

Special
16 Pages

How You Can Tune In the World

ELECTRONICS ILLUSTRATED

By the Publishers of MECHANIX ILLUSTRATED

JANUARY • 35 CENTS

Build a Theremin
for *FUN*



A Professional's Theremin

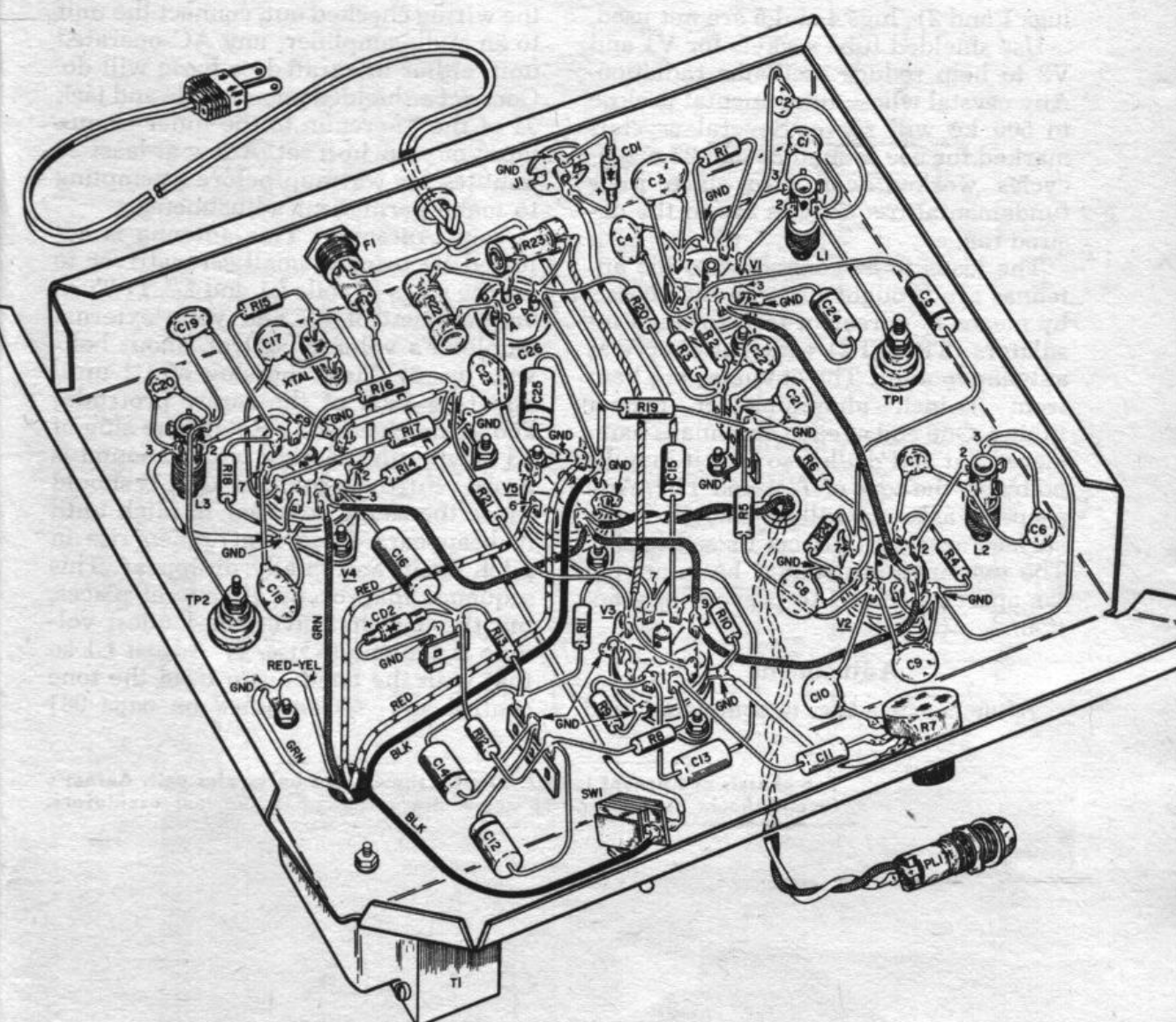
Souped-up unit works with any PA or hi-fi system.

By Dan Horowitz

RECENTLY we've heard a lot about electronic musical instruments—electronic organs, guitars, vibraharpes, etc. But the weirdest and most exciting electronic musical instrument of them all is the theremin. Invented in the early days of radio, it has been used mainly to

produce eerie sound effects, but in the hands of experts it has played melodies, and produced sounds similar to a choir of voices or other more conventional musical instruments. For about thirty-five dollars you can build *EI's* version of the theremin and create your own in-





Underchassis view of completed unit. If tube sockets without ground tabs are used, install separate grounding lugs under the socket mounting screws.

eresting compositions for this most fascinating instrument.

Construction

The Theremin can be built easily by anyone with some experience in electronic construction. The layout shown in the pictorial should be followed carefully.

Drill the required holes and mount the components. Then wire up the power supply and filament leads making sure that the latter are dressed close to the chassis. Next wire the oscillator sections (V1, V4) and the audio stage (V3). If desired, the oscillator coils (L1, L2, L3) can be prewired before assembly. On these coils note that the red dot is in the position shown (between

lugs 1 and 2), lugs 4 and 5 are *not* used.

Use shielded tube sockets for V1 and V2 to help reduce oscillator radiation. Any crystal whose fundamental is close to 500 kc will serve. Several crystals marked for use around 26 and 27 megacycles worked well also since their fundamental frequencies are in the desired range.

The leads to be connected to the antennas are brought through the chassis by means of porcelain feed-through insulators (TP1, TP2) which also serve as antenna mounts. The antennas are bent from $\frac{3}{8}$ -inch aluminum or copper tubing. One end of each antenna is hammered flat and drilled so that it may be bolted to the tops of TP1 and TP2. Any shape of antenna will do since it is the surface area that affects its sensitivity. The two antennas should be relatively far apart as shown to prevent interaction.

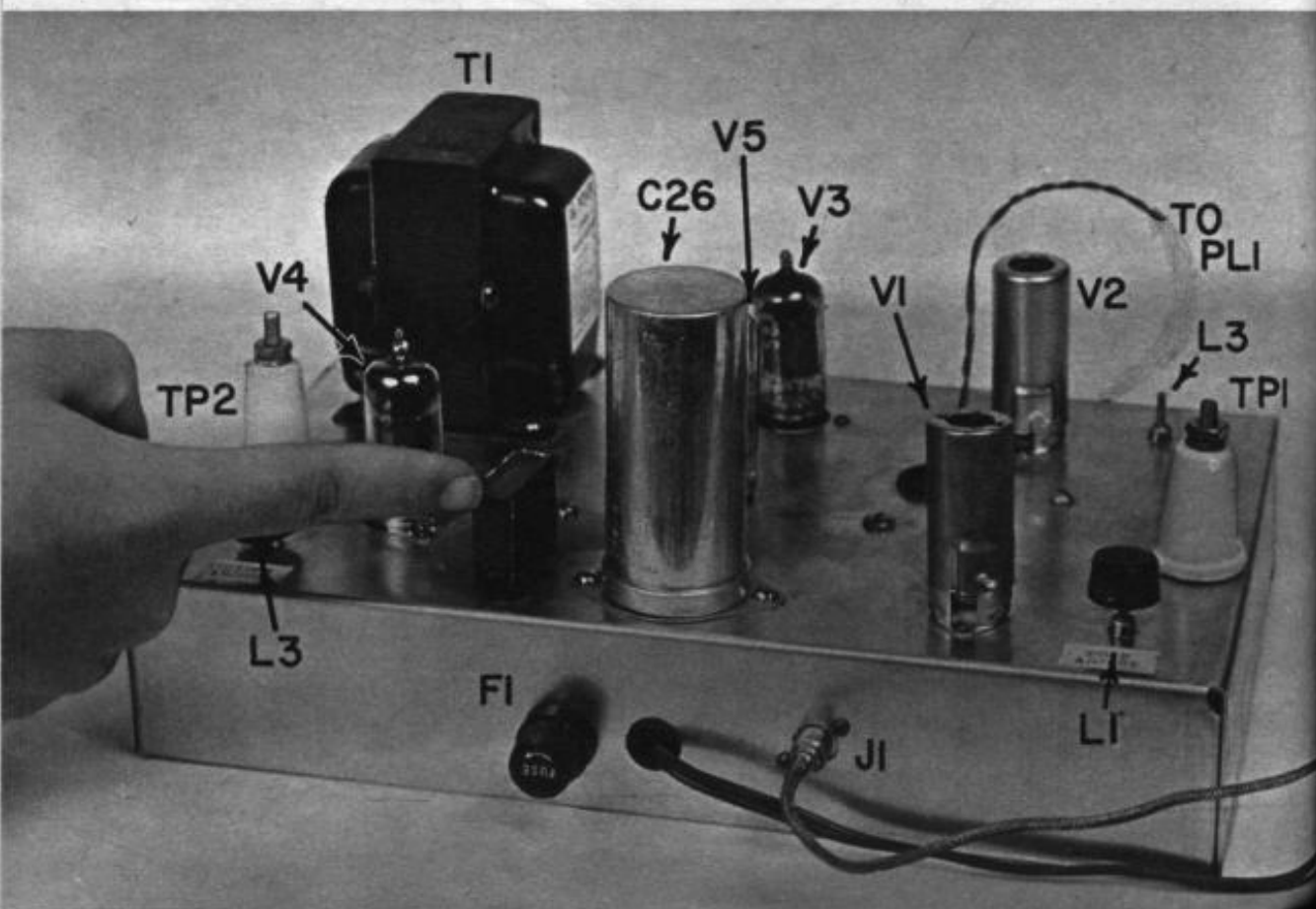
Adjustment

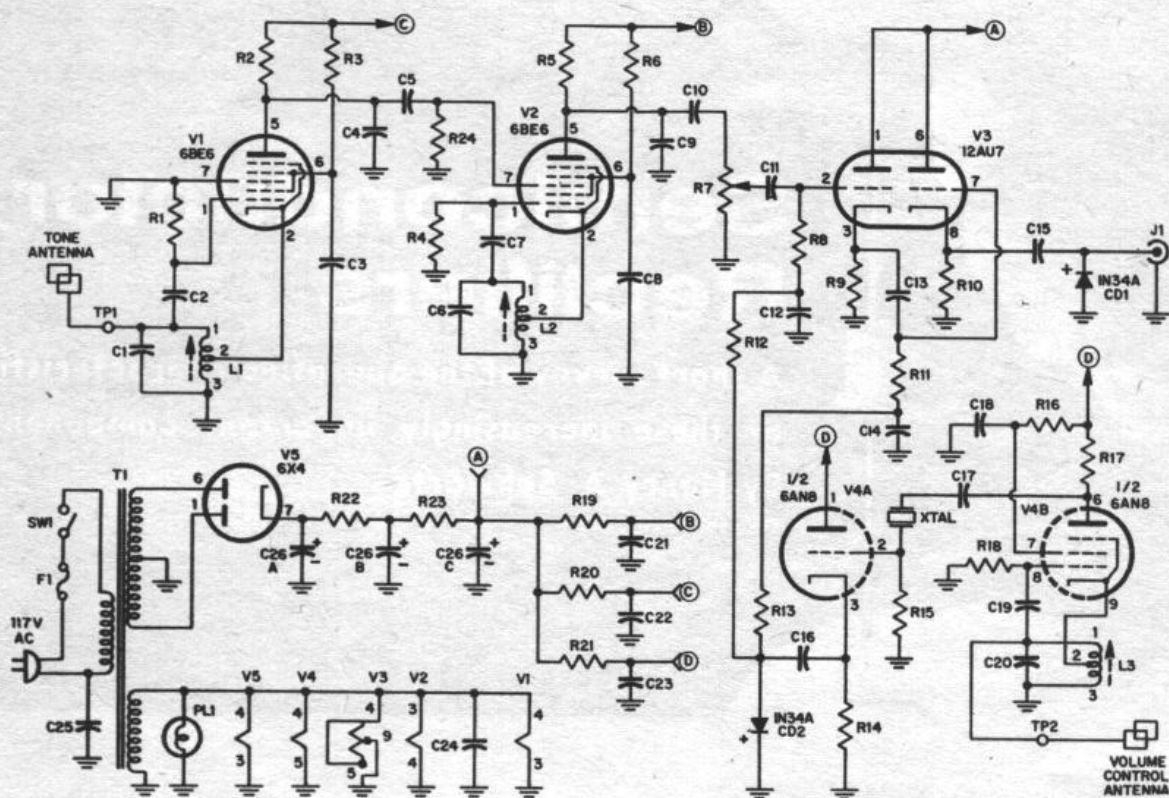
After construction is completed, and

the wiring checked out, connect the unit to an audio amplifier; any AC-operated unit, either integrated or basic will do. Connect a shielded phono cable and jack J1 of the Theremin to the tuner or aux input of your hi-fi set. Allow at least 20 minutes for warmup before attempting to make permanent adjustments.

Tone Antenna. This antenna is adjusted by using a small screwdriver to set the slugs of coils L1 and L2. 1) Turn volume control R7 and your external amplifier's volume control, about half-way up. 2) Turn the slug of L2 until about $\frac{1}{2}$ inch of the screw protrudes above the chassis. 3) Rotate the slug of L1 slowly until a high pitched sound is heard. Further rotation of L1 should cause the sound to lower in pitch until it disappears (zero beat), then rise in pitch again and finally disappear. This sequence may occur at several places, but the one that gives the loudest volume is the one to use. 4) Adjust L1 so that with the hand away from the tone control an- [Continued on page 98]

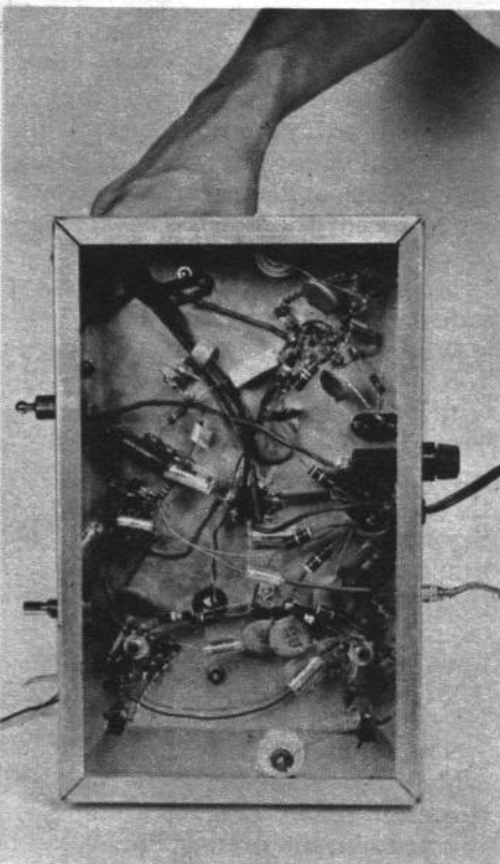
Top chassis component layout. Crystal shown may be surplus unit. Author's layout should be followed to avoid interaction of the various oscillators.





PARTS LIST

Resistors— $\frac{1}{2}$ watt, 10% unless otherwise indicated
 R1, R4, R18—22,000 ohms
 R2, R5, R17—100,000 ohms, 1 watt
 R3, R6, R14—47,000 ohms, 1 watt
 R7—500,000 ohms potentiometer (audio taper)
 R8, R11—680,000 ohms
 R9, R10—56,000 ohms
 R12, R13, R15—120,000 ohms
 R16—270,000 ohms
 R19, R20—4,700 ohms, 1 watt
 R21—3,900 ohms, 1 watt
 R22, R23—1000 ohms, 5 watt
 R24—100,000 ohms
 Capacitors: All capacitors 600 volt disc or tubular unless otherwise indicated
 C1, C6—470 mmf
 C2, C7—47 mmf
 C3, C10, C11, C13, C15, C17, C21, C22—.01 mf
 C4, C19—56 mmf
 C5, C9—.005 mf
 C8, C12, C14, C16, C18, C23, C24—.05 mf
 C20—680 mmf
 C25—.03 mf
 C26—30-20-20 mf, 3-350-V electrolytic can
 V1, V2—6BE6
 V3—12AU7/ECC82
 V4—6AN8
 V5—6X4
 F1—1 amp fuse and assembly
 PL1—No. 47 pilot lamp and assembly
 L1, L2, L3—oscillator coil (Miller 70-OSC)
 TP1, TP2—porcelain feed-through insulators
 T1—power transformer, secondary: 240-0-240 @ 50ma or higher, 6.3-volt @ 3amp.
 CD1, CD2—IN34A Crystal Diode
 SW1—SPST toggle switch
 Xtal—500 KC (available from Texas Crystals, Crystal Drive, Fort Myers, Florida)
 Misc.—Aluminum chassis 7"x11"x2", cabinet, antennas, Xtal and tube sockets



A Professional's Theremin

Continued from page 59

tenna a low frequency tone is produced. When the hand is moved in toward the antenna, the pitch should rise. Note that on one side of the null the tone rises as the hand is moved closer to the antenna and on the other side of the null the sound lowers in pitch. Careful adjustment of L1 will yield the desired range of about 6 or 7 octaves.

Volume Antenna. 1) With the left hand close to the tone antenna, slowly turn L3 until a null is produced. 2) Adjust L3 so that the right hand turns the sound on only when held about 2 inches away from the volume antenna (and the left hand is close to the tone antenna).

Playing The Theremin

Initially the beginning thereminist discovers the variety of strange noises that can be made. Low range grunts and growls can be produced by means of quick sweeping motion of the hands. Similarly, in the high range, wails and squeaks result. The midrange, however, has the best musical tone.

The theremin may be used to play individual notes, or can slide from note to note. Generally a combination of both techniques will be useful. To play individual notes, place the left hand in position near the tone antenna to "select" the desired note and then move the right hand briefly near the volume antenna to sound a note. The procedure is repeated for each successive note. With practice you can play scales. A slight wavering of the hand or fingers give the one a vibrato which lends more color to the tone.

How The Theremin Works

The circuit produces an audio tone by combining the outputs of two RF Hartley oscillators V1 and V2. Pentodes are used because they yield a larger output than triodes and they are more stable under a varying load. V2 also serves as a mixer for the outputs of the two oscillators to obtain the difference frequency which is the audio tone. When a hand is brought near the tone antenna, V1's oscillation frequency changes because the hand adds capacity across tank coil L1.

The audio tone appears at the plate of mixer V2 and is coupled to the grid (pin 2) of V3 through volume control R7. Any RF in the signal is bypassed to ground by capacitor C9 and by the input capacitance of V3. V3 is wired as two cathode followers, the output of one feeding the other, with the grid bias (and hence gain) of both controlled by V4A.

The output of V3's second cathode follower is

applied to output phono jack J1. Diode CD1 is connected across J1 to "distort" the waveform for a more musical sound.

The pentode portion of the 6AN8 (V4B) is a Hartley oscillator operating close to 500 kc. The output of V4B is coupled to the crystal which is in series with R15. At its resonant frequency, the crystal has minimum impedance and therefore the maximum signal voltage appears across R15. This is applied to the grid of V4A.

The cathode follower output of V4A is rectified by diode CD2 to produce a negative bias voltage which serves to cut off V3. When V4's frequency of oscillation is varied by hand capacitance near the volume antenna the oscillator frequency shifts from the resonant frequency of the crystal. Since the crystal will not pass this new frequency, there's less signal applied to the grid of V4A and the lower negative bias developed permits the audio signal to get through V3.

The power supply circuits are conventional. A full wave rectifier (V5) is employed with additional filtering to prevent the oscillators from interacting through the power supply.

VOLTAGE (DC unless otherwise indicated
measured to chassis ground)

PIN #	1	2	3	4	5	6	7	8	9
V1	-4 to -6	1.4 AC	0	6.3 AC	150- 200	60- 70	0	X	X
V2	-4 to -6	1.4 AC	6.3 AC	0	150- 200	60- 70	-3.5	X	X
V3	310	-15	8.5	0	0	310	-15	8.5	6.3 AC
V4	300	approx. 4 AC	26	6.3 AC	0	95	40	-1.4	.4 AC
V5	240- 250 AC	0	0	6.3 AC	0	240- 250 AC	330 AC	X	X

RESISTANCE (measured to chassis ground)

PIN #	1	2	3	4	5	6	7	8	9
V1	22K	0	0	near 0	high	high	0	X	X
V2	22K	0	near 0	0	high	high	100K	X	X
V3	high	approx. 900K	56K	0	0	high	approx. 900K	56K	near 0
V4	high	120K	47K	near 0	0	high	high	22K	0

HOT NEWS IN PROSPECTING
FEBRUARY E1