No. 1 WIRELESS SCHOOL
AR2 RECEIVER

D. GREGORY
36 A.
R.320.

AT 6
AR 7

GENERAL: Receiver is for General Purpose Reception in aircraft, and normally operates from a 12v aircraft battery. It adapts itself for 24v operation, and is then termed an AR7 Receiver. Frequency range is 140 k.c. to 400 k.c. and 480 k.c. to 21,000 k.c. in five ranges, selected by band change switch.

FACILITIES: Three types of reception are provided, RT, MCW and CW, with facilities for Direction Finding. Intercommunication (I/C) in the aircraft is available through the I/C switching unit, and full sidetone facilities are avilable when used with Transmitter ATI. Remote control is incorporated, whereby control of Frequency, Mode of Operation, RF Gain, ON-OFF Switching and DF Loop are transferred to the Pilot's position.

CONTROLS: All functional controls are on the front panel which also has the HT fuse in upper left corner, cable wall mounting plug at lower right, antenna terminal, and a frequency tuning drive unit, linked mechanically to the remote head.

ELECTRICAL CIRCUITS

GENERAL: Receiver is a 6-tube superheterodyne with bfo for CW and a seventh tube built in as an amplifier for the I/C system. All antenna, r.f. and oscillator coils mount with the wave switch in a turret assembly which is fixed on the receiver chassis proper.

ANTENNA SECTION: The aircraft antenna connects to the primary of the antenna transformers through switch sections SI and S2. S2 selects proper coil for each range, while SI is part of the Mode of operation switch, which on first three positions (RT, MCW, CW) connects the antenna directly to the antenna transformers through S2. These transformers are conventional, except for the tertiary windings on No. 1 and No. 2 bands, which are described later in connection with Direction Finding.

Condensers CII-12-13 from primary to secondary increase the antenna coil gain at the high end of the band, keeping the gain uniform. Section of S4 shorts out unused secondaries, preventing dead-end resonances, the unused primaries not being shorted as they do not show this effect. Antenna primaries are untuned, the secondaries tuned by a section of the gang condenser. Temperature compensating condensers are used throughout the rf section to stabilize the frequency through wide temperature changes, and in the antenna circuit these are C6-7-8. S4 connects the secondaries through C19 to the grid of first rf tube, C19, preventing low-resistance coil windings from shorting AVC voltage to ground. When used with ATI, the antenna post connects to the aircraft antenna through the keying relay, and shorts to the ground when

the transmitter is on the air, preventing overloading and possible damage to the antenna transformer.

RF AMPLIFIER STAGE: This tube is a 6SK7, remote cut-off pentode, with AVC applied through decoupling resistor R1, the Cathode bias resister R2 connects to ground through R13, which is the RF gain control, varying bias on the grid and consequently the gain of the stage. A Wave Trap is incorporated in this circuit, preventing signal voltages at or near the IF from building up in the RF amplifier. It is a simple parallel resonant circuit, tuned by means of an adjustable iron core, acting as a rejector circuit to the undesired frequency. Screen current feeds through R3, with C3 as a by-pass, and plate current is fed through R4, with C37 as a plate filter.

The proper RF primaries and secondaries are selected by S7 and S8, with the primary and secondary of the unused sections shorted when not in use. Temperature compensating condensers are C30-34 inclusive and No. 3 band has C35 to improve gain at the hf end. No. 5 band has only a single winding, with plate current fed through L4 and C23 used as coupling and as a blocking condenser. This arrangement gives maximum possible gain, with but small sacrifice in selectivity.

RF OSCILLATOR CIRCUIT: This tube is a 6K8 Triode-Hexode with the triode section as a plate-tuned feed-back oscillator, the tube and circuit being chosen for their frequency stability. Coils are selected with S5 and S6 which shorts out the unused coils except T6, which is not shorted, due to pronounced resonance effect when this is done. Plate coils are tuned by the oscillator section of the gang condenser, and C79-83 are temperature compensators, paralleling the air trimmers. On No. 1 band, the oscillator transformer has no grid winding. R9 prevents overexcitation at the high frequency end of the range, and C41 couples to the oscillator grid. R8 is an osc, grid leak and R11 isolates RF currents from C70. The 6K8 is under AVC through decoupling resistor R5, with C38 preventing short-circuiting of the control voltage, and cathode resistor R7, connects to R13.

IF AMPLIFIER: The 6K8 output couples directly to T17 whose primary and secondary are individually tuned to the IF of 445 kc by moveable iron cores (permeability tuning), and the output (T18) similarly tuned. The capacitors in shunt with the coils are temperature compensators, two being used to obtain required stability. The 6SK7 is not under AVC, though R14 cathode resistor connects to RF Gain Control R13. Plate current is filtered by R18, C53 with screen current supplied by a similar filter, R15-C48. Secondary of T18 connects across the plate of 6SQ7 second detector, and the diode load resistor R16, through RF filter R38, both bypassed by C51.

AUDIO AMPLIFIER: This stage is the triode section of the 6SQ7 Duo-Diode-Triode, resistance-coupled to the 6K6G AF Pentode, which is transformer-coupled to the headphones. AF voltage is applied across AF Gain Control R17 through C52. The arm of R17 connects to 6SQ7 grid through S13 and S9, with C55 in series to isolate the sidetone circuit from the setting of this arm. The AF gain is in the circuit in R/T and CW positions only, being disconnected by S13, and the circuit operated at full gain in the other three positions.

The same condition exists when S9 is in "Remote" setting. Cathode bias for the triode develops across R21, and circuit changes caused by S14 do not affect this bias as its grid returns above the switch. S14 is explained under the AVC Circuit.

BEAT FREQUENCY OSCILLATOR: This stage uses a 6J5 Triode as a plate-tuned osc. with S14 arranged to connect plate voltage when in the "CW" position. The osc. coil is permeability-tuned and air trimmer C73 is used to vary the pitch of the beat note. C74 and C101 are compensators and the output capacity couples from the grid to the second-det. diode through C76.

AVC CIRCUIT: The signal from T18 couples to the AVC diode through C56 with R23 as the AVC load, and the voltage across it is filtered by R22 and C46, and applied to the RF and 1st Det. Grids. With S14 on RT, R21 is grounded and the only delay voltage on the AVC Diode is the drop across it. (.8v). AVC operates at very low signal inputs on R/T as a result. To increase sensitivity when on D/F, the conventional AVC is not used, but if removed entirely the receiver could be overloaded, producing an apparent reversal of quadrants on a range station. To avoid this, a large delay voltage is applied, so that AVC does not operate unless the AF output is driven to maximum. Required delay is obtained with S14 on any setting but R/T by R21 to a tap on the voltage divider AR26-R28, placing another 4v delay on the AVC circuit. This does not effect 6SQ7 bias, as the grid return is above S14. This arrangement provides an input vs. output curve, rising to maximum output level of the 6K6G as if no AVC were applied, levelling off at this point to inputs of 1 volt.

RF GAIN CONTROL: Resistor R13 operates from the receiver front panel, and when on "Remote" is shorted by S9, and R34 on the remote box is substituted. The RF gain varies bias on the RF, 1st-Det. and IF tubes, controlling the gain of these stages. When control is fully counter-clockwise, the tubes are biased to cut-off, and when full to the right, the cathode resistors R2-R7-R14 serve as minimum-bias resistors and the receiver has maximum gain.

DIRECTION FINDING: These facilities are avilable on No. 1 and No. 2 bands, 140-400 and 480-1300 k.c. respectively. DF is accomplished in two separate steps. (1) Mode of operation Switch is set in the DF position, connecting the loop to the receiver, and disconnecting the aircraft antenna. Rotating the loop through 360 degrees gives a "figure-of-eight" pattern, indicating bearing by points of minimum response. (2) The sense of the received signal is determined by combining the loop signal and aircraft antenna signal, which is done by the Mode of Operation Sw. in "Sense" position. Their phase relations are such that they produce a cardioid response pattern, which can be used to indicate sense bearing of the received signal. The tertiary windings on the antenna transformers couple in the energy from the aircraft in the "Sense" position.

REMOTE CONTROL: Switch S9 transfers control from Local to Remote, switching the following controls to the Remote Head: (a) Receiver tuning. (b) RF Gain. (c) Power on-off. (d) Mode of Operation Sw. When the receiver is on remote, AF Gain is out of the circuit, (RF Gain only is used), and the mode of operation and wave band switches are operated by 12v electric motors M2 and M3 which are energised by relays P1 and P2. These relay contacts short the grid of 6K6G output when the motor is in action, and also act as an electric brake to stop the motor at the proper position.

POWER SUPPLY UNIT: The Dynamotor has Motor Generator armature windings on a common shaft, with a common shunt field. It operates from a 12v battery, and generates approximately 180v for receiver HT. Adequate filtering is provided to prevent hash interference from both Motor and Generator commutatots. The output is fused with a .5 ampere fuse on the receiver front panel, and a 10 amp. fuse is in series with the 12v battery lead.

SIDETONE CIRCUIT: When used with the AT1, a portion of the transmitter audio output is fed into the 1st AF stage of the receiver in such a way that it is heard in the receiver headphones independent of frequency settings of both transmitter and receiver, and without switching of any kind. By means of a sidetone gain control on the receiver front panel, volume may be adjusted from zero to maximum. Resistor R19 is included to isolate the AF gain control from the setting of the sidetone volume.

INTERCOMMUNICATION UNIT: This system is provided for communication between members of the crew in the aircraft. The 6K6G i/c amplifier mounts in the receiver chassis, although not a part of the basic receiver. Switching facilities for microphone and headphones are controlled by a separate i/c switchbox, and the microphones are equipped with a press-to-talk button, completing the circuit as long as button held in.

24-VOLT OPERATION: 12 and 24-volt units are identical, differing only in minor circuit changes which are as follows:

(1) Change the tube filament panel FP-1 to 24-volt connection.
(2) Insert resistors R44 and R45 in series with remote control motors M2 and M3 respectively.
(3) Substitute a 24-volt dynamotor for the 12-volt unit. Dropping resistor is impractical here as approximately 50 watts would be wasted, representing an excessive non-productive load on battery.
(4) Replace the microphone resistor R30 with R43.
(5) Change the pilot lamps in the receiver, remote unit, and loop head, to 24v.
(6) Replace relays P1 and P2 with 24-volt types.

VOLTAGE TESTS: With 12 volts on the LT of the receiver, the following voltages plus or minus 10% should be obtained with the mode of operation switch on R/T, and the band switch on No. 1 band.

TUBE:	RF	ID	IF	2D	AF	IC	BFO
Plate Voltage	165	165	165	50	165	165	See (2) Below
Screen Grid Volts	85	85	95	--	170	170	
Cathode volts min.	2.4	2.0	3.0	See (1)	14	14	
Cathode volts max.	30	30	30		14	14	

Notes:

(1) Check the VS-5 Cathode voltage with the mode of operation switch in each of the positions RT, MCW, CW, DF and SENSE. Voltages should be:

6SQ7 Cathode: RT - 0.8 All others - 4.8 volts.

(2) Check the BFO voltage with the mode of operation switch on CW.

(3) The battery drain from a 12v battery operating an AR2 should be 3.75A.

(4) The battery drain from a 24v battery operating an AR6 should be 2.0A.

MAINTENANCE NOTES:

AR2 RECEIVER:

(a) Check the conditions of tubes.
(b) Check for dust particles and shorting of plates of main tuning condensers.

(c) Check position of dial mask with relation to "Wave Band" switch.
(d) Check remote control "Wave-Band" motor and "Mode of Operation," motor and relays.
(e) Check that screws holding gears to the shaft are always tight.
(f) Make sure that all controls on front of set are tightened and set up in their proper positions.

LUBRICATION

All lubricated parts should be inspected and relubricated once every twelve months to ensure smooth operation and to prevent undue wear. The lubrication requirements cannot be fulfilled with ordinary oils and greases and none other than those recommended should be used: the lubricants specified have been tested over an operating range of temperatures from + 55 degrees C. to -40 C. Motor and gang capacitor bearings as well as those bearings carrying gears for dial mechanism should not be treated with an excess of oil or grease that might tend to leak out or spatter on the adjacent parts. Fibre gears or metal gears engaged with fibre gears do not require any lubrication and no lubricants of any kind should be applied to switch sections or shafts on electrical contacts.

The parts to be lubricated and the recommended lubricants for them are as follows:

(a) - Receiver tuning drive - Suncup "C".
(b) - Motor Drive unit Gear Box - Suncup "C".
(c) - Remote Control Unit.
(d) - Loop Control Unit.
(e) - D/F Loop Unit.
(f) - Dynamotor Bearings - Mixtures of 50% Sperry Gyro oil #3. and 50% #20 SAE lubricating oil.
(g) - Remote control Motor Bearings - - Same as for (f)
(h) - Gang Capacitor Bearings - Armand Blended Cream.
(i) - Flexible Shafting. Should be lubricated by pulling the shafting through the lubricant as the shafting is shoved into the casing. In order to relubricate the shafting after it has been in service, the attachments should be removed from one end and the shafting pulled from its casings. The recommended lubricant is "Imperial High Temperature Graphite Grease."

BACKLASH:

Develops due to gear wear in the tuning drive mechanism and can be removed by an adjustment provided for that purpose.