



hallicrafters

littlephone

2-WAY FM RADIO-TELEPHONE
25-50 MC

OPERATING and SERVICE
INSTRUCTIONS



the hallicrafters co.

MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 24, U. S. A.

GENERAL DESCRIPTION



Hallicrafters HT-21 "littlefone"

Hallicrafters HT-21 "littlefone" is a complete, self-contained radio-telephone station consisting of a standard FM receiver and transmitter operating on a fixed frequency. Being powered by batteries, the unit is completely portable. Any two or more of these units will provide instant, dependable two-way radio communication. These portable "littlefone" units may also be tied in with "littlefone" mobile and central station units, HT-25 and HT-23 as well as existing higher powered FM equipment. Where a tunable receiver is desired, use the economical Hallicrafters Model S-82 which tunes from 30 to 50 megacycles.

The basic model designation system of the "littlefone" series of radio equipment is as follows:

- a. All portable "littlefone" units designed for operation on 25 to 50 megacycles are designated Model HT-21.
- b. To the above model number is added a series of letter designations to indicate low (L) or high (H) power transmitter, dry (D) or wet (W) batteries and (S) for squelch.

OPERATING INSTRUCTIONS

To operate the "littlefone", extend the antenna and place the power switch on the right side of the case in the up position. Next, adjust the volume control on the top of the case until the noise just disappears. To transmit, press the button on the handset and talk. To listen, simply release the button. The operating range of the unit will depend upon the geographical and physical characteristics of the operating location. To turn the unit off, return the power switch to the down position.

WARNING

DO NOT USE THIS RADIO EQUIPMENT IN THE IMMEDIATE VICINITY OF ELASTIC CAPS OR ELECTRICAL DETONATORS.

IMPORTANT

It is the requirement of the Federal Communications Commission that this radio equipment be licensed. The appropriate application form (F.C.C. Form 401) can be obtained by request from Federal Communications Commission, Washington 25, D.C. or from your local F.C.C. field office. The completed form should be filed with the Federal Communications Commission, Washington 25, D.C.

CIRCUIT DESCRIPTION

RECEIVER

The receiver is a crystal controlled, double conversion type FM receiver employing twelve tubes and two crystal diodes. All tubes are of the sub-miniature type and are socket mounted. The tube complement is given in the Service Parts List.

A signal at the operating frequency is received at the antenna and is amplified by the 1st and 2nd RF amplifiers, V-1 and V-2. This amplified signal is applied to the 1st mixer, V-3, where it is mixed with the injection voltage from the plate circuit of the crystal oscillator, V-11, at the proper harmonic of the crystal frequency. The second harmonic is used on receivers operating from 25 to 35.98 megacycles and the third harmonic, on receivers operating from 36 to 50 megacycles. The first intermediate frequency is less than the crystal frequency by 1.7 megacycles. The first IF signal is amplified by the 1st and 2nd IF amplifiers, V-4 and V-5, and then applied to the signal grid of the 2nd mixer, V-6. Here it is mixed with the injection voltage from the screen grid of the crystal oscillator, V-11, at the crystal frequency, obtaining the second intermediate frequency of 1.7 megacycles. This IF signal is amplified by the 3rd IF amplifier, V-7, and the 1st and 2nd limiters, V-8 and V-9. After limiting, the signal is applied to the discriminator where the audio is then recovered. The audio signal is amplified by the audio amplifier, V-10, to supply the audio output of approximately five milliwatts to the earpiece of the handset. A squelch circuit is provided to quiet the receiver when no signal is being received. A 2E41 diode-pentode (V-12) is used as a noise limiter and rectifier. Noise voltage is taken from the grid of the 1st limiter, V-8, amplified, rectified and applied to the grid of the audio amplifier, V-10, biasing it to cutoff. When a signal is received, the limiter grid voltage increases and cuts off the noise amplifier. Thus, the cutoff voltage is removed and the audio amplifier operates normally.

TRANSMITTER

The transmitter is a standard crystal controlled FM transmitter. All tubes are of the sub-miniature type and are socket mounted. The tube complement is given in the Service Parts List. The crystal oscillator, V-13, supplies RF voltage at the crystal frequency to the grids of the modulators, V-14 and V-15. Phase modulation is developed in the grids of these tubes. The output of the modulators is multiplied through a series of four multipliers, V-16, V-17, V-18 and V-19; 27 times on transmitters operating from 25 to 29.5 megacycles, 32 times from 29.54 to 33.5 megacycles, 36 times from 33.54 to 44.5 megacycles, and 48 times from 44.54 to 50 megacycles. The output from the final multiplier is applied to the buffer-driver, V-20, which in turn drives the final amplifier stage. The final consists of a single triode for models LDS and LWS and two triodes connected in parallel for model HWS, giving 0.75 and 2 watts output respectively. A pi network is used in the final tank circuit to couple the output of the transmitter to the quarter wave whip antenna. The microphone employed is a single button carbon type.

POWER SUPPLY

The power supply is a synchronous vibrator type for model LWS and a nonsynchronous vibrator type for model HWS. Primary power is supplied from two ER-11-2 batteries for the LWS model and from two ERH-25-2 batteries for the HWS model. Both battery types are 2 volt Willard lead-acid storage cells. The two batteries are connected in parallel to supply the vibrator circuit. The filament voltage for all tubes is 1.25 volts. Resistance wire from the relay to the receiver and transmitter filament strings drops the voltage to the proper value.

Dry batteries are used to power model LDS. The battery complement consists of one 1½ volt "A" battery and three 45 volt "B" batteries. (See REPLACEMENT DRY BATTERIES on page 7 for listing of battery types.) Approximately 16 hours of operation may be expected before battery replacement is necessary.

ACCESSORIES

Order parts by Hallicrafters Part Number and Description

Description	Hallicrafters Part Number	Cross Reference
Shoulder carrying case for LDS and LWS	14-317	P-4320
Shoulder carrying case for HWS	14-316	P-4737
Back pack harness	14-315	P-4437
Replacement handset assembly with cord and plug	41X18708	P-4197
Hand microphone and earpiece/shoulder loud speaker assembly with cords and plugs (specify earpiece or speaker)	41X18761	P-4414
Switch and cord assembly for use with lip or throat mike and earpiece or shoulder loud speaker	41C18790	-----
Earpiece assembly complete with cord and plug for use with 81B089 or 41C18790	85B134	P-4461
Shoulder loud speaker (2" x 3") with cord and plug for use with 81B089 or 41C18790	41X18782	P-4767
Hand microphone and cord assembly for use with earpiece 85B134 or loud speaker 41X18782	81B089	P-4423
Lip microphone for use with 41C18790	81B091	-----
Throat microphone for use with 41C18790	81B092	-----
Shoulder loud speaker holder for back pack harness	41X18783	P-4763
Universal AC battery charger (105-125 volts, 50/60 cycles)	21-140	-----
6 Volt DC battery charger	21-141	-----
Wall mounting bracket for "littlefone"	67-1999	-----

SERVICE

The Hallicrafters Company maintains an extensive system of authorized factory service centers where any required service can be accomplished promptly and efficiently at a nominal charge. These same service centers can also accomplish the semi-annual frequency measurement required by the F.C.C. The sign shown at the right is displayed by all authorized service centers. Any service work performed on this radio equipment must be under the supervision of an F.C.C. commercial licensed operator holding a 2nd Class Radio Telephone or higher grade of license.



ALIGNMENT INSTRUCTIONS

EQUIPMENT REQUIRED

1. Signal generator covering 1.7 MC, 7.2 - 11.3 MC and 25 - 50 MC. Measurements Corp. Model 80 or equivalent.
2. Vacuum tube voltmeter (VTVM) with 0-3 and 0-30 volt DC ranges.
3. 0-50 ma. DC milliammeter.
4. Absorption wavemeters covering 2.5 to 50 megacycles to determine proper tuning of multiplier stages in transmitter and receiver.
5. Frequency measuring equipment capable of measuring the transmitter output frequency to within .005%.
6. A 1 megohm resistor connected in series with the VTVM probe to minimize loading and detuning.

TRANSMITTER ALIGNMENT

Before starting alignment of the transmitter, remove the plate voltage from the buffer and final amplifier stages. This is accomplished on models LWS and HWS by disconnecting the single pin plug on the power supply chassis and on model LDS by disconnecting the connector from the small 45V. "B" battery. Also connect a short circuiting jumper between terminals 1 and 2 of the handset socket to place the filament voltage relay in the energized or transmit position. Refer to Figs. 1 and 2 for location of all alignment adjustments and test points. The adjustment and test points are also shown on the schematic diagram.

1. Connect the VTVM to A or B (grid of either modulator) and adjust 1 (oscillator plate) for max. neg. voltage at the crystal frequency (marked on top of crystal). Approx. -3 volts.
2. Connect the VTVM to C (1st multiplier grid) and adjust 2 (modulator plate) for max. neg. voltage at the crystal frequency. Approx. -20 volts.
3. Connect the VTVM to D (2nd multiplier grid) and adjust 3 (1st multiplier plate) for max. neg. voltage at the harmonic of the crystal frequency specified in the chart below. Approx. -20 volts. Then touch up 2 (modulator plate).
4. Connect the VTVM to E (3rd multiplier grid) and adjust 4 (2nd multiplier plate) for max. neg. voltage at the harmonic of the crystal frequency specified in the chart below. Approx. -14 volts. Then touch up 3 (1st multiplier plate).
5. Connect the VTVM to F (4th multiplier grid) and adjust 5 (3rd multiplier plate) for max. neg. voltage at the harmonic of the crystal frequency specified in the chart below. Approx. -25 volts. Then touch up 4 (3rd multiplier plate).
6. Connect the VTVM to G (buffer grid) and adjust 6 (4th multiplier plate) for max. neg. voltage at the harmonic of the crystal frequency specified in the chart below. Approx. -15 volts for models LDS and LWS and approx. -20 volts for model HWS. Then touch up 5 (3rd multiplier plate).
7. Remove the plate voltage from the final amplifiers by disconnecting wire jumper H (see Fig. 2). Then apply plate voltage to the buffer stage by connecting the milliammeter between the single pin plug and jack on models LWS and HWS or in series with the small 45V. "B" battery on model LDS.
8. Adjust 7 (buffer plate) for dip in buffer plate current as indicated on milliammeter.
9. The buffer stage has been neutralized at the factory and should normally not require readjustment. To determine if adjustment is necessary, first remove the plate voltage from the buffer stage by disconnecting the milliammeter. Then connect the VTVM to J (final grid resistor). If the stage is properly neutralized, an indication of approximately -.2 volt or less will be obtained on the VTVM. If neutralization is required, follow the procedure outlined under BUFFER NEUTRALIZATION.
10. The final amplifier stage has also been neutralized at the factory and should normally not require readjustment. A check may be made to determine if adjustment is necessary as follows:
 - (a) Set 9 (output loading capacitor) for maximum capacity by setting the solder spot on the rotor plate opposite the one on the stator plate.
 - (b) Connect the VTVM to J (final grid resistor).
 - (c) Apply plate voltage to the buffer stage by reconnecting the milliammeter. Retune 7 (buffer plate) for dip in plate current. Tune 11 (final grid) for max. neg. voltage on VTVM.
 - (d) Tune 10 (output tuning capacitor) through resonance. If the final amplifier stage is not neutralized, a large dip in grid voltage will be noted as 10 is tuned through resonance; if properly neutralized, little change in grid voltage will be noted (approximately 6 volts or less). If neutralization is necessary, follow the procedure outlined under FINAL AMPLIFIER NEUTRALIZATION.

Littlefone Operating Freq. (MC)	CRYSTAL HARMONIC			
	1st. Mult.	2nd. Mult.	3rd. Mult.	4th. Mult.
25.00 - 29.5	3	9	27	27
29.54 - 33.5	4	8	16	32
33.54 - 44.5	3	9	18	36
44.54 - 50.0	4	12	24	48

11. Set 9 (output loading capacitor) for maximum capacity by setting the solder spot on the rotor plate opposite the one on the stator plate. Apply plate voltage to the final amplifiers by connecting wire jumper H.
12. Connect the VTVM to J (final grid resistor). Tune 10 (output tuning capacitor) for minimum plate current. Slightly retune 11 (final grid) for maximum grid voltage as indicated on the VTVM. Repeat the procedure several times, tuning 10 for minimum plate current and 11 for maximum grid voltage. Correct adjustment of the final amplifiers is indicated by a VTVM reading of -18 to -25 volts for models LDS and LWS and -25 to -42 volts for model HWS.
13. Connect the antenna.
14. Adjust 10 (output tuning capacitor) for resonance as indicated by minimum plate current. Then decrease the value of 9 (output loading capacitor) in small steps, each time retuning 10 for minimum plate current. Proper operation with rated power output is obtained with plate currents of approx. 20 ma. for models LDS and LWS and approx. 40 ma. for model HWS.
15. Align the receiver if required.
16. Place the chassis in the case and retune the antenna as outlined in Step 14. To gain access to the output tuning adjustments, 9 and 10, remove the button plugs from the holes in the side of the case.

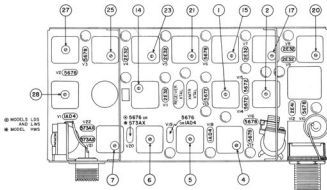


Fig. 1. Top View of Chassis Showing Location of Alignment Adjustments and Tubes

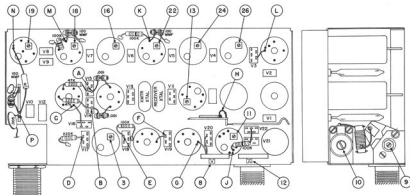


Fig. 2. Bottom and Side Views of Chassis Showing Location of Alignment Adjustments and Test Points

BUFFER NEUTRALIZATION

1. Before neutralizing the buffer, follow the instructions given in Step 9 on page 4.
2. To neutralize the buffer stage, adjust 8 (buffer neutralizing capacitor) for a minimum reading on the VTVM. Then retune 7 (buffer plate) and 11 (final grid) to provide a maximum reading on the VTVM. Repeat the procedure until a VTVM indication of approximately $-.2$ volt or less is obtained.
3. Apply plate voltage to the buffer stage by reconnecting the milliammeter. Connect the VTVM to G (buffer grid) and touch up 6 (4th multiplier plate) to maximize buffer grid voltage.

FINAL AMPLIFIER NEUTRALIZATION

1. Before neutralizing the final amplifiers, follow the instructions given in Step 10 on page 4.
2. To neutralize the final, make small adjustments of 12 (final neutralizing capacitor) for minimum reaction in grid voltage as 10 (output tuning capacitor) is tuned through resonance. With each small adjustment of 12, retune 11 (final grid) to maximize the VTVM indication. When neutralization is complete, tuning 10 through resonance will not have any appreciable effect upon the VTVM indication.

RECEIVER ALIGNMENT

1. Connect the VTVM to K (2nd mixer grid resistor) and adjust 13 (oscillator screen) for max. negative voltage. Approx. -1 volt.
2. Connect the VTVM to L (1st mixer grid) and adjust 14 (oscillator plate) for max. neg. voltage at the correct harmonic of the crystal frequency. Approx. -1 volt. Adjust for the 2nd harmonic on models operating from 25 to 35.98 MC and the 3rd harmonic from 36 to 50 MC.
3. Set the signal generator at 1.7 MC and connect it to K (2nd mixer grid resistor).
 - a. Connect the VTVM to M (1st limiter grid resistor). Adjust 15 and 16 (2nd mixer plate) and 17 and 18 (3rd IF plate) for maximum indication.
 - b. Connect the VTVM to N (disc. input) and adjust 19 (disc. primary) for maximum indication. Approx. 10 volts, positive or negative.
 - c. Connect the VTVM to P (disc. output) and adjust 20 (disc. secondary) for zero reading on the VTVM. The correct zero point is between a positive and negative maximum.
4. Set the signal generator at the 1st IF frequency (1st IF = Crystal Freq. ~ 1.7 MC) and connect it to K (2nd mixer grid resistor). Connect the VTVM to P (disc. output). Carefully adjust the signal generator frequency for a zero reading on the VTVM.
5. Disconnect the generator and connect it to L (1st mixer grid). Connect the VTVM to M (1st limiter grid resistor). Adjust 21 and 22 (2nd IF plate), 23 and 24 (1st IF plate) and 25 and 26 (1st mixer plate) for maximum indication on the VTVM.
6. Connect the VTVM to P (disc. output). Connect the generator to the antenna input and set it at the receiver operating frequency by tuning for a zero reading on the VTVM. Then connect the VTVM to M (1st limiter grid resistor) and adjust 27 (2nd RF plate) and 28 (1st RF plate) for maximum indication. Approx. -3 volts for 0.3 microvolt input.
7. Attach the antenna and check the discriminator setting against a transmitter on the receiver operating frequency. The VTVM indication at P (disc. output) should be zero volts, plus or minus 0.1 volt. If not, readjust 20 (disc. sec.) until a zero reading is obtained. Then connect the VTVM to M (1st limiter grid resistor) and touch up all adjustments except 13 (oscillator screen) for max. neg. voltage.
8. In instances where the receiver crystal operates at a frequency slightly different from that indicated on the holder, lower than normal sensitivity may be noted. To remedy such a condition, follow the procedure outlined below.
 - a. Using a tunable receiver such as Hallicrafters S-82 as an indicating device, zero beat the signal generator with a transmitter on the receiver operating frequency.
 - b. Connect the signal generator to the antenna input and the VTVM to N (disc. input).
 - c. Touch up all IF adjustments including the disc. primary for max. neg. voltage. Keep the generator output as low as possible when making these adjustments.

VOLTAGE DATA

All voltages were measured with a vacuum tube voltmeter between tube socket terminals and chassis. Filament voltage is 1.25 volts.

Tube	Function	HT-21 HWS		HT-21 LWS		**HT-21 LDS	
		Plate	Screen	Plate	Screen	Plate	Screen
V-1	1st RF Amplifier	100	40	78	31	78	31
V-2	2nd RF Amplifier	100	80	78	62	78	62
V-3	1st Mixer	22	22	17	17	17	17
V-4	1st IF Amplifier	100	35	78	27	78	27
V-5	2nd IF Amplifier	105	25	82	20	82	20
V-6	2nd Mixer	115	60	90	47	90	47
V-7	3rd IF Amplifier	115	25	90	20	90	20
V-8	1st Limiter	35	28	27	22	27	22
V-9	2nd Limiter	40	28	35	22	35	22
V-10	Audio Amplifier	110	25	86	20	86	20
V-11	Receiver Oscillator	85	85 Ⓞ	75	75 Ⓞ	75	75 Ⓞ
*V-12	Squelch	60	25	47	20	47	20
V-13	X'mtr Oscillator	90	35	85	32	90	32
V-14	Modulator	90	23	85	18	74	16
V-15	Modulator	90	23	85	18	74	16
V-16	1st Multiplier	90	65	85	46	74	44
V-17	2nd Multiplier	90	65	85	46	74	44
V-18	3rd Multiplier	90	50	85	42	74	40
V-19	4th Multiplier	90		85		74	
V-20	Buffer	120		110		132	
V-21	Final Amplifier	130		115		135	
V-22	Final Amplifier	130		115		135	

* Measured with volume control set fully clockwise.

** Measured with fresh batteries.

Ⓞ Measured from B+ side of screen tank circuit to chassis.

REPLACEMENT DRY BATTERIES

Schematic Symbol	Type	RCA	Burgess	Eveready	Bright Star	General	Mont. Ward	Olin	Philco	Ray O-Vac	Sears	Willard
BA-301	45V. "B"	VS055	XX30	455		W30A		6211	P105			
BA-302,303	45V. "B"	VS015	Z30	738	30-59	V30AA				P7R30		V30AA
BA-304	1½V. "A"	VS004	4F	742	462	4F1	21	4816	P94	P94A	6430	4F1

PREVENTIVE MAINTENANCE

A regular preventive maintenance procedure should be followed to prevent unnecessary interruption in the operation of this equipment. This maintenance procedure should include the following:

- (1) Make a semi-annual check of the operating frequency as required by the F.C.C. to assure that it is within .005% of the assigned operating frequency.
- (2) Take periodic meter readings and, in case of abnormal readings, check tubes.
- (3) Periodically check the receiver sensitivity with the receiver in the case. (Normal sensitivity is approx. -3 volts at M (1st limiter grid resistor) for 0.3 microvolt at the antenna input.)
- (4) If the receiver sounds distorted, check the discriminator setting against a transmitter on the receiver operating frequency. (See Step 7 under Receiver Alignment.)
- (5) Check the battery electrolyte level and add distilled water if necessary. Keep the level even with the mark on the battery case.
- (6) After approximately 8 hours of operation, remove the batteries from the case and check to determine if charging is required. When removing batteries, be careful not to damage the polystyrene ventilation opening on the side of the case. To check batteries, tilt the battery slightly and observe the position of the ball(s) in the battery. When batteries are fully charged, these balls float at the top of the electrolyte. Willard ER-11-2 batteries require charging if the red ball sinks to the bottom while the Willard ERH-25-2 batteries require charging when both the blue and white balls sink to the bottom. When charging batteries, the power switch on the "Littlefone" should be off. Be careful to limit the charging current to the value indicated on the battery.
- (7) Check the antenna loading by observing the combined buffer and final amplifier plate current. This is accomplished on models LWS and HWS by connecting a 50 ma. DC meter between the single pin plug and jack on the power supply chassis and on model LDS by connecting the meter in series with the small 45 volt "B" battery. Proper operation with rated power output is indicated by plate currents of approximately 20 ma. for models LDS and LWS and approximately 40 ma. for model HWS.

BATTERY CHARGERS

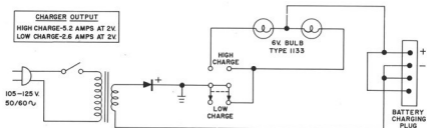


Fig. 3. Universal AC Battery Charger (Hallicrafters Part No. 21-140)

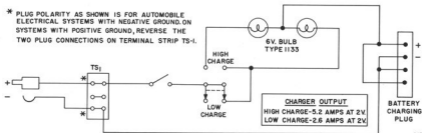


Fig. 4. Six Volt DC Battery Charger (Hallicrafters Part No. 21-141)

MODEL HT-21 HWS SPECIFICATIONS

TYPE: Portable FM Transmitter - Receiver

FREQUENCY RANGE: 25 to 50 MC

TRANSMITTER:

1. Power Output	2.0 watts.
2. Frequency Stability	0.005% from -20° to + 70° Centigrade. Crystal controlled, Crystal frequency multiplied 27 times from 25.0 to 29.5 MC, 32 times from 29.54 to 33.5 MC, 36 times from 33.54 to 44.5 MC and 48 times from 44.54 to 50 MC.
3. Modulation	Phase. ± 15 KC deviation (no modulation limiter).
4. Antenna	Quarter wave flexible whip. 50 ohm output impedance.
5. Spurious Radiation	60 db down.
6. Pre-emphasis	Standard 6 db per octave.
7. Distortion	9% with 100% modulation at 1000 cps.
8. Power Supply	2 volt non-synchronous vibrator plus 2 rechargeable wet storage batteries. Current drain - 6.3 amps at 2 volts.
9. Power Requirements	Filament - 1.25 volts at 1.2 amps Plate - 130 volts at 58 ma.
10. Power Input to Final	130 volts at 22 ma.
11. Duty Cycle	1 minute on, 1 minute off for 8 hours.
12. Microphone	Telephone handset with single button carbon mike and push to talk button.

RECEIVER:

1. Sensitivity	0.3 microvolt or better for 20 db signal to noise ratio.
2. Selectivity	60 db at 45 KC. 95 db at 60 KC.
3. Frequency Stability	0.005% from -20° to + 70° Centigrade.
4. Receiver Type	Superheterodyne. Double conversion crystal controlled local oscillator.
5. Spurious Response	All more than 75 db down.
6. Audio Output	5 milliwatts with 15% distortion. 3 milliwatts with 5% distortion.
7. Receiver De-emphasis	Standard 6 db per octave.
8. Antenna	Same as for transmitter.
9. Squelch	0.18 microvolt to open.
10. Power Supply	Same as for transmitter. Current drain - 2.6 amps at 2 volts.
11. Power Requirements	Filament - 1.25 volts at 0.63 ma. Plate - 100 volts at 13 ma.
12. Receive Time	14 hours before recharging batteries.

WEIGHT: 14 pounds with case, telephone handset, vibrator power supply and 2 lead acid storage batteries.

MODEL HT-21 LWS SPECIFICATIONS

TYPE: Portable FM Transmitter - Receiver

FREQUENCY RANGE: 25 to 50 MC

TRANSMITTER:

1. Power Output 0.75 watt.
2. Frequency Stability 0.005% from -20° to + 70° Centigrade, Crystal controlled. Crystal frequency multiplied 27 times from 25.0 to 28.5 MC, 32 times from 29.54 to 33.5 MC, 36 times from 33.54 to 44.5 MC and 48 times from 44.54 to 50 MC.
3. Modulation Phase. ± 15 KC deviation (no modulation limiter).
4. Antenna Quarter wave flexible whip. 50 ohm output impedance.
5. Spurious Radiation 60 db down.
6. Pre-emphasis Standard 6 db per octave.
7. Distortion 9% with 100% modulation at 1000 cps.
8. Power Supply 2 volt synchronous vibrator plus 2 rechargeable wet storage batteries. Current drain - 4 amps at 2 volts.
9. Power Requirements Filament - 1.25 volts at 10 amps
Plate - 115 volts at 35 ma.
10. Power Input to Final 115 volts at 15 ma.
11. Duty Cycle 1 minute on, 1 minute off for 4 hours.
12. Microphone Telephone handset with single button carbon mike and push to talk button.

RECEIVER:

1. Sensitivity 0.3 microvolt or better for 20 db signal to noise ratio.
2. Selectivity 60 db at 45 KC. 95 db at 60 KC.
3. Frequency Stability 0.005% from -20° to + 70° Centigrade.
4. Receiver Type Superheterodyne. Double conversion crystal controlled local oscillator.
5. Spurious Response All more than 75 db down.
6. Audio Output 5 milliwatts with 15% distortion.
3 milliwatts with 5% distortion.
7. Receiver De-emphasis Standard 6 db per octave.
8. Antenna Same as for transmitter.
9. Squelch 0.18 microvolt to open.
10. Power Supply Same as for transmitter. Current drain - 2.6 amps at 2 volts.
11. Power Requirements Filament - 1.25 volts at 0.63 amps.
Plate - 100 volts at 12 ma.
12. Receive Time 6.5 hours before recharging batteries.

WEIGHT: 10 pounds with case, telephone handset, vibrator power supply and 2 lead acid storage batteries.

MODEL HT-21 LDS SPECIFICATIONS

TYPE: Portable FM Transmitter - Receiver

FREQUENCY RANGE: 25 to 50 MC

TRANSMITTER:

1. Power Output	0.75 watt
2. Frequency Stability	0.005% from -20° to +70° Centigrade. Crystal controlled. Crystal frequency multiplied 27 times from 25.0 to 29.5 MC, 32 times from 29.54 to 33.5 MC, 36 times from 33.54 to 44.5 MC and 48 times from 44.54 to 50 MC.
3. Modulation	Phase. ± 15 KC deviation (no modulation limiter).
4. Antenna	Quarter wave flexible whip. 50 ohm output impedance.
5. Spurious Radiation	60 db down.
6. Pre-emphasis	Standard 6 db per octave.
7. Distortion	9% with 100% modulation at 1000 cps.
8. Power Supply	(1) 1½ volt "A" battery and (3) 45 volt "B" batteries (See page 7 for listing of battery types.)
9. Power Requirements	Filament - 1.25 volts at 1.0 amps. Plate - 90 volts at 16 ma, 135 volts at 13 ma.
10. Power Input to Final	135 volts at 13 ma.
11. Duty Cycle	1 minute on, 1 minute off.
12. Microphone	Telephone handset with single button carbon mike and push to talk button.

RECEIVER:

1. Sensitivity	0.3 microvolt or better for 20 db signal to noise ratio.
2. Selectivity	60 db at 45 KC. 95 db at 60 KC.
3. Frequency Stability	0.005% from -20° to +70° Centigrade.
4. Receiver Type	Superheterodyne. Double conversion crystal controlled local oscillator.
5. Spurious Response	All more than 75 db down.
6. Audio Output	5 milliwatts with 15% distortion. 3 milliwatts with 5% distortion.
7. Receiver De-emphasis	Standard 6 db per octave.
8. Antenna	Same as for transmitter.
9. Squelch	0.18 microvolt to open.
10. Power Supply	Same as for transmitter.
11. Power Requirements	Filament - 1.25 volts at 0.63 amps. Plate - 90 volts at 11 ma.

WEIGHT: 10 pounds with case, telephone handset and batteries.

INFORMATION FOR COMPLETING F.C.C. FORM 401, REV. JUNE 1951 MODEL HT-21 HWS

13. Description of transmitting apparatus proposed to be installed			
Make <div style="text-align: center;">Hallicrafters Co.</div>		Type or Model No. <div style="text-align: center;">HT-21 HWS</div>	
Tube complement	Number and type of tubes	Normal plate current per tube	Plate voltage
Oscillator stage	(1) CK-5672	2.6 ma.	90
Intermediate stages	(1) CK-5678 Mult. (1) CK-5678 Mult. (1) 1AD4 Mult. (1) CK-5676 Mult. (1) CK-573AX Driv.	1.6 ma. 1.6 ma. 3.5 ma. 5.6 ma. 14.0 ma.	90 90 90 90 120
Final radio stage	(2) CK-573AX	11.0 ma.	130
Modulator	(2) CK-5672	2.0 ma.	90
Type of oscillator circuit Crystal controlled electron coupled		Plate power supply for last radio stage Rated Current <u>22 ma.</u>	
Type or class of modulation Armstrong, multiplied 27 times from 25.0 to 29.5 MC, 32 times from 29.54 to 33.5 MC, 36 times from 33.54 to 44.5 MC and 48 times from 44.54 to 50 MC.		Rated Voltage <u>130 volts</u>	
Which radio stage is to be modulated? Modulator stage.		State maximum percentage of modulation 15 KC @ 1000 cycles	
State maximum rated carrier power 2.0 watts		Indicate frequency range of transmitter 25-50 MC	
14. a. What apparatus is included as an integral part of the transmitter for automatically holding the frequency within the allowed frequency tolerance? <div style="text-align: center;">James Knights Co. Type H17 Crystal</div>			
b. Within how many cycles or within what percentage of the assigned frequency is this apparatus designed or guaranteed by the manufacturer to hold the operating frequency? <div style="text-align: center;">.005 %</div>			
c. State type, number, if any, and name of manufacturer of frequency-control apparatus <div style="text-align: center;">James Knights Co. Type H17 Crystal</div>			
d. Is frequency-control apparatus automatically maintained at constant temperature? <div style="display: flex; justify-content: space-between;"> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> </div>			

INFORMATION FOR COMPLETING F.C.C. FORM 401, REV. JUNE 1951

MODEL HT-21 LWS

13. Description of transmitting apparatus proposed to be installed			
Make <div style="text-align: center;">Hallicrafters Co.</div>		Type or Model No. <div style="text-align: center;">HT-21 LWS</div>	
Tube Complement	Number and type of tubes	Normal plate current per tube	Plate voltage
Oscillator stage	(1) CK-5672	2.1 ma.	85
Intermediate stages	(1) CK-5678 Mult.	1.1 ma.	85
	(1) CK-5678 Mult.	1.1 ma.	85
	(1) 1AD4 Mult.	3.2 ma.	85
	(1) CK-5676 Mult.	4.0 ma.	85
	(1) CK-5676 Driv.	7.0 ma.	110
Final radio stage	(1) CK-573AX	15.0 ma.	115
Modulator	(2) CK-5672	1.6 ma.	85
Type of oscillator circuit <div style="text-align: center;">Crystal controlled electron coupled</div>		Plate power supply for last radio stage	
Type or class of modulation Armstrong, multiplied 27 times from 25.0 to 29.5 MC, 32 times from 29.54 to 33.5 MC, 36 times from 33.54 to 44.5 MC and 48 times from 44.54 to 50 MC.		Rated Current <u>15 ma.</u>	
		Rated Voltage <u>115 volts</u>	
Which radio stage is to be modulated? <div style="text-align: center;">Modulator stage</div>		State maximum percentage of modulation <div style="text-align: center;">15 KC @ 1000 cycles</div>	
State maximum rated carrier power <div style="text-align: center;">0.75 watt</div>		Indicate frequency range of transmitter <div style="text-align: center;">25-50 MC</div>	
14. a. What apparatus is included as an integral part of the transmitter for automatically holding the frequency within the allowed frequency tolerance? <div style="text-align: center;">James Knights Co. Type H17 Crystal</div>			
b. Within how many cycles or within what percentage of the assigned frequency is this apparatus designed or guaranteed by the manufacturer to hold the operating frequency? <div style="text-align: center;">.005 %</div>			
c. State type, number, if any, and name of manufacturer of frequency-control apparatus <div style="text-align: center;">James Knights Co. Type H17 Crystal</div>			
d. Is frequency-control apparatus automatically maintained at constant temperature? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>			

INFORMATION FOR COMPLETING F.C.C. FORM 401, REV. JUNE 1951

MODEL HT-21 LDS

13. Description of transmitting apparatus proposed to be installed

Make <div style="text-align: center;">Hallicrafters Co.</div>		Type or Model No. <div style="text-align: center;">HT-21 LDS</div>	
Tube Complement	Number and type of tubes	Normal plate current per tube	Plate voltage
Oscillator stage	(1) CK-5672	2.1 ma.	90
Intermediate stages	(1) CK-5678 Mult. (1) CK-5678 Mult. (1) 1AD4 Mult. (1) CK-5676 Mult. (1) CK-5676 Driv.	1.1 ma. 1.1 ma. 3.2 ma. 4.0 ma. 6.0 ma.	74 74 74 74 132
Final radio stage	(1) CK-573AX	13.0 ma.	135
Modulator	(2) CK-5672	2.0 ma.	74
Type of oscillator circuit Crystal controlled electron coupled		Plate power supply for last radio stage Rated Current <u>13 ma.</u> Rated Voltage <u>135 volts</u>	
Type or class of modulation Armstrong, multiplied 27 times from 25.0 to 29.5 MC, 32 times from 29.54 to 33.5 MC, 36 times from 33.54 to 44.5 MC and 48 times from 44.54 to 50 MC.		State maximum percentage of modulation 15 KC @ 1000 cycles	
Which radio stage is to be modulated? Modulator stage		Indicate frequency range of transmitter 25-50 MC	
State maximum rated carrier power 0.75 watt		State maximum percentage of modulation 15 KC @ 1000 cycles	
14. a. What apparatus is included as an integral part of the transmitter for automatically holding the frequency within the allowed frequency tolerance? <div style="text-align: center;">James Knights Co. Type H17 Crystal</div>			
b. Within how many cycles or within what percentage of the assigned frequency is this apparatus designed or guaranteed by the manufacturer to hold the operating frequency? <div style="text-align: center;">.005 %</div>			
c. State type, number, if any, and name of manufacturer of frequency-control apparatus <div style="text-align: center;">James Knights Co. Type H17 Crystal</div>			
d. Is frequency-control apparatus automatically maintained at constant temperature?		Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	

SERVICE PARTS LIST FOR TRANSMITTER-RECEIVER

Order parts by Hallicrafters Part Number and Description

Schematic Symbol	Description	Hallicrafters Part Number	Cross Reference
CAPACITORS			
C-1,54,57	25 mmf. 500 V., ceramic.	47A288	174-0008-00
C-2,3,4,5,27,48,49, 60,61	.005 mfd. 450 V., ceramic disc.	47A168	174-0020-00
C-6,8,11,13,15,16, 25,31,33,38	.02 mfd. 400 V., tubular	47A277	173-5003-00
C-7,10,12	.1 mmf. gimmick.	-----	-----
C-9,22,23,68	.01 mfd. 450 V., ceramic disc.	47A217	174-0021-00
C-14,18,28,36,74	100 mmf. 500 V., ceramic.	47X30UK101K	174-0017-00
C-17,19,35	1 mmf. 500 V., gimmick.	47A160-2	174-0001-00
C-20,26,37,45,52,53, 55,59,60	.002 mfd. 400 V., tubular.	47A276	173-5000-00
C-21	500 mmf. 500 V., ceramic.	47A278	174-0016-00
C-24,47,50	1000 mmf. 500 V., ceramic.	47A280	174-0019-00
C-29	25 mmf. 500 V., ceramic.	47A285	174-0010-00
C-30,39,40,42,43, 44,45,46,47	10 mmf. 500 V., ceramic.	47X20CK100F	174-0005-00
C-32,49,70	5 mmf. 500 V., ceramic.	47A289	174-0022-00
C-41	5 mmf. 500 V., ceramic (operating freq. between 27-35MC).	47A289	174-0022-00
C-41	10 mmf. 500 V., ceramic (operating freq. between 25-27MC).	47X20CK100F	174-0005-00
C-46	2.2 mmf. 500 V., gimmick.	47A160-4	174-0002-00
C-51	250 mfd. 6 V., electrolytic.	45A201	170-0003-00
C-56,58,61,62,64, 69,71	5, 10 or 15 mmf. 500 V., ceramic (see chart below for value)	-----	-----
	5 mmf. 500 V., ceramic	47A289	174-0022-00
	10 mmf. 500 V., ceramic	47X20CK100F	174-0005-00
	15 mmf. 500 V., ceramic	47B0150K5	-----

Littlefone Operating Freq. (MC)	C56	C58	C61	C62	C64	C69 (LDS & LWS)	C69 (HWS)	CT1 (LDS & LWS)	CT1 (HWS)
25.00 - 29.5	-----	-----	10	10	15	10	10	15	15
29.54 - 33.5	15	15	10	5	10	10	5	15	10
33.54 - 35.0	-----	10	10	5	10	5	5	10	10
35.00 - 44.5	-----	10	-----	-----	5	5	-----	10	5
44.50 - 50.0	-----	5	-----	-----	-----	-----	-----	-----	-----

C-63	1 - 3.5 mmf. ceramic trimmer (buffer neutralizing capacitor).	47A287	171-0004-00
C-72	2.5 - 6 mmf. ceramic trimmer (final amp. neutralizing capacitor).	47A286	171-0005-00
C-73	2.5 - 15 mmf. ceramic trimmer (output tuning capacitor).	44A415	171-0001-00
C-75	10 - 100 mmf. ceramic trimmer (output loading capacitor).	44B414	171-0002-00

RESISTORS

R-1,12	1 megohm 1/2 watt, carbon.	23X20X105K	160-0160-00
R-2,4,6,8,10,23,24, 25,26,27,35,36,44	100,000 ohms 1/2 watt, carbon.	23X20X104K	160-0136-00
R-3	1.00 ohms; #28 nichrome wire (5 inches).	87A2433	P-4649-1
R-5,14,16,17,18,19	960,000 ohms 1/2 watt, carbon.	23X20X564K	160-0154-00
R-7,21,22,28,42	220,000 ohms 1/2 watt, carbon.	23X20X224K	160-0145-00
R-9,15,40	150,000 ohms 1/2 watt, carbon.	23X20X154K	160-0140-00
R-11,50	1000 ohms 1/2 watt, carbon.	23X20X102K	160-0088-00
R-13,48	10,000 ohms 1/2 watt, carbon.	23X20X103K	160-0112-00
R-20	Volume control: 500,000 ohms.	25B975	162-0008-00
R-29,30,31	2200 ohms 1/2 watt, carbon.	23X20X222K	-----
R-37,38,41,43,45	47,000 ohms 1/2 watt, carbon.	23X20X473K	160-0138-00
R-39	27 ohms 1/2 watt, carbon.	23X20X270K	160-0001-00
R-40	39,000 ohms 1/2 watt, carbon.	23X20X393K	160-0126-00
R-47	510 ohms 1/2 watt, carbon.	23X20X511K	160-0081-00
R-49	.585 ohms; #28 nichrome wire (3-1/32 inches).	87A2434	P-4649-2

COILS AND TRANSFORMERS

L-1,2	Choke, RF	53A260	P-4648
L-3	Coil, final plate (operating freq. below 37 MC)	51B1522	P-4645-2
L-3	Coil, final plate (operating freq. above 37 MC)	51B1571	P-4645-3
T-1	Transformer, 1st RF	50C546	P-4636
T-2	Transformer, 2nd RF	50C547	P-4637
T-3,4,5	Transformer, 1st mixer, 1st IF, and 2nd IF (see schematic diagram).	50C569	-----
T-6,7	Transformer, 2nd mixer and 3rd IF	50C537	P-4382
T-8	Transformer, discriminator	55C183	P-4383
T-9	Transformer, modulation and audio output	50C548	P-4282-3
T-10	Transformer, oscillator (receiver)	50C549	P-4638
T-12	Transformer, oscillator (transmitter)	50C550	P-4639
T-13	Transformer, modulator plate	50C551	P-4640
T-14	Transformer, 1st and 2nd multiplier	50C552	P-4641
T-15	Transformer, 3rd multiplier	50C553	P-4642
T-16	Transformer, 4th multiplier	50C554	P-4643
T-17	Transformer, buffer.	-----	P-4644

SERVICE PARTS LIST TRANSMITTER-RECEIVER (Cont.)

Schematic Symbol	Description	Hallcrafters Part Number	Cross Reference
PLUGS AND SOCKETS			
PL-1	Plug, power supply	41B18762	-----
PL-2	Plug, handset	35-022	144-0006-00
SO-2	Socket, handset	10A491	145-0003-00
SO-3	Socket, antenna	10A490	P-4261
	Socket, crystal	6A417	141-0012-00
	Socket, tube; 6 pin	6A418	141-0006-00
	Socket, tube; 9 pin	6A419	141-0004-00
TUBE COMPLEMENT			
V-1,18	1AD4: 1st RF amplifier and 3rd multiplier	90X1AD4	140-0002-00
V-2,3,6,10,16,17	CK5678: 2nd RF amplifier, 1st mixer, 2nd mixer, audio amplifier, 1st multiplier, 2nd multiplier	90XCK5678	140-0015-00
V-4,5,7,8,9,11	2E32: 1st IF amplifier, 2nd IF amplifier, 3rd IF amplifier, 1st limiter, 2nd limiter, oscillator (receiver)	90X2E32	140-0004-00
V-12	2E41: squelch	90X2E41	-----
V-13,14,15	CK5672: oscillator (transmitter), modulators	90XCK5672	140-0013-00
V-19	CK5676: 4th multiplier	90XCK5676	140-0014-00
V-20	CK5676: buffer (models LBS and LWS)	90XCK5676	140-0014-00
V-20	CK573AX: buffer (model HWS)	90XCK573AX	140-0012-00
V-21,22	CK573AX: final amplifiers	90XCK573AX	140-0012-00
MISCELLANEOUS PARTS			
	Antenna (specify operating frequency)	57-159	P-4199-A
	Cord, handset; coiled	87-3567	131-0002-00
GR-1,2	Crystal diode, germanium	19A1879	149-0005-00
X-1	Crystal, receiver (specify frequency)	19A1880	Knights Type H17
X-2	Crystal, transmitter (specify frequency)	19A1881	Knights Type H17
	Handset	85-125	131-0001-00
	Handle for case	41B18707	P-4143
	Hinge pin	74A554	P-4702-3
	Knob, volume control	15-502	126-0001-00
	Latch (top section)	30A248	P-4276-1
	Operating and Service Instructions	94X902	-----
RY-1	Plug, button	17-123	129-0006-00
	Relay	21B139	150-0001-00
	Ring, retaining; for mtg. 6 pin tube sockets	76A917	130-0004-00
	Ring, retaining; for mtg. 5 pin tube sockets	76A918	130-0003-00
	Top compartment of case	66C824	P-4758

SERVICE PARTS LIST HT-21 HWS POWER SUPPLY

Schematic Symbol	Description	Hallcrafters Part Number	Cross Reference
POWER SUPPLY ASSEMBLY (COMPLETE)			
	Power supply, model HWS; complete and assembled in bottom compartment of case; does not include batteries	41X18714	-----
CAPACITORS			
C-101,102	250 mmf, 500 V., mica; toothpick type	47A279	172-5000-00
C-103	.5 mfd, 100 V., tubular	46A196	173-0005-00
C-104	.004 mfd, 160 V., tubular	46A195	173-5001-00
C-105A & B	Dual 30 mfd, 250 V., electrolytic	45A202	170-0002-00
RESISTORS			
R-101	220 ohms 1/2 watt, wirewound	241RX221E	161-0072-00
COILS AND TRANSFORMERS			
L-101	Choke, RF	53A261	136-0003-00
T-101	Transformer, vibrator	52-252	134-0003-00
PLUGS AND SOCKETS			
PL-102	Plug, 1 pin; for test meter	35A023	144-0001-00
PL-103	Plug, battery connector	41X18756	-----
SO-101	Socket, power supply	6A426	P-4756-1
SO-102	Jack, insulated; for test meter	6A424	141-0001-00
SO-103	Socket, battery charging	6A431	141-0002-00
SO-104	Socket assembly, battery connector	41X18711	-----
	Consists of the following:		
	Socket plastic body	35-024	P-4457-4
	Retainer, bottom; plastic	8A1772	P-4457-5
	Contact, small	18-113	128-0002-00
	Contact, large	18-114	128-0001-00
	Socket, vibrator	6A425	141-0007-00

SERVICE PARTS LIST HT-21 HWS POWER SUPPLY (Cont.)

Schematic Symbol	Description	Hallcrafters Part Number	Cross Reference
MISCELLANEOUS PARTS			
SR-101,103,104,105	Rectifier, selenium; 50 ma.....	27A165	149-0003-00
SR-102,106	Rectifier, selenium; 65 ma.....	27A166	149-0004-00
E-101	Vibrator.....	27B177	143-0002-00
S-101	Switch, on-off; spst.....	60-484	138-0001-00
	Battery, 2 volt storage; Willard ERH-25-2.....	27B164	121-0002-00
	Bottom compartment of case.....	66C823	P-4725
	Bushing, polystyrene; mounted on side of case.....	77A564	P-4332
	Latch (bottom section).....	30A249	P-4276-2
	Tube, battery ventilation; rubber.....	8A1786	P-4736-1

SERVICE PARTS LIST HT-21 LWS POWER SUPPLY

Schematic Symbol	Description	Hallcrafters Part Number	Cross Reference
POWER SUPPLY ASSEMBLY (COMPLETE)			
	Power supply, model LWS; complete and assembled in bottom compartment of case; does not include batteries.....	41X18731	-----
CAPACITORS			
C-201,202,203	250 mfd, 500 V., mica; toothpick type.....	47A279	172-5000-00
C-204	.5 mfd, 100 V., tubular.....	46A196	173-0005-00
C-205	.013 mfd, 600 V., tubular.....	46A201	173-5002-00
C-206A & B	Dual 20 mfd, 250 V., electrolytic.....	45A202	170-0002-00
RESISTORS			
R-201	220 ohms 1/2 watt, wirewound.....	24BX321E	161-0072-00
R-202	510 ohms 1/2 watt, carbon.....	23X20X511K	160-0081-00
COILS AND TRANSFORMERS			
L-201	Choke, RF.....	53A261	136-0003-00
T-201	Transformer, vibrator.....	52-253	134-0004-00
PLUGS AND SOCKETS			
PL-202	Plug, 1 pin; for test meter.....	35A023	144-0001-00
PL-203	Plug, battery connector.....	41X18756	-----
SO-101	Socket, power supply.....	64A426	P-4756-1
SO-202	Jack, insulated; for test meter.....	64A424	141-0001-00
SO-204	Socket, battery charging.....	64A431	141-0002-00
	Socket assembly, battery connector.....	41X18711	-----
	Consists of the following:		
	Socket plastic body.....	35-024	P-4457-4
	Retainer, bottom; plastic.....	8A1772	P-4457-5
	Contact, small.....	18-113	128-0002-00
	Contact, large.....	18-114	128-0001-00
	Socket, vibrator.....	64A425	141-0007-00
MISCELLANEOUS PARTS			
E-201	Battery, 2 volt storage; Willard ER-11-2.....	27B168	121-0001-00
S-201	Vibrator.....	27B167	143-0001-00
	Switch, on-off; spst.....	60-484	138-0001-00
	Bottom compartment of case.....	66C818	P-4704
	Bushing, polystyrene; mounted on side of case.....	77A564	P-4332
	Latch (bottom section).....	30A249	P-4276-2
	Tube, battery-ventilation; rubber.....	8A1750	P-4424-1

SERVICE PARTS LIST HT-21 LDS POWER SUPPLY

Schematic Symbol	Description	Hallcrafters Part Number	Cross Reference
PLUGS AND SOCKETS			
	Battery connector assembly (for battery BA-301).....	87-3587	121-0003-00
	Plug, battery; 2 prong.....	10A227	132-0003-00
	Plug, battery; 3 prong.....	10A284	132-0004-00
SO-101	Socket, power supply.....	6A439	P-4756-1A
MISCELLANEOUS PARTS			
	Bottom compartment of case.....	66C826	P-4785
F-301	Fuse, 1/16 amp.....	39-374	124-0003-00
	Latch (bottom section).....	30A249	P-4276-2
S-301	Switch, on-off; spst.....	60-499	138-0007-00

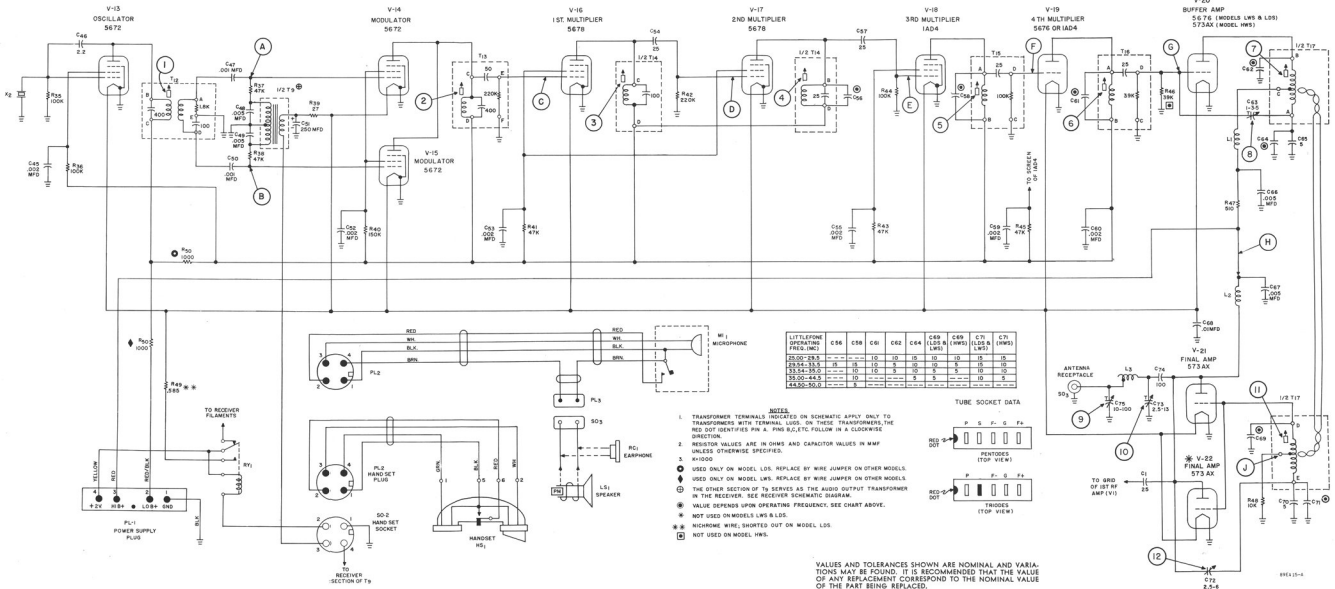
**MODEL HT-21 HWS
POWER SUPPLY**



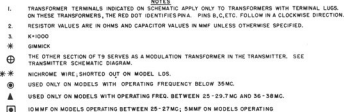
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POWER SUPPLY**



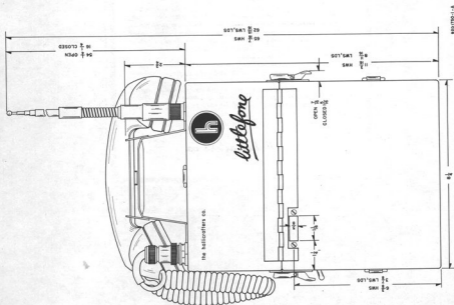
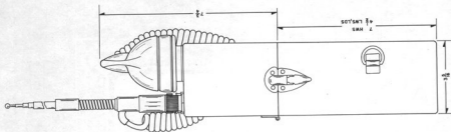
(TRANSMITTER SECTION)



(RECEIVER SECTION)



VALUES AND TOLERANCES SHOWN ARE NOMINAL AND VARIATIONS MAY BE FOUND. IT IS RECOMMENDED THAT THE VALUE OF ANY REPLACEMENT CORRESPOND TO THE NOMINAL VALUE OF THE PART BEING REPLACED.



Warranty

"The Hallicrafters' Company warrants each new radio product manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture which under normal installation, use and service discloses such defect, provided the unit is delivered by the owner to our authorized radio dealer, wholesaler, from whom purchased, or, authorized service center, intact, for examination, with all transportation charges prepaid within ninety days from the date of sale to original purchaser and provided that such examination discloses in our judgment that it is thus defective.

This warranty does not extend to any of our radio products which have been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation, or to use in violation of instructions furnished by us, nor extend to units which have been repaired or altered outside of our factory or authorized service center, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith not of our own manufacture.

Any part of a unit approved for remedy or exchange hereunder will be remedied or exchanged by the authorized radio dealer or wholesaler without charge to the owner.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of our radio products."

Form No. 948A22

the Hallicrafters co.