Build a Legal In-Flight AIRLINE RECEIVER

Hear pilot-to-control conversations while in-flight with low-cost Varactor-tuned crystal set.

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UNTIL NOW, "armchair pilots" wishing to listen to airplane-to-tower communications have had to confine their activities to ground-based monitoring. But the project described here—essentially a vhf crystal set with a small audio amplifier—will allow reception of such conversations when the user is on board an airliner. It will do so *without creating any hazard* to the plane's navigation system. The receiver is easily built, using readily available, inexpensive parts.

About the Circuit. Unlike superheterodyne receivers, whose local oscillators generate signals which can interfere with reception in the 108-to-118-MHz radio-navigation band, this project can be used with complete safety. The heart of the project is a 4-transistor audio amplifier with a built-in speaker, shown schematically in Fig. 1. Power switch *S1* is ganged with *R1*, the volume control. The amplifier draws current from a single 9-volt transistor battery, *B1*.

A few modifications transform this amplifier module into an airline receiver, shown schematically in Fig. 2. The receiver comprises a tuned r-f circuit (*L1*, *C1* and *D1*), a demodulator (*D2*) and the modular audio amplifier. The tuned circuit is unusual in one respect—it uses a voltage variable capacitor or Varactor as the variable capacitance. This diode, when reverse biased over a range of 0 to 9 volts, behaves like a variable capacitor of 5 to 15 pF. Because *C1* is in series with *D1*, the effect of the fixed capacitor is neglible. The combination of *L1*, a small hand-wound coil, and *D1* resonate to provide coverage from 118 through 135 MHz. (Construction details for *L1* are given on the next page.)

A short piece of insulated, stranded hookup wire serves as an antenna. The wire is terminated with a pin or banana plug (*P1*), and is connected to the rest of

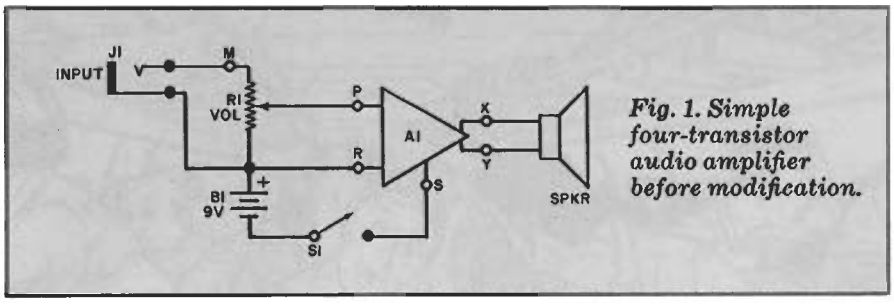

Fig. 1. Simple four-transistor audio amplifier before modification.

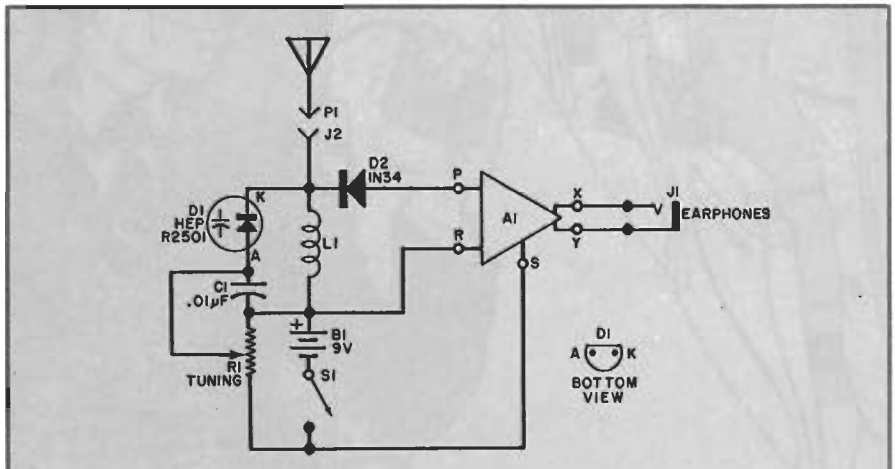

Fig. 2. Schematic of the amplifier with minor additional circuits needed to make airline receiver.

PARTS LIST

A1—Modular Amplifier (Radio Shack 277-1008 or equivalent)
B1—9-volt transistor battery
C1—0.01-μF, 50-V disc ceramic capacitor
D1—5-15-pF voltage-variable capacitance diode (Motorola HEP R2501—do not substitute)
D2—1N34 germanium diode
J1—Miniature phone jack (part of A1)
J2—Pin or banana jack
L1—Five turns of No. 24 enamelled copper wire on a ⅜-inch form, approx. 10 turns per inch
P1—Pin or banana plug
R1—Volume/tuning control (part of A1)
S1—Spst switch (ganged with R1, part of A1)
Misc.— Dynamic earphone (8 ohms), hook-up wire, solder, etc.

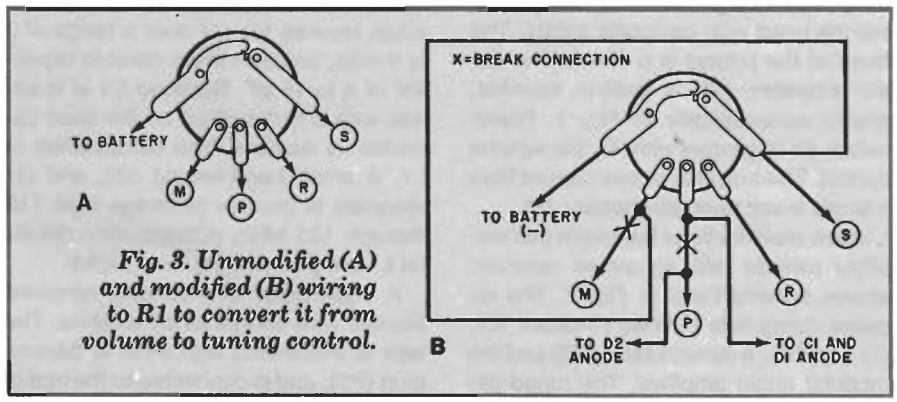

Fig. 3. Unmodified (A) and modified (B) wiring to R1 to convert it from volume to tuning control.

the circuit via *J2*, a pin or banana jack. Signals are thus applied to the tuned circuit, which is resonated by means of *R1*. This potentiometer, which served as the volume control in the unmodified amplifier, functions as a voltage divider to apply variable reverse bias across *D1*.

After the vhf signal has been boosted by the parallel LC circuit, it is demodulated by germanium diode *D2* and applied to the audio amplifier. The output of the amplifier drives a dynamic earphone plugged into jack *J1* (the former input to the amplifier).

Construction of the receiver is greatly simplified by modifying a ready-built audio module and adding a few additional components. In the author's prototype, a Radio Shack 277-1008 amplifier was used. However, other units can be used equally well. The additional components fit in place of the module's speaker.

Start by removing the three small Phillips screws which secure the amplifier pc board to the plastic enclosure. Then remove jack *J1* and unsolder the leads running to it. Raise the pc board and unsolder the leads connected to the speaker. Remove the speaker by softening the glue holding it to the plastic enclosure. Use acetone or nail-polish remover and pry the speaker away with a sharp knife. Then attach what were the speaker leads (points X and Y) to *J1*. Polarity is not important.

Refer to Fig. 3A and 3B for the following steps. Open the pc foil running from the volume control (*R1*) to the amplifier input (point P) and to the input jack (point M) by scraping it off with a sharp blade. Connect the terminal previously running to point M to one side of switch *S1* (point S), which is ganged with *R1*. Solder a wire to the wiper of *R1* and connect the other end to one side of *C1* and the anode of *D1*. Then solder a wire to the pc foil that formerly ran to the wiper of *R1* (on the other side of the break in the foil), and attach the other end of the wire to the anode of *D2*.

Next, drill a hole about 1-9/16" (3.97 cm) from the top of the enclosure on the left side (as viewed from the rear) to accommodate *J2*, the antenna input jack. Mount the jack and secure the pc board to the enclosure with the three small Phillips screws. To form *L1*, wind five turns of No. 24 enamelled copper wire on a ⅜-inch (9.53-mm) form, spaced about 10 turns per inch. Scrape the insulation off the ends of *L1* and position the coil in the speaker cutout of the pc board. Connect *D1*, *D2*, *L1*, and *C1* as indicated in the schematic, using *J2*

for mechanical support. Be sure to observe correct polarity for the diodes or you will damage them. Solder all remaining connections.

Alignment. The best way to align the receiver is to couple it to a signal generator producing an output at 125 MHz with internal 400-Hz modulation. Connect a small dynamic earphone to *J1* and set the tuning control (*R1*, the former volume control). Compress or expand the winding of *L1* for maximum audio output. If you can't get access to a signal generator with the required output, just go to your local airport. Connect a short (one foot or so) wire terminated with a suitable plug to *J2*, and listen to transmissions from the airport tower. Adjust *L1* for best reception with *R1* at center position.

Operation. The airline receiver is very simple to use. When you are taking a flight, try to get a seat near the window. Attach the antenna wire to the window with a small piece of masking tape, and plug the earphone into *J1*. This will allow you to monitor the pilot's conversations without causing a commotion.

You will not usually know the exact frequencies used by a particular airplane. Airport towers generally transmit and receive below 120 MHz. Other communications can be found anywhere between 120 and 135 MHz. Between takeoff and the time when a plane reaches cruising altitude, its pilot will use several frequencies in succession, communicating with the tower, departure control, and possibly to the particular airline controller. Similarly, the pilot will use several frequencies during the descent.

Each conversation will be brief, lasting only a few seconds. Accordingly, an important characteristic of this receiver is its broad selectivity as compared to that of a superheterodyne receiver. The user can therefore leave the tuning control at its center position. The pilot's transmission will still be heard—even if the tuned circuit is not resonant exactly at the operating frequency. The receiver can be quickly retuned for optimum reception if desired. Another possibility is to continuously tune the receiver back and forth, scanning the band until you can hear the pilot's voice.

When using the receiver, you may try to explain to the stewardess what you are doing in case other passengers think you are using a radio that might foul up airline communications. Your radio is similar to a tape recorder which would be permitted on board. ◇