

## Assembly - #142 Theremin

This kit is an improved version of the circuit printed in the November 1967 issue of Popular Electronics. This revised version features shielded enclosed coils and potentiometer tuning. This change makes alignment easier and less likely to change. The potentiometer tuning is far less critical than the previously used variable inductor tuning. Assembly is now simplified since the circuit board may be mounted away from the front panel.

### Assembly

Paint the metal front panel in the color of your choice. The metal is primer coated and any type of spray enamel will stick to the finish. Mark the Volume and Pitch controls with "Instant Lettering" or some similar product. Place the panel inside the case and mark the mounting screw locations with a pencil. Punch a starting hole in each spot with an ice pick or awl. Place the circuit board in the approximate position shown, mark the case and punch starting holes for it in the same way.

Mount the potentiometers and the slide switch to the front panel. Put a lock washer between the control and the back of the panel. Put the knobs on the control shafts. Mount the panel in the cabinet.

If your board appears dirty, or dull on the copper side it should be cleaned before the parts are assembled on it. Use a Brillow, or SOS pad and rub the copper pattern until it is bright and shiny.

Assemble the parts on the circuit board as shown on the top view of the board. Leave about 1/8 inch between the bottom of the transistors and the board. Pull other parts down against the board. Bend the leads over on the copper side, trim and solder.

Solder wires approximately 5 inches long to points A, D, E, F, G, H, and J. Strip one end of the shielded cable. Connect the inner conductor to point C and the ground braid to the ground strip around the edge of the board. Solder the black lead of the battery connector to point B. Mount the board in the case with the wood screws and spacers.

Turn the case with the top up and position the antenna plates. These plates may be painted a different color if you wish. Position the plates with a point of each facing the center of the case. The edges of the plates should be about one inch from the right and left sides of the case. Mark this position with a pencil. Using contact cement (Plyobond or similar) cement the antenna plates to the case top with the copper side down. Follow directions for the type cement you have purchased for this use.

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Turn the case bottom up and solder the wires from points J and H on the board to the antenna plate bottoms. Solder the remaining wires to the controls and the switch as shown. Feed the shielded cable through the hole in the rear of the case. Solder the phono connector to the end of the cable.

### Alignment

Set the front panel controls to center of rotation. Install a Burgess 2U6, or equivalent 9 Volt battery (not supplied in Kit). Turn the slugs in coils L-1 and L-2 approximately two turns into the can from a position flush with the top. Use a nonmetallic tuning tool to adjust the coils. A metal screwdriver will effect the tuning and may break the slug. Place a temporary jumper from the junction of R-20, C-15 to circuit ground. This will allow the circuit to operate at full volume until this portion of the circuit is aligned.

Connect the phono plug to an amplifier or music system. Turn the amplifier on and listen for a beat note as you slowly turn the slug in L-1. There will be a point of zero beat which will produce a rising pitched sound if the slug is turned in or out slightly. This is the proper setting. Turning control R-22 should produce the same effect, but be much less critical than the slug. Set the slug in L-1 so that the control will produce approximately the same amount of pitch change at either end of rotation.

q Remove your temporary jumper in the volume circuit. Turn the slugs on L-3 and L-4 approximately to the center of the can. Turn R-22 to one side of "zero beat" setting so that the pitch portion of the circuit will produce a signal. Adjust L-3 slowly and listen for a sudden increase in volume. L-3 should be set just before this point is reached. Check the setting by bringing your hand near the volume antenna plate. If the volume does not increase set L-3 a bit closer to the point at which volume increases. This adjustment is more critical than the pitch adjustment and must be made carefully. The control R-23 should have enough range to shift the volume from off to slightly on.

The voltages indicated in the troubleshooting chart were taken with a 20,000 Ohm per Volt Multimeter, and with a fresh 9 Volt battery. Reading on the various oscillators are made with the coils shorted. The RF voltage present when the oscillator is operating will cause some meters to read incorrectly.

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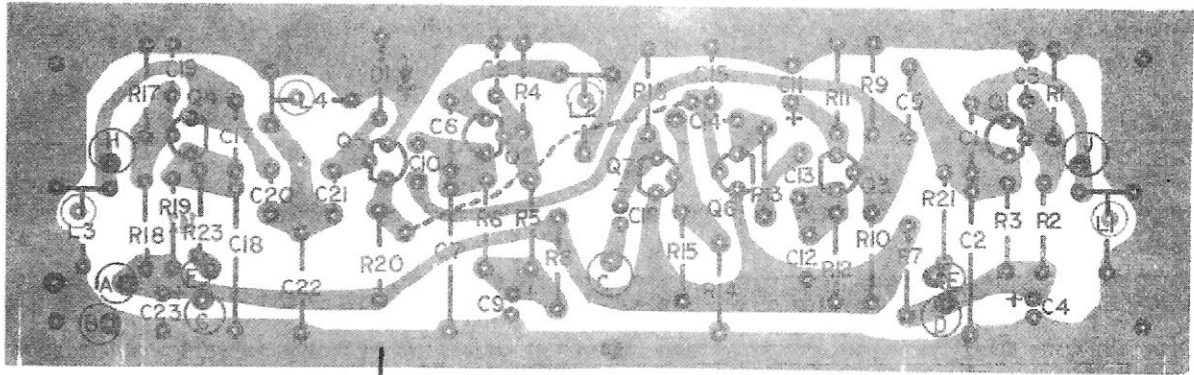
### Voltage Chart

	Emitter	Base	Collector	
Q-1, Q-2, Q-4	5.8 Volts	5.2 Volts	0 Volts	
Q-3	.25 Volts	.85 Volts	6 Volts	
Q-5	0 Volts 0 Volts	0 Volts .6 Volts	9.0 Volts 2.0 Volts	Minimum Volume Maximum Volume
	Source	Gate	Drain	
Q-6	9.0 Volts 9.0 Volts	9.0 Volts 2.0 Volts	- -	Minimum Volume Maximum Volume
Q-7	6 Volts	3.5 Volts	9.0 Volts	

The above readings were made with a 20,000 Ohm/Volt Multimeter. All readings are with respect to circuit ground. Controls set to maximum resistance. Oscillator transistors Q-1, Q-2, and Q-3 measurements made with the coils L-1, L-2, and L-3 shorted to prevent RF from effecting readings. Above readings could vary  $\pm 20\%$  due to component tolerances.

If the above readings are found to be correct but the circuit still will not operate, Proceed as follows.

Problem	Check
No Output Sound	Q-1 and Q-2 for oscillation and on approximately the same frequency using an oscilloscope. If oscillators are working, check collector of Q-3 for presence of audio frequency beat signal as slug in L-1 is turned. If beat frequency is present here, trace through volume stage Q-6 and source follower Q-7 to find problem.
No Volume Control	Q-4 for oscillation using an oscilloscope. Check input circuit of Q-5 and be sure diode is in with proper polarity. Collector Voltage of Q-5 should drop as L-4 is tuned to operating frequency of Q-4.



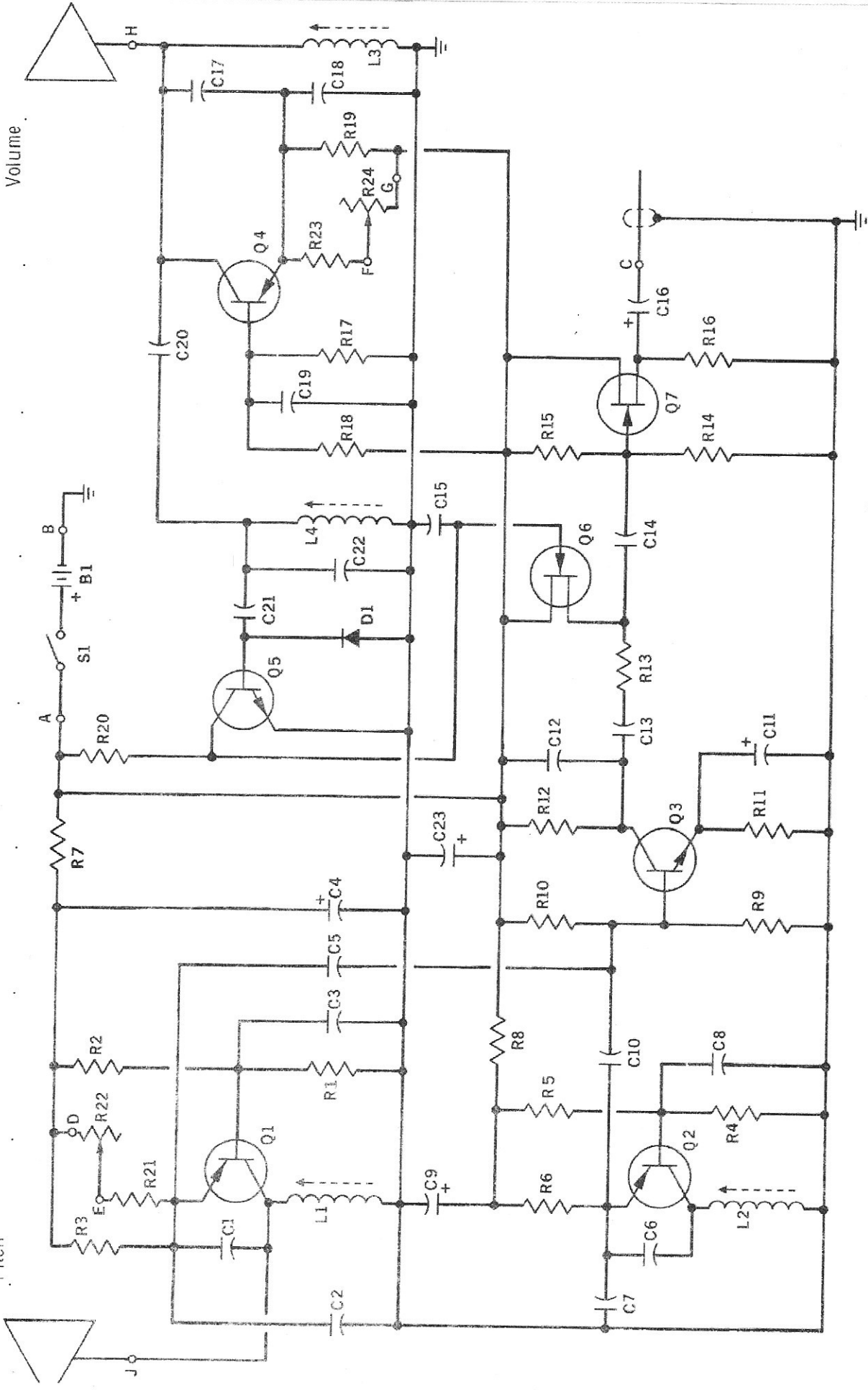
R20

### Parts List

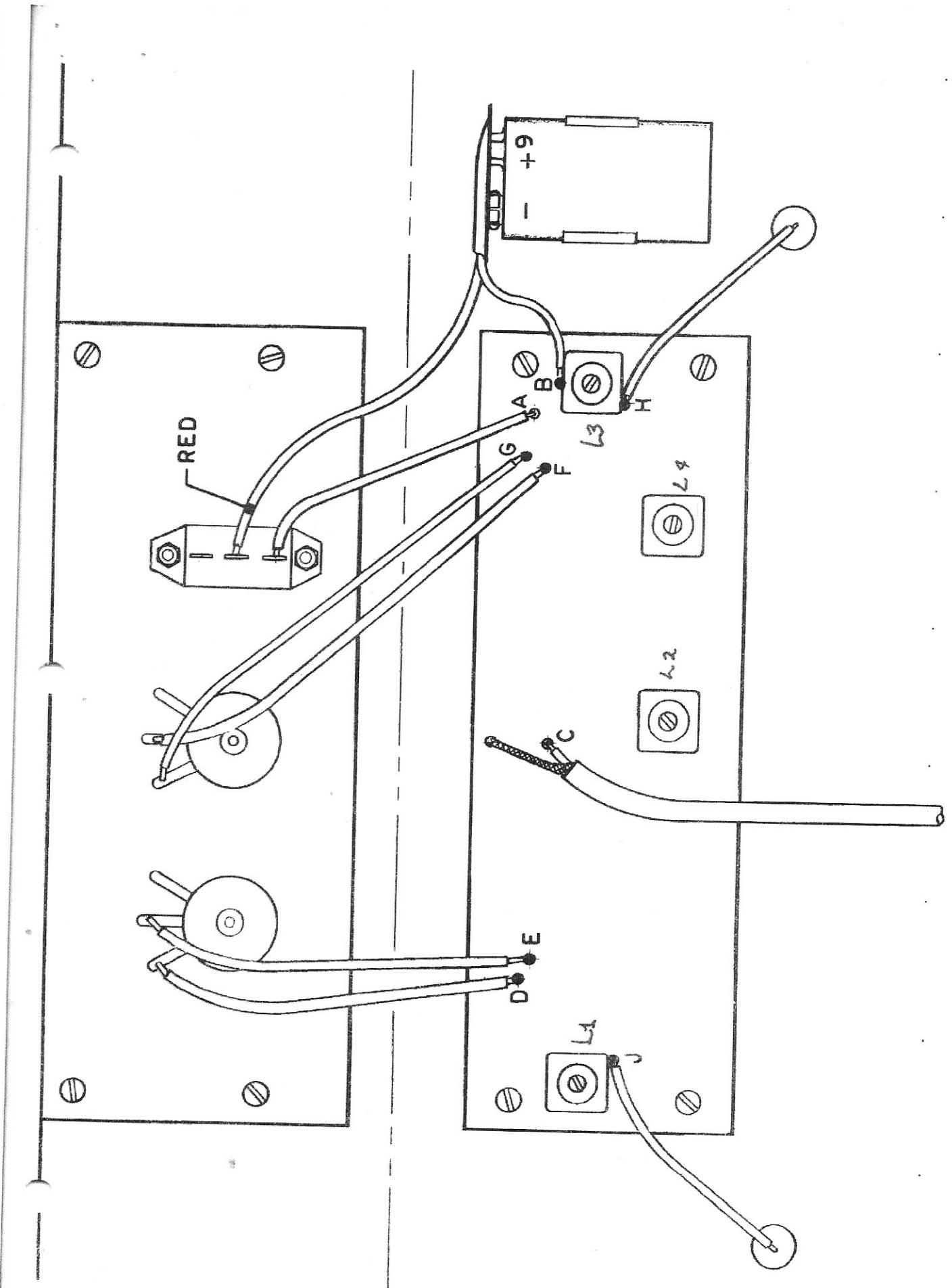
C1, C6	390 pf polystyrene capacitor
C17, C22	1000 pf polystyrene capacitor
C3, C8, C19	0.1 uF disc ceramic capacitor
C4, C9	10 uF, 16 Volt electrolytic capacitor
C5, C10	60 pf capacitor
C11	220 uF 6.3 Volt electrolytic capacitor
C12, C14, C15	0.001 uF disc ceramic capacitor
C13	0.01 uF disc ceramic capacitor
C16	4.7 uF, 15 Volt electrolytic capacitor
C2, C7, C18	10,000 pf polystyrene capacitor
C20, C21	4.7 pf capacitor
C23	100 uF 16 Volt electrolytic capacitor
D1	1N34A diode or equivalent
L1, L2, L3, L4	50-300 uH adjustable coil (387-120)
Q1, Q2, Q4	MPS3638 transistor (Motorola) <i>2N5087</i>
Q3, Q5	MPS6566 transistor (Motorola) <i>2N5210</i>
Q6, Q7	TIS-58 n-channel FET transistor (Texas Instruments)
R1, R4, R17	47,000 ohms
R2, R5, R18	33,000 ohms
R3, R19	4.7K ohm
R6, R7, R8, R11	1000 ohms
R9, R12, R16, R20	10,000 ohms
R10	100,000 ohms
R13	1 megohm
R14, R15	4.7 megohms
R21, R23	470 ohm
R22, R24	5 K linear potentiometer
S1	S.p.s.t. slide switch
Misc.	Etched circuit board, circuit board for control antennas, cabinet, battery mounting clip, shielded Audio cable, two small knobs, spacers, hookup wire, solder, etc. Battery not included in kit.

Pitch

Volume



Theremin - Schematic



Theremin - Bottom View