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FROM THE EDITOR...

Was 1982 a good year for wines? We knew 1982 was bad for GM and the oil companies. Chances are one out of ten of our readers was out of work. But, the worst of it, to our eyes, was that 101 Electronics Projects was not published. We lucked out in 1982!

I have faith, 1983 is here and so is 101 Electronics Projects. There are a few old faces on the staff, and a few new ones. What is most important to you and I is that 101 Electronics Projects is being published again by a new Publisher who will also publish 99 IC Projects, Electronics Hobbyist, Electronics Theory Handbook, Hobby Computer Handbook and Computer Readout. Yes, I'm sure you recognize most of the magazine titles, and you will enjoy reading them again. So watch your newsstand where you purchased this magazine for other C&E Hobby Handbooks in the near future.

You will find a lot of new mini-circuits in this issue of 101 Electronics Projects. The circuits provided were selected for their popularity, utility, serviceability, and adaptation to other circuits to make larger projects. As a bonus, we offer 31 Integrated Circuits to whet your appetite for our upcoming 99 IC Projects magazine.

As the old saying goes, "we are in the market for a few" good electronics articles. We'd like authors, pros and amateurs alike, to submit articles on construction projects that have been built and are operating successfully. Your articles on electronics projects will enable us to produce "bigger and better" magazines in the future.

So, come on you budding authors, submit your articles to Hank Scott in care of this magazine.

Yours for bigger projects,

Hank Scott

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Editor
C & E HOBBY HANDBOOKS INC.
300 West 43rd Street
New York, N.Y. 10036

Low No Go

My cassette pre-recorded tapes sound screechy in my car tape player. They sound good in the home player. Why?

—A.A., Brookfield, CT

Five will get you ten that they are Dolby encoded. The encoding boosts the highs which sound terrible in playback units without Dolby. Turn your tone control down a bit and kill some of the high frequencies.

Wind Power

I set up a fan-generator combination on a small tower and now I get about 30 amps AC at 15 volts. I'm using a car's alternator as the generator. What can I do with this power after seeing it is not reliable because the wind varies in speed?

—E.E., Ellenville, NY

You're talking about 450 watts of power. Pass it through a resistor and use the heat to assist your regular heating and hot water system. Maybe the resistive load can be placed on your garage floor which will keep the car warm for fast starts on very cold mornings. The wind is fickel and you can't rely on a fixed frequency output or constant voltage output. But, a resistor doesn't care provided it can take the maximum power or current available. For maximum power transfer, the lead-in line must be *10 copper wire or better.

Mom Knows Best

I bought a 50-ft. coil of RG-8U coax with wired-on connectors. It's 15-ft. longer than I need, but my mother says it makes no difference since very little signal is lost in that 15-feet. Is she right?

—D.K., Merchantville, NJ

Your mom is right. The signal loss is 15-ft. of RG-8U can't be detected except with very sensitive lab test gear. Also, you may foul up the connector connection and lose all or a good part of your incoming and outgoing signals.

No One Ever Bothers

To what do I connect the green screw on a three-prong receptacle?

—D.M., Wilmington, DE

Just about everybody does not bother to connect it to anything at all. However, I prefer to connect the green screw to the metal box it is installed in. Also, I connect the ground lead from the power cable to the box at the same point. I make these connections by drilling a hole and installing a self-tapping screw. Do this and noisy electrical appliances will not interfere with radios and TV's in the home. Your local electrical supply store has snap-on clips that will eliminate the need for drilling holes and self-tapping screws.

Poor Wiring?

I connected an electrical ground to the brass screw on the outlet plate next to my shortwave receiver. The rig is very noisy. When I connect the ground lead to another outlet plate the noise disappears. Why?

—C.M., Ft. Benning, GA

I bet the ground connection to the plate and metal box behind it is poor or non-existent. Use an electricians trouble lamp and touch one head to the hot line in the box (black wire) and the other lead to the metal box. The lamp should glow with normal brilliance. If not, something is wrong. Another test—connect an ohmmeter between the two brass plates you mentioned. The resistance should be zero. But play safe; first connect an AC voltmeter from plate to plate making sure there is no AC voltage potential between the two.

A Four Alarmer

I happened to be in a burning building and could not get my walkie-talkie CB rig to work. Can the plasma gases of the fire do this to radio communications?

—F.H., Detroit, MI

I was once in a burlesque house when it was raided and I couldn't hear the band. Everybody has problems. As for yours, I can't answer it, but I advise you to be more selective in the future about the site you transmit from. The first thing people in a burning building should do is get the H— out, and fast. By the way, do you play with matches?

Ask Hank, he knows!
Hank Scott, Editor

The Answer Man

by Hank Scott

Hank Scott, our Workshop Editor, wants to share his project tips and experience with you. Got a question or a problem with a project you're building—ask Hank. Should you find a clever solution to a basic problem—tell Hank. Please remember that Hank's column is limited to answering specific electronics project questions that you send to him. No, Hank can't answer your letters, but he will use them to create his column. Let Hank hear from you.

Switcheroo!

I modernized my home's electrical system by inserting screw-in circuit breakers in place of the ordinary "one-blow" fuses. My neighbor said I am breaking the law. Is he right?

—J.J.A., Paxton, MA

No, because the circuit breakers you installed are perfectly acceptable provided they are of the correct rating for your home's wiring. However, you are wrong in saying that you modernized. You haven't increased the laod capacity of your home's wiring at all. I suggest that you consult your local power company. They will be happy to advise you—and it's free.

Can't Pull It In

I can't get my transistor radio to work in the attic. What gives, Hank?

—D.L., Macon, GA

I can't get my son to clean the basement; we both have problems. But yours is easy to explain. Many homes have aluminum foil laid under the roof tile, the foil acting as a large shield preventing radio signals from coming through. Also, interior insulation packaged in foil is often placed in the rafters effectively reducing, if not practically eliminating, radio waves. The lower levels of the house have gaps in the walls called windows and doors that permit passage of radio waves. The wall insulation does limit the radio signals requiring external radio and FM antennas for otherwise weak signals that are now totally lost.

6SN7, 6K6, 6AL5, etc.

I have some old radio tubes from about 1950. Can I sell them?

—F.T., Bloomington, IN

Sure you can if you can find a buyer. The tubes of that period are not valuable, and many of the types you listed at the bottom of your letter are still available brand new! Visit a flea market—never can tell!

Play A Tune

What is the frequency of the piano keys around middle C? I want to align my piano with an audio generator.

—D.J., Pennsville, NJ

A-22, A*-233, B-247, C-262, C*277, D-294, D*-311, E-330, F-349, F*370, G-392, G*415, A'-440. Lots of luck!

Cleared Up

My television set's focus is poor at home, but in the repair shop it's perfect. I see this with my own eyes. Why?

—C.L.N., Richmond Hts, OH

Your antenna system has line reflections due to mismatching of antenna to the lead-in line to the TV receiver. This is not so at the TV repair shop because the pros there realize the importance of a good clean TV signal. Check your TV antenna and lead-in wire. If so, install a sturdy unit and use coax cable with line matching transformers.

Red Dust

I have an 8-track player that has been playing great for about a year now. Recently I have been having problems keeping the playback head clean. After about five minutes the head is covered with a dark red-brown coating. If I leave it alone the sound gets so dull it's hard to understand. What's wrong?

—C.R., Newark, NJ

Old tapes that tend to flake or new, cheap ones can be the cause of the problem. If the problem occurs on a new quality tape, the head may be worn beyond use or some sharp edge in the mechanism is scraping the oxide free and the head is collecting it.

101 Electronic Projects 1983

INTEGRATED CIRCUIT PROJECTS

101 ELECTRONIC PROJECTS

1. MILADAPTER FOR DVM

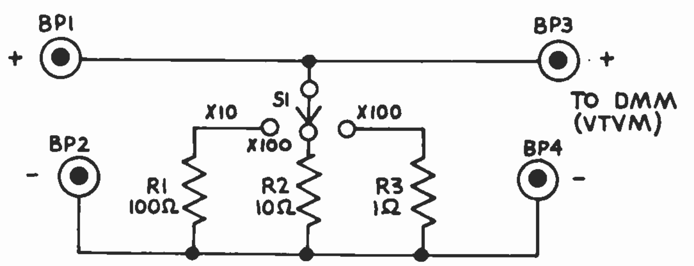
Poke around your junkbox and you may discover most of the parts you need to convert your digital voltmeter (DVM) to an accurate DC milliammeter.

To use the Miladaptor you simply multiply the DVM reading by X10, X100 or X1000 to obtain the DC current. For example, if the DVM indicates 0.1 volt and S1 is set to X100, the current is 0.1 X100 or 10 milliamperes. If the DVM indicates 0.25 volts and S1 is set to X1000, the current is 0.25 X1000 or 250 milliamperes.

The circuit under test connects to binding posts BP1 and BP2; the DVM connects to binding posts BP3 and BP4. Switch S1 must be the make-before-break type. Start with S1 in the X1000 position and downrange until the DVM indicates a convenient reading. The procedure is a must when using a VTVM or multimeter with a meter indicator.

PARTS LIST FOR MILADAPTER FOR DVM

BP1, BP3—Insulated binding post, red
BP2, BP4—Insulated binding post, black
R1—100 ohm, 1-watt, 5% resistor
R2—10-ohm, 1-watt, 5% resistor
R3—1-ohm, 1-watt, 5% resistor
S1—3-pole, single-throw rotary switch, shorting type



2. SIGNAL ANNUNCIATOR

An action takes place! A switch is tripped, and the buzzer, light, siren, bell—any type of alarm or signal—goes off! You know it is happening and this is important. The signal annunciator circuit does this job very well. In fact, it provides a LED light as a silent signal if you wish. The real versatility of the circuit is the possibility of controlling up to eight (8) separate points where the action can take place and have the alarm signal sound when the relay is activated. This is where the annunciator function of the circuit comes into action. Now, one of eight or less signals can alert an attendant by the action of a relay closing, and providing a LED indication of where the switch is activated. In a burglar alarm system this is desirable. Restaurants can use the annunciator device to call waiters to the kitchen for food that has been prepared. The ideas are limited only by your imagination.

Should you use only the switch circuit, all the parts you require are S1, R1, Q1, D9 and K1. Should you require two or more circuits, diode D1 becomes important, for if it were not used, the closing of S2 would light LED2 and LED1. Diode D1 acts as a reverse current block in this situation. Ditto for D2 when switch S1 is closed. Expanding the circuit for additional signal switches requires use of additional diodes.

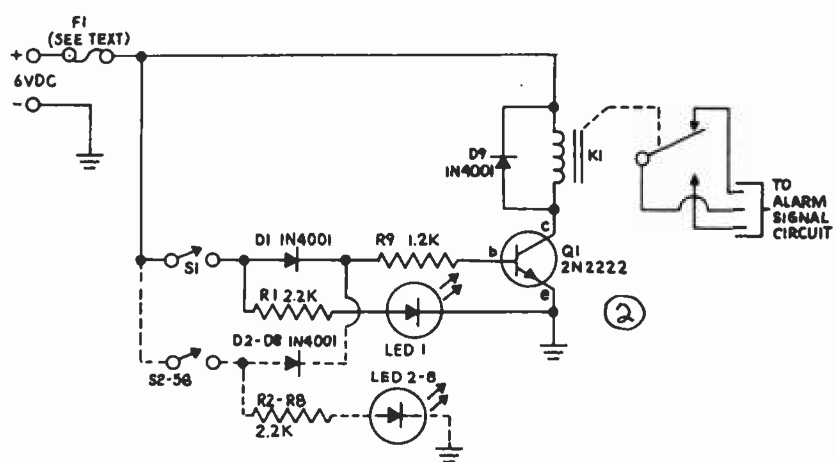
The relay circuit is activated by the +6 VDC. The relay contacts of K1 are completely isolated so that they may be used for any purpose. For example, 5-VDC relays seldom handle large currents, so relay K1 can be used to activate another relay that has a 117-VAC coil and whose contacts can handle 30 amperes. Now we have the possibility of a single transistor circuit being used to control the compressor of a 25,000 BTU air conditioner.

Except for the relay contact circuits, the wires and cables used to interconnect the signal-annunciator circuit need be of the caliber used in bell and telephone circuits. A ¼ to ½-ampere fuse is all that is required to protect the circuit. Actual value varies with the relay, NPN transistor and number of circuit signal legs used.

What if you need a ten-signal circuit, or maybe more? Most probably the transistor Q1 could handle it all, but should Q1 or K1 fail, all circuits would be down. It is a good idea to use another transistor and relay circuit after nine or more switch circuits are installed.

PARTS LIST FOR SIGNAL ANNUNCIATOR

D1-D9—1N4001 silicon rectifier diode
F1—¼ to ½-A fuse—select lowest permissable value
K1—5-VDC, SPDT relay (Radio Shack 275-215 or equiv.)
LED1-LED8—Light emitting diode, selected color, any lens type
Q1—2N2222 NPN silicon transistor
R1-R8—2,200-ohm, ¼-watt 10% resistor
R9—1.200-ohm, ¼-watt 10% resistor
S1-S8—Any type of SPST switch, usually with spring return for automatic reset—exact type optional with application



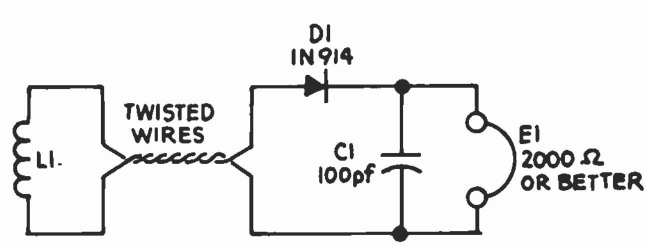
3. SIMPLIEST MODULATION MONITOR

How simple is simple? Then take a peek at the schematic diagram of the Simplest Modulation Monitor This simple monitor for AM ham transmitters requires no connection to the transmitter. Just position the loop near the final tank or antenna matching coil until the signal is heard in the headphones. In fact, if you live or work near a broadcast transmitting station, you could use this monitor as an inexpensive "Walkman." To be a bit more selective, you could replace L1 with an antenna coil from a transistor radio and tuning capacitor. One advantage of the circuit is that the batteries never run down—what batteries?

E1—Magnetic headphone, 2000 ohms or better
L1—Coil, 3 turns on 1-½-in. diameter form, use any thin gauge wire—add a few turns if necessary

PARTS LIST FOR SIMPLEST MODULATION MONITOR

C1—100-pF disc capacitor
D1—1N914 diode



4. SIMPLE XTAL AM RADIO

No matter how young or old you are, if you did not ever assemble a self-powered crystal radio, there's something lacking in your electronics hobbyist experience. This simple project can be put together in an hour, and will keep a 5 to 10 year old out of mischief for over a week—maybe launch the child onto a life-long hobby.

To begin, pick up some #22 or #24 enamelled wire from the local parts store. Chances are your junkbox doesn't have any. Then scrounge a 365-pF capacitor from an old tube-type radio and a germanium diode from an old project. Forget about a silicon diode—it's **inefficient** in this circuit!

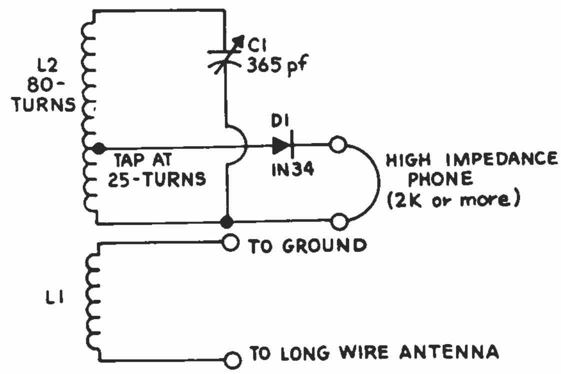
Wind the two coils, L1 and L2, on 1-7/8-in. diameter form. A wood dowel is OK, but you may have a pill bottle about that size. You'll need about 2-1/2-in. of length to hold the two coils. Wind the coils carefully, neatly, and with no space between each winding of the same coil. Keep about a one-turn space between the two coils. Wind L1 first, then wind L2 second. After the first 25 turns, tap the diode to L2 and finish the winding. It doesn't matter which terminal of the diode connects to the coil because diode D1 is the only polarized part in the project.

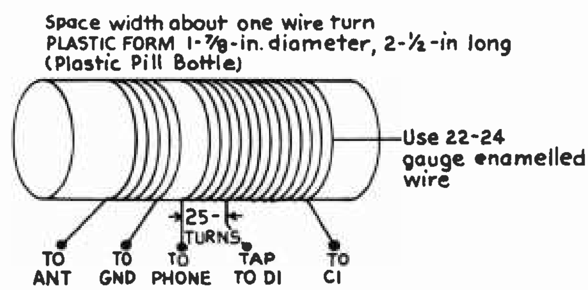
Be sure to use high-impedance headphones. The old 2000-ohm "cans" used by hams are the minimum impedance-type you can use. Crystal headphones are about the best. Do not use transistor radio ear-plug headphones since they are usually under 10 ohms.

Be sure to use a long-wire antenna. Run some wire across your roof or out to a tree. At least 25 to 100 feet are needed, not counting lead-in wire required for the antenna. 50,000-watt stations within 1000 miles may be heard. Local 10,000-watt local stations usually have a 50 to 100-mile effective range. Of course, if electrical noise is high in your area, weak stations will be swamped.

PARTS LIST FOR SIMPLE XTAL AM RADIO

C-1—365-pF variable tuning capacitor
D1—1N34 germanium diode, or any other germanium signal diode
L1—25-turns of #22 or #24 enamelled copper wire tight-wound on a 1-7/8-in. form.
L2—80-turns of #22 or #24 enamelled copper wire with tap at 25th turn nearest coil L1 on same form as coil L1
1—High-impedance headphone





5. SAWTOOTH SIGNAL GENERATOR

The sawtooth signal generator is very useful as a general-purpose source of audio test signals and sweep circuits. Here we have a basic UJT (unijunction transistor) oscillator, but instead of using a resistor to charge the timing capacitor, a transistor constant-current source (Q1) is employed instead. This results in a sawtooth that rises linearly as a function of time, since the capacitor's charging rate is constant. When a simple resistor is used to charge a capacitor, the waveform produced is curved like a shark fin, since the charging current falls off as the voltage on the capacitor increases.

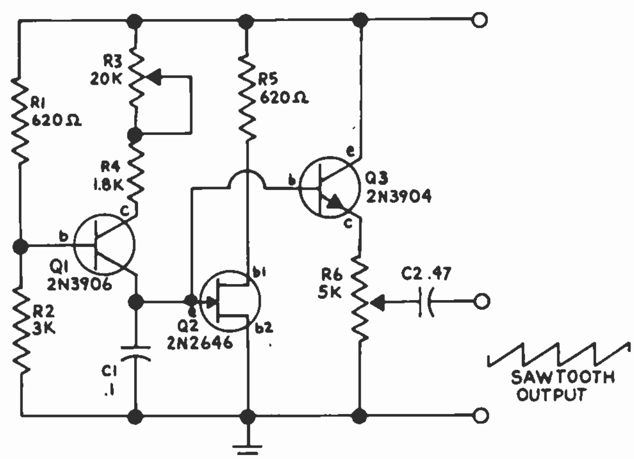
The charging current available from constant-current source transistor Q1 is adjustable by means of potentiometer R3. The higher the current, the faster C1 gets charged, and the higher the frequency of the resultant sawtooth voltage developed across the capacitor. Therefore, decreasing R3 increases the frequency. With the values shown, the generator's output frequency can be varied from roughly 100 to 1000 Hz.

Since unijunction Q2 breaks down and discharges capacitor C1 very quickly, we get a near-perfect sawtooth shape: slow, linear ascent, and rapid, vertical decline. Emitter follower Q3 acts as a buffer between C1 and whatever load you connect. Maximum peak-to-peak amplitude is roughly 6 volts, which level-control potentiometer R6 allows to be cut down to any convenient voltage level needed.

This circuit lends itself to gate-ramp circuits, and sweep circuits in oscilloscopes. Its applications grow as you get deeper into the hobby.

PARTS LISTS FOR SAWTOOTH SIGNAL GENERATOR

C1—.1-uF Mylar capacitor
C2—.47 uF Mylar capacitor
Q1—2N3906 PNP transistor
Q2—2N2646 unijunction transistor
Q3—2N3904 NPN transistor
R1, R5—620-ohm, ½-watt, 10% resistor
R2—3000-ohm, ½-watt, 10% resistor
R3—20,000-ohm trimmer potentiometer
R4—1800-ohm, ½-watt, 10% resistor
R6—5K audio-taper potentiometer



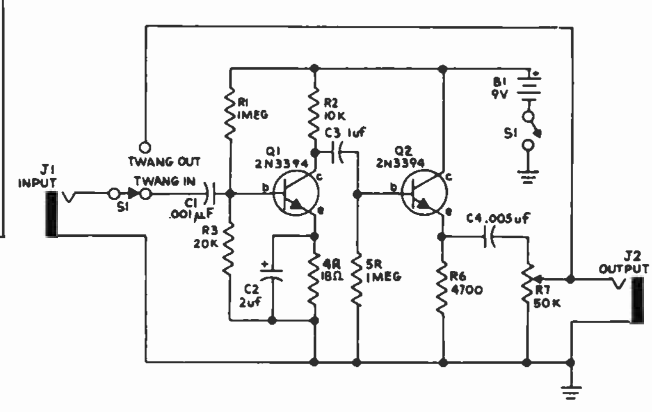
6. TWANG-TASTIC

When was the last time you heard the sound of a classical guitar? It seems no one cares for the sound of a plain, unadorned guitar. First they added fuzz, then big-boom bass, next it was reverberation and screaming highs. Now the in sound is **twang,** a guitar sound that more or less approximates a banjo or mandolin. Twang-Tastic produces these unusual sounds from an ordinary electric guitar by cutting the bass, severely distorting the midband and highs, and then amplifying the distortion. It might read "bad" to you, but it sure sounds good if you are under 30 years of age!

You can assemble the Twang-Tastic in any type of cabinet. Switch S1 cuts the twang effect in and out while switch S2 turns the unit on and off. Output control R7 should be set so the Twang-Tastic has the same volume level as the straight guitar feed-through. Various degrees of twang are obtained by varying the output so the guitar picks up with the level controls built into the guitar.

PARTS LIST FOR TWANG-TASTIC

B1—9-volt battery
C1—0.001-uF disc capacitor 25-WVDC or better
C2—2-uF electrolytic capacitor, 15- WVDC or better
C3—1-uF electrolytic capacitor, 15- WVDC or better
C4—0.005-uF disc capacitor, 15-WVDC or better
J1, J2—Phone jack, open circuit
Q1, Q2—NPN transistor, 2N3394
R1, R5—1 Megohm, ½-watt, 10%
R2—10,000-ohm, ½-watt, 10% resistor
R3—20,000-ohm, ½-watt, 5% resistor
R4—18-ohm, ½-watt, 10% resistor
R6—4700-ohm, ½-watt, 10% resistor
R7—50,000-ohm potentiometer
S1, S2—SPST switch, toggle or slidetype



7. BUDGET AUDIO WATTMETER

Most experimenters never buy an audio wattmeter. Use is usually limited to audio amplifiers and audio experimenting is on the wane. However, for those few times each year you work on an audio project, an audio wattmeter is invaluable! At those times, many experimenters connect an 8-ohm, high wattage resistor across the output terminals of the amplifier's output terminals, measure the output voltage, and then compute the wattage. Why go through all that trouble.

Here's an easy way to measure an amplifier's output power without trying to convert voltage to power measurements. Resistor R1 provides the load for your amplifier and should be rated at least twice the maximum amplifier power output; for example, if your amplifier puts out 25 watts, R1 should be rated at least 50 watts.

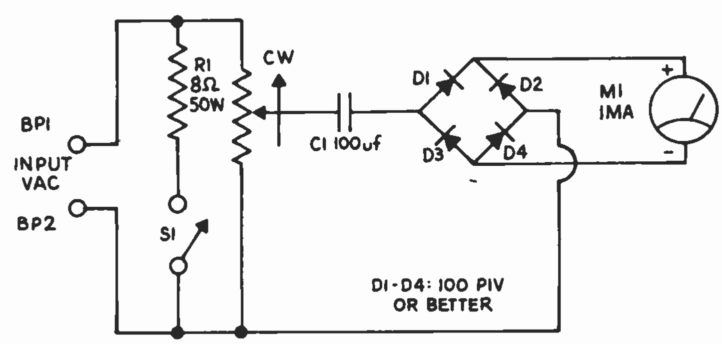
The meter scale must be hand calibrated, and will take some time and effort, but once done it's done for good. Remove the scale cover from meter M1 and borrow an AC variable autotransformer, or connect a 1000 Hz signal generator to the amplifier output. Only a sine-wave frequency source may be used. Connect the output of the autotransformer (or amplifier) to binding posts BP1 and BP2, and connect an AC voltmeter (VOM) across the binding posts. Set R2 to off—full counter-clockwise if correctly wired. This occurs when the wiper of R2 is at the bottom of R2 in the diagram. Adjust the autotransformer (or amplifier) output until the AC meter indicates 20 V rms—the voltage for 50 watts across 8 ohms. With R1 set correctly at the bottom terminal (at ground) meter M1 should not show any pointer movement.

Adjust potentiometer R2 for a full scale indication on meter M1. Seal R2's shaft with a drop of Glyptol or nail polish. Reduce the voltage across the binding posts in accordance with the table shown and mark the meter scale accordingly.

A hint: do not allow resistor R1 to heat up! Make all measurements quickly. As R1 gets warm, its value will begin to drift. Should you use several resistors to make R1 (to effect a high wattage rating) select half with a negative temperature coeefficient; the other half with a positive coefficient. Do not use a wire-wound resistor since it has an inductance and will upset your budget audio wattmeter reading.

PARTS LIST FOR BUDGET AUDIO WATTMETER

BP1, BP2—Insulated binding posts, one red, one black
C1—100 uF, 50 VDC non-polarized capacitor
D1, D2, D3, D4—A-A, 400-PIV diode
M1—0-1 mA DC meter
R1—8-ohm, 100-watt resistor, see text
R2—5000-ohm linear taper potentiometer



8. FIELD STRENGTH METER (FSM)

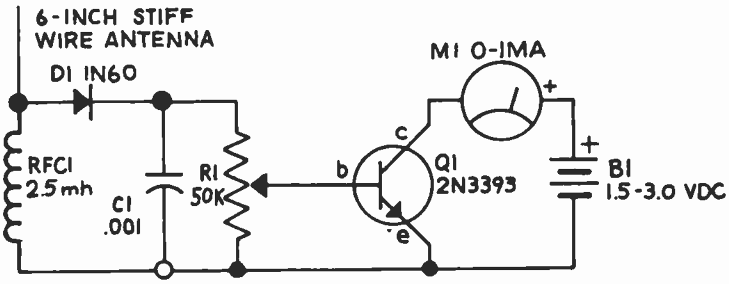
A kilowatt transmitter will pin the needle of regular FSMs (field strength meters) if used in the shack, but you need high sensitivity to get readings from low-power oscillators, flea power transmitters and CB walkie-talkies. This simple, amplified FSM has a sensitivity of 150 to 200 times that of ordinary models. It indicates full scale when other meters can't budge off the bottom pin.

Dependable frequency range is approximately 3 to 30 MHz. A metal enclosure is recommended, with a stiff wire antenna about 6-inches long. For compactness, RFC1 should be a miniature 2.5-mH choke.

To operate the unit, sensitivity control R1 is adjusted for 1/3 to 3/4-scale reading. Avoid working too close to the top of the scale, since it can saturate transistor Q1, producing full-scale readings at all times. Back off on R1 as you make transmitter adjustments to keep the needle at approximately half scale. Any high-gain NPN small-signal transistor can be substituted for the 2N3393 used for Q1. Should the meter read backwards or not move, try reversing diode D1—you may have connected it backwards!

PARTS LIST FOR FIELD STRENGTH METER

B1—1.5 to 3.0-VDC battery, use AA type
C1—0.001-uF disc capacitor
D1—1N60 (just about any germanium diode will do the job)
M1—0-1 mA DC meter
Q1—2N3393 NPN transistor or equivalent, see text
R1—50,000-ohm potentiometer
RFC1—2.5-mH choke—J.W. Miller 6302 or equivalent

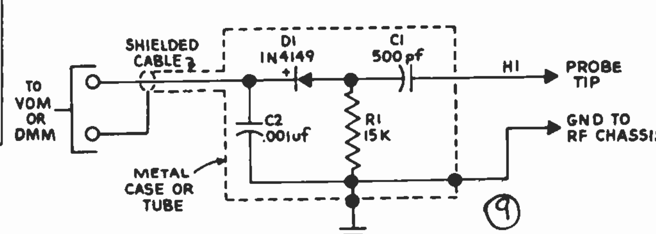


9. RF PROBE FOR VOM AND DDM

Make your first RF Probe now! Don't wait for a need because without it, a simple RF test or service task is a hit or miss proposition. Assemble the RF Probe in a metal can or tube, add a shielded cable and you'll make relative measurements of RF voltages to 200 MHz on a 20,000 ohms-per volt volt-ohm meter (VOM) and digital multimeter (DMM). RF voltage must not exceed approximately 100V, the breakdown rating of the 1N4149 diode.

PARTS LIST FOR RF PROBE FOR VOM AND DDM

C1—500-pF, 400-VDC capacitor
C2—.001-uF, disc capacitor
D1—1N4149 diode
R1—15,000-ohm, ½-watt, 10% resistor



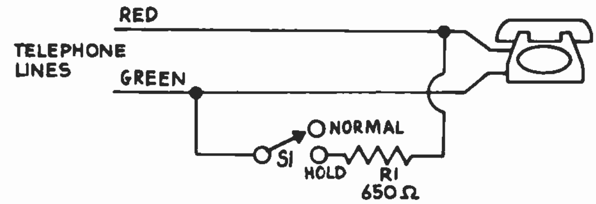
10. TELEPHONE HOLDUP

The holdup part of this project is made by the makers of telephones. The price of adding a hold feature to your telephone is only the cost of one ½-watt resistor and a SPST switch. If that's all there is to it, why didn't you add one to your phone a long time ago? Well, playing with phone circuits several years ago was like bugging the FBI—something you weren't to do. The telephone company liked it that way because they wanted to do it and get all the bucks. Today, you own the wiring in your home, not the telephone company; and you are probably thinking in terms of adding your own phones. Good idea. Now, if you wish, you can add a hold feature to your phone by placing a series switch and 650-ohm resistor across the line. Close the switch when you want to place the call on hold and open the switch when you want to talk again. With switch S1 closed you can hang the phone up on its receiver, but be sure to remove the phone before you open the switch or else you may accidentally hang up on the incoming call.

Remember, when the phone is left on hold, no one can call in and you can't call out. Also, only two of the lines that reach your telephone are really part of the phone line, and these are most often the red and green wires that are in the cable between your phone and the wall. Other wires in the cable may carry power for lighting your phone, or may carry nothing. Check carefully. Also understand that if you make a connection to the phone line that inhibits the phone company's ability to provide service, they have the right to disconnect you for as long as they like. This is a proven, simple circuit that should cause no difficulty.

PARTS LIST FOR TELEPHONE HOLDUP

R1—650-ohm, ½-watt, 5% resistor
S1—SPST toggle switch



11. BASIC OPTO-ISOLATOR

Here's a very simple opto-isolator circuit that you can build this evening. Its unique circuit character is that you can build it, understand it, and modify it to any special requirement you wish. It can ring an alarm whenever the mail is dropped in a slot. It can separate a battery circuit from the AC line providing remote installation without special circuits—bell wire will be good enough. It can be made to do just about anything your imagination will let you think up.

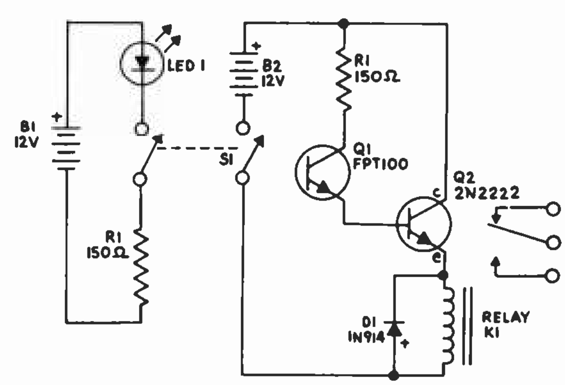
Whenever the phototransistor sees the LED's light, it pulls up the base of relay driver transistor Q2 and pulls in the relay. Stick something between LED1 and Q1 and the relay releases. D1 shunts out the relay's inductive kickback preventing distruction of transistor Q2.

If you point LED1 and Q1 in the same direction, they will act together as a reflective sensor. Then if anything comes close enough to bounce the light from LED1 back into Q1 (assuming both are kept in the dark—any light will trigger Q1), the relay will pull in. The circuit can also be used without R1 and LED1 as a light-or no light-operated alarm—but then we do not have an opto-isolator circuit. The LED1 circuit is powered by B1. The transistors are powered by B2, or they may be powered from the AC line via a DC voltage regulated circuit.

It doesn't take a quick mind to realize that should electrical isolation not be necessary, the circuit could be hooked up to only one battery and switch S1 would be a SPST switch.

PARTS LIST FOR BASIC OPTO-ISOLATOR

B1, B2—12-VDC battery
D1—Diode, 1N914 or equiv.
K1—SPDT relay, 12-VDC
LED1—Light emitting diode
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
R1—250 ohm, ½-watt, 10% resistor
R2—2700 ohm, ½-watt, 10% resistor
S1—DPST toggle switch



12. CELLAR TIDE INDICATOR

Cellars are no longer storage areas for castoff furniture, clothes, pots and pans, and other unwanted used items. Cellars have become playrooms, dens, extra living quarters, Ham shacks, workshops—useful and valuable space for just about every at-home activity. A lot of expensive building materials, furniture, electronic equipment and other family items can be damaged if a water pipe breaks or a washing machine valve or hose breaks. Additionally, should your sump pump fail, you may not know about it until you have an indoor swimming pool.

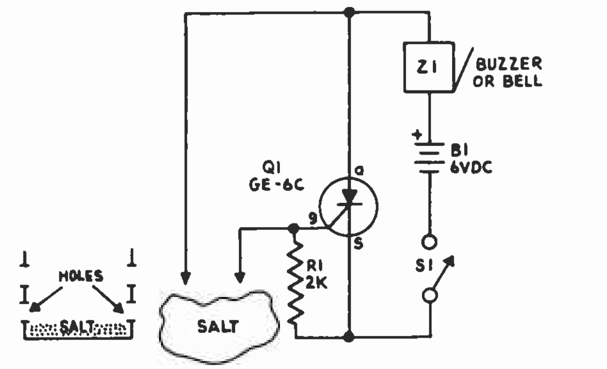
Jokingly we call it the Cellar Tide Indicator, when actually it is a water-level alarm. This alarm will warn you instantly of water flooding by sounding an alarm bell. When water mixes with a small pile of salt the resulting puddle shorts the probes, thereby applying a trigger to SCR1's gate. The SCR fires, closing the alarm buzzer or bell circuit. Any sensitive-gate SCR such as the GE C6 series can be used.

The salt can be placed in a small metal can about the size of a small ash tray. Drill a series of holes around the can as close as possible to the bottom. Secure the probes so they are suspended right above the salt. Any water flowing into the can will mix with the salt and cause a conducting puddle that will rise to the probes. The probes can be about ¼-in. of exposed solid insulated wire. The wires can be taped to the side of the can, just as long as the exposed tips don't contact the can.

Why use a 6-volt battery? Well, should you have a power failure or the fuse to the sump pump blows, you will be able to be alerted by a fail safe battery backup. While waiting for the alarm to go off, let's hope the tide stays permanently out!

PARTS LIST FOR CELLAR TIDE INDICATOR

B1—6-volt lantern or motorcycle battery
R1—2000-ohms, ½-watt, 10% resistor
S1—SPST switch
Q1—Silicon controlled rectifier, GE C6 10 volts PIV or higher (GE-C6 or equivalent)
Z1—6-volt alarm bell or buzzer (select a loud one)



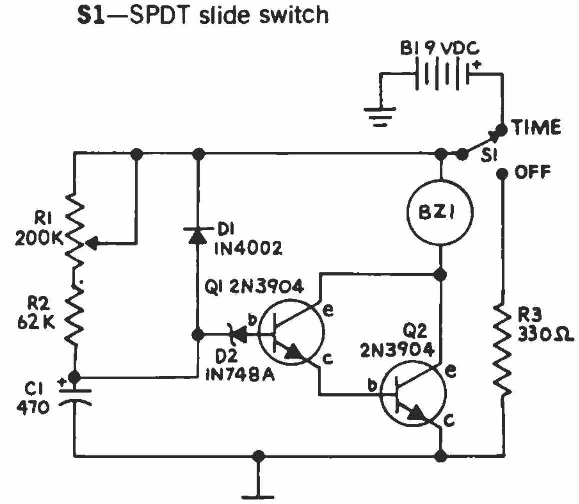
13. DELAY TIMER

Here is a useful delay timer circuit that little Tom Thumb would have approved of—it's small both in size and in cost. With S1 in contact with +9-V DC, capacitor C1 gradually charges through resistors R1 and R2. When the potential across C1 reaches 5.5-volts, base drive flows into the Q1-Q2 Darlington pair through Zener diode D2. This causes the transistors to conduct collector current and activate buzzer BZ1, a miniature, solid state device that emits a pleasant, shrill tone to signal the end of the timed interval. To reset the timer, flip S1 so that it contacts R3, which functions to discharge timing capacitor C1 through diode D1.

Using trimmer R1, you can adjust the timed interval to any value between 30 and 120-seconds. We use this timer to control the development of Polaroid instant films, but you can probably find dozens of other uses, too.

PARTS LIST FOR DELAY TIMER

B1—9-volt transistor battery
BZ1—9-VDC solid-state buzzer (Radio Shack 273-052)
C1—470-uF, 25-W VDC electrolytic capacitor
D1—1N4002 diode
D2—1N748A, 3.9-volt, ½-watt Zener diode
Q1, Q2—2N3904 NPN transistor
R1—200,000-ohm tripmer potentiometer
R2—62,000-ohm, ½-watt, 5% resistor
R3—330-ohm, ½-watt, 5% resistor
S1—SPDT slide switch



14. MIKE MIXER

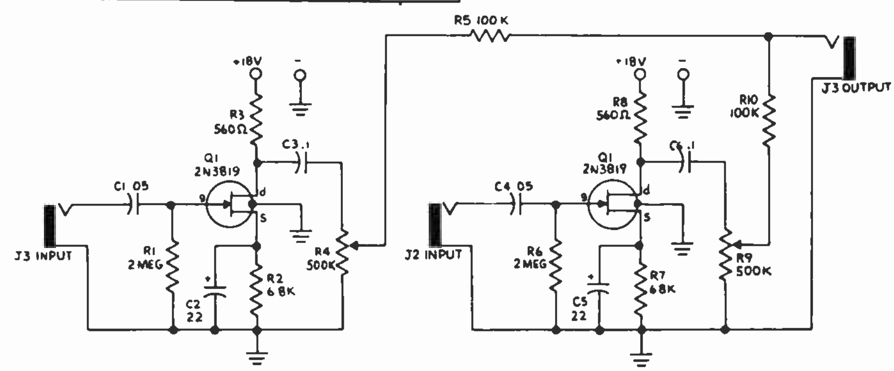
Very often you use one microphone too many for the amplifier system you own. And, if you are serious about sound recordings, take a look at our Mike Mixer. Our Hi-fi mike mixer does its mixing after amplification so the amplifiers compensate for the mixer loss first, thereby improving the signal-to-noise ratio as compared with simple mixers that mix first and amplify after the mixer.

Using FET semiconductors with their **high imput** impedance, this basic mixer can be used with high impedance crystal and ceramic microphones. It does not attenuate low frequency response whatsoever through low impedance loading of the microphone.The mixer's response is 1-to-20,000 Hertz.

Two mixers can be built into the same cabinet for stereo use. Even with two independent (stereo) mixers, current drain is on the order of a few milliamperes and two series-connected transistor 2U6-type batteries can be used.

PARTS LIST FOR MIKE MIXER

C3, C6—0.1-uF, 50-WVDC capacitor
Q1, Q2—2N3819 Field-effect transistor
R1, R6—2-megohm, ½-watt, 10% resistor
R2, R7—6800-ohm, ½-watt, 10% resistor
R3, R8—560-ohm, audio taper potentiometer
R5, R10—100,000-ohm, ½-watt, 10% resistor
C1, C4—0.05-uF, 50-WVDC capacitor
C2, C5—22-uF, 10-WVDC electrolytic capacitor

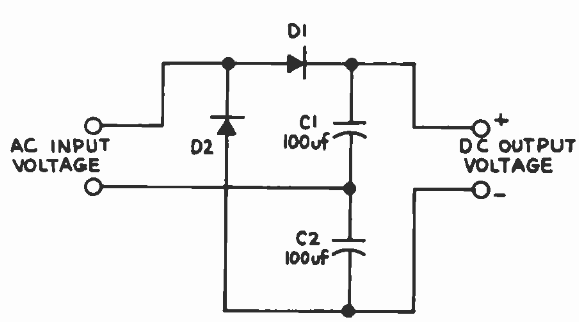


15. VOLTAGE DOUBLER

Very often the experimenter will need DC voltages higher than can be had rectified from the AC line or existing power transformers. Hence, the need for a voltage doubler. A peek at the circuit reveals that a DC charging loop passes through D1 and C1, and D2 and C2, during alternate half cycles of the alternating current. However, the DC load is connected across both charging capacitors effectively doubling the available rectified voltage. Capacitors C1 and C2 should be a minimum of 100-uF and rated at twice the DC output voltage. The larger the capacity, the greater will be the filtering.

PARTS LIST FOR VOLTAGE DOUBLER

C1, C2—100-uF electrolytic capacitor or larger, WVDC should be twice DC output voltage
D1, D2—500-milliampere (or larger) rectifying diode rated P1V at least twice DC output voltage



16. PHOTOFLOOD STRETCHER

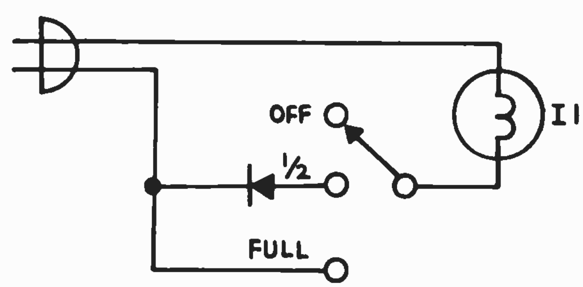
Flash units are very popular with photographers because of their speed, which allows action to be captured, and their portability. However, it's extremely difficult to visualize a shot with flash because the light appears only at the instant of exposure. High-intensity photofloods, on the other hand, are on continuously; therefore, the photographer can readily compose a shot, paying attention to details such as eveness of illumination across the field and shadow placement.

As the photofloods burn, however, they generate a great deal of heat, which can be discomforting both to the photographer and the subject. In addition, it's wasteful of the photoflood lamp's already limited lifetime (about 8 hours for an EBV No. 2) to have it on any longer than absolutely necessary. You can use this simple dimmer to cut down the lamp's intensity during composition, thereby reducing the heat generated and extending the lamp's useful life. With S1 in its middle position, power to the lamp is reduced about 40 percent because of rectifier D1. When you're ready to expose, flip S1 to full power. NOTE: On half-power, the lamp's color balance is shifted toward the red, so be careful not to make exposures at half-power with color film.

It is interesting to note that this same circuit can be used to extend the life of a ordinary tungsten bulb used in lamps and lighting fixtures. Diode D1 can be permanently installed holding the power level to about 60% of its rated value saving lots of watts and extending the lamps life. However, the lamp will glow dimmer than it would should the diode be removed. One suggestion is to increase the lamps power (which kills the watts savings) for more light with the bulbs extended life remaining practically the same as before.

PARTS LIST FOR PHOTOFLOOD STRETCHER

D1—1N5404 rectifier rated 400 PIV, 3-amps
I1—EBV No. 2 500-watt photoflood lamp
S1—single pole, 3-position switch with contacts rated 10-Amps, 120 VAC



17. SAWTOOTH OSCILLATOR

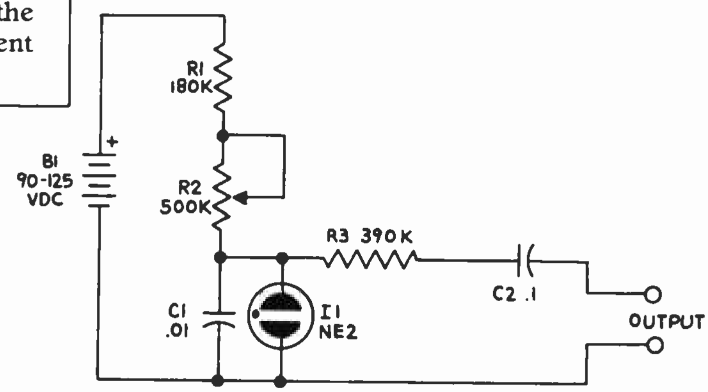
Here's a golden oldie of a circuit updated for today's electronics hobbiest. This unusual oscillator employs the firing and quenching characteristics of a gas-filled neon lamp as an electronic switch to charge and discharge capacitor C1. Originally the circuit was used for novel purposes. It provided a blinking light with no moving parts. Then, the switching rate was stepped up to the frequency of moving machinery to "stop" it by strobe action. Radio buffs use the sawtooth oscillator to generate RF harmonics that cover and go beyond the broadcast radio band.

Basically, a neon bulb consists of two electrodes surrounded by neon gas plus, if the lamp is intended for use in total darkness, a small quantity of radioactive material is added to one of the electrodes inside the glass bulb. Radiation serves to partially ionize the neon gas. Bulbs designed to operate in room light will have their neon gas partially ionized by ambient electromagnetic radiation; therefore, no radioactive material need be added.

So little of the neon gas is ionized initially that, for all practical purposes, the neon lamp behaves electrically like a very high resistance. However, if the voltage between its electrodes is raised sufficiently high, the neon gas within the lamp will ionize completely. This causes the lamp to revert to a low-resistance state and glow with a bright orange color. To turn the lamp off, the voltage across its electrodes must drop several volts below the potential that originally triggered the lamp. The rise of the voltage across C1 does not happen suddenly—actually, the voltage rises up at a fixed rate determined by the time constant R x C where R is the total resistance of R1 and R2 in ohms and C is the capacitance in farads. The fall time is caused by I1 firing causing a short circuit across C1 causing the voltage to drop almost instantly. To cause the sawtooth period to be shortened, decrease the value of either C or R, or both. Contrarywise, increase the resistance or capacitance and the period of the sawtooth will increase, effectively lowering the repitition rate or frequency of the sawtooth oscillator. In the sawtooth oscillator circuit shown here, C1 charges through R1 and R2 to a potential of roughly 65 volts. At this point, the neon lamp fires and discharges C1. As the voltage drops below a voltage level, the neon lamp reverts to a high impedance, which allows C1 to charge once again. The frequency of the sawtooth-shaped oscillation developed once again. The frequency of the sawtooth-shaped oscillation developed across C1 can be adjusted by means of R1. As a final note, beware of the high voltages present in this circuit. Also, never reduce the value of R1 below 180,000 ohms. It serves to current flowing through the NE2.

PARTS LIST FOR SAWTOOTH OSCILLATOR

C1—.01-uF, 250V Mylar capacitor
C2—.1-uF, 250V Mylar capacitor
I1—NE2 neon lamp
R1—180,000-ohm, ½-watt, 10% resistor
R2—500,000-ohm linear-taper pot
R3—390,000-ohm, ½-watt, 10% resistor



18. TONE TESTER

The basic circuit of the Tone Tester is a Harley oscillator whose tone is determined by the setting of R2. Just about any wiring or layout will work, but audio output transformer T1 must be the type used in table radios. A miniature transistor transformer might not oscillate, or if it does, will produce only "clean" high tones, with no raucous or low frequency tones.

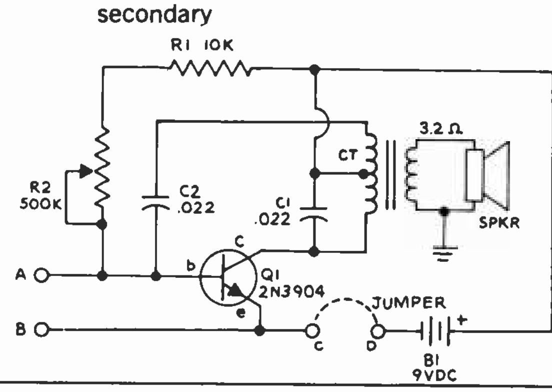
For code practice oscillator (CPO) operation connect a hand key across points C and D. For a "make" intruder alarm, connect one or more normally open magnetic switches across points C and D. For a "break" intruder alarm connect a jumper across C and D and connect a series wire circuit across A and B, which disables the oscillator though power is applied. An intruder breaking the series circuit, or a normally closed magnetic switch, causes the alarm to sound off.

For use as a signal generator, connect C and D and attach a shielded test signal lead directly across the speaker terminals.

Service Note: If the Tone Tester fails to oscillate, generally due to transistor differences, change C2's value slightly.

PARTS LIST FOR TONE TESTER

B1—9-V battery
C1, C2—0.022-uF, 25-VDC capacitor
Q1—2N3904 NPN transistor
R1—10,000-ohm, ½ watt resistor
R2—500,000-ohm pot
Spkr—3.2-ohm speaker
T1—Output transformer: 5000-ohm, center-tapped primary to 3.2-ohm secondary



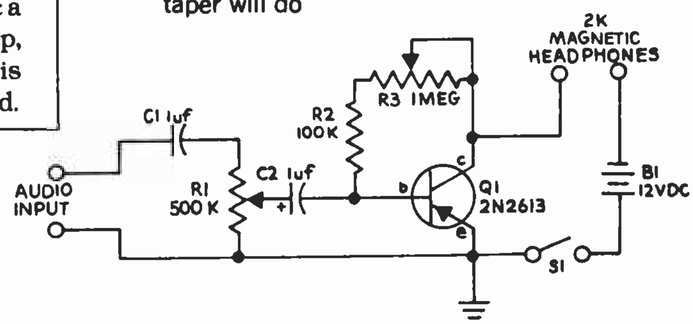
19. HI-Z 'PHONE BOOSTER

Quite often the audio output from small, home-brew projects is just barely sufficient to produce a recognizable signal in standard experimenter magnetic earphones. Yet a handful of surplus components will provide enough gain to turn that whisper sound into a roar.

Specifically intended for use with magnetic earphones of from 1000 to 5000 ohms impedance, the HI-Z 'Phone Booster can do double-duty as an audio signal tracer. Transistor Q1 can be any PNP of the 2N2613 variety. Even the 10-for-a-buck kind will work. Volume control R1 should have an audio taper. Distortion control R3 can have any taper. Make certain C2's polarity is correct; the positive terminal connects to volume control R1 (wiper terminal). Adjust distortion control R3 for best sound quality. If you use a jack and plug to connect your headphones to this amp, you can eliminate on-off switch S1 because power is removed whenever the headphones are disconnected.

PARTS LIST FOR HI-Z 'PHONE BOOSTER

B1—Battery, 12 volts (two RCA VS068 in series or equivalent)
C1—0.1-uF capacitor, 15-WVDC or better
C2—1-uF electrolytic capacitor, 15-WVDC or better
Q1—PNP transistor, 2N2613 or equivalent
R1—500,000-ohm audio taper potentiometer
R2—100,000-ohm, ½-watt, 10% resistor
R3-1 . Megohm potentiometer, any taper will do

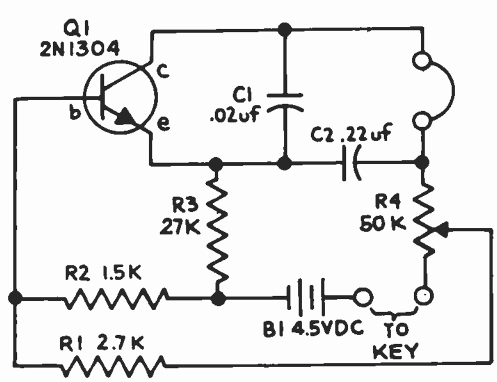


20. CODE PRACTICE OSCILLATOR

What could be cheaper than assembling a Code Practice Oscillator (CPO) from parts laying about the workbench or junkbox. Using component values given, the tone frequency is approximately 800 Hz. It can be changed by substituting different values for C1 and C2, but maintain the same capacity ratio. That is, C2 should always be about 10 times larger than C1. Battery current drain is only about 1 milliampere. Transitor Q1 is an NPN germanium type and almost any replacement for it will work in the circuit.

PARTS LIST FOR CODE PRACTICE OSCILLATOR

B1—4.5-V battery
C1—0.02-uF, 10-WVDC capacitor
C2—0.22-uF, 10-WVDC capacitor
E1—2000-ohm magnetic earphone
Q1—2N1304 NPN transistor or equivalent
R1—2700-ohm, ½-watt, 10% resistor
R3—1500-ohm, ½-watt, 10% resistor
R4—50,000-ohm potentiometer



21. BASIC BURGLAR ALARM

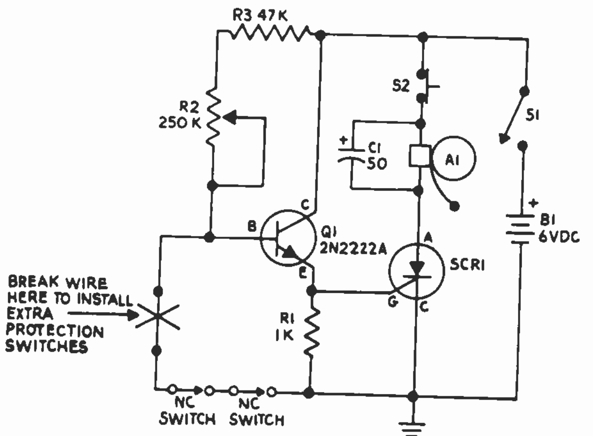
Almost without exception, professional burglar alarms are the so-called "supervised" type, meaning a closed circuit loop in which current, no matter how low a value, always flows so that cutting any of the wiring causes the alarm to sound. Early closed circuit alarms were entirely relay operated, and a high resistance which developed anywhere in the circuit usually caused the alarm to false-trip, which always seem to happen in the wee hours of the morning. Solid-state supervised circuits, such as this Basic Burglar Alarm, are relatively insensitive to the high resistance developed in contacts through normal aging.

The switches shown as "N.C. (normally closed) Switch" can be any normally closed or continuous device, such as window foil. Battery B1 is a 6-volt lantern battery which will give service for almost as long as its shelf-life because the continuous current drain is only about 100 A. Once the alarm is tripped, it can be turned off only by opening master power switch S1, or "bell stop" PB1, a normally-closed pushbutton switch. (Both switches should be concealed.)

To adjust: Open the protective circuit. While measuring the voltage across R1, advance R2 so the meter reading rises from zero towards 1-volt. At less than 1-volt, the alarm bell should trip. If it doesn't, you have made an assembly error. Finally adjust R2 for a 1-volt reading, disconnect the meter and restore the protective circuit.

PARTS LIST FOR BASIC BURGLAR ALARM

A1—6-VDC alarm bell or siren
B1—6-volt lantern battery
C1—50-uF, 6-WVDC electrolytic capacitor
Q1—2N2222A NPN transistor or equivalent
R1—1,000-ohm, ½-watt, 10% resistor
R2—250,000-ohm linear taper potentiometer
R3—47,000-ohm, ½-watt, 10% resistor
SCR1—GEMR-5 silicon controlled rectifier
S1—SPST switch
S2—SPST normally-closed pushbutton switch

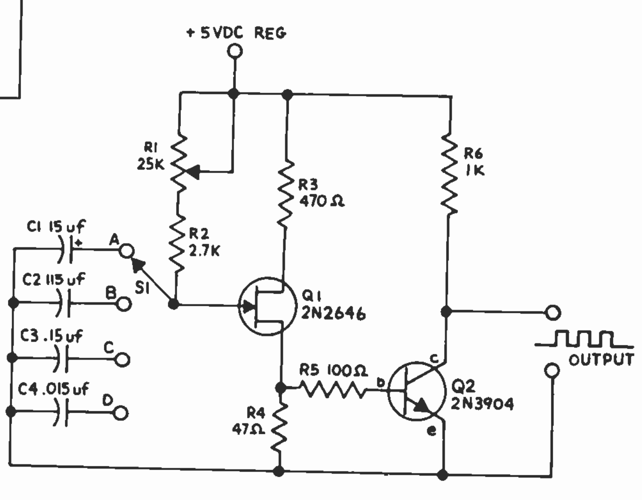


22. VARIABLE CLOCK FOR TTL AND CMOS

Here is a simple Variable Clock or pulse generator that can be useful in a variety of applications, from audio to logic. The heart of the circuit is the familiar UJT (unijuction transistor) relaxation oscillator, Q1. Potentiometer R1 adjusts the repetition rate over a range of one decade, while range switch S1 allows selection of one of four decade ranges. The total range of adjustment goes from 0.5 ppSec (pulses per second) to 5000 ppSec., which is more than enough for most purposes. Voltage spikes across resistor R4 are amplified and "squared up" by transistor Q2. The

PARTS LIST FOR VARIABLE CLOCK FOR TTL AND CMOS

C1—15-uF, 10-WVDC tantalum capacitor
C2—1.5-uF, 25-WVDC non-polarized mylar capacitor
C3—0.15-uF, 25-WVDC mylar capacitor
C4—0.015-uF, 25-WVDC mylar capacitor
Q1—2N2646 unijunction transistor
Q2—2N3904 NPN transistor
NOTE: All fixed resistors rated ½-watt, 5% tolerance unless otherwise noted
R1—25,000-ohm linear-taper potentiometer
R2—2,700-ohms resistor
R3—470-ohms resistor
R4—47-ohms resistor
R5—100-ohms resistor
R6—1,000-ohms resistor
S1—single pole, 4-position rotary switch



output consists of 5-volt-high pulses that may be used to drive TTl, CMOS or an audio circuit (in which case, you can couple the pulses through a 1.0-uF capacitor).

Range "A" setting of switch S1 is slow enough to be useful when breadboarding logic circuitry, since slow clocking allows you to observe circuit operation easily. If you attach a wire lead to the output and set S1 to range "D", you can generate harmonics up to several MHz.

23. 100 KHZ MARKER

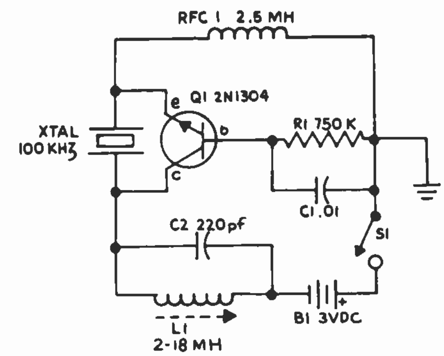
If you don't have 100-kHz Marker built into your shortwave receiver, you're no different than 95% of the others in your SWL hobby. Few shortwave receivers below the deluxe class have really accurate dial calibration. But with a 100-kHz frequency standard like our Marker, you'll know with great precision where the receiver is tuned.

The 100-kHz Marker is a common-base oscillator producing sufficient signal through the air if constructed in a plastic cabinet. with a metal cabinet, a short antenna approximately 12-in. long should be connected to Q1's collector through a 50-pF capacitor. In some instances the antenna will have to be connected to the receiver antenna terminal.

Wiring is not critical and almost any layout will work. If the oscillator doesn't start, change R2's value by approximately 20% until you get consistent oscillator operation. If you want to zero beat the crystal against station WWV, install a 50-pF trimmer in series or in apallel with the crystal. Use which ever connection works since the specific crystal type determines the series or parallel connection. Now that you know where you are, good DXing.

PARTS LIST FOR
100-kHz MARKER

B1—Two 1.5-V AAA batteries
C1—0.01-uF, 10-WVDC capacitor
C2—220-pF silver mica capacitor
L1—Coil, 2-18 mH
Q1—2N1304 NPN transistor
R1—750,000-ohm, ½-watt, 10% resistor
RFC1—2.5 mH RF choke
S1—SPST switch
XTAL—100-kHz crystal



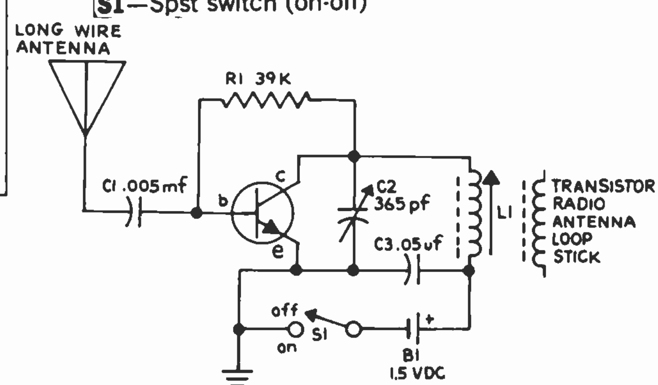
24. RF-BCD BOOSTER

Pep up the transistor radio by adding a RF stage and couple the boosted BCB signal to the receivers built-in antenna loop. The RF-BCB is a low cost project that can pack a lot of extra sensitivity into an ordinary transistor pocket radio. You'll be able to do some extensive broadcast band DX'ing with that pocket portable the bank gave you when you opened an account.

Assemble the unit in a small plastic cabinet with coil L cemented to the side or back of the cabinet; use an adhesive such as General Electric's RTV. Connect from 10 to 80 feet of antenna wire to the input, and position

PARTS LIST FOR
RF-BCB BOOSTER

B1—15-volt penlight AA battery
C1—0.005-uF disc capacitor, 25 VDC or better
C2—365-pF miniature tuning
C3—0.05-uF disc capacitor, 25 VDC or better
L1—Loopstick for C1
Q1—2N1304 NPN transistor
R1—39,000-ohm, ½-watt resistor
S1—Spst switch (on-off)



this pocket booster flat against the radio with L1 directly behind the loopstick antenna built into the radio. Tune capacitor C2 to the approximate frequency you want to receive, then turn on the radio and listen to the signals boom in. Keep in mind that the receiver's normal AVC action will mask any boost applied to strong signals. Hetrodyning will increase as more and more signals become strong enough to hear.

25. MERCURY TILT ALARM

Build this simple circuit and you'll have a device which can serve as a luggage or test equipment theft alarm, or just a fun thing. To protect your portable items from snatchers who'll tote it away when you turn your back, install the Mercury Tilt Alarm. Switch S3 can be artfully hidden so that you could disable the circuit when you move the packaged valuable about.

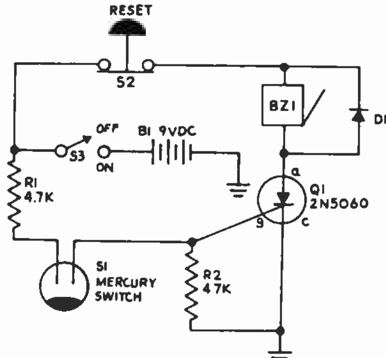
In the schematic diagram, mercury switch S1 is normally open. However, should the equipment in which the alarm has been installed be picked up and tilted, S1 closes and thereby supplies gate current to the SCR. Q1 then latches in a conducting state; causing current to flow through buzzer BZ1. The buzzer will sound until pushbutton S2 is pushed to reset the circuit. For best results, use an electromechanical, rather than piezoelectronic buzzer, since it will emit more noise. As for S2, be sure it is artfully hidden also.

The Mercury Tilt Alarm can be made to fit inside a small plastic box so that it will fit inside a coat. Hang your coat in a restaurant knowing full well should the alarm go off, the thief would drop it and take off.

The circuit will function on 6, 9 or 12-volts DC. So use what is best for your purposes. Be sure BZ1 matches the battery it uses.

PARTS LIST FOR MERCURY TILT ALARM

B1—9-volt battery
BZ1—9-volt buzzer
D1—1N4002 diode
Q1—2N5060 SCR
R1, R2—4,700-ohm, ½-watt, 10% resistor
S1—Normally-open mercury switch
S2—Normally-closed pushbutton switch
S3—SPST toggle switch

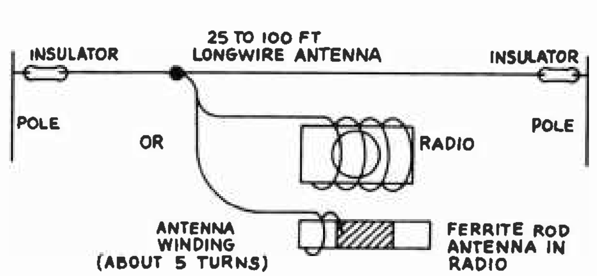


26. PASSIVE BC BOOSTER

Your pocket transistor radio antenna system is designed to pull in local broadcast-band stations that are either local or very high power—you need a signal with oomph! Now, you could make that "one lunger" more sensitive and try some DX with the Passive BC Booster. Also, for those people who work in, or live in, buildings that effectively kill BC signals, the Passive BC Booster can bring life to that transistor radio that could only detect the noise from flourescent lamps.

All you have to do is simply bring in the end of an outdoor "longwire" antenna and wrap the end around the radio about 5 times.

Even better reception is possible if you open the radio and wrap about 5 turns around the rod antenna immediately adjacent to the antenna coil mounted on the rod. Make certain the ends of the outdoor antenna are insulated with glass or ceramic insulators. In fact, very often an insulated wire about 10-to 20-feet long that is left dangling out a high-story window is all that is needed for an antenna.



27. RADIO OP'S SPEAKER SQUELCH

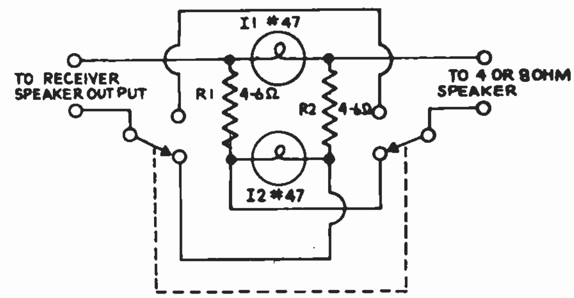
During the Big II—that's World War II—ship-board radio operators were required to man the radio shack 24 hours a day forever listening to the frequencies used by ships at sea. Using receivers with squelch circuits as we have today, their ears and nerves were shattered after a few days of 4 hours on and 8 hours off. It didn't take long for all ships at sea to install the Radio Op's Speaker Squelch circuit in the loudspeaker circuit.

Just a couple of *47 pilot lamps scrounged from old tube radios and two resistors are all that's needed to squelch your broadcast or shortwave receiver. And if you can't scrounge the lamps, they're available at just about every radio parts distributor and service shop. Switch S1 is needed onto bypass the squelch for very weak signals.

In many instances, the Radio Op's Speaker Squelch circuit will provide a basic attenuation of the noise background, not complete squelch, considering the low cost and ease of construction. Just about any enclosure, plastic or metal, can be used. One tip is to use ordinary stand-off terminals and mount them on the loudspeaker mounting screws. The switch can be located on the speaker cabinet or on the side of the receiver.

PARTS LIST FOR RADIO OP'S SPEAKER SQUELCH

11, 12—#47 pilot lamp
R1, R2—4 to 6-ohm, 1-watt, 10% resistor
S1—Dpdt switch



28. TELEPHONE TURKEY CALLER

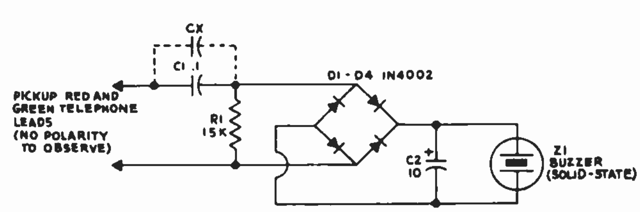
After you have installed 14 telephones in your home, each with its own ringer, one incoming phone call can shatter the nerves of the strongest of individuals. Also, the net ringer equivalent exceeds the telephone company's limit by a magnitude or two. So, start disconnecting ringers which is easy to do—remove the yellow lead in the phone. Still, to reduce the total ringer equivalent down to your local's equivalent may severely limit signaling in all corners of the house including the garage and basement. That's where the Telephone Turkey Caller comes in! It's ringer equivalent is mighty low, it'll let you know the phone is ringing, and it'll not rattle your nerves.

The approximately 20-Hertz ringing current that comes down the phone line passes through C1 and R1. The diode bridge, D1-D4, rectifies this current and jolts solid-state buzzer, Z1, into action. Capacitor C2 smoothes out the pulsating DC to take some of the sharpness out of the sound of Z1.

Capacitor CX is added to C1 in parallel—in effect, algebraically summating the total effective capacitance. As C1 is made larger, the buzzer will be louder, but you will get "kickbacks" or loud clicks whenever anyone is dialing on a rotary phone. This is not a problem with touch-tone lines, but you can hear static bursts.

PARTS LIST FOR TELEPHONE TURKEY CALLER

C1—.1-uF, 500-WVDC Mylar capacitor
C2—10-uf, 25-WVDC electrolytic capacitor
CX—See text
D1-D4—1N4002 silicon rectifier diodes (substituted parts must be rated at 200-PIV or better)
R1—1500-ohm, ½-watt, 10% resistor
Z1—Solid-state buzzer (Radio Shack 273-060)



Increase the value of C1-CX slowly until you get the performance you want. Whatever you do, do not exceed a total of .47 uF.

Capacitor C2 will produce a smoothe, non-pulsating DC if it is too large. If it is too small, you will hear low-level ticks instead of chirps.

So, part values are critical. Stick to those recommended in the Parts List and only make slight value modifications should the sound not be to your liking.

29. HARMONIC BUSTING GENERATOR

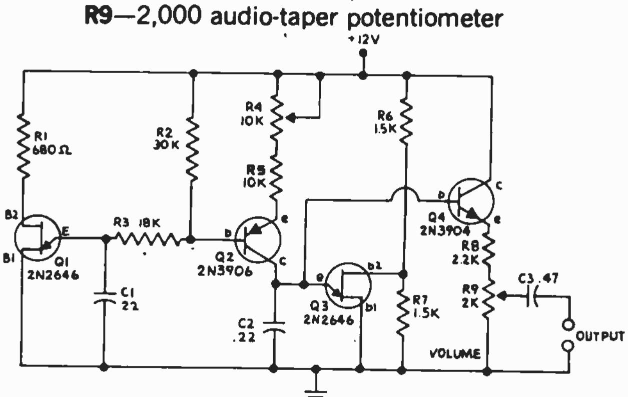
No one wants to listen to noise, but at times it has useful purposes such as alerting people and animals to a dangerous situation. Yes, animals react to sound, and an obnoxious noise will drive a house pet from a room when a situation is dangerous, like prior to turning on a power saw or grass mower. And the last thing you'd want to do is lock anyone in a building for the weekend. The tone starts out at a relatively high pitch which, over a period of about one second, swoops downward in frequency. Then, the signal jumps abruptly to its initial pitch and commences its downward plunge once more. The effect is approximately as pleasant as running your nails over a blackboard, and as such it will get people's attention—if not their admiration.

Transistor Q1 together with resistors R1, R2, R3 and capacitor C1 comprise a conventional UJT (unijunction transistor) relaxation oscillator with a period of approximately one second. The roughly sawtoothed voltage developed across C1 drives current source Q2, the output of which charges capacitor C2. Adjustment of potentiometer R4 affects the magnitude of the current and, hence, the rate at which capacitor C2 charges. Unijunction transistor Q3 discharges C2 when the voltage on the capacitor reaches 4.2 volts, or so. The rate at which the voltage on the capacitor reaches 4.2 volts, or so. The rate at which the voltage on C2 oscillates is in the audio range and is much faster than that of the waveform developed across C1.

After C2's discharge, the capacitor once again gets charged up by current from Q2. Since Q2's charging current is a function of the voltage across C1, the rate at which C2 charges will vary (in fact, diminish) over the 1-second interval it takes for C1 to charge. Once Q1 discharges C1, Q2's charging current returns to a high value, and the frequency of the sawtooth waveform across C2 jumps back to its initial high value.

Emitter follower Q4 reads the signal developed on C2 and provides a buffered audio output with a maximum peak-to-peak amplitude of about 1-volt. Volume potentiometer R9 can be used to vary the magnitude of the output, which should drive an audio amplifier through its high-level input. Because of its rich output, do not overdrive the loudspeaker system else the tweeter section overheat!

C1—22-uF, 25V electrolytic capacitor
C2—.22 uF Mylar capacitor
C3—.47-uF Mylar capacitor
Q1, Q3—2N2646 unijunction transistor
Q2—2N3906 PNP transistor
Q4—2N3904 NPN transistor
R1—680-ohm, ½-watt, 10% resistor
R2—30,000-ohm, ½-watt, 10% resistor
R3—18,000-ohm, ½watt, 10% resistor
R4—10,000 trimmer potentiometer
R5—10,000-ohm, ½-watt, 10% resistor
R6, R7—1,500-ohm, ½-watt, 10% resistor
R8—2,200-ohm, ½-watt, 10% resistor
R9—2,000 audio-taper potentiometer

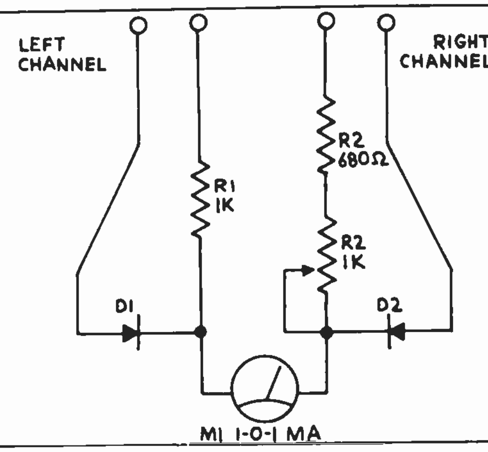


30. BALANCE TESTER FOR AUDIO

Trust your ears all the time and you may be in trouble. Recently the author returned from a 30 minute car trip driven by him with the window open. Upon entering his home he turned on his stereo system only to discover that the left channel was low. A quick balance control adjustment corrected that, or at least he thought it did. A half hour later he discovered that the right channel was low and made the adjustment realizing that he returned

PARTS LIST FOR BALANCE TESTER FOR AUDIO

D1, D2—Silicon diode rectifier rated at 100 PIV at any low current
M1—Zero-centered, DC milliampere meter—any inexpensive type
R1—1000-ohm, ½-watt, 10% resistor
R2a—680-ohm, ½-watt, 10% resistor
R2b—1000-ohm potentiometer



the amplifier to its original setting. What was wrong? Were his ears deceiving him? Driving with the car window open in the auto somehow dulled the sensing ability to handle a simple audio balance adjustment. Simply put, our author suffered from temporary hearing insensitivity.

To avoid his problem, and the problem experienced by others who have hearing loss, the audio balancing tester was created for just this purpose. Essentially, the tester's circuit senses and rectifies a small portion of the signal sent to the loudspeakers by the audio stereo amplifier. When the tester's meter, a zero-center type, is centered at zero, the output to the speakers is balanced. Normally, resistor R2a and R2b should be one 1000-ohm resistor so that both halves of the circuit are identical and balance. However, not all speakers, even matched pairs produce equal outputs. The cause usually is a combination of losses due to reduced gain in one stage of the amplifier, one set of speaker leads are much longer, the speakers age differently, the speaker positioning in the room causes more attenuation for one speaker than another, and a few other reasons. So, R2 was split in two and made adjustable. The method for adjusting R2b is simple, provided you can get the assistance of several friends. With their eyes closed, let them point to the source of the sound from the speakers when playing monophonic music while blindfolded. Mono music will seem to come from one source point. When several people point to the same point in the midsection of the speaker placement, the meter is adjusted for zero indication.

You may want to mark the point on the setting of R2b where R2a and R2b add up to 1000-ohms so that you could use the unit as a portable test instrument for other stereo systems.

Remember to test the balance of a system with a monophonic music source. Also, you can leave the unit in the circuit and let it monitor stereo output on a relative basis. You'll be surprised how stereo programming in some recordings is extremely separated and in others it is not.

31. DISCRETE FREQUENCY DIVIDER

When you want to reduce or divide the input frequency pulses by a predetermined amount, most hobbyists turn to their TTL or CMOS cookbooks seeking a chip that'll do the job. Well, here's a circuit that divides frequency using almost as few parts as a one chip circuit and doing it with discrete semiconductors. As such, it is a bit more flexible in application than a "chip" circuit.

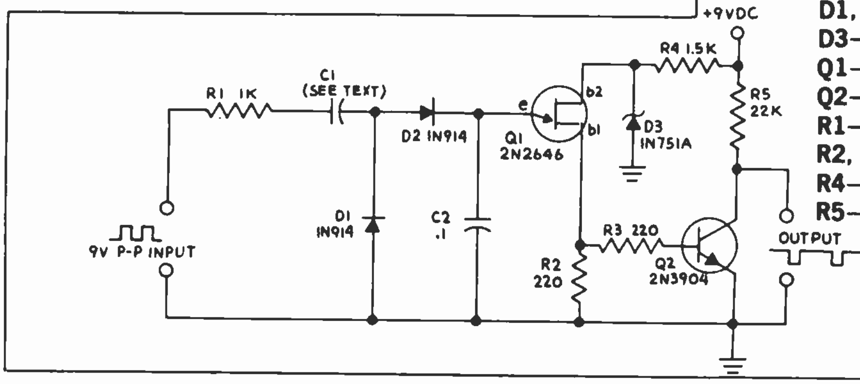
Capacitors C1 and C2 together with diodes D1 and D2 constitute a simple **charge pump,** which feeds the emitter of a unijunction transistor, Q1. Normally, C1 is chosen to be smaller than C2, and in this circuit values of C1 between .02 and .1 microfarads should be satisfactory. With each positive-going transition of the digital input signal, C1 transfers a small amount of charge to C2, which acts as a reservoir. This accumulated electronic charge is prevented from leaking away by D2. As successive input pulses transfer more and more charge to C2, the voltage across C2 naturally rises.

Eventually, the voltage on C2 will become high enough to cause Q1's emitter to break down and discharge C2 through R2. When this happens, Q2 amplifies and inverts the voltage pulse appearing across R2. This amplified pulse may then be used to clock a subsequent circuit. Transistor Q1's emitter reverts to ahigh-impedance state once again after C2 has been discharged. Thus, the whole process can repeat itself.

The ratio of C2 to C1 will determine the number of positive-going input pulses needed to accumulate the necessary threshold potential on C2. With C2 equal to C1, the frequency will be divided by a factor of 1. The higher the C2:C1 ratio, the more input pulses needed and, as a result, the greater the frequency division obtained. This circuit is sensitive to the magnitude of its input pulses, so keep the input amplitude at 9 volts, or thereabouts. Satisfactory performance with input signals as high as 10 kHz will be obtained with the parts listed.

PARTS LIST FOR DISCRETE FREQUENCY DIVIDER

C1—.02 to .1-uF (see text)
C2—.1-uF, Mylar capacitor
D1, D2—1N914 silicon signal diode
D3—1N751A, 5.1V, ½W Zener diode
Q1—2N2646 unijunction transistor
Q2—2N3904 NPN transistor
R1—1,000-ohm, ½-watt, 10% resistor
R2, R3—220-ohm, ½-watt, 10% resistor
R4—1,500-ohm, ½-watt, 10% resistor
R5—22,000-ohm, ½-watt, 10% resistor



32. MAGIC TV KEY

There are times when the children should not be watching television. We all know that, but how can we secure the TV set in a secretive way? Well, with the Magic TV Key you could turn the receiver on and off secretly using a permanent magnet.

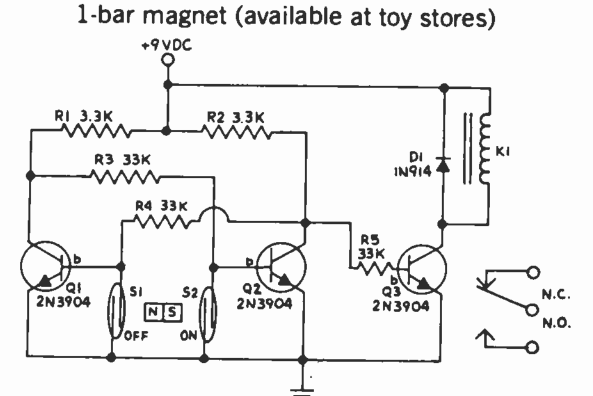
Bring your magnet close to S2, and the reed switch will close. This shunts all current away from transistor Q2's base and sends its collector potential high. As a result, base drive is available for Q1 and Q3. Transistor Q3 obliges by conducting and thereby causing relay K1's N.O. (normally open) contacts to close. Q1 conducts too, and this sends Q1's collector to ground potential. Therfore, when you remove your magnet from S2, Q2 remains latched in a non-conducting state, since Q1's collector is low.

Now, suppose you approach S1 with your magnet. Once the reed switch closes, it shunts base current from Q1, thus causing Q1's collector potential to go high. As a result, Q2 receives base current that causes it to conduct, which sends its collector to ground potential. This removes base drive from Q3, so relay K1 is no longer energized. When you remove your Magic Key magnet, the circuit remains latched in this OFF condition, since Q2's grounded collector cannot supply base current to transistor Q1.

Diode D1, a 1N914 silicon diode shorts out the high-voltage inductive kick developed by relay K1's coil when Q3 cuts off. In effect, D1 extends the life of Q3.

PARTS LIST FOR MAGIC TV KEY

D1—1N914 silicon diode
K1—6-volt, 500-ohm relay
Q1, Q2, Q3—2N3904 NPN transistors
R1, R2—3300-ohm, ½-watt, 10% resistor
R3, R4, R5—33,000-ohm, ½-watt, 10% resistor
S1, S2—magnetic reed switches
1-bar magnet (available at toy stores)

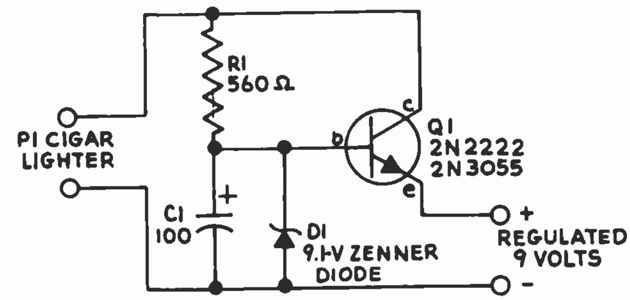


33. CAR POWER TAP

One big problem with 9-volt batteries is that they often go dead just when you need them most. If you are a highway dictator—you record business letters and notes while driving from one business appointment to another—then use the car's power to drive the recorder and save the batteries for those moments when no other power source is available. Our Car Power Tap delivers up to 800 milliamperes of regulated 9-volt power from your car's cigar lighter or any power jack you may install. Just plug in the Car Power Tap and a 2N222 NPN transistor in conjunction with a 9.1-volt Zener diode does all the work. Should you need a bit more than 800 milliamperes, then use a 2N3055 for Q1. Play it safe, be sure to attach either unit to a heat sink. It is always a good idea to include a protective fuse in the circuit. Try one that is about .5 ampere. Stay away from slow-blow types or else you may pop some fuses in the car during an accidental short.

PARTS LIST FOR CAR POWER TAP

C1—100-uF electrolytic capacitor
D1—Zener diode, 9.1-V at ¼-watt
P1—Cigar lighter plug
Q1—NPN transistor, 2N2222 or 2N3055 (see text)
R1—560-ohm, ½-watt, 10% resistor



34. CB MOD BLINKER

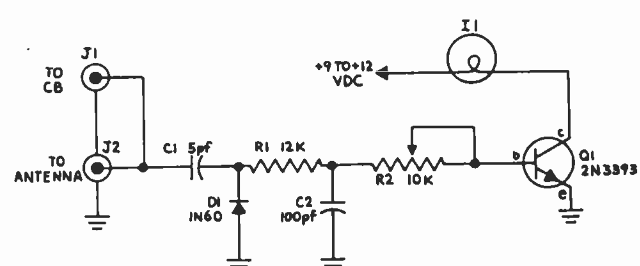
For less than a couple of bucks—even less if the junkbox is cooperative—you will know for sure that what you put into the mike is really getting to your sky hook. Working directly from a minute sample of the transceiver's RF output, the CB Mod Blinker will glow only if there is a carrier output and modulation. So if no one replies to your call and the lamp glows in step with your modulation, you can at least be certain it's not the transceiver that's at fault.

If the unit is built into a small metal box, jacks J1 and J2 should match the existing transmission line connectors. If you build the CB Mod Blinker directly into your transceiver, simply connect capacitor C1 to the RF output jack (and forget about J1 and J2). To adjust, simply talk into the mike in your normal voice and adjust trimmer potentiometer R2 until lamp I1 flashes in step with the modulation. If I1 will not flash regardless of R2's adjustment, substitute a higher gain transistor for Q1 (try a 2N3392). You may want to replace I1 with a LED. If so, include a series resistor with it, and decrease its value slowly until the LED glows normally.

The nice plus you get from the CB Mod Blinker is the reaction of your friends when they see the light. It's effect is greatest on YL's.

PARTS LIST FOR CB MOD BLINKER

C1—5-pF, 500 VDC ceramic disc capacitor
C2—100-pF, 500 VDC ceramic disc capacitor
D1—Germanium diode, 1N60
I1—6 or 8-volt, 30 to 60 mA miniature lamp
J1, J2—Coaxial jack
Q1—NPN transistor, 2N3393 or equivalent (see text)
R1—12,000-ohm, ½-watt, 10% resistor
R2—10,000-ohm trimmer potentiometer



35. MISER PILOT LIGHT

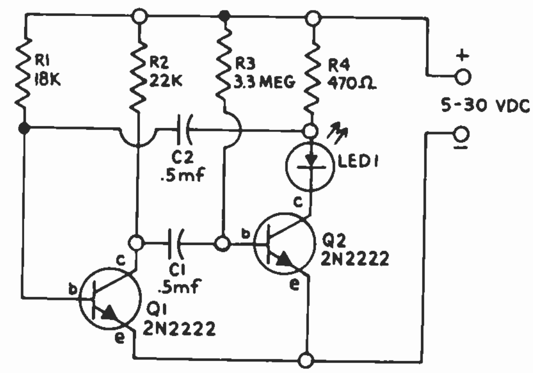
The ordinary light emitting diode (LED) burns up 20 milliamperes of power when ever it's lit. Use a LED as a power-on indicator in battery-operated projects and equipment and it will bleed the battery dry should you forget to turn the unit off. In fact, its friendly glow is not noticed unless it is blinking at you. That's what the Miser Pilot Light does and it does it with very little current. Since the light is off more than it is on, the Miser Pilot Light uses under 1 milliampere for 15-volt supplies. At 5-VDC, the circuit uses about one-quarter milliampere average.

The real extra feature of the circuit is that it can be powered by batteries rated from 5-to 30-volts DC.

Transistors Q1 and Q2 are part of a free-running multivibrator with LED1 in the collector circuit of Q2. As Q1 and Q2 are alternately switched to a conducting state, so is LED1. Build the Miser Pilot Light into your next battery project, and save those expensive batteries.

PARTS LIST FOR MISER PILOT LIGHT

C1, C2—.5-uF, 50-WVDC disc capacitor
LED1—Light-emitting diode, any color
Q1, Q2—2N3904, 2N2222, ECG123, or most any NPN, general-purpose, low-power transistor
R1—180,000-ohm, ¼-watt, 10% resistor
R2—22,000-ohm, ¼-watt, 10% resistor
R3—3.3-Megohm, ¼-watt, 10% resistor
R4—470-ohm, ¼-watt composition resistor

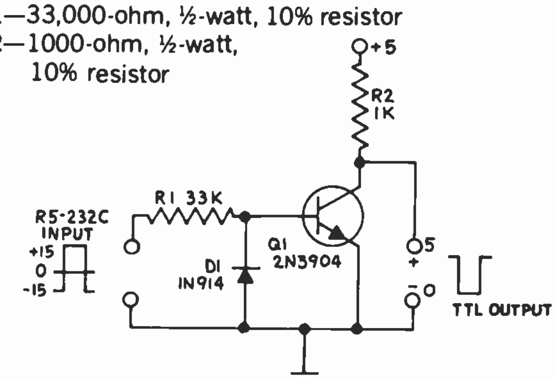


36. RS-232C TTL CONVERTER

There are two sides to the interfacing problem introduced by the previous project. Not only must TTL signals be converted to RS-232C levels, but RS-232C signals may have to be converted to TTL, too. Fortunately, the latter problem is even simpler to solve than the former. All that's needed is a simple saturating switch, transistor Q1, with its base protected by a diode. This prevents the negative excursion of the RS-232C signal from breaking down the emitter/base junction of Q1. As was the case in the previous project, you must build one converter for each signal line to be interfaced. To some experimenters, a Zener diode may be all that is necessary. Forget it! Zeners are noisy devices. Also, noise pulses below their firing point would ride through a clipper circuit playing havoc with the RS-232C transmission.

PARTS LIST FOR RS-232C-to-TTL CONVERTER

D1—1N914 silicon diode
Q1—2N3904 NPN transistor
R1—33,000-ohm, ½-watt, 10% resistor
R2—1000-ohm, ½-watt, 10% resistor



37. TTL -TO-RS-232C CONVERTER

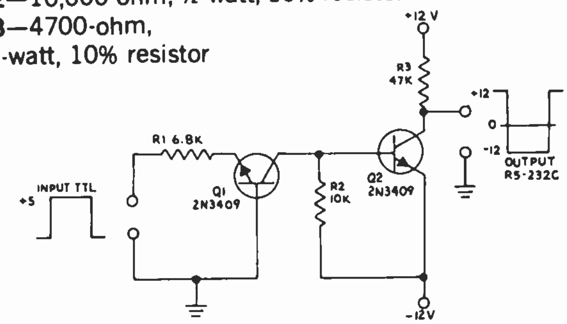
If you happen to be a computer hobbyist, no doubt you are familiar with the EIA's RS-232C standard, which governs certain aspects of the communication between a computer and its peripherals. By peripherals, of course, we mean things like a CRT terminal, a printer, a modem or whatever else you could dream up. By convention, a high signal is defined by RS-232C as being greater than +3 volts, but no greater than +15 volts. Low signals, on the other hand, must be less than -3 volts, but no less than -15 volts. The region from -3 volts to +3 volts is a limbo area, and signals within this range do not qualify as valid input/output (I/O).

The problem that confronts many an experimenter is one of interfacing a project to his computer. In most instances, digital devices will be based on TTL circuitry, the maximum signal excursion of which is from ground to +5 volts. However, a more typical TTL signal would swing from +.4 volt to +3.5 volts. How do you convert such a signal to levels acceptable to the RS-232C convention?

It's easy, and requires just two transistors. Common-base stage of transistor Q1 acts as a level-shifter that couples the TTL signal to Q2, a saturating switch. Q2's output swings between -12 volts and +12 volts, levels compatible with RS-232C. Note that this is an inverting circuit: High inputs yield in low outputs, and vice-versa. Since computer-to-peripheral communication usually requires several I/O Lines, you will need to build one converter for each line in use. Also, see the companion RS-232C-to-TTL converter in this issue.

PARTS LIST FOR TTL—to-RS-232C CONVERTER

Q1, Q2—2N3904 NPN transistors
R1—6800-ohm, ½-watt, 10% resistor
R2—10,000-ohm, ½-watt, 10% resistor
R3—4700-ohm, ½-watt, 10% resistor



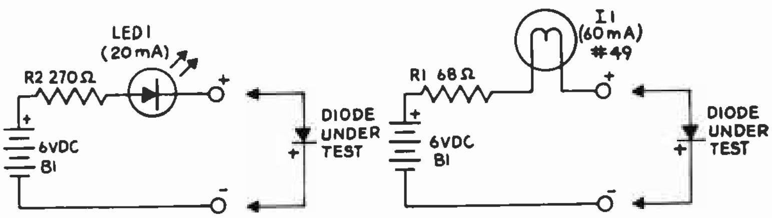
38. SIGNAL DIODE CHECKER

Low voltage signal diodes are easily tested with this "go/no-go" checker. The only restriction is that a diode under test be rated to handle at least 60 mA when using the #49 lamp version and at least 20 mA when using the light emitting diode (LED) version.

If the diode is good, the lamp or LED will light in one direction, and remain dark when the diode is reversed. If the lamp or LED stays on when the diode is reversed, the diode is shorted. If the lamp or LED stays dark when the diode is reversed, the diode is open.

PARTS LIST FOR SIGNAL DIODE CHECKER

B1—6-VDC battery, use type AA cells
I1—#49 lamp
LED1—Light emitting diode, any type lens
R1—68-ohm, ½-watt, 10% resistor
R2—270-ohm, ½-watt, 10% resistor

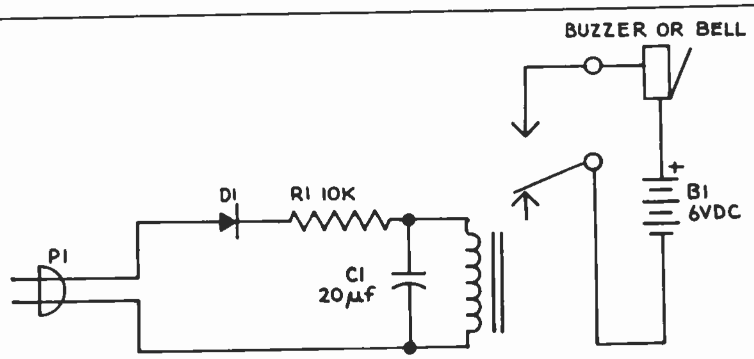


39. POWER FAILURE ALARM

If you have two-weeks supply of choice steaks for 2 in the freezer, you'd want to know when the AC line power fails! So would your tropical fish, or electric burglar alarm system. How about the ordinary electric alarm clock? Never fear again the effects of an unknown power failure while you are asleep. The instant the juice fails,

PARTS LIST FOR POWER FAILURE ALARM

B1—6V battery, use rechangeable types if possible
C1—20-uF, 150-WVDC electrolytic capacitor
D1—Silicon diode rated at 400-PIV, 1-ampere
K1—3000-5000-ohm sensitive relay coil, see text
P1—AC line plug and line cord
R1—10,000-ohm, ½-watt, 10% resistor
1—6VDC commercial home buzzer



the Power Failure Alarm's raucous buzz let's you know about it, even in the wee hours of the morning.

To keep current consumption (and operating costs) at rock bottom, a very sensitive relay is used for K1. As long as AC power is supplied, K1 is activiated and the buzzer contacts are held open. When power fails, K1's contact springs back, completing the battery connection to the buzzer.

Relay K1 is a "model radio-control" type relay with a pull-in current of approximately 1.5 to 3mA.

Resistor R1 should be increased until it just does not hold open relay K1. Then, decrease its value 10 percent. Now, you will get some warning of a "brown out"—voltage drop below 100 VAC. Brown-out voltages can kill your refrigerator motor. It would be best to unplug the refrigerator during the brown out and hope its of short duration.

40. BCB RECEIVER ALIGNMENT OSCILLATOR

It's a small test item with a big name, but this 455-Khz crystal signal generator provides a signal for testing and aligning radio IF circuits. The unit is built on a perfboard or some other rigid mounting to achieve good circuit stability. A metal cabinet reduces radiation so the signal fed to the receiver will be primarily determined by level control R2.

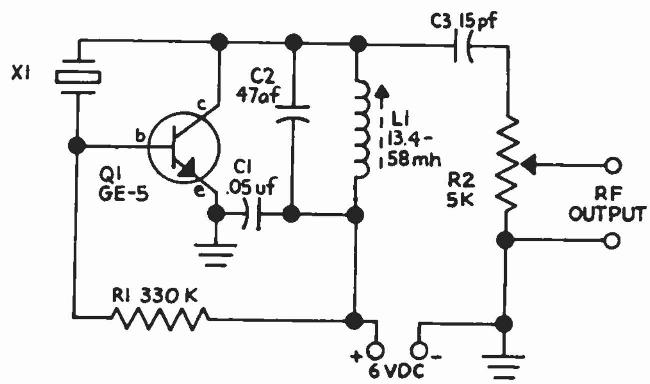
To align the completed circuit, adjust L1's slug for maximum S-meter reading in a receiver or connect R2 to an oscilloscope and adjust L1 for maximum output.

Turn the power supply **on** and **off** several times to make certain the oscillator fails to start every time, adjust L1's slug **slightly** until you obtain immediate and consistent starting each time the power is applied.

The unit requires 6VDC to operate. However, more best benches have 5VDC regulated supplies, and this power can be used in this circuit. Be careful of polarity when connecting.

PARTS LIST FOR BCB RECEIVER ALIGNMENT OSCILLATOR

C1—.05-uF, 25-50-WVDC capacitor
C2—47-pF silver mica capacitor
C3—15-pF silver mica capacitor
L1—3.4.-5.8 mH RF coil J.W. Miller 21A473RB1 or equivalent
Q1—GE-5 NPN transistor
R1—330,000-ohm, ½-watt, 10% resistor
R2—5000-ohm, potentiometer
S01—Crystal socket to match X1
X1—455-kHz crystal



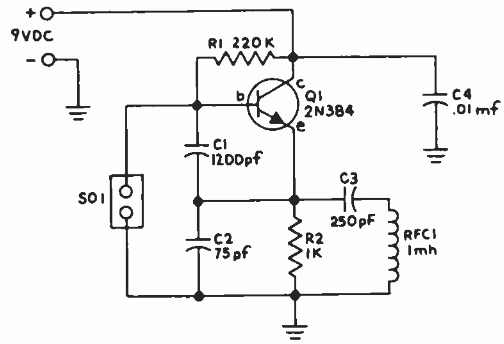
41. CRYSTAL BAND MARKER

Can't find that rare, weak SW signal from Lower Slobbovia? You will if you use this Crystal Band Marker. Obtain crystals on or near your favorite SW stations, plug 'em into the spotter and you'll transmit powerhouse markers on the shortwave bands. If your receiver has a BFO it will sound a loud **beep** when you tune the spotter's signal. With no BFO, simply tune around the frequency until the receiver gets deathly quiet. Either way, you'll calibrate your receiver with great accuracy.

The Crystal Band Marker can be assembled on a small section of perfboard with flea clips for tie points. For good performance, all components must be firmly mounted and well soldered. A common 2U6 9-volt battery in the circuit will last for months, if not for its total shelf life.

Crystals in this circuit are fundamental type, not overtone. Many low-cost surplus crystals are available, but even if you can't get the correct frequency, 50¢ might get you right next door. A few dollars for a new crystal will put you directly on frequency if you want the utmost accuracy.

A connection between the Crystal Band Marker and receiver is not needed. Simply position the spotter near the receiver antenna and start tuning until you find the marker signal.



PARTS LIST FOR CRYSTAL BAND MARKER

C1—1200-pF silver mica capacitor
C2—75-pF silver mica capacitor
C3—250-pF, 100-WVDC disc capacitor
C4—0.01-uF, 25 WVDC capacitor
Q1—2N384 PNP transitor
R1—220,000-ohm, ½-watt, 10% resistor
R2—1000-ohm, ½-watt, 10% resistor
RFC1—1-mH radio-frequency choke
S01—Crystal socket
NOTE: For crystals, pick up surplus types whenever possible to keep costs down.

42. BASIC COLOR ORGAN

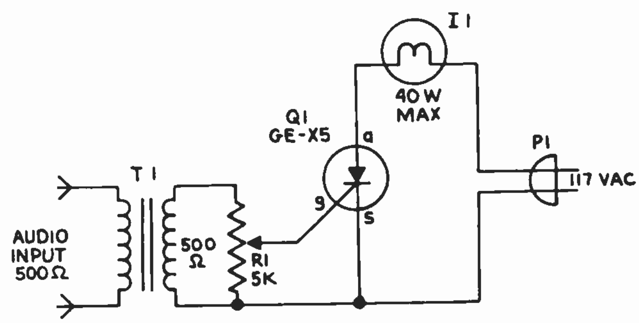
"Light action" tied to activities in the playroom or rock bands can be designed at home by you! Here is a Basic Color Organ circuit that is certain to keep your party from becoming a drag. Connected to your hi-fi amplifier's speaker output (across the speaker terminals) it will throb in time to the music. Paint the bulb red or deep blue and your party room will take on the atmosphere of a rock club.

Transformer T1 can be any matching transistor type in the range of 500/500 to 2500/2500 ohms. Note that none of the connections from SCR1 or its components are connected to ground. For safety's sake, you must keep the 117-volt line voltage from the amplifier connections—that's the reason for T1. To adjust, set potentiometer R1 "off" and adjust the amplifier volume control for a normal listening level. Then adjust R1 until lamp I1 starts to throb in step with the beat.

You could effectively isolate the highs and lows, even mid-range frequencies by tieing the primary of T1 to the tweeter, mid-range and woofer terminals. Or, you could design simple tone circuits which are placed in front of several duplicate Basic Color Organ circuits. Start thinking—you'll come up with some good ideas!

PARTS LIST FOR BASIC COLOR ORGAN

I1—117V lamp, not to exceed 40 watts.
P1—AC line plug and line cord
R1—Potentiometer, 5000-ohms
Q1—Silicon Controlled Rectifier, GE-X5 or equivalent
T1—Transistor audio output transformer, subminiature type—see text

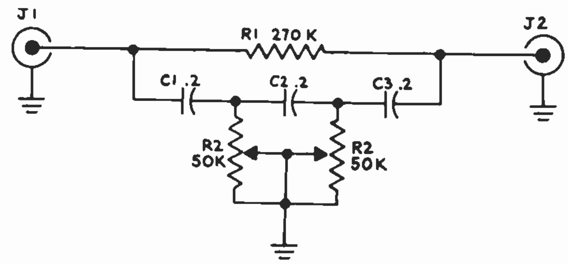


43. 78-RPM OLD SMOOTHIE

Your old Bing Crosby records will sound much better on your stereo hi-fi sound system after a little work has been done to equalize their sound. Bing's first records were on the old 78's. The early days saw some new but not too good audio recording instruments and techniques. Yes, they were good for the old black shellack records but not for the modern LP's. Just wire up our 78-RPM Old Smoothie—a device that you can assemble in a few minutes. Mount the project in a shielded can or box to keep AC hum to a minimum. Connect the output of your old 78 player to the Old Smoothie, and its output to a tape recorder. Set potentiometer R2 to a maximum resistance to attenuate the high mid-frequencies common to most 78-RPM recordings. Then adjust potentiometer R3 for the most pleasing sound you can get from the recording. If you lose too much of the mid-range (Bing's voice) in the playback, then reduce its resistance by rotating the potentiometer. Do it a bit at a time and go back to toying with potentiometer. When the results are optimum, record the disk—A and B sides. In effect, the 78-RPM Old Smoothie is an equalizer that bring the old 78-RPM disks back to life. You'll find that a slight adjustment may be needed from artist to artist, label to label, and style to style. A little bit of patience and your 78's will be on tape for your listening pleasure.

PARTS LIST FOR 78-RPM OLD SMOOTHIE

C1, C3—0.25-uF mylar capacitor
C2—0.02 uf mylar capacitor
J1, J2—phono jack, RCA type
R1—270,000-ohm,½-watt, 10% resistor
R2, R3—50,000-ohm potentiometer, linear taper



44. AUDIO PEAK CLIPPER

One sure way to avoid sending the PA speaker cones across the room is by inserting an Audio Peak Clipper in the circuit. Now, when the clowning comic drops the mike, the speakers will not blow—but, God help the mike.

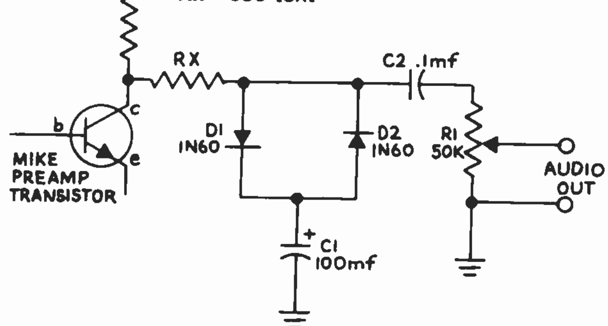
An effective speech and noise clipper for transmitters and PA systems can be made from only two diodes and a capacitor.

Connect the diodes to the collector of the microphone preamplifier, the stage with at least a 1V peak-to-peak audio output voltage. The diodes clip at approximately .2V, allowing overall amplifier gain to be increased without speech peaks producting over-modulation or excess peak power output.

Capacitor C1's voltage rating must be at least equal to the DC supply voltage at the preamp collector. If the preamp uses a negative supply, reverse C1's polarity. The output level to the rest of the amplifier is determined by the R1. If the diodes cause distortion in the preamplifier, add resistor Rx, as shown. Use the necessary value between 1000 and 10,000 ohms.

PARTS LIST FOR AUDIO PEAK CLIPPER

C1—100-uF electrolytic capacitor (see text)
C2—0.1 uF capacitor
D1, D2—1N60 diode
R1—50,000-ohm, audio taper potentiometer
Rx—see text

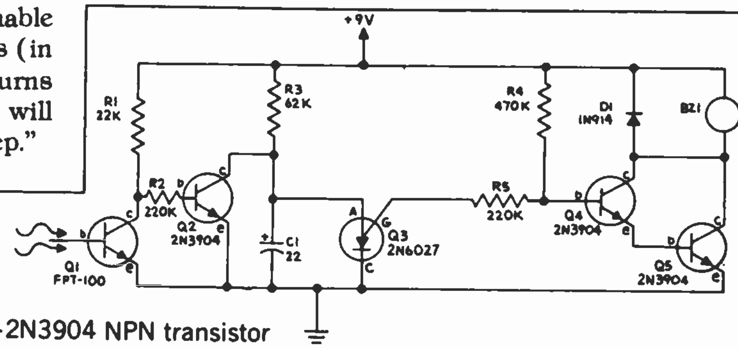


45. LIGHT SWITCH ANNUNCIATOR

Momentarily interrupt the beam of light shining on Q1, and you get a one-second "beep" from light switch annunciator. Most likely you've encountered circuits of a similar nature in retail stores, where the buzzing sound signals your entrance and alerts salesmen to their prey. Obviously, a great many other applications are possible as well.

With light shining on Q1's sensitive face, the phototransistor conducts heavily and shunts current away from the base of Q2. But when the beam of light is interrupted, Q1 ceases to conduct—thus allowing current to flow through R1 and R2 into Q2's base. The collector of Q2 then conducts current and rapdily discharges capacitor C1. This allows Q3's gate lead (G) to swing high, thereby turning on Q4, Q5 and the buzzer.

Assuming that the interruption of the beam was only temporary, Q2's collector will now have ceased to conduct current. This allows C1 to charge until it reaches a level sufficient to trigger Q3, a programmable unijunction transistor (PUT). When that happens (in about 1 second), Q3's gate potential drops, which turns off Q4, Q5 and the buzzer. Another interruption will repeat the whole process and yield one more "beep."



PARTS LIST FOR LIGHT SWITCH ANNUNCIATOR

BZ1—piezoelctronic buzzer, 6-9 VDC
C1—22 uF, 16 WVDC electrolytic capacitor
D1—1N914 silicon diode
Q1—FPT-100 NPN phototransistor
Q2, Q4, Q5—2N3904 NPN transistor
Q3—2N6027 programmable unijunction transistor
R1—22,000-ohm, ½-watt 10% resistor
R2, R5—220K-ohm, ½-watt 10% resistor
R3—62,000-ohm, ½-watt 10% resistor
R4—-ohm, ½-watt 10% resistor

46. DURATION TIMER

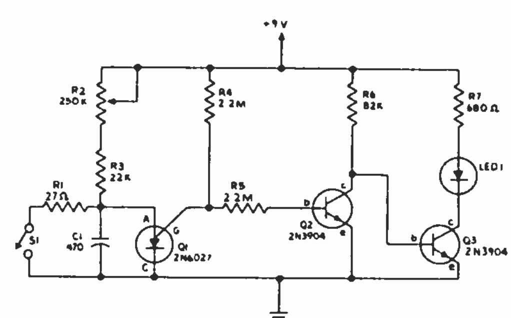
Need an inexpensive means of timing events from 10 seconds to 2 minutes in duration? If so, then this circuit is for you. With switch S1 closed, capacitor C1 is completely discharged, and the gate potential of programmable unijunction transistor Q1 is high. Thus, Q2 is turned on, Q3 is turned off, and LED1 is extinguished.

Once S1 is opened, capacitor C1 begins to charge through R1 and R3. The larger the resistance of R2, the more slowly C1 charges. As the voltage on C1 climbs, it eventually exceeds the threshold potential of Q1's anoide: about 5.3 volts. When this happens, Q1's gate drops low—thereby turning Q2 off and Q3 on. LED1 then lights up to indicate the end of the timed interval. (Sharp-eyed readers may note that Q1's configuration is similar to that of a relaxation oscillator. Although this is true, Q1 does not oscillate; it merely latches, since the resistance of R2 and R3 is so low as to preclude oscillation.)

To reset the circuit, you must discharge C1 by closing S1. With the aid of a clock equipped with a second hand, it is possible to calibrate a dial scale for R2 using increments of 10 seconds, or so.

PARTS LIST FOR DURATION TIMER

C1—470 uF, 25V electrolytic cap.
LED1—red light-emitting diode
Q1—2N6027 programmable unijunction transistor
Q2, Q3—2N3904 NPN transistor
R1—27-ohm, ½-watt 10% resistor
R2—250,000 linear-taper potentiometer
R3—22,000-ohm, ½-watt 10% resistor
R4, R5—2.2-megohm ½-watt 10% resistor
R6—82,000-ohm, ½-watt 10% resistor
R7—680-ohm, ½-watt 10% resistor
S1—SPST toggle switch



47. OLD SOL BATTERY CHARGER

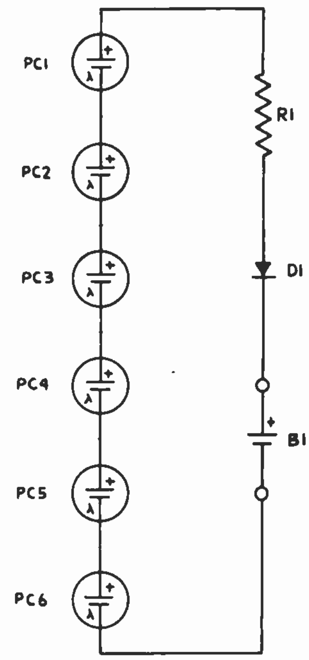
Tired of charging your NiCd cells? Then let Old Sol do the work for you free-of-charge. In this circuit, photovoltaic cells supply the charging current, which is limited to a safe level by R1. Diode D1 prevents the battery from discharging through the solar cells during periods of darkness.

NiCd cells of different sizes require different maximum charging currents for best results. Currents in excess of the recommended values result in rapid evolution of oxygen gas within the cell. When this happens, oxygen-gas pressure is relieved through vents, and a significant portion of the cell's chemical contents may be lost in the process. The net effect is reduced cell life; therefore, resistor R1 should be selected to limit the charging current to a safe level.

To do this, break the circuit and insert a DC milliameter in series with B1. (Watch those polarities!) Expose the solar cells to the brightest sunshine they can expect to receive, and make note of the charging current. The recommended charging rates for various NiCd cells are: 50 mA for AA cells, and 100 mA for C or D cells. To obtain these currents, the suggested values of R1 are approximately 18 ohms (for AA cells) and 9.1 ohms (for C or D cells). With your milliameter, measure the actual charging current produced by your circuit with the resistor appropriate to your chosen cell size. If the current exceeds the safe level, replace R1 with a larger resistance. As a final note, be sure to select solar cells capable of supplying the desired charging current.

PARTS LIST FOR OLD SOL BATTERY CHARGER

B1—1.25V rechargeable NiCd battery
D1—1N4001 rectifier diode
PC1-PC6—.5-volt silicon photovoltaic cell (see text)
R1—current-limiting resistor (see text)

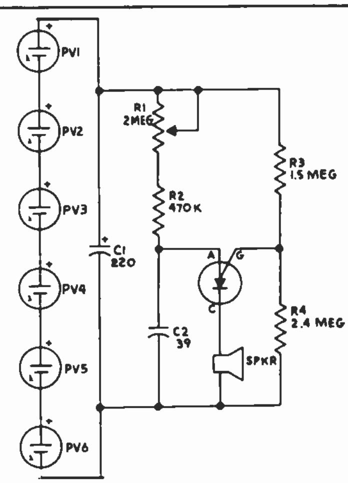


48. Solar-Powered Metronome

You'll never miss a beat because of dead batteries with this metronome. As long as there is a little sunlight or lamplight to illuminate the silicon solar cells, the circuit will keep ticking away merrily. The six series-connected solar cells provide a supply potential of 3-volts for the PUT relaxation oscillator. Potentiometer R1 can be adjusted to yield the desired pulse rate. Should you wish to lower the output volume, a small resistor on the order of 10-ohms may be installed in series with the speaker.

PARTS LIST FOR SOLAR-POWERED METRONOME

C1—220-uF, 25-WVDC electrolytic capacitor
C2—0.39-uF, 25-WVDC mylar capacitor
PV1, PV6—0.5-VDC silicon solar cells (Radio Shack #276-120 or equiv.)
Q1—2N6027 programmable unijunction transistor
R1—2,000,000-ohm linear-taper potentiometer
R2—470,000-ohm, ½-watt 5% resistor
R3—1,500,000-ohm, ½-watt 5% resistor
R4—2,400-000-ohm, ½-watt 5% resistor
SPKR—8-ohm PM miniature speaker



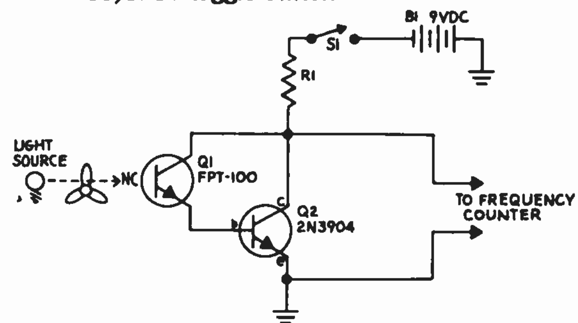
49. BEAM BUSTER ADAPTER

If you own a frequency counter, you can use this nifty little circuit to measure the rate of rotation of motors, fans and anything else that revolves and can break a beam of light. In the accompanying schematic, you can see that light from the bulb is chopped by the rotating fan blades. This chopped light beam then falls on the light-sensitive face of phototransistor Q1. Transistor Q2 amplifies the photo-current from Q1's emitter to yield a rectangular waveform approximately 9-volt in amplitude at the output. Naturally, the frequency of the output is related to the fan's speed of rotation.

$$RPM = \frac{\text{Freq. (hZ)} \times 60}{\text{\# of beam interruptions per second}}$$

Suppose we obtain a frequency reading of 100 Hz with the 3-bladed fan illustrated here. Obviously there are 3 interruptions per revolution. The actual speed is therefore 2000 RPM. For best results, mount Q1 in a small, hollow tube (an old pen barrel for example) with its light-sensitive face recessed with respect to one end. This will ensure that only the chopped beam strikes the phototransistor.

PARTS LIST FOR BEAM-BUSTER ADAPTER
B1—9-volt transistor battery
Q1—FPT-100 phototransistor (or equiv.)
Q2—2N3904 NPN transistor
R1—10,000-ohm, ½-watt 5% resistor
S1)SPST toggle switch

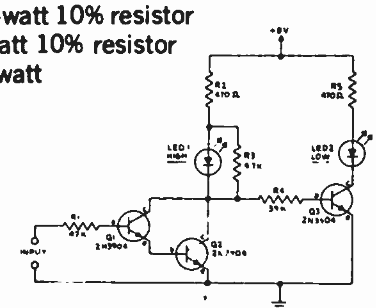


50. LOGIC PROBE

As most digital experiments are aware, a logic probe is nothing more than a convenient tool to indicate whether the voltage at a circuit node is high or low. The simple probe presented here will do just that using two LEDs for output. If the input voltage exceeds approximately 1.5 volts, the Q1-Q2 Darlington pair is biased into conduction, and LED1 is illuminated.

On the other hand, if the input voltage is below Q1-Q2's switching threshold, Q1 and Q2 stop conducting. As a consequence, LED1 extinguishes, Q3 gets turned on, and LED2 lights. If you find that both LED1 and LED2 light during a test, it means that the input signal is oscillating between high and low levels. The 1.5-volt switching threshold of Q1-Q2 is a good match for TTL circuits.

PARTS LIST FOR LOGIC PROBE
LED1—green light-emitting diode
LED2—red light-emitting diode
Q1, Q2, Q3—2N3904 NPN transistor
R1—47,000-ohm, ½-watt 10% resistor
R2, R5—470-ohm, ½-watt 10% resistor
R3—4,700-ohm, ½-watt 10% resistor
R4—39,000-ohm, ½-watt 10% resistor



51. UNI JUNCTION TRANSISTOR TESTER

Having read this far in the book, you must certainly have noticed that a number of our projects feature unijunction transistors. The unijunction, or UJT to you abbreviators, cannot be used in linear circuits (such as amplifiers) in the same way that a conventional bipolar transistor can. Instead, you will find the UJT in timing and oscillating circuits for the most part. In order to test a UJT, therefore, it appears logical that a representative timing circuit should be used to do the job.

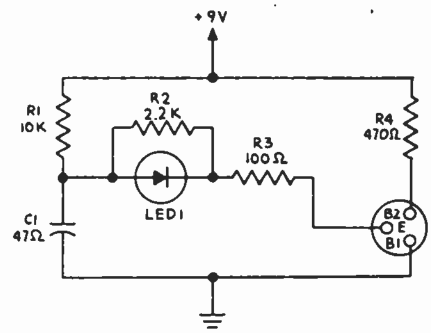
To operate the UJT tester presented here, begin by plugging your unijunction into SO1. This circuit is similar to the classical UJT relaxation oscillator, except that an LED and current-limiting resistor (R3) have been inserted in series with the emitter lead. Initially, capacitor C1 will charge up through R1, and the voltage on C1 will gradually rise.

Once the potential on C1 becomes large enough to force the UJT's emitter to break down, C1 gets discharged through LED1, R3 and the UJT's emitter. After discharge, the emitter terminal returns to a high-impedance state, and the capacitor charges once more.

Each time the capacitor discharges through the LED, a flash of light is produced. This serves as a simple Go/no Go indication of the UJT's ability to oscillate. Resistor R2 is used to swamp the LED's high impedance in the OFF state, thus enabling the UJT to break down more readily.

PARTS LIST FOR
UNIJUNCTION TRANSISTOR TESTER

C1—47 uF, 16-WVDC electrolytic capacitor
LED1—red light-emitting diode
R1—10,000-ohm, ½-watt 10% resistor
R2—2200-ohm, ½-watt 10% resistor
R3—100-ohm, ½-watt 10% resistor
R4—470-ohm, ½-watt 10% resistor
S01—transistor socket



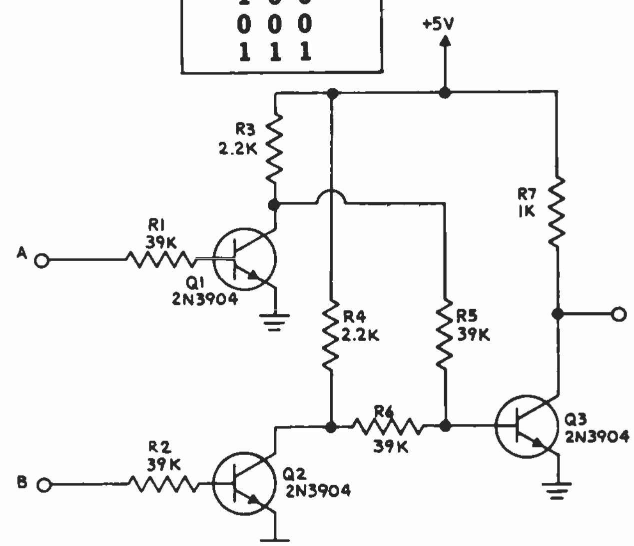
52. DISCRETE GATE

If you want to build an AND gate without resorting to IC's, here is the way to do it. As can be seen from the schematic diagram, all that's necessary is a handful of resistors and transistors. Although we would not recommend that you forsake IC's entirely, it's nice to know how to make do when integrated logic is unavailable.

The accompaning Truth Table concisely describes the AND gate's operation. The 1s denote a high voltage level, while the 0s denote a low level (i.e., ground potential). Note that the only way to obtain a high output from an AND gate is to send both inputs high simultaneously.

TRUTH TABLE

A	B	C
1	1	0
1	0	0
0	0	0
1	1	1



PARTS LIST FOR
DISCRETE AND GATE

Q1, Q2, Q3—2N3904 NPN transistor
R1, R2, R5, R6—39,000-ohm, ½-watt 10% resistor
R3, R4—2,200-ohm, ½-watt 10% resistor
R7—1,000-ohm, ½-watt 10% resistor

53. ELECTROLYTIC CAPACITOR TESTER

In conjunction with a watch or clock capable of resolving seconds, this simple circuit can be used to measure the value of any electrolytic capacitor. With the capacitor in question connected to the binding posts (watch polarities), press and release S2; then, time how long it takes for LED1 to come on.

Multiply the time by the appropriate scale factor, and you have the capacitance. For example, suppose S1 is in position B, and that 19 seconds have elapsed before the lighting of LED1. The capacitance is then equal to:

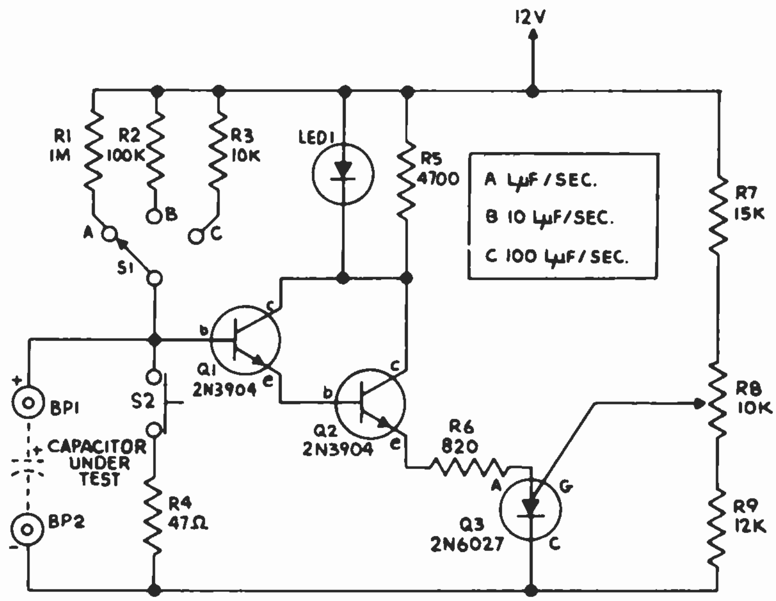
19 sec × 10uF/sec = 190 uF.

Circuit theory is quite simple. As the capacitor charges (through R1, R2 or R3), the voltage on the capacitor rises. Darlington pair Q1-Q2 buffers the capacitor voltage and feeds it to the anode terminal of Q3. When the capacitor voltage reaches a certain threshold level, determined by the setting of R8, the anode of programmable unijunction transistor Q3 breaks down and allows current to flow through R6, which lights LED1. The amount of time necessary for the voltage on a capacitor to rise to a specified level through a given reasistance is directly proportional to the size of the capacitor. So, by measuring the charging interval, we also measure the capacitance. To reset the circuit and discharge the capacitor, just press and release S2.

To calibrate the circuit, you will need a 22-uF tantalum electrolytic capacitor. Set S1 to position A (1uF/sec), and set R8 to its midpoint. Connect the capacitor to the binding posts, then press and release S2. Time how long it takes before LED1 lights. If it takes longer than 22 seconds, move R8's wiper downward slightly. If less than 22 seconds elapse, move R8's wiper upward slightly. Repeat the process until it takes exactly 22 seconds for LED1 to light. Calibration is now complete.

PARTS LIST FOR ELECTROLYTIC CAPACITOR TESTER

BP1, BP2—binding posts
LED1—light-emitting diode
Q1, Q2—2N3904 NPN transistor
Q3—2N6-27 programmable unijunction transistor
R1—1 Megohm, ½-watt, 5% resistor
R2—100K-ohm, ½-watt 5% resistor
R3—10,000-ohm, ½-watt 5% resistor
R4—47-ohm, ½-watt 10% resistor
R5—4700-ohm, ½-watt 10% resistor
R6—820-ohm, ½-watt 10% resistor
R7—15,000-ohm, ½-watt 10% resistor
R8—10,000-ohm trim potentiometer
R9—12,000-ohm, ½-watt 10% resistor
S1—SP3T rotary switch
S2—N.O. pushbutton switch



54. BATTERY BACKUP

Sometimes, it is advantageous to supplement a conventional AC power supply with battery back-up. In case of a power failure, the battery cuts in so that the circuit in question can function without interruption. Burglar alarms, computer memory boards, and timing or control systems are a few of the circuits that can benefit from battery back-up.

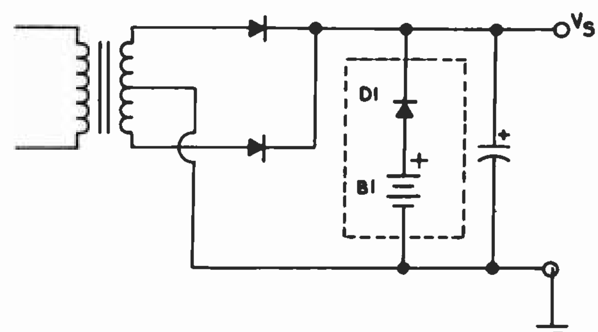
The accompanying schematic shows how easy it is to add battery back-up to an existing AC supply. Under normal conditions with AC power intact, voltage Vs on the supply's filter capacitor exceeds the voltage of battery B1. As a result, diode D1 is reversebiased, and it prevents supply current from flowing into battery B1.

When the line voltage fails, Vs starts to drop. Once it reaches a level about 1-volt less than the battery voltage, it stops dropping. At this point, battery B1 is powering the circuit through D1.

Let's suppose Vs equals 11 volts. We could choose a battery voltage somewhat less than this—for example, 9 volts. Once the power fails, our circuit will be running on about 8 volts (9V minus 1V for the diode drop). Many circuits can tolerate a diminished supply potential with no ill effect. Make sure your choice of battery can supply all the current demand.

PARTS LIST FOR BATTERY BACK-UP

B1—Battery of appropriate size (see text)
D1—1N4001 silicon rectifier diode



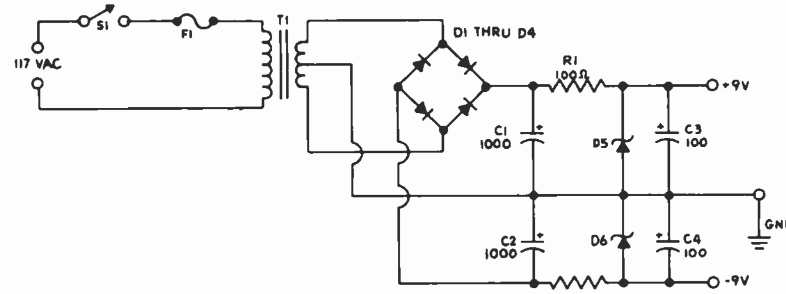
55. DUEL OUTPUT REGULATED CONTROL

Those of you who experiment with op amps know that them little critters demand a split power supply in most instances. If you've been making do with batteries, you might like to step up in class with the simple, dual-output, regulated power supply diagrammed here. Not only will you be able to experiment with op amps, but you can also use either the positive or negative half of the supply by itself when dual outputs are not needed.

Center-trapped transformer T1 feeds four rectifier diodes arranged in the familiar full-wave-bridge configuration. Opposing taps on the bridge furnish positive and negative rectified current to filter capacitors C1 and C2. Conventional shunt-type zener-diode voltage regulators (D5 and D6), fed by current-limiting resistors R1 and R2, provide output voltages of +9V and -9V. You can draw between zero and 40 mA from either half of this supply with no ill effect.

PARTS LIST FOR DUAL-OUTPUT REGULATED CONTROL

C1, C2—1000uF, 25-WVDC electrolytic capacitor
C3, C4—100 uF, 16-WVDC electrolytic capacitor
D1, D4—1N4002 rectifier diode
D5, D6—9-volt, 1-watt zener diode
F1—⅛ A, slow-blow fuse
R1, R2—100-ohm, ½-watt 10% resistor
S1—SPST switch
T1—24 VCT, 300 mA transformer

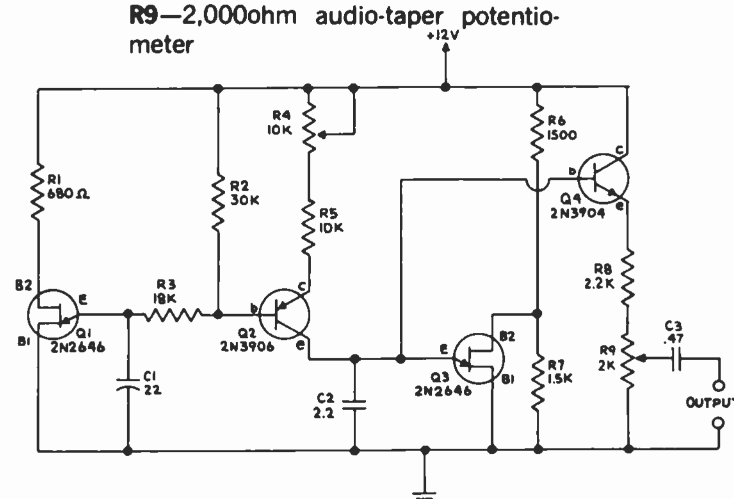


56. THE OBNOXILLATOR

This little audio oscillator emits a sound that's obnoxious to both man and beast, which is why we call it an obnoxillator. The tone starts out at a relatively high pitch which, over a period of about one second, swoops downward in frequency. Then, the signal jumps abruptly to its initial pitch and commences its downward plunge once more. The effect is approximately as pleasant as running your nails over a blackboard, and

PARTS LIST FOR THE OBNOXILLATOR

C1—22-uF, 25 WVDC electrolytic capacitor
C2—.22-uF mylar capacitor
C3—.47-uF mylar capacitor
Q1, Q3—2N2646 unijunction transistor
Q2—2N3906 PNP transistor
Q4—2N3904 NPN transistor
R1—680-ohm, ½-watt 10% resistor
R2—30,000-ohm, ½-watt 10% resistor
R3—18,000-ohm, ½-watt 10% resistor
R4—10,000 trimmer potentiometer
R5—10,000-ohm, ½-watt 10% resistor
R6, R7—1,500-ohm, ½-watt 10% resistor
R8—2,200-ohm, ½-watt 10% resistor
R9—2,000ohm audio-taper potentiometer



as such it will get people's attention—if not their admiration.

Q1 together with R1, R2, R3 and C1 comprise a conventional UJT relaxation oscillator with a period of approximately one second. The roughly sawtoothed voltage developed across C1 drives current source Q2, the output of which charges capacitor C2. Adjustment of R4 affects the magnitude of the current and, hence, the rate at which capacitor C2 charges. Unijunction transistor Q3 discharges C2 when the voltage on the capacitor reaches 4.2 volts, or so. The rate at which the voltage on C2 oscillates is in the audio range and is much faster than that of the waveform developed across C1.

After C2's discharge, the capacitor once again gets charged up by current from Q2. Since Q2's charging current is a function of the voltage across C1, the rate at which C2 charges will vary (in fact, diminish) over the 1-second interval it takes for C1 to charge. Once Q2 discharges C1, Q2's charging current returns to a high value, and the frequency of the sawtooth waveform across C2 jumps back to its initial high value.

Emitter follower Q4 reads the signal developed on C2 and provides a buffered audio output with a maximum peak-to-peak amplitude of about 1-volt. Volume control R9 can be used to vary the magnitude of the output, which should drive an audio amplifier through its high-level input.

57. SNEAKY COMBINATION LOCK

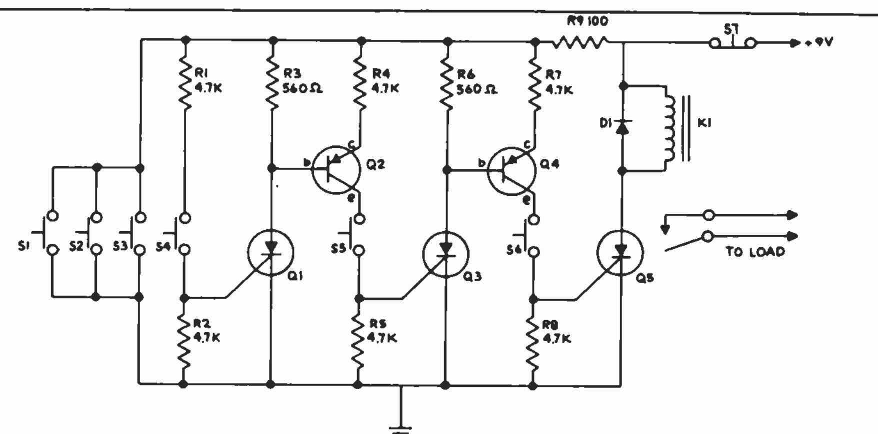
Now you can lock up your valuable electronic equipment and prevent tampering with this handy electronic combination lock. Press S4, S5 and S6 in sequential order (the switches can be mounted in any physical order), and you latch K1 in the ON state, thus turning on your load in the process. Hitting S7 momentarily will reset the circuit.

When S4 is pressed, gate current is supplied to Q1, which causes this SCR to latch in a conducting state. This pulls current through R3 and turns on current source Q2. Consequently, when S5 is later pressed, Q2 is able to supply a pulse of gate current to Q3, thereby latching this SCR. At the same time, current source Q4 is activated by the latching of SCR Q3. Thus, when S6 is pressed, Q4 supplies a pulse of gate current that latches Q5 in a conducting state. As a result, relay K1 pulls in.

Whenever one of the dummy switches—S1, S2, S3—is pressed, Q1 and Q3 are rest to their non-conducting states. Therefore, whenever a potential intruder hits one of these dummies, he defeats his own attempt at picking your lock. Pressing S7 removes power from the circuit and unlatches all the SCRs—Q5 included. Relay K1 therefore gets de-energized, and your circuit is locked up tight.

PARTS LIST FOR SNEAKY COMBINATION LOCK

D1—1N914 silicon diode
K1—6-volt, 500-ohm relay
Q1, Q3, Q5—2N5060 sensitive-gate SCR
Q2, Q4—2N3906 PNP transistor
R1, R2, R4, R5, R7, R8—4700-ohm, ½-watt 10%, resistor
R9—100-ohm, ½-watt 10% resistor
S1, S6—normally open pushbutton switch
S7—normally closed pushbutton switch



58. STEREO SPEAKER PROTECTOR

The advent of the superamplifier, capable of supplying 100 to 200 watts per channel on a continuous basis, has been both a blessing and a curse to the audiophile. The blessing is that a recording's dynamic range can now be more faithfully reproduced, even with inefficient loudspeakers. Unfortunately, these amps are so powerful that loudspeakers can often be overdriven, and eventually destroyed, if sufficient care is not exercised. If your amp lacks provisions for speaker protection, you may want to build the speaker protector diagrammed.

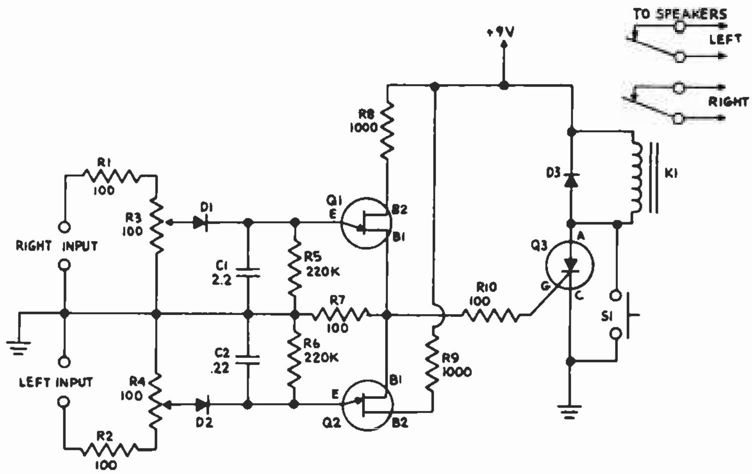
The contacts of relay K1 are hooked in series with your right- and left-hand speakers in such a way that, when K1 is unenergized, its contacts close and complete the circuit to each loudspeaker.

Inputs to the protection circuit come from your amp's outputs (the same outputs that drive the speakers). If the signal feeding the 'right' input is sufficiently large to charge C1 to a potential greater than the breakdown voltage of Q1's emitter, a voltage pulse will appear across R7. Similarly, excessive inputs to the 'left' channel will also produce a pulse across R7, this time due to the discharge of C2 by Q2. The pulse across R7 triggers SCR Q3, which latches in a conducting state and energizes K1. This interrupts both speaker circuits, and the resulting silence should alert you to a problem. Cut back on your amp's volume; then, press and release S1 to reset the circuit and restore normal operation.

The circuit can be adjusted to trip at lower levels from 15 to 150 watts rms. To calibrate, feed a deliberately excessive signal to the 'right' input, and raise R3's wiper up from ground until K1 pulls in. Disconnect the signal from the 'right' input, and apply it to the 'left' input. Press S1 to reset the circuit, and raise R4's wiper up from ground until K1 pulls in again. The circuit is now calibrated. Your calibration signal should preferably be a continuous tone, but a musical passage of fairly constant loudness will probably suffice. K1's contacts should be rated to carry a 3 to 5-amp load.

PARTS LIST FOR STEREO SPEAKER PROTECTOR

C1, C2—.22-uF, 15 WVDC capacitor
D1, D2, D3—1N914 silicon diode
K1—6-volt relay, DPDT contacts (see text)
Q1, Q2—2N2646 unijunction transistor
Q3—2N5060 sensitive-gate SCR
R1, R2—100-ohm, ½-watt 10% resistor
R3, R4—100-ohm linear-taper potentiometer
R5, R6—220K-ohm, ½-watt 10% resistor
R7, R10—100-ohm, ½-watt 10% resistor
R8, R9—1,000-ohm, ½-watt 10% resistor
S1—N.O. pushbutton switch

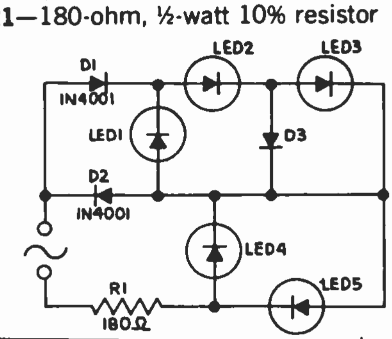


59. DIODE PUZZLE

This innocuous-looking little circuit will provide a good indication of how well you really understand the rectifier diode and the light-emitting diode. Your task is to determine which of the five LEDs will light up when 6.3 volts AC is applied to the circuit. We won't give you the answer; to find that out, just breadboard the circuit. However, we will supply you with a couple of hints. First, the forward voltage drop of a rectifier diode is approximately .8 volt, while that of an LED is about 2 volts. Naturally, rectifiers conduct current in one direction only. LEDs will light up only when their anodes (arrows) are 2-volts more postive than their cathodes (bars). Finally, you can expect to find 3 LEDs lit and 2 LEDs dark. Pencils sharpened? OK, begin.

PARTS LIST FOR DIODE PUZZLE

D1, D2, D3—1N4001 rectifier diode
LED1, LED5—red light-emitting diode
R1—180-ohm, ½-watt 10% resistor



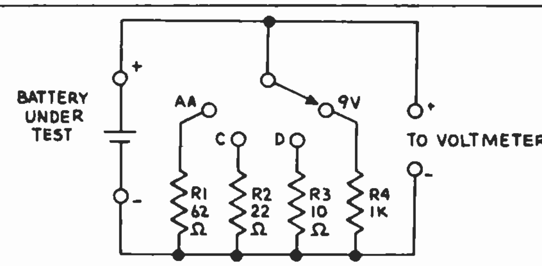
60. DRY CELL/BATTERY TESTER

Perhaps you have seen the advertisements for battery testers and had a good chuckle at the ridiculously inflated prices being demanded. If you had the opportunity to disassemble one of these electronic marvels, all you would find would be a very cheap meter and a couple of resistors. In just a few minutes' time, you can lash together a battery tester yourself.

Resistors R1 through R4 provide suitable loads for the various batteries to be tested, while a VOM or an electronic multimeter is used to read the cell voltage. If the indicated voltage is much below the nominal battery potential, give your battery the heaveho, and buy another. Resistors R1, R2 and R3 have been selected as loads for ordinary 1.5-volt, zinc-carbon AA, C and D cells, respectively, while R4 is appropriate for the standard 9-volt, zinc-carbon, transistor-radio battery. When a 1.5-volt cell registers 1.2 volts, it is relatively weak. By the time it reaches 1.0-volt, it's done for.

PARTS LIST FOR
DRY CELL/BATTERY TESTER

R1—62-ohm, ½-watt 10% resistor
R2—22-ohm, ½-watt 10% resistor
R3—10-ohm, ½-watt 10% resistor
R4—1,000-ohm, ½-watt 10% resistor
S1—SP 4-position rotary switch



61. DIFFERENTIAL THERMOMETER

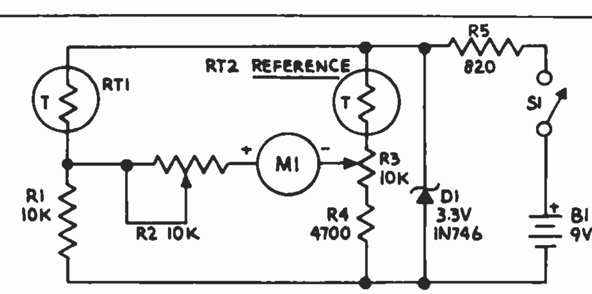
In some instances, we are more interested in the temperature difference between two points than in the absolute value of the temperature at either point. Making such relative temperature measurements calls for a differential thermometer like the one diagrammed here.

To zero this instrument, place the two thermistors in close proximity, and allow a minute or two for them to reach thermal equilibrium. With R2 set for minimum resistance, adjust R3 to obtain a zero (center-scale) indication on Meter M1. Now, leave the reference thermistor, RT2, right where it is, but move RT1 to a point at a different temperature.

If RT1's new environment is warmer than the environment of RT2, RT1's resistance will decrease, and M1 will deflect upscale. Conversely, if RT1 is now colder than RT2, M1 will deflect downscale from zero. R2 may be used to vary the meter's sensitivity.

A note about components: Just about any negative-temperature-coefficent thermistor having a restance of 10K ohms at 25 ° C, will do. Note that meter M1 should have its zero position at center scale, thus allowing for temperatures greater or less than the reference. Always re-zero the instrument when changing the reference temperature.

A possible application for this thermometer lies in estimating the effectiveness of forced-air cooling within a piece of equipment. Since the flow of cooling air within a computer or other piece of equipment is drastically altered once the cover is removed, an electronic differential thermometer of the sort described here is really the only practical way of identifying hot spots with the cover in place.



PARTS LIST FOR
DIFFERENTIAL THERMOMETER

B1—9-volt transistor battery
D1—1N746, 3.3V, ½-watt Zener diode
M1—50-0-50 uA DC microameter
R1—10,000-ohm, ½-watt 10% resistor
R2, R3—10,000 linear-taper potentiometer
R4—4,700-ohm, ½-watt 10% resistor
R5—820-ohm, ½-watt 10% resistor
RT1, RT2—negative-temperature-coefficient thermistor, 100,000-ohms @ 25 ° C. (Fenwal UUT-41J1 or equivalent)
S1—SPST switch

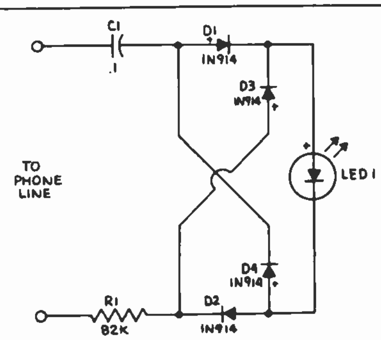
62. LED TELEPHONE RING INDICATOR

Know what makes your phone ring? A 20 Hertz AC signal at anywhere from 60 to 120 Volts, depending on your phone company. That same bell-ringing signal can be used to light an LED with the circuit shown here, without significantly loading the telephone line. C1 provides DC isolation to help foolproof this project. The .1 value shown works, but you may want to increase it to .5 microfarads. Use a mylar capacitor (like the Sprague "Orange Drop" series) rated at 250-450 working volts or more.

Why so high? The telephone company keeps its line clear of ice and trouble by daily sweeping a pulse of high voltage throughout the system. Too low a working voltage could mean trouble for them, and that is absolutely the last thing you want to cause. We might even suggest connecting to the telephone lines only temporarily to verify circuit operation. This will help avoid accidents and trouble. D1 through D4 act as a full wave bridge to deliver the AC ringing voltage as DC to LED1. R1 limits this current through the circuit.

PARTS LIST FOR LED TELEPHONE RING INDICATOR

C1—.1-uF 100-WVDC capacitor
D1, D2, D3, F4—Diode, 1N914 or equivalent
LED1—Light emitting diode, red-color lens
R1—82,000-ohm ½-watt, 10% resistor



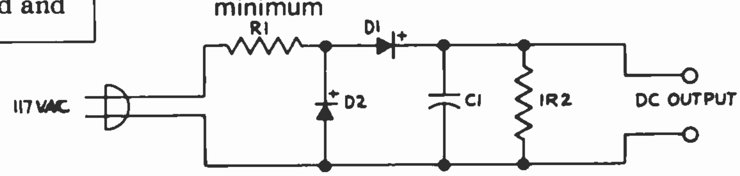
63. LO-HUM POWER SUPPLY

Just a handful of components are needed for a line-powered low-voltage low-current supply for powering audio preamplifiers.

The values for different voltage and current outputs are given in the Parts List. Pick the set you need and wire up. D1 and D2 are silicon rectifiers rated at a minimum of 200 PIV at any current.

PARTS LIST FOR LO-HUM POWER SUPPLY

D1, D2—Silicon rectifiers rated 200 PIV minimum



64. WILD WEST GUN FIGHT GAME

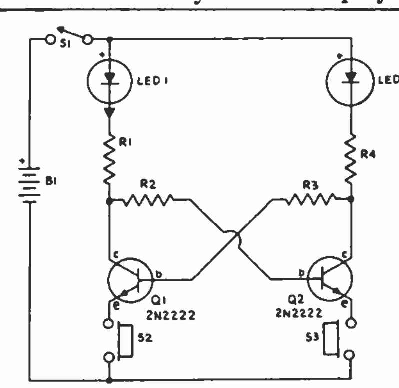
Okay, podner, the first one to push the button lights the light on his side, and blocks the other light from turning on.

You can yell "draw" by closing S1. But instead of a switch, you can find a trickier way of closing the contacts.

Try rolling a steel ball bearing down a channel with the contacts on the bottom. When the ball completes the circuit, go for your trigger buttons. Or you can just leave S1 closed. Once both "triggers" (S2 and S3) are released, this game is automatically set to be played again.

PARTS LIST FOR WILD WEST GUN FIGHT GAME

B1—6.15 VDC battery
LED1, LED2—Light emitting diodes
Q1, Q2—NPN transistors (2N2222 or similar)
R1, R4—150-390-ohms, ½-watt, 10% resistor
R2, R3—22,000-56,000-ohm, ½-watt, 10% resistor
S1—SPST switch (see text)
S2, S3—Normally open momentary or micro, switches

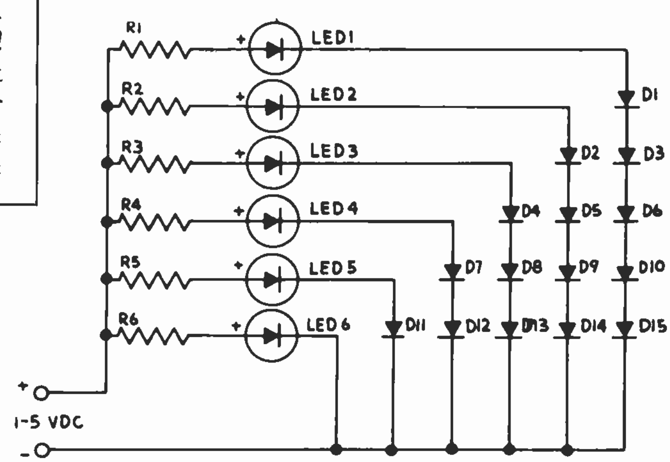


65. LED BAR GRAPH DISPLAY

This circuit takes advantage of the forward voltage drop exhibited by silicon diodes. Each leg of the circuit shows a light emitting diode in series with a current limiting resistor and a different number of diode voltage drops, from 0 to 5. You may use any kind of diode you wish, including germanium, silicon, even expensive hot carrier types (although they won't exhibit quite as much drop, they're very expensive, and too large a current could burn them out).

Depending on the diodes you choose, each will exhibit a forward voltage drop between 0.3 and 0.7 volts! For consistency, stay with diodes of the same type, or at least the same family. Those twenty-for-a-dollar "computer" diodes will do just fine. To expand the range of this LED "meter," use two resistors as a volt-age divider at the input. Connect one across the + and - terminals, the other from the + terminal to the voltage being measured. The LEDs will then be monitoring a range determined by the ratio of those resistors, as determined by this formula:

The voltage across the input, divided by the sum of the resistances and multipled by the voltage being measured. Or:



PARTS LIST FOR
LED BAR GRAPH DISPLAY

D1-15—Silicon diodes (such as 1N914)
R1, R2, R3, R4, R5, R6—120-270-ohm resistors, ½-watt
LED1, LED2, LED3, LED4, LED5, LED6—Light emitting diodes

66. SLIDE SHOW STOPPER

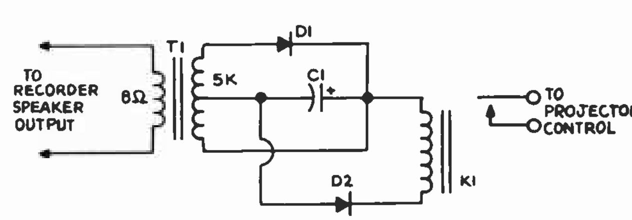
Soundless slide shows are dull, dull, dull! But a stereo recorder can automate the whole show so slides change automatically in step with the commentary.

Record your commentary on the left track. At the instant you want slides to change, record a one-second noise or tone burst on the right track. Connect the programmer between the recorder's right speaker output and the projector's remote control cable. Make a test run to determine the right-track volume setting to make noise or tone bursts activate relay K1. No fancy tone generators needed here. Just give a hearty Bronx cheer into the mike of the left channel only!

Then start the tape from the beginning. The audience will hear your commentary or spectacular music-and sound reproduction through a speaker connected to the recorder's left channel, while the signal on the right channel automatically changes the slides.

PARTS LIST FOR
SLIDE SHOW STOPPER

C1—25-uF, 50-WVDC electrolytic capacitor
D1, D2—1-A/400-PIV silicon rectifier, Motorola 1N4004
K1—2500-ohm coil plate-type relay
T1—5000-ohm, CT, audio-output transformer



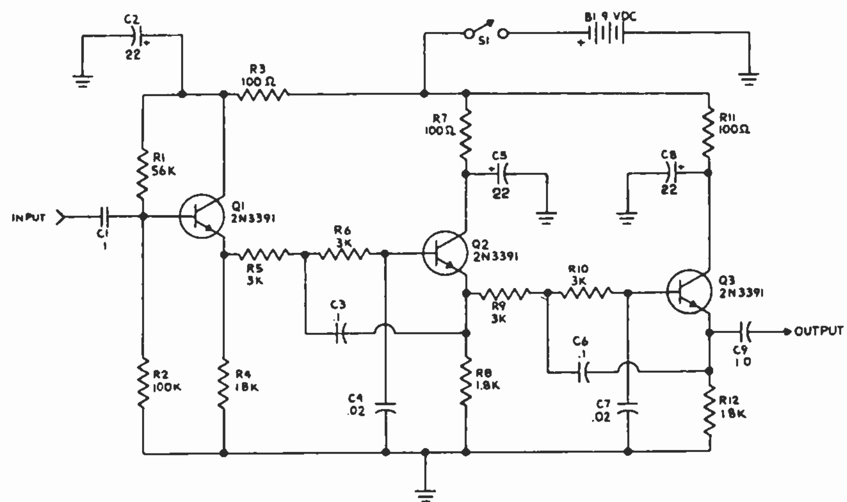
67. LOW-PASS AUDIO FILTER

If you own an old inexpensive receiver, chances are it could use a little extra selectivity. In that case, you should consider adding a filter. You could add an IF filter, but it's probably easier, and certainly less expensive, to tack on the simple low-pass audio filter diagrammed here. With the constants shown, it has a corner frequency of 1000 Hz—perfect for CW (code) reception. For voice, reduce the values of R5, R6, R9 and R10 to 1200-ohms. The filter's voltage gain is unity (1) so it won't upset things no matter where you insert it. In put impedance is about 30K-ohms—high enough to cause negligible loading.

To install the filter, break into the receiver's audio chain at some convenient point—preferably at a point where the audio voltage is small, say, 1-volt peak-to-peak or less. You may wish to include a bypass switch, too. This will allow you to shunt the signal around the filter and restore the original performance of the receiver.

PARTS LIST FOR LOW-PASS AUDIO FILTER

B1—6 to 12-volt battery
C1, C3, C6—0.1-uF, 25 WVDC mylar capacitor
C2, C5, C8—22-uF, 20-WVDC tantalum capacitor
C4, C7—0.02-uF, 25-WVDC mylar capacitor
C9—1.0-uF, 25-WVDC non-polarized mylar capacitor
Q1, Q2, Q3—2N3391 NPN transistor
Note: All resistors rated ½-watt, 5% tolerance unless otherwise noted.
R1—56,000-ohms
R2—100,000-ohms
R3, R7, R11—100-ohms
R4, R8, R12—1,800-ohms
R5, R6, Ro, R10—3,000-ohms
S1—SPST toggle switch



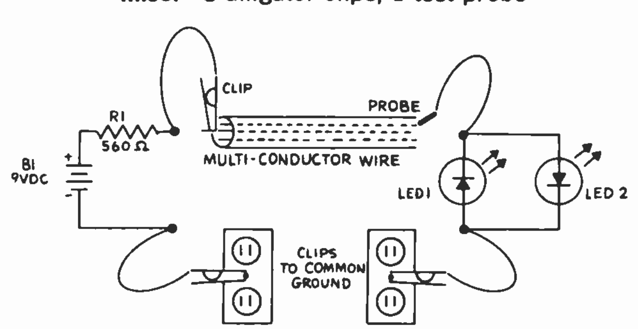
68. WIRE TRACER

Problem! You've just snaked a multi-wire computer and/or intercom cable through two floors, five bends, and two "pull" boxes, and you have the creepy feeling that one of the wires broke in the process. Then, you discover upon trimming away the outer jacket, that all of the wires are the same color. What to do? Simple, just check 'em all with this simple wire tracer. Clip one end of the LED1/LED2 circuit to the same ground source, and touch the other end to each wire. When you find the wire being tested, one of the two LEDs will light.

It doesn't matter which LED lights. We use two only to prevent confusion in the event a polarity gets reversed. This way, one LED is certain to light. The LEDs can be any "general purpose" type available. Battery B1 is a 9-volt transistor radio-type.

PARTS LIST FOR WIRE TRACER

B1—9-volt transistor radio battery
LED1, LED2—general purpose LED, 0.02 mA
R1—560-ohm, ¼-watt resistor
Misc.—3 alligator clips, 1 test probe



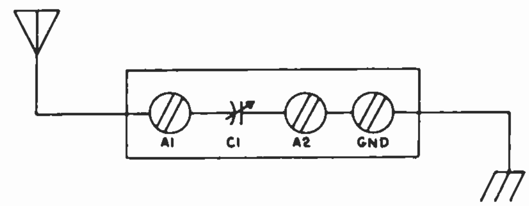
69. ADD AN ANTENNA TRIMMER

One part? That's all, but it can make a big difference in your shortwave listening. The American Radio Relay League's ARRL Handbook the ham operator's "bible," can help you understand the complex nature of radio waves and how this circuit (is one part a circuit?) helps your antenna match your receiver at any given frequency.

But for right now, all you need to know is that when you add this trimmer (or connect it to these leads through coax, but only a very short length), you can adjust it to make your receiver really hot wherever it's tuned. It works by helping your receiver take advantage of all the signal your antenna can pick up. Try it and see.

PARTS LIST FOR ADD AN ANTENNA TRIMMER

C1—60-pf trimmer



70. SHORTWAVE LOW-BAND CONVERTER

Ever listen in on the long waves, from 25-500 kHz? It's easy with this simple converter. It'll put those long waves between 3.5 and 4.0 MHz on your SWL receiver.

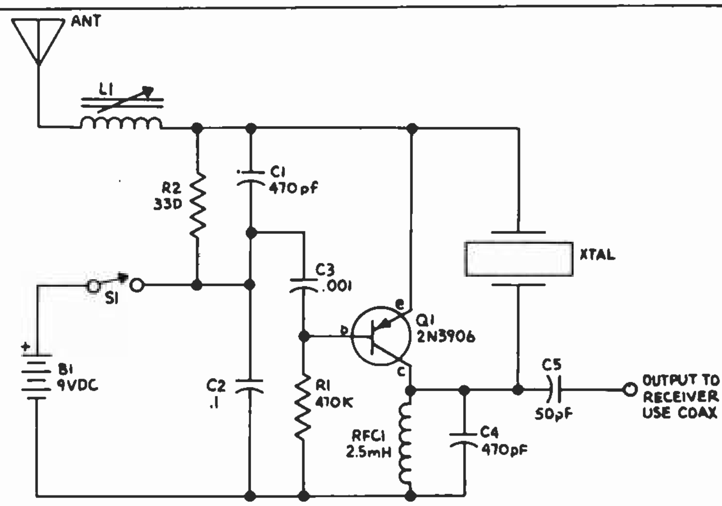
Q1 acts as a 3.5 MHz crystal oscillator, mixing the crystal frequency with the long wave input from the antenna and forwarding the mix to your receiver.

L1 is a standard broadcast loopstick antenna coil. The crystal is available from many companies by mail order, or is likely to be at a ham radio store near you. You could also use a 3.58 MHz TV color crystal.

Adjust the slug of L1 for your best signal after tuning to a strong station.

PARTS LIST FOR SHORTWAVE LOW-BAND CONVERTER

B1—9VDC battery
C1, C4—470-pF capacitor
C2—.1-uF capacitor
C3—.001-uF capacitor
C5—50-pf capacitor
L1—Loopstick coil, BCB type
Q1—PNP transistor, 2N3906 or equiv.
R1—470,000-ohm resistor, ½-watt
R1—330-ohm resistor, ½-watt
RFC1—2.5 mH choke
S1—SPST switch
XTAL—3.5 MHz crystal



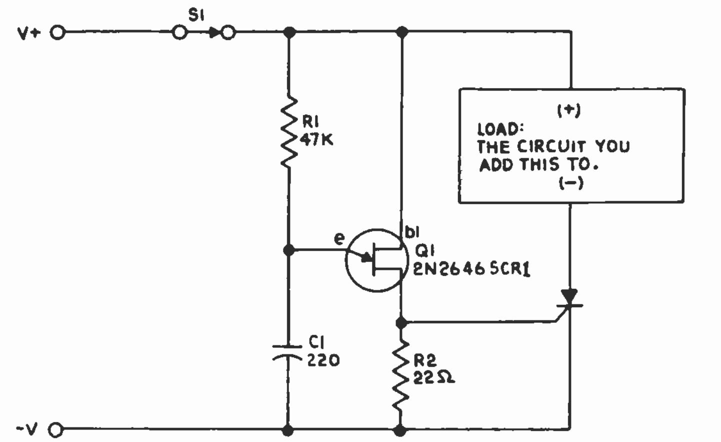
71. TURN-ON DELAY

Turn the switch on and the circuit you're controlling (LOAD) won't turn on until 10 seconds later with this UJT delay. The SCR is the "switch" that eventually permits current to flow through the load. But the SCR won't turn on until the UJT timer circuit delivers a pulse to its gate. This happens after a time delay determined by the product.

Choose a value for SCR1 that can easily handle the maximum current the load will draw, plus a margin for safety, and the voltage of the power supply, plus a margin for safety. For a 9-12 Volt circuit drawing up to ⅛ amp or so, a 20 Volt 1 Amp SCR should do nicely. Since S1, when turned off, interrupts the flow of current through the SCR, turn-off for the load happens immediately.

PARTS LIST FOR TURN-ON DELAY

C1—220-uF, 250WVDC electrolytic capacitor
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—47,000-ohm, ½-watt, 10% resistor
R2—22-ohm resistor, ½-watt
SCR1—See text
S1—SPST



72. HANG-UP BURGLAR ALARM

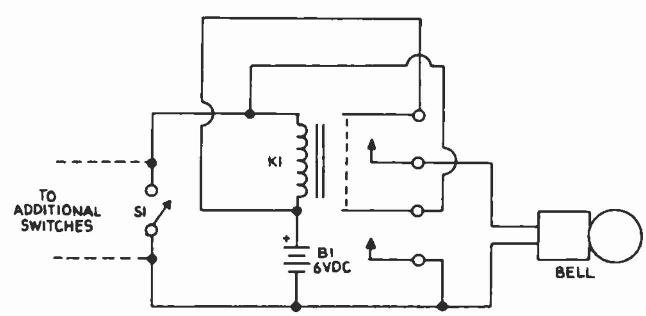
Open a fancy commercial burglar alarm and all you'll find inside is this ordinary relay latching hang-up circuit.

The input terminals are connected to parallel-wired normally open (N.O.) magnetic switches, or wire-type security switches stretched across a window that **close** a bell contact circuit when the wire is pushed or pulled.

When a security switch closes the series battery circuit, relay K1 pulls in. One set of contacts closes the alarm bell circuit, while the second set "latches" the battery circuit. Even if the security switches are opened, the alarm remains on. To disable the alarm, or for reset, install a concealed switch in series with one battery lead.

PARTS LIST FOR HANG-UP BURLAR ALARM

B1—6-V lantern battery
K1—6-VDC dpst relay
BELL—6-VDC alarm bell
S1—SPST n.o. switch

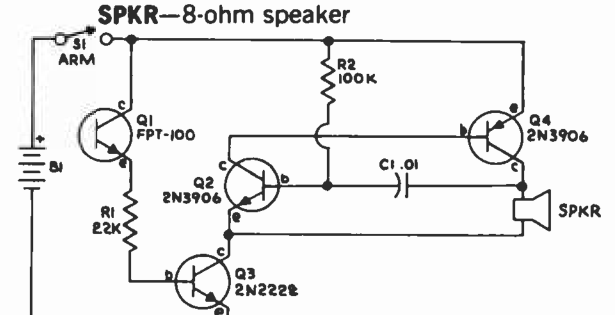


73. ATTACHE ALARM

Who knows what evils lurk, ready to pilfer the Twinkies out of your attache case when you're not looking? This squealer does. Because when you arm the alarm by turning on S1, the lightest touch will set it off. More accurately, the touch of light. Light striking Q1 turns on transistor switch Q2, which energizes oscillator Q3-Q4. And that blows the whistle.

PARTS LIST FOR ATTACHE ALARM

B1—9 VDC battery
C1—.01-uF capacitor
Q1—Photoelectric transistor, FPT-100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
Q3—NPN transistor, 2N3904 or equiv.
Q4—PNP transistor, 2N3906 or equiv.
R1—2200-ohm, ½-watt, 10% resistor
R2—100,000-ohm, ½-watt, 10% resistor
S1—SPST switch
SPKR—8-ohm speaker



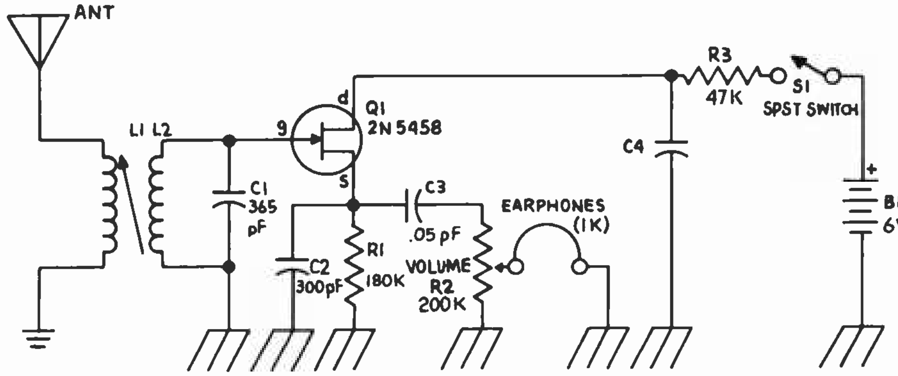
74. HIGH PERFORMANCE TRANSISTOR RADIO

Here's a neat way to update your crystal set, assuming you can still find it. Or use these few inexpensive parts to build from scratch. Instead of using a cat's whisker or a diode, this radio uses the very sensitive junction of a junction FET as its detector. This makes it a very "hot," very sensitive high impedance detector. Then the JFET does double duty by converting the high input impedance to a lower output impedance—low enough and with enough drive to power a set of high impedance headphones or a high impedance earphone (about 1K or so).

The antenna coil is one of those simple loopsticks you've seen at the parts stores. (Or you might want to wind your own on an oatmeal box.) The broadcast variable capacitor is one of the tuning capacitors taken from and old, defunct radio. You can use any long wire for the antenna, but if you string it outdoors, be sure to use a lightning arrestor. You can also clip an alligator clip to your bedspring, a windowscreen, or the metal part of a telephone.

PARTS LIST FOR HIGH PERFORMANCE TRANSISTOR RADIO

B1—6-15 VDC battery
C1—Approx. 356-pF broadcast-type variable capacitor
C2—300-600-pF capacitor
C3—.05-.5-uF capacitor
C4—.22-1.0-uF capacitor
L1/L2—Ferrite loopstick, or ferritebar BCB antenna coil
Q1—N-channel JFET (Junction Field Effect Transistor) (2N5458, MPF102 or eqiv.)
R1—18,000-47,000-ohm resistor, ½-watt
R2—20,000-100,000-ohm potentiometer
R3—4700-10,000-ohm resistor, ½-watt

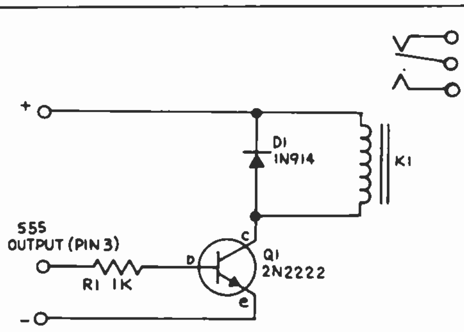


75. 555 SWITCH HITTER

The 555 integrated circuit is a very versatile timer when you need a time delay or any kind of regular timed event. But if you try to draw more than 100 or 200 milliamps through it, you'll soon be drawing a blank and a new 555 from your parts drawer. With these simple additions, you can draw as many amps as your relay's

PARTS LIST FOR "555" SWITCH HITTER

D1—Diode, 1N914 or equivalent
Q1—NPN transistor, 2N2222 or equivalent
R1—1000-ohm, ½-watt, 10% resistor
K1—Relay, (rated at least equal to system voltage)



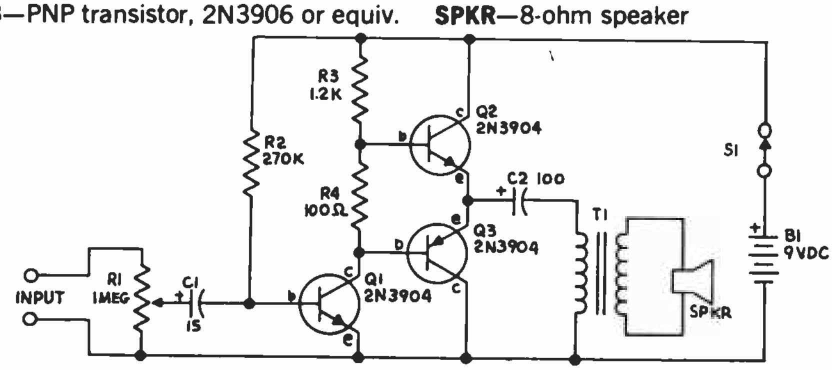
contacts will carry. Q1 acts as a relay driver, triggered by the output of the 555 (pin 3) through a 1000 Ohm resistor (R1). Relay K1 can be driven from the 555's power supply (choose an appropriate coil voltage for K1) or from a separate positive power supply if the 555's supply can't handle the extra load. Q2 can handle up to 800 milliamps itself, so any relay coil that draws less than that (100 Ohms or so more than satisfies this) will work fine. Similarly, other loads can be substitutded for K1-D1.

76. AUDIO UTILITY AMP

This circuit may look familiar if you're in the habit of glancing at the schematics of your portable radios and recorders. This is a very popular way of getting a signal to a speaker. Transistor Q1 acts as a driver for complentary pair Q2 and Q3. Q2 and Q3 take turns conducting as they follow the input signal, so they can

PARTS LIST FOR AUDIO UTILITY AMP

B1—9 VDC battery
C1—15-uF electrolytic capacitor, 15 VDC (or greater than needed)
C2—100-uF electrolytic capacitor, 15 VDC (or greater than needed)
Q1, Q2—NPN transistor, 2N3904 or equiv.
Q3—PNP transistor, 2N3906 or equiv.
Note: All fixed resistors are ½-watt, 10%
R1—1-Megohm potentiometer
R2—270,000-ohm resistor
R3—1200-ohm resistor
R4—100-ohm resistor
S1—SPST switch
T1—500:8-ohm matching transformer
SPKR—8-ohm speaker



deliver a healthy signal through C2 to T1. T1 is suggested to reduce the loading that a low speaker impedance would cause if connected directly ' .1 C2 and ground; a higher impedance speaker or headphone could connect directly.

You can also use this circuit as a signal tracer to listen in on what's happening inside some of the other circuits on these pages. Just clip a lead between the minus leads of both projects and use one lead of a .01 microfarad capacitor in series with the input as a probe.

77. LAMP DIMMER

Using almost all "junk box" parts, or those easily found at local parts distributors, this budget-priced lamp dimmer can be assembled directly inside a lamp socket, lamp base, or electrical outlet box (replacing a wall switch).

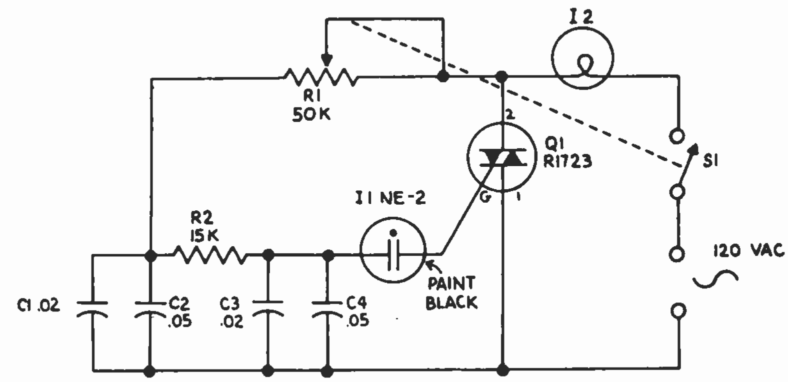
Triac Q1 can handle up to 75-watts without a heat sink. Over 75 watts, sink Q1 to the metal enclosure, or a small heat sink insulated from the socket (if you build the dimmer into a socket). If you mount Q1 on the enclosure, make certain none of the Triac's leads "short" to the enclose. Use silicon heat sink grease between Q1 and the sink.

I1 is an ordinary NE-2 neon lamp. If it will somehow be exposed to light, paint the lamp black, or some other opaque color. (I1's "trigger" voltage threshold is affected by light.)

Because the neon lamp has a firing threshold above zero volts, the lamp cannot be turned fully off with the control. Rather, switch S1 snaps the lamp on to a very subdued brilliance which can be faded up to almost maximum lamp brilliance. Make certain R1 is wired so it is a maximum resistance just before S1 switches from on to off.

PARTS LIST FOR LAMP DIMMER

C1, C3—0.02-uF, 50 WVDC ceramic disc capacitor
C2, C4—0.05-uF, 50 WVDC ceramic disc capacitor
I1—NE-2 neon lamp
I2—75-watt or smaller standard lighting fixture
Q1—HEP-R1723 Triac
R1—50,000-ohm, linear taper potentiometer
R2—15,000-ohm, ½-watt, 10% resistor
S1—SPST switch (part of R1)



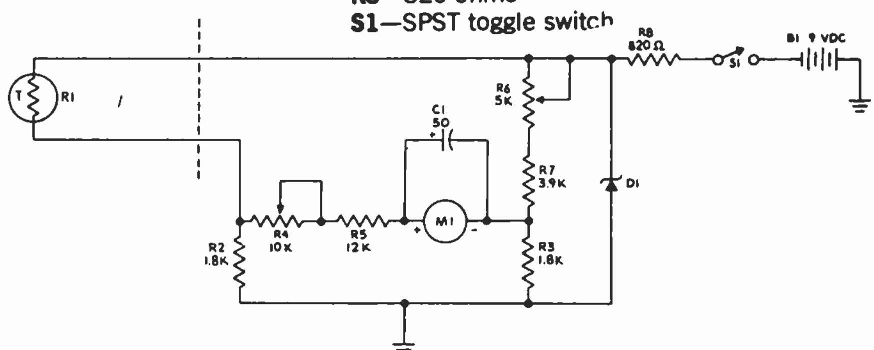
78. OUTDOOR THERMOMETER

With this electronic thermometer you can be sitting by a nice, cozy fire and reading the temperature outdoors, however frigid it may be, without ever catching a chill yourself. The circuit is a simple one based on a readily available Fenwal thermistor (Burstein-Applebee, among others, sells them). For the sake of accuracy, only thermistor R1 should be exposed to temperature extremes; the rest of the components should be kept indoors in an environment where the temperature is reasonably constant.

To calibrate, you'll need a thermometer of known accuracy and access to temperatures near 0° and 100° F, the lower and upper limits respectively of this thermometer's range. Set R4 and R6 to their midpoints. Subject R1 to the hot temperature and adjust R4 until M1 reads the correct temperature. Now subject R1 to the cold temperature and adjust R6 to get the right reading on M1. Because the two adjustments interact, repeat the entire procedure two more times.

PARTS LIST FOR OUTDOOR THERMOMETER

B1—9-volt transistor battery
C1—50-uF, 16 WVDC electrolytic capacitor
D1—1N746A, 3.3-volt, ½-watt Zener diode
M1—0 to 100 microamp DC ammeter
Note: All resistors rated ½-watt, 5% tolerance unless otherwise noted.
R1—thermistor rated 1,000-ohms @ 25° C (Fenwal part #JB31J1)
R2, R3—1,800-ohms
R4—10,000-ohm trimmer potentiometer
R5—12,000-ohms
R6—5,000-ohm trimmer potentiometer
R7—3,900-ohms
R8—820-ohms
S1—SPST toggle switch



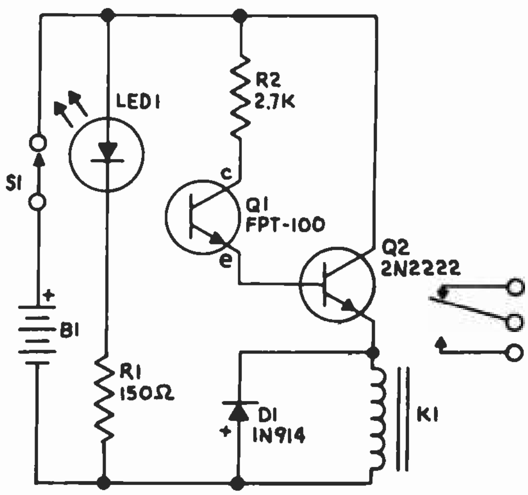
79. PHOTOELECTRIC SNITCHER

How would you like to know whether or not the postal person brought you any post? Or how about a circuit to start something going whenever you put a card in a slot? That's what this little photorelay is all about. Whenever the phototransistor sees the LED, it pulls up the base of relay driver Q2 and pulls in the relay. Stick something between the LED and Q1 and the relay releases. D1 shunts out the relay's inductive kickback.

If you point the LED and Q1 in the same direction, they will act together as a reflective sensor. Then if anything comes close enough to bounce the light from the LED back into Q1 (assuming both are kept in the dark—any light will trigger Q1), the relay will pull in. The circuit can also be used without R1 and LED1 as a light-or no-light-operated alarm.

PARTS LIST FOR PHOTOELECTRIC SNITCHER

B1—12-VDC battery
D1—Diode, 1N914 or equivalent
K1—SPDT relay, 12-VDC
LED1—Light emitting diode
Q1—Phototransistor, FPT100 or equivalent
Q2—NPN transistor, 2N2222 or equivalent
R1—150-ohm ½-watt, 10% resistor
R2—2700-ohm ½-watt, 10% resistor
S1—SPST switch



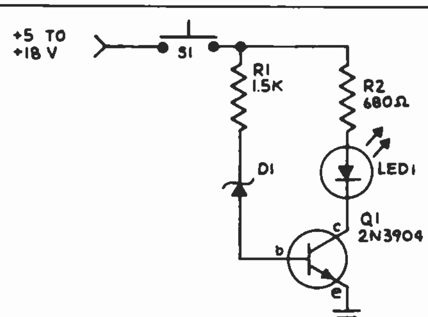
80. BATTERY MONITOR

Tired of playing guessing games with your batteries? With this battery-voltage monitor you'll know at a glance whether or not batteries need replacement. The circuit's compact size, which comes about because it's a meterless voltage monitor, makes it easy to build into an existing piece of equipment. To use the device, press S1 and, if LED1 lights up, your batteries are still good. If not, throw them away.

Transistor Q1's gain makes the monitor very sensitive to changes in voltage. Consequently, LED1 is either ON or OFF with little ambiguity most of the time. The voltage level being sensed is determined by Zener diode D1's rating and the base-emitter voltage drop of Q1. Specifically, the switching point is equal to the Zener voltage plus 0.75-volts. For example, a 5.6-volt Zener diode will wet the trip level at approximately 6.35-volts. The voltage level you choose should be less than the battery's nominal voltage when fresh. A 9-volt battery, for example, might be useless when its voltage drops to 7.5-volts; however, the exact point at which a battery becomes useless depends both on the battery and on the application. Finally, it's best to test the battery with a normal load current being drawn from it by the project or gear.

PARTS LIST FOR BATTERY MONITOR

D1—Zener diode (see text)
LED1—light emitting diode rated 20-mA @ 1.7-VDC
Q1—2N3904 NPN transistor
R1—1,500-ohm, ½-watt, 5% resistor
R2—680-ohm, ½-watt, 5% resistor
S1—Normally—open, SPST pushbutton switch



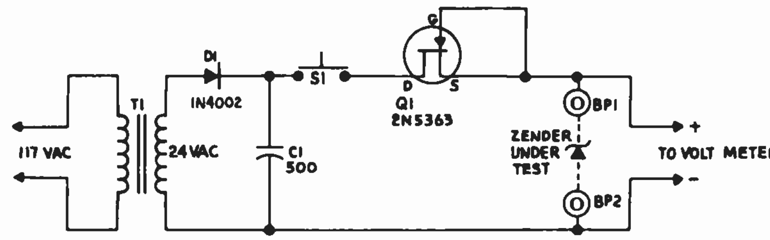
81. ZENER DIODE TESTER

If you're at all familiar with the surplus market, you know that zener diodes presently abound in surplus—at tremendous discounts, too. The problem with buying surplus, however, is that many diodes are unmarked or incorrectly marked. Consequently, these must be tested to verify their working voltages. Another problem crops up when you buy so-called "grab bags" of components. The zeners you find may be legibly marked, but unless you happen to have a data sheet for those particular diodes, they will require testing to identify the zener voltages. You can do your testing quickly and easily with the circuit presented here.

T1, D1 and C1 comprise a simple half-wave rectifer system. Pressing S1 sends a DC current through current limiter Q1 and the diode under test. Q1 regulates the current to a value of about 10 mA regardless of the zener voltage. You can use your VOM or voltmeter to monitor the voltage drop across the zener; values as high as 25-volts can be reliably tested in this circuit. If you get a very low reading, say 0.8-volts, you have the diode in reverse. Interchange the zener's connections.

PARTS LIST FOR ZENER DIODE TESTER

BP1, BP2—Multi-way binding posts
C1—500-uF, 50 WVDC electrolytic capacitor
D1—1N4002 diode
Q1—2N5363 n-channel JFET (junction field-effect transistor)
S1—Normally-open SPST pushbutton switch
T1—120-VAC to 24-FAC @ 300-mA power transformer



82. POWER TOOL TORQUE CONTROL

As the speed of an electric drill is decreased by loading, its torque also drops. A compensating speed control like this one puts the oomph back into the motor.

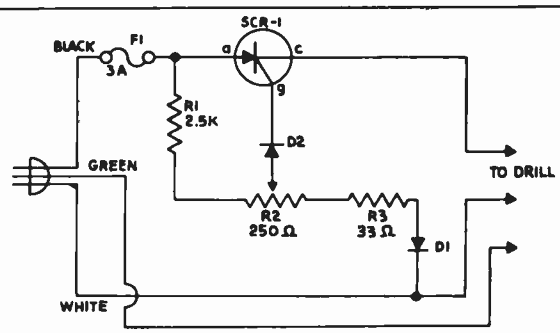
When the drill slows down, a back voltage developed across the motor—in series with the SCR cathode and gate—decreases. The SCR gate voltage therefore increases relatively as the back voltage is reduced. The "extra" gate voltage causes the SCR to conduct over a larger angle and more current is driven into the drill, even as speed falls under load.

The only construction precaution is an extra-heavy heat sink for the SCR. The SCR should be mounted in a ¼-in. thick block of aluminum or copper at least 1-in. square; 2-in. if you drill for extended periods.

Should your drill use a three-wire power cord, be sure to connect the green wire to avoid introducing a shock hazzard.

PARTS LIST FOR POWER TOOL TORQUE CONTROL

D1, D2—1A, 400 PIV silicon rectifier
F1—3-A "Slo-blo" fuse
R1—2500-ohm, 5-watt, 10% resistor
R2—250-ohm, 4-watt potentiometer
R3—33-ohm, ½-watt, 10% resistor
SCR1—8-A, 400-PIV silicon controlled rectifier



83. SHAPED OUTPUT CODE OSCILLATOR

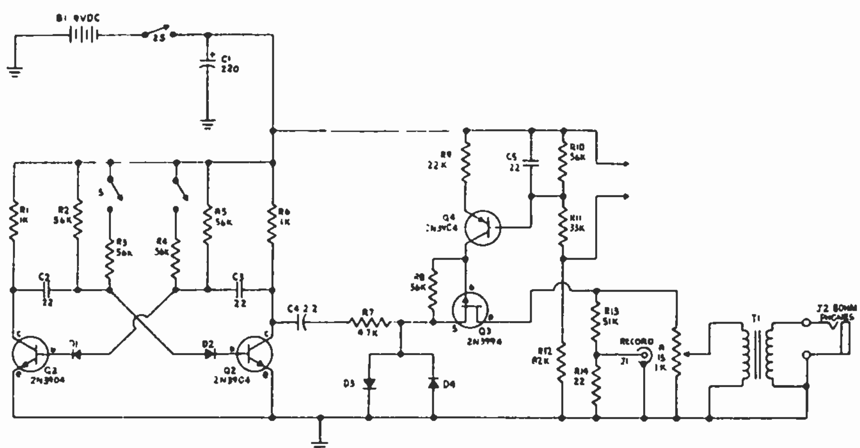
Most code-practice oscillators are keyed by switching the oscillator transistor's supply voltage on and off or by driving the transistor into and out of saturation. This has the advantage of being simple, and it provides tolerable results if a speaker is to be driven. However, the sound of a CPO is like Chinese water torture to the uninitiated, so public opinion usually dictates that you practice with headphones. What you hear then is the "kerchunk" that occurs each time the key is opened or closed. If you want a nice, pure tone signal devoid of "kerchunks," you have to shape the rise and decay of the tone. Here's a circuit that does just that.

The basic tone is generated by a multivibrator (Q1 & Q2) at a pitch determined by S1; low pitch with S1 open, high with S1 closed. This tone is fed through C4 to a clipper (D1, D2) and FET Q3, which functions as a signal attenuator. How much of a signal passes through the FET is determined by its gate potential, controlled by current source Q4 together with capacitor C5, the associated resistors, and your key. With the key down, the signal from Q3's drain is available for recording (J1) and for headphone listening (J2). R15 controls the volume.

Smaller values of C5 will yield a more abrupt attack and decay, while larger values can be used to produce mellower results. If you cannot find a 2N3994 FET for Q3, substitute a 2N5461. The great majority of these will work fine, but if you still hear a tone with the key up, try a different 2N5461.

PARTS LIST FOR CODE OSCILLATOR

B1—9-volt transistor battery
C1—220-uF, 25-VDC electrolytic
C2, C3—0.22-uF, 25-VDC mylar capacitor
C4—2.2-uF, 25-VDC mylar capacitor
C5—0.22-uF, 25-VDC mylar capacitor
D1, D2, D3, D4—1N914 diode
J1—RCA-type phono jack
J2—standard 2-conductor phone jack
Q1, Q2, Q4—2N3904 NPN transistor
Q3—2N3994 or 2N5461 p-channel JFET (junction field-effect transistor)
Note: All resistors rated ½-watt, 5% tolerance unless otherwise noted.
R1, R6—1,000-ohms
R1-R5, R8, R10—56,000-ohms
R7—4.700-ohms
R9—22,000-ohms
R11—33,000-ohms
R12—82,000-ohms
R13—51,000-ohms
R14—22-ohms
R15—1,000-ohm audio-taper potentiometer
S1—DPST slide switch
S2—SPST toggle switch
T1—1,000-ohm to 8-ohm audio transformer

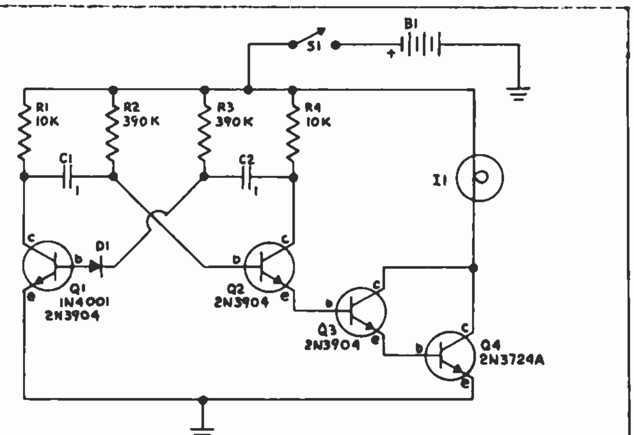


84. PORTABLE EMERGENCY FLASHER

For camping or highway emergencies, here is a solid-state light flasher that's compact and reliable. Q1, Q2 and the associated resistors and capacitors comprise a conventional 2-transistor multivibrator. Q2's emitter

PARTS LIST FOR PORTABLE EMERGENCY FLASHER

B1—6-volt lantern (heavy duty) battery
C1, C2—1.0-uF, 25-VDC non-polrized mylar capacitor
D1—1N4001 diode
I1—N82 lamp rated 6.5-VDC @ 1-amp
Q1, Q2, Q3—2N3904 NPN transistor
Q4—2N3724A NPN transistor
R1, R4—10,000-ohm, ½-watt, 5% resistor
R2, R3—390,000-ohm, ½-watt, 5% resistor
S1—SPST toggle switch



signal drives the Q3-Q4 Darlington pair, which turns on high-current lamp I1. The light flashes on for about 0.4-second, then darkens for about the same period of time before turning on again. Power for the circuit comes from a standard 6-volt lantern battery. You could probably build the entire flasher circuit inside the housing of your lantern, and actuate it only when necessary. If longer battery life is desired, and decreased illumination is acceptable, you could substitute a less power-hungry 6-volt lamp for I1.

85. PHOTOFLOOD DIMMER

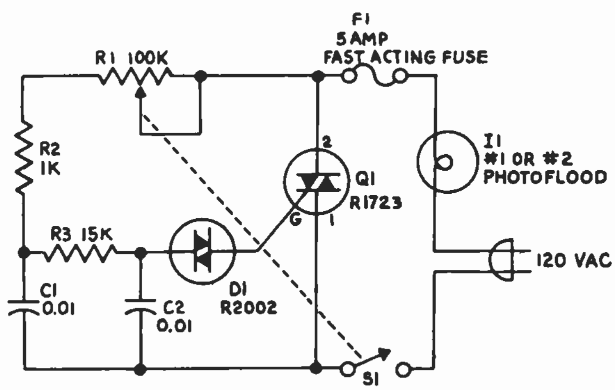
Professional quality photographic lighting requires complete control of the studio lights, and that's just what you'll get with the pro-type, full-range 500-watt dimmer. Each one can handle one 500-watt #2, or two 100-watt #1 photoflood lamps, and the lighting range can be adjusted from full off to full on.

Triac Q1 must be mounted to a large heat sink, preferably the metal cabinet used to house this dimmer. Make certain you insulate Q1 from the cabinet.

Fuse F1 **must** be used, otherwise, the surge current that occurs when 500-watt photofloods burn out will instantly destroy Q1. F1 must be a fast-acting fuse such as the type 8AG. The slower fuses such as the 3AG and the slo-blo offer no protection. Switch S1 is part of intensity adjustment R1, and R1 should be wired so it represents maximum resistance just before S1 switches off. (While S1 cannot normally handle a 500 watt load, in this circuit, it switches when the lamp is off and has no trouble handling any size photoflood.)

PARTS LIST FOR PHOTOFLOOD DIMMER

C1, C2—0.01-uF, 50-VDC cermaic disc capacitor
F1—8AG 5-Amp fast-acting fuse
D1—Diac, 30-V breakover, Radio Shack 276-1050
Q1—Triac, 6-A type, Radio Shack 276-1020
R1—100,000-ohm, linear taper potentiometer w/SPST switch
R2—1,000-ohm, ½-watt, 10% resistor
R3—15,000-ohm, ½-watt, 10% resistor
S1—SPST switch, part of R1

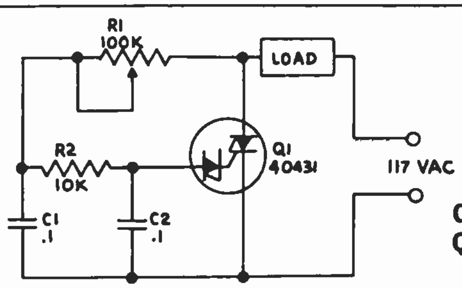


86. VARI-REV MOTOR CONTROL

Old universal appliance motors and shaded-pole induction motors salvaged from inexpensive turntables can be easily converted to slow-speed hobby drills, chemical stirrers, vari-speed turntables, moveable display drives, etc. It's done with a full-wave Triac speed controller.

Unlike other speed controllers, which require an external trigger device, Q1 combines both the Triac and Diac trigger diodes in the same case.

The motor used for the load must be limited to 6 amperes maximum (or 740 watts). Triac Q1 must be



PARTS LIST FOR VARI-REV MOTOR CONTROL

C1, C2—0.1-uF, 200-VDC capacitor
Q1—RCA 40431 Triac Diac
R1—100,000-ohm linear taper potentiometer
R2—10,000-ohm, 1-watt resistor

provided with a heat sink, which can be the metal cabinet. Build up a marblesize mound of epoxy on the cabinet and insert Q1's case into the epoxy. When the epoxy hardens the Triac's heat is dissipated to the cabinet. Make certain Q1's case is not shorted to the cabinet and is insulated by the epoxy.

With the component values shown on the parts list, the Triac controls motor speed from full **off** to full **on.**

87. SIDETONE OSCILLATOR

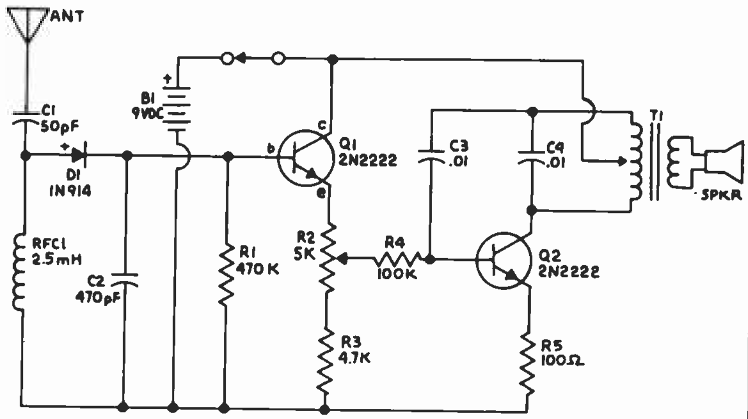
CW (continuous wave, the form of modulation involving a simple turning on and off of the RF carrier) is the simplest way for a beginning ham to transmit to his fellow hams. And the famous Morse Code is how he gets his message across. But Morse is a lot easier to send if you can hear what you're sending. This circuit lets you do just that.

A short length of wire near the transmitter picks up RF as it's transmitted and acts as the antenna for our circuit. This RF is detected by D1, smoothed by C2, and used to turn on and off, following the Q1 transmitter signal exactly. Q1 switches the positive supply through R2 to beep oscillator Q2 through the center tap of T1. The values shown produce a pleasant, easily distinguishable tone.

Q1, Q2—NPN transistor, 2N2222 or equiv.
R1—470,000-ohm resistor, ½-watt
R2—5000-ohm potentiometer
R3—4700-ohm resistor, ½-watt
R4—100,000-ohm resistor, ½-watt
R5—100-ohm resistor, ½-watt
RFC1—2.5-mH choke
T1—1000; 8-ohm transformer, center-tapped
SPKR—8-ohm speaker

PARTS LIST FOR SIDETONE OSCILLATOR

B1—9VDC battery
C1—50-pf capacitor
C2—470-pf capacitor
C3, C4—.01-uF capacitor
D1—Diode, 1N914

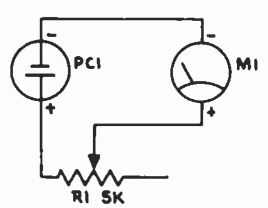


88. PHOTO PRINT METER

Every print a good print! That's what you get with the photo print meter.

Meter M1 can be just about anything up to 0-1 DC mA. But if you prefer low light levels and long exposures, install a sensitive meter of 500 uA or less.

When light from the enlarger falls on the solar cell (PC1), a voltage is generated that is in proportion to the amount of light. Sensitivity control R1 allows the user to set the meter indication to a convenient value.



PARTS LIST FOR PHOTO PRINT METER

M1—100,250, or 500-uA DC meter
PC1—Solar cell
R1—5000-ohm potentiometer linear taper

To use the meter, first make a good normal print in your normal manner from a No. 2 or No. 3 negative. Then, do not disturb the enlarger setting, but integrate the light by placing a diffusing disc or opal glass under the lens. Place the solar cell on the easel and adjust R1 for a convenient meter reading, say, full scale. The meter is now calibrated.

When using it, focus the enlarger, use the diffuser, and adjust the lens diaphragm until you get the reference meter reading. Then use the exposure time previously found for the calibration print. Suggested reading: Ilford Manual of Photography, obtainable from any photo store. Also, check Kodak publications available at the same place.

89. ADD-A-TWEETER

Any single-voice coil speaker is hard pressed to handle both low and high frequencies simultaneously—and it's the highs that suffer most. A much cleaner sound can usually be obtained from speakers 6 inches or larger if the highs are pumped through a tweeter. It can be any small speaker rated 4 to 6 ohms of approximately 2 to 3 inches in diameter.

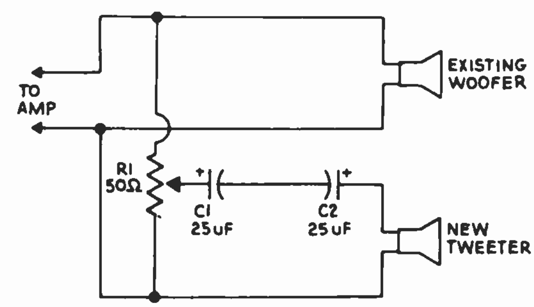
The back-to-back capacitors, C1 and C2, permit only the highs from about 1500 Hz up to pass into the tweeter. By keeping the lows out of the tweeter, the highs come out cleaner, and there's no chance of the greater low frequency power "blowing" the tweeter. Potentiometer R1 is used to match the tweeter's output level to that of the woofer—because small speakers are generally much more efficient than large speakers. If you eliminate R1, the highs will literally scream in your ears.

PARTS LIST FOR ADD-A-TWEETER

C1, C2—22-uF, 50-WVDC electrolytic capacitor

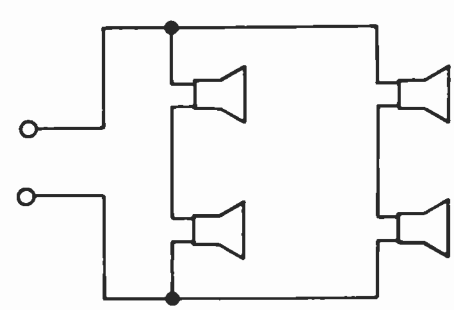
R1—50-ohm wirebound potentiometer, 1 or 2 watts.

Misc.—Cone type tweeters are suitable for use with this circuit.



90. SPEAKER SYSTEM EXPANDER

This neat arrangement lets you connect multiple speakers to your system's speaker terminals without upsetting the impedance match. This series-parallel arrangement of speakers exhibits the same impedance as a single speaker, assuming all speakers are of equal impedance and individually match the rating of the system. And inasmuch as the bass response of arrayed speakers is somewhat additive, you will find more bottom to your sound than any one of the speakers could have delivered alone. Of course, it takes more power to drive an array than a single speaker, but most modern music systems have plenty to spare.



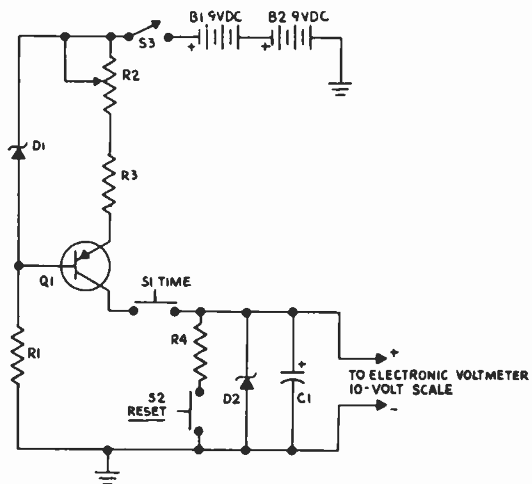
91. EVM TIMING ADAPTER

If, like many other experimenters, you own an electronic voltmeter—VTVM, FETVM or whatever—you might like to try this timely circuit. Connected to a high-impedance volt-meter set to read 10-volts DC full-scale, the adapter permits the measurement of time intervals up to 100-seconds long. Either analog or digital readouts are acceptable, although digital meters do have an edge as far as resolution is concerned. To convert voltage to time in seconds, just multiply by ten.

Referring to the schematic, it is apparent that when TIME button S1 is pressed, constant-current source Q1 will begin to charge timing capacitor C1. Since charging is being done by a constant current, the voltage across C1 rises linearly with time. Once S1 is released, the voltage on C1 remains "frozen" long enough for you to take a reading. Press S2 to discharge C1 before taking another measurement. Trimmer R2 can be adjusted so that 10-volts is reached in 100 seconds.

PARTS LIST FOR EVM TIMING ADAPTER

B1, B2—9-volt transistor battery
C1—10-uF, 20-WVDC tantalum capacitor
D1—1N748A 3.9-volt, ½-watt Zener diode
D2—1N749A 12-volt, ½-watt Zener diode
Q1—2N3906 PNP transistor
R1—2,700-ohm, ½-watt, 5% resistor
R2—10,000-ohm, ½-watt, 5% resistor
R3—27,000-ohm, ½-watt, 5% resistor
R4—100-ohm, ½-watt, 5% resistor
S1, S2—normally open SPST pushbutton switch
S3—SPST toggle switch



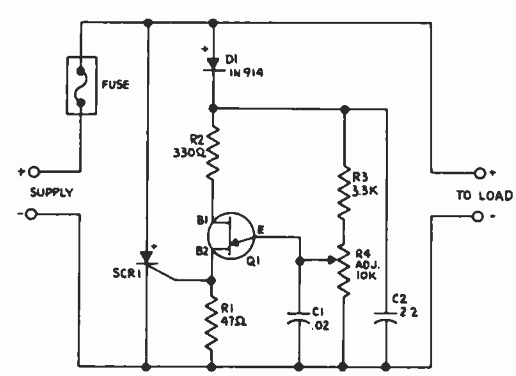
92. ADJUSTABLE CROWBAR

This crowbar circuit takes advantage of the electrically well-defined switching point of UJT (unijunction transistor) Q1. Q1's actual trip point voltage is set by trimmer R4. The Q1 circuit is isolated from the load by D1. When Q1 conducts, it triggers SCR1, shorting the supply and blowing the fuse. Choose SCR1 to handle more than the rated fuse current at the maximum supply voltage.

To test for your trip point (when setting it, for example), disconnect the LOAD. Substitute a lamp of the proper voltage (the supply voltage or a little more) for the fuse. Set the voltage at the supply voltage terminals for the trip point you desire, then adjust R4 until the test lamp just lights.

PARTS LIST FOR ADJUSTABLE CROWBAR

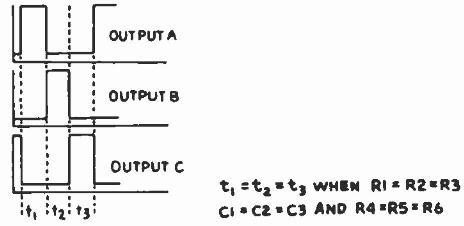
C1—.02-uF capacitor
C2—2.2-uF capacitor
D1—Diode, 1N914 or equiv.
R1—47-ohm, ½-watt, 10% resistor
R2—330-ohm, ½-watt, 10% resistor
R3—3300-ohm, ½-watt, 10% resistor
R4—10,000-ohm trimmer potentiometer
Q1—UJT (Unijunction Transistor) 2N2646 or equiv.
SCR1—See text



93. SQUARE-WAVE GENERATOR

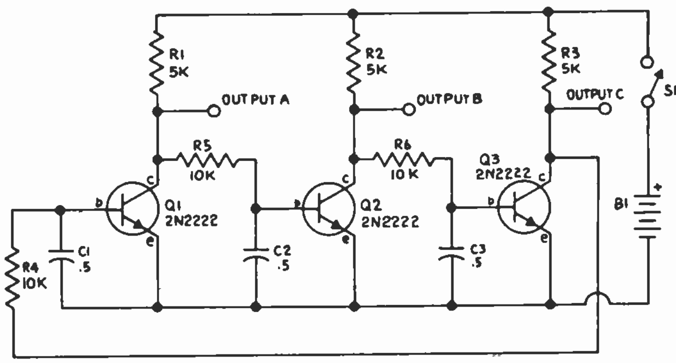
Here is a versatile square wave generator capable of surprising performance. It can deliver clock or switching pulses, act as a signal source, and more. And because the outputs take turns switching, it can be used as a simple sequence generator or as a multiple-phase clock.

The component values indicated will support a range of output frequencies from a few pulses per second up into the high audio range. And this square wave output is rich in harmonics. If you use a 5-volt power supply, this circuit can trigger TTL IC's.



PARTS LIST FOR SQUARE-WAVE GENERATOR

B1—6.15 VDC battery
C1, C2, C3—.5 uF capacitor
Q1, Q2, Q3—NPN general purpose transitor (2N2222, 2N3904 or equiv.)
R1, R2, R3—500-2700-ohm, ½-watt resistor
R4, R5, R6—10,000-47,000-ohm, ½-watt resistor
S1—SPST switch



94. SPEAKER-MIKE

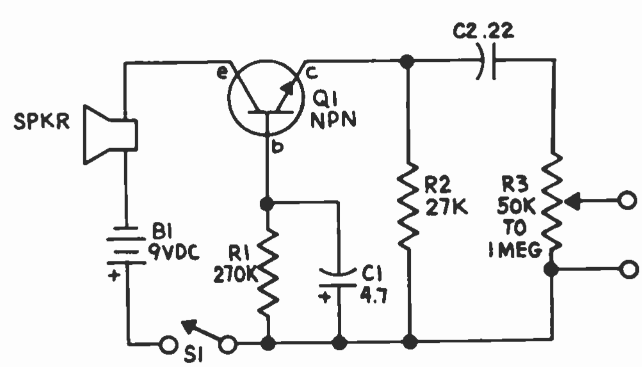
A "junk box" speaker and a general purpose transistor, plus a few other "general purpose" components are all that are required for a high-output microphone substitute. While not hi-fi quality by any stretch of the imagination, the Speaker-Mic handles voice frequency signals very well.

Transistor Q1 can be just about any general-purpose NPN with a beta of about 50 to 150. The speaker can be anything you have lying around of virtually any impedance rating in the range of 3.2 to 42-ohms. If the entire circuit, including battery, is assembled in a small metal enclosure, you'll end up with a hand-sized "amplified microphone."

The volume level is adjusted with potentiometer R3, which can be any audio taper unit from 50,000-ohms to 1-megohm. You can substitute a linear taper potentiometer if you have one lying around, but you'll find the adjustment range is scrunched together on one end of the shaft's rotation.

PARTS LIST FOR SPEAKER-MIC

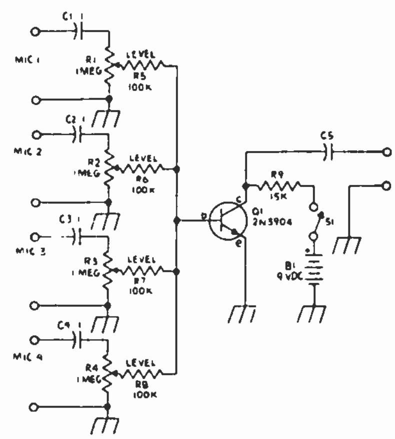
B1—9-volt transistor radio battery
C1—4.7-uF, 10-WVDC electrolytic capacitor
C2—0.22-uF, 10-WVDC mylar capacitor
Q1—general purpose NPN transistor, see text
R1—270,000-ohm, ½-watt 107. resistor
R2—27,000-ohm, ½-watt 107. resistor
R3—audio taper potentiometer, see text
S1—SPST switch



95. LOW-IMPEDANCE MIKE MIXER

There's no reason to limit yourself to using one mike at a time when you have this circuit to help you with your recording—or any other purpose. You can set up a small microphone mixing console. For pizzazz, you could use slide-style controls for R1-4; for miniaturization, you could use tiny trimmer resistors.

Each control adjusts the level of its associated microphone as they are mixed together. This gives you the versatility of making one mike louder or softer without upsetting the level of any of the others. Transistor Q1 provides a bit of amplification to compensate for losses in mixing, and to assure good level at the input.



PARTS LIST FOR LOW-IMPEDANCE MIKE MIXER

B1—9 VDC battery
C1, C2, C3, C4—.1-uF capacitor
C5—10-uF, 15-WVDC capacitor
Q1—PNP transistor, 2N3904 or equiv.
R1, R2, R3, R4—1-Megohm potentiometer, audio taper
R5, R6, R7, R8—100,000-ohm, ½-watt, 10% resistor
R9—15,000-ohm, ½-watt, 10% resistor
S1—SPST switch

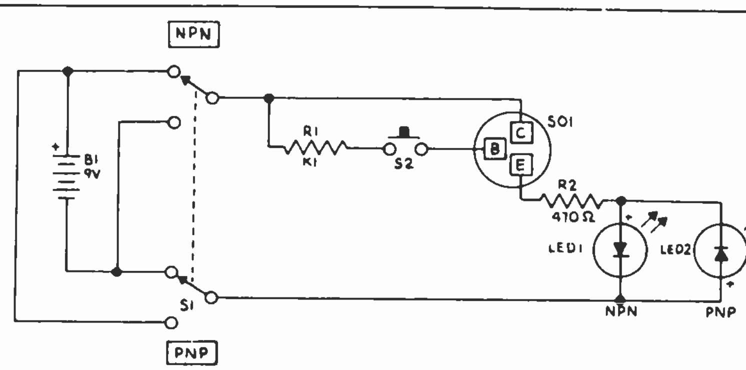
96. TRANSISTOR CHECKER

It's poushbutton-easy to check transistors with this tiny marvel. Just plug the transistor in and push S2. If it's good and you wet the PNP-NPN switch S1 properly, the appropriate LED will light.

Don't know the type? That's okay. Plug it in and try both S1 switch positions while you watch for the appropriate LED to light. You can even test diodes using the collector-emitter leads on the socket. The collector-emitter leads can also be used to check continuity.

PARTS LIST FOR TRANSISTOR CHECKER

B1—9 VDC battery
LED1, LED2—Light emitting diode
R1—1000-ohm resistor, ½-watt
R2—470-ohm resistor, ½-watt
S1—DPDT switch
S2—Momentary push button switch
S01—Transistor socket



97. CONSTANT-CURRENT OHMS ADAPTER

Ever notice how confusing it is to read the OHMS scales on your multimeter? The numbers are so crowded together at the high end that meaningful readings are almost impossible to make. Top-of-the-line meters get around the problem by employing a constant-current source, and so can you with this adapter. You'll be able to read resistances accurately and unambiguously on the **linear** voltage scales of your meter.

In the schematic diagram, note that the resistor under test is tied between BP1 and BP2. Whenever S2 is pressed, a regulated current flows out of Q1's collector and through the resistor. By Ohm's Law, this current generates a voltage across the resistor that's directly proportional to its resistance. Any one of five test currents—from 10-mA to 0.001-mA—can be selected via S1.

To calibrate the test currents, hitch a multimeter to the adapter's output terminals; make sure the meter is set to measure current. Press S2 and adjust the trimmers one at a time to obtain the five required currents. No resistor should be connected to BP1 and BP2 during calibration.

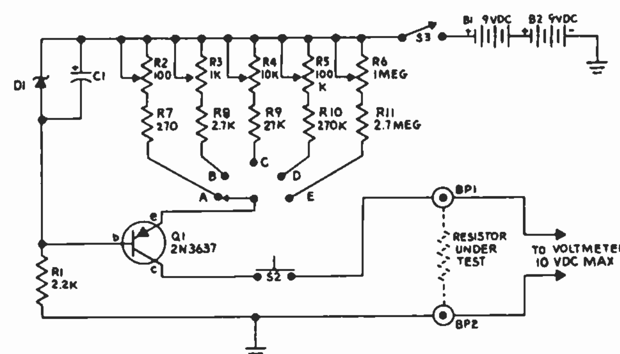
When measuing resistance, use the following conversion formula:

$$\text{Resistance (kilOhms)} = \frac{\text{Voltage}}{\text{Current (mA)}}$$

For example, a resistor that produces a 7.56-volt reading when fed a current of 0.01-mA must have a resistance of 756-kilohms (756K). Use smaller currents with larger resistances, and don't exceed a level of 10-volts during testing. If you do, switch S1 to the next smaller current. Finally, for best accuracy, make sure that the imput resistance of your meter is much greater than that of the resistor under test. With a 10-Megohm meter, the resistor under test should be no larger than 1-Megohm to keep errors under 10%.

PARTS LIST FOR CURRENT OHMS ADAPTER

B1, B2—9-volt transistor battery
BP1, BP2—binding posts
C1—10-uF, 20-VDC tantalum capacitor
D1—1N748A, 3.9-volt, ½-watt zener diode
Q1—2N3676 PNP transistor
Note: All resistors rated ½-watt, 5% tolerance unless otherwise noted.
R1—2,200-ohms
R2—100-ohm trimmer potentiometer
R3—1,000-ohm trimmer potentiometer
R4—10,000-ohm trimmer potentiometer
R5—100,000-ohm trimmer potentio meter
R6—1,000,000-ohm trimmer potentio-meter
R7—270-ohms
R8—2,700-ohms
R9—27,000-ohms
R10—270,000-ohms
R11—2,700,000-ohms
S1—single pole, 5-position rotary switch
S2—normally open SPST pushbutton switch
S3—SPST toggle switch

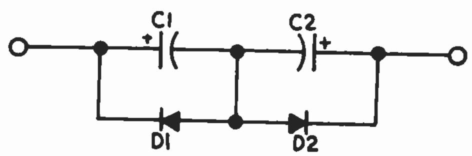


RANGE	CURRENT
A	**10 mA**
B	**1 mA**
C	**0.1 mA**
D	**0.01 mA**
E	**0.001 mA**

98. HOME MADE NPO CAPACITOR

From time to time, all of us encounter circuits that require, large, **non-polarized** capacitors. Unfortunately, these are scarcer than the proverbial hen's teeth. Looking through some catalogs, you'll soon discover that capacitors larger than 10-uF are usually electrolytics, which are polarized devices. Electrolytic capacitors cannot be used in AC circuits, where the voltage undergoes periodic reversals in polarity. Such reversals destroy the insulating layer between the plates of an electrolytic capacitor, and the device soon fails.

So what can be done when you need a non-polarized capacitor for a hi-fi crossover or a motor-starting circuit, and all that you can find are electrolytics? One alternative is to get some aluminum foil and roll your own, but there's an easier way. Just hook two electrolytics back-to-back as we've diagrammed here, then add two current-steering diodes. These diodes ensure that each capacitor sees only voltage of the correct polarity. C1 and C2 should be identical, and each one should have a capacitance equal to the value needed for proper circuit operation. Make sure that the capacitors have working voltages equal to about three times the RMS value of the AC voltage in the circuit. Also, choose diodes having a PIV rating greater than or equal to the capacitor's rating.



PARTS LIST FOR HOME MADE NPO CAPACITOR

C1, C2—identical elecrolytic capacitors
D1, D2—idential silicon rectifiers
Note: Be sure to match voltage ratings of rectifiers and capacitors.

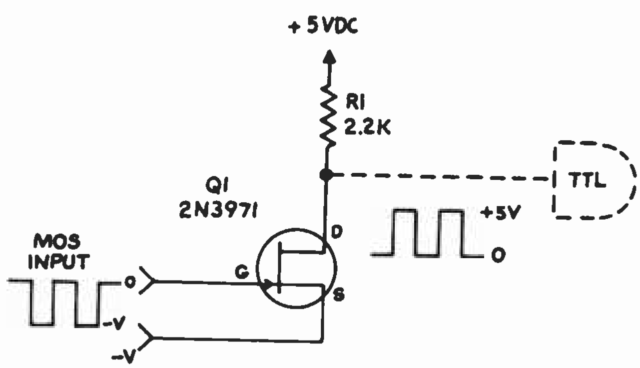
99. SIMPLE TOUCH SWITCH

Looking for a way to add a touch of class to your digital projects? Try this touch switch. Not only does it add a note of distinction to a project, but it's bounce-free as well. Whenever a finger touches the contact plate, stray 60 Hz powerline interference is coupled into the circuit due to the antenna effect of your body. The 60 Hz pickup is rectified and filtered to provide a negative bias on Q1's gate, thus causing Q1 to turn off and Q2 to turn on. As a result, Q2's collector drops to ground potential. When the touch plate is released, the potential at Q2's collector terminal once again jumps high. You can use the output to drive either CMOS or TTL with ease.

Note that if you do your experimenting in a place devoid of 60 Hz powerline radiation—in the middle of a field of wheat, for example—the circuit will not work. The average home is full of 60 Hz radiation, however, so the switch should function well. If you have some difficulty, connect your system's electrical ground to an earth ground (the screw on your AC outlet's cover plate). This will boost the signal pickup.

PARTS LIST FOR SIMPLE TOUCH SWITCH

C1—0.1-uF, 50-WVDC ceramic capacitor
D1, D2—1N914 diode
Q1—2N5953 n-channel JFET (junction field effect transistor)
Q2—2N3904 NPN transistor
Note: All resistors rated ½-watt, 5% tolerance unless otherwise noted.
R1—1,000,000-ohms
R2—22,000,000-ohms
R3—27,000-ohms
R4—1,000-ohms
TP—copper or aluminum touch plate



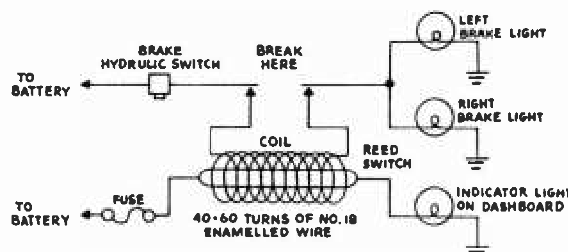
100. BRAKE LIGHT INDICATOR

How many times can you recall that a car driver pulls his load up along side of your sparkling chariot and reads you the riot act because your brake lights are not working? That is not as bad as some local yokel in blue saying, "Pull over there, boy." What you need is a brake light indicator on the dash that positively tells you your brake lights are working or are not working. No, you just can add a pilot light to the brake light line because all that indicator will tell you is that the brake light switch on the master cylinder or somewhere in the brake hydrolic lines is functioning correctly, and maybe your brake lights are working. Nor do you want to place optoelectronic devices in the rear of the car to sense the actual light and activate a circuit that let's you know all is well—because the method is too exotic, the work too difficult, and the price is too high!

Here is a simple circuit that is "fail-safe" and gives you the protection you and your family require. Simply wind approximately 40 to 60 turns of No. 18 wire around a metal dowel that is approximately the diameter of a magnetic reed switch. Leave about two inches of excess wire for leads. Slip out the metal dowel (or nail) and insert the magnetic reed switch. Connect this package in series with the brake signal line in your car as shown in the diagram. When you step on the brake, the large direct current to the rear brake lamps will create a strong magnetic field that will close the reed switch. You may have to add a few turns, but before you do so, rotate the reed switch inside the coil of wire—this may do the trick. Once you have the correct position and/or correct number of turns, coat the coil assembly with epoxy and cement the reed switch in place. Then, insulate the coil assembly by wrapping securely with electrical plastic tape.

By selecting the correct number of turns for the coil, should one lamp burn out and the other(s) remain lit, the reduction in total current will be such that the reed switch would not close. No parts list is given with this project and you'll design and specify your needs from the diagram for your particular car.

Should the reed switch fail or dashboard indicating lamp burn out, the brake light system will continue to function normally. You'll get a false indication, but the driver behind you will see your red!

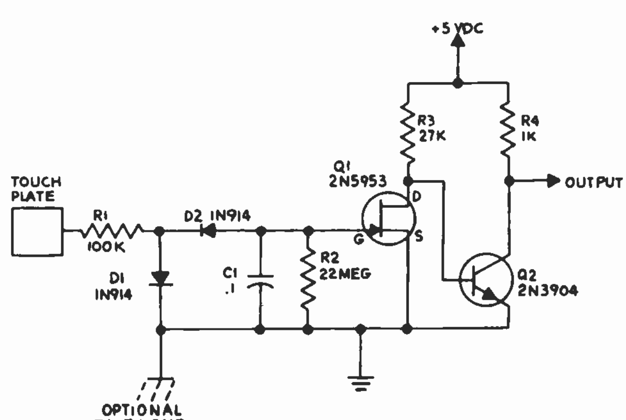


101. MOS-TO-TTL LOGIC INTERFACE

Here is a problem encountered from time to time by the advanced computer hobbyist: How do you mate the signals from MOS logic (the foundation of many microprocessor and peripheral ICs) to TTL logic (the most convenient and readily available logic form from which to construct add-on circuitry)? The problem stems from the fact that MOS signals swing between ground and some negative voltage (-V in the diagram), while signals for TTL should swing from ground to something greater than +2.8-VDC (+3.5-VDC usually). One of the easiest solutions requires just one resistor and one n-channel field effect transistor. Note that Q1's source (S) lead goes to the negative supply potential of the MOS circuitry, and its gate (G) gets driven by the MOS input signal. TTL loads can be driven directly by the output signal available at Q1's drain (D). Finally, not that R1 is tied to the +5-VDC TTL supply and that the level-shifted output signals have been inverted: negative-going input pulses swing positive at the output, and vice sersa. The circuit works well at data transmission rates less than 1 or 2 MHz. To interface faster clock signals or very abrupt pulses, use one of the commerically available level-shifter ICs.

PARTS LIST FOR MOS-TO-TTL LOGIC INTERFACE

Q1—2N3971 N-channel JFET (junction field effect transistor)
R1—2,200-ohm, ½-watt, 5% resistor



INTEGRATED CIRCUIT PROJECTS

1. THEREMIN JUNIOR

Let's return now to prehistoric times, at least as far as electronic music is concerned. Way back then, nearly forty years ago, an odd-looking and equally odd-sounding instrument known as the Theremin was born. Playing the Theremin entailed waving one's arms spastically between two sets of antennas. The purpose of all this was to modulate the RF fields in the vicinity of these antennas, thereby producing accompanying changes in the frequency and volume of the sound emitted by the instrument.

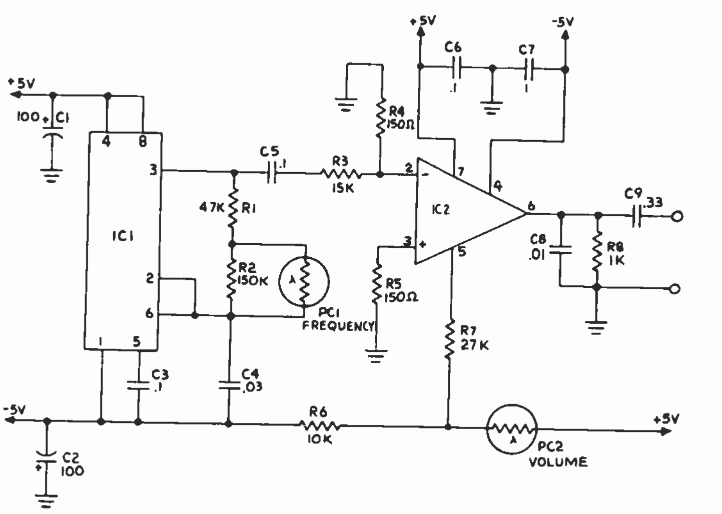
Controlling the sound was both difficult and inexact. As a result, the Theremin never gained widespread popularity, but was instead relegated to the domain of avant-garde composers and science-fiction-movie soundtracks.

Despite the shortcomings, the Theremin is great fun to play, so we decided to create a simple solid-state circuit, Theremin Junior, for those of you too young to have experienced the real thing. In this instance, photocells replace the Theremin's antennas. To play, you move your hands to cast shadows on two photocells, one of which controlls pitch—the other, volume. PC1, the pitch-control photocell, varies in resistance as the intensity of the light shining on its surface varies. This causes a change in the frequency of square-wave oscillator IC1.

Similarly, modulating PC2's resistance with light changes the voltage at pin 5 of IC2, which controls the gain of the circuit. High light intensity results in high frequency and high volume. Frequencies between 150 and 4800 Hz, approximately, can be produced at a maximum amplitude of about 0.5 volt peak-to-peak.

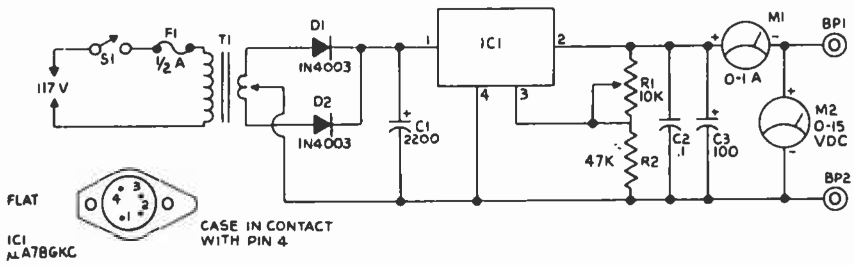
PARTS LIST FOR THEREMIN JUNIOR

C1, C2—100 uF, 16-WVDC electrolytic capacitor
C3, C5, C6, C7—.1 uF ceramic disc capacitor
C4—.03 uF mylar capacitor
C8—.01 uF mylar capacitor
C9—.33 uF mylar capacitor
IC1—555 timer
IC2—RCA 3080 transconductance op-amp
PC1, PC2—cadmium sulfide photocell (Radio Shack 276-116 or equiv.)
R1—4,700-ohm, ½-watt 10% resistor
R2—150,000-ohm, ½-watt 10% resistor
R3—15,000-ohm, ½-watt 10% resistor
R4, R5—150-ohm, ½-watt 10% resistor
R6—10,000-ohm, ½-watt 10% resistor
R7—27,000-ohm, ½-watt 10% resistor
R8—1,000-ohm, ½-watt 10% resistor



2. VARI-REG POWER SUPPLY

There are lots of good power supplies on the market, but why not build your own and save a bundle? This circuit can provide voltages between 5 and 15-volts DC at currents up to one ampere. Be sure to heat-sink the uA78GKC regulator by bolting it to either a commercial aluminum heat sink or to your supply's cabinet (if it's made of aluminum). Mount C2 and C3 as close as possible to pins 2 and 4 of IC1. If you cannot locate a 28 VCT transformer, go to something slightly higher, say 32 VCT. The same goes for the transformer's current rating; for example, you could use a 2-amp device.



PARTS LIST FOR VARI-REG POWER SUPPLY

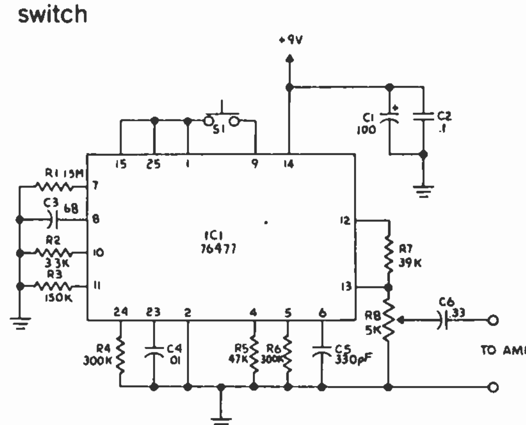
BP1, BP2—binding post
C1—2200-uF electrolytic capacitor, 40-WVDC
C2—0.1-uF ceramic disc capacitor, 35-WVDC
C3—100-uF electrolytic capacitor, 25-WVDC
D1, D2—1N4003 (1A, 200 PIV) rectifier diode
F1—0.5-Ampere slow-blow fuse
IC1—uA78GKC adjustable voltage regulator
M1—0-to-1 Amp DC meter
M2—0-to-15 Volt DC meter
R1—10K-ohm linear-taper potentiometer
R2—4700-ohm, ½-watt 5% resistor
S1—SPST toggle switch
T1—28VCT, 1.2-Amp power transformer (see text)

3. KABOOM CHIP

No, IC1 does not disintegrate in a fiery blast when S1 is pressed, but it does feed a mighty impressive burst of explosion-like noise to your amplifier. The more powerful your amplifier is, the more realistic the effect becomes. Just be sure that your speaker can handle the power safely. Maximum output from this circuit is about one volt peak-to-peak, which you can feed to the high-level input of any amp. One final note of caution: Don't overdo it, or you may find your home surrounded by the local SWAT team.

PARTS LIST FOR KABOOM CHIP

C1—100-uF, 25-WVDC electrolytic capacitor
C2—.1uF ceramic disc capacitor
C3—.68-uF mylar capacitor
C4—.01 uF mylar capacitor
C5—330-pF. polystyrene capacitor
C6—.33 uF mylar capacitor
IC1—SN76477 sound-effect generator
R1—1.5 Megohm-ohm, ½-watt 10% resistor
R2—3,300-ohm, ½-watt 10% resistor
R3—150,000-ohm, ½-watt 10% resistor
R4, R6—300,000-ohm, ½-watt 10% resistor
R5—47,000-ohm, ½-watt 10% resistor
R7—39,000-ohm, ½-watt 10% resistor
R8—5,000-ohm audio-taper potentiometer
S1—SPST normally open pushbutton switch

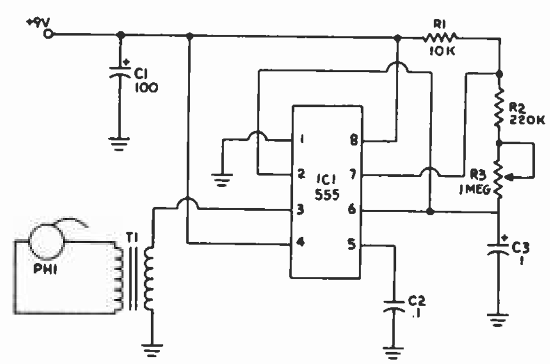


4. JOGGING PACESETTER

One of the problems faced by the beginning jogger, especially on city streets, is that of maintaining a constant pace. Tractor-trailer trucks, careening cars, and ill-mannered dogs can all interrupt your concentration. While there is little that can be done about these nuisances, this little pacesetter may make them less severe. A miniature earphone in your ear driven by a 555 timer produces regularly spaced "ticks" just like a metronome. The pace can be adjusted via R3 from a leisurely one stride per second to a sole-blistering six paces per second. The whole circuit complete with a 9-volt transistor radio battery weighs only a few ounces.

PARTS LIST FOR JOGGING PACESETTER

C1—100-uF electrolytic capacitor, 16 VDC
C2—0.1-uF ceramic disc capacitor, 35 VDC
C3—1.0-uF tantalum electrolytic capacitor, 20 VDC
IC1—555 timer
PH1—8-ohm miniature earphone
R1—10K, ½-watt 5% resistor
R2—220K, ½-watt 5% resistor
R3—1-Megohm trimmer potentiometer
T1—Miniature audio output transformer —1,000-ohm primary/8-ohm secondary

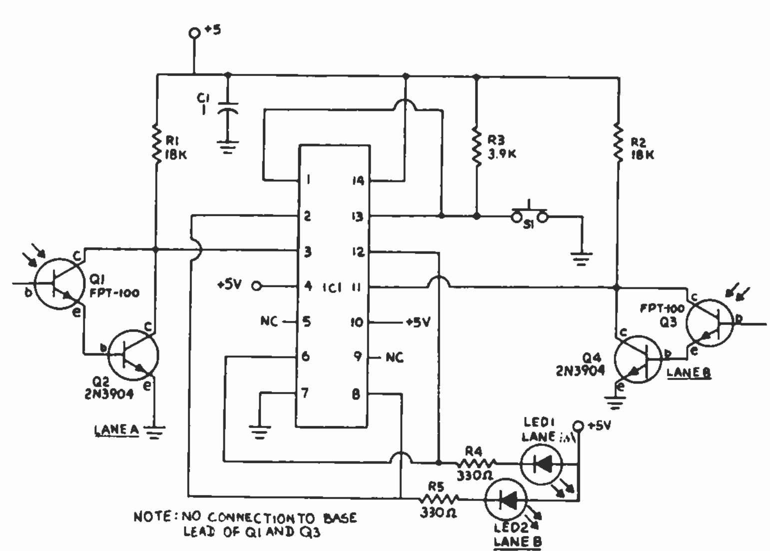


5. SLOT CAR RACE REFEREE

Build this optoelectronic judge and end forever those quarrels over who really won the race. Install phototransistors Q1 and Q3 at the finish line, but in separate lanes of your slot-car track so that the light-sensitive face of each device is facing upwards. The best method would be to cut a small hole into the track for each phototransistor, and mount each unit flush with the track's surface. Arrange for light to fall on both Q1 and Q3; a small desklamp will work well, but ambient room light will usually suffice. Press S1 and both LEDs will go off. The first car to cross the finish line interrupts the light beam and causes the appropriate LED to light up.

PARTS LIST FOR SLOT CAR RACE REFEREE

C1—0.1-uF ceramic disc capacitor, 35-WVDC
IC1—7474 dual D-type flip-flop
LED1, LED2—light-emitting diode
Q1, Q3—FPT-100 NPN phototransistor
Q2, Q4—2N3904 NPN transistor
R1, R2—18K-ohm, ½-watt 10% resistor
R3—3900-ohm, ½-watt 10% resistor
R4, R5—330-ohm, ½-watt 10% resistor
S1—normally open SPST pushbutton switch



6. METERLESS VOLTMETER

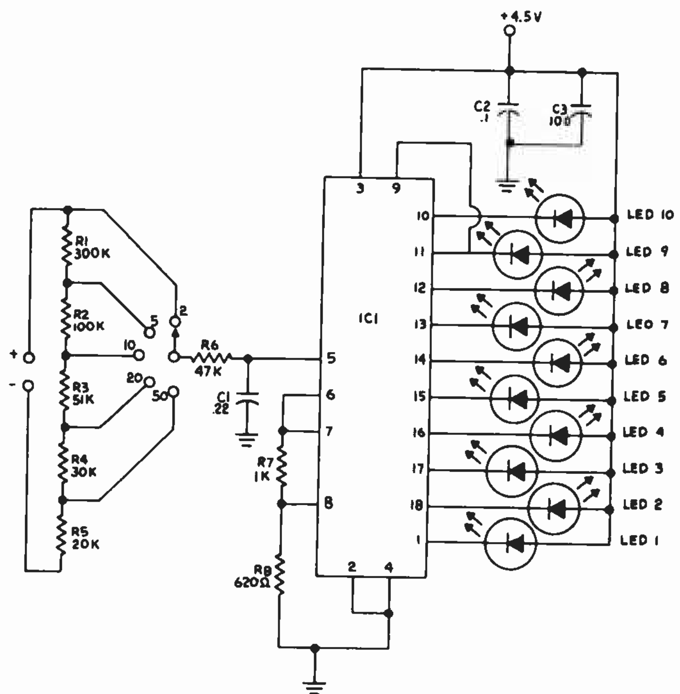
Here is a DC voltmeter that is light, rugged and, best of all, **cheap.** Instead of a meter, it uses the National Semiconductor LM3914 display driver and ten light-emitting diodes to measure voltage in five ranges. As the voltage present at the instrument's input rises above ground level, first LED1 lights, followed by LED2 and so on until, finally, LED10 comes on.

We have chosen the dot-display mode, so only one LED is on at a time. This is more energy-efficient than a bargraph display (which this chip is also capable of producing). Capacitor C1 filters out any extraneous AC components of the input signal, thus elminating display jitter.

Should you be inclined to absent-mindedness, take heart because you will have a tough time clobbering this meter regardless of how careless you are. Inputs as high as 100 portionately higher overloads can be tolerated on the higher voltage ranges. Full-scale sensitivites of 2, 5, 10, 20 or 50 volts DC may be selected with S1. Each LED represents a voltage increment one-tenth of full scale. Three AA cells in series can supply power for this circuit.

PARTS LIST FOR METERLESS VOLTMETER

C1--.22 uF mylar capacitor
C2--.1 uF ceramic disc capacitor
C3--100 uF, 10V electrolytic capacitor
IC1—LM3914 dot/bar display driver (National Semiconductor)
LED1 thru LED10—light-emitting diodes
R1--300,000-ohm, ½-watt 5% resistor
R2--100,000)-ohm, ½-watt 5% resistor
R3--51,000-ohm, ½-watt 5% resistor
R4--30,000-ohm, ½-watt 5% resistor
R5--20,000-ohm, ½-watt 5% resistor
R6--47,000-ohm, ½-watt 5% resistor
R7--1,000-ohm, ½-watt 5% resistor
R8--620-ohm, ½-watt 10% resistor
S1—SP5pos. rotary switch



7. THERMAL LATCH

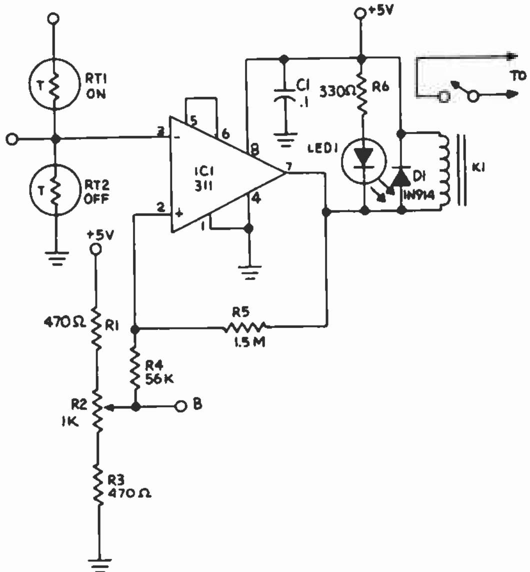
This is a tricky control circuit based on temperature. Touch thermistor RT1, and a moment or two later both LED1 and K1 will be energized. They will stay in that condition after you release RT1. Later, if you decide to turn things off, just touch RT2 until LED1 extinguishes. After you release RT2, the circuit will remain in the off condition.

One preliminary adjustment must be made before you can use the circuit. Connect a voltmeter (20,000 ohms/volt or greater) between points A and B. If the meter deflects backwards, reverse its leads. Adjust R2 for exactly zero voltage on your voltmeter's most sensitive scale. That's it.

For those who care about such things, what we have here is a thermistor voltage divider driving a Schmitt trigger built around an LM311 comparator. As a thermistor heats, its resistance decreases. Hence, the voltage at the junction of RT1 and RT2 is a function of the heat suppled by your finger or hand. This circuit is intended for use at normal room temperatures, that is, 70°-80° F. If the ambient temperature is in the vicinity of human body temperature, clearly you will not have much effect on the circuit by touching it.

PARTS LIST FOR THERMAL LATCH

C1—.1uF ceramic disc capacitor
D1—1N914 silicon diode
IC1—311 comparator
K1—6-volt, 500-ohm relay or 5-volt TTL-logic relay
LED1—Light-emitting diode, any color
R1, R3—470--ohm, ½-watt 5% resistor
R2—1,000-ohm trimpot
R4—56,000-ohm, ½-watt 10% resistor
R5—1.5 Meg-ohm, ½-watt 10% resistor
R6—330-ohm, ½-watt 10% resistor
RT1, RT2—Negative-temperature-coefficient thermistors, 10K ohms or greater at 25°C. For example, Fenwal #GB41P12 or equiv.



8. DC-MOTOR CONTROLLER

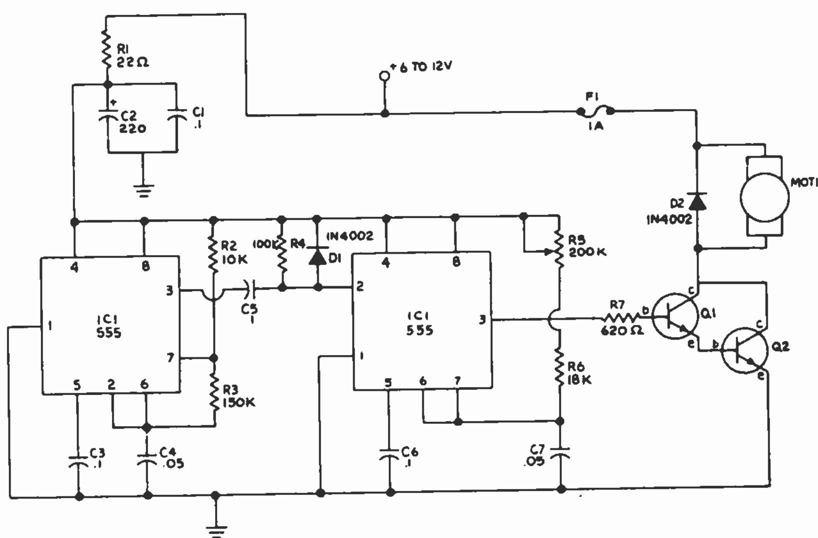
The obvious way to control the speed of a small DC motor is with a series rheostat. Although this has the advantage of simplicity, it is far from a satisfactory solution. Motors "choke out" at low speeds because they lose torque as well as rotational velocity.

A much better way to control the speed of a small, permanent-magnet DC motor is with the pulse-width-modulator circuit in the accompanying schematic. Oscillator IC1 operates at a constant rate of 100 Hz and periodically triggers monostable IC2. Once triggered, IC2 sends its output (pin 3) HIGH for a time interval determined by R5. With the components specified, IC2's pulse duration can be set anywhere from 1 to 10 milliseconds. Transistors Q1 and Q2 couple IC2's pulse output to the motor.

Since IC2 is being driven by a 100-Hz signal (with a period of 10 milliseconds), this means that the signal at IC2's output will spend between 10% and 100% of its time HIGH. The lower this percentage is, the smaller the average current applied to the motor becomes. Naturally, this results in less velocity, but adequate torque is still maintained to prevent stalling. Be sure to mount Q2 on a small heat sink.

PARTS LIST FOR DC-MOTOR CONTROLLER

C1, C3, C5, C6—.1 uF ceramic disc capacitor
C2—200 uF, 25V electrolytic capacitor
C4, C7—.-5 uF mylar capacitor
D1, D2—1N4002 rectifier diode
F1—1-amp fuse
IC2, IC2—555 timer
MOT1—DC permanent-magnet motor, 6 to 12 volts
Q1—2N3904 NPN transistor
Q2—2N3055 NPN power transistor
R1—22-ohm, ½-watt 10% resistor
R2—10,000-ohm, ½-watt 10% resistor
R3—150,000-ohm, ½-watt 10% resistor
R4—100,000-ohm, ½-watt 10% resistor
R5—200,000 linear-taper potentiometer
R6—18,000-ohm, ½-watt 10% resistor
R7—620-ohm, ½-watt 10% resistor

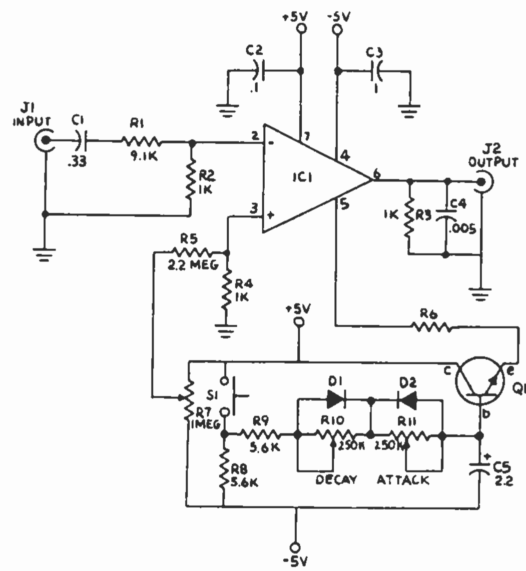


9. MUSICAL MODULATOR

Feed this circuit a sample audio tone, and it gives you back a muscial note with selectable attack, sustain and decay. Input impedance is 10,000-ohms, output impedance is 1000-ohms, and the gain is unity. Best results will be obtained with signal imputs having amplitudes of 1-volt peak-to-peak or less. When S1 is pressed, the output volume rises at a rate determined by attack control R11. As long as S1 is pressed, the sound will be sustained. Releasing S1 causes the note to decay at a rate determined by decay control R10. Try sine, square or triangular wave inputs for muscial notes. With a noise input you can imitate such things as gunshots and explosions. Trimmer R7 can be adjusted to cancel out any audible "thumping" (noticeable with very rapid attack or decay).

PARTS LIST FOR MUSICAL MODULATOR

C1—0.33-uF capacitor, 35-WVDC
C2, C3—0.1-uF mylar capacitor, 35-WVDC
C4—0.005-uF mylar capacitor, 35-WVDC
C5—2.2-uF electrolytic capacitor, 16-WVDC
D1, D2—1N914 diode
IC1—RCA CA3080 transconductance amp
J1, J2—phone jack
Q1—2N3904 NPN transistor
R1—9100-ohm, ½-watt 10% resistor
R2, R3, R4—1000-ohm, ½-watt 10% resistor
R5—2.2 Megohm-ohm, ½-watt 10% resistor
R6—15,000-ohm, ½-watt 10% resistor
R7—1 Megohm trimmer potentiometer
R8, R9—5600-ohm, ½-watt 10% resistor
R10, R11—250,000 linear-taper potentiometer
S1—normally open SPST pushbutton switch

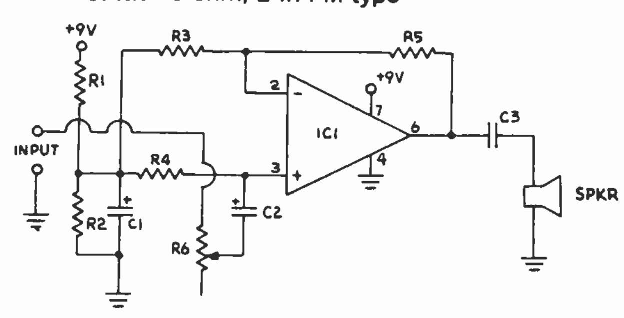


10. MICRO-MINI PA

Designed for very private listening, this little amplifier sports a tiny loudspeaker of 1⅛ to 2 inches diameter. The gain may be varied through a feedback resistor from about 1 to 100. Only a single power supply, which may be a nine volt transistor radio battery, is required.

PARTS LIST FOR MICRO-MINI PA

C1—100-uF electrolytic capacitor, 100-WVDC
C2—100-uF electrolytic capacitor, 6-WVDC
C3—100-uF electrolytic capacitor, 10-WVDC
IC1—741 op amp
R1, R2—5,600-ohm, ½-watt 10% resistor
R3—1,000-ohm, ½-watt 10% resistor
R4—50,000-ohm, ½-watt 10% resistor
R5—100,000-ohm, ½-watt 10% resistor
R6—100,000-ohm audio taper potentiometer
SPKR—8 ohm, 2-in PM type

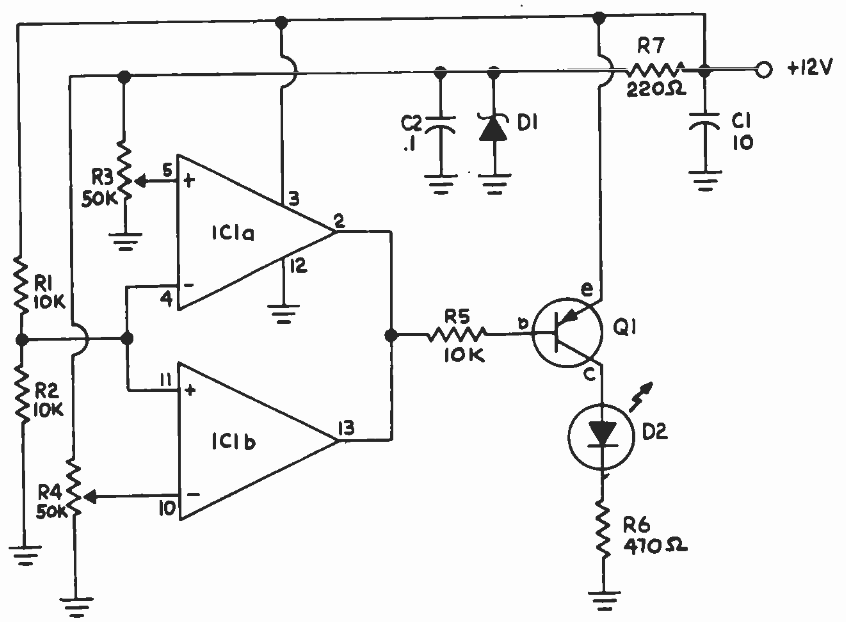


11. ALTERNATOR MONITOR

This circuit will monitor the output of the alternator of any car with a 12 volt electrical system and indicate if the charging system is either underchanging or overcharging. This is accomplished by using 2 sections of a quad voltage comparator IC and connecting the outputs in an "OR" configuration so that the LED will become lit if section A or section B of the comparator detects an improper voltage level. The circuit is connected into any circuit which is active when the car is in operation, such as the ignition or radio circuit. This prevents drain on the battery when the car is not in use. To calibrate the circuit, connect an adjustable DC power supply to the + and - inputs of the circuit. Set the power supply to 13.4 volts and adjust R3 so that the voltage at pin 5 of IC1A is maximum. Then adjust R4 so that the LED just goes out. Set the power supply to 15.1 volts and adjust R3 so that the LED just goes out. The LED will now become lit if the voltage is outside the permissible range of 13.5 to 15.0 volts when the engine is running.

PARTS LIST FOR ALTERNATOR MONITOR

- **C1**—10-uF electrolytic capacitor, 15-WVDC
- **C2**—0.1-uF ceramic capacitor, 15-WVDC
- **D1**—9 VDC Zener diode
- **D2**—large LED
- **IC1**—339 quad comparator
- **Q1**—2N4403
- **R1, R2, R5**—10,000-ohm, ½-watt 10% resistor
- **R3, R4**—50,000-ohm linear-taper potentiometer
- **R6**—470-ohm, ½-watt 10% resistor
- **R7**—220-ohm, ½-watt 10% resistor



12. CONTROL SYSTEM

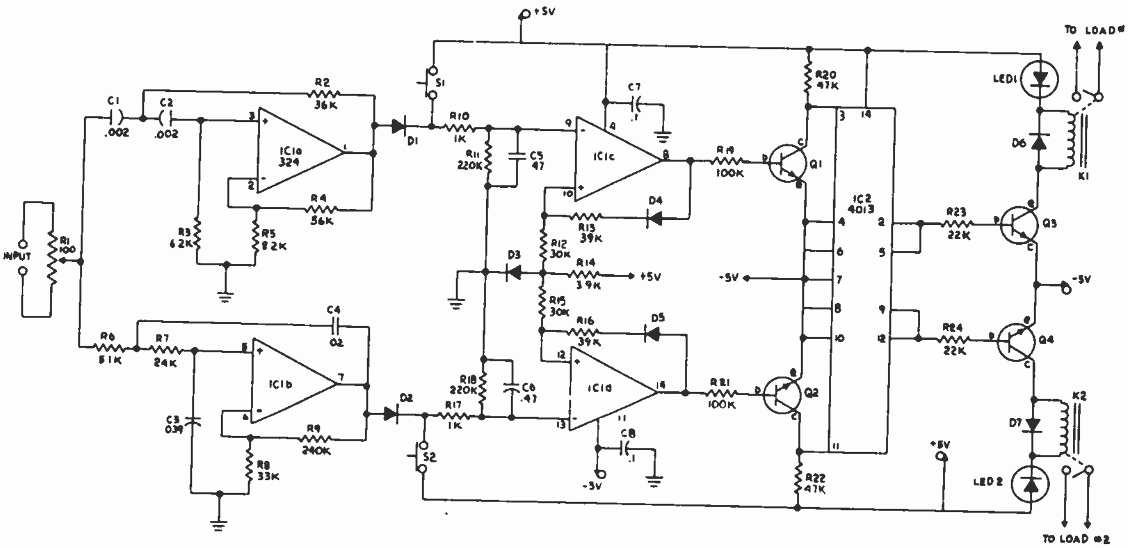
Let's say that you need a programmable control system that can perform a timed sequence of operations. This sounds like a job for a high-priced computer, doesn't it? In many instances, however, just a cheap cassette recorder can do a respectable job—provided, of course, that you build this 2-channel controller.

High-frequency signals (above 5000 Hz) at the controller's input are amplified by high-pass filter U1a, then detected and used to clock one half of a dual flip-flop (U2). Each tone burst toggles the flip-flop, causing relay K1 to alternately open and close. These high-frequency audio signals have no effect on low-pass filter U1b, but frequencies below 500 Hz will produce the same effect in the lower channel as high frequencies in the upper channel, with the result that K2 alternately opens and closes on successive bursts of low frequency audio.

Feed the signal from your recorder's speaker output jack to the controller's input. Record a short sequence of tones—about 300 Hz for the low channel, and 7500 Hz for the high channel. Play back the tape-recorded sequence, and adjust R1 somewhat past the point where toggling of the relays starts. The LED go on and off with the relays and serve as convenient indicators of channel activity. Pushbuttons S1 and S2 can be used to change the status of a channel independently of the audio input. Whistles, turning forks and electronic oscillators can all be used as tone sources. Whichever you use, strive to keep the level of the recorded signal constant.

PARTS LIST FOR CONTROL SYSTEM

C1, C2—.002-uF polystyrene capacitor
C3—.039-uF polystyrene capacitor
C4—.02-uF polystyrene capacitor
C5, C6—0.47-uF mylar capacitor
C7, C8—0.1-uF ceramic disc capacitor
D1-D7—1N914 diode
IC1—LM324 quad op amp integrated circuit
IC2—4013 CMOS dual flip-flop integrated circuit
K1, K2—6-VDC, 500-ohm relay
LED1, LED2—light-emitting diode
Q1-Q4—2N3904 NPN transistor
R1—100-ohm trimpot (all resistors 10% unless otherwise noted).
R2—36000-ohm, ½-watt 5% resistor
R3—6,800-ohm, ½-watt 5% resistor
R4—56,000-ohm, ½-watt 5% resistor
R5—8,200-ohm, ½-watt 5% resistor
R6—5,100-ohm, ½-watt 5% resistor
R7—24,000-ohm, ½-watt 5% resistor
R8—33,000-ohm, ½-watt 5% resistor
R9—240,000-ohm, ½-watt 5% resistor
R10, R17—1,000-ohm, ½-watt 10% resistor
R11-R18—220,000-ohm, ½-watt 10% resistor
R12-R15—30,000-ohm, ½-watt 10% resistor
R13, R16—39,000-ohm, ½-watt 10% resistor
R14—3,900-ohm, ½-watt 10% resistor
R19, R21—100,000-ohm, ½-watt 10% resistor
R20, R22—47,000-ohm, ½-watt 10% resistor
R23, R24—22,000-ohm, ½-watt 10% resistor
S1,S2—pushbutton switch, normally open



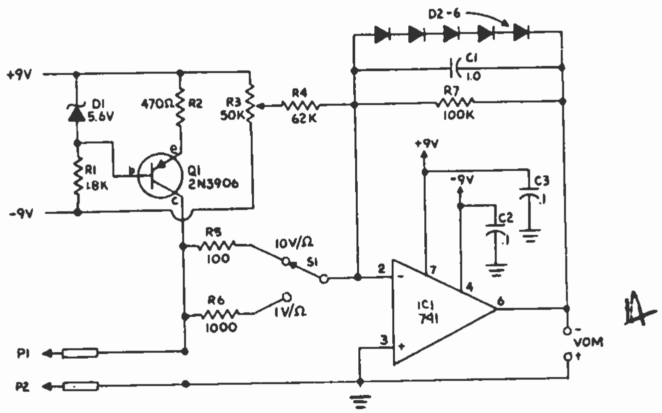
13. MILLIOHMS ADAPTER

Few experimenters have the equipment to measure resistances of less than one ohm, and even fewer of them could care to do so. But the ability to measure resistance in the milliohm range can be very handy. For instance, motor manufacturers routinely check their coils with milliohmmeter. Since the next resistance is proportional to the length of wire on the coil form, measuring the resistance provides a simple, non-destructive method for checking the number of turns on a coil. With a milliohmmeter you can even check the relative quality of switch contacts and solder joints.

Current source Q1 drives a constant 10-milliamp current through whatever resistance lies between probes P1 and P2. U1 amplifies the voltage generated across the resistance by the current flowing through it. You read the voltage at IC1's output on your VOM and multiply by the appropriate scale factor—10V/ohm with S1 up, 1V/ohm with S1 down—to get the resistance. Before reading, short the probes together, and adjust R4 for zero output. Use needle-type probes, since they easily pierce surface oxide films (which can introduce significant resistance of their own). Keep the output voltage below one volt; in other words, the **maximum** resistance you can measure is one ohm, so set the VOM to the 1-volt scale.

PARTS LIST FOR MILLIOHMS ADAPTER

C1—1.0-uF mylar capacitor
C2, C3—0.1-uF ceramic disc capacitor
D1—5.6-VDC ½-watt zener diode
D2-D6—1N914 silicon diode
IC1—741 op amp
P1, P2—test probes
Q1—2N3906 PNP transistor
R1—1,800-ohm, ¼-watt resistor (all fixed resistors 5%, unless otherwise noted.)
R2—470-ohm, ¼-watt resistor
R3—50,000-ohm linear taper potentiometer
R4—62,000-ohm, ¼-watt resistor
R5—100-ohm, ¼-watt resistor
R6—1,000-ohm, ¼-watt resistor
R7—100,000-ohm, ¼-watt resistor
S1—SPDT toggle switch

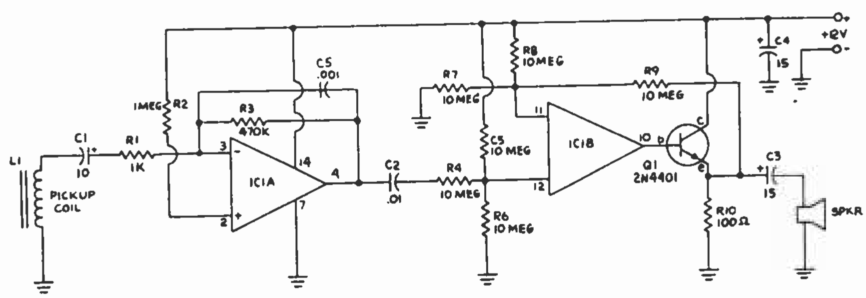


14. TELEPHONE VOICE PICKUP

You can pick up and amplify the voice signals from your telephone by using this simple IC circuit and a small pickup coil. The circuit has sufficient output to drive a loudspeaker. One section of a quad op amp is used as a high-gain voltage amplifier. This increases the relatively low output of the pickup coil (a few millivolts) to a sufficient level to drive the loudspeaker. The circuit draws about 60 milliamperes from a 12 volt power source. You can purchase a ready made pickup coil or construct one yourself using about 200 turns of fine enamel wire wound around an iron core. Place the pickup near the telephone receiver for best results.

PARTS LIST FOR TELEPHONE VOICE PICKUP

C1—10-uF, 25-WVDC electrolytic capacitor
C2—.01-uF, 15-WVDC ceramic disc capacitor
C3, C4—15-uF, 15-WVDC electrolytic capacitor
C5—.001-uF, 15-WVDC ceramic disc capacitor
IC1—3900 quad amplifer
L1—inductance pickup coil (see text)
Q1—2N4401
R1—1,000-ohm, ½-watt 10% resistor
R2, R4—1,000,000-ohm, ½-watt 10% resistor
R3—470,000-ohm, ½-watt 10% resistor
R5, R6, R7, R8, R9—10,000,00-ohm, ½-watt 10% resistor
R10—100-ohm, ½-watt 10% resistor
SPKR—8-ohm PM type speaker

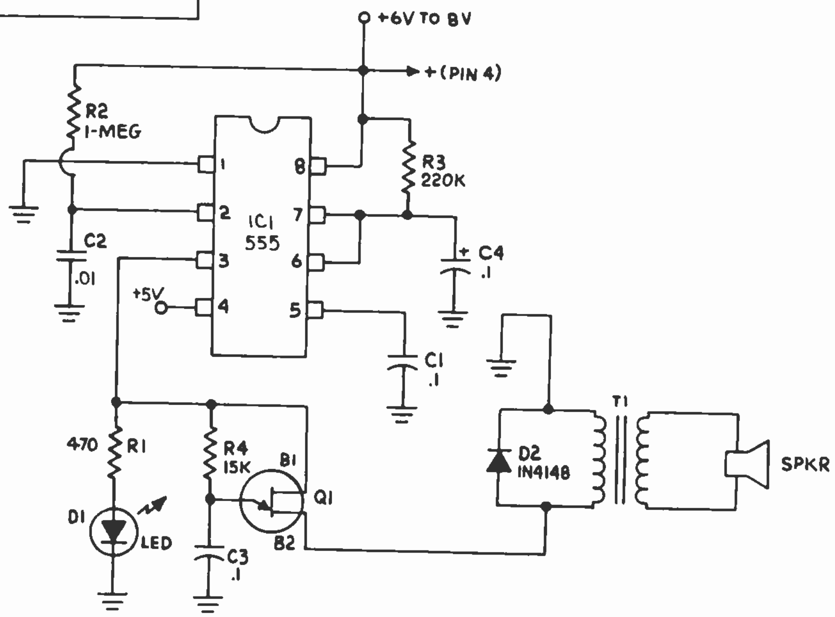


15. HANDS OFF

This circuit finds the 555 timer as a watchdog ready to cry out if an inquisitive finger comes too close. The trigger input is terminated with a one megohm resistor, attached to a coin or some other small metallic object. Hand capacity is sufficient to initiate the timer for about five seconds. The output is fed not only to a warning LED, but to a unijunction type oscillator, whose tiny two-inch speaker can make itself heard throughout the room.

PARTS LIST FOR HANDS OFF

C1—0.1-uF ceramic capacitor, 15-WVDC
C2—0.01-uF ceramic capacitor, 15-WVDC
C3—0.1-uF ceramic capacitor, 15-WVDC
C4—1-uF electrolytic capacitor, 15-WVDC
D1—Light-emitting diode, any color
D2—1N4148 diode
IC1—555 timer integrated circuit
Q1—2N2646 field-effect transitor
R1—470-ohm, ½-watt 10% resistor
R2—1,000,000-ohm, ½-watt 10% resistor
R3—220,000-ohm, ½-watt 10% resistor
R4—15,000-ohm, ½-watt 10% resistor
SPKR—8-ohm PM type speaker
T1—audio output transformer 500-ohm primary/8-ohm secondary

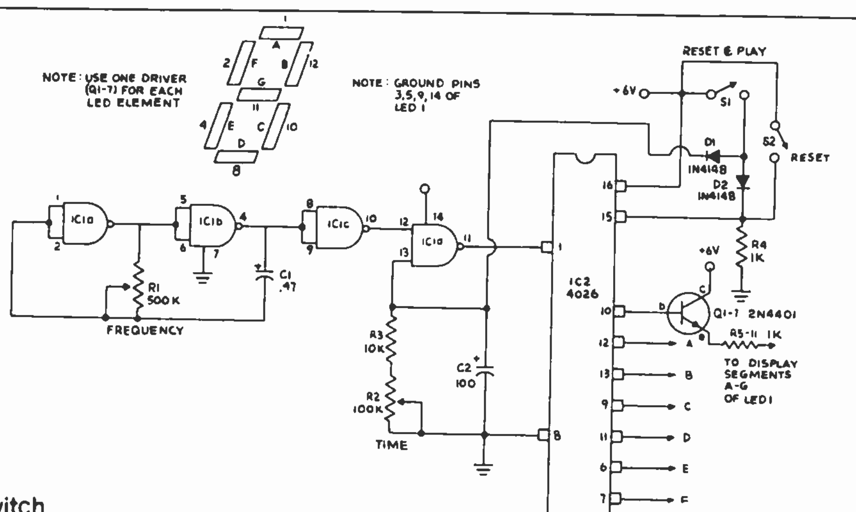


16. MINI-DIGITAL ROULETTE

A more adult form of entertainment can be obtained from the 4026 counter and display previously described. The clock input terminal is connected via a pushbutton switch to the "Basic Pulse Maker" and two

PARTS LIST FOR MINI-DIGITAL ROULETTE

C1—0.47 to 2.2-uF electrolytic capacitor, 15-VDC
C2—100-uF electrolytic capacitor, 15-VDC
D1, D2—1N4148 or 1N914 diode
IC1—4011 quad NAND gate
IC2—4026 decade counter
LED1—DL-750 7-segment display
Q1-Q7—2N4401 transistor
R1—500,000-ohm linear-taper potentiometer
R2—100,000-ohm linear-taper potentiometer
R3—10,000-ohm, ½-watt 10% resistor
R4-R11—1,000-ohm, ½-watt 10% resistor
S1, S2—SPST momentary-contact switch



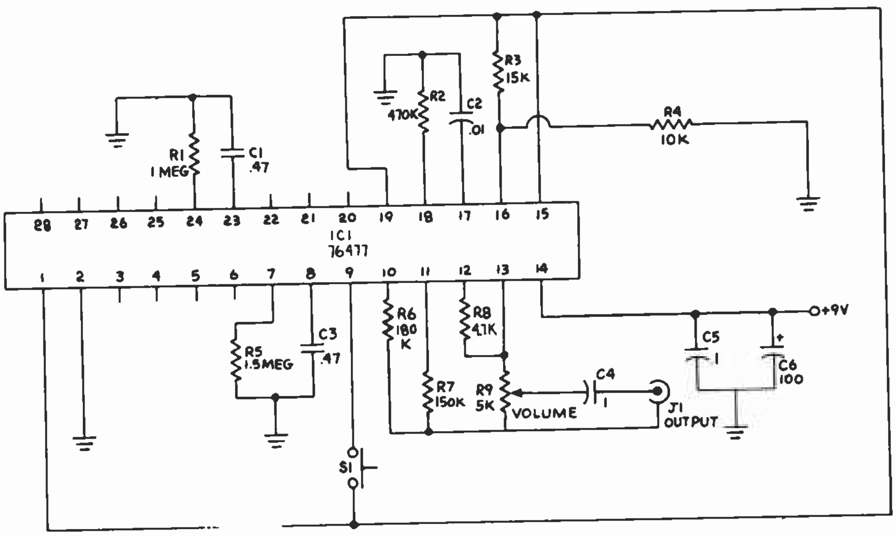
to nine players select a number. Then, press the button. The input frequency should be 10-Hz or higher and the Reset may zero the display first, although there is statistically little or no effect upon subsequent outcomes. When the switch is released, the counter holds on one number, which is displayed until reset or new counts arrive. If a Zero appears on the display, it may be assumed that the Bank takes all wagers, thus keeping the system in fresh batteries.

17. FEATHERWEIGHT FOGHORN

Despite its small size, this circuit generates an authentic-sounding foghorn blast. Couple the output signal to a good amp and loudspeaker, press switch S1, and you'll unleash a blast that will untie the shoelaces of anyone within hearing distance. The output signal has a 1-volt peak-to-peak maximum amplitude, which is just right for driving the AUX or TUNER inputs of most hi-fi or PA amplifiers. You can change the pitch to suit your own taste by substituting a different value of resistance for R2; larger resistances lower the pitch while smaller ones raise it. Be sure to use a socket with the IC.

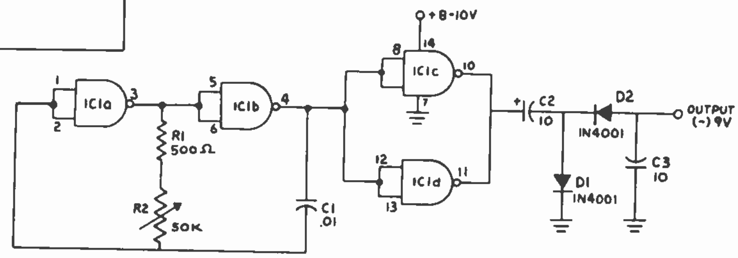
PARTS LIST FOR FEATHERWEIGHT FOGHORN

C1, C3—0.47-uF mylar capacitor, 35-WVDC
C2—0.01-uF mylar capacitor, 35-WVDC
C4—1.0-uF mylar capacitor, 35-WVDC
C5—0.1-uF ceramic disc capacitor, 35-WVDC
C6—100-uF electrolytic capacitor, 16-WVDC
IC1—SN76477 sound generator
J1-phono jack
R1—1 Megohm-ohm, ½-watt 10% resistor
R2—470K-ohm, ½-watt 10% resistor
R3—15K-ohm, ½-watt 10% resistor
R4—10K-ohm, ½-watt 10% resistor
R5—1.5-Megohm-ohm, ½-watt 10% resistor
R6—180K-ohm, ½-watt 10% resistor
R7—150K-ohm, ½-watt 10% resistor
R8—47K-ohm, ½-watt 10% resistor
R9—5K audio-taper potentiometer
S1—SPST normally open pushbutton switch



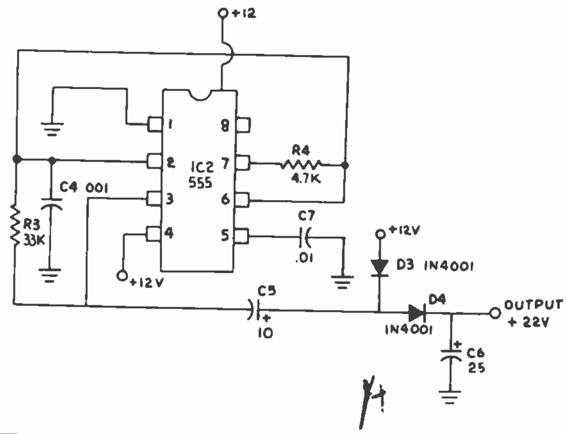
18. POSITIVE INTO NEGATIVE

Certain IC chips and other circuit elements often require small negative potentials of small current drain, necessitating the construction of bulky transformer-operated supplies. Operating a 1 KHz or higher frequency, the pulse generator shown below drives a voltage-doubler circuit furnishing a negative potential approaching that of the positive input supply. With a 10volt input, and output of about −9VDC was measured into a 20,000 ohm load. A voltage tripler or quadrupler circuit may also be emplyed for higher potentials (positive or negative) as well. For loads requiring up to 50 ma, the type 555 timer in astable mode is an ideal choice.



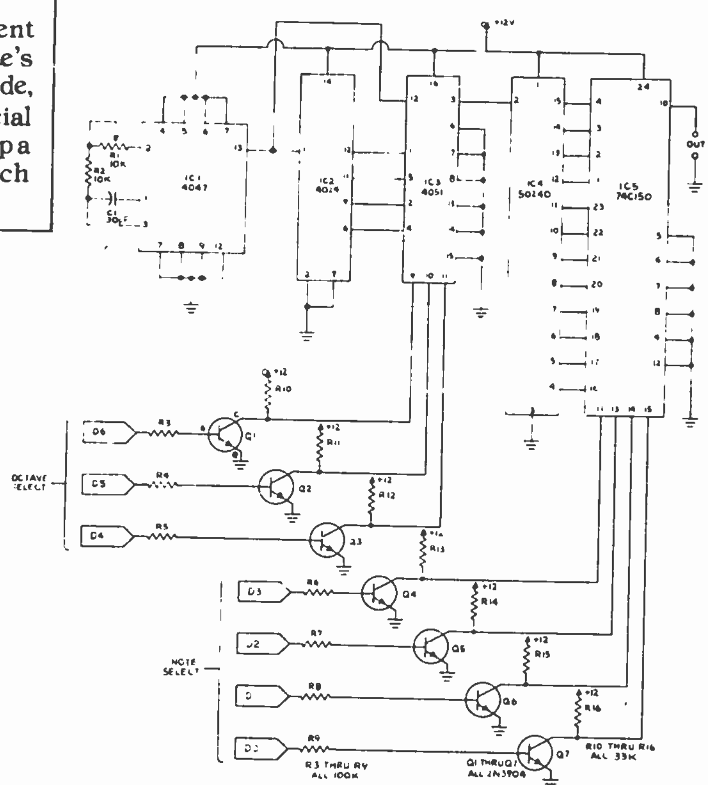
PARTS LIST FOR POSITIVE INTO NEGATIVE

C1—0.01 to 0.1-uF ceramic capacitor, 15-WVDC
C2, C5—10-uF electrolytic capacitor, 25-WVDC
C3—10 to 100-uF electrolytic capacitor, 25-WVDC
C4—0.001-uF ceramic capacitor, 15-WVDC
C6—25-uF electrolytic capacitor, 25-WVDC
C7—0.01-uF electrolytic capacitor, 25-WVDC
1N4001 diode
IC1—4011 quad NAND gate
IC2—555 timer
R1—500-ohm, ½-watt 10% resistor
R2—50,000-ohm linear-taper potentiometer
R3—33,000-ohm, ½-watt 10% resistor
R4—4,700-ohm, ½-watt 10% resistor



19. COMPUTER-CONTROLLED NOTE GENERATOR

Computer music can be created in many different ways. One method is to specify all of a note's parameters—frequency, harmonic structure, amplitude, and attack/sustain/decay times—as well as special effects by means of software. Naturally, this gobbles up a lot of memory, thus making such an approach



PARTS LIST FOR COMPUTER-CONTROLLED NOTE GENERATOR

C1—30-pF polystyrene capacitor
IC1—4047 CMOS multivibrator, intergrated circuit
IC2—4024 CMOS binary divider integrated circuit
IC3—4051 CMOS 8:1 multiplexer integrated circuit
IC4—50240 Mostek top-octave generator integrated circuit
IC5—74C150 16:1 CMOS multiplexer integrated circuit (National)
Q1-Q7—2N3904 NPN transistor
R1—10,000-ohm trim potentiometer (all resistors 10% unless otherwise noted.)
R2—10,000-ohm, ½-watt resistor
R3-R9—100,000-ohm, ½-watt resistor
R10-R16—33,000-ohm, ½-watt resistor

impossible for the owner of a very small computer. All is not lost, however. By augmenting your system with some inexpensive hardware, the software burden is diminished.

This computer-controlled note generator produces 5 octaves of the equally tempered chromatic scale under the control of one of your computer's 8-bit parallel ports (only 7 bits of which are used). Lines D6 through D4 select the octave, while lines D3 through D0 select one of the twelve notes within that octave.

The lowest octave is selected by a binary 0 on lines D6 through D4. A binary 1 selects the next higher octave, and so on until you reach the highest octave, coded by a binary 4 (100). (Note: D6 is the most significant bit; D4 is the least significant.) Codes higher than 4 yield no output.

The note-selection lines behave similarly, except that 12 codes are used. (Here D3 is the most significant bit, and D0 is the least significant.) Binary 0 gives you a C*. D is produced by a binary 1, and binary 2 yields D*. This continues on up the scale until you reach binary 11, which gives the twelfth note, C. Codes above binary 11 give no output.

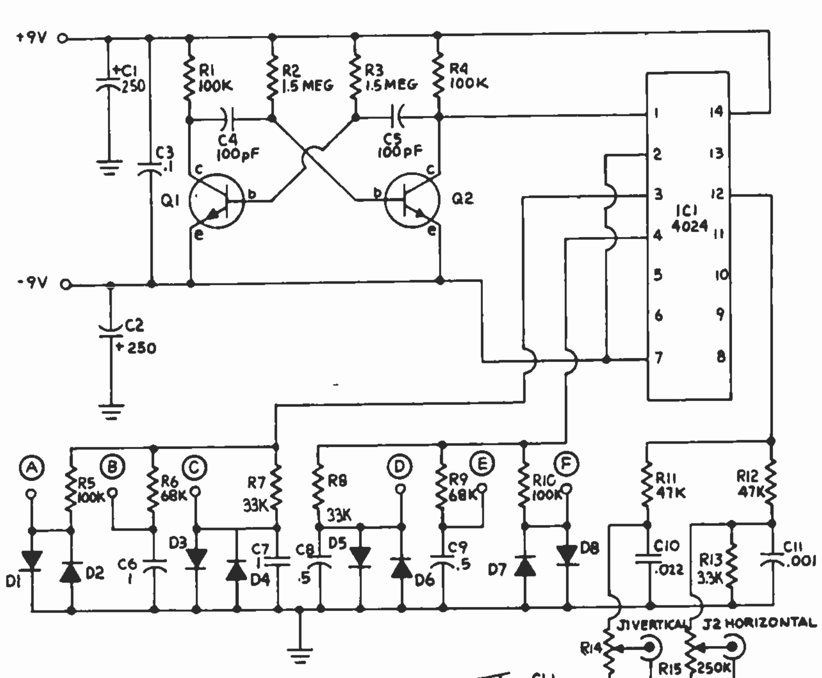
Turning can be accomplished by adjusting R1 to produce a 1,000, 120 Hz signal at pin 13 of IC1, or you can tune by ear against some pitch reference. The output at pin 12 of IC5 is a square wave that can be filtered and/or shaped (see the computer-controlled keyer circuit). The software we'll leave to you. In general, your programming burden has been reduced to the generation of a rhythmic sequence of 7-bit binary codes.

20. VIDEO PATTERN GENERATOR

Those of you with oscilloscopes might enjoy bread boarding this pattern generator. Feed the signal at J1 to your scope's vertical input, and connect the horizontal input to J2. Attach the clips to the selected pairs of test points, then adjust potentiometers R14 and R15 to create complex images. Output signals are about 1-volt, peak-to-peak.

PARTS LIST FOR VIDEO PATTERN GENERATOR

C1, C2—250-uF electrolytic capacitor, 25 VDC
C3—0.1-uF ceramic disc capacitor, 35 VDC
C4, C5—100-pF polystyrene capacitor, 35 VDC
C6, C7—1.0-uF mylar capactitor (non-polarized), 35 VDC
C8, C9—0.5-uF mylar capactitor 35 VDC
C10—0.022-uF mylar capacitor, 35 VDC
C11—0.001-uF mylar capacitor, 35 VDC
CL1, CL2—alligator clip
D1 thru D8—1N914 diode
IC1—4024BE CMOS ripple divider
J1, J2—phono jack
Q1, Q2—2N3904 NPN transistor
R1, R4, R5, R10—100K-ohm ½-watt 10% resistor
R2, R3—1.5-Megohm ½ watt 10% resistor
R6, R9—68K-ohm, ½-watt 10% resistor
R7, R8—33K-ohm, ½-watt 10% resistor
R11, R12—47K-ohm, ½-watt 10% resistor
R13—3300-ohm, ½-watt 10% resistor
R14, R15—250K linear-taper potentiometer



B	C	B	B	A	A	C
C	E	D	B	B	F	D

TRY CONNECTING CLIPS TO THESE PAIR OF POINTS

21. PRECISION VOM CALIBRATOR

Until now, most of the calibrator circuits appearing in hobby magazines could not be considered as primary reference standards. Instead, they were **transfer standards,** since the builder would be instructed to align his calibrator using a voltage reference of known accuracy. The obvious reaction of most readers was: "If I had access to an accurate voltage reference to begin with, why would I want to build this calibrator?"

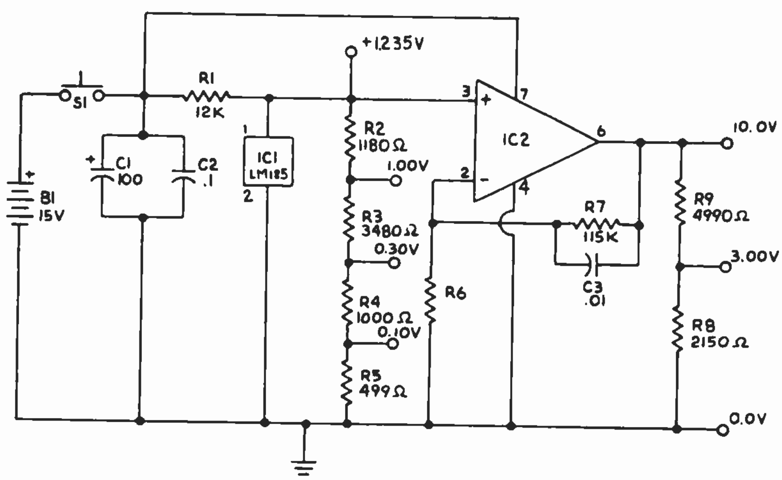
Our sentiments exactly. Now National Semiconductor comes to the rescue with a voltage reference IC, the LM185, having an output of 1.235 bolts 1%. What's more, this voltage remains stable in the face of changing ambient temperature and supply current.

The circuit diagrammed here produces six useful reference voltages from .100 V to 10.0 V. As noted above, the 1.235-volt output is accurate to within 1%. All of the other outputs are accurate to within 2% except for the 3-volt output, which has a tolerance of 4%. Reduced accuracy on all derived outputs is the result of errors introduced by the 1% resistor tolerances. Bear in mind, however, that worst-case accuracies are quoted here.

Be certain that the input resistance of the instrument being calibrated greatly exceeds the resistance at the circuit node being read. Most of you who worry about calibration have high-impedance (10-megohm) FET voltmeters, the loading effects of which are negligible here.

PARTS LIST FOR
PRECISION VOM CALIBRATOR

B1—ten AA cells in series to yield 15 volts
C1—100 uF, 25 V electrolytic capacitor
C2—.1 uF ceramic disc capacitor
C3—.01 uF polystyrene or mylar capacitor
IC1—LM185 1.235-volt reference IC (National Semiconductor)
IC2—3140A FET-input op amp (RCA)
All Resistors ½w, 1% precision unless noted otherwise
R1—12,000-ohm, ½-watt 10% resistor
R2—1,180-ohm, ½-watt resistor
R3—3,480-ohm, ½-watt resistor
R4—1,000-ohm, ½-watt resistor
R5—499-ohm, ½-watt resistor
R6—162,000-ohm, ½-watt resistor
R7—115,000-ohm, ½-watt resistor
R8—2,150-ohm, ½-watt resistor
R9—4,990-ohm, ½-watt resistor
S1—SPST normally open pushbutton switch



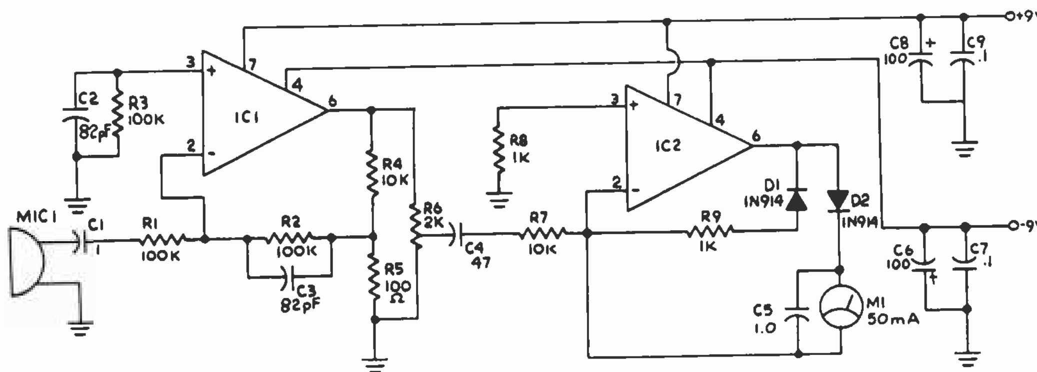
22. SOUND-LEVEL METER

With this sound-level meter you can easily measure the relative loudness of sounds in the range from 20 to 20,000 Hz. Although your readings will not be calibrated in terms of—or even be linearly proportional to-true sound power, this circuit should very adequately fill the bill.

Amplifier IC1 multiples the signals from microphone MIC1 by a factor of 100. This amplied signal is then applied to IC2, which functions here as a precision rectifier. Meter MI is tucked into one of IC2's feedback loops, where it measures a rectified and filtered direct current proportional to the sound level. Potentiometer R6 allows you to adjust the intrument's sensitivty to match the application—anything from audience-applause measurement to sound-system installation.

PARTS LIST FOR SOUND-LEVEL METER

C1, C7, C9—.1 uF ceramic disc capacitor
C2, C3—82 pF polystyrene capacitor
C4—.47 uF mylar capacitor
C5—1.0 uF mylar capacitor
C6, C8—100 uF 25V electrolytic capacitor
D1, D2—1N914 silicon diode
IC1—RCA 3140 FET-input op amp
IC2—741 op lamp
M1—0-50 microamp DC meter
MIC1—crystal microphone cartridge
R1, R2, R3—100,000-ohm, ½-watt 10% resistor
R4, R7—10,000-ohm, ½-watt 10% resistor
R5—100-ohm, ½-watt 10% resistor
R6—2,000-ohm linear taper potentiometer
R8, R9—1,000-ohm, ½-watt 10% resistor

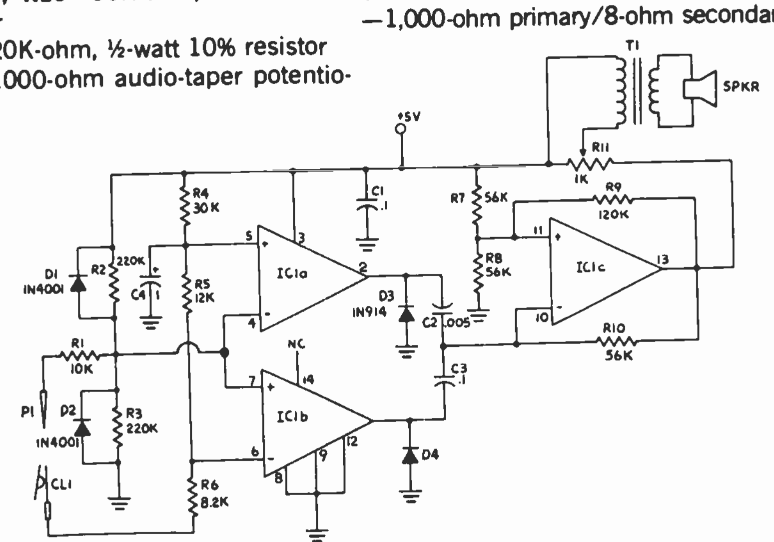


23. AUDIBLE LOGIC PROBE

Here is the old familiar logic probe but with a new twist. Instead of displaying logic status with LEDs, it does the job aurally. The logic-1 state, 2-volts or greater, is signalled by a high tone. On the other hand, a low tone

PARTS LIST FOR AUDIBLE LOGIC PROBE

C1—0.1-uF ceramic disc capacitor, 35-WVDC
C2—0.005-uF mylar capacitor, 35-WVDC
C3—0.1-uF mylar capacitor, 35-WVDC
C4—1.0-uF tantalum capacitor, 10-WVDC
CL1—Alligator clip
D1, D2—1N4001 diode
D3, D4—1N914 diode
IC1—LM339 quad comparator integrated circuit
P1-Metal probe tip
R1—10K-ohm, ½-watt 10% resistor
R2, R3—220K-ohm, ½-watt 10% resistor
R4—30K-ohm, ½-watt 5% resistor
R5—12K-ohm, ½-watt 5% resistor
R6—8200-ohm, ½-watt 5% resistor
R7, R8, R10—56K-ohm, ½-watt 10% resistor
R9—120K-ohm, ½-watt 10% resistor
R11—1000-ohm audio-taper potentiometer
SPKR—8-ohm miniature speaker
T1—miniature audio output transformer—1,000-ohm primary/8-ohm secondary



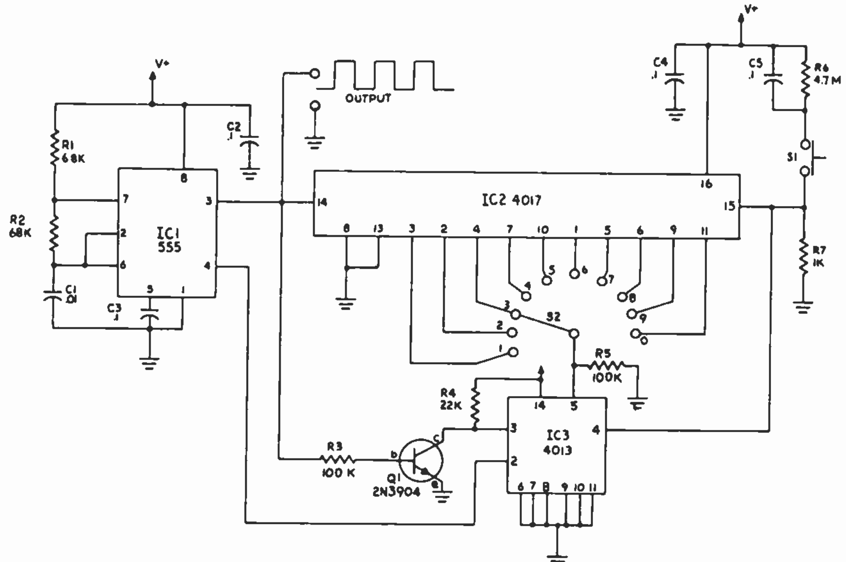
sounds to indicate the logic-O state, 0.8-volt or less. Inputs between 0.8 and 2-volts produce no output. (Note that this probe is designed especially for TTL and cannot be used for any other logic family.) The circuit requires a regulated 5-volt supply, which means that it can be powered by the same supply used by the TTL circuitry under test. Output can be taken from a miniature speaker, as shown in the schematic, or you may use a miniature earphone. Potentiometer R11 sets the output volume level.

24. PULSE-BURST GENERATOR

This is a fiendishly clever circuit for the digital experimenter. Just press S1, and this pulse-burst generator delivers the exact number of glitch-free pulses you need (as determined by the setting of S2). You can select anywhere from one to ten pulses, which the circuit furnishes at a rate of 1 kHz. If necessary, the pulse rate can be slowed down by using a larger value of capacitance for C1. With a 10 mf electrolytic unit as the timing capacitor, pulses arrive at a one-per-second rate, which is slow enough for visual observation (on an LED display, for instance). Any potential (V+) between +5 and +15 volts can be used, depending on the requirements of the circuitry you intend to drive.

PARTS LIST FOR PULSE-BURST GENERATOR

C1—.01uF-mylar capacitor
C2, C3, C4, C5—0.1-uF ceramic disc capacitor
IC1—555 timer integrated circuit
IC2—4017 CMOS decade counter integrated circuit
IC3—4013 flip-flop integrated circuit
Q1—2N3904 NPN transistor
R1—6,800-ohm, ½-watt 10% resistor
R2—68,000-ohm, ½-watt 10% resistor
R3, R5—100,000-ohm, ½-watt 10% resistor
R4—22,000-ohm, ½-watt 10% resistor
R6—4,700,000-ohm, ½-watt 10% resistor



25. MELODIOUS SEQUENCER

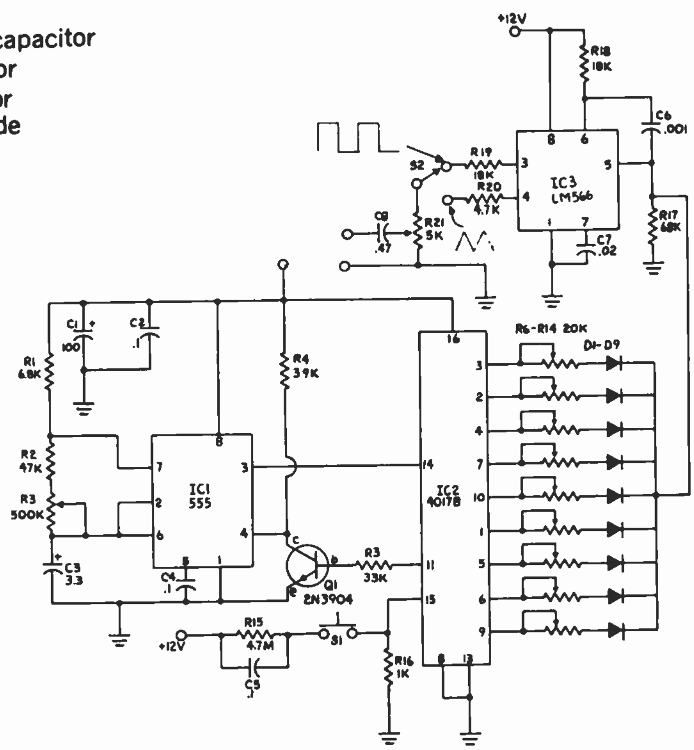
Press pushbutton S1, and this circuit will play you a short melody up to nine notes long. The immediate effect of pressing the button is to reset counter IC2 and set pin 3 of the counter HIGH. A voltage, determined by the setting of the pot attached to pin 3 of IC2, gets fed to the input of voltage-controlled oscillator IC3.

IC3's output consists of either a squarewave or a triangular wave, one of which can be selected by S2. The frequency of both these waveforms is identical and is determined by the voltage fed to the VCO. Potentiometer, R21 is the circuit's volume control.

Meanwhile, back at counter IC2, a pulse has just arrived from oscillator IC1. This increments the counter by one, causing pin 2 of the counter to go HIGH, and pin 3 to return to a LOW state. Successive pulses from IC1 cause the HIGH signal to advance along IC2's output (3, 2, 4...9). The ninth pulse send pin 11 high, thereby turning Q1 on and halting the oscillation of IC1. Pressing S1 sends pin 11 LOW and allows normal sequencing to resume.

Potentiometer R3 controls the tempo, which can be varied from 5 notes per second to one note every two seconds. Trimmers R6 through R14 are used to set the pitch of individual notes over the range from 200 to 2000Hz. If you desire a shorter sequence of notes, omit pots and diodes from the end of the sequence starting with pin 9 of IC2 and working backwards.

PARTS LIST FOR MELODIOUS SEQUENCER
C1—100 uF, 25-WVDC electrolytic capacitor
C2, C4, C5—.1 uF, ceramic disc capacitor
C3—3.3 uF, 25-WVDC electrolytic capacitor
C6—.001 uF, polystyrene capacitor
C7—.02 uF, mylar capacitor
C8—.47 uF, mylar capacitor
D1-D9—1N914 silicon diode
IC1—555 timer
IC2—4017B CMOS decade counter
IC3—LM566 voltage-controlled oscillator
Q1—2N3904 NPN transistor
R1—6,800-ohm, ½-watt 10% resistor
R2—47,000-ohm, ½-watt 10% resistor
R3—500,000 trimpot resistor
R4—3,900-ohm, ½-watt 10% resistor
R5—33,000-ohm, ½-watt 10% resistor
R14—20,000 trimpot resistor
R15—4.7 Megohm, ½-watt 10% resistor
R16—1,000-ohm, ½-watt 10% resistor
R17—68,000-ohm, ½-watt 10% resistor
R18—10,000-ohm, ½-watt 10% resistor
R19—18,000-ohm, ½-watt 10% resistor
R20—4,700-ohm, ½-watt 10% resistor
R21—5,000-ohm, audio-taper potentiometer
S1—SPST normally open pushbutton switch
S2—SPDT switch

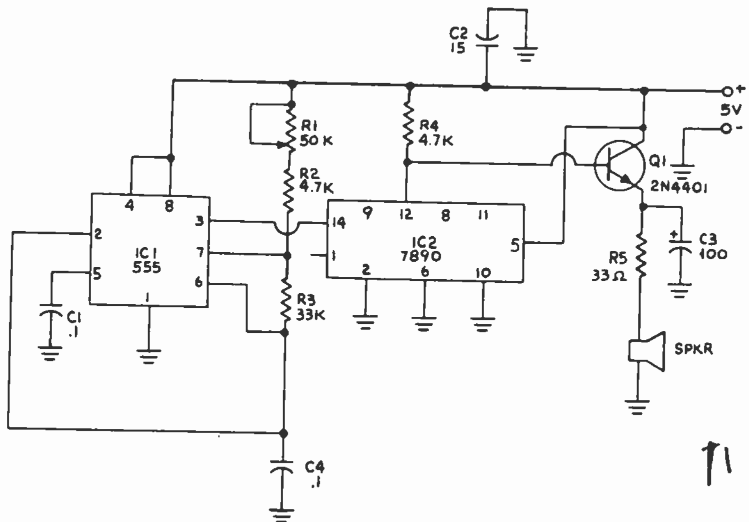


26. GUITAR TUNER

By taking advantage of the frequency stability of the 555 timer IC operating in an astable mode, an oscillator can be constructed which can be used as a tuning aid for the guitar. The first string of the guitar, E, produces a note with a frequency of 82.4 Hertz. The frequency of the oscillator is set to twice this value, 164.8 Hertz, and then followed by a divide-by-two stage to produce the desired frequency. The purpose of the divide-by-two stage is to guarantee that the waveform produced has a duty cycle of exactly 50%. This produces a note with no second harmonic distortion. The frequency of oscillation of the circuit is set by adjustment of R1, R2, and C2 also determine the frequency of oscillation but these components are fixed values and need no adjustment. The output of IC2 is fed to an emitter follower to provide current gain to drive a loudspeaker. C3 acts as a low-pass natural sounding note. The circuit is powered by a 5-volt supply, and this voltage **must** fall within the range of 4.75 to 5.25 volts for IC2 to operate properly.

PARTS LIST FOR GUITAR TUNER

C1, C4—0.1-uF ceramic capacitor, 15-WVDC
C2—15-uF electrolytic capacitor, 15-WVDC
C3—100-uF electrolytic capacitor, 15-WVDC
IC1—555 timer
IC2—7490 decade counter
Q1—2N4401
R1—50,000-ohm linear-taper potentiometer
R2, R4—4,700-ohm, ½-watt 10% resistor
R3—33,000-ohm, ½-watt 10% resistor
R5—33-ohm, ½-watt 10% resistor
SPKR—8-ohm PM type speaker

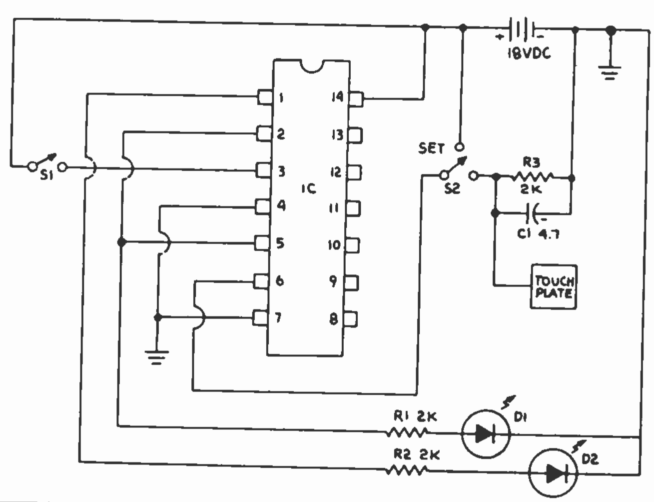


27. TOUCH 'N FLIP

Ever wonder how a touch plate, like the kind you see on some elevator buttons, works? This circuit will give you a good feel for how the touch plate works in a circuit and lets you experiment further. The plate can be just a small piece of metal or aluminum foil. Start by sliding S2 to "set" then back to R3. Now press S1. LED's D1 and D2 will flip. Now touch the plate to flip them back. The sensitivity of the touch plate will depend on humidity in the room and on R3 and C1. You can experiment with those in various ways.

PARTS LIST FOR TOUCH 'N FLIP

C1—4.7-uF 15-WVDC
D1, D2—large LED
IC1—4011 quad NAND gate
R1, R2, R3—2,000-ohm, ½-watt 10% resistor
S1—SPST momentary contact pushbutton switch
S2—SPDT slide switch



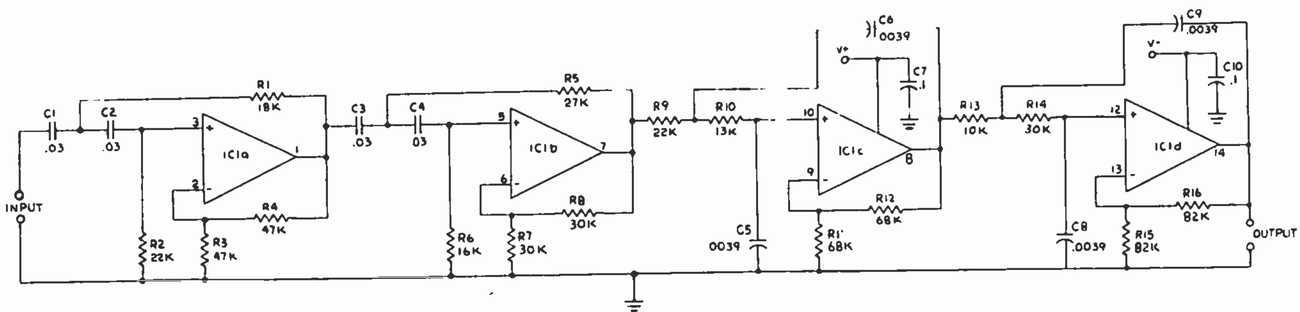
28. AUDIO BANDPASS FILTER

There are two different approaches to bandpass-filter design. The first involves use of a high-Q resonant network. You'll find this type of device sold as a CW filter, an application in which it excels. However, the selectivity of a resonant bandpass filter is such as to favor a very few frequencies to the exclusion of all others, and this makes it useless in voice reception. To filter the garbage out of an SSB transmission, you need a filter that freely passes the band of frequencies between about 300 and 2500 Hz but drastically attenuates frequencies outside the passband. An audio filter of this type is constructed by cascading (i.e., hooking in series) very sharp high- and low-pass fitlers.

That's what we've done here U1a and U1b comprise a sharp, 4-pole Butterworth high-pass filter with a 300-Hz cut-off. The two remaining stages function as a low-pass 4-pole Butterworth filter having a 2500-Hz cut-off frequency. Overall circuit gain is 16. Insert the filter into your receiver's audio chain at a point where the input signal level will be less than 100mV peak-to-peak. If the filter's extra gain causes problems, chop its output down with a resistive divider. A dual supply furnishing anywhere between 2.5 V and 15V can be used to power the circuit.

PARTS LIST FOR AUDIO BANDPASS FILTER

C1-C4—0.03-uF polystyrene capacitor
C5, C6, C8, C9—.0039-uF polystyrene capacitor
C7, C10—0.1-uF ceramic disc capacitor
IC1—LM324 quad op amp integrated circuit
R1—18,000-ohm, ½-watt 5% resistor
R2, R9—22,000-ohm, ½-watt 5% resistor
R3, R4—47,000-ohm, ½-watt 5% resistor
R5—27,000-ohm, ½-watt 5% resistor
R6—16,000-ohm, ½-watt 5% resistor
R7, R8, R14—30,000-ohm, ½-watt 5% resistor
R10—13,000-ohm, ½-watt 5% resistor
R11, R12—68,000-ohm, ½-watt 5% resistor
R13—10,000-ohm, ½-watt 5% resistor
R15, R16—82,000-ohm, ½-watt 5% resistor



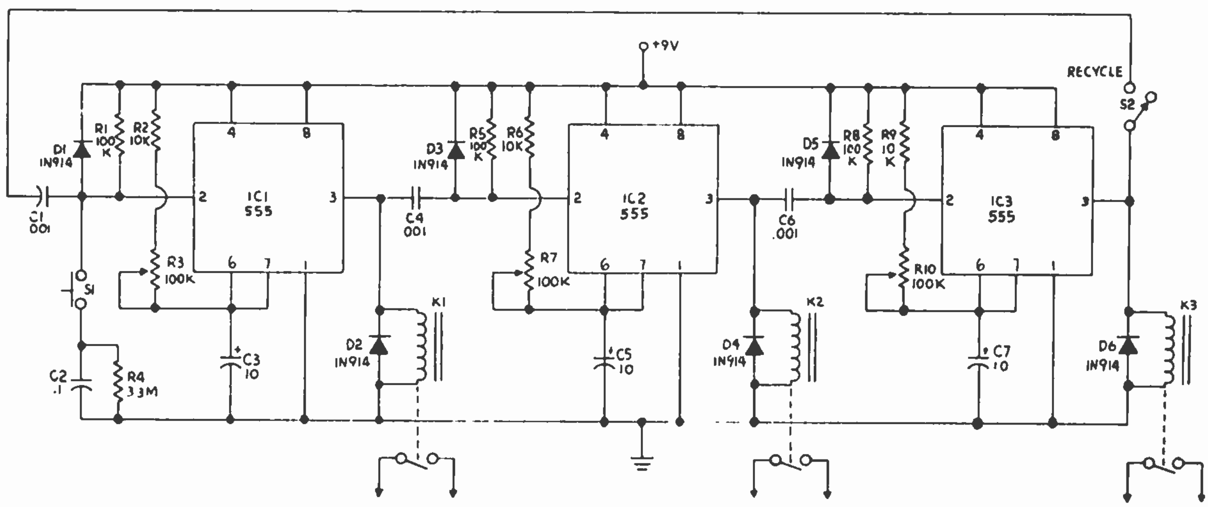
29. SEQUENTIAL TIMER

Press S1, and relay K1 pulls in for a time interval determined by the setting of R3. When IC1 times out and K1 opens once again, IC2 gets triggered. This causes K2 to pull in for an interval determined by R7's setting. Finally IC2 will time out and trigger IC3, thereby causing K3 now to pull in. Once IC3 times out and K3's contacts open, action ceases if S2 is flipped to the right. However, if S2 had been flipped to the left, IC1 would have once again been triggered as IC3 timed out, thus starting the whole cycle over again.

With the values shown, each timer can be adjusted for times from .1 to 1 second. If your application demands longer timing intervals, simply increase the size of the timing capacitors (C3, C5 and C7) and/or the timing resistors (R1-R3, R6-R7, and R9-R10). One application of the circuit that comes to mind is in flash photography. Let each relay fire a separate, cheap flash unit. With the timers adjusted for rapid fire, you'll be able to take stroboscope-like pictures that you couldn't take with a single conventional flash unit because re-cycle times (.3-.5 second) are too long. With three units, each flash has ample time to re-cycle while the others are firing. You might also try using color film and putting a separate colored filter over each flash tube.

PARTS LIST FOR SEQUENTIAL TIMER

C1, C4, C6—.001-uF mylar capacitor
C2—0.1-uF ceramic disc capacitor
C3, C5, C7—10-uF, 25-WVDC electrolytic capacitor
D1-D6—1N914 diode
IC1, IC2, IC3—555 timer integrated circuit
K1, K2, K3—6-VDC, 500-ohm relay
R1, R5, R8—100,000-ohm, ½-watt 10% resistor
R2, R6, R9—10,000-ohm, ½-watt 10% resistor
R3, R7, R10—100,000-ohm, linear-taper potentiometer
R4—3,300,000-ohm, ½-watt 10% resistor
S1—pushbutton switch, normally open
S2—SPDT switch

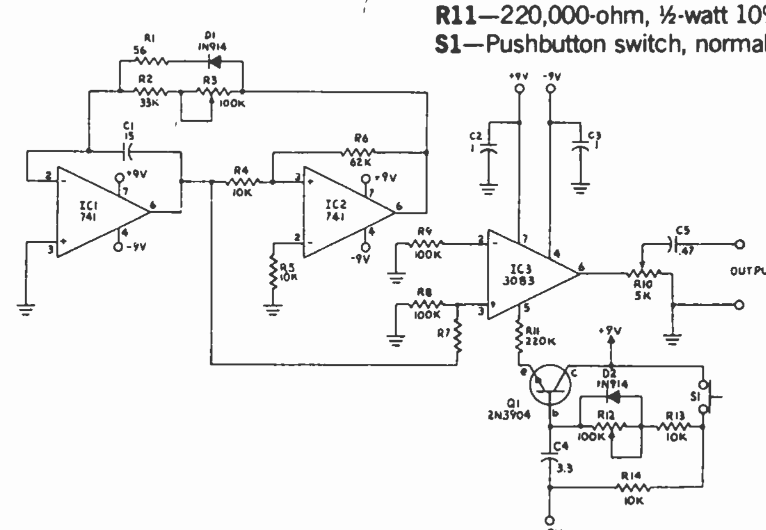


30. SLIDE TROMBONE

This is a novel little instrument that can be played through your stereo system. IC1 and IC2 comprise a ramp generator, the frequency of which is adjusted by R3. The range of adjustment spans two octaves from 150 to 600 Hz. The ramp signal is fed to modulator IC3, which imparts a natural-sounding attack and decay to

PARTS LIST FOR SLIDE TROMBONE

C1—0.15-uF mylar capacitor
C2, C3—0.1-uF ceramic disc capacitor
C4—3.3-uF, 25-WVDC electrolytic capacitor
C5—0.47-uF mylar capacitor
D1, D2—1N914 diode
IC1, IC2—741 op amp integrated circuit
IC3—3080 transconductance amp integrated circuit (RCA)
Q1—2N3904 NPN transistor
R1—5,600-ohm, ½-watt 10% resistor
R2—33,000--ohm, ½-watt 10% resistor
R3, R12—100,000-ohm, ½-watt 10% resistor
R4, R5, R13, R14—10,000-ohm, ½-watt 10% resistor
R6—62,000-ohm, ½-watt 10% resistor
R7—3,900-ohm, ½-watt 10% resistor
R8, Ro—100-ohm, ½-watt 10% resistor
R10—5,000-ohm audio-taper potentiometer
R11—220,000-ohm, ½-watt 10% resistor
S1—Pushbutton switch, normally open



the note the sounds when S1 is pressed. R12 allows adjustment of the note's decay interval, and R10 controls the volume. Maximum signal amplitude at the output is 500 mV peak to peak (sufficient to drive an amp's high level input). To play, just R3 for a particular note; press S1; slide R3; then release S1. You can make things easy by calibrating R3 in terms of muscial notes. Either a slide or rotating pot can be used for R3, depending on your playing preferences.

31. PSEUDO-RANDOM GENERATOR

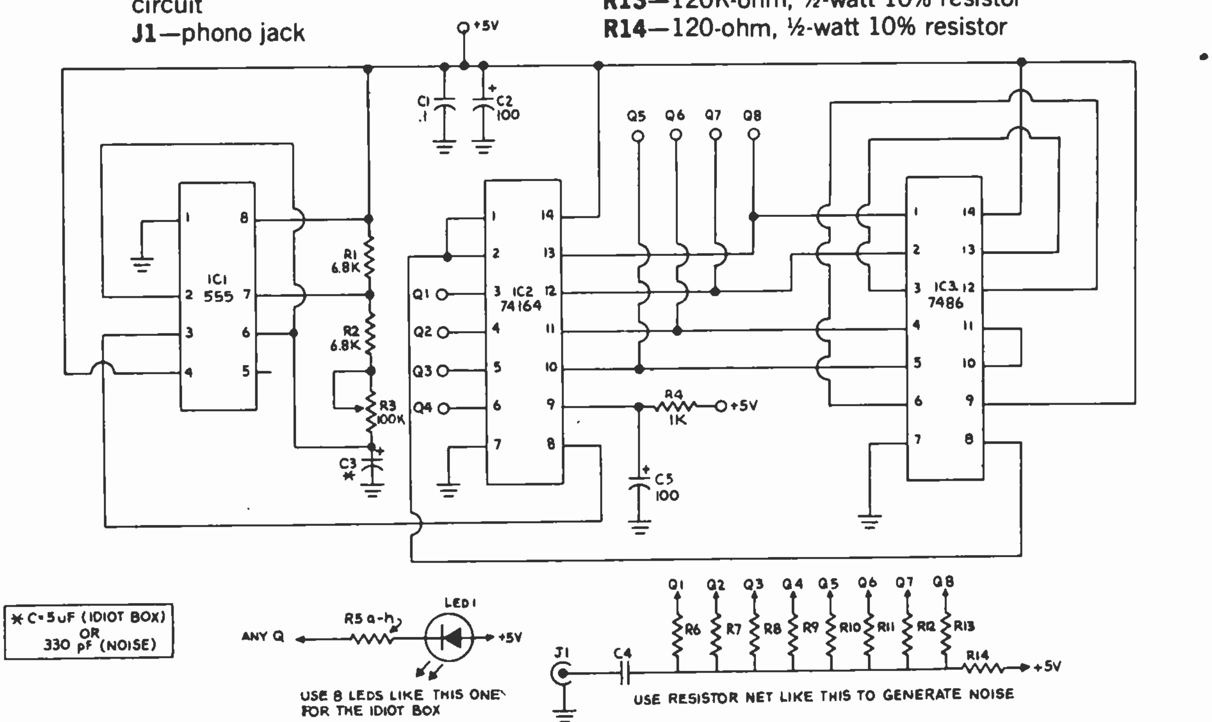
A pseudo-random sequence generator is like a scrambled counter. Instead of counting 1,2,3,4,..., the PRSG might yield an output of 2,9,7,1...The PRSG shown here supplies a sequence of 255 scambled numbers, available in binary form at the eight outputs (Q1) through Q8). Some applications:

First, you might hook up an LED and a 330-ohm resistor to each output as illustrated. Use a 5-uF electrolytic capacitor for C3, and you'll have a dandy idiot box, which will blink impressively on your desk, but do nothing.

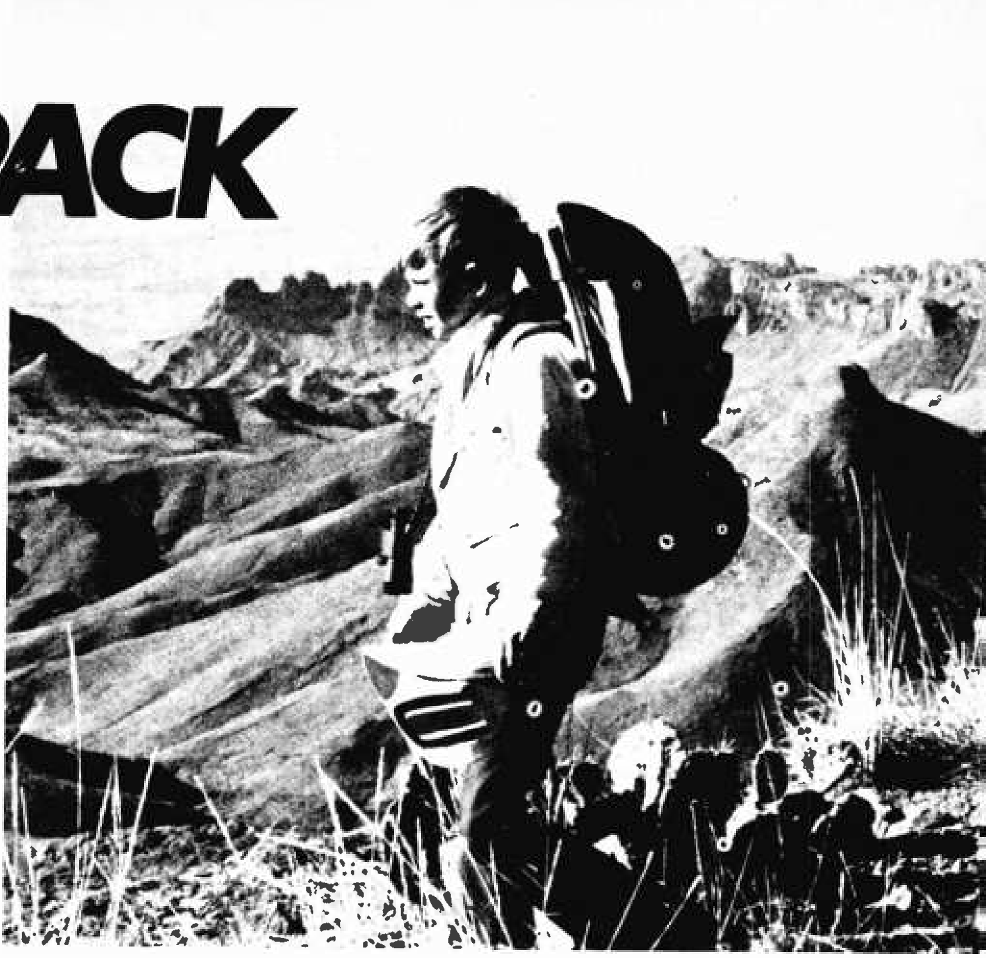
Or, you could hook up the resistor network diagrammed, and use a 330 pF polysyrene capacitor for C3. You'll get a 1-volt peak-to-peak noise voltage at J1 which can be used to generate interesting percussive sounds in conjunction with the Musical Modulator presented elsewhere in this issue.

PARTS LIST FOR
PSEUDO-RANDOM GENERATOR

C1—0.1-uF ceramic disc capacitor, 35-WVDC
C2, C5—100-uF electrolytic capacitor, 10-WVDC
C3—5-uF 10-WVDC electrolytic or 330-pF polystyrene capacitor (see text)
C4—1.0-uF mylar capacitor (non-polarized), 35-WVDC
IC1—555 timer integrated circuit
IC2—74164 shift register integrated circuit
IC3—7486 quad EX-OR gate integrated circuit
J1—phono jack
LED1 thru LED8—Light-emitting diode
R1, R2—6800-ohms-ohm, ¼-watt 10% resistor
R3—100K linear-taper potentiometer
R4-R6—1000-ohm, ¼-watt 10% resistor
R5a thru R5h—-ohm, ½-watt 10% resistor
R7—2200-ohm, ½-watt 10% resistor
R8—3900-ohm, ½-watt 10% resistor
R9—8200-ohm, ½-watt 10% resistor
R10—15K-ohm, ½-watt 10% resistor
R11—33K-ohm, ½-watt 10% resistor
R12—62K-ohm, ½-watt 10% resistor
R13—120K-ohm, ½-watt 10% resistor
R14—120-ohm, ½-watt 10% resistor



BACKPACK AMP



Take your electronic instrument anywhere with this low cost portable amplifier

Musicians who play acoustic instruments, such as trumpet, saxophone, or violin, for that matter, have never experienced the problem of the electronic musician on an outing where he or she is separated from an electrical source for an amplifier (assuming that one had even managed the task of bringing one along). It's admittedly pretty hard to entertain your friends with an electric piano which lacks electricity. What then, is the answer to this dilemna?

It's quite simple, actually—build a Backpack Amp. Designed to operate from "C" or "D" cells, or two or three small lantern batteries, the all-in-one-IC Backpack Amp will directly drive a speaker from the output of virtually any electronic instrument without need for additional amplification. Install the Backpack Amp in a small cabinet along with a 6 or 8-inch speaker and you can take your electric guitar, or whatever, with you on holidays.

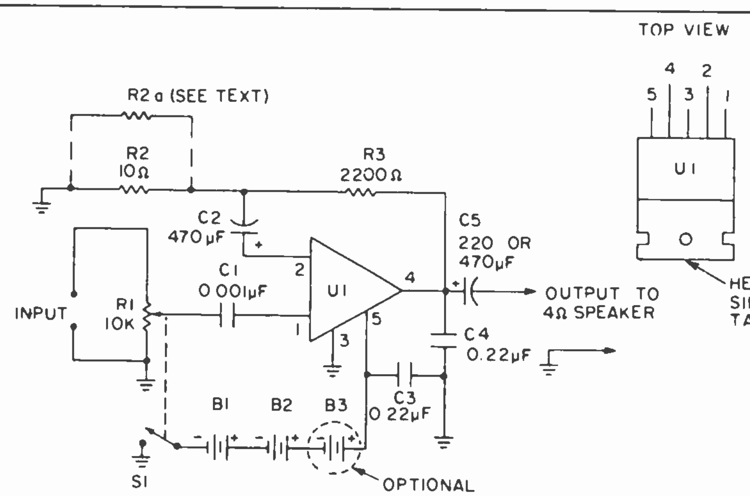
The Circuit. The Backpack Amp is assembled on a printed circuit board measuring 2¾ by 3⅝-inches. All active components which make up the preamplifier and power amplifier are contained in a single LM383T integrated circuit, which is available from Radio Shack. The resistor and capacitor values are considerably different than those given in the IC's data sheet (which is usually supplied with the IC). If you want the lowest distortion level from your electronic instruments use our values.

With a 12 to 18-volt power supply, the Backpack Amp will deliver from 1 to 3-watts into a 4-ohm load. Most replacement-type speakers are 4-ohms, and a 6 or 8-inch speaker is suggested. If all you have around, or can get, are 8-ohm speakers, we suggest you use two, parallel-wired 6-inch, 8-ohm speakers. (The amp will work with one 8-ohm speaker, but 1-watt is about the maximum low-distortion output even with an 18-volt power supply.)

The value used for capacitor C1 is 0.001-μF only if the amp will be used with an electric guitar. It compensates for the relatively higher low frequency output of an electric guitar pickup and prevents low frequency overload of the loudspeaker. If the Backpack Amp will be used with a synthesizer, you will probably be happier with the sound quality if C1 is 0.01-μF. If you use a 0.01-μF unit and find the low frequencies are overloading the speaker, sim-

PARTS LIST FOR BACKPACK AMP

- **B1, B2, (optional B3)**—6-volt lantern battery (see text)
- Note: Capacitor voltage rating must be equal to power supply voltage rating.
- **C1**—0.001-uF mylar capacitor (see text)
- **C2**—470-uF electrolytic capacitor
- **C3, C4**—0.22-uF mylar capacitor
- **C5**—220-uF or 470-uF electrolytic capacitor
- **R1**—100,000-ohm audio taper potentiometer with SPST switch attached (S1)
- **R2**—10-ohm, ½-watt 5% resistor
- **R3**—2200-ohm, ½-watt 5% resistor
- **S1**—SPST switch (part of R1)
- **SPKR**—see text
- **U1**—LM383T audio amplifier integrated circuit
- **Misc.**—Cabinet, screws, grille cloth, wire, solder, printed circuit etching materials, suitable input jack and matching plug, etc.



ply replace C1 with a 0.001-μF unit.

The correct value for R2 is usually 10-ohms. If you find your instrument's output is on the low side, and you have all gain controls wide open and still can't overdrive the amp, then tack-solder another 10-ohm resistor (shown as R2a in the schematic) across R2. If you need even more gain, R2 can be lowered to 2.2-ohms, but keep in mind that a 2.2-ohm resistor isn't the easiest of things to locate in this day and age.

Construction. Using any method you prefer, make the PC board using the supplied template. Note carefully the large copper foil area: it is part of U1's heat-sink and must not be eliminated. Don't substitute a thin foil strip as a *ground* connection. The foil rectangle in the middle of the PC board provides the anti-hum grounding for potentiometer (volume control) R1's shaft and frame. Again, don't substitute a thin foil strip because it might not contact R1's case when the potentiometer is installed. Depending on the particular style of potentiometer used, drill the proper size mounting hole where indicated by the dot in the foil rectangle.

Double-check the polarity of C2 and C5 before soldering. In particular, make certain C2's *positive* terminal goes to IC pin # 2. (It might not look correct but it really is.)

The IC must be mounted with a heat sink. From scrap aluminum, cut a section about ⅞ by 1¼-inch. Using the long dimension, bend a ⅝-inch tab. Drill a hole in the tab for a #4 bolt as close as possible to the "L" section (so as much metal as possible will be under the IC when the IC is positioned over the hole; but double-check that the tab does not touch any of the IC leads.)

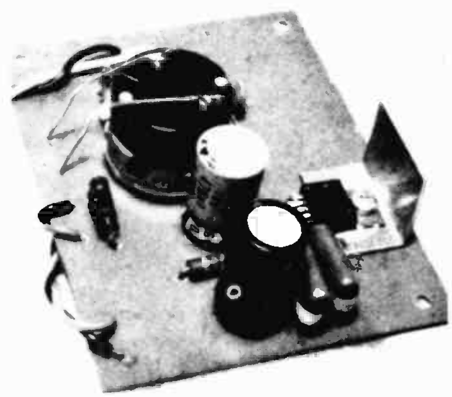
Using long-nose pliers, bend U1's leads to correspond with the holes in the PC board. To avoid shorts, the leads are offset: Nos. 1, 3 and 5 are close to the IC body; Nos. 2 and 4 are bent about ½-inch away from the body.

Place a drop of silicon heat sink grease on the underside of IC's mounting tab, position the IC on the sink, and then secure the IC and sink to the PC board with a #4 bolt, lockwasher, and nut. Place the lockwasher between the nut and the heat-sink foil on the PC board, and tighten securely.

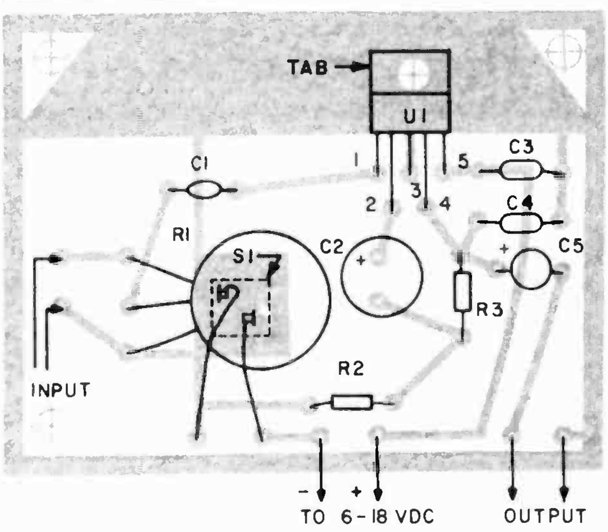
Installation. The Backpack Amp can be installed in any cabinet you prefer. (Note that it has a three-hole mounting.) If you can possibly locate a *potentiometer bushing extender*, which appears and then disappears in the marketplace from time to time, you can mount the amp with a single nut around the volume control's shaft.

While the power supply can be made up out of flashlight batteries, two or three series-connected small 6-volt lantern batteries make the most convenient and reliable portable power source.

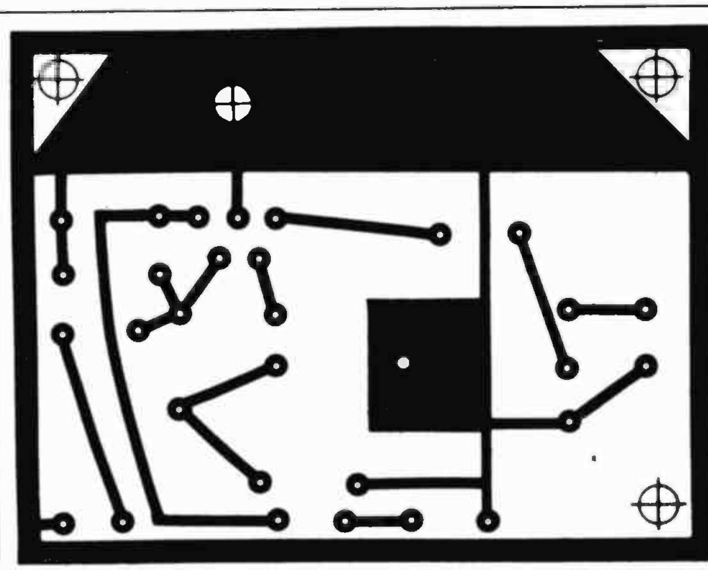
When it's all done, you and your ARP can head for the hills and commune with Mother Nature to your heart's content. ■



The completed PC board, showing U1 mounted with it's homebrew heatsinks.



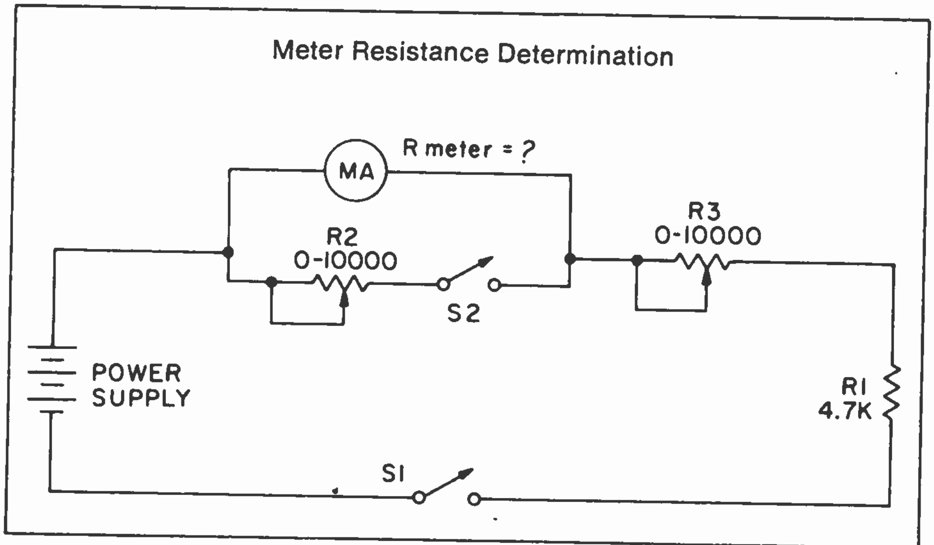
The component placement guide above shows the SPST switch mounted on the back of volume control R1 (dotted line box). External switch can be substituted for R1/S1.



The full-scale printed circuit template has two areas of solid foil which must be duplicated on your board. The large area at top helps heatsink U1, the other grounds R1 to minimize humming.

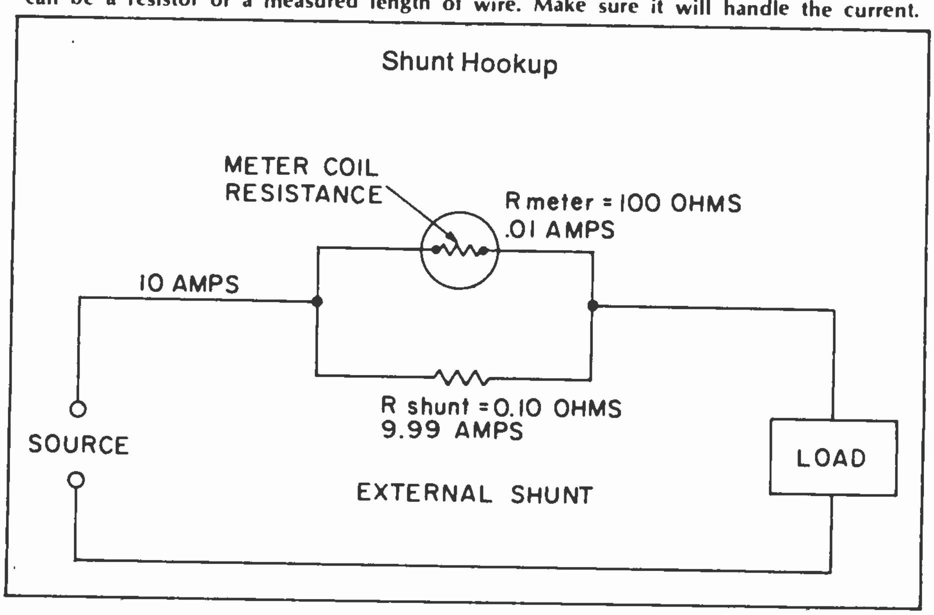
HIGH-AMP METERS

Keep up with current events by expanding your meter's amp-ability



To determine the internal resistance of a meter construct a circuit like the one illustrated above. If you don't have the parts in your junk box then check an electronics surplus outlet.

A shunt resistor bypasses the bulk of the current around the meter while allowing a regulated amount to pass through the meter's coil and give an accurate reading. A shunt can be a resistor or a measured length of wire. Make sure it will handle the current.



WITH THE RISING COST of test equipment it is advantageous to be able to perform several operations with one meter. For instance a DC milliammeter can be converted to read higher values of current by adding a shunt to bypass the bulk of the current around the delicate meter. By following a few simple steps a milliammeter can be converted to read 10 to 20 amps or more. The first step is to determine the internal resistance of the meter. From this you can calculate the shunt resistance needed and the type of material to be used.

To find the internal resistance of the meter, construct the test circuit illustrated here. The 4700 ohm resistor is used to limit current and serves no other purpose. Start with the power supply set to zero volts, leaving S2 open and S1 closed. Slowly increase the current flow by varying R3 until the meter needle moves to full-scale deflection. Without touching the setting of R3, close S2 and adjust R2 until the meter reads half of full scale. According to Ohm's Law the resistance of the meter and of R2 are now equal. Open switch S2 and measure the resistance across R2. This value will be equal to the internal resistance of the meter.

Shunt. Precise shunt resistance is important for accurate current readings and must be chosen carefully. With the shunt connected across the meter, most of the current is diverted past the meter. This is the theory behind a small meter being able to read high currents. The shunt can be a wire, steel or copper bar, or almost any material that will offer the proper resistance. To determine the needed shunt resistance we will consider an example. If we want a 0 to 10 milliammeter to be able to read full-scale for a current of 10 amps. Therefore 10 mA will flow through the meter when 9.990 Amps are diverted through the shunt. If the meter resistance was 100 ohms, using Ohm's Law the voltage across this parallel circuit is found by using the following equation:

$$\begin{aligned} E &= (\text{Current}) \times (\text{Resistance}) \\ &= (0.01 \text{ amps}) \times (100 \text{ ohms}) \\ &= 1 \text{ volt} \end{aligned}$$

Using the calculated voltage and solving Ohm's Law for resistance the proper shunt can be found. This derivation is shown below:

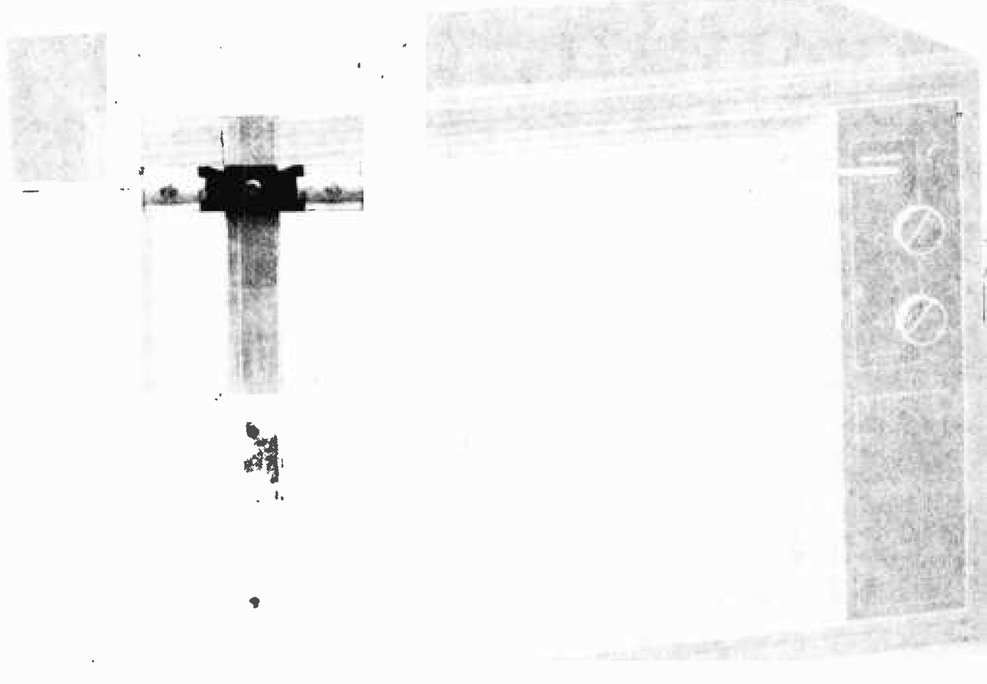
$$\begin{aligned} \text{Resistance} &= \frac{\text{Voltage}}{\text{Current}} \\ &= \frac{1 \text{ Volt}}{9.990 \text{ Amps}} \\ &= .1001 \text{ Ohms} \end{aligned}$$

In this case the milliammeter would be capable of giving a readout directly in amperes.

By following these few simple steps you will greatly expand the versatility of your test equipment. It will increase your ability to handle a greater variety of test and trouble shooting situations. ■

MIGHTY MIDGET

This compact TV antenna boosts metropolitan reception



TELEVISION RECEPTION in some urban and suburban areas is only fair. Rabbit ears do not provide sufficient gain or directional pattern. A somewhat better antenna is necessary.

The "Mighty Midget" was designed for just such applications. Its one-element construction is inherently broadband making it useful on a variety of channels. It is also less directional than a multielement antenna, resulting in acceptable performance from more than one direction.

The prototype antenna was comprised of two telescoping whips. They were adjusted while viewing several channels, recording the optimum element lengths for each. The table shows the results of this approach.

This TV dipole is actually a modification of the Windom antenna applied at VHF. The Windom was a popular amateur radio antenna in the early days of shortwave radio communications. A center-fed dipole has a characteristic impedance at its feedpoint of 72 ohms. Lorn Windom fed his antenna 14% *off*-center (36% from one end). His antenna showed a higher impedance on even-multiple harmonic frequencies, and could be fed with 300 ohm transmission line with very little mismatch. Thus, we use standard, low cost 300 ohm line to transmit the TV signal from Mighty Midget to our TV set. The antenna location is chosen for a perfect TV picture.

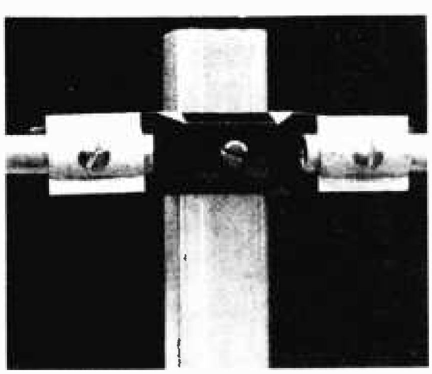
Our Mighty Midget has one advantage over Windom's design: Because of the high frequencies involved, our antenna has very thick elements compared with their lengths. This results in wideband performance.

EXPERIMENTAL LENGTHS OF ELEMENTS

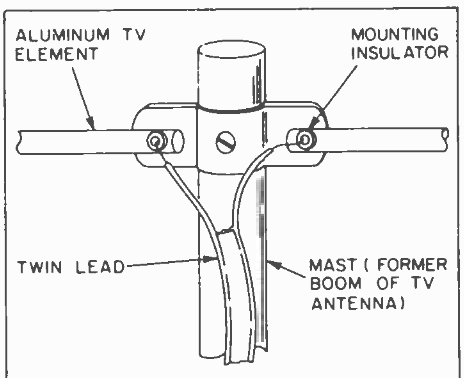
TV Channel	Optimum dipole elements "A"		"B"
2	48"	+	48"
4	36"	+	12"
5	48"	+	31"
6	22"	+	16"
7	46"	+	5"
10	48"	+	36"
12	48"	+	36"

Construction: The parts for this antenna are readily available: A broken or discarded TV antenna. All that will be needed are two elements: one 48" and one 36" long. The mounting insulator also will be needed to support the elements. The original boom may be used as a short mast; it is already contoured to fit the insulators holding the aluminum elements. The other elements are broken off and discarded. The remaining insulators may be left on or removed at your discretion. If a long rear element is still salvageable, much of your work is already done for you. The 48" x 36" lengths may be achieved by squeezing down on each element at the appropriate point with a pair of cutters. The end of the element is then bent up and down until

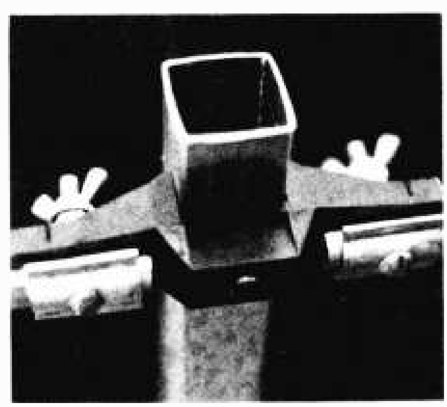
(Continued on page 95)



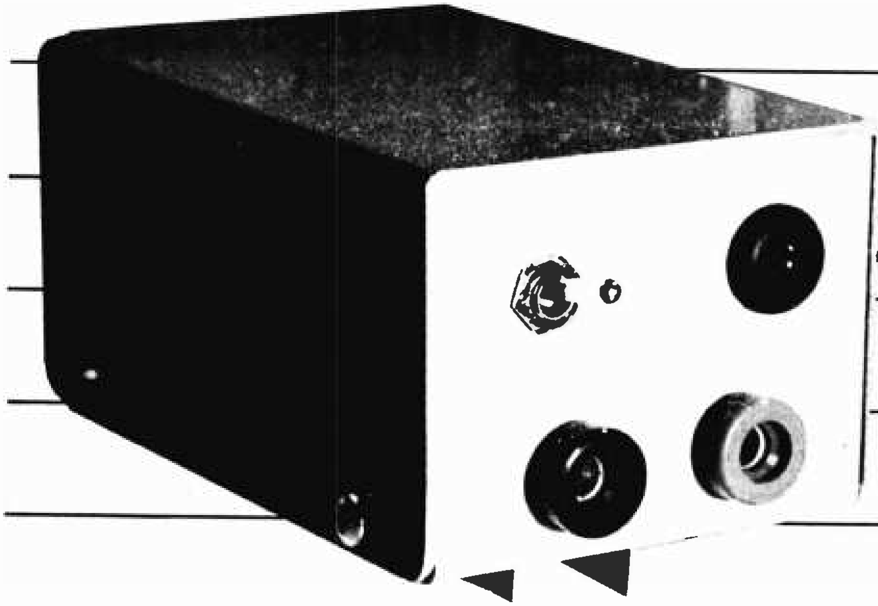
The Mighty Midget has hefty construction and will take any sort of battering. With three heavy bolts, it's hard to damage.



A connector on each side of the mast is used for holding the 300-ohm TV cable.



Sturdy wing nuts are utilized to hold and allow for easy removal of the TV wire.



BUILD A SIMPLE VOLTMETER AND SCOPE CALIBRATOR

Make your test instruments precision measuring devices without breaking the bank

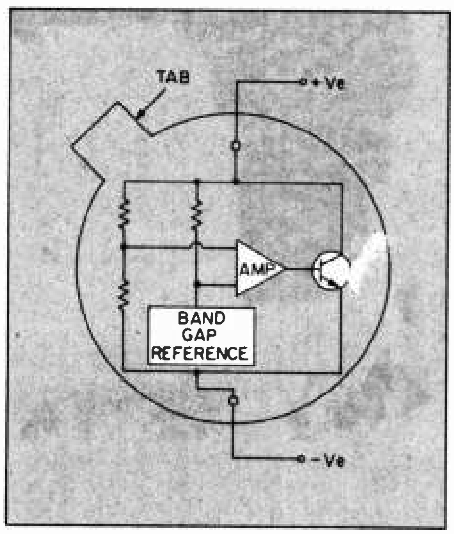
PRECISION VOLTAGE MEASUREMENTS require a calibrated source against which to compare the readings of the voltmeter or oscilloscope. In really high-class measurements, where absolute accuracy is needed, laboratories will use something like a Weston cell and a precision potentiometer. But to the hobbyist, such instruments are both too costly and, in most cases, more accurate than is necessary. In the past, the hobbyist had to be content with zener diode calibrators. Unfortunately, these diodes are not the best and tend to drift. But today, a new breed of regulator is available. Several manufacturers are now offering regulator/reference source ICs using *band gap* zener diodes, and internal amplifiers. These ICs give the hobbyist a low-cost method for building a reference voltage source.

Calculate Your Needs. The circuit in Fig. 1 is sufficient to operate as a hobbyist-grade voltage calibrator. Only a power supply (in this case a battery), a resistor, the regulator IC, and a means for turning it on and off are required.

The value of the series resistor depends upon the reference current selected and the power supply voltage. The reference current may be set at any point in the range of 2 to 120 milliamperes, provided that the overall power dissipation is kept to less than 300 milliwatts. In practice, however, one is advised to select a value in the 2 to 5 mA range. In the example of Fig. 1 we have selected 8.75 mA for a very special, high level, technical reason—we had a 4.2-volt battery and a 200-ohm resistor in the junkbox at the time.

The series resistor's value is computed as:

$$Rl = \frac{Eb - Eo}{Ir}$$



Here is an internal schematic of the band gap zener diode, which serves as the heart of the calibrator. Use the tab on the case as the reference point for making circuit connections. No heatsink is required here.

Where:
Eb is the battery voltage
Eo is the output voltage (1.26 or 2.45-volts)
Ir is the reference current
Rl is the resistance in series with the IC

Example:
In the circuit of Fig. 1, we used a 4.2-volt mercury battery, and selected a reference current of 8.75 mA. Find the value of the resistor needed for *Rl*. A ZN458 (2.45 volts) is used.

$$Rl = \frac{(4.2-2.45)\ volts}{(0.00875)\ Amp}$$

$$Rl = \frac{(1.75)}{(0.00875)} = 200\text{-}ohms$$

The resistor used should be a low temperature coefficient type. We used a wirewound precision resistor for *Rl*, and selected it because it was in the junkbox. Contrary to the example above, we actually selected the reference current based on the resistors on hand. An ordinary carbon composition resistor could be used, but the results are not guaranteed.

Construction. The construction of the calibrator is shown in Fig. 3. The largest part in the project is the battery, so a small LMB aluminum box was selected to house the calibrator. The electronic circuitry was built using the banana jacks as tie points; no wire board is needed. The battery holder is ordinarily used with size "C" batteries, but the Mallory TR233 (4.2-volt mercury cell) fits nicely. The battery holder was fastened to bottom of the box using a small 4-40 machine screw. Small rubber feet can then be glued to the box to offset the "bump" created by the screw head. If you want to avoid this, however, it should be easy to superglue the battery holder flush to the aluminum.

The ZN458 has a 100 *parts per million* (PPM) drift specification, the ZN458A is a 50 ppm device, while the ZN458B is a 30 PPM device. The voltage output is nominally 2.45-volts DC. (measured at 2 mA reference current), but may have an absolute value between 2.42 to 2.49-volts. With no additional circuitry, then, these devices will produce an accuracy of ±40 millivolts, or better. This voltage cannot easily be adjusted without external circuitry, but you can use any of the standard IC operational amplifier voltage regulator circuits to set the output voltage to a standard level. Fig. 2 shows a circuit that is usable for this purpose. The ZN458 is used to set the voltage at the noninverting input of the op amp. The output voltage can then be trimmed to the desired value by potentiometer *R3*. This circuit is an ordinary op amp noninverting follower, so the desired output voltage can be derived in the following equation:

$$Eo = Eb\left(\frac{R3 + R2}{R1} + 1\right)$$

The table shows values for *R2/R3* needed for output voltages of 5 and 10-volts. Note that the resistors used in this circuit must be low temperature coefficient precision (1%) resistors, or drift will result. It is even more important in this circuit, than in the circuit of Fig. 1. The trimmer potentiometer should be a ten-turn, precision type, so that very tight control over the adjustment of the output voltage is possible.

There is, however, a hitch in this variable output circuit. It is not inherently "calibrated" as is the case of Fig. 1. Although this circuit is capable of better accuracy, initially, it must be adjusted. You will have to find a very accurate voltmeter, or precision reference potentiometer to make the initial adjustment. After this adjustment, however, it should remain in calibration for a long time. ■

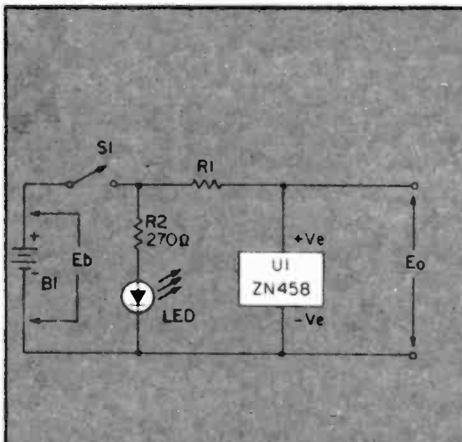


Fig. 1. This is a basic schematic used to demonstrate the calculations necessary to determine the value of the associated components used in the regulator circuit. Refer to the text for a full explanation.

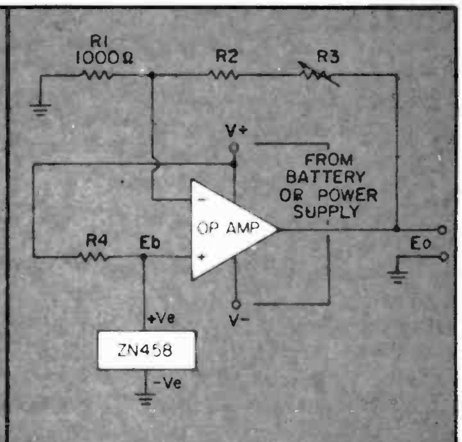


Fig. 2. This schematic depicts a variable regulated power supply, with the source being either a battery or a line-powered DC source. Refer to the table below and text, to determine your own parts needs.

TABLE 1—ZENER SELECTION

Type	Voltage	Drift
ZN423	1.26	—
ZN458	2.45	100 ppm
ZN458A	2.45	50 ppm
ZN458B	2.45	30 ppm

TABLE 2—R2/R3 SELECTION

Output Voltage	R2	R3
5	1000-ohms	100-ohms
10	2600-ohms	500-ohms

The four most popular low-voltage band gap zener diodes are listed above, with their respective drift figures. Obviously, the smaller the drift figure (in terms of parts per million) the more accurate the calibrator circuit will be. Use the highest tolerance parts available, in order to enhance the accuracy of the circuit. Refer to the text for an explanation of the significance of the values given for R2 and R3 in Table 2 above.

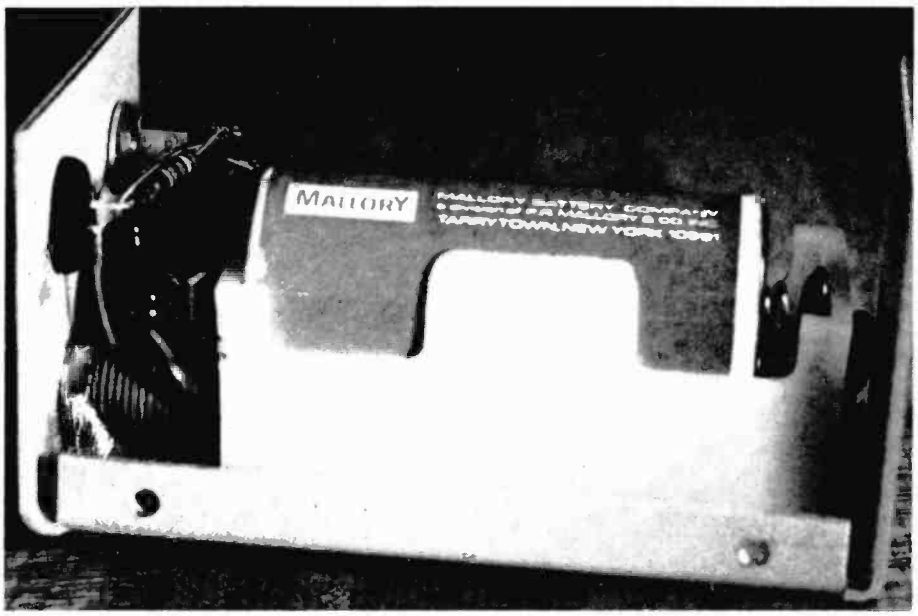
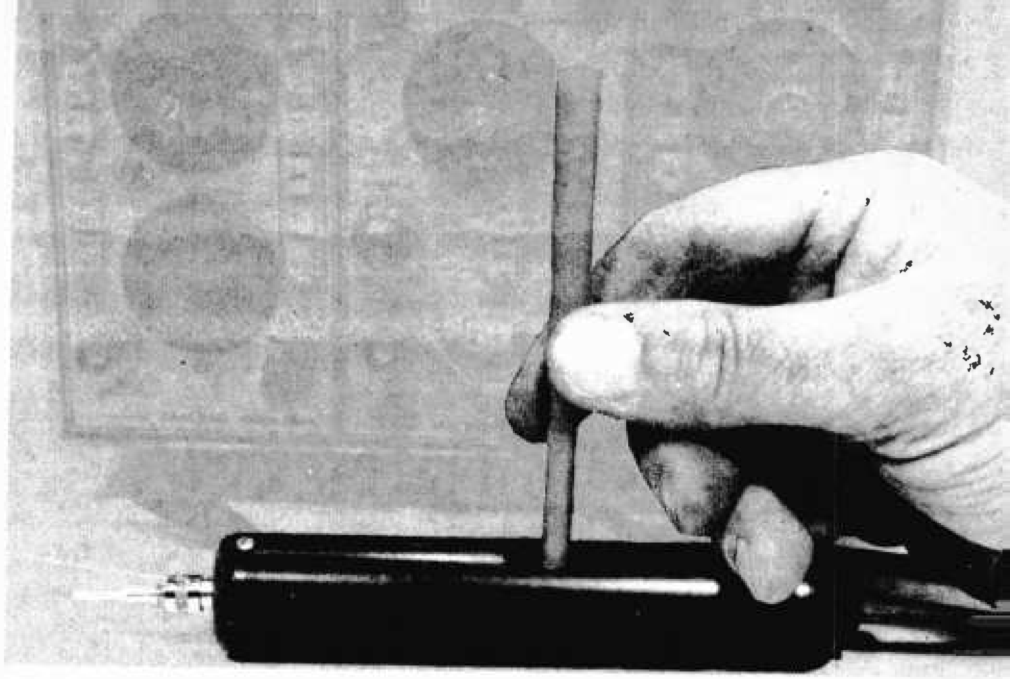


Fig. 3. The compact construction of the calibrator is seen here. We wired all components to the terminals of the banana jacks first, and then bolted in the battery holder to the bottom of the chassis to allow working room for assembly. You may choose to utilize either perfboard or even a printed circuit board for your model. This will allow you to mount it directly inside the cabinet of whatever test instrument you wish to calibrate. With this method you can always have a reliable source of instrument calibration with you, no matter where you might happen to be doing your repair or field operations.

LO CAP PROBE

Simple probe helps your oscilloscope perform at high frequencies



"WHAT YOU SEE is what you get" might be A-okay for a television comic, but it's not necessarily true when you use an oscilloscope.

It is unfortunate, but true, that a scope's performance is specified from the input terminals to the scope itself, but does not include the test probe or connecting wires. For this reason a service-grade scope rated out to 4 MHz, or 7 MHz, or even a laboratory scope rated out to 20, 50, or 100 MHz, might poop out on something as mundane as a 60 Hz square wave, delivering a CRT display with rounded leading edge while the real waveform is truly square. Worse than that, connecting your scope into an RF circuit may completely change the loading, or tuning of the circuit which is under test.

Here's Why. Forget for a moment that the scope has a frequency-compensated input. That has no bearing on your measurements, which is affected by the cable between the circuit being tested and the scope input. An ordinary shielded test lead approximately 3 feet long has a capacity of about 100-300 pF, depending on the type of shielding. If a "bare" test lead is connected into a circuit it is effectively loading the circuit with 100-300 pF: just imagine what this will do to an RF circuit, or any high frequency circuit from about 10k Hz up. "What you see *isn't* what you get in this case."

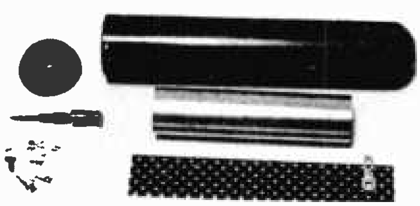
Also, consider the average scope's 1-megohm "high impedance" input. "High impedance" is a relative term: one equipment's "high impedance" is another's "low impedance." For example, imagine a transistor or integrated-circuit amplifier with a 500k or 1-megohm bias or feedback resistor. Connecting a scope's input across either value will completely change the operating parameters of the circuit. Or imagine what a 1-megohm "load" across a tuned RF input circuit will do: the "Q" might drop like a rock, not to forget the detuning effect of the test lead capacitance of the lead itself.

Follow the Labs. Commercial labs get around both the capacity loading and 1-megohm impedance by using a "10X low-capacity" test probe for the scope input. This device does two things: It makes the input capacity to the scope's test lead appear to be about 5-10 pF; and it raises the input impedance into the test cable—the impedance seen by the circuit being tested—to nominally 10 megohms (a value that won't affect any circuit the hobbyist will use or test).

Easy to Build. A 10X Low Capacity Test Probe circuit is shown in Fig. 1. Basically, it consists of two components: trimmer capacitor C1 and resistor R1. C1 is generally any small trimmer wtih a maximum capacity in the range of 25-50 pF. R1 should be 9 megohms for a precise 10:1 voltage division: ie: the scope will indicate 1 volt P-P if the input to the cable is 10 volts P-P. However, 9 megohms, or anything close, is usually unattainable by the hobbyist. If you substitute a 10 megohm 5% resistor for R1 the accuracy will be sufficient for almost all applications (nominal voltage readout error will be about 10%).

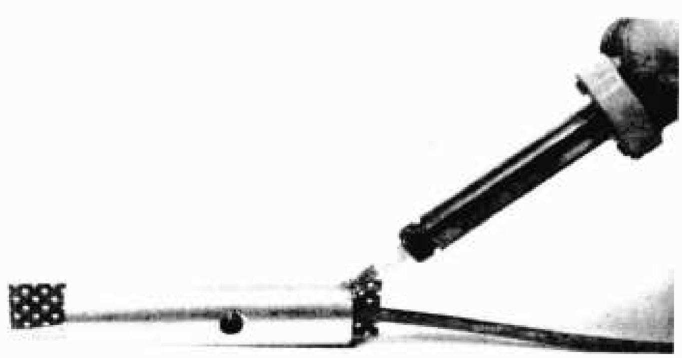
In A Shielded Probe. The 10X probe must be assembled in a shielded test probe; if not shielded, hand capacity will induce "hum" into the signal, and add capacity loading to the circuit.

A shielded probe kit, the Keystone 1810, was used for the 10X probe assembly. The Keystone probe kit contains an insulated probe shell, a shielding sleeve, perforated wiring board (sized to fit inside the shield), probe



The Keystone 1810 shielded test probe kit before assembly. These are hard to get parts.

Trimmer capacitor wired onto strip of perf board. Be careful of parts shorting out in close spaces in which you'll be working.



As the text discusses, tack solder the test probe shield to the solder lug you've installed on the perf board. Do not fold the lug over the shield.

tip, and "flea" clips (soldering terminals). That's all you need.

Temporarily mount C1 to the perf-board and see if you can slide the shield over the assembly without having the shield short the trimmer capacitor. If it touches a metal part of C1, file the edges of the perf-board so it will sit lower in the sleeve and not short C1. When the shield can slide over the assembly secure C1 to the board with flea clips, as shown in the photographs. Install R1 across the C1 flea clips on the opposite side of the board (there isn't room for C1 and R1 on the same side) of the board.

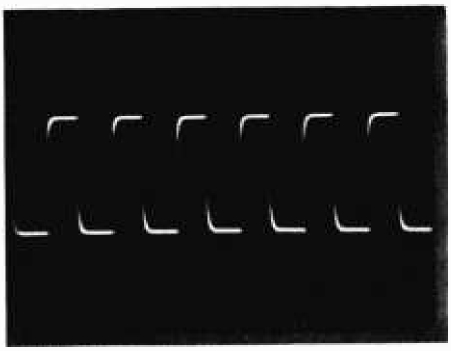
Solder about 3-inches of solid No. 20 or No. 22 wire to the front flea clip, the one on the opposite end from the solder lug which is factory installed on the perf board. This wire will eventually connect to the test probe tip.

Cut a piece of shielded wire to about 3-feet. You can use an ordinary audio patch cable with the phono plugs cut off the ends. Solder the center conductor to the rear flea clip; solder the shield to the solder lug and bend the solder lug at right angle to the perf-board. Make certain when you solder wires to the flea clips that C1 and R1 are also soldered to the clips.

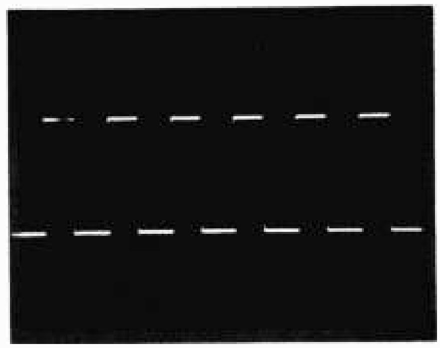
Slide the probe shield over the perf-board from the front until it touches the solder lug. Carefully mark the sleeve directly over the trimmer capacitor's adjusting screw. Remove the sleeve and drill a ¼-inch hole at the mark (careful, the sleeve is very thin). Solder an insulated stranded wire approximately 8-inches long to the solder lug's grommet—where it's secured to the perf-board. (This wire will pass out the hole in the rear of the probe cover and will connect to an alligator ground clip) that you use.

Now slide the shield over the perf-board, press it against the solder lug, and tack solder the shield to the solder lug. Do not fold the lug over the shield as it might prevent the cover from being slipped into place. Screw the probe tip into the probe's front cap, and then thread the solid wire from the perf-board through the probe, pulling on the wire so the perf-board is tight against the cap. Secure the wire to the probe tip. Measure the distance from the cap to the hole in the shield and transfer this measurement to the probe cover. Drill a ¼-inch hole in the cover at the mark. This will be the access hole for the capacitor C1.

Next, assemble the probe and install the required connector (to match your scope's input) at the free end of the shielded cable coming out the back.



Too much capacity shows up in a rounded leading edge, as shown here in Figure 2A.



Here, C1 has been adjusted correctly. Leading edge is perfectly square, here in Fig. 2B.

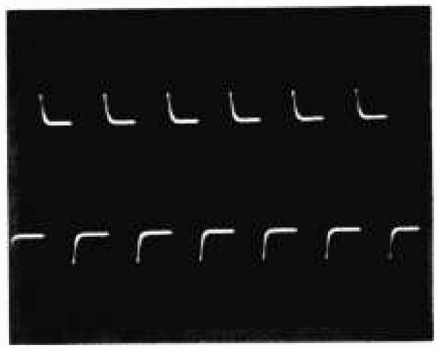
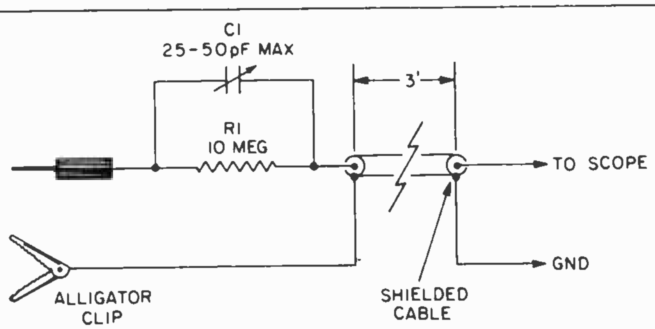


Fig. 2C. Peaked leading edge, shown, results from too little capacity in C1 adjustment.



PARTS LIST

C1—Trimmer capacitors 25 or 5 OpF max., see text
R1—10,000,000 ohm, ¼ or ½ watt resistor, 5%, see text

Misc.
Alligator grounding clip
Scope input connector
Keystone 1810 test probe

The Keystone 1810 test probe kit is available from Custom Components, Box 153, Malverne, N.Y. 11565. Price is $4 plus $2 postage and handling per total order: Canada add $1 additional. No foreign orders. N.Y. State residents must add sales tax.

Alignment. You must align the low capacity probe using some form of square waveform in the range of 60-1000 Hz. This can come either from the calibration voltage built into your scope or the square wave output of a sine-square signal generator. You can even use a broad pulse from a pulse generator if you have such an instrument in your workshop.

Touch the low capacity probe to the square waveform output, adjust your scope for a convenient CRT display, and then using an insulated alignment screwdriver, adjust C1 for a perfectly square *leading edge*, as shown in Fig. 2B. If you have too much capacity the leading edge will be rounded, as in Fig. 2A. If you have too little capacity the leading edge will peak, as shown in Fig. 2C. Perfect adjustment is a *perfectly square leading edge*. Once C1 is adjusted it need never be changed as long as the same scope is used.

Using the probe. Remember to multiply the CRT voltage indication by 10 to obtain the correct voltage at the test probe. For example, if the scope is set for 1 volt per division, and the peak-to-peak waveform is 1.5 divisions, the actual voltage at the test probe is 1.5 volts p-p x 10, or 15 volts p-p. ■

Make your home an aviary with this new telephone ringer.

BY HERB FRIEDMAN

AN EXTRA RINGER in the bedroom or living room is always a good idea but the thought of waking up to a klaxon or having guests jolted out of their seats by a clanging bell is a bit too much for anyone.

However, if you would like a peaceful way to announce that your phone is ringing, use Telechirp. This device produces a low level chirp (or warble) instead of a clang or bong.

Easy To Build. The Telechirp is a simple device requiring few components and is easy to piece together. It is powered by the ringing signal of your telephone.

Electronic buzzer BU1 will produce a high frequency whistle (approximately 5 kHz) when 2-12 volts DC is applied to its wires. Normally, the output of the buzzer is a continuous tone because the applied voltage is continuous (DC). As used in the Telechirp, however, the buzzer chirps in step with the 20 Hz ringing current.

The 20 Hz ringing current passes through capacitor C1 to the diode bridge consisting of D1-D4. Partial filtering of the bridge's output is provided by C2. The resultant pulsating DC is applied to the buzzer, producing a high frequency chirp each time the phone rings.

All components are critical. Any change in values produces improper operation. Make only those changes or substitutions we specify. A silicon rectifier or full-wave bridge rated 200 PIV or higher can be substituted for D1-D4.

While the PIV can be lower, 200 PIV provides a good safety margin. For most applications C1 should be a .1 uF Mylar capacitor rated 500 VDC. (Again, a lower rated capacitor of 100 VDC could be used but 500 VDC provides greater protection.)

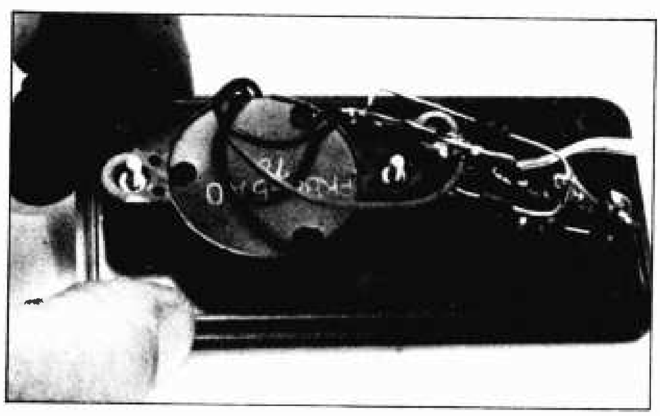
If C1 is made larger, say 0.47 uF, the output of the buzzer will be louder but you will also get kickback, meaning the buzzer will pulse in step with the telephone dial's pulses. If your phone has Touch-Tone® dialing, kickback is not a problem, but line static might cause the buzzer to tick.

Capacitor C2 is also critical. If made larger than 10 μF, it will produce a smooth, non-pulsating, DC and the output of the buzzer will be a continuous high frequency tone, which is not an attention-getter. If C2 is smaller than 10 mF there will be too much AC and the buzzer will tick instead of chirp; a nice sound but not loud enough for general use.

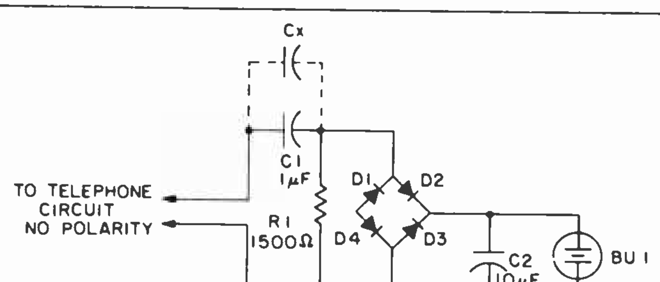
The Telechirp can be connected to your telephone circuit with ordinary zip-cord or speaker wire.

Telephone circuits do vary. Keep in mind that Telechirp is intended for a quiet location, but if the chirp produced by your telephone's ringing signal is too low, connect capacitor Cx, 0.05 uF disc, across C1.

The Telechirp can be used as a quiet warning that someone is dialing out on the phone circuit. If capacitor Cx is raised to 0.1 or 0.2 mF, the device will produce chirps in step with the dial pulsations each time someone dials out. (It works with rotary dial telephones.) The total value of capacitors C1 and Cx should never exceed 0.47 mF, nor should the value of R1 be changed by more than 10%. ■

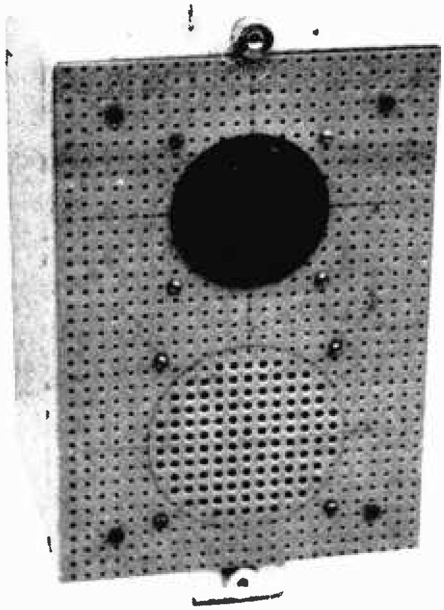


To make Telechirp, it doesn't take a lot of parts or a PC board. Just hook up the few parts with a terminal strip and Telechirp will sing away. Be very careful when you put together the diode bride. Make sure the diodes are properly polarized.



PARTS LIST FOR TELECHIRP

BU1—solid state buzzer, Radio Shack 273-060
C1—0.1-uF, 500 VDC mylar capacitor
C2—10-uF, 25-VDC electrolytic capacitor
Cx—see text
D1-D4—silicon diodes on small silicon rectifier rated 200 PIV
R1—1500-ohm, ½-watt, 10% resistor
Misc.—cabinet, terminal strip, wire, solder, hardware, etc.



ICE-BOX HI-FI

This lightweight speaker system is as close as your local hardware store

BY FRED JOHNSON

HERE IS A SPEAKER SYSTEM that is small in size, light in weight, and delivers true high fidelity sound when connected to your audio power source, car radio or tape player.

This unique speaker system consists essentially of two speaker units, a light weight enclosure, a prepunched perf-board, that is modified to become a speaker mounting baffle and grille, hook-up wire and glue. Sounds simple? This do it yourself project consists of an assembly of parts, more than a complex construction job.

The speaker enclosure looks like a small cold chest made of styrofoam Breadboard. Styrofoam is responsible for the minimal weight. This material is acoustically dead. Hence, it can be used to house speaker components, if the enclosure is small enough to minimize acoustic resonance.

Styrofoam will pass low frequency sound like a sieve. This problem is solved by coating all styrofoam surfaces with white glue. Elmer's "Glue-All" or other white glue that is made for bonding styrofoam to itself or to other materials, must be used.

The cold chest box enclosure, listed in the parts list, can be found in stores, labeled as a Bait Box. It is white, speckled with spots of green. A rope handle is provided for ease of handling. The rope is driven through the cover and secured to the box. The outside dimensions are 6⅞ by 9¾-inches. The same width and length of the perf-board speaker baffle. The overall depth is 6½-inches including the cover.

The Assembly. Using a small paint brush, spread a light coating of glue over the inside of the box to seal the panel surfaces. White glue dries clear and fast, and adds strength to the styrofoam. Give it a second coat of glue to insure sound tightness. Do not coat the cover, until an opening is cut to clear the speaker components.

Figure 1 shows the perf-board modifications to convert it to a speaker baffle and grille. Check the length and width of the perf-board when you buy it, they vary somewhat in size. Cut the 2¾-inch diameter tweeter opening with a circle cutter and redrill the holes inside a 3⅝-inch diameter pencil scribed circle, forming a grille for the 4-inch speaker mounting.

The cut-out in the styrofoam cover which clears the speaker units is shown in Fig. 2. Do not glue the cover to the perf-board and mask assembly.

Figure 3 is a section view at the front of the box opening. Note that two wood cleats are glued inside the box for securing the baffle and cover to the box with six, 2-inch long machine screws that are screwed into the cleats. These screws clamp the baffle/mask assembly to the enclosure and provide access should it ever be required. The speaker components are bolted to the perf-board/mask assembly and are tightened with nuts and lockwashers.

The Speaker Components. It is unusual to see two speaker units installed in such a small enclosure as this. True "Hi-Fi" sound cannot be attained without the use of a good tweeter. Radio Shack has added a one-inch dome tweeter to their speaker line, that provides wide dispersion of high frequencies. This unit is almost as good as the

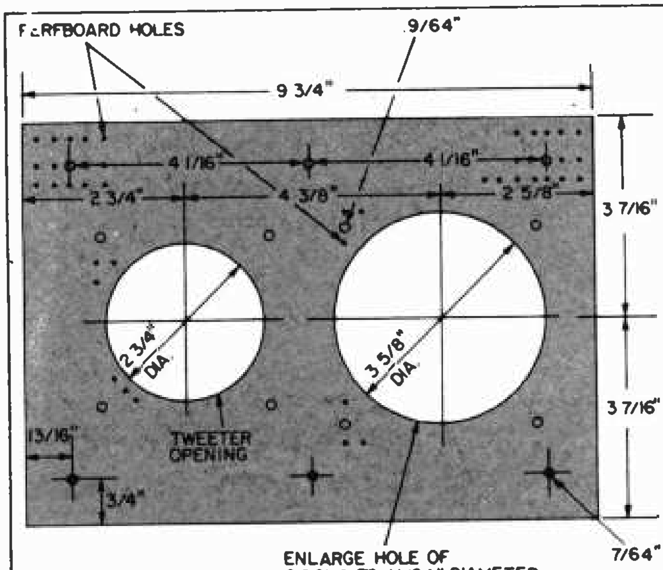


Fig. 1. Perfboard drilling for Ice-Box Hi-Fi. There are a lot of holes to drill, so be careful, because the perfboard can splinter.

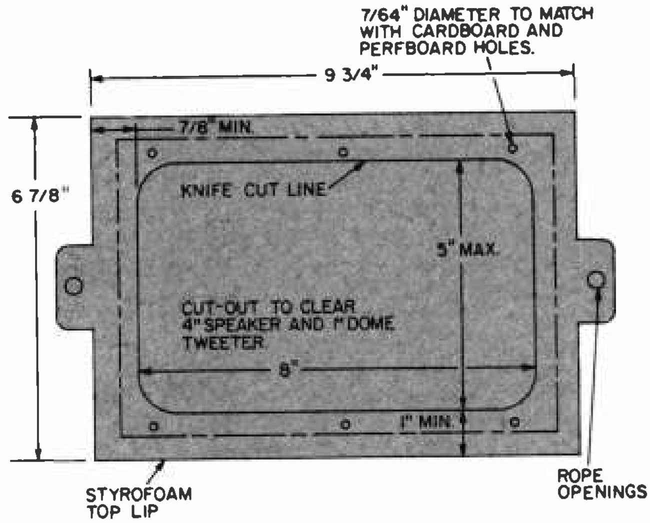
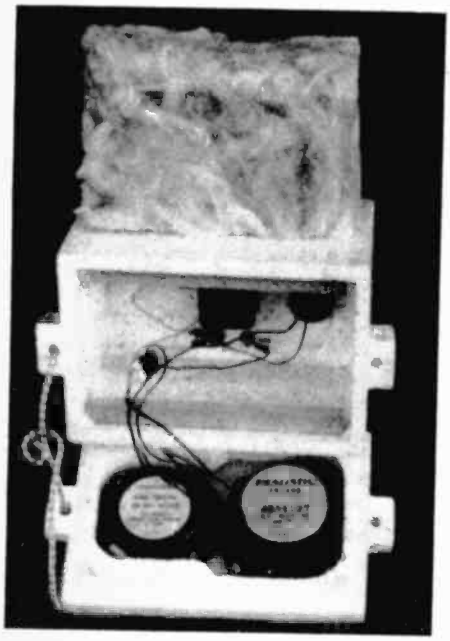


Fig. 2. Cutting and drilling outline for the styrofoam top panel. When coating the styrofoam with glue to make it accoustically opaque, let the glue dry before installing it on the main frame. You do not want to glue the two styrofoam parts together at all.



Inside look at the drivers mounted in our little speaker system. If you use care, everything will fit nicely, and snugly.

Philips Dome Tweeter from Holland that is used in some of the most expensive speaker systems.

A 3.3-uF capacitor is furnished with the tweeter for cross over at 4000 Hz and above. High frequency attenuation is provided by use of an "L" pad. This "L" pad is hooked-up to the outside winding of the pad.

Smooth performance is assured by employing a filter network shown in the wiring diagram. The 20-ohm resistor in the network cancels the effect of the tuned circuit set up by the 2.5 MH inductance and the 4-MF capacitor in the filter.

For wire connection into the enclosure cut a slot in the back for a terminal strip and secure the terminal with 6-32 by ¾-inch long machine screws or use 1-inch long brass screws with nuts and washers.

Upon final assembly, cut a section of 4-inch thick building grade fiberglass to fit inside the enclosure. Try not to compress the fiberglass around the edges. Cut a recess to clear the inductance coil, mounted in the back.

When you have completed the assembly, hook it up to one channel of your home stereo system. You will be amazed by the sound quality from such a small box. You may be tempted to assemble two of this design for stereo use, or perhaps use it as an extension speaker for high quality sound. ■

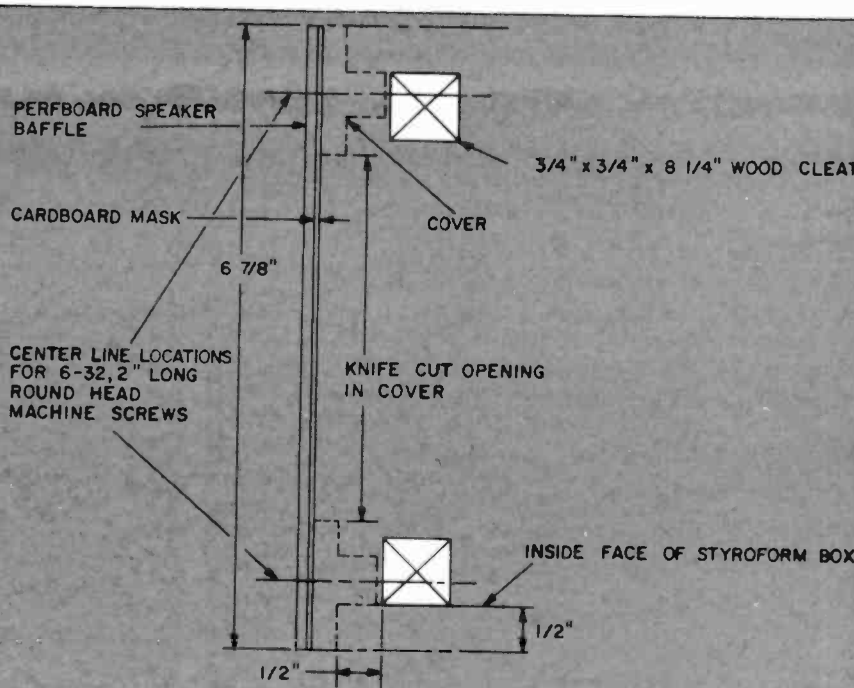
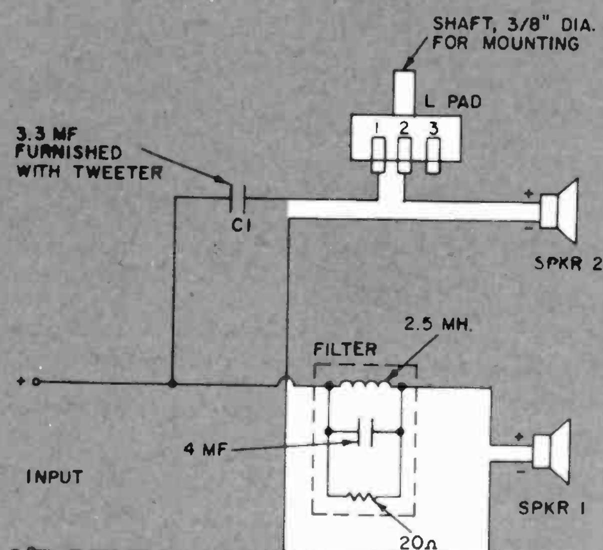


Fig. 3. Cross section of the styrofoam cover of Ice-Box Hi-Fi. The two 8¼-inch long wooden cleats are very important, since they serve to seal up the speaker.



PARTS LIST FOR SPEAKER

C1—3.3-uF capacitor (see Driver No. 2)
Driver No. 1—4-inch cone type speaker (Radio Shack 40-1197 or equiv.)
Driver No. 2—1-inch dome type tweeter (includes C1) (Radio Shack 40-1276 or equiv.)
Filter—audio type filter network (Radio Shack 40-808 or equiv.)
Pad—audio type "L" pad (Radio Shack 40-980, or equiv.)
Misc.—Ice-less cold chest, without inside compartment. Mfg. by Standard Cellulose & Novelty Co., Inc., 90-02 Atlantic Ave., Ozone Park, New York 11416.
8—6/32 round head machine screws, ½-inch long
6—as above, 2-inch long
1—as above, 2½-inch long
2 wood cleats, ¾ x ¾ x 8¼-inch long
Nuts for above cardboard mask 6⅞ x 9¾-inch, see Fig. 2. Pre-punched perf-board 6⅞ x 9¾-inch, see Fig. 1. Building grade, 4-inch fiberglass 5¾ x 8¾-inch. Elmers Glue-All or equal, terminal strip or brass machine screws (see text), hook-up wire, solder, etc.

MICROPROCESSOR SURVEY

By Ed Noll

LSI's CMOS dividers: Counting circuits for 50 or 60 Hertz applications

LSI COMPUTER SYSTEMS, INC. manufactures five large scale integration CMOS dividers. They can be driven by clock pulses, or directly by AC sine waves. Part designation, function and output when the clock source is either a 50-Hz or a 60-Hz line frequency are shown in the chart below. The basic equation is:

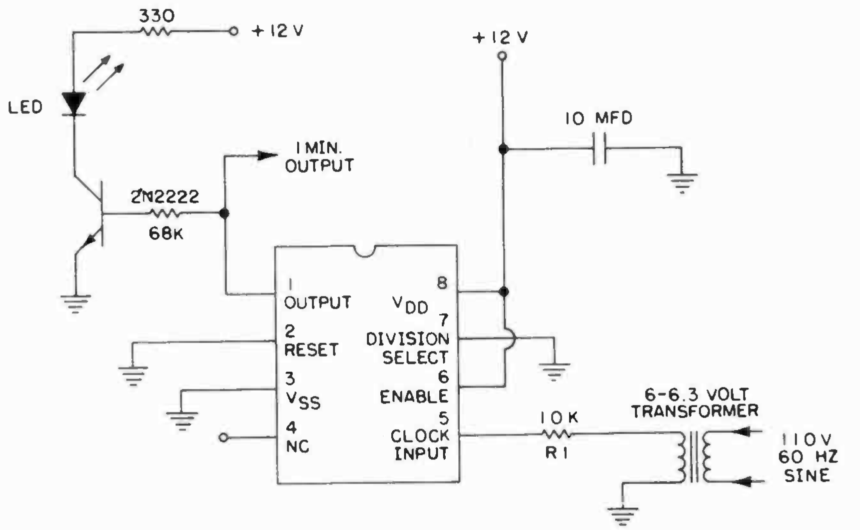
$$\text{PERIOD} = \frac{\text{DIVIDE BY}}{\text{FREQUENCY}}$$

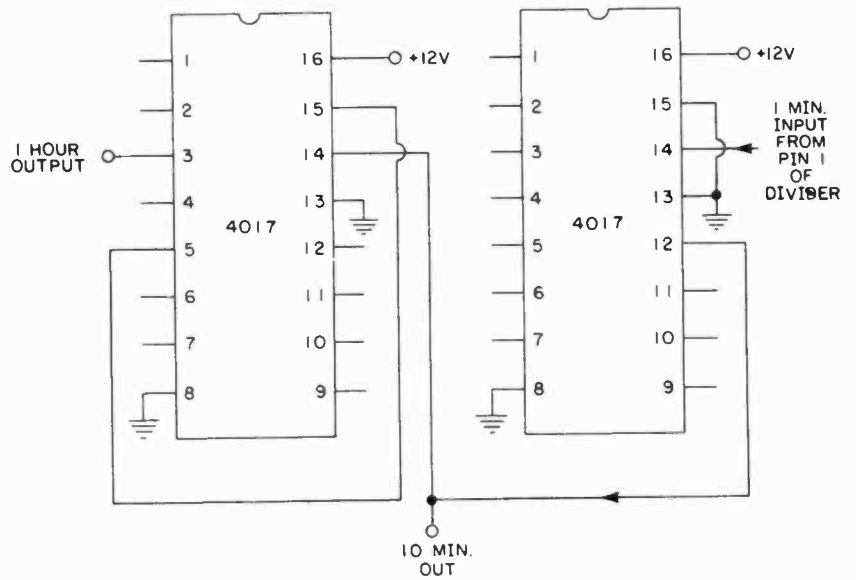
Note that, for the RED 3000/3600, the output is 1 square-wave cycle per minute. Dividing 3600 by 60 equals a period of 60 seconds, or 1 minute. In a region using 50-Hz electricity, 3000 divided by 50 also produces 60 seconds or an output of 1 pulse per minute. Divide ratio chosen depends upon power frequency in obtaining the output periods given in the chart.

The division selected depends upon whether pin 7, Fig. 1, is operated at logic 0 (low) or logic 1 (high). For the five devices, a logic 0 pin 7 produces a division of 6, 60, 120, 360 or 3600. A logic 1 at this pin results in divisions of 5, 50, 100, 300 or 3000.

The Basic Circuit. To use the small 8-pin RED 3000/3600 LSI to convert 60-Hertz line frequency to 1 pulse per minute output, you need only a low-voltage 60-Hz source that can be derived from a small transformer as shown in Fig. 1. The maximum clock input voltage at pin 5 should not have a peak-to-peak voltage change that exceeds the difference of potential connected between pin 8 (V_{DD}) and pin 3 (V_{SS}).

The circuit will, however, operate at considerably lower clock voltages. If input signals swing below V_{DD}, or higher than V_{SS}, connect a series resistor R1 in the clock signal path to pin 5. Input current should be limited to a maximum of 2 mA. A square-wave output voltage can be removed at pin 1. It will have a period of exactly one minute.





Using the small, eight-pin RED 3000/3600 LSI, shown in Fig. 1 at the top, to convert 60-Hz line frequency to 1 pulse per second requires only a low-voltage 60-Hz source, such as the one derived from the transformer shown in the circuit diagram. The circuit will function at voltages considerably lower than the 6-6.3 volts specified, but input current should be limited to a maximum of 2 mA. Two 4017s can be clocked by the output of the divider to obtain 10-minute and 1-hour outputs, as shown in Fig. 2 at bottom. Multiply Fig. 1 circuit by ten.

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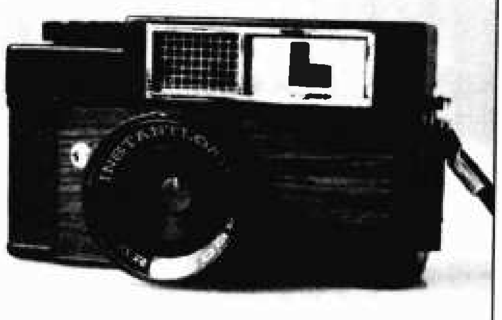
400,000 famed Instantload cameras must be sold. The importer is drastically overstocked and must sacrifice price for volume. You have seen this "type" camera (we cannot mention brand names) selling for many times more in stores nationally. To move them fast we will offer these quality cameras at just $6 apiece. Once sold, we do not know if further stock will be available at this price.



The full-size Instantload uses the 126 Instamatic film cartridge.

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The perfect camera and an excellent gift since it is durable, easy to operate and uses the standard 126 INSTAMATIC film cartridge (no mess or fuss loading your film). Full-size photos in color or black & white, prints or slides. Complete instructions accompany this lightweight, fixed focus camera built to provide years of perfect pictures.

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To apply for this very special camera offer print your name, address and zip code on a piece of paper and send $6 plus only $2 for speedy shipping & handling (total: $8 per camera ordered) along with *this sale notice* to:

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BUILD 20 RADIO AND ELECTRONICS CIRCUITS

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PROGRESSIVE HOME RADIO-T.V. COURSE

Training Electronics Technicians Since 1946

Now Includes
- ★ 12 RECEIVERS
- ★ 3 TRANSMITTERS
- ★ SQ. WAVE GENERATOR
- ★ SIGNAL TRACER
- ★ AMPLIFIER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ Solid State Circuits
- ★ Vacuum Tube Circuits

YOU DON'T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the low price you pay. The Signal Tracer alone is worth more than the price of the kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector Circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, coils, volume controls, switches, solid state devices, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

• SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE • QUIZZES
- TELEVISION BOOK • RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

SOLID STATE

Today an electronics technician or hobbyist requires a knowledge of solid state, as well as vacuum tube circuitry. The "Edu-Kit" course teaches both. You will build vacuum tube, 100% solid state and combination ("hybrid") circuits.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 514-FC Hewlett, N.Y. 11557

Please rush me free literature describing the Progressive Radio-TV Course with Edu-Kits. No Salesman will call.

NAME ....

ADDRESS ....

CITY & STATE .... ZIP ....

PROGRESSIVE "EDU-KITS" INC.

1189 Broadway, Dept. 514-FC Hewlett, N.Y. 11557

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

CIRCLE 11 ON READER SERVICE COUPON