R18-5-1

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The R-390A/URR: A Receiver Review

The R-390A/URR (hereafter 390A) is a workhorse receiver of the U.S. military, used by the Navy, Air Force and Army. In the words of the Army technical manual for the receiver, "Radio Receiver R-390A/URR provides reception of continuous wave (cw), modulated continuous wave (mcw), and amplitude modulation (am) (including single sideband (ssb)) signals over a continuous frequency range of 0.5 to 32 megacycles (mc). The receiver is a superheterodyne type with multiple frequency conversion. Double conversion is used when the receiver operates from 8 to 32 mc and triple conversion from 0.5 to 8 mc."

What does the nomenclature R-390A/URR mean? It is assigned according to a joint procedure used by the branches of the U.S. military. "R" of R-390A indicates that the device is a receiver (as opposed to T, for example, which would indicate that the device is a transmitter); "390" indicates that the device is at least the 390th model of receiver designed for the U.S. military; "A" indicates that the device incorporates a major modification or modifications into the original design, the R-390. The "URR" indicates that the device is a complete set in itself, and is a universal radio receiver.

There are two technical manuals available for the 390A. One is the U.S. Army TM 11-856A, also known by the newer number TM 11-5820-358-35. The other is the U.S. Navy 0967-063-2010. These may be obtained for around $16.00 from Sam S. Consalvo, 7218 Roanne Drive, Washington, DC 20021, or from Fair Radio Sales Co., Inc., 1016 East Eureka Street, Lima, Ohio 45802, or from other dealers in surplus military communications equipment. If obtained from another source, ascertain that the two large, foldout schematics (near the back cover) are present in the technical manual; otherwise, the value of the manual is reduced—especially if you or another has to perform troubleshooting on the 390A.

The 390A was designed by Collins Radio Company, as was its predecessor, the R-390, and was built ca. 1957-1960 on contract by AMELCO, Electronics Assistance Corp., Imperial Electronics Inc., Motorola, Stewart-Warner, and possibly some others. Some claim that there is a difference among them, but it is minimal, as they were all built to meet the same MILSPEC requirements, and assemblies are generally interchangeable among 390As built by varying manufacturers (but not always, some modifications have been authorized). I have not seen any significant differences among the 390As built by varying manufacturers

The 390A is built very sturdily, which is an advantage for one who gives his receiver heavy usage. The weight of the receiver is a disadvantage, however, to some. It is a flexible receiver, of immediate utility to the MW and SW BC DXer, the SWL, the utility DXer, and the ham.

The 390A weighs some 75 lbs without a mounting cabinet. With a mounting cabinet, it weighs 84 to 88 lbs. Some cabinet types which will accommodate the 390A are the CY-979A and the CY-4516A/S. Spectronics, Inc., 1009 Garfield, Oak Park, Illinois 60304, has a cabinet which will accommodate the 390A, for about $15.00. If you are intending to purchase a 390A, ascertain whether you are physically capable of carrying it.

The dimensions of the 390A are (1) 10 7/16 inches from top to bottom of the front panel (somewhat less at the rear panel), (2) 19 inches across the frontpanel, (3) 18¼ inches horizontally between mounting holes, and (4) 14 5/8 inches from front panel to rear panel (not including 1 7/16 inches projection of the two vertical front-panel handles on each side).

Except for the antenna trimmer, and the various trimmer capacitors used for alignment throughout the 390A, there are none of the usual variable capacitors used for tuning in the 390A that are found in the more common communications receivers. Instead, inductors tuned by ferrite slugs positioned by racks and cams, accomplish the tuning in the 390A. The variable-frequency oscillator (abbreviated VFO, called the permeability-tuned oscillator—PTO—in Collins receivers), which is tuned by the KILOCYCLE CHANGE control at the 390A frontpanel, is tuned by such a variable inductor. The 390A's excellent tuning linearity and tracking may be attributed to this usage of variable inductors for tuning.

<u>POWER REQUIREMENTS</u> The 390A may be operated from 115 VAC or 230 VAC, 50 or 60 Hz mains, by operating a voltage changeover switch located on the power supply subassembly. It is therefore not easily adaptable to portable or emergency operation away from mains power, without a generator or dynamotor.

<u>BREAKDOWN</u> The 390A consists of six subassemblies, which may be removed from the mainframe for troubleshooting and repair. These are:

1. IF subassembly
2. AF subassembly
3. VFO subassembly
4. power supply subassembly
5. RF subassembly
6. crystal oscillator subassembly.

<u>TROUBLESHOOTING</u> Troubleshooting the 390A is simple or difficult, depending mainly on the degree of training and experience of the technician. Using the technical manual, a simple signal generator, and a Volt-Ohm meter (capable of reading to 600 VAC, 700 VDC, and 1 megohm), one should be able to locate and repair the greatest majority of the problems likely to be encountered in the 390A.

<u>REPAIR PARTS</u> Repair parts, depending on their ratings and dimensions, may be more or less difficult to obtain. The more common components, such as resistors, capacitors, chokes, and crystals are readily available from electronic parts retailers or through mail-order houses. Other items, such as transformers (AF, IF and RF), potted capacitors, tuning slugs, and meters, are more difficult to acquire and may have to be ordered from a dealer who deals in 390As.

If replacements are required, the mechanical filters are a definite liability, because Collins Radio Company quotes $150 per mechanical filter in single-lot quantities.

<u>TUBE COMPLEMENT</u> The 390A uses vacuum-tube circuitry throughout. The tube complement consists of: 1, OA2 voltage regulator; 3, 6AK6s; 3, 6C4s; 1, 6DC6; 2, 26Z5s; 2, 5654/6AK5s; 6, 5749/6BA6s; 6, 5814s (nearest non-MILSTRIP equivalent is the 12AU7WA); and 1, 3TF7 ballast tube. The 3TF7 is no longer readily available, and may be <u>directly</u> substituted by the 3TF4 (or 3HTF4, which is the same type tube), available from parts stores, or from the author. The other types are more readily available.

The U.S. Navy ordered a field change that changed the 26Z5 rectifier tubes throughout the Fleet, with solid-state silicon rectifiers. The same modification can be performed by the DXer on his/her receiver. Two diodes are required for this modification, and the PTC205 diode (1000 P.I.V., 500 mA) will serve (available from Radio Shack as SN 276-1114). Otherwise, any other diode of 1000 P.I.V., 500 mA, rating should serve equally well.

<u>CONTROLS and INTERFACES</u> Controls, interconnects and meters located on the 390A front panel are:

1. KILOCYCLE CHANGE (tuning)
2. MEGACYCLE CHANGE (bandswitch)
3. LOCAL GAIN (volume control)
4. LINE GAIN (volume control)
5. RF GAIN
6. ANTENNA TRIM
7. FUNCTION (power on/off, AGC on/off, calibrator on/off)
8. AUDIO RESPONSE (wide/sharp)
9. BREAK IN (on/off)
10. BFO (on/off)
11. BFO PITCH
12. BANDWIDTH (selectivity)

R18-5-2

13. AGC (AGC time constant)
14. LIMITER (on/off, clipping adjust)
15. CARRIER LEVEL (meter)
16. LINE LEVEL (meter)
17. LINE METER (line meter attenuation adjust)
18. DIAL LOCK
19. ZERO ADJUST (calibrate)
20. PHONES (jack)

Controls and interconnects located on the 390A rear panel are:

21. OVENS (on/off)
22. POWER (line cord connector)
23. IF OUTPUT
24. ANTENNA
    a. BALANCED
    b. UNBALANCED
25. terminal connections:
    a. LOCAL AUDIO
    b. LINE AUDIO
    c. PHONES
    d. RF GAIN
    e. AGC NORMAL/DIVERSITY
    f. DIODE LOAD
    g. BREAK IN

PURPOSES OF CONTROLS AND INTERFACES The purposes of the various controls, interconnects and meters are:

3. LOCAL GAIN controls audio output level of local audio channel and PHONES output;
4. LINE GAIN controls audio output level of line audio channel (line audio channel is independent of local audio channel, and can be used to drive a phone line or recorder, for example);
12. BANDWIDTH selects 0.1, 1, 2, 4, 8, or 16 kHz selectivities;
13. AGC selects slow, medium, or fast AGC time constant (see notes);
14. LIMITER adjusts clipper threshold, or removes it from the circuit altogether (see notes);
15. CARRIER LEVEL meter fulfils the requirement as an "S" meter, but is accurately calibrated in 10 dB units (see notes);
16. LINE LEVEL meter measures level of audio that is present at line audio channel output (see notes);
17. LINE GAIN switch selects range (off, +10, 0, or -10) of line meter, in VUs (see notes);
23. IF OUTPUT jack permits access to receiver 455-kHz IF for interfacing of spectrum analyzers, product detectors, or the like;
24. ANTENNA permits connection to unbalanced (longwires or verticals) or balanced (dipoles or loops) antennas (see notes);
25. terminal connections, a. LOCAL AUDIO permits a direct connection (via a 500 or 600-Ohm matching transformer, to a loudspeaker;
    b. LINE AUDIO connections are balanced and isolated from ground;
    c. PHONES (see notes);
    e. AGC NORMAL/DIVERSITY permits direction interconnection of receiver IF with strip recorders and oscilloscopes for subaudible heterodyne analysis and propagation studies;
    f. DIODE LOAD (see notes).

FURTHER NOTES ON CONTROLS AND INTERFACES:

6. ANTENNA TRIM is rather critical in an environment of strong signals within the band of interest; especially the mediumwave band, where signal intensities of volts may be encountered. Misadjustment of this control in such an environment may cause intermodulation distortion and cross modulation, but it is not difficult to adjust;

13. AGC (time constants) FAST, MEDIUM and SLOW AGC time constants settings have respective time constants of 0.015, 0.3, and 5 seconds. The first is very useful as it permits rapid response at the carrier meter to subaudible heterodynes (carrier beats). The second would ordinarily be used for tuning around the band(s). The third time constant is very useful, on shortwave, for leveling the rapid fluctuations of AGC due to fluttery received signals, for improved intelligibility. It is equally useful, on mediumwave, for listening to crowded channels, especially the "graveyard" local, class-IV channels. Using that time

14. LIMITER The 390A limiter is as effective as any other limiter, plus the clipping threshold (both positive and negative thresholds are adjusted simultaneously by the limiter control) can be varied continuously from off to -20 dB. Nevertheless, the U.S. Army Signal Corps would have been much better advised, when determining what specifications to order in the design contract to Collins, to have specified a noise blanker rather than a limiter. This is the achilles heel of the 390A;

15. CARRIER LEVEL meter The 390A carrier meter is referenced to 0 dB, which is equivalent to 2 microvolts;

16. LINE LEVEL meter The line meter is calibrated from -20 to +3 VU (volume units), the VU being equal to 1 milliwatt (1 mW) across 600 Ohms. When read in conjunction with the line meter level selector switch, it permits adjustment of the line audio channel output from -30 to +13 VU;

20. PHONES jack Requires interface with headsets of 600 Ohms or more. 2 mW of audio power is available at the phones jack, but by bridging terminals 6 and 8 of TB102 at the rear panel of the 390A (LOCAL AUDIO and PHONES), the full 500-mW audio output of the local audio channel is available at the phones jack;

21. OVENS ON/OFF When operating the 390A with ovens on (these ovens are located at the VFO and at the 2nd crystal oscillator), a half-hour warmup period is required for full stability. However, the stability advantage of operating the 390A with ovens energized is minimal unless the 390A is to be operated in colder-than-normal ambient; constant, the very rapid flutter and the noise associated with phase cancellations of the dominant carriers on a channel (by which, ordinarily, the AGC would allow the receiver gain to rise, while sidebands remain at relatively constant levels, producing the distortion of double-sideband, reduced carrier as received on an A-M receiver) is very nearly eliminated;

24b. ANTENNA (UNBALANCED) is the usual connection to the antenna. A type UG-709/U (type "C") connector is required for this connection. A static discharge and R-F voltage-limiting protection circuit bridges the unbalanced antenna input to ground. This protection is lacking at the balanced antenna input. When connecting a balanced, outdoor antenna (such as a dipole) to the 390A, use of a balun transformer is recommended to permit connection to the unbalanced antenna input, in order to derive some protection from the input discharge circuit. Of course, always disconnect an outdoor antenna from any receiver when it is not in use, and during local thunderstorms.

25f. DIODE LOAD An external audio amplifier may be bridged between the diode load terminals and ground, via a 0.1-microfarad, 600-VDC paper capacitor, inserted in series with the "hot" lead, in order to bypass the 390A's internal audio amplifiers. The audio output of the 390A's internal local and line audio channels generate distortion and phase shift; and while the resulting audio is satisfactory for communications work, the 390A is capable of excellent fidelity when utilizing its 16-kHz bandwidth and an external audio amplifier. When so connected, the 390A local and line gain controls will not control the volume at the external amplifier.

ELECTRICAL CHARACTERISTICS A résumé of some of the notable 390A electrical characteristics follows:

Sensitivity The technical manual calls for a sensitivity of between 4 and 5 microvolts for 10 dB signal-plus-noise to noise ratio (S+N/N). The Drake SPR4 and the Hammarlund HQ-180 have better sensitivity than the 390A, but the 390A was not designed as a DX receiver. The 390A is designed for use in a high signal density environment. At MW BC frequencies, the 390A's sensitivity is more than adequate, except perhaps in rural districts, because ambient (natural and man-made) noise forms an irreducable floor under which weak signals become unreadable and are lost. In rural districts, a preselector may be useful if the ambient noise level is low. In both situations, especially the rural, an amplified loop may be helpful. However, an amplified loop may seriously degrade the very good strong-signal handling capabilities of the 390A in high signal-density districts, especially if its gain is unnecessarily high. A loop with hi-Q characteristics would help in avoidance of intermodulation distortion and cross modulation. At SWBC frequencies above about 7000 kHz, where ambient noise imposes a gradually less severe limitation on weak signal readibility, the 390A sensitivity may become an important limitation. A preselector would be helpful at these frequencies, also.

Selectivity The 390A has four mechanical filters of 16, 8, 4 and 2 kHz bandwidths, at 6 dB down. These same filters possess bandwidths of 3.70, 5.85, 16.00, and 19.4 kHz, respectively, at 60 dB down, for shape factors of 1.85, 1.46, 2.00, and 1.21 (A shape factor of 1.00 implies a perfect selectivity). The 0.1 and 1.0 kHz bandwidths are achieved using the summation of the 2-kHz mechanical filter bandpass and that if a crystal filter. The mechanical filters provide excellent selectivity, and generally are capable of "splitting" two signals separated by 1 kHz or less.

Stability No definite specifications for overall stability are called out in TM 11-5820-358-35; nevertheless, after a 1:30 hour warmup period, a -470 Hz drift in a typical 390A was observed after a period of 8 hours. This is a rather pessimistic figure, in my experience, as in this instance, the internal ovens were energized shortly before the end of the warmup period, and a resultant residual shift of -270 Hz is included in this figure of overall, longterm drift. 100 Hz per hour is probably a pessimistic expression of the midterm drift.

Strong Signal Handling Capability is the ability to receive weak or strong signals without intermodulation distortion or cross modulation, when an intense signal or intense signals are present on adjacent channels. The R390A has very good strong signal handling capability, the best that I have observed of any receiver that I have operated, although there are better receivers in this respect. This strong signal handling capability is of crucial importance to the MWBC DXer who resides in an area of intense MW signals, and only somewhat less so to the SWBC DXer.

Image Rejection I have observed no images in the 390A in either the MW or SW bands, despite attempts to induce them. This is partially due to the use of three tuned-RF stages ahead of the first mixer below 8 MHz. At 1 MHz, the image frequency is 35 MHz, and at 7 MHz, it is 41 MHz. Above 8 MHz, the 390A is dual conversion. At 8 MHz, the image frequency is 14 MHz; at 16 MHz, it is 22 MHz; at 31 MHz, it is 37 MHz. It is considered likely that images at about -70 dB can be observed by someone who has a signal generator, the output of which is calibrated. If anyone who can perform an image measurement on a 390A, will advise me, I will include the results with a sequel to this review.

Frequency Conversion Scheme The 390A tunes from 500 kHz to 32000 kHz in six bands. These bands are tuned in 1-MHz spreads (except the first band of 500 to 1000 kHz), and the resulting superficial appearance is that it tunes in 30, 1-MHz bands, and one, 500-kHz band. These bands consist of 2-to-1 tuning spreads, and are (1) 500-1000 kHz, (2) 1000-2000 kHz, (3) 2000-4000 kHz, (4) 4000-8000 kHz, (5) 8000-16000 kHz, and (6) 16000-32000 kHz.

Below 8 MHz, the signal frequency is additively mixed with a crystal-controlled, local oscillator frequency of 17 MHz, to yield a first, variable IF frequency of 17500 to 25000 kHz. This variable IF frequency is then subtractively mixed with one of eight frequencies generated by a second crystal-controlled local oscillator. The resultant is a second variable IF frequency of 3000 to 2000 kHz. This is subtractively mixed with a frequency of 3455 to 2455 kHz, generated by the VFO, to yield a 455 kHz, fixed-frequency IF, which is then processed in the typical manner.

Above 8 MHz, the first mixer and the 17-MHz crystal oscillator are bypassed, and the signal frequency is fed directly into a mixer, where it is mixed subtractively with one of 24 frequencies generated by the second crystal oscillator, after which the frequency-conversion scheme is identical to the 500-to-8000 kHz scheme.

The six bands, the first crystal oscillator, and the frequency of the second crystal oscillator, are selected by the MEGACYCLE CHANGE control. The frequency of the tuned-RF signal circuits, of the first variable-frequency IF tuned circuits, and of the second variable-frequency IF tuned circuits, are differentially controlled by the MEGACYCLE CHANGE and the KILOCYCLE CHANGE controls. The VFO frequency is directly controlled by the KILOCYCLE CHANGE control.

FREQUENCY CALIBRATION The 390A frequency readout is numerically calibrated at 1 kHz intervals, with intermediate markings at 200 Hz intervals. When properly calibrated at the nearest 100-kHz calibration point, errors of plus-or-minus 150 Hz, maximum, were observed against exactly known frequencies, in a typical 390A. The 390A uses a unique, odometer-type, Veeder-Root, numerical counter. The left two digits are driven by the MEGACYCLE CHANGE control, and represent MHz, and tens of MHz. The right three digits are driven by the KILOCYCLE CHANGE control, and represent kHz, tens of kHz, and hundreds of kHz.

calibration procedure Calibration is effected by setting the 390A readout to an exact, 100-kHz calibration, and by setting the FUNCTION switch to CAL. This disconnects the antenna from the receiver front end, and energizes the 100-kHz calibration generator, which generates a calibration point at every 100-kHz interval from 500 kHz to 32000 kHz. Then the BFO PITCH control is set to "0", and the BFO is energized. Then the ZERO ADJUST control is tightened down. This disengages the VFO from the from the frequency readout. The KILOCYCLE CHANGE control is manipulated for a zero beat, the ZERO ADJUST control is loosened up, the FUNCTION switch is returned to AGC (or MGC), and the set is thereby calibrated. This should be performed whenever the 390A is changed from one MHz range to another, if exact frequency readout is desired. Otherwise, there may be a residual error of up to 2 kHz when passing from one MHz range to another.

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The R-390A/URR: A Receiver Review

Part II

Since my earlier article on the R-390A was published in the latter quarter of 1977, more information has come to light, some clarifications are in order, and I would like to present some thoughts on this receiver.

First, under the subheading "Further notes on controls and interfaces," category 13. AGC, the last half of this paragraph, beginning with "Using this time..." was inadvertently cut off in publication in IRCA's DX Monitor, and appended to category 21, Ovens on/off, after line 7. This was confusing.

Second, the R-390A was not primarily designed to demodulate single-sideband transmissions. Its envelope-type diode detector generates a high degree of distortion when receiving single-sideband transmissions, especially under strong-signal conditions. The IF output jack on the rear panel of the R-390A permits connection to an SSB convertor (the Navy uses the CV-591/URR), a radioteletype convertor, or a facsimile convertor.

Some radio amateurs rewire the diode detector in a product detector configuration for SSB demodulation. I wouldn't advise this, as it spoils the resale value of the receiver (especially since many or most radio amateurs solder atrociously).

END USERS Aside from the U.S. Army, Air Force, and Navy, the R-390A has been used by the U.S. Coast Guard, Marine Corps, National Guard, and the National Oceanic and Atmospheric Administration (NOAA).

AVAILABILITY I suspect that the R-390A will not be appearing on surplus markets much longer, at least not in the quantities appearing in the past. The R-390A is being replaced by the R-1051( )/URR in the Navy; and I am told that it is being replaced, or has been replaced completely, in the Air Force, and the Army. It will probably continue to be used by the Reserves and the Guard for some time.

TECHNICAL MANUALS The Army technical manual (TM 11-5820-358-35) gives the best technical discussion of the theory of operation of the circuitry of the R-390A, while the Navy technical manual (0967-063-2010) has the clearest schematics (four large basic schematic foldouts, plus numerous simplified schematics), has a more detailed parts break down, is clad with thick, blue plastic covers, but presupposes a greater technical knowledge than does the Army manual. I recommend that the serious R-390A technician acquire both manuals.

MANUFACTURERS An additional manufacturer, Teledyne Corporation, has come to light. Aside from prototypes, it is known that the Collins Radio Company did not manufacture any R-390As. However, Collins did overhaul a number of them on contract. Since it is customary for the overhauling activity to replace the original nomenclature identification tag (in the case of the R-390A, attached below the ANTENNA TRIM control) with its own, identification tags of Collins, and of Bendix Field Engineering Corporation (to name another that I know) will appear on some R-390As.

R-390 FAMILY There are six receivers, all designed by Collins, that are related in circuitry and chronology of design and manufacture. These could be termed a family because of their generic resemblance. They are: R-388/URR, R-389/URR, R-390/URR, the subject receiver, R-391/URR, and R-392/URR. The R-388 was also available on the OEM market as the Collins 51-J4, lacks the odometer dial (It has the more conventional, "slide-rule" dial), differs the most from its successors in having a final (fixed) IF of 500 kHz, and being of much lighter physical construction. the R-389 has motorized and manual tuning, and tunes from 15 to 1500 kHz in two tuning spans. The R-390 is superficially identical to the R-390A, but actually differs in having two R-F stages, having different subassemblies than the "A", and lacks mechanical filters (among some very obvious differences). The R-391 is essentially an R-390 (not an"A") which has motorized tuning. The R-392 is much lighter than the "A", lacks mechanical filters, and operates from 28 volts, DC. Of the family, the R-390A has the best strong-signalhandling capabilities; the R-392 has the poorest.

An additional receiver of which I am aware that was designed and built by Collins for military usage, and which resembles the R-390A in many respects, is the R-648/ARR, a solid state receiver. This was probably procured only by the Air Force, as it is designed solely for airborne use.

POWER REQUIREMENTS The R-390A consumes 270 watts of power, with VFO and second crystal oscillator ovens turned on.

TUBE COMPLEMENT All of the vacuum tubes utilized in the R-390A, with the exception of the 26Z5W rectifier tubes (V801 and V802) and the 3TF7 current regulator (ballast) tube (RT501), are still still readily available on the commercial retail market. The 26Z5W is no longer manufactured, although it may be still available through some surplus dealers. The Navy's field change for shipboard use installed 1N561 diodes in place of the 26Z5W tubes.

Don't replace the 3TF7 with a fixed resistor, except as a temporary measure while waiting to acquire a replacement 3TF4 (3HTF4), because it reduces the stability of the receiver's VFO and BFO. Rewiring the heaters of the VFO (V701) and the BFO (V505) to operate from internal 6.3 volts A-C power likewise reduces receiver stability. As stated in part I of this article, the 3TF4 is available, albeit with some delay. If you have no source, write me.

INTERFACES The type UG-709/U connector, at last check, was available from Fair Radio Sales (see paragraph three of part I of this article for address). This is a a type C-to-RG-58/U (or similar coaxial cable) connector. Alternatively, one may chose to acquire a UG-636A/U type C-to-BNC adaptor, allowing connection to a male BNC connector. The UG-636A/U is available as Amphenol part number 83200 from electronics parts stores (perhaps requiring a special order).

MODIFICATIONS Aside from the substitution of diodes for V801 and V802 (26Z5Ws), conversion of the diode envelope detector to product detector configuration (not advisable), bridging of R101 for full 500 mW of audio output at the front panel PHONES jack (see Further Notes on Controls and Interfaces, item 20 of part I), there are some other standardized modifications that have been performed on the R-390A. I am aware only of those performed by the U.S. Navy, and one other, all of which will be recounted here. One of them adds a rectangular metal cover with AN type connectors for terminating audio and A-C power cables on the rear panel. This is installed over rear panel terminal boards TB102 and TB103, and FL101's input terminals. This, a field change, was installed only on shipboard R-390As by the Navy, and can be removed at the purchaser's option. Another two modifications are field changes which place a DIODE LOAD test jack and an elapsed time indicator on the front panel, and are trivial. Another provides for the interchanging of P205 and P206 (at the front of antenna shorting relay K101), and grounding of one terminal of the BALANCED ANTENNA jack J104. This permits the accessing of the 125-ohm input impedance of the R-390A at J103, via the R-F voltage limiting protection bridge circuit (unavailable at the 125 OHM BALANCED input without modification).

Another modification, one that can be performed to advantage, is the removal of the loading resistors across the primary and secondary of I-F transformers T501 and T502, and across the primary of I-F transformer T503 (resistors R511, R512, R553, R554, and R522, respectively). It is necessary to remove the cover of each I-F transformer in turn to perform this modification. Disconnect only one end of each resistor in order to facilitate reconnection for resale at a later date. Do not disconnect all resistors without accomplishing the following procedure: Begin at R511 and work backwards, disconnecting each resistor in turn. It is reported that the I-F circuits of some R-390As will break into self-oscillation if all loading resistors are removed; therefore, it is wise to disconnect them serially and after determination that lifting no particular resistor has caused the I-F circuit to break into self-oscillation. Replace the covers of each transformer. Realignment of the I-F transformers is advisable, most especially of those of those R-390As whose I-F circuits were stagger tuned.

PARTS AND TOOLS Look at the underside of an R-390A and at the shaft that joins the KILOCYCLE CHANGE control to the VFO (which is the cylindrical inclosure behind that control). On that shaft, a coupling may be seen, which coupling is termed an OLDHAM COUPLER. It permits the KILOCYCLE CHANGE control to drive the VFO freely and smoothly despite whatever small degree of misalignment may exist between the control shaft and theVFO drive shaft. Between the front, driving disk, and the rear, driven disk, is an interstitial disk, termed a "spider". This spider sometimes falls out when the R-390A is in transport. Without it, the VFO cannot be driven by the KILOCYCLE CHANGE control, and the R-390A will not tune.

R18-5-4

This spider, Collins part number 505-0483-002, is available from Collins Radio Group; 400 Collins Road, N.E; Cedar Rapids, Iowa 52402, for about $6.00 each. A smaller spider, Collins part number 505-1766-002, will serve satisfactorily. It is available for about $3.00 from the same source.

In aligning the R-390A, removing its knobs, the Oldham Coupler, adjusting the gear trains, and removing the I-F subassembly, a splined tool is necessary. This is known as a Bristo wrench, and is further discribed a #8, splined, 6-flute, socket-head wrench. This is available as Collins part number 540-7922-002, from Collins Radio Group. This is a metal-handled tool with a 90° bend and with the splined shaft embedded in the long arm. A hex-key type version is available from many or most hardware stores for about 10¢ each.

PERFORMANCE CHECKS There are some performance checks that can be performed easily on the R-390A. According to the technical manuals, the internal 100-kHz oscillator will cause deflection of at least 40 dB at the CARRIER meter when the R-390A is tuned to a harmonic of 100 kHz, and the receiver is in the CAL function. I would suggest that this check be performed on the 02 or 03 MHz frequency spans, while peaking the ANTENNA TRIM control for maximum CARRIER meter deflection. Another simple check is to set the receiver dial to 00 000.0 MHz. At this dial setting, the 17 MHz first crystal oscillator signal is passed by the first, variable IF, which is coincidentally tuned to 17 MHz. After rocking the KILOCYCLE CHANGE control for maximum CARRIER LEVEL meter deflection, the meter should deflect fully to the right and peg.

Another, more quantitative check, is to inject radio-frequency test signals at various test points on the R-390A R-F subassembly.

Using an unmodulated R-F signal generator of 50-ohm output, unterminated, and injecting the test signal of the frequencies and voltages indicated below to the test points enumerated, and with the controls set to the specified positions, a CARRIER LEVEL meter deflection of at least 20 dB should be obtained:

CONTROL SETTINGS: (X=setting irrelevant)

AGC:	X	FUNCTION:	AGC
ANT TRIM:	0	KILOCYCLE CHANGE	100.0
AUDIO RESPONSE:	X	LIMITER:	X
BANDWIDTH:	4 KC	LINE GAIN:	0
BFO ON/OFF	OFF	LOCAL GAIN:	0
DIAL:	01 100.0	LINE METER:	OFF
DIAL LOCK:	X	MEGACYCLE CHANGE:	01
BFO PITCH:	X	OVENS ON/OFF	X
BREAK IN	X	RF GAIN:	10
		ZERO ADJ:	X

TEST POINT:	SIGNAL GENERATOR INJECTION TEST FREQUENCY (kHz):	SIGNAL GENERATOR INJECTION TEST VOLTAGE (uV):
E211	455.0	750
E211	2900.0	300
E210	2900.0	65
E210	18100.0	100
E209	18100.0	100
E209	1100.0	30

ADDITIONAL SOURCE An additional source for various R-390 series parts and tools is Dames Communications System, 10 Schuyler Avenue, North Arlington, New Jersey 07032.

Any comments concerning Part I or II of this article, any corrections, or any additions to the foregoing, are welcomed. Send them to CHARLES A. TAYLOR, 939 N. EASTERN AVENUE, INDIANAPOLIS, INDIANA 46201, or to my most current address, if you are aware of it. If enough material comes to hand to justify it, a part III may be prepared.