FOR SURPLUS HOUNDS

By Bart Lee, KWPE2DLT

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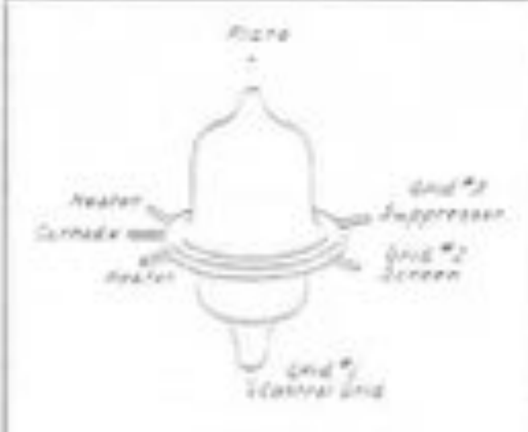
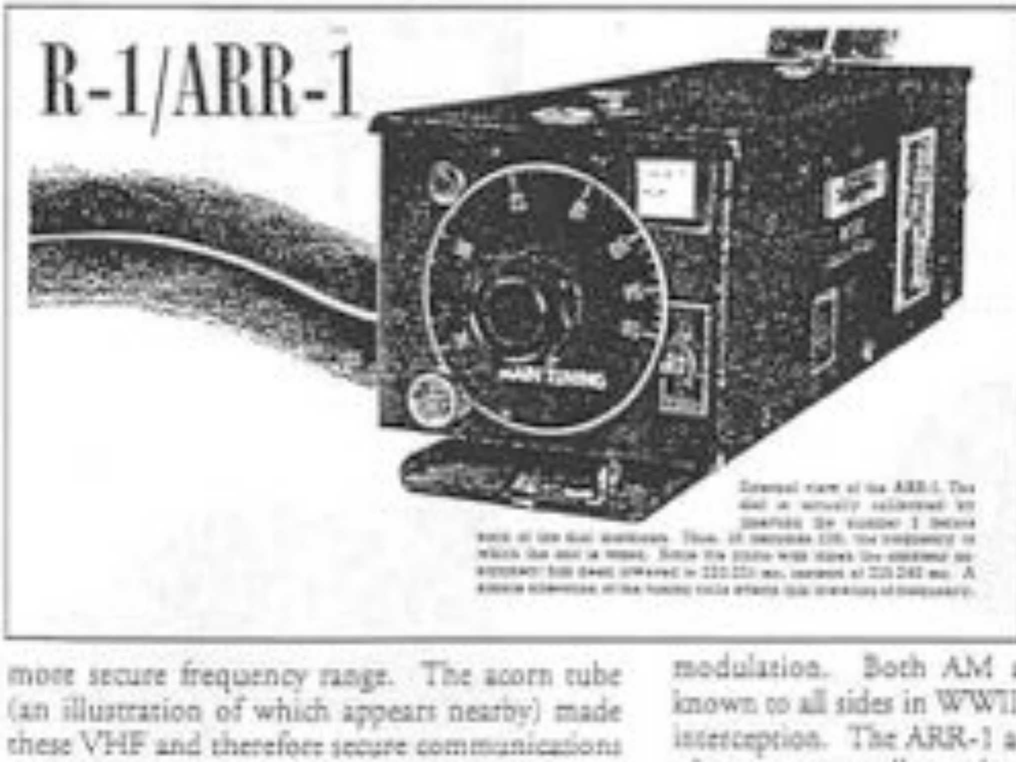
FROM LITTLE ACORNS ... The ARR-1



The location of the terminals of the 954 tube is shown actual size.

The "acorn" tube made VHF possible because it could oscillate up into the hundreds of mega-Hertz. Such Very High Frequency made wartime communications more secure during the second World War. The enemy could easily listen to high frequency communications, but above 30 megaHertz, intercept capability fell off rapidly. Hence, a drive to implement VHF as a more secure frequency range. The acorn tube (an illustration of which appears nearby) made these VHF and therefore secure communications available upon its introduction in 1935. One of the earliest sets to use the acorn tubes was the National 1-10, tuning from 10 meters, 30 mHz, to one meter, 300 mHz, introduced about 1940. The acorn tube's configuration also made it ideal for circuits in small rugged packages, such as avionics. Using these State of the Art acorn tubes (the 954 and 955), frequencies as high as 300 mHz could be worked (line of sight, of course). Unfortunately, in WWII, the Nazi intercept service soon could listen that high as well.



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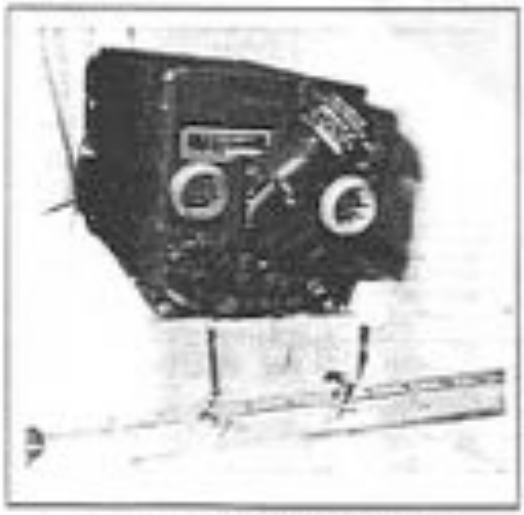
The ARR-1 (of the Navy ZB-2 radio set) provided an answer to the quest for secure VHF flight communications. Using the acorn tubes, it was small and rugged. Using VHF it was beyond most but not all communications intercept capabilities. The real secret was in the mode of modulation. Both AM and FM were well known to all sides in WWII, at least in terms of interception. The ARR-1 added a new process, what we now call a sub-carrier. (These are common in the FM and TV satelite bands today, but the ARR-1 was the first radio to implement the technique). The VHF transmitter sent out a carrier between 234 and 258 mHz, to be received by the ARR-1. The carrier was modulated with a 700 kHz subcarrier, and that subcarrier in turn was voice (or otherwise) modulated at the transmitter. Any intercept operator might well pick up the 200 mHz

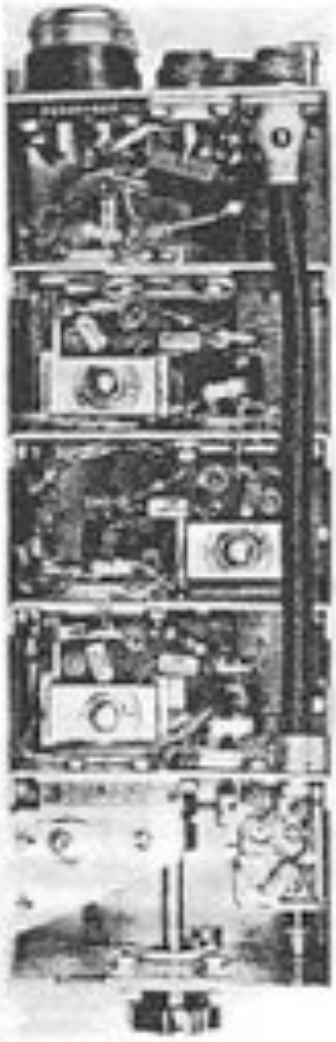
carrier, but would not be able to then tune the subcarrier and demodulate it. The ARR-1 acted as a converter to detect the subcarrier and pass it on to a standard flight receiver tuning at 700 kHz. The ARR-2 used the same circuits in its front end, with 6AK5 tubes, and added the 700 kHz circuits, a detector and audio stages).

After WWII the ARR-1 provided hams with a good platform for VHF experiments in the 220 mHz band. It was small at 3" by 3" by 10" and not only rugged enough for mobile work, but also "one of the most beautifully built pieces of surplus imaginable -- with its acorn tubes and ganged, slug-type tuning mechanism." So rhapsodized Leroy W. May in *Radio and Television News*, in January, 1949 (p. 46) (a conversion article). His modifications turn the ARR-1 into a regular converter. An ARR-2 schematic appears in the *Surplus Schematic Handbook*, (1960) at p. 15. The ARR-2 is a somewhat larger, boxier set with the tuning indicator at the bottom left. In both the ARR-1 and -2, the tuning indicator leaves off the '2' of the 200 mHz range, reading 34 to 58 for 234 mHz to 258 mHz.

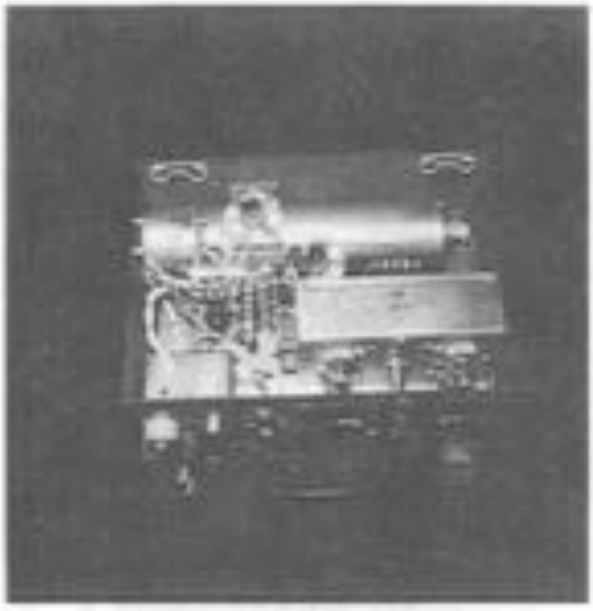


ARR-2 Radio with tubes in foreground

The ARR-1 is a nice little set to go with a collection of small WWII radio gear. It sits on the shelf nicely with the ARC-5 Command sets, and the BC-1206 aircraft beacon receiver. It would certainly be trickier to operate, but it nevertheless remains an object of technological interest for its then novel circuit and communications technique, and its successful use of the acorn tubes in their intended VHF range. ##



Top view of the ARR-1 unit



TS 24A / ARR-2

ARR-1, ARR-2 REVISITED:

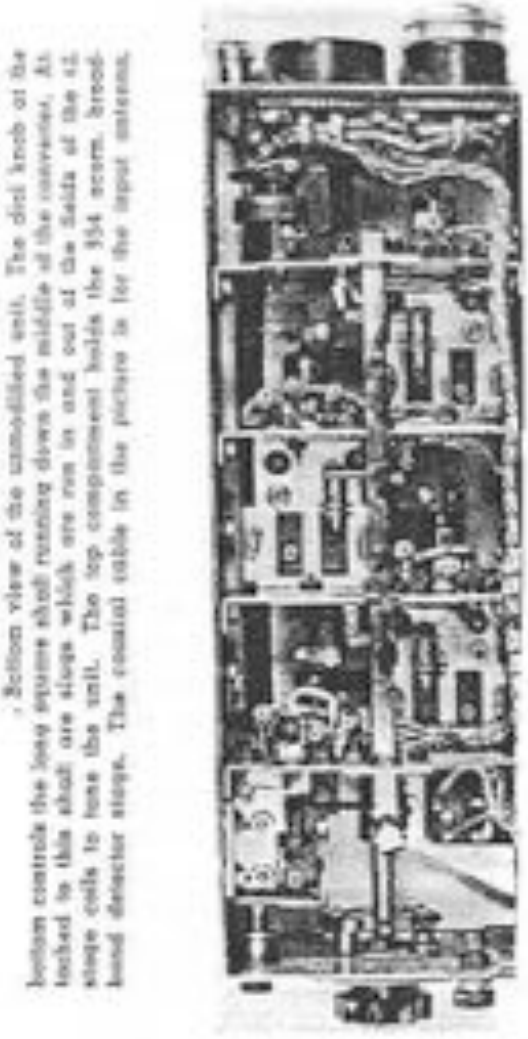
The ARR-1 and ARR-2 descriptions in this column have given rise to some comment from Lud Sibley of the Antique Wireless Association, set forth in the sidebar. As one can imagine, alignment and testing of the then-novel subcarrier required special equipment. A signal generator had to put out the VHF carrier at various frequencies over 200 mHz, then modulate it with a subcarrier on various frequencies between 540 kHz and 830 kHz. Photos of that signal generator appear nearby, the "TS-24A/ARR-2 portable test oscillator."

Battery powered, this signal generator also employed acorn tubes at the VHF frequencies, and a cavity resonator. See the nearby photos for the interior layout, including the resonator in the back, under the acorn tube. Note also the calibration curve on the inside cover, for the subcarrier frequency, called the IF. Lud sends along a description of the first subcarrier use in the Navy. It employed the "ZB" converter for the "RU" receiver in naval aircraft (the nomenclature evolved to ARR-1 later). The "YE" Aircraft Homing System provided a homing beacon for aircraft carriers, as the very top antenna on the bridge. Planes flew directly in on the beam, and this made a difference in at least one major battle in the Pacific.

After successful use on aircraft carriers, the beach landing system evolved in 1942, with a beacon whose nomenclature was "YN." This beacon, along with a split signal of Morse "A" (.-) and Morse "N" (-.) from a shipboard operator, led the landing craft in. Use of the subcarrier feature permitted as many as 30 beacons at once. It is a likely speculation that the subcarrier system provided beacons for beach landings such as that at Normandy. The first men on the beach set up the beacon, set to the subcarrier frequency for that location at the landing site. Then the ARR-1 connected to a broadcast band receiver, or the ARR-2 alone, with loop antennas, provided directional bearings for the landing craft assigned to each site. This system is set forth in detail, with illustrations, in Louis A. Gebhard, EVOLUTION OF NAVAL RADIO-ELECTRONICS AND CONTRIBUTIONS OF THE NAVAL RESEARCH LABORATORY. (Naval Research Laboratory, Washington, DC, 1979) at 271 ff (courtesy of Lud Sibley).

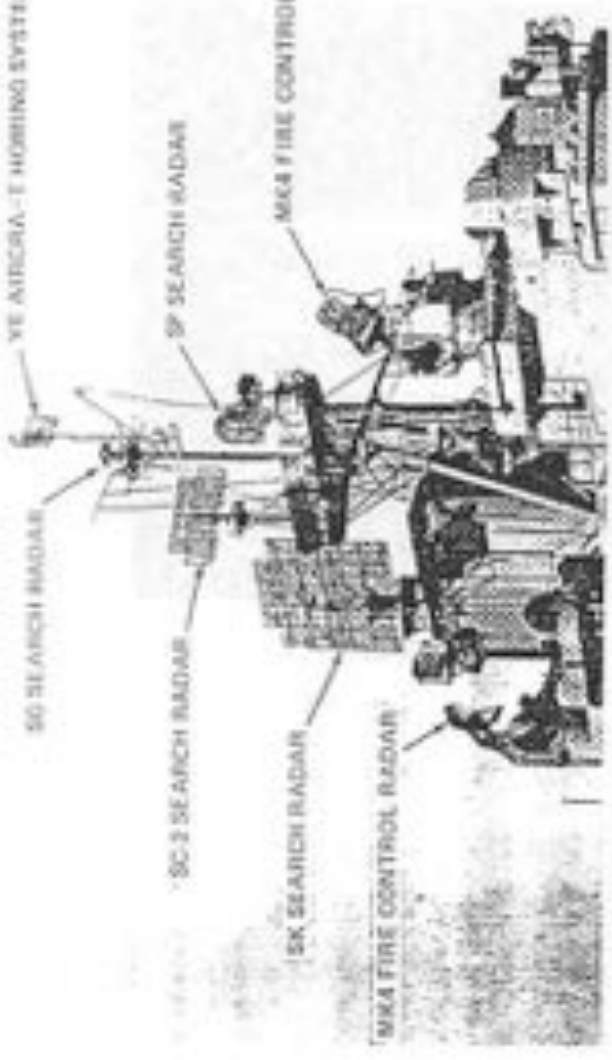
Subcarrier modulation first appeared in the late 1920s in the laboratories of John

Hays Hammond, Jr. in New York. He claimed the invention. Benjamin Meissner, who worked with Hammond, later claimed to have first discovered the technique, and made a persuasive claim to priority in the invention. Incidentally, both men were founding members of the Institute of Radio Engineers (along with the likes of Lee de Forest and David Sarnoff). Hammond was number 63 and Meissner number 70.

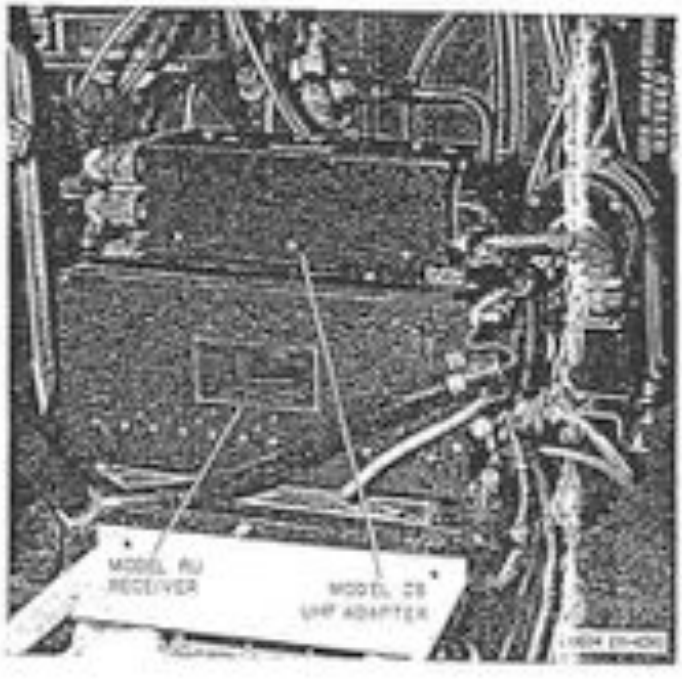


Bottom view of the unmodified unit. The dial knob at the bottom controls the long square shaft running down the middle of the converter. Attached to this shaft are steps which are run in and out of the fields of the six steps coils to tune the unit. The top compartment holds the 354 acorn, broadband detector steps. The coaxial cable in the picture is for the input antenna.

THE PRIMARY AIRCRAFT-TO-CARRIER RADIO HOMING SYSTEM USED BY ALL CARRIERS AND THEIR AIRCRAFT DURING WORLD WAR II THE MODELS YE-2B



CARRIER INSTALLATION OF MODEL YE AIRCRAFT HOMING EQUIPMENT



ARR-1, ARR-2

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I've just seen "Little Acorns" story in the CHRS Journal. Good stuff. Some supplementary thoughts come to mind.

The other guys got acorn tubes, too. I recently inspected the schematic of a Japanese VHF radar from fairly late in the war - Type 140, if I remember right. Its front end used four "UN" - 954 acorn tubes. I've seen new-in-the-box UN-954s of that vintage made by Hitachi. The British got manufacturing information on them, too; used some in VHF radars, but had great trouble making them in quantity and officially gave them up for new equipment circa 1940.

On the ZB homing adapter: the series contained at least ZB-1 through ZB-4 before the device was redesignated R-1/ARR-1. The early ones used some weird early-style coax fittings for the antenna and output; the later ones, the usual SO-239 "UHF" connector. If you inspect a later RU-series receiver or an ARB, you'll see on top the two studs that held the ZB. I believe that the main reason for inclusion of a broadcast band receiver in the Navy's AN/ARC-5 system was for compatibility with the ZB/ARR-1 ... until the AN/ARR-2 was developed to fit the same mounting racks. The enclosed pages from the Naval Electronics Lab official history contain some good detail, if vague, about the ZB.

The old-time story about the double modulation system being "secure" is more or less radio-amateur myth - you read it in the old articles in CQ, et al., but that's it. In this simple AM-on-Am system, a competent intercept operator tuned to the carrier would hear nothing, all right; but tuning down or up 700 kHz would bring in the two sidebands of the "secret" modulation with their information signal. If the intercept operator had a panoramic adapter, he'd see a unique head-and-shoulders pattern immediately: a carrier set between two weaker sidebands. The Japanese were competent in this area; they developed a 200 mHz airborne search receiver to detect signals from the SD air-warning radar on U.S. submarines, and sank a few with it. The only security that the ZB scheme offered was that it was basically line-of-sight,; an aircraft carrier could bring its planes home without breaking radio silence on HF.

The R-1/ARR-1 could be honored as being the first receiver designated under the ten-new "AN" nomenclature. (Of course, there was a foul-up: it was a converter rather than a complete receiver, and should have been "CV-1/ARR-1" or some such. So it goes.)

On the ARR-2: the photo shows what appears to be an interesting variant (R-4X?) with a remote channel-change motor (?) and extra connector. Anyhow, I enjoyed your story! s/ Lud. ##

220 mc conversion (the only practical band to use this unit on). For this conversion the RF coils can be squeezed a bit and an external oscillator fed into J-106. This oscillator may tune either 221-225 mc or 219 to 224 mc.

The earlier model of this equipment, the ARR-1, was quite similar circuitwise, but used acorn tubes.

HANDBOOK OF MAINTENANCE INSTRUCTIONS for RADIO RECEIVING EQUIPMENT *AN/ARR-1 (INCLUDING INSTRUCTIONS FOR TEST SET *TS-1/ARR-1)

PART 1
RADIO RECEIVING EQUIPMENT *AN/ARR-1

SPECIAL NOTICE

Many Navy ZB-2 and ZB-3 equipments have been modified for Army use, and are referred to in Army installations as Radio Receiving Equipment *AN-ARR-1. These equipments are stamped as follows:
RADIO RECEIVER: Navy Type No. CZE-69076, CZR-69076, or CW-69076 are stamped "MODIFIED (SIMILAR TO *R-1/ARR-1)."
RELAY: Navy Type No. CZE-29173, CZR-29173, or CW-29173 are stamped "MODIFIED 12 OR 24 VOLTS (SIMILAR TO *RE-1/ARR-1)" or, "MODIFIED 12 OR 24 VOLTS (SIMILAR TO *RE-1A/ARR-1)."
These modified equipments are mechanically and electrically identical, and are interchangeable as complete component units. References in this book apply equally to these equipments, except where otherwise noted.

SECTION I
GENERAL DESCRIPTION

1. GENERAL.

Radio Receiving Equipment *AN/ARR-1 is designed for use on aircraft and for operation in conjunction with standard aircraft radio receivers. Radio Receiving Equipment *AN/ARR-1 can be used to receive radio-frequency signals in the frequency range of 234 to 258 megacycles, which signals are amplitude-modulated by a telegraphically keyed radio-frequency signal in the range of 540 to 850 kilocycles. This unit then delivers the keyed-modulation component of the signal to the input circuit of the communication receiver, where it is further amplified and converted into an audio-frequency signal. The resulting audio-frequency signal is keyed in conformity with the keying present on the modulation frequency of the received signal. The range of this equipment is approximately 40 to 70 miles at an altitude of 10,000 feet, with greater ranges at higher altitudes.

2. COMPONENTS, DIMENSIONS AND WEIGHTS.

a. EQUIPMENT SUPPLIED.—The following components are supplied with Radio Receiving Equipment *AN/ARR-1:

Quantity	Name of Part	Overall Dimensions (in inches)	Weight (in lbs.)
1	Radio Receiver *R-1/ARR-1, less Mounting *MT-2/ARR-1, but with the addition of 4 Tubes JAN-956 installed in sockets. or Radio Receiver: Navy Type No. CZE-60076, CZR-60076, or CW-60076, stamped "MODIFIED (SIMILAR TO *R-1/ARR-1)" complete with one mounting base, 4 tubes of Navy type CRC-956, or equal, installed in sockets.*	12¼ x 3⅝ x 3⅛	3.63
1	Mounting *MT-2/ARR-1 for Radio Receiver *R-1/ARR-1.*	12¼ x 3⅝ x ⅜	0.25
1	Slip cover.	12¼ x 4 x 4	0.31
1	Relay *RE-1/ARR-1, less Mounting *MT-3/ARR-1. or Relay *RE-1A/ARR-1, less Mounting *MT-3/ARR-1. or Switching Relay: Navy Type No. CZE-29175, CZR-29175, or CW-29175, stamped "MODIFIED 12 or 24 VOLTS (SIMILAR TO *RE-1/ARR-1)," complete with one mounting base.** or Switching Relay: Navy Type No. CZE-29175, CZR-29175, or CW-29175, stamped "MODIFIED 12 or 24 VOLTS (SIMILAR TO *RE-1A/ARR-1)," complete with one mounting base.**	4 15/16 x 4 x 2 5/16	1.40
1	Mounting *MT-3/ARR-1 for Relay *RE-1/ARR-1 or Relay *RE-1A/ARR-1.**	4 15/16 x 4 x ⅜	0.20
1	Antenna *AT-5/ARR-1, including one Plug PL-259.	12" long	0.56
4	Plug PL-259.†	diameter ¾	0.063 each
1	Plug PL-P63 (used with open wiring to Radio Receiver *R-1/ARR-1).	diameter 1¼	0.19
1	Plug PL-P74 (used with open wiring to Relay *RE-1/ARR-1 or Relay *RE-1A/ARR-1).	diameter 1⅛	0.18
	Adapter M-359.†	1¼ x 1⅛ x ¾	0.10
As required	Cable WC-549-A or later productions thereof (or Radio Frequency Cable RG-8/U or RG-31/U).	Approximately 20 ft. long††	0.11 per ft.
2	Socket Cap M-163-A.*	diameter 1⅛	0.063 each
1	Switch S-5A.‡		
			Total Weight 8.9

* The modified navy receiver includes the mounting base and two Socket Caps M-163-A. If this receiver is furnished instead of Radio Receiver *R-1/ARR-1, Mounting *MT-2/ARR-1 and the two Socket Caps M-163-A will not be required.

** The modified navy relays include the mounting base. If either of these relays is furnished instead of Relay *RE-1/ARR- or Relay *RE-1A/ARR-1, Mounting *MT-3/ARR-1 will not be required.

† Adapter M-359 will be used where a right-angle connection of Plug PL-259 must be made.

†† Cable WC-549-A or later productions thereof (or Radio Frequency Cable RG-8/U or RG-31/U) is supplied in bulk. Typical lengths are as follows:

Antenna *AT-5/ARR-1 to Radio Receiver *R-1/ARR-1 ..... 15 feet

Radio Receiver *R-1/ARR-1 to Relay *RE-1/ARR-1, or Relay *RE-1A/ARR-1 ..... 3 feet

‡ This component is furnished from Air Corps stock, and designated by the code word (ZB).

A. EQUIPMENT REQUIRED BUT NOT SUPPLIED.—A communications equipment consisting of Radio Compass SCR-269- (*) or Radio Receiver BC-946-B, which is part of Radio Receiving Equipment SCR-274-N, must be supplied in order to provide a complete and operative equipment. These equipments are capable of receiving keyed CW signals in the frequency range of 540 to 850 kilocycles. This receiving equipment must be complete with all accessories, including headset and primary power supply. In addi-

* Asterisk in parentheses indicates that Radio Compass SCR-269-D, SCR-269-F, or SCR-269-G may be used.

tion to the above. Radio Receiver BC-946-B must be equipped with Adapter FT-310-A and Plug PL-P56 for supplying operating power to Radio Receiving Equipment *AN/ARR-1. (See figs. 18 and 22.)

A decode card is required but not supplied with such equipment. These cards are available from the Operations Officer.

3. POWER REQUIREMENTS.

Power for the equipment is supplied by the communications radio receiving equipment. A voltage supply of 14 volts at 0.54 ampere or 28 volts at 0.38 ampere and a plate voltage of 250 volts at 12 milliamperes are required.

4. DESCRIPTION OF COMPONENTS.

a. RADIO RECEIVER *R-1/ARR-1.—The receiver is housed in a black, crackle-finished, rectangular metal cabinet which contains all the equipment required to

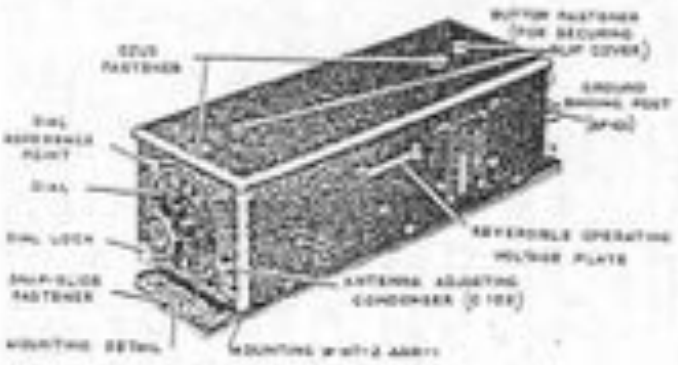

*Figure 2—Radio Receiver *R-1/ARR-1, Front View*

tune, amplify, and demodulate the received signal and deliver the modulation component to the input circuit of the communications receiver. The front and rear panels contain the controls and sockets as shown in

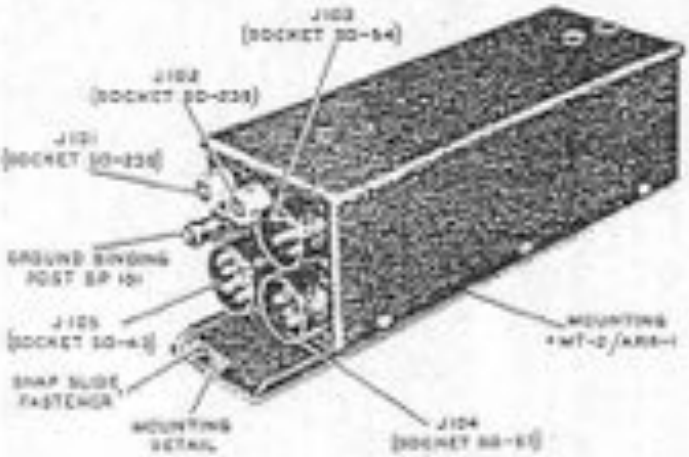

*Figure 3—Radio Receiver *R-1/ARR-1, Rear View*

figures 2 and 3. On the front are a tuning dial, a dial lock, and an antenna-trimming adjustment marked ANT. TRIM. The rear panel has a grounding post and five receptacles.

b. MOUNTING *MT-2/ARR-1.—The mounting, shown in figure 1, consists of an aluminum plate with two mounting details and four countersunk holes. Figures 2 and 3 show it attached to the receiver. Some mountings do not contain the nomenclature "*MT-2/ARR-1."

c. RELAY *RE-1/ARR-1 (OR RELAY *RE-1A/ARR-1).—The relay is constructed of black crackle-finished metal. Figure 4 shows the front of the

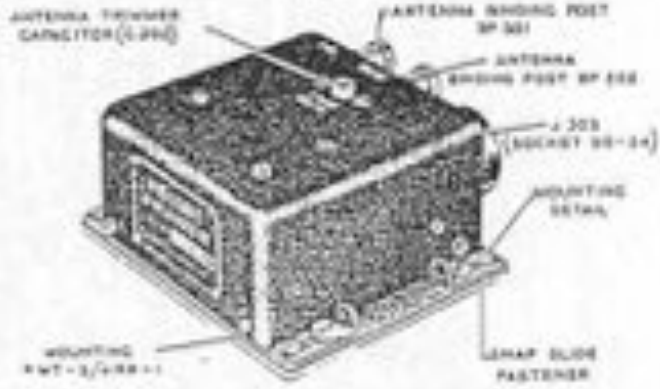

*Figure 4—Relay *RE-1/ARR-1 (or *RE-1A/ARR-1), Front View*

relay and the nameplate. The rear, shown in figure 5, has three receptacles and two binding posts (many of the modified Navy equipments have only one binding post). The top of the relay has an input aligning adjustment.

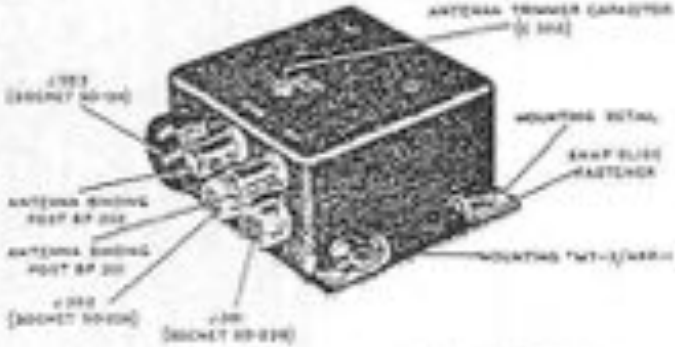

*Figure 5—Relay *RE-1/ARR-1 (or *RE-1A/ARR-1), Rear View*

d. MOUNTING *MT-3/ARR-1.—This mounting, shown in figure 1, consists of an aluminum plate with four mounting details and four countersunk holes. In figures 4 and 5 it is shown attached to the rotary relay.

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RO-29691 | ISSUE 2

OPERATING PROCEDURE FOR "TS-24A/ARR-2 PORTABLE TEST OSCILLATOR

CALIBRATE

1. CONNECT TEST LEAD FROM CAL JACK TO FREQUENCY MEASURING EQUIPMENT.
2. ROTATE TIME SWITCH BEYOND 5 MINUTE POINT. IF EXTERNAL POWER SUPPLY IS USED TURN POWER SWITCH TO EXT POWER SUPPLY.
3. SET CHANNEL SELECTOR TO DESIRED POSITION.
4. TURN ADJUSTING SCREWS ALL IN.
5. SET ADJUSTMENT SCREWS OF EACH CHANNEL TO POSITIONS DETERMINED FROM APPROXIMATE CALIBRATION CHART ON INSIDE COVER.
6. SET MEASURING EQUIPMENT TO PROPER FREQUENCY.
7. FREQUENCY MEASURING [illegible] FOR [illegible] SIGNAL.
8. TUNE CORRECT CHANNEL TO ZERO BEAT.
9. REPEAT STEPS 6, 7, AND 8 FOR EACH CHANNEL TO BE TUNED.
10. RECHECK EACH CHANNEL AFTER ALL POSITIONS HAVE BEEN TUNED.
11. CLOSE DOORS COVERING ADJUSTING SCREWS AND SAFETY WIRE.

RECEIVER I.F. ALIGNMENT

1. CONNECT TEST LEAD FROM TEST JACK OF OSCILLATOR TO TEST POINT ON FRONT PANEL OF RECEIVER.
2. SET MODULATION CONTROL SWITCH OF OSCILLATOR TO ON.
3. SET CHANNEL SELECTOR OF RECEIVER AND OSCILLATOR TO SAME POSITION.
4. SET ADJUSTING SCREWS IN RECEIVER TO POSITIONS SHOWN ON APPROXIMATE RECEIVER CALIBRATION CHART.
5. SET OFF-NAV-VOICE TO VOICE.
6. SET BEAT NOTE CONTROL MIDWAY BETWEEN MAXIMUM AND MINIMUM.
7. TURN OSCILLATOR ON BY ROTATING TIME SWITCH BEYOND 5 MINUTE POINT. IF EXTERNAL POWER SUPPLY IS USED, TURN POWER SWITCH TO EXT POWER SUPPLY.
8. TUNE OSCILLATOR AND DETECTOR COILS IN RECEIVER FOR MAXIMUM OUTPUT LEVEL. ADJUST SENSITIVITY CONTROL ON CONTROL UNIT FOR MINIMUM READABLE SIGNAL.
9. REPEAT FOR EACH CHANNEL.
10. RECHECK ALL CHANNEL FREQUENCIES.
11. SET MODULATION CONTROL SWITCH OF OSCILLATOR TO OFF.
12. SET OFF-NAV-VOICE TO NAV. CHECK BEAT NOTE RANGE AND READJUST BEAT FREQUENCY OSCILLATOR COIL IN RECEIVER IF NECESSARY.

RECEIVER V.H.F. ALIGNMENT

1. CONNECT RECEIVER TO V.H.F. ANTENNA SYSTEM.
2. INSERT OSCILLATOR ANTENNA IN ANTENNA JACK.
3. TURN OSCILLATOR ON BY ROTATING TIME SWITCH BEYOND FIVE MINUTE POINT. IF EXTERNAL POWER SUPPLY IS USED, TURN POWER SWITCH TO EXT POWER SUPPLY.
4. SET CHANNEL SELECTOR CONTROL OF RECEIVER AND OSCILLATOR TO SAME POSITION.
5. SET OFF-NAV-VOICE CONTROL TO NAV.
6. ADJUST BEAT NOTE CONTROL FOR MAXIMUM OUTPUT.
7. ADJUST V.H.F. TUNING CONTROL FOR MAXIMUM [illegible] OSCILLATOR AT [illegible] DISTANCE FROM RECEIVER AND ANTENNA FOR MINIMUM READABLE SIGNAL.
8. LOCK RECEIVER V.H.F. TUNING CONTROL.