A Tuning Eye in World War Two – the ARR-3 FM Sonobuoy Receiver

By Bart Lee, K6VK, CHRS Fellow, AWA Fellow

Rarely does a tuning eye, say a 6E5 (or successor), appear on the face of an army or navy radio.

A 6E5 Tuning Eye, from: Classic-Tubeware-Kunisch.de via Pinterest

The [AN]/ARR-3 FM receiver displays one, and thereby hangs a tale.

Scott Robinson, Audio Engineer *par excellence*, cradles the recent addition to the Jon Winchell Communications Center, a R2A/ARR-3.

Aircraft Anti Submarine Warfare (ASW) came to the fore in World War Two. The ARR-3 is an aircraft sonobouy receiver, to get signals from dropped sonobuoys that can hear submarines. The buoys detect sounds made by subs, *e.g.*, prop rotation. The buoys then modulate an FM carrier with the detected sounds, each buoy on a different frequency. The ARR-3 can tune to any one of several frequencies (~ 60 to 75 MHz +). The modulating audio is

wideband, up to at least 10 KHz. The tuning eye helped the operator to tune it in accurately; it may also have helped the operator understand what he was hearing, as the eye flickered, etc. as the FM signal varied.

[AN] R-2A/ARR-3, Bart Lee Collection; soon to join the CHRS Winchell Communications Center

Trained operators could infer a great deal about a target sub from what sounds it gave off, especially at the higher audio frequencies. It is likely that the high audio bandwidth in effect provided a high audio resolution. Rapid audio changes could show on the flickering phosphor of the eye tube.

Retired Naval Officer Tim Sammons, N6CC writes:

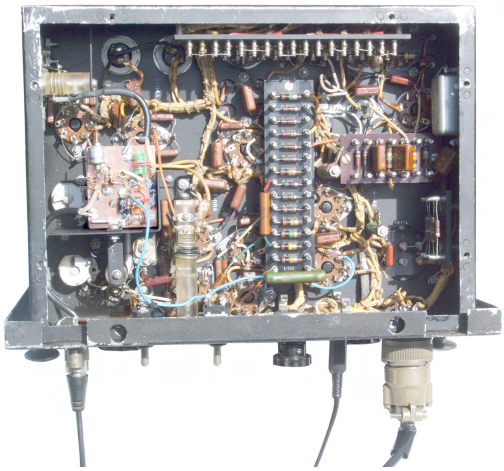
"I spent a lot of time "listening in" to the more modern AN/ARR-75 sonobuoy systems in the 1970-1990's. Yes, sonobuoys (and sub passive sonar) can not only hear the buoys hitting the water - (and the aircraft that dropped them) but can also sometimes even hear the hydrophone wire unspooling on its way down (up to 1000 feet long...)

A good sonar tech can hear the proverbial "Fish Fart in Fiji" with a sonobuoy...

"The triangulation process actually uses the doppler effect to reveal if the sub is approaching or departing a hydrophone. It's very accurate in determining "closest point of approach" (doppler shift becomes zero). With multiple buoys you can tell location pretty accurately as well as the target's course, and the sonar Op can also tell you the approximate speed of the target (as well as the sub Type…) An interesting business..."

The ARR-3 system included:

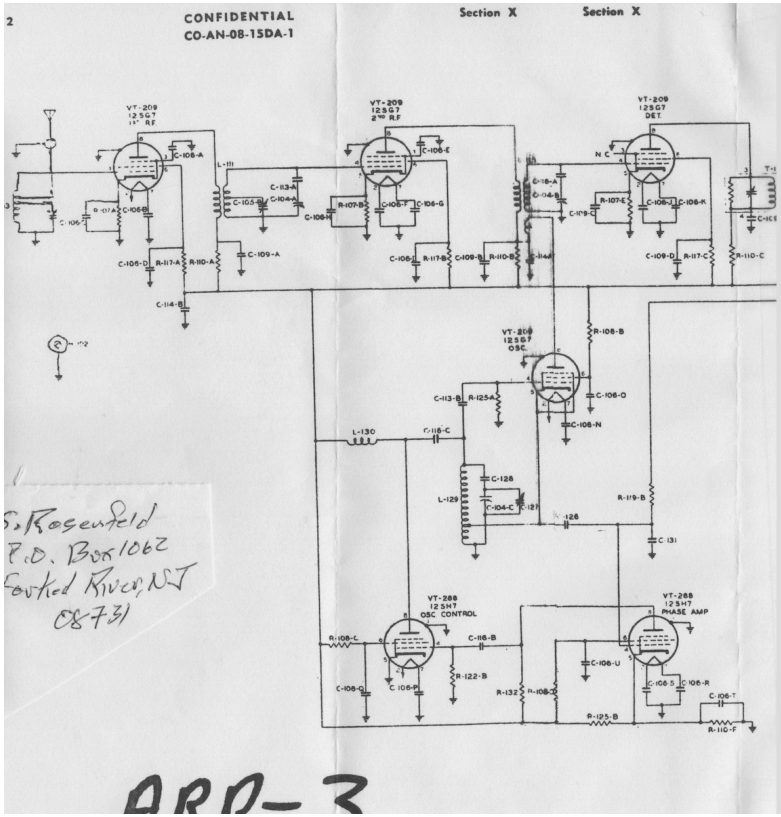
ARR-3*	Sonobuoy Rcvr U/W CRT-1 (RC-222) [***]
R-2/	ARR-3 Rcvr, 68-74 MC, 150 kc FM
AT-3*/AR	ARR-3 Ant
CU-1	ARR-3 Ant Coupler
DY-5*/AR	ARR-3 Dynamotor
H-3*/AR	ARR-3 Headset
MT-13/	ARR-3 Shock Mount
TS-153/AP	Field Intensity Meter



ARR-3 Photos (3) from Michael Kane, VK4ZKT (note PCB mod for current FM broadcast reception); via Brooke Clark*

A schematic diagram follows, from the manual:

* CRT-1B Expendable Radio SonoBuoy © Brooke Clarke [N6GCE] 2014 - 2021. https://www.prc68.com/I/CRT-1BSonobuoy.html



S. Rosenfeld
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ARR-3

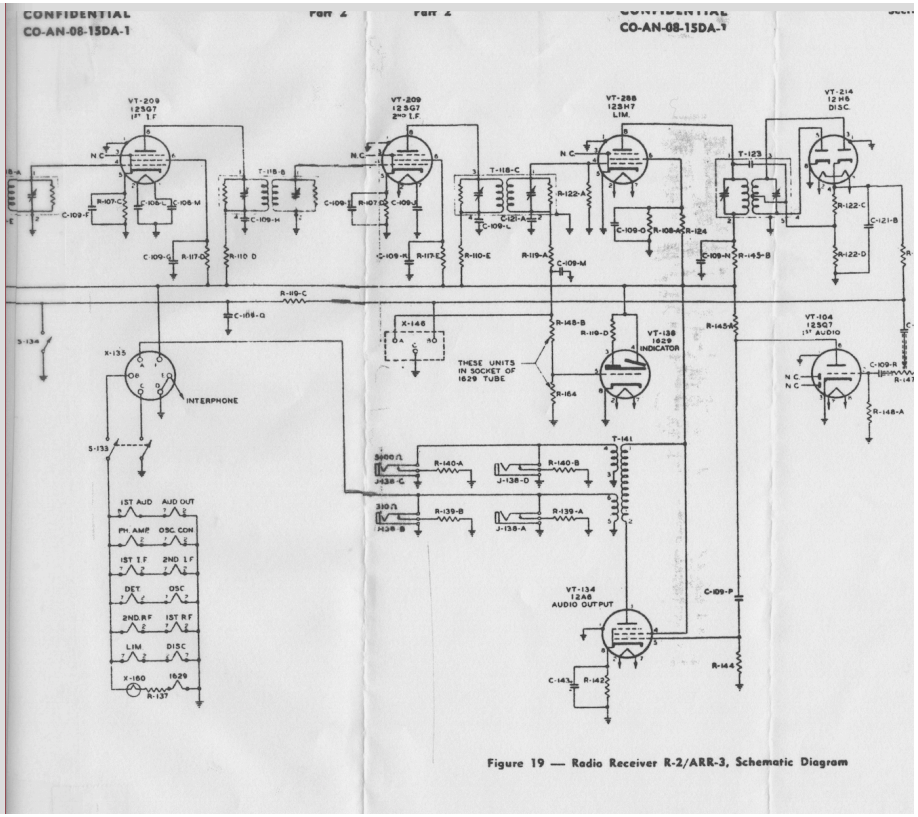
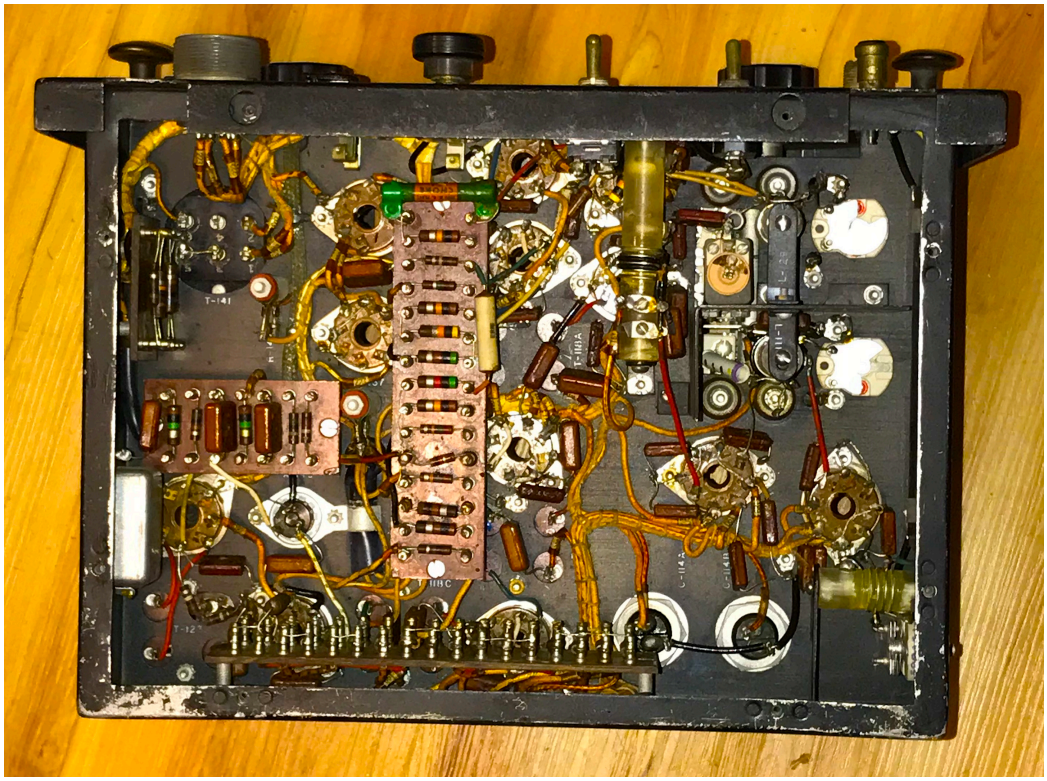


Figure 19 — Radio Receiver R-2/ARR-3, Schematic Diagram

Note the “Phase Amp” in this sophisticated FM circuitry. This circuit aimed to provide maximum audio fidelity to the operator.

The receiver employed five 12SG7 tubes, and three 12SH7, a 12SQ7, a 12A6 and a 12H6, as well as the 1629 eye tube.



The CommCenter ARR-3 chassis (Bart Lee photo)

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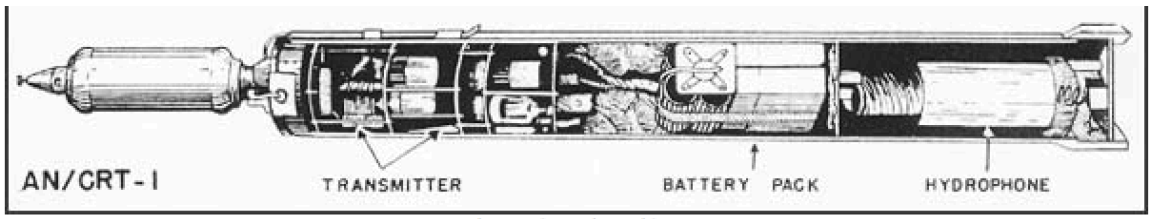
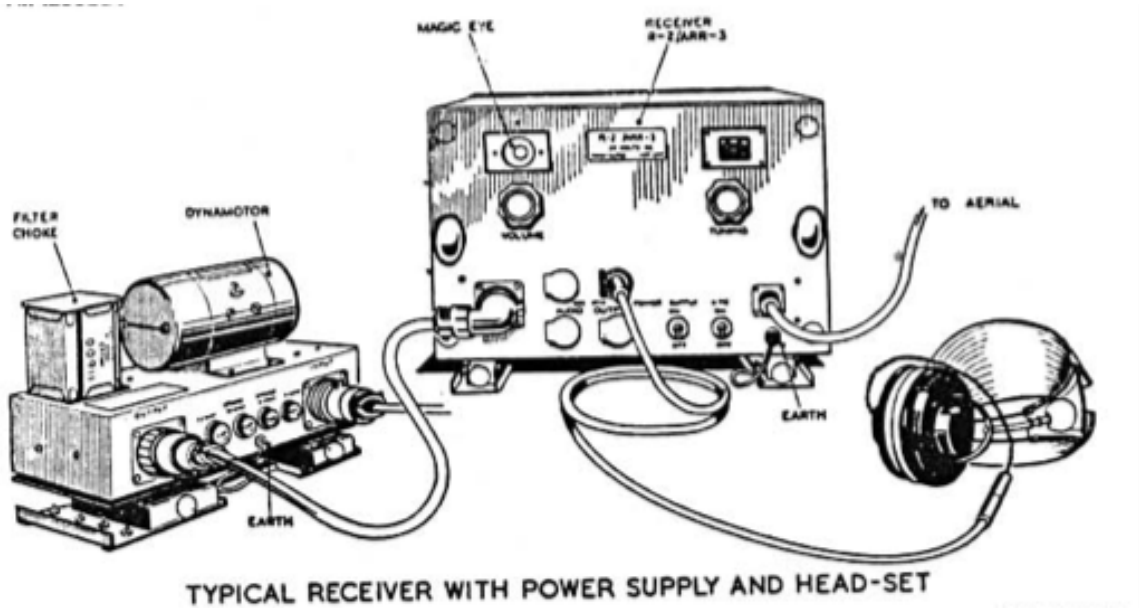
The ARR-3 needed something to hear: the sonobouy and its hydrophones. Two different types of sonobuoy appear to have had different, nearby, frequencies.



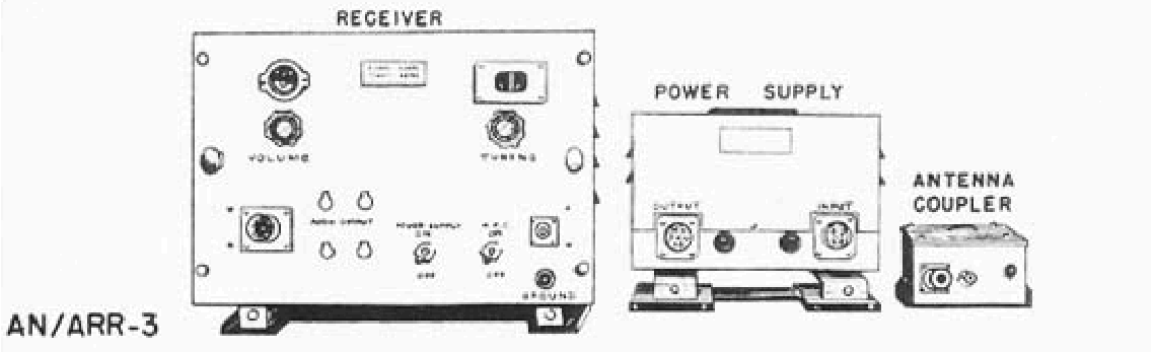
AN/ARR-3 and AN/CRT-1



TYPICAL RECEIVER WITH POWER SUPPLY AND HEAD-SET

From a 1949 British Admiralty publication: Sonobuoy ARI.8256, via Brooke Clark. Note headphones.

A US document shows the US line-up (below):



From: AN/CRT-1 and AN/ARR-3 Sono-Radio Buoys

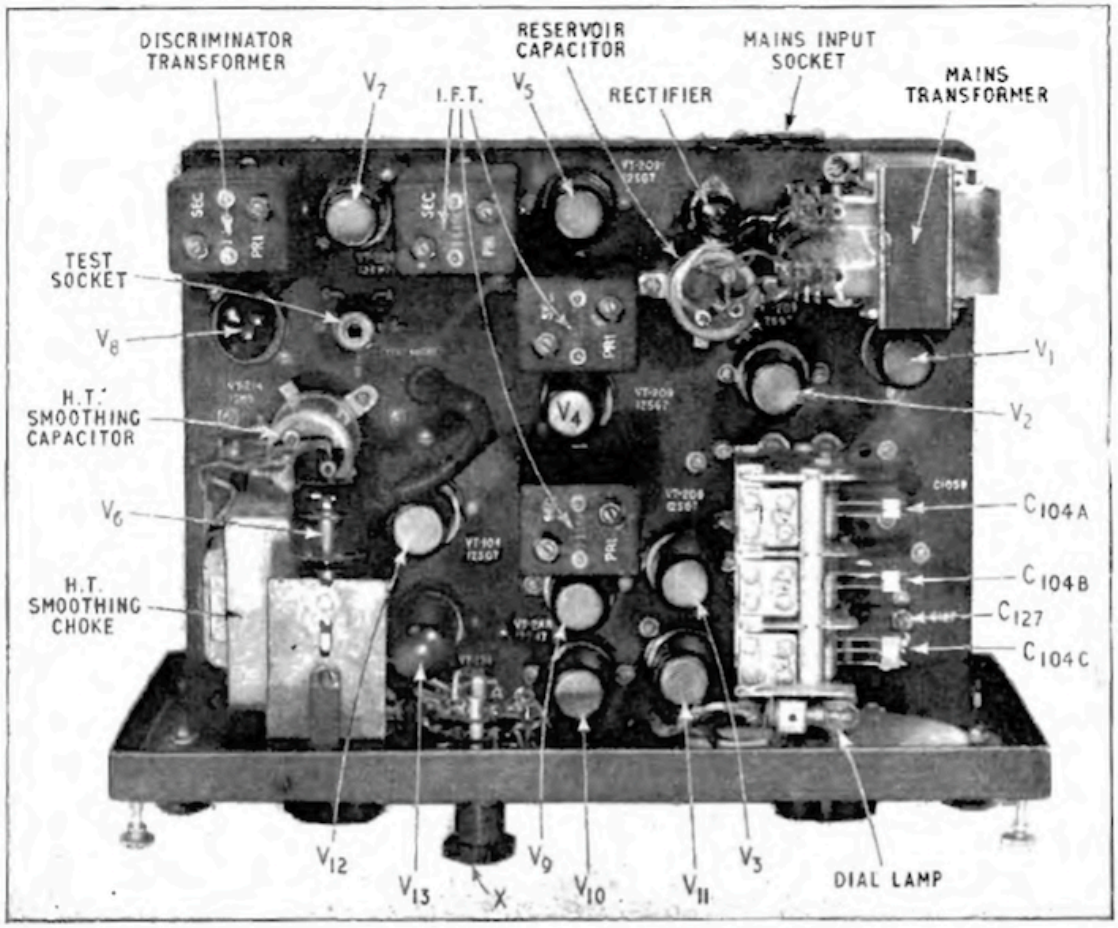
A 1958 conversion article lays out the chassis parts (after a conversion):

The ARR3 Sonobuoy Receiver

Conversion for V.H.F./F.M. Broadcast Reception

By CAPT. R. V. TAYLOR*

[Wireless World [UK], Nov. '58, Page 544]



Top view of the chassis after modification. Mains transformer, rectifier and reservoir capacitor are accommodated in the right-hand rear corner. N.B.: I.F.T.-primary trimmers are "live."

546 WIRELESS WORLD, NOVEMBER 1958

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Brooke Clark, N6GCE (see note above) explained the system as evolved (in a personal email):

"I recently have figured out, with important information from Van [William Van Lennep], the ARR-3 frequency plan and published it on the web page for my CRT-1B sonobuoy.

https://prc68.com/I/CRT-1BSonobuoy.html#Frequency_Plan

https://prc68.com/I/Sonobuoy.shtml

"The key idea is that the R-2/ARR-3 worked with the CRT-1A and when the CRT-1B came out they added a whole new band of frequencies for it adjacent to the old band.

"A major confusion factor is that pretty much all references to the ARR-3 receiver do not distinguish between the R-2 and R-2A versions. The R-2A/ARR-3 covers both of those bands. My guess is that this was done to provide a wider IF bandwidth for the CRT-1B since it has a wider audio bandwidth."

Clark also points out that machinery bolted to a sub's hull would make a lot of underwater noise. The Navy, having figured this out, then started mechanically and acoustically isolating such machinery from the hull in various ways.

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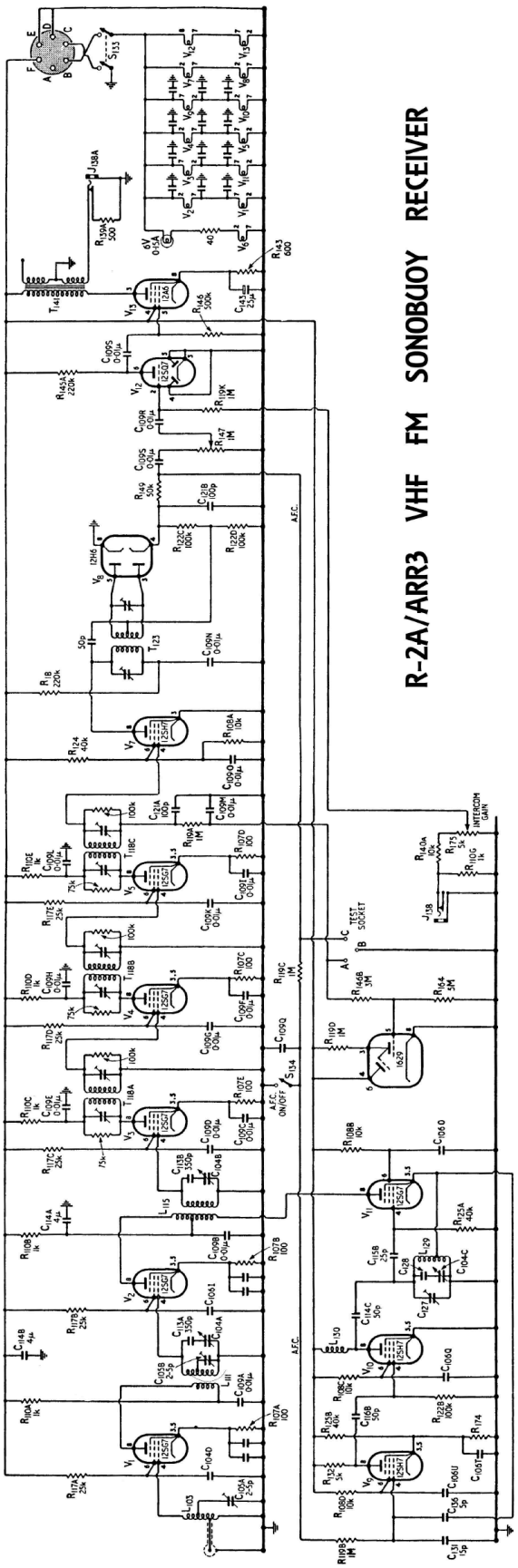
So, inferring a submarine nearby, the ASW aircraft would drop several sonobuoys around its presumed position. The ARR-3 heard the hydrophones on various frequencies. Doppler triangulation could provide an approximate position. On the other hand, the sub's sonar likely could hear, according to Scott Robinson, the sound of nearby aircraft engines. That would be a clue to "run silent" – indeed, stay silent – with as little acoustical energy getting out as possible. The stakes in this game were life and death, and surely still are.

+++ [Another schematic diagram follows:]


R-2A/ARR3 VHF FM SONOBUOY RECEIVER

Re “Magic Eye Tubes”: The 6E5 tube dates from 1935, and used by RCA as of 1936. It found its best use in test equipment and also as a tuning device in consumer higher-end radios, an effective marketing adjunct. The type 1629 followed at 12 volts. The ARR-3 used a 1629. ARC-5 transmitters used *interior* 1629s for tuning.

And see:

https://www.magiceyetubes.com

https://hackaday.com/2021/01/22/meet-the-magic-eye-vacuum-tube/

Also see the wiki:

https://en.wikipedia.org/wiki/Magic_eye_tube

with a very nice GIF.

(09 III ’23 v3 de K6VK) ##