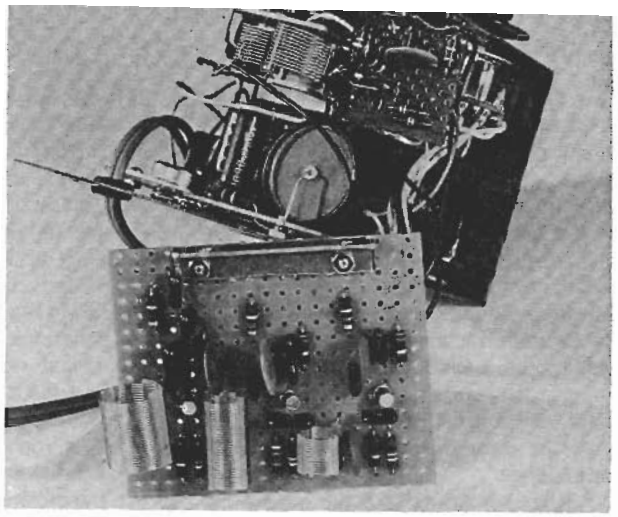


INSIDE THE RUFF GEN, a handy test oscillator that you can build to meet your needs. Parts are inexpensive and most are not critical.

SIGNAL GENERATOR APPLICATIONS

An rf signal generator is much more than a mere alignment tool. Here are some uses that'll lead you to develop others.

By JIM HUFFMAN

THE SIGNAL GENERATOR IS ONE OF those everyday instruments that has literally thousands of applications. Thirteen interesting uses are described in detail in this article. In addition, we will show you how to build a basic signal generator of your own.

The first group of eight generator applications will primarily interest the experimenter. Here we go:

1. Heterodyne Frequency Meter Although the signal generator is a reliable source of known frequencies, it has little value when checking the output frequency of a frequency generating device such as an oscillator. By adding the circuit shown in Fig. 1, you can convert the signal generator to a heterodyne frequency meter. The unknown signal is applied to the input of the frequency meter and the signal generator is tuned until the two signals zero beat. At zero beat, you simply read the unknown frequency from the signal generator. Note: when an rf heterodyne meter arrangement is being used, make sure you are not reading a harmonic of the generator. It is a good idea to know the approximate frequency range for the unknown signal to insure a harmonic is not being used. (Using the "Ruff Gen" here eliminates the worry when using the sinusoidal output.)

2. Grid Dip Meter The circuit shown in Fig. 2 doesn't make the generator into an actual "grid" dipper, but it does function in the same way. When the loop is brought near a resonant circuit and the signal frequency is tuned to the resonant frequency of the network, the meter indicates a dip showing the tuned circuit loading the output of the signal generator. You can also connect the generator output leads directly across a tuned circuit and look for a rise on a suitable ac voltmeter.

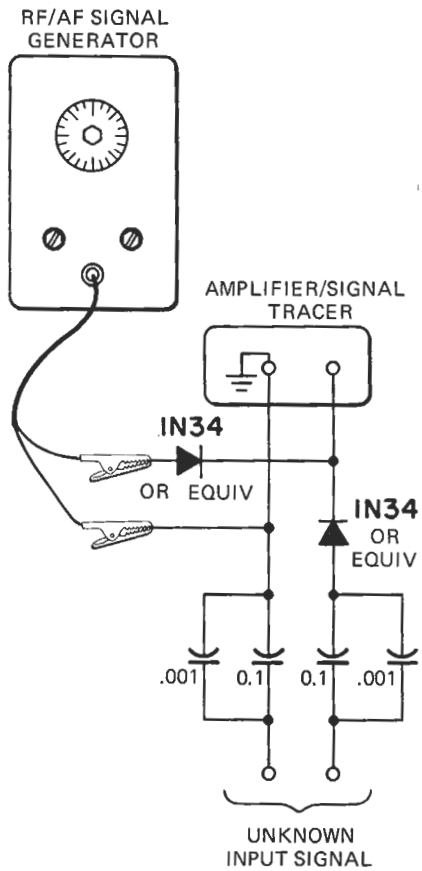
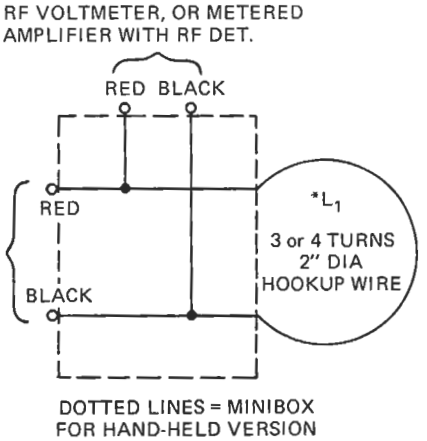


FIG. 1—HETERODYNE FREQUENCY METER. The signal generator can be used as a heterodyne frequency meter with this circuit. The .001-μF capacitors work at rf, while the .1-μFs couple audio. Make sure the unknown input signal is about the same level as the rf generator output. Both should be somewhere between 0.5 and 1.0 volt.

FIG. 2—GRID DIPPER. You can find resonant frequencies, unknown C and L, and many other values when you add this circuit to a signal generator. Optimize L1 for your generator and top frequency you wish to use.



3. Input/Output Impedance Measurements By using the arrangement shown in Fig. 3, you can use the signal generator to measure the input and output impedances of amplifiers. Fig. 3 shows how to measure input impedance. Variable resistor R_Z is adjusted until the output voltage reads one-half the maximum value. The value of the variable resistor is measured at this point and this value is approximately the same as the input impedance. Of course, this method does not give the imaginary components of the impedance.

Fig. 3-b shows how the output impedance is measured. Again, adjust for one half the maximum reading. This

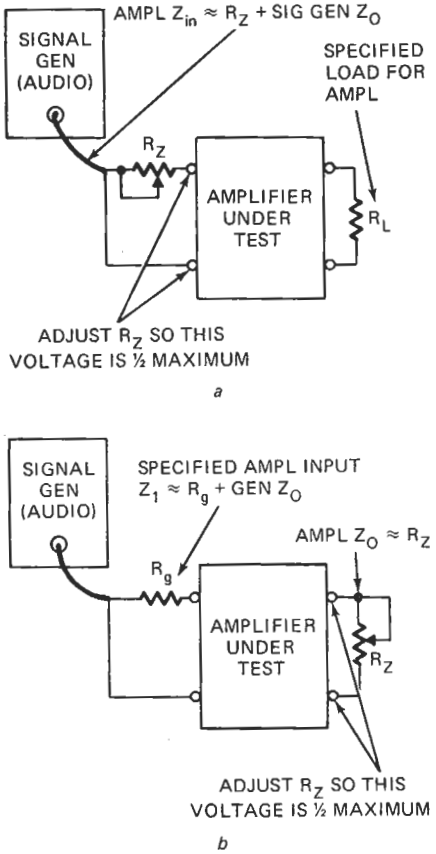


FIG. 3—INPUT/OUTPUT IMPEDANCE MEASURING. (a) above setup used to measure Z_{in} (for any 4-terminal network). (b) is the Z_{out} setup. In either arrangement, the signal generator must have adequate output to drive the amplifier under test.

time the resistor reads the output impedance. This method will work for any amplifier whether one-stage or multistage.

4. Frequency Response The signal generator can be used to measure the frequency response of an amplifier or network. Merely find the two points at which the output voltage is 0.707 times the maximum value. In other words if an amplifier's maximum output voltage is 1 volt and the generator frequency is 50 Hz and 100 kHz before the signal drops to 0.707 volt, then the response is –3 dB from 50 Hz to 100 kHz. If the meter reading varies little between these ranges, then the amplifier is essentially flat between the upper and lower cutoff frequencies. On the other hand, there may be points within the 50–100 kHz at which the voltage drops to or below the 0.707 volts and the output is not flat between these ranges. Make sure the output of the signal generator is constant, this may mean occasional readjustment of the output level of the generator.

5. Transformers Signal generators let you determine the transformer turns ratio at the frequency for which the transformer is designed. Merely insert the proper frequency at a given input level to the transformer, say, 1 volt. Measure the output voltage and set up a ratio of input volts to output volts. In the example: 1 volt to X volts. The transformer turns ratio is then 1:X. If the output voltage (X) is 2 volts, the ratio is 1:2. If the transformer is a power type, 60 Hz: in operation with 110 Vac in, the output voltage would be 220 Vac.

You can also check transformer efficiency by connecting the signal generator to the primary, with the prescribed load on the secondary. Now calculate the power in the primary and secondary ($P = E^2/Z$). Where Z primary is equal to the load resistance times the turns ratio squared. Transformer efficiency is given from $\%(P_{out}/P_{in})$.

6. VFO Connect a buffer between the rf signal generator and the input of the transmitter (Fig. 4). The coil and capacitor LC are there to filter out spurious outputs from your generator. Coil and capacitor data are given in the table. (Note. The Ruff Gen may be used directly in this application because it is extremely stable and has no harmonic output.)

7. Transmitter To the rf generator with modulated output, you can add the vfo circuit shown in Fig. 4 and modulate for an AM transmitter. This is a milliwatt input job. The input to the buffer stage can be held at less than 100 mW by adjusting the drive. This means the generator can be used legally with no license on the AM broadcast band, Citizens band, or television audio. If you hold a proper ham ticket, you can use the outfit on the amateur bands for a QRP (low power) rig. QRP operation is fun in these days of 2 kW linears.

8. Strobe Light Driver The audio generator can be used as sort of a visual tachometer in that it can be used to drive a strobe light. When the generator frequency coincides with the mechanical frequency, motion freezes. Don't figure on stopping the motion completely, as the phase of the light and motor drift somewhat. And don't forget to convert revolutions-per-minute to cycles-per-second. Just multiply the audio frequency by 60.

BAND	L1	C1	C2	C3
80	5 μH	500 pF	.01	.1
40	3 μH	250 pF	.01	.01
20	5 μH	25 pF	.001	.005
15	.8 μH	80 pF	.001	.001
10	.5 μH	50 pF	.001	.001
8 MHz*	2.5 μH	250 pF	.01	.01

* (6 & 2 METERS)

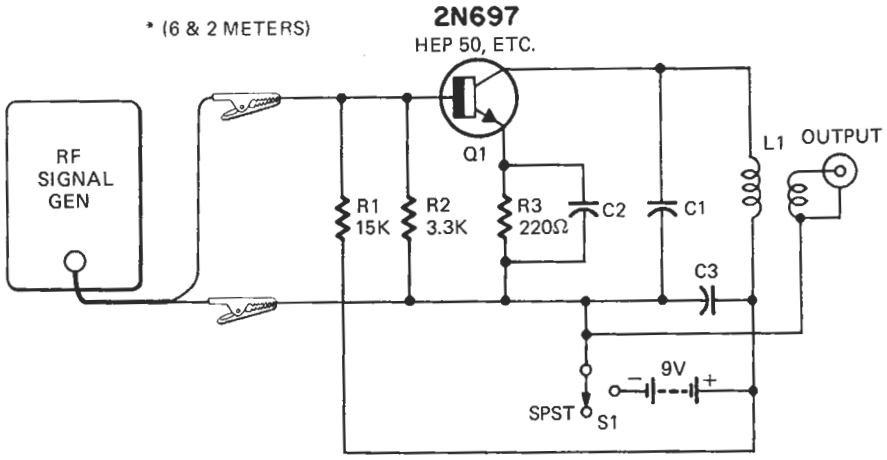


FIG. 4—SIGNAL GENERATOR VFO. The signal generator makes a decent VFO with the addition of a buffer. Q1 can be almost any npn transistor that will work at the highest output frequency you plan to use. You can even use a pnp transistor if you reverse the battery polarity.

Technician applications

1. Check The Condition Of Capacitors Just connect the capacitor in series with generator output and your meter. Now sweeping the generator from low to high frequencies should produce low to high output voltage variations. But if the output is constant, the capacitor is open. If you have trouble reading the outputs or cannot detect changes too well, try connecting a 1000-ohm resistor across the meter terminals.

2. Inductor Checker Inductors can be checked in the same manner as

capacitors. As the frequency goes up, the impedance of the coil goes up, and the voltage at the meter goes down. Use the 1000 ohm resistor if you do not obtain very substantial readings at first.

3. Sweep It If you don't mind going inside your rf generator, add a Varicap sweeper. This changes the frequency when a unijunction supplies a variable sweep voltage. Fig. 5 shows the schematic of such a sweeper. If you cannot gain enough sweep range, use a 1N5148 varactor.

4. FM Source With the circuit of Fig. 5 and your rf signal generator you have a source of FM that can be used to check out FM receivers. The circuit works on the same principle as the electronic sweep generator except consider the input as audio and not sweep signals. The audio will be adjustable from about 1 to 2 kHz (ignore the sweep output to the scope).

5. Horizontal Bar Generator The standard rf generator with 400 Hz signal modulation will produce horizontal bars on a television receiver. This signal simplifies vertical linearity and height

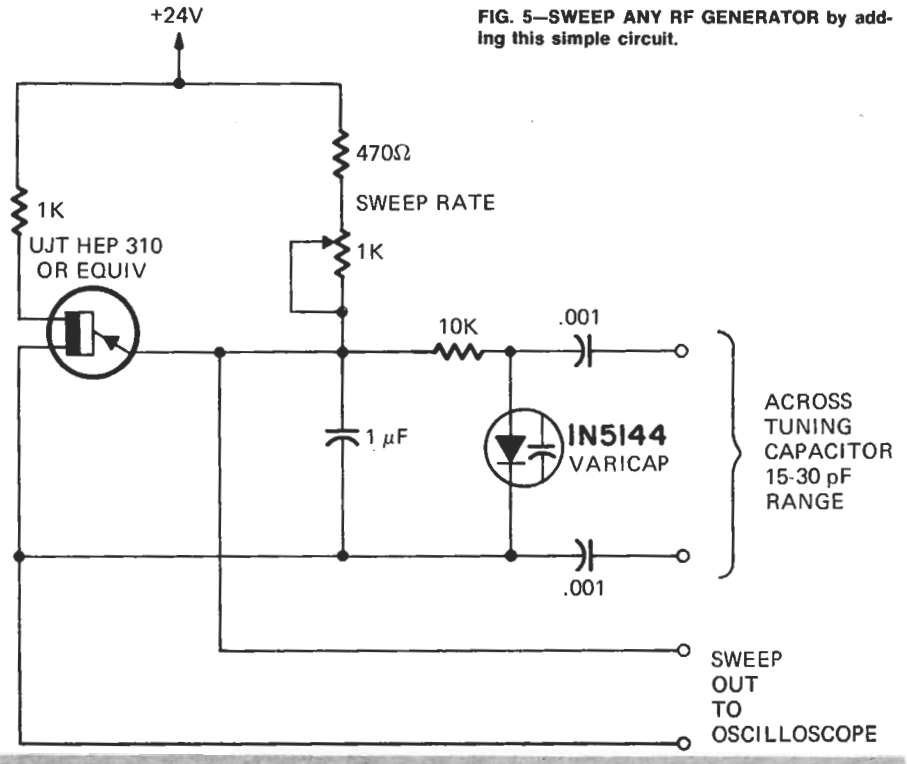
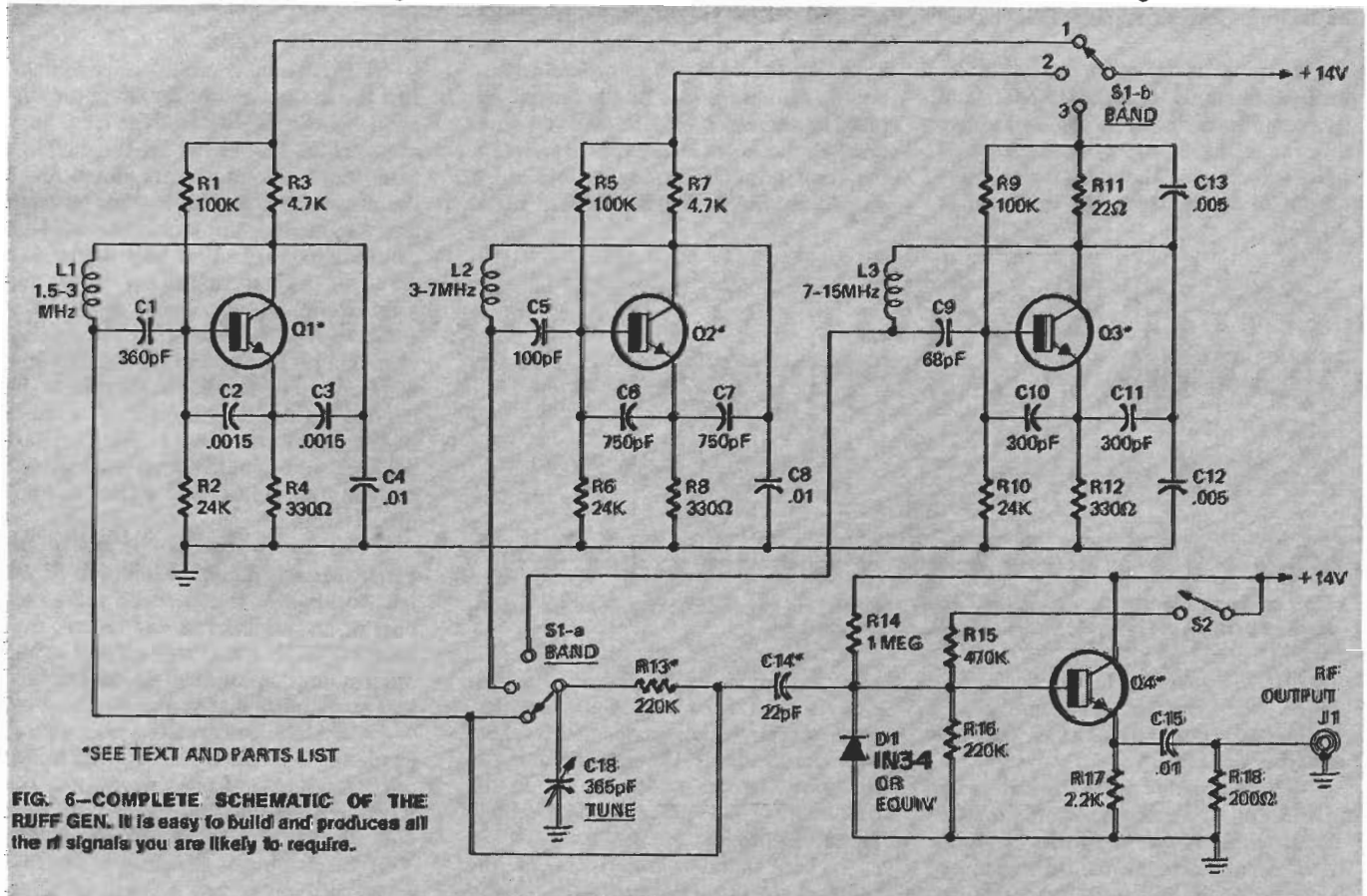


FIG. 5—SWEEP ANY RF GENERATOR by adding this simple circuit.



*SEE TEXT AND PARTS LIST

FIG. 6—COMPLETE SCHEMATIC OF THE RUFF GEN. It is easy to build and produces all the rf signals you are likely to require.

PARTS LIST

All resistors ½-watt 10% unless noted
R1, R5, R9—100,000 ohms
R2, R6, R10—24,000 ohms
R3, R7—4700 ohms
R4, R8, R12—330 ohms
R11—22 ohms
R13, R16—220,000 ohms
R14—1 megohm
R15—470,000 ohms
R17—2200 ohms
R18—200 ohms (5%)
R19—1000 ohms

All capacitors silver mica unless noted
C1—360 pF
C2, C3—.0015 μF, at least 50V, ceramic
C4, C8, C15—0.01 μF ceramic
C5—100 pF
C6, C7—750 pF
C9—68 pF
C10, C11—300 pF
C12, C13—.005 μF ceramic
C14—22 pF
C16—2000 —F, 50 V, electrolytic
C17—1000 μF, 15 V, electrolytic
C18—365 pF variable (1 5/16H x 1 %W x 113/16D). See text

D1—1N34 or equal
D2—50 V, 1A, full-wave bridge
D3—400 mW, 12 - 13 volt Zener
L1—27 turns B&W 3012 (¾" dia x 32 tpi)
L2—34 turns B&W 3004 (½" dia x 32 tpi)
L3—14 turns B&W 3004 (½" dia x 32 tpi)
Q1, Q2, Q3, Q4—2N914 or equal
Q5—15W silicon npn power transistor
S1—2 pole, 3 position rotary (see text)
S2—double rocker switch (spst/spst)
T1—24 V 500 mA transformer (sec), 117 Vac (pri)
MISC—perf board, hardware, knob, 5 x 5 x 5 box, 3" dial, BNC jack, grommets, line cord

adjustment. Connect the rf generator output directly across the TV's antenna terminals. Then adjust the frequency until the bars appear. Now adjust the vertical linearity (and height) controls till the bars are evenly spaced up and down on the screen.

Building the Ruff Gen

Now that you have been introduced to some uses for the signal generator, it's time to get one. If you don't already have an rf signal generator, the Ruff Gen would be ideal. In fact, some of the features of the Ruff Gen might make you want to supplement your existing signal generator with this one. The circuit was originally designed when a source of nearly sinusoidal rf energy was needed. If you have ever used a commercial signal generator, you know that the output is anything but sinusoidal. Also, stability is somewhat wanting in the cheaper commercial units so this rf generator also fills this gap. Speaking of cheaper, we have the third reason for building this unit. It is less expensive than many units.

Since the rf generator only operates on fundamentals to about 15 MHz and it is sometimes desirable to use it above this range, harmonic generation capability is included. The normal sine-wave output of the generator is distorted at the flick of switch S2, harmonics can be added when needed. This unit is not modulated, but modulation may be added if desired.

Three separate oscillators are used in the unit for optimum performance. The oscillators are basically Colpitts types. Somewhere a trade-off had to occur because of the multiband feature, and this was in the tuning capacitor. The same 365-pF capacitor tunes all three bands. Figure 6 shows the scehmatic diagram for the generator. Fig. 7 is the power supply.

Power for the unit is regulated by an emitter follower voltage source; one of the simplest regulators. Actually, the greatest advantage is in the fact that power supply ripple is held to a minimum (around 15 mV). There is no power on/off switch, the power supply is "on" as long as the unit is plugged in. The only real advantage here is the creation of the heat from the regulator which tends to stabilize the temperature inside the generator. The heat also prevents moisture buildups when the case temperature undergoes one of the rapid excursions sometimes associated with a garage workshop.

Since one of the primary considerations is that the unit be inexpensive, the entire unit was designed around the bargain pages of a mail-order catalog. Almost everything needed can be found there, excluding the case, etc.

Construction hints

Perf-board is used throughout, but a printed circuit could easily be fabricated since the wiring has no crossovers.

Three boards make up the unit. They are the power supply, oscillator, and amplifier boards. Each board is mounted within the case on angle brackets fabricated from a defunct utility box. Note the transformer mounting method. The transformer was the cheapest/best unit available, but there appeared to be no way to mount it on a board. Mounting was finally solved by pushing some no. 22 solid hookup wire through the holes at the four corners of the transformer. The wires are simply looped around and then soldered for a very stable mounting method. No heat sink is used for the power transistor, since the power dissipated is no where near the available 15 watts the unit can dissipate at room temperature. On the oscillator board the coils are merely glued in place.

Then there is the issue of the switches. In the interest of money; you can order an assortment of rotary switches, in hopes that you find one that would work and restock the junkbox with the rest. I had to remove an spst on/off switch from the switch I used. For only 99 cents, it was a worthwhile experience and it paid off in the form of 9 additional rotary switches (and the spst, too). Should you want to go the more conservative route, you can merely order the 2-pole 3-position switch specified in the parts list.

The variable capacitor will have to be raised in the air on a strip of aluminum 1 inch wide and 7 5/16 inches long. Bend the strip ⅝ in either side of center down to a 90 degree angle. You should now have a U-shaped bracket. Now put mounting ears on the bracket by bending ¾ inch of the ends away from the center. Drill for the capacitor and mount. There is actually three way support for the capacitor. Two directions from the mounting ears on the bracket and one way from the vernier dial and capacitor shaft. This capacitor is a common type. Radio Shack's No. 272-1344 looks good. Others can be used with minor alterations in the mechanical layout of the generator.

The rocker switches should be mounted on spacers to recess them in the panel. I got the spacers from the rotary switch that was modified to make a band switch. Letter the front, mount the switches, and vernier, glue some grommets on the bottom for feet and you are in business.

Calibration steps

Calibration is really no problem. Just use the procedure for using the signal generator as a heterodyne frequency meter (Fig. 1), borrow an rf generator from someone and you are all set. Since the ranges should have a slight overlap any way, no attempt was made to add a calibrate control. You can adjust the value of R13 to achieve a more distorted output (more harmonics) if desired. In fact, there may be some merit in making R13 a potentiometer to allow a degree of harmonic distortion to be controlled at the generator. For more distortion of the lowest frequency oscillator, you would have to increase coupling capacitor C14 which is optimized at 22 pF.

The signal generator in one of its many forms is a helpful addition to the lab workbench. It can check the bandpass of an amplifier, tuned circuit, mechanical filter, etc. It will do any of the other things mentioned in this article and many more that you might think of.

Certainly, constructing your own rf generator is not as challenging as building a receiver, but the versatility of the Ruff Gen should merit the little time and effort that it takes to build it. The Ruff Gen's output is nearly a sinusoid so that it is extremely helpful in determining network response since there are no harmonics to confuse what you see. Harmonics may be added at will when needed merely by switching the output amplifier to a different amplifier mode and thus increasing harmonic distortion.

At any rate, whether you build, buy, or just apply; you will find the extremely handy signal generator a welcome device on your bench. **R-E**

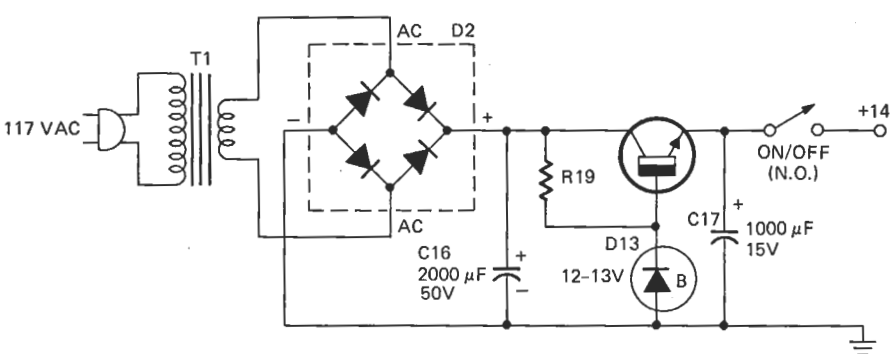


FIG. 7—POWER SUPPLY for the Ruff Gen. It is a simple, yet regulated supply. Note the unconventional position of the on-off switch. See text for explanation.