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THE 'APT-2' ACTIVE ANTENNA TUNER — by Mark Connelly, VK1ION

Part 1

INTRODUCTION

This article gives construction plans and usage notes for an active parallel tuner with regeneration capability. The high-impedance FET input with switch-selectable coupling levels for different length aerials permits tuning of antennae as short as a 2-ft. car whip and as long as a Beverage over 1000 ft. Aside from wires, the APT-2 can also serve as a tuned gain stage after an active loop; it can also be a tuner/amplifier for a loophead coil. The DXer can fabricate a whole series of loopheads, using cheap ferrite rods available from Etco & other surplus houses.

The frequency range for non-regenerated 'normal' wire tuning is approx. 150 to 6000 kHz. With regeneration, the range is approx. 150 to 2000 kHz.

Even in the non-regenerative mode, tuning sharpness is quite satisfactory for most DX applications. The APT-2 tuner provides pre-selection which, when the tuner is properly adjusted, can eliminate many spurious responses, especially on inexpensive receivers operated in an urban environment. It can also provide considerable gain over the signal achievable by a direct connection of the wire to the receiver. For this reason, it makes an excellent shortwire tuner. Even the signal from a Beverage can be increased, at least in rural areas where overloading isn't a concern.

The regeneration option built into the APT-2 distinguishes it from the earlier APT-1, mentioned briefly in my recent article 'Modular Phasing Systems'.

Sharpness and gain can be further enhanced by employing regeneration. Although regenerative tuning is touchy and time-consuming, the results are often well worth the effort. The APT-2, when used in a regenerative mode, allows receivers of mediocre selectivity, such as a car radio, to be readily capable of foreign split MW DX reception. Where only heterodynes were heard against domestic stations prior to using the APT-2 tuner, foreign split DX audio can often be extracted when the APT-2 is 'in-line'.

The APT-2 provides a low-impedance output, suitable for most recejver inputs. All inputs & outputs provide DC-blocking. In non-regenerative mode, the tuner can be used as a wire-tuning module in a modular phasing system.

Figures 1, 2, & 3 are electrical schematics characterising the tuner. Table 1, accompanying Figure 2, gives an idea of 'ballpark' frequency range switch settings to use for a given frequency. Figure 4 is the parts layout 'roadmap' for the A1 (Front End Card) subassembly. Tables 2 through 5 are the materials (parts) lists for the APT-2 tuner. Table 6 (hole list) and Figures 5 (a,b,&c) (hole pictorials) will be used to guide the drilling of holes during the APT-2 assembly procedure immediately following Figures 5 (a,b, & c).

This tuner should be a worthwhile addition to any DXer's shack.

Assembly of APT-2 Tuner

1. Read the entire article thoroughly to get an idea of how to prepare for APT-2 construction. Keep the article at the workbench, as it will be necessary to refer to it constantly.
2. Obtain necessary parts [see parts lists].
3. Organise work area: Ensure that area is comfortable, well-lighted, and sufficiently spacious. The following tools & shop supplies should be available: accurate steel ruler, calipers, or micrometer; sharp-pointed metal scribe; several sizes of Phillips & 'regular' (slotted); screwdrivers; nutdrivers for 4-40 & 6-32 nuts; variable-speed electric drill; drill bits (see hole list); 'pilot-hole' drill bit (approx. dia.=0.08 in.); small diagonal cutters; longnose pliers; slip joint pliers; soldering pencil (in the 25 to 45 watt range) with holder stand; rosin-core solder; solderwick; solder sucker; file; vise mounted on sturdy bench; X-Acto knife; hacksaw; and digital-multimeter or volt-ohmmeter.

FIGURE 1

Main Schematic: APT-2 Active Parallel Tuner with Regeneration

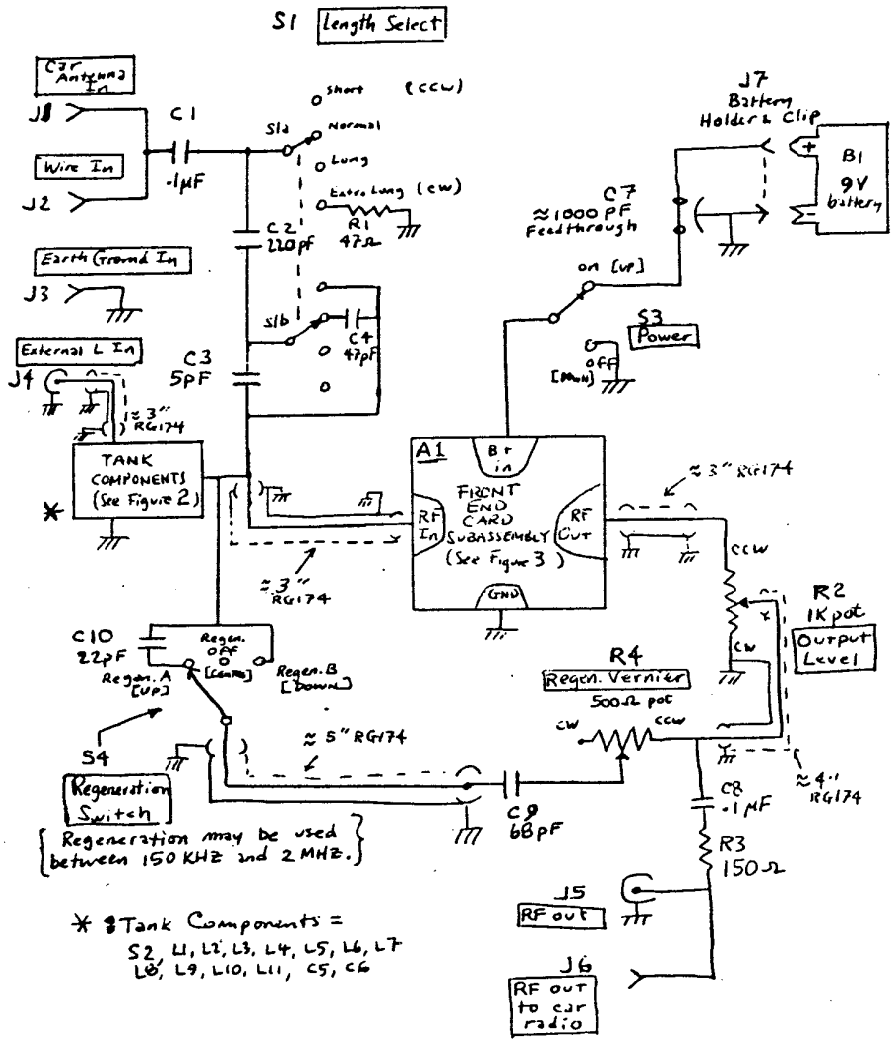

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FIGURE 2

Tank Circuit Schematics APT-2

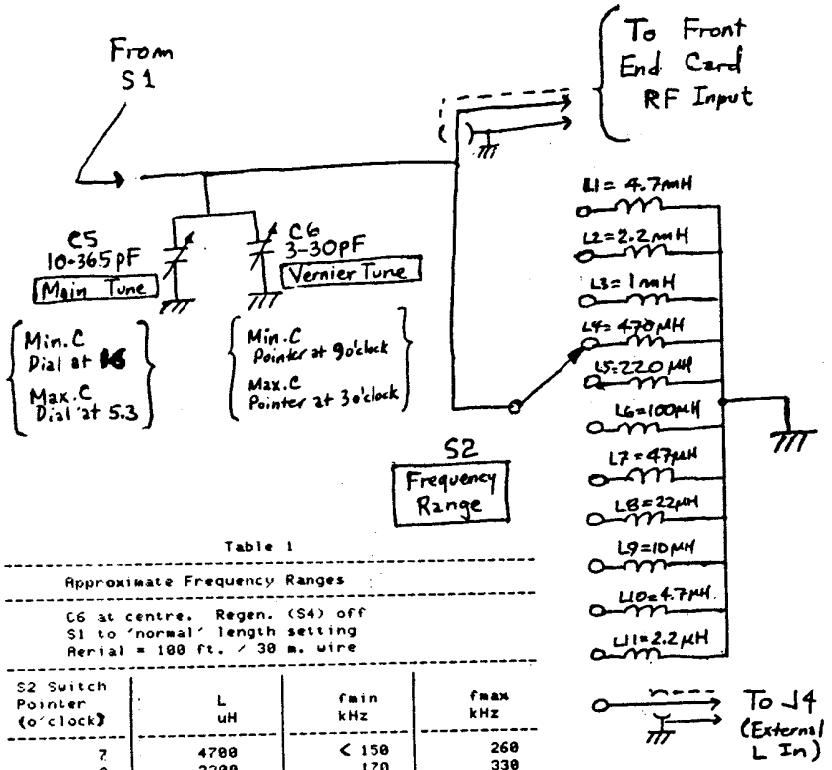

Table 1

Approximate Frequency Ranges

C6 at centre. Regen. (S4) off
S1 to 'normal' length setting
Aerial = 100 ft. / 30 m. wire

S2 Switch Pointer (o'clock)	L uH	fmin kHz	fmax kHz
7	4700	< 150	260
8	2200	170	330
9	1000	260	520
10	470	380	710
11	220	470	890
12	100	820	1600
1	47	1200	1950
2	22	1660	3330
3	10	2700	4400
4	4.7	3850	5550
5	2.2	5500	8300
6	EXTERNAL	*	*

* = range depends on ext. L value

TABLE 2

APT-2 Level 1 Parts List

A1	Front End Card sub-assembly	[see Level 3,4 parts lists]
B1	9 volt battery	Duracell MN1604
C1	.1 uF ceramic	RS 272-135
C2	220 pF ceramic	RS 272-124
C3	5 pF ceramic	RS 272-120
C4	47 pF ceramic	RS 272-121
C5	10-365 pF mini.variable	Mouser 24TR210
C6	3-30 pF air variable	GC/Calectro A1-225
C7	feedthrough cap, approx 1000pF	several Erie or Spectrum types
C8	.1 uF ceramic	RS 272-135
C9	68 pF mica	Mouser 23DM068
C10	22 pF mica	Mouser 23DM022
J1	Motorola jack	RS 274-712
J2	red binding-post banana jack	RS 274-662
J3	black binding-post banana jack	RS 274-662
J4	BNC jack	RS 278-105
J5	BNC jack	RS 278-105
J6	Motorola jack	RS 274-712
J7	battery connector/holder	Acme
L1	4.7 mH	Mouser 43LH247
L2	2.2 mH	Mouser 43LH222
L3	1 mH	Mouser 43LS103
L4	470 uH	Mouser 43LS474
L5	220 uH	Mouser 43LS224
L6	100 uH	Mouser 43LS104
L7	47 uH	Mouser 43LS475
L8	22 uH	Mouser 43LS225
L9	10 uH	Mouser 43LS105
L10	4.7 uH	Mouser 43LS476
L11	2.2 uH	Mouser 43LS226
R1	47 ohm	RS 271-009
R2	1K pot	Mouser 31CB301
R3	150 ohm	RS 271-1312
R4	500 ohm pot	Mouser 31CR205
S1	4-position rotary switch	Mouser 10WH034 or 10YX034
S2	12-position rotary switch	RS 275-1385
S3	SPDT (on/on) toggle	RS 275-613
S4	SPDT (on/off/on) toggle	RS 275-325
-	hookup wire [as req'd]	RS 278-1296
-	bussuire [as req'd]	RS 278-1341
-	RG174 coax.cable [as req'd]	Mouser 515-1156-12

TABLE 3

APT-2 Level 2 Parts List

C5		4-40 X .375 screw	Mouser	529-Y4R6/100
C5	[QTY=2]	#4 lockwashers	Mouser	529-PLN4/100
C5	[QTY=2]	4-40 hex nuts	Mouser	529-4CD/100
C5		#4 solder lug	Mouser	565-1416-4
C6	[QTY=2]	4-40 X .375 screws	Mouser	529-Y4R6/100
C6	[QTY=2]	#4 lockwashers	Mouser	529-PLN4/100
G1		4-40 X .25 screw	Mouser	529-Y4R4/100
G2		4-40 X .25 screw	Mouser	529-Y4R4/100
G3		4-40 X .25 screw	Mouser	529-Y4R4/100
G4		4-40 X .25 screw	Mouser	529-Y4R4/100
G1		4-40 hex nut	Mouser	529-4CD/100
G2		4-40 hex nut	Mouser	529-4CD/100
G3		4-40 hex nut	Mouser	529-4CD/100
G4		4-40 hex nut	Mouser	529-4CD/100
G1		#4 solder lug	Mouser	565-1416-4
G2		#4 solder lug	Mouser	565-1416-4
G3	[QTY=2]	#4 solder lugs	Mouser	565-1416-4
G4		#4 solder lug	Mouser	565-1416-4
J1	[QTY=2]	6-32 X .375 screws	Mouser	529-Y6R6/100
J1	[QTY=2]	#6 lockwashers	Mouser	529-PLN6/100
J1	[QTY=2]	6-32 hex nuts	Mouser	529-6CDS/100
J6	[QTY=2]	6-32 X .375 screws	Mouser	529-Y6R6/100
J6	[QTY=2]	#6 lockwashers	Mouser	529-PLN6/100
J6	[QTY=2]	6-32 hex nuts	Mouser	529-6CDS/100
J7	[QTY=2]	4-40 X .375 screws	Mouser	529-Y4R6/100
J7	[QTY=4]	4-40 hex nuts	Mouser	529-4CD/100
J7	[QTY=4]	#4 lockwashers	Mouser	529-PLN4/100
C6		knob	Mouser	45KN013
R2		knob	Mouser	45KN013
R4		knob	Mouser	45KN013
S1		knob	Mouser	45KN013
S2		knob	Mouser	45KN013
-		chassis box	RS	270-238

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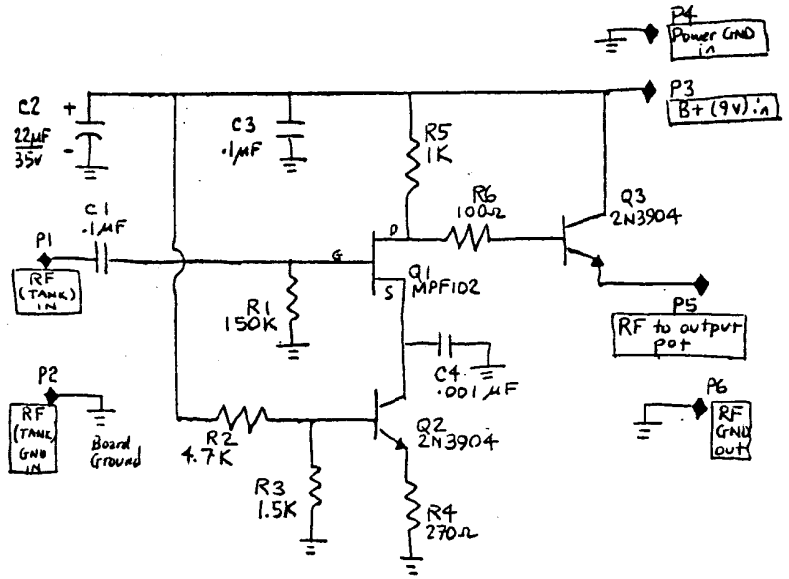
FIGURE 3

Schematic for Front End Card subassembly (A1 of APT-2)



NOTES

1. Component designations for parts on A1 are a completely separate entity from the designations of APT-2 components external to A1. (In other words, C1 of Figures 3 & 4 is a different component from C1 of Figure 1.)
2. The nominal power input voltage is +7 to +18 VDC. The tuner may be operated on +10 to +16 VDC; for peak performance in that voltage range, change R2 of the A1 subassembly from 4.7K to 10K.

TABLE 4

APT-2 Level 3 Parts List
A1 Front-End Card Subassembly (electrical)

C1	.1 uF monolithic	RS 272-111
C2	22uF/35v	RS 272-1026
C3	.1 uF monolithic	RS 272-111
C4	.001 uF ceramic	RS 272-126
Q1	MPF102	RS 276-2062
Q2	2N3904	RS 276-1603
Q3	2N3904	RS 276-1603
R1	150K	RS 271-047
R2	4.7K	RS 271-1330
R3	1.5K	RS 271-025
R4	270 ohm	RS 271-1314
R5	1K	RS 271-1321
R6	100 ohm	RS 271-1311

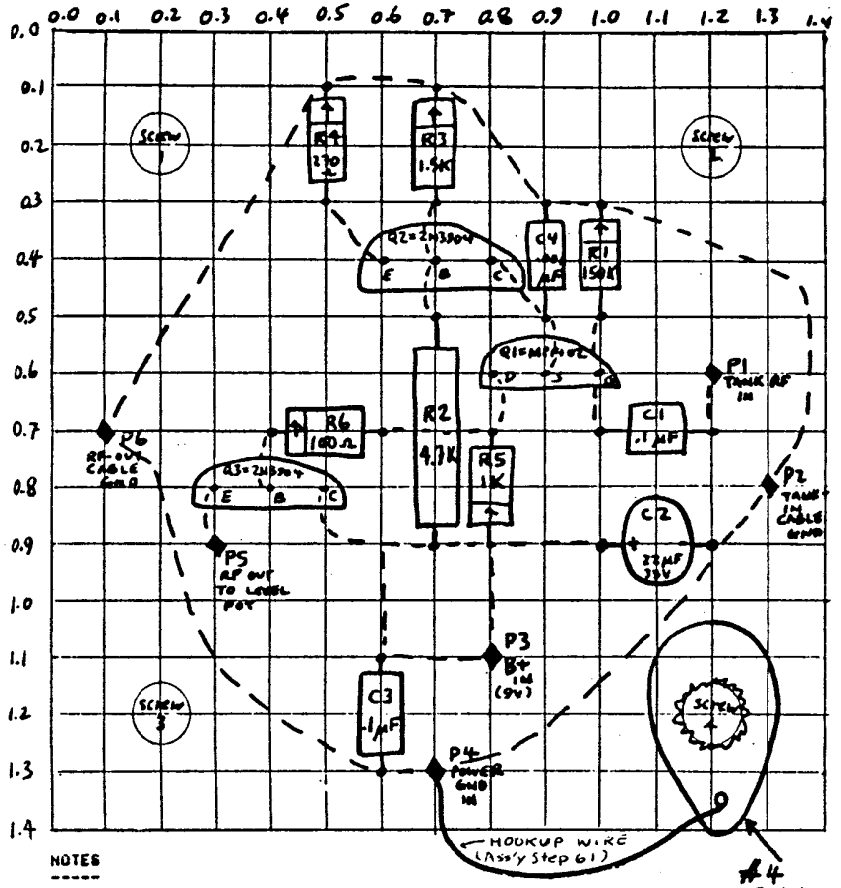
TABLE 5

APT-2 Level 4 Parts List
A1 Front-End Card Subassembly (mechanical)

P1	pushpin 'flea-clip' terminal	RS 270-1392
P2	pushpin 'flea-clip' terminal	RS 270-1392
P3	pushpin 'flea-clip' terminal	RS 270-1392
P4	pushpin 'flea-clip' terminal	RS 270-1392
P5	pushpin 'flea-clip' terminal	RS 270-1392
P6	pushpin 'flea-clip' terminal	RS 270-1392
-	perfboard[cut to 1.4X1.4 in.]	RS 276-1395
-	[QTY=4] 4-40 X .5 spacers	Mouser 565-2332
-	[QTY=8] 4-40 X .25 screws	Mouser 529-Y4R4/100
-	#4 solder lug	Mouser 565-1416-4
-	[QTY=7] #4 lockwashers	Mouser 529-PLW4/100

FIGURE 4

"Roadmap" for Front End Card subassembly (A1 of APT-2)



NOTES

1. Dimensions are in inches (board size 1.4 in. X 1.4 in.)
2. Dashed lines indicate underside wiring (using component leads and/or added bare busswire).
3. The end of a resistor marked with an arrow (↑) indicates the LONG LEAD side of a vertically-mounted resistor (5 total), R2 is mounted horizontally.
4. Mounting & wiring of components is done during assembly steps J5&16.
5. Grid lines are only to assist in locating components; they do not imply connections. Crossings of grid lines correspond to the small holes built into the perfboard.

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Figures 5(a,b,&c) are the APT-2 HOLE-DRILLING PICTORIALS

For hole locations & sizes, refer to Table 6.

The chassis box (Radio Shack # 270-238) consists of two metal pieces: a top (outer) piece and a bottom (inner) piece. All components are to be mounted on the TOP (OUTER) PIECE. This piece measures approximately 2.906 in. (vertically) by 5.175 in. (horizontally) on its TOP side and approximately 2.125 in. (vertically) by 2.906 in. (horizontally) on its LEFT and RIGHT sides. Note how hole-locating X & Y coordinates are defined in Figures 5 (a,b,&c).

The numbers adjacent to holes on the pictorials correspond to the hole numbers in Table 6.

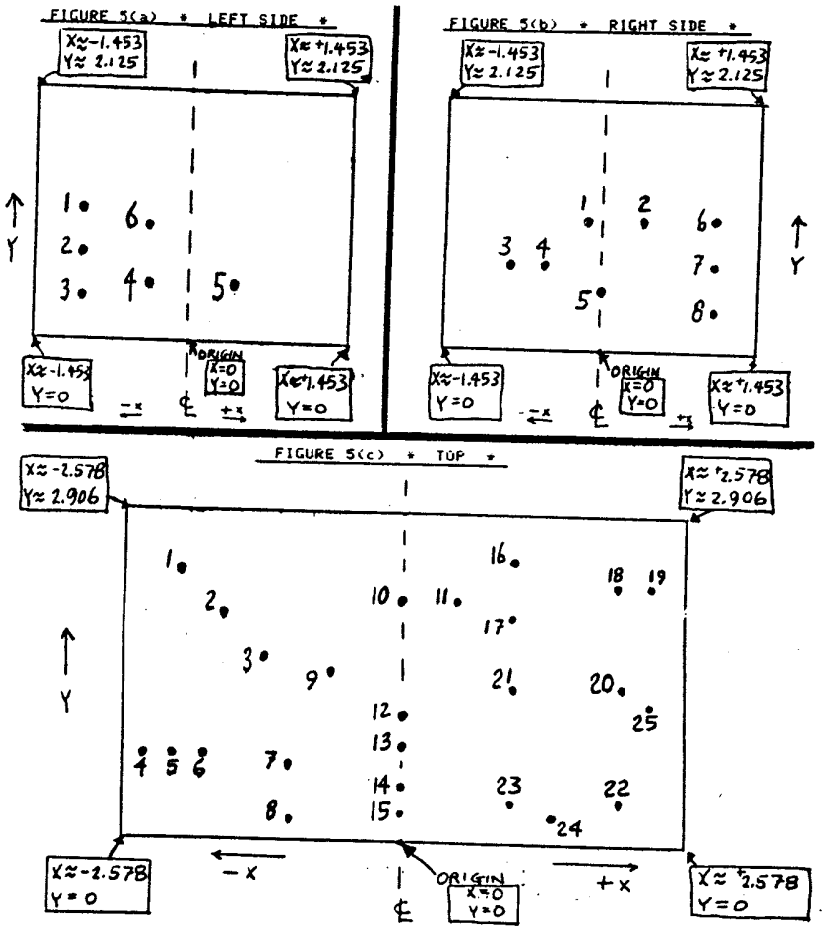


TABLE 6

Hole list for APT-2 regeneration-capable tuner
(X=horiz.distance from vert. centreline:- = left of CL,+ = right)
(Y=vertical distance from lower horizontal edge of side observed)

LEFT SIDE

Hole	Comp.	Description	X(in.)	Y(in.)	DIA(in.)
1	J1	ear ant.jack,screw 1	-1.0	1.144	0.14
2	J1	ear ant.jack, body	-1.0	0.75	0.5
3	J1	ear ant.jack,screw 2	-1.0	0.356	0.14
4	J3	GNDin-blk banana jack	-0.375	0.5	0.3125
5	J2	WIREin-red banana jack	0.375	0.5	0.3125
6	G4	GND screw for J3	-0.375	1.0	0.0

TOP

Hole	Comp.	Description	X(in.)	Y(in.)	DIA(in.)
1	C5	Main Tune Cap, screw	-2.0	2.375	0.113
2	C5	Main Tune Cap, shaft	-1.625	2.0	0.277
3	C5	Main Cap,stator clearance	-1.25	1.625	0.3125
4	C6	Vernier Cap, screw 1	-2.3285	0.75	0.113
5	C6	Vernier Cap, shaft	-2.0625	0.75	0.25
6	C6	Vernier Cap, screw 2	-1.7965	0.75	0.113
7	S1	Length Switch, shaft	-1.0	0.6875	0.375
8	S1	Length Switch, tab	-1.0	0.1875	0.14
9	G1	GND screw for S2	-0.625	1.5	0.113
10	S2	Freq.RangeSwitch, shaft	0.0	2.125	0.375
11	S2	Freq.RangeSwitch, tab	0.5	2.125	0.14
12	S4	Regen. Switch, shaft	0.0	1.125	0.25
13	S4	Regen. Switch, tab	0.0	0.875	0.113
14	S3	Power Switch, shaft	0.0	0.5	0.25
15	S3	Power Switch, tab	0.0	0.25	0.113
16	J4	External Coil Jack	1.0	2.5	0.375
17	G2	GND screw for J4	1.0	2.0	0.113
18	R2	OutputLevelPot, shaft	1.9375	2.25	0.3125
19	R2	OutputLevelPot, tab	2.25	2.25	0.14
20	A1	FrontEndCard, screw 1	2.0	1.375	0.113
21	A1	FrontEndCard, screw 2	1.0	1.375	0.113
22	A1	FrontEndCard, screw 3	2.0	0.375	0.113
23	A1	FrontEndCard, screw 4	1.0	0.375	0.113
24	J7	BatteryHolder, screw 1	1.375	0.25	0.113
25	J7	BatteryHolder, screw 2	2.25	1.25	0.113

RIGHT SIDE

Hole	Comp.	Description	X(in.)	Y(in.)	DIA(in.)
1	C7	B+ in feedthrough cap	-0.125	1.125	0.188
2	G3	Power-GND-in screw	0.375	1.125	0.113
3	R4	Regen.VernierPot, shaft	-0.875	0.75	0.3125
4	R4	Regen.VernierPot, tab	-0.5625	0.75	0.113
5	J5	RF out (BNC)	0.0	0.5	0.375
6	J6	RF out to car RX, screw 1	1.0	1.144	0.14
7	J6	RF out to car RX, body	1.0	0.75	0.5
8	J6	RF out to car RX, screw 2	1.0	0.356	0.14

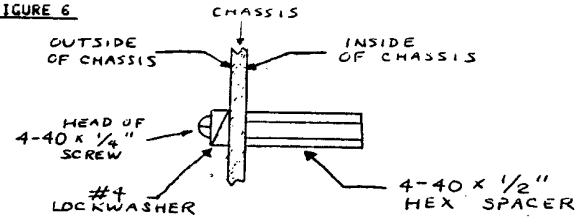
NOTE: Diameters of RIGHT SIDE holes 1&3 may vary depending upon C7 & R4 used. In general, it is wise to verify hole locations & sizes, based upon the components available at the time of APT-2 construction.

Assembly of APT-2 Tuner (continued)

4. Verify that hole locations & diameters in the documentation conform to the parts acquired. Adjust hole list (Table 6), if necessary, before proceeding.
5. Use ruler, scribe, & the hole list to mark hole locations on the chassis box. Push the scribe into the metal to a sufficient depth that the 'pilot' drill bit will stay in place when preliminary drilling is done.
6. Drill all marked hole locations with the 'pilot' bit.
7. Drill all holes with the .113 in. diameter bit.
8. Drill all holes listed as .14 in. diameter or greater with the .14 in. diameter bit.

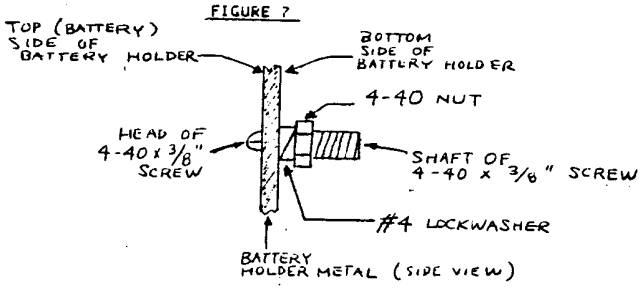
9. Drill all holes listed as greater than .14 in. diameter and less than or equal to .25 in. diameter with the actual final size bit.
10. Drill all holes listed as being over .25 in. diameter with the .25 in. drill bit, and then with the actual final size drill bit.
11. Put chassis box aside (until step 18).
12. Enlarge the mounting hole of the Main Tuning Capacitor (C5) by means of drilling with a .113 in. bit.
13. Cut the perfboard (for the A1 subassembly) to correct size (1.4 in. X 1.4 in.). Cuts should be made along straight rows & columns of board holes.
14. Drill four .113 in. diameter holes at the eventual screw locations near the perfboard corners, as indicated in Figure 4 (the A1 layout drawing).
15. Mount components onto perfboard: refer to Figure 4 (layout), Figure 3 (schematic), and Tables 4 & 5 (levels 3 & 4 parts lists).
16. Connect components together on underside of perfboard; use bussuire where necessary. The dashed lines in Figure 4 indicate physical locations of underside connections. The A1 schematic should also help. Solder the connections & cut off excessive leads. Screws, lockwashers,& solder lug will be added to A1 later.
17. Put the assembled A1 card aside temporarily.
18. Install hardware assemblies at TOP side chassis box holes 20, 21, 22, & 23: refer to Figure 6 to follow. The spacers thereby installed are used for subsequent mounting of the A1 card inside the chassis box.

FIGURE 6



19. Four additional 4-40 X .25 screws, three #4 lockwashers, and a #4 solder lug should be kept aside for subsequent mounting of the A1 Front End Card (step 38).
20. Prepare the battery holder for mounting by installing two hardware assemblies of the type shown in Figure 7. One assembly is to be installed at each of the two holes on the battery clip. The nuts & lockwashers installed at this time are essentially being used as short spacers.

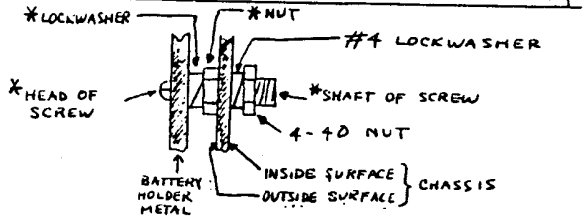
FIGURE 7



21. Place the battery holder on the chassis box so that its connector clips are close to the right edge of the TOP side of the chassis. The screw shafts of Figure 7 should be inserted into TOP side holes 24 & 25.
22. Mount the battery holder to the chassis with hardware as indicated in Figure 8.

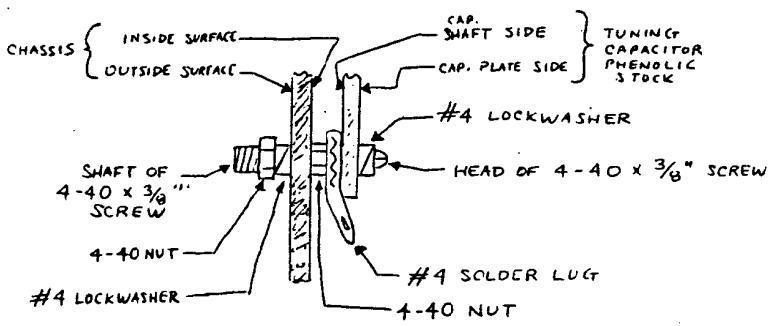
FIGURE 8

{ * = HARDWARE INSTALLED IN FIGURE 7 }



23. If desired, reduce the shaft length of S2, the 12-position switch, to about 0.75 in. [use a hacksaw, place shaft of switch in bench vise]. Remove hardware from shaft(until step26)
24. Assemble inductors onto the 12-position switch (S2): Start by locating the switch pin immediately adjacent to the locating tab [in a counterclockwise (CCW) direction, as viewed from the connection side (back) of the switch]. Solder one end of the 4.7 mH inductor to that pin; leave the other lead free. To the next switch contact pin, going CCW (as viewed from back of switch), solder one lead of the 2.2 mH inductor. To subsequent [increasingly CCW] pins, install one end of each of the following inductors: 1 mH, 470 uH, 220 uH, 100 uH, 47 uH, 22 uH, 10 uH, 4.7 uH, & (finally) 2.2 uH. There will be one (outer) contact pin left open (that between 2.2 uH & 4.7 mH); the wiper arm (inner) pin will also, at present, be free of any connections.
25. Connect all of the free inductor leads together with a bussuire to form a circular wire ring about an inch from the switch contact connection pins. Solder leads & cut off excessive wires.
26. Install the 12-position inductor [Freq. Range] switch S2 onto the chassis box: switch body inside box; shaft through TOP side hole 10; tab to TOP hole 11. Secure S2 by using the nut & the washer supplied with the switch.
27. Remove the OUTER of the two nuts from the shaft of the Main Tuning Capacitor. Do not disturb the INNER shaft nut. Set the outer nut aside until step 29.
28. Mount the Main Tuning Capacitor (C5) at TOP side hole 1 by using the hardware assembly depicted in Figure 9. The capacitor shaft should protrude through TOP side hole 2.

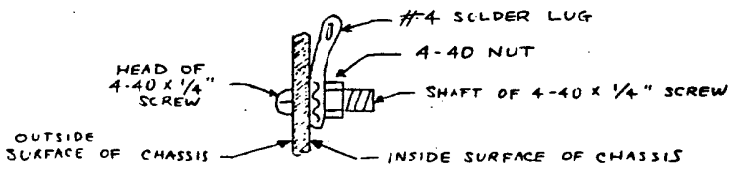
FIGURE 9



29. The shaft of the Main Tuning Capacitor should be secured by attaching the nut removed in step 27.
30. Place the Vernier Cap. (C6) inside the box so that its shaft protrudes through TOP side hole 5. The rotor lug of C6 should be pointing towards C5. Secure C6 by means of a 4-40 X .375 screw & #4 lockwasher at TOP side hole 7 and with the same type hardware at TOP side hole 6.

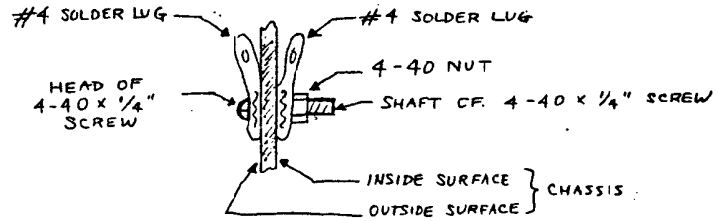
31. Mount the 4-position rotary switch (S1) by using the hardware supplied with the switch. The shaft should exit the chassis box at TOP side hole 7; the locating tab should be in TOP side hole 8.
32. Mount the SPDT on/off/on switch (S4) at TOP hole 12 [shaft] and TOP hole 13 [tab on locating washer]: use hardware supplied with the switch.
33. Mount the SPDT on/on switch (S3) at TOP hole 14 [shaft] and TOP hole 15 [tab on locating washer]: use hardware supplied with the switch.
34. Mount grounding hardware assemblies: G4 at LEFT side hole 6, G1 at TOP side hole 9, and G2 at TOP side hole 17. Each assembly should resemble Figure 10.

FIGURE 10



35. Mount grounding hardware assembly G3, in accordance with Figure 11, at RIGHT side hole 2.

FIGURE 11



36. Install a BNC jack (J4) at TOP side hole 14: use the nut & the lockwasher provided with the jack.
37. Install the 1K pot (R2) at TOP side hole 18 [shaft] & hole 19 [tab]: use hardware supplied with pot.
38. Mount the A1 card on the four spacers installed in step 17. The component side of the card faces away from the spacers, the wiring side faces towards the spacers. The side of the A1 card with P5, the RF-out pushpin, should be oriented so that is closest to, and parallel to, the inside of the chassis box RIGHT side (which appears to be the left side as you view the the inside of the box with the bottom cover off). Figure 12 shows the hardware to be used at the 'card screw 4' location (the lower right corner of the A1 card if the card is observed from the underside of the box / component side of card); this hardware mates with the spacer at chassis TOP side hole 23. Figure 13 shows the hardware used at the other three A1 card corner holes: these mate with spacers situated at TOP side holes 20, 21, & 22.

FIGURE 12

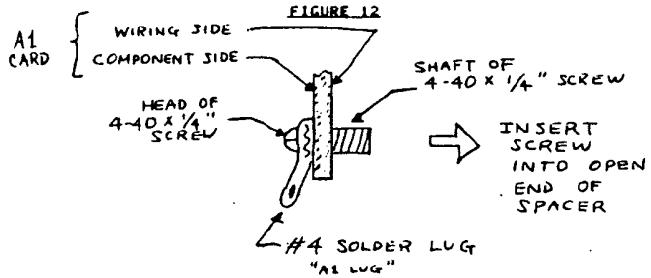
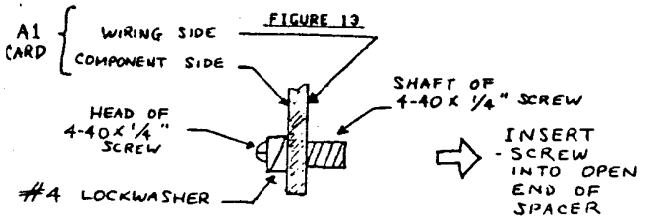
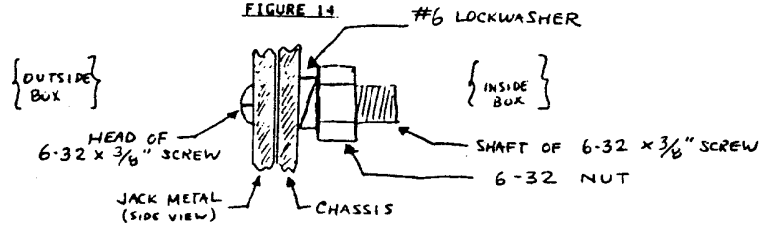


FIGURE 13



39. Install red banana binding-post jack (J2) at LEFT side hole 5: use nut & lockwasher supplied with jack.
40. Install black banana binding post jack (J3) at LEFT side hole 4: use nut & lockwasher supplied with jack.
41. Install Motorola jack (J1) body through LEFT side hole 2. Position the screw holes on the jack so they line up with LEFT side holes 1 & 3. Mount the jack according to Figure 14.

FIGURE 14

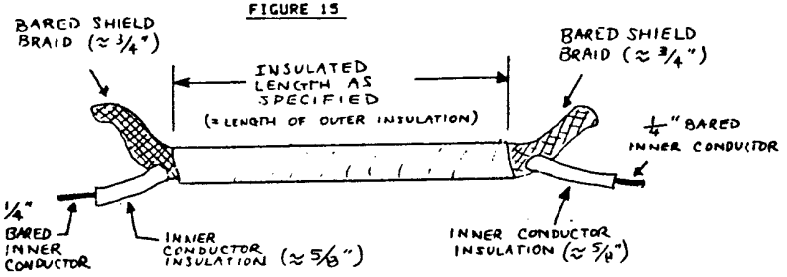


42. Install Motorola jack (J6) body through RIGHT side hole 7. Use the same hardware scheme as employed in Figure 14: J6 is to be secured at RIGHT side holes 6 & 8.
43. Install the B+ feedthrough capacitor (C7) at RIGHT side hole 1: use hardware supplied with capacitor.
44. Install BNC jack (J5) at RIGHT side hole 5: use hardware supplied with jack.
45. Install the 500 ohm pot (R4) at RIGHT side hole 3 [shaft] & hole 4 [tab]: use Hardware supplied with pot.
46. Install (supplied) dial knob on C5 (Main Tune Cap.).
47. Install Mouser type 45KN013 knobs on the shafts of C6, S1, S2, R2, & R4. Set pointers as follows:

C6	Pointer at 3 o'clock with C6 plates fully meshed
S1	Pointer halfway between 9 o'clock & 12 o'clock with S1 at most-counterclockwise (CCW) position
S2	Pointer at 6 o'clock with switch-contactor at presently-open pin between the 2.2 uH & the 4.7 mH inductors.
R2	Pointer at 8 o'clock with pot fully CCW
R4	Pointer at 8 o'clock with pot fully CCW

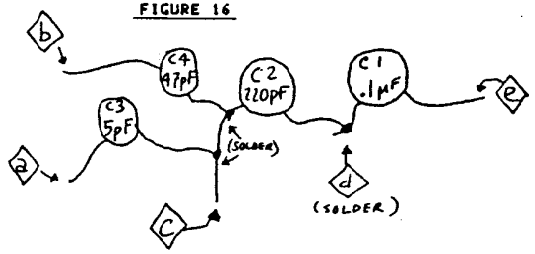
48. Prepare five lengths of RG174 or RG188 coaxial cable in the manner of Figure 15. Three of the cables are each to have an insulated length of 3 inches; one should have an insulated length of 4 inches; and one should have an insulated length of 5 inches.

FIGURE 15



49. Use solder to 'tin' all bared leads of the above cables.
50. Fabricate the component assembly of Figure 16. Make note of the lead designations assigned.

FIGURE 16

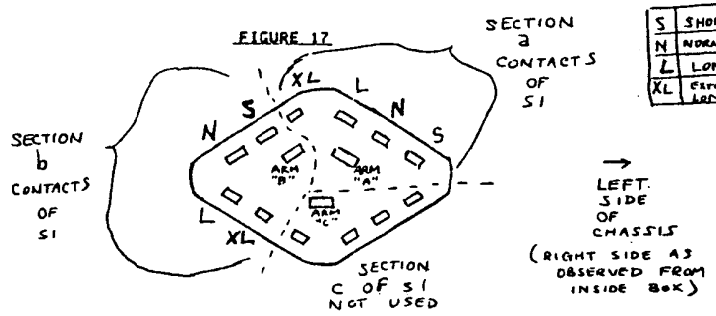


51. Observe Figure 17, a view of the contacts of S1, the antenna Length Select switch, as seen while viewing the inside of the chassis box.

S1 POSITION NOMENCLATURE

S	SHORT
N	NORMAL
L	LONG
XL	EXTRA LONG

FIGURE 17



52. Connect (by soldering, then cutting excess leads) the component assembly of Figure 16 to S1 contacts of Figure 17 in accordance with the following list:

lead 'a' to S1, section a, wiper arm
lead 'b' to S1, section a, 'N' contact
lead 'c' to S1, section a, 'S' contact
lead 'd' to 2-inch piece of hookup wire
other end 'd' hookup wire to S1, section b, wiper arm
lead 'e' to J1 (wire in jack)

53. Connect a 47 ohm resistor (R1) from S1, section b, 'XL' contact to the upper pin of S3.
54. Solder one (shortened) lead of a 150 ohm resistor (R3) to J5. Attach a .1 uF capacitor (C8) to the other lead of R3. (The lead length at the C8/R3 junction should be as short as possible). Solder the free lead end of end of C8 to the R4 CCW pin [the contact of the R4 pot which measures zero-ohms to the R4 wiper arm when R4 is set fully CCW as viewed from the outside (right side) of the chassis box].
55. Place a 22 pF capacitor (C10) from the upper pin of S4 to the lower pin of S4. Minimise lead lengths. Solder; then cut off excessive leads.
56. Solder the shortened lead of a 68 pF capacitor (C9) to the wiper arm of R4. Let the other C9 lead hang free, until assembly step 59.
57. Prepare eleven (11) pieces of insulated hookup wire, each with bared & solder-tinned ends of approx. 3/16 in. The lengths of hookup wire to be prepared are as follows [lengths specified in terms of INSULATED length; add approx. 3/8 in. for total lengths]: 1 in. (2 pieces); 2 in. (5 pieces); 2.5 in. (3 pieces); and 4 in. (1 piece).
58. Connect BARE SOLID BUSS WIRES (5 total); one wire (of the shortest possible length) between each following pair of points: [1] J3 & G4 lug; [2] C6 rotor pin & C5 GND lug (that of Figure 9); [3] C5 GND lug & C5 rotor lug; [4] upper pin, S3 & G1 lug; and [5] R2, CW pin & G2 lug. Solder each connection & cut off excessive bussuires.

59. Install the coaxial cables which were prepared in step 48; These should be installed in accordance with Table 7. [Note: L ring is bussuire ring of ass'y step 25]

Table 7

Insulated Length (inches)	End 1 InnerCond. to	End 1 Shield to	End 2 InnerCond. to	End 2 Shield to
3	arm, S2	L ring	P1 of A1	P2 of A1
3	EXTLpin,S2	L ring	J4	G2 lug
3	P5 of A1	P6 of A1	CCW pin,R2	CW pin, R2
4	arm, R2	CW pin, R2	CCW pin,R4	G3 lug
5	arm, S4	G1 lug	C9free end	G3 lug

All connections should be properly soldered & trimmed.

60/61. Install the hookup wires which were prepared in step 57.
60. The first 2 connections to be made are on the outside of the chassis box: [1] solder one end of a 2 in. hookup wire to the POSITIVE (+) battery bracket (J7) terminal; solder the other end of this wire to the external lead of feedthrough C7. [2] Solder one end of a 2 in. wire to the NEGATIVE (-) terminal of the (J7) battery bracket; solder the other end of this wire to the exterior G3 lug.
61. Connect (by soldering) 9 hookup wires on the inside of the chassis box in accordance with Table 8.

Table 8

Ins. Length (in.)	End 1 to	End 2 to
1	S4, upper pin	P1 of A1
1	A1 lug (Fig. 12)	P4 of A1
2	S1, section a, arm	C6, stator pin
2	C6, stator pin	S2, arm
2	J5	J6
2.5	J1	J2
2.5	C6, stator pin	C5, stator pin
2.5	S3, arm	P3 of A1
4	S3, lower pin	C7

ASSEMBLY OF THE APT-2 TUNER IS NOW COMPLETED.
Before 'powering-up', check all wiring against the schematics (Figures 1 & 2 at the beginning of the article). Clean flux from all solder joints with a cotton swab dipped in alcohol. Use an air gun, if available, to blow wire, insulation, & solder scraps out of the chassis box. Screw the bottom cover onto the chassis box with the 4 sheet-metal screws provided with the box. Affix gummed labels, if desired, near controls & jacks.

You may now proceed to the section on Using the APT-2. It is best to practice using the tuner on the MW broadcast band during steady-state daytime conditions in order to gain familiarity with its operation; fading signals could confuse things in the beginning.

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THE APT-2 ACTIVE ANTENNA TUNER - Part 2

by Mark Connelly, WA1ION

This is the second part of a two part construction article. Part 1 appeared in last week's DXM and dealt with how to build it; part 2 tells how to use it.

Using the APT-2

1.0 NORMAL TUNING (wire or car whip operation)

1.0.0 Initialisation

1.0.1 Set S1 to 'extra-long' if wire length exceeds 500 ft. in an area with no strong local stations [hereafter defined as 'rural' areal or if antenna is longer than 200 ft. in an area with strong local signals [hereafter defined as an 'urban' areal. Set S1 to 'long' if the antenna is shorter than the 'extra-long' specification, but longer than 200 ft. [rural] or 50 ft. [urban]. Set S1 to 'normal' if the antenna is shorter than the 'long' specifications, but longer than 20 ft. Set S1 to 'short' if antenna is 20 ft. or shorter. Double all length specs. if operating frequency is lower than 400 kHz.

1.0.2 Connect the appropriate antenna to J1 or J2.

1.0.3 Set S4 to centre (regeneration off).

1.0.4 Set C5 & C6 to centre (variable capacitors half-meshed).

1.0.5 R2 to fully counterclockwise (CCW): (maximum output level).

1.0.6 R4 position doesn't matter at this time.

1.0.7 Connect receiver, with coaxial cable, to J5 or J6. The receiver should be of a shielded (metal case) variety. A transistor portable radio can be used if its rod antenna is kept far enough from the wire aerial to prevent unwanted feedback & instability.

1.0.8 S3 (power) to ON (up).

1.0.9 S2, the frequency range switch, can be preset by referring to Table 1 ;this, however, is optional: S2 will be accurately set in steps 1.1.1 to 1.1.3.

1.1.0 Tuning

1.1.1 Run S2 through all of its positions: find the position which yields the maximum DESIRED FREQUENCY signal. (Don't peak on a spur.)

1.1.2 Adjust C5 for peak signal. If C5 yields maximum signal at fully open [16 on C5 dial], move S2 one step clockwise (CW) (= next lowest value inductor) and then repeak C5. If C5 had yielded maximum signal at fully-meshed [5.3 on C5 dial], move S2 one step CCW (= next highest inductor) and repeak C5.

1.1.3 If, in step 1.1.2, a good peak couldn't be found, or, as the desired signal peaked, an off-channel station's audio simultaneously became clear (e. g. spur or cross-modulation overloading), set S1 one position CW (next longer-antenna position) & re-iterate steps 1.1.1 & 1.1.2.

2.0 REGENERATIVE TUNING for higher gain & selectivity

NOTES: (1) With APT-2 design, regeneration is only used at frequencies lower than 2 MHz. (2) The battery must be 'fresh' (7 volts minimum, loaded) for regeneration to work properly, even though 'normal' tuning can be achieved with batteries running as low as 5v.

2.0.0 Initialisation

2.0.1 Tune the antenna 'normally' by performing all Part 1 steps.

2.0.2 Set R2 to fully CW (= minimum output level).

2.0.3 If operating frequency is less than 400 kHz, set S1 to 'normal' and go to step 2.1.7.

2.0.4 Set S4 to Regenerate-A (Up) (C10 in regen. line).

2.0.5 Set R4 to centre of range (pointer at 12 o'clock).

2.1.0 Tune/Regenerate

2.1.1 Slowly turn R2 CCW until the desired signal is just above the noise level.

2.1.2 Adjust C5 for peak: this will typically be at a higher dial position (lower capacitance) than had been set in the normal tuning procedure. If maximum signal occurs with C5 at min. C [= '16' on C5 dial], set S2 one step CW (next lowest inductor) & repeak C5. If, at any time, regeneration (squealing) breaks out, move R2 slightly CW until it stops.

2.1.3 After C5 has been peaked, gradually turn R2 slightly CCW in SMALL INCREMENTS, while simultaneously repeaking C5 after each incremental R2 adjustment.

2.1.4 When regeneration breaks out, or when selectivity is so tight that received audio becomes 'mushy', carefully play C5 & R2 so that, to the best of your ability, you have a C5-peaked-signal condition at the 'borderline of regeneration', as set by R2.

2.1.5 At this point C6 (the vernier tune capacitor) and R4 (the regeneration vernier pot) can be 'played' for fine adjustment of peaking and desired selectivity. Anytime R4 is adjusted, C6 (and/or C5) will have to be retweaked for a peak.

2.1.6 If, in step 2.1.4, regeneration did not occur, set R4 to min. R (fully CCW; pointer at 8 o'clock) and re-iterate steps 2.1.1 through 2.1.5. If regeneration still doesn't occur, go to step 2.1.7.

2.1.7 If you could not achieve regeneration in the previous steps, or if frequency is less than 400 kHz. [from step 2.0.3], set S4 to Regenerate-B (down; C10 no longer in series with regen. line). Set R4 to centre. Perform steps 2.1.1 through 2.1.5. If, when doing step 2.1.2, a peaked condition cannot be achieved, set S1 one step clockwise (next-shortest-antenna position), redo step 2.1.2 & proceed forth from that step.

3.0 REGENERATING THE OUTPUT OF AN AMPLIFIED LOOP OR THE OUTPUT OF A PHASING UNIT (ACTIVE OR PASSIVE)

3.0.0 Active (= built in amp.) Loop

3.0.1 Connect the loop initially to the receiver, peak desired frequency in normal manner with loop tuning capacitor. [Note that APT-2 isn't connected to anything yet.]

3.0.2 Position loop in usual manner to obtain null of 'pests'. Then, remove loop cable from receiver.

3.0.3 Set APT-2 S1 to 'long'.

3.0.4 Connect loop output HIGH (inner conductor of shielded cable from loop) to J2 of APT-2. Connect loop ground (cable shield) to J3 of APT-2.

3.0.5 Treat the loop output as if it were the signal from a wire. Perform part 1, starting at step 1.0.3.

3.0.6 Once the loop signal has been peaked through the APT-2 in the part 1 'normal tuning' manner, repeak the LOOP tuning capacitor, if necessary. Then, if necessary, touch up the loop's physical null position.

3.0.7 Regenerate by executing part 2 procedures, starting at step 2.0.2. (In step 2.0.3, don't change the position of S1.)

3.1.0 Phasing Unit

3.1.1 Connect the phasing unit to the receiver and execute customary phasing procedures. Then, remove the cable from the receiver's antenna inputs.

3.1.2 If the phaser is passive, set APT-2 S1 to 'normal'; if the phaser is active, set APT-2 S1 to 'long'.

3.1.3 Connect coaxial cable from phasing unit output & ground to J2 (HIGH) & J3 (GND) of APT-2.

3.1.4 Treat the phaser output signal as if it were the signal from a direct wire aerial connection: perform part 1, starting at step 1.0.3.

3.1.5 Regenerate by performing part 2, starting at step 2.0.2 (in step 2.0.3, don't change position of S1).

4.0 USE OF APT-2 AS LOOPHEAD TUNER/AMPLIFIER

NOTES: (1) The term 'loophead', for the purposes of this discussion, refers to the actual pickup coil part of a loop antenna system. (2) Two loopheads will probably be required for complete coverage of the 500-1700 kHz MW band. Other heads may be fabricated for LW, BC, 160m, etc.

4.0.0 Preliminary Setup

4.0.1 Fabricate air-core or ferrite loophead(s) to be used. These should be of a single-winding type with connections to be made at each end of the winding.

4.0.2 For each head, prepare a piece of RG174 cable of 2 ft. maximum length. One end of the cable should be fitted with a BNC plug; the other end should have bared leads (shield and centre conductor).

4.0.3 On each head, solder the bared centre conductor of a prepared cable to one lead of the loophead winding.

4.0.4 Solder a short insulated hookup wire jumper from the prepared-cable bared shield to the other lead of the loophead winding.

4.0.5 Connect the BNC plug of the cable (whose other end goes to the loophead) to J4, the external coil input jack of the APT-2.

4.1.0 Normal Tuning of Loophead

NOTE: Receiver should preferably be of a shielded type so that unwanted feedback / undesired oscillation may be avoided.

4.1.1 Do not connect anything to J1 or J2 of APT-2.

4.1.2 If the receiver is being operated on batteries or if a cable greater than 3 ft. is to connect J5 or J6 to the receiver, a ground connection to J3 is desirable. The ground chosen may be an earth ground rod or pipe, a mains ground, or a vehicle chassis ground.

4.1.3 Set APT-2 controls initially as follows:

S1 to 'long'
S2 to EXT. L (6 o'clock pointer position)
C6 to centre (12 o'clock or 6 o'clock)
R2 to fully CCW (= maximum output)
S4 to centre (regeneration off)
S3 to Power ON (up)
Position of R4 is irrelevant at this time.
C5 is to be adjusted in next step.

4.1.4 Connect receiver to J5 or J6 of APT-2. Tweak C5 to obtain maximum signal at frequency of interest.

4.1.5 Position loophead for null of 'pest' and/or peaking of a desired station.

4.2.0 Regenerative Tuning of Loophead

4.2.1 Perform steps 4.0.1 through 4.1.5 as a prerequisite.

4.2.2 Perform these steps in the order indicated: 2.0.2, 2.0.4, 2.0.5, and 2.1.1.

4.2.3 Adjust C5 for peak. If regeneration (squealing) breaks out, move R2 slightly CW until it stops.

4.2.4 Perform steps 2.1.3 through 2.1.5.

4.2.5 If regeneration could not be achieved, set S4 to Regenerate-B (down) and re-iterate steps 2.0.2, 2.0.5, 2.1.1, 4.2.3, and 4.2.4.

NOTE: Frequency coverage range with a given loophead may differ in the 'normal-tune' mode from that noted in the 'regenerative-tune' mode. Normal-mode range is generally greater as the parallel capacitance of the regeneration circuit is not switched in.

5.0 LOOPHEAD INDIRECT COUPLER

5.0.1 The loophead may be placed close to a wire, pipe, or electrical conduit to which a direct connection cannot (and/or should not) be made. One example is the the conduit going to the electric meter on the outside of a house. Of course, the loophead, in this application, will not have nulling capability.

5.0.2 Position loophead near coupling source.

5.0.3 Perform 'normal tuning' steps 4.1.1 through 4.1.4.

5.0.4 Move loophead through various placements near the coupling source to maximise signal; then repeak C5.

5.0.5 Perform steps 5.0.2 to 5.0.4, then 4.2.2 to 4.2.5 if regeneration is desired.