History of Ham Radio

(1925 -1955)

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Sept 21, 2021

Agenda

- 1920's: Modern era established
- 1930's: Technology evolution
  - Electronic advancements
  - McGill ARC station (1931)
  - Amelia Earhart's radio (1937)
- 1940's: Radio technology
  - WW2 HF aircraft radio
  - Radar technology
  - WW2 VHF aircraft radio
  - Band re-allocations
  - Emerging technologies
- 1950's: Golden era
  - Homebrew stations
  - Surplus conversions
  - Kit radios
  - Appliances

1920's: The Modern Era

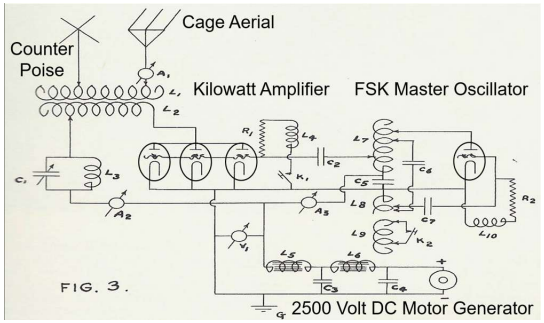
In the 1920's, the following pivotal events launched the modern amateur radio era:

- 1921: Atlantic finally spanned on 200 meters by amateurs responding to transatlantic challenge
- 1923, 1924: Two way amateur inter-continental communication was achieved
- 1924, 1927: Amateurs get assigned fixed bands on 160, 80, 40, 20, 10 and 5 meters
- 1926: Spark gap is banned on all amateur radio bands. Amateur radio is now fully electronic.
- 1927: International callsign prefixes are assigned

Radio Equipment

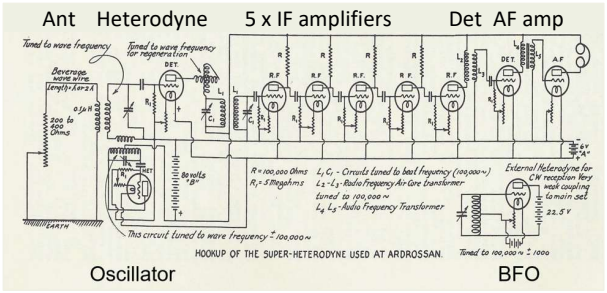
Transmitters use MOPA (Master Oscillator Power Amplifier) architecture

- Crystal control not economically viable yet
- Transmitting tubes are expensive, audio output tubes often used in TX RF stages

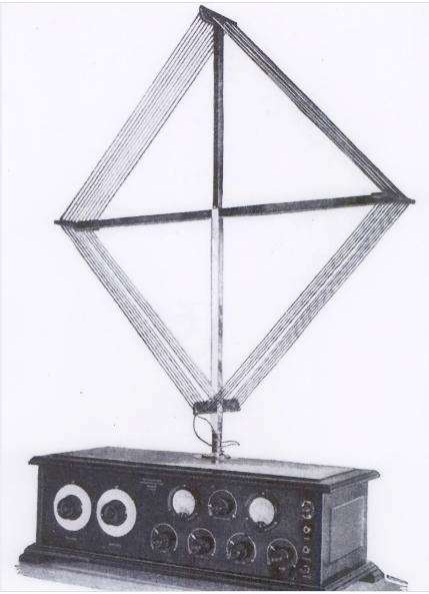


Receivers take the following forms heading into the 1930's:

- Super-heterodyne: Superior receiver performance, more complex to build
- Regenerative: Regen detector with RF and AF stages, much easier to build



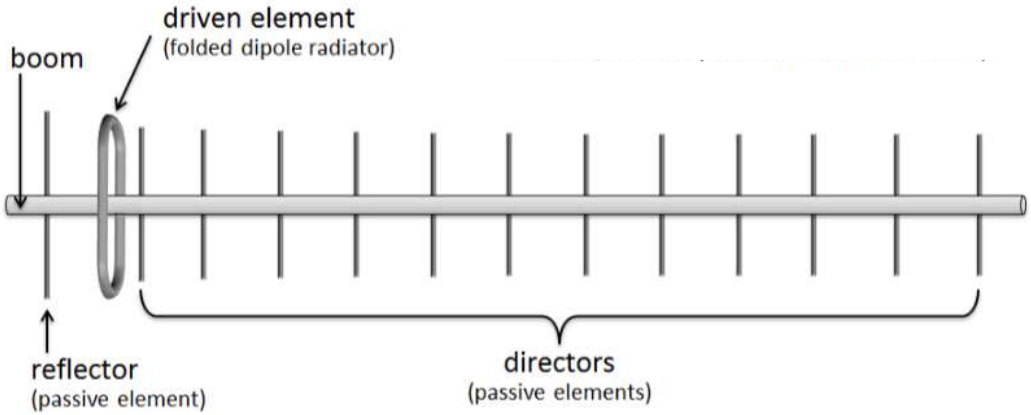
Antenna Technology



- Directional nature of antennas was known by both Hertz and Marconi
- Rotatable M-field antennas (i.e. directional loops) were common in the 1920s

1926: Shintaro Uda and Hidetsugu Yagi invented modern directional antenna (Uda-Yagi)

- Created antenna with multiple parallel resonant elements with significant directional gain
- Three basic elements: reflector, driven element and director element
- Destructive interference on reflector end and constructive interference on director end
- Widespread during WW2 on Allied and Axis aircraft for airborne radar
- Some amateur use during the 1930s, mainly on VHF bands
- Ubiquitous in post-war era as UHF/VHF broadcast television and ham VHF/HF antennas



1930’s

<u>Worldwide communication becomes commonplace</u>

Operating awards are introduced

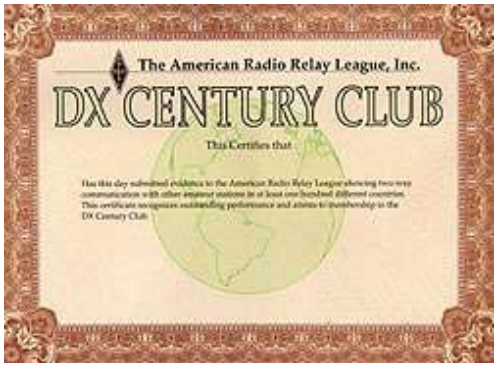
- DXCC (150 countries)
- WAS (48 states)
- WAC (6 continents)

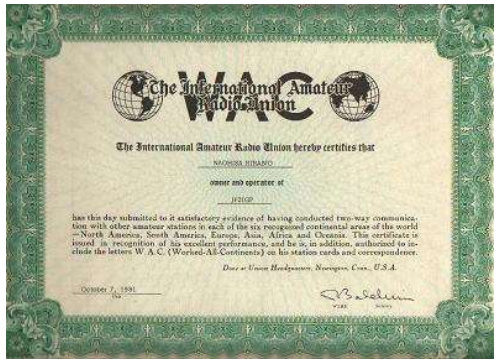
VHF Operation

- Technology limits VHF operation to 5, 2.5 and 1.25 meter bands

Radio Technology

- Difference between 1920’s and 1930’s radio technology is substantial
- Availability of electronic components widespread and prices drop substantially
- More selective and sensitive receivers are possible
- More stable and powerful transmitters are possible



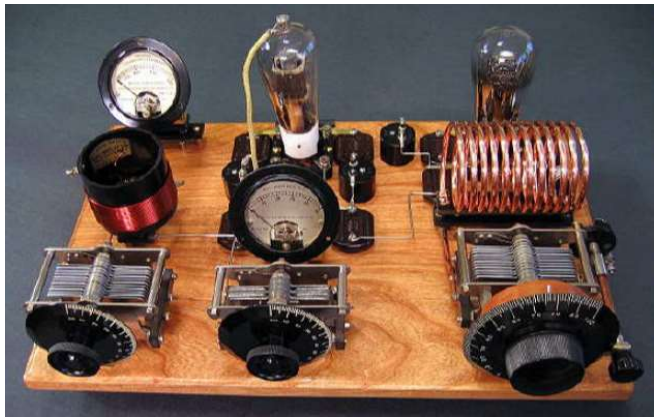


1930’s

<u>Construction medium changes from wood to metal</u>

1920’s: Breadboard (or wooden base) with Bakelite front panel

- Easy to build with simple tools: hand drill and screwdriver
- Electrical connections can be created (screwed) directly on wood (insulator)
- Bad RF performance without metal shield on base
- Instability increases as frequency increases



1930’s: Full metal chassis and metal panel

- More effort required to build: electric drill, chassis punches, file set
- Electrical connections require terminal strips
- Better RF performance: good grounding and shielding
- Stability good with HF and VHF frequencies

1930's

Transmitters become cheaper and more stable

Transmitting tube prices drop significantly in the 1930's

1921: 50 watt tube = $30.00 250 watt tube = 110.00

1937: 50 watt tube = $7.50 200 watt tube = $21.50

Crystals are affordable and widely used in transmitters

- Rock bound transmitters much more stable than LC based transmitters

Receivers are more sensitive and selective

- 1920's: Primitive "Balloon" tubes; 4, 5 ,6, 7 pin base; triodes and tetrodes
- 1930's: Metal (shielded) octal tubes; pentodes and multi-element

➔ Newer tubes are more sensitive and more stable (shielded + less microphonic)

1931: McGill Amateur Radio Club

December, 1931 QST featured McGill ARC (then VE2CP, now VE2UN)

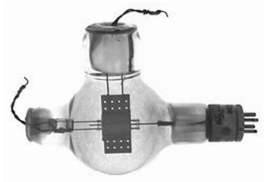
Club founded in 1921 ➔ 100th anniversary in 2021.

<u>HV power supply</u> consisted of the following antiquated items:

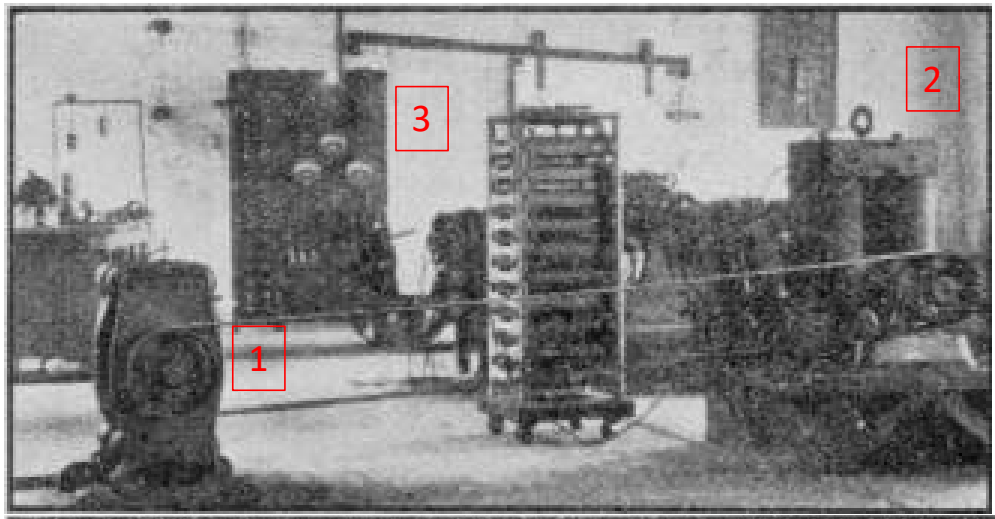
1. 3 KW street lighting DC generator (1500 volts)
2. Belt driven by AC motor
3. Control panel for motor and generator

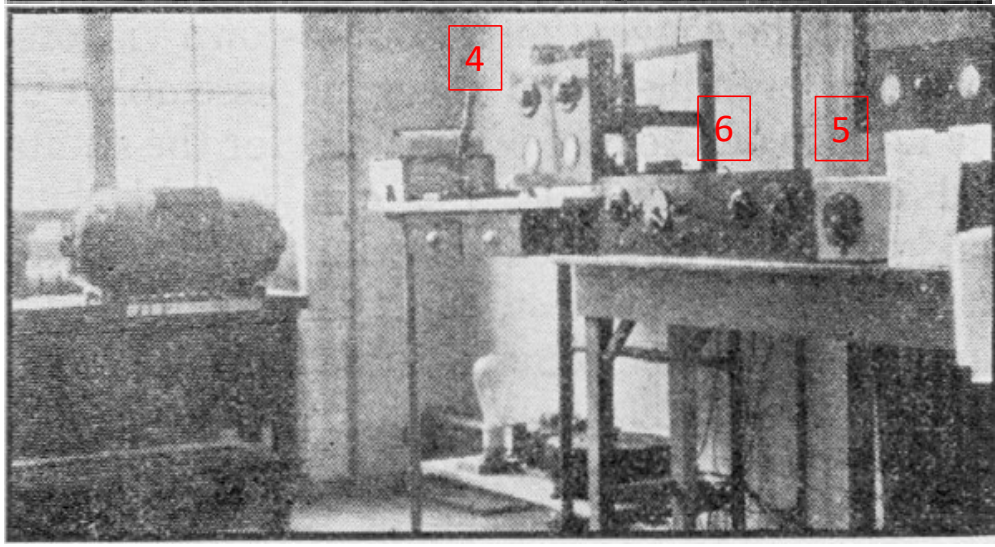
<u>Actual radio station</u> consisted of the following equipment:

4. 100 watt Tx with UX852 as tuned-plate tuned-grid oscillator



5. Antenna Tuner
6. Receiver used 224 space charge detector and two 227's AF amp





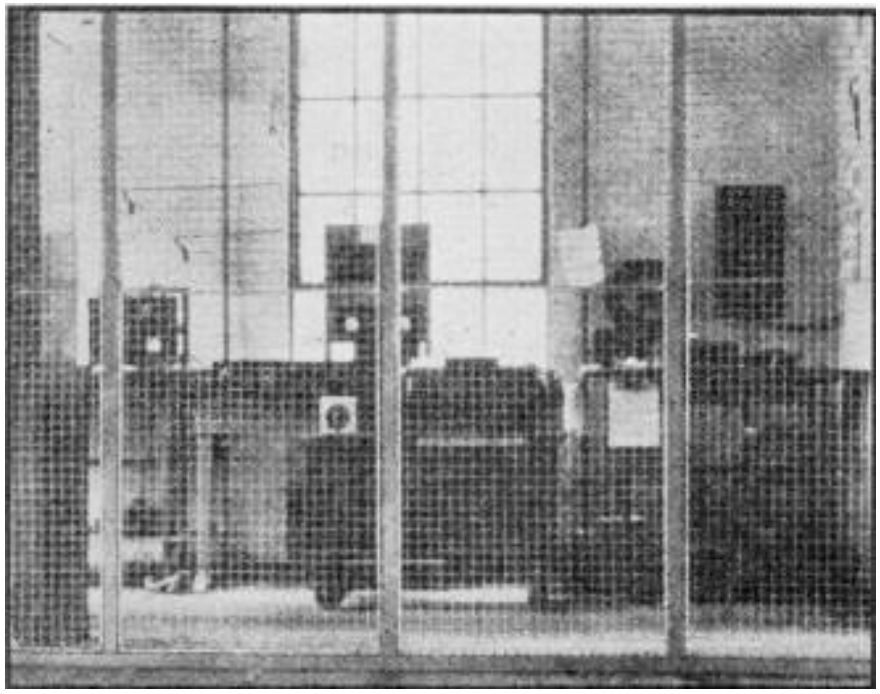
1931: McGill Amateur Radio Club

Station environment was very dangerous and was enclosed behind metal cage

Cross-referencing Dec 1931 QST article with 1931 McGill yearbook

➔ Specified station's range consistent with equipment described in QST article

- Canada, US north east, southern & western states and Cuba
- McGill ARC members sent messages on behalf of fellow students



Cipriani Mastrianni Dr. Howes Ross Johnson

The Radio Association

President: ANDY CIPRIANI Vice-President: BOB JOHNSON
Secretary-Treasurer: DON ROSS

THE McGill Radio Association got away to a flying start early last October when the first meeting for the season 1930-31 was held. The President, A. J. Cipriani, pointed out the benefits to be derived from the organization and extended a hearty welcome to all new members. Following this address, M. A. Mastrianni was elected Secretary for the coming year.

The activities of the Association have, since then, been of a high calibre. With H. Ross Smyth, R. E. L. Johnson, and M. A. Mastrianni filling the positions of code instructors, the new members who were as yet unlicensed operators quickly learned the code and became accustomed to general operating practices. Early in December, the Government Radio Inspector addressed the members of the Association and conducted an examination for the members desiring to obtain operating certificates. All of the members taking this examination were successful.

The 100-watt short wave transmitter was put into operation early in October, operating under the call letters VE2CP. As the operating staff consists of twelve operators, the station is on the air for the greater part of the day, as each operator has a definite operating time. Traffic is handled daily by the station, and messages for all parts of Canada and the United States are quickly put through. McGill students availed themselves of the opportunity of sending Christmas and New Year greetings free of charge via VE2CP. Numerous contacts have been made with several provinces of Canada and all of the New England and Atlantic States, while contacts with many western and southern states and Cuba are not infrequent.

The Radio Association is the only means offered by the University of obtaining code instruction and practical operating experience.

1930's

<u>Commercial ham receivers start to appear on market</u>
Priced out of reach for most hams. Homebrew radios dominate for next 2 decades

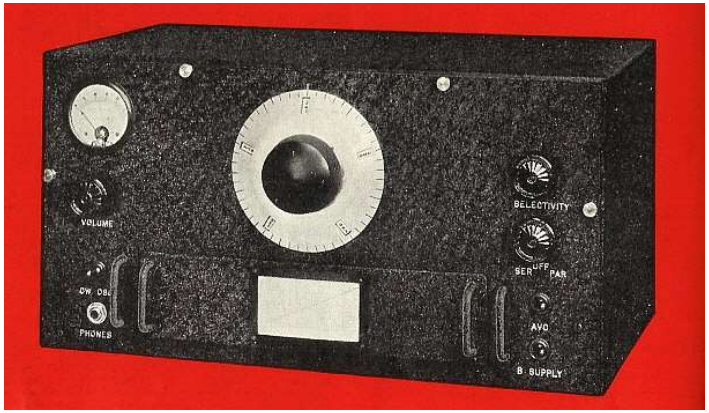
Radio Manufacturer Engineers: RM-69 (0.5 to 31 Mhz) with dual dials
- 9 tube superheterodyne, $135 (1935)➔ $2700 (2021)

Hallicrafters: Super Skyrider (0.5 to 62 Mhz)
- 7 tube superheterodyne, $150 (1937)➔ $2900 (2021)

National : HRO (1.7 to 30 Mhz), Individual plugin drawer per band
- 10 tube superheterodyne, $300 (1937)➔ $5800 (2021)

Hammurlund: Super Pro (0.54 to 20 Mhz)
- 16 tube superheterodyne, $380 (1937)➔ $7000 (2021)

RCA: CGR-32-1 (1.5 to 26 Mhz)
- 10 tube superheterodyne, $495 (1937)➔ $9900 (2021)
- Used on USCGC Itasca, Amelia Earhart's tracking ship



Radio Direction Finding

1) <u>Ground based RDF</u> (Transmitter Location)

a) Via 2 or more receiving stations, transmitter location found via triangulation

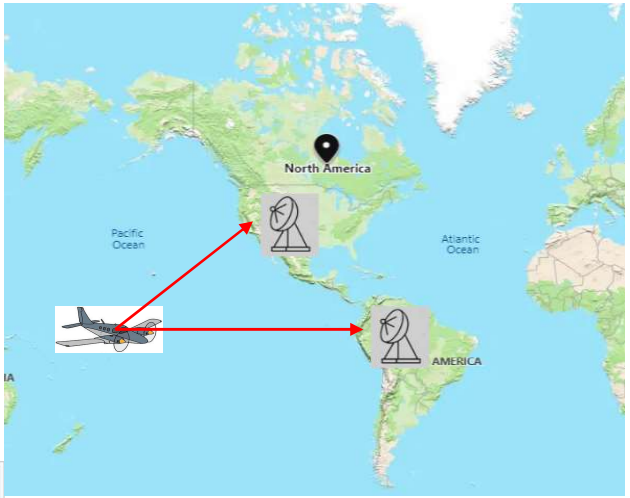
b) Alternatively, one Rx station can be used with 2 or more fixed antennas

1909: Ettore Bellini and Alessandro Tosi invented first practical RDF system

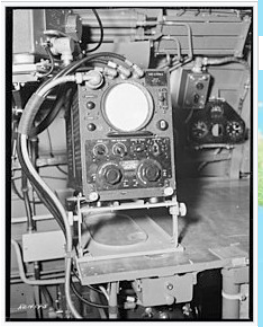
- Two fixed antennas at 90° and small rotating loop (radiogoniometer)

1935: Robert Watson-Watt improves B-T RDF with 4 x antennas and CRT

- Faster than B-T RDF system, almost instantaneous



2) <u>Air based RDF</u> (Radio Navigation)

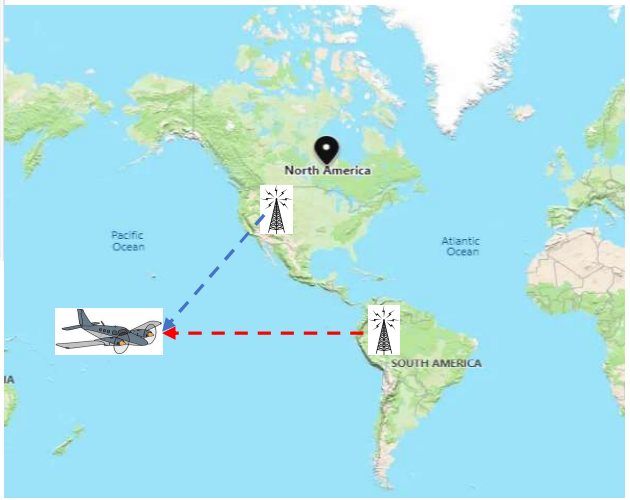


a) One lone ground station can provide bearing for radio compass.

b) Via 2 or more ground stations, aircraft finds its location by triangulation

RDF is quantum leap in navigation compared to celestial navigation

- Post WW2, LORAN is primary nautical navigation system
  - Location determined via time delay between pair of stations
- Post WW2, VOR (VHF Omnidirectional Range) is primary aviation navigation system
  - Direction via phase delay between sweeping signal and “North” reference signal
- GPS replaces LORAN starting in 1980 and majority of VOR sites in 2000’s



Amelia Earhart

Amelia Earhart, famous aviator with radio (KHAQQ) on board

- Her radio setup exemplified mid-1930's radio technology

Lost at sea during global circumnavigation attempt

- Disappeared crossing Pacific ocean near Howland Island

Amelia Earhart

- Developed interest in flying at Toronto CNE airshow in 1920
- Became #16 FAI licensed woman pilot in 1921
- Solo crossing of the Atlantic in 1932 in Lockheed Vega 5B
- First solo flight California to Hawaii in 1935

Global Circumnavigation

1519: Ferdinand Magellan took 3 years to circle globe by ship

1930: First global circumnavigation in Zeppelin by Hugo Eckener

1931, 32: First global circumnavigation in airplane by Wiley Post

- Both times over Europe and Russia

1937: First global circumnavigation attempt by woman

- Lockheed Electra 10E with navigator Fred Noonan
- Flew the more difficult equatorial route

Amelia Earhart & Fred Noonan

Howland Island

1937 Amelia Earhart flight path

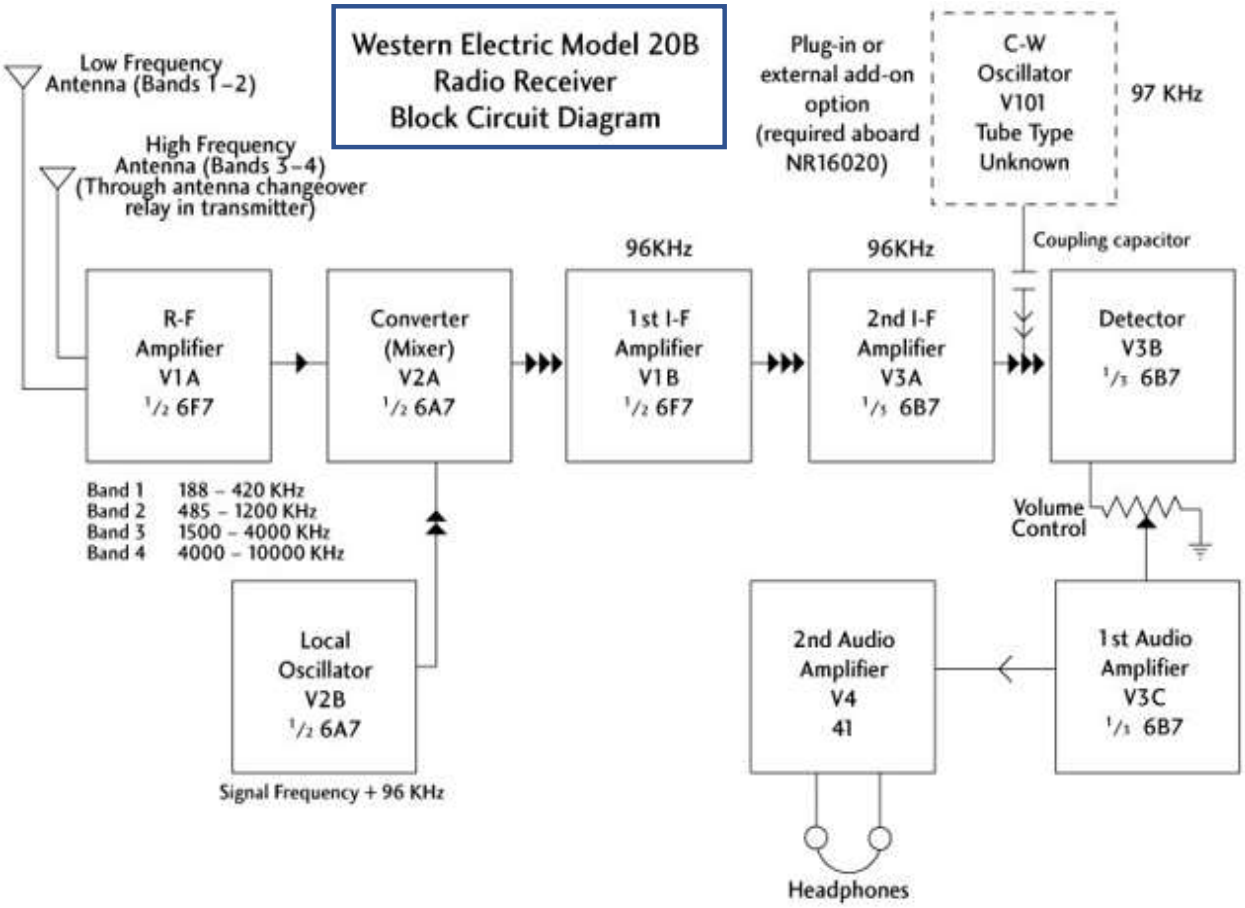
Amelia Earhart

Main Receiver: Western Electric Model 20B

- Typical 1930s four band receiver
- 5 x tube Superhet
- Coverage: 188 KHz to 10 MHz
- AM/CW capability
- Model 27A remote control head

20 B Radio Receiver with 27 A Control Unit

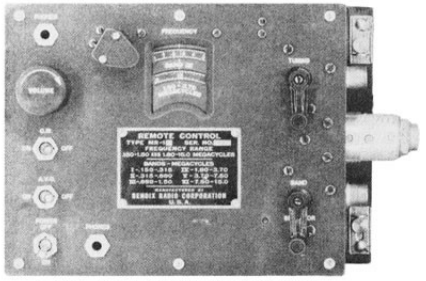
Figure 184. Western Electric Airplane Receiver for Remote Control.



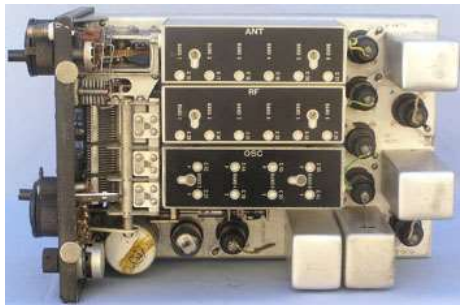
Amelia Earhart

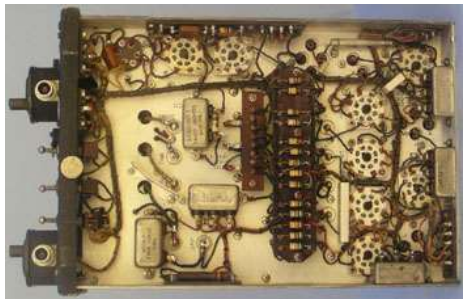
Compass Radio: Bendix RA-1B

- MR-1B control head in cockpit
- Radio compass indicator on dashboard between 2 yokes
- RA-1B MF Receiver (8 tube superhet)
  - Coverage: 150KHZ to 18 Mhz
- Loop Antenna for RDF



TYPE MR-1B REMOTE CONTROL

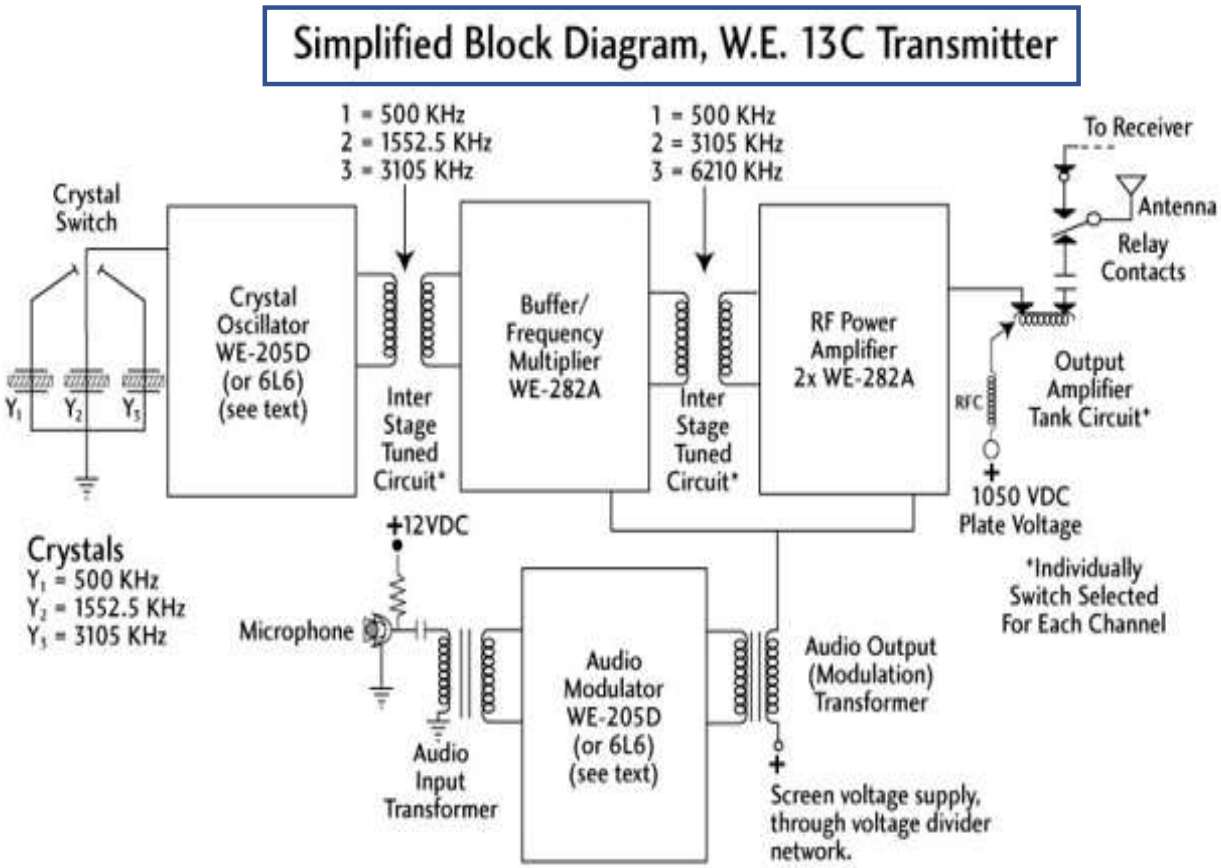




Amelia Earhart

Transmitter: Western Electric WE13C

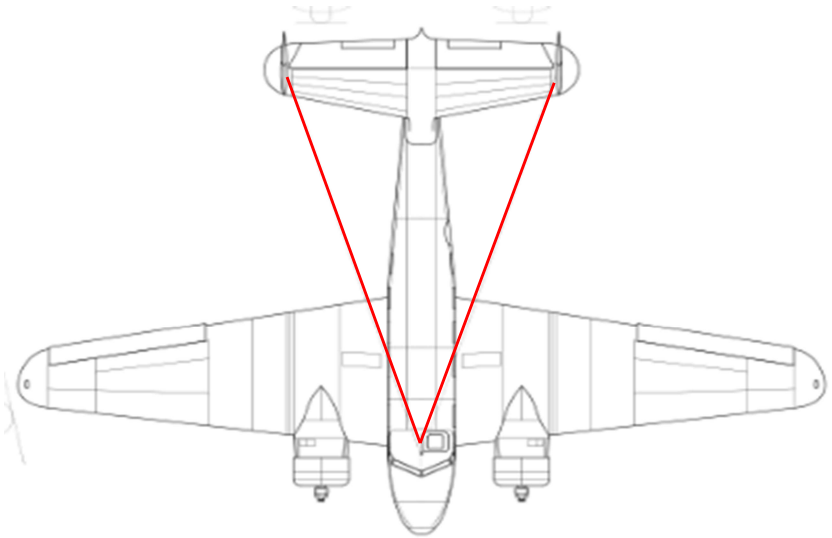
- AM screen modulated, CW capable
- Used carbon microphone (low fidelity)
- 50 watts output
- Xtal controlled
  - 500 Khz (emergency, navigation)
  - 3.105 Mhz (night)
  - 6.210 Mhz (day)

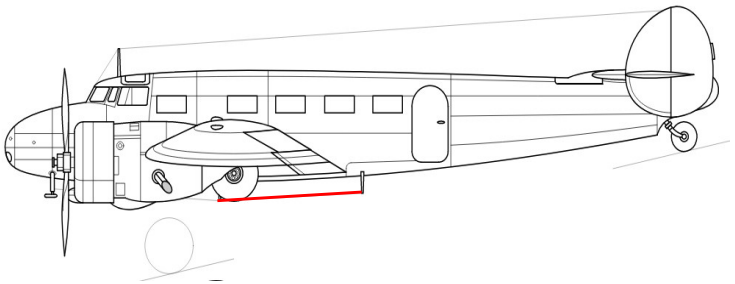


Amelia Earhart

Aircraft Antennas

- HF Ant 1: 46 ft “V” from stabilizers to fuselage mast (Tx only)
- HF Ant 2: Below fuselage belly (Rx only)
- MF Ant: 250 ft trailing antenna
- Loop antenna for RDF above cockpit

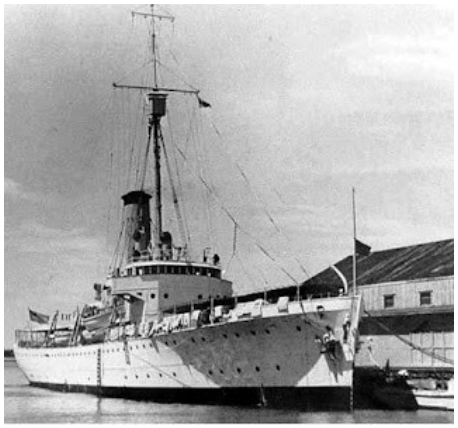




Amelia Earhart

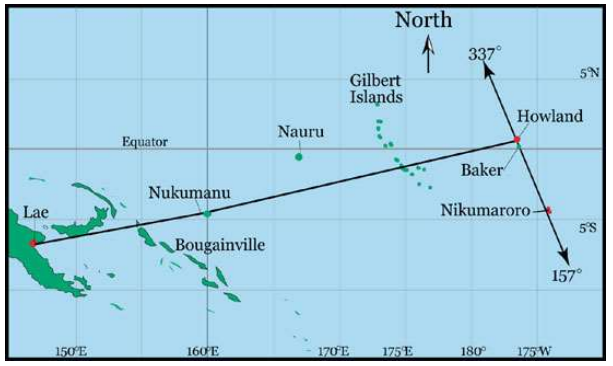
What happened ?

- Earhart left Lae, New Guinea; first 2000 mile stretch across Pacific ocean on July 2, 1937
- Running low on fuel and could not find Howland Island (2.5 km x 1 km)
- Noonan navigated by celestial navigation and RDF to USCGC Itasca near Howland Island
- Earhart preoccupied with aircraft weight and left behind the following key items :
  Trailing MF antenna, Bendix compass receiver + remote unit and Morse code key



USS Itasca

- USCGC Itasca could hear Earhart's transmissions. Last transmission was 8:43 AM
  "We must be on you, but cannot see you…we are flying on the line 157 337"
- Earhart could not hear the USCGC Itasca transmissions.
- Loss at sea due to one or more factors below:
  - Weather: Wind blowing South East and clouds hindered celestial navigation
  - Receiver failure: Blown fuse, dead tube or belly antenna damage ?
  - Overconfidence: Earhart flew previous segments mostly without RDF



Location of Earhart's 1st planned stop

Whereabouts of Earhart, Noonan and their plane never found

- Theory 1: Crashed into sea. Plane with no Avgas could have floated for a while
- Theory 2: Landed on Nikumaroro (Gardner) Island (360 miles south)

Nikumaroro (Gardner) Island

1967: Ann Pellegreno successfully completed Earhart's original route using Lockheed 10E with "modern" radio and navigation equipment

1940's: Aircraft Electronics

Typical large bomber during World War 2 had a crew of up to 10 members.
Pilot, copilot, navigator, radioman, bombardier, 5 gunners along aircraft
Level of onboard electronics greatly increased since 1930's.

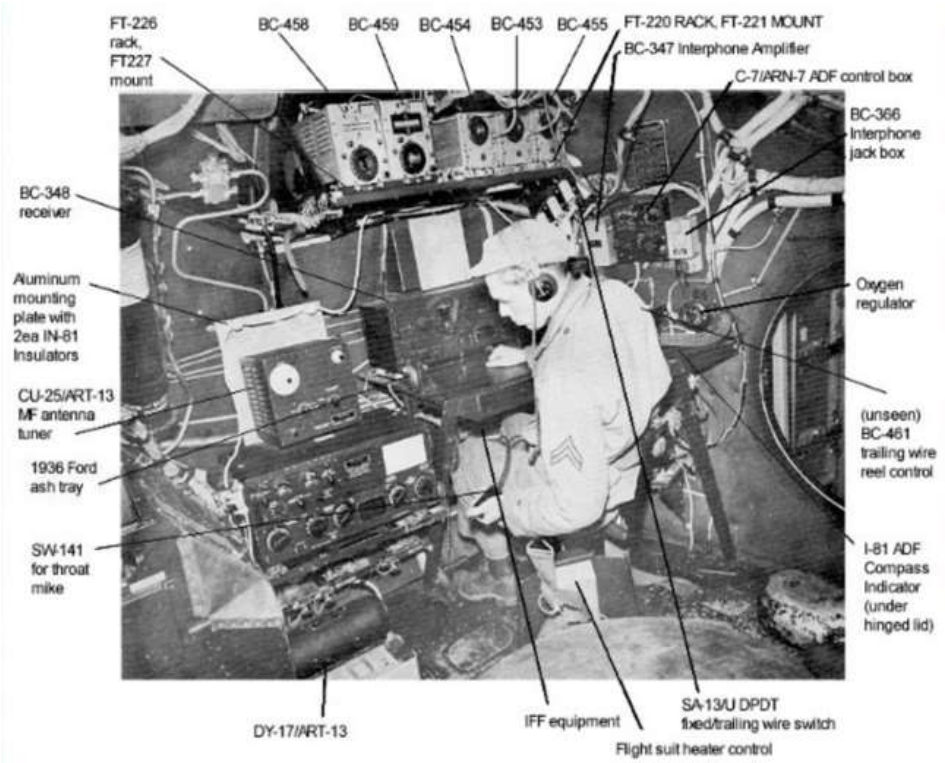
1. **Liaison radio:** Plane to ground base communication by radioman
Liaison transmitter was the BC-375E used with BC-348 receiver
Towards end of war, BC-375E replaced by more advanced ART-13.

2. Command radio: Plane to plane communication by pilot
SCR-274N command series with 3 x receivers and 2 x transmitters
They replaced similar looking black ARC5 radios earlier in WW2

3. Compass radio: Navigator would track beacon or find plane's position by triangulation of 2 or more ground stations. Compass radio BC-434A not in photo.
Compass receiver had directional loop antenna for 100-1500 kc.

4. Beacon radio: Rx for instrument landing during adverse conditions
A typical unit used on the B-24 was BC-357B which operated at 75 MHz

5. Interphone system. All crew stations had BC-366 jack box connected to central BC-347 interphone amplifier for headset and throat microphone.
Each member could select any radios and call other crew members via jack box.



1939-1945: Radios

Technology that won WW2, would gain a second life in many post-war ham stations

- BC375E – Liaison transmitter AM/CW using 1920's MOPA design. BC191 - Ground version
- BC348 – Liaison receiver superhet (200 KHz - 18 MHz) with crystal filter
- ART13 – Liaison Tx with 10 pushbutton pre-set frequencies, motorized tuning, PTO and Pi network
- SCR274 (ARC5) – Command VFO based Tx and superhet Rx
- Marconi T1154 Liaison Transmitter using 1920's MOPA design
- Marconi R1155 Liaison Receiver superhet (75 KHz - 18 MHz)

Lancaster RAF bombers
T1154 Tx & R1155 Rx

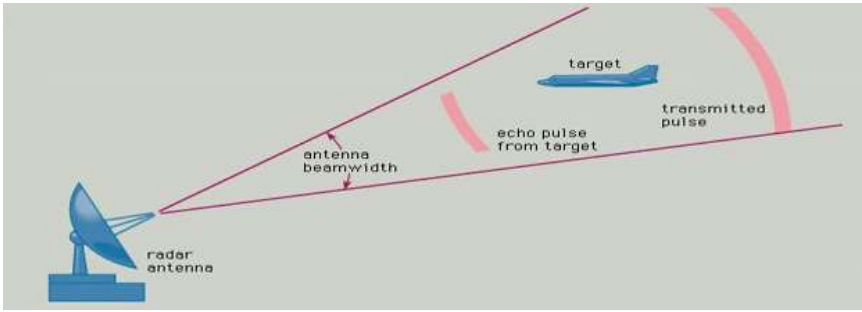
B17, B24, B25
BC375 Liaison TX

All US Bombers
BC348 Liaison RX

B29: Enola Gay and Bock's Car
Collins ART13 Liaison TX

Most US Aircraft
ARC5 / SCR274
Command RX/TX sets

Radar

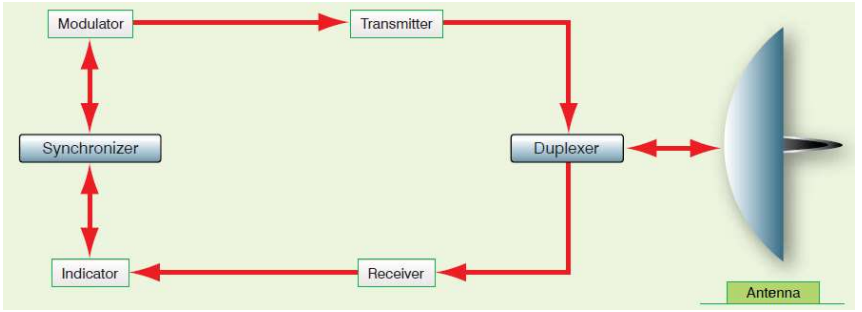


Radar developed in the pre-war era to track aircraft and ships

- Tx sends short RF burst periodically via rotating antenna
- Rx on same antenna measured return time of reflected RF signal
- CRT displays bearing and distance

1904: Christian Hülsmeyer invents spark gap based proto-radar

1935: Robert Watson-Watt invents electronic radar 60 mi (97 km)
Watson-Watt stopped for speeding in Canada in 1956 by police with radar gun
"Had I known what you were going to do with it I would never have invented it"
– Robert Watson-Watt



1938: British radar system "Chain Home" online 24 hours around the clock

Deployed against heavy German air attacks during "Battle of Britain"

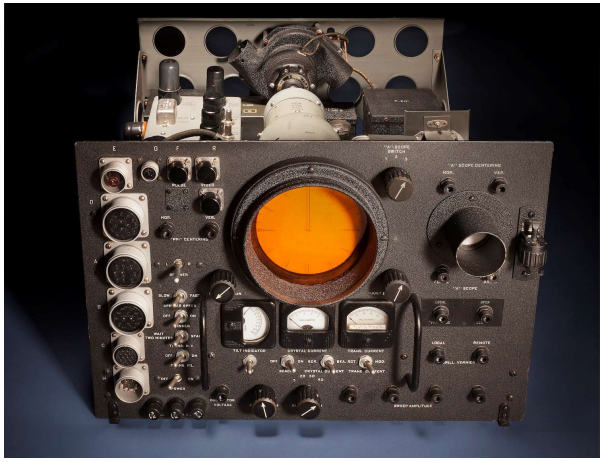
- Operated around 30 MHz (HF band), not optimal deployment
- Watson-Watt stated something that worked was better than nothing at all
- Range was 1.5 degrees above horizon or a few miles

1939: British physicists at University of Birmingham invented cavity magnetron oscillator (high power microwave oscillator)

First US Army Radars

- SCR-268 (@ 205 MHz) for controlling antiaircraft gunfire
- SCR-270 (@ 100 MHz) for detecting aircraft.
  Attacking aircraft at Pearl Harbor detected by 6 x SCR-270 installations in Hawaii,
  Blips were dismissed. Operator called superiors and blips were assumed to be B17s from San Francisco

Radar



Importance of radar in consumer electronics and amateur radio

Development of radar advanced VHF / UHF technology and general electronics.

- VHF / UHF transmitting and receiving tubes
- Magnetrons
- CRT displays and sweep electronics
- Microwave semiconductor diodes (e.g. 1N21, 1N23)

Made the following post war technological developments possible.

- VHF / UHF supported large bandwidth (i.e. 6 MHz) for television and FM radio (i.e. 200 KHz)
- Microwave ovens are possible thanks to magnetrons
- Aircraft communication and VOR (108-136 MHz)
- Amateur radio VHF / UHF equipment

1939-1945: VHF Technology

Surplus VHF/UHF radio equipment advanced the popularity of bands above 30 MHz

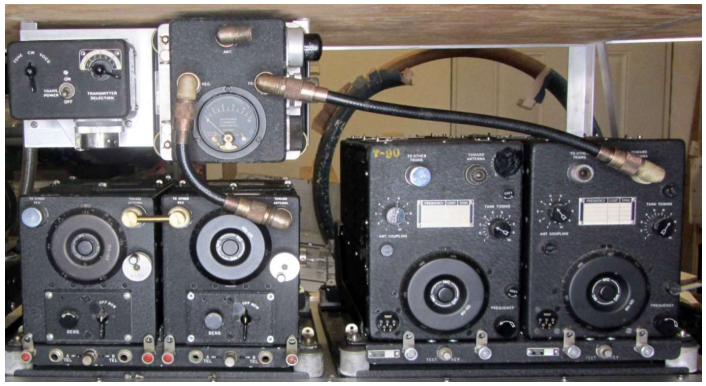
- Pre-WW2, operating on frequencies above 30 MHz was extremely difficult
- Very VHF/UHF few tubes and equipment existed

Post WW2 era

- Decommissioned radar and VHF command sets flooded the surplus market
- Cheap surplus radios became a very inexpensive and easy way to get on VHF
- Most were crystal controlled

UK, Canada & Russia
No.19 Tank transceiver
(HF and VHF **229-241 MHz**)

ARC-3 Aircraft VHF Transceiver
100-156 MHz



ARC-5 VHF Aircraft command sets T-90, R-113
100-156 MHz

SCR522 Aircraft VHF Transceiver
100-156 MHz

Band Reallocation

160 meters:

- After WW2, LORAN navigation systems are heavy users of 160 meters
- Severe 160 meter restrictions imposed until 1980: power levels, time of day, geography (coastal vs inland)

15 meter band:

- CW introduced in 1952 and phone permitted in 1953

11 meter band:

- Introduced in early 1950's for amateur radio service and reallocated on Sept 11, 1958 for CB usage
- In 1963 CB operators would outnumber ham operators.

10 meter band:

- Upper 0.3 MHz taken away from amateur radio service in 1947

Existing VHF bands are reallocated and **new bands added:**

- 5 meter band (56-60 Mhz) reassigned to 6 meters (50-54 Mhz)
- 2 ½ meter band (112-118Mhz) reassigned to 2 meters (144-148 Mhz)
- 1 ¼ meter band (224-230 Mhz) reassigned to 220-225 Mhz
- UHF bands from starting 420 MHz to 20 GHz added to amateur radio frequencies

CW and AM predominant modes until late 1950's

SSB would overtake AM in the 1960's

Emerging Technologies

Transistor

- Invented in 1948 by Bell labs team: Shockley, Bardeen and Brattain
- Used in hearing aids, portable AM radios and computers in 1950's
- Not widespread in amateur radio until 1960's and 1970's

SSB

- Theorized in 1921 by John R. Carson, first amateur SSB transmission in 1934.
- SSB starts to displace AM as predominate voice communication mode in early 1960's

Television (Fast Scan)

- Commercial broadcasting start post-WW2
- Amateur radio TV operation delayed until affordable surplus cameras become available
- Operation on 450 MHz or higher because of high bandwidth required (4MHz)

RTTY

- Amateur radio operation as surplus Model 26 machines become available
- First digital mode used in amateur radio. Initially using ASK, then FSK
- Eventually Model 33 ASR units become the standard for ham radio operation

1950s: Golden Era

Prior to WW2, almost all ham equipment was homebrewed.

Post-WW2 amateur radio landscape significantly changes due to WW2 surplus and economic boom.

Hams now had several options to get on the air as opposed to just one pre-war (i.e. homebrew).

1. Homebrewers:

- Make their own chassis, wind own coils, build equipment up from discrete parts
- WW2 Surplus made quality RF components and transmitting tubes available for well below actual cost

2. Converters / repurposers:

- Hams convert non-ham radios to work on ham bands
- Many WW2 surplus HF and VHF radios convertible to ham radio with minimal to moderate effort and cost

3. Kit builders:

- All parts provided, but skill is still required (soldering, wiring, etc.)
- Post WW2 economic strength of US and Canada results in more disposable income to purchase kits

4. Appliance Users:

- Use separate commercial receivers and transmitters. Transceivers start to appear in the 1960s
- Use commercial mostly equipment and might setup own antenna
- Post WW2 economic strength of US and Canada makes commercial radios more affordable

Homebrewers

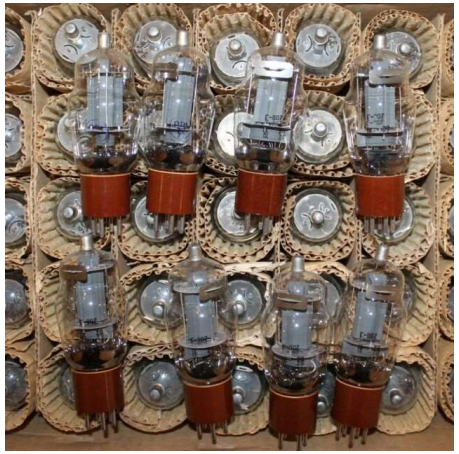
Principal way of getting on the air since Marconi's time.

- Homebrewing started declining in 1950's with the popularity of kits and commercial radios

Post-WW2 era had an abundance of surplus parts

- Amateurs built HF equipment that operated above QRP range thanks to cheap surplus HF tubes: 807, 1625, 211, 811, 813
- VHF / UHF bands opened up thanks to cheap surplus VHF /UHF Rx and Tx tubes: 9001, 9002, 9003; 829, 4D21, 2C39
- Quality RF components salvaged from WW2 equipment helped construct radios that were good performers

➔ Common practice was using homebrew transmitter with commercial receiver



Conversion

Post-WW2 era flooded with surplus radio equipment.

Many stores catered to this market

Most famous area was NYC radio row, razed in 1960's to make way for WTC towers

Many military radios could be made useable for amateur radio with minor mods

- ARC5/SCR274 command Rx/Tx
- BC348 receiver and ART13 transmitter
- ARC-3, ARC-5 VHF and SCR-522 VHF transceivers

Some radios not useable without major modifications

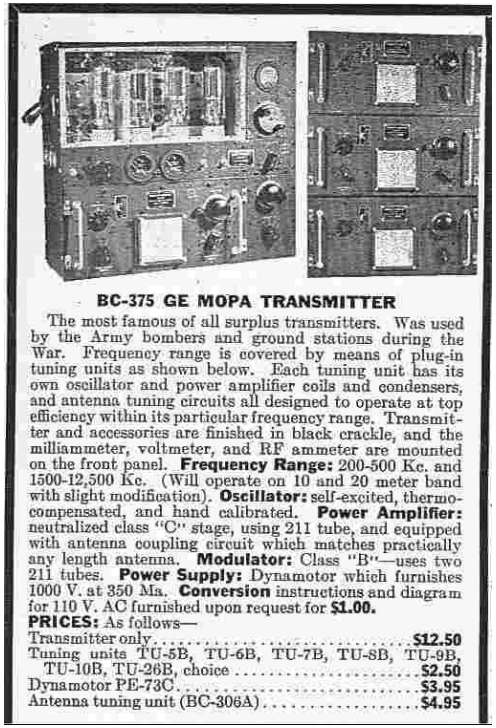
- BC375 transmitter (1948 as low as $12.50)

"Keys to the kingdom" are in 3 books published in 1948 by Evenson and Beach

- Surplus Radio Conversion Manual Vol 1, 2 and 3
- Provide details for mods needed for ham radio operation

<u>Common mods included the following:</u>

- HF frequency mods not needed. VHF radios require Xtal change
- Convert power for 28 DC volts to 110 AC volts
- Add Rx volume control, alter AF output Z from 600 to 8 ohms
- Tx carbon microphone input to dynamic microphone input
- Antenna input/output impedance to 50 or 75 ohms

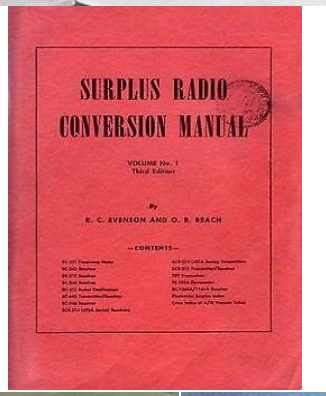


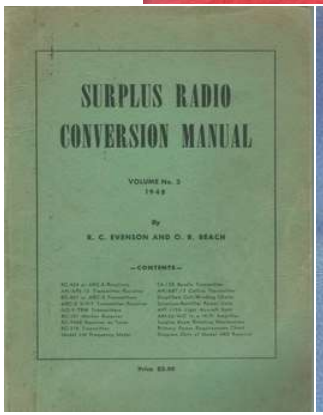
BC-375 GE MOPA TRANSMITTER

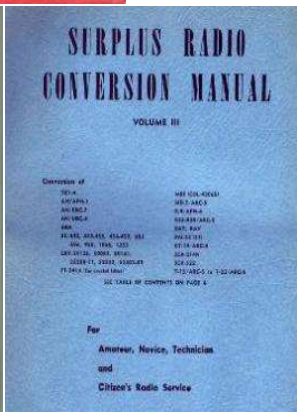
The most famous of all surplus transmitters. Was used by the Army bombers and ground stations during the War. Frequency range is covered by means of plug-in tuning units as shown below. Each tuning unit has its own oscillator and power amplifier coils and condensers, and antenna tuning circuits all designed to operate at top efficiency within its particular frequency range. Transmitter and accessories are finished in black crackle, and the milliammeter, voltmeter, and RF ammeter are mounted on the front panel. **Frequency Range:** 200-500 Kc. and 1500-12,500 Kc. (Will operate on 10 and 20 meter band with slight modification). **Oscillator:** self-excited, thermo-compensated, and hand calibrated. **Power Amplifier:** neutralized class "C" stage, using 211 tube, and equipped with antenna coupling circuit which matches practically any length antenna. **Modulator:** Class "B"—uses two 211 tubes. **Power Supply:** Dynamotor which furnishes 1000 V. at 350 Ma. **Conversion** instructions and diagram for 110 V. AC furnished upon request for **$1.00.**

PRICES: As follows—

Transmitter only	**$12.50**
Tuning units TU-5B, TU-6B, TU-7B, TU-8B, TU-9B, TU-10B, TU-26B, choice	**$2.50**
Dynamotor PE-73C	**$3.95**
Antenna tuning unit (BC-306A)	**$4.95**







Era of Kits

Kit industry blossomed after WW2

Kits could be bought on installment plans, not possible in 1930s

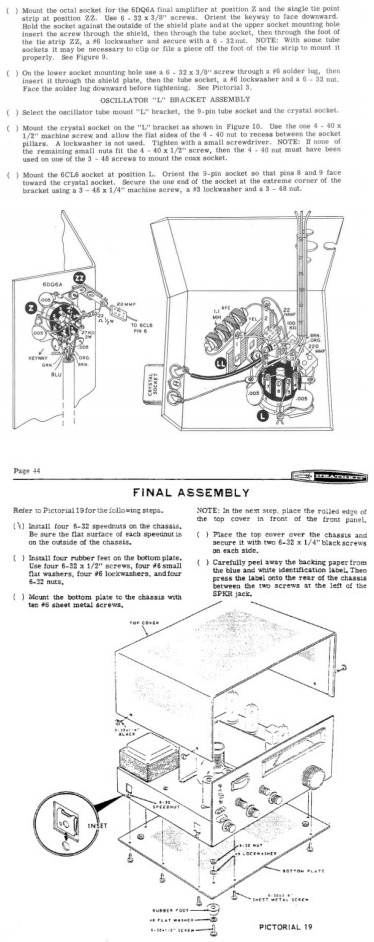
- Amateur radio
- Audio and HiFi
- Test instruments

Prominent manufacturers included:

- Heathkit (1947-1992)
- EICO (1945-1999)
- Allied Radio (1921- bought by Radio Shack in 1970)
- Lafayette (1931-1981)

Kits featured the following:

- More expensive than a similar homebrew radio
- Kits were much cheaper a factory built radio
  - Heathkit AT1 ($30) and Heathkit AR3 ($30)
- Finished radio had a nice professional look
- Provided detailed construction instructions for novice builders


( ) Mount the octal socket for the 6DQ6A final amplifier at position Z and the single tie point strip at position ZZ. Use 6 - 32 x 3/8" screws. Orient the keyway to face downward. Hold the socket against the outside of the shield plate and at the upper socket mounting hole insert the screw through the shield, then through the tube socket, then through the foot of the tie strip ZZ, a #6 lockwasher and secure with a 6 - 32 nut. NOTE: With some tube sockets it may be necessary to clip or file a piece off the foot of the tie strip to mount it properly. See Figure 9.

( ) On the lower socket mounting hole use a 6 - 32 x 3/8" screw through a #6 solder lug, then insert it through the shield plate, then the tube socket, a #6 lockwasher and a 6 - 32 nut. Face the solder lug downward before tightening. See Pictorial 3.

OSCILLATOR "L" BRACKET ASSEMBLY

( ) Select the oscillator tube mount "L" bracket, the 9-pin tube socket and the crystal socket.

( ) Mount the crystal socket on the "L" bracket as shown in Figure 10. Use the one 4 - 40 x 1/2" machine screw and allow the flat sides of the 4 - 40 nut to recess between the socket pillars. A lockwasher is not used. Tighten with a small screwdriver. NOTE: If none of the remaining small nuts fit the 4 - 40 x 1/2" screw, then the 4 - 40 nut must have been used on one of the 3 - 48 screws to mount the coax socket.

( ) Mount the 6CL6 socket at position L. Orient the 9-pin socket so that pins 8 and 9 face toward the crystal socket. Secure the one end of the socket at the extreme corner of the bracket using a 3 - 48 x 1/4" machine screw, a #3 lockwasher and a 3 - 48 nut.

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FINAL ASSEMBLY

Refer to Pictorial 19 for the following steps.

( ) Install four 6-32 speednuts on the chassis. Be sure the flat surface of each speednut is on the outside of the chassis.

( ) Install four rubber feet on the bottom plate. Use four 6-32 x 1/2" screws, four #6 small flat washers, four #6 lockwashers, and four 6-32 nuts.

( ) Mount the bottom plate to the chassis with ten #6 sheet metal screws.

NOTE: In the next step, place the rolled edge of the top cover in front of the front panel.

( ) Place the top cover over the chassis and secure it with two 6-32 x 1/4" black screws on each side.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear of the chassis between the two screws at the left of the SPKR jack.

PICTORIAL 19

Commercial radios

Next generation of commercial receivers appear on the market in the 1940-1950s

Hams could now buy radio equipment on installment plans

- Considerably cheaper and more advanced than 1930's generation of radios.
- Separate receivers and transmitters was the norm
- Transceivers would appear in 1960's

Notable manufacturers included:

- Hammarlund HQ110A receiver ($190)
  - Iconic receiver with built-in clock
- National NC125 receiver ($150)
  - Quality mid-level receiver
- Hallicrafters S40B receiver ($130)
  - Mid-level and cheaper transformer-less radios like S38C ($60)

Commercial radios

Commercial transmitters appeared on the market starting in the 1940-1950s

Notable manufacturers included:

- E.F. Johnson: Valiant and Ranger AM/CW transmitters ($250 and $375)
  - Iconic big central VFO dial
- Central electronics: 20A, one of first SSB transmitters ($250)
  - Used an outboard SCR274 Tx as VFO
- Collins 75A1 receiver and 32V3 transmitter (1st generation)
  - 6 bands (inc 11 meters) and real AM modulation
  - $700 for RX ($7000 in 2021) and $900 for TX ($9000 in 2021)

Conclusion

1930s ushered in improved and more economical electronics

- Better performing receivers
- More powerful and stable transmitters
- Worldwide communication was the norm and operator awards introduced

1940s: Post WW2 brought the following

- Cheap war surplus equipment and parts
- VHF / UHF technology advances as an offshoot of radar technology
- Reallocation of old bands (5, 2.5, 1.25 meter) + new UHF bands
- Emerging technologies: Transistors, SSB, TV and RTTY

1950s: Golden age of Amateur Radio during post WW2 economic boom

- Homebrewing is no longer the only option to get on the air and the decline of homebrewing era begins
- Surplus WW2 HF and VHF radios can be repurposed for amateur radio
- Amateur radio kits become widespread
- Flood of commercial radio equipment at affordable prices
- Stations consist of separate receiver and transmitters
- AM usage peaks in mid-1950s with SSB just around the corner

Questions ?