REAL Audio for the R-390A

by Bill Kleronomos, KDØHG
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For some time now, I have been amazed as to how a great receiver such as the R-390A with its mechanical filters, excellent dynamic range and highly accurate digital readout could have a local audio amplifier put to shame by a $2.99 pocket transistor radio! Barely capable of putting out a half watt of audio at some 10% distortion over a highly restricted bandwidth, the audio stages in the R-390A do not befit a receiver built in the good old "cost is no object" days of military procurement. 1

I decided to once and for all solve this major annoyance on an R-390A that had recently been given a major civilian overhaul by both Ray,NØDMS and myself. It has been common practice to add an outboard amplifier to this receiver to provide some real audio wattage, however, this does nothing to correct the restricted frequency response and high distortion inherent in the stock audio stages. The receiver still sounds lousy - just louder!

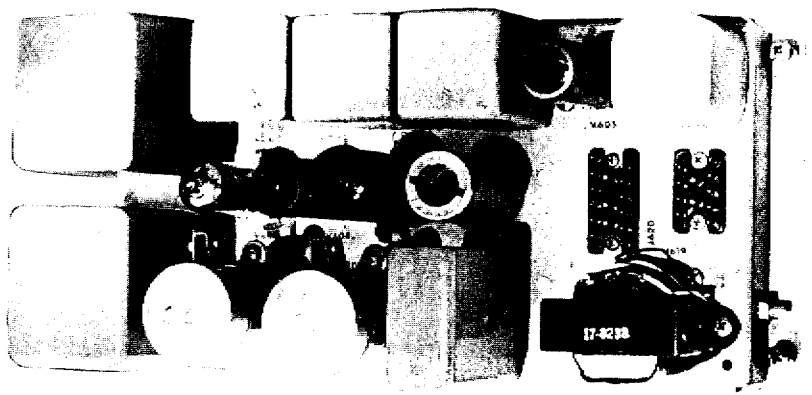
This modification can be accomplished in five to ten hours on the work bench. It involves the replacement of the stock audio amplifier with a push-pull class AB, final along with an associated preamplifier and phase inverter. The new final amplifier is a twin tetrode designed for VHF amplifier duty, the Amperex/RCA 6360. Inexpensive and readily available, this tube is an excellent audio amplifier. In general, the circuit is based on the designs that graced the back pages of the RCA receiving tube handbooks of the 1960s. This particular rendition is capable of an audio output in excess of five watts with a measured THD of less than .5%. Although the output transformer is not on par with those used in the best high fidelity designs due to space restrictions, the use of over 25 dB of inverse feedback makes for an essentially flat and clean audio response from about 70 Hz to about 9 kHz.

Note—this modification cannot be done on the R-390 due to the presence of the squelch tube on the audio chassis of the earlier model receiver, but it could be considered for other brands and models of receivers where the components will fit.

To prevent taking up this entire issue of ER with a step-by-step procedure, a la Heathkit, I'll describe what needs to be done in general terms as well as providing revised schematics. It is essential to have the military manual and schematics on hand prior to proceeding, and to spend some time prior to starting with the audio module on the work bench in front of you pondering the best way to proceed. Most of the new components can be placed on the terminal board replacing the old parts and many of the original harness wires can be reused in new roles without adding new wiring. If properly and carefully thought out, it's hard to tell from the bottom of the chassis that major revisions have been made. If you are squeamish about hacking on your prize audio chassis, no problem - spares are cheap, common and available from a number of sources. Buy a spare chassis and fire up the soldering iron!

Mechanical and Chassis Details

Begin by removing the tubes and filter capacitors (note that the filter capacitors are NOT interchangeable!) Remove the flat cover plate next to the connectors; mount the new audio output transformer in this space. Mount a 5- or 6-lug terminal strip underneath the chassis on one of the transformer mounting screws. Later, C7



Modified audio chassis. Note location of new output transformer.

and R9 will be mounted on it. If there is a ground lug with a wire attached which used to be mounted by one of the cover plate screws, attach it instead to the grounded lug of the new terminal strip.

Clip the wires off of the sockets for local AF output V603 and driver V602. Make sure to tag the heater leads as they are removed for future re-use. Unbolt the socket for V603. By the use of a 3/4" chassis punch carefully centered over the hole for this socket, punch a hole for a new 9-pin miniature tube socket. Mark and drill two new holes for mounting hardware and mount a new 9-pin socket in place of the old 7-pin. If the new socket doesn't have built in ground lugs, add one under one of the mounting screws. Orient this new socket so the keyway is in the same direction as those on the other sockets.

Wiring Overview

Step one is to modify the line amplifier circuit to function without the use of driver V602. Examine the schematic of figure 1. Simply put, the old 6AK6 line output is replaced by a 6AH6, and the cathode bias for this circuit is revised. This new V604 is driven directly from the line gain pot via C607. Driver V602B is no longer needed due to the higher transconductance of the 6AH6. This change frees up use of the socket formerly used for V602 for the preamp/phase inverter used in the new local audio stage.

The conversion of the line amplifier is easy and provides good practice for the local audio amplifier conversion. Begin by comparing the schematic of the modified line amplifier with that published in the R-390A manual. Note that R626 and R621 are removed from the terminal board. Then if R625 is replaced with a 390 ohm the cathode resistance will be the sum of the existing R623 (47 ohm) and the new R625 (390 ohm) - sufficiently close to the specified 430 ohm value. The wire that ran from C607 to pin 7 of V602B is identified with an ohmmeter (it was clipped off at the V602 socket - above) and connected to pin 1 of V604. Clip out the now unused C608. Lastly, add the new cathode bypass for V604 either at the tube's socket or at the terminal board.

The local amplifier is modified in generally the same manner. Compare schematics, look for places on the terminal board to reuse with new components, identify the wiring for possible reuse, and lastly, clip out no longer needed components. Example: The plate and screen resistors for the new audio stages can be put on the PC board where R611 and R622 used to be.

For some reason I have found it easier to wire up the new amplifier stages be-

R-390A from previous page

ginning at the output and working my way back toward the volume control pot.

Once the conversion is completed, check and recheck the wiring with an ohmmeter at the tube sockets. Don't forget to clip out and remove C609, the cathode bypass for V601A. This adds a bit of degeneration to the audio preamp and reduces its distortion. If any of the pins of the two connectors on the chassis show traces of corrosion or severe oxidation (gold is NOT green!), burnish the pins with a strip of VERY fine sandpaper such as 1500 grit, followed by a wash of contact cleaner. Don't burnish off the plating on the pins.

If the completed amplifier motorboats or oscillates when put into use, the feedback is incorrectly phased. Reverse either the primary or secondary connections of the new audio output transformer. This amplifier is unconditionally stable and a number of modified units have been tried in a couple of receivers. If it dosen't work, wiring errors or other problems exist!

Due to the change from a nominal 600-ohm to an 8-ohm audio output impedance, the level at the headphone jack will be too low for use with most headphones. Reduce the value of R101, the headphone level dropping resistor, as required. Merely jumper a suitable value resistor from TB102 pins 6 and 8 on the rear of the receiver's chassis. A suitable value is in the 330 ohm to 1 K range. This is the only change that needs to be made to the receiver itself.

I have noticed that for some reason, some R-390As introduce noticable audio distortion when the AGC is switched to the 'Fast' position. I recommend the use of medium AGC for best results. I also suggest a prescription alignment of the entire receiver, especially the IF strip and proper setting of the IF gain pot. The factory stock noise limiter also introduces considerable distortion when switched on.

A good finishing touch to the newly modified chassis should be relabeling the tube sockets for the correct tube types. Copy this article along with any construction notes and add it to your receiver's manual for future reference. Tube shields on the modified audio chassis are unnecessary. In fact, the Amperex data sheet for the 6360 tube advises that they should not be used.

The sound of an R-390A with this audio upgrade is, in a word, fantastic. I'd recommend the use of a decent speaker such as a bookshelf type with reasonable efficiency as available from Radio Shack. When listening to the standard AM or SW broadcast bands you will soon notice things that you couldn't hear in the past, such as how good AM broadcast can sound. Many of the new digital transmitters and associated audio processors have a quality and fidelity of sound that rivals that of FM broadcast. On the other hand, many broadcasters could clearly use the services of any one of the number of 'Real Radiomen' who operate AM on the amateur bands and understand how to make a transmitter work right!

So, heat up that workshop this fall and dig into that audio chassis. You won't be dissapointed with the 'new' R-390A you end up with. ER

1. Authors note: In some circles, Collins Radio receivers are as well known for their average to rotten audio quality as they are for their stability and accurate calibration in others. This brings to mind the "wisdom" stated at least once or twice: "If you want to know where they are, buy a Collins, if you want to hear them, buy a National".

Editor's Note:

A couple of weeks ago while we were attending a hamfest at Longmont, Colorodo (near Bill's QTH in Lyons), we had the opportunity to check-out his modified R-390A. My assessment is that it sounds better than any communications receiver I've ever listened to. I'm looking forward to hearing what other people have to say about this mod after they've installed it on their R-390As.

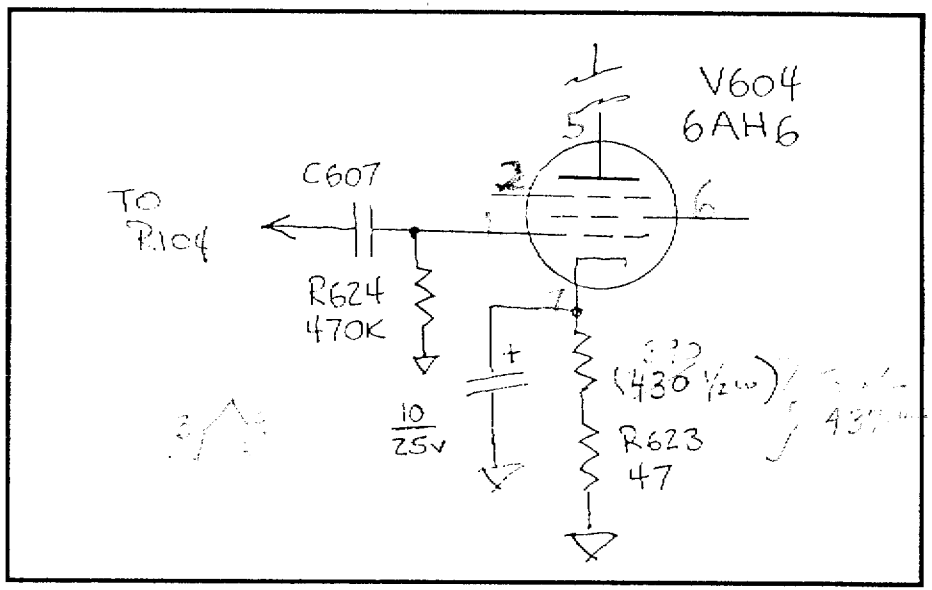


Figure 1. Revised line amplifier.

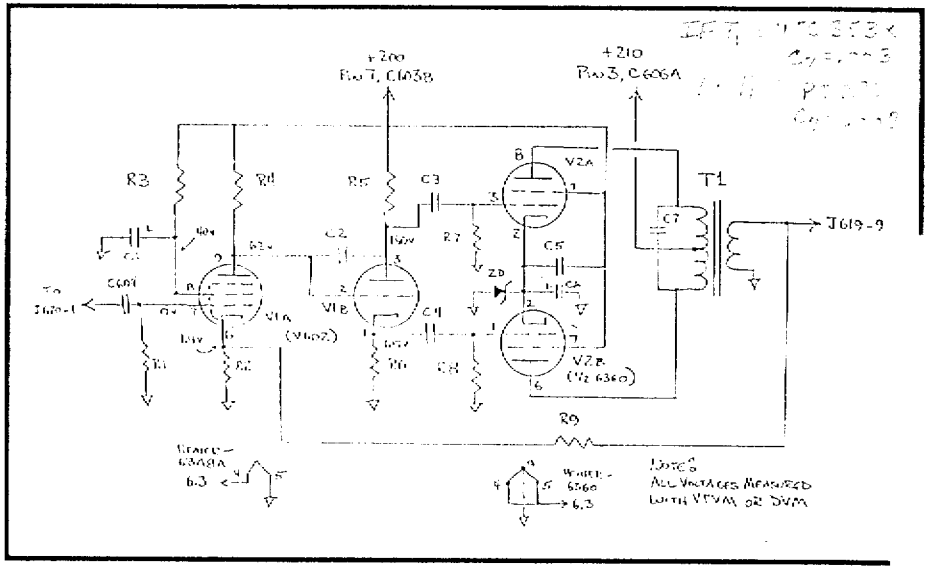


Figure 2. New local audio amplifier.

Parts List For Figure 2

C2, C3, C4, C604	.1 uF 250 volt mylar/paper	R2	820 1/2 watt 5%
C1	1 uF 250 volt electrolytic	R5, R6	15K 1 watt 5%
C2	47 pF 500 V ceramic	R9	4.7K 1/2 watt 5%
C5	.001 uF 500 volt ceramic	ZD	24 volt, 5 or 10 watt zener diode
C6	100uF 25 volt electrolytic or tantalum	T1	8 watt rated universal output transformer such as UTC S-53X or Antique Electronic Supply P/N PT-291. Set impedance taps for 8000 ohm primary to 8 ohm secondary.
C7	.003 uF 1KV ceramic		
R1, R7, R8	100K 1/2 watt 5%	V1 (V602)	6BA8A
R4	100K 1 watt 5%	V2 (V603)	6360 or 6360A
R3	470K 1/2 watt 5%		

Real Audio for the R-390A Revisited

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It's certainly been gratifying over the last few years to note how many people have seized tools and soldering iron and made a great receiver even better by upgrading the audio section according to my original ER article in issue number 42 October, '92. As I noted previously, the RF design of the R-390A is second to none and will never be duplicated, but the audio sections were deliberately designed to deliver only a restricted-bandwidth signal at a level of perhaps a half watt. Not only that, but a close examination of the original Collins designed audio chain reveals that feedback has been added to the amplifiers in a deliberate attempt to further restrict dynamic range. I can only make educated guesses as to why the receiver was designed in this manner, but it suffices to say that while the original audio section was adequate for CW, RTTY and local monitoring purposes through a typical military "tinbox" speaker or communications headphones, it certainly isn't up to the task where quality, wide-range audio is desired with the use of today's limited efficiency high fidelity mini-speakers. And if anyone's noticed, today's speakers are usually 4 to 8 ohms- not 600!

Having modified a number of audio chassis for individuals over the last couple of years, I've gone up the learning curve regarding my original design. With a number of my originally modified chassis having been used for several years, sometimes on 365 x 24 duty, it can be said the circuit is as bulletproof as the rest of the receiver - the tubes and components are run so conservatively that no failures have been reported to me. The tubes in my own receiver still check at 100% in my tester. About two years ago I made some minor revisions to the design in response to a minor annoyance and in an effort to achieve an even better sound.

The annoyance I'm referring to is that the sound quality of the original design was to some extent dependent on the brand of 6BA8 tube used. While the sound with any tube used was always pretty good, nevertheless I felt the circuit should perform in a more consistent manner from unit to unit. I ran a number of 6BA8 tubes through exten-

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Parts List

R1 470K, 1/2W
R2 470,1/2W
R3 33K, 1W
R5, R6 15K, 1W
R7, R8 100K, 1/2W
R9 4.7K, 1/2W
C1 (C6O4) .1 uF metal film, 100V
C2 33 to 47 pF, 300 volt
C3, C4 .1 uF 250 volt
C5 .001 uF 1 KV ceramic
C6 100 uF, 25 to 30 volt electrolytic
C7 .002 uF, 500 volt metal film
T1 8000 ohm to 8 ohm PP output transformer, @ 8 watts. Antique Electronic Supply #PT-291 suggested.
VI 6DJ8 or 6922
V2 6360
ZD 24 volt, 5 watt zener diode

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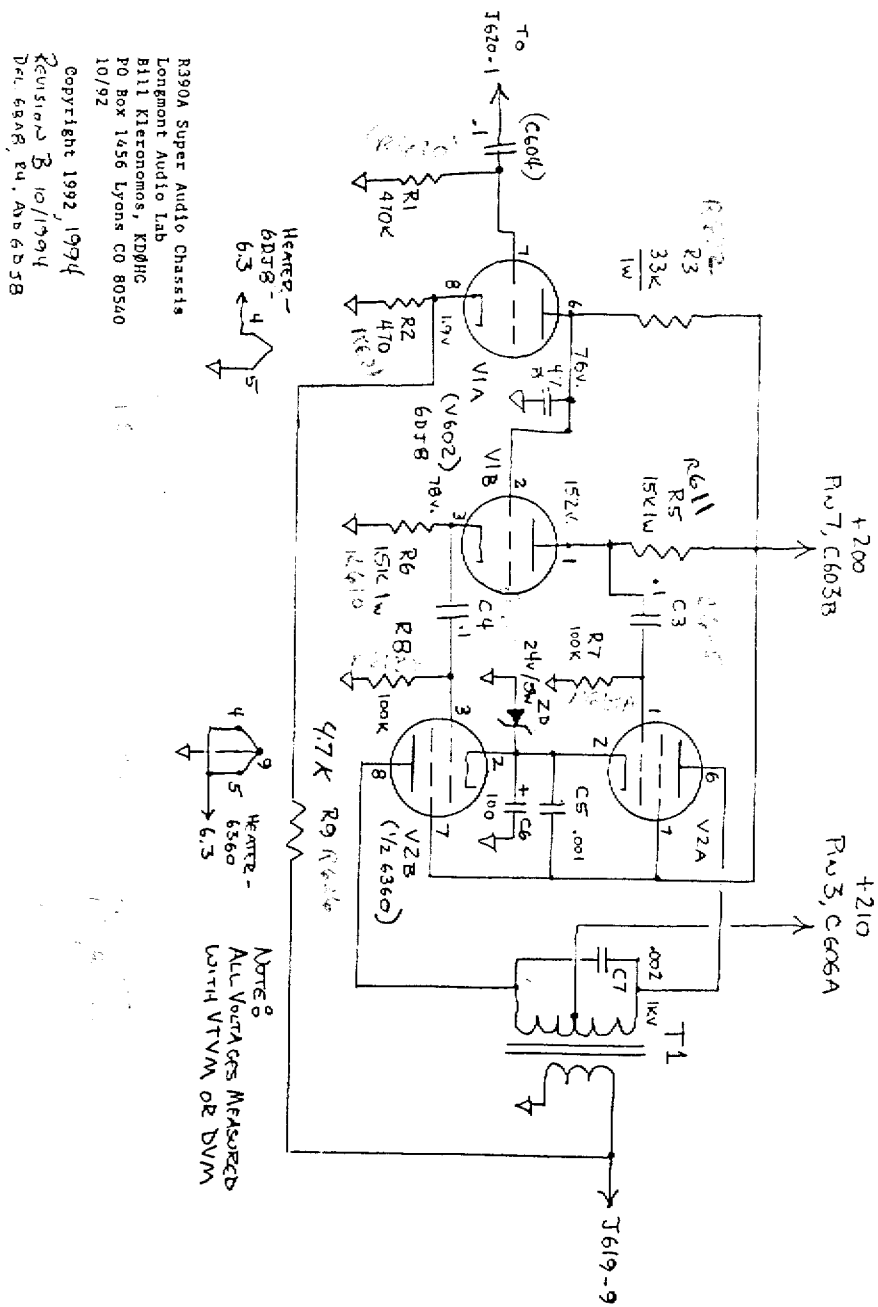

Real Audio for the R-390A from page 34

sive tests, but I could never attribute any one tube characteristic to a particular sonic quality, and frankly, to this date I'm still baffled! My resolution of this problem was to go back to the drawing board and replace the 6BA8 with the audiophile-friendly 6DJ8 or 6922 dual triode. This change makes the sound of the chassis much more consistent and with the added benefit of what I perceive as a smoother sound, probably due to the well-regarded sonic signature of a triode as compared to a pentode.

Revising one of the chassis using the 6BA8 is relatively easy, requiring the removal of the unneeded screen dropping resistor and bypass capacitor. The stabilization capacitor at the grid of the former 6BA8 will need to be connected from grid to ground instead of from grid to plate as it was, and pin 9 of the socket, the internal shield of the 6DJ8, will need to be grounded. The plate and cathode pin-out of the 6DJ8's second section (1 & 3) is the opposite of the original 6BA8's triode section, so the wires will need to be swapped. The stabilization capacitor I referred to may be any value from 33 pF to 47 pF, mica or ceramic, but don't leave it out - the 6DJ8 can be one hot VHF amplifier/oscillator so don't give it an excuse to fly.

R3, the plate resistor for the first amplifier stage needs to be changed from its former 100 K to 33 K, 1 watt, and R2, the cathode resistor needs to be changed from 820 ohms to 470 ohms, 1/2 watt. R1, the grid resistor for the first triode section may be up to 470 K in value - you can leave the factory-original 470 K in place that was connected from ground to pin 7 of V602 (or V1, the new 6DJ8). Finally, there was a typo error in the original ER article - note that the cathode bypass capacitor of the 6360 output stage is supposed to be 100 uF, 25 or 30 volts and not the 10 uF originally specified (and corrected the following issue). With parts on hand, this whole revision of the original design should only take an hour or two.

Due to the overall negative feedback loop, the original article's cautions about the polarity of the output transformer are still valid. If the circuit oscillates, squeals, or makes funny noises on turn-on, reverse the winding of either the primary or secondary of the output transformer. Sometimes there won't be an oscillation but instead the audio may be "peaky" sounding, distorted, or excessively loud where just cracking the volume control may blow you out of the room with audio. Reversing a winding of the transformer will cure the problem. In any case, try the connection both ways and choose the winding polarity of the OPT that results in the least, or smallest audio output for a given setting of the volume control.

The brand of 6DJ8 used isn't critical - you may use the mil-spec 6922 version if it suits you. I've personally been very pleased with the sound quality of the economy-priced Russian 6DJ8s sold by AES and others to the audio industry. They seem to be durable; I've been using one in my own receiver for a year and a half with no problem. I've also discovered there is a British military spec equivalent to the 6360 output tube with the part number CV2798. I've used them as available and they work well; it may be easier to find and less expensive than the 6360 in some parts of the world.

As was the original, this revised version of my modified R-390A audio chassis is perhaps the single most worthwhile change one can make to a great receiver - I urge reviewing the original ER article before proceeding with this project for the first time. Happy listening! **ER**

R-388 US Military Contract List

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A few years ago, I bought my first R-390A from Rev. Joe Pinner, KC5IJD. Being a mechanical engineer by trade, I was impressed by its complexity, performance, and robust construction. About that same time, an article ran in Electric Radio about the history of the R-390A. Within that article was a list of contracts and numbers produced. I became interested in the history of the radio, so I began a most informal poll asking users for their contract and serial numbers in an attempt to verify the R-390A contract information.

It didn't take long to realize that there were many holes and inaccuracies in the R-390A data best known to that date.

Along the research trail, I ran into Wally Chambers, K5OP, and Les Locklear. They were keeping rig data as well, so we all pooled our slips of paper and bar napkin notes to come up with the most accurate R-390A list compiled to date. The results of this research have recently been contributed to Electric Radio by Les Locklear.

A natural offshoot of the R-390A research activity was contract data on other radios, and I began keeping information on most of the classic Collins receiver designs. I will report out on these different radios in future issues of Electric Radio, but in this issue, we will cover the R-388.

Many readers of these pages already know that the R-388 is the military version of the Collins 51J-3. This radio covers .500 Mcs to 30.5 Mcs in thirty bands of 1000 Kcs each, AM and CW. These radios were very popular in industrial and military installations. They were also available to amateurs and SWL's, but like most quality gear of the period, it was expensive for amateurs. This is a comparison of R-388 specifications compared to the better known R-390A.

	R-388	R-390A
Freq Coverage	0.5-30.5 Mcs	0.5-32.0 Mcs
Dial	analog	mech/digital
Fixed IF	500 Kcs	455 Kcs
Filters	tuned circuit	mechanical
Weight	43 lbs	75 lbs
No of tubes	18	25
PTO	70E-15	70H-12/others
PTO Range	2.0-3.0Mc	2.455-3.455Mc
Audio	1.5W, 4/600Ω	.5W, 600Ω
Power Req'd	85W	220W
No. of Ovens	None	Three
CW audio filter	No	Yes
Construction	single frame	modular
Tuning torque (in/lbs)	0.4	1.0
US Mil ordered, approx	10,600	54,000

In operation, the user will find that the R-388 is easier to tune. The operation of the tuning knob is very smooth, however there is no significant flywheel effect as found on a Hammarlund SP-600. An average R-390A, on the other hand, requires a more deliberate twist of the tuning knob to overcome the friction of all the works, and is less attractive as a band surfer. From an overall performance standpoint, the R-390A is hard to beat.

Shown below is the US military contract information that I have to date (this article will likely scare up more). Naturally, this doesn't include any production for civilian use, or numbers for military orders for US allies.

The high serial numbers shown indicate the highest number contributed to

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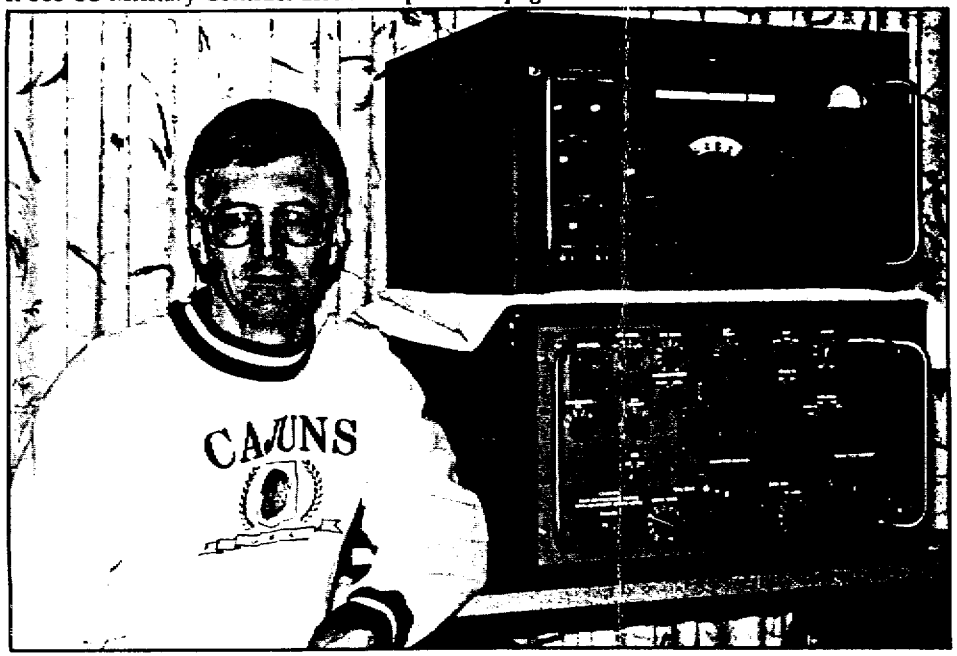
R-388 US Military Contract List from previous page



The author with his two of his favorite receivers: R-388, top; R-390A, bottom.

me by an owner, so it can be inferred that at least that many were made under each contract. A high s.n. of "0" means that from various pieces of documentation this is a known contract, but no examples surfaced in my survey.

Compiling an R-388 contract list is like counting stars; there is a finite number out there, but each time you count, the number gets higher. It would appear that Uncle Sam placed many orders of small numbers. Interestingly enough, the R-388 orders go out well beyond the dates of availability of the new R-390 and R-390A. Perhaps this was for reasons of economy or ease of use.

According to the information available, all R-388's were made by Collins.

Not shown in the list below is a contract for R-388A's (same radio, but with mechanical filters, equivalent to the Collins 51J-4), NObsr-69046. I don't have any serial number data for this contract, however civilian serial numbers as high as 7000 have been contributed. There were likely some r[illegible]s made for government agencies other than the military.

Future installments will cover the R-389, R-390, R-391, R-392, and R-725.

Any info on these rigs contributed now would make the future installments all the more complete. **ER**

R-388 US Military Contract List

NObsr-49132 (AN/URR-23A) 91
NObsr-52527 (AN/URR-23A) 180
19624-PHILA-50 976
1908-PHILA-51 355
3096-PHILA-51 8
3131-PHILA-51 919
3155-PH-51 1379
3164-PH-51 153
3167-PHILA-51 491
3357-PHILA-52 1672
3362-PHILA-52 109
3469-PHILA-52 20
3470-PHILA-52 1449
25635-PHILA-53-36 2193
25067-PH-54-55 363
21318-PH-56 88
30951-PH-56 0
30951-PHILA-57 0
37003-PC-62 171
Total of high serial numbers 10617

Designing the Collins 30K from page 14

supply before the 866A mercury vapor rectifiers had time to warm up. I tried a scheme of connecting the filament of a 12H6 twin diode in series with the bleeder of the bias supply and operating a relay from current passed by the diodes. The 5R4GY bias rectifier had to warm up before the 12H6 started to warm up which gave a 22 second delay. It would also provide protection from bias supply failure. The use of the 12H6 for extra delay was discarded to save cost, most of which was due to the need for a 300 mA bias supply instead of 75 mA. This deletion reduced the delay to approximately 5 seconds which meant that the operator had to be the "30 sec. timer".

The Boonton Q-Meter was a very important RF test instrument. We could use it to measure coil inductance and Q, capacitance, and coefficient of coupling between coils. A neon bulb on the end of an insulating rod was also very helpful. We used it to search out parasitic circuits. HF caused a pink glow, a LF parasite caused a yellow glow and a violet glow indicated a VHF parasitic oscillation. We could follow the resonant circuit path by moving the bulb along the circuit path where the color was strongest.

Models 30K-2, 3, 4, and 5

These were all intended for commercial service. There were some users who wanted to be able to communicate between different locations independently of the telephone system. One example was the Corps of Engineers who controlled the water flow through dams. All they needed was a day and a night frequency. These transmitters were crystal controlled with two sets of tuned circuits. Relays were used to switch the tuned circuits from one frequency to the other. They used single-ended pi-networks for the RF output networks. As I remember, most of the differences between models were related to methods of remote operation.

Concluding Remarks

It was fun working on the development of this transmitter. The Company allowed us quite a bit of freedom to use ingenuity in our designs. Most of the engineers at Collins were hams and they frequently stopped by to see how it was coming. I had lots of free advice. My office mate was Lou Couillard who was developing the 75A receiver at the same time. A color photograph of the 30K in the laboratory appeared on the cover of the November issue of *RADIO NEWS*. Clyde Hendrix, WØHBG, came to Cedar Rapids to personally take delivery of serials No. 1 of the 75A and the 30K with the 310A exciter. Years earlier he had purchased a Collins 30FXB when the company was just getting started. **ER**

A 1927 TNT Oscillator from page 33

tude of RTTY signals. My final score showed 30 valid exchanges and two QSO's with fellows who were simply curious. I think the chirpy, raspy TNT signal was a success. Several people commented on it - N2EZ said it was the lousiest signal on the band! Hooray! Halfway through the contest, I loosened the antenna coupling slightly, dropping the output to 2.5 watts. This seemed to steady the signal a bit. I feel that the project was a complete success except for one thing - I didn't receive a single OO (official observer) notice! Maybe next year I'll short out the filter choke! **ER**

References

1. ER #82, Feb. 1996
2. ER #83, March 1996
3. Old-Timer's Bulletin, Antique Wireless Ass'n, Dec. 1987

From: bowes@ibm.net
Received: from x6.boston.juno.com (x6.boston.juno.com [205.231.101.23])
by x15.boston.juno.com (8.6.13/8.7.Alpha.4/1.34.kim) with ESMTP id VAA05445
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X-Mailer: Ultimedia Mail/2 Lite, IBM T. J. Watson Research Center

R390A Audio Mods

Given the number of responses that I have had in the past three hours regarding the R390a audio mods, I, at my own peril, will make the following offer to all list members and any other solder-smoke sniffing hams who might desire such information in order to raise the levels of deposited lead in their bloodstreams.

As I mentioned in an earlier post, I have gone through the information in the original ER article by Bill Kleronomos and done some revisions and refinements. The revisions are relatively minor and mostly involve the fattening up of a couple of the caps in the audio stream which were left at their original size in the ER article. The refinements are that I have gone through and documented part placement for each of the components involved in the modification, and I have redrawn the schematic on the computer in order to make it more readable. The schematic indicates the placement of the parts i.e., on TB601 or on the audio chassis proper.

Included with the schematic is the full parts list for the modification, and a few hints and kinks as to how to best reutilize the existing terminal board and wiring harness. The information also includes what changes must be made to the wiring harness in order to facilitate the mod. All told, the information that I have compiled should allow nearly any industrious ham possessing above "tech-lite" skills to go ahead and do the 6360 "Kleronomos" mod with a minimum amount of head scratching and aggravation.

Now for the offer:

If you will send me $3.00 "AND" an SASE, I will send you a copy of the information that I have put together regarding this mod. This info will not include a copy of the original article as it is probably copyrighted by ER and I don't need to get into that hassle. I believe that you will find

From: "Lon W. Cottingham" <k5jv@swweb.net>
Received: from x11.boston.juno.com (x11.boston.juno.com [205.231.100.26])
by x15.boston.juno.com (8.6.13/8.7.Alpha.4/1.34.kim) with ESMTP id XAA26893
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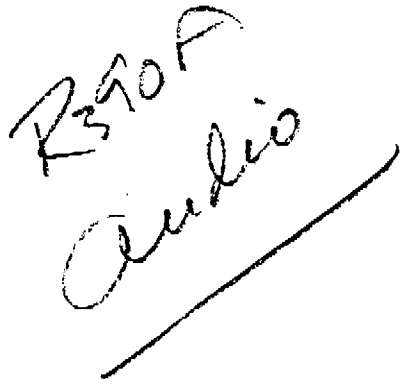
X-Mailer: Microsoft Internet Mail 4.70.1155



Greetings All:

Since I'm not a current BA subscriber, I don't know if this message will be posted--but this is in response to the earlier posting by Lon, K5JV re: my audio chassis mod that I was just sent a copy of via e-mail.

First, let me thank Lon for his kind words!
Let me make some corrections to his posting....

The article I wrote in ER, October 1992, Vol # 42, "REAL AUDIO FOR THE R-390A" that Lon refers to contains some typographical errors. If you choose to "roll your own", make sure to obtain the following issue for the corrections! I have since revised the circuit published in the article and the current design has more consistent and better performance than the published one both overall and with respect to normal component variations.

I still am doing the modification, but I will be moving sometime in the next couple of months and during the move I won't be able to accept any orders. Please reply by e-mail (wkleros@csn.net) or call (303) 823-6438 if interested.

Best to all-

-Bill
KD0HG

PT-291 OUT 'T TRANSFORMER

PRIMARY* TO SEC. TERM	IMPEDANCE RATIO	USE FOR
1 & 2	10,000	P-P 6F6,6K6,6V6,41,42 TO 1 OHM
2 & 3	5,100	P-P 6F6,6K6,6V6,41,42 TO 2 OHMS SINGLE 6F6, ETC. TO 1.5 OHMS
C & 1	2,300	P-P 6F6,6K6,6V6,41,42 TO 4 OHMS SINGLE 6F6, ETC. TO 3 OHMS
C & 2	1,050	P-P 6F6,6K6,6V6,41,42 TO 8 OHMS
C & 3	500	SINGLE OR P-P 45 TO 8 OHMS

* For push-pull operation use red for B+, blue and brown for plates.
* For single outputs use Blue for plate and brown for B+.

USED FOR 6AQ5 AUDIO MOD
→ 2900 = 4W 2901 = 8W 2904 = 18W

MERIT COIL AND TRANSFORMER CORP.

Chicago 40 *Illinois*

UNIVERSAL OUTPUT TRANSFORMER INSTRUCTION SHEET

A-2900, A-2901, A-2904

(For Single or Push-Pull Pri.)

PRI.: PLATE START BROWN, B+ RED, PLATE FINISH BLUE

FOR SINGLE PRI. USE BROWN FOR B+ BLUE FOR PLATE

SINGLE	43-45-50-2B6 6L6-6F6 25A7G-25A6	31-33-42-47 59-89-2A5 6B5-6F6-6N6G	89-1G5G-6K6G 6A4	41-49-6G6G 6K6G	10-38-950 12A7-1J5G
PUSH-PULL	48-2A3-6A3 6A5G-6B4G 6L6-25L6	45-46-59-79 6L6-6Y7G	30-43-50-53-2B6 6V6-6N7-12A5	19-42-49-52-89 6A6-6B5-6F6 6N6G-1J6G	41-47-79 1G5G-6A4-6K6 6Y7G-31-33

SEC. TAP	VOICE COIL IMPEDANCE — OHMS				
2-3	.17	.30	.34	.42	.59
3-4	.19	.34	.38	.48	.68
4-5	.30	.53	.61	.76	1.06
1-2	.51	.89	1.02	1.27	1.78
2-4	.73	1.28	1.46	1.82	2.54
5-6	.83	1.44	1.65	2.06	2.89
3-5	.96	1.67	1.92	2.39	3.35
1-3	1.27	2.23	2.54	3.18	4.46
2-5	1.97	3.45	3.94	4.92	6.90
4-6	2.12	3.70	4.22	5.30	7.40
1-4	2.48	4.32	4.92	6.18	8.65
3-6	3.60	6.30	7.24	9.00	12.6
1-5	4.45	7.80	8.90	11.1	15.6
2-6	5.32	9.35	10.70	13.3	18.7
1-6	9.15	16.0	18.3	22.8	32.0
PRI. LOAD IMPEDANCE	4000	7000	8000	10000	14000