TECH R/C 8 CHANNEL
RECEIVER INSTRUCTIONS

THEORY

The performance and reliability of the Royal 73B receiver been greatly increased by taking advantage of the recent lopments in CMOS and JFET technology. Several models of the 73B receiver have been flying for over a year and a half without a failure of any kind.

The design engineers at Royal have been given the charter to design the best equipment that is available to the model industry. This has allowed us to design equipment without worrying about saving cost by cutting corners. We have elected to use quality components to obtain predictable performance instead of utilizing the inexpensive low performance components that are so prevalent in the model industry today. This Royal design philosophy has resulted in a superb model receiver which has the following salient features:

- Superior spurious response rejection and low noise is obtained by using a junction FET in the RF amplifier and mixer stage. Even though the cost of the JFET is about three times the cost of a comparable RF transistor.
- Increased selectivity and sensitivity is provided by using three IF stages (4 IF cans) instead of the usual two stages of IF.
- The combination of the RF amplifier and added IF amplifier stage provides excess receiver gain that can be used for stabilization to prevent regeneration. This has been accomplished by decoupling each of the superhetrodyne amplifier stages and using appreciable negative feedback in each of the amplifier stages in the IF strip. This results in a receiver that has high sensitivity, low noise and is rock stable through all flight regimes.
- The receiver part count and current drain has been improved by using a CMOS eight bit shift register for the decoder. The current drain for the complete eight channel receiver without servos is only 12 ma.

Technical Description

A block diagram and schematic for the 73B receiver is shown on Figure 1 and 2 respectively.

The front end of the receiver uses a parallel tuned circuit (L_1, C_1) to improve RF selectivity and to provide a better impedance match to the antenna and JFET RF amplifier.

The RF amplifier uses a JFET in a common-gate configuration. The common-gate configuration was selected in preference to a common-source configuration based upon the testing and literature search that we have performed. The common-gate configuration is rock stable compared to common-source operation. Neutralization is not required and interaction between the input and output coils is significantly reduced for the common-gate configuration. We have also found that the overall performance of a JFET RF amplifier is superior to a bipolar transistor.
The mixer stage (Q_2) that is used in this receiver is identical to the mixer we introduced in the 1970 receiver. The JFET mixer provides better mixer efficiency, a wider dynamic range, less mixing distortion and a lower noise input than can be obtained with a diode or transistor. For these reasons this design is being duplicated by several other RC manufacturers. A bipolar transistor mixer will provide higher conversion gain but will exhibit spurious responses that are not acceptable for a top of the line receiver. We are thoroughly convinced that the very best receivers will lize both a JFET RF amplifier and mixer stage if top formance and not cost is the prime objective.

The local oscillator (Q_7) is a modified Pierce oscillator which is crystal controlled to operate at the desired frequency. The oscillator circuit is biased to allow operation over a wide range of power supply voltage (2.5 to 6 volts).

The IF strip will not be discussed in detail since it is standard and straight forward in design. should be noted, however, that the relative large emitter resistors are not bypassed and thus provide negative feedback. It is also interesting to note that all the amplifier stages discussed thus far including the oscillator are electrically isolated from one another to futher preclude the possibility of feedback and regeneration.

The active detector stage utilizes an emitter follower transistor (Q_6) to provide a high input impedance. The high detector impedance sharpens the tuning of the last IF transformer since it does not load the last IF stage. The detector and oscillator circuit were also both used in the 1970 receiver version.

Since the DC voltage at the emitter of the detector goes negative with increasing signal strength, this voltage is fed back to the base of each of the IF transistors to provide AGC. Resistor R_{20} and C_{18} form the AGC filtering and feedback circuit.

The detector output circuit is filtered by C_{17} to remove any IF frequency that may be present on the pulsed signal. Additional signal filtering is also provided by R_{25} and C_{25} to further aid in eliminating noise that may be present on the pulse signal.

Transistor Q_8, R_{26} and $C_{23\&24}$ provides a power supply filter that is used to eliminate noise spikes resulting from the CMOS shift register and servo electronics. This filter circuit isolates the superhet from the decoder and servos. This eliminates servo cross talk and chatter that can be found in some of the new three wire IC servo amplifiers.

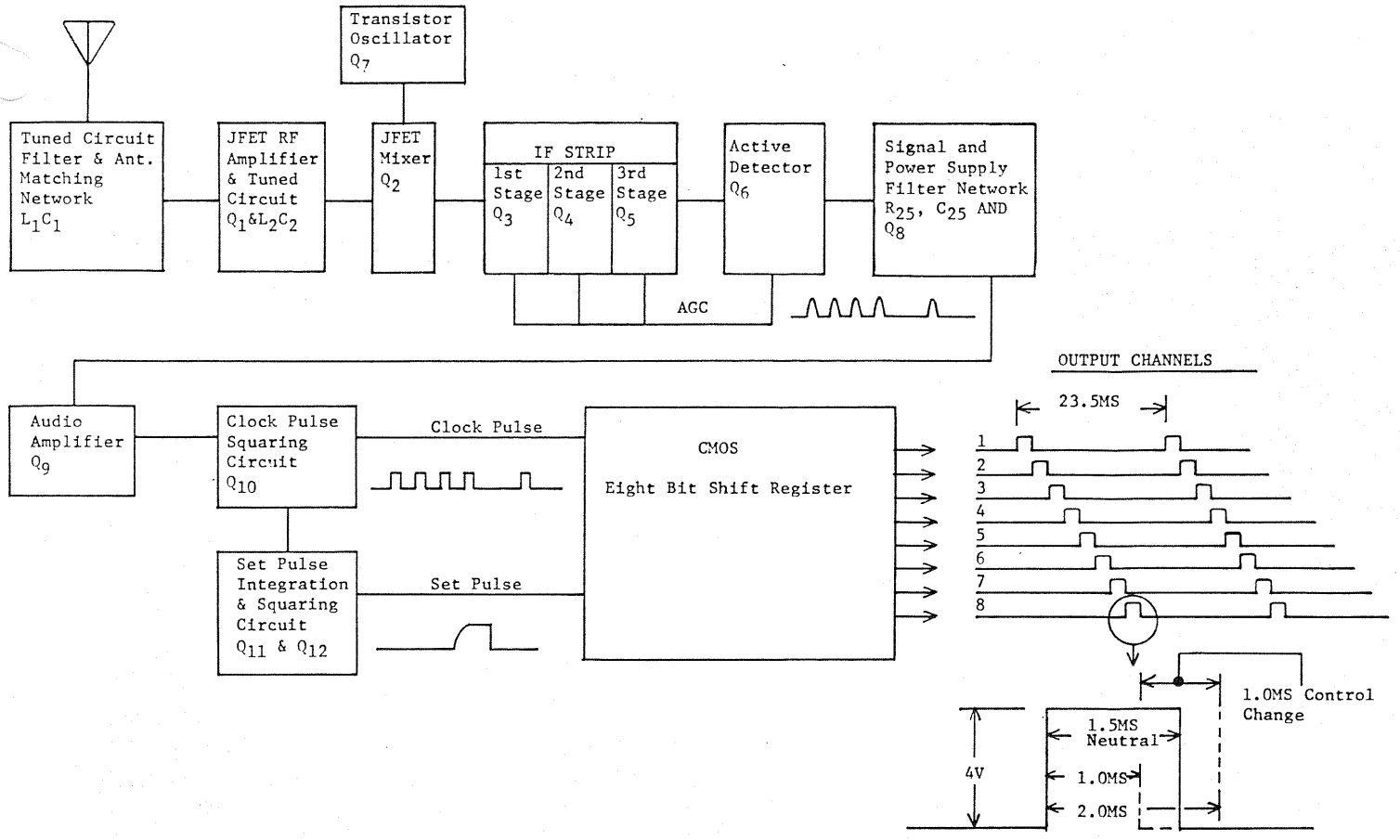
The filtered detected output pulses are then fed to an audio amplifier (transistor Q_9) and squaring circuit (Q_{10}) to obtain a fast rise time on the clock pulses. The squaring amplifier circuit Q_{10}, is used to drive both the shift register and set pulse circuits.

Transistors Q_{11}, Q_{12} and associated components form the set pulse circuit. The emitter of transistor Q_9 is driven to plus each time a clock pulse is present. Capacitor C_{25} and resistor R_{28} forms an integrating circuit that has a time constant of sufficient length to hold the emitter of Q_9 above the turn off voltage of transistor Q_{10} (.6 volt) during the time the clock pulses are presiding. However, sufficient time is allocated between the last clock pulse and the first pulse of the next data chain to allow capacitor C_{28} to discharge to nearly ground potential. When the voltage reaches a value of about .6 volt the base emitter junction of transistor Q_{10} will be reversed biased which will cause transistor Q_{10} to be turned off. The collector of Q_{10} will then be pulled to plus by resistor R_{27} and will remain at plus until the first clock pulse turns Q_{10} on. This forms the set pulse. This positive set pulse is fed to the shift register to place a "1" in the first register. The clock pulses are then used to shift the "1" through the register a stage at a time.

The shift register consists of two four-bit serial in parallel out CMOS registers which are externally interconnected to form an eight bit register. The complete eight bit decoder is packaged in sixteen pin dual inline which does not require external components. The more expensive CMOS shift register was selected because the power consumption is considerably less than T^2Logic and it will work at a lower voltage level.

The eight outputs of the shift register are directly connected to the servo plugs so they can be used by the servo amplifiers.

FIGURE 1 RECEIVER BLOCK DIAGRAM



Soldering Suggestions:

A. Keep your soldering iron clean by frequently rubbing the tip over a wet sponge.
B. Heat the PC board pad and component lead simultaneously unless experience shows that one or the other takes more heat, then heat that part first.
C. Feed a small amount of solder to the joint immediately, wait until the solder flows then add enough solder to complete the joint.
D. Wipe the soldering iron tip up the component lead when the joint is complete.
E. Clip the component lead. (Leads may be bent and clipped).
F. Use only #22 gage solder, joints should not exceed 1/32in. in height.

General Notes

Unpack the kit carefully, and check parts against parts list. Separate components by type to aid in identification while building this kit. Example: Resistors, ceramic disc caps, Tantalum caps, major parts, IF can, coils, etc. Muffin tins are ideal to sort parts for this application.

Assembly Notes

The circuit board in the receiver, when assembled, measures approximately 2" x 1.5" and contains 11 differnent wires, and 104 circuit components. Therefore, it is suggested that you take your time while assembling this kit. Use extreme care when installing components so that they fit directly over their intended place on the circuit board.

Before starting assembly check PC board to see that all holes have been drilled, if one is not open, use a #69 drill. Assembly will be done in stages, complete each stage before starting the next.

NOTE: For good soldered connections, you must keep your soldering iron clean.

Due to the small foil area around the circuit board holes and the small areas between foils, it will be necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use only an adequate amount of solder. Diodes, transistors, etc., can be damaged if subjected to excessive amounts of heat. Excessive heating usually occurs when the iron is too cold and has to be left on the joint too long, or poor technique causes long heating times. When installing each component, bend its leads flat against the same foil, from which they extend. Then cut the leads off at the outside diameter of the pad around the lead on the foil side of the circuit board. This will hold the components in place until they are soldered, and will provide a larger solder area. This larger solder area is important because of the great amount of vibration that the receiver must withstand.

Resistors will be called out by resistance value, (in ohm, Kohm, or Mohm), and color code. Capacitors will be called out by capacitance value and type. The IF cans, and coils, must be seated down on the circuit board, and no component should be allowed to protrude above the top of the tallest of these items. This will ensure that the unit will fit into its case.

Consult the overlay drawing and schematic often to insure correct installation of parts.

Check all capacitors for excess molding material and scrape off leads if necessary. When installing capacitors leave a small space between the base of the capacitor and the PC board. This will prevent shorting out capacitors under vibration. See fig. 2-1.

Check off each step as you proceed.

Read each step completely before starting and complete that step before proceeding to the next step.

A "feed through" is a resistor remnant placed through the PC board. Bend over and solder lead remnants top and bottom. Clip off excess.

8CH RECEIVER PARTS LIST

Quant.	Ref. No.	Description	Part No.
11	C4,6,8,9,11,12 13,14,19,25,27	.01uf disc cap	001044
2	C7,18	4.7uf Tant cap A/L	001141
	C10,15,17,23	.05uf disc caps	001049
	C31	.001uf disc cap	001035
1	C22	.002uf Disc cap	001039
1	C29	.005uf disc cap	001043
3	C16,24,30	33uf Tant cap A/L	001160
1	C28	.1uf disc cap (104Z)	001051
1	C26	2.2uf Tant cap A/L	001138
1	R26	270ohm 1/4w res. large	000024
2	R2,5	47ohm 1/4w res. large	000015
3	R3,19,31	2.7K 1/4w res. large	000036
3	R7,11,28	100K 1/4w res. large	000055
3	R6,10,14	1K 1/4w res. large	000031
2	R8,12	150ohm 1/4w res. large	000021
5	R9,13,16,17,24	100ohm 1/4w large res.	000019
2	R18,25	4.7K 1/4w res. large	000039
3	R20,32,34	27K 1/4w res. large	000048
1	R27	470K 1/4w res. large	000063
1	R29	10K 1/4w res. large	000043
2	R30,33	47K 1/4w res. large	000051
2	Q1,2	E-2175 FET	000458
4	Q3,4,5,7	MPS3563	000464
2	Q6,10	SPS401K	000444
4	Q8,9,11,12	SPS400K	000443
1	L3	Toko IF Yellow	000897
2	L4,5	Toko IF White	000898
1	L6	Toko IF Black	000899

3"	#28 magnet wire (secondary of L7)	
2"	#22 Teflon sleeving	
1	Dual 4 bit shift Reg. CD-4015	000460
1	5/16" dia. grommet	002185
1	PC board	000801
1	Royal Decal	002191
6" ea.	Hook-up wire Red, Blk, Yel, Wht, Blue Vio, Brn, Red/Wht, Org, Grn	
1/2"	1/8" heat shrink	
3"	1/32" heat shrink	
36"	#26 Ant. wire	
1	Receiver Case	002357
1	Connector Block 6Ch	003218
	8Ch	003220

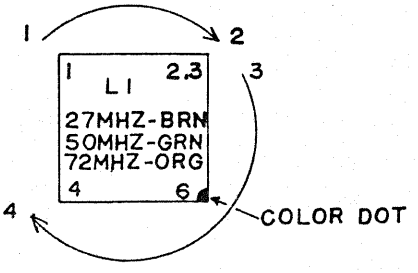
Frequency Parts Pack

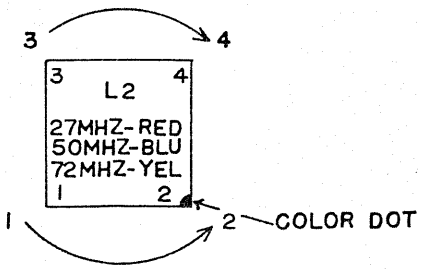
	27MHZ	50MHZ	72MHZ	75MHZ
C1	47pf	33pf	15pf	10pf
C2	-	-	10pf	10pf
C5	68pf	33pf	~~20pf~~ 22pf	15pf
C20	20pf	20pf	~~20pf~~ 22pf	~~20pf~~ 22pf
C21	15pf	15pf	~~10pf~~ 15pf	~~10pf~~ 15pf
L1	1-002369	1-002367	1-002365	1-002365
L2	1-002368	1-002366	1-002364	1-002364
L7	10uhy	4.7uhy	.56 ~~.82~~uhy	.56 ~~.82~~uhy
Xtal	3rd O.T.	3rd O.T.	5th O.T.	5th O.T.
R21	100K	27K	27K	27K
R23	270 ohms	100 ohms	~~100~~ ohms 1K	~~100~~ ohms 1K

Tech Note 74-1
Tech R/C 8 Receiver (R9version). For improved sensitivity on 27mhz receiver, change L1 coil to the "A" revision, (see winding specs below).

1. Start in Hole #1, wind CW
   2¼ turns to hole #2. #26 gage.
2. Start in hole #3, wind CW
   8½ turns to hole #4. #26 gage.

COILS FOR ROYAL 8CH. RECEIVER
TOP VIEWS



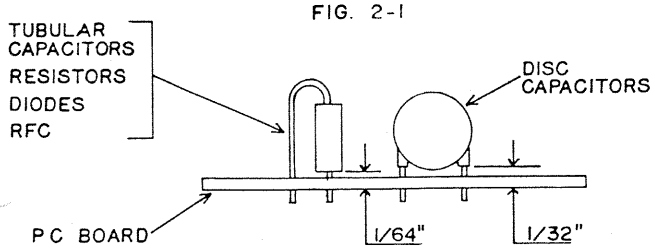


WINDINGS	72-75 MHZ		50 MHZ		27 MHZ	
	L1	L2	L1	L2	L1	L2
1-2 #26	1 1/4	5 1/4	1 1/4	6 1/4	4 1/4	*10 1/4
3-4 #26	4 1/2	6 1/4	4 1/2	7 1/4	6 1/2	*11 1/4

*USE #28 GAUGE
ALL OTHERS #26

FIG. 2

FIG. 2-1



All parts and feed through holes marked with "t", (there are nine places to be soldered-refer to overlay), must be soldered on top and bottom side of the PC boards. These will be installed first. Solder top side first and make sure all resistors set up straight. Check the fit of the PC Board in the receiver case, sand edges if required.

1.( ) Install R16 100ohm res. (brn, blk, brn)
2.( ) Install feed through in hole marked "T", located just to the right of R20. Be sure to bend the lead over on both sides of PC board.
3.( ) Install R12 and 8 150ohm res. (brn, grn, brn)
4.( ) Install feed through just below C9.
5.( ) Install R28 100K res. (brn, blk, yel)
6.( ) Install R31, 2.7K res. (red, purp, red)
7.( ) Install R23: 27MHZ-270ohm (red,purp,brn)
or 50 and 72MHZ-100ohm (brn,blk,brn)
8.( ) Install feed through next to Q11 and next to pin 1 of IC-1.
9.( ) Install feed through to right of the crystal. Leave this feed through 3/4" long on the top side of the PC board.
10.( ) Check to see that a feed through and resistor leads are soldered on the top side of the PC board. Clean the board thoroughly, removing all soldering resin. If this step is not done thoroughly you will probably ruin the receiver trying to rework it later.

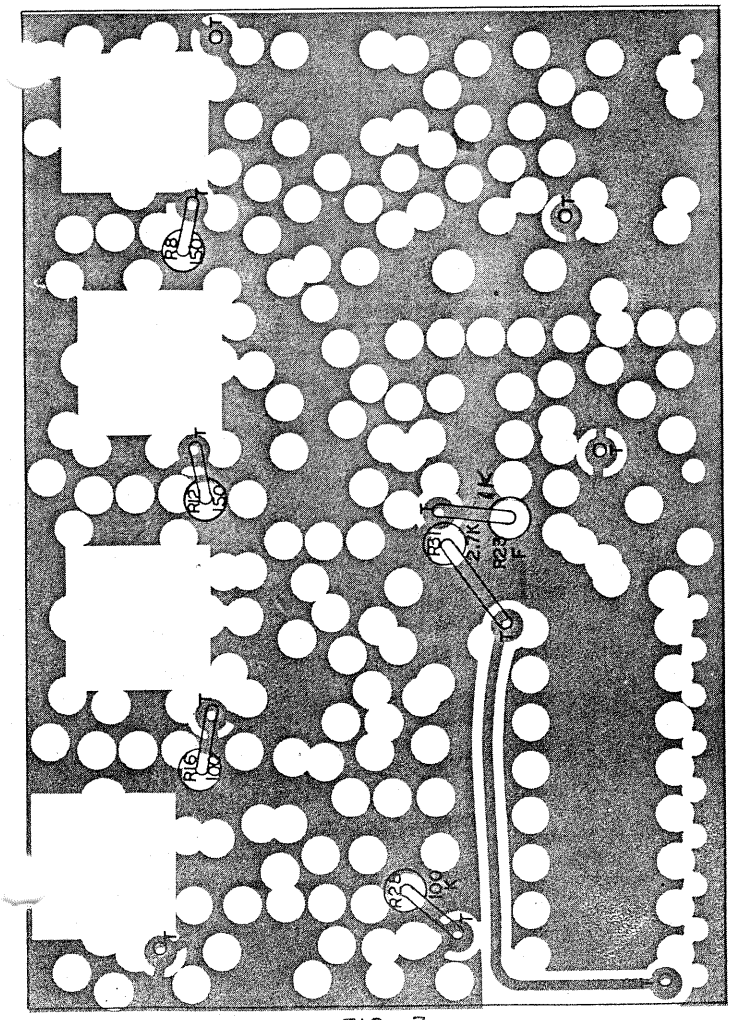


FIG. 3

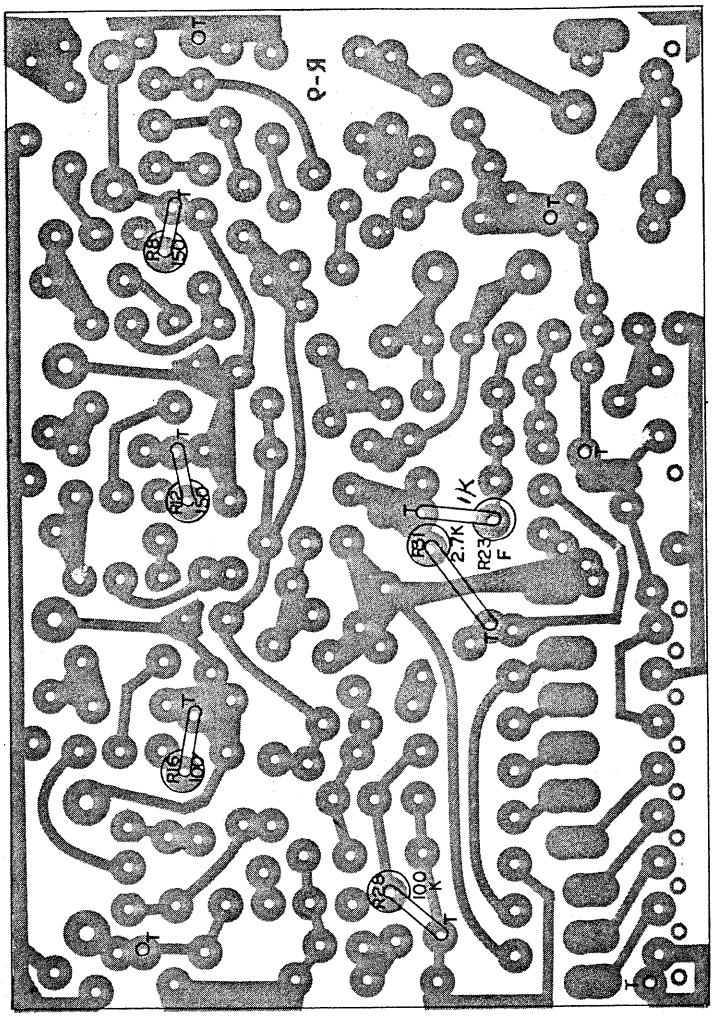
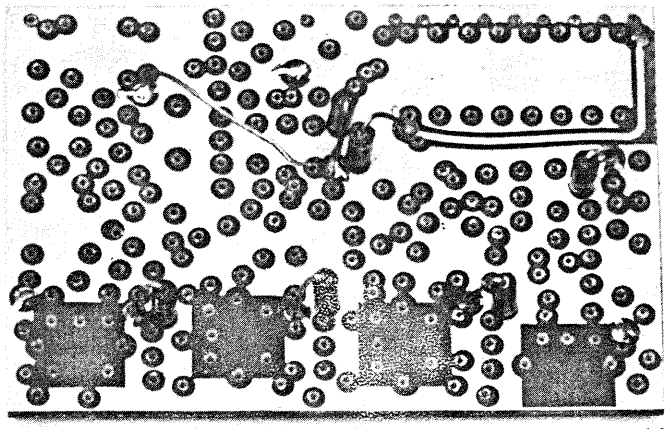


FIG. 4



A. Note: When installing IF transformers solder one lead first then check to make sure the can is firmly seated (square) on the PC board. Then solder one lead on each can, continue to skip from one can to the next so that heat does not build up in the IF can.

B. ( ) Install L6 Blk. IF transformer.

11.( ) Install L3 Yel, L4 Wht, L5 Wht.

12.( ) Clip the two secondary pin leads off the "BLACK" IF. See Fig. 2-2. If the pins are clipped too short, the can will be ruined.

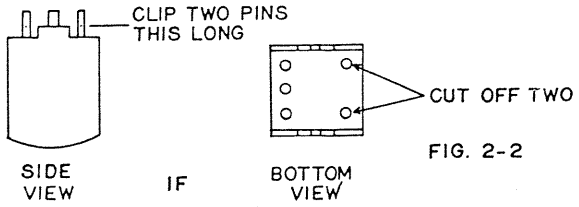


FIG. 2-2

) Form the leads on 3 pieces MPS3563 transistor. See fig. 2-3.

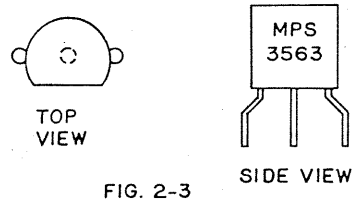


FIG. 2-3

Hold the transistor lead near the plastic body so that the bending stresses are not transferred inside the transistor body. All transistor leads will be formed the same way.

15.( ) Install Q3,4,5, MPS3563. The bottom of the transistor case should be 1/16" above the PC board. See fig. 2-4.

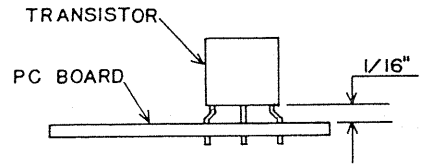


FIG. 2-4

16.( ) Install R7 and R11 100K res. (brn, blk, yel) - sleeve the lead on each resistor so they can not short to the IF transformer can. Use sleeving cut to 1/4".
17.( ) Install C6,8,9,12,14 .01uf disc caps.
18.( ) Install R6,10,14 1K res. (brn, blk, red) Use 1/4" sleeve on lead of R6.
19.( ) Install C18 4.7uf Tant. Red end down.
20.( ) Install R20 27K (red, purp, org)
21.( ) Install C17 .05 disc cap.
22.( ) Install Q6 401K transistor.
23.( ) Install R18,25 4.7K res. (yel, purp,red)
24.( ) Install C13 .01 disc cap.
25.( ) Install R17, 13 100ohm res. (brn, blk, brn). Sleeve the lead of R13.
26.( ) Install R19 2.7K (red, purp, red)
27.( ) Install C15 .05 disc cap.
28.( ) Install C24 33uf Tant. Red end down.
29.( ) Install C11 .01 disc cap.
30.( ) Install C16 33uf Tant. Red end down.
31.( ) Install R9,24 100ohm (brn,blk,brn)
32.( ) Install C10 .05uf disc cap.
33.( ) Install R5 47ohm (yel,purp,blk)
34.( ) Install C25 .01uf disc cap.
35.( ) Install C26 2.2uf Tant. Red end down.
36.( ) Install C27 .01 disc cap.
37.( ) Install Q9 M400 transistor.
38.( ) Install R27 470K (yel,purp,yel)
39.( ) Install R29 10K (brn,blk,org)
40.( ) Install R30 47K (yel,purp,org)
41.( ) Install Q10 401K trans. Form leads in triangle.
42.( ) Install R26 270ohm (red,purp,brn)
43.( ) Install C23 .05 disc cap.
44.( ) Install Q8 M400 trans.
45.( ) Install C19 .01uf disc cap.
46.( ) Install C22 .002uf disc cap.
47.( ) Install R21: 27MHZ-100K (brn,blk,yel)
or 50 and 72MHZ-27K (Red, Purp, Org.)

When installing L1 & L2 refer to fig. 2 for color dot location.

NOTE: When installing coil L1 & L2 use a small amount of contact cement on the bottom of the coil form to hold the coil onto the PC board.

48.( ) Install L1. Note color dot on the L1 coil goes in hole #6. Enlarge two holes for dual leads.
49.( ) Install L2. Note color dot on the L2 coil goes in hole #2.

50.( ) Clip off case ground lead, (See Fig. 2-5), on 2ea. E2175 FET if it has not been done. This step is not necessary if the Epoxy FET is supplied.

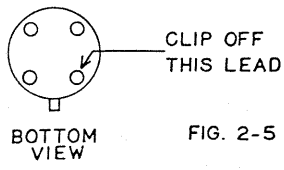


FIG. 2-5

51.( ) Install Q2 E2175 FET.
52.( ) Install R2 47ohm. Yel,Purp,Blk.
53.( ) Install C5 20pf(72MHZ) 15pf(75MHZ)
or 33pf (50mhz)
or 68pf (27mhz)
54.( ) Omit this step.
55.( ) Install Q1 FET.
56.( ) Install C4 .01uf disc cap.

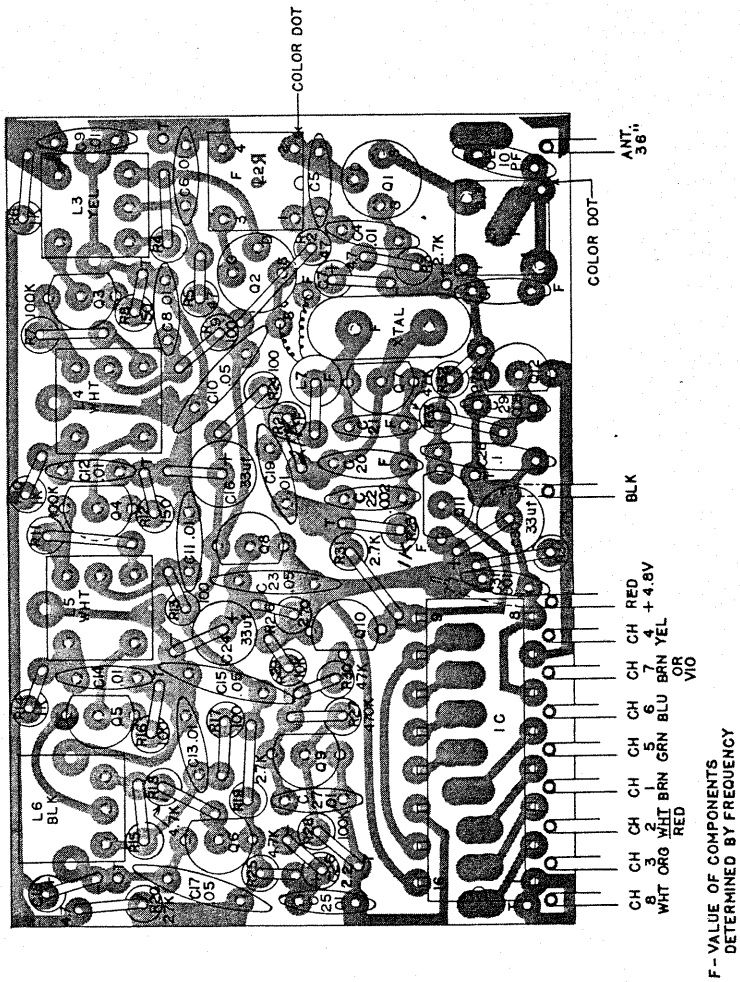


FIG: 5

7.( ) Install L7 RFC ~~.82~~ 1.5 6uhy for 72MHZ & Sec. 2 turns #28.
See fig. 2-7. 4.7uhy for 53MHZ & Sec. 4 turns #28.
10 uhy for 27MHZ & Sec. 3 turns #28.
Use a small amount of pliobond to hold secondary winding.

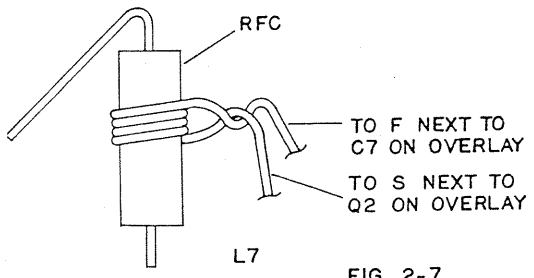


FIG. 2-7

8.( ) Install C20 20pf Mica cap.
9.( ) Install C21 10pf for 72MHZ
15pf for 50MHZ
15pf for 27MHZ
10.( ) Install Q7 MPS3563 trans.
11.( ) Install R3, 2.7K (red,purp,red)
12.( ) Install C7 4.7uf . Red end down.
13.( ) Install crystal with solder seal hole at top nearest L7 end. Then tin the opposite end near the top and solder the ground wire to this tinned spot on the crystal. See fig. 2-8.

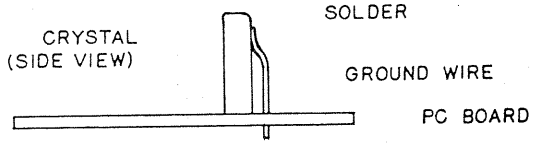


FIG. 2-8

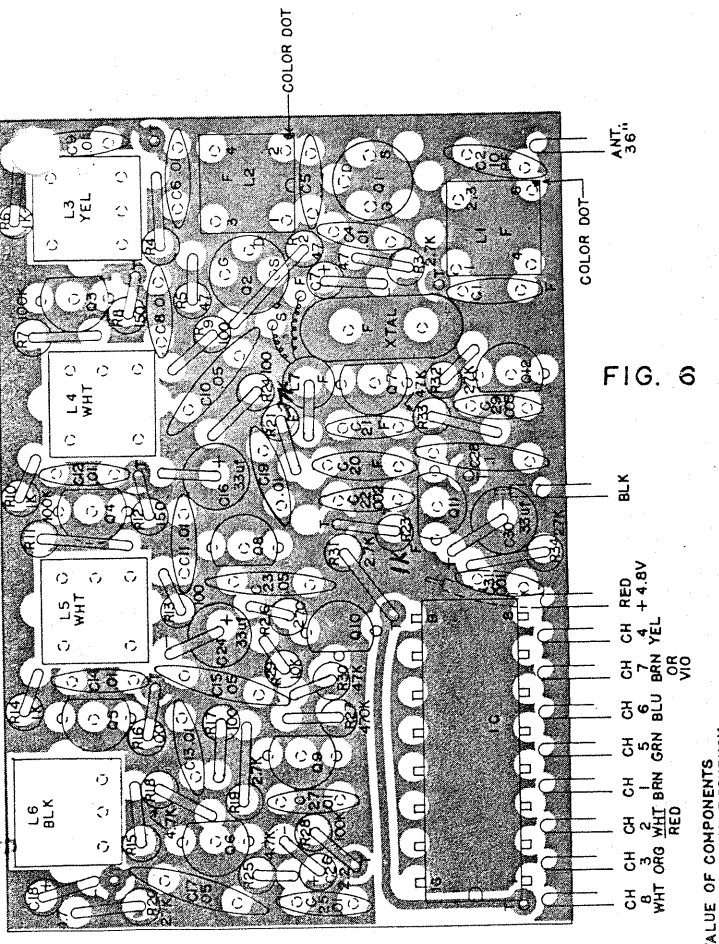
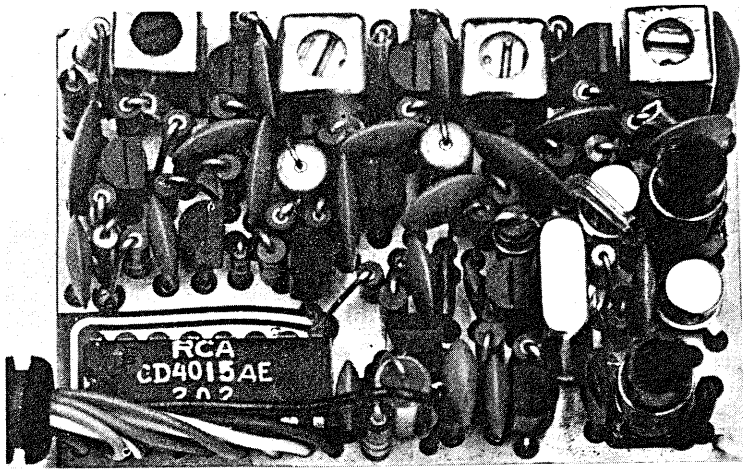


FIG. 6

16.( ) Install C1 15pf for 72MHZ or 10pf for 75MHZ
68pf for 50MHZ
47pf for 27MHZ
65.( ) Install C2 10pf on 72MHZ version only.
66.( ) Install R32 27K (red,purp,org)



67.( ) Install R33 47K (yel,purp,org)
68.( ) Install Q12 M400 trans.
69.( ) Install C29 .005uf disc cap.
70.( ) Install C28 .1uf disc cap. Scrape leads.
71.( ) Install Q11 M400 trans.
72.( ) Install C30 33uf Tant. Red end up.
73.( ) Install R34 27K (red,purp,org)
74.( ) Install C31 .001 disc cap.
75.( ) Install IC-1. Cut out or indent goes next to the end of the PC board.
76.( ) All components are now installed, clean the clad side of board thoroughly.
77.( ) Solder one 36" long piece of #26 flex wire to the correct antenna pad near L1.
Use pad to the right of C2 for 72MHZ
Use pad to the left of C2 for 50 and 27MHZ
78.( ) Strip 3/32 and tin the following 6" wires, 2ea. brn,org,wht/red,grn,blue,wht,yel,red,blk, wires
79.( ) Tin all 8 pads under the IC and the pad for the red & blk. power wire.
80.( ) Install all wires per fig. 7 . Solder the wire to the appropriate pad and then run the wire through the proper hole. Finally, clean the PC board and inspect all the solder joints. Rework if necessary.
81.( ) Run the wires over the IC and lightly twist CCW. Cut the wire off 4" from the IC end of the PC board.

Wiring the Receiver Connector Block

82.( ) Prepare the connector block by cutting all the pins to 1/8" long except one noted. See fig. 2-9.

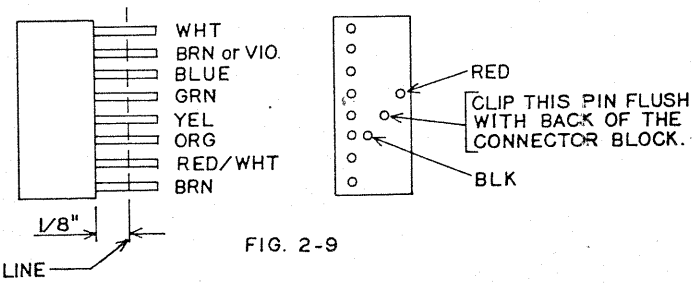


FIG. 2-9

83.( ) Tin all pins with a medium heavy coat of solder.
84.( ) Slide one 1/4" grommet over the receiver wire bundle.
85.( ) Cut 10 pieces 1/32" dia. heat shrink 1/4" long.
86.( ) Cut two pieces 1/8" dia. heat shrink 1/4" long. Slide both pieces over the receiver wire bundle.
87.( ) Strip all 10 wire 1/8" and tin.
88.( ) Slide one piece 1/32" dia. heat shrink over each wire.
89.( ) Solder all 10 wires to the connector block per fig 7 and 2-9.
90.( ) Slide the 1/32" heat shrink tubing over the connector block pin and shrink. Contruction is complete.

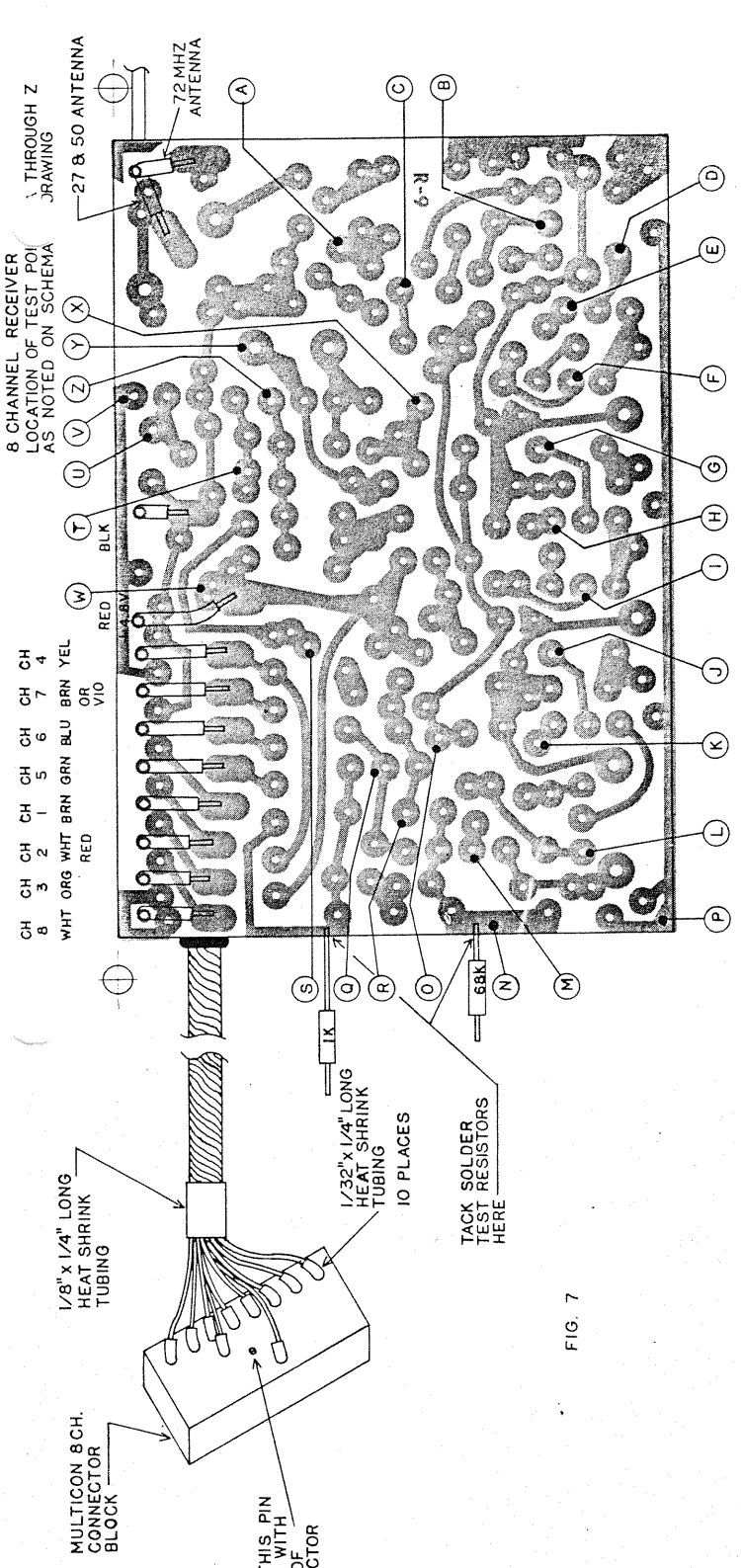


FIG. 7

Check out and Tune Up Procedure

1.( ) Connect 4.8V-5.0V to the receiver. Red lead on the connector block is "plus" and the black lead is "minus". Temporaily install a Milliamp meter in series with the red lead. With the power on, the current drain should be 11 to 18 MA. (Tx off) If current drain is higher inspect for parts in wrong place or solder bridges.

2.( ) Scope Tune-Up (Start with power off)

A. Tack solder one 68K resistor to point "N", emitter of Q6. This point is the pad on the edge of the PC board near C17.

B. Tack solder one 1K resistor to ground. A ground pad is also on the end of the PC board near C25.

C. Attach the scope to the 68K resistor and ground the scope to the 1K resistor.

D. Set the scope at .5V/CM or 1V/CM and 1MS/CM. Scope trace should be near ground.

E. Turn the receiver power supply on and the scope trace (DC scope) should move up to near supply voltage.

F. Turn on a properly tuned transmitter of the correct frequency. Now a pulse train should appear. Pulse train amplitude will be approx. 6 volts with a strong signal.

G. Move the transmitter away from the receiver until the pulse amplitude is approx. .5 volts. Peak L1, L2, L3, L4, L5 and L6 for maximum amplitude. Keep moving the transmitter away to maintain .5 volts pulses.

H. Complete the sequence of tuning L1 through L6 at least three time until you are satisfied that all coils are properly tuned.

3.( ) Check for pulse at the IC pins. If Tx syc pause time is too short (approx. 6.5MS min.) pulses will not appear at the IC pins.

4.( ) Range check for adequate operating range with antenna fully extended.

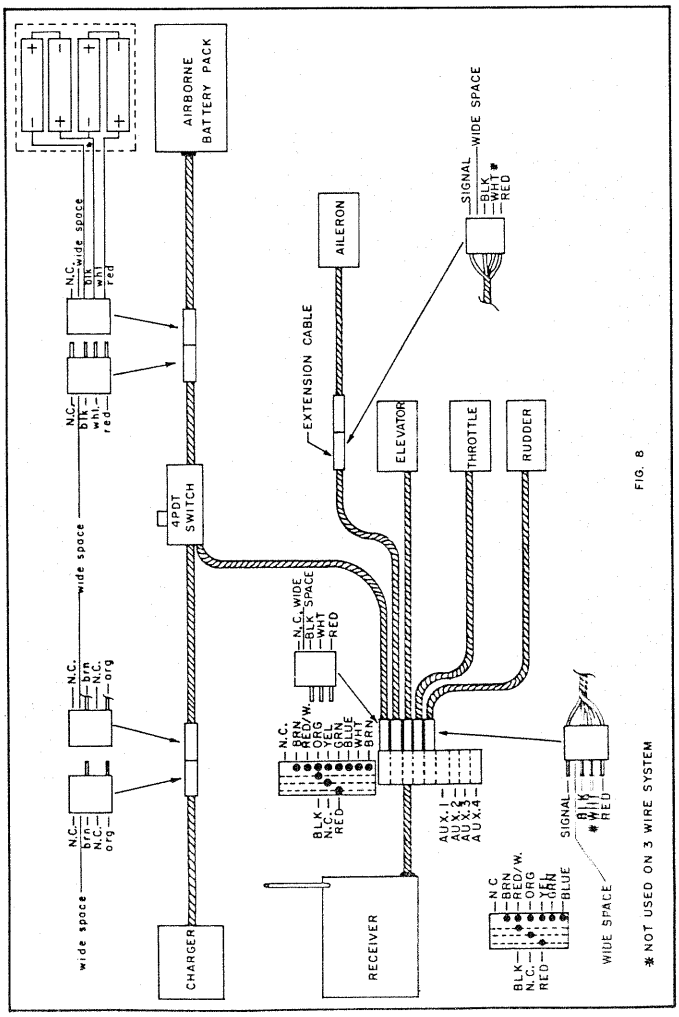
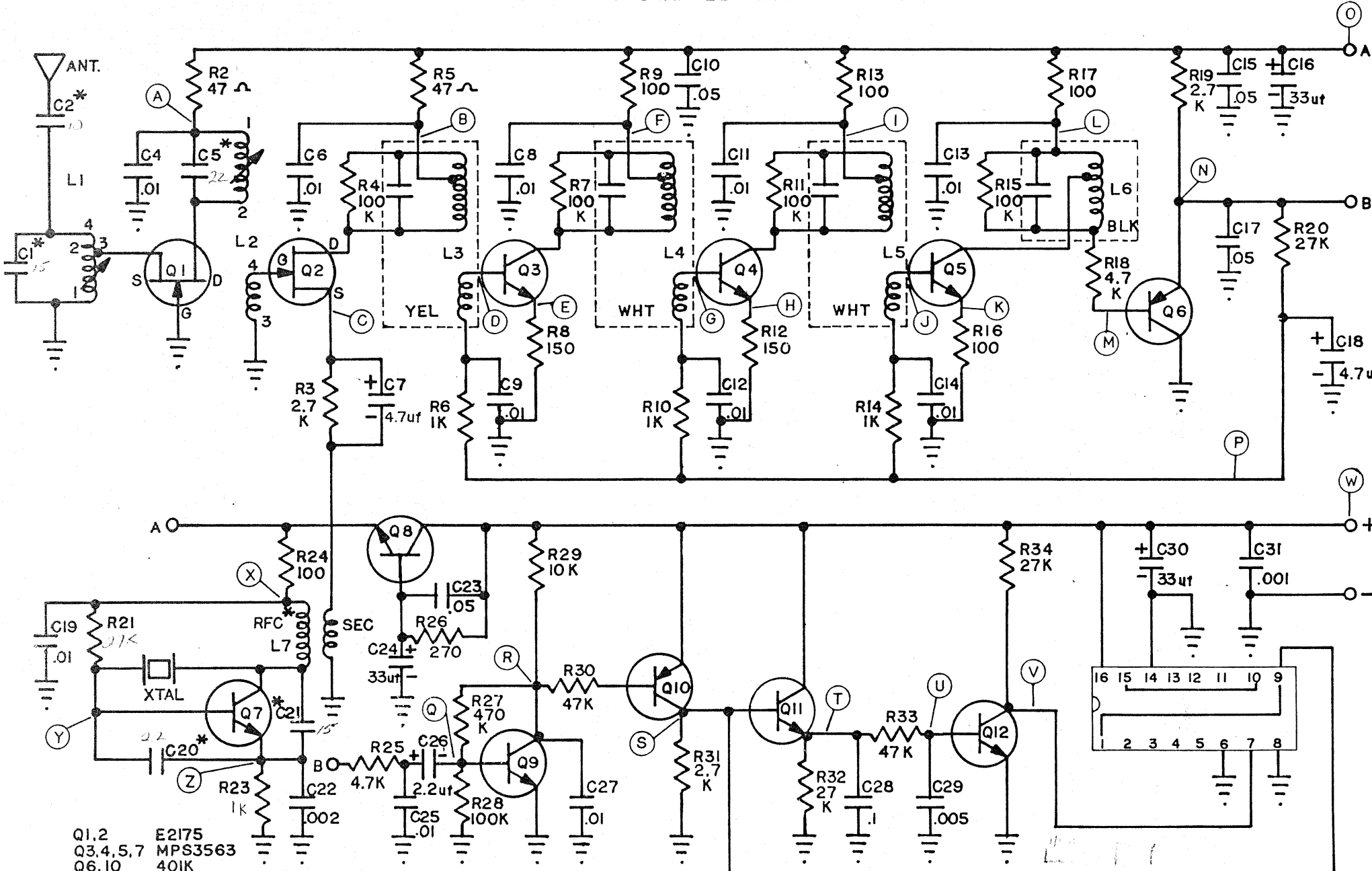


FIG. 8

8 CHANNEL RECEIVER



Q1,2 E2175
Q3,4,5,7 MPS3563
Q6,10 401K
Q8,9,11,12 M400

*VALUE DETERMINED BY FREQUENCY

If the receiver shows a tendency to trigger the decoder with the TX off, R4 and R15 may be added. Add one resistor and then retest. Add the second resistor if needed.

FIG. 9