bring about instability. When the key-switch is in the B position the general purpose transmitters and their associated receivers must never be switched on together or a persistent howl will ensue. The transmitter must be switched off before switching on the receiver or vice-versa.

C_1 C_4 C_5 C_2 C_3	Condensers
R_1 R_2 R_3 R_{11} R_5 R_6 R_{10} R_7 R_4 R_9 R_{12} R_8 R_{13} R_{14}	Resistances
S_2 T_1 V_1 T_2 V_2 S_1 T_3 T_4	Miscellaneous



Condensers	
C_1	500 μμF
C_2	50 μμF
C_3	50 μμF
C_4	100 μμF
C_5	100 μμF

Resistances	
R_1	500 Ω
R_2	500 Ω
R_3	0·5 MΩ
R_4	0·15 MΩ
R_5	15,000 Ω
R_6	1 MΩ
R_7	1 MΩ
R_8	50 Ω
R_9	15,000 Ω
R_{10}	2 MΩ
R_{11}	5,000 Ω
R_{12}	50,000 Ω
R_{13}	75 Ω
R_{14}	75 Ω

AMPLIFIER A.1134. THEORETICAL CIRCUIT DIAGRAM